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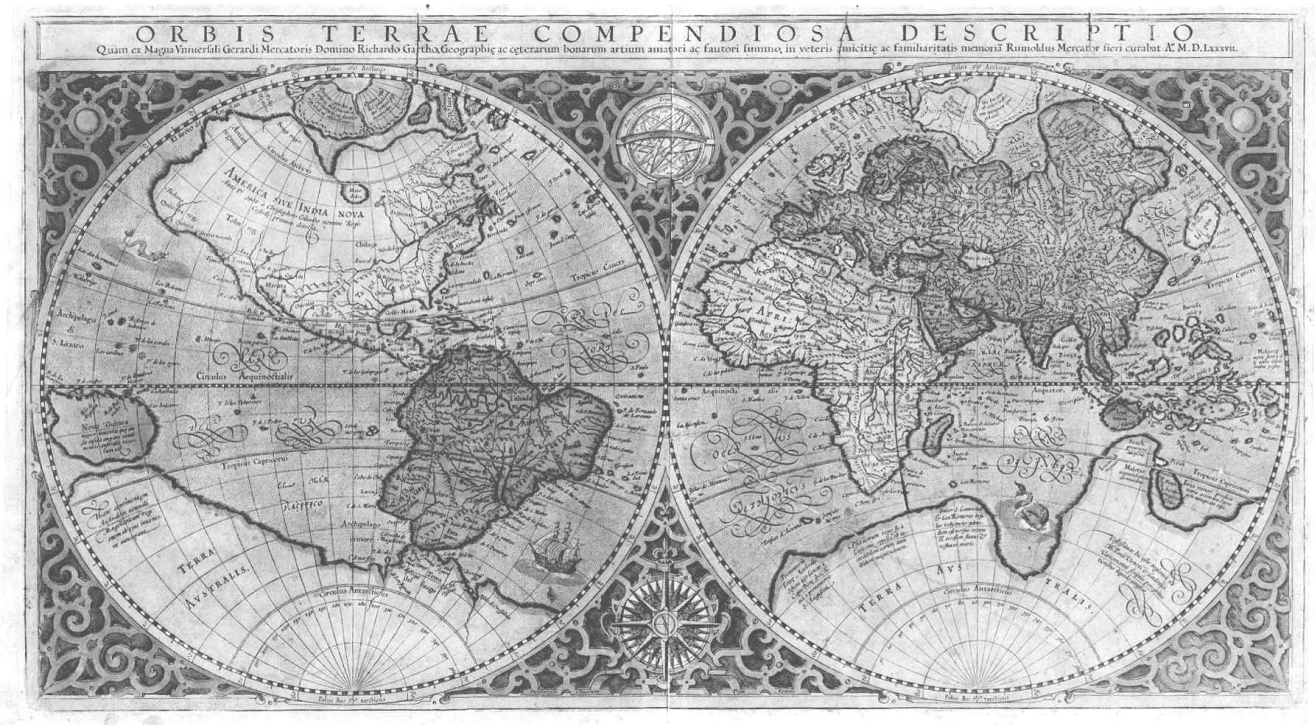

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SECTION I
NAVIGATION AND MARITIME TRANSPORT

APPROACHES ON CONTAINER SHIP STABILITY CRITERIA

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ABSTRACT

The paper proposes new evaluation criteria for the container ship stability based on computer calculations. As it know when sail through heavy weather a vessel is exposed to a significant variation of stability in waves and lead to loss of intact stability. Understanding the dynamic stability in waves is a big challenge because ship's behaviour cannot be framed in clear mathematical and physical rules. For this reason any effort in order to assess the stability of the vessel is welcomed. One solution to evaluate the response of the vessel in heavy seas according to some parameters variations could be the OCTOPUS program developed by AMARCON.

Keywords: *parametric resonance, surf-riding and broaching, ship's stability*

1. INTRODUCTION

As per the last UNCTAD 2015 report, seaborne shipments have increased by 3.4 per cent in 2014, that is the same rate as in 2013. Additions in volumes exceeded 300 million tons taking the total to 9.84 billion tons. The containerised trade was estimated to have increased by 5.3 per cent and reached 171 million TEUs. Slow steaming, implemented as a response to oil and bunker fuel increasing price, is estimated to have resulted equivalent of 7.0 per cent of the global container fleet capacity. Despite the lower and bunker fuel costs, slow steaming remain a practice in container shipping and nothing seems to change in this aspect. Meantime, shipowners continue to order very large new vessels, very recent ordering being of 11 second generation of Triple-E container vessel with a capacity of 19,630 TEUs each. In order to realize the economies of scale, the average vessel size for all new orders by top 15 companies, is above 10,000 TEUs which is double compared to the current average size of vessels in the existing fleet of each company.[1]

These trend have produced significant changes in the design and operation of the commercial ships over the last several decades. An aspect of the operation of such vessels is sailing in rough seas. Increase of containers space and transport efficiency could not have been achieved without a parallel development of sophisticated hulls with very high form stability, combined with slender lines and low resistance. These new hull forms show a significantly larger variation in stability during a wave passage compared to more traditional forms. The wide beam of many container vessels usually results in large GM values. In some cases where the vessel is partly loaded, the GM appear to have been excessive. This can become very problematic if the vessel is caught in heavy weather causing cargo-securing arrangements to break and containers to fall overboard. Ship's stability in following and heading seas may be also equally dangerous due to an unexpected roll motion, caused by parametric resonance. Parametric resonance can arise for modern container carriers due to the particular hull forms used to achieve an optimal trade-off between high service speeds and maximum container payload above deck. These changes, and their impact on the intact stability performance of ships, have motivated the development of the intact stability criteria by the IMO. In 1995 the Maritime Safety Committee approved the Guidance to the master for avoiding dangerous situations in following and quartering seas. From the beginning the Guidance was to be reviewed and improved, in respect to large ships, and on the basis of new technical developments and in the light of experience gained from its application. Also for the ships which are equipped with on-board computer, the Administrations are encouraged to use specially developed software which would take into account the main particulars, actual stability and dynamic characteristics of the ship in real voyage conditions.[2]
After many years, in 2008 was adopted the International Code on Intact Stability which presented mandatory and recommendatory stability criteria and other measures for ensuring safe operating of ships.

2. LARGE CONTAINER SHIP BEHAVIOUR AND DANGEROUS PHENOMENA IN HEAVY SEAS

The current large container ships have a specific hull shape, the submerged part; due to hydrodynamic efficiency has a narrow bow and aft parts. But then, the upper part of the hull, due to cargo stowage considerations, is usually wide. Unlike the large bulk carriers or tankers, the large container ships has about half of hull wall-sided and this is a challenge for dynamic stability of the ship in rough seas.[3]

As per Swedish Club report, half of the cost of total claims was for container vessels. When a container vessel sails through heavy weather the container stacks will be under a lot of stress and damage to the hull or cargo are not uncommon. In some cases where the vessel is partly loaded, the GMs appear to have been excessive. This can become very problematic if the vessel is caught in heavy weather because can causing cargo-securing arrangements to break and containers to fall overboard. The reason why hull damage occurs when vessels sail in heavy weather is the same as the reason for cargo damage. If crews do not slow down or alter course to avoid large waves, there is risk of the hull damage. It is not surprising that 33% of all H&M heavy weather

claims happen in the Atlantic and Pacific oceans. Of these claims 48% are for container vessels, 27% for bulker vessels and 15% for RoRo vessels .[4]

The effect of stability variation in waves has been an expanding research in the last decades. After some vessels have experienced dangerous and unexpected rolling, the investigations have shown that these motions are based on phenomena known as parametric resonance (synchronous and parametric roll resonance). There can be additional dangers by reduction of intact stability caused by riding on the wave crest on successive high wave or surf-riding and broaching in following seas.[5] The phenomena described in Table 1 can occur when a ship is sailing in high seas and meets the conditions.The phenomena can be separated or combined.

Table 1. Dangerous phenomena, terms of appearance and ship's behavior in heavy seas

Phenomena	Condition 1	Condition 2	Ship's behavior
Surf-riding and broaching-to	Following and quartering seas	Wave speed is critical between 1,8√L and 3√L and L = ship's length	Large heeling, ship's head changing and capsizing danger
Reduction of intact stability caused by riding on the wave crest at midship	Following and quartering seas	Wave length is larger than 0.8 x ship length and wave height is larger than 0.04 x ship length	Intact stability decreases substantially
Synchronous rolling motion	All directions	Encounter wave period is nearly equal to the natural rolling period of ship	Large rolling motions
Parametric rolling motion	Head and bow wave	Encounter wave period is nearly half of the natural rolling period of ship	Unstable and large roll motions

The dynamic behaviour of a ship in following and quartering seas is very complex. Ship motion is three-dimensional and various detrimental factors or dangerous phenomena such as additional heeling moment due to deck in water, water shipping and trapped on deck or cargo shift due to large roll motions, may occur in combination with the above-mentioned phenomena simultaneously or in a sequence. New research have been made in the last years leading to IMO 2008 Code of Intact Stability where mandatory and recommendations relating to intact stability was introduced. Parametric roll resonance, pure loss of stability, and broaching-to are among the primary modes of stability failures which are being addressed. It was recognized that in view of a wide variety of types, sizes of ships and their operating and environmental conditions, problems of safety against accidents related to stability have generally not yet been solved.[6]

In particular, the safety of a ship in a seaway involves complex hydrodynamic phenomena which up to now have not been fully investigated and understood.

Motion of ships in a seaway should be treated as a dynamical system and relationships between ship and environmental conditions like wave and wind excitations are recognized as extremely important elements. Based on hydrodynamic aspects and stability analysis of a ship in a seaway, stability criteria development poses complex problems that require further research.[7] Nowadays are working on the Second Generation of Intact Stability Criteria based on principle of increasing complexity by multi-tiered approach. The working group on intact stability criteria concentrated to the level 2 formulation for the parametric roll and pure loss of stability.[8]

3. MATEMATICAL BACKGROUND OF PARAMETRIC RESONANCE

The Mathieu equation is the simplest mathematical model of parametric roll and it has been used to analyse this phenomenon. Considering a ship in longitudinal seas and there is no wave heeling moment:

$$(I_x + A_{44})\ddot{} + B_{44}\dot{} + \Delta GM(t) = 0. \quad (1)$$

Here, B_{44} is the linear damping coefficient, Δ is the weight displacement of a ship, I_x is the transverse moment of inertia, A_{44} is the added mass in roll and GM is metacentric height. The variation of GM at wave through in time can be written as:

$$GM(t) = GM_m + GM_a \cos(_e t), \quad (2)$$

Here, $_e$ is the encountered wave frequency, GM_m is the mean value of GM and GM_a is the amplitude of GM changes in waves:

$$GM_a = 0.5(GM_{max} - GM_{min}); \quad (3)$$

$$GM_m = 0.5(GM_{max} + GM_{min}). \quad (4)$$

GM_{max} and GM_{min} are the maximal and minimal instantaneous values of GM for a number of wave crest positions along the ship hull. Substitution of the definition of (2) into the roll equation (1) and its division by the inertial coefficient result the following equation for roll motion:

$$\ddot{} + 2\delta + (^2_m + \frac{2}{a}\cos(_e t)) \cdot t = 0. \quad (5)$$

Here:

$$_m = \sqrt{\frac{\Delta \cdot GM_m}{I_x + A_{44}}}; \; _a = \sqrt{\frac{\Delta \cdot GM_a}{I_x + A_{44}}}; \; \delta = \frac{1}{2}\frac{B_{44}}{I_x + A_{44}}; \quad (6)$$

For transforming (5) into standard form of Mathieu equation dimensionless time is introduced:

$$\tau = {}_{e}t \rightarrow t = \frac{\tau}{e}. \quad (7)$$

Substitution (7) into roll equation (5) :

$$\frac{d^2}{d\tau^2} + 2\mu\frac{d}{d\,\tau} + {}^{2}_{m} + {}^{2}_{a}\cos(\tau)) \cdot = 0. \quad (8)$$

The coefficients of equation (8) are the dimensionless quantities:

$$\mu = \frac{\delta}{e}; {}_{m} = \frac{m}{e}; {}_{a} = \frac{a}{e}. \quad (9)$$

The next substitution eliminates damping by introducing new variable x:

$$(\tau) = x(\tau) \cdot \exp(-\mu t). \quad (10)$$

The finally expresses roll in the form of the Mathieu equation by substitution equation (10) into (8):

$$\frac{d^2x}{d\tau^2} + \left(p + q\cos(\tau)\right) \cdot x = 0. \quad (11)$$

Here:

$$p = ({}^{2}_{m} - \mu^2); q = {}^{2}_{a}. \quad (12)$$

The Mathieu equation is a linear differential equation with variable coefficients. It solution cannot be expressed in elementary functions. As is known, the Mathieu equation (11) may have two type of solutions or Mathieu functions: bounded or “stable” (Figure 1) and unbounded or “unstable” (Figure 2), depending on combination of coefficients p and q.

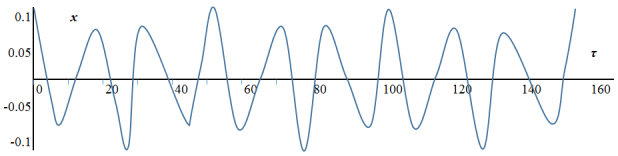

Figure 1 Bounded Solution of the Mathieu Equation p=0.1; q=0.2

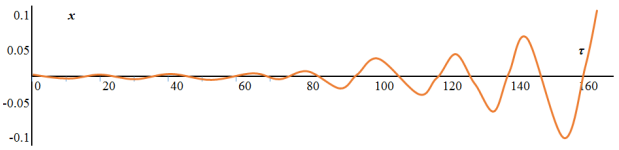

Figure 2 Unbounded Solution of the Mathieu Equation p=0.15; q=0.2

The Ince-Strutt diagram (Figure 3) show the relation between combinations of coefficients p and q, and the solutions bounded or unbounded. The shaded areas correspond to unbounded solution and blank area to bounded. As parameter q reflects the level of GM change in waves, the diagram can be considered in terms of amplitude of parametric excitation vs the square of non-dimensional frequency. The first zone of instability is for p = 0.25 and the frequency ratio of 2 means that the excitation frequency is twice the natural roll frequency at this point and the unbounded motion in this zone is known as principal parametric resonance.

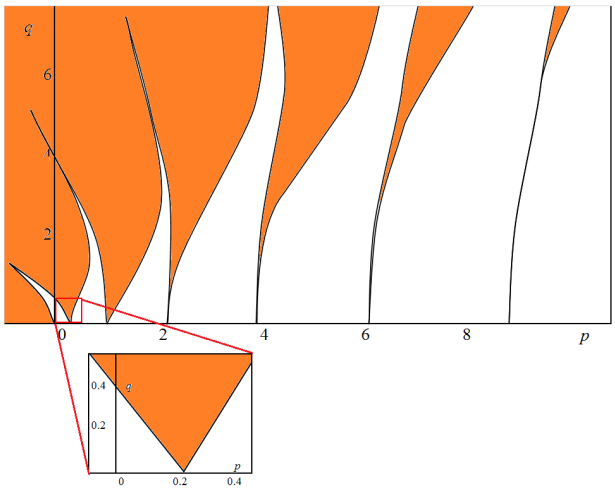

Figure 3 Ince-Strutt Diagram

The Mathieu equation (11) has a bounded solution because the damping was excluded (10) therefore, the corresponding roll, □(τ), decays with the damping decrement, μ if $x(\tau)$ is a periodical solution of the Mathieu equation, as shown Figure 1. An unbounded solution of the Mathieu equation, $x(\tau)$ (as in Figure 2), does not necessarily mean that rolling will be unbounded because the exponential term exp(-μτ) might undo the effect of boundlessness by damping the solution back to a decaying form. It also means that there is a threshold value for roll damping for each pair of Mathieu parameters, p and q. If roll damping is less than the threshold value, roll will be unbounded as the solution of the Mathieu equation. If the roll damping is larger than the threshold, roll is still bounded, even if the Mathieu equation is unbounded.[9]

4. COMPUTER ANALYSIS OF SHIP’S OSCILATIONS USING OCTOPUS PROGRAM

Nowadays, one of the vessels cacteristics is the seakeeping performance because the ship’s beahviour has an important influence in safety. Actually static stability criteria are based on dynamic roll behaviour. It was observed that a considerable reduction of the transverse stability and very large roll angles can result when we compare a ship’s stabilty in still water and following waves.[10]

This can happen for fast ship in following waves with waves length egual to ship length. It is a big challenge for sea-fastenig of containers at deck due to large accelerations because of combined sway and roll motions. In the past, dynamic efects caused by ship motions were accounted for in a very simple way, even were ignored in a lot of cases. The increased ship size and its speed have lead to an extension of these standard calculations, consideration of the hydrodynamic loads on the hull, vertical accelerations. Large local loads can appear when the vertical relative acceleration of the forefoot of the ship exceeds a threshold value, when

hitting the wave surface at re-entrance after bow emergence (slamming). Very high peak pressure (7 times atmospheric pressure or more) have been measured and can cause damage to the bottom. Slamming also can cause an increase of bending moment due a vertical vibration of the ship's hull. In the last decades, research on ship's maneuverability was stimulated strongly by increasing the ship size problems, example for container vessel and enormous developments in the computer industry related new possibilities for computer simulations and the performance of dedicated motion analyses is not only required but also beneficial. Sometimes, the vessel and cargo have their own specific limitations and restrictions on maximum allowable accelerations and motions. Traditionally, maritime transports are engineered to satisfy design criteria in terms of allowable wave heights. The allowable wave height depend on the wave parameters like period, spectrum shape and spreading but also operational parameters like vessel heading and speed which have a major effect on the response level in certain sea state. A general procedure for the calculation of the design values for motions, accelerations or leg bending moments includes:

- Vessel stability analysis to derive the proper mass and stability parameters
- Assessment of environmental conditions which may be encounterd
- A motion response analysis resulting in design motions, accelerations or other responses in critical locations on the vessel and cargo.

Our research for this kind of analysis was done with the sofware OCTOPUS Office 6 (AMARCON).[11]
The analysis sequence applied by this program is showed in Figure 4.

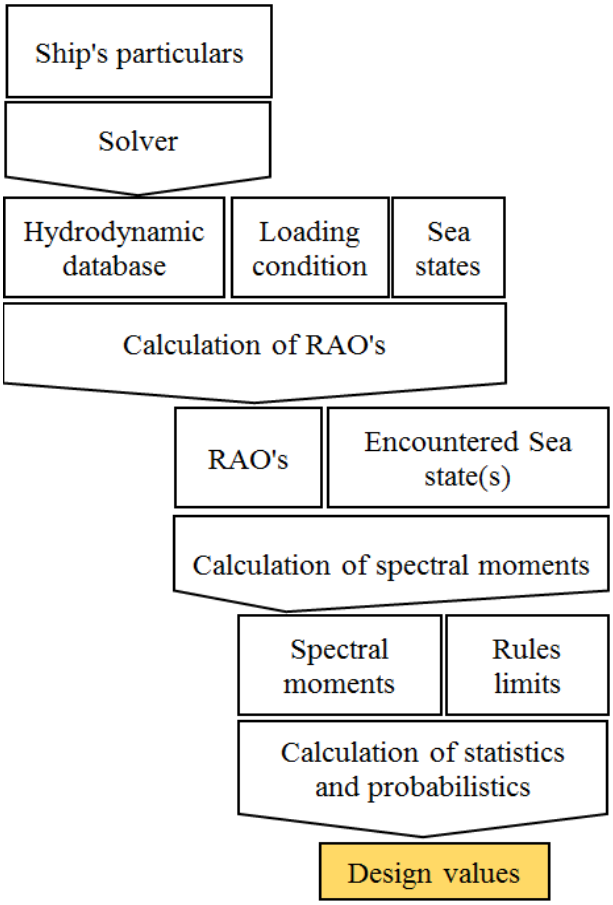

Figure 4 Analysis sequence for calculating design value with Octopus software

Motion transfer functions (called RAO or Response Amplitude Operators) in six degrees of freedom are the basis for the calculation of transport design values. In order to observe the ship behaviour simulation, we chose a Panamax vessel with the main features as follow:
Length 285 m,
Beam 32.2 m,
Draft 15m
Mass 41050 T
GM 3m
We chose also a voyage through Nord Atlantic (Hamburg – New York) and bellow are presented the systematized results.

The Response Amplitude Operator (RAO) of the wave loads shown in Figure 5. The critical zone for roll (Amplitude) is between 70°and 85° (heading means the direction of the waves counted from aft, anticlockwise).

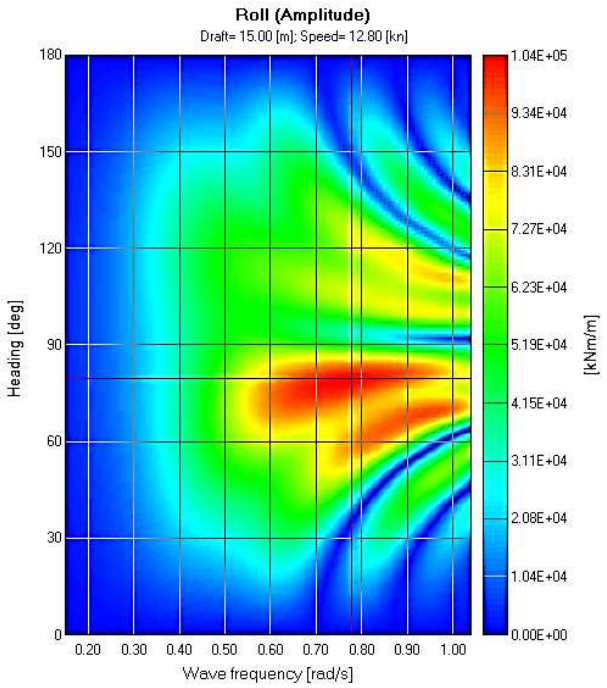

Figure 5 RAO – Roll (Amplitude)

The moment is showed depending on wave frequency as in Figure 6 were maximum amplitude (1.03E+05 kNm/m) coresponding to a frequency of 0.80 rad/s.

In the same way we can check all the six motions (surge, sway,heave, roll, pitch and yaw) for the various drafts and speeds of the vessel.

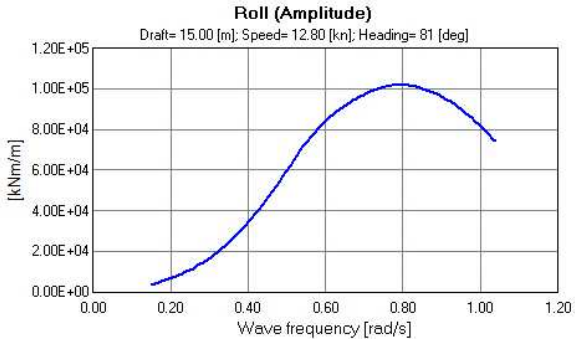

Figure 6 RAO – Roll (Amplitude)

We can see also the variation of the transverse moment for one point at amidship on the main deck, X point as in Figure 7 or the accelerations in same point due to roll motion like in Figure 8. Is well to know values because we can cross check the fastening system allowance for the containers for example. We can easy observe the critical heading (135°) for specific wave frecquency (0.37 rad/s) but we have the whole spectrum of wave direction meaning that we alter the ship's course to resonable value of parameters.

The maximum value of acceleration's amplitude of X point is as RAO figure, 1.65 deg/s^2/m. When the vessel keep an approximate same course and speed for a long period, we can generate an envelope of the Sea States responses, where the values are calculated for the selected speed and heading and let us at least to make an idea about the most possible extreme (MPE) parameter.

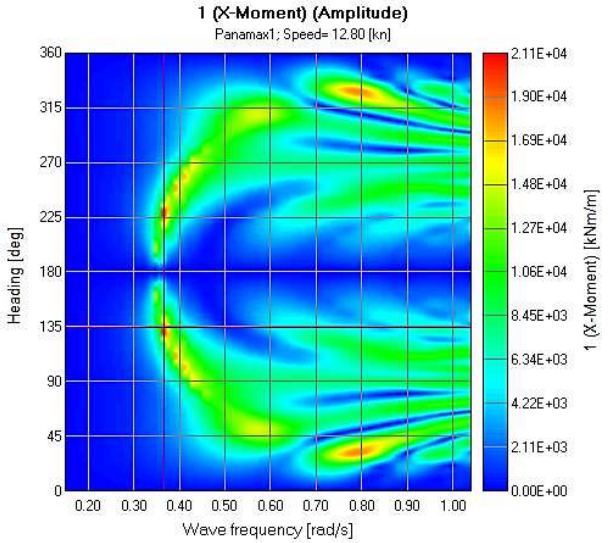

Figure 7 RAO for X Moment Amplitude (kNm/m)

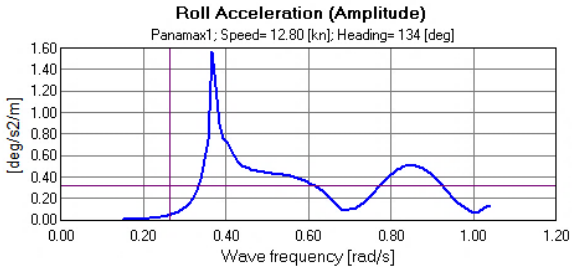

Figure 8 RAO for X Roll acceleration (m/s2/m)

For example in Figure 9 the maximum roll angle could be 37 degree for a wave heading of 70^0 but we can "cut" the curve to the maxim value of 25 degree if we can keep the waves in headings between 150^0 and 210^0, means that we have to alter the course only to fulfil the above condition.

Of course if we increase the speed we slightly improve the response resulted, only right decisions should be taken into account. We can chose all the other five response (pitch, yaw, surge, sway, heave), matches to the six degree of freedom for ship motions and also different speeds for others navigational areas.[12]

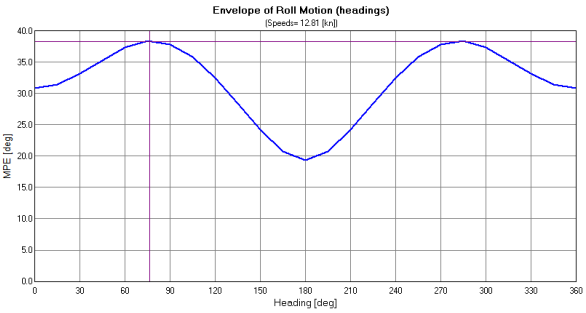

Figure 9 Envelope of Roll Motion (headings)

Very useful information about ship behaviour and dangerous phenomena are revealed, accessing the short term sea statistic of the program (Figure 10). The diagram is for different sea state and of course most

possible extremes (MPE) are in beams seas (wave direction from around 90^0 and 270^0).

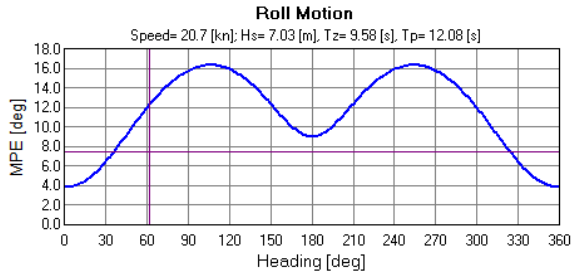

Figure 10 Roll Motion MPE [deg]

The polar diagram is very close to other programs dealing with parametric rolls as we can see in Figure 11. It is very easy to observe the dangerous areas in which the combination between vessel speed and wave direction (heading) can introduce parametric resonance with some or all the components. We can simulate the variation of these parameters and observe the significant or not response of the ship motions. (The diagram is available for all six response motions).

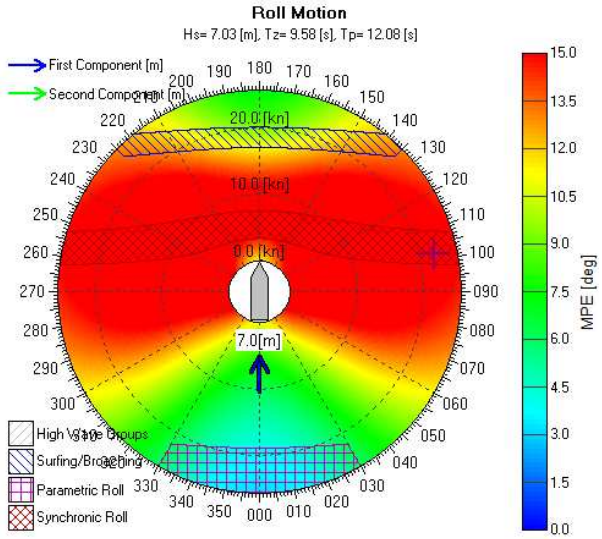

Figure 11 Roll Motion Diagram

4. CONCLUSIONS

Container ship is optimized to carry a large quantity of cargo but the design requirements for this purpose, lead to specific behaviour of the vessel in heavy seas. It is already known that container ship has a vulnerability to stability failures in waves, especially for parametric roll and pure loss of stability. The research revealed some aspects regarding state of art in stability criteria proposed by IMO and the latest physical and mathematical interpretation of the dynamic stability of the ship. It is also proposed a way to help all those interested in using a computer program – OCTOPUS for a better assessment of the ship stability in different sea conditions.

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CONSIDERATIONS REGARDING SHIPS STABILIY LOSS IN SEVERE SEA CONDITIONS AND THE IMPACT ON SAFETY OF NAVIGATION

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ABSTRACT

The paper presents the importance of ship's intact stability. It is evidenced the factors that contribute to correlation between ship's stability with safety of ship and safety of navigation. Ship stability failure is presented as a threat to safety of navigation and this aspect is presented in a form of casualties involved in loss of ship stability in severe sea conditions in order to emphasis the causes that leads to ship stability loss. A study of various ship stability casualties in heavy weather conditions is presented and the causes are analysed. The actual intact ship stability criteria are analysed and the importance of a new generation of stability criteria for preventing ship stability loss in severe sea conditions is highlighted.

Keywords: *safety, stability, casualty, navigation, criteria.*

1. INTRODUCTION

The paper presents important considerations regarding the ship stability loss problem with special emphasis on stability loss in severe sea conditions and the correlation with safety of navigation. The connection between the factors that affect intact ship stability in severe sea conditions and the modes of stability failure in such situations are illustrated. Moreover, the analysis of intact ship stability regulations in force revealed the fact such modes of stability failures are not covered and thereafter can not be prevented by the ship's officers on board vessel.

2. SHIP STABILITY CASUALTIES A SERIOUS THREAT TO SAFETY OF NAVIGATION

Ship survivability against capsize in severe sea conditions has become one of the reasons of the areas of primary concern among ship stability researchers and designers in recent years [11]. When a ship is subjected to the effect of large waves it may capsize according to a number of different scenarios, depending on the magnitude and direction of the wave excitation and the ship's own capability to resist such excitations [11]. Resonant or breaking waves approaching a ship from the side ("beam seas") have a potential to excite large rolling which could result in capsize, especially if the intensive oscillation of the ship causes shift of cargo or, if a considerably quantity of water is shipped on the deck [11].

In practice, the ships could loose intact stability under the impact of waves and wind in several ways. Typically, it is a chain of events rather than a single event. For example, due to high or abnormal waves, a ship could sustain rudder failure or even more could loose power, which might then cause it to heavily rolling in beam seas, thus in turn leading to shift of cargo and dangerous list of the vessel. Moreover, huge amount of water is shipped on deck and the worst result is capsizing.

Another frequent scenario is when the wave produce important damage to ship structure, for example to hatch covers and/or coamings, deck equipment or the hull itself and the result is flooding of cargo holds or other compartments, loss of freeboard and eventual sinking. Failure of structural integrity is common to many loss scenarios so it is of paramount importance to find out the order of magnitude of stresses imposed by large waves.

More dangerous can be a group of steep and relatively long waves approaching a ship from the bow ("head seas") or from the stern ("following seas"), as waves of this kind are known to incur significant reductions in roll restoring capability for many types of vessels and they instigate dangerous coupled motions [11].

As part of the ship stability assessment, a study of casualties investigated by different maritime administrations related to ships stability failures has been undertaken and relevant accident scenarios are presented in this chapter.

The casualties presented here are the only real case incidents happened in the last decade and for which investigations were carried and reports issued by different maritime administrations. However, in this period the number of casualties involved was greater but was not reported, nor investigated by maritime administrations.

3. ANALYSIS OF SHIP STABILITY CASUALTIES IN SEVERE SEA CONDITIONS

A thorough study of research has been undertook on a number of 37 ships involved in real casualties related to intact ship stability failure in severe sea conditions in the last 10 years..

The results of the undertaken research of the casualties revealed the following relationships between different factors involved:

3.1 Relationship between casualties and type of ship

In all 37 casualties analyzed the ships concerned were container ships, general cargo ships, Ro-Ro ships and passenger ships. The distribution is shown in figure 1.

Although there were not many major casualties in terms of loss of lives, resulting from casualties involving containerships, this particular ship type has more of its fair share of losses due to incidents involving cargo damage, stability and structural failure.

Major accidents in the last decade include the loss of the container vessels "MSC Carla" in 1998, and "MOL Comfort" in 2012, which broke into two and the extensive damages suffered by the container vessel "APL China" in 1999 due to severe sea conditions. Statistics indicate that incidents involving containerships account up to about 7% of the total [10].

In terms of incident categories, containerships differ from most other ship types in that share error accounts for a high percentage of all major incidents.

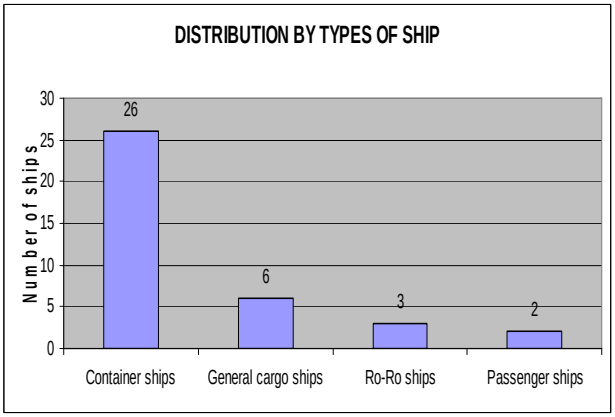

Figure 1 Distribution of casualties by types of ships analyzed

The result is an equally high percentage of cargo damage. Although containerships follow the same pattern as the majority of cargo vessels, as far as the types of damage are concerned, they do differentiate in various aspects. The statistics available show that the percentage of incidents is higher in newer containerships, decreasing as they age, while in other cargo ship types, higher incidents rates occur at their middle age [10].

3.2 Relationship between casualties and type of cargo

The types of cargo, carried on board vessel at the time of casualty occurrence, are shown in figure 2.

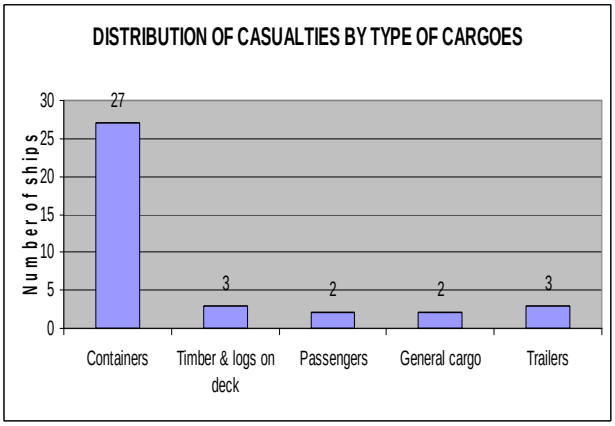

Figure 2 Distribution of casualties by type of cargoes

Although was not a great variety of cargoes, it may be noted, however, that in all cases of general cargo ships, included here the timber and logs carried on deck, the secondary effect of intact stability failure was shifting of cargo, both on deck as well as inside cargo holds. Moreover, in one case, the shifting of cargo led to capsize and sinking of vessel.

3.3 Relationship between casualties and length of ships

According to casualties analyzed it can be noted that more than half number of casualties, i.e. 25 casualties, occurred in ships over 200 m in length. Moreover, 17 casualties occurred in ships between 260 m and 340 m and all of these ships were container carriers. Distribution of casualties by ship's length is shown in Figure 3.

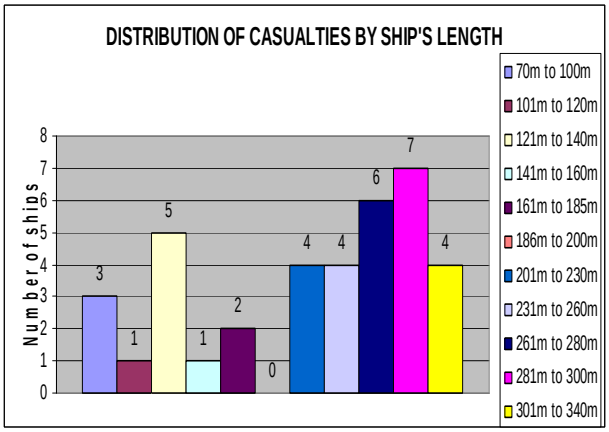

Figure 3 Distribution of casualties by ship's length

It can be concluded that as the length of the ship increase, this is more vulnerable to dangerous situations in severe sea conditions.

3.4 Relationship between casualties and geographical distribution

The result of the analysis, for the area where the casualty occurred, are illustrated in Figure 4.

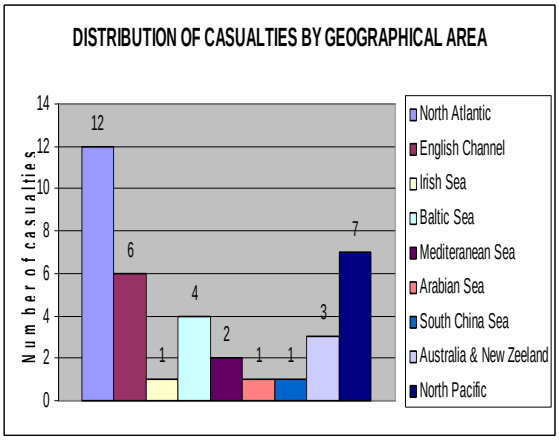

Figure 4 Distribution of casualties by geographical area

Figure 5 implies that the majority of marine accidents occurred in open seas, up to 70%, while in coastal waters was of 30%. This is understandable because the adverse weather conditions, like wind and waves, are more intensive and at a high grade at open seas.

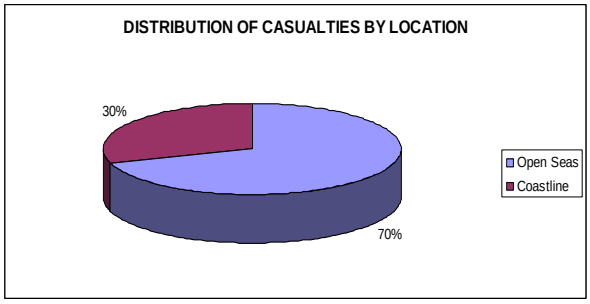

Figure 5 Distribution of casualties by location

3.5 Relationship between casualties and period of the year

The distribution by geographical area can be correlated with the period of the year when the casualties occurred, as illustrated in figure 6.

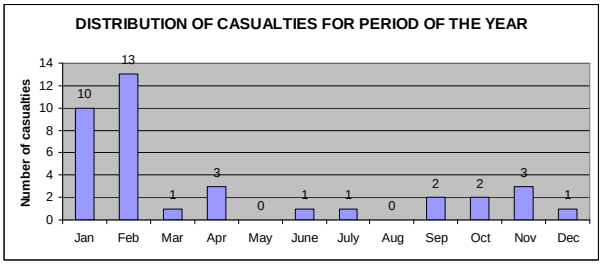

Figure 6 Distribution of casualties for the period of the year

From the analysis of the period of the year when the casualty occurred, it can be seen that most dangerous period is winter, although some casualties occurred in months attributed to summer period, but in south hemisphere.

3.6 Relationship between casualties and wind

For weather condition the wind is an important factor affecting navigational safety of ships. From Figure 7 it could be seen that all casualties occurred in a sea state equal to or higher than very rough sea, where according to Beaufort scale, wind speed is between 15 and 19 m/s (30 to 37 knots).

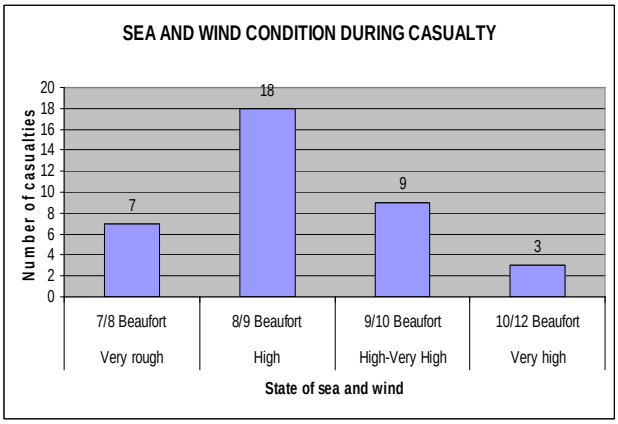

Figure 7 Sea and wind condition during casualty

3.7 Relationship between casualties and wave height

The wave height is another important factor affecting navigational safety of ships and has important influence on occurrence of marine casualties. From figure 8, it could be seen the probable wave height during casualty (according to Beaufort scale).

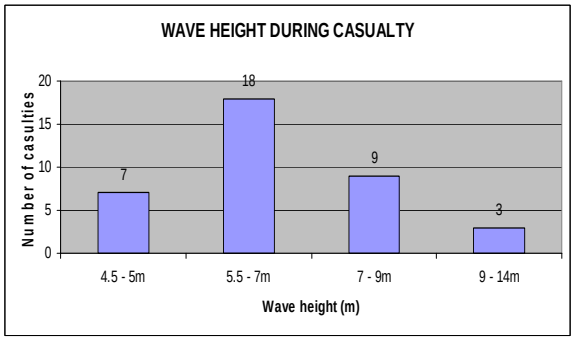

Figure 8 Wave heights during casualty

3.8 Relationship between casualties and encountered wave direction

In Figure 9 is represented the encountered wave direction of ship during casualties.

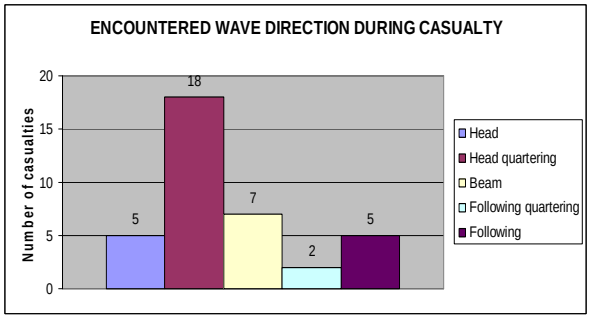

Figure 9 Encountered wave directions during casualty

Analyzed ships were sailing most often in head seas (including here also the head quartering seas) and less

often in following and following quartering seas. However, regardless the encountered wave direction all ships had difficulties in severe seas and developed large rolling angles and heavily pitching motions.

Based on the analysis presented, it can be concluded that the casualties involved listing or capsizing occurred in severe sea conditions are generated by the phenomena which are fully influenced by the design (hull form) of the ship and environmental characteristics, especially direction, height and speed of the waves. Thus, phenomena like parametric rolling, pure loss of stability or broaching can be the causes that lead to loss of ship stability in severe sea conditions.

What is important to be mentioned is the fact that all these possibilities for loss of ship intact stability in waves are not governed by any mandatory regulations or Codes and they are only vaguely presented in form of guidance which in our opinion is very little in comparison with the importance of the problem. In this respect we are of the opinion that a rethinking of the intact ship stability problem from the dynamic point of view is of major importance. The impact of ship's intact stability assessment on seaworthiness and safety of navigation is revealing the importance of the problem that can lead to precious information for understand the stability failure causes.

4. ANALYSIS OF ACTUAL INTACT SHIP STABILITY CRITERIA AND REGULATIONS

The General Stability Criteria of IS Code 2008 reveals that the regulations are still based on the same assumptions, according to which the ship indicator of stability safety is the righting arm curve on calm water.

The assumed Weather Criterion of the same Code, is simply to use, it is based on physical phenomena / modelling but was adjusted with capsizing casualties in the form of the wind velocity. In other words, the wind velocity in the weather criteria does not represent the actual sea state and has rather empirical meanings. Since the weather criteria involve such an empirical factor, it is not easy to improve the criteria [1]. However, the simplified modelling takes into account only beam waves and wind, why no internal degree of freedom, like shifting of cargo or water on deck, was introduced [7]. In fact, it concerns only one mode of ships loss and the level of safety is largely unknown.

Adoption of the described prescriptive requirement and structural model was possible only because it was based on statistical evaluation of data for ships capsized and operated safely during the long time of the first formulation of criteria in 1948 in Register of Shipping of USSR [8]. The crucial element of the criterion, the value of wind pressure, was adopted in such a way, that the resulting critical KG value would correspond to average KG values of the population of vessels existing at the time of development of the criterion, that were considered safe in operation (trial calculations showed that the majority of existing ships at that time satisfied adopted weather criterion) [8].

The Weather Criterion is the only amongst all of the IMO criteria taking into account the influence of waves and only one being based on a balance between heeling and righting levers. Although it considers the dynamics of ship roll motions, at least in a simplified way, this prescriptive scenario is not suitable to assess phenomena endangering ships in head, following and quartering waves and it also never was intended to be used in such a way [4].

The safety level guaranteed to the ships by the compliance with stability criteria, however, is in general unknown and it is still a big open problem. It is indeed typical to open the way to alternatives by stating that "*a level of safety has to be guaranteed, as a minimum, by any alternative assessment"* [9]. Statements like this are often used to try to avoid excessive relaxation of safety standards, but in fact are less meaningful than they could appear [9]. Of course, ship safety at sea was greatly improved by the development and implementation of present stability criteria, as contained in IS Code 2008, and other measures (for example the assignment of freeboard), although being these measures recommendatory in nature or not so widely adopted.

In addition, it is clear that the safety level is unequally distributed among different ship typologies and, even inside a given ship typology, it appears to be strongly dependent on ship size. This is particularly true for the General Criterion, which is the result of a global re-active approach. It mixes indeed in the same pan good and bad designs in a set of standards most of which not having a clear physical relation with the phenomena they are trying to avoid [9]. In addition, the present version of Weather Criterion, due to its relatively poor, although physical, modelling spreads unevenly the safety level among ship types [2].

From the point of view of ship's safety this is however, not the final solution. The evidence is given by the stability casualties that continue to occur despite the fact that those ships meets the existing IMO stability criteria [1].

The existing stability criteria may also be not applicable to some type of modern ships incorporating novel design features especially because original criteria as resolution A.167 developed more than forty years ago were based on casualty statistics that included mainly vessels under 100 m in length [6]. With many modern ships there is no previous experience in relation to safety and stability and satisfying existing criteria may not assure required level of safety [6].

In order to achieve sufficient level of safety with respect to stability, all elements creating stability system have to be taken into account [5]. Taking into account the fact, that only part of the casualties are caused by faulty or bad design of the ship, the safety requirements that refer mainly to design features of the ship cannot ensure sufficient level of safety, in particular with regard to ships having design features [7].

What is much more important to be mentioned is the fact that current intact stability criteria do not cover all the dynamic instabilities of ships in waves. Phenomena like pure loss of stability, parametric rolling, broaching and surfriding, which are presently encountered by ships, especially in severe sea conditions, are not treated.

Part of those phenomena are presently addressed by the MSC.1/Circ.1228 [3] but does not provide any ship-

dependent information concerning the considered failure mode. IMO has given in this guidelines [3], a diagram (fig. 10) highlighting the potential occurrence of high wave group encounters; however, the information is given in a dimensionless format only by a ratio of ships speed V_s and wave period T_W, whilst α is the encounter angle.

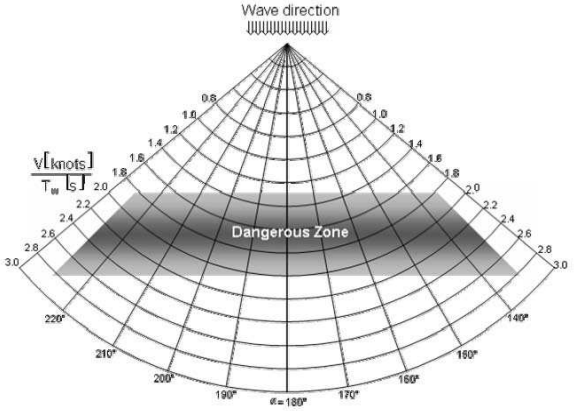

Figure 10 Diagram Indicating Dangerous Zone due to High wave group encounters [3]

5. A NEW GENERATION OF STABILITY CRITRERIA AS A POSSIBLE SOLLUTION FOR ASSESSMENT OF SHIP STABILITY IN SEVERE SEA CONDITIONS

Methods that can be used for the assessment the vulnerability of ships in front of the new modes of stability failures in severe sea conditions, from the beginning of the voyage, as a measure of safety, has to be developed in a form of stability criteria and to be integrated in the actual intact ship stability regulations.

Within the recent years, IMO through his Sub-Committee on Stability and Load Lines and on Fishing Vessels Safety, start working on a framework for development of New Generation Intact Stability Criteria, with the scope of issuing an assessment methodology to identify the ships vulnerable to dynamic instabilities in severe seas. However, the methodology is very complex and is still under development being far away from application in practice.

The reality proved that these few steps are not enough to ensure safety of ships and therefore it is very important that extensive researches and studies for assessment the dynamic instabilities of ships have to be carried out.

Due to new designs of the ship's hull, the dynamic characteristics of new ships can differ considerably from conventional ships. This aspect provides also new necessities in respect of ship safety and put the ships owners in front of new challenges regarding the guidance for operation.

Hence, today the assessment of ship stability in waves, based on dynamic criteria, became an important task among researchers. This is because the ship response to large waves is associated with significant nonlinearities.

Based on the analysis presented it can be concluded that presently, the assessment of intact ship stability is confined to the fulfilment of empirical criteria related to the static lever arm curve for still water condition only. The IMO stability criteria are prescriptive rules based on practical experiences quite many years ago. In this respect, it is obvious that new approaches must be implemented in order to issue valid, simple and trustworthy methodology to provide the shipmaster with a decision support tool to prevent ship's stability loss in different conditions encountered in severe sea conditions during the voyage.

The lack of an existing intact dynamic stability criteria (into present stability criteria) for the phenomena covering the stability variation in waves creates some doubts and could entail that all ships may be susceptible to stability loss in this conditions [2], i.e. parametric rolling, pure loss of stability, broaching, surf-riding. Therefore, the development of dynamic stability criteria for such particular situations can become a top priority for the maritime community

6. CONCLUSIONS

In order to be assessed correctly the casualties of intact stability, regularities noticed in the course of statistics analysis, regarding for example the influence of some hydrodynamic phenomena as well as types of cargoes carried on board ships, must allow formulating the causes of failures.

Like in any accident type, for the purpose to adopt the relevant safety measures and regulations to prevent such an accident in the future or to minimize the losses, in ship stability casualties it is essentially to keep a strictly statistic of those casualties. Hence, intact ship stability failure casualties have to be taken into consideration like separate events in the statistics.

An important lesson can be learned from the presented casualties, that the intact ship stability failure is in many cases a chain of events, especially on those related to design, operational and environmental factors. The events must be analyzed separately and ideally would be that the solutions to be integrated into a single framework.

The above study indicates that the occurrence of ship stability casualties in the last 10 years has its statistical laws and has different relationship with conditions of ships and some influent factors, which is valuable for the officers of maritime safety administrations and seafarers to consider, because that accident data from above study is reliable data from official resources. But it is also suggested that the findings of above study should be properly referenced and used by consideration of local environments, practical conditions and individual experiences.

The findings of above study can be beneficial to the maritime safety administrations to adopt decision-making on maritime safety management, but is also important to carry out statistics and analysis of marine casualties to help to adopt proper safety management measures.

Moreover, the study can be a useful guidance for masters and officers on board vessel in order to understand the factors that contribute to ship stability failure during the voyage and to take preventive

measures to avoid putting the ship in such dangerous situations.

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ANALYSIS OF THE MIDSHIP SECTION'S FATIGUE USING FINITE ELEMENT METHOD FROM A CARGO SHIP

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ABSTRACT

The midship section is subject to a long-term claim caused by an increased number of containers on the unit area.

The fatigue is playing a determinant role in this work, but in order to assess the fatigue, the normal, shear and Von Mises stresses on the midship section should be determined using the finite element method.

Keywords: *fatigue, CAD, finite element method, stress, midship section.*

1. INTRODUCTION

The cargo ships are the most employed ships in the naval transport. With those help, containerized goods are carried over the seas. [1].

The present paper is treating a cargo ship with heliport, designed with the help of the CAD software and the NX Software from Siemens.

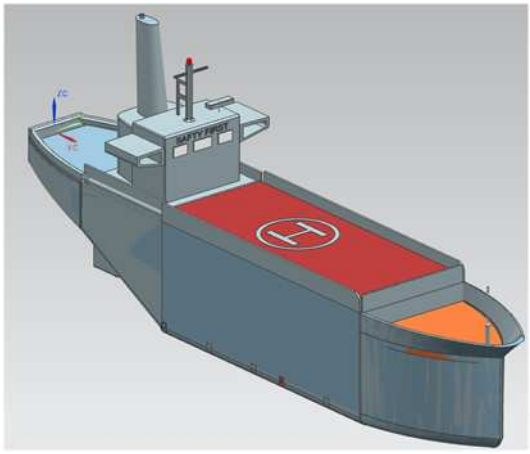

Figure 1 Cargo ship with heliport

This type of cargo ship is used mostly for transportation of dangerous goods and that is why the red area signalling as it is shown in the Fig.1, occurs.

In the next figure the top view is presenting the heliport area, the surface on deck of the ship, where the helicopters are landing.

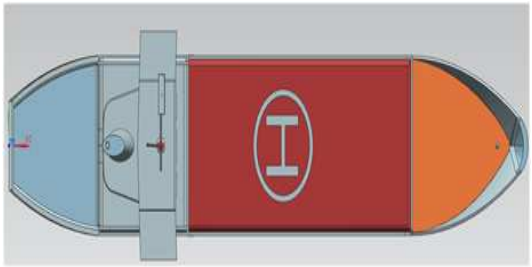

Figure 2 Top view

In order that the ship designed is in accordance with the current standards, we have studied various documentations and we have consulted naval field experts [2].

2. DESCRIPTION OF DRAWINGS

The NX Software from Siemens is well known for its rapid and complex Computer Aided Design [3].

A great deal of execution drawings have been used for this computer aided design of the ship.

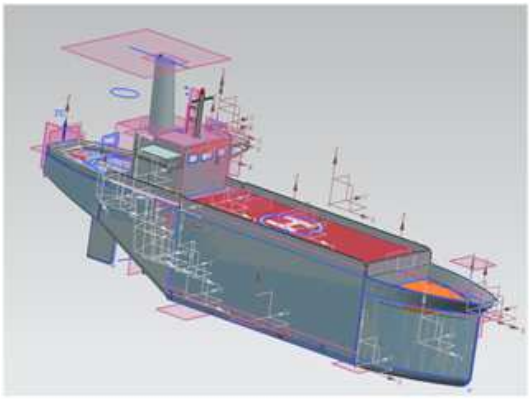

Figure 3 Original execution drawing

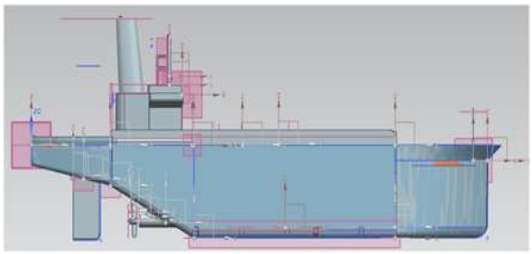

Figure 4 Side-view of the original drawing

The main equipment of the ship, such as the propeller, the rude, the funnel and the wheelhouse as well as the radar and signaling equipment etc, have been also taken into consideration.

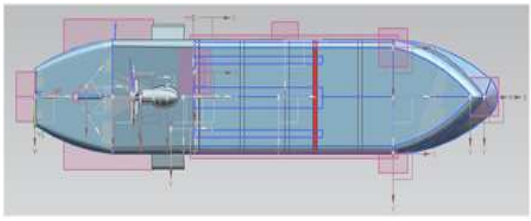

Figure 5 Bottom-view. Original drawing

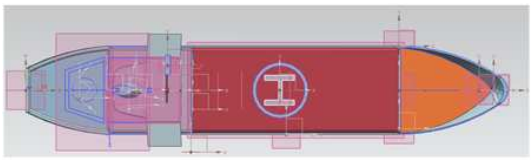

Figure 6 Top view. Original drawing

As it can be observed, it is rather hard to see in the original drawing, that is why we have used the Hidden Command in order to hide the execution layers, execution dots and execution lines.

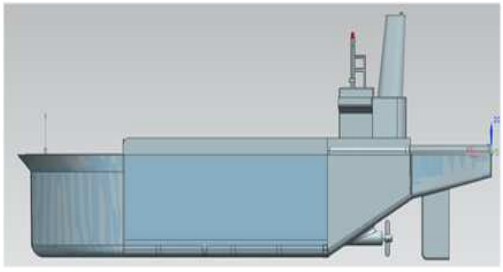

Figure 7 Side view using the Command: Hidden

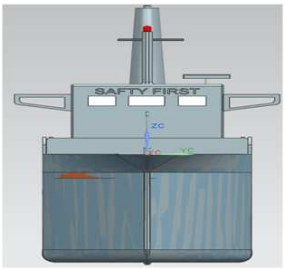

Figure 8 Front view using Hiden command

Using the command Hide, the ship can be now easily seen. In all presented views (lateral, front, bottom), details can be now easily observed (ex. SAFETY FIRST).

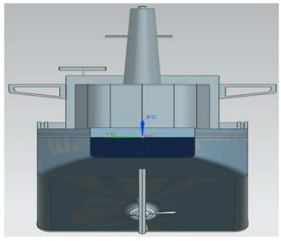

Figure 9 Back view using the command Hide

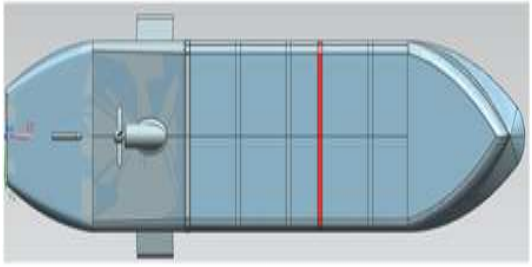

Figure 10 Bottom view without layers

3. THE INNER OF THE STORAGE AREA

Although many software programs exist in the field of the naval building, very few of them are helping their users to "enter" the inner of the ship. Though the NX Software from Siemens, is not a dedicated software for the shipbuilding, it can be very helpful to analyse the loading of the ship.

Let's suppose that the ship is to be unloaded in the harbour and in the storage area of the main warehouse of the ship are existing 4 containers (Figure 11).

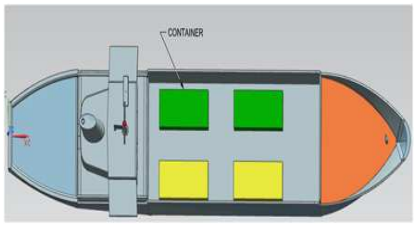

Figure 11 Ship loaded with containers

In the Figure 12 the thickness of the hull can be also read. In order to observe the containers more easily, the thickness of the hull and the double bottom we have carried out a cross section of the ship.

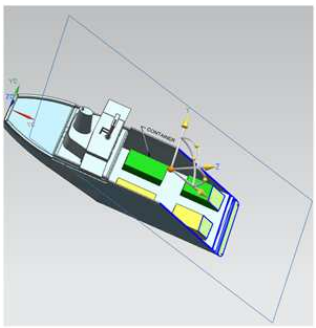

Figure 12 Cross section of the loaded ship

Later, we will show the ship after the unloading of the four containers, has been made.

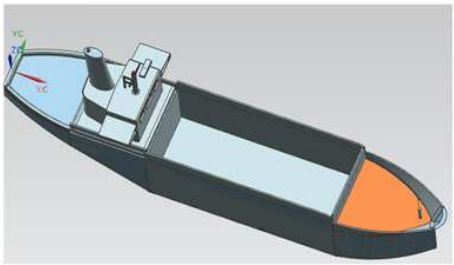

Figure 13 Top view of the unloaded ship

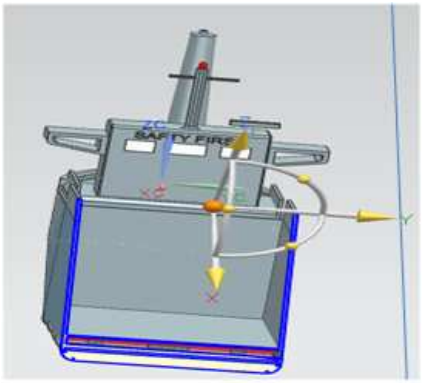

Figure 14 Cross section of the unloaded ship

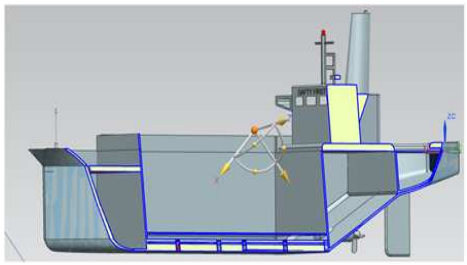

Figure 15 Longitudinal section of the unloaded ship

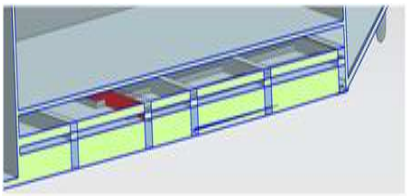

Figure 16 Midship and double bottom section

3. THE ANAUSIS OF A SMALL UNIT AREA FROM THE MIDSHIP SECTION

Due to the fact that the midship section is subject to high pressures because of the containers, we have chosen to analyze the stresses occurred using the finite element method.

Because of the high dimensions of the midship sections, sections that are carried out by welded joints, we have decided to analyze only a small area of the midship section.

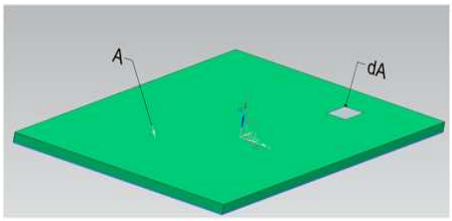

Figure 17 Midship section (A) with its unit area (dA)

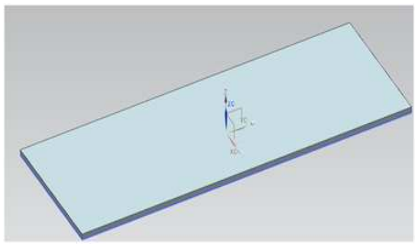

Figure 18 Unit area (dA)

We are starting by meshing the unit area dA (length 6000 mm, breadth 2000 mm and thickness 400 mm) with elements of CETRA Type (10), and then we are loading it with a pressure of 100 Mpa.

The unit area dA is made out of AISI Steel 1005, having the Suprafata dA este realizata din otel tip AISI Steel 1005, having the Young's Modulus of 2.1 10^5 MPa, Poisson's Ratio of 0,25 and density of 7.872e-006 kg/mm^3.

But before loading with the pressure of 1000 MPa (figure 19) , it is recommended to check the formability (mouldability) of the material. As already known, the formability is the ability of a given metal workpiece to undergo plastic deformation without being damaged. The plastic deformation capacity of metallic materials, however, is limited to a certain extent, at which point, the material could experience tearing or fracture (breakage) [4].

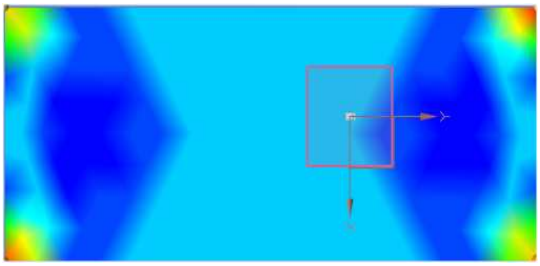

Figure 19 Analize formability – one step

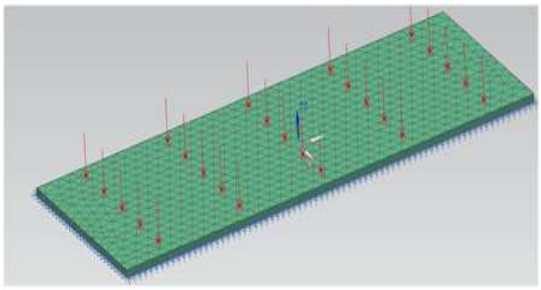

Figure 20 Area loaded with a pressure

Consequently to the pressure applied on the area dA, using the finite element method, we have obtained following results:

Von Mises stress (σ_{echV} or σ_v) according to the Strength of Materials Vth Theory, from failure theories, the maximal shear stress (τ_{max}) and the maximal normal stress (σ_{max}) [5].

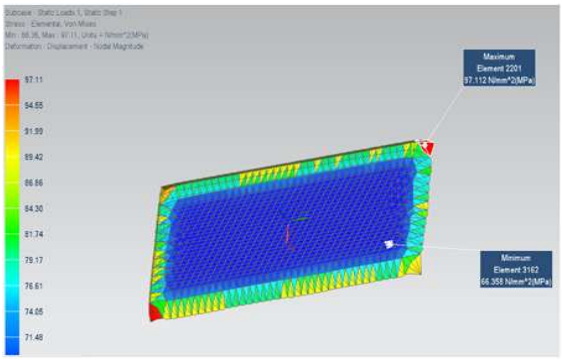

Figure 21 Von Mises stress

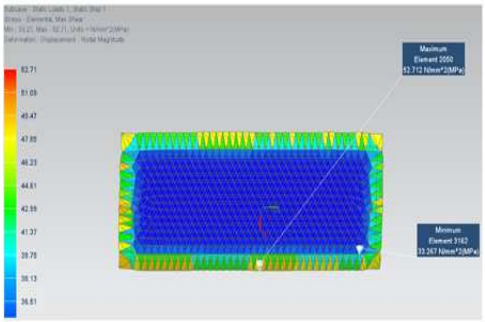

Figure 22 Maximal shear stress

As it can be seen in the Figures 21, 22 si 23 low values of the stresses are recorded in the middle and increased values are recorded at the edges of the plate, meaning that the sheet is considerably more stressed at their margins.

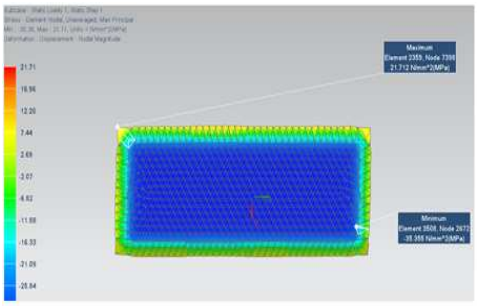

Figure 23 Maximal normal stress

5. CONCLUSIONS

The determination of the stresses have been carried out using finite element method in order to obtain an advanced durability. In the frame of the advanced durability take part: fatigue life, strength safety factor and fatigue safety factor [6].

The fatigue of the materials is a phenomenon regarding the materials' modifications of the properties due to the variable amplitude loadings, thus most of the materials failing under the cyclic loading. An effect of the fatigue is the occurrence of micro cracks and the progressive fracturing of the material while in service. Materials' fatigue is also important in transport and the marine industry [5].

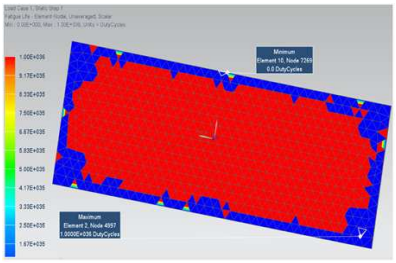

Figure 24 Fatigue life

In the Figure 24 it can be observed that the values of the fatigue life are decreasing at the margins, with the only exception of the value of the maximal fatigue, the rest of the fatigue life's values being more increased in the middle of the steel plate.

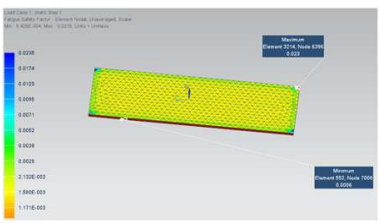

Figure 25 Strength safety factor

In the Figure 25, the values of the strength safety factor are very small inside the plate of steel, excepting the minimal value and some higher values at the margins of the unit area dA, the maximal values being recorded at the corners. Thus it can be concluded that the strength safety factor has high values only in the corners.

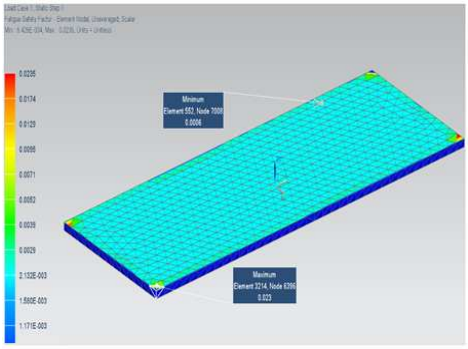

Figure 26 Fatigue Safety factor

It can be remarked that in the Figure 26 the values of the fatigue safety factor are very small in the inside, excepting the minimal value and some higher values together with the maximal values in the corners, the conclusion being that the safety factor is high only in the corners.

Consequently, the midship sections should have a higher strength in time, at different variable strains; their fatigue is to be checked by means of the finite element method analysis.

The midship section is extremely important for the safety of the naval transports, because when broken due to heavy weights, the deep floor and the keel could be also broken, thus eventually causing the flooding of the ship. The conclusion of our work is that the midship section, thus calculated could withstand high pressures, even in bad wheather conditions causing high pitch and high rolling.

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COMPARATIVE ANALISYS OF ENERGY EFFICIENCY INDICATORS FOR A CRUDE OIL SUPER-TANKER SHIP

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ABSTRACT

Main ideea of this paper is not only the study of the Energy Efficiency Design Index for a crude oil super tanker ship, witch is a mandatory technical measure for the new ships, but also the study of Energy Efficiency Operational Indicator whitch is a voluntary mesurement for ships in service.

Keywords: *energy efficiency design index, energy efficiency operational indicator, technologies.*

1. INTRODUCTION

This paper aims is to improve the energy performance of a crude oil super tanker ship of 305000 dwt, by studying the possibility of introducing alternative energy sources and improving existing equipment onboard.

Initialy, the ship has no energy efficiency technologies but, for this paper, our purpose is to introduce alternative technologies on board like shaft generators and motors, wind turbines and photovoltaic pannels. After that we calculate efficiency operational index and indicator for both states of ship and conclude the results.

2. CONSIDERATIONS ON ENERGY EFFICIENCY OPERATIONAL INDEX - EEOI AND ENERGY EFFICIENCY DESIGN INDEX - EEDI

2.1.Energy Efficiency Design Index - EEDI

Energy Efficiency Design Index (EEDI) is a measure of ships energy efficiency (g/t·nm) and is calculated by the following formula [1]:

$$\frac{\left[\begin{array}{c}(\prod_{f=1}^{n} f_i)(\sum_{f=1}^{nME} P_{ME(i)} * C_{FME(i)} * SFC_{ME(i)}) + (P_{AE} * C_{FAE} * SFC_{AE}) + \\ + \left((\prod_{f=j}^{n} f_j * \sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{neff} f_{eff(i)} * P_{AEeff(i)} C_{FAE} * SFC_{AE})\right) - \\ (\sum_{i=1}^{neff} f_{eff(i)} * P_{eff(i)} * C_{FME} * SFC_{ME})\end{array}\right]}{f_i * Capacity * f_w * v_{ref}}, \quad (1)$$

C_F - is a non dimensional conversion factor for fuel consumption, measured in *g* and CO_2 emission,

V_{ref} - is the ship speed, measured in nautical miles per hour (knot),

Capacity – is deadweight of the ship,

P - is the power of the main and auxiliary engines, measured in kW,

$P_{ME(i)}$ - is 75 per cent of MCR for each main engine,

$$P_{ME(i)} = 0.75 \times (MCR_{MEi} - P_{PTOi}); \quad (2)$$

$P_{PTO(i)}$ - is 75 per cent of nominal power of each shaft generator,

$P_{PTI(i)}$ - is 75 per cent of the rated power consumption of each shaft motor divided by the weighted average efficiency of the generators,

$P_{eff(i)}$ - is the output of the innovative mechanical energy efficient technology for propulsion at 75 per cent main engine power,

$P_{AEeff(i)}$ - is the auxiliary power reduction due to innovative electrical energy efficient technology measured at $P_{ME(i)}$,

P_{AE} - is the required auxiliary engine power to supply normal maximum sea load including necessary power for propulsion machinery / systems and accommodation [4],

For the reference crude oil super tanker, main engine has a power up to 10000 kW, and P_{AE} is written:

$$P_{AE(MCRME>10000\,kW)} = (0.025 \times \sum_{i=1}^{nME} MCR_{MEi}) + 250 \quad (3)$$

SFC - is the certified specific fuel consumption, measured in g/kWh, of the engines,

f_j - is a correction factor which for the crude oil super tank is written:

$$f_j = \frac{0.516 L_{PP}^{1.87}}{\sum_{i=1}^{nMEP}{}_{iME}} \quad (3')$$

f_w - is a non-dimensional coefficient indicating the decrease of speed in representative sea conditions of wave height,

$f_{eff(i)}$ - is the availability factor of each innovative energy efficient technology,

f_i - is the capacity factor for any technical / regulatory limitation on capacity, and should be assumed to be one (1.0) if no necessity of the factor is granted:

$$f_i = \frac{0.00115 L_{PP}^{3.36}}{capacity}. \quad (4)$$

2.2. Energy Efficiency Operational Indicator - EEOI

The Energy Efficiency Operational Indicator is defined as the ratio of mass of CO_2 (M) emitted per unit of transport work.

The Energy Efficiency Operational Indicator is calculated with this formula:

$$EEOI = \frac{Fuel_{consuption} C_{Carbon}}{Cargo_{transported} Distance}. \quad (4')$$

The unit of EEOI depends on the measurement of cargo carried or work done, e.g., tonnes CO2/(tonnes · nautical miles), tonnes CO2 / (TEU nautical miles), tonnes CO2/(person · nautical miles), etc

3. CALCULATION OF ENERGY EFFICIENCY INDICATORS FOR TWO KIND OF POWER SYSTEM CONFIGURATIONS

3.1.Calculation of Energy Efficiency Design Index for crude oil super tanker in design version

To calculate the EEDI will adopt a number of parameters for the main engine, auxiliary engines, innovative technology and transport parameters according to the formulas below.

Parameters for main engine:

1. Conversion factor for heavy fuel oil:

$$C_{FME} = 3.1144. \quad (5)$$

2. Main engine power:

$$P_{ME} = 0.75 \times (MCR_{MEi} - P_{PTOi}) = 0.75 \times (27020 - 0) = 20265\ kW. \quad (6)$$

2. Specific fuel consumption:

$$SFC_{FME} = 163.6\ \frac{g}{kWH} \quad (7)$$

Parameters for auxiliary engines:

1. Necesary power for auxiliary engines;

$$P_{AE(MCRME>10000\,kW)} = (0.025 \times \sum_{i=1}^{nME} MCR_{MEi}) + 250 = 0.025 * 27020 + 250 = 925.5\ kW. \quad (8)$$

2. Conversion factor for marine diesel oil:

$$C_{FAE} = 3.20. \quad (9)$$

3. Specific fuel consumption:

$$SFC_{FAE} = 190\ \frac{g}{kWH}. \quad (10)$$

4. Corection factor:

$$f_j = \frac{0.516 L_{PP}^{1.87}}{\sum_{i=1}^{nME} P_{iME}} = \frac{0.516 * 324^{1.87}}{27020} = 0.945. \quad (11)$$

5. Power for shaft generator (for design ship there is no shaft generators):

$$P_{PTI} = 0\ kW. \quad (12)$$

6. Availability factor of each innovative energy efficient technology.

At design ship there is no efficiency technology.

$$f_{eff} = 1\ . \quad (13)$$

7. Auxiliary power reduction due to innovative electrical energy efficient technology.

At design ship there is no efficiency technology.

$$P_{AEeff} = 0\ kW. \quad (14)$$

Parameters for inovatie technology:

At design ship there is no efficiency technology.

Parameters for ship transport work:

1. Capacity factor:

$$f_i = \frac{0.00115 L_{PP}^{3.36}}{capacity} = \frac{0.00115 * 324^{3.36}}{305301} = 1.025. \quad (15)$$

2. Factor for decrease of speed in representative sea conditions of wave height:

$$f_w = 1. \quad (16)$$

3. Ship speed:

$$v_{ref} = 15.38. \quad (17)$$

3. Ship deadweight:

$$capacity = 305301\ tdw. \quad (18)$$

After these parameters, we can calculate Energy Efficiency Design Index for crude oil super tanker in design version:

$$EEDI = \frac{f_i x P_{ME} x C_{FME} x SFC_{FME} + P_{AE} x C_{FAE} x SFC_{FAE}}{f_i x f_w x v_{ref} x capacity}; \quad (19)$$

$$EEDI = \frac{0.945x20265x3.1144x163.6+925.5x3.20x190}{1.025x1x15.38x305301}; \quad (20)$$

$$EEDI = \frac{9757444.88+562704}{5225989.86} = 2.14\,\frac{g}{t} * knots. \quad (21)$$

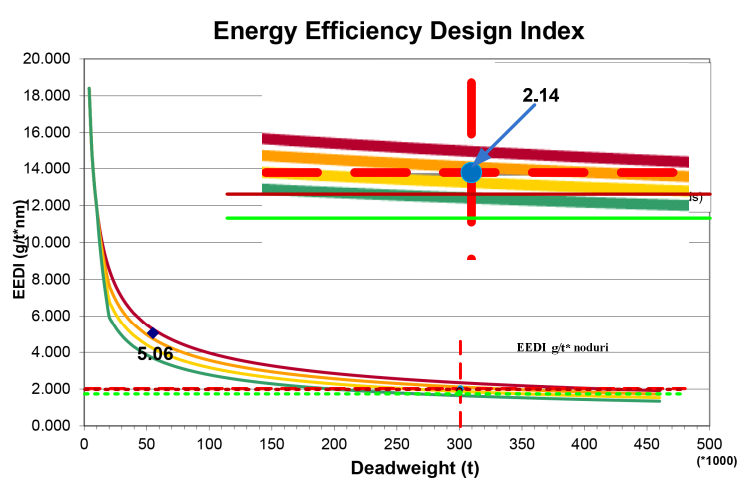

Figure 1 Value and interpretation of EEDI for ship initial design

After calculation is concluded that value of EEDI are within the tier 1 and tier 2 (figure 1). So, for design ship we have a good result.

3.2. Parameters for calculation of Energy Efficiency Design Index for crude oil super tanker with energy efficient technologies.

For crude oil super tanker ship we adopt three type of energy efficient technologies onbord [5]:

- shaft generator;
- wind turbines;
- photovoltaic pannels.

Against 1.1 paragraph we have some parameters for efficient ennergy:

1. Power for shapt motor:

$$P_{PTI} = 0.75x\frac{P_{SM}}{\eta_{SM}} = 812.5\ kW; \quad (22)$$

$$P_{SM} = 976\ kW. \quad (23)$$

2. Power for shaft generator:

$$P_{PTO} = 0.75xP_{SG} = 731.25\ kW; \quad (24)$$

$$P_{SG} = 976\ kW. \quad (25)$$

3. Availability factor of each innovative energy efficient technology (we have the same factor for wind turbines and photovoltaic pannels) [2].

$$f_{eff} = 1. \quad (26)$$

4. Auxiliary power reduction due to innovative electrical energy efficient technology.

This time, we have wind turbines ennergy and photovoltaic pannels ennergy like electrical energy efficient technology [3]:

$$P_{AEefftturbine} = 250\ kW; \quad (27)$$

$$P_{AEeffpannels} = 15\ kW. \quad (28)$$

3.3. Calculation of EEDI (option 1, we use shaft motor, wind turbines and photovoltaic pannels)

$$EEDI = \frac{f_i x P_{ME} x C_{FME} x SFC_{FME} + (P_{AE} + f_i x P_{PTI} - f_{eff} x P_{AEeff}) x C_{FAE} x SFC_{FAE}}{f_i x f_w x v_{ref} x capacity} \quad (29)$$

$$EEDI = \frac{9757444.88 + [1693.31 - 265] x 3.2 x 190}{5225989.86}. \quad (30)$$

$$EEDI = \frac{9757444.88 + 868414}{5225989.86} = 2.03\frac{g}{t} * knots. \quad (31)$$

At point 3.3. we had a value of 2.03 $g/t * knots$ (figure 2).

So, like result, was a drop with 0.11 $g/t * knots$.

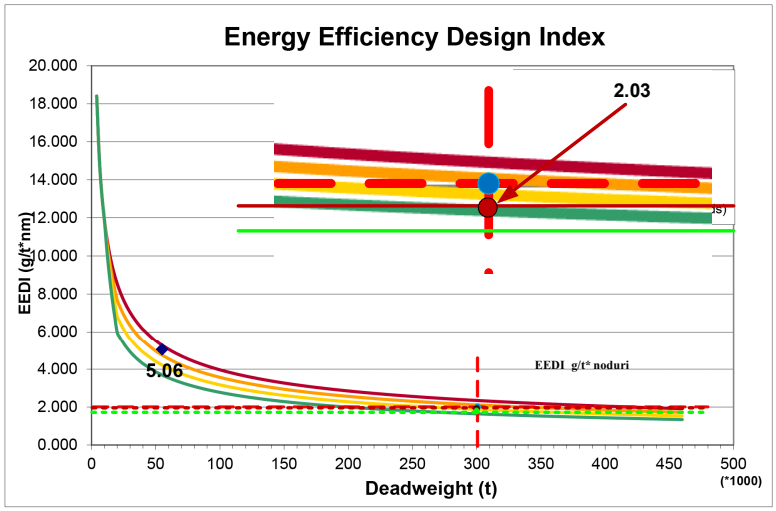

Figure 2 Value and interpretation of EEDI for ship with efficient energy and shaft motor

3.4. Calculation of EEDI (option 2, we use shaft generator, wind turbines and photovoltaic pannels)

$$EEDI = \frac{f_i x P_{ME} x C_{FME} x SFC_{FME} + (P_{AE} - f_{eff} x P_{AEeff}) x C_{FAE} x SFC_{FAE}}{f_i x f_w x v_{ref} x capacity} \quad (32)$$

$$EEDI = \frac{10021513.4 + 112.06 x 3.2 x 190}{5225989.86} \quad (33)$$

$$EEDI = \frac{10089645.88}{5225989.86} = 1.93\ g/t * knots \quad (34)$$

At point 3.4. we had a value of 1.93 g/t ∗ knots (figure 3), so like result was a drop with 0.21 g/t ∗ knots.

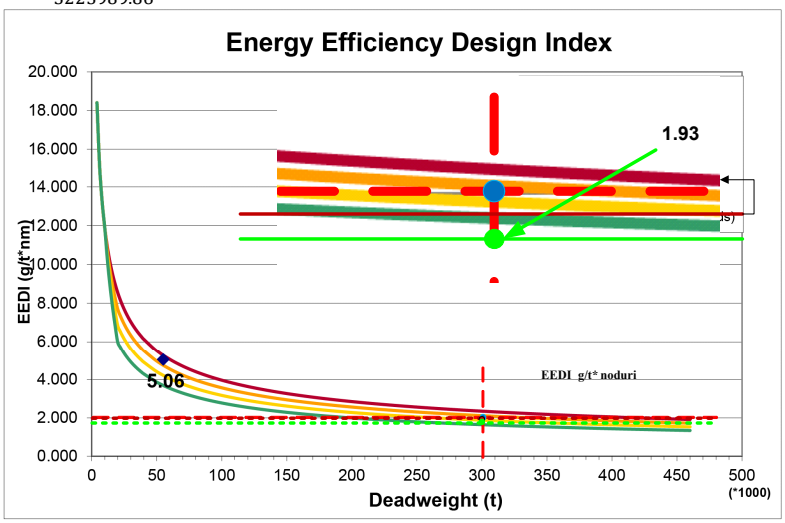

Figure 3 Value and interpretation of EEDI for ship with efficient energy and shaft generator

3.4. Calculation of Energy Efficiency Operational Indicator for crude oil super tanker without efficiency energy technologies

To calculate EEOI we will adopt a ship voyage of 30 days. So, we have parameters below.

1. Fuel consumed (tones):

$$Fuel_{consumed} = 977.20 + 52.30 = 1029.5\ tones\ HFO, \quad (35)$$

$$Fuel_{consumed} = 143.2\ tones\ MDO. \quad (36)$$

2. Carbon factor for each type of fuel:

$$C_{Carbon} = 3.1144\ for\ HFO; \quad (37)$$

$$C_{Carbon} = 3.20\ for\ MDO. \quad (38)$$

3. Crude oil transported:

$$Cargo_{transported} = 250000\ tones. \quad (39)$$

4. Distance during ship vayage (miles):

$$Distance = 6506\ miles; \quad (40)$$

$$EEOI = \frac{1029.5x3.114+143.2x3.20}{250000x6506} = 2{,}253\ 10^{-6}\ \frac{tCO2}{t}x\ miles. \quad (41)$$

In conclusion we observe that EEOI value is 2.253 gCO2/t x mile. In figure no. 4 we had good result.

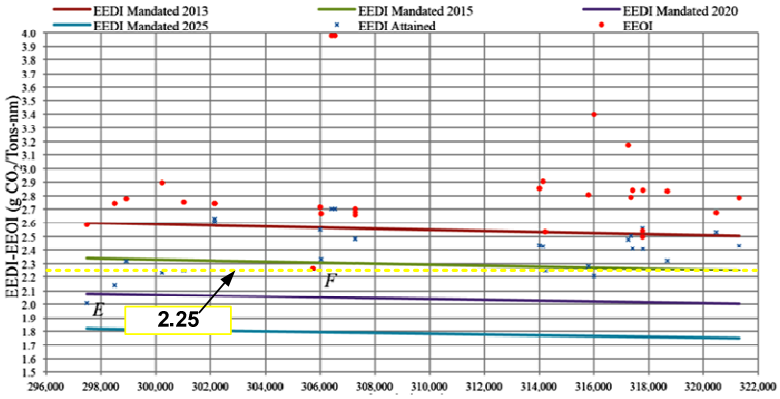

Figure 4 Interpretation of EEOI for ship without efficient technologies

3.5. Calculation of Energy Efficiency Operational Indicator for crude oil super tanker with efficient energy technologies

We calculate EEOI for a voyage of 30 days. To calculate the operational index we adopt the parameters below.

1. Fuel consumed (tones):

$$Fuel_{consumed} = 977.20 + 3.5 = 980.25\ tones\ HFO; \quad (42)$$

$$Fuel_{consumed} = 143.2\ tones\ MDO. \quad (43)$$

2. Carbon factor for each type of fuel:

$$C_{Carbon} = 3.1144\ for\ HFO. \quad (44)$$

$$C_{Carbon} = 3.20\ for\ MDO \quad (45)$$

3. Crude oil cargo:

$$Cargo_{transported} = 250000\ tones \quad (46)$$

4. Distance during ship travel (miles):

$$Distance = 6506\ miles \quad (47)$$

$$EEOI = \frac{980.25x3.114+143.2x3.20}{250000x6506} = 2{,}15\ 10^{-6}\ tCO2/t\ x\ mile \quad (48)$$

In conclusion we observe that EEOI value is 2.15 gCO2/t x mile. In figure no. 5 we had a very good results.

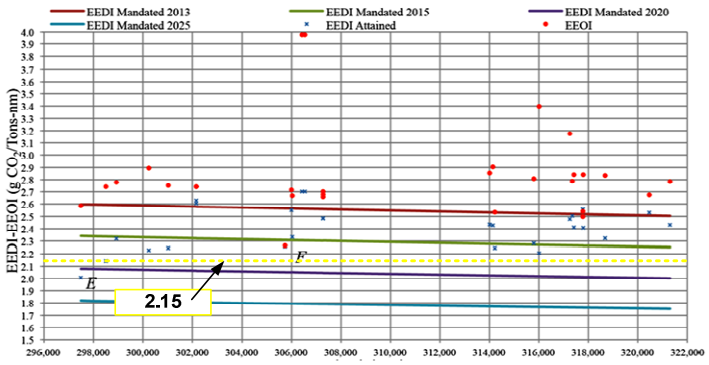

Figure 5 Interpretation of EEOI for ship with efficient technologies

4. COMPARATIVE ANALISYS OF ENERGY EFFICIENT TECHNOLOGIES RESULTS

4.1. Comparative analisys of Energy Efficiency Design Index.

In conclusion, comparative results for the values of EEDI are:

1.for option no.1 with shaft motor, wind turbines and photovoltaic pannels, we had a value of 2.03 $g/t * knots$, against 2.14 $g/t * knots$ with ship without energy afficient technologies. So, was a drop with 0.11 $g/t * knots$;

2.for option no.2 with shaft generator, wind turbines and photovoltaic pannels, we had a value of 1.93 $g/t * knots$, against 2.14 $g/t * knots$ with ship without

energy efficient technologies. So, was a drop with 0.21 $g/t * knots$.

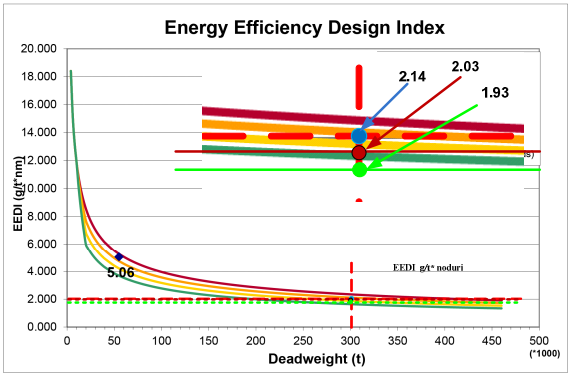

Figure 6 Interpretation of EEDI

4.2. Comparative analisys of Energy Efficiency Operational Indicator

Calculating EEOI, we observe that value is 2.15 gCO2/t x mile against the ship voyage without efficient ennergy technologies with value of 2.253 gCO2/t x mile. So was a drop of 0.10 gCO2/t x mile.

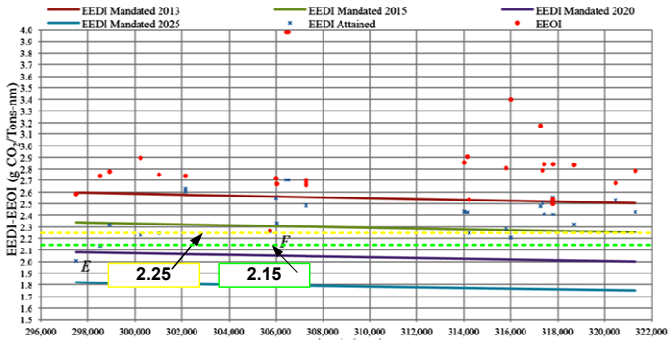

Figure 7 Interpretation of EEOI for ship with efficient technologies

5. CONCLUSIONS

By calculating energy efficiency indicators for two kind power configuration of a crude oil super tanker ship, we try to show witch is the difference between a ship with and without inovative technologies onboard.

In design state, power configuration of ship was only the main engine, auxiliary engines and boiler.

Also, we adopt efficient technologies onboard like shaft motor and generator, wind turbines and photovoltaic pannels [6].

In modern state, power configuration of ship was the main engine, auxiliary engines, boiler, shaft motor or shaft generator, wind turbines and photovoltaic pannels.

After calculation of energy efficiency indicators we had results with a difference of $0.11\ g/t * knots$ and $0.21\ g/t * knots$ for Energy Efficiency Design Index - EEDI and 0.10 gCO2/t x mile for Energy Efficiency Operational Indicator - EEOI.

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CONSIDERATIONS ON THE POWER SYSTEM RECONFIGURATION FOR A VERY LARGE CRUDE CARRIERS TANKER SHIP

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ABSTRACT

The concept of energy efficiency (or energy optimization) has become, today, one of the main concerns of humanity to the whole world.

In recent decades, the maritime industry, has strived to optimize the fuel consumption of ships through the development of engines and propulsion systems, improved hull design, or using alternative energies, this way making a reduction in the amount of CO_2 released to the atmosphere.

Main ideea of this paper is to improve the energy performance of a crude oil super tanker ship of 305000 dwt, by studying the possibility of introducing alternative energy sources onboard.

Keywords: *shaft generator, wind turbines, photovoltaical pannels, efficiency.*

1. INTRODUCTION

This paper consist in concepts modernization of a very large crude carriers of 305000 dwt.

In this work, we have included the reconfiguration of ship power system, introducing new generation systems like shaft generators, wind turbines and photovoltaical pannels.

Initialy, the ship has no energy efficiency technologies included, but, for this paper, our purpose is to introduce alternative reconfigurations technologies onboard to make the ship more efficient.

2. CURRENT STATUS OF ALTERNATIVE ENERGY DEVELOPMENT ONBOARD OF SHIPS

One of the main problems of ship industry is to reduce CO_2 emission.

Several alternatives are proposed to reduce or replace fossil fuels onboad ships like: sails, kites, electricity for shore supply, biodiesel, wind turbines, photovoltaic pannels or hydrogen fuel cells [1].

These sources of energy can be used on its own or in connection with, what are called, hybrid systems for power generation onboard a ship. These are systems for generating energy that is actually green renewable.

Along time is been developing several concepts of eco ships.

One of the projects is Aquarius MRE System which use a lot of rigid sails and solar panels to form a vessel based on a system of renewable energy. On large vessels can be installed up to 20 rigid sails, while smaller ships will require only one or two sails (figure 1).

Aquarius MRE system is not intended to be the main source of propulsion of ships. Instead, the system is designed to work with other technologies, in order to reduce fuel consumption by up to 20% and emissions of toxic gases.

On this kind of ship, the total installed solar power could be 500 kW or more.

Figure 1 Aquarius MRE concept

Another concept is Fery Medaka Solar (solar ferry Medaka – Figure 2).

Eco Marine Power is leading a project to develop an eco ship designed to operate as a ferryboat for urban areas.

Medaka is a ferryboat that not only uses solar power as a renewable energy source, but will also use a range of other features that will be more softly with environment than traditional models of existing ferries.

For example, will be used a hybrid electric propulsion system, which will be much easier to maintain and have a lower cost than diesel.

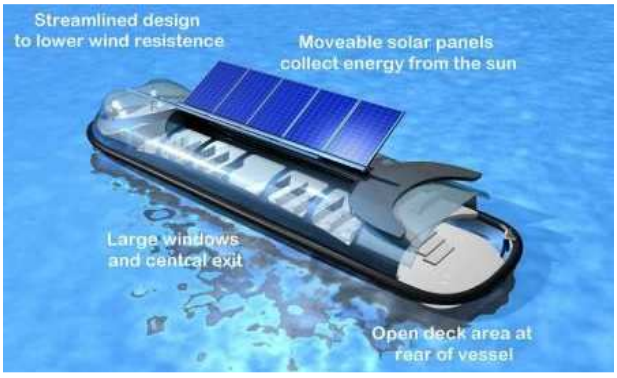

Figure 2 Solar Medaka ferryboat

Finally, a new concept which bring together all sources of renewable energy, is the ship E / S Orcell (Figure 3), produced by Wallenius Wilhelmsen.

Orcelle will have an optimal cargo loading capacity of 85000 m^2, equivalent to 14 football fields. This represents a 50% increase in space available in modern ships carry cars, being able to carry 6500 vehicles.

Figure 3 Orcell eco ship

3. ESSENTIAL CONSIDERATIONS ON POWER SYSTEM RECONFIGURATION FOR A VERY LARGE CRUDE CARRIERS OF 305000 DWT.

In first state the ship is not equipped with innovative technologies to enhance energy efficiency. This is why on I will propose some measures to equip the ship with innovative technology, like: one shaft generator, five wind turbines and photovoltaic pannels.

3.1. Power system reconfiguration using a shaft generator

There are two type of operating modes for the energy system of the ship equiped with shaft generators.

1. Power Take Off Operation

In power take-off (PTO) operation, the shaft generator operates as a generator (figure 4). The shaft generator drive can operate in island mode (single generator) or in parallel mode with other auxiliary generators.

Shaft generator drive uses droop control to adjust voltage and frequency when operating parallel with other generators. The shaft generator drive is seen as one of the generators in the system.

In addition to basic features, the shaft generator drive includes extra functionality. The shaft generator drive can compensate unbalanced loads in the grid and also provides reactive power compensation.

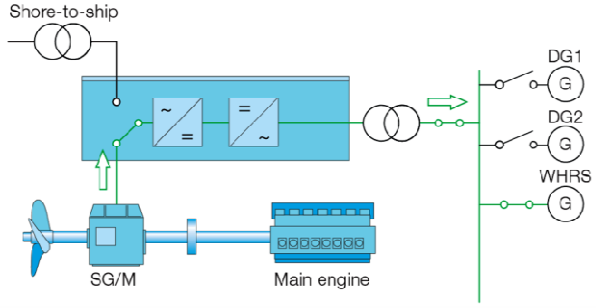

Figure 4 Power Take Off Operation

2. Power Take In Operation

In power take-in (PTI) operation mode, the shaft generator functions as a motor. The power is taken from auxiliary generators and the shaft generator drive operates the motor (figure 5).

The take-me-home feature can be used if the main engine has malfunctioned. The main engine can be decoupled from the shaft line so that the shaft generator can operate independently, allowing the main engine to be repaired.

The motoring power of the shaft generator can be used to boost main engine power. The shaft generator drive can drive the shaft generator/motor in synchronization with main engine.

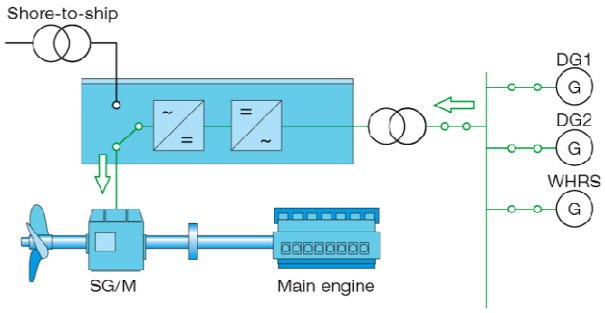

Figure 5 Power Take In Operation

There are three type of shaft generators if we refer to frecvency.

To illustrate the variation, the electric power diagrams (Figure 6) are shown for the CFE (constant frecvency electrical), RCF (renk constant frecvency) and GCR (gear constant ratio) principles. The diagrams are shown for basic layouts, but it is important to note that other shaft generator layout ranges based on a particular engine load profile could be selected to ensure that the electric power from the shaft generator is available for most preferred main engine load conditions.

Figure 6 Electric power vs main engine power

Analyzing above, for the reference ship, we will choose a shaft generator CFE type, because of its constant frecvency electrical functioning.

PTO shaft type generator / CFE (figure 7) is able to produce constant frequency electricity with changes of main engine speed. If this type of generator uses a speed reducer, the alternator may have an embedded electronic converter, which provides correction for various speed of main engine, and therefore correction the speed of the alternator. As an alternative solution, and very usual one, electricity is produced with variable frequency and after is converted into electrical energy with constant frequency by thyristors.

CFE shaft generators are capable of operating in parallel mode with other generators when the main engine power is between 75 % and 100 %. Between 40 % and 75 % of main engine power, electric power produced by the generator is reduced in proportion to main engine load. Such generators are commonly used than those directly fitted on the engine because there is no limitation on the installation onboard [4].

Overall efficiency of such a system is between 84 % and 88%.

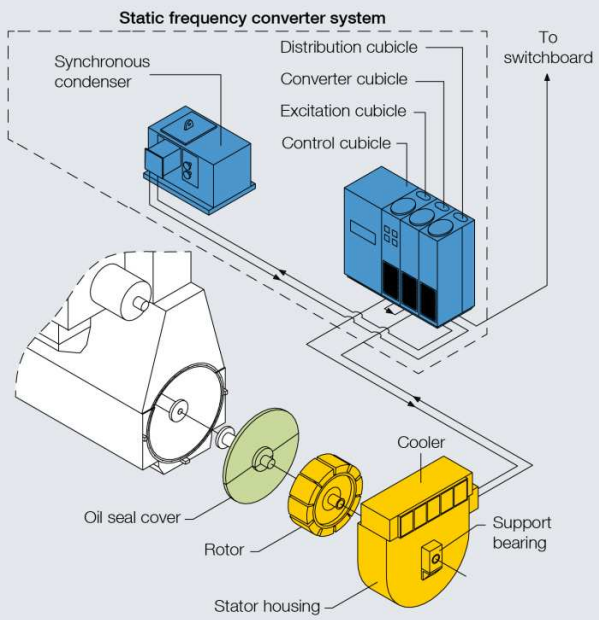

Figure 7 CFE type shaft generator

For reference ship we choose a Cumins HCM 6 type shaft generator (figure 8).

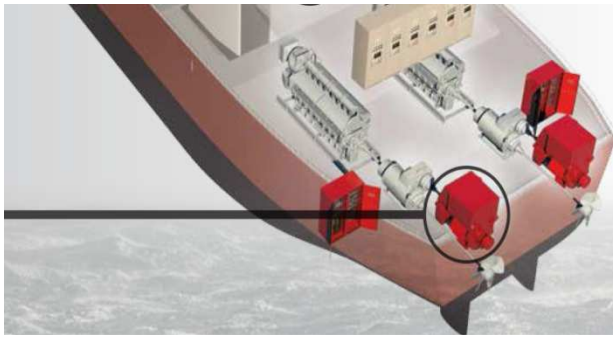

Figure 8 Cummins type shaft generator

Main parameters of HCM6 shaft generator are:
-power: $P = 976\ kW$;
-nominal voltage: $U_N = 440\ V$;
-speed: $n = 600\ rpm$;
-frecvency: $f = 60\ Hz$
-phase number: $m = 3$;
-power factor: $cos\varphi = 0.8$.

The shaft generator HCM6 is CFE type (Figure 9) and reaches rated power when the main engine has a load between 40% and 110 %. Because of during the ship voyage the turbogenerator is operating at more than 50 % main engine load, and because we want as much fuel economy, the shaft generator is a very good solution.

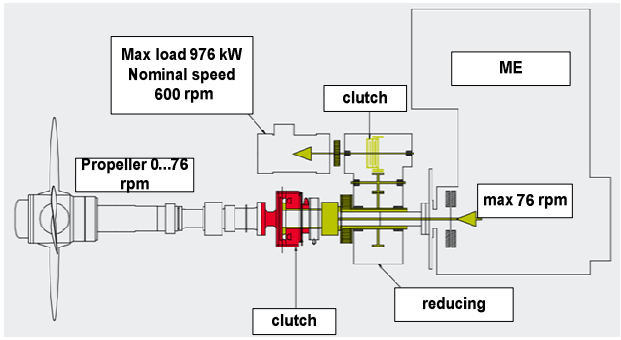

Figure 9 CFE type shaft generator

Also, during the ship voyage it can be used in paralel mode, both, turbogenerator and shaft generator.

From the experience of voyages, ship needs no more than 900 kW of electrical power, so, a shaft generator power of a 976 kW is a good choosen.

Finally, we have the ship electric power system configuration:
- two diesel generators YANMAR type, of 1700 kW each,
- one turbogenerator of 1100 kW,
- one emergency generator of 620 kW,
- a shaft generator of 976 kW.

3.2. Power system reconfiguration using photovoltaic pannels

The new solar cells with spherical shape and narrow dimensions, could revolutionize the field of photovoltaic solar energy application.

Japan, leader in photovoltaic technology, has developed new solar cells with tiny spherical shape between 1 mm and 1.5 mm diameter as opposed to the traditional 72 mm flat cells.

A negative electrode and a positive one, opposite each other, are positioned in the center of the surface "p" type and " n" type (Figure 10).

This positioning of the electrodes makes the cell to be non - directed and may occur even distribution of the generated amperage. Sensitive cell which can take light from any direction is called three-dimensional light capture.

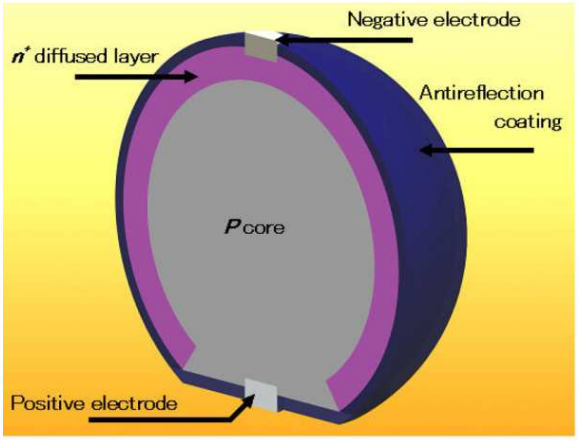

Figure 10 Spheral cell

We will study the possibility of placing solar onboard reference ship.

The panels are formed of spherical cells with PV module witch comprise a number of 12 spheral cells. Spheral cells can be conected in paralel or series (figures 11, 13, 14) to produce voltage power and high amperage. Lights is concentrated four times more with a hight efficiency [2].

Depending on available ship space,we calculate the number of solar modules, the number of photovoltaic pannels and the hence area to be located.

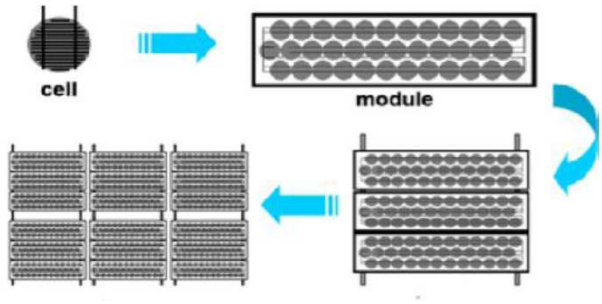

Figure 11 Pannels with spheral cell

We put solar panels on port and starboard platforms uppon bridge. We calculated the areas of location and got the following results as shown in Figure 12:

- we have two areas, on top, of 52 squere meters each, making a total area of 104 square meters for placement of solar panels [3],
- we have two areas, on the bow, of 50 square meters each, making a total area of 100 square meters for placement of solar panels,
- on the aft area we have two of 50 square meters each, making a total area of 100 square meters for placement of solar panels,

Finally, we have a total of 304 square meters for placement of solar panels.

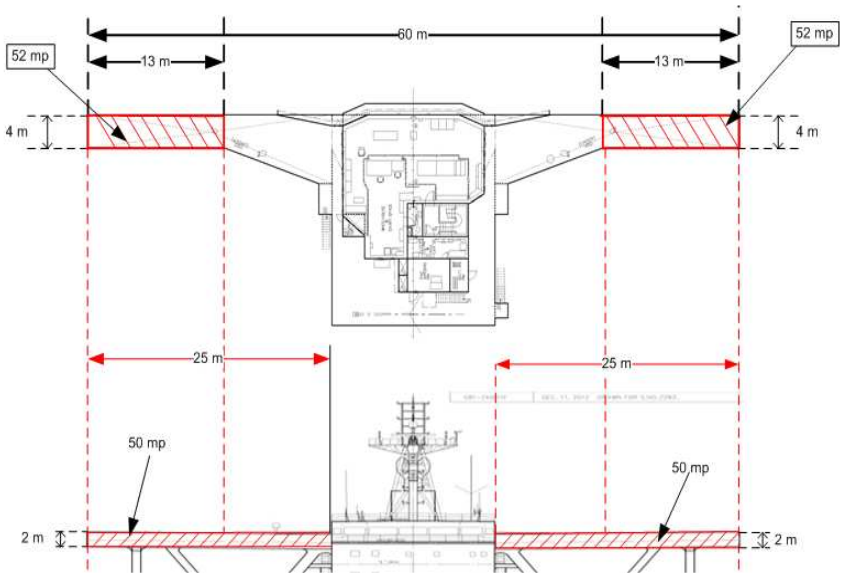

Figure 12 Areea for placement of solar panels

A modul area:

$$S = 24 \text{ x } 15 \text{ mm} = 360 \text{ mmp} = 0.00036 \text{ m}^2 . \quad (1)$$

Number of modules:

$$Nm = 304 / 0.00036 = 844444 \text{ pieces}, \quad (2)$$

Number of cells:

$$Nm = 844000 \text{ pieces} = 844000 \text{ x } 12 = 10128000 \text{ cells}. \quad (3)$$

We put cells on photovoltaic pannels as to supply batteries of 48 V. So, we will have 126600 cells in paralel mode and 80 cells în series mode.

Total electric voltage:

$$U = U_{cell} N_{cellparalel} = 0.6 * 80 = 48 \, V. \quad (4)$$

Total electric amperage:

$$I = I_{cell} N_{cellseries} = 0.025 * 126600 = 316.5 \, A. \quad (5)$$

Total electric power:

$$P = IU = 48 * 316.5 = 15.192\ kW. \quad (6)$$

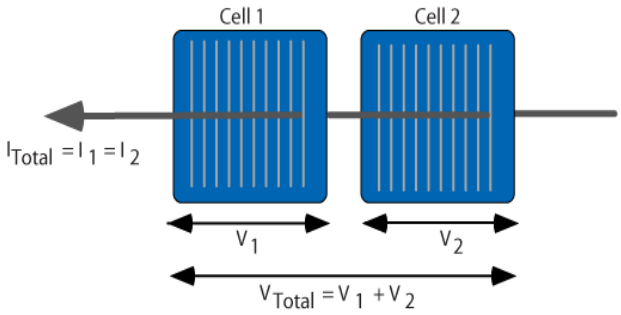

Figure 13 Series mode of cells

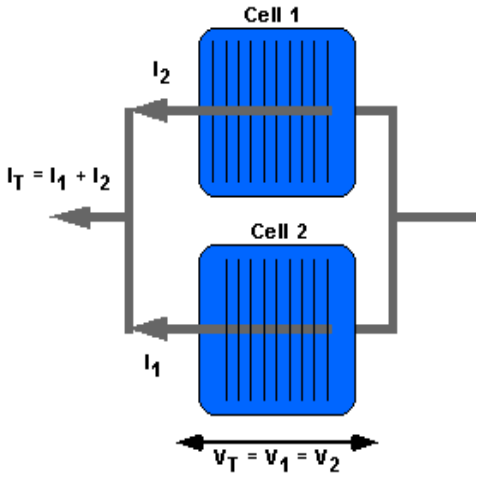

Figure 14 Paralel mode of cells

3.3. Power system reconfiguration using wind turbines

The wind turbine is device that converts kinetic energy from wind in mechanical energy. If the mechanical energy is used to produce electricity, the device may be called wind generator.

Advantages of vertical axis wind turbine against horizontaly one:

-they are easier to maintain because moving equipment are placed closer to the ground platform,

-propeller blades are vertical, so there is no need a rudder for the propeller orientation,

- vertical turbines have increased aerodynamic efficiency at high and low pressure,

-for the same diameter of the propeller blades vwrtical turbine has a larger diameter than the turbine with horizontal axis,

-vertical turbines are more efficient in areas with wind turbulence because the propeller blades are placed close to the ground,

- propeller blades have a lower rotational speed, so can resist stronger winds than horizontal-axis turbines,

Lentz wind turbines have type cup blades which provides efficiency at low wind speed, safe operation and low noise. It is recommended to operate in parallel with photovoltaic panels thereby ensuring greater energy security.

For reference ship we choose a Lentz wind turbines with dimensions below.

Table 1. Wind turbines dimensions

Power	50 kw
Rotor diameter	10 m
Number of blades	12
Electric voltage	96 V
Nominal wind speed	12 m/s
Minimum wind speed	2.5 m/s
Maximum wind speed	30 m/s
Hight	20 m

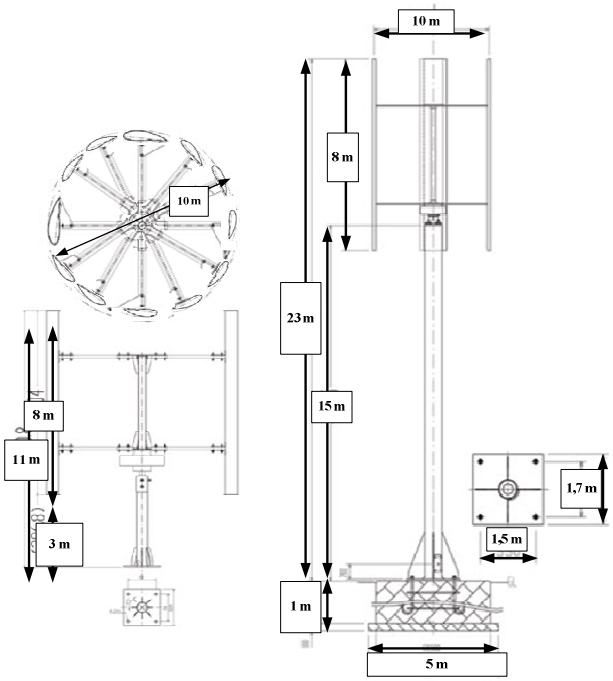

Figure 15 Lentz wind turbine dimensions

The ship will be equipped with five turbines wind turbines, with a total power of 250 kW (figure 15, 16).

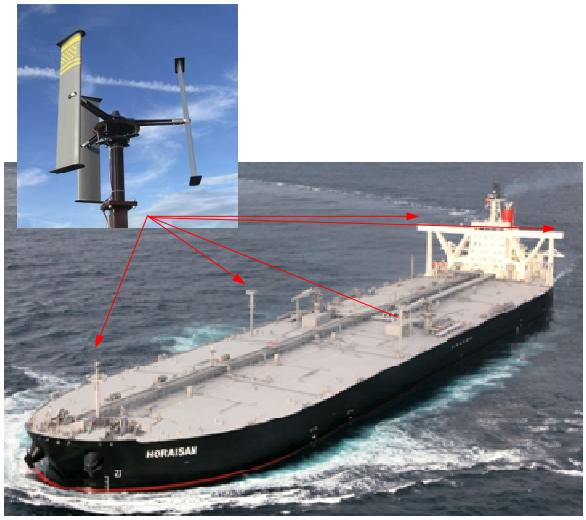

Figure 16 Ship equiped with wind turbines

4. OPERATIONAL COMPARATION BETWEEN FIRST AND RECONFIGURATED POWER SYSTEM

In table below we have real operation parameters for very large crude carriers of 305000 dwt [5].

This is a operation comparation between first power system (auxiliary engines and turbogenerator) and reconfigurated system (auxiliary engines, turbo generator, shaft generator, wind turbines, photovoltaic pannels).

We can observe that reconfigurated system cover required ship energy only if the main engine has a load bigger than aproximatly 30%.

The table contains different speed of ship and different load of main engine.

Also, we can amphasize that innovative energy cover energy required by the ship in 95% of cases from table [6].

This things also means a fuel economy.

Maximum power produced by innovative technlogy onboard is 981 kW witch means o very good efficiency.

Table 2. Comparation between first ship power system and reconfigurated power system (real operation parameters)

knots	%	MT	MT	MT	KW	KW	KW	KW	If	KW	KW
Speed	MCR ME	ME	AE	Boiler	AE	TG	T	T	Efficient	SG (0.75 PTO)	WT+PP
12.04	32.33	38.9	3.70	8.50	676	274	950	981	Y	731.25	250.00
11.29	31.62	35.6	3.50	8.00	668	259	927	981	Y	731.25	250.00
12.52	32.06	37.6	3.80	8.60	719	272	991	981	N	731.25	250.00
12.33	32.60	36.7	3.70	7.90	691	271	962	981	Y	731.25	250.00
12.46	31.98	36.0	4.20	8.90	1232	792	2024	981	N	731.25	250.00
12.42	30.82	34.7	4.90	10.70	893	269	1162	981	N	731.25	250.00
12.79	31.27	35.2	4.00	7.50	765	276	1041	981	N	731.25	250.00
13.21	31.98	36.0	3.90	7.20	681	259	940	981	Y	731.25	250.00
11.79	30.24	30.2	3.90	8.10	594	277	871	981	Y	731.25	250.00
13.00	38.09	36.1	3.80	7.60	663	272	935	981	Y	731.25	250.00
13.63	32.42	36.5	3.70	7.60	648	261	909	981	Y	731.25	250.00
14.16	32.32	37.9	4.90	10.00	1191	776	1967	981	N	731.25	250.00
13.29	32.78	36.9	4.90	10.50	691	257	948	981	Y	731.25	250.00
13.32	31.12	36.5	4.20	8.10	678	267	945	981	Y	731.25	250.00
16.33	79.14	89.1	0.40	0.60	0	828	828	981	Y	731.25	250.00
16.92	83.91	98.4	0.00	0.00	0	901	901	981	Y	731.25	250.00
16.25	82.25	92.6	0.00	0.00	0	813	813	981	Y	731.25	250.00
16.20	82.20	96.4	0.00	0.00	0	749	749	981	Y	731.25	250.00
12.27	76.74	29.7	0.90	9.00	0	747	747	981	Y	731.25	250.00
14.41	52.76	41.1	2.31	7.70	681	277	958	981	Y	731.25	250.00
10.49	30.11	25.1	3.90	7.30	681	276	957	981	Y	731.25	250.00
		HFO		MDO							
Total:		977.2	52.3	143.2	12152	9373	21525	20606		15356.25	5250.00

Table legend:
ME- main engine;
AE – auxiliary engine;
TG – turbo generator;
SG – shaft gennerator;
WT – wind turbine;
PP – photovoltaic pannels.

5. CONCLUSIONS

Refference ship economic speed is 15 knots. If during a voyage the ship operate at economic speed, result that auxiliary engines are not used and required electrical power will be covered only by the innovative technology system.

Also, fuel consumed will be only heavy fuel oil by the main engine.

This paper treat not only theoretical aspects but also real operational parameters for power systems onboard.

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NUMERICAL ANALYSIS OF A CARGO VESSEL MOTION

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ABSTRACT

A modern ship design procedure can be seen as an iterative process where requirements, regulations and rules including, amongst others, analysis of seakeeping and intact stability criteria issued by the International Maritime Organization and ship design solutions are compared in order to achieve an optimum solution. The combination of the ever growing population together with high demand for goods and increasing oil prices have resulted in the design of merchant ships that are optimized for minimum resistance and maximum load capacity. Certainly, prediction of ship motion can be done in many different ways. Testing several full scale ships would unquestionably give the best estimate, but would of course be too costly and practically impossible. Another way of analysing ship motion is by testing ship models in wave basins. Although a better option than testing full scale ships, it is often time consuming and costly. A third option is the prediction of ship motion by computer simulation. Computer simulations are done with respect to simplified models. These models represent physical reality to a degree that depends on the simplifications and assumptions made. The aim of this paper is to determine via numerical methods with Ansys CFX the motion of a Cargo vessel involving modeling the ship seakeeping for 2 DOF. The paper is showing how, by using advanced numerical simulation techniques, one may describe accurately the ship motion due to the marine environment conditions like waves and wind. This simulation was done in order to have the input data for further studies like the sloshing effects of liquid freight inside the hold of the cargo ship; study to be described inside some subsequent articles. As the sloshing effect take place, the structure of the ship is loaded and in some points of the structure the stress may become critical. By using the motion curves calculated, all these intricate simulations may be successfully developed.

Keywords: *Ship motion; CFD, Finite Volume Analysis*

1. INTRODUCTION

A modern ship design procedure can be seen as an iterative process where requirements, regulations and rules including, amongst others, analysis of seakeeping and intact stability criteria issued by the International Maritime Organization and ship design solutions are compared in order to achieve an optimum solution [5][8]. The combination of the ever growing population together with high demand for goods and increasing oil prices have resulted in the design of merchant ships that are optimized for minimum resistance and maximum load capacity.

Modern merchant ships, seen today, differ however significantly from the ships that were used in the statistical studies upon which the IMO criteria are based, both in size and hullform [3].

Certainly, prediction of ship motion can be done in many different ways. Testing several full scale ships would unquestionably give the best estimate, but would of course be too costly and practically impossible.

Another way of analysing ship motion is by testing ship models in wave basins. Although a better option than testing full scale ships, it is often time consuming and costly. A third option is the prediction of ship motion by computer simulation. Computer simulations are done with respect to simplified models. These models represent physical reality to a degree that depends on the simplifications and assumptions made [7].

During the last decades, several unified models describing ship motion due to maneuvering in waves have been developed. A nonlinear unified state-space model for ship manoeuvring and control in seaway, where the unified model is obtained by superimposing a maneuvering and seakeeping model [1]. The potential and viscous damping terms in the model established by Fossen are presented by a so called state-space approach where instead of using the convolution integral which is used to derive the damping forces in classic theory a linear reduced-order state-space model is used to approximate the damping forces [1]. Thus, achieving the standard representation used in feedback systems.

Regarding the wave excitation forces, they include the Froude-Krylov and diffraction forces (1 order wave loads) as well as the wave drift force (2 order wave loads). Hua and Palmquist describe a time domain ship motion simulation program (SMS) where two mathematical models, a wave induced model and a manoeuvrability model, are incorporated into a unified model [2]. The unification of the models is obtained by assuming that no interference between the turning motion introduced by ship maneuvers and the velocity potential, diffraction or radiation waves is attained, thus making it possible to superimpose the given models.

The damping forces, in contrast to the method described in Fossen are derived to the time domain through the convolution integral [1]. As to the wave exciting forces, only the Froude-Krylov and diffraction (first and second order wave loads) are included, where the Froude-Krylov force is treated nonlinearly.

Furthermore, Min-Guk and Yonghwan introduced a unified model for ship maneuvering in waves where the interaction between the manoeuvring and seakeeping model is done similar to the unified models presented above [6]. That is, the seakeeping and manoeuvring problems are coupled and solved simultaneously. The emphasis of the program is on the 2nd order wave drift obtained by using a direct pressure calculation method which is seen as an important factor in the ship trajectory calculations [4].

The aim of this paper is to determine via numerical methods with Ansys CFX the motion of a Cargo vessel involving modeling the ship seakeeping for 2 DOF.

2. CAD AND FINITE VOLUME ANALISYS (FVA) MODEL OF THE SHIP

In order to achieve the goal stated above, the ship under consideration is the one given in the figure 1 having the following characteristics:

- Length-290 m
- Heigth-32 m
- Draught-11.1 m
- DW-57.700 t
- Engine type MAN B&W 6S50MC-8.200 kW
- Thickness of the steel plate-22 mm
- Steel density-7800 kg/m^3.

The geometry of the ship is developed by using the software SolidWorks 2015 as seen below:

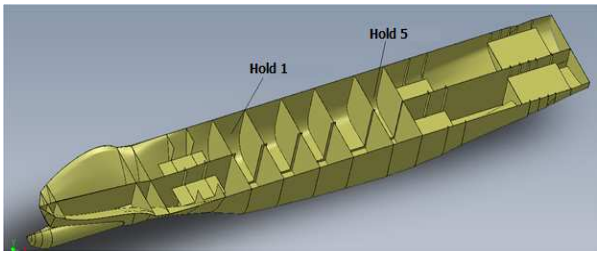

Figure 1 Cargo vessel under consideration

After the generation of the geometry some geometrical properties are to be automatically calculated:

- Ship mass-29212771.5516 kg
- Ship body volume-3745.2271 m^3
- Ship area-102516.6000 m^2
- Center of mass coordinates [m] including the freight : X = 155.3927; Y = 17.6088; Z = -11.9597.
- Calculated moments of inertia [kg/ m^3]:
  - Ixx = 16830893681.8206
  - Ixy = 155000920198.2467
  - Ixz = -104240912271.1265
  - Iyx = 155000920198.2467
  - Iyy = 2751913141157.2334
  - Iyz = -6430523122.9927
  - Izx = -104240912271.1265
  - Izy = -6430523122.9927
  - Izz = 2756311538962.6108

The ship is having 5 storage hold carrying alumina inside the hold 1, 3 and 5 filled 50%.

The strategy of ship modeling is that the body will be treated as a rigid body with the entire mass concentrated inside the center of gravity following with the study of the ship motion as heave (Oz axis) and pitch (around Oy axis).

The action and reaction of the sea upon the ship will be carried out using the Fluid Structure Interaction (FSI) of the fluid and the vessel body.

Inside ANSYS CFX software module the Beta option will be activated allowing the direct calculation of the ship motion. The rigid body is encompassing a fluid domain to which the OZ motion (Oz) and pitch motions are permitted.

The Beta option of the software is supposing that the ship is not changing the shape during its evolution inside the fluid domain and this is a simplified case of FSI with the benefit of tremendously reducing the computing power needed for solving the numerical problem. In this approach all the forces and moments are supposed to act only upon the center of mass of the structure and as per the Charles theory the entire motion of the body will be described only by the center of mass motions.

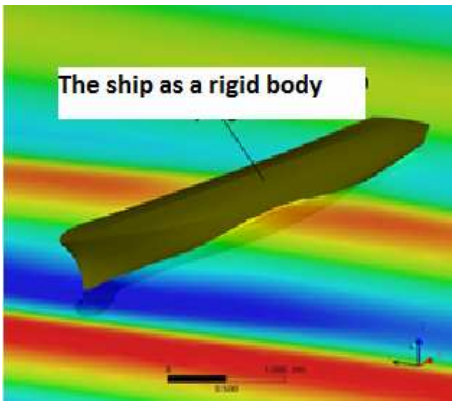

Figure 2 The ship seen as a rigid body

In order to simulate the air above the sea, the sea itself and their interface the multiphasic option of the fluid will be activated. When using the multiphasic option of the fluid model there are a sum of phenomenon which are interacting as the buoyancy, the impulse and momentum exchange in between phases, mass exchange, superficial tension etc. that are involved. In our case the interface is separating two distinct phases, the gaseous one (air) and the liquid one (sea water). At that interface both phases are moving with the same speed and the flow is free. The mass fractions inside any fluid or gaseous phases is equal to 1 but the interface is defined by the mass fraction of 0.5.

In order to generate the waves inside the fluid domain we'll simulate a moving wall or Flapper. The fluid domain is parallelipipedic (like a testing hydrodynamic tank) providing enough space ahead and behind the ship in order the waves to develop like in the figure below:

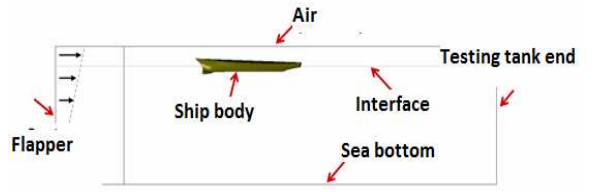

Figure 3 Fluid domain

Once this strategy established the CFX model is generated like in the figure below (along with the boundary conditions):

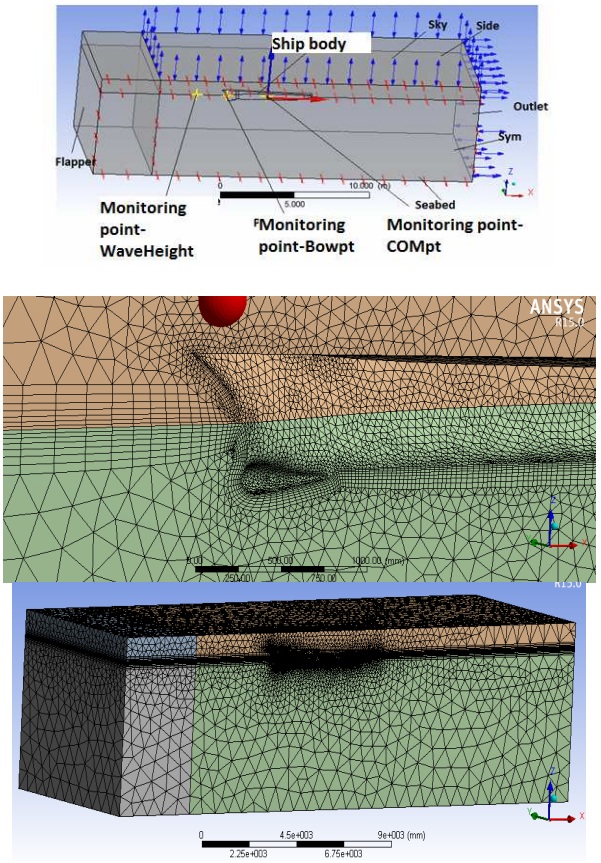

Figure 4 CFX Model and the boundary conditions

There are established three monitoring points in order to have the at the end of the simulation the graphs for ship motions:

- WaveHeight is placed ahead of the ship body and is measuring the wave height impacting the ship.
- Bowpt is monitoring the vertical displacement of the ship.
- COMpt is monitoring the vertical displacement of the center of mass of the ship.

The pitch is calculated from geometrical considerations and displacements of points Bowpt and COMpt with a new variable defined in Ansys as follows:

appxPitch=atan2(probe(Total Mesh Displacement Z)@Bowpt -probe(Total Mesh Displacement Z)@COMpt,2.49[m])

The simulation is done as transient with steps of 0.1 sec within an interval of 10 seconds.

3. CFD SIMULATION RESULTS

After 500 iterations the software is automatically calculating the ship motion as below. There are two zones: the first one corresponds to transitory behavior of the forming waves somehow stochastic, and a second stabilized zone where the waves get their shape and the ship motion is stabilized.

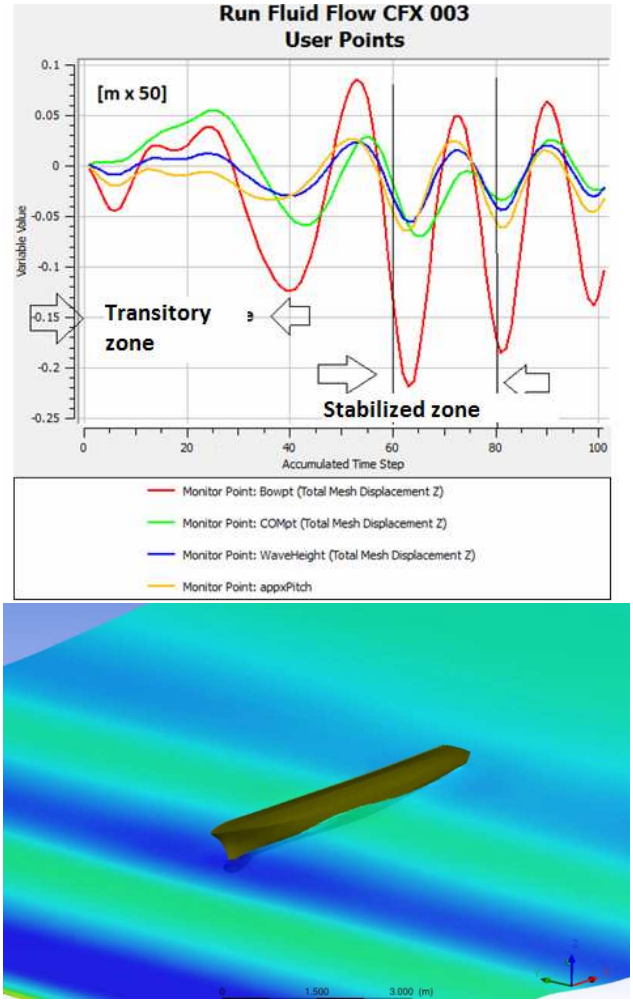

Figure 5 Motion curves and the seakeeping ship

For the final time step (10 sec) there are some other calculated parameters of interest to be shown as in Figure 9.

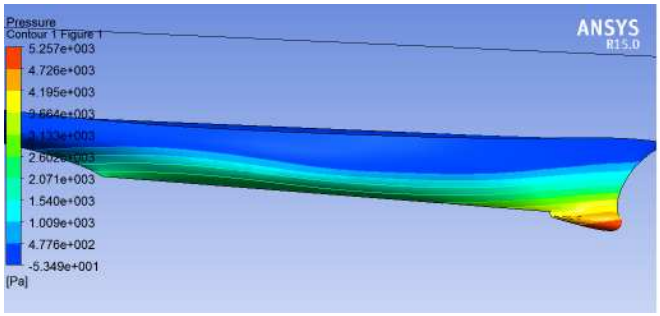

Figure 6 Pressure fields distribution on the ship body

The pressure distribution fields as seen above, is revealing an maximum value of 5257 Pa at the bowsprit.

Below is shown the sea water velocity along to the ship vessel with a maximum of 0.25 m/s in the same bowsprit region.

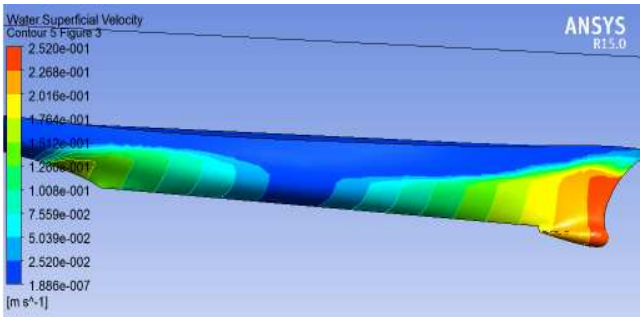

Figure 7 Water velocity fields distribution on the ship body

The water buoyancy force (BForce) is almost constantly distributed along the body with an average of 9766 kg/(m^{2}s^2).

On the other hand the flow parameters of the fluid domain were calculated as well.

For instance the pressure distribution onside the fluid is like in the figure below:

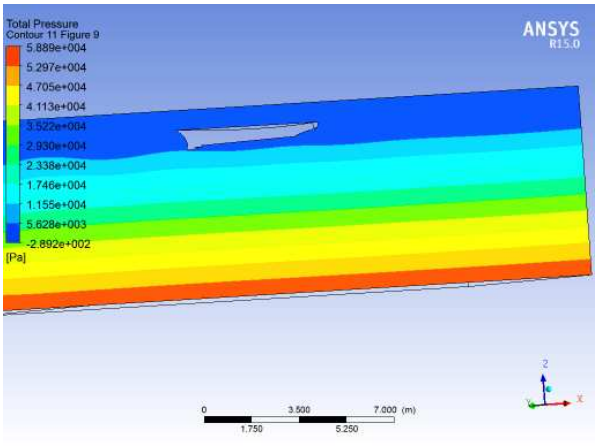

Figure 8 Pressure distribution inside the fluid domain

The maximum pressure of 5.88e4 Pa is placed on the bottom of the sea due to the hydrostatic pressure see in Figure 9.

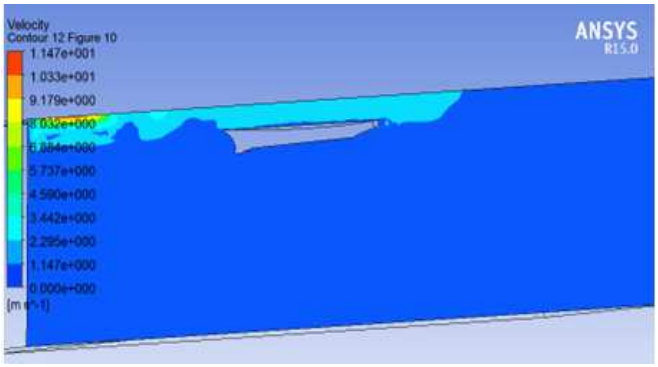

Figure 9 Fluid velocity distribution inside the fluid domain

The air velocity is having the maximum value of 11.4 m/s above the ship.

The interface parameters are calculated as well. For instance the wave velocity is to be seen below.

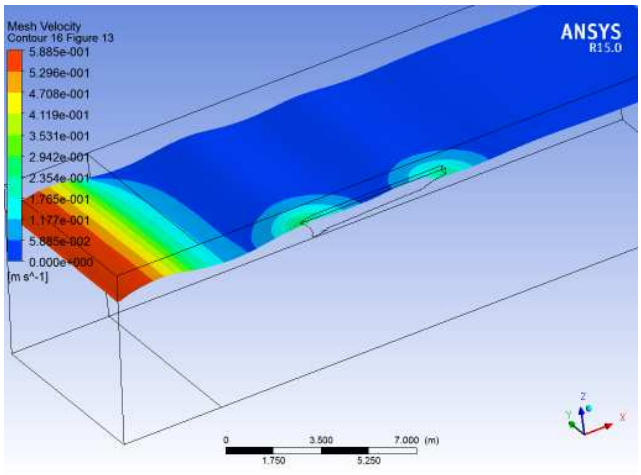

Figure 10 FE Mesh velocity

The maximum Finite Elements mesh velocity is to be recorded near the Flapper with its maximum of 58.8 m/s.

The waves are exerting a certain pressure as below with an maximum of 319 Pa due to the wave height in Figure 11.

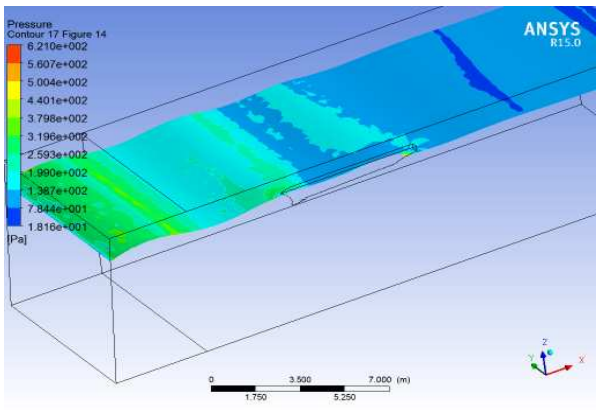

Figure 11 Wave pressure

Thus the water velocity will be max. 1.59 m/s due to the interaction to the structure in Figure 12.

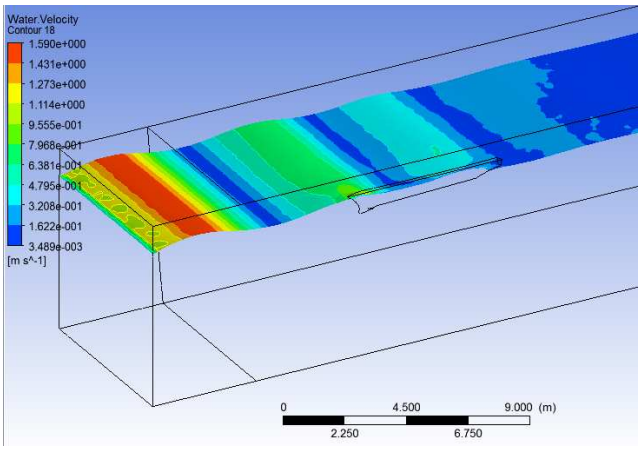

Figure 12 Water velocity

4. CONCLUSIONS

The target of this paper was to show how, by using advanced numerical simulation techniques, one may describe accurately the ship motion due to the marine environment conditions like waves and wind.

This simulation was done in order to have the input data for further studies like the sloshing effects of liquid freight inside the hold of the cargo ship, study to be described inside some subsequent articles.

As the sloshing effect take place, the structure of the ship is loaded and in some points of the structure the stress may become critical.

By using the motion curves calculated and given in Figure 5, all these intricate simulations may be successfully developed.

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STUDY OF SHIPYARD INTERVENTION BASED ON ANSYS SOFTWARE

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ABSTRACT

The shipbuilding industry is a segment of a continuous engineering development facing many problems generated by flexible environment that induces considerable force in the resistance of ship structures. Determination of stresses and strain of shipbuilding plate is done with commercial software ANSYS for five study cases. Shipbuilding has changed since building the training ship in 1939 and all rivet bonding are replaced by weld plates.

Keywords: *shipyard intervention, structural analysis, stress, deformation.*

1. INTRODUCTION

In recent years, structural analysis has emerged as a means of checking the current buildings eligible low-cost technique, including shipbuilding. In the current analysis were considered normal stresses occurring on the surface of the sheet plus alter those caused by waves. In this article we studied the use of rivets in the laps shell and use or disposal seams. Examples of research is the Training Ship "Mircea", a ship built in 1938 in Germany whose structure is combined resistance based riveting. Removal of rivets and sheet applications will affect vessel flexibility, while welds will induce internal stresses in the material without it being subjected to external forces. To perform the test it was used a CAD environment. CAD environment used is ANSYS, and the method of calculation was "Finit Element Method" (FEM). The results from the analysis are compared with the limit values of stresses and displacements accepted.[4,5]

2. PROBLEM DESCRIPTION

The article is focused on shipyard repairs related to frame plates for ships that were built using both rivets bonding and fixing their plates on truss elements. Fixing riveting work using doubling the tables over a distance of 200 mm, and current technology runs by welding the front, sheet in the middle area (area riveting) will lose weight and will also influence the deformation and stress as shown next in ANSYS simulations.

Figure 1 Training Ship "Mircea" shipyard intervention

3. NUMERICAL INVESTIGATION

Methods for solving problems by FEM

The main stages of the application of finite element calculation are:

1. The finite element discretized structure in which only the nodes to be interconnected, whose movements are chosen as unknowns.
2. Choose interpolation functions and is calculated for each element matrix B.
3. Determine the matrices of rigidity and stiffness matrix elements of the mesh.
4. Determine the nodal forces vector, write the system of equations, and determine the unknowns.
5. Calculate movements of the points of interest on any item and then tensions.
6. Given the tensions and movements in the required check points of strength and stiffness conditions.

Accuracy of results depends on the fineness of the mesh and how the conditions of continuity on the sides of the elements. Their fulfillment is influenced by the interpolation functions in areas with high gradient variation must be taken to a higher degree, which leads to higher order elements. Construction subjected to analysis is modeling in a CAD environment, ANSYS, meeting the specifications of construction distance between 600mm truss elements, tin is used A32 12mm thick and yield strength of 315 N / mm2. [9,12,15]

The current analysis is performed for five cases, varying the length of the sheet metal replacement joint area, the riveted with the welded.

4. INPUT DATA FOR MESHING AND SOLUTION

The study uses FEM for displacement and stress in various cases as presented in geometry built in DesignModeler component of ANSYS (Figures 2,6).

Data collected for computational purposes is based in measurements and observations onboard Training Ship "Mircea". The fluid pressure used is,

$Pz = 4.353x10^{6}Pa$ for a wave action in the area of intervention.

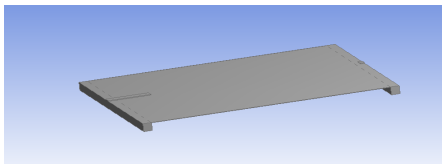

Figure 2 CAD geometry on DesignModeler Case #1

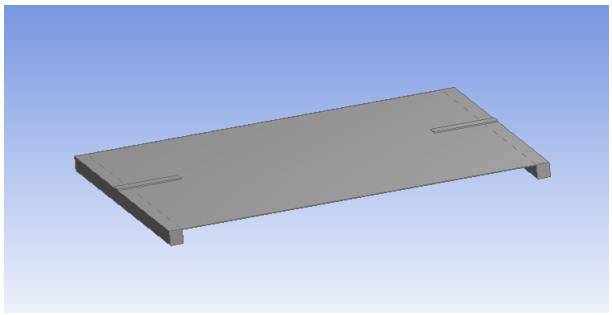

Figure 3 CAD geometry on DesignModeler Case #2

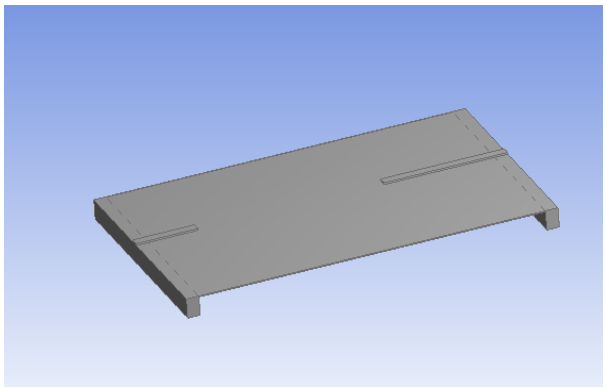

Figure 4 CAD geometry on DesignModeler Case #3

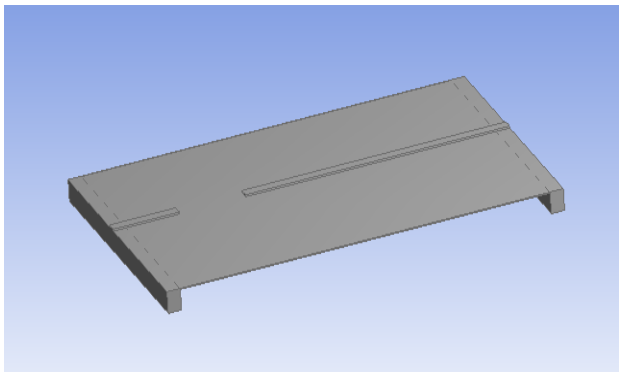

Figure 5 CAD geometry on DesignModeler Case #4

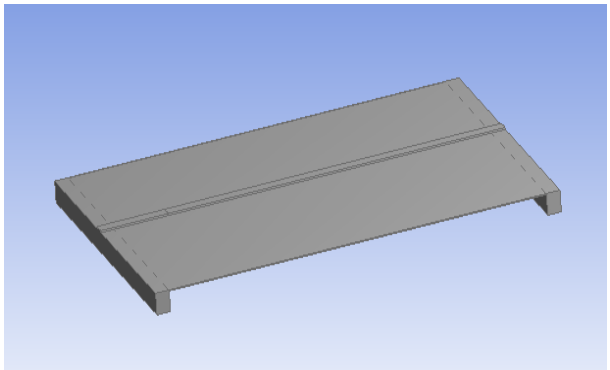

Figure 6 CAD geometry on DesignModeler Case #5

Before being analyzed according to the FEM shaft is meshed in elements by ANSYS meshing procedure according to Figures 7 and 8:

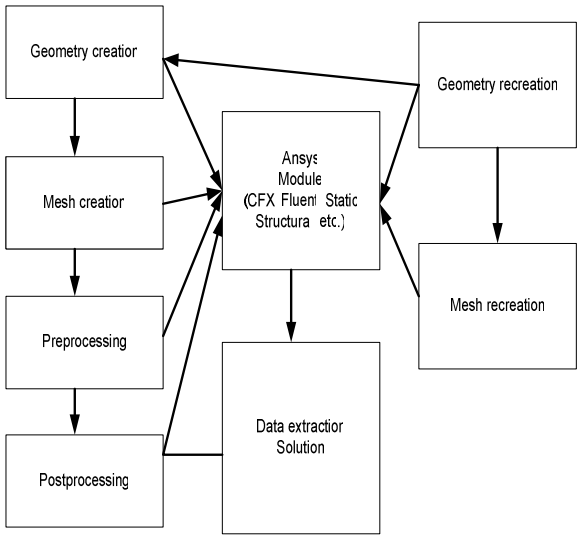

Figure 7 Meshing connections inside solver

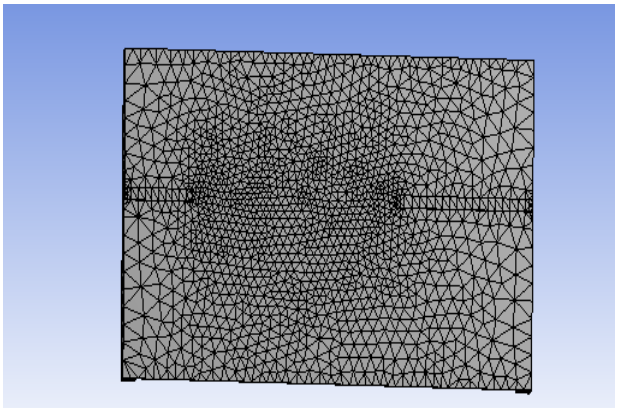

Figure 8 Automatically generated mesh for finite element analysis

5. NUMERICAL RESULTS AND DISCUSSION

Stress Study

The stress study on surface was done on the table with a equivalent wave force uniformly distributed.[10,11]

After the simulation in case #3 is observed the following results:

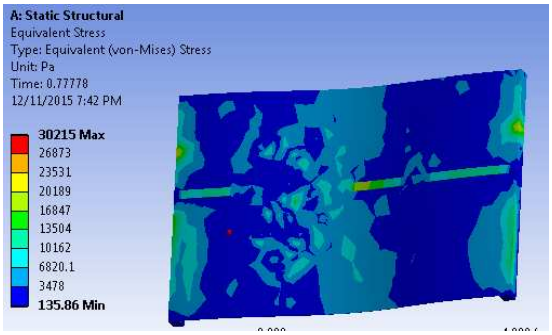

Figure 9 Stress Study

Figure 9 shows that the stress concentration area adjacent to the riveting and tension peaks occur at the

transition from riveting to the welded area, so this is a vulnerable area. However it notes that areas where there is less tense riveting stress and focus the remaining area.

Vibration Study

In what follows, the element in all five cases defined above is subjected to vibration frequency between 15Hz and variations of 105Hz.

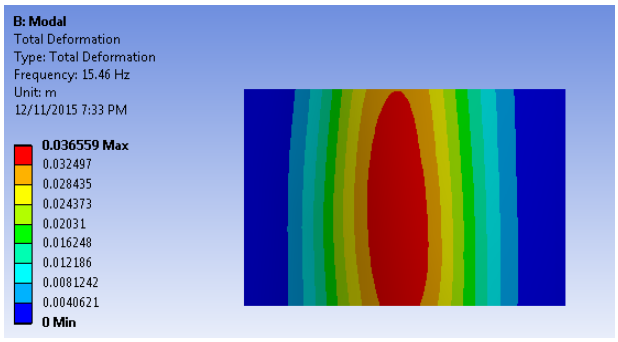

Figure 10 Vibration study at 15Hz

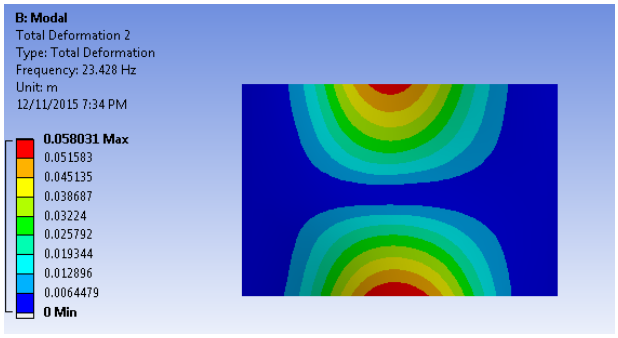

Figure 11 Vibration study at 23Hz

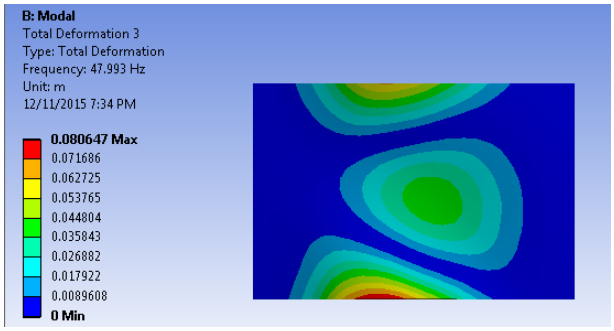

Figure 12 Vibration study at 48Hz

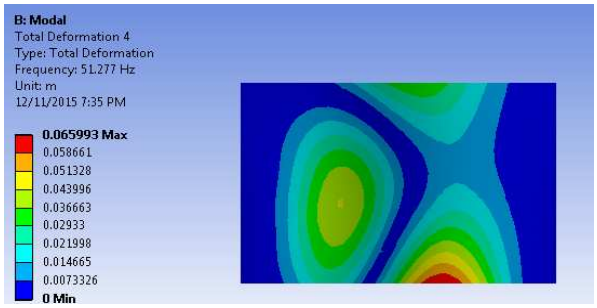

Figure 13 Vibration study at 51Hz

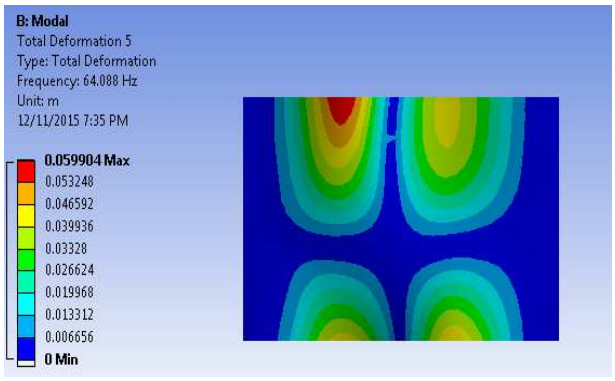

Figure 14 Vibration study at 64Hz

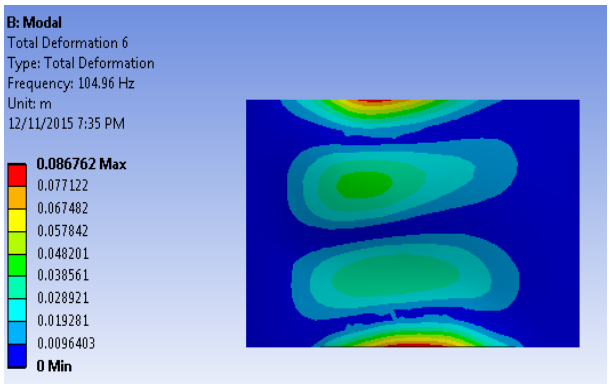

Figure 15 Vibration study at 105Hz

Deformation Study

The total deformation of the application of the pressure force uniformly distributed wave, as presented for static force in Figure 16.

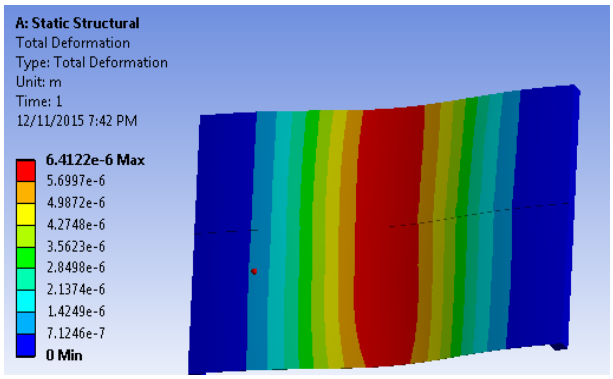

Figure 16 Deformation Study in Static Structural

It is noted that the movements are influenced by the overlapping plates and the modified mass/thickness of the studied area. A solution will be valid when any point of material will present stress values according to theory guides [13,14]. Collected data will be presented in table 1.

All presented values indicate that total deformation and stress are modified in all five cases according to Figures 17 and 18. Presented values indicate a high difference in all simulated situations and these results are usable in shipyard repairs and other technical studies regarding impact on old ships with modern technology.

Table 1. Solution values for all 5 cases

Study case	Mising belt length [metres]	Total deformation in Total deformation Study [micrometres]	Total deformation in Total deformation Study [N/m^2]
Case #1	2.4	12.1	52145
Case #2	1.8	8.35	34778
Case #3	1.2	6.41	26873
Case #4	0.8	4.44	12080
Case #5	0	2.42	4897

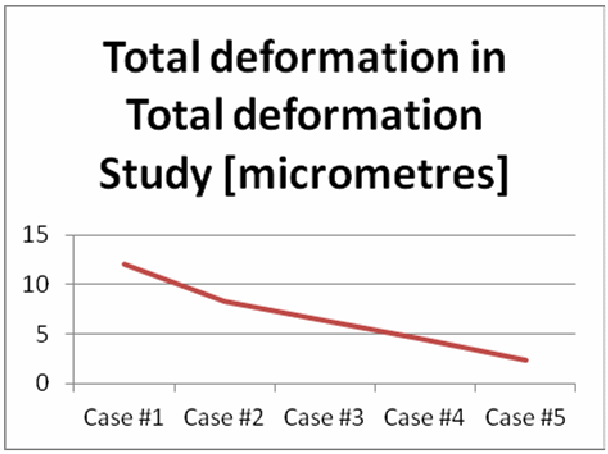

Figure 17 Total deformation variation

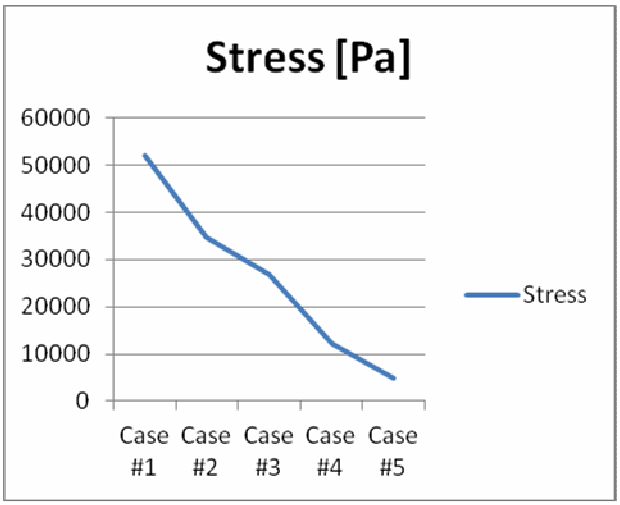

Figure 18 Stress variation according to case

6. CONCLUSIONS

This work has reviewed the influence of modern technology in shipyard repairs over an old riveted hull built in 1938 based on forces generated real working environment. In this analysis we have shown that different configuration influences the deformation in ANSYS software analysis. This work has presented five different cases and results for each case in figures and tables. The analysis performed in this article has studied the impact of the shipyard intervention using current technology. It was observed that the area removed has a role in reducing deformation and stress. The advantage is that there riveted plates induce less internal stresses in the material as presented in case 5.

The results of this study may help the shipbuilding industry in future hull repairs by optimizing the dynamic behaviour of the hull and reducing the costs over these types of repairs.

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COLLOCATIONS IN MARITIME ENGLISH

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ABSTRACT

The paper presents an approach to collocations in Maritime English for their manual extraction and classification using one of the Admiralty publications – Sailing Directions (Pilot Books). Firstly, collocations are defined in general. Secondly, the field of Maritime English, in the broader sphere of English for Specific Purposes (ESP) is stated and then Pilot Books are described. Finally, classification of the collocations is given.

Keywords: *English for Specific Purposes (ESP), Maritime English, Sailing Directions, collocations, Pilot Book.*

1. INTRODUCTION

The topic presents a particular research interest because in all special terminologies the respective terms collocate (typically combine) with certain words (adjectives, nouns, verbs, etc.) forming the so-called terminological collocations.

Dealing with collocations (terminological collocations in particular) the research calls for their definition.

A collocation can be defined as "a sequence of two or more consecutive words, that has characteristics of a syntactic and semantic unit, and whose exact and unambiguous meaning or connotation cannot be derived directly from the meaning or connotation of its components"[Choueka 1988].

Some examples of collocational expressions as given in [Choueka 1988] are the following:

personal nouns (names of specific, individual, unique entities): e.g.

Ronald Reagan
President Reagan
United Nations

common nouns: e.g.

ice cream
high school
artificial intelligence

idiomatic expressions: e.g.

change mind
sit down
hit and run
research and development

and idioms like:

once upon a time

Thus, it generally assumed that a collocation consists of two or more words which have a strong tendency to be used together. For example, in English you say:

turn off the light,
not
close the light
strong coffee,
not
powerful coffee
She was attacked in broad daylight,
not
She was attacked in bright daylight

The WorldNet gives five definitions of 'collocation'. Here we present two of these:

- *Phrases composed of words that co-occur for lexical rather than semantic reasons, for example, a heavy smoker is one who smokes a great deal, but someone who writes a great deal is not a heavy writer. This seems to be a lexical fact, not related to the meanings of smoker or writer.*
- *The frequency or tendency some words have to combine with each other. For instance, the phrases "tall person" and "high mountain" seem to fit together readily without sounding strange. A non-native speaker might talk about a "high person" or "tall mountain," and this construction might sound slightly odd to a native English speaker. The difference is in collocation.*

Collocation is an intuitive ability of competent English speakers to put words in correct combinations. Such "an arbitrary and recurrent word combination" [Benson 1990] proves to be an obstacle to most ESL learners who are already too busy with the other rules of the English language when they use the language.

There are two types of collocations, namely grammatical and lexical [Benson 1985a, 1985b]. Grammatical collocations are those which consist of a "dominant word" such as a verb, a noun or an adjective followed by a grammatical word, in most cases a preposition, as can be seen in examples like *sought after, deal with, take care of*, and so on. As to lexical collocations, they are usually formed by two "equal" lexical components in combinations like adjective +noun, noun +verb and verb +noun [Benson 1985a:62].

It is this interlingual incongruence which can give rise to second-language learning difficulties and problems of translation equivalence. "Collocations constitute a key component in the lexicon of natural language. Translators and/or interpreters should, therefore, possess a high syntagmatic competence alongside their paradigmatic competence. Unnaturalness comes as an immediate consequence of the translator's/interpreter's inability to call up the relevant collocations in the target language."[Abdullah Shakir & Mohammed Farghal, 1992-3].

2. ENGLISH FOR SPECIFIC PURPOSES (ESP)

We are interested in collocations in the domain of shipping that is why we have to define the scope of English for Specialized Purpose. We take the definition of Dudley-Evans [1998] which points out that ESP has 2 characteristics:

Absolute Characteristics

1. ESP is defined to meet specific needs of the learners
2. ESP makes use of underlying methodology and activities of the discipline it serves
3. ESP is centered on the language appropriate to these activities in terms of grammar, lexis, register, study skills, discourse and genre.

Variable Characteristics

1. ESP may be related to or designed for specific disciplines
2. ESP may use, in specific teaching situations, a different methodology from that of General English
3. ESP is likely to be designed for adult learners, either at a tertiary level institution or in a professional work situation. It could, however, be for learners at secondary school level
4. ESP is generally designed for intermediate or advanced students.
5. Most ESP courses assume some basic knowledge of the language systems

Having defined ESP in general we have to pay special attention to give a definition of ME as part of ESP. There are many versions of the English language in the world today. The most well-known variants are separated by large expanses of ocean. Maritime English is a product of life on the ocean itself.

There are at least three reasons for its appearance:

- the need for clear communication:
- the development of a set of terms to refer to the parts of ships, and the procedures involved in sailing them.
- the globalisation of the shipping industry.

3. MARITIME ENGISH AND TERMINOLOGICAL COLLOCATIONS

Among the specialists, working in the field, there is consensus regarding the name of the language for specialized purposes used among the professional discourse community as Maritime English Language. [Trenkner, 2002].

This calls for its defining and description. Defining the aims, the subject, and the field of the Specialized English Language and the Maritime English in particular. The development of linguistics as a whole influences upon the approaches of defining and describing these fields. Different theoretical approaches have different definitions, defining the language for specialized purposes.

There are specialized spheres which refer to the professional differentiation of the human activity. The research in the field of language for specialized purposes (ESP) started in the 60's of the last century but the idea exists even a century ago.

There are three main divisions in the research of the ESP: 1) linguistic description (characteristics),

2) cooperation with other disciplines, 3) researches in the field of methodology of teaching [Prichard 2000].

There are specialized fields in every language and they comply with the professional division in the human activities. The well defined research in the field of language for specialized purposes started in the 60's of the past century but the idea of *Fachsprache* and *langue de specialite* exists even a century before.

Sager et al define languages for specialized purposes as "semi- autonomous, complex systems based on and extracted from the general language." [Sager et al. 1980]

According to the same authors [Sager et al. 1980] the specialized language is "subdivision of the language from pragmatic as well as extra-linguistic point of view". Sager defines what levels of the language.
system of the specialized languages are influenced by this division.

According to him they can be looked upon as individual systems on grammatical, semantic and pragmatic level or as a combination of some of them.

He finds it sufficient to establish a separate pragmatic level, as a separate group of users, different topics, and different situations.

Not so clearly recognizable are the signs of separation on lexical and grammatical level. Therefore research in specialized language should be made both in terms of differences in the modes of expression and in relation to the field of use.

M. K. Halliday [1993] called these subdivisions of the language variants of the language, adopting the term *register*. According to Halliday, the term used for the first time by Reid in 1956 and later developed by Er [Er, Ellis 1977]. He defined register as a variant of the language "depending on its use" - what we say, determined by what we do (the nature of the social activity in which we are involved) and expresses the diversity of social processes of a particular situation.

The important question for him is: What kind of situational factors determine the choice that will be made in the language system. Halliday separates specialized languages as a special case register. The register shall be determined by the "linguistic features that are usually associated with the configuration of situational factors – with certain grades of *field of discourse, tenor of discourse, mode of discourse "* [Halliday, Hasan 1976: 22].

1. Field of discourse - refers to the institutional environment of the implementation of the communicative act.
2. Tenor of discourse - refers to the relationships between participants in the communicative act.
3. Mode of discourse – refers to the agreed channel of communication.

In this sense, B. Pritchard (2001) noted that Maritime English is mainly determined by the field of

discourse, but can be influenced by the tenor of discourse and the mode of discourse.

The register used will depend mainly on the situational constraints set by the adequacy of the communicative situation. Therefore, according to him, Maritime English can be treated as a **"set of registers"** [Pritchard 2000], for example, navigation, technical, legal, commercial, spoken, written, limited etc. i. e. "All means of the English language that are used for communication by the international maritime community, contribute to the safety of shipping and support maritime business." [Trenkner 2000]. According to P. Trenkner "... specialized language must be viewed in the context of human activities linked to the specific objectives of certain activity, which for Maritime English refers to be considered in the context of the activities carried out by seafarers in shipping" (2002 Trenkner 1). Maritime English is seen as a variant of the commonly used English and has all its characteristics of a national, multinational or supranational language, i.e. as *a lingua franca* and can be described as a flexible, dynamic, multifunctional system or means of communication.

We accept the definition of P. Trenkner [2002: 2], delimiting Maritime English.

"Maritime English language is a combination of all those possibilities of the English language to be used as means of communication by the international maritime community, contribute to the safety of shipping and support maritime business."

This definition was adopted by the maritime community and has served as a leading one in many researches related to the efforts to improve communications at sea and the developments related to the standardization of the language used in maritime communication.

Our research work is focused on some maritime collocations extracted from pilot book.

3.1 Definition of 'Terminological Collocation'

WorldNet does not provide any definitions of the phrase 'terminological collocation'. Therefore, if we take the first definition of 'collocation' cited above, namely, "a phrase composed of words that co-occur for lexical rather than semantic reasons", and make the necessary changes by adding the terminological component, then we can propose the following **definition of terminological/specialized collocation'**:

> *A terminological phrase composed of a base term and other words that co-occur for lexical rather than semantic reasons.*

Marie-Claude L'Homme and Claudine Bertrand [2000] distinguish between specialized lexical combinations and collocations. Specialists usually agree on the fact that both collocations and specialized lexical combinations (SLC) conform to a conventional usage within a community. Mel'čuk et al [1995] mention that collocations cannot be accounted for in terms of regular syntactic or semantic rules. Bergenholtz & Tarp [1995] claim that special language users with insufficient linguistic knowledge will not be able to know whether a given word combination is correct in a particular field (e.g. in the field of Shipping), which sequence among the following is correct: ……rock + verbs….). L'Homme & Bertrand contend that "collocations are conventional within a given linguistic community; specialized lexical combinations are conventional within a group of specialists." Learners of a language or a special language must acquire them as such since they are unpredictable. This "unpredictability" justifies their insertion in a reference tool and has largely determined our choice of topic and aim of this thesis.

4. ADMIRALTY PUBLICATIONS. PILOT BOOKS

A pilot book or Admiralty sailing directions is one of the most important navigational publications published by the British hydrographic office. Each pilot book refers to a specific area. Its limits are given on the cover of the pilot book e.g. North Sea (East) Pilot NP 55.

4.1 Structure and contents of the pilot book

Each pilot book consists of diagrams, illustrations and explanatory notes. It also includes short glossary of foreign names and terms, a few chapters referring to description of the regions, some appendices and panoramic pictures of shore landmarks, lighthouses, mountain peaks etc.

Pilot books provide the required information for performing safe navigation which cannot be provided by the charts or some other nautical publications. Therefore pilot books should be read together with the charts given in a particular pilot book. Supplements to pilot books are published annually. The more important changes are published in the *Notices to Mariner.*

The first part, called "Navigation and regulations" comprises:

- Limits of the book
- Navigational dangers and hazards
- Traffic and operaqtions
- Charts
- Aids to navigation
- Pilotage
- Radio facilities
- Ragulations
- Signals
- Distress and rescue

The second part, called "Countries and ports" consists of:

- Principal ports, harbours and anchorages
- Port services

The third part, named "Natural conditions", gives information about:

- Maritime topography
- Currents and tidal streams
- Sea level and tides
- Sea and swell
- Climate and weather

We have to make our research on the follow terms and we found the word that they collocate with:

- **Bank** - The rising ground bordering a lake, river or sea. Underwater plateau that rises up from the ocean floor, creating shallow water where fish feed.
- **Bar** - An obstruction under the sea made of rocks, mud or sand which would prevent certain deep draught vessel from entering a port. Shallow water usually made of sand or mud, usually running parallel to the shore. Bars are caused by wave and current action
- **Flat** - A place covered with water too shallow for navigation with vessels ordinarily used for commercial purposes. The space between low and high water mark along the edge of an arm of the bay, tidal river;a container with two end walls and open sides.
- **Reef -** To reduce sail spread or area by rolling or folding that portion adjacent to a yard or boom and making it fast thereto. In square sails this reduction is made in the head, while in fore-and aft sails it is done in the foot
- **Rock -** An isolated Rocky formation or a single large stone, usually one constituting a danger to navigation. A "pinnacle Rock" is a sharp-pointed Rock rising from the bottom.

The following table presents the words which collocate with the term under research. There is the percentage of their occurrence in the pilot book.

Bank:

Word	**In text**	**+ Bank**	**percentage**
North	285	42	14,7%
Shallow	74	17	23%
River	225	11	5%
Sand	693	23	3%
Drying	157	61	39%
Narrow	184	3	2%

Bar:

Word	**In text**	**+ Bar**	**percentage**
Inner	204	5	2,4%
Sand	693	12	1,7%

Flat:

Word	In text	+ Flat	percentage
Tidal	591	10	1,6%
Mud	31	2	6%
Sand	693	6	0,8%

We classified the collocations as:

- Collocate noun + Base noun: For example – *Extensive area of flat sand,*
- Collocate verb + Base noun: *to wind the bar*
- Base noun + Collocate verb: For example - *Rock rises above the seabed*
- Collocate adjective + Base noun: For example - *Narrow Bank*

In conclusion it must be pointed out that collocations in ESP and in Pilot books have their own peculiar characteristics. They are not arbitrary and they must be treated in cohesive clusters. This is actually helped by the very nature of these collocations being knowledge items in the domain of specialists and trainees in navigation. Organizing the collocations of the particular domain will help the specialists and the trainees organize the knowledge in the domain for the purposes they aim at.

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SECTION II
MECHANICAL ENGINEERING AND ENVIRONMENT

NUMERICAL FRAZZLE MODELING OF WHEEL-RAIL CONTACT (STICK-SLIP EFFECT)

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ABSTRACT

The article proposes study of the frazzle of the portal crane during in the motion of braking. In specifically the study is refers to highlight the phenomen of "stick - slip". The mechanic phenomen is achieving in the numerical modeling of contact between wheel and rail during braking. The numerical modeling will be done using the computer program Matlab Simulink and FEM software ANSYS. When friction occurs then an intermittent slippage it's hearing a acoustic phenomenon. This explains why the sounds is generated by the bow moving on the wire of the violin or the squeal during braking of the wheels on the rail.

Keywords: *stick and slip effect, coefficient of friction, partial slip.*

1. INTRODUCTION

In the most shipyards are using the lifting equipment moving on rails. This paper present a study of the movement of portal cranes.

It highlights one of the issue of Mechanics contact and Physics friction, namely the slipping intermittently phenomenon called "stick-slip" between a wheel crane and the rail. In the first figure it is presented a 3D model of the rail-wheel. This model was made in 3D design software NX 7.5. Also it is represented the calculation scheme during braking the wheel on the rail.

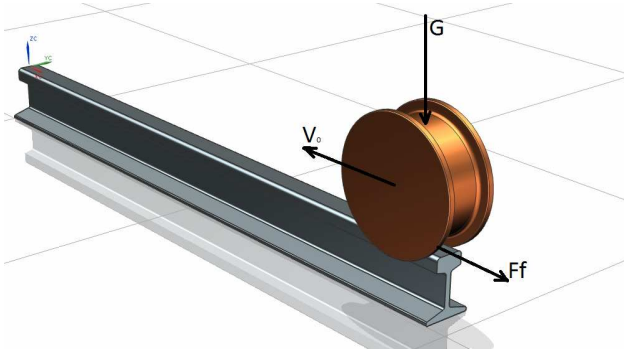

Figure 1 3D model rail-wheel

The friction force is oppose to the relative motion of two surfaces in contact or of two elements sliding against each other.

The phenomenon of "stick-slip" includes two problems. First the problem the contact and second is the dependence of the coefficient of friction with the relative velocity between the two surfaces. In first problem we have the Hertzian contact theory. And in the second problem we have unhertzian theory with the friction contact [1].

This phenomenon of intermittent slipping occurs is the most engineering applications and also in nature. For example the vibrations produced by the bow on the wire of the violin or harp, produce the sounds. That high-frequency sound is given by the intermittent friction. Same happens with the sound of crickets and other locusts [2].

Earthquakes occur because of this phenomenon. At the time when two tectonic plates are in contact and a relative movement occurs between them, a tension arises then is followed by a strain producing vibration in the earth crust.

2. DESCRIPTION OF DYNAMIC MODEL OF THE STICK-SLIP PHENOMENON.SIMULATION OF THE EFFECT USING MATLAB SIMULINK

To full fill the conditions of static friction tangential force must be less than the product of the coefficient of friction and normal force ($T<\mu P$). Meanwhile the contact area is divided into a "stick" area and a "slip" area. Sizing those depends on the ratio of tangential force and normal force [2]. Once tangential force size exceeds normal force size, generates relative motion between those two bodies and thus begins dynamic friction. Stick-slip phenomenon encountered in a variety of engineering applications but also in other domain, shows both types of friction, both static and dynamic. There is a variation of friction force that causes intermittent slipping called "stick – slip".

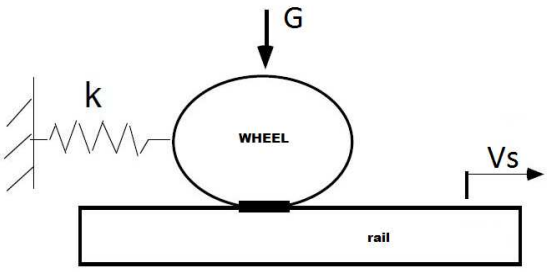

Figure 2 Dynamic model of "STICK-SLIP" phenomenon

Figure 2 presents the dynamic model of the "stick-slip" phenomenon for wheel-rail. In figure 2 we have the

following notation: k - modulus of elasticity of the surface, G- force of gravity pressing a wheel and Vs-velocity brake. Was considered the following idea: braking occurs when the wheel is stationary and has a track relative motion [4]. The wheel stays glued to the rail and when it is pulled by the rail track tends to restore because of elasticity [3]. This phenomenon produces vibrations in the system. Vibrations are followed by sounds with frequencies between 0.6 and 2 kHz.

The dynamic system proposed it is with one degree of freedom and has the following equation;

$$m\ddot{x} + c\dot{x} + kx = F_f(\dot{x}, x, t, F_n, ..), \quad (1)$$

and

$$F_f = \mu F_n .$$

3. CASE STUDY. NUMERICAL MODELING OF "STICK-SLIP" EFFECT

In the case of numerical modelling we will solve the differential equation (2) using Matlab Simulink computer software. To resolve we will rewrite equation (2) in a form suitable for inserting in Matlab Simulink blocks.

Processing the differential equation (1) we get a final shape for the sliding intermittent movement "stick-slip";

$$m\ddot{x} + kx - (\mu_s - \mu_k)e^{-(\frac{Vs-\dot{x}}{V_0})}G = \mu_k G . \quad (2)$$

In differential equation (2) μ_s - represent coefficient of static friction and μ_k - represent the coefficient of kinetic friction.

These coefficients are determined experimentally and taken into standards tables [5].

For example, steel-steel friction coefficient of static friction is 0.4 and kinetic coefficient is 0.2.

Rewriting equation is found in relation (3):

$$\ddot{x} = \frac{\mu_k G - kx + (\mu_s - \mu_k)e^{-(\frac{Vs-\dot{x}}{V_0})}G}{m} . \quad (3)$$

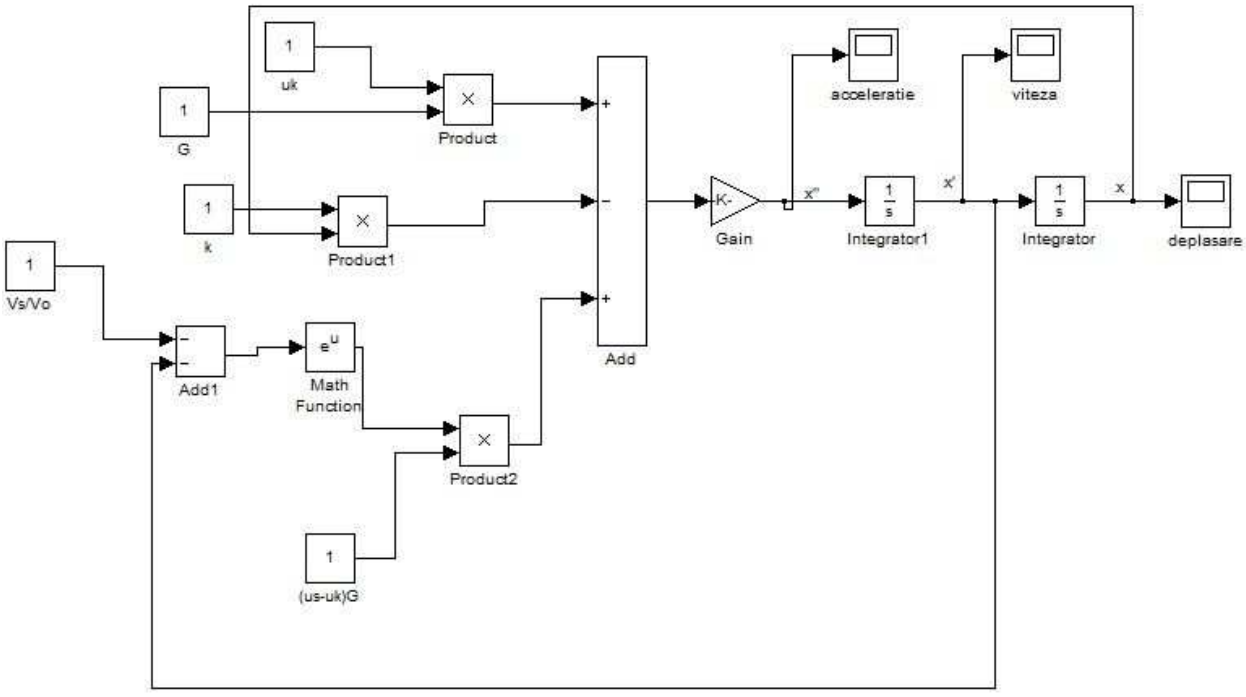

Figure 4 The scheme of solving the equation of slick-slip motion

In Figure 4 you can see the block scheme for solving differential equations in relation (3). To obtain the results we will introduce the following initial data reprinted in table 1.4.

Table 1. Initial figures

No	Wheel reaction (G)	Coefficient of static friction (μ_s)	Coefficient of kinetic friction (μ_k)	Initial Velocity (V_0)	Speed brake (V_s)	Modulus of elasticity (k)
1	200000 N	0.4	0.2	10mm/s	0.001mm/s	210000

Following the numerical modelling will be obtained results for the movement variation and velocity braking variation. And we deduce from these two the "slick-slip" effect [6].

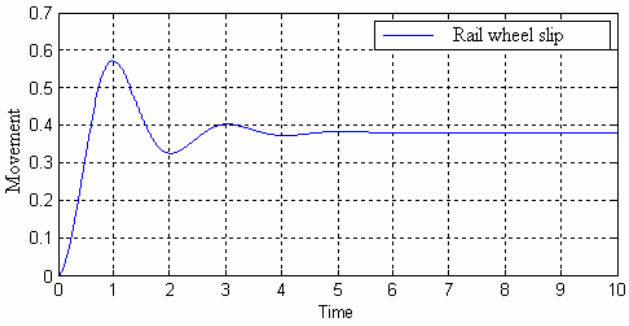

Figure 5 Motion graphic

In Figure 5 can be seen the graphic motion during rail wheel slip. In the studied case we have a maximum displacement of 0.55 mm. As seen, slipping is flashing for 5s.The effect of stick-slip as seen, last for 5 seconds.

In Figure 3 we see the sliding velocity variation. We note that it has positive and negative value. In sliding phase maximum velocity is 0.9 mm/s. When the bonding occurs, the velocity has a negative value because the stick effect tends to restrain the movement. As you seen in the picture the vibration is a damped one. The vibration occurs within 0 and 5s.

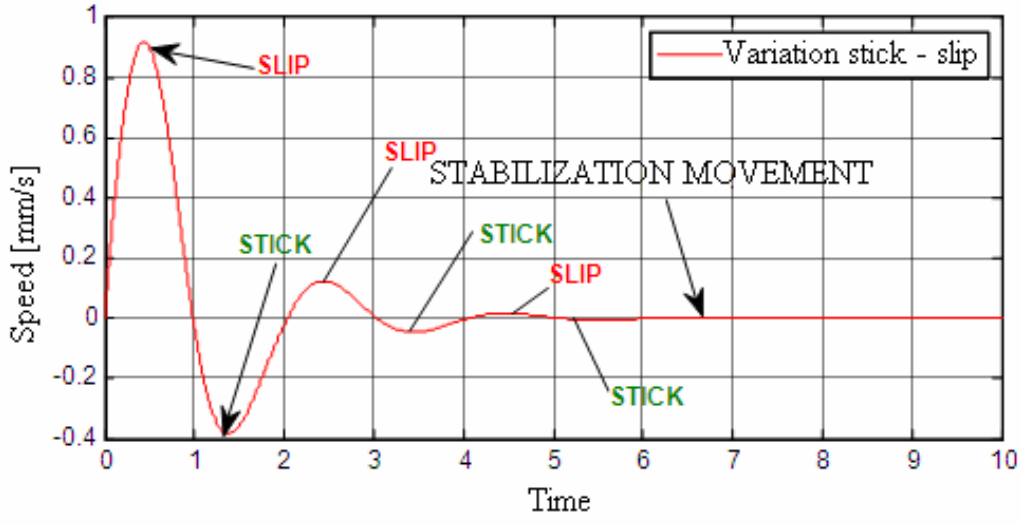

Figure 6 STICK-SLIP graphic

In Figure 7 can be observed the variation of the acceleration under stick-slip effect.

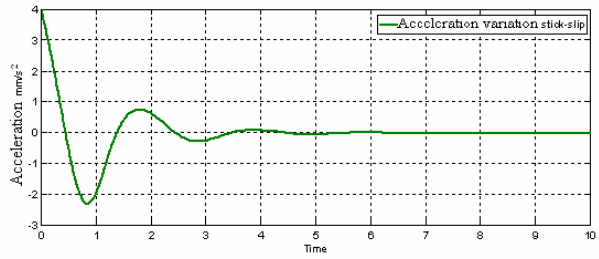

Figure 7 Acceleration graphic

In sliding phase we have an accelerated movement with a 4mm/ s^2 value.

When the mechanical system is falling under the stick effect a slowdown tends to hold back the sliding movement.

But due to the large inertia wheel continues to slide. In a period of 10s stick-slip effect occurs three times.

We have a varied accelerated movement.

The stick-slip effect produce this variation of the movement.

4. DETERMINATION OF WHEEL STRESS UNDER THE STICK-SLIP EFFECT

To determine the stress that occurs during braking has been used the ANSYS software.

It has been used the calculation scheme of figure 8 in which was framed the rail on the lower base, has been defined the friction contact using the coefficients of friction from Table 1, has been applied a force pressure and a velocity.

The analysis has been made in "Transient Structural" module.

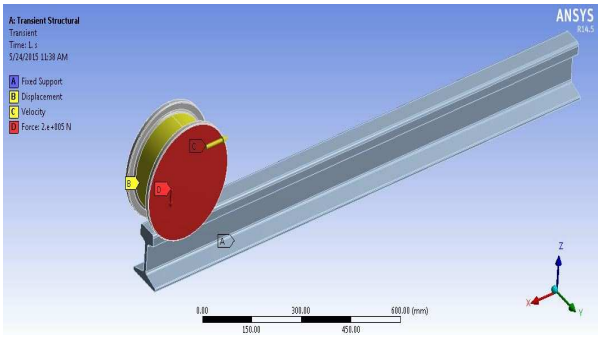

Figure 8 Calculation scheme

The 3D model was meshed in 5717 tetrahedral finite elements and 1,380 nodes. Mesh network can be seen in figure 9.

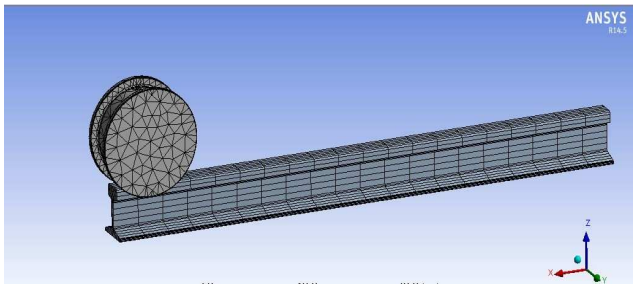

Figure 9 The Meshing of 3D model

This FEM analysis determine the stress of wheels during braking.

The analysis results can be seen in figure 10. Under the effect of brake the stress of the wheel range from 0 to 13.7 Mpa.

Maximum stress appears at the end of the contact surface, in the corners of the wheel. The stress are not so high because the speed of the wheel it is very small during braking operation.

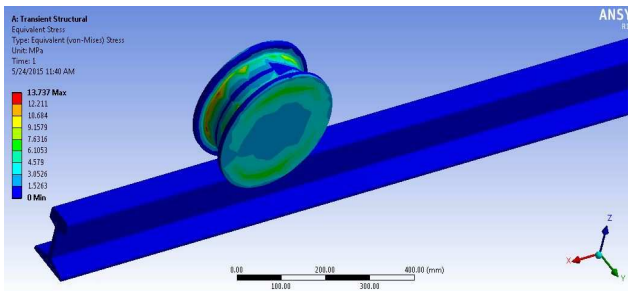

Figure 10 The distribution of stress in the wheel

5. CONCLUSIONS

In this paper work was presented the stick-slip effect of the system of brake.

- The Stick-slip effect produces vibrations and acoustic phenomen in the mechanical system
- The results of simulation demonstrate that this effect is quite dangerous because the mechanical vibrations caused by this phenomenon can resonate with the mechanical system, with devastating effect.
- The simulation has been done on a specific case and in normal operating conditions.
- From the FEM analysis, the mechanical system is functioning in safe operating conditions.
- The stress from the wheel are well below the allowable limit of the material.
- This calculation can be used for any type of wheel out during braking.

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THE R32 REFRIGERANT - A SOLUTION FOR SHIP REFRIGERATION PLANT

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ABSTRACT

The paper concentrates on a theoretical investigation on the performance of the vapour compression refrigeration cycle. Generally, the refrigeration plants on merchant vessels play a vital part in carrying refrigerated cargo and provisions for the crew on board and also air conditioning for accommodations. In reefer ships, the temperature of the perishable or temperature sensitive cargo such as food, chemical, or liquefied gas, is controlled by the refrigeration plant of the ship. The work presents a comparative study between the new R32 refrigerant and R22, R407C and R134a.

Keywords: *cooling capacity, R32 refrigerant, GWP, ODP, refrigeration plant.*

1. INTRODUCTION

According to the CIA's The World Factbook, there were about 38,000 registered merchant ships in the world in 2010, out of which about 920 were designed as refrigerated cargo ships. There are about 1100 merchant ships, with HCFC-22 being the main refrigerant. In addition, there are approximately 30,000 merchant ships which have refrigerated systems for crew food supply, again, mainly using HCFC-22. Because of the proliferation of self-contained refrigerated container systems on container ships, there are many more ships than those designed for only refrigerated cargo that are also carrying some refrigerated cargo. There are more than 500,000 such containers that have individual refrigeration units of about 5 kW cooling capacity. Refrigerants in this sector are transitioning from CFC-12 to HFC-134a and R-404A/R-507A.

The main purpose of the refrigeration plant of the ship is to avoid any damage to the cargo or perishable material. Refrigeration prevents the growth of micro-organisms, oxidation, fermentation and drying out of the cargo.

Refrigeration is required to prevent natural decomposition. In chemistry, a common agent of decomposition is heat, which can reduce both inorganic and organic compounds to their natural constituents. Refrigeration is applied to goods in order to minimize this process. For fruit cargo (living cargo), the cooling process is used to reduce the metabolic processes that would normally lead to ripening.

The refrigeration and air conditioning industry has made tremendous progress over the past two decades in reducing the use of ozone depleting refrigerants [6]. The original targets of the Montreal Protocol, established in 1987 to reduce emissions of ozone depleting substances, are being met and exceeded. Another consequence of these initiatives is that during the 1990s and the early part of the present century, there was a considerable uncertainty regarding future refrigerant options.

2. ANALYZED REFRIGERANTS

In view of the Ozone depletion and Global Warming phenomena, Montreal and Kyoto Protocols restrict the use of CFCs and HCFCs in the refrigerating systems. The Montreal protocol has given a phase out schedule for the removal of R22 refrigerant from usage [7].

An ideal refrigerant should be energy efficient and require small system dimensions. It should be chemically and thermally stable, compatible with all relevant construction materials and compressor lubricants, non-toxic, non-flammable and with no detrimental effect on the global environment [1]. At the same time, it should be non-expensive and easily available.

In order to compare the theoretical data, we have chosen the following refrigerants: R32, R22, R407C and R134a.

The refrigerant R32 demonstrates very good heat transfer characteristics [3]. R32 has excellent thermodynamic properties as a refrigerant. In terms of refrigeration characteristics, it is similar to the refrigerants R502 and R22. R 32 is toxicologically safe and extremely stable thermally and chemically.

R22 is the most commonly used refrigerant in the world. The refrigerant R22 has been used in residential and commercial air-conditioners due to its excellent chemical and thermodynamic properties [2]. R22 contains Cl, and when it escapes contributes to the ozone depletion in the atmosphere. The ozone depletion potential of R22 is approx. 5% of R12 or R11. R22 is a medium pressure refrigerant like ammonia, although it has the advantage of a smaller pressure ratio. From January 1st 2010, import, produce, sell and / or use virgin R-22 is prohibited, according to Regulation (EC) No 2037/2000 on substances that deplete the ozone layer, although reclaimed R-22 can still be used until 2015.

The refrigerant R407C is a zeotropic mixture of R125, R32 and R134a (25/23/52% by weight) with a temperature glide of approx. 7 K. It is a long-term alternative to R22 in certain applications [7]. The choice of heat exchangers is of critical importance for the use of R 407C. When an R22 plant with shell and tube heat exchangers on the condenser side and on the evaporator side is converted to R 407C, it may result in a reduction of the refrigerating capacity by 10% and a reduction in the coefficient of performance of up to 18%. Compatibility with metals is comparable to that of R22

All standard materials used in refrigeration machine construction may be used.

R134a was introduced as the first refrigerant substitute. It may replace R12 in practically all

applications, such as in household refrigerators, automobile air conditioners, heat pumps and commercial refrigeration. R134a is non-flammable and toxicologically safe.

R134a is thermally and chemically stable. Its compatibility with metals is comparable to that of R12. All metals and metal alloys standardly used in refrigerating machine construction may be utilized.

In Table 1 we have shown the physical, safety and environmental data of the refrigerants [1].

Table 1. The physical, safety and environmental data of the refrigerants

Refrigerant	Chemical formula or composition	Boiling point at 1.013 bar ^{0}C	Critical values		ASHRAE 34 Safety group	ODP	GWP
			Temperatures ^{0}C	Pressures bar			
R22	CHCIF2	-40.8	96.1	49.9	A1	0.05	1700
R32	CH2F2	-51.7	78.1	57.8	A2	0	650
R407C	R32/125/134a	-43.8	86.0	46.3	A1	0	1530
R134a	CH2FCF3	-26.1	101.1	40.6	A1	0	1300

3. METHOD OF ANALYSIS

The study concentrates on a theoretical investigation on the performance of the vapour compression refrigeration cycle [4]. The refrigerants R22, R134a, R407C were used as the working fluid for the comparison with the R32 refrigerant.

The simulation has been done on a single-stage process with internal heat exchanger. The conditions for the ideal refrigeration cycle are:

- the evaporating temperature t_0 = -30, -20, -10, 0, 10 ^{0}C.
- the condensing temperature t_k= 40 ^{0}C.
- the system capacity = 50 kW.
- the compressor isentropic efficiency = 1.
- the sub-cooling temperature = 5 ^{0}C.
- the superheating temperature = 10 ^{0}C.

The main parameters of performance analysis such as refrigeration capacity, mass flow rate, compression work, volume flow, pressure ratio, evaporating pressure, volumetric refrigeration capacity, compression discharge temperature are investigated for various evaporating temperatures ranging between -30 ^{0}C and 10 ^{0}C and a constant condensation temperature of 40 ^{0}C.

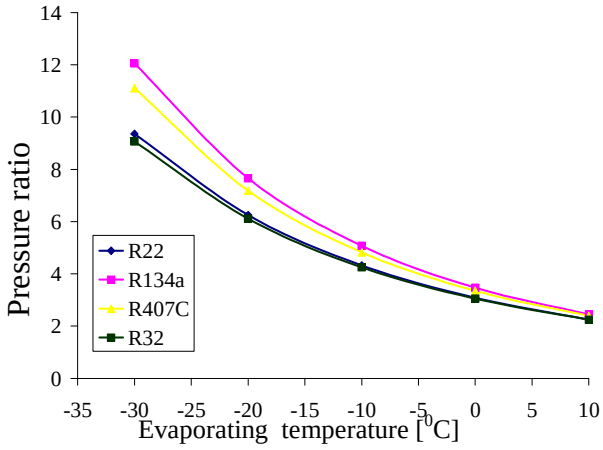

Figure 1 Pressure ratio Vs. evaporating temperature

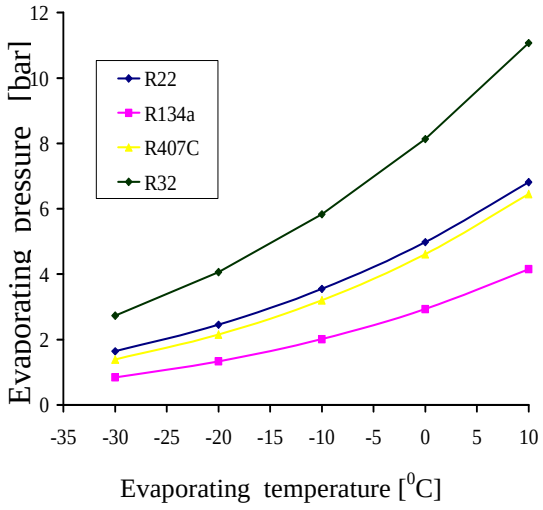

Figure 2 Evaporating pressure Vs. evaporating temperature

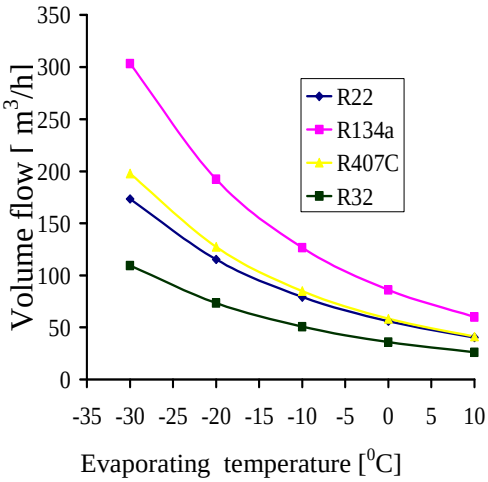

Figure 3 Volume flow Vs. evaporating temperature

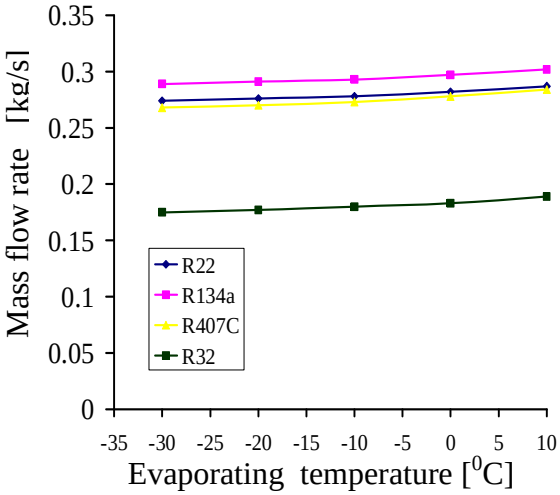

Figure 4 Mass flow rate Vs. evaporating temperature

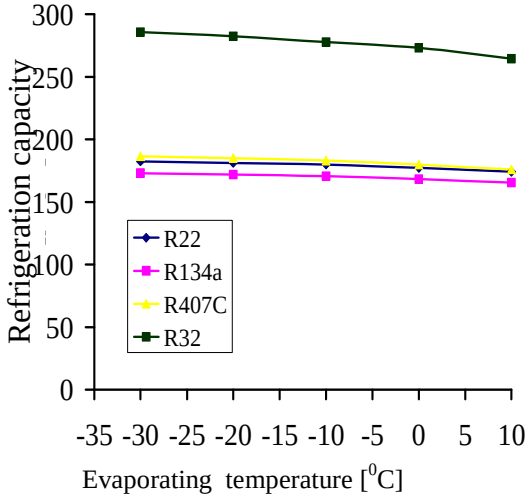

Figure 5 Refrigeration capacity Vs. evaporating temperature

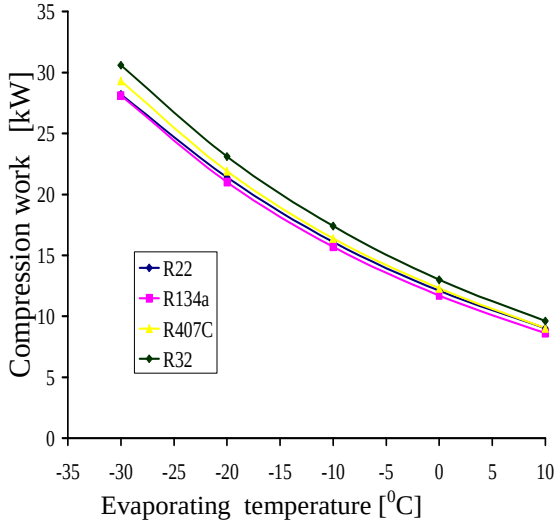

Figure 6 Compression work Vs. evaporating temperature

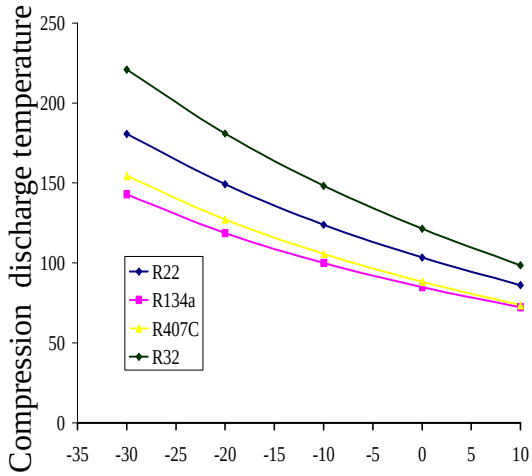

Figure 7 Compression discharge temperature Vs. evaporating

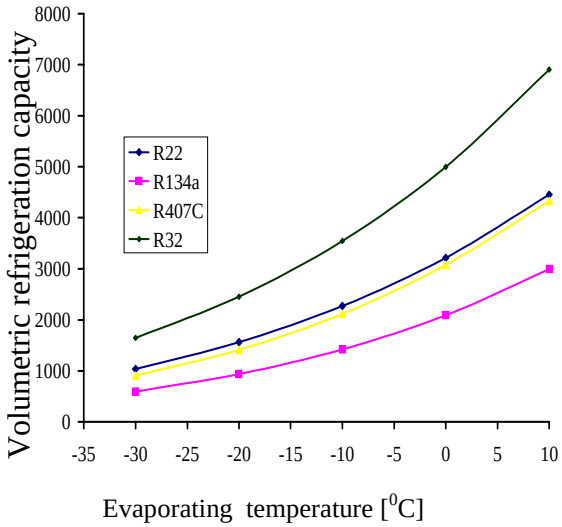

Figure 8 Volumetric refrigeration capacity Vs. evaporating temperature

4. CONCLUSIONS

Looking at Figures 1 and 2, we can see that although the evaporating pressure of R32 refrigerant is the largest, the pressure ratio of the same refrigerant is one of the lowest, which leads to the conclusion that, from the energetic point of view, R32 is very good to be used in refrigeration systems.

In Figure 3, we have presented the volume flow versus the evaporative temperature. From this figure, it can be seen that, for the same refrigerating capacity, R32 presents the lowest volume flow rate. This graphic is in accordance with Figures 4 and 5. This is an advantage for using R32 like refrigerant, because it leads to a smaller amount of refrigerant in the refrigerating system. Because R32 has a large refrigeration capacity, the mass flow rate (and the volume flow rate) will be small

Consequently, the pipes diameters will be smaller and, at the same time, the heat transfer surface area of the heat exchangers (evaporator and condenser) will be smaller.

In Figures 6 and 7, the compression work and the compression temperature discharge versus the evaporative temperature are presented. The R32 compressor has higher compression work and compressor discharge temperature compared to other refrigerants. We can see that the compression discharge temperature is too high. An acceptable discharge temperature could be set by controlling vapour injection flow rate. The liquid injection into the compressor suction line is an alternative to control discharge temperature; however, by using liquid injection, the performance will decrease, as power consumption will increase and efficiency will decrease. The figure 8 shows the volumetric refrigeration capacity variation versus the evaporating temperature. The volumetric refrigeration capacity represents the ration between refrigeration capacity and the suction volume flow rate and is in accordance with Figures 3 and 5.

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CFD STUDY ON THE REDUCTION OF NOX EMISSIONS FROM MARINE DIESEL ENGINES

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ABSTRACT

The aim of this study is to simulate the reduction of NOx emissions by using different reduction technologies, the effect of combination between the use of EGR and injection timing on the formation of NOx emissions will be discussed and illustrated. The first strategy of NOx reduction is the combination between 10% EGR and to retard the start of injection 3 degrees. The second strategy is the combination between 5% EGR and to retard the injection 6 degrees. The study uses ANSYS ICE program to predict the reduction in NOx emissions.

Keywords: *Diesel engines, NOx, NO, EGR, injection timing.*

1. INTRODUCTION

In this study the influence of using two reduction technologies at the same time on the formation of NOx will be discussed and illustrated. Due to the strict regulations of NOx emissions, diesel engines companies and developers are seeking to meet the new strict regulation of NOx by developing new feasible technologies [3]. The excess using of one method for reducing NOx emissions leads to negative results in terms of fuel consumption and the formation of particulate matters [9-10]. Hence, the combination between more than one method of NOx reduction at moderate level can lead to increase the NOx reduction with less negative effects on other engine parameters. This study discusses only the effects of combining EGR with injection timing on the formation of NOx.

2. THE STEPS OF SIMULATION

The simulation is applied on naturally aspirated direct injection DI diesel engine. Engine operation regime is speed 1440 rpm, and engine torque 150 N.m. the designed geometry is illustrated in figure 1. ANSYS ADM program was used for decomposing the sector geometry as it can be seen in Figure 2. ANSYS ICEM was used for dividing the sector geometry into a small cells this step designated mesh step. FLUENT program was used for calculating the solution.

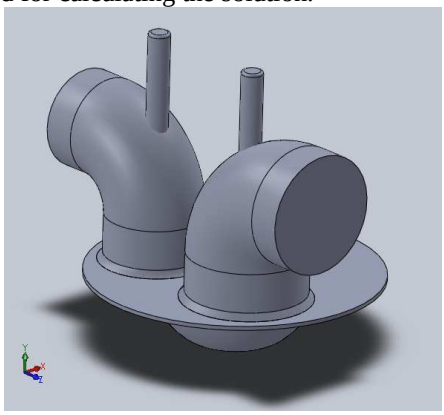

Figure 1 The geometry

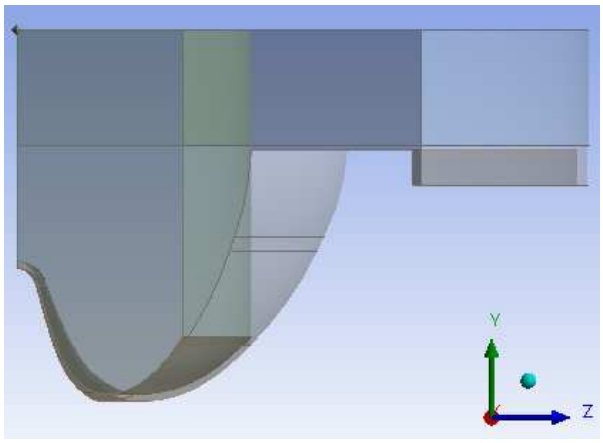

Figure 2 The sector geometry

The simulation was performed between 330 CAD and 485 CAD. The initial pressure, temperature, and composition of in-cylinder gases at the start of the simulation were computed using a MATLAB code which calculates the parameters of cylinder gases during the compression stroke. Other boundary conditions such as the temperature of cylinder walls were set to in a good agreement with temperature in the literature.

3. RESULT DISCUSSION

3.1 First strategy of NOx reduction:

The influence of combination of 10% EGR and retarding the start of injection 3 degrees on the formation of NO is illustrated in figure 3. It can be seen the combination between the EGR and the injection timing at these rates leads to a big reduction in Volume-Average mole fraction of NO. The combination between EGR and injection timing results in the reducing the rate of rise of NO mole fraction due to the reduction in the temperature of cylinder gases and due to the reduction in the ignition delay period.

Figure 4 shows Mass-Average mass fraction of NO at different methods of NOx reduction, it can be seen that recirculating 10% of exhaust gases leads to higher reduction in mass fraction of NO than the reduction by retarding the injection 3 degrees. The level of reduction

in mass fraction of NO by the combination of both methods is significantly higher than the use of only one method of reduction.

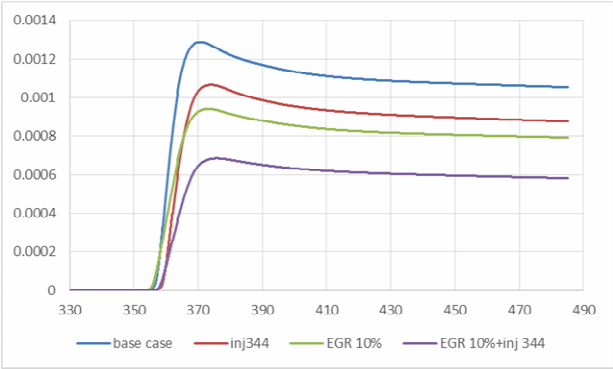

Figure 3 Volume-Average mole fraction of NO as a function of crank angle

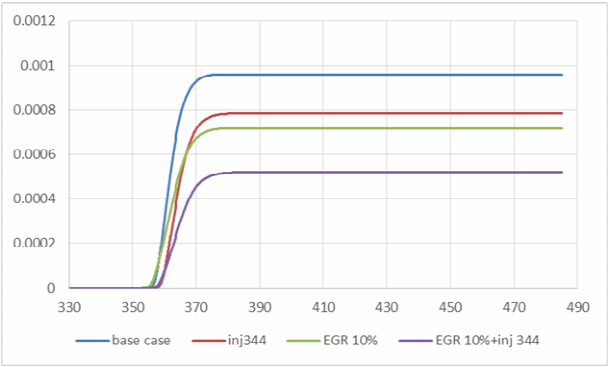

Figure 4 Mass-Average mass fraction of NO as a function of crank angle

The NO density is illustrated in figure 5 as a function of crank angle degrees at three cases of NO reduction methods. It can be seen that the type of method affects the peak value of NO density. Figure 6 shows the Volume-Average rate of NO as a function of crank angle degree. It can be noticed the effect of each method of NO reduction on the peak value of the rate of NO. It can be seen that by using 10% EGR, the peak value of NO rate decreases 46.41%, while the NO reduction is 24.04%by retarding the start of injection 3 degrees, and when the both method are combined the rate of NO is reduced by 62.49%.

It can be noticed in figure 6 that the sharpness of the curves of Volume-Average rate of NO is linked with the amount of formed NO and the time of NO formation. Hence, the reduction in the formed NO leads to lower sharpness in the curve which represents the Volume-Average rate of NO, and vice versa.

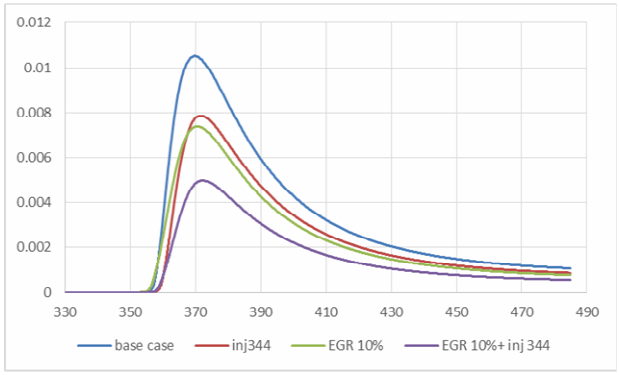

Figure 5 Mass-Average NO density as a function of crank angle [kg/m3]

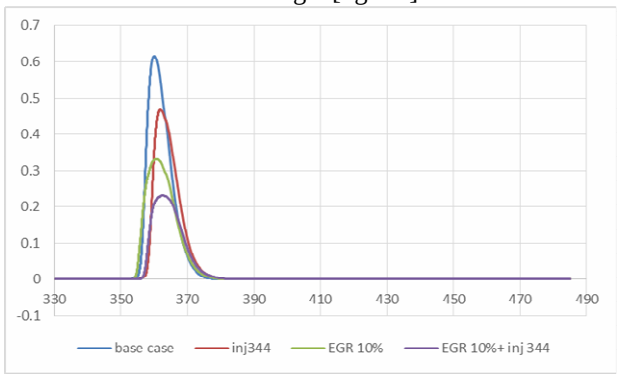

Figure 6 Volume-Average rate of NO as a function of crank angle [kgmol/m3-s]

Figure 7 shows the Volume-Average rate of prompt NO. It is obvious how the shape of the curves varies according to the method of reduction. It can be seen that using 10% EGR reduces the peak of prompt NO and reduces the amount of Prompt NO when it compared with retarding the injection 3 degrees. The use of both reduction methods lead to higher reduction in prompt NO which will lead to a relative small reduction in the total formed NO.

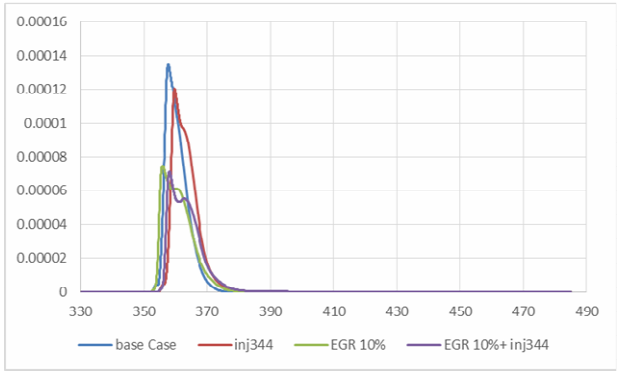

Figure 7 Volume-Average rate of prompt NO as a function of crank angle [kgmol/m3-s]

3.2 The second strategy of NOx reduction:

The second strategy depends on reducing the EGR rate to 5% and to retard the start of injection for 6 degrees. It can be seen in figure 8 that the influence of 10% EGR rate on the Volume-Average mole fraction of NO is less than the influence of retarding the start of

injection 6 degrees. Hence, the shape of the curve of total volume-average mole fraction of NO is similar to the shape of the curve of NO that presents retarding the start of injection more than the shape of the curve of NO which presents 5% EGR, in terms of where the peak value of mole fraction occurs. Figure 9 shows mass-average mass fraction of NO, it is obvious as well how the use of EGR with retarded start if injection by 6 degrees leads to a significant reduction in mass fraction on NO.

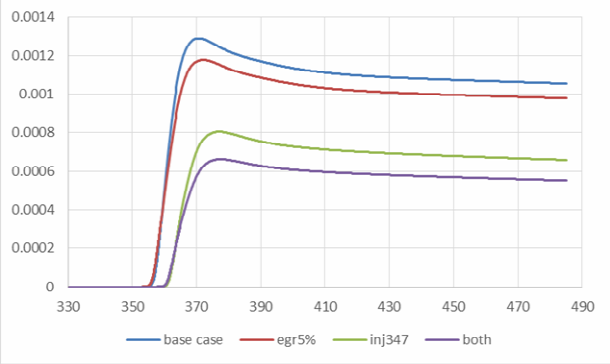

Figure 8 Volume-Average mole fraction of NO as a function of crank angle

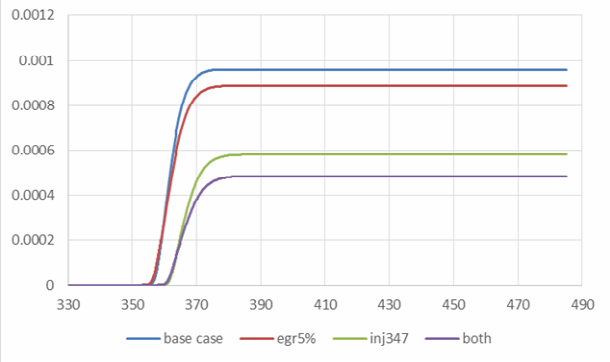

Figure 9 Mass-Average mass fraction of NO as a function of crank angle

Figure 10 shows the curves of NO density, it can be seen that the curve of total NO density is similar to the curve of NO density with 6 degrees of retarding the start of injection more than the curve of NO density with 5% EGR, because of the contribution of retarding the start of injection in the reduction of NO is greater than the contribution of 5% EGR in the reduction of NO. Figure 11 shows the Volume-Average rate of NO as a function of crank angle degrees. It is obvious how the second strategy of no reduction leads to a significant reduction in the peak value of the rate of NO. On the other hand figure 12 shows the influence of different methods of NO reduction on the Volume-Average rate of prompt NO.

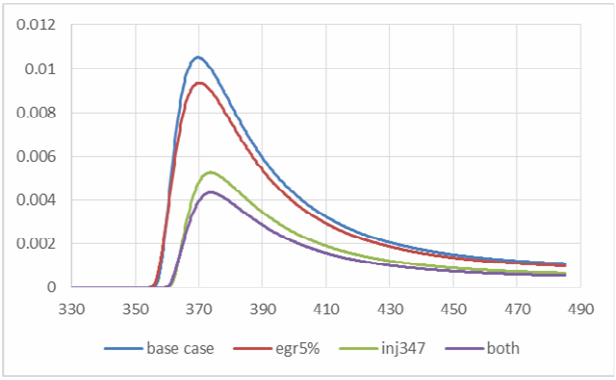

Figure 10 Mass-Average NO density as a function of crank angle [kg/m3]

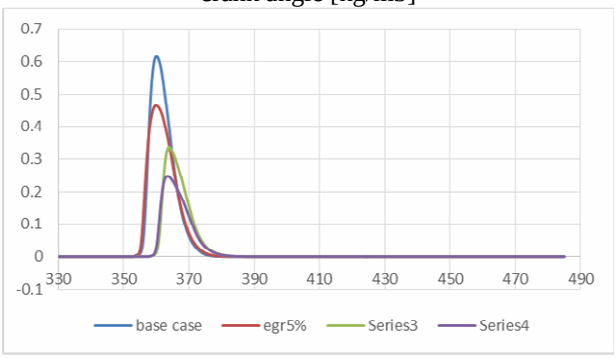

Figure 11 Volume-Average rate of NO as a function of crank angle [kgmol/m3-s]

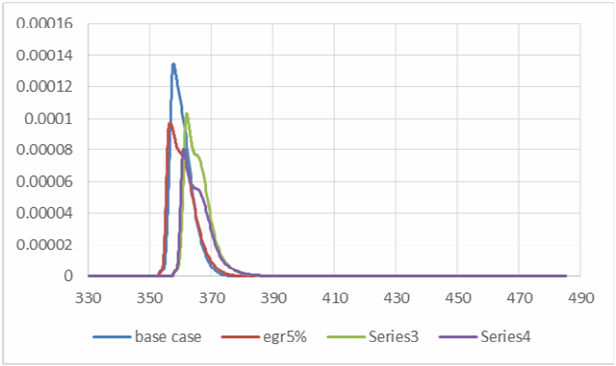

Figure 12 Volume-Average rate of prompt NO as a function of crank angle [kgmol/m3-s]

The influence of each strategy on the formation of total NO is shown in figure 13. The first strategy is at the left side and the second strategy is at the right side. By comparing the results of first and second reduction strategies, it can be noticed that using the first strategy leads to 44.93% and by using the second strategy the reduction in NOx emissions reaches 47.77%.

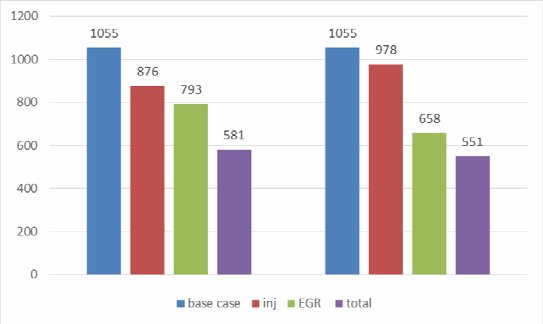

Figure 13 NO fraction at different reduction cases [ppm]

4. CONCLUSIONS

After comparing the results of first and second reduction strategies, it can be concluded that the rate of NO reduction by using the both strategies is almost the same. Hence, fuel consumption is the main factor that determines which of these strategies is the best to be used. The second strategy is the preferable strategy for reducing NO. Since the effect of EGR on increasing the BSFC [4] is less than the effect of retarding start of the injection, and because of the limited ability to reduce NO by changing the injection timing [10].

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PREDICTION OF NOX EMISSIONS FROM MARINE DIESEL ENGINES BASED ON EDDY DISSIPATION MODEL

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ABSTRACT

The aim of this study is to predict the NOx emissions from marine diesel engines by using computational fluid dynamics (CFD). ANSYS program is the simulation software that was used for performing this study. The commercial code of eddy dissipation model (EDM) is the code that was used for simulating the combustion process. The simulation is carried out between 330 CAD and 485 CAD. The principle steps of simulation are illustrated and explained. The result of simulation is validated with result of the experiment that was carried out on direct injection diesel engine.

Keywords: *Diesel engine, CFD, NOx, NO, Prompt NO, eddy dissipation model.*

1. INTRODUCTION

Diesel engines are the predominant engines that used for moving ships, trucks, and other kinds of transportations means. They are reliable and economical engines, but one of the main shortcomings of these engines is their NOx emissions. Hence, many researches and studies have been carried out for developing the diesel engines due to the increase in pressure on diesel engines companies to develop more clean engines and to reduce the NOx gases.

Computational fluid dynamics (CFD) method has been used for developing diesel engines for better reduction in NOx emissions, because CFD is considered a good choice for decreasing the cost, time, and efforts of diesel engine development process.

ANSYS program offers four commercial codes for simulating the different cases of combustion. EDM is the code is used for performing this simulation because it is the most suitable code for simulating the combustion in diesel engines.

2. EDDY-DISSIPATION MODEL

Eddy-Dissipation Model is considered the best choice between the commercial codes because it was created for simulating the premixed-combustion. The principle of Eddy-Dissipation Model is based on the combustion process inside the combustion chamber is so fast, and both the oxidant and the diesel fuel present in separated eddies. Hence, the combustion process depends on the rate of eddies dissipation, or in other words the rate of mixing. Hence, the rate of combustion is related to the time of mixing the species that enter the reaction at molecular level. The rate of combustion can be expressed by the following equation [6].

$$R_f = A \cdot \bar{c}_f (\varepsilon / k)(kg / m^3 / s). \quad (1)$$

Where: A is a constant, $\bar{c}_f$ the local time-mean fuel concentration, ε the dissipation turbulent of kinetic energy, k turbulent kinetic energy.

3. SIMULATION SETUP

The combustion chamber's geometry is created using one of CAD programs, Figure 1.

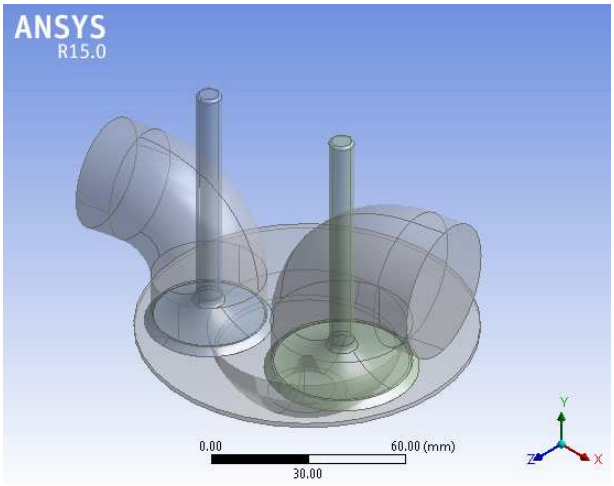

Figure 1 combustion chamber geometry

After drawing the combustion chamber geometry at the top dead centre, the geometry is imported and decomposed by ADM program, the result of this step being presented in Figure 2.

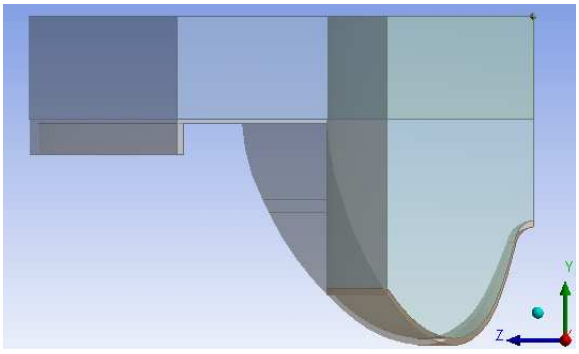

Figure 2 The sector geometry

The next stage is the generation of the mesh, the decomposed geometry being automatically divided into

very small cells. The initial conditions of engine fluids such as the pressure and temperature of in-cylinder gases should be defined at setup step. Other parameters such as the composition of in-cylinder gases and the temperature of combustion chamber walls should be defined as well. Then the calculation of solution is performed by using FLUENT program.

4. EXPERIMENT

The experiment was carried out on direct injection naturally aspirated diesel engine at Constanta Maritime University, see figure 3. The experiment was performed under the following conditions, ambient air temperature is 30.88 C, atmospheric pressure is 1.013 Bar, and humidity is 51%. Engine speed is 1440 rpm, and engine torque is 150 N.m.

The principle engine specifications are listed in table 1.

Table 1. Principle engine specification

Parameter	Value	Unite
Bore	117	mm
Stoke	115	mm
Compression ratio	17.5	
Injector holes	4	
Hole diameter	0.024	mm
Start of injection	19 BTDC	Degree

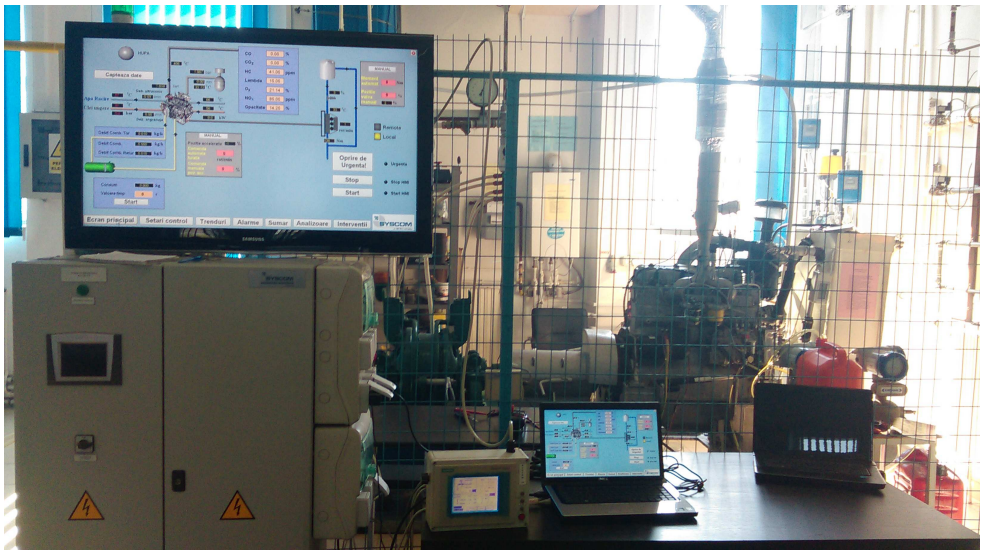

Figure 3 Engine test stand

The device which was used for measuring the NOx emissions is manufactured by ECO ELECTRO SERVICE Company and it is able to measure NOx emissions in the (0-5000) ppm range, figure 4.

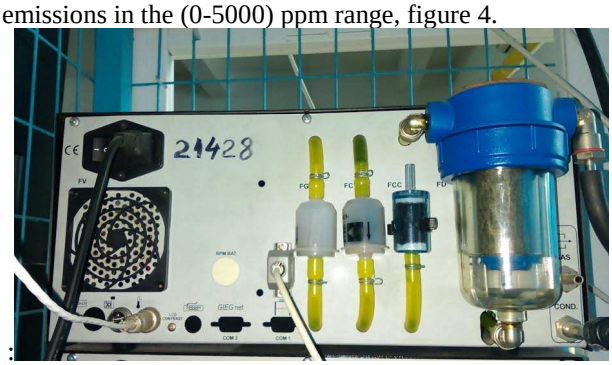

Figure 4 Gas emission analyzer

5. RESULTS DISCUSSION

In this section we discuss the results reached by the use of the EDM for the prediction of NOx emissions. Figure 5 shows the In-cylinder temperature at 359 CAD.

It can be noticed the variation of cylinder temperature between the high temperature zones of the flame front and the other zones where the temperature is lower.

Figure 6 shows the cylinder pressure as a function of crank angle between 330 CAD and 390 CAD.

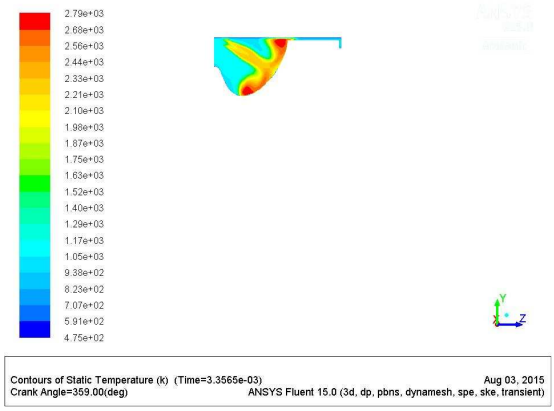

Figure 5 In-Cylinder temperature [K]

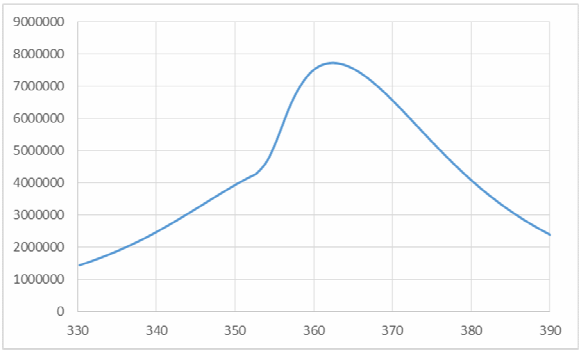

Figure 6 Cylinder pressure as a function of crank angle [Pa]

Figures 7 shows Volume-Average mole fraction of NO as a function of crank angle degree. It can be seen the value of mole fraction of NO increases rapidly at the start of combustion process till it reaches its peak value at 10 degrees after the top dead centre, then it starts to decrease till reaching almost a stable value near to exhaust valves open. The results of simulation are very accurate when it is compared with experimental result, since the simulation result of mole fraction of NO emission is 1055 ppm and the experimental result is 1170 ppm.

On the other hand it can be seen in figure 8 that the value of Mass-Average of NO increases rapidly at the first phase of combustion, then at 17 degrees after the top dead centre the value of Mass-fraction of NO freezes because there is no significant amount of NO is formed due to the reduction in temperature of in-cylinder gases.

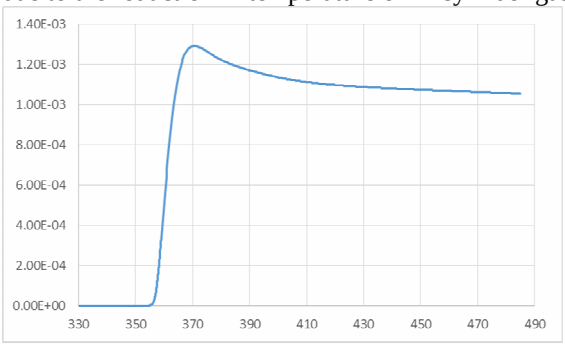

Figure 7 Volume-Average mole fraction of NO as a function of crank angle

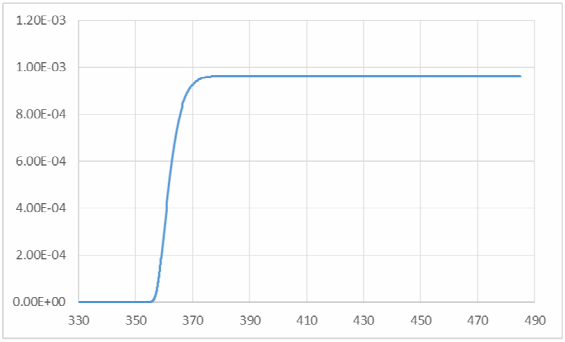

Figure 8 Mass-Average mass fraction of NO as a function of crank angle degree

The curve of mass-average NO density is illustrated in figure 9. The NO density increases from zero to its peak value at several degrees after the top dead centre, then it starts to decrease gradually till the exhaust valves open. Note that the NO density depends on two main factors, the first factor is the formed NO inside the combustion and the second factor is the instant volume of engine cylinder.

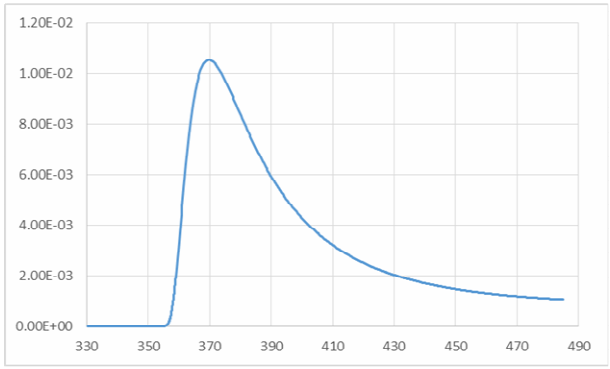

Figure 9 Mass-Average NO density as a function of crank angle [kg/m3]

The curve of volume-average rate of NO is illustrated in figure 10. The value of rate of NO increases sharply due to the high rate of heat release during the first phase of combustion, after reaching the peak value of rate of NO, the curve starts to drop down. During the expansion phase, the temperature of cylinder gases drops down, the speed of the reactions of forming NO decreases as a results of the reduction of cylinder gases, but the decomposition process of NO still occurs even with very small rates [1]. The negative value of the rate of NO during the late phase of expansion stroke can be attributed to the previous reason.

Figure 11 shows the volume-average rate of prompt NO, the contribution of prompt NO in the total NO is very small. Note that the difference between the values of rate of NO and the rate of prompt NO represents the rate of thermal NO.

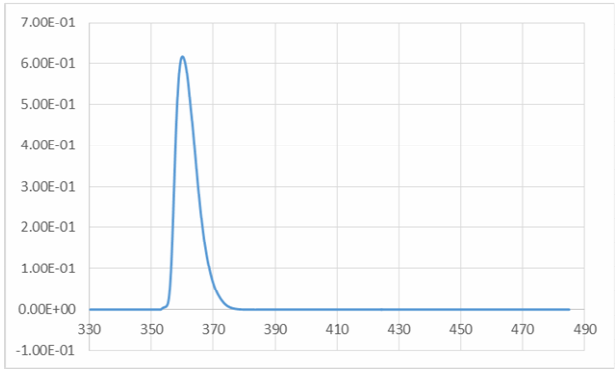

Figure 10 Volume-Average rate of NO as a function of crank angle [kgmol/m3-s]

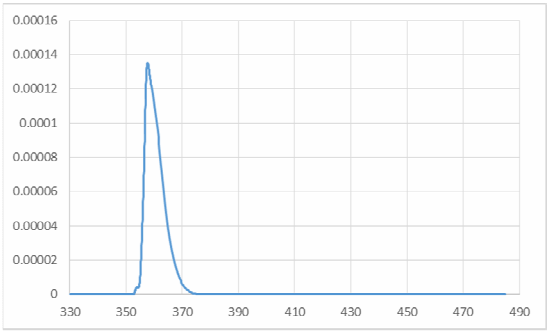

Figure 11 Volume-Average rate of Prompt NO as a function of crank angle [kgmol/m3-s]

6. CONCLUSIONS

NOx emissions were predicted by the use of eddy dissipation model (EDM) and computational fluid dynamics (CFD) method. The result of simulation is in good agreament with the experimental result, the difference between the simulated result and the experimental result is 9.83% which is considered a very accurate result for this complicated kind of simulation.

The shape of the curves of Volume-Average mole fraction and Mass-Average mass fraction of NO is in good agreement with the shape of these curves in the literature. It can be seen how the curve of mass fraction of NO freezes after several degrees from the top dead centre, and how the curve of mole fraction of NO decreases slightly after reaching its peak value. Hence, it can be concluded that EDM model is a good model to be used in the process of diesel engines development for reducing the NOx emissions.

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THE COMPLEX DESIGN OF NAVAL BALL VALVE

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ABSTRACT

This article is a design study using NX Siemens CAD and computer fluid dynamic analysis (CFD) for the complex type of naval valve, also called three way ball valves (TWB). This valve' design was based on descriptive drawings of component parts, all dimensions being chosen and established by the authors. Computer Fluid Dynamic analysis is based on finite element method (FEM), meshing, boundary condition and loads, finally we get important conclusions regarded by velocities of fluid inside body valve.

Keywords: *TWB, CAD NX Siemens, Revolve, Extrude, Velocities, CFD.*

1. INTRODUCTION

These ball valves are among least expensive have wide range of applications for all size including very large sizes in oil pipelines and maritime industries. They are used for liquids (water, oil, chemical liquid products), steam or gas fluids. These TWB are generally used at unrestricted bore at full opening and have low operating torque, normally not used for gas-flow throttling [1].

Basic geometry involves a spherical ball located in the three ways body form. The ball has a hole made along of two axes arranged at an angle of 120˚ degrees. Full operating movement is 120˚ degrees rotation of the ball.

2. CONSTRUCTION OF TWB

The basic design of TWB is illustrated in the Figure 1:

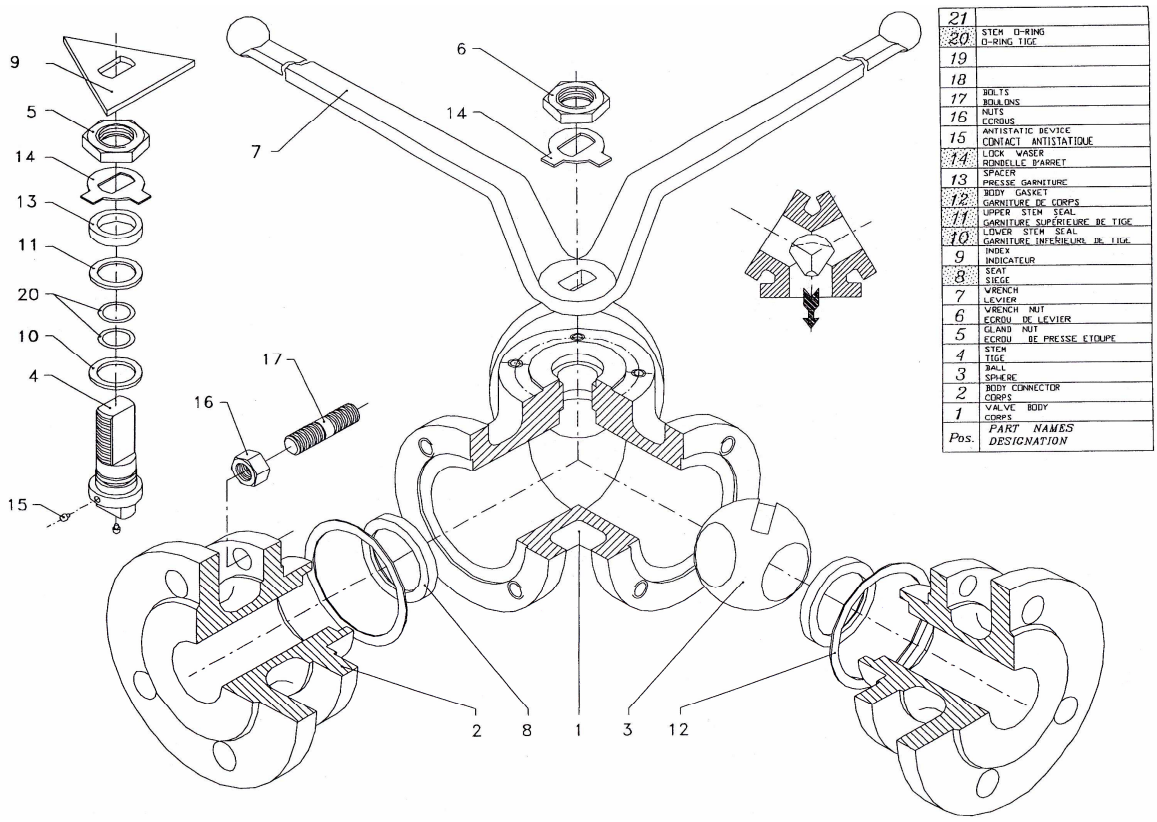

Figure 1 Components parts of TWB; 1-body valve; 2-body connector; 3-ball sphere; 4-stem; 5-gland nut; 6-wrench nut; 7-wrench; 8-seat; 9-indicator; 10-lower stem seal; 11-upper stem seal;12- body gasket; 13-spacer; 14-lock washer; 15-antistatic device; 16-nuts; 17-bolts; 20-stem o-ring.

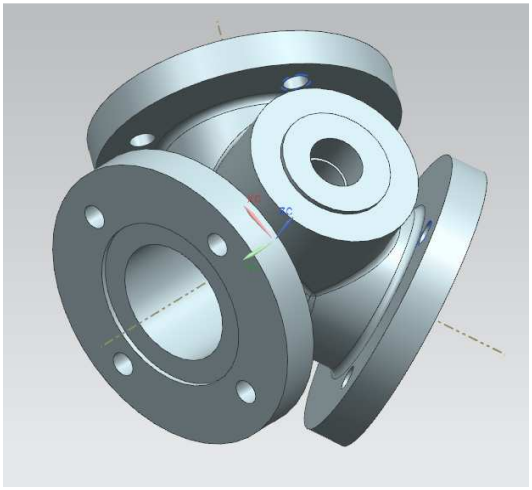

Figure 3 The principal viewing of body valve

The essential features of TWB are the body (1), the body connectors (2), ball (3) and stem (4). Full flow is obtained when the hole inside of the ball is aligned with inlet and outlet flanges in the direction of flow with 120º. When the stem is rotated with 120º using lever or wrench the flow is blocked in the third flange and lock washer (14) may be incorporated to limit movement of lever or continuous rotation may be possible [2]. Larger ball valves may be operated by handwheels through

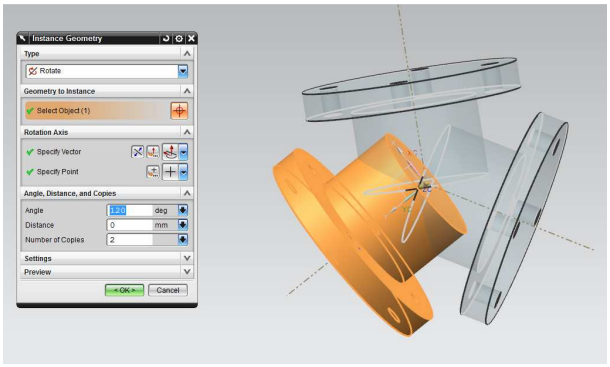

Figure 2 The *Instance Geometry* menu

reduction gearing or by powered actuators.

In all cases opening/closing torque is low because the only friction forces involved are those of the ball rotating against its seats and the friction offered by the stem o-rings and lower, upper stem seals [2].

2.1 3D Design of body valve

The 3D Design consists of modelling each component of TWB assembly using NX Siemens CAD solution [2].

Since the body valve is composed of three flanges, on their axes of reference, we sketch flange one by one arranged at 120˚; next we extrude until they touch themselves and form body of valve. Another efficient way to realise the body valve is to use the *Instance Geometry* menu; if we make the first flange we may copy two times the flange disposed at 120˚ between them. (Figure 2).

The complete body will be realised above of united extruded parts from Figure 2; we make another circular sketch, and finally extrude and unite it with basic part (Figure 3).

2.2 3D Design of body connectors

The most important role of body connector (2) is lashing the seat (8) and subsequently to blend with body valve using circular flange. Together body connector and seat make a subassembly presented in Figure 4.

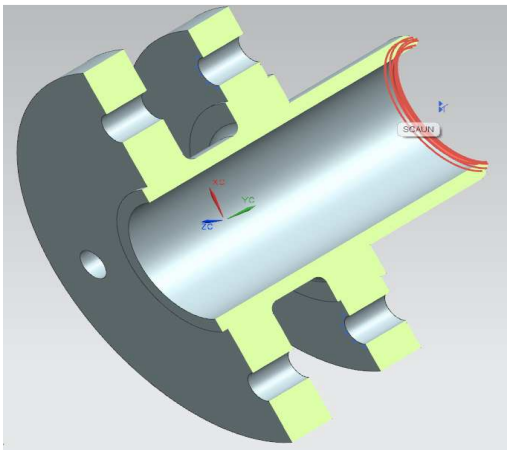

Figure 4 The sectioned viewing of subassembly body connector and seat

2.3 3D Design of ball

The usually feature to design a ball in NX Siemens is *Sphere* command using precise diameter. The execution of the hole is made using *Extrude* which help us to project two circles on the external surface of sphere

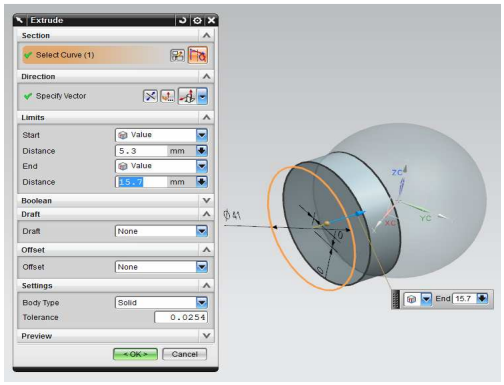

Figure 5 The *Extrude* operation for projection of circles

(Figure 5). Next we chose the orientation of vector around which implementing *Revolve* operations (Figure 6).

Finally, *Revolve* operation must have selected in the

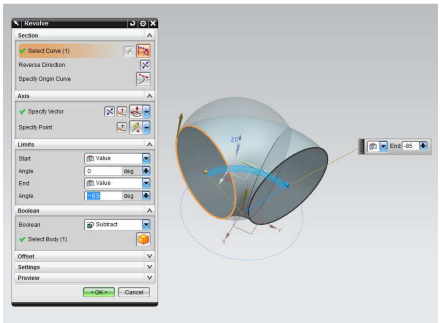

Figure 6 The *Revolve* operation

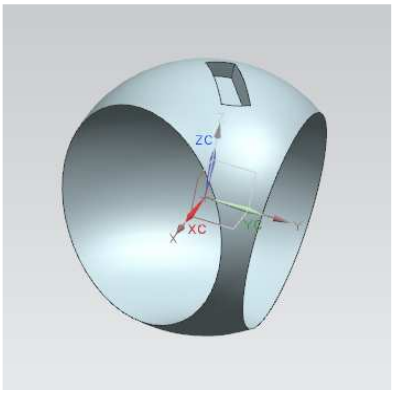

Figure 7 The principal viewing of ball

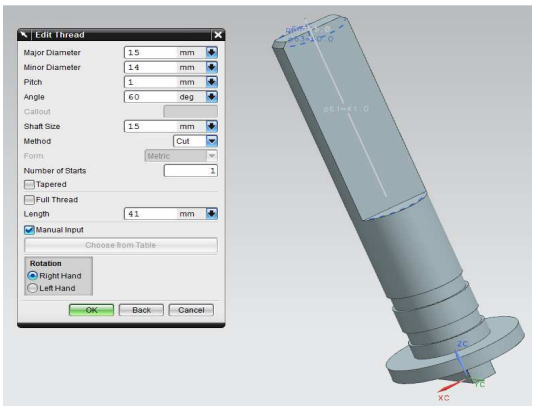

Figure 8 The principal viewing of stem and thread operation

menu the option Boolean *Subtract* because the purpose is to remove the material through entire hole (Figure 7).

2.4 3D Design of stem

The stem is the part which will be rotated and must be in permanent contact with the ball. The rectangle end of the stem will be located inside of the rectangle hole on external surface of ball (Figure 7). The design operation compounds successive extrude operations and at the opposite rectangle end we realise *Thread* operation using the menu presented in Figure 8.

2.5 The assembly of component parts

The components parts was added using touching, infer center axis, concentric constraints. The final assembly is created when component objects are added to the assembly part file, each component object is mated with the corresponding objects. 3D Design of TPV is presented in the figures no. 9 [3].

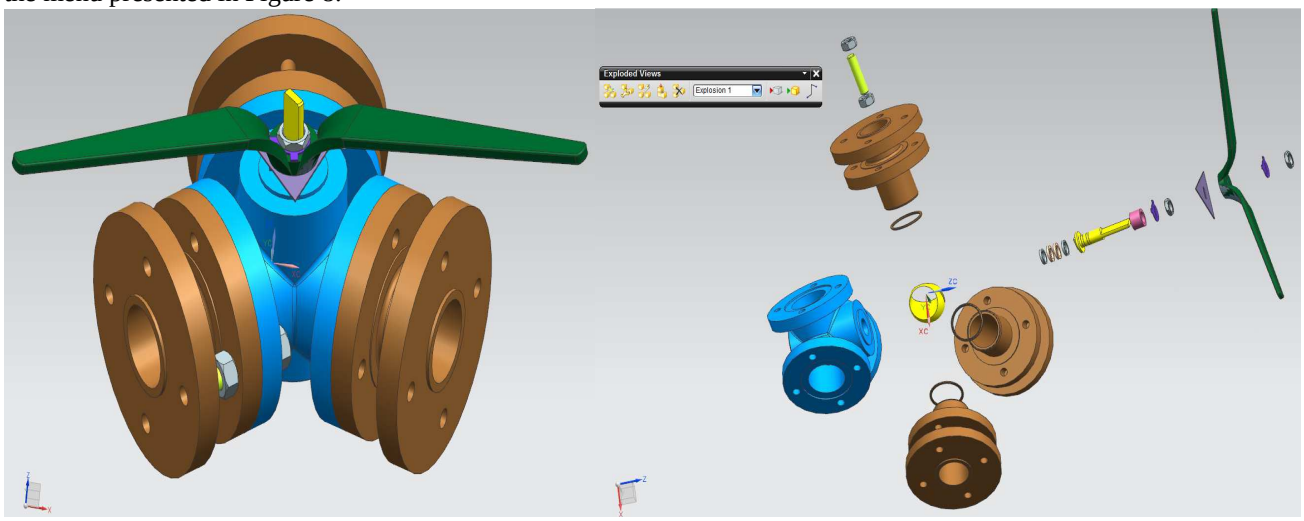

Figure 9 Unexplode and exploaded viewings of 3D assembly TWB

3. COMPUTER FLUID DYNAMICS

Computational fluid dynamics, usually abbreviated as CFD, is a known field of fluid mechanics that uses numerical methods and algorithms to solve and analyse problems that involve fluid flows [3]. Computers are used to perform the calculations required to simulate the interaction of liquids and gases with surfaces defined by boundary conditions. With high-speed supercomputers, better solutions can be achieved. Efficient algorithms have been developed to solve the Navier-Stokes equations used in the flow analysis around ship hulls, the work contributed to the numerical solution of the viscous flow around ship-like bodies is discussed in [4]. An experimental and numerical of a three-dimensional, complex geometry, control valve was performed for model validation and improved understanding of valve flow features is discussed in [5]. On-going research yields software that improves the accuracy and speed of complex simulation scenario such as turbulent flows [6].

3.1 Methodology

The required parts, body valve, body connectors and ball of TWB designed with NX Siemens were transferred to Advanced Simulation module of the same NX Siemens software.

We consider two different situations: first situation, when the volume occupied by fluid is fully open ball valve and the second is that moment of partially open ball valve. During meshing operation the fluid will be divided using the proper tetrahedral TET(4) elements,

total number of elements 62995 for the first situation and 29126 elements for the second situation (Figure 10)

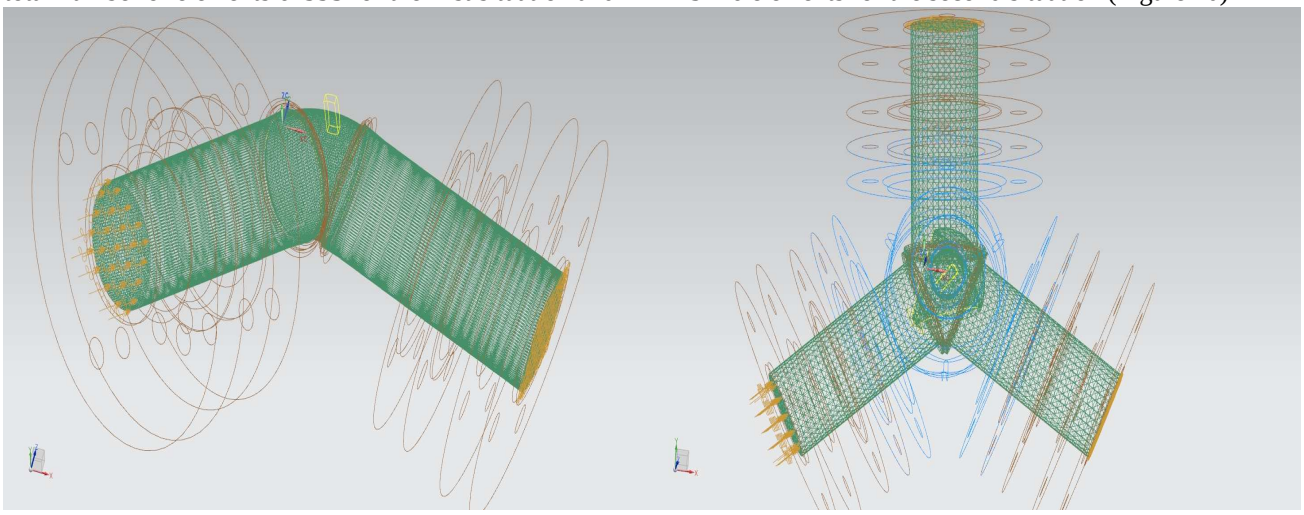

Figure 10 Meshing of fluid volume; a.-first situation; b.-second situation

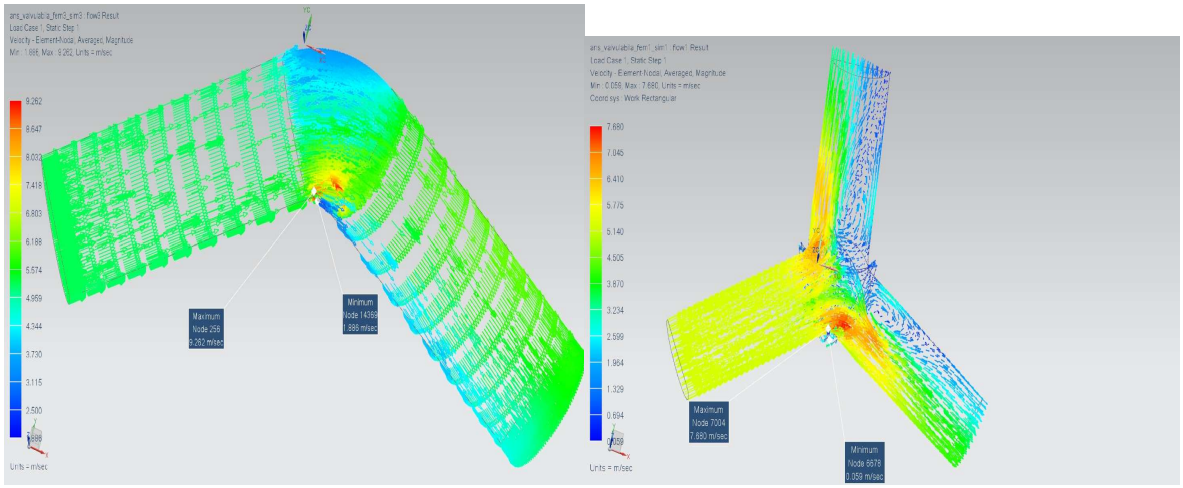

Figure 11 Velocities of fluid; a.-first situation; b.-second situation

3.2 Boundary conditions

For all situations it is assigned water as the fluid with the volume flow 25 m^3/h and temperature 15˚C at inlet zone. The outlet zone of TWB has the atmospheric pressure and 15ºC. As we can see in Figure 9 for the second situation we have two outlet zone because of partially open ball valve.

4. CONCLUSIONS

In practise, generally known is centrality – this is the alignment of two concentric circles, such as the ball and stem or the seats and body. If improperly aligned, there can be uneven forces for sealing or rotation of the valve; that why is important the alignment and adequate design of each part of TWB.

Often occur the cavitation effect which is the formation and collapse of bubbles when high velocity fluid flows through a valve and the liquid goes below the vapor pressure.

Seldom, because of malfunction could appear second situation and the seats (8) and ball (3) are exposed to high velocities (Figure 10) and pressure and make serious damages.

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HOW TO APPLY THE EASW METHODOLOGY DURING A WORKSHOP RELATED TO IMPROVING SKILLS AND COMPETENCIES FOR RENEWABLES

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ABSTRACT

Constanta Maritime University and Varna Business agency are implementing, as partners, the project Green Energy Cluster Constanta Dobrich, within Romania–Bulgaria Cross–Border Cooperation Programme 2007–2013. An activity scheduled in the Work Package 5 is the organization of a workshop entitled "Workforce for renewables–skills and competencies improvement pathway", during two days. This workshop is developed on the fact that green jobs require new competencies. In order to be able to provide, at the end of this activity, a statement elaborated by the participants, the EASW methodology was proposed as a basis.

In this paper are given the features of this methodology, resulting that the workshop implementation requires: a group of 30 participants, invited from residents, students, authorities, experts in RES and business representatives, an organizing team, facilitators and an adequate time for the preparation and running of the workshop.

This workshop will provide to the project a statement, as deliverable, indicating proposals for reaching an improvement in the skills and competencies in RES, in the cross border area.

Keywords: *skills, competencies, RES, workshop, methodology.*

1. INTRODUCTION

Constanta Maritime University and Varna Business Agency are implementing the project "Green Energy Cluster Constanta–Dobrich", within Romania Bulgaria Cross Border Cooperation Programme 2007–2013.

This project is based on the Cluster structure which creates the pre-conditions and favorable environment for long-term partnership and thus the Green Energy Cluster "Constanta-Dobrich" ensures propitious milieu for the flourishing of further cooperation initiatives and represents a solid foundation for the joint development of "hard" infrastructure cross-border projects in the RES development.

The overall objective of this project is to ensure sustainable favorable conditions in the cross-border region for both catalyzing mastered growth of the regional clean energy industry and maximizing the clean energy potential of local industries, federating expertise, knowledge and resources from Bulgaria and Romania through the establishment and deployment of a Cross-border Green Energy Cluster "Constanta-Dobrich" [1].

Through this project it is intended to provide answers to specific questions arised in the cross border area and, if possible, to state some fresh and new ideas on energy domain and how to create new jobs in the RES.

The main problem the project aims to tackle the chaotic, environmentally-hostile, regionally unbalanced and vision-deprived growth of renewable energy production in the cross-border region Dobrich-Constanta. The region has an excellent potential for renewable energy production -especially wind energy- but there is a lack of structured cooperation between the neighbouring regions and at the same time there is a significant misbalance in built and projected facilities, in R&D initiation and transfer, in workforce development (there is no common vision for the workforce development for the growing demand for specialists in the region nor vocational services or training centers) and in the approaches to deal with authorities and NGO.

The green jobs require new skills. While this thing is energetically significant, as a result of major investments and renewable energy extensions (which gave birth to new jobs), the main necessity is to revise and update the workers' existing skills. Romania and Bulgaria seems not attempted to anticipate the professional skills or to create ecological jobs at a national level, jobs based on patterns of quantitative projections. By analysing the existing training programs in the renewable energy sources field, one can notice that the specific training programs for the 'key' jobs are missing. This failure is mainly determined by the lack of professional training standards.

The method proposed for discussion is based on European Awareness Scenario Workshops – EASW since the method rises the challenge of facing the environmental problems of the cross border area (towns - cities or villages) by its own inhabitants. This is described in the following [2-6].

All involved actors (residents - decision makers - technocrats - commerce and industry) participate in round - table discussions and present their proposals, which, following the EASW methodology, are evaluated and reformulated by the same participants during a two day process (a plenary session on the first day and a group session for the drafting of a specific statement on the second day).

This procedure promotes dialogue between all interested parties and local groups, enhances understanding of local conditions or problems and facilitates consensus on proposed solutions. According to its application, the EASW method could be a tool for:

- information and learning;
- understanding and participation in the decision making process, common planning for the future;

- identifying responsibilities and priorities or just any combination of the above.

The original EASW method takes place in two days and involves four groups of participants: the residents/students, the policy makers, the technology experts and the private sector representatives. The groups discuss the given issues, following a defined methodology and present their first results. These results are restructured and reprocessed during the second part of the workshop, in which the participants are divided in four theme-groups, following the four major issues of workforce for renewables: **the need of descriptors for new skills and new jobs in RES, the approach of enterprise in respect with workforce development in RES, identification of specific skills in RES for the cross-border area, promoting of jobs in RES for different social categories.**

2. THE EASW METHODOLOGY

Creating new jobs in RES is possible only when it is rooted in the concerted efforts of residents, public and private companies, local authorities and experts in technology and the environment.

Nationally and internationally, the human factor has an important role, even vital, in promoting green energy. That is why all begins with the education and instruction of the population. According to the European Union and the European Strategy 2020 regarding the economical increase, all the members of the E.U., including Romania, have to accomplish three goals, energetically speaking, until 2020, namely: decreasing the greenhouse gas emission by 20% compared to 1990, increasing the renewable energy consumption within the European mixture of energy by 20% and increasing the energetically efficiency by 20%.

Preparing for these changes means to adjust the existing training programs and the qualifications and also to create new ones where necessary, according to the number of green jobs that can be created until 2020.

The aim of the "Workforce for renewables – skills and competencies improvement pathway" Workshop:

- the exchange of ideas, views and knowledge among residents/students, authorities, technological experts, private sector representatives
- the definition and discussion of similarities and differences regarding problems and solutions, as these are perceived by the various participating groups
- the definition and discussion of the major obstacles to create the new jobs in RES domain
- the promotion of new ideas and directions for future actions, policies and initiatives to create jobs that have to be accessible to all levels of education, at a local and regional level.

2.1 Implementation

In order to implement the Workshop "Workforce for renewables – skills and competencies improvement pathway" the following are necessary:

- **a group of 30 participants** (representing the residents, students, authorities, technological experts, private sector representatives);
- **the organizing team** (Romania's representatives in project implementation who will be responsible for managing the workshop);
- **the four facilitators (**the existence of an experienced facilitator for each group; the facilitator is an experienced person, a workshop participant, a member of the project team or an invited person);
- **adequate time** for preparing and conducting the workshop.

Table 1. Workshop schedule (timing)

Estimated time	Activity
20 minutes	**Role group session**
	The work will be opened by a member of the project implementation team (moderator of the workshop) which will announce the list of participants (by presenting each for feedback common to the four working groups) and will present those four facilitators group that will stimulate the activity of each group. Working groups will be facilitated by presentations of the speakers on the first day of the workshop.
15 minutes	**Objectives, Program and Method**
	The moderator will explain the program schedule and also explain the advantages of working in a specific four group. The idea for people to contribute and exchange a varied and sufficient number of ideas and perspectives during each discussion.
10 minutes	The facilitators give instruction and clearly explains the method, as well as its rules and roles. Once the above-mentioned instructions have been given, participants are invited to consult the rules. For each participant shall be provided worksheets 1 and 2.
	The facilitator provides workgroup few keywords which participants develop ideas. Members of each group are encouraged to have discussions among themselves - brainstorming.
45 minutes	Each participant records his ideas of action on the worksheet 2 (introduce the worksheet to the group). Each group is asked to generate 5 -6 ideas / actions. If a group makes numerous ideas / actions, it is guided to prioritize first actions to be put in the general discussion. Each group will create a poster.
60 minutes	**Plenary presentation of the 4 posters**
	Each group shows generated poster before the plenary, the poster would being presented by another member of

	the group, not necessarily by the facilitator, in order to boost participation. The group presenter summarize the main findings from their group work. Free discussions.
60 minutes	**Results of the groups' sessions**
	Completion of final statement for RO based on the previous partial statements.
60 minutes	**Joint statement development RO-BG**

2.2 Organisation of a scenario workshop

TIME: Two days

- a plenary session on the first day,
- a group session for the drafting of a specific statement on the second day.

Working session on the 2nd day will be followed up:

PROCEDURE: During the Workshop participants are divided into four groups, where they discuss current and future problems, seek solutions and suggest changes that are crucial for the improvement of creating jobs in the RES.

Small Group Instructions

- **Brainstorm solutions** - Consider new and not-so-new ideas,
- **Choose a solution** - Select the best idea, vote if necessary,
- **Make decisions** - Develop an action; Record the action plan on the poster.

1. **The facilitator** – and possibly also the chairpersons of the group sessions – play a crucial role in this process. They must be well skilled, informed and be able to create a friendly atmosphere so that everybody feels involved. Also the other staff members should be well trained so as to ensure an effective support team.
2. The discussion themes have been previously communicated to participants, trough the Agenda and during the 1st day.
3. The use of tools that stimulate the visualisation of outcomes tends to contribute to increased participant motivation: posters and keywords help participants to make them feel involved in the process. This applies also to the projection of a video or slides introducing the theme.
4. The success of the workshop depends also on the ability to adapt the methodology and the existing tools (including scenarios) to specific conditions. The methodology should be put in the right context, in a proper way. Participants should be invited to discuss on a subject that involves them directly. Essential is that they feel themselves "protagonist" of the themes debated and problems faced.
5. The participants should have a certain ability to look forward in an open-minded, creative and constructive way.
6. Putting together participants from different social groups and different views. It is this open exchange of differing views that often helps to become aware of different possible future scenarios. In its turn, this may facilitate the realisation of practical ideas.

2.3 Phases of a Workshop

Introduction and Incentive

Short presentation of the previously read by their participants' scenarios. The scenarios presented below are consistent with the presentations from Day 1 of the workshop.

Scenario1: The need of descriptors for new skills and new jobs in RES

Scenario2: The approach of enterprise in respect with workforce development in RES

Scenario3: Identification of specific skills in RES for the cross-border area

Scenario 4: Promoting of jobs in RES for different social categories.

A facilitator presented the rules and goals of work but left the participants freedom in managing group work. The facilitator encouraged participants to deliberate on, criticize, and draw ideas from the four scenarios in preparing their group's vision without, however, constraining the discussion to the scenarios content.

Stating ideas in role groups

Participants divided in four groups, according to their expertise i.e. **students, professionals, decision makers and experts,** express their ideas with regard to the workforce for renewables. This is based not only on the scenarios but also on factors such as their own experience, criticism on the proposed plans and personal frame of reference. The technique of two by two person's discussions (double interviewing) is used in order to formulate the best and worst future scenario. Finally, through round table discussions held separately in each of the groups, the main objectives for a sustainable future are selected and registered on a poster.

Discussion of ideas, General Assembly

Poster presentation and discussion of the role groups' ideas follows. A representative **(an experimented person)** from each of the four groups will present their respective vision to the rest of the groups in order to take advantage of their experience also.

Theme groups: "What should be done?"

On the second day, presentations based on experience from the first day of the workshop, work will focus on determining the manner in which ideas can be realised. Participants will be divided into four different theme groups related to what "should be done" about implementing their views in the following areas: the need of descriptors for new skills and new jobs in RES, the approach of enterprise in respect with workforce development in RES, identification of specific skills in RES for the cross-border area, promoting of jobs in RES for different social categories. The technique of writing on worksheet to propose actions is used. Each participant records his ideas for actions on worksheet 2. The group of experienced facilitators presents all the ideas to in the group, whereas the feasibility of each idea is discussed and actions are proposed.

The actions selected in each group are presented on a poster. If a group performs several actions, they

prioritize the group proposed actions to be put in the general discussion. Special care should be taken in the poster presentation in order to make the proposals explicit and appealing to the rest of the workshop participants, as the final actions proposed by the working groups will be defined by general voting.

Selection and Assessment of ideas

The ideas expressed by the working groups will be presented to the General Assembly in the form of posters. A general votes prioritises the proposals. Voting will enable ranking of ideas / actions when this process is necessary. They can vote any proposed actions, which are presented - except their own groups.

Final steps

Participants together with the experienced facilitator will evaluate the prioritised actions of the scenario workshop and it will develop the final poster of group. Completion of final statement for RO based on the previous partial statements.

Dissemination

The ideas and conclusions of the workshop are presented within the project actions. An important precondition for successful dissemination activities is the quality of the evaluation and the quality of the summaries and abstracts complementing the final report.

2.4 The participants

For the implementation of a workshop most important is the participation of citizens for the different groups. We will select 30 participants which will be distributed to the four working groups according to their accumulating experience. Thus, there will be four groups of participants:

2.4.1 Residents, Students Group

The residents' role group is composed of the following type of participants: welling formed and "educated" citizens and residents, possibly two-three representatives of the local or regional environmental movement, active residents or member of a community group.

2.4.2 Technology Expert Group

The technology expert role group is comprised of the following type of participants: technology experts, researchers or technology consultants, professors - with expertise in energy and construction and installation of renewable energy plants.

2.4.3 Private Sector Group

The private sector role group includes business people who represent the local or regional business community in one of the following sectors: environmental industry, works contracting, construction or investments.

2.4.4 Policy Makers Group

Interest groups are any organization of people with policy goals who work within the political process to promote such goals. These groups attempt to influence policy in various ways including: to influence policy-making - policy makers are actively involved either in making policy or in influencing policy; they can design policies, codify and formalize policies, and assess or approve policies; policy makers could vote on or propose policy, the broader community's opinion. The policy maker is a person who has the power to influence or determine policies and practices at an international, national, regional or local level**.** Actors can be politicians, civil servants, lobbyists, advisors, domain experts, auditors, etc. They can be a member of an administration, of a political group, parliament, council, or a member or representative of an interest group. Roles and responsibilities can vary depending on the context. Besides direct stakeholders, there are other participants with influencing power in the policy making process, especially media and citizens. They try to influence administrations and politics using different channels such as television, radio, newspapers and the Internet.

3. CONCLUSIONS

EAWS methodology is a useful tool used in the two days workshop entitled: “Workshop for renewables–skills and competencies improvement pathway”. This method is able to rise the challenge of facing the environmental problems of the cross border zone, through the inhabitants living in towns and villages.

This method was successfully used in order to promote dialogue between the parts invited to participate and having interests in RES field, in the mentioned area. The use of the method is a way of finding consensus on proposed solutions.

By the use of this method the organisers are able to provide a statement including different point of views on the improvement pathway of skills and competencies related to workforce for renewables.

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A POINT OF VIEW ON THE ROLE OF THERMODYNAMICS IN THE EDUCATION OF FUTURE ENVIRONMENTAL ENGINEERS

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ABSTRACT

The aim of this article is to point out the strong link between Thermodynamics and ecology. Since ancient times there is a strong connection between man and nature, but the development of our society, based on an increased substance and energy consumption, led to the observation in the degradation of environment.

Therefore, modern and future industry need specialists able to deal with these challenges, having skills and a approach suitable to such problems. In Constanta Maritime University are educated future environmental engineers on basis of a curricula which allows facing the energy crisis, green energy production and sustainable development.

In the sections of this paper are used concepts as ecosystem, energy, ecology in order to point out the need of a student learning and thinking, on the basis of Thermodynamics principles, when it is about the approach of industrial processes in our modern days.

By some examples, it is shown that Thermodynamics is an useful discipline in the explanation of ecological phenomena.

Keywords: *Thermodynamics, ecosystem, energy, ecology, specialist.*

1. INTRODUCTION

At the international level it is registered a rapid development of all industry sectors based on high degree of energy and resources consumption.

The progress of our society and the economic growth have to go hand in hand with efforts towards a wise use of energy resources and environmental protection, this being the challenge to be faced by specialists with skills specific to environmental friendly production and energy conversion and also to resource recycling, green planning, designing and assessment of industrial processes.

The above leads to the necessity of competencies gained during academic education, resulting on the labor market the environmental engineer, graduating the specialisation Industrial Environmental Engineering, within Constanta Maritime University.

These engineers will be able to deal with the fact that industrial economy is considered to be a network of industrial processes extracting resources from our planet and turning them into commodities provided to the society and to understand the services specific to ecosystems and their constrains.

Our students finalize their studies during two cycles, cycle I and cycle II, as seen in Figure 1.

Cycle I		
Disciplines	No. of hours	No. of credits
Compulsory	1569	120
Optional	-	-
Facultative	56	-
Sum of Compulsory and Facultative hours	1624	120

Cycle II		
Disciplines	No. of hours	No. of credits
Compulsory	994	74
Optional	574	46
Facultative	168	-
Sum of Compulsory and Facultative hours	1568	120

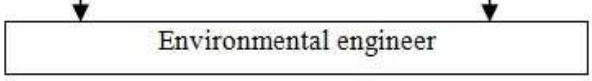

Figure 1 Environmental engineer graduating from CMU

Some of the disciplines included in the curricula are: mathematics, physics, chemistry, biodiversity, hydrology, ecopedology, environmental chemistry, thermodynamics, ecological monitoring, elements of corrosion, and electrochemistry, wind engineering, costal engineering, environmental biotechnologies.

The environmental engineer is the one trained to face concepts as conservation and management of natural resources and energy consumption during industrial processes, in a sustainable manner.

Thermodynamics, also called the science of energy, is introduced to future environmental engineers during their second year of study, first cycle and has the status of compulsory discipline being structured into 42 course hours and 28 hours of applications.

2. SHORT REVIEW ON ECOSYSTEMS, ENERGY, ECOLOGY

Industrial growth have a direct impact on the global ecosystem, human health being in close relationship with the health of ecosystems. In fact, ecosystems are material and organic habitats in which live different types of species and populations

Our modern life is not possible without energy consumption, most of energy sources relying on ecosystem services, such as water flows or biomass.

Energy production, conversion and consumption have influence on ecosystems, these being the way in meeting the increase of energy needs.

Ecology approach of industrial processes and energy concept has to deal with the complexity of living systems.

Regarding ecosystems, the following statements are very useful to be point out:

- every ecosystem is an open system fixed in an environment which provides energy-matter input and where evacuates energy-matter output;
- an ecosystem shows different stages of organization and works hierarchically;
- an ecosystem organism cannot exist isolated, but only in connection with other ones;
- all real ecosystems are irreversible.

Our students, future environmental engineers, have to be trained to use thermodynamic concepts in solve industrial problems through an ecological perspective. They have to handle thermodynamic principles within ecology frame, to explain the behaviour of ecosystems in terms of thermodynamics laws, to select the concepts suitable to be used in order to describe the energy transfer and impact on ecosystems, as the relationship between these aspects is given in Figure 2.

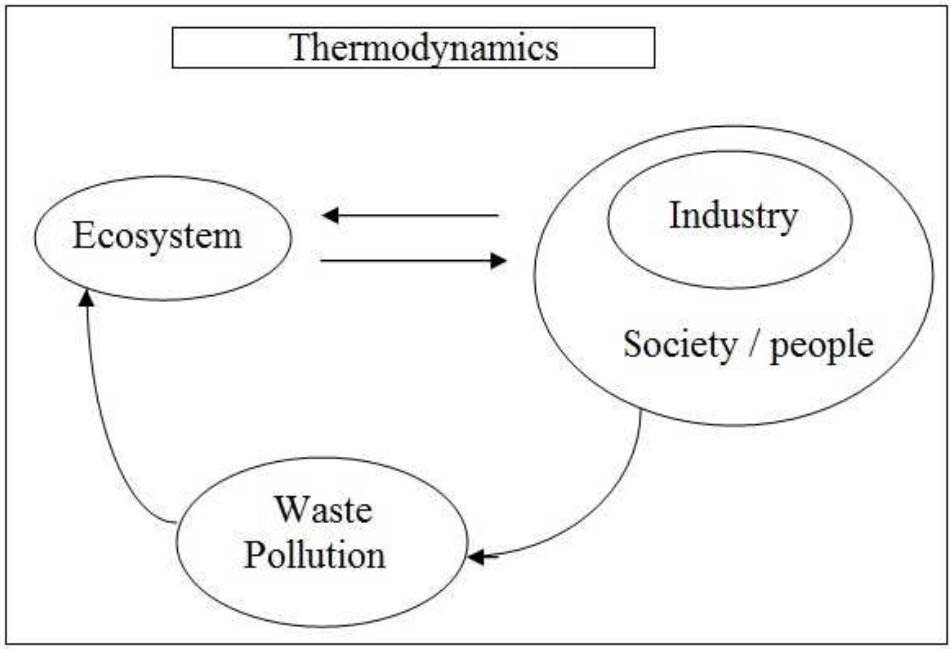

Figure 2 Picture of discipline of Thermodynamics and ecological knowledge

3. THE IMPORTANCE OF THERMODYNAMICS IN THE ECOLOGICAL KNOWLEDGE

Thermodynamics is a discipline found in the curricula of engineering programs, dealing with the heat and its raport with energy and work.

A challenge identified during Thermodynamics classes is to make students be aware of the connection between the laws of thermodynamics and ecology, since both industrial and ecological processes are limited by the available energy and its transformation into useful work.

All energy and materials flows between the society and the environment are based on the principles of Thermodynamics, which are absolutely needed for the understanding of the ecological constrains of our development.

The first principle states that energy cannot be created nor destroyed, but can only be transformed from one form to an other.

Results that the total mass of material resources getting in a process is the same at the end of it.

The total mass of production inputs is given by the sum between the mass of finished products and the global mass of wastes, the phenomena of pollution being a result of non efficient transformation of natural resources into finished products – when our planet is considered to be a system respecting the laws of Thermodynamics.

According to the second principle, the total entropy in isolated systems can only increase and energy is transformed to a more dispersed, less useful form.

When the level of organization of substance and energy is increased, their utility is also increased and vice versa.

First case is the case of low entropy, while the second is the case of high entropy. The second principle clearly states that free and unbound energy to be used in a process is lost in an irreversible manner, when its potential is used.

This law is respected by man kind systems and ecosystems, in order to decrease the entropy in a system being needed to invest without stop in new energy.

To decrease entropy in a system, it is necessary to rise the total entropy in its environment.

The more and more reduced amount of useful energy on our planet is the result of the continuously conversion of substance into energy and of useful energy into non-useful.

The same second principle introduces the concept of exergy, which is, briefly, the quality of energy. It is the measure of the useful work which can be achieved by a system when it is brought to equilibrium with its surrounding.

When discussing about ecosystems, it is convenient to choose a reference system where all the parts are inorganic at the highest oxidation state.

From thermodynamic point of view, ecosystems are open thermodynamic systems.

The climax of the ecosystem is assimilated to a dynamic equilibrium, meaning the steady-state, for which the entropy production within a system is balanced by the entropy flow from the system to its environment.

To be more specific, we take into consideration $1m^2$ of beach which is occupied by a natural ecosystem (coast plants), kept in a climax state.

For this type of ecosystem exists a natural periodicity and during this time, the internal energy of the ecosystem will rise with a value of gross primary production, measured in calories or joules.

A part of the production is util for respiration with a later conversion into heat.

The rest of the production is found into litters and other types of organic matters, to be taken by consumers. The amount of latter is quite small and it is dedicated to the support of the metabolism of the consumer; at the end it is also converted into heat.

For this reason, the latter might be included in the process of plant respiration.

Due to the fact that the system is at dynamic equilibrium, a suitable part of dead organic matter in litter and soil has to be decomposed.

In this way, it is obtained a place for additional dead organic matter from annual net primary production.

The previous dead organic matter must be burned, resulting that the chemical energy is converted into heat.

The thermodynamic parameters in the ecosystem, temperature and pressure, and in its environment are considered to be equal, as we consider isothermal and isobaric processes.

The total variation of entropy for open systems is formed by the entropy due to heat production caused by irreversibilities in the system and the entropy change process between the system and its environment. The equation is as follows:

$$dS_{tot} = d_i S + d_e S; \quad (1)$$

having in view that:

$$dS = \frac{dQ}{T}, \quad (2)$$

where:

Q – heat,

T – the current absolute temperature.

By integrating equation 1, considering one year as a natural period, results:

$$S_{final} - S_{initial} = \int_t^{t+1} \frac{P_r(\tau) + D(\tau)}{T(\tau)} d\tau - \delta_e S; \quad (3)$$

where:

P_r – heat released during the process of respiration;

D – heat released due to the process of decomposition of “dead organic matter”.

The overall metabolism of the ecosystem is equal with the metabolism of its vegetation.

The models used previously in the analysis of a industrial process where not in a close relationship with the environment, that is why the analysis based on both of the Thermodynamics principles is the proper path to be followed in modern times.

Thermodynamics is a useful discipline when explaining ecological situations, as the ones presented below:

- the speed of a water stream in a marine environment lowers the impact of competition and as well of predation, thus being registered an increase of the biological diversity,
- plants provide biomass to reduce limiting factors,
- at high latitudes, the number of species and the level of biodiversity is diminished,
- in regions with low diversity, predators switch to alternate nuriture with less prey-predator oscillations,

- a poor diversion of species leads to a slowing in some ecosystems and to a reduced level of primary production.

4. CONCLUSIONS

This paper was an attempt specific to the effort done in order to prove how important are thermodynamic principles and concepts in the explanation of ecological phenomena.

In the context of the development of our modern industrial society, when people are responsible for the changes in the ecological system of our planet, it is need the intervention of a specialist in the industrial processes, trained in accordance with the concept of ecological education.

The discipline of Thermodynamics contributes to the construction of the features of such a specialist, in Constanta Maritime University this being the environmental engineer.

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LIMITS OF THE CLOSED THIN WALL SECTION HYPOTHESIS – CASE STUDY: RING-LIKE CROSS SECTIONS

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ABSTRACT

Methods of analysis in strength of materials use simplifying hypotheses. These assumptions are useful to minimize the overall amount of calculi. Torsion of beams having thin wall sections use Bredt's hypothesis that states that the shear flow is uniform, i.e. constant in the cross-section which has a 'closed' hollow box form. Usually a thin wall is defined by the ratio $\frac{H}{b}>10$, where H is one of the major dimensions of the section and b is the thickness of the wall. Because there aren't calculus relations for thick wall closed sections having a rectangle-like shape, Bredt's hypothesis cannot be tested using the strength of materials 'classic' theory. However, for ring-type sections there are so called 'classic' calculus relations. The paper explores the extents of each type of hypotheses which use either the thick wall or the thin wall theory for ring-type sections. In this way, the ratio between the inner diameter and the outer diameter, $k=\frac{d_i}{D_e}$, $k\in[0,1]$ is the variable for which the calculus relations are tested. There were considered the relations used to compute the stresses and the relations used to compute the rate of change of the angle of twist. The resulting functions of k are graphically represented and their variation is analyzed especially for the $k\in[0.9,1.0]$ range of values, that are applicable for thin wall sections. The conclusion is that for the ring-type particular shape, the results of both types of hypotheses are closed one to the other. However, if accurate values of the shear stresses are needed in the $k\in[0.9,1.0]$ range of dimensions, there should be used the relations specific to the thin wall section theory. Significant differences are expected for other shapes of 'closed' cross sections.

Keywords: *closed thin wall section, Bredt's assumption, ring-type section, classic calculus relations, comparison.*

1. INTRODUCTION

Strength of materials is an academic discipline that offers methods of analysis of the structures. An important feature of the resulting calculus methodologies is the minimization of the volume of calculi, fact which requires the use of some simplifying hypotheses.

One of the simplifying assumptions concerning the beams loaded by twisting moments is Bredt's hypothesis, which may be used for thin wall sections.

Usually a thin wall section is defined as the cross section for which $\frac{H}{b}>10$, where H is one of the major dimensions of the section and b is the thickness of the wall.

The problem is to discern the range of the $\frac{H}{b}$ ratios in which may be used either the classic calculus relations, or the relations based on Bredt's hypothesis[1], for a ring-type section.

2. CALCULUS RELATIONS

Let us consider a ring-like cross section whose outer diameter is D_e and the inner diameter is d_i.

We define:

- the ratio of the diameters as $k=\frac{d_i}{D_e}$, $k\in[0,1]$;
- the thickness of the ring type section's wall, $b=\frac{D_e-d_i}{2}=\frac{1-k}{2}\cdot D_e$;
- the diameter along the midline $D_{midline}=\frac{D_e+d_i}{2}=\frac{1+k}{2}\cdot D_e$.

For thin wall sections, the ratio between an overall dimension of the section and the thickness of the wall is larger than 10, in our case $k\in[0.9,1.0]$.

In the following sections we use the calculus relations of the shear stresses and of the rate of change of the angle of twist, [10], firstly by considering the classic calculus relations and then by considering the relations specific for the thin wall sections.

In this way we are able to compare the results of the calculi performed using the previously mentioned relations, i.e. the according calculus assumptions.

2.1 Calculus of the stresses

If the thickness of the ring, b, is large, the maximum shear stresses may be computed using the relation:

[1] also known as the Bredt-Batho hypothesis

$$\tau_{\max} = \frac{|M_x|}{W_P} \le \tau_a \,, \quad (1)$$

where

$$W_P = \frac{\pi}{16} \cdot \left(1 - k^4\right) \cdot D_e^3 \quad (2)$$

is the polar section modulus.

By replacing W_P in relation (1), it results

$$\tau_{\max} = \frac{|M_x|}{\frac{\pi}{16} \cdot \left(1 - k^4\right) \cdot D_e^3} = \frac{16 \cdot |M_x|}{\pi \cdot D_e^3} \cdot \frac{1}{\left(1 - k^4\right)}, \quad (3)$$

If the thickness of the wall is small the section may be considered as a thin wall section. For these sections there may be applied Bredt's hypothesis that states that the shear flow is uniform, i.e. $\tau \cdot b = cst.$ in the cross-section which has a 'closed' hollow box form. The maximum shear stresses may be computed using the first formula of Bredt:

$$\tau_{\max} = \frac{|M_x|}{2 \cdot \Omega \cdot b_{\min}} \le \tau_a \,, \quad (4)$$

where Ω is the area enclosed by the midline of the section, i.e.

$$\Omega = \frac{\pi}{4} \cdot D_{midline}^2 \,. \quad (5)$$

By replacing the average diameter, it results

$$\Omega = \frac{\pi}{4} \cdot \frac{(1+k)^2}{4} \cdot D_e^2 = \frac{\pi}{16} \cdot (1+k)^2 \cdot D_e^2 \quad (6)$$

By replacing the thickness of the wall, b, and the average area, Ω, in (4), it results

$$\tau_{\max} = \frac{|M_x|}{2 \cdot \frac{\pi}{16} \cdot (1+k)^2 \cdot D_e^2 \cdot \frac{(1-k)}{2} \cdot D_e},$$

i.e.

$$\tau_{\max} = \frac{|M_x|}{\frac{\pi}{16} \cdot (1+k)^2 \cdot (1-k) \cdot D_e^3},$$

and it results

$$\tau_{\max} = \frac{16 \cdot |M_x|}{\pi \cdot D_e^3} \cdot \frac{1}{(1+k)^2 \cdot (1-k)}. \quad (7)$$

Relations (3) and (7) will be used in the following section to compare the values of the shear stresses.

2.2 Calculus of the rate of change of the angle of twist

For a large value of the thickness, b, the rate of change of the angle of twist is

$$\theta = \frac{d\varphi}{dx} = \frac{|M_x|}{G \cdot I_P} \quad (8)$$

where

$$I_P = \frac{\pi}{32} \cdot \left(1 - k^4\right) \cdot D_e^4 \quad (9)$$

is the polar moment of inertia.

It results

$$\theta = \frac{|M_x|}{G \cdot \frac{\pi}{32} \cdot \left(1 - k^4\right) \cdot D_e^4} = \frac{32 \cdot |M_x|}{\pi \cdot G \cdot D_e^4} \cdot \frac{1}{\left(1 - k^4\right)}. \quad (10)$$

For a thin wall section, the rate of change of the angle of twist is given by the second formula of Bredt:

$$\theta = \frac{|M_x|}{G \cdot I_t}, \quad (11)$$

where

$$I_t = \frac{4 \cdot \Omega^2}{\oint \frac{ds}{db}}, \quad (12)$$

is designated torsional constant[2], area constant[3] or effective polar area moment[4].

In the previous relation ds is the infinite small length along the midline of the section and db is the infinite small thickness of the wall. For a ring-type section, the integral in relation (12) is

$$\oint \frac{ds}{db} = \frac{\pi \cdot D_{midline}}{b} = \pi \cdot \frac{\frac{1+k}{2} \cdot D_e}{\frac{1-k}{2} \cdot D_e} = \pi \cdot \frac{1+k}{1-k}, \quad (13)$$

By replacing (6) and (13) in (12), it results

$$I_t = 4 \cdot \frac{\left[\frac{\pi}{16} \cdot (1+k)^2 \cdot D_e^2\right]^2}{\pi \cdot \frac{1+k}{1-k}}$$

i.e.

$$I_t = \frac{\pi \cdot D_e^4}{64} \cdot (1+k)^3 \cdot (1-k). \quad (14)$$

By replacing (14) in (11), it results

$$\theta = \frac{|M_x|}{G \cdot \frac{\pi \cdot D_e^4}{64} \cdot (1+k)^3 \cdot (1-k)},$$

i.e.

$$\theta = \frac{32 \cdot |M_x|}{\pi \cdot G \cdot D_e^4} \cdot \frac{2}{(1+k)^3 \cdot (1-k)}. \quad (15)$$

Relations (10) and (15) will be used in the section 4 in order to compare the values of the rate of change of the angle of twist.

[2] http://www.colorado.edu/engineering/CAS/courses.d/Structures.d/IAST.Lect09.d/IAST.Lect09.pdf, accessed on September 30, 2015

[3] Alexander Blake (editor), §3.4-3 Torsion of Thin-Wall, Closed Hollow Tubes, Handbook of mechanics, materials and structures, ISBN 0-471-86239-8

[4] http://www.public.iastate.edu/~e_m.424/Torsion%20of%20thin%20sections.pdf, accessed on September 30, 2015

3. COMPARISON BETWEEN THE VALUES OF THE SHEAR STRESSES

In order to evaluate the differences between the relations employed to compute the stresses, let us define the function $f_{1\sigma}(k)$ as a ratio of the relations (3) and (7), i.e.

$$f_{1\sigma}(k)=\frac{\frac{16\cdot|M_x|}{\pi\cdot D_e^3}\cdot\frac{1}{(1-k^4)}}{\frac{16\cdot|M_x|}{\pi\cdot D_e^3}\cdot\frac{1}{(1+k)^2\cdot(1-k)}}.$$

We transform this function in order to have a simpler form:

$$f_{1\sigma}(k)=\frac{(1+k)^2\cdot(1-k)}{(1-k^4)}=\frac{(1+k)^2\cdot(1-k)}{(1-k^2)\cdot(1+k^2)},$$

$$f_{1\sigma}(k)=\frac{(1+k)^2\cdot(1-k)}{(1+k)\cdot(1-k)\cdot(1+k^2)}=\frac{(1+k)}{(1+k^2)}.$$

It results

$$f_{1\sigma}(k)=\frac{1+k}{1+k^2}. \qquad (16)$$

The variation of the $f_{1\sigma}(k)$ function is presented in the following figure.

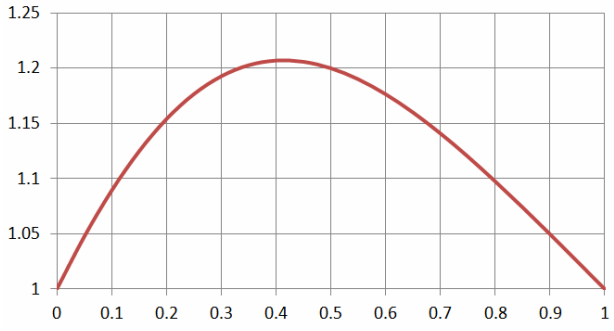

Figure 1 – Variation of the $f_{1\sigma}(k)$ function

By analyzing the most remote value of the $f_{1\sigma}(k)$ function with respect to 1 ('1' means that the results are the same) in the $k\in[0.9,1.0]$ range, it results $f_{1\sigma}(k=0.9)=1.049724$. This means that the results of the two calculus methods are close one to the other. Even though, if accurate results are needed, the first formula of Bredt should be used for the calculus of the shear stress.

4. COMPARISON BETWEEN THE VALUES OF THE RATE OF CHANGE OF THE ANGLE OF TWIST

Let us define the function $f_{1\theta}$ as the ratio of relations (10) and (15).

$$f_{1\theta}=\frac{\frac{32\cdot|M_x|}{\pi\cdot G\cdot D_e^4}\cdot\frac{1}{(1-k^4)}}{\frac{32\cdot|M_x|}{\pi\cdot G\cdot D_e^4}\cdot\frac{2}{(1+k)^3\cdot(1-k)}},$$

We transform $f_{1\theta}$ in order to have a simpler form:

$$f_{1\theta}=\frac{(1+k)^3\cdot(1-k)}{2\cdot(1-k^4)}=\frac{(1+k)^3\cdot(1-k)}{2\cdot(1-k^2)\cdot(1+k^2)},$$

$$f_{1\theta}=\frac{(1+k)^3\cdot(1-k)}{2\cdot(1+k)\cdot(1-k)\cdot(1+k^2)}.$$

It results

$$f_{1\theta}=\frac{1}{2}\cdot\frac{(1+k)^2}{(1+k^2)}. \qquad (17)$$

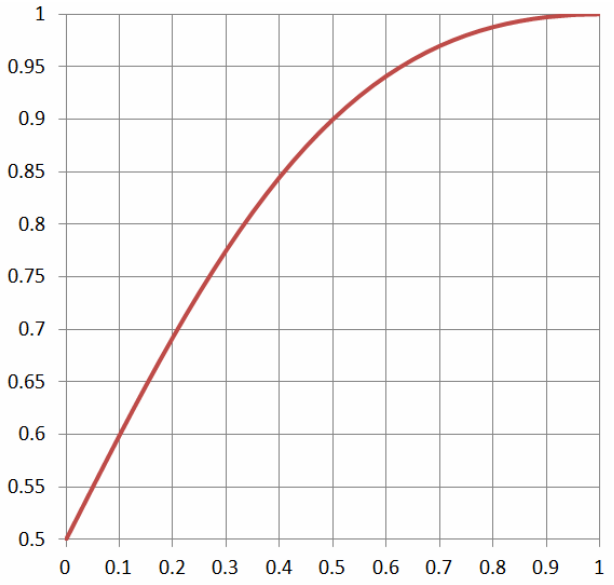

Figure 2 – Variation of the $f_{1\theta}(k)$ function

By analyzing the maximum value of the $f_{1\theta}(k)$ function with respect to 1 ('1' means that the results are the same) in the $k\in[0.9,1.0]$ range, it results $f_{1\theta}(k=0.9)=0.999343$. This means that the results of the two calculus methods are very close one to the other.

5. CONCLUSIONS

The automatic calculus in strength of materials is a long run concern of the authors, [1], [2], [7], and [9].

Computer aided analytical studies based on the strength of materials theory must use the appropriate calculus relations, in accord with the simplifying hypotheses used to deduce these formulas. The best method to conceive general and intelligent software applications is to create parameterized models and to test the appropriateness of the calculus relations with respect

to the dimensions of the geometric model, i.e. to verify if the simplifying hypotheses are respected.

The paper explores the limits of Bredt's hypothesis used for thin wall cross sections for a particular case, the ring-type section, for which there are calculus relations in the thick-walls assumption.

According to the results of the study, for the $k \in [0.9, 1.0]$ range, i.e. $\frac{D_e}{b} > 10$, this means for a thin wall tube, the values of the stresses and of the rate of change of the angle of twist computed using both types of relations are close one to the other. Although, if very accurate results of the stresses must be computed, there should be used the first formula of Bredt. Important differences between the results are expected for other shapes of 'closed' cross sections.

Testing the limits of the simplifying hypothesis is far more important if alternate calculus methods are conceived without considering the 'classic' assumptions, approach which is more general. These studies use more advanced mathematical instruments which must be implemented as original software applications, [3].

6. ACKNOWLEDGMENTS

Ideas regarding the models based on the strength of materials theory are the result of the studies developed in the framework of the MIEC2010 bilateral Ro-Md research project, "Mathematical Models for Inter-Domain Approaches with Applications in Engineering and Economy", [6], under the supervision of the National Authority for Scientific Research (ANCS), Romania, which is the follow-up of the ID1223 scientific research project: "Computer Aided Advanced Studies in Applied Elasticity from an Interdisciplinary Perspective", 2007-2010, [4], under the supervision of the National University Research Council (CNCSIS), Romania.

Ideas regarding the analytical models and the automatic calculus in structural studies are partial results of the models developed in the scientific research study 'Development of computer assisted marine structures', which is a component of the RoNoMar project, [5], [8], 2012.

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TESTS REGARDING THE DIMENSIONS OF THE 'NARROW' RECTANGLES BELONGING TO OPEN THIN WALL SECTIONS

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ABSTRACT

Strength of materials theory is based on several simplifying hypotheses which were conceived in an era of technological development when the calculus instrument was not advanced. One of the goals of the according methods of analysis was to include a small volume of calculi. Therefore, the calculations should consider the limits of the simplifying hypotheses in order to have accurate results. According to the torsion of open thin wall sections theory, the cross section loaded by a twisting moment must be divided in 'narrow' rectangles for which the recommended ration of the sides should be $\frac{h}{b}>10$. There are no analytical methods to assess the variation of the shear stresses and of the angle of twist with respect to the $\frac{h}{b}$ ratio. However, if a unique rectangle is considered, there are methods to compute the shear stress and the angle of twist. For variable $\frac{h}{b}$ ratios there may be noticed the values of the shear stress and of the angle of twist for both rectangular sections and a cross section having a 'narrow' rectangle shape. The first test is dedicated to the evaluation of the values of the $\frac{h}{b}$ ratios which are in the 'transition' zone from one hypothesis to the 'narrow' rectangle hypothesis. Moreover, the error between the values computed under the both types is also evaluated, being possible to assume if the $\frac{h}{b}=10$ is the appropriate ratio from which the 'narrow' rectangle hypothesis may be used. This is an exploratory examination, more accurate methods being used in the follow-up studies where the results of the analytic model will be compared with the results of the numerical models based on the finite element method. The second test considers an open thin wall section which may be discretized in several 'narrow' rectangles. The conclusion is that the 'mid-line' rule used to divide the section is a sufficient condition in order to have a unique value of the torsion second moment of area also known as the torsional moment of inertia, I_t.

Keywords: *open thin wall section, narrow rectangles, ratio of the sides, classic calculus relations, tests.*

1. INTRODUCTION

Calculus methodologies based on the strength of materials theory must take into account the limits of the simplifying hypotheses on which the theory is based. A direct effect is the small volume of calculi to be performed by the structural analyst, which is an important aspect if a modern calculus instrument is not available.

In the past 50 years the calculus instrument evolved from the slide rules[1] to electronic pocket calculators[2] and furthermore, to the nowadays advanced computers.

Testing the limits of the simplifying hypothesis is important for several reasons:

- creation of the computer based analytic models must use the proper calculus relations with respect to the current dimensions of the structure, in accord to the assumptions employed in the theory;
- some hypotheses may be disregarded if modern computing techniques are used.

Some of the simplifying assumptions concern the open thin wall sections loaded by twisting moments. These sections may be divided in so-called 'narrow' rectangles for which $\frac{h}{b}>10$, where h is the largest side of the current rectangle.

Regarding this type of load and section we identify two issues:

- if the $\frac{h}{b}$ ratio which theoretically must be larger than 10 is an accurate hypothesis;
- if there may be identified an optimal method to divide an open thin wall section in a set of 'narrow' rectangles.

In order to answer to these questions in an initial approach we will consider some tests based on analytical relations. At a later stage we will use more advanced

[1] which is a mechanical analog computer, https://en.wikipedia.org/wiki/Slide_rule, accessed on November 29, 2015

[2] https://en.wikipedia.org/wiki/Calculator, accessed on November 29, 2015

calculus methods, i.e. the finite element method, to answer to the aforementioned questions.

2. TEST NO. 1 – A SIMPLE 'NARROW' RECTANGLE

Let us consider a rectangle cross section having the sides $h > b$, loaded by the M_X twisting moment.

According to the theory, [11], for the ratio $1 < \frac{h}{b} < 10$, the variation of the stresses is presented in figure 1, and the maximum stresses are:

$$\begin{cases} \tau_{\max\max} = \dfrac{M_X}{\alpha \cdot h \cdot b^2} \\ \tau_{\max} = \dfrac{M_X}{\alpha' \cdot h \cdot b^2} \end{cases} . \quad (1)$$

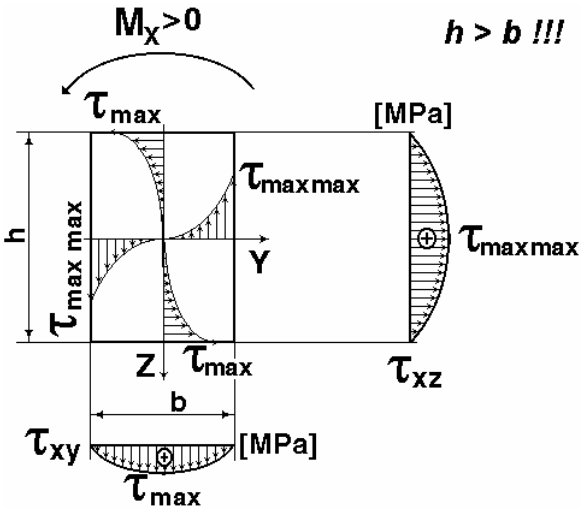


Figure 1 – Variation of the shear stresses in a rectangle cross section loaded by a twisting moment

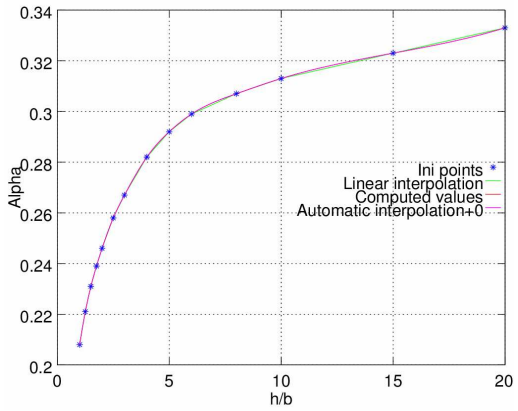
The angle of twist between two sections located at length ℓ is

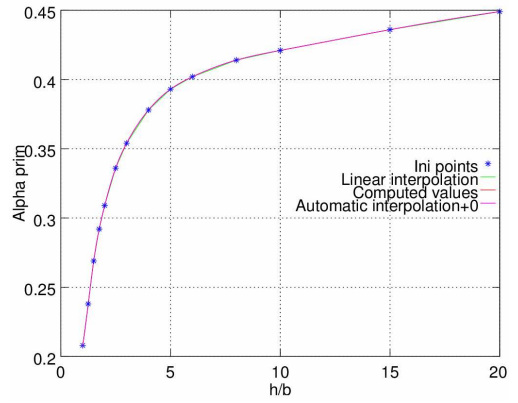
$$\Delta\varphi = \frac{M_X \cdot \ell}{\beta \cdot h \cdot b^3 \cdot G} . \quad (2)$$

Coefficients α, α' and β are depending on the $\frac{h}{b} > 1$ ratio and their values are listed in tables. Using the original software instrument presented in [10], there were plotted the α, α' and β diagrams, figure 2. Some methods to interpolate their values are given in [7]. In this case we use the spline interpolation:

$$f(x) = \sum_{i=1}^{N} [H(x - x_i) - H(x - x_{i+1})] \cdot \cdot \left[A_i \cdot (x - x_i)^3 + B_i \cdot (x - x_i)^2 + C_i \cdot (x - x_i) + D_i\right] \quad (3)$$

where f is α, α' and β, x is $\frac{h}{b}$, $H(x)$ is Heaviside's unit function and $N = 13$ is the number of intervals.





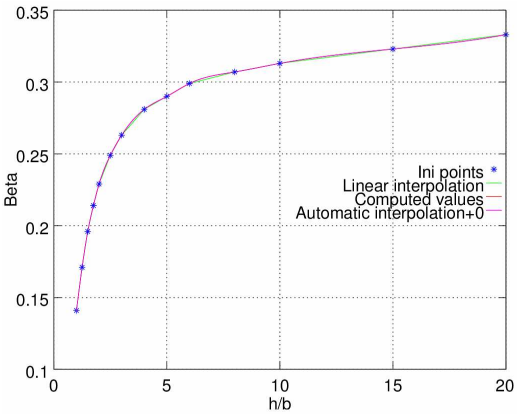


Figure 2 – Variation of the α, α' and β coefficients

$$H(x - x_j) = \begin{cases} 0, & x < x_j \\ +\dfrac{1}{2}, & x = x_j \\ +1, & x > x_j \end{cases}, \ \forall x_j \quad (4)$$

However, these relations are approximating the values listed in tables for which $\alpha = \frac{1}{3}$ and $\beta = \frac{1}{3}$ for $\frac{h}{b} \to \infty$.

Other relations to compute the α, α' and β coefficients are based on the theory of elasticity approaches which use trigonometric series, [11].

For β there are also some relations which approximate its value, such as:

$$\beta = \frac{1}{3} - 0.21 \cdot \frac{b}{h} \cdot \left(1 - \frac{b^4}{12 \cdot h^4}\right). \quad (5)$$

Moreover, for $\frac{h}{b} > 5$, there are considered the relations[3]:

$$\alpha = \beta = \frac{1}{3} \cdot \left(1 - 0.63 \cdot \frac{b}{h}\right) \quad (6)$$

According to the theory, [11], for the ratio $\frac{h}{b} > 10$, the rectangle is considered to be 'narrow', the according calculus scheme being presented in figure 3.

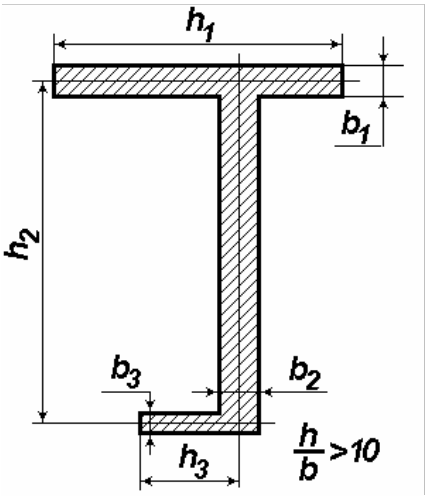


Figure 3 – Dimensions of the 'narrow' rectangles of an open thin wall section

The stresses are computed using the relation

$$\tau_i = \frac{M_X}{I_t} \cdot b_i, \quad (7)$$

where I_t may be computed using the relation

$$I_t = \frac{1}{3} \cdot \sum_{j=1}^{N} \left(h_j \cdot b_j^3\right) \quad (8)$$

and it is designated torsion second moment of area[4], or torsional moment of inertia[5].

The angle of twist between two sections located at distance ℓ is calculated using the relation

$$\Delta\varphi = \frac{M_X \cdot \ell}{G \cdot I_t}. \quad (9)$$

The question is what is the $\frac{h}{b}$ ratio from which the classic rectangle may be considered a narrow rectangle? In order to answer to this question we consider the maximum shear stresses and the angle of twist.

In order to study these problems we consider the particular form of relation (8) for a unique 'narrow' rectangle and it results:

$$I_t = \frac{h \cdot b^3}{3}. \quad (10)$$

We replace (10) in (7) and it results:

$$\tau^{narrow\ rectangle} = \frac{M_X}{\frac{1}{3} \cdot h \cdot b^3} \cdot b = \frac{M_X}{\frac{1}{3} \cdot h \cdot b^2}. \quad (11)$$

By equaling $\tau_{\max\max}$ from relation (1), with the shear stress expressed by relation (11), i.e.

$$\frac{M_X}{\alpha \cdot h \cdot b^2} = \frac{M_X}{\frac{1}{3} \cdot h \cdot b^2},$$

it results

$$\alpha = \frac{1}{3}. \quad (12)$$

Next we consider the angle of twist (9) in which we replace (10) and it results the angle of twist for a unique 'narrow' rectangle:

$$\Delta\varphi^{narrow\ rectangle} = \frac{M_X \cdot \ell}{\frac{1}{3} \cdot h \cdot b^3 \cdot G}. \quad (13)$$

By equaling relations (2) and (13) it results

$$\frac{M_X \cdot \ell}{\beta \cdot h \cdot b^3 \cdot G} = \frac{M_X \cdot \ell}{\frac{1}{3} \cdot h \cdot b^3 \cdot G},$$

i.e.

$$\beta = \frac{1}{3}. \quad (14)$$

From the table where coefficients α and β are listed we notice that for both (12) and (14), the ratio $\frac{h}{b}$ should be infinite. However, in the limits of the 'narrow' rectangle theory, i.e. for $\frac{h}{b} \geq 10$, from the according tables we have for $\frac{h}{b} = 10$

$$\alpha = \beta = 0.313, \quad (15)$$

which leads to a relative error of α and β with respect to (12) and (14) of

$$\varepsilon_{\alpha,\beta} = 6.1\%. \quad (16)$$

[3] http://faculty.arch.tamu.edu/media/cms_page_media/4198/NS24torsion.pdf

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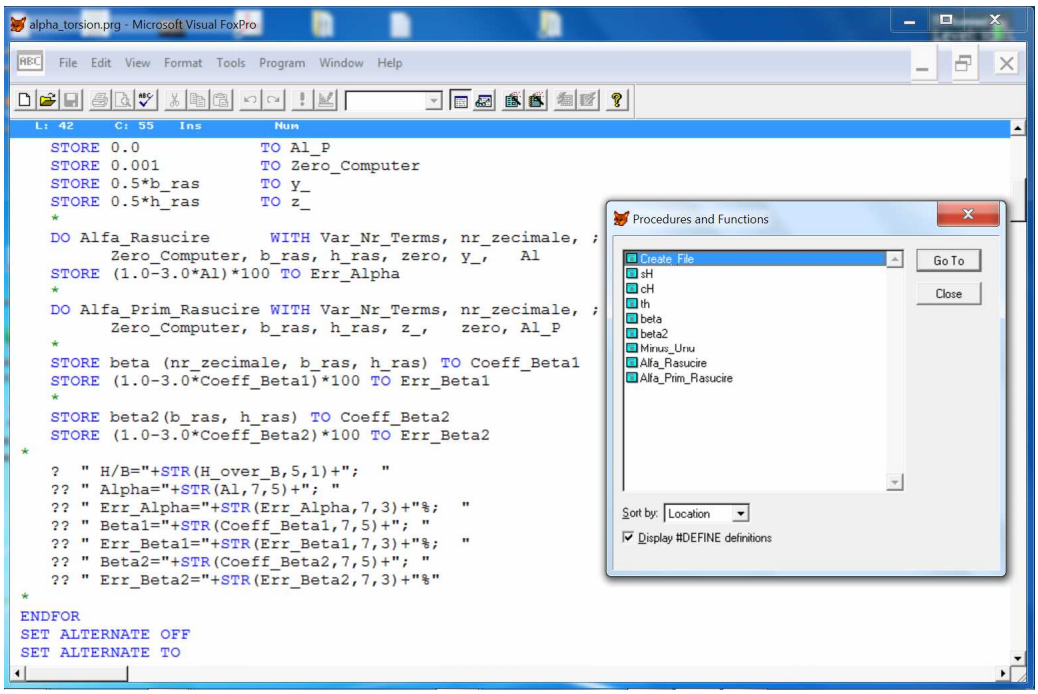

Figure 4 – Computer code developed to determine the values of α, β and the according errors

Table 1 – Values of α, β and the according errors with respect to (12) and (14)

$\frac{h}{b}$	[-]	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
α	[-]	0.3093	0.3125	0.3151	0.3173	0.3192	0.3210	0.3224	0.3237	0.3249	0.3261	0.3267	0.3278	0.3288	0.3294	0.3305	0.3309	0.3320	0.3324
ε_α	[%]	7.206	6.243	5.470	4.811	4.231	3.700	3.277	2.890	2.529	2.183	1.974	1.657	1.335	1.182	0.857	0.730	0.385	0.278
β	[-]	0.3071	0.3099	0.3123	0.3142	0.3158	0.3172	0.3183	0.3193	0.3202	0.3209	0.3216	0.3223	0.3228	0.3233	0.3238	0.3242	0.3246	0.3249
ε_β	[%]	7.878	7.003	6.302	5.730	5.252	4.848	4.502	4.202	3.939	3.707	3.501	3.317	3.151	3.001	2.865	2.740	2.626	2.521
$\beta_{(5)}$	[-]	0.3071	0.3100	0.3123	0.3142	0.3158	0.3172	0.3183	0.3193	0.3202	0.3209	0.3216	0.3223	0.3228	0.3233	0.3238	0.3242	0.3246	0.3249
$\varepsilon_{\beta_{(5)}}$	[%]	7.875	7.000	6.300	5.727	5.250	4.846	4.500	4.200	3.937	3.706	3.500	3.316	3.150	3.000	2.864	2.739	2.625	2.520

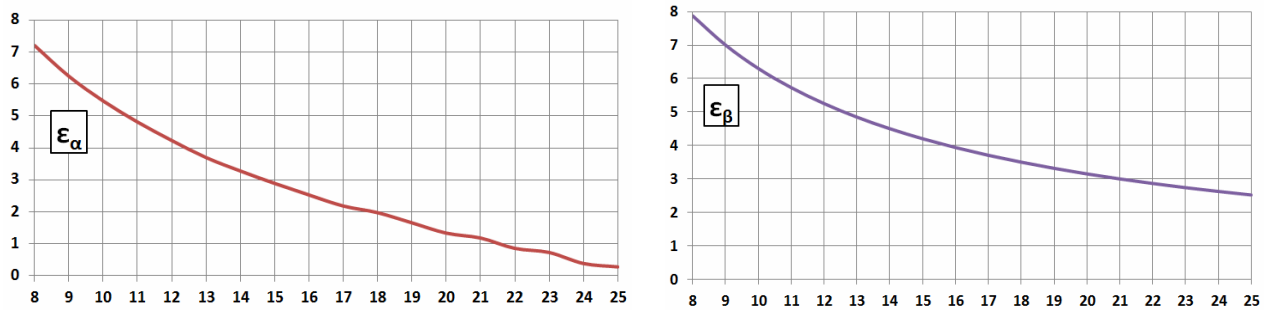

Figure 5 – Error variation of the α and β coefficients with respect to $\frac{h}{b} \in [8, 25]$

It results that for a unique rectangle, the $\frac{h}{b}=10$ ratio leads to an error of 6.1% and the error will decrease if the $\frac{h}{b}$ ratio will increase.

In order to have a quantitative assessment of this variation between the error the $\frac{h}{b}$ ratio we use the relations of α and β provided by the theory of elasticity, [11]. For β it is also used relation (5).

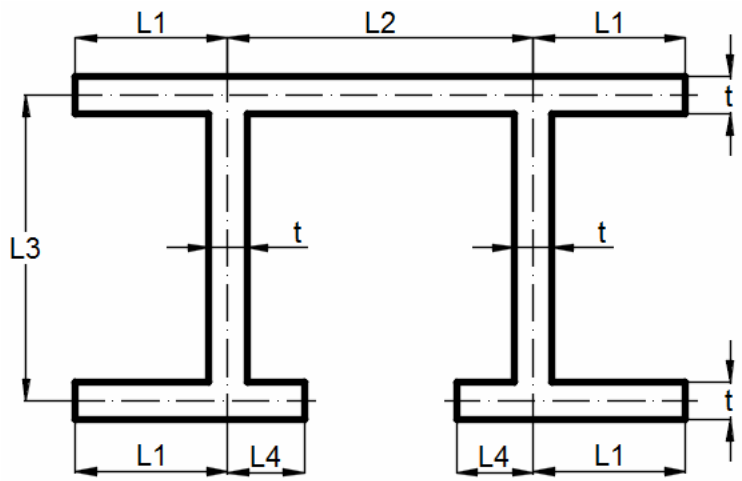

Figure 6 – Case study: composite cross section which can be discretized in 'narrow' rectangles

Figure 4 presents the computer code and the list of procedures and functions. As it can be noticed, coefficient β is computed using two methods.

The results are presented in table 1. The values of the β coefficient, values computed using the relation resulted from the theory of elasticity and by the use of relation (5), are close one to the other. The variations of the relative errors with respect to the values (12) and (14) are presented in figure 5.

3. TEST NO. 2 - COMPARISON BETWEEN THE DISCRETIZATIONS OF THE OPEN THIN WALL SECTIONS IN 'NARROW' RECTANGLES

In order to evaluate the differences between the discretizations we consider the cross section presented in figure 6.

Taking into account relation (8) we notice that the 'thickness' of the wall is powered by 3, therefore it has a great importance in the calculus of the torsion second moment of area. It results that the first criterion in the discretization of an open thin wall section in 'narrow' rectangles is the thickness of the wall.

Next we may consider several discretizations of the section following the rule: *"dimensions of the 'narrow' rectangles are measured along the mid-line of the cross section"*. It results that for any type of discretization, the torsion second moment of area is:

$$I_t = \frac{1}{3}\cdot\left[\overbrace{\left(L_1+L_2+L_3\right)\cdot t^3}^{\text{the topmost horizontal rectangle}} + \overbrace{2\cdot\left(L_3\cdot t^3\right)}^{\text{the vertical rectangles}} + \right. \tag{17}$$

$$\left. + \underbrace{2\cdot\left(L_1+L_4\right)\cdot t^3}_{\text{the bottommost horizontal rectangles}}\right]$$

It results that the 'mid-line rule' is sufficient in order to have a unique result of the torsion second moment of area and, further on, of the shear stress and of the angle of twist.

4. CONCLUSIONS

The creation of computer based analytic studies and models is a constant concern of the authors, the automatic calculus which uses the strength of materials theoretical background being an important aspect, [1], [2], [7], and [9]. In this type of studies, especially for parametric definitions of the calculus domain, there must be used the appropriate calculus relations, in accord with the current hypotheses.

Regarding the open thin wall sections loaded by twisting moments, this type of cross sections may be divided in 'narrow' rectangles. According to the so called classic hypothesis, the ratio of a 'narrow' rectangle must be $\frac{h}{b}>10$. There are no analytic methods to verify this ratio, i.e. this assumption. However, there may be considered a unique rectangle, whose ratio $\frac{h}{b}$ may be considered variable. For $\frac{h}{b}<10$ ratios, there may be used the calculus relations deduced for rectangular cross sections. In this case, there may be analyzed the errors between the shear stresses and angles of twist computed by the use of rectangular cross section hypothesis and using the 'narrow' rectangle assumption. It results that the extreme values of the α and β coefficients must be, according to (12) and (14), $\frac{1}{3}$. However, there was analyzed the variation of the α and β coefficients in order to identify a transition domain of the $\frac{h}{b}$ ratio between the previously mentioned assumptions. The ε_α and ε_β errors for $\frac{h}{b}=10$ are larger than 5% and they are decreasing under 3% for $\frac{h}{b}>20$.

However, in order to have conclusive results, this study will be followed by a thorough examination of an open thin wall section whose $\frac{h}{b}$ ratio of the 'narrow' rectangles will be variable, study which will use the finite element method. The evaluation of the limits of the simplifying assumptions was a constant concern of the authors, being developed new calculus methods based on numerical methods implemented in original software instruments, [3].

The second test reveals that the 'mid-line rule' is sufficient in order to have a unique result of the torsion second moment of area and, further on, of the shear stress and of the angle of twist.

5. ACKNOWLEDGMENTS

Concepts of computer analytical models based on the strength of materials theory were developed in the framework of the MIEC2010 bilateral Ro-Md research project, "Mathematical Models for Inter-Domain Approaches with Applications in Engineering and Economy", [6], under the supervision of the National Authority for Scientific Research (ANCS), Romania, which is the follow-up of the ID1223 scientific research project: "Computer Aided Advanced Studies in Applied Elasticity from an Interdisciplinary Perspective", 2007-2010, [4], under the supervision of the National University Research Council (CNCSIS), Romania.

Development of analytical models using the automatic calculus in structural studies was also accomplished in the scientific research study 'Development of computer assisted marine structures', which is a component of the RoNoMar project, [5], [8], 2012.

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CASE STUDY REGARDING THE PRODUCTION OPTIMIZATION AND THE ACCORDING COMPUTER BASED SOLUTION

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ABSTRACT

Production demassification leads to small series production or unique product production. The according activities may be expressed with respect to project management principles. A particular production process requires a customized solution, in this way the use of an original software instrument being necessary to synthesize the relevant indicators of the project and to conceive optimization scenarios. The paper presents a case study and the original software solution that allows a flexible and optimized approach regarding the optimization of the processes.

Keywords: *Production demassification, project management, time optimization, original software.*

1. INTRODUCTION

The cost of a given industrial product and its just-in-time production are very important in the merchantability of that given product. At present there are several software instruments used for the production data management, production monitoring and product lifetime management. However, in the design of the optimal technology of a given product the most general approach is given by the project management theory. In the following sections are presented a case study and the original software which was tested for several scenarios.

2. CASE STUDY

Let us consider the activities in a given project, all the details being presented in figure 1.

We calculate the length of the critical path which is the longest series of sequential operations:

$$L_{D_1} = \ell_{01} + \ell_{14} + \ell_{47} = 2+4+3 = 9;$$

$$L_{D_2} = \ell_{01} + \ell_{12} + \ell_{25} + \ell_{57} = 2+1+6+4 = 13;$$

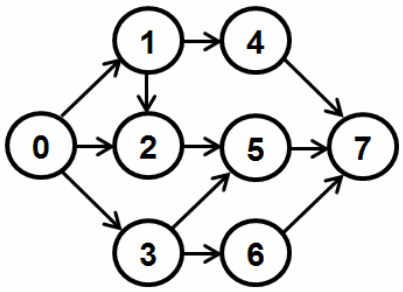
$$L_{D_3} = \ell_{02} + \ell_{25} + \ell_{57} = 5+6+4 = 15;$$

$$L_{D_4} = \ell_{03} + \ell_{35} + \ell_{57} = 3+2+4 = 9$$

$$L_{D_5} = \ell_{03} + \ell_{36} + \ell_{67} = 3+3+3 = 9;$$

$$\max\left(L_{D_i}\right) = \max(9, 13, 15, 9, 9) = 15.$$

Early start date of the (i, j) activity is $t_m^i(i, j) = t_i^m$. Early finish date of the (i, j) activity is $t_m^t(i, j) = t_i^m + d_{ij}$. Late finish date of the (i, j) activity is $t_M^i(i, j) = t_i^M$. Late start date of the (i, j) activity is $t_M^i(i, j) = t_j^M - d_{ij}$. The early start date of the following activity is $t_m^t((i, j)+1) = t_{m\,j}$. Total time reserve of the (i, j) activity is $R_t(i, j) = t_M^t - t_m^t = t_j^M - t_i^m - d_{ij}$. The free time reserve of the (i, j) activity is $R_\ell(i, j) = t_j^m - t_i^m - d_{ij}$.



No.	Activity	Activity symbol	Activity duration	No of units
1	A	0-1	2	5
2	B	0-2	5	4
3	C	0-3	3	7
4	D	1-2	1	3
5	E	1-4	4	6
6	F	2-5	6	8
7	G	3-5	2	2
8	H	3-6	3	4
9	I	4-7	3	5
10	J	5-7	4	3
11	K	6-7	3	6

Figure 1 - Graph of the activities, duration and units allocated to each activity

According to the previous definitions, the early start dates are:

$$t_0^m = 0,$$

$$t_1^m = \max\left(t_0^m + d_{01}\right) = 2,$$

$$t_2^m = \max\left(t_0^m + d_{02}, t_1^m + d_{12}\right) = \max(5, 3) = 5,$$

$$t_3^m = \max\left(t_0^m + d_{13}\right) = 3,\ t_4^m = \max\left(t_1^m + d_{13}\right) = 6,$$

$$t_5^m = \max\left(t_2^m + d_{25}, t_3^m + d_{35}\right) = \max(5+6, 3+2) = 11,$$

$$t_6^m = \max\left(t_3^m + d_{36}\right) = 6,$$

$$t_7^m = \max\left(t_4^m + d_{47}, t_5^m + d_{57}, t_6^m + d_{67}\right) =$$

$$= \max(6+3, 11+4, 6+3) = 15.$$

Similarly, considering that the minimum duration of the project is $T = 15$, the late finish dates are

$$t_7^M = 15,\ t_6^M = \min\left(t_7^M - d_{67}\right) = 15-3 = 12,$$

$$t_5^M = \min\left(t_7^M - d_{57}\right) = 15-4 = 11,$$

$$t_4^M = \min\left(t_7^M - d_{47}\right) = 15-3 = 12,$$

$$t_3^M = \min\left(t_5^M - d_{35}, t_6^M - d_{36}\right) =$$

$$= \min(11-2, 12-3) = \min(9, 9) = 9,$$

$$t_2^M = \min\left(t_5^M - d_{25}\right) = 11-6 = 5,$$

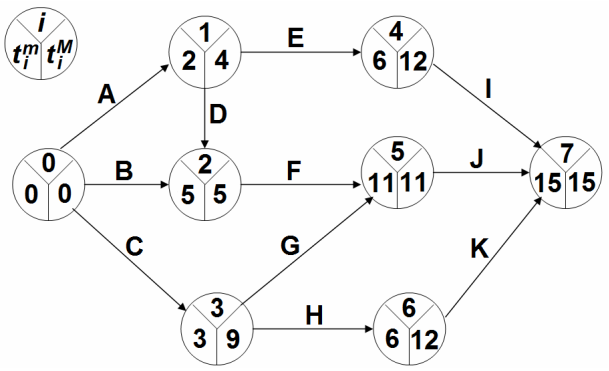
$$t_1^M = \min\left(t_4^M - d_{14}, t_2^M - d_{12}\right) =$$

$$= \min(12-4, 5-1) = \min(8, 4) = 4,$$

$$t_0^M = \min\left(t_1^M - d_{01}, t_2^M - d_{02}, t_3^M - d_{03}\right) =$$

$$= \min(4-2, 5-5, 9-3) = \min(2, 0, 6) = 0.$$

The early finish date of the j event is $t_j^m = d_{\max}(1, j)$. According to Ford's algorithm, in a graph without circuits the early finish date is $t_j^m = \max_{(i,j)\in\Gamma}\left(t_i^m + d_{ij}\right)$, $1 < j \le n$. For the initial event, we have $t_0 = 0$, $j = 0$. The according results are stored in table 1.



Node	Early finish	Late finish
0	0	0
1	2	4
2	5	5
3	3	9
4	6	12
5	11	11
6	6	12
7	15	15

Figure 2 - Graph assigned to the project by the use of the Critical Path Method and the according 'early' and 'finish' dates.

Table 1. Information regarding the duration of the activities and the according relevant dates

No	Activ	Nodes	Durat.	Min. Term		Max. term		Min. term to start next activity	Time reserve	
				start	finish	start	finish		free	total
1	**A**	0-1	2.0	0.0	2.0	2.0	4.0	2.0	0.0	2.0
2	**B**	0-2	5.0	0.0	5.0	0.0	5.0	5.0	0.0	0.0
3	**C**	0-3	3.0	0.0	3.0	6.0	9.0	3.0	0.0	6.0
4	**D**	1-2	1.0	2.0	3.0	4.0	5.0	5.0	2.0	2.0
5	**E**	1-4	4.0	2.0	6.0	8.0	12.0	6.0	0.0	6.0
6	**F**	2-5	6.0	5.0	11.0	5.0	11.0	11.0	0.0	0.0
7	**G**	3-5	2.0	3.0	5.0	9.0	11.0	11.0	6.0	6.0
8	**H**	3-6	3.0	3.0	6.0	9.0	12.0	6.0	0.0	6.0
9	**I**	4-7	3.0	6.0	9.0	12.0	15.0	15.0	6.0	6.0
10	**J**	5-7	4.0	11.0	15.0	11.0	15.0	15.0	0.0	0.0
11	**K**	6-7	3.0	6.0	9.0	12.0	15.0	15.0	6.0	6.0

Figure 4 presents the graph of the activities and the reserve time and it is necessary for the subsequent study.

One of the important problems in the project management of an industrial production process is the resource leveling which analyses the available resources, compare them to the requirements of the ongoing projects and allocates them in an optimal way. Sometimes, projects, tasks or activities will overlap, creating constrains regarding the resources, especially manpower. An effect of the rational allocation of the resources is the fact that the personnel doesn't work overtime, i.e. additional costs are avoided.

In this way, figure 5 uses the information from figure 4 and presents the resource distribution in the initial conditions. As it can be noticed, it is a great imbalance between the units allocated in the final stage of the project, i.e. 3, and the maximum number of units, i.e. 19 or 20.

Starting from this allocation, figure 5, there were studied several scenarios of optimization.

First scenario is presented in figure 6. It reduces the intensity of resource assignments in the middle period of the project, by increasing the workload in the final period.

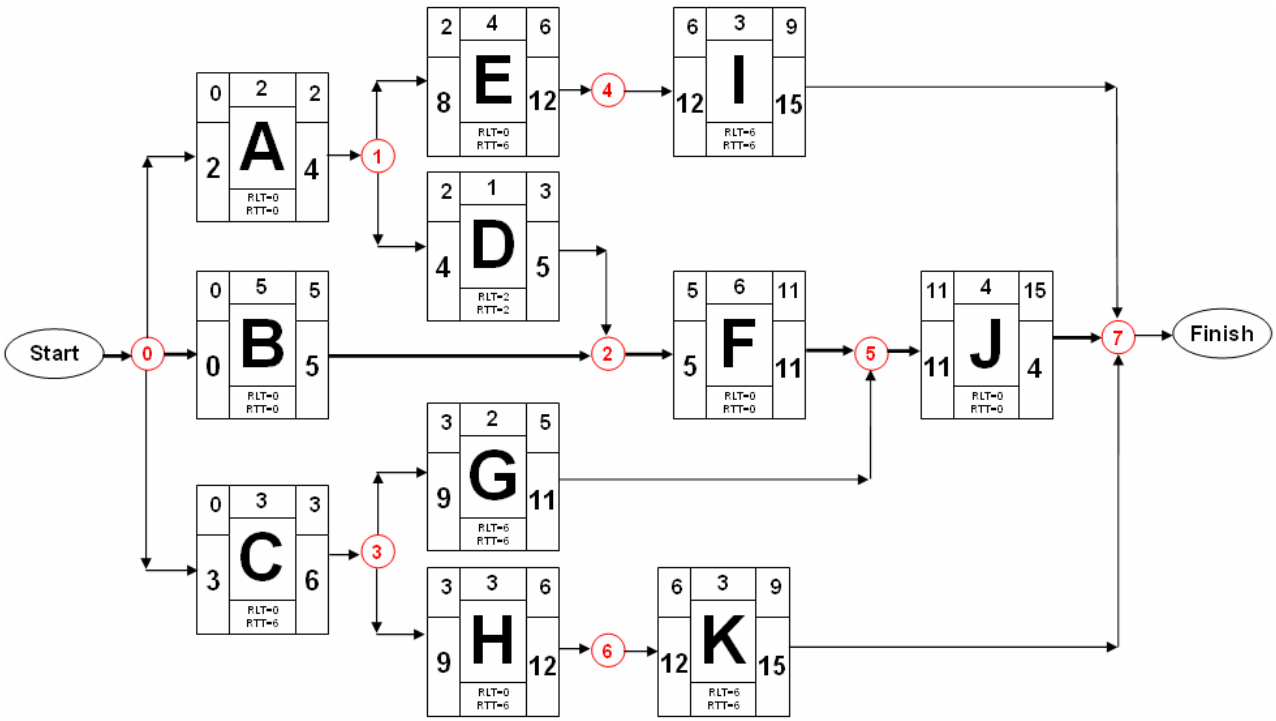


Figure 3 - Graph of the network with the activities represented in the nodes of the graph – PERT chart

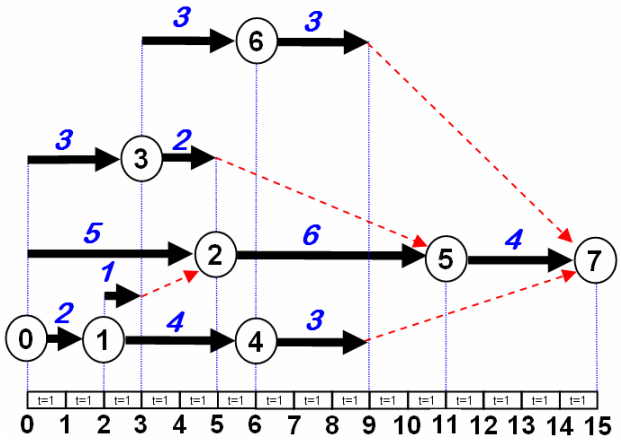


Figure 4 - Graph which presents the reserve time

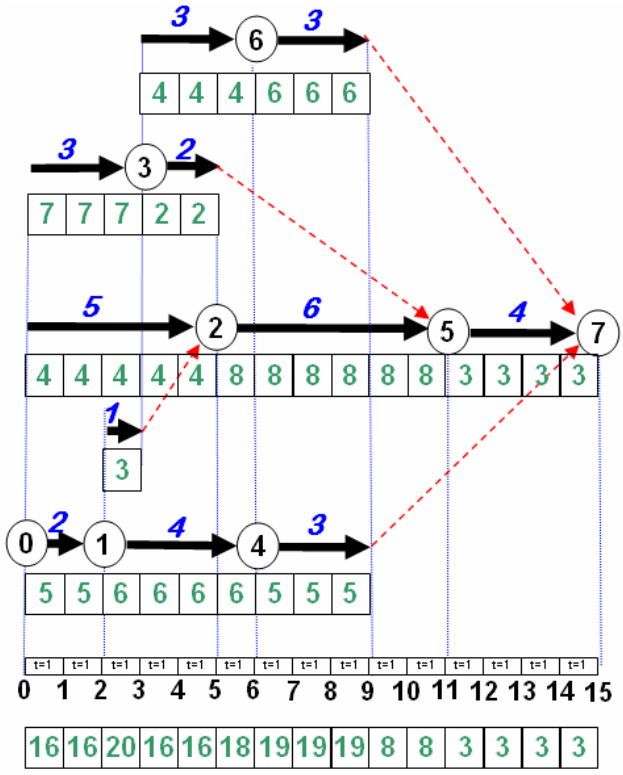


Figure 5 - Resource distribution – initial conditions

According to the initial allocation of the resources, we notice a maximum of 20 units from work interval no. 3, compared to 3 units in the intervals 12, 13, 14 and 15, which leads to a maximum imbalance of 17 conventional units.

According to the optimization scenario no. 1, in the work interval no. 3 we have 20 units and in the work interval 12 we have 7 units, therefore the maximum imbalance is 13 conventional units. The imbalance is smaller in this scenario.

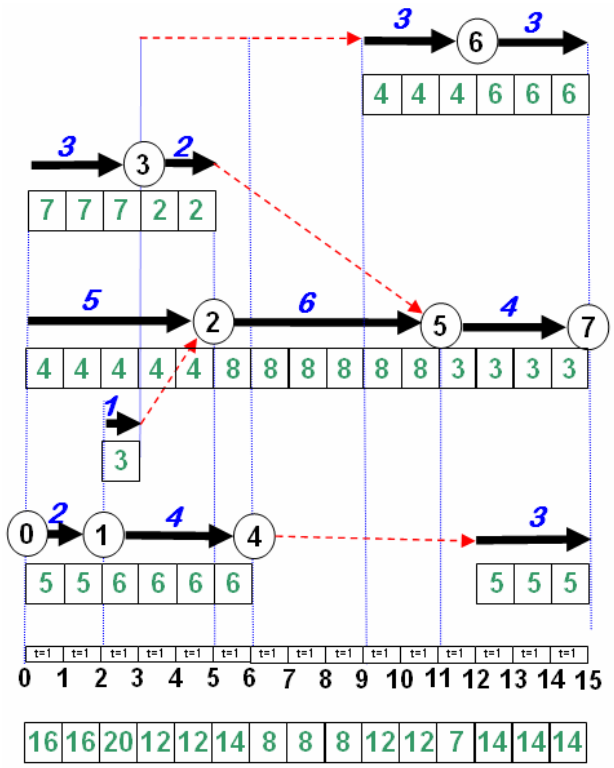


Figure 6 - Resource distribution, optimization scenario no. 1

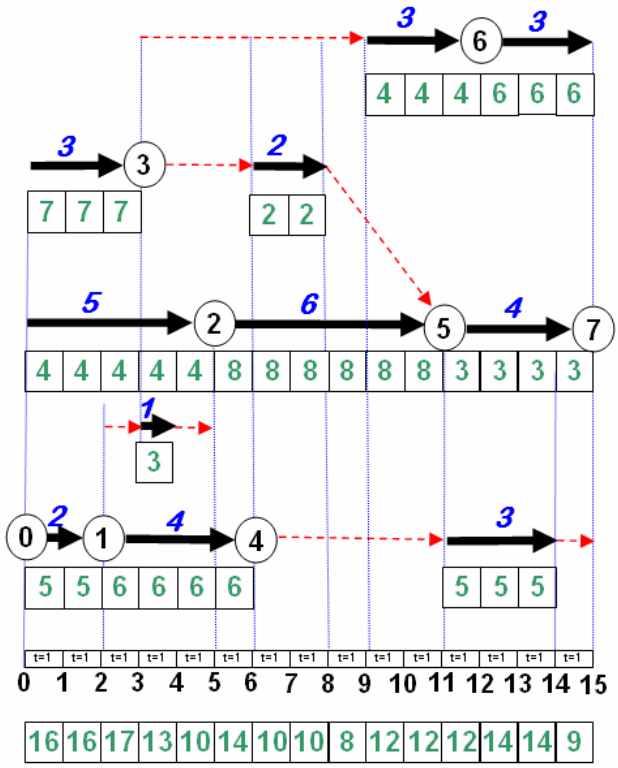


Figure 7 - Resource distribution, optimization scenario no. 2

We notice the following inconveniencies:

- the periods in the middle of the project, i.e. work intervals 7, 8 and 9 are loaded with 8 units, which means that we have a continuous period of low workload;
- the peak noticed in time interval no. 3, consisting of 20 units still exists in this optimization scenario.

For the second optimization scenario, figure 7, we have the following aims:

- to decrease the maximum value of 20 units, in order to minimize the overall imbalance;
- to schedule activities from the first part of the project to the middle period of the project, in order to decrease the imbalance;
- to increase the flexibility of the scheduling of some activities within the project, if possible.

In this optimization scenario the maximum imbalance is 17-8=9 units, the middle period of the project is additionally loaded in comparison with the previous scenario and the D (1-2), G (3-5) and I (4-7) activities can be easily moved in the adjacent intervals.

Another parameter which can be checked is the imbalance while passing from a time unit to the following one, being known that the changes must be rationally done, based on the principles of the management of change. However, in order to fulfil the general aim that the fluctuation of the manpower must be as less as possible, there must be analyzed the types of the activities and the possibility to reuse the human resources from one activity to the next one.

There may be noticed that in the initial conditions, along the last 4 work intervals of the project there are used only 3 units. This period may be used in extreme situations when delays may occur, to increase the intensity of the work in order to maintain the deadline of the project.

The duration of the project is of 15 work periods and this critical path could not be modified by conceiving optimization scenarios. The only optimization which was possible is in regard to the resource leveling.

Even optimization scenario no. 2 is a suboptimal solution, it is the best scenario so far, because:

- the resource load is low; the average value is 187/15=12.466; the extreme values are 17 and 8 conventional units, which are in a relative symmetric position with respect to the average value;
- the maximum variation of the resource from one interval to the other is 11 in the initial scenario, 8 in the first optimization scenario and 5 in the second optimization scenario; this sudden variation has a significant decrease in the second optimization scenario and it is located before the last time period of the project, which is normal taking into account the forthcoming end of the project;
- because of the small imbalances along the project, there are also small variations of the according expenses;
- the last work period of the project has 9 units; the value is smaller in comparison with the previous work periods, being possible to execute additional activities, if necessary, in order to maintain the deadline of the project.

Because of some additional constraints it is not possible to minimize the time allocated to the activities and it is not possible to parallelize some activities.

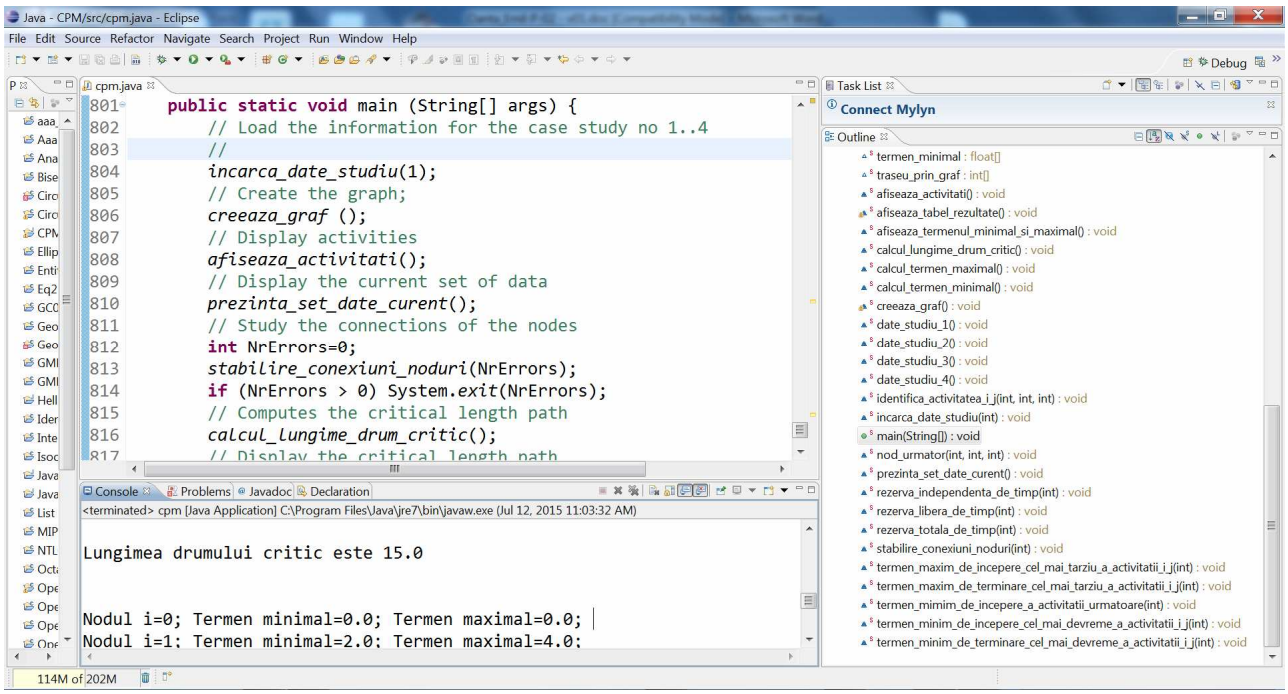


Figure 8 - Software application developed in Java, employed to perform the calculi in the framework a project management problem

4. ORIGINAL SOFTWARE APPLICATION

Commercial project management applications offer various facilities, such as scheduling, project portfolio management, resource management, document management, workflow system, reporting and analyses, budget management, time tracking and invoicing. However, in order to have a simple instrument to perform all the previous calculi, we developed an original software application presented in Fig. 8. The application consists of more than 800 computer code lines and it was written in Java using the Eclipse cross-platform environment. The software was tested using several input datasets and it may be easily adapted to solve new time-optimization problems.

5. CONCLUSIONS

In the knowledge based economy, the production demassification means to manufacture small series of products or even unique products, which usually are the result of a project. Particular projects can be optimally managed if customized software instruments are developed, instruments based on project management principles. The paper is an example in this trend regarding the development of instruments which are optimized and focused to solve a particular project.

6. ACKNOWLEDGEMENT

Ideas regarding the development of integrated models of engineering and economics were studied in the framework of the MIEC2010 bilateral Ro-Md research project, “Mathematical Models for Inter-Domain Approaches with Applications in Engineering and Economy”, [6], under the supervision of the National Authority for Scientific Research (ANCS), Romania, which is the follow-up of the ID1223 scientific research project: "Computer Aided Advanced Studies in Applied Elasticity from an Interdisciplinary Perspective", 2007-2010, [3], under the supervision of the National University Research Council (CNCSIS), Romania.

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MIXED ANALYSIS IN DYNAMIC MACHINERY SYSTEMS

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ABSTRACT

A mixed analysis was done in Strength of Materials Laboratory using experimental stand PT 500 and Machine Diagnostics Toolbox Type 9727 with Pulse Labshop. This paper presents the general use of the measurement equipment in machinery systems based on a fixed test configuration and bearing damages. Results are distinctive for each bearing fault according to vibration frequency for known bearing damage. The analysis present comparative information for a bearing fault identification, using two different measuring equipments.

Keywords: *machinery diagnostic, vibration measurement, mixed analysis, experimental stand, bearing fault diagnosis.*

1. INTRODUCTION

All rotating mechanical systems onboard ships cause vibrations in bearing supports and all components are transmitted to ship body. Evolution of machinery systems: engines, shafts, gearbox, pumps, fans and generators require damage detection in early states of damage in order to avoid damage in related components like: fixtures, couplings and bolts. A Complex analysis is a way to investigate all rotating machinery systems including bearing damage details.

Training future marine officers in assessing machinery systems issues onsite and work with actual vibration meters will offer preventive maintenance techniques that improve performance.

Bearing maintenance and proper analysis are the keys to keeping equipment up and running, optimizing performance and decreasing downtime. Early damage stage can be detected now onboard using vibration sensors for any operating component, for example in fig 1 we present types of bearings A, B and C.

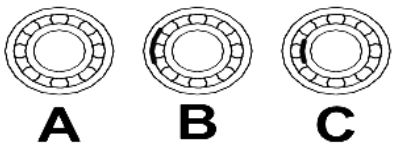

Figure 1 Bearing used in experiment on PT 500:
A-Undamaged roller bearing
B-Roller bearing with damage to outer ring
C- Roller bearing with damage to inner ring

The are often caused by:

- Insufficient maintenance practices;
- Mishandling;
- Improper installation and adjustment practices;
- Inadequate lubrication;
- Gradual deterioration due to wear, tear, stress fatigue and corrosion.

All operating equipment onboard ship can be a source of vibration and could cause a chain reaction in damaging system components due to large amplitudes/forces applied at resonance rotation speed.

Investigation of vibration can provide crucial information about mechanical system components and can improve performance [1].

Analysis of vibration signal is used as a diagnostic tool for dynamic mechanical systems. It is very important for a correct analysis to use the best choice for equipment and transducers for capturing and recording vibration signals. Depending on operating mechanical systems conditions we will use the best signal processing technique.

2. MEASURING EQUIPMENTS DESCRIPTION

2.1. Experimental STAND PT 500

Experimental stand PT 500 is designed by GUNT and it will run according to manual specifications and the results will be monitored with the second measuring equipment. Vibration analysis is a tool in estimating the condition of a machinery system. The slow change in the vibration spectrum provides indications of the remaining life of a system component and can be used as a criterion for its replacement. The mixed analysis can provide the spectral distribution and can deliver accurate information on the type and location of the damage for onboard ship components. The default PT 500.12 kit will be used in a setup for evaluation of different faults and simultaneously Pulse Labshop will measure vibration spectrum during 60 seconds in each test. The radial load on the system is set using the belt pre-tension measuring device included. The load will remain the same (fixed load) during all tests and the value used is 150 N. The accessory setup is mounted on the base plate of the machinery diagnosis base system PT 500. To measure and evaluate the experiment, the vibration analyser PT 500.04 is set up like in Figure 2 and Figure 3 for measurement and evaluation of the experiment.

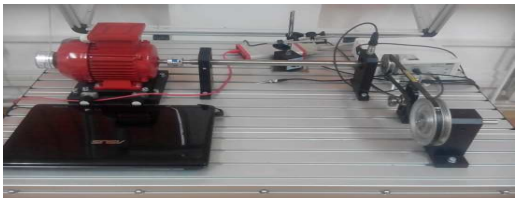

Figure 2 PT 500.04 Computerised Vibration Analyser

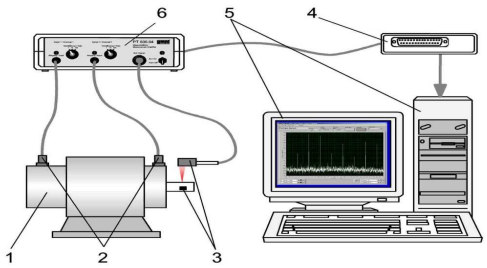

Figure 3 PT 500.04 Computerised Vibration Analyser
Legend: 1 vibrating machinery, 2 acceleration transducers, 3 shaft with reference sensor, 4 USB box, 5 PC (PC not included), 6 amplifier / filter

The kit includes accelerometers and a measuring amplifier and dedicated analysis software to record the vibration phenomena in studied cases for speed range 500 to 3000 rpm. Experiments on PT 500 will present data related to:

- vibrational spectrum of the running noise of roller bearings;
- influence of damage to outer race, inner race or roller body, on the spectrum;
- estimating service lives of roller bearings;
- influence of the lubricant on the vibration spectrum;
- detection of faulty roller bearings;
- understanding and interpreting frequency spectra;
- use of a computerized vibration analyzer.

2.2. Measurement With Machine Diagnostics Toolbox Type 9727 (Yellow Box)

The Machine Diagnostics Toolbox provides a complete suite of tools required to perform machine diagnostics on stand PT 500.12. It consists of Machine Diagnostics Toolbox Type 9727 and the versatile Machine Diagnostics Toolbox Software Bundle Type 7910 presented in Figure 4.

Figure 4 Machine Diagnostics Toolbox Type 9727 (Yellow Box**)**

Optimal analysis results for stand PT 500 evaluation can be achieved with this toolbox in hand when diagnosing a wide range of machine fault types especially those caused by faulty rotating parts inside onboard equipments.

Type 9727 includes the multichannel PULSE data acquisition unit Type 3560-B, and a Dell™ notebook PC with Pulse Labshop 12 installed and packaged in a ruggedized and weatherproof carrying and connector case. Type 7910 is a bundle of PULSE application software (Figures 8-13.) dedicated to any machine diagnostics.

In the PT 500 setup the vibration phenomena is studied in 15 cases for speed range 500 to 3000 rpm for 60 seconds in each test case for new bearing A or faulty bearing B/C [2,3,4]. The load will remain the same (fixed load) during all tests at 150 N and the measurement is done with precision pre-tension measurement device.

3. ANALYSIS OF THE MEASURED VIBRATION

The measurements were processed and analyzed by means of FFT analysis. FFT analysis is a powerful tool in the field of vibration and it has been used for many years. It provides accurate information and reliable data in order to estimate the overall level of noise or the contribution of a different source [6,7]. Since the Fast Fourier Transform is a well-known mathematical concept, a short description will be presented next.

The Integral transform, used in the FFT analysis, transforms a continuous time signal extending over all time, $-\infty < t < +\infty$, into a continuous frequency spectrum also extending over all frequencies, $-\infty < f < +\infty$. It can be said that this is the ideal transform, which in principle could be applied to all practical signals. However, since it requires knowledge of all of the time signal it can in practice only be applied to relatively short transient signals while "continuous" signals must be handled by other means.

For periodic time signals, the well-known Fourier series are used. Here, only one period of the time signal has to be specified and included in the transform. In this case we find that a periodic and continuous time signal is transformed into a discrete frequency spectrum, exhibiting all the harmonic frequencies.

Also, the signals can be analyzed by using samples. Here the discrete samples of the time domain are transformed into a periodicity of the frequency spectrum, thus demonstrating the basic symmetry of the Fourier transform between time and frequency [7,8]. Cases for experimental tests on PT 500 stand are presented in table no.1.

Table 1. Test cases registered during tests on PT 500 with Pulse Labshop

Running speed [rpm]	**Bearing A**	**Bearing B**	**Bearing C**
500	Track 1A	Track 1B	Track 1C
1000	Track 2A	Track 2B	Track 2C
1500	Track 3A	Track 3B	Track 3C
2000	Track 4A	Track 4B	Track 4C
2500	Track 5A	Track 5B	Track 5C

4. EXPERIMENTAL RESULTS AND MIXED ANALYSIS

4.1. Experimental Results Measured On Pt 500

Detection of faults in early stages prevents any other damage on bearings, shafts and camshafts inside marine equipment. The PT 500 stand is a good detector for amplitude spectra (Figures 5-7.). The maximum value and the recorded frequencies are presented n table no.2.

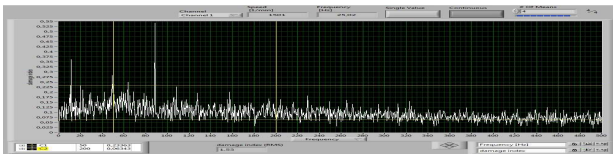

Figure 5 Bearing A on PT 500 stand

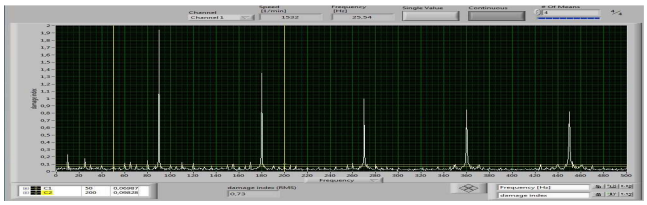

Figure 6 Bearing B on PT 500 stand

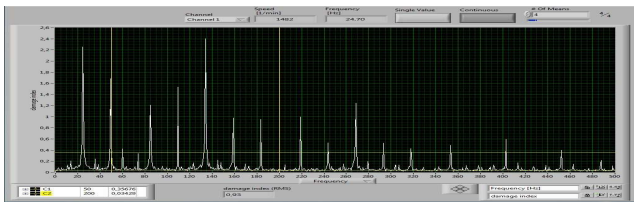

Figure 7 Bearing C on PT 500 stand

Running speed [rpm]	Bearing A shaft frequency [Hz]	Bearing B defect frequency [Hz]	Bearing C defect frequency [Hz]
500	8,3	29,8	46
1000	16,6	58	91
1500	25,0	92	133
2000	33,3	121	181
2500	41,6	152	223

4.2. Experimental Results Measured On Machine Diagnostics Toolbox Type 9727

Faults detection in onboard operation can be used in early detection of damages and is recommended to use specific equipment and for each machinery component to evaluate operation in accordance to specific producer technical specifications [9]. Results for Machine Diagnostics Toolbox Type 9727 are presented below.

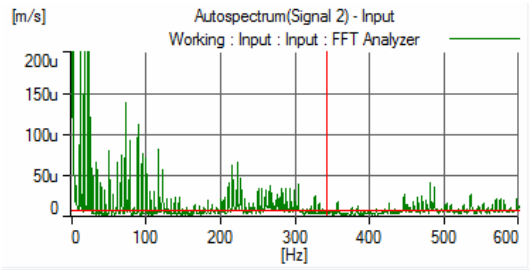

Figure 8 FFT analysis on bearing A vertical vibration 1500 rpm

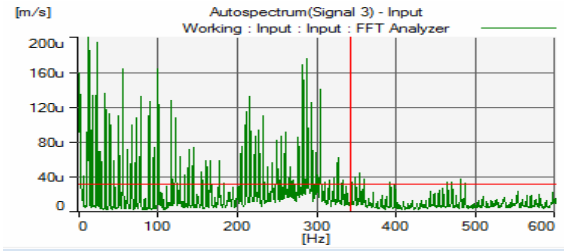

Figure 9 FFT analysis on bearing A horizontal vibration 1500 rpm

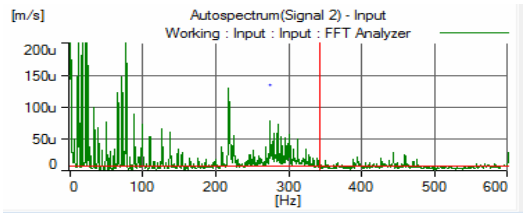

Figure 10 FFT analysis on bearing B vertical vibration 1500 rpm

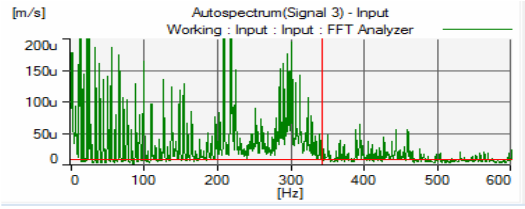

Figure 11 FFT analysis on bearing B horizontal vibration

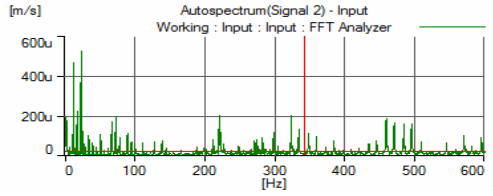

Figure 12 FFT analysis on bearing C vertical vibration 1500 rpm

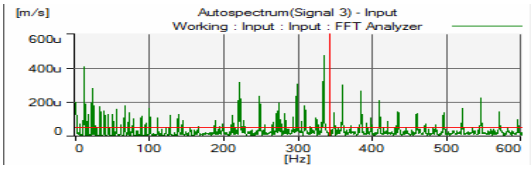

Figure 13 FFT analysis on bearing C horizontal vibration

Vibration defect amplitude is proportional to radial load applied by the belt tensioned at 150 N. Increase in speed results in increase in vibration frequency and all calculations are done assuming that the outer ring is stationary and the load direction is fixed.
From the experimental data collected in this study we observe that:

1. For an outer race defect (B) each ball generates an impact over the damage location, as measured the damage frequency is dependent to shaft speed f_{01}=3,64 f_{Shaft} (90 hz for 1500 rpm) also we can analyze harmonics from 2^{nd} to 5^{th} . Measured damage index for bearing B is 0,73.

2. For an inner race defect (C) the fundamental frequency is located at 135 Hz and the side bands are located at +/- 25 Hz. Measured damage index for bearing B is 0,90 [1,8].

The presented work on the experimental stand can be applied also to:

- Turbine blades - identification of broken or distorted blades.
- Roller-bearing elements - identification of cracks in inner race, outer race or roller defects.
- Gearboxes - identification of cracked or broken teeth.
- Induction motors - identification of unbalanced rotors.
- Propeller - identification of broken or distorted blades.
- Flexible coupling.

Table 2. Results for defect frequency during tests on Machine Diagnostics Toolbox

Table.2. Results for amplitude/frequency during tests on PT 500 [rpm]	**Bearing A Damage index/Hz**	**Bearing B Damage index /Hz**	**Bearing C Damage index /Hz**
500	0,12/25	1,43/30	1,66/45
1000	0,14/25	1,50/60	1,83/90
1500	0,17/25	1,9/90	2,40/135
2000	0,18/25	1,95/120	2,53/180
2500	0,20/25	1,99/150	2,61/225

5. CONCLUSIONS

Inner race and outer race defects can be successfully detected by measuring vibration with Pulse Labshop. The defect signal is clearly present in the present analysis presented on machinery diagnostic system. Vibration defect amplitude is proportional to radial load applied by the belt. Increase in speed results in a increase in vibration frequency.

Fault bearing diagnosis is a determination of a specific fault or failure that has occurred to a dynamic machine and it is estimated of time to failure and risk for one or more existing and future failure modes. This research was focus on the improvement of machinery fault diagnosis by choosing their own measuring equipment and transducers and placing them for machinery health monitoring and fault bearing diagnosis.

With the development of modern multi-sensor technology and advanced signal processing techniques, more and more features can be extracted for condition monitoring and fault diagnosis.

In present paper, investigations have been done to find the application of signal processing technique for detection of bearing faults. To detect the bearing faults, FFT based power spectrums were used. The peaks on the spectra represent the resonance frequencies of the system where the bearing is installed. The natural frequencies that are excited by the defect's impact are located between 30 and 250 Hz. The amplitude ratio at the resonance frequency between faults and healthy bearings is very significant. The accelerometer represents the best sensor in identification the bearing condition and tracking the fault size by using high frequency techniques.

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[9] PT 500 Gunt de stand and Pulse Labshop documentation and software

NUMERIC SIMULATION FOR A J-LAY SUBSEA PIPELINE LAUNCHING SYSTEM

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ABSTRACT

Over the last decade deepwater pipelaying has gone through a spectacular development. In the early 90s a water depth of 300 meters was considered deep, while today depths of 2000 meters are common practice. The unprecedented global demand for oil and gas is the main drive in the offshore petroleum industry, which in turn demands improved pipeline technology. The installation of pipelines and flowlines constitute some of the most challenging offshore operations handled, and the required engineering sophistication, as well as the share size and complexity of the vessels used, has developed pipelaying into an engineering discipline of its own accord [13]. Present trends in the marked indicates an increase in deepwater projects as well in length as depth, according to [12]. In this paper, following the trend of involving the Finite elements models and using Ansys 15 software advanced features, a J-Lay subsea pipe J-Lay launching system shall be approached, in order to determine the main stresses and strains inflicted by the upper structure of launching system of a vessel over the pipe. The integrity of the subsea pipe during launching from a J-Lay vessel is the most important criteria to judge a successful launching. In the J-Lay systems as the one presented in this paper the vessel launching structure is stressing the pipe sometimes beyond the elastic domain and the verification of the stresses inside the pipe is of a paramount importance. This paper is providing a modern involvement of Finite Elements Methods in calculating stresses and strains during launching, being the basis for any optimization studies. The optimization of the launching geometry will be the object of another paper.

Keywords: *Subsea Pipelying; Numeric Simulation; J-Lay.*

1. INTRODUCTION

Over the last decade deepwater pipelaying has gone through a spectacular development. In the early 90s a water depth of 300 meters was considered deep, while today depths of 2000 meters are common practice. The unprecedented global demand for oil and gas is the main drive in the offshore petroleum industry, which in turn demands improved pipeline technology. The installation of pipelines and flowlines constitute some of the most challenging offshore operations handled, and the required engineering sophistication, as well as the share size and complexity of the vessels used, has developed pipelaying into an engineering discipline of its own accord [13]. Present trends in the marked indicates an increase in deepwater projects as well in length as depth, according to [12].

Purpose build pipelay vessels equipped with dynamic positioning systems are used for installation of offshore pipelines. The pipe is clamped on to the vessel by heavy tension equipment and extended in a production line accommodating either S-lay or J-lay, which are the two main pipelay methods. The S-lay method is fast and economical and dominates the pipelay market. The pipe is extended horizontally and it describes an S-shaped curve to the seabed. The upper part (overbend) is supported by a submerged supporting structure called a stinger to control curvature and ovalization, and the curvature in the lower curve (sagbend) is controlled by pipe tension. The strain must be checked against pipe design parameters to stay within limits for buckling and ovalization. In deep waters, the weight of the pipe makes it difficult to maintain a stinger supported overbend due to the increased pipe tension, but the tension may be reduced by adopting the J-lay method where the pipe is extended near vertically and thus eliminates the overbend. The methods are seen to be complementary [15].Both methods are well described in recent textbooks such as [2], [7] and [14]. The present trends in deepwater pipelay systems are described in [8] and the references therein. Mathematical models are vital in pipeline design for analysis of pipelay parameters and for operability analysis.

Commercially developed computer tools, e.g., OFFPIPE, RIFLEX and SIMLA, that are based on finite element models has become the universal method for modelling pipelay operations in the industry. These models captures well the dynamics of the pipe and has replaced simpler models, e.g., the static catenary model and stiffened catenary model [3], [16], which was exploited in earlier years.

In this paper, following the trend of involving the Finite elements models and using Ansys 15 software advanced features, a J-Lay subsea pipe J-Lay launching system shall be approached, in order to determine the main stresses and strains inflicted by the upper structure of launching system of a vessel over the pipe.

2. NUMERIC SIMULATION INPUT DATA

The case study has as departure point the data of a real vessel given in the following Figure 1.

The first thing to be done was the 2D CAD geometry generation and that was built with SolidWorks 2015 as seen in the Figure 2.

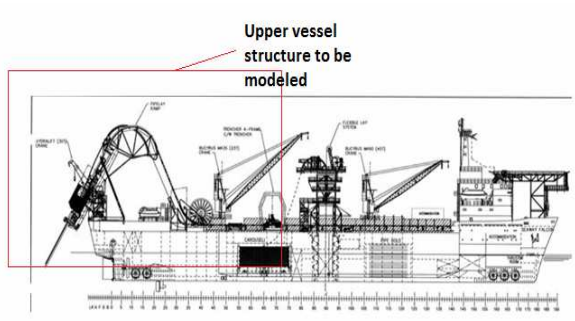


Figure 1 The upper launching J-Lay system to be modeled with finite elements

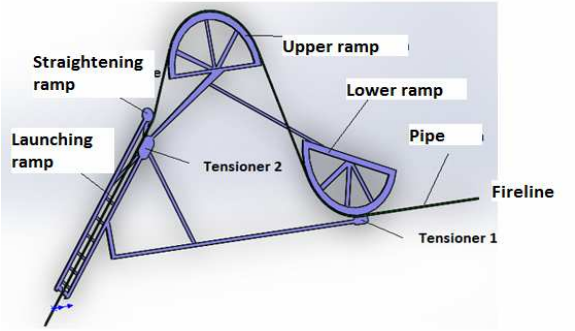


Figure 2 The 3D Geometry model

In figure 2 the pipe is coming from the fireline where the pipe was welded, is passing through the first tensioner where 50 kN force is imposed over the pipe, and by passing through the lower and upper ramps the pipe is forced to take the launching posture needed for the J-Lay launching. The pipe is straightened by the Straightening ramp and the launching angle is imposed by the Launching ramp. The Tensioner 2 together with the Tensioner 1 is controlling the tension inside the pipe for the entire launching path including the touch down point where the pipe is hitting the seabed.

The Launching ramp is imposing the launching angle which for this study is taken as 45^0.

The main pipe data are as follows:

- Outer diameter-220 mm;
- Wall thikness-18.3 mm;
- Yielding strength-448 MPa;
- Steel density-7850 kg/m^3;
- Coating thickness-2.35 mm
- Coating material density-900 kg/m^3.

The launching mechanical system data are:

- The launching ramps roller friction coefficient-0.01;
- Lower and upper ramps diameters-15.9 m

Some other dimensions are given in Figure 3.

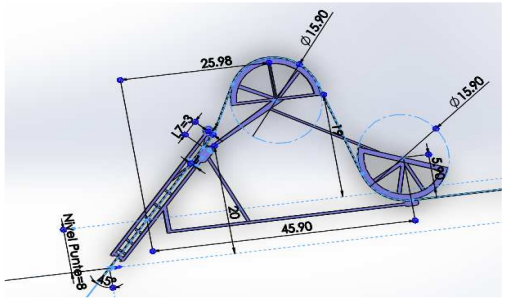


Figure 3 Mechanical model dimensions

The model above will be imported inside Ansys 15 Design Modeler module for further processing.

In Ansys 15 the Explicit Dynamics module is launched with the given geometry.

The materials selected for the FEM simulation are:

- The upper structure of the vessel is modelled as Rigid since there is no interest in calculating the stresses inside this structure
- The pipe itself is modelled of Nonlinear (Bilinear) Steel with the main data as below:

Properties of Outline Row 4: Structural Steel NL

	A	B	C	D	E
1	Property	Value	Unit		
2	Density	7850	kg m^-3		
3	Isotropic Elasticity				
4	Derive from	Youn...			
5	Young's Modulus	2E+11	Pa		
6	Poisson's Ratio	0.3			
7	Bulk Modulus	1.6667E+11	Pa		
8	Shear Modulus	7.6923E+10	Pa		
9	Bilinear Isotropic Hardening				
10	Yield Strength	4.48E+08	Pa		
11	Tangent Modulus	1.45E+09	Pa		
12	Specific Heat	434	J kg^...		

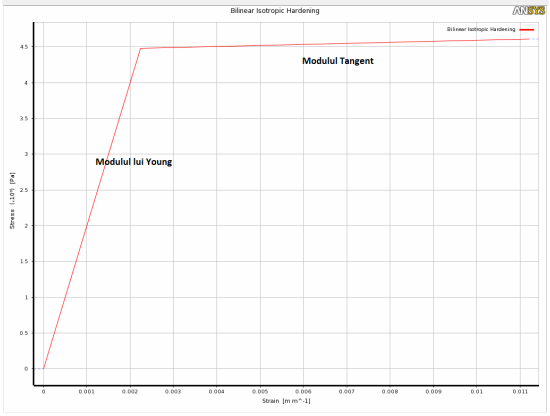


Figure 4 Pipe steel bilinear properties

Once the material is defined, the finite elements mesh is generated as below:

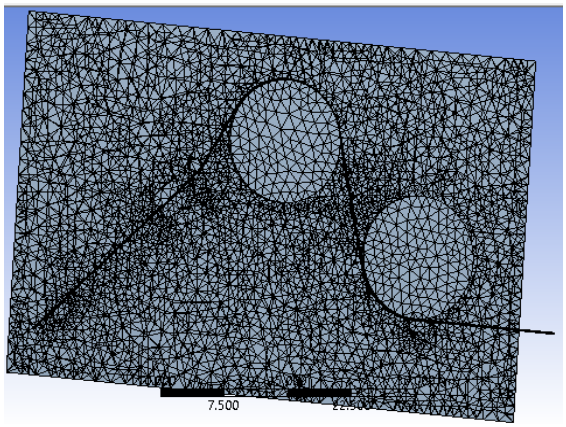


Figure 5 Finite elements mesh for the structure and the pipe

Moreover in this stage there are defined the Boundary conditions as below:

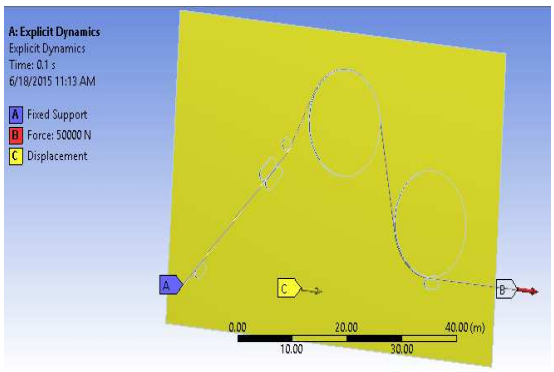


Figure 6 Model Boundary conditions

They are:

- A-Fixed support-applied to the left end of the pipe
- B-Tensioner 1 force applied to the right end of the pipe
- C-Vessel structure displacement from left to right which is taking place with a speed of 1.1 m/s and has the value of 0.1 m.

These boundary conditions are modelling the advance of the launching vessel during the launching process and is causing the stresses and deformations over the pipe material.

In order to read the simulation results four sections are defined as below:

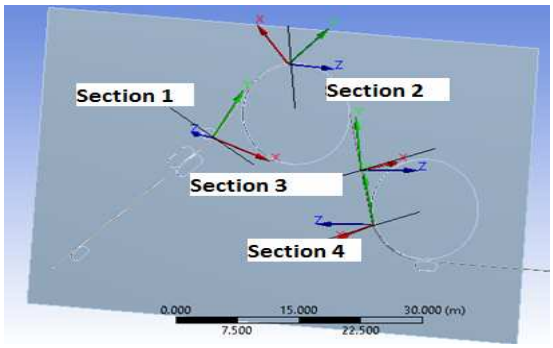
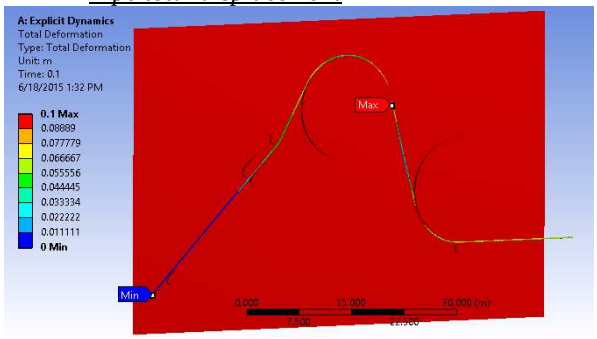


Figure 7 Sections defined to read the results

For this study and being limited by the size of this paper, only the Section 3 is considered.

3. SIMULATION RESULTS

- *Pipe total displacement*



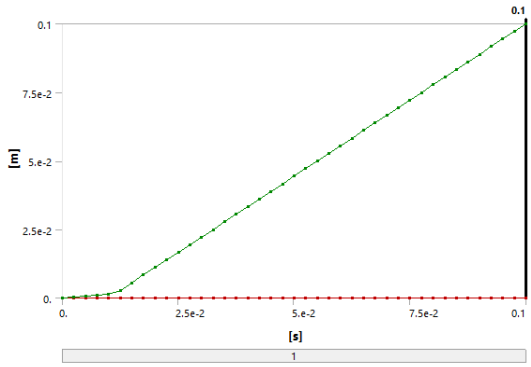


Figure 8 Pipe total displacement and its evolution in time

As seen above the vessel structure displacement is 0.1 m as imposed via the boundary conditions and the pipe portion in the front of the upper ramp has the same value. The rest of the pipe has lesser displacements since the pipe is "sliding" over the ramps rollers.

Inside the section 3 the total displacement is like below:

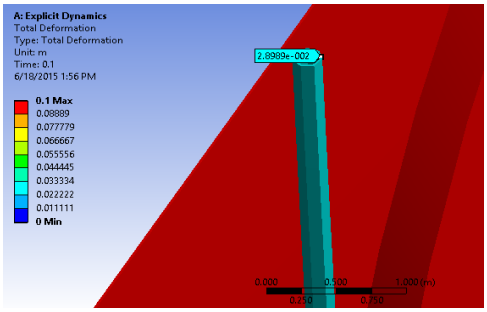


Figure 9 Pipe total displacement in Section 3

In this reading section the total displacement of the pipe is 2.89e-2 m, almost three time lesser than the structure displacement. This difference will cause stresses and deformations of the pipe in this section.

- *Equivalent elastic strain*

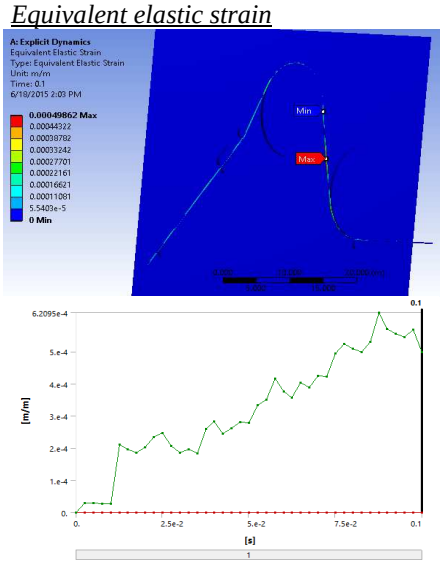


Figure 10 Pipe equivalent elastic strain and its evolution in time

The maximum value is calculated for Section 3 having the value of 4.9e-4, far below the strain of the yielding plastic domain. The first conclusion is that the pipe material is inside the elastic domain thus the pipe integrity being preserved.

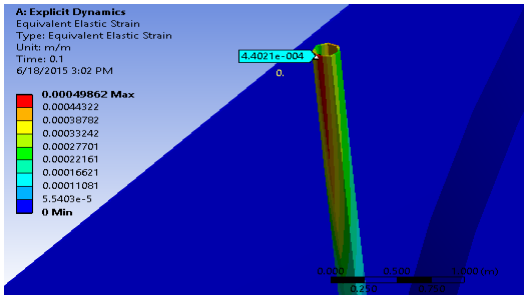


Figure 11 Equivalent elastic strain in Section 3

Above the pipe equivalent elastic strain for Section 3 is shown.

- *Pipe equivalent stress*

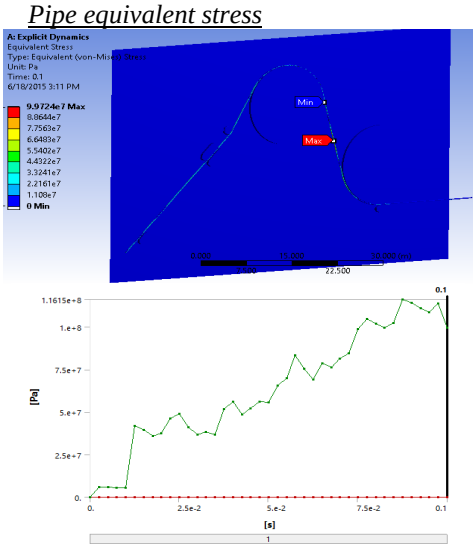


Figure 12 Pipe equivalent stress and its evolution in time

The maximum von Mises stress is 9.97e7 Pa, some four times smaller than the yielding strength of 448 MPa, the conclusion above pulled that the pipe is remaining in the elastic domain being confirmed. The pipe is keeping its integrity and the launching system is working safely from this standpoint.

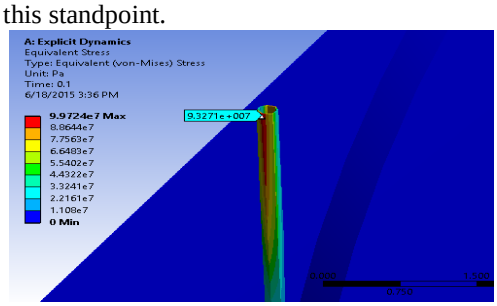


Figure 13 Section 3 equivalent stress

4. CONCLUSIONS

The integrity of the subsea pipe during launching from a J-Lay vessel is the most important criteria to judge a successful launching. In the J-Lay systems as the one presented in this paper the vessel launching structure is stressing the pipe sometimes beyond the elastic domain and the verification of the stresses inside the pipe is of a paramount importance.

This paper is providing a modern involvement of Finite Elements Methods in calculating stresses and strains during launching, being the basis for any optimization studies. The optimization of the launching geometry will be the object of another paper.

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NUMERIC OPTIMIZATION FOR A J-LAY SUBSEA PIPELINE LAUNCHING SYSTEM

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ABSTRACT

Economical and political factors have changed the conventional point of view on the development of new submarine pipelines crossings: in fact, the laying of present lines is now driven by the increasing globalization of the market, with longer distances covered from producers to end-users, and not only by the exploitation of new offshore resources. Therefore, new capabilities to operate in deep waters are needed more and more, with ongoing development plans considering projects in water depths up to 3500 m and more. This paper is following another paper issued by the same authors in which the strains and deformations of the very same J-Lay launching system were calculated. Now we'll make a step further in order to optimize the geometry and dimensions of the structural arrangement of the launching ramps in order to have the smallest stresses inside the subsea pipe during launching. The integrity of the subsea pipe during launching from a J-Lay vessel is the most important criteria to judge a successful launching. In the J-Lay systems as the one presented in this paper the vessel launching structure is stressing the pipe sometimes beyond the elastic domain and the verification of the stresses inside the pipe is of a paramount importance.

This paper is providing a modern involvement of Finite Elements Methods in calculating the optimum launching system arrangement in order to have the minimum equivalent stress inside the subsea pipe during launching. After optimization the maximum calculated stress inside the pipe is 8.06e7 Pa instead of 9.97e7 Pa before optimization, therefore a reduction of 19% is to be reached by simply lowering the upper ramp and decreasing the force developed by the Tensioner 1.

Keywords: *Subsea Pipelying; Numeric Simulation; J-Lay; Optimization.*

1. INTRODUCTION

Economical and political factors have changed the conventional point of view on the development of new submarine pipelines crossings: in fact, the laying of present lines is now driven by the increasing globalization of the market, with longer distances covered from producers to end-users, and not only by the exploitation of new offshore resources. Therefore, new capabilities to operate in deep waters are needed more and more, with ongoing development plans considering projects in water depths up to 3500 m and more.

In view of these challenging demands, the offshore industry has been called to develop a new and reliable installation technology for ultra deep waters and difficult sea bottoms, to improve the robustness of engineering predictions of in-service behaviour over the entire design lifetime, and to find the suitable technological means of dealing with environmental hazards, typical of such extreme conditions [1]. Many advances have already been made in recent years, but there is still a substantial need for materials and laying technologies improvements and for more refined engineering tools of analysis and simulation, particularly during the installation, which is the most severe condition for pipeline design [2].

The most appropriate technique for installations in deep waters is the so-called ''J-lay method'', whose name comes after the shape of the pipeline during the laying and consists in lowering the pipe almost vertically into the water by an inclined ramp (Fig. 1a). When compared with the ''S-lay method'' [3], used in shallow waters, Fig. 1b, the most important characteristics of the J-lay method are (i) the reduction of the distance between the vessel and the touch down point (TPD), thus facilitating the dynamic positioning, (ii) the drastic reduction of the horizontal force at the barge to be supplied by the vessel engines, and (iii) the elimination of the over-bend curved part at the end of the stinger, which, among others, can produce dangerous residual stresses; furthermore, it reduces the pull tension required at the vessel to lay the pipeline and eliminates the long and vulnerable stinger. This advantages usually prevail over the disadvantages which are (i) that the processing operations are more difficult along the steep ramp, leading to slower laying rates, (ii) the capability to lay the pipeline within a narrow corridor with stringent lay tolerances, and (iii) bigger vessels with greater installed power are needed to grant the dynamic positioning under all possible operating conditions. All these considerations lead to higher production costs for the '' J-lay method'', nevertheless it is sometimes the only technique able to grant the successful laying, in case deep waters have to be crossed, and allows the exploitation of more opportunities in other cases.

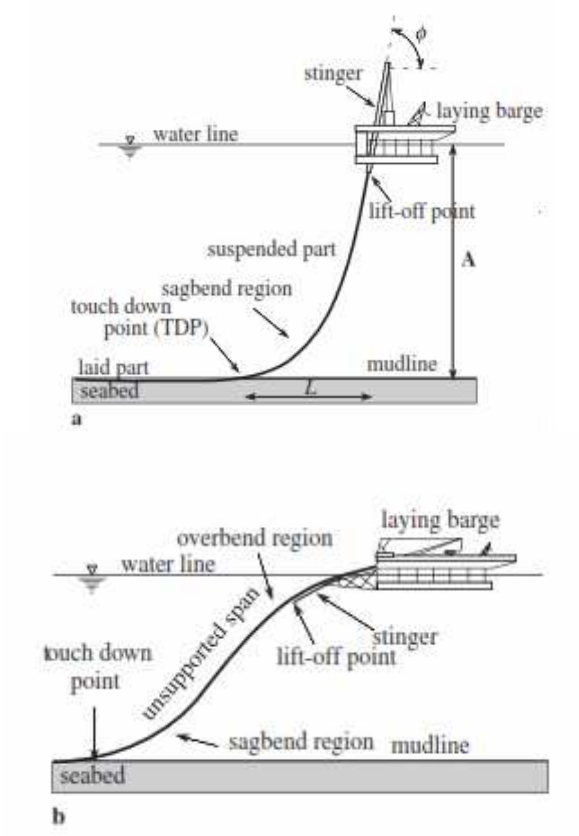


Figure1 Deployment of marine pipelines by (a) the J-lay, and (b) the S-lay methods

This paper is following another paper issued by the same authors in which the strains and deformations of the very same J-Lay launching system were calculated. Now we'll make a step further in order to optimize the geometry and dimensions of the structural arrangement of the launching ramps in order to have the smallest stresses inside the subsea pipe during launching.

2. MODEL INPUT DATA

The case study has as departure point the data of a real vessel given in the following figure 2. This is the same as the one used by the authors in the paper named "Numeric Optimisation for a J-Lay Subsea Pipeline Launching System" so that the input data has to be the same. Therefore the model input data is the same.

The first thing to be done was the 2D CAD geometry generation and that was built with SolidWorks 2015 as seen in the Figure 2.

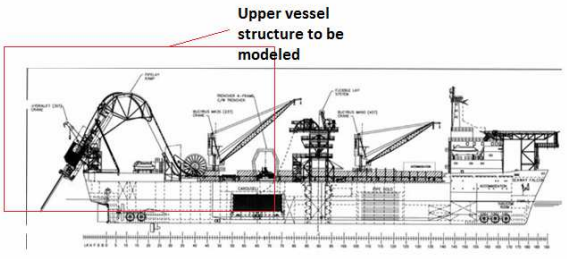


Figure 2 The upper launching J-Lay system to be modelled with finite elements

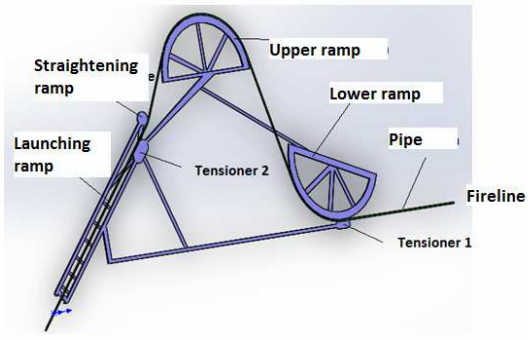


Figure 2 The 3D Geometry model

In Figure 3 the pipe is coming from the fire-line where the pipe was welded, is passing through the first tensioner where 50 kN force is imposed over the pipe, and by passing through the lower and upper ramps the pipe is forced to take the launching posture needed for the J-Lay launching. The pipe is straightened by the Straightening ramp and the launching angle is imposed by the Launching ramp. The Tensioner 2 together with the Tensioner 1 is controlling the tension inside the pipe for the entire launching path including the touch down point where the pipe is hitting the seabed.

The Launching ramp is imposing the launching angle which for this study is taken as 45^0.

The main pipe data are as follows:

- Outer diameter-220 mm
- Wall thikness-18.3 mm
- Yielding strength-448 MPa
- Steel density-7850 kg/m^3
- Coating thickness-2.35 mm
- Coating material density-900 kg/m^3

The launching mechanical system data are:

- The launching ramps roller friction coefficient-0.01
- Lower and upper ramps diameters-15.9 m

Some other dimensions are given in Figure 3.

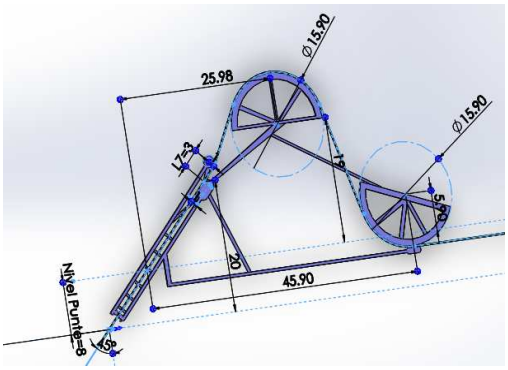


Figure 4 Mechanical model dimensions

The model above will be imported inside Ansys 15 Design Modeler module for further processing.

In Ansys 15 the Explicit Dynamics module is launched with the given geometry.

The materials selected for the FEM simulation are:

- The upper structure of the vessel is modelled as Rigid since there is no interest in calculating the stresses inside this structure

- The pipe itself is modelled of Nonlinear (Bilinear) Steel with the main data as below:

Properties of Outline Row 4: Structural Steel NL

	A	B	C	D	E
1	Property	Value	Unit		
2	Density	7850	kg m^-3		
3	Isotropic Elasticity				
4	Derive from	Youn...			
5	Young's Modulus	2E+11	Pa		
6	Poisson's Ratio	0.3			
7	Bulk Modulus	1.6667E+11	Pa		
8	Shear Modulus	7.6923E+10	Pa		
9	Bilinear Isotropic Hardening				
10	Yield Strength	4.48E+08	Pa		
11	Tangent Modulus	1.45E+09	Pa		
12	Specific Heat	434	J kg^...		

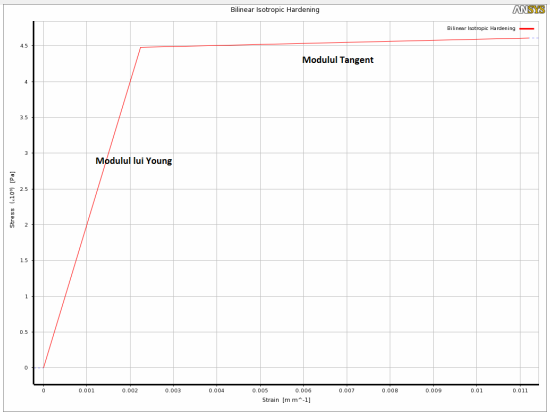


Figure 5 Pipe steel bilinear properties

Once the material is defined, the finite elements mesh is generated as below:

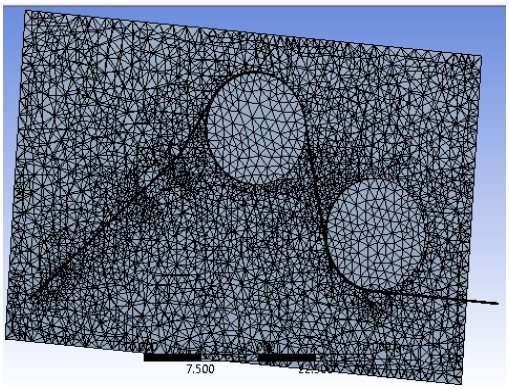


Figure 6 Finite elements mesh for the structure and the pipe

Moreover in this stage there are defined the Boundary conditions as below:

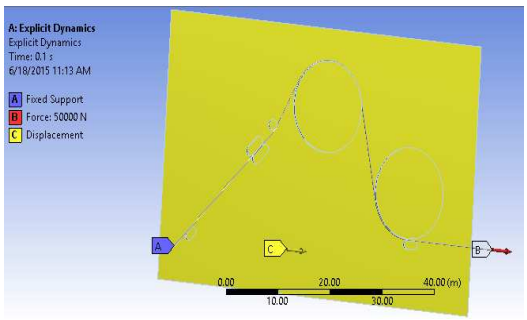


Figure 7 Model Boundary conditions

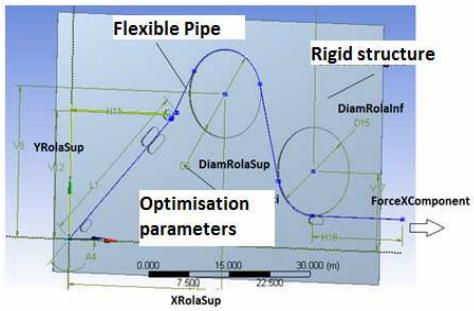
They are:

- A-Fixed support-applied to the left end of the pipe
- B-Tensioner 1 force applied to the right end of the pipe
- C-Vessel structure displacement from left to right which is taking place with a speed of 1.1 m/s and has the value of 0.1 m.

These boundary conditions are modelling the advance of the launching vessel during the launching process and is causing the stresses and deformations over the pipe material.

In order to read the simulation results four sections are defined as below:

In order to perform the optimization the Response Surface optimization module of Ansys 15 will be used. For this some geometrical parameters are to be defined as below:



Outline of Schematic B2: Design of Experiments

	A	B
1		Enabled
3	Input Parameters	
4	Explicit Dynamics (A1)	
5	P2 - DiamRolaSup	☑
6	P3 - DiamRolaInf	☑
7	P4 - XRolaInf	☐
8	P5 - YRolaInf	☐
9	P6 - DiamRolaSup1	☐
10	P7 - YRolaSup	☑
11	P8 - XRolaSup	☑
12	P9 - DiamRolaInf1	☐
13	P11 - Force X Component	☑

Figure 8 Geometrical optimization parameters

These parameters are:

- The upper ramp diameter named "DiamRolaSup"
- The lower ramp diameter named "DiamRolaInf"
- Oy coordinate of the centre of the upper ramp named "YRolaSup"
- Ox coordinate of the centre of the upper ramp named "XRolaSup"
- The tensioner 1 force named "Force X Component"

The parameter to be optimized or in plain words the "target" of the optimization is "The Equivalent Stress Maximum" which will be forced to be the minimum by selecting the proper geometrical parameters.

In order to do this the input optimization parameters are allowed to have a variation within some limits as below:

Table 1. The limits of the optimization parameters

	Name	Lower limit	Upper limit
P2	DiamRolaSup	14.31 [m]	17.49 [m]
P3	DiamRolaInf	14 [m]	15.9 [m]
P7	YRolaSup	24.3 [m]	29.7 [m]
P8	XRolaSup	32 [m]	35 [m]
P11	Force X Component	45000 [N]	55000 [N]

With these values the software is defining a design space with 27 design points and for any and each design point the maximum equivalent stress is calculated as in the table below:

Table 2. Design points for the design space

Nam	P2 -	P3 -	P7 -	P8 -	P11 -
1	15.9	14.95	27	33.5	50000
2	14.31	14.95	27	33.5	50000
3	17.49	14.95	27	33.5	50000
4	15.9	14	27	33.5	50000
5	15.9	15.9	27	33.5	50000
6	15.9	14.95	24.3	33.5	50000
7	15.9	14.95	29.7	33.5	50000
8	15.9	14.95	27	32	50000
9	15.9	14.95	27	35	50000
10	15.9	14.95	27	33.5	45000
11	15.9	14.95	27	33.5	55000
12	15.449	14.681	26.23	33.07	51417
13	16.351	14.681	26.23	33.07	48583
14	15.449	15.219	26.23	33.07	48583
15	16.351	15.219	26.23	33.07	51417
16	15.449	14.681	27.76	33.07	48583
17	16.351	14.681	27.76	33.07	51417
18	15.449	15.219	27.76	33.07	51417
19	16.351	15.219	27.76	33.07	48583
20	15.449	14.681	26.23	33.92	48583
21	16.351	14.681	26.23	33.92	51417
22	15.449	15.219	26.23	33.92	51417
23	16.351	15.219	26.23	33.92	48583
24	15.449	14.681	27.76	33.92	51417
25	16.351	14.681	27.76	33.92	48583
26	15.449	15.219	27.76	33.92	48583
27	16.351	15.219	27.76	33.92	51417

3. OPTIMISATION RESULTS

After performing the calculations the maximum equivalent stress inside the pipe for each design points are like below:

Table 3. Calculated equivalent stresses for the design points

Name	P10 - Equivalent	Name	P10 - Equivalent
1	1.0952E+08	15	1.133E+08
2	1.0535E+08	16	1.0386E+08
3	1.0918E+08	17	1.055E+08
4	1.069E+08	18	1.1497E+08
5	1.1282E+08	19	9.5574E+07
6	1.0819E+08	20	9.4076E+07

7	1.0929E+08	21	1.0179E+08
8	1.0001E+08	22	9.2343E+07
9	1.0199E+08	23	9.3792E+07
10	1.0704E+08	24	1.1137E+08
11	1.0713E+08	25	1.0535E+08
12	9.8601E+07	26	1.1988E+08
13	9.9875E+07	27	1.1843E+08
14	1.0843E+08	22	9.2343E+07

The software is automatically calculating the response surfaces and from the condition of having the minimum equivalent stress three optimum candidates will pop up:

Table 4. The optimum candidates

	Diam Rola up (m)	P3 – Diam Rola Inf (m)	P7 – YRola Sup (m)	P8 – Xrola Sup (m)	P11 - Force X Component (N)	P10 – Equivalent Stress Maximum (Pa)
Can	17.49	15.4	24.3	35	4500	8.063+
Can	15.342	14.2	24.3	34.93	4885	8.52+0
Can	16.916	15.5	24.5	34.81	4609	9.21+0
Initial	15.9	15.9	27	33.98	5000	9.9724

The first optimum candidate will be selected and is to be seen that the Upper Ramp has the diameter increased from 15.9 m to 17.49 m and the Y coordinate of this ramp is decreasing from 33.9 m to 24.3 m. The tensioner force is to be decreased from 50 kN to 45 kN.
An sensitivity analysis can be performed in order to see which of the geometrical input parameters have the biggest impact over the magnitude of the equivalent stress inside the pipe during launching.

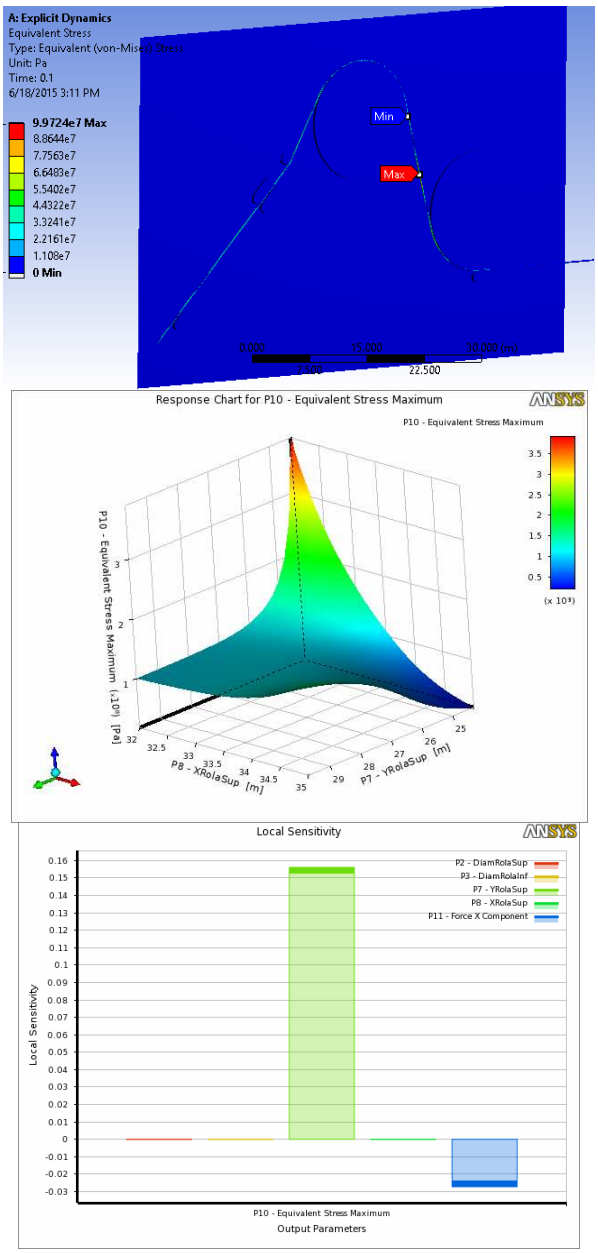


Figure 9 Sensitivity analysis

As seen in the graphs above the biggest impact over the equivalent stress have the Y position (vertical position) of the upper ramp and the force developed by the Tensioner 1. Fortunately both might be changed before launching the pipe so that the optimum values can be accommodated for the optimal geometrical arrangement.

In order to validate the results the equivalent stress before and after optimization was calculated.

- *Pipe equivalent stress before optimization*

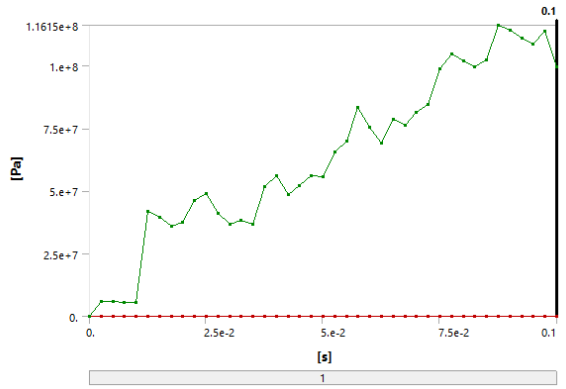


Figure 10 Pipe equivalent stress and its evolution in time before optimisation

The maximum von Mises stress is 9.97e7 Pa, some four times smaller than the yielding strength of 448 MPa, the conclusion above pulled that the pipe is remaining in the elastic domain being confirmed. The pipe is keeping its integrity and the launching system is working safely from this standpoint.

- *Pipe equivalent stress after optimization*

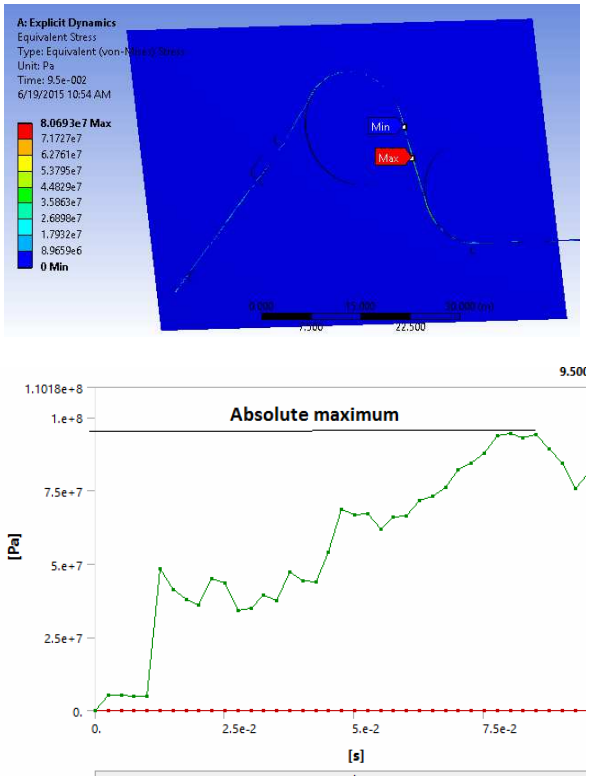


Figure 11 Pipe equivalent stress and its evolution in time after optimization

As seen above after optimization the maximum calculated stress inside the pipe is 8.06e7 Pa instead of 9.97e7 Pa before optimization, therefore a reduction of 19% is to be reached by simply lowering the upper ramp and decreasing the force developed by the Tensioner 1.

4. CONCLUSIONS

The integrity of the subsea pipe during launching from a J-Lay vessel is the most important criteria to judge a successful launching. In the J-Lay systems as the one presented in this paper the vessel launching structure is stressing the pipe sometimes beyond the elastic domain and the verification of the stresses inside the pipe is of a paramount importance.

This paper is providing a modern involvement of Finite Elements Methods in calculating the optimum launching system arrangement in order to have the minimum equivalent stress inside the subsea pipe during launching. After optimization the maximum calculated stress inside the pipe is 8.06e7 Pa instead of 9.97e7 Pa before optimization, therefore a reduction of 19% is to be reached by simply lowering the upper ramp and decreasing the force developed by the Tensioner 1.

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SEAS AND OCEANS, SUPPLIERS OF THE NEW AND INNOVATIVE RENEWABLE ENERGY

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ABSTRACT

The seas and oceans have the potential to become important sources of clean energy. Marine renewable energy, which includes both offshore wind and ocean energy, presents an opportunity to generate economic growth and jobs, enhance the security of the energy supply and boost competitiveness through technological innovation, contributing to the decarbonisation goals.

In the context of a decrease of the primary resources, the blue energy generated by the oceans and seas captured the interests of many countries. We see today many studies, researches, projects that crossed the borders of the countries, developed by collaborative mixed teams. The results are promising, the success is guaranteed.

The present paper is a desk research on the ocean energy in Europe and not only in this region, showing the best practices in this area of activity and their implementation.

The conclusions are very clear and sustained by the figures; the blue energy gained its own place in the mix energy of many countries. This inexhaustible resource seems to gain more and more interests year by year.

Keywords: *blue energy, currents energy, ocean energy, renewable resource, tidal energy, wave energy.*

1. INTRODUCTION

Energy Strategy is "a complex activity that involves the initiation, conduct and correlation of the political, economic, technical and environmental actions in order to ensure the national energy security, diversification of internal and external supply sources, to improve and diversify forms of energy production, the increase production efficiency and energy consumption, improving pollutant impact of energy production and consumption "[2].

Integrated Energy Strategy consists of a "set of interrelated measures that directs the energy sector to the most efficient, equitable and environmentally compatible use of resources."[1].

Globally, it is estimated that total energy demand in 2030 will be about 50% higher than in 2003, and oil demand will be about 46% higher. The secure known oil reserves can sustain the current levels of consumption only until 2040, and those of gas until 2070, while the world reserves of coal provides for more than 200 years even to an increase in the level of operation. Projections indicate an economic growth, which would imply a higher consumption of energy resources.

In terms of the structure of primary energy consumption worldwide, evolution and prognosis of the reference made by the International Energy Agency (IEA) highlights for the period 2010-2020 a quicker increase in the share of the renewable sources and natural gas.

It is estimated that about a quarter of the primary energy resources needs at the global level, will still be covered by coal. Along with increasing energy consumption and coal consumption will increase. Data from the World Energy Council (WEC) show an increase of nearly 50% of global coal mining in 2005 compared to 1980.

The increase of the prices for the fossil energy and dependence on imports makes it extremely necessary to the production and exploitation of renewable energy for heat, electricity and fuel.

Developing the renewable energy is a central objective of the European Commission's energy policy in Europe and of the most important countries in the world. There are several reasons for this. Renewable energy has an important role to play in reducing carbon dioxide emissions (CO2) - a major objective. The increase of the share of renewable energy in the energy balance brings durability. It also helps to improve energy security by reducing dependence on growth of imported energy sources. Renewable energy sources are expected to be competitive economically with conventional energy sources in the medium and long term.

Among renewable energy, the ocean energy occupies a low place, but the potential of this source is very high. According to a recent study, the marine energy has a double potential compared to that of the entire nuclear energy produced in the present moment all over the world, and it is more reliable than wind and solar energies. It is estimated that it will take at least 5-10 years for the technology to get out of the demonstration phase and decrease costs so that marine energy can compete economically with that from other energy sources.

European Association for Ocean Energy (EU-OEA) has released another study, according to which, by 2050, marine energy could provide 15% of Europe's energy needs. [3]

2. OCEAN ENERGY

As oceans cover over 70% of Earth’s surface, ocean energy (including wave power, tidal current power and ocean thermal energy conversion) represents a vast source of energy, estimated at between 2,000 and 4,000 TWh per year, enough energy to continuously light between 2 and 4 billion 11W low-energy light bulbs.

Ocean energy can be harvested in many forms. Wave energy depends on wave height, speed, length, and the density of the water. Tidal stream energy is generated from the flow of water in narrow channels whereas tidal range technologies (or 'tidal barrages') exploit the difference in surface height in a dammed estuary or bay. Ocean energy can also be generated from temperature differences between surface and sub-surface water while salinity gradient power relies on the difference in salinity between salt and fresh water [3].

The ocean energy has some particular aspects, as follows:

- The ocean energy resource available globally exceeds the present and projected future energy needs. In the EU, the highest potential for the development of ocean energy is on the Atlantic seaboard, but is also present in the Mediterranean and the Baltic basins and in the Outermost Regions. For the North America, and particularly for U.S., the tidal power occurs only in Maine and Alaska; ocean thermal energy conversion is limited to tropical regions, such as Hawaii, and to a portion of the Atlantic coast; the wave energy has a more general application, with potential along the California coast. The western coastline has the highest wave potential in the U.S.; in California, the greatest potential is along the northern coast. Exploiting this indigenous resource would help to mitigate EU dependence on fossil fuels for electricity generation and enhance energy security. This may be particularly important for island nations and regions, where ocean energy can contribute to energy self-sufficiency and replace expensive diesel-generated electricity.
- The ocean energy sector can become an important part of the blue economy, fuelling economic growth in coastal regions, as well as inland.
- Ocean energy has the potential to create new, high-quality jobs in project development, component manufacturing and operations.
- Scaling up the deployment of ocean energy could contribute to the decarbonisation goals. Developing all sources of low-carbon energy in a cost-effective manner is very important in order to reduce the greenhouse gas emission.
- Ocean energy electricity output is different to that derived from other renewable energy sources. This means that ocean energy could help to balance out the output of other renewable energy sources such as wind energy and solar energy to ensure a steady aggregate supply of renewable energy to the grid.
- Ocean energy devices tend to be entirely or partially submerged and therefore have a low visual impact. As the scope for expansion of land-based renewable energy generation becomes constrained, the marine space offers a potential solution to public acceptance issues related to visual impact, which may hinder renewable energy developments on land.

2.1 Tidal energy

Tidal energy has been used since about the 11th Century, when small dams were built along ocean estuaries and small streams. The tidal water behind these dams was used to turn water wheels to mill grains.
Tidal current energy takes the kinetic energy available in currents and converts it into electricity.

Tides occur regularly in certain coastal areas in the world, with amplitudes that can sometimes reach 14 -18 m, causing slow oscillations of level of marine waters. For an efficient utilization of energy from tides, certain natural conditions are required. First, the amplitude of the tide to be at least 8 m, and, secondly, that there is a natural pond (typically an estuary) to communicate with the ocean by an extremely narrow opening. These natural conditions only occur in 20 areas of the world (for example: the Atlantic coasts of France, Great Britain, USA, Canada, in northern Australia, eastern China).

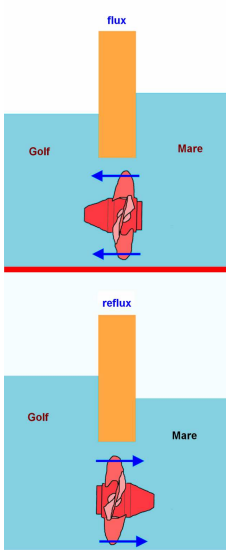

Figure 1 Operation of a power plant using tide power [5]

Some of the plants in the world that use the tidal energy are:
- Central Lake Sihwa, South Korea; the largest in the world, completed in 2011; 254 MW

Figure 2 Central Lake Sihwa, South Korea [6]

- Rance Tidal Power Station in the estuary Rance – installed power of 240 MW power; tidal amplitudes reaching over 13 m;

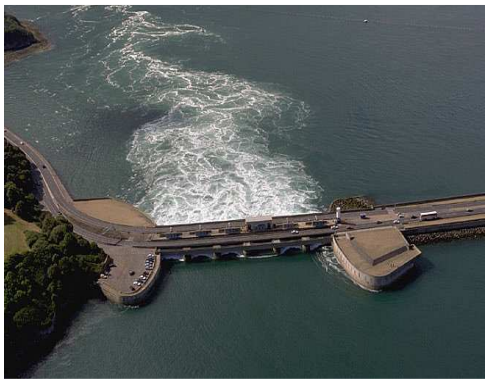

Figure 3 Rance Tidal Power Station [7]

- North America – "Annapolis Royal Generating Station", put into operation in 1984, in the Bay of Fundy; installed power: 20 MW.

2.2 Marine currents

Marine currents are carriers of particularly high kinetic energy. Thus, it was calculated that an ocean current with a width of about 100 m, 10 m depth and speed of 1m / s, for one year could provide a kinetic energy of about 2000 kwh. [8]

2.3 Waves

The waves are a form of energy storage transmitted by wind energy calculable and worthy of consideration. Calculations have shown that waves with height of 1 m, length 40 m and period of 5 s, have a power of around 5 KW on a1 m wide front.

Wave energy research worldwide has experienced great magnitude in the last years. Today, capture and convert wave energy is widely applied in many buoys and signaling installations. But realization of energy power plants based on waves requires longer efforts currently being carried out a sustained activity in many countries.

Numerous research institutes in hydraulic and energy in the US, France, Britain and Japan have in their activities program, production of the installations in order to the wave energy.

And some projects are under study aiming sea energy recovery by using the temperature difference between the different layers of the World Ocean water. Frequently, in the warm sea waters there are large temperature differences between the surface layers and the depth, differences that would allow the operation of power plants based on the use of two different temperature heat sources.

Currently, there are hundreds of signaling buoys using wave energy, manufactured by China and Japan, and strives to achieve high power plants. These plants are based on different principles. Analyzing the operation of these plants, it can be seen that all have a common feature, namely training through turbine generators. It should be noted that the axial air turbines may have higher returns because of their intubation.

Types capture wave energy installations currently investigated can be grouped as follows:

- Plants capture wave energy for the shore (shoreline) and near the shore (nearshore)

• Installations with oscillating column - OWC (oscillating water column). Consisting essentially of an enclosure in which waves that penetrate form an oscillating column. This column acts a volume of air passing through an air turbine valve;

• Installations TAPCHAN. They consist of a pool where the waves coming through a specially designed channel cause the water to accumulate at a higher sea level. The obtained difference level allows powering the turbines;

• Plants swinging hinged panel. In a specially designed space, a panel varies due to waves propagate horizontally and operates a hydraulic pump. The pump feeds a hydraulic turbine.

- Plants capture wave energy for large areas (offshore)

• Danish plant with pump and float. It is an installation where a float operates a pump that it is anchored to the seabed, acting hydraulic turbines;

• Swedish plant HOSEPUMP. It is based on a cylinder made of elastomers, driven by a float, allowing the expulsion of water from the interior, feeding of a hydraulic pump and the drive power of a turbine;

• McCABE PUMP WAVE installation. It is consisting of some pontoons that move toward a central pontoon, acting hydraulic pump which supplies more hydraulic turbines;

• PELAMIS installation. It consists of several large size tubes, connected to one another by hinges which, because of the angular inclinations caused by waves, acts some liquid pump. In turn, the pumps operate the turbines connected with the electric generators (power plant from Portugal) [9].

In Europe, according to the EU report, the ocean energy resource available globally exceeds the present and projected future energy needs. In the EU, the highest potential for the development of ocean energy is on the Atlantic seaboard, but is also present in the Mediterranean and the Baltic basins and in the Outermost Regions. Exploiting this indigenous resource would help to mitigate EU dependence on fossil fuels for electricity generation and enhance energy security. This may be particularly important for island nations and regions, where ocean energy can contribute to energy self-sufficiency and replace expensive diesel-generated electricity.

With technological improvements and additional public support for early stage development, the ocean energy sector may be able to develop to a similar scale as offshore wind over time. Ocean energy currently is an infant industry, within which wave and tidal stream technologies are relatively more developed than other technologies. There are currently 10MW of installed wave and tidal stream capacity in the EU, which is almost a three-fold increase from 3.5MW four years ago. Located in the UK, Spain, Sweden and Denmark, these projects are mostly pre-commercial, demonstrating the

reliability and survivability of tested devices. Huge growth is already predicted, however, with some 2GW of projects in the pipeline (predominantly in the UK, France and Ireland). If all of these projects are implemented, they could supply electricity to more than 1.5 million households. [4]

As a practical example, in Europe, Scotland runs the largest wave energy project in the world.

Scotland began in January 2015 construction of the largest tidal energy project in the world; the investment will be developed off the coast of Scotland. MeyGen project could power nearly 175,000 homes through a network of 269 turbines on the seabed off the Ness Quoys Caithness, north-east Scotland. Scotland has access to one of the richest marine energy resources in the world. According to the report, it is expected that by 2020 can be installed capacity of 1,300 MW in Scottish waters, adding 100 MW each year.

The first deliveries to the national electricity grid could take place in 2016. [10]

In Portugal there is a new type of power plant that uses wave, ranked as the largest wave power plant functional, Agucadoura Waves Farm, near Póvoa de Varzim, 5 km from shore. It cost about $ 13 million (the majority to achieve electrical cables underwater), and has an output of 2.25 MW of energy.

Although it may seem expensive at first glance, this solution competes in efficiency / cost, both solar panels and wind turbines. And being the first implementation, the wave energy will increasingly be better exploited. An advantage of this power plant is that the waves provide energy continually.

Generators that turn wave power into electricity were produced by Pelamis Wave Power Limited Scottish Company, and have an individual capacity of 750 kW. Each has a diameter of 3.5 meters, and a length of 140 meters.

Portuguese plan a second phase of the project, when they will increase the number of generating 3 to 28. And then it will produce 21 megawatts of power, enough for about 15,000 homes. [11], [12]

Figure 4 Agucadoura Waves Farm [12]

Among the projects that are using wave energy, there is also the largest hydropower turbine in the world, SeaGen turbine in Strangford Lough, Ireland.

Related wind turbines, but powered by the movement of water and no wind, hydro turbines transform the currents from the depths of the oceans into electricity. SeaGen of 1.2 megawatts, which consists of a pair of turbines, each with 20 meters in diameter, is currently the only commercial-scale hydropower turbine in the world. Propeller blades have the ability to rotate 180 degrees depending on the direction of movement of currents and may be removed from the water for maintenance, the common nature of their work being underwater.

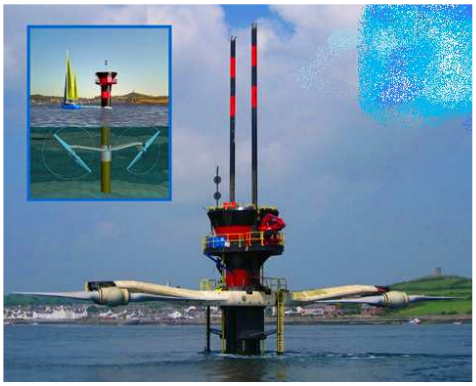

Figure 5 The largest hydropower turbine in the world, SeaGen turbine in Strangford Lough, Ireland [12]

A succesful non-European project that has been already implemented is CETO 5 in Australia.

An Australian company has developed a system that produces electricity using ocean movements, specifically the power of the waves.

CETO 5 system was already connected to the mains of Australia. CETO 5 is composed of three large buoys completely immersed into water and water pumps. When ocean waves hitting the buoys, the pumps are activated that push water under pressure into electric turbines. At the same time, is fed to a desalination system. Australian authorities are already planning system implementation CETO 6, which will provide four times more energy than CETO 5.

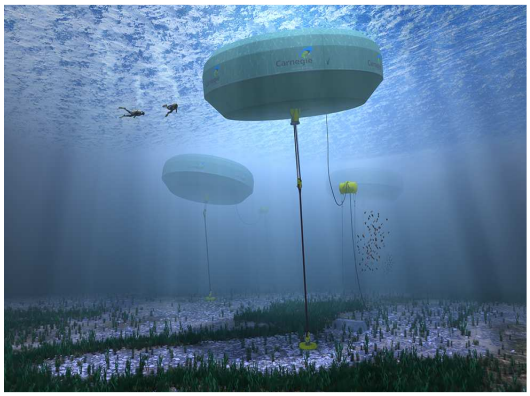

Figure 6 CETO 5 [13]

3. ACTION PLAN FOR OCEAN ENERGY IN EUROPE

In Europe, the commission to the European Parliament established an Action plan for Ocean Energy. [4]

For pre-commercial ocean energy technologies, however, a stable and low risk framework of support is crucial as it ensures the bankability of projects and thus allows for the growth of installed capacity. The European Commission issued guidance on best practice for renewable energy support schemes. The guidance therefore allows for projects of first commercial scale deployment and thereby recognises the need for a targeted support framework for technologies such as ocean energy.

There were sets out a two-step action plan that will assist this promising industrial sector in developing its potential.

First phase of action (2014 – 2016)

Ocean Energy Forum

An Ocean Energy Forum will be set up, bringing together stakeholders in a series of workshops in order to develop a shared understanding of the problems at hand and to collectively devise workable solutions. It will be instrumental in building capacity and critical mass as well as fostering cooperation through the involvement of a wide range of stakeholders. The forum will also explore the synergies with other marine industries, particularly offshore wind, in matters relating to supply chains, grid connection, operations and maintenance, logistics and spatial planning.

Ocean Energy Strategic Roadmap

Based on the outcomes of the Ocean Energy Forum, a Strategic Roadmap will be developed setting out clear targets for the industrial development of the sector as well as a timeframe for their achievement. This roadmap will be elaborated jointly by industry, Member States, interested regional authorities, NGOs and other relevant stakeholders through a structured and participative process, as outlined above. The roadmap will bring together findings from all areas relevant to the development of the industry and provide an agreed blueprint for action in order to help the ocean energy sector move towards industrialisation.

Second phase of action (2017-2020)

European Industrial Initiative

An European Industrial Initiative could be developed based on the outcomes of the Ocean Energy Forum. In order to establish a viable European Industrial Initiative, however, the industrial stakeholders must first have a clear strategy for the development of the sector and they must be well organised in order to be able to deliver on its objectives.

Sector-specific guidelines for the implementation of relevant legislation

Based on the experience gathered in the administrative issues and finance workstream and the environment workstream, guidelines could be developed to streamline and facilitate the implementation of the Habitats and Birds Directives and Article 13 of the Renewable Energy Directive as well as to assist with maritime spatial planning processes. The aim of these guidelines will be to reduce uncertainty through the provision of clearer and more specific guidance for the licensing of relevant projects and thus ease the burden faced by public authorities and project developers.

4. CONCLUSIONS

All the forecasts estimate that the energy demand will increase in the next years. The primary resources prove their limitations in time: until 2040 for the secure known oil reserves, gas until 2070, the world reserves of coal for more than 200 years, at the current levels of consumption. But the projections show an economic growth that naturally will be done with a higher consumption of energy resources.

In the last decades, it was noticed the concerns of the specialists to find new energy resources in order to sustain the increasing energy demand. Thus, the mix energy of the countries showed changes in the last years, the renewable energy resources gaining more and more shares.

Thus, it is time to explore all possible options in a sustained and collective effort to mitigate the effects of climate change and to diversify the portfolio of renewable energy sources. Supporting innovation in low-carbon energy technologies can help to tackle these challenges.

The growth of the wind and solar energy sectors in recent years clearly demonstrates that concerted efforts to put in place appropriate policy and funding frameworks can provide the incentives required by industry to deliver results. It is noticed the trend of encouraging the investments in renewable energy technologies through revenue support schemes, capital grants and research funding, but only a few have dedicated support in place for ocean energy.

Although ocean energy deployment figures are modest compared to the offshore wind sector, commercial interest in the sector is increasing, as evidenced by the growing involvement of large manufacturers and utilities. If we translate this information in figures, we will see that in the EU power mix, in 2014, the Ocean Energy is about 0.03% compared to 0% in 2000, a modest share, indeed, but an important presence from the point of view of this sector potential.

For Europe, there are estimations that by 2050, the marine energy could provide 15% of Europe's energy needs.

As oceans cover over 70% of Earth’s surface, ocean energy (including wave power, tidal current power and ocean thermal energy conversion) represents a vast source of energy, estimated at between 2,000 and 4,000 TWh per year, enough energy to continuously light between 2 and 4 billion 11W low-energy light bulbs.

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OFFSHORE MARINE ENERGY IN THE EUROPEAN AREA

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ABSTRACT

In the energy system, the renewable energy sources (RES) play an increasingly important place, contributing to a sustainable and efficient development, compatible with a cleaner environment. Among these energy sources, the marine RES, and especially the offshore energy increased from one year to another.

The paper contains a desk analysis of the offshore energy area, showing figures, images, dates and conclusions on these new technologies and their effects on short and long terms. Also, a SWOT analysis is included, representing a necessary assessment of the strong and weak points, trying to adjust the strengths to the opportunities and reduction at a minimum level of the threats, eliminated the weak points.

The projects based on this type of energy source, their positive results outline a promising perspective for the investors and authorities. The benefits are conclusive in this area: this inexhaustible and free resource generates energy with zero emissions, provides permanent and temporary jobs, services and economic growth, a balanced proportion between supply and demand of energy.

Keywords: *marine RES, ocean energy, offshore energy, offshore wind farm, wind turbine.*

1. INTRODUCTION

The concept of sustainable development means all forms and methods of socio-economic development that focuses primarily on ensuring a balance between social, economic and ecological elements of natural capital. [10] The best known definition of this concept is certainly one given by the World Commission on Environment and Development (WCED) report "Our Common Future", also known as the Brundtland Report: "Sustainable development is development that aims to satisfy the needs of the present without compromising the ability of future generations to meet their own needs."

Unanimously, it is recognized that economic development cannot be stopped, but that strategies need to be changed so as to match the ecological limits offered by the environment and the planet's resources.

Closely related to the notion of sustainable development is that one of the energy strategy. Energy Strategy is "a complex activity that involves the initiation, conduct and correlation of the political, economic, technical and environmental actions in order to ensure the national energy security, diversification of internal and external supply sources, to improve and diversify forms of energy production, the increase production efficiency and energy consumption, improving pollutant impact of energy production and consumption "[1].

The energy sector of a country is stronger when multiple ways of producing energy exist, so when there are multiple systems of energy and is less resistant when there is only one way of applied producing energy. The solution for the future stability of everyday life is from the energetic point of view, the existence of several energy systems in parallel.

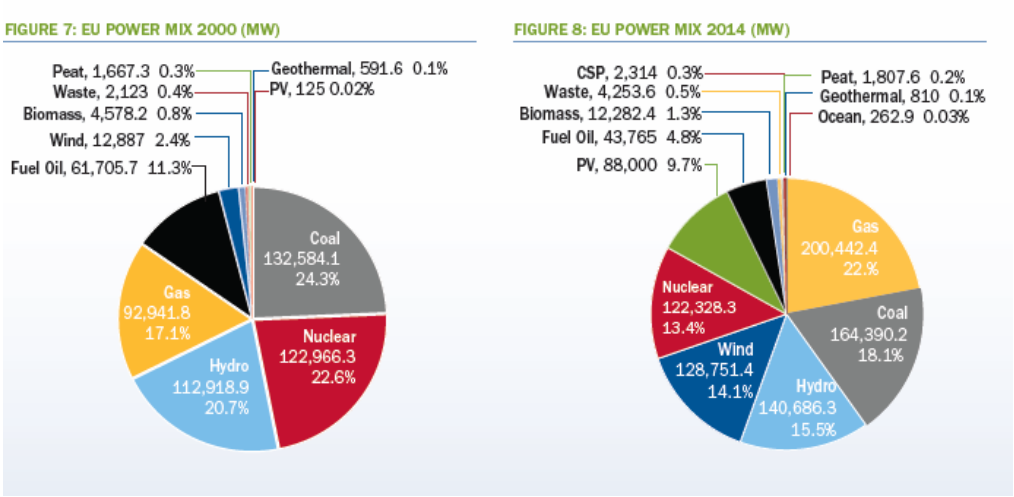

Figure 1 EU power mix [5]

In the latest period, it is noticed that the countries that are net importers of energy direct their efforts to the renewable energy and improving energy efficiency. However, in many countries, it is reconsidered the nuclear option, following the events at Fukushima - Japan in 2011. [3]

At the European level, Member States have very different energy mixes. The mix varies considerably from country to country and evolve with time due to the geographical conditions of the respective countries, such as the availability of and access to the natural resources, national policy options, such as the decision of whether or not nuclear energy, change of the financial incentives, progress in terms of technology, the requirements for decarbonisation and developing internal market. It was agreed, commonly, three main objectives to be achieved by 2020 (often referred to as "20 20 20 2020"): reducing CO2 emissions by 20% compared to 1990, increasing to 20% the proportion of the renewable resources in total EU energy mix and increase the energy efficiency by 20%. These objectives are also basic elements of the Europe 2020 strategy for smart, sustainable and favourable inclusion.

2. OFFSHORE WIND POWER

The seas and oceans have the potential to become important sources of clean energy. Marine renewable energy, which includes both offshore wind and ocean energy, presents the EU with an opportunity to generate economic growth and jobs, enhance the security of its energy supply and boost competitiveness through technological innovation.

While land-based wind energy will remain dominant in the immediate future, installations at sea will become increasingly important. Compared to onshore wind, offshore wind is more complex and costly to install and maintain but also has a number of key advantages. Winds are typically stronger and more stable at sea than on land, resulting in significantly higher production per unit installed. At sea, wind turbines can be bigger than on land because of the logistical difficulties of transporting very large turbine components from the place of manufacturing by road to installation sites on land. Wind farms at sea also have less potential to cause concern among neighbouring citizens and other stakeholders unless they interfere with competing maritime activities or impact negatively on important marine environmental interests. In fact, wind farms at sea may be advantageous to protect marine ecosystems and may generate synergies with other emerging uses of the sea such as offshore aquaculture, which can benefit from the substructures of wind farms.

In Europe and not only in this region, the works are very advanced in this direction of the offshore wind farms.

The reports launched in 2015 by EWEA (European Wind Energy Association) offers a comprehensive image of the offshore wind market in 2014 and overall in Europe.

Below, there are figures and data taken out from the aforementioned reports.

Onshore and offshore annual markets [5]

Offshore wind installations in 2014 were 5.3% less than in 2013, with 1,483.3 MW of new capacity grid connected. Offshore wind power installations represent 12.6% of the annual EU wind energy market, down from 14% in 2013.

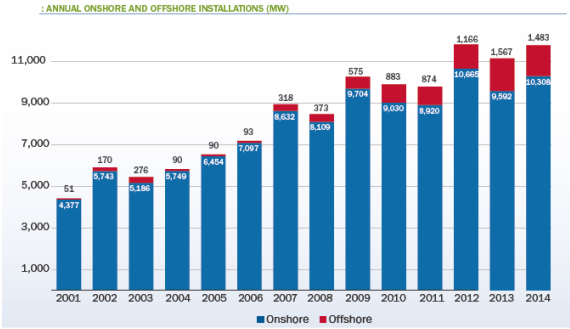

Figure 2 Annual onshore and offshore installations (MW) [5]

Year 2014 in figures

- 408 new offshore wind turbines in nine wind farms and one demonstration project were fully grid connected between 1 January and 31 December 2014. The new capacity totals 1,483.3 MW - 5.34% less than in 2013;
- 536 turbines were erected during 2014, an average of 5.9 MW per day. 373 of these turbines are awaiting grid connection;
- Work is on-going on 12 projects.
- 2,488 turbines are now installed and grid connected, making a cumulative total of 8,045.3 MW in 74 wind farms in 11 European countries;

Once completed, the 12 offshore projects currently under construction will increase installed capacity by a further 2.9 GW, bringing the cumulative capacity in Europe to 10.9 GW.

During 2014, work was carried out on 17 offshore wind farms in Europe, thus:

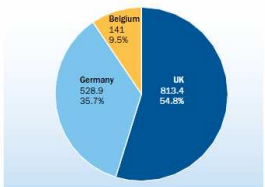

FIG 1: SHARE OF ANNUAL OFFSHORE WIND CAPACITY INSTALLATIONS PER COUNTRY (MW)

TABLE 2: NUMBER OF TURBINES AND MW FULLY CONNECTED TO THE GRID DURING 2014 PER COUNTRY (MW)

Country	Belgium	Germany	UK
No. of farms	1	5	4
No. of turbines connected	47	142	219
MW connected to the grid	141	528.9	813.4

Figure 3 Share of annual offshore wind capacity installations per country (MW) [4]

Of the total 1,483.3 MW connected in European waters, 50.7% were in the Atlantic Ocean, and 49.3% were located in the North Sea.

Siemens continues to be the top offshore wind turbine supplier in terms of annual installations. With 1,278 MW of new capacity connected Siemens accounts for 86.2% of the market. Vestas (141 MW, 9.5%), Areva (45 MW, 3%) and Senvion (12.3 MW, 0.8%) are the other turbine manufacturers who had turbines grid connected in full-scale wind farms during 2014. Samsung connected its demonstration turbine to the grid in Fife, UK (7 MW, 0.5%).

Similarly, in terms of units connected, Siemens remains at the top with 340 3.6 MW turbines and nine 6 MW offshore wind turbines (85.5% of connected wind turbines) connected in European waters during 2014. Siemens is followed by Vestas which connected 47 3 MW turbines (11.5%), Areva (nine turbines of 5 MW, 2.2%) and Senvion (two turbines of 6.15 MW, 0.5%). Samsung, connected one demonstration turbine of 7 MW.

The average capacity rating of the 408 offshore wind turbines connected to the grid in 2014 was 3.7 MW, smaller than in 2013. The popularity of Siemens' 3.6 MW turbine (340 wind turbines connected in 2014) keeps the average turbine size near the 4 MW mark, despite the emergence and installation of larger rated turbines.

Cumulative market figures

A total of 2,488 wind turbines are now installed and connected to the electricity grid in 74 offshore wind farms in eleven countries across Europe. Total installed capacity at the end of 2014 reached 8,045.3 MW, producing 29.6 TWh in a normal wind year, enough to cover 1% of the EU's total electricity consumption.

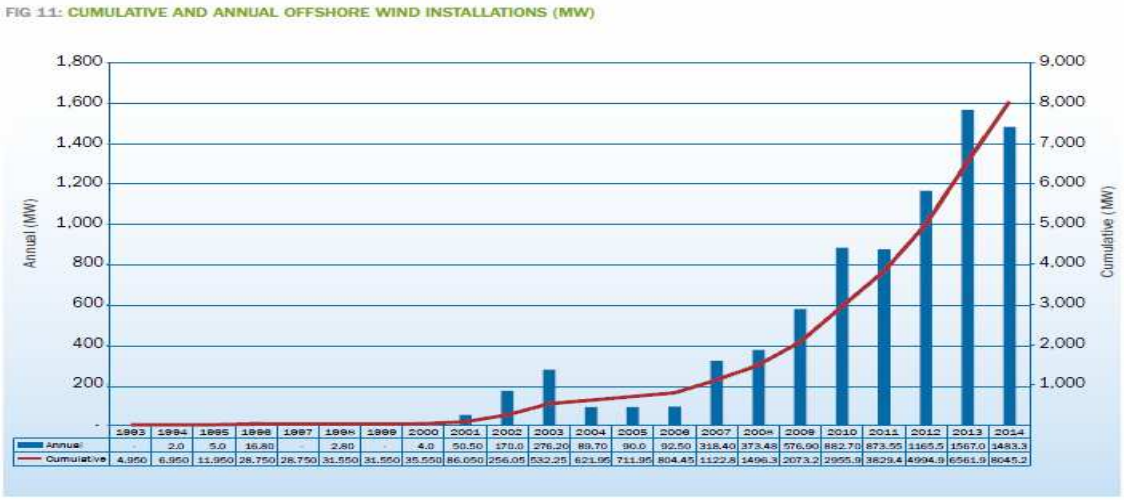

Figure 4 Cumulative and annual offshore wind installations (MW) [4]

The UK has the largest amount of installed offshore wind capacity in Europe (4,494.4 MW) - 55.9% of all installations. Denmark follows with 1,271 MW (15.8%). With 1,048.9 MW (13% of total European installations), Germany is third, followed by Belgium (712 MW: 8.8%), the Netherlands (247 MW: 3.1%), Sweden (212 MW: 2.6%), Finland (26 MW: 0.3%), Ireland (25 MW), Spain (5 MW), Norway (2 MW) and Portugal (2 MW).
The 8,045.3 MW of offshore wind capacity are mainly installed in the North Sea (5,094.2 MW: 63.3%). 1,808.6 MW or 22.5% are installed in the Atlantic Ocean and 1,142.5 MW (14.2%) in the Baltic Sea.

Predictions for 2015 and 2016[4]

The market outlook for 2015 remains stable in terms of capacity to be brought online. There are twelve projects under construction - representing 2.9 GW - in the pipeline for the next 12 to 18 months. Five of these projects had some wind turbines connected to the grid in 2014; once completed they will result in a further 1.18 GW of capacity taking the cumulative offshore wind capacity to a minimum of 9.2 GW in Europe. However, predictions of reaching 10 GW by 2015 are well within industry expectations.

In the year 2015 we see Germany overtake the UK in annual grid connected capacity. The largest wind farms to be fully completed will be RWE's Gwynt y Mor (576 MW) followed by Global Tech 1 (400 MW), both expected in Q1.

In the year 2016, however, we will see a slump in the market, featuring a low level of wind turbines being connected. The UK is unlikely to fully commission any hundred-MW scale offshore wind farms, though the 50 MW Kentish Flats Extension may be started and commissioned. Outside of the UK, only Germany and the Netherlands are expected to bring capacity online in 2016 with DONG Energy's Gode Wind 1 and 2 and ENECO´s Westermeerwind.

Further in the future, EWEA has identified 26.4 GW of consented offshore wind farms in Europe and future plans for offshore wind farms totalling more than 98 GW.

Wind farm size

In 2012, the average size of connected offshore wind projects was 286 MW while in 2013 it was 485

MW. In 2014, it was 368 MW. This is the result of the completion in 2013 of the record breaking London Array (630 MW).

Related to this project, London Array expansion, postponed in 2014 was relaunched in 2015, thus, the British will have the largest offshore wind farm in the world. It is to be built off the coast of Yorkshire, where they will be installed no less than 400 wind turbines.
When completed, the project Dogger Bank Creyke Beck will be two times higher than the current largest offshore wind farm in the UK, which includes two plots of 200 wind turbines located on an area of 500 square kilometers.

Wind turbines will power 1.8 million homes - about 2.5% of the total electricity demand in the UK. [6]

The use at a maximum level of the available energy in the UK creates jobs and businesses in the country, while providing the best deal for consumers and reducing dependence on foreign imports. [7]

Related to the off-shore wind power, a further promising concept is offshore floating wind power. The deepening offshore coastal areas on the Atlantic seabed make offshore turbines with fixed foundations too expensive. A floating platform that is anchored to the seabed could be a more cost-effective solution in those waters. There are currently two offshore wind floating demonstration projects in operation, in Portugal and Norway. [2]

The world's first floating wind turbine on a large scale, Hywind, supported at a depth of 220 meters was assembled in Åmøy Fjord near Stavanger, Norway, in 2009, before the implementation of the North Sea.

The "Hywind" was developed by the companies Siemens and StatoilHydro and it is tested in order to provide a detailed analzsis of this concept.

Hywind turbine was designed for placement at depths of 120-700 m, which could open up many opportunities in offshore wind turbine technology. The turbine has a length of 107 meters, is anchored with steel hoses and center of gravity is below the water surface. [8]

Figure 5 Hywind offshore floating turbine via Flickr CC

According to a new report by the European Wind Energy Association, the total electricity consumption in the European Union could have - in fact, it may be exceeded by more than four times – by the floating offshore wind farms in the deep waters of the Sea North. The report also calls on the EU to set new renewable energy targets for 2030.

The report argues that floating wind turbines - and / or other wind turbines specially adapted for deep waters of the North Sea - should be an important part of EU energy infrastructure in the future. According to the European Wind Energy Association (EWEA), regardless of the development costs, the floating turbines - because of their very low use of steel - are competitive in terms of cost with the conventional turbines, which are installed in waters deeper than 50 meters.

The report states that if the appropriate policies are implemented now in order to impel the development and implementation of the next-generation floating turbines, the offshore wind EU total capacity could reach 150 GW by 2030.

The offshore wind sources are in a solid growth. But solid figures cannot counter that wind industry is experiencing instability policies and regulations, economic crisis and austerity. If European governments guarantee the stability of the policy and will solve the problem of connecting to the network, the offshore wind industry will have an important contribution to the energy needs. [9]

3. SWOT ANALYSIS

The SWOT analysis on the marine RES represents a necessary assessment of the strong and weak points, trying to adjust the strengths to the opportunities and reduction at a minimum level of the threats, eliminated the weak points.

The present SWOT analysis includes the four points, covering the marine RES: the offshore marine energy.

From the Strengths category, there can be listed:

- The RES sector expansion in recent years has favored the increase of the interest in exploiting the offshore wind energy.
- The offshore wind provides energy with zero emissions that not pollute in accordance with the objectives of reducing the pollution worldwide.
- The offshore wind energy is inexhaustible and free resources, the wind has unlimited potential compared with primary limited energy resources. The marine energy is a vast, indigenous, clean and renewable source.
- The energy generated by offshore wind could be transferred into mechanical and electrical energy.
- The energy produced by offshore wind could be used complementary with the solar energy.
- The offshore wind speed is higher than onshore wind speed, leading to a higher production of energy.
- The offshore projects are bigger than onshore projects.
- In the case of the onshore turbines, part of the marine RES, there was noticed that the blades, in their rotational motion associated with the noise can cause a state of stress in the residential areas. In offshore turbines, the long

distance from the shore, including here from the populations, excludes this inconvenience. Thus, the wind farms at sea cause less concern among neighbouring citizens
- Larger experience in the wind energy sustains the expansion of the offshore wind energy.
- The development of the offshore wind energy in a specific region will provide significant contributions to the local economy and community. The positive impact will be resulted from the capital invested associated to the project implemented thus providing permanent and temporary jobs, services and economic growth.
- The use of offshore wind energy contributes to a more balanced proportion between supply and demand of energy and gives a greater level of independence from the limited primary resources. It contributes to the energy security of countries/regions and decreases the dependence on imports of energy from other regions.
- The continuous need to the efficiency increase of the technologies used in the offshore wind energy exploitation leads to the development of the research activity, distinguishing a permanent opening to the renewal and improvement.

In the Weaknesses area, there can be included:
- There is a low infrastructure that leads to higher cost for integration of the energy generated by the offshore wind into the existing energy network. The energy produced at sea is difficult to distribute on land. It is therefore necessary to extend the interconnection capacity.
- At the offshore wind turbines that are not connected to the National Energy System, it is necessary to store the energy in batteries, resulting higher costs to maintain the plants and installations.
- The offshore energy is not constant over time, depending directly on the wind speed; thus this marine source of energy is characterized by unpredictability of wind speed.
- There are higher expenses for construction and maintenance of the offshore wind plants, which in the absence of a solid and appropriate government support transform this type of energy source: marine RES, in an undesirable area for potential investors.
- Larger expenses are reflected in higher rates of these sources of energy compared to other energy resources.

In the Opportunities sector, the following are contained:
- Working-out of the land for the onshore wind turbines
- Working-out of the primary resources
- The existence of the government programs of financial support in developing this renewable energy source represents prerequisites for investors to reduce the risks of these investment projects.
- Complementary investment guided to the commercial space area
- The development of offshore wind turbines with larger blades and more effective
- New technologies which attempts to climb obstacles appeared after the current operation (floating offshore turbines).
- The existence of programs and ongoing concerns in Europe and worldwide on pollution and strategic objectives of reducing pollution and integration of RES (and implicitly marine RES) in the energy mix creates opportunities for RES development (implicitly marine RES)

In the Threats, there are included:
- Higher costs for the offshore wind turbines compared to onshore ones; hence the higher investments and high interest in the onshore area, a real obstacle for the development of the offshore wind turbines. The offshore turbines will not be preferred until the land for the onshore ones is not worked out.
- There are risks arising from the novelty of the procedure and lack of experience in some specific fields working with some new technologies that have not long.
- The international financial problems
- Changing consumption behavior of consumers
- Legislative instability and lack of adequate measures for financial support
- Involvement of politics at a high level in this area of activity and legislative changes arising from this trend
- Competition that it faces from the onshore wind energy sector (and other RES sectors) and the oil and gas industry for financing, equipment and expertise

4. CONCLUSIONS

Undoubtedly, the RES sector gained an important place in the energy mix of many countries in the last years. The trend is natural in a growing economy; in a society with limited primary resources where the intention is to limit the environmental pollution, the solution is to find and use the alternative energy sources. Within these renewable energy sources, the marine RES occupy a significant place, due to the characteristics of these resources. In this context, it is appropriate and relevant to mention the benefits faced by maritime wind energy; based on them, there are outlined directions for action to be taken in order to promote, develop this type of energy.

Among the benefits compared to the production of onshore wind energy, it can be mentioned:
- production units at sea are larger than on land;
- winds are stronger and more stable at sea than on land;
- wind farms at sea cause less concern among neighbouring citizens.

This type of wind farm can be beneficial for the protection of certain marine ecosystems and can also allow other new uses of the sea to be developed, especially offshore aquaculture, which can benefit from the substructures of wind farms.

This energy is also a vast, indigenous, clean and renewable source.

Other sources of energy production should also be developed on a large scale, such as tidal, wave, thermal or marine current energy.

The development of maritime wind energy is a relevant alternative because it contributes to the implementation of clean energies.

The figures are promising: in the European Union, the offshore wind power installations represent around 12% - 14% of the annual EU wind energy market in the last 2 years.

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SPECIFICS OF THE TOPOCLIMATES, IN A MICROCLIMATE PROFILE ON THE BEACH AND THE HILLSIDE – CONSTANTA

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ABSTRACT

This study measurements were performed simultaneously regarding the evolution of some climatic parameters in the microclimate space. Depending on the different place of placing the observation stations, these differ in the measured values (wind temperature, precipitations).

Keywords: *microclimate profile, Constanta, wheater data*

1. INTRODUCTION

On 03/09/2014, measurements were performed simultaneously regarding the evolution of some climatic parameters in the microclimate space of beach and beach slope "Modern" from Constanta, in order to track the active surface role in the topoclimatic variations. In order to highlight some features, we measured the temperature of: the sand, the sea water, the grassy active underlying surface, the air at a height of 20 cm and a height of 2 m, the speed, the direction and maximum wind gust, the sky coverage with clouds, the clouds type, the soil conditions, the degree of sea agitation, the quantity of precipitations. All these took place, considering the topoclimate's contact with different states manifested in this space, but on the underlying surface. One of the automatic weather stations was installed right on the beach 10 m from the Black Sea water (Station A) and (Station B) above the beach "Modern" on the plateau level, on a grassy field, the level difference between the two stations being of 80 m.

Figure 1 Placement of the portable weather stations type "DAVIS" (station A, and B)

2. MATERIAL AND METHODS

At the start of the observations, at 12 noon, the sky was cloudy, the wind was blowing with speeds between 7 and 9 m/s with gusts of 10-12 m/s (*Station A*) in the NE direction, and at the (*Station B*) the wind speed was higher than 10-13 m/s with gusts up to 15 m/s, visibility with values bigger than 10 km.

The observations were carried out every 15 minutes using the following machines and instruments:

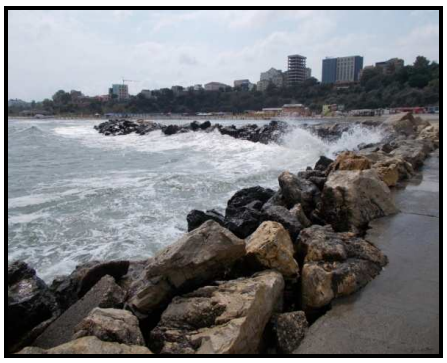
- Portable automatic weather station (Figure 2), manufactured in America (DAVIS), composed of: display for the wind temperature and speed, wind sensor consisting of wind direction indicator and bucket system to indicate the speed; support for sustaining the tail assembly;
- Thermometers manufactured in Germany with the scale between -25 and + 45ºC (to determine the air and water temperature) and between -25 and + 70ºC (to determine the soil temperature);
- Observations regarding visibility, cloud coverage and clouds type or the visual effect.

Synoptically, according to the three maps received from the satellite, maps obtained from the Regional Meteorological Centre Dobrogea, (wind map, precipitations map and baric systems map) a cyclonic field prevailed, with values of the atmospheric pressure Figure 5, between 1005 and 1010 mb (between the hours 8 and 12 has rained, and that is precisely why the observations began after the rain ceased, the measured rainfall was of 1.5 mm).

Figure 2 Parts of the portable automatic weather station type "DAVIS"

Passing to the analysis of the obtained weather parameters, we will find that the air temperature behaves differently, according to the near surface and the air movements dynamic. Thus, from analyzing the air temperature values at the height of 2 m, it was found that it is lower on station A than the air temperature recorded at the same height on station B, with 0.4 – 0.5 ^{o}C (Table no. 1 and no. 2), and much higher on the sand surface that stores the heat during the day, comparatively with the grass, the difference being of 4 – 6 ^{o} C (reference hour 12:3. And 14:00). Also at the height of 20 cm, the air temperature differs, being higher on the seafront with up to 0.6 – 0.9 ^{o} C. If, until the hour 13, the temperature had gone upwards then began to descend gradually. The sky was covered with Cumulus and Cumulonimbus inferior type clouds. The wind blew hard at the beginning of the observation, being able to cause disturbances in the registered meteorological elements values. At the station A we recorded average wind speeds of 4 to 7 m/s with gusts of 7-10 m/s, and at the station B the average wind speed was higher than 5-10 m/s with gusts of 9-15 m/s. On the beach located within a bay, at high wind gusts the deflation phenomena was found (sand transport up to the height of 1.5 m). At the station B, we consider that the wind speeds were influenced, being channeled by the high buildings nearby. Compared with the data recorded at the Meteorological Station Constantza (Table 3) located 6 km from the station A and B, the air pressure values ranged between 1010.3 mb and 1011.5 mb. At one point there was a variation in the air pressure of 1.2 mb (Table 3), which generated as the emergence of the rain shower phenomena at the weather station Constanta in both locations (A and B), the precipitations quantity being of 1.5 mm. In terms of the wind speed, this is approximately from the same direction in all the three observation points, only as the Constanta station (to note the wind map “A” where, in the pale green area, are indicated speeds of 10-15 m/s, and in the darker green area even speeds of 15-20 m/s). Only that the speed differs, the beach being an open place, or the place where the weather station Constantza is currently located is a sheltered place. At the station B located on the seafront, the wind speed and direction are different from the other two locations. In regards to the sea water temperature, it is the same in both locations of 24.6ºC (station A and weather station), and the agitation degree of the sea 3 - 4, meaning waves with heights between 0.5 and 2.5 m.

The instrumental observations, on topoclimatic profiles, at the beach "Modern" at the sea water level, and at the station no. 2, Constanta from the seafront, led to the conclusion that each elemental landscape develops its own conditions. These conditions depend on the nature of the active underlying surface varied as roughness which can be: soil covered with wet or dry sand, grassy soil, bodies of water or vegetation.



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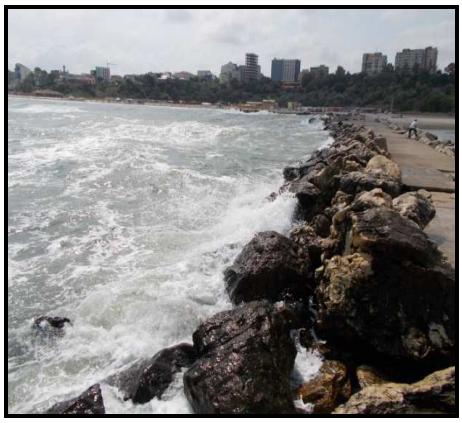
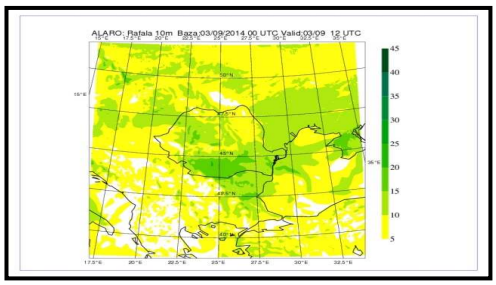


2.

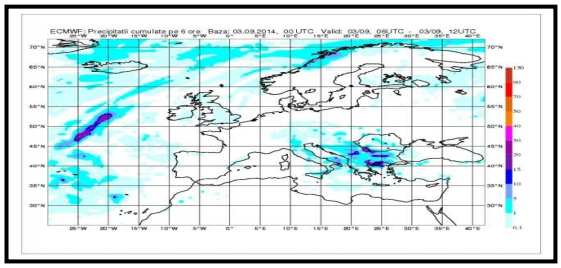
Figure 3 The beach "Modern" in Constanta where measurements were performed

In the conditions of a blue sky with Sun, the weather parameters’values are different if we consider the moderating role of the sea water that stores heat in the surface layer, influencing the air temperature.

By analyzing with a chart (Figure 5) the differences between the temperatures recorded in the two locations, these are obvious with an increase of the actual value in the station A, until around the hours 13:15, after which there is a decrease, increase which in station B is slower as well as the decrease; the seawater role is obvious compared to the grassy area.



A



B

Figure 4 The synoptic map of the wind (A) and the precipitations (B) from the day of 03.09.2014

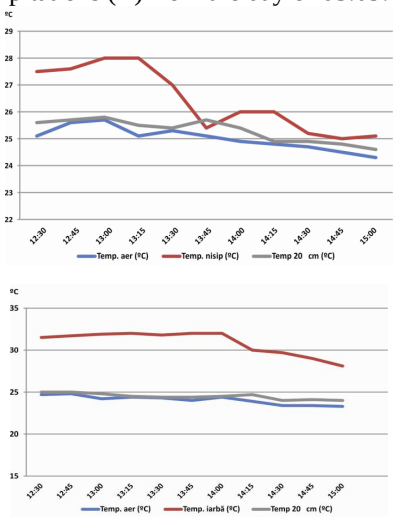


Figure 5 Air temperature variation in station A and B on the day 3.09.2014

3. RESULTS

The results on this study are presented in Table 1, Weather data recorded on the beach "Modern", station A, Table 2, Weather data recorded on the beach "Modern", station B, and Table no.3 grassy soil, Weather data recorded at the weather station Constanta on the day of 3.09.2014

4. CONCLUSIONS

On the hillside located on the beach "Modern", outcrop the Sarmatian limestones visible from place to place, and covered with a thick blanket of loess, some of them clothed in vegetation consisting of a herbaceous and shrubs carpet. The waterfront, in some places, seems to be active morphologically due to the dynamic factors, plus the slides, slumps, torrents, that is why, in the beach area on the hillside, occurred white buckthorn, willow, lilac, castor plantations, in order to fix the soil and stop the appearance and triggering of actual geomorphologic processes.

The conclusion is as follows: depending on the different place of placing the observation stations, these differ in the measured values (wind temperature, precipitations).

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Table no.1 Weather data recorded on the beach "Modern", station A

Hour	Temperature (ºC)				Wind (m/s)			State sand	Degree coverage		Degree high agitation	Quantity prec. (mm)
	air	sand	water	20cm	Dir.	Speed	Gusts max.		Nebulous	Type clouds		
12:30	24,7	31,5	-	25,0	NE	10	15	moist	6/6	Cu	3J	1,5
12:45	24,8	31,7	-	25,0	N	10	15	moist	6/6	Cu	3	
13:00	24,2	31,9	24,6	24,8	N	9	14	moist	5/5	Cu	4	
13:15	24,4	32,0	-	24,5	N	7	11	dry	6/5	CuCi	4	
13:30	24,3	31,8	-	24,4	NE	7	11	dry	6/6	Cu	4	
13:45	24,0	32,0	-	24,4	ENE	6	9	dry	7/7	CuCb	4	
14:00	24,4	32,0	24,6	24,5	ENE	5	8	dry	7/7	CuCb	4	
14:15	23,9	30,0	-	24,7	NE	5	8	dry	7/7	CuCb	4	
14:30	23,4	29,7	-	24,0	ENE	4	7	dry	7/7	CuCb	4	
14:45	23,4	29,0	-	24,1	N	6	10	dry	7/7	CuCb	4	
15:00	23,3	28,1	24,6	24,0	N	5	9	dry	8/8	CuCb	4	

Table no.2 Station B

Hour	Temperature (ºC)				Wind (m/s)			State soil	Degree coverage		Degree high agitation	Quantity precipitations (mm)
	air	sand	water	20 cm	Dir.	Speed	Gusts max.		Nebulous	Type clouds		
12:30	25,1	27,5	-	25,6	N	7	10	moist	6/6	Cu	3	1,5
12:45	25,6	27,6	-	25,7	N	6	9	moist	6/6	Cu	3	
13:00	25,7	28,0	-	25,8	NNE	5	8	moist	5/5	Cu	3	
13:15	25,1	28,0	-	25,5	N	6	8	dry	6/5	CuCi	3	
13:30	25,3	27,0	-	25,4	NNE	5	8	dry	6/6	Cu	4	
13:45	25,1	25,4	-	25,7	N	4	9	dry	7/7	CuCb	4	
14:00	24,9	26,0	-	25,4	NE	3	7	dry	7/7	CuCb	4	
14:15	24,8	26,0	-	24,9	NNE	3	7	dry	7/7	CuCb	4	
14:30	24,7	25,2	-	24,9	NE	4	7	dry	7/7	CuCb	4	
14:45	24,5	25,0	-	24,8	NNE	4	7	dry	7/7	CuCb	4	
15:00	24,3	25,1	-	24,6	N	3	6	dry	8/8	CuCb	4	

Table no.3 grassy oil

Hours	Temperature (ºC)				Wind (m/s)			State sand	Degree sky coverage with clouds		Degree agitation	Quantity prec
	air	Air pressure	Sea water	Phenomena	Dir.	Speed	Gust max.		Nebulous	Type clouds		
12:30	24,2	1010,6	-	-	NE	2	9	dry	6/6	Cu	3	-
13:30	25,1	1010,3	-	-	NNE	3	11	dry	6/6	CuCb	3	-
14:30	25,0	1011,5	24,6	-	NNE	2	8	dry	7/7	CbAc	3	-
15:30	25,2	1011,4	-	av.pl.	NNE	2	7	dry	7/7	CbAc	2	0,0
16:30	24,5	1010,4	-	av.pl.	NNE	1	6	dry	7/7	CbAc	3	0,0

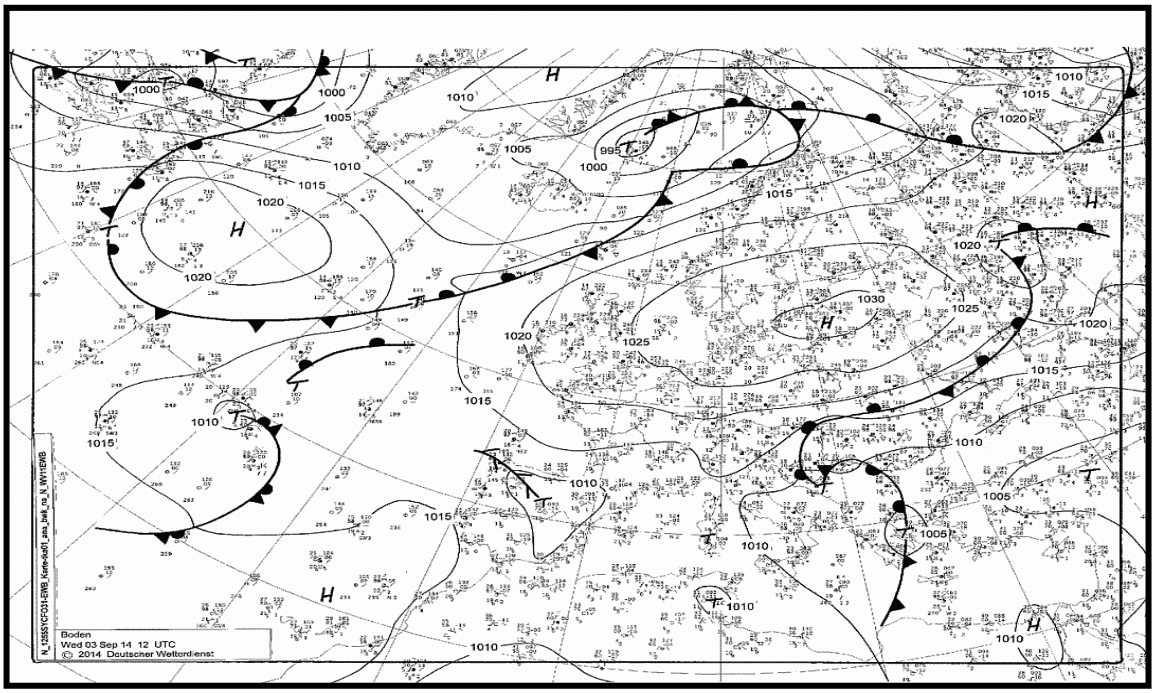

Figure 5 Synoptic map at ground level from 03.09.2014, hour 12

DAMAGE ANALISYS OF A GEAR BOX SHAFT UNDER UPSET WORKING CONDITIONS USING ANSYS nCODE

[1]VELCEA DOREL-DUMITRU, [2]RADU IULIAN, [3]CALIMANESCU IOAN

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ABSTRACT

Determining the fatigue life of parts under periodic, sinusoidal vibration is a fairly straightforward process in which damage content is calculated by multiplying the stress amplitude of each cycle from harmonic analysis with the number of cycles that the parts experience in the field. The computation is relatively simple because the absolute value of the vibration is highly predictable at any point in time. The purpose of this paper is the damage estimation of a gear box shaft subjected to severe overloads. This is part of an upset conditions testing to which a statistical significant population of gear boxes is subjected in order to have confidence and demonstrate the reliability of the device. Prior to this the simulation with finite element analysis (FEA) might be done in order to have a clue and a benchmark for testing.

In our simulation using nCode under Ansys Workbench, we concluded that the upset conditions to which the gear box was subjected, at least for the analised shaft, had or will have no noticeable impact

Keywords: *Damage Analysis, Fatigue, nCode, Finite Element Analysis, Gear box Shaft*

1. INTRODUCTION

Determining the fatigue life of parts under periodic, sinusoidal vibration is a fairly straightforward process in which damage content is calculated by multiplying the stress amplitude of each cycle from harmonic analysis with the number of cycles that the parts experience in the field. The computation is relatively simple because the absolute value of the vibration is highly predictable at any point in time.

Vibrations may be random in nature in a wide range of applications, however, such as vehicles traveling on rough roads or industrial equipment operating in the field where arbitrary loads may be encountered. In these cases, instantaneous vibration amplitudes are not highly predictable as the amplitude at any point in time is not related to that at any other point in time. As shown in Figure 1, the lack of periodicity is apparent with random vibrations.

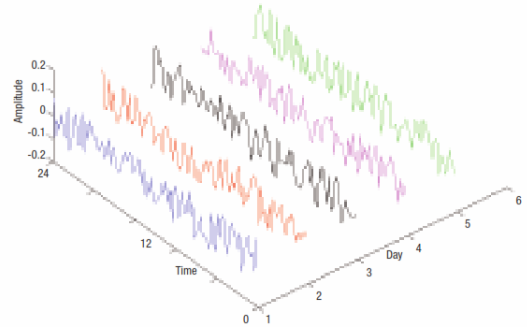

Figure 1 Random vibrations measured for vehicle on a rough road showing periodicity for single, dual and quad disk configuratio

The complex nature of random vibrations is demonstrated with a Fourier analysis of the random time–history shown in Figure 2, revealing that the random motion can be represented as a series of many overlapping sine waves, with each curve cycling at its own frequency and amplitude.

With these multiple frequencies occurring at the same time, the structural resonances of different components can be excited simultaneously, thus increasing the potential damage of random vibrations.

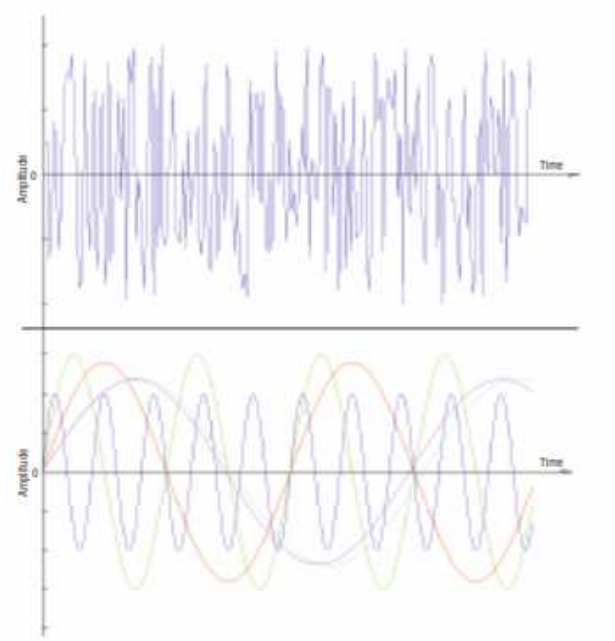

Figure 2 Random time–history can be represented as a series of overlapping sinusoidal curves.

The software nCodeDT provides the fatigue analysis “engine” for DesignLife in ANSYS and other, third party, fatigue analysis products.

The way that a fatigue analysis is carried out by nCodeDT and the methods used are controlled by the fatigue configuration file, which defines the hierarchy and properties of the objects that comprise the fatigue job. This configuration and the object properties can be viewed and edited using the DesignLife Configuration Editor, which can be accessed from within DesignLife by selecting the Advanced Edit option on any of the CAE fatigue analysis glyphs.

ANSYS 15 Workbench provides the environment for nCodeDT to be integrated with other structural ANSYS modules as seen in the Figure 3.

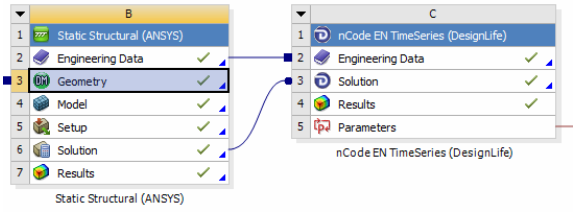

Figure 3 nCode integration in ANSYS Workbench

The purpose of this paper is the damage estimation of a gear box shaft subjected to severe overloads. This is part of an upset conditions testing to which a statistical significant population of gear boxes is subjected in order to have confidence and demonstrate the reliability of the device.

Prior to this the simulation with finite element analysis (FEA) might be done in order to have a clue and a benchmark for testing.

2. THE COMPUTER AIDED DESIGN (CAD) MODEL

In order to proceed with the FEA simulation, is a must to generate the CAD model. In order to do this the SolidWorks 2015 software was deployed. The shaft is looking as seen in the figure below:

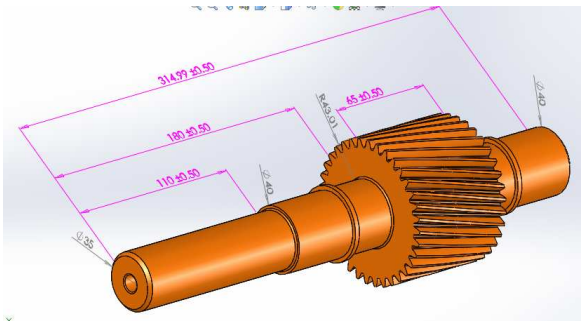

Figure 3 CAD Model in SolidWorks 2015

The shaft is having a helical gear in between two roller bearings. The overall length of the shaft is 315 mm and the bearing mounting diameter is 40 mm, the top land gear diameter being 86 mm as seen above. This CAD model is exported inside the ANSYS Workbench for further processing.

3. THE FEA MODEL

First of all the material properties are to be defined. The shaft material is Carbon Steel SAE1045-450-QT with the mechanical properties as defined below:

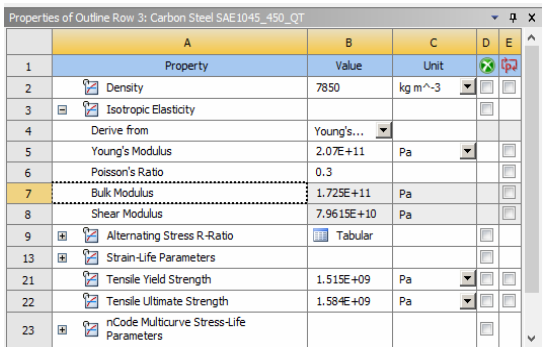

Figure 4 SAE1045-450-QT mechanical properties

The finite elements meshing is given in the Figure 5 comprising 32985 elements with 56947 nodes.

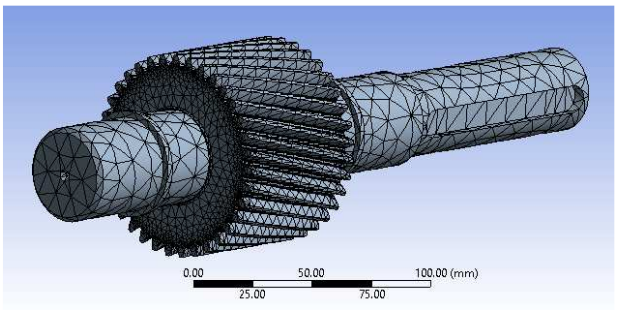

Figure 5 Finite elements Meshing

For the static structural analysis in ANSYS done before deploying nCode, the loads and supports are provided like in the figure below:

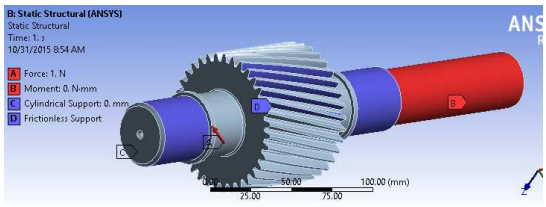

Figure 6 Boundary conditions for the static structural model

The roller bearing support is modelled as Cylindrical support (C on the figure) mimicking the roller bearing action.

The pair of gears teeth interlocking is modelled with a Frictionless Support (D on figure).

The radial force developed inside the helical gear transmission was defined as 1 N (A on figure), following that the time-history which will be imported inside nCode from field measurements, to multiply this value in order to model the real case.

The force is applied progressively as seen in the figure below:

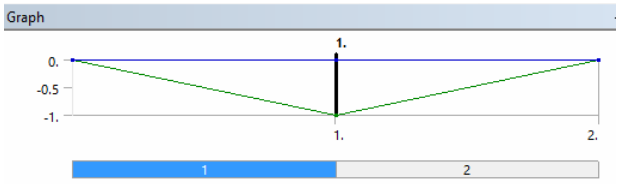

Figure 7 The force progressive application

The moment is defined as 1000 Nmm (B on figure) is applied on the key shaft extension and will be imported inside nCode from field measurements, to multiply this value in order to model the real case, the same as for the force. In the same manner, the moment will be progressively applied when the force is reaching its maximum, as to be seen below:

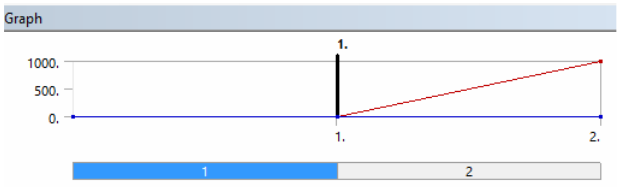

Figure 8 The moment progressive application

4. THE STATIC STRUCTURAL MODEL RESULTS

The "dummy" loads of 1 N for the force and 1000 Nmm for the moment won't provide realistic results for the static structural analysis, but is useful to study the generated results in order to have o rough idea over the stress and deformation distribution inside the shaft.

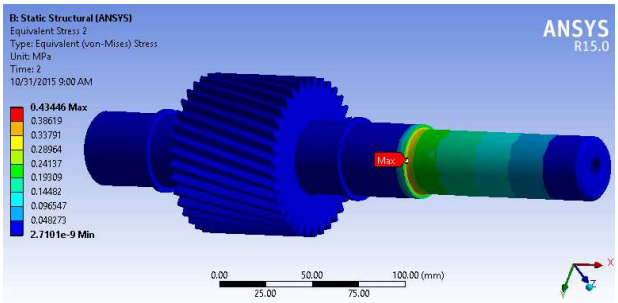

Figure 9 Equivalent stress distribution

As seen above the peak of the equivalent stress is reached in the region of the diameter jump in between the journal baring region and the key region.

The same distribution is followed by the Equivalent elastic strain as seen in the Figure 10.

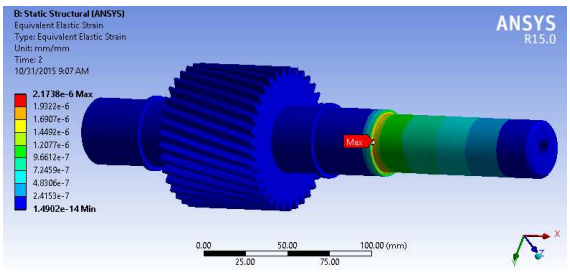

Figure 10 Equivalent elastic strain distribution

5. DAMAGE ANALISYS USING nCODE

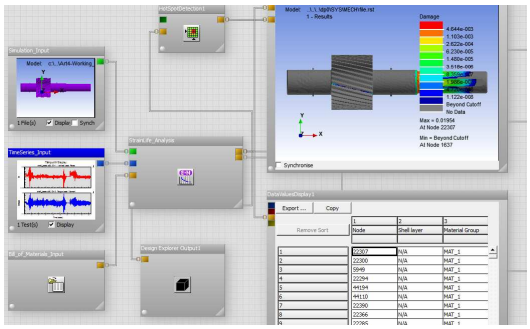

Figure 11 nCode Workflow

The nCode software is working with the so called "glyphs" which may be adapted into a workflow depending on the problem to be solved. As seen in Figure 11 for our problem the glyphs to the left are inputting the simulation coming from Ansys structural, the Time series input and the material properties. All are converging into the main solving engine, the glyph of Strain Life analysis.

The Ansys structural and the material properties were defined above.

The time history of the loads are inputted from the field measurements and they are given in the next figure:

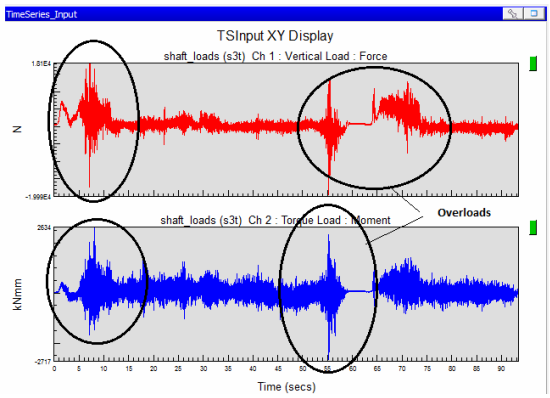

Figure 12 Force and moment time history

The force time history (with red in the Figure 12) are having two zones of disturbances where its value is varying between 1.81e4 N to -1.999e4 N.

On the other hand the moment is varying in between 2634 kNmm and -2717 kNmm. These values are to be multiplied with the Structural analysis force scale of 1 N and moment of 1000 Nmm.

Once nCode is performing the calculations, the results are displayed as seen in the figure below:

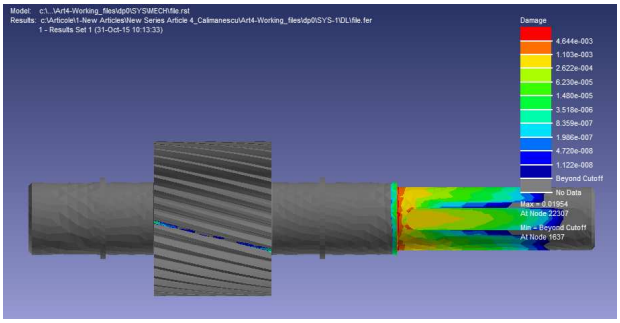

Figure 13 Calculated damage by nCode

The maximum damage is calculated inside the zone where the diameter jump determine a stress concentrator and there the damage is 4.644e-3. If the damage was equal to unit then the shaft failure would be certain. Since the calculated damage is a way smaller than 1 then the upset working conditions are not expected to damage the shaft.

6. CONCLUSIONS

Ansys software has its own fatigue and life calculation module. The incorporation of nCode inside Ansys Workbench has provided a larger palette of options and resources for Life evaluation of a wider class of problems.

In our simulation using nCode under Ansys Workbench, we concluded that the upset conditions to which the gear box was subjected, at least for the analised shaft, had or will have no noticeable impact.

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STRESS FATIGUE LIFE OPTIMISATION OF AN AIRPLANE LANDING GEAR LEVER ARM USING ANSYS nCODE

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ABSTRACT

In this paper we'll show a way to optimise the shape of an airplane landing gear lever arm in order to increase the confidence that its behaviour is improved in terms of life. The main tool to be used under Ansys Workbench is the optimisation via Response surface module. Ansys software has its own fatigue and life calculation module. The incorporation of nCode inside Ansys Workbench has provided a larger palette of options and resources for Life evaluation of a wider class of problems. As was demonstrated the nCode module of Ansys is more accurate in terms of life calculation as teh native Ansys fatigue module can predict, and that's why the nCode is more suitable to be used for optimisation simulations. In our simulation using nCode under Ansys Workbench, we've concluded that the optimised geometry shows a bigger life expectancy as the initial model. This way of dealing with the fatigue issues is certainly due to improve the safety of the sensitive devices as the landing gear of an airplane.

Keywords: *Fatigue, nCode, Finite Element Analysis, Gear lever arm, Optimisation.*

1. INTRODUCTION

In this paper we'll show a way to optimise the shape of an airplane landing gear lever arm in order to increase the confidence that its behaviour is improved in terms of life. The main tool to be used under Ansys Workbench is the optimisation via Response surface module.

Response surface methodology (RSM) is a collection of mathematical and statistical techniques for empirical model building. By careful design of experiments, the objective is to optimize a response (output variable) which is influenced by several independent variables (input variables). An experiment is a series of tests, called runs, in which changes are made in the input variables in order to identify the reasons for changes in the output response.

Originally, RSM was developed to model experimental responses (Box and Draper, 1987), and then migrated into the modelling of numerical experiments. The difference is in the type of error generated by the response. In physical experiments, inaccuracy can be due, for example, to measurement errors while, in computer experiments, numerical noise is a result of incomplete convergence of iterative processes, round-off errors or the discrete representation of continuous physical phenomena (Giunta et al., 1996; van Campen et al., 1990, Toropov et al., 1996). In RSM, the errors are assumed to be random.

The application of RSM to design optimization is aimed at reducing the cost of expensive analysis methods (e.g. finite element method or CFD analysis) and their associated numerical noise. The problem can be approximated with smooth functions that improve the convergence of the optimization process because they reduce the effects of noise and they allow for the use of derivative-based algorithms. Venter et al. (1996) have discussed the advantages of using RSM for design optimization applications.

For example, in the case of the optimization of the calcination of Roman cement the engineer may want to find the levels of temperature (x_1) and time (x_2) that maximize the early age strength (y) of the cement. The early age strength is a function of the levels of temperature and time, as follows:

$$y = f(x_1, x_2) + \varepsilon, \quad (1)$$

where ε represents the noise or error observed in the response y. The surface represented by $f(x_1, x_2)$ is called a response surface.

The response can be represented graphically, either in the three-dimensional space or as contour plots that help visualize the shape of the response surface.

Contours are curves of constant response drawn in the xi, xj plane keeping all other variables fixed. Each contour corresponds to a particular height of the response surface, as shown in Figure 1.

ANSYS 15 Workbench provides the environment for nCodeDT used for life evaluation to be integrated with other structural ANSYS modules as seen in the Figure 2.

As seen above the initial model is solved for the given loads with the Static Structural module of Ansys, then the life is computed under the nCode module, and the optimisation of the shape is done with the RS module of Ansys which will help us to decide for the best design.

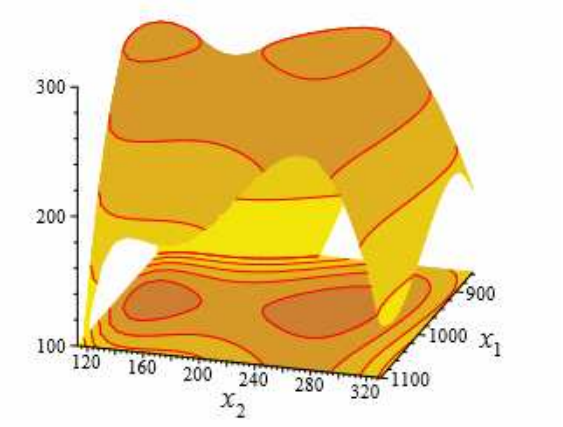

Figure 1 Three-dimensional response surface and the corresponding contour plot for the early age strength of Roman cement where x_1 is the calcination temperature (°C) and x_2 is the residence time (mins)

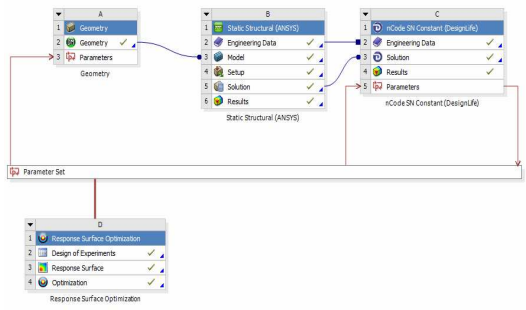

Figure 2 nCode integration in ANSYS Workbench and the optimisation workflow

2. THE COMPUTER AIDED DESIGN (CAD) MODEL AND THE OPTIMISATION PARAMETERS DEFINITION

In order to proceed with the FEA simulation, is a must to generate the CAD model. In order to do this the SolidWorks 2015 software was deployed. The lever arm is looking as seen in the figure below:

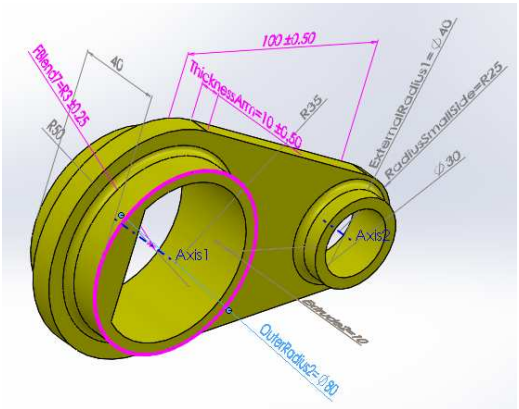

Figure 3 CAD Model in SolidWorks 2015 with optimisation parameters

The lever arm has two eyes used to transmit the load and there were defined six design parameters which can be seen on the above figure. They are:

Outline of All Parameters

	A	B
1	ID	Parameter Name
2	Input Parameters	
3	Geometry (A1)	
4	P1	ExternalRad1
5	P3	ThicknessArm
6	P4	ThicknessExtrude1
7	P5	RadiusSmallSide2
8	P10	OuterRadius2
9	P11	Extrude2
10	P12	FBlend7.FD1
11	nCode SN Constant (DesignLife) (C1)	
12	P7	StressLife_Analysis .SNEngine_CertaintyOfSurvival

Figure 4 Design parameters

The input design parameters are geometrical parameters denoted with P1, P5, P3, P10, P11, P12 and the output parameter is the Stress Life (P7) which must be optimised in the maximisation direction.

3. THE FEA MODEL

First of all the material properties are to be defined. The lever arm material is wrought aluminum-copper alloy 2014-T6 with the mechanical properties as defined below:

Properties of Outline Row 3: 2014-T6

	A	B	C	D	E
1	Property	Value	Unit		
2	Density	2793	kg m^-3		
3	Isotropic Elasticity				
4	Derive from	Young...			
5	Young's Modulus	7.2395E+10	Pa		
6	Poisson's Ratio	0.33			
7	Bulk Modulus	7.0975E+10	Pa		
8	Shear Modulus	2.7216E+10	Pa		
9	Alternating Stress R-Ratio	Tabular			
13	Tensile Ultimate Strength	4.6195E+08	Pa		
14	nCode Multicurve Stress-Life Parameters				
18	nCode MaterialType	100			

Figure 5 2014-T6 mechanical properties

The finite elements meshing is given in the Figure 6 comprising 7676 elements with 3927 nodes.

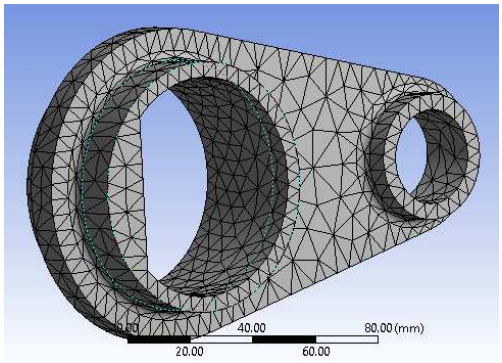

Figure 6 Finite elements Meshing

For the static structural analysis in ANSYS done before deploying nCode, the loads and supports are provided like in the figure below:

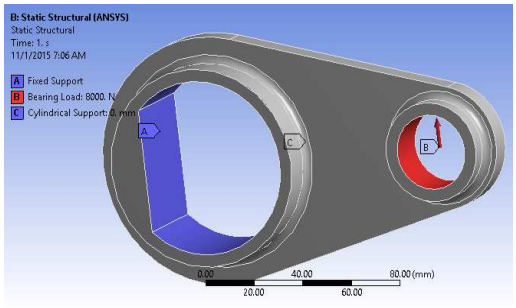

Figure 6 Boundary conditions for the static structural model

The transmitted force is 8000 N (B on figure 6) inputted as bearing load, the bigger eye is providing the support under the notation A for the fixed support for the plain zone and C as cylindrical support for the rest of the eye.

4. THE STATIC STRUCTURAL MODEL RESULTS FOR THE INITIAL MODEL

In this first stage the static structural analysis of the initial model was performed.

First of all the equivalent stress is calculated as seen in the following figure:

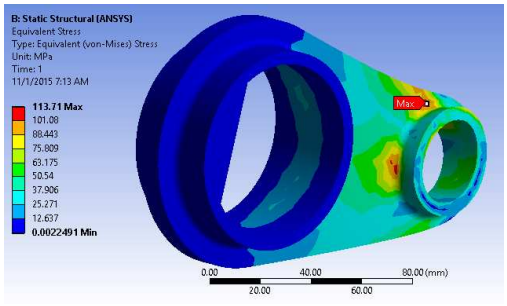

Figure 7 Equivalent stress distribution for the initial model

As seen above the maximum stress is calculated for the fillet area of the small eye and it has the magnitude of 113 MPa. This is the area where trouble is expected.

The total deformation is shown in Figure 8.

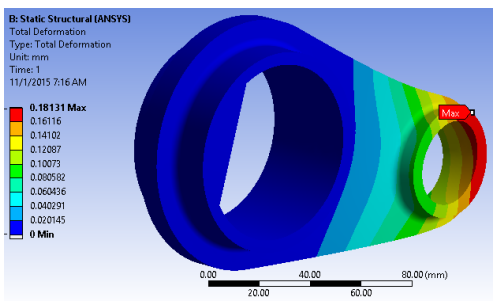

Figure 8 Total deformation distribution for the initial model

Under the load the smaller eye is moving with 0.18 mm.

The strain distribution is:

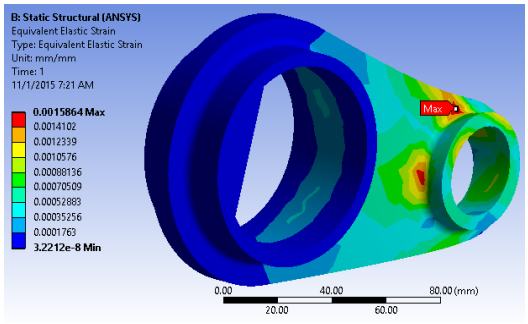

Figure 9 Strain distribution for the initial model

The maximum strain is calculated as 0.158%.

The calculated life for initial lever arm is 2.14e5 cycles which one designer may consider too small. The target is to modify the above mentioned geometrical parameters in order to have the life bigger.

5. DESIGN OPTIMISATION

The module of RS optimisation is establishing 46 design points where the six input parameters are statistically variated using the algorithm of the Central Composite design. The local sensitivities of the output parameter as a function of the input parameters are given in the Figure 10:

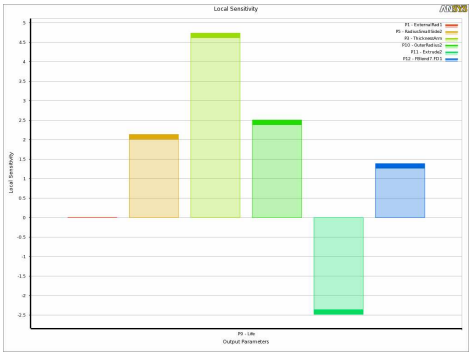

Figure 10 Local sensitivities

From the above graph we may conclude that the most influential parameter is the lever Thickness and the width of the Extrude 2 of the second arm.

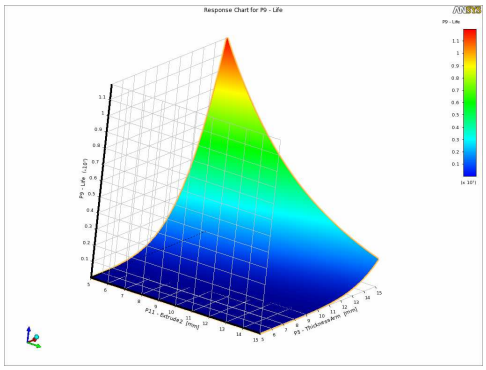

Figure 11 Response surface for the lever thickness and the width of the small eye

On the second place the fillet radius of the smaller eye and the external radius of the smaller eye are having the next bigger impact upon the lever arm life as seen in the response surface below:

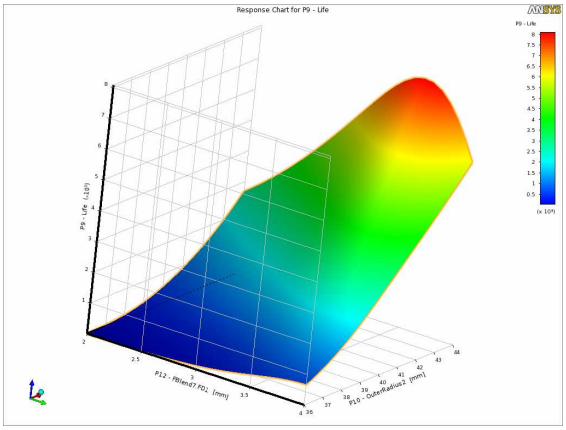

Figure 12 Response surface for the lever smaller eye outer radius and extrusion width

The outer radius of the bigger eye has virtually no impact upon the lever arm since the critical region for life is that where the load is acting, namely the smaller arm:

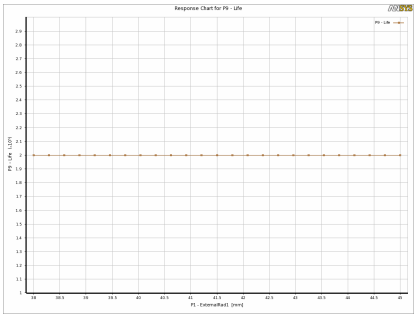

Figure 13 Response surface big eye outer radius

By placing the condition that the output parameter namely the lever arm Life, the software is proposing three best candidates for the designer perusal. We may choose the first Candidate marked with yellow on the following Table:

Table 1 Candidates for the optimum design

Name of Optimum	P1 - ExternalRad 1 (mm)	P5 - RadiusSmallSide 2 (mm)	P3 - ThicknessA rm (mm)
Candidate Point 1	38	30	15
Candidate Point 2	41.7765	29.0713594	14.7855213
Candidate Point 3	44.0445	29.8799531	14.8038112
P10 - OuterRadius2 (mm)	P11 - Extrude2 (mm)	P12 - FBlend7.FD1 (mm)	P9 - Life
44	5	2.27741627	51625543.9
43.1592	5.12578301	2.08965515	25810268.8
41.71536	8.77426281	2.93713824	19535013.9

6. THE STATIC STRUCTURAL MODEL RESULTS FOR THE OPTIMISED MODEL

The Optimised lever arm (with Candidate 1 dimensions) now is once more calculated inside the Structural module of Ansys. The CAD geometry is shown in the following figure:

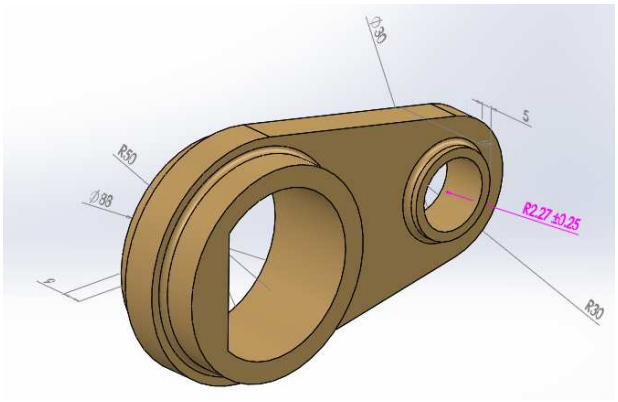

Figure 14 The optimised CAD model

First of all the equivalent stress is calculated as seen in the following figure.

As one may be seen, the maximum equivalent strass is now 67 MPa and its position is shifted from the fillet zone of the inner zone of the small eye.

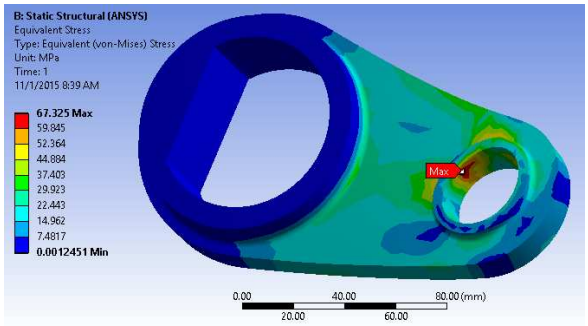

Figure 15 Equivalent stress distribution for the optimised model

The total deformation is shown in Figure 16.

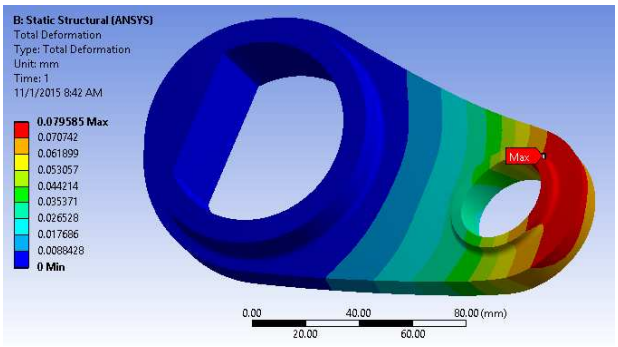

Figure 16 Total deformation distribution for the initial model

Under the load the smaller eye is moving with 0.079 mm, half the initial deformation of 0.18 mm.

The strain distribution is:

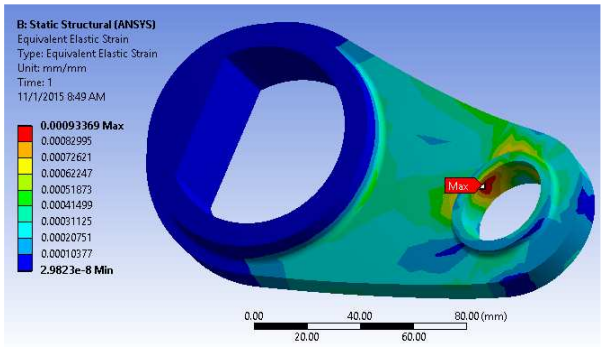

Figure 17 Strain distribution for the initial model

The maximum strain is calculated as 0.093% smaller than the initial one of 0.158%.

The calculated life for initial lever arm is 5.16e7 which is much better than the initial one of 2.14e5 cycles.

As mentioned above, Ansys has its own fatigue calculation module. This module was activated and some results are shown in the followings.

Some input data are needed for Ansys before proceeding with fatigue calculation. The first is to define mean stress correction theory to be deployed, and we'll choose the Goodman's as seen below:

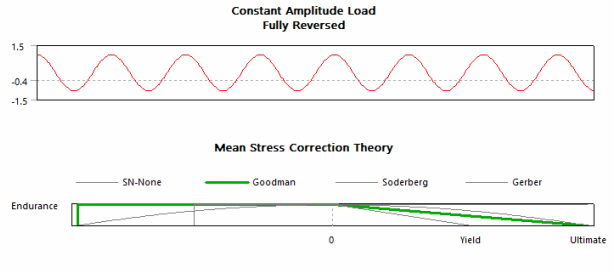

Figure 18 Goodman mean stress correction theory

The calculated life by Ansys is showing that the life is bigger than 1e8 cycles which is somehow bigger than the one calculated with nCode.

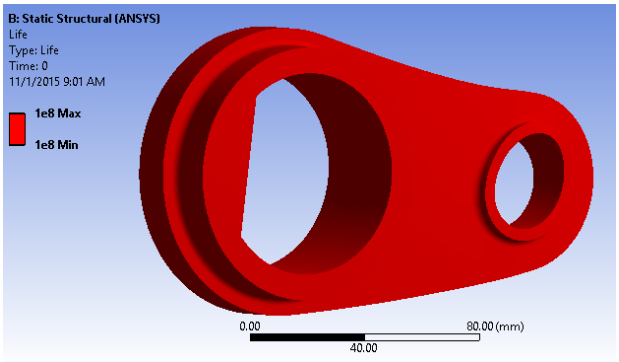

Figure 19 Life calculated with Ansys

Ansys is calculating a safety factor as well:

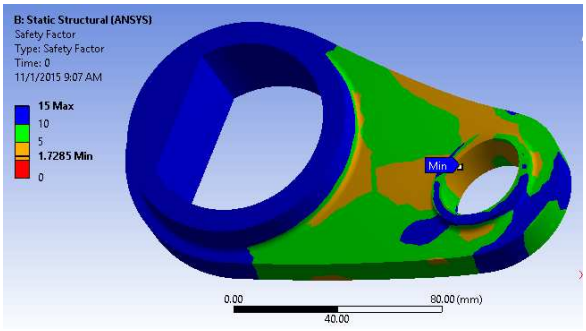

Figure 20 Safety factor

The smallest safety factor is the smallest inside the small eye where its value is 1.78.

7. CONCLUSIONS

Ansys software has its own fatigue and life calculation module. The incorporation of nCode inside Ansys Workbench has provided a larger palette of options and resources for Life evaluation of a wider class of problems.

As was demonstrated the nCode module of Ansys is more accurate in terms of life calculation as teh native Ansys fatigue module can predict, and that's why the nCode is more suitable to be used for optimisation simulations.

In our simulation using nCode under Ansys Workbench, we've concluded that the optimised geometry shows a bigger life expectancy as the initial model. This way of dealing with the fatigue issues is certainly due to improve the safety of the sensitive devices as the landing gear of an airplane.

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SECTION III
ELECTRONICS, ELECTRONICAL ENGINEERING AND COMPUTER SCIENCE

THE INTELLIGENT SENSORS FOR HOUSE RISKS FACTORS

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[1]Rig Service S.A., [2]Constanta Maritime University, Romania

ABSTRACT

Intelligent house is the new name of the house which can be monitored at the distance using different sensors. This paper presents a prototype at reduced scale of the house equipped with various sensors which prevent the risk factors. The risk factors could be the humidity, gas, temperature, et.al. All the data are sent by phone and alarms ring if the values are not in the normally ranges. This prototype demonstrates that it is able to take over the real status of the environment and to process it in a timely manner in order to prove its effectiveness.

Keywords: *intelligent sensors, risk factors, monitoring, intelligent system.*

1. INTRODUCTION

The human security concept is used frequently in security analysis. The security subject is the human . The security degree must be the start point of each study in this domain, independent of the analysis level (local, regional, national or global). It might say the security involves lacking of the danger, riscs and the threats of the human being, individual interests and values. The risk represents the probability to produce and the capability to response in case of dangerous and the unpredictable situations [1, 2]. The security main objective is the system's stability.

The general concept of protection from risk factors to any building aims the following objectives:

- Protection of human life;
- Protection of property;
- Prevent business interruption.

The state of art in the monitoring and detection systems includes the components: detectors, central signaling, alarm devices, automatic protection systems, fire-extinguishing and device to transmit the defects.

This paper presents the risk factors detection in the miniature house. Electronics devices were chosen to detect and notify the fire and floods.

2. THE SYSTEM COMPONENTS

The miniature house was built of the special cardboard and assembled with a transparent acrylic adhesive (Figure 1). For more pleasing design, the house was dressed in different coloured sticker. The security systems are implemented using the compatible electronics devices which can be interconnected and configured. The gas, pyro, humidity and temperature sensors were placed on the house and controlled using a certain microcontroller kit.

The controlling system is represented by the mother board Seeduino v2.21, the establishes by software the data flux and the normally or abnormally working rages for sensors. The electronic circuit in the figure 2 uses 5V power supply.

Figure 1 The miniature house design

Each sensor working range is defined by software.

The electric connexions between all the devices are presented in the figure 2. Each room has sensors, functioning on demands. For example in the bathroom it is necessary humidity and temperature sensors while in the kitchen it is necessary gas sensor to indicate gas leakage.

The result of the data sensors correlation could say precisely if it a true or false alarm. For this, it is necessary the more sensors than we used which could indicate the level of water, the gas types. In this case the algorithm could be built, after the normal and abnormal ranges identification. The errors of disaster identification are minima. The optimal method to prevent must be identified precisely such as:

In the bathroom:

If the humidity and temperature sensors have the abnormal values that the water is closed.

In the kitchen:

If the gas and temperature sensors are the abnormal values there is a fire that the gas is off and the flood water is on.

Each utility must have a system to be opened and closed automatically.

In our case the alarms ring when the sensor value cross the threshold value established by the system builder.

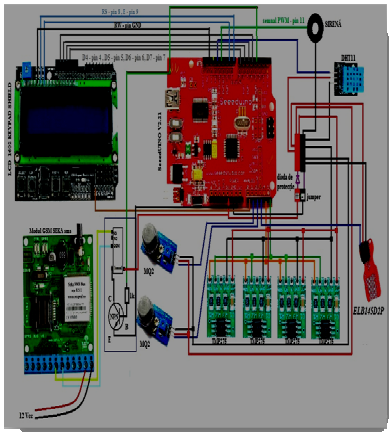

Figure 2 Electronic circuit to control the security system in the house

Behind the house is placed a display (Figure 3) which shows the sensor's values for each room [3, 4, 5, 6]. Using a keypad included in the display we can switch the rooms.

Figure 3 The display module of the system, placed behind the house

The house temperature is monitored using four sensors TMP275 with the 0,5 degree accuracy, connected to microcontroller with I^2C interface. In case of fire the sensor's values change in abnormally range and the alarm is ringing.

The gas sensors MQ2 are placed in house to detect the fire or gas (Figure 4). These sensor are analogic, they are very sensitive to GPL, propane and hydrogen. They could detect the methane or other gases as well.

The flood is detected using ELB145D2P (water/rain sensor) device. It is a simple sensor to identify the water liquid level. This sensor was designed to detect plain water, precipitation, liquid level or liquid leak. The sensor measures the conductivity.

The humidity is detected using DHT11 device, which is a mixt sensor which detect the temperature and humidity.

Figure 4 The fire and flood sensors placed on the ceiling

The sensors data are transmitted to the distance using GSM Seka, sms (Figure 5). This module placed behind the house. It communicates with the phone to prevent an abnormally behaviour of the system.

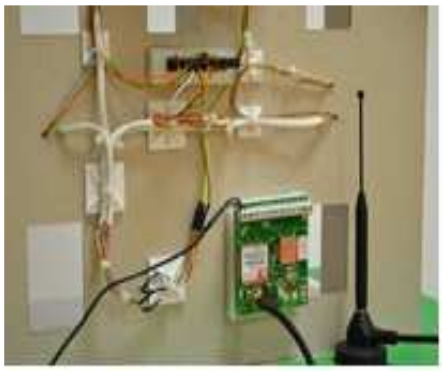

Figure 5 Distance communication module

This module is used to achieve fast transmission of alarm messages from burglary or fire power directly to the user using the GSM mobile phone network.

General characteristics of the devices include:

- 6 configurable input/ output ports;
- SMS text configurable, max. 15 characters;
- activation time configurable per output port from 1 to 254 seconds or permanently;
- port activation by phone call or SMS rejection;
- programming via SMS (3 levels of access);

The assembly image of the systems is shown in Figure 6. The interconnection wires are made using dedicated shields.

Figure 6 The modules used to monitor the house risks factors

The electronic modules used in the project are compatible with Arduino card.

3. THE SOFTWARE IMPLEMENTATION

The hardware system is controlled using the software implemented in microcontroller [7,8]. The first subroutine contains the initialisation code in which one establishes the communication speed. The Arduino program has two sections: the 'setup', executed once when supply the board or pressing the Reset button, is practically section that initializes microcontroller and the 'infinity loop' which executes the control and command subroutines.

The microcontroller used is Atmel, it could program the IDE provided by this company but because this programming environment is rigid we used the options offered by the MIT Media Lab, namely programming environment Arduino especially for devices based on language processing. Any Arduino board (in this case Seeeduino) already contains a bootloader on each microcontroller for interfacing and running applications written in the Arduino:

When loading card Seeeduino, the initialization of program begin with:

```
void setup() {
  Serial.begin(9600); baud rate
  Wire.begin();
  lcd.begin(16, 2);
}
```

The system is controlled using a phone which displays the same command as the LCD.
The communication module could be setup to the mobile phone by a user defined as Master. The setup code SMS is: **add.<pos>.<numar>.<drepturi filtre> .**

- **add** = command to add a new user
- **pos** = indicate the position in the list of contacts (phone book) in the SIM card. It is important to note the position because deleting users is done on the basis of this position. The numbering starts with positions number 1
- **numar =** the nomber of user
- **drepturi filtre** = describe the rights of users and types of messages (filters messages).

The LCD display the parameters in each room for example in the dining room (sufragerie). The monitored factors are the humidity and temperature (Figure 7).

Figure 7 The livingroom monitoring

```
void loop () {
  float t0 = getTemperature(0);
  float h0 = dht.readHumidity();}
```

The subroutine for change the rooms are:

```
int b = button();
  if(b > -1) {

    if(b == 1 && cadru < 4) {
//increment cadru , b==1 represent UP button
        cadru++;
   }
    if(b == 2 && cadru > 0) {
//decrement, b==2 represent DOWN
        cadru--;
   }
}
```

The parameters can be different for each room depending on the sensors installed there.

Figure 8 The frame of the 4 monitoring zone

Figure 9 The alarm identification

In case alarm an interruption occurs and a subroutine is running. The LCD displays the alarm (ALARMA) and the alarm type such as flood in the Figure 9 (INUNDATIE).

4. CONCLUSION

The monitoring system presented is a hybrid system implemented with gas, temperature, humidity, fire and flood sensors. These are placed on the house and are connected to the mother board with a LCD and alarm a distance communication system. This project represents the bridge between the monitoring and preventing systems which can be used by the persons. The software are simple, accessible using Arduino. Remote monitoring using the telephone is the modern element added in the project

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AUTOMATED TEST PLATFORM FOR CHARACTERIZATION OF ANGULAR DEPENENCE IN OPTOELECTRONICS AND RFID

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ABSTRACT

The angular dependence is a concern of system designers in applications where the performance of the system depends of the position and orientation of its components. Considering either an optoelectronic system (consisting of an emitter and a receiver), or a RFID communication system (consisting of a reader and a transponder), the relative angular position between the system components determines the capability of the system to function properly. This paper summarizes the automatic test procedures developed by the authors for an extended and accurate evaluation of the angular dependence of optoelectronic and RFID systems [1-3]. The paper presents an automated platform implemented for this purpose, which can be customized in order to fit the requirements for system characterization in both optoelectronic and RFID applications, and also the measurement results for various system components tested (optical emitters /receivers and RFID readers/transponders).

Keywords: *angular dependence, system characterization, automated platform, optoelectronics, RFID.*

1. INTRODUCTION

The angular dependence in optoelectronic and RFID systems can be analyzed in the traditional way, using a manual platform consisting of a fixed part with the analysing equipment and a mobile part, equipped with a positioning goniometer, where the device under test (DUT) is mounted.

Unfortunately this method has the following disadvantages:

- low precision in positioning the DUT under a certain angle, because it depends of the errors in reading the goniometer gradations by the operator;
- poor reproducibility in reaching twice precisely the same angular displacement of the DUT, also due to the manual positioning/reading errors;
- slowness of the overall measuring process.

An automated platform eliminates the above mentioned disadvantages of the manual method, providing the following advantages:

- high precision of positioning the DUT at a certain angle by using a stepper motor;
- good reproducibility in achieving the same angular displacement of the DUT;
- rapidness of the measuring process.

2. AUTOMATED TEST PLATFORM

The block diagram of the automated platform is presented in Figure 1. A microcontroller unit (MCU) connected to a PC via RS232 serial interface performs the following actions:

- commands the stepper motor through the motor driver;
- commands the analysing equipment;
- processes the signal acquired from the DUT.

The stepper motor must place the mobile platform in a reference position, which corresponds to a 0 degree angle. This is accomplished by using a photo-interrupter (through hole slotted optical switch) as a position sensor that detects the presence of the mobile platform in the reference position.

Once the reference position has been reached, the mobile platform position is incremented step by step (using a half step command for the stepper motor in order to achieve a higher resolution of the characteristic in relation with the angular position).

The signal from the analysing unit is acquired by the MCU for each angular position. This measuring process continues until the main axis of the DUT is again perpendicular to the main axis of the analysing equipment, but in the opposite direction, which corresponds to a 180 degree angle.

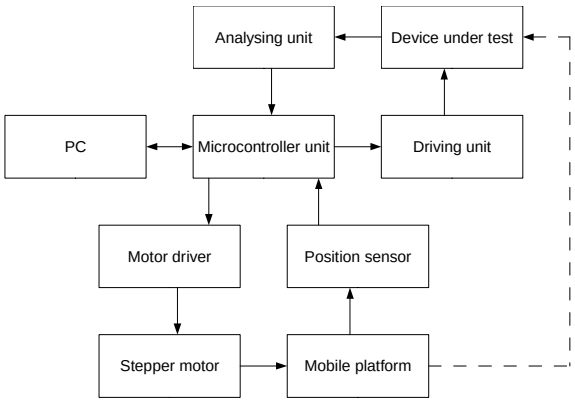

Figure 1 Block diagram of the automated platform

3. PLATFORM CUSTOMIZATION FOR OPTOELECRONIC DEVICES

The spatial characteristics of the optoelectronic devices presented in most of the manufacturers' datasheets are hypothetic ones, not the measured ones.

The symmetry of the spatial characteristics shown in those datasheets is ideal, so in reality we will find an asymmetry that might occur because device chip is not

precisely centred into the package, or because the package material is non-homogenous.

3.1 Platform implementation

The block diagrams of the automated platforms customized for light emitting diodes (LED), photodiodes (PD), phototransistors (PT) and integrated photo-detectors (IPD) characterization are presented in Figure 2, Figure 3 and Figure 4.

The microcontroller performs the following actions:

- commands the stepper motor via the motor driver;
- commands the light source via the LED driver;
- provides the start-of-conversion signal for the A/D converter (ADC);
- acquires the signal data from ADC;
- processes the numerical data and sends the results to the host PC.

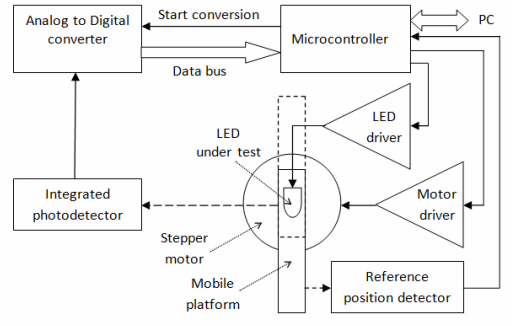

Figure 2 Block diagram of the platform for LED radiated pattern determination.

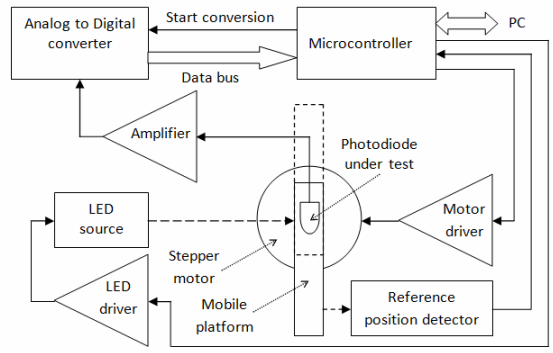

Figure 3 Block diagram of the platform for PD and PT sensitivity pattern determination

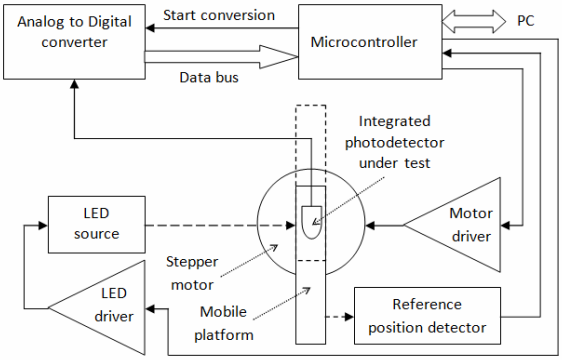

Figure 4 Block diagram of the platform for IPD sensitivity pattern determination

The block diagrams presented in Figure 2, Figure 3 and Figure 4 are very similar, the only difference being the absence of the amplifier in the diagram presented in Figure 3, because the IPD provides a level of the signal high enough that it can be converted by the A/D converter without needing to be amplified.

The software diagram is presented in Figure 5.

The acquired data can be post-processed and displayed in Cartesian and polar representations.

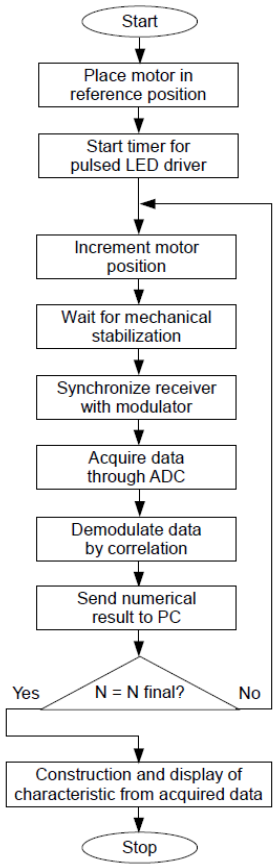

Figure 5 Software diagram for the customized platform for optoelectronic devices characterization

3.2 Platform experimental model

The experimental model of the platform for optoelectronic devices characterization is presented in Figure 6, and the graphical user interface in Figure7.

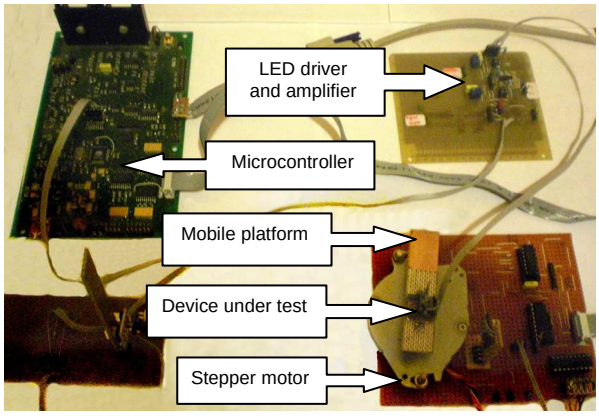

Figure 6 Implementation of the platform for optoelectronic devices characterization

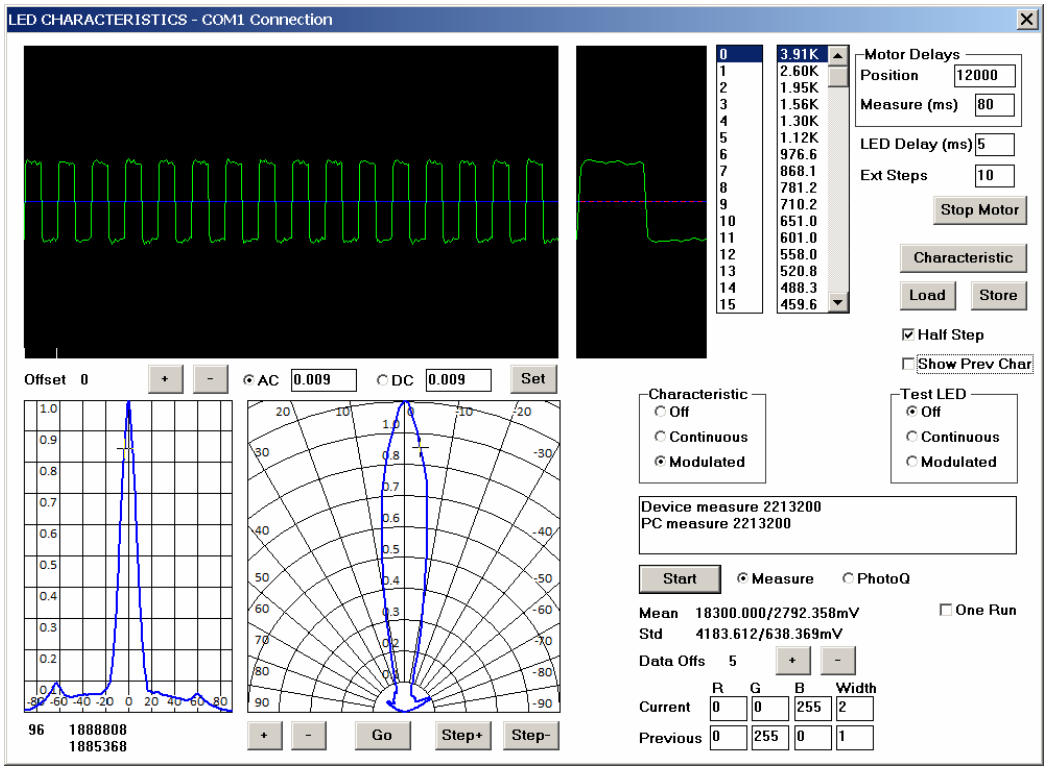

Figure 7 Graphical user interface of the platform for optoelectronic devices characterization.

3.3 Experimental results for optoelectronic devices

Figures 8-11 present the spatial characteristics of LED, PD, PT and IPD determined with the automated platform.

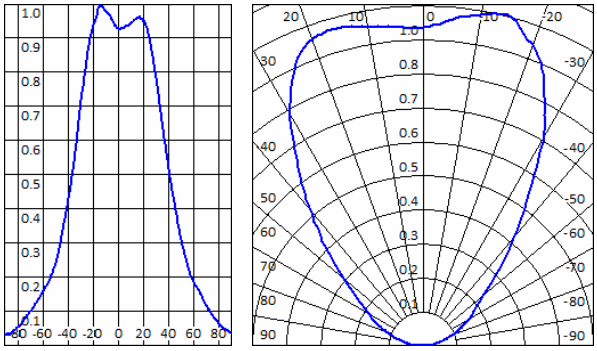

Figure 8 Measured radiated pattern of LED [4]

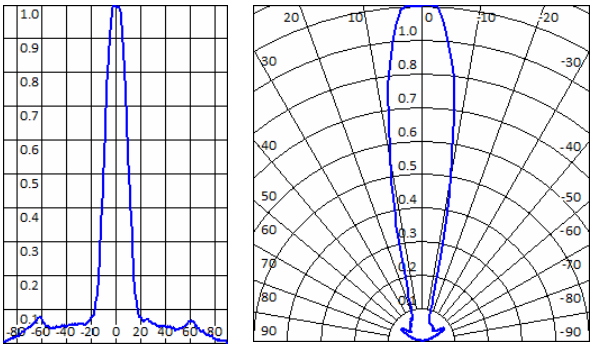

Figure 9 Measured sensitivity pattern of PD [5]

From the results shown Figure 8, Figure 9, Figure 10 and Figure 11, one can see that all of them show asymmetries, while the spatial characteristics provided by manufacturers in the datasheets [4-6] induce somehow the inaccurate idea of symmetry. Only the spatial characteristic from Figure 11 has been also presented by manufacturer as being asymmetrical [7].

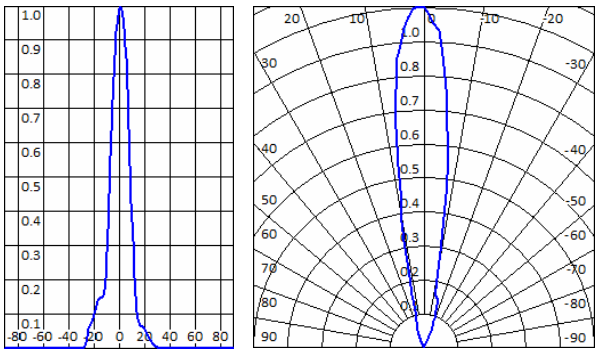

Figure 10 Measured sensitivity pattern of PT [6]

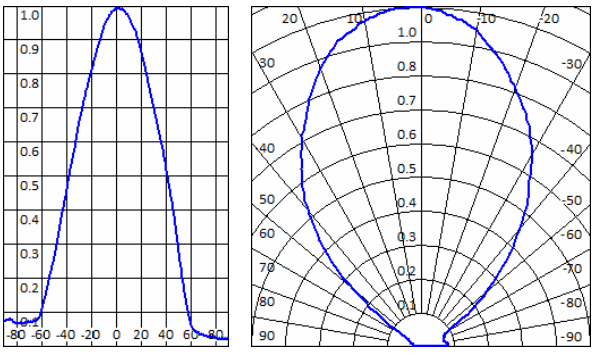

Figure 11 Measured sensitivity pattern of IPD [7]

4. PLATFORM CUSTOMIZATION FOR RFID DEVICES AND SYSTEMS

The authors have defined in [3] the angular characteristic as a tool for evaluating the quality of communication between RFID reader and transponder at several orientations of the transponder coil relative to the reader antenna.

4.1 Platform implementation

The block diagram of the automated platform customized for RFID systems (transponders and antennas) characterization is presented in Figure 12.

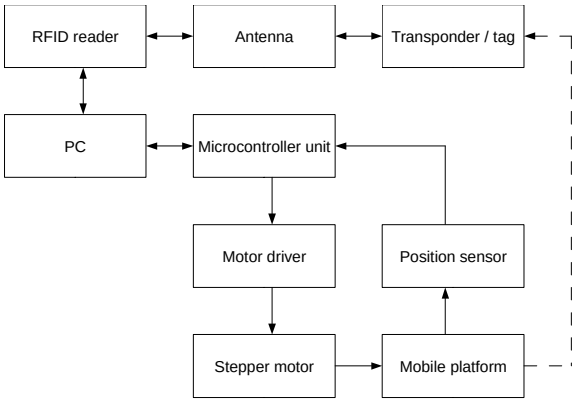

Figure 12 Block diagram of the platform for RFID transponders characterization

The implemented platform supports two types of readers, corresponding to the carrier frequencies of 125 KHz and 13.56 MHz, produced by Freaquent Froschelectronics [8, 9].

The software diagram is similar with the one used for the customized platform for optoelectronic devices and systems characterization, the difference being in the interaction with the RFID reader.

4.2 Platform experimental model

The experimental model of the platform for RFID systems characterization is presented in Figure 13, and the graphical user interface in Figure 14.

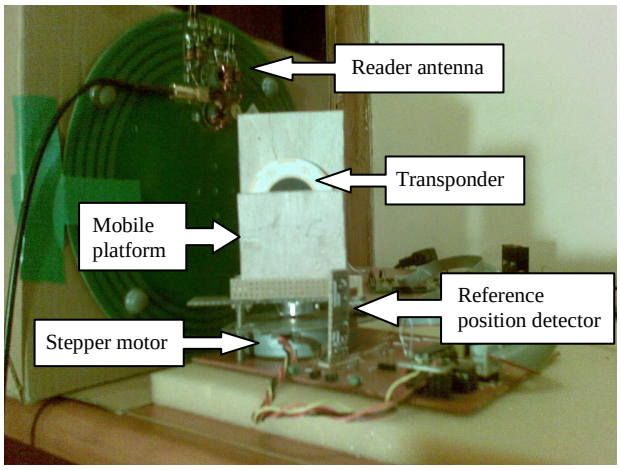

Figure 13 Implementation of the platform for RFID systems characterization

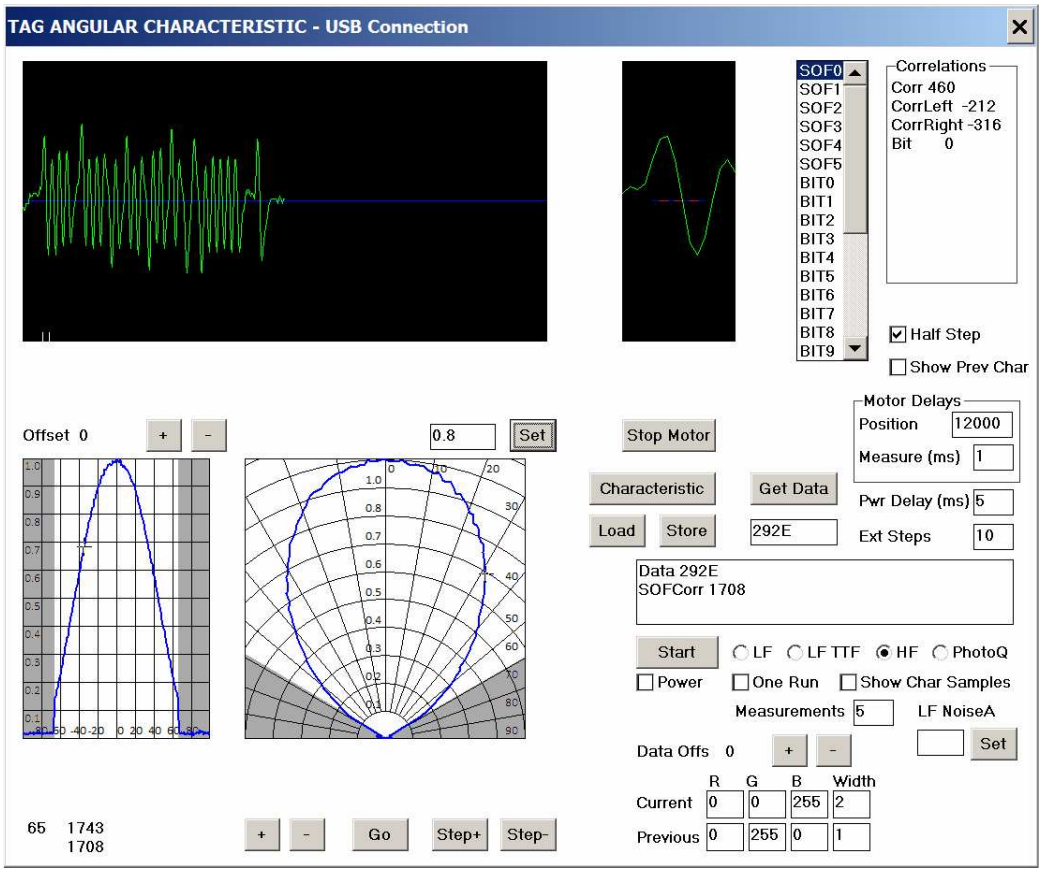

Figure 14 Graphical user interface of the platform for RFID systems characterization.

4.3 Experimental results for transponders characterization

Various transponders for RFID applications at 125 KHz and 13.56 MHz, with different constructive approaches and housing (plastic, glass, customised for documents identification and also a tag simulator), have been analysed and the characteristics measured are presented below. Gray-shaded domains graphs mark the positions where correct reading could not be achieved.

a) Transponder operating at 13.56 MHz, embedded in a plastic token (being under test in Figure 13), has the results presented in Figure 15.

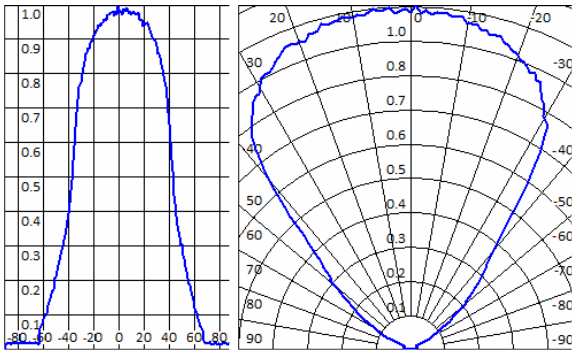

Figure 15 Characteristics obtained for tag and antenna shown in Fig. 13

b) Glass housing transponder for animal/item identification (operating at 125 KHz) has been measured at 3 cm (Figure 16) and at 15 cm from antenna (Figure 17). One remarks the reduction of the area of correct reading at 15 cm, compared with the one at 3 cm.

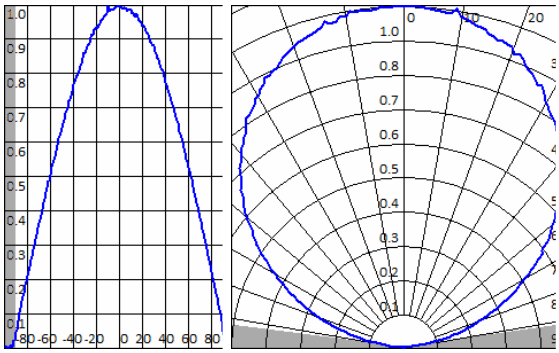

Figure 16 Glass housing transponder for animal/item identification placed at 3 cm from antenna.

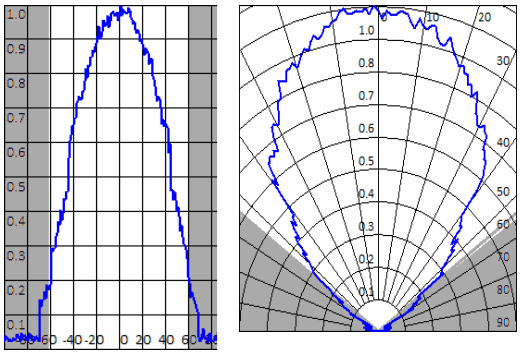

Figure 17 Glass housing transponder for animal/item identification placed at 15 cm from antenna.

c) Transponder for document identification (operating at 13.56 MHz) has been measured at 5 cm (Figure 18) and at 10 cm from antenna (Figure 19).

Fig. 18 shows a characteristic of the transponder different than expected (in the region from -55 degrees to +55 degrees), and the explanation found for that behaviour is related to the presence of a voltage limiter included by the transponder manufacturer in the tag integrated circuit (IC). The tag IC is powered from the reader antenna field, through the tag antenna (coil). The purpose of the voltage limiter is to prevent the voltage collected from the tag coil exceeding a predefined limit in order that the tag IC is not overpowered when the transponder is closer to the reader antenna and the magnetic coupling is higher in such a situation.

A model of a tag with voltage limiter has been presented by authors in [3] and the simulations performed with and without limiter demonstrated the influence of the voltage limiter on the characteristic.

Also in order to support this explanation an experiment has been done using a tag simulator described in [10] instead of a real tag. The tag simulator is not a software simulator, but an electrical micro-controller based device that is able to communicate with the reader in the same way as a real transponder does, and one could be sure that it contained no voltage limiter. The results obtained with the tag simulator are presented in Figure 20 and they are indeed close to what we would normally expect.

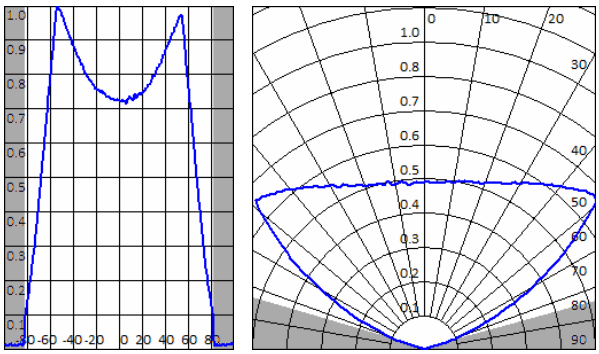

Figure 18 Transponder for document identification placed at 5 cm from antenna

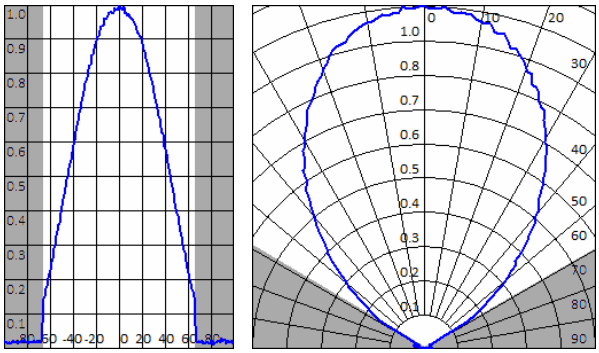

Figure 19 Transponder for document identification placed at 10 cm from antenna.

The characteristic shown in Figure 19 was taken at a higher distance from antenna than the one in Figure 18 and consequently the limiter was less active at the

increased distance, while being more active at short distance. The effect is that the characteristic presented in Figure 18 shows a dip instead of a peak at maximal coupling.

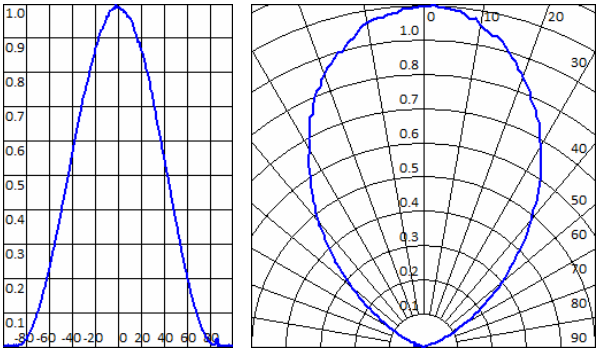

Figure 20 Angular characteristic obtained with tag simulator

4.4 Experimental results for tunnel antenna characterization

A more complex RFID system that can be analysed is a tunnel antenna intended for the identification of a collection of objects labeled with RFID tags, which are placed in a tray. This can be achieved by using at least two complementary antennas in order to cover all the possible orientations of the tags.

An example such tunnel, patented by Freaquent Froschelectronics, is presented in [11]. The tags are expected to lie in a plane parallel to the longitudinal axis of the tunnel but have any orientation within that plane.

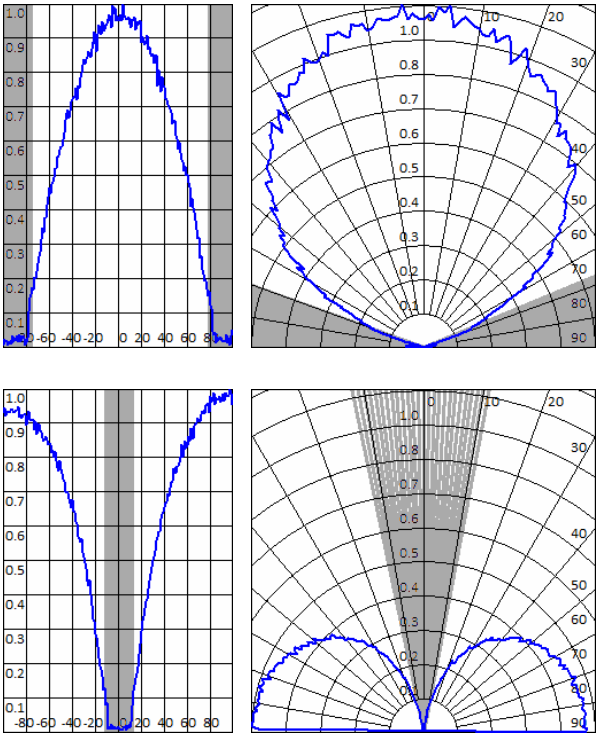

Figure 21 Characteristics of two complementary antennas in the tunnel.

By placing our platform at several positions on the longitudinal axis one can check whether the antennas cover all orientations as expected. The results obtained from two complementary antennas in the tunnel are presented in Figure 21. It can be seen that the domains of correct reading are complementary, in the sense that the angular positions poorly covered by one antenna are better covered by the other.

5. CONCLUSIONS

The paper is an overview of the authors' research activities and results in this field over the past two years. The platform presented, with the proposed customizations, may help system designers in obtaining a thorough exploration of the conditions that would occur during exploitation, in a manner less affected by subjectivism and human errors.

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SECTION IV
ENGLISH FOR SPECIFIC PURPOSES

TEACH IT WITH A CLOUD

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ABSTRACT

The purpose of this paper is to suggest activities through which teachers of Maritime English can help their students to bridge the gap betwenn the mastery of structures and the use of language to communicate meanings in real situations.

Throughout the history of language teaching, theories and methods have gone a recurring cycle. And yet, technological progress has taken its toll in the sense that students of EFL have a strong liking that internet-based learning. When it comes to learning Maritime English the going gets tough meaning that the task of the teacher is somewhat made difficult. In order to ease the pain of passing knowledge on to the eager beaver student of maritime English we have considered appropriate to present in this paper a newly-formed concept used as a teaching/ learning tool: word clouds. And, as the achievements of the past cannot but be ignored, we have also focused on some old-fashioned methods of teaching specialized vocabulary.

Keywords: *word clouds, learning techniques, specialized vocabulary.*

1. INTRODUCTION

The need for word clouds in EFL classes has arisen from the same contemporary, painstaking reality of living in a visual society. Everything nowadays is about image and the visual imprint it leaves behind lurking in a person's brain. A word cloud may provide students with a graphic technique likely to enable them to remember concepts, ideas or vocabulary much easier. It is a powerful tool which improves learning and clears up thinking.

What is more, it helps structuring information, better understand, and recall new ideas or words. In the field of Maritime English teaching there is a stringent need for learning tools as it is quite difficult for Maritime English students to acquire new vocabulary. We have deemed useful to present in this paper a possible approach to teaching specialized vocabulary.

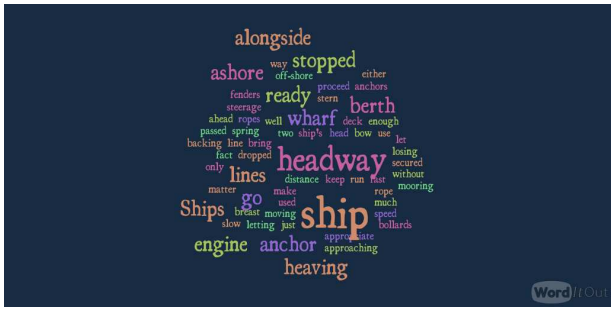
Word clouds are very trendy and really work wonders for any student who is undeniably very into apps. There are several sites which provide free word clouds generators. Apart from presenting word clouds as a teaching tool, this paper also highlights the usage of internet resources in the learning process.

Here is a list of the most visited sites which teachers of EFL use extensively in their work in the classroom and beyond:

- VocabGrabber is an amaizingly creative tool which allows students to analyze a group of words. It analyzes thr text and and generates lists of the most used vocabulary words and shows how these words are used in context. All you have to do is copy a text from a document and paste it into the box then click Grab vocabulary. It creates automatically a list of words that can be filtered and saved. Moreover, if you click on any word a snapshot of the Visual Thesaurus will appear together with definitions of that word, and examples of that word in the text.
- WordItOut is another instance of a free cloud creation tool for teachers.
- TagCrowd is a word cloud generator which produces clean, organized word clouds which reaffirm the role of this amusing toy turned into a learning tool

Word clouds are a very useful tool when it comes to calling to mind previously read material providing a helping hand for students revising for examinations. As was but natural, this modern learning tool has disadvantages as well, such as prioritizing words by frequency of use whereas key concepts may be excluded.

Here is an example of a word cloud on the topic of mooring:



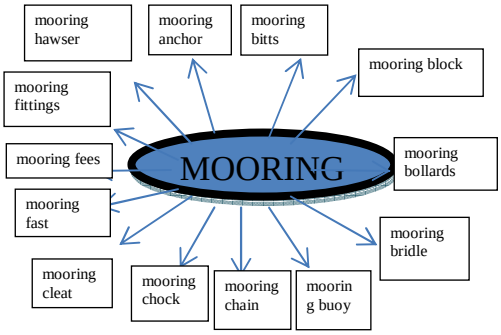
2. TRADITIONAL TEACHING METHODS

Obviously, there is nothing new about the idea that communicative ability is the goal of foreign language learning. What changed is the approach used by teachers who had to adapt their knowledge to an ever-changing social environment based on visual aids and prompts.

Better still, it goes without saying that old school teaching techniques shall never die. When having to teach in EFL classroom an arid topic such as mooring, a teacher might find it helpful to use a bingo game where the students have to cross out on their handouts the appropriate word for a definition that the teacher reads

out loud. The old-fashioned matching columns exercise or the brainstorming technique might serve the teaching purpose as well.

The necessary information to build up these exercises goes as follows:



Mooring
Definition: The act of bringing a vessel to a complete stop in a relatively protected coastal area in such a fashion that it can be sailed away again in less than one week's time by the same number of people who moored it without heavy equipment; an arrangement for securing a vessel to a mooring buoy or a pier; an anchor or weight, permanently attached to the sea floor, with a buoy going to the surface, used to hold the boat in a certain area.

Mooring anchor
Definition: A second or extra anchor used for holding a ship at her mooring.

Mooring bitt
Definition: A strong pair of iron, steel or wooden posts on a ship's deck, around which ropes or cables are wound and held fast.

Mooring buoy
Definition: A buoy secured to a permanent anchor sunk deeply into the bottom.

Mooring dolphin
Definition: A structure that supports fittings to which a vessel's mooring lines are secured.

Mooring line
Definition: Any hawser by which a vessel is secured to a dock or mooring. It may be made of natural materials (manila), synthetics, (polypropylene), or wire. Under certain circumstances the anchor chain is detached from the anchor and a section of that is used to secure the vessel.

Mooring pipe
Definition: A casting which prevents chafing of mooring lines passing through bulwark plating.

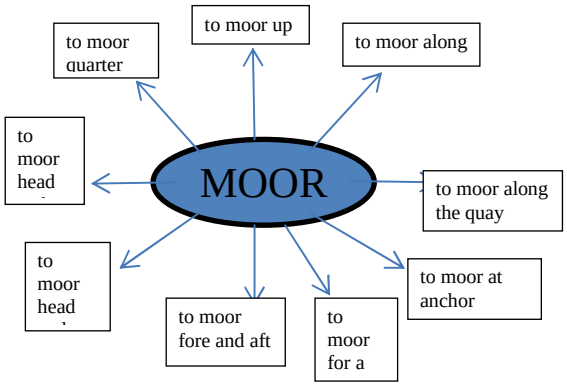
Mooring rings
Definition: The rings by which the chain is attached to large stones used for moorings. Sometimes the bolts that hold these rings pass clean through the stone, and are secured underneath, but a more secure plan than this is known as a Lewis.**Moorings**
Definition: The place where a vessel is moored. Also, anchors with chains and bridles laid in rivers for men-of-war to ride by.

Single buoy mooring
Definition: A large buoy, design to be anchored permanently at sea, to which large ships can be moored.

Single mooring point
Definition: Tanker terminal using a single buoy or fixed structure to fasten the vessel and carry out cargo operations. The ship can swing freely around this point.

Moor
Definition: To secure a ship in position by two or more anchors and cables. To attach a vessel to a buoy, or buoys. To secure a vessel by attaching ropes to positions ashore.

Moor a ship



Definition: Lay out anchors of a ship in such a manner as she may most conveniently ride with safety.

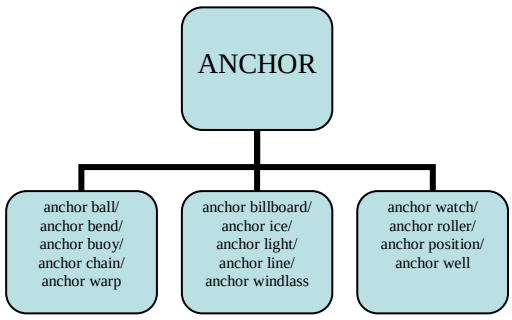
Moor to
Definition: To secure a ship by more than one cable.

Moorage
Definition: Charges assessed for mooring a vessel to a pier or wharf.

Mooring
Definition: The act of bringing a vessel to a complete stop in a relatively protected coastal area in such a fashion that it can be sailed away again in less than one week's time by the same number of people who moored it without heavy equipment; an arrangement for securing a vessel to a mooring buoy or a pier; an anchor or weight, permanently attached to the sea floor, with a buoy going to the surface, used to hold the boat in a certain area.

Unmoored
Definition: With anchors a-weigh. A vessel is also said to be "unmoored" when she is riding to a single anchor, as to be moored two anchors must be down, or she must be fast to a permanent mooring.

Another interesting example that greatly appeals to students is the word *anchor*.
Starting from the definition of the word *anchor* which brings about new information such as the fact that it can be used figuratively (someone who reads the news on a television news broadcast is called a an anchor (man or woman)) the teacher may then follow up with a diagram presenting the various collocations with the noun *anchor*.



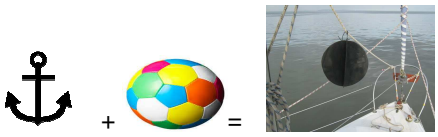
Similarly, in the case of the word *anchor*, the manner of displaying the lexical field is of utmost importance.

One possible approach is to present first a set of nouns (*ball*, *bend*, *buoy*, *chain*, *ice*, *light*, *line*, *windlass* etc) and ask the students to find a connection among them. Besides the fact that they belong to the maritime field, they all collocate with the word *anchor*.

Another appealing manner of presentation might be the usage of pictures in a drag and match game on the board.

Example:

anchor + ball =



Regarding the difficult task of teaching specialized vocabulary, good teachers today, as in the past, follow the so-called cognitive-code theory, that is, the inductive presentation of a linguistic item or category, with tasks and activities that will lead to habit formation of features of pronunciation, morphology, and syntax – which will, in turn, lead to fluency and accuracy.

By loosening control and encouraging students to emit spontaneous utterances from the repertoire of the linguistic items they have stored in their memories, good teachers have always led their students to the kind of interaction and communication in class that duplicates communication in the real world. Today, however, the majority of teachers focus more specifically on social communication as the major objective of language teaching.

Certainly, there is nothing new about the idea that communicative ability is the goal of foreign language learning. What is new is that teachers now pay attention to both the structural and functional aspects of language, combining these in a more complete communicative view.

In the first stage, learners are exposed to situations where they use their language resources for communicating meaning. In the case of word clouds this will be achieved starting from mere words presented in context and guessing their meaning.

In the second stage, learners use language to convey an intended meaning effectively in a specific situation.

In order to make students wish to communicate, it is necassary to bring interesting subjects of conversation in the classroom (in the case of the topic of *mooring* the sujects may revolve around the idea of safety, for instance; see http://www.seahealth.dk/ Mooring – Do it safely, a pdf document rich in visual resources perfect for communicative goals in EFL classes)

Guessing games are the simplest and most well-known activities in which one individual or groups discovers and item of information known to another (or only the teacher!)

In this respect, a most precious and useful teaching and learning tool is the Quizlet – a free program for bothe students and teachers where one can create sets of flashcards, practise pronunciation, and create tests in order to assess progress.

Last but not least, humour might be perfectly functional in learning a language in general, and even maritime English in particular.

Humour activates motivation and directs attention, but it can also be used in other events as weel, from stimulating recall to enhancing retention to eliciting performance and providing feedback.

While students learning English in America frequently find much to laugh at with their new American friends, the structured humour of jokes remains very difficult to unbderstand, as there are so many ways to miss the point of a joke.

Background information might be necessary in order to fully understand a joke. Certain subjects often cause laughter among americans whereas those subjects may not be laughed at in our country.

The task of the teacher shall then be to clarify the puns and explain the butts.

Example:

A young naval student was being put through the paces by an old sea captain.

”What would you do if a sudden storm sprang up on the starboard?”

”Throw out an anchor, sir,” the student replied.

”What would you do if another storm sprang up aft?”

”Throw out another anchor, sir.”

”And if another terrific storm sprang up forward, what would you do then?” asked the captain.

”Throw out another anchor, sir.”

”Hold on,” said the captain. ”Where are you getting all those anchors from?”

”From the same place you're getting your storms, sir.”

Similarly, we may use a funny picture for teaching purposes, such as describing objects in order to practise adjectives:

4. CONCLUSIONS

We have witnessed over the past decade a significant change in attitude to language teaching and learning. The factors that have brought it about are too numerous to be listed exhaustively.
As a result, language teaching has become more realistic in terms of what teachers and learners can actually achieve within the framework of a foreign language course, including a limited number of classes per week, and also relevant as to the aims and objectives of the language course being taught/ attended.

What modern methodologists try to pint out is the fact that if knowledge of use must necessarily include knowledge of usage, the reverse is not the case.
Teaching approaches emphasize the central role of language as a social phenomenon.

Communicative competence must go hand in hand with global education as we are all citizens of the world.
Bilingualism and biculturalism are not sufficient for living and participating in today's interdependent world. It is our responsibility as teachers and educators to prepare our learners to cope not only with the world's universal problems and behaviours but with its many ethnic and cultural systems.

At present, students are keen on learning fast and have a feeling of immediate gratification in the sense of being able to be part of a communicative process.

The many internet-based resources are a must for present-day teachers who find themselves compelled to convey their knowledge by means of modern techniques. Our EFL classes are now shaped by ppts, apps, jpgs, tweets, or whatapps. Be it as it may, as the ultimate goal remains the acquisition of the international language of communication – English.

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EXPRESSIONS MOULDED IN BRITISH AND RESTORED IN AMERICAN WORDYARDS

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ABSTRACT

Since neither the Indians nor the War of Independence brought about changes in the total stock of words and idiomatic combinations of their language, British and American have kept a very close association. From the time of the first passengers disembarking from the May Flower to present day cross-Atlantic tweetings, 'the two nations divided by one common language' countries have shared in the development of English lexis. Many words and phrases used in the USA have retained Elizabethan English meanings although some have been jettisoned in the Mother Country. Of course, there are many American phrases which have not been imported by other countries; for example, '*lead-pipe cinch*' (an absolute certainty: *It's a lead-pipe cinch they'll be there*), and '*presto chango*' (a sudden change or transformation, as a magic trick in which one object appears to be suddenly transformed into another) are widely understood in the US, but would receive puzzled looks in other countries.

The purpose of this paper is to see what idioms are, their characteristics and classification and, last but not least, to find Romanian idioms that have the same meaning as those used in the English-speaking world.

Keywords: communication, idioms, particular meanings, degree of opaqueness

1. INTRODUCTION

In all languages words tend to get together in a huge number of ways and patterns. This universal tendency of words occurring repeatedly in the same clusters is called 'constructual tendency' (Kjellmer, 1994).

The literal meanings of the individual words of a phrase are of secondary importance and the emphasis is wholly put on the meaning of the whole word cluster in idiomatic expressions. Hence idioms have two levels: separate words put together, and a meaning as a single unit. Thus the meaning of the whole is figurative and, in most of the cases, commonly known.

The idiomatic structures of a language also reflect the culture where the language is spoken. Idioms are very widely used in spoken language, and many of us do not always even notice when we are using an idiom. However, they occur in poetry and literature, too. You will find examples of idioms originating from Shakespeare or the Bible.

2. APPROACHES TO DEFINING IDIOMS

All the researchers who studied idioms agree that they are strings of words, which, put together, mean something different from the individual words when they stand alone. In order to define idioms it is imperative to identify the characteristics that make them so different from the rest of expressions.

The idioms share some features that separate them from literal expressions, and they are both semantic and syntactic. The first is semantic opacity, or what has come to be known as 'noncompositionality', the fact that the meaning of an idiom cannot be deduced from a sum of the meanings of its parts; in this sense, the meaning of an idiom is 'not motivated' (Bussman, 1996). The second criterion relates to the apparent morphological and transformational deficiencies of idioms, since they do not allow the syntactic variability displayed in freer sequences of words. Operations such as passives, internal modifications and topicalization cannot occur with the idiomatic meaning being retained. Idioms are, therefore, syntagmatically and paradigmatically fixed (Moon, 1998). In addition to these criteria, it has been observed that idioms belong to an informal register, and they are figurative or metaphorical in meaning. They are more often than not untranslatable (Fernando, 1994).

3. GRADING BASED ON DEGREE OF INTELLIGIBILITY

One of the simplest ways of grading idiomaticity is to classify idioms based on the semantic intelligibility of their meaning. Basically, this means that the literal expression of a word string is compared to its idiomatic meaning. In other words, it is a matter of how transparent or opaque they are. A change from white to black was proposed by Fernando (1994) and the following classes of expressions were found: transparent, semi-transparent, semi-opaque and opaque. For each of the four stages a number of expressions will be given together with the meaning, and, sometimes the origin when it is an eye catcher.

3.1 transparent

These are not idioms at all, they only have a literal meaning.

as easy as pie

Meaning: Very easy.

Origin: One of the many similes in English that have the form '*as X as Y*'.

Don't die like I did.

Meaning**:** don't waste your life

Origin: George Best (1946 - 2005) was famous not only for his football talent, but also for his womanising and

drinking - the latter of these preoccupations was the cause of his death.

fish or cut bait

Meaning: it means 'either get to work in a productive manner or do something else and let someone else work'.

Back to the drawing board

Meaning: Start again on a new design or plan after the failure of an earlier attempt.

Origin: This term has been used since WWII as a jocular acceptance that a design has failed and that a new one is needed.

beauty is only skin deep

Meaning: Physical beauty is superficial.

Origin: Proverb. First used by Sir Thomas Overbury in his poem Wife, 1613: "All the carnal beauty of my wife, is but skin deep."

The same year the poet died of natural death.

fall from grace

Meaning To fall from position of high esteem.

Origin From the Bible, *Galatians 5:4*

failing to plan is planning to fail

Meaning: Literal meaning .

3.2 semi-transparent

They mark the transit to idioms. The can have a literal meaning, a figurative meaning or both.

As happy as a clam

Meaning: Very happy and content.

Origin: Why would clams be happy? It has been suggested that open clams give the appearance of smiling. The derivation is more likely to come from the fuller version of the phrase, now rarely heard - 'as happy as a clam at high water'. Hide tide is when clams are free from the attentions of predators;

an arm and a leg

Meaning: A large, possibly exorbitant, amount of money.

Origin: In this case the tale is that portrait painters used to charge more for larger paintings and that a head and shoulders painting was the cheapest option, followed in price by one which included arms and finally the top of the range 'legs and all' portrait. … thinks there's no truth in that story.

a sledgehammer to crack a nut

Meaning: to use disproportionate force or expense to overcome a minor problem.

Origin: Sledgehammers are large iron hammers which were first used in England in the 15th century. 'Sledge' was the original name of this form of hammer; so 'sledgehammer' is something of a tautology.

beggars can't be choosers

Meaning: People with no other options must be content with what is offered.

3.3 semi-opaque

These are idioms because it is not easy to decode since literal meaning is odd.

been there, done that

Meaning: To have experienced the topic under discussion, to the point of boredom or complacency.

Origin: This phrase began life in the early 1970s, in the short form 'been there', which had the same meaning as 'been there, done that'.

don't change horses in midstream

Meaning: Don't change your leader or your basic position when part-way through a campaign or a project.

Origin: From a speech by Abraham Lincoln.

3.4 opaque

Idioms whose literal meaning is unintelligible.

even at the turning of the tide

Meaning: Normally the phrase is used to denote some change from a previously stable course of events. The 'turning of the tide' is literally the change of the tide from incoming to outgoing, or vice-versa.

Origin: From Shakespeare's Henry V.

Batten down the hatches

Meaning: Prepare for trouble.

Origin: Lost in the days of sail, but Bob Dylan uses in one of his songs the lines:

They battened down the hatches

But the hatches wouldn't hold.

On your beam ends

Meaning: Hard up; in a bad situation.

Origin: The beams here are the horizontal transverse timbers of ships. This nautical phrase came about with the allusion to the danger of imminent capsize if the beam ends were touching the water.

flotsam and jetsam

Meaning: Ships' goods which are lost at sea. Also used figuratively in non-nautical contexts to means *odds and ends, bits and pieces*.

Origin: there's a simple mnemonic that helps distinguish flotsam from jetsam. flotsam (or floatsome) are those items which are floating as a consequence of the action of the sea. jetsam are those which have been jettisoned by a ship's crew (although that may float too of course).

B**ag and baggage**

Meaning: All of one's possessions.

Origin: The phrase is of military origin. 'Bag and baggage' referred to the entire property of an army and that of the soldiers in it. To 'retire bag and baggage' meant to beat an honourable retreat, surrendering nothing. These days, to 'leave bag and baggage' means just to clear out of a property, leaving nothing behind.

A shot in the arm

Meaning: A stimulus.

Origin: This expression derives from the invigorating effect of injecting drugs. A shot is of course US slang for an injection, either of a narcotic or medicinal drug. Nowadays it got another meaning, as in the following example: More foreign investments can give economy a shot in the arm.

all singing, all dancing

Meaning: Full of verve and vitality; more recently - with many features or attributes.

origin: from the advertising of musical films.

barking up the wrong tree
Meaning: making a mistake or a false assumption in something you are trying to achieve.

Origin: The allusion is to hunting dogs barking at the bottom of trees where they mistakenly think their quarry is hiding.

the living daylights
Meaning: A person's eyes; more recently, the life force or consciousness.

Origin: Unknown, but the release of the 1987 film *The Living Daylights*, the fifteenth in the James Bond series, reawakened usage of this old phrase.

backroom boy
Meaning: One who works in anonymity in an organization while others take on more public roles.
Origin: First used to describe the anonymous technicians and scientists who worked behind the scenes in the UK during World War Two.

back-seat driver
Meaning: Someone who criticizes from the side lines. A newspaper offered this excellent definition: "A back-seat driver is the pest who sits on the rear cushions of a motor car and tells the driver what to do. He issues a lot of instructions, gives a lot of advice, offers no end of criticism. And doesn't do a bit of work."
Origin: Throughout the 20th century U.S. fire departments used large articulated ladder trucks. These had both front and rear-wheel steering to enable the long vehicles to turn in city streets.

make a bee-line for
Meaning: Go directly towards.
Origin: The phrase derives from the behaviour of bees. When a forager bee finds a source of nectar it returns to the hive and communicates its location to the other bees, using a display called the *Waggle Dance*. The other bees are then able to fly directly to the source of the nectar, that is, 'make a beeline' for it.

the bee's knees

Meaning: Excellent - the highest quality.
Origin 1. Bees carry pollen back to the hive in sacs on their legs. It is tempting to explain this phrase as alluding to the concentrated goodness to be found around a bee's knee.
2. It is also sometimes said to be a corruption of 'business', but there's no evidence to support that.

bet your bottom dollar
Meaning: bet your last coin.

blonde bombshell
Meaning A glamorous blonde.

buckle down
Meaning: Apply oneself to hard work. (e.g. *You should buckle down to improve your score*.)

a bunch of fives
Meaning: A fist. The fives are the five fingers.

butterfingers

Meaning A name playfully applied to someone who fails to catch a ball or lets something slip from their fingers.

carte blanche
Meaning: Having free rein to choose whatever course of action you want.

Origin: From the French, meaning 'white (or blank)

paper' - the military term for surrender.

damp squib

Meaning: Something that fails ignominiously to satisfy expectations; an anti-climax, a disappointment.
Origin: A squib is a form of firework, usually cylindrical in shape with a paper fuse at one end, which provides a mild explosion - think 'dynamite lite'. Clearly, fireworks work when they are dry, not damp.

dead cat bounce
Meaning: A small and temporary recovery in a financial market following a large fall.
Origin: When a financial market suffers a consistent fall traders attempt to detect when prices are at their lowest and then buy stocks hoping for a bargain. If they buy too soon prices may rise temporarily but then decline again. This is called the dead cat bounce.

dead from the neck up

Meaning: stupid; dull;

dead to the world
Meaning:
1. a dramatic way of explaining the status of being so overworked, stressed out, sleep deprived, and/or having so much schoolwork that a person feels forced to freeze all social interactions for a while.
2. sound asleep or unconscious, as in *The alarm clock went off but Joseph was dead to the world*.
3. alcohol intoxicated. *By midnight almost everybody was dead to the world.*
Never take the expression literally.

dead ringer
Meaning: An exact duplicate.
Origin: A *ringer* is a horse substituted for another of similar appearance in order to defraud the bookies.
Coming more up to date we have 'car ringing', which is the replacing of the identification numbers on a stolen car with those from a genuine (usually scrapped) vehicle

die-hard

Meaning: A person who holds stubbornly to a minority view, in defiance of the circumstances.
(The title of the 1988 film *Die Hard* was chosen to signify both the 'hardness', that is, toughness, of the lead character and the difficulty that he and the bad guys had in killing each other.)

dock your pay
Meaning: Make a deduction from a person's pay.

Origin: Ships may be docked by bringing into an anchorage or resting place'. The docking of pay is altogether different. That relates to the Old English 'dock' - 'to cut short, particularly of the hair or tail of an animal'.

don't go there
Meaning: Don't bring that up; don't broach that topic; I don't want to discuss that.

don't keep a dog and bark yourself
Meaning: Don't pay someone to do a task and then do it yourself.
draw a blank
Meaning: To fail to recall a memory or fail in some speculative effort.

Drop in the bucket
Meaning: A very small portion of the whole.
Origin: *The Bible*, Isaiah

eat my hat

Meaning: A display of confidence in a particular outcome; for example, 'She's always late. If she gets that train I'll eat my hat'.

economical with the truth

Meaning: Conveying an untrue version of events by leaving out the important facts. A euphemism for lying, in short.

excuse my French

Meaning: Please forgive my swearing.
Origin: A coy phrase used when someone who has used a swear-word attempts to pass it off as French. The coyness comes from the fact that both the speaker and listener are of course well aware the swear-word is indeed English.

the face that launched a thousand ships

Meaning: A reference to the mythological figure Helen of Troy. Her abduction by Paris was said to be the reason for a fleet of a thousand ships to be launched into battle, initiating the Trojan Wars.

C. Marlowe, in *Doctor Faustus*, had Faust ask:
Was this the face that launched a thousand ships
And burnt the topless towers of Ilium?
3. Expressions with literal meaning

fall guy

Meaning: A scapegoat; one who takes on the responsibilities or workload of others. Here 'fall' is used with the criminal slang meaning of 'arrest' or 'period in prison'. More recently, it has also come to mean a person who is easily duped or outmanoeuvred.

fall off the back of a truck

Meaning: A euphemism for 'acquired illegally'.
Origin: When anyone accounts for their possession of an article by saying it 'fell off the back of a truck', they may be assumed not to be its legal owner - that is, it is stolen. This coy language, which feigns innocence but actually emphasizes illegality by using a phrase that is reserved for illegal dealing, is similar to The Godfather's 'an offer he can't refuse'.

4. CONCLUSIONS

The meaning of idioms is not the sum of their literal component, but idioms have the literal realization as a surface representation which comprises the figurative and idiomatic meaning. Hence, there is a link between the surface representation and the idiomatic meaning. Idioms are words put together, stored as a single ‘big word’(Wray, 2000) The literal realization of idioms may seem oddly or illogically constructed, syntactically ill-formed, or ‘ungrammatical’, because idioms are often relics of former, older language, the syntactic forms of which have disappeared throughout time. They are like general purpose ships, they can carry several types of cargo, but some of it might prove dangerous. If an idiom does not get any ‘likes’ or not enough, it can sink the ship, or stay afloat with a different meaning.

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FEATURES OF EST, A SUBFIELD OF ESP, WITH A FOCUS ON MARITIME (ENGINEERING) ENGLISH

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ABSTRACT

This article focuses on the features of maritime (engineering) English in terms of EST (English for Science and Technology) and on the specific needs of students of EST, i.e. maritime (engineering) English along with teachers' role in integrating general English vocabulary in EST/maritime (engineering) English classes. As far as future (maritime) engineers are regarded, English teachers need to steer their boat carefully in order to meet the specific needs of students of EST, a subfield of ESP (English for Specific Purposes). Maritime (engineering) English involves basic general English proficiency prior to the study of specialized vocabulary. It is a teacher's task to assist students in attaining the linguistic skills they need in their future profession.

Keywords: *ESP, EST, maritime English, engineering English, maritime English teachers, linguistic skills.*

1. INTRODUCTION

Irrespective if one learns English for general purposes or for occupational ones, vocabulary acquisition is the most important part in the learning process, given the fact that no proper communication in a foreign language is possible without words. As far as future (marine) engineers are regarded, English teachers need to steer their boat carefully in order to meet the specific needs of students of EST (English for Science and Technology), a subfield of ESP (English for Specific Purposes).

This article focuses on the features of maritime (engineering) English in terms of EST and on the specific needs of students of EST, i.e. maritime (engineering) English along with teachers' role in integrating general English vocabulary in EST/maritime (engineering) English classes.

The category concerned with the research and teaching of the language of specific subject matters in English is referred to as English for Specific Purposes. Numerous authors, scientists and researchers have defined, classified and approached ESP from various perspectives throughout its almost fifty years of existence.

In defining ESP, Hutchinson and Waters [1] emphasised the similar characteristics of ESP learning and general English. They see ESP "as an approach, not as a product" and the key element in their definition is the learner's need. ESP is more "an approach to language learning, which is based on learner need" than "a particular kind of language or methodology". Hence, it is not the teaching methodology or the language that is significant in ESP, but the student's needs and goals and this should be the basis of ESP classes. Robinson's [2] definition of needs refers to what learners "have to be able to do at the end of their language course". Accordingly, ESP is a target-oriented training process based on needs analysis. Thus, two of the main features of ESP are that ESP courses are devised for a clearly defined time period and students are more likely to be adults.

2. ESP CLASSIFICATION

Dudley-Evans and St John [3] stressed that beside student needs, ESP focused on the language of specific disciplines. Furthermore, they added the variable characteristic of an ESP specific methodology applied in some cases. Accordingly, their definition of ESP reads as follows:

"1. Absolute characteristics:

- ESP is designed to meet specific needs of the learner;
- ESP makes use of the underlying methodology and activities of the disciplines it serves;
- ESP is centred on the language (grammar, lexis, register) skills, discourse and genres appropriate to these activities.

2. Variable characteristics

- ESP may be related to or designed for specific disciplines;
- ESP may use, in specific teaching situations, a different methodology from that of general English;
- ESP is likely to be designed for adult learners, either at tertiary level institution or in a professional work situation. It could, however, be used for learners at secondary school level;
- ESP is generally designed for intermediate or advanced students. Most ESP courses assume basic knowledge of the language system, but it can be used with beginners."

Moreover, the difference between ESP and general English teaching is not so much the specificity of language, but rather the specific needs of people attending these courses.

General English and ESP are divergent not only in the nature of the student but also in the goal of teaching. While general English focuses on all four language skills (reading, writing, listening and speaking are supposed to be stressed upon to the same extent), ESP depends on the needs analysis to determine which skills are the most relevant for the students and syllabi thereof are designed accordingly. Engineers, for example, need to be able to convey ideas effectively, comprehensibly and influentially both in writing and orally, so the

communication skills should prevail over all the other skills.

3. ABILITIES CLASSIFICATION

Consistent with the characteristics of ESP or EST in our case, other authors, among whom Gatehouse [4], have identified the abilities necessary for successful professional activities of future engineers:

- the ability to use informal language to communicate effectively, regardless of the occupational context;
- the ability to use the particular jargon of the specific occupational context;
- the ability to use a more generalized set of academic skills, such as carrying out research and responding to reports or memoranda.

EST lecturers need to be aware that vocabulary teaching and learning do not play the leading part in such skills that require an advanced level of language proficiency. Moreover, in many cases, intermediate students are not fluent enough in English to be able to focus on how to organise and structure documents using the rhetorical patterns used in scientific and technological written texts. Instead, they need more basic language training. In this case, teachers of English for science and technology need to pay attention to the first two abilities almost entirely. First, they have to improve the students' level of general English while teaching them more specialised communication skills.

In terms of maritime English and especially in matters of communication at see, be it ship-to-ship/ship-to-shore or onboard communication in a multinational crew, it is important to admit that students who have already dealt in high school with a lot of grammar and general vocabulary will not improve their communicative competence in maritime English significantly by studying more of the same. Actually, they need to develop their lexical awareness and their ability to combine individual words they are familiar with (e.g. *rod, engine*) into word combinations (e.g. *connecting rod, engine bedplate*). In this way, they will be able to attain genuine fluency and improve language processing. Maritime English as a subfield of ESP or better yet EST is focused more on language in an occupational context than on teaching/learning linguistic and grammar structures. Maritime (engineering) English is taught as a constituent part of a particular subject matter area significant to its learners. This combination of English and EST proves to be very motivating for students because they have the opportunity to apply what they learn in maritime English classes to their major field of study. The possibility to use the linguistic structures in a relevant context supports what has been taught and boosts motivation.

Actually, the "specific" in ESP stands for the specific goal of these people to learn English. They can "tackle" maritime English through a relevant domain that is going to be their field of expertise for the rest of their professional life, which means they will be able to apply what they learn in maritime English classes straightaway in their studies and work. This approach increases the significance of what they learn as students and allows them to make use of the English they already know to learn even more English, which will eventually turn out to be an incentive for their interaction within multinational crews and self-confidence in dealing with specialised texts.

4. EST VOCABULARY CLASSIFICATION

Just like general English vocabulary, EST vocabulary can also be divided into active and passive. Active vocabulary is the one that a speaker or writer is able to use, whereas passive vocabulary is the one that can be only recognised and understood without being mastered enough to be used. Both active and passive vocabulary can be additionally subdivided depending to the pertaining oral and written skills. Nevertheless, pursuant to the specific context, i.e. the scientific and technical field the speaker has to deal with, so that a word can fall under a section or another, especially if it has different meanings.

Robinson [2] classified ESP vocabulary in three categories according to their semantic ambiguity:

- the super-specialised vocabulary belonging to each scientific or technical field or subfield. These words refer to precise concepts; consequently, they have no semantic ambiguity, i.e. every word has a single and definite meaning in the scientific or technological field under consideration. The meaning corresponds to a concept which is referred to by a term: *laser, goniometer, embargo, microscope*. A teacher has to determine what exactly of this vocabulary to teach.
- general technical and scientific terms that make up the vocabulary used on a large scale, referring to actions, situations and/or processes common to various fields of technology or science: *reliable, to improve, to repair, failure, progress* etc. Although part of this lexis may be basic (if it refers to simple tools or usage instructions), it may also be more intricate - in technology, for instance, there are many transverse activities pertaining to several technical domains and which require beyond basic proficiency in language and vocabulary use. Robinson [2] points out that the semantic ambiguity of this class of words, despite being a little higher than that of ultra specialised terms, remains quite low.
- terms originating in general English. This category of vocabulary is actually on the edge between general English and EST. These words exist and may be used on an everyday basis and some of them can be encountered in any type of communication, but most of them are more frequently used in EST, as they are a constituent of EST lexis. Beside that, it is quite impossible to rate some of them as belonging to a specific field, e.g. *computer, thermometer, video* etc. This is the class of the most ambiguous words since the definite meaning may not always be instantly detectable even to a student who knows the word. A simple verb like *to draw* can pose a problem in itself: a housewife will simply *draw* the curtains, while a ship designer will *draw* lines on a drawing board and a lawyer will *draw* a deed. Other examples include words like *beam, draft, (to) charge, (to) set* etc.

5. MARITIME (ENGINEERING) ENGLISH AS PART OF ESP WITH ROMANIAN STUDENTS

As showed above and in *An Insight into Maritime English for Engineering Students* [5] also, "strictly technical words are characterized by the absence of exact synonyms, e.g. words such as *crankshaft*, or *to bunker*." However, particularly among multinational crew members, it is highly critical for maritime engineers to be able to provide words and phrases with similar meaning in order to make themselves clearly understood by their colleagues. For instance, while some of them are able to switch between phrases like "*extinguish* a fire" or "*put out* a fire" or "holds should be vented *carefully*" or "[…] *thoroughly*", mainly because these words are also used in general English, they should bear in mind the fact that not just any words or phrases are all-general. There are words that fall under both categories, i.e. they can have both technical and non-technical usage. Words like *iron*, *force*, *strength*, *tension* or *stress* have the same meaning in several technical fields.

Specialized technical word combinations play a more important role in ESP than they do in general English which is rather more lexically diffuse, though by no means less significant. It is just that it takes a great amount of practice for non-native speakers of English to become fluent in this respect and to know these (more often than not) contextually triggered phrases by heart. Thus, as far as general English is concerned, Romanian students come to find out that the Romanian phrase *a da un examen* is translated into English by *to take an exam*, not **to "give" an exam* and *a lua un examen* is *to pass an exam*, not **to "take" an exam*. Likewise, in maritime English a ship *makes water* while in Romanian she *"takes" water* i.e. *nava ia apă*.

Due to their scarce knowledge or perhaps to mere ignorance of the special field they are going to work in, some present-day students tend to associate general English words like *list* with familiar translations like *listă* instead of the correct technical term *canarisire*. When confronted, most of them admit they have no idea what *canarisire* actually means, let alone the shipping meaning of the English word *list*. Even more frustrating is it for EST teachers to find out that there are students who do not simply bother to filter the "information" before they come up with translations such as *zaharisire* (i.e. *saccharifying*) only because it sounds similar to the Romanian *canarisire*. Another problem is posed by words like *forecastle /'fəuksl/*. Although they are advised of the correct pronunciation, most students regard it as a compound word (fore-castle) and treat is as such. Speaking of unfortunate word association they make, they mistake this one for the Romanian *castel*, i.e. the equivalent of *castle*. I, personally, have come to the conclusion that the only hope for them to pronounce it correctly is for them to sail on board vessels with crews made up of native speakers of English.

"Engineering English is well known for its passive verbs (e.g. Auxiliary engines, together with alternators, *are mounted* on a common bedplate and *are installed* on shock absorbers.), abbreviated relatives (*hand-operated device*, *electronics capable of self-repair*), long noun groups (*fresh water cooling pumps*, *oil-fired boiler burner*) which can prove rather difficult to understand and use if enough attention is not paid. By seeing the contexts and collocates, the learners can get a much better idea of the use of a word than they would achieve by merely looking it up in the dictionary." This is why it is not only practical and useful but extremely important for them to have access to genuine engineering texts during their studies of ESP. Their exposure to the context in which they are going to make use of their engineering English skills enables them to enhance their ability to read and produce a linguistically accurate and relevant discourse in their specific occupational area.

6. THE ROLE OF ESP TEACHERS

ESP teachers in turn need to gain a good insight into various professional fields and related domains thereof in order to enhance their understanding of the vocabulary they teach and to constantly upgrade their knowledge. Worldwide, teachers select teaching materials based on their availability. Moreover, materials have an influence on the content of the course. Frequently, this also serves as an argumentation for and explanation of the use of the same syllabus over the years with different generations of students. On the other hand, in some universities lecturers depend on certain materials and are required to teach the same topics from the same old books over and over again. Theoretically, there is nothing wrong with using the same materials if we speak, for instance, of using the same text or audio/video aid to develop reading or listening comprehension skills. As for the lexis, it is not just the vocabulary per se, but the content and information it provides that needs to be accurate and coherent with the present-day technology. Based on my personal experience as a maritime engineering English lecturer, I know it for a fact that concepts and things that I used to teach 15 years ago have become obsolete in the ever-developing world of marine engineering. Hence, not only do EST teachers have to learn the specialised vocabulary but they need to keep a permanent contact with specialists in the field (in our case, with marine engineers) so as to convey up-to-date knowledge to their students.

Beside that, it is part of their job to raise student awareness of the necessity of ESP and of its interdependence of, and causal connection with the entire maritime field. A huge drawback in this endeavour is that the ESP syllabus is not always consistent with the syllabi in the subject matter areas that students major in. For first-year students it is a little disheartening to take in such a great amount of information: they have to deal both with the basics of seamanship in their mother tongue and to learn the equivalent English terms. The latter, of course, is the case for students throughout their entire academic schooling time, as later on they are faced with engineering English. It is just that the impact is a bit stronger with junior students. Here is where EST lecturers step in and play a significant role in keeping students focused on the importance of maritime English for their future career. Apart from this role, teachers are the ones who design and organise the course, they assist students in their efforts, give them feedback on their

progress, help them identify problems and find solutions involving the skills they need to focus on.

7. THE ROLE OF ESP STUDENTS

Alongside the teacher, students themselves have a role to play in ESP classes. When choosing their professional path, most of them have already got an idea of what the life of seafarers is like. As for the Romanian maritime students, especially in the cities on the Black Sea coast, many of them have relatives and friends who go at sea, irrespective of rank and working place, so they are quite familiar with this environment. Consequently, they come to maritime English classes with a precise interest for learning, a certain degree of subject matter knowledge and well-built learning goals and strategies. Having a clear orientation of their education toward a certain field, they regard the English training as a complement to their orientation. The process of gaining subject matter knowledge makes it easier for them to identify a genuine context for the specialised vocabulary of ESP classes. Youth and adults must work a little harder than children to acquire a new language, but the skills they carry along to the task helps them learn more efficiently and sometimes even faster. Although their English may be quite limited at times, the language learning capabilities of youth and adults in ESP classes are tremendous. They constantly enrich their knowledge and vocabulary and become more fluent in their domains while also adapting their linguistic behaviour to new roles and new circumstances.

Of course, a good teacher will never discontinue teaching general English along with maritime English if placement tests show certain gaps in students' knowledge, that have to be coped with before carrying on to a higher level. Maritime (engineering) English teachers shall always bear in mind that they teach English as a foreign language, so they need to integrate general English in the EST teaching process, in order to help students achieve proficiency.

Students' role now in maritime (engineering) English classes is to develop their English language skills so as to reflect their mother tongue knowledge and skills. From this point of view, maritime English becomes a very powerful tool for them to attain an aim.

8. CONCLUSIONS

In conclusion, maritime (engineering) English as a subfield of ESP, or more precisely of EST, involves basic general English proficiency prior to the study of specialized vocabulary. It is a teacher's task to assist students in attaining the linguistic skills they need in their future profession.

The aim of this article has been to highlight the manner in which a teacher needs to be able to weave general English into EST based on the classification of EST vocabulary and on the abilities necessary for successful professional activities of future marine engineers.

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HOW TO EMBED GENERAL ENGLISH GRAMMAR AND VOCABULARY IN MARITIME ENGLISH TEACHING

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ABSTRACT

This article is aimed to provide various manners in which to reach the same goal, i.e. to embed general English grammar and vocabulary in maritime (engineering) English classes. Research has revealed that almost half of the accidents at sea are due to poor knowledge of maritime English. Hence, it is quite a challenge for maritime English lecturers to know what and, more importantly, how to teach future maritime engineers. It is vital for all seafarers, regardless of their rank on board, to be able to communicate in English. As for marine engineers, just like deck officers, they need to master all four skills even if, depending on the circumstances, some skills may prevail at times. Therefore, it is desirable for them to convey coherent and cohesive messages about their work, both orally and in writing.

Keywords: *maritime English, engineering English, general English, maritime English teachers, marine engineers.*

1. INTRODUCTION

"The term *Engineering* is derived from the Latin *ingenium*, meaning *cleverness* and *ingeniare*, meaning *to contrive, devise*.

Engineering is a broad discipline which is often broken down into several sub-disciplines. These disciplines concern themselves with differing areas of engineering work. Although initially an engineer will usually be trained in a specific discipline, throughout an engineer's career the engineer may become multi-disciplined, having worked in several of the outlined areas. Engineering is often characterized as having four main branches:

Chemical engineering – The application of physics, chemistry, biology, and engineering principles in order to carry out chemical processes on a commercial scale, such as petroleum refining, microfabrication, fermentation, and biomolecule production.

Civil engineering – The design and construction of public and private works, such as infrastructure (airports, roads, railways, water supply and treatment etc.), bridges, dams, and buildings.

Electrical engineering – The design, study and manufacture of various electrical and electronic systems, such as electrical circuits, generators, motors, electromagnetic/electromechanical devices, electronic devices, electronic circuits, optical fibers, optoelectronic devices, computer systems, telecommunications, instrumentation, controls, and electronics.

Mechanical engineering – The design and manufacture of physical or mechanical systems, such as power and energy systems, aerospace/aircraft products, weapon systems, transportation products, engines, compressors, powertrains, kinematic chains, vacuum technology, and vibration isolation equipment.

Beyond these four, a number of other branches are recognized." [1]

"*Marine engineering* often refers to the engineering of boats, ships, oil rigs and any other marine vessel or structure, but also encompasses oceanographic engineering. Specifically, marine engineering is the discipline of applying engineering sciences, and can include mechanical engineering, electrical engineering, electronic engineering, and computer science, to the development, design, operation and maintenance of watercraft propulsion and also on-board systems and oceanographic technology, not limited to just power and propulsion plants, machinery, piping, automation and control systems etc. for marine vehicles of any kind like surface ships, submarines etc..

The purely mechanical ship operation aspect of marine engineering has some relationship with naval architects. However, whereas naval architects are concerned with the overall design of the ship and its propulsion through the water, *marine engineers* are focused towards the main propulsion plant, the powering and mechanization aspects of the ship functions such as steering, anchoring, cargo handling, heating, ventilation, air conditioning, electrical power generation and electrical power distribution, interior and exterior communication, and other related requirements. In some cases, the responsibilities of each industry collide and is not specific to either field. Propellers are examples of one of these types of responsibilities. For naval architects a propeller is a hydrodynamic device. For marine engineers a propeller acts similarly to a pump. Hull vibration, excited by the propeller, is another such area. Noise control and shock hardening must be the joint responsibility of both the naval architect and the marine engineer. In fact, most issues caused by machinery are responsibilities in general." [2]

2. COMMUNICATION SKILLS IN MARITIME ENGLISH

The primary focus in the higher education of engineering students lies on technical subjects. Having finished their training, most of these students carve out an engineering career, working as engineers or as scientists in the industry or for the government in their own country, regardless of their occupational engineering field. Marine engineers are a special case. They pursue a career at see, worldwide, on board ships. Most of the world fleet is manned by multinational crews and the international language at sea is (maritime)

English. They may be excellent engineers but unless they can convince their foreign colleagues of their worth, their engineering abilities may go unnoticed and frustrating situations may occur. Therefore, "good communication in Maritime English is essential for creation and maintenance of effective working environments and safety of the crew, and generally safety at sea and at ports." [3] Research has revealed that almost half of the accidents at sea are due to poor knowledge of maritime English. Hence, it is quite a challenge for maritime English lecturers to know what and, more importantly, how to teach future marine engineers.

It is vital for all seafarers, regardless of their rank on board, to be able to communicate in English. As for marine engineers, just like deck officers, they need to master all four skills even if, depending on the circumstances, some skills may prevail at times. One can never definitely say whether it is more important for a marine engineer to read and understand technical texts in English or to listen and understand utterances of his colleagues as well as to speak clearly and make himself understood especially in an emergency situation or, if we think of the managerial level to write comprehensible reports and/or requests. It is desirable for them to convey coherent and cohesive messages about their work, both orally and in writing. Good communication skills are important for one to succeed in technical professions and correct writing skills are a proof of professionalism. Mistakes make the message less efficient by distracting the reader's attention from the purpose of the communication. Engineers are usually very well organized persons, so it is expected that their sentences are clear and concise and can be understood by non-professionals, too.

3. GRAMMAR AND VOCABULARY IN MARITIME ENGLISH CLASSES

The specialized lexis that marine engineers have to master is inherently based on general-use vocabulary, so beside being proficient in maritime English, they need to have a good command of general English as well. At the core of elaborate technical topics are everyday pieces of vocabulary and grammar to deal with, including (but not limited to this particular order and these particular categories):

- *Countable and uncountable nouns* (words that are always plural, e.g. *pliers*, *overalls*, *scissors* etc.). Of course, the English syllabus needs to be adapted to the needs of the students and when teaching, it is appropriate to provide examples from the students' major subject area (see above). Likewise, it is important for them to learn how to make uncountable terms countable by means of *a pair of…*, *a piece of…* or *a tube of….*

- *Quantifiers* can be taught separately or along with countable/uncountable nouns. In technical professions it is vital to discriminate between *few* and *a few* or *little* and *a little*. A good exercise is to have students put a number of similar sentences in order from the most to the least, where the only difference is the beginning, i.e. *some of, none of, most of, a lot of, a little of, all of* [4].

- *Adjectives and degrees of comparison*. Among a multitude of classroom activities in this respect, teachers can have students work in pairs trying to describe an engineering item in terms of positive features as opposed to a different thing, comparably less important / efficient / useful. This is a good way to also integrate vocabulary related to:

- *Shapes and materials* – in the same way, working in pairs, one student can be asked to describe a thing without naming it precisely until their partner guesses what it is. The partner may ask questions such as *Is it made of iron or of steel? Is it round…?* Depending on the available teaching aid, teachers can have students listen to a dialogue and then, given the incomplete transcript, have them fill in the blanks in the conversation.

- Describing engineering items is a good opportunity for students to practice their knowledge on *Dimensions and units of measurement* such as temperature, speed, pressure along with *numbers* and *multipliers*. Thus, continuing the afore-mentioned activity they can describe the weight, diameter, length or speed of a certain thing they have in mind. Another attractive classroom activity is to have students play Hangman, while trying to find words similar in meaning to the underlined part in a sentence, e.g. *Steel that does not rust or stain stays shiny for a long time.*
_ t _ _ n _ _ _s s _ _ l _. [5]

- *Direction and location*, e.g. *outboard, astern, abaft to, amidships* or *upside, in the bottom left corner* etc. A type of exercise for this (and the next) topic is to provide students with a table and have them match the definitions to the correct terms. [6]

- *Opposites*, e.g. *shallow - deep, tight - loose, thin - thick*

- *Derivatives*, e.g. *long – length - to lengthen, to adjust – adjustable – adjustment*. Presented with technical texts, students identify derivatives or the come up with other derivatives of their own. [7]

- Words with different general and technical meanings, e.g. *draft, beam*.

- *Verbs referring to actions that engineers do*, e.g. *to repair, to dismantle*. These are verbs which are commonly used in standard trouble-shooting orders and operating and maintenance procedures. Given the fact that nowadays most of the ships are manned by multinational crews, marine engineers should be able to express the same order or indications in various possible ways to make sure they have been understood by their co-workers of different nationalities. They need to be familiar with words from the same semantic field such as *connect, attach, join* or *place, locate, position, set* or *raise, lift, heave* etc. A useful exercise is to describe certain procedures or to explain engineering failures. Another productive exercise is to have students fill in the gaps with words provided beforehand, e.g. *The cylinder head _____ fuel injectors*. or *The engine block _____ cylinder liners.*

- *Passives* are widely used in technical texts where there is rather a focus on what and how something was done than on the doer of the action. Passives are also used in reports in order to avoid superfluous repetitions of personal pronouns like *I* or *we*. It is necessary for

students to be able to understand and recognize as well as to distinguish between actives and passives. A good practice is by means of describing production processes or how components of engineering items are put together. Blakey [8] suggests rewriting shipping related sentences in the passive voice. Another topic is very well introduced under this chapter, i.e. *time relaters*. Thus, students are to study the sequence of events in building a ship, for instance, and write them out in a text using time relaters (*first, then, next, after that, afterwards, while, during, before, later, eventually, finally*) to introduce each stage in a sentence.

- *Modals* may be used in health and safety requirements or in various ways to express commands in English. While also practicing vocabulary on a vital topic in their profession, students can be asked to lay out safety requirements at the work place by making use of *must, should, ought to* etc.

- *Causal verbs*: general causal verbs like *to have, to get, to make, to cause* or specific causal verbs such as *to result in, to let, to allow, to increase, to reduce, to lower*. For the beginning, lessons on *cause and effect* may start with an exercise where pairs have been mixed up, so that students have to find the corresponding parts and join them together by making use of the appropriate verbs, e.g. *poor lubrication – friction; ship instability – improper loading;* Subsequently, they can study a diagram of an engine pressure indicator and complete the blanks in given sentences using the pertaining verbs, e.g. *The piston is driven downwards, __ the flywheel to rotate*. [8] These verbs are very often used in engineering texts and they need to be very well mastered along with cause and effect relations expressed through:

- Logical *connectors* like *because* or *as*, phrases of cause like *as a consequence of, due to, on account of* or sentence connectors of cause, e.g. *accordingly, consequently, therefore, thus, hence* etc. The exercises described above apply to this category as well.

- *Prepositions of place* can have several meanings and some of them are also used as *prepositions of time*, e.g. *in, on, at* Prepositions of place in particular may very well be integrated in the lesson on *opposites*. There are a lot of types of exercises to do in this context. Students can complete sentences with the appropriate prepositions or they can be asked to provide directions by using opposed prepositions, e.g. *up - down, behind – in front of, across – along* etc.

More vocabulary and grammar categories can be combined in another classroom activity, i.e. a list dictation. This is supposed to raise students' attentiveness and, based on brainstorming, help them give their best in terms of reasoning. Thus, the teacher can keep dictating at a slow pace a list of words while either writing them on the blackboard or have students write them down in their notebooks until they can guess that the category is *materials, uncountable nouns* or any of the above mentioned categories.

4. DIFFERENT WAYS TO REACH THE SAME GOAL

The other way round, starting from a particular topic, teachers can tackle a multitude of grammar and vocabulary chapters. Considering, for example, the fact that engineers are keen on many technical topics even on those only slightly related to their own specialisation, one of the preferred topics to embed in English classes are inventions. Of any kind. We can use inventions to have students exercise all four skills. They are able to debate ceaselessly about inventions or to read or listen about them or, the more gifted ones may even enjoy writing about inventions at any level.

Types of inventions to exercise on may include:

- accidental inventions;
- useless inventions,
- obsolete inventions;
- disappeared inventions;
- dangerous inventions;
- inventions related to various fields of activity: housework, transportation, mining, agriculture, medicine etc.

Starting from this topic, students can speak, read, listen or write about and exercise on:

- Advantages and disadvantages – here teachers can introduce *adjectives and degrees of comparison.*
- *Materials* used in inventing things.
- New concepts introduced by inventions (people's *reactions* to them).
- Past tenses, e.g. *The inventor was trying to find … when he invented …*
- Inventors of many things (passives: __ *was invented by X.*)
- The way specific inventions work (make use of causal verbs).
- Conditionals, e.g. *If you operate this device, then…; If this device hadn't been invented, …*
- Modals, having students try and guess what must have happened when something was invented or what may happen in the future e.g. *This invention might be the one to change the course of history*.
- Predictions, where students may predict how likely things are to happen, e.g. *It will probably disappear in the future.*
- *Used to* speculating on how people used to do things before a particular thing was invented, e.g. *Before the invention of the car, people used to…*
- Numerals – have students try to guess the year of the invention
- Putting a sequence of events or things in the correct order, according to various criteria, e.g. *importance, utility, likeliness to disappear*
- Making a top of a given number of inventions from a particular time period – this activity is a very good speaking exercise and it yields very good results when practiced in pairs.
- Given a table where they have to match the right-hand column with the left-hand column students match the way something works to the description of the invention.
- History of inventions in engineering and Noble Prizes for engineering inventions.

This list is not intended to be exhaustive and is a mere example of classroom activities with (maritime) engineering students.

5. CONCLUSIONS

Maritime engineering English teachers should always take into account the fact that in order for students to acquire specialized vocabulary, they need a solid foundation in terms of general use vocabulary and basic grammar notions. Consequently, teachers have to tailor their courses following a thorough needs analysis with respect to the proficiency that students are to attain in their communication skills.

The significance of maritime English worldwide is never overrated. This article has only provided some suggestions as to various manners of teaching and helping students come to terms with maritime English based on the inherent grammar and vocabulary and eventually communicate effectively and professionally in English.

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SECTION V
TRANSPORT ECONOMICS

IMPACT OF ENERGY TRANSITION ON ECOMOMY

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ABSTRACT

This paper analyses the impact of Energiewende on German markets, industry, utilities and households. It identifies and discusses public support, greenhouse emissions, economic growth and energy security as factors associated with the successful energy transition. The paper also gives an insight of the outcome of Romanian energy policies, aimed to provide energy security, sustainable development and energy efficiency. The results of two cases are then compared, giving consideration to present status and prospects of development. The paper formulates conclusions pertinent to the critical analysis.

Keywords: *energiewende, energy transition, renewables, carbon emissions, energy security, power generation mix, base load, power distribution, social cost, market liberalisation, markets, utilities, household, industry.*

1. INTRODUCTION

The German concept of Energiewende refers to the energy transition and was developed in 1980 when a study advocated that economic growth could be achieved contemporaneous with reduction of energy consumption. Energiewende envisages the transformation of Germany's energy supply system to renewables through energy efficiency, nuclear phase out, and setting emissions targets [21], aiming at long term energy security and a low carbon economy [9].

Similarly with Germany, in terms of energy consumption Romania reduced its energy consumption after the fall of the authoritarian regime in 1990. During the following years, adoption and implementation national and European Union regulations led to increased energy efficiency, a shift in power generation mix and reduced industrial energy consumption [8]. Subsequent recent national strategies aimed to reduce energy intensity by 40% between 2004 [1] and 2015 and 41% between 2007 and 2020 [2].

This paper critically discusses the impact of Germany's Energiewende on German economy, and compares its outcome with the Romanian energy case.

2. ENERGYWENDE IMPACT ANALYSIS

The specific goal of the German energy policy makers is to increase the renewable energy share of the overall energy use and reduce greenhouse gases emissions [22].

The primary energy consumption (PEC) maintained relatively flat between 1973 and 2013 with increased share of renewable energy detrimental to petroleum and coal (Figure 1).

Energiewende generally addresses electricity, heat and transportation sectors, with focus on electricity generation referred below throughout this paper.

Following factors were identified as associated with successful energy transition to renewables:

- Public support;
- Greenhouse emissions;
- Economic growth;
- Energy security.

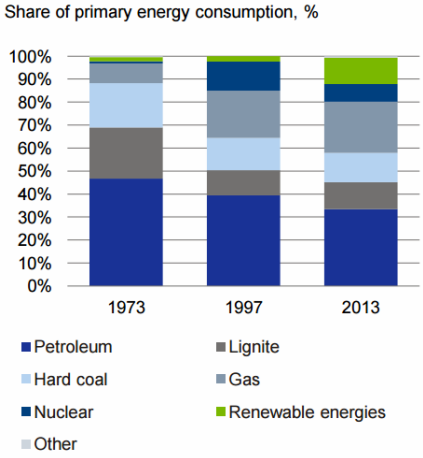


Figure 1 Evolution of PEC in Germany between 1973 and 2013 [4]

Strong popular support for timely transition to renewables was gained by the Sustainable Energy Coalition (SEC) as illustrated in Figure 2.

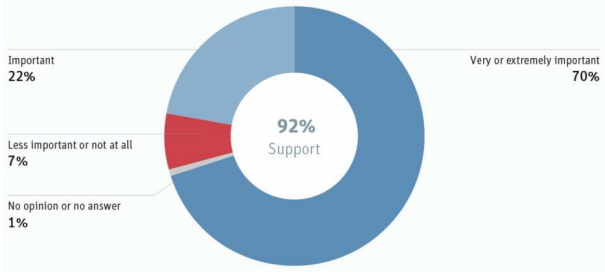


Figure 2 Energiewende public support in 2014 [20]

The public support was maintained by creation of more jobs (Figure 3) in renewable than in conventional energy [18], in accordance with the increased share of renewables in electricity production.

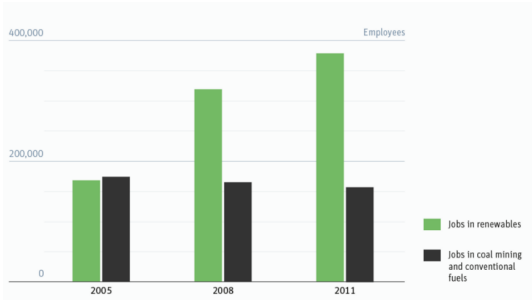


Figure 3 Jobs created in renewables compared with conventional fuels [22]

With regard to the reduction of greenhouse gas emissions, largely driven by carbon emissions, the figure below shows mixed results. Overall, the carbon emissions show a descending trend from 1990 to 2014. The early 1990s saw a significant decrease of carbon emissions, mainly attributed to restructuring of the East German power sector. The carbon emissions peaked in 2007 contemporaneous with strong economic growth and then sharply decreased during the economic downturn until 2009 (Figure 4).

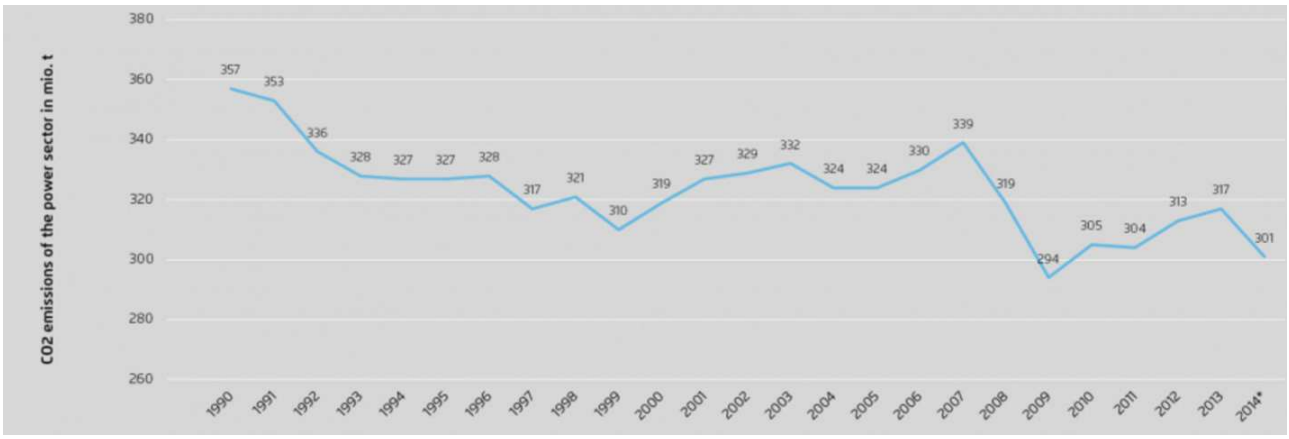


Figure 4 CO2 emissions in Germany between 1990 and 2014 [3]

Although the carbon emissions were reduced in 2009 compared to 1990, sustainable carbon emissions reduction in power generation sector contemporaneous with the economic growth depicted by GDP growth rates below (Figure 5) does not appear to be substantiated.

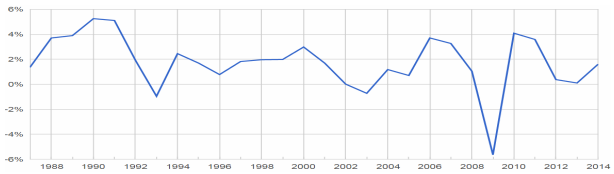


Figure 5 Germany's GDP between 1985 and 2014 [12] Public Data based on World Bank Statistics

During the period 2009-2013 Germany registered economic growth, but the carbon emissions similarly grew despite the Energiewende Energy Concept measures adopted in 2010 [21]. Meanwhile, due to government policies and incentives, the share of renewables in the power generation mix increased to 23.9 percent (Figure 6).

The Energiewende paradox [6] is depicted by simultaneous increase between 2009 and 2013 of carbon emissions and share of renewables. This paradox may be explained by the increase of coal in the energy mix [10], rather than the reference point chosen as 2009 figures during the economic downturn.

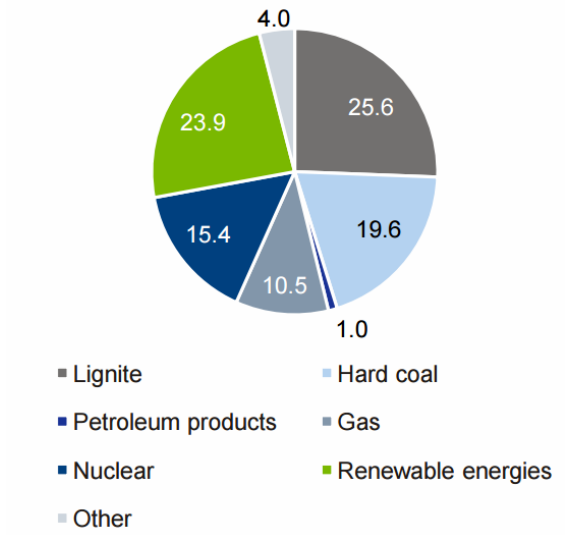
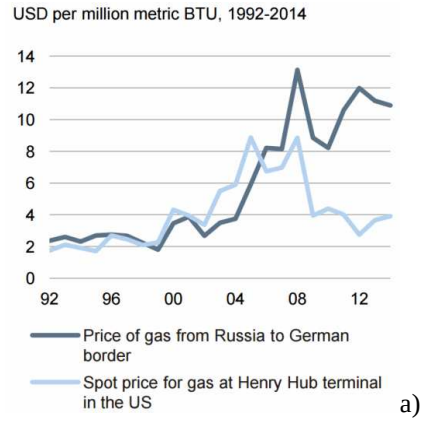
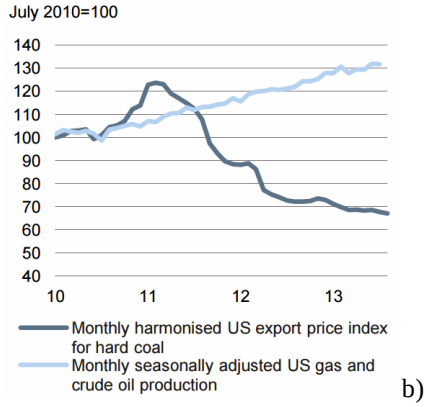


Figure 6 Share of Gross electricity generation, 2013 [4]

Notwithstanding the increased share of renewables in the power mix, the gas and coal prices (Figure 7) made indigenous and US imported coal increasingly profitable compared to the Russian gas, which was associated by German policy makers with energy security issues.



a)



b)

Figure 7 Evolution of gas prices (a), coal prices (b) [4]

Highly incentivised renewables affected energy markets and contributed to decreased gas competitiveness, along with the failure of the European emissions trading scheme, which Germany recently considered that needs to be reformed [5].

The commercial attractiveness of coal led to a shift in German fossil power generation sector from gas to coal. A contributing factor was the Fukushima nuclear incident, which triggered the government decision to phase out its nuclear plants by 2020, while 40 percent of nuclear capacity was permanently switched within a week [13]. The decision to prematurely phase out the nuclear plants left Germany with little choice for securing the power grid base load.

With limited options ahead, Germany chose to ensure energy security through construction of new power plants using coal as opposed to gas. The result of this approach was an increase share of coal in the German power generation mix, detrimental to nuclear and gas (Figure 8) and increased carbon emissions.

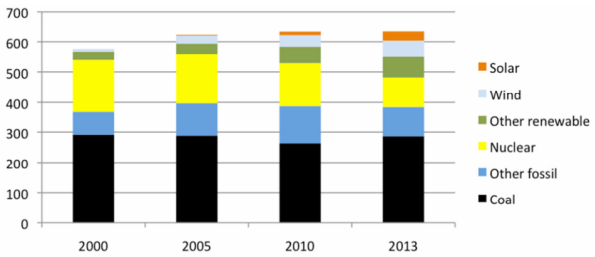


Figure 8 German power generation mix between 2000 and 2013 (BMU 2012) in [18]

These trends are expected to continue given the phase-out of the remaining nuclear reactors. New coal power plants expected to retire after 2050 decrease Germany's chances to achieve its 2050 targets.

The population largely supported the government targets set out in Energiewende, but increasingly disliked the additional cost associated with it [17]. German companies depending on electricity were exempt from the paying to subsidise the Energiewende. The costs were thus supported by households and other companies.

The spread of renewable energy at a significant and increasing scale brought a decline in the prices for renewables for example with 66% in 2012 compared to 2006 for solar PV [19]. However, according to the German policies, the costs of renewables at the end consumer remain flat for a determined period of time, even though the production prices dropped. Consequently, the expected short term costs were and continue to be passed on to consumers and it is estimated that an average household paid in 2013 an extra EUR 260 to subsidise renewables, while companies became less competitive in the global market [22].

Figure 9 shows cost of industrial electricity in Germany compared to the United States, illustrating the burden on German energy consumers which may drive industry relocation [21].

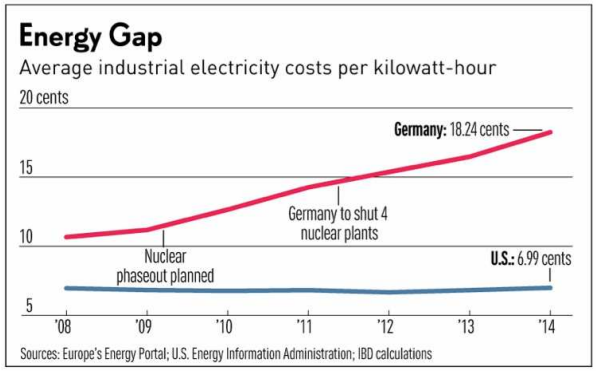


Figure 9 Energy gap between German and US industrial electricity cost [6], from Europe's Energy Portal, US Energy Information Administration and IBD calculations

In terms of social costs, the burden fell especially on poor households which subsidised the renewable energy, while richer households benefited from micro power generation [21].

The regulatory package associated with Energiewende provided investment certainty and allowed the small firms to compete with large corporations in energy production. On the downside, the market capitalisation of the utility companies halved between 2008 and 2013 and their credit rating dropped [20]. These companies were expected to contribute with the base load in the power generation mix and investments in the new grid. One might argue that the utilities are no longer in the financial position to do that in current situation and new business models should be developed to maintain profitability of utility companies [18].

The Economist [22] argues that the German economy turned into a quasi-planned one, with perverse

outcomes. Gerbert et al [11] also questioned the degree of German power market liberalisation and considered that this should be acknowledged and new fundamentals of policy making should be introduced.

Interestingly, 2014 figures showed that Germany managed to reduce the carbon emissions from power sector while the economy grew (Figure 4). It is yet to see if this is sustainable on the long run, because this may well be attributed to mild winter and more energy efficient economy, rather than a cleaner one.

A cleaner economy would suggest increased share of renewables in absence of nuclear power and without an increased share of gas. However, intermittent and not yet storable renewables are considered primarily a source of reserve capacity, but not suitable to supply the power grid base load. That translates in a decoupling of renewable energy production from the installed capacity [21].

An alternative to coal base load may be the cooperation with France, i.e. exporting renewable energy during peak production and importing nuclear power during periods of low renewable electricity generation [6]. This suggests that, although at the grid is reliable on the short term [16] grid interconnectivity bottleneck needs to be addressed by further development of interconnections with neighbouring grids to avoid grid congestion which threatens grid reliability [21]. Transition and distribution infrastructure is capital intensive and Germany needs to find the economic mechanism to put that in practice.

3. ROMANIAN ENERGY SECTOR

The aim of the Romanian energy strategy is to provide energy security, sustainable development and energy efficiency, somewhat similarly to Germany. Compared to the 1990 figures, Romania managed to severely reduce the energy consumption (Figure 10), primarily because of the decline in industrial energy consumption [1].

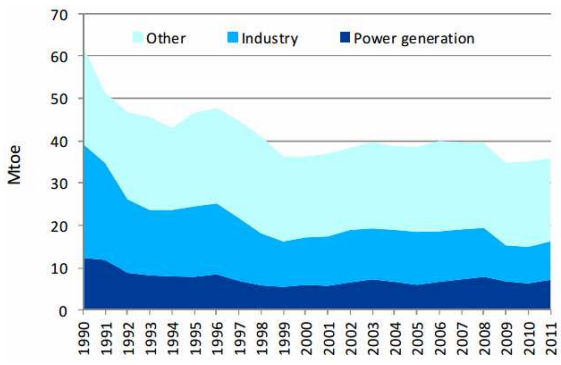


Figure 10 Romania energy consumption trends by sector [1]

Gas registered the largest fall in the primary energy consumption, because of a mix of factors, including associated costs and energy security related issues (Figure 11).

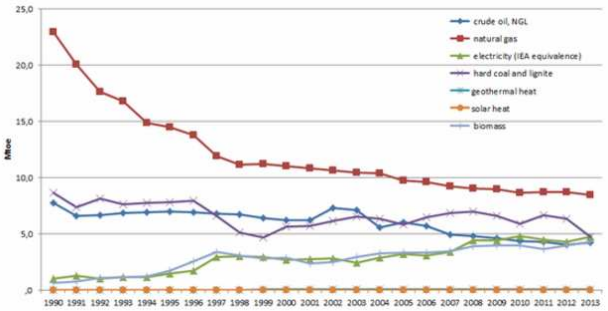


Figure 11 Primary production of energy in Romania between 1990 and 2013 [2]

Although the transportation energy consumption increased compared to the 1990 figures and doubled its share, the electricity consumption dropped to 48 TWh in 2011, depicting an overall descending trend of industrial energy consumption (Figure 12).

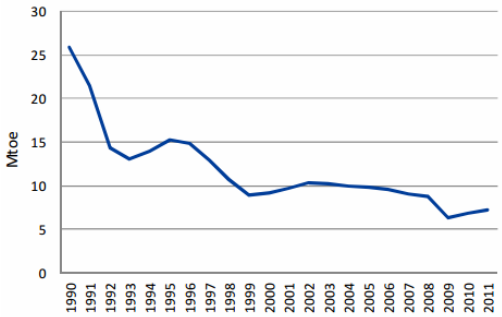


Figure 12 Decrease of industrial energy consumption [1]

The drop in industrial energy consumption clearly set the scene for the ambitious Romanian strategic goals. These were also supported by the increased energy efficiency of households and especially the power generation and thermal power plants (Figure 13).

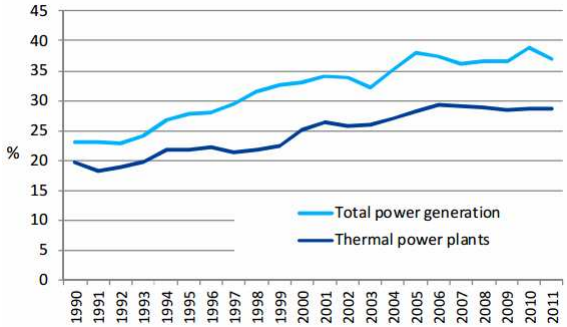


Figure 13 Efficiency of power generation and thermal power plants [1]

Contemporaneous with the above, Romanian coal and lignite domestic consumption decreased by more than 28% in 2013, because of the combined effect of upgrade, phase out of old and installation of new generation coal based thermal power generation plants (Figure 14).

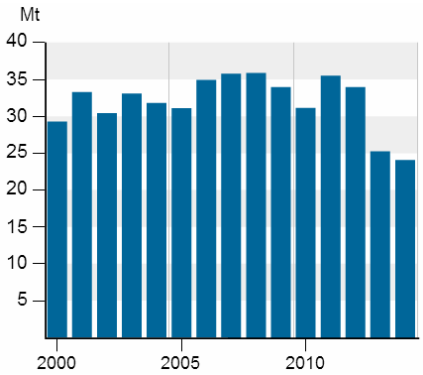


Figure 14 Romania's coal and lignite domestic consumption [8]

The fossil fuel energy sector was incentivised by the government renewable energy framework, which set a target of 24% renewables in final energy consumption by 2020. In fact, by 2013 Romania already surpassed the European average of the share of renewables in electricity production (Figure 15)

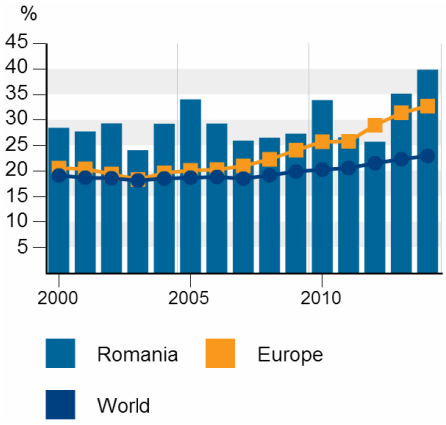


Figure 15 Romania's share of renewables in electricity production [8]

According to the Romanian Nation Institute for Statistics [14], 98.4% of electricity resources derived from internal production in 2014, largely because of the increase of power generation. Notably, wind power generation increased by 37.2% and photovoltaics increased by a stunning 248.8%, compared to 2013. The trend continued in 2015, when the November figures showed an increase of net electricity export by 2.2 TWh compared to the same period of 2014 [15].

Going forward, it is interesting to see the Romanian Government's approach ion towards decreasing the energy consumption and increasing energy efficiency, considering the already downsized industry sector (Figure 16).

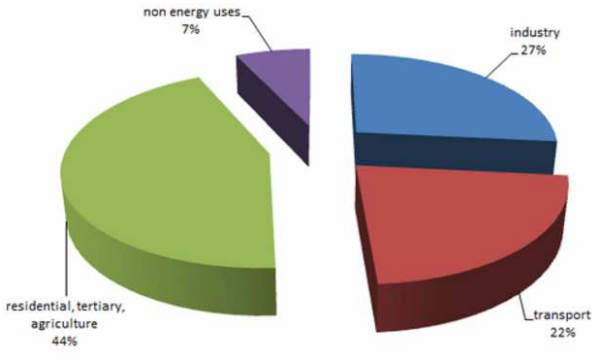


Figure 16 Total final energy consumption by sector in Romania 2013 [2]

4. COMPARATIVE ANALYSIS

Comparing the two countries, the shift towards renewables appears a common target. In terms of public support for the new energy policies, the Romanian approach seems to be driven by the Government, rather than the public opinion, unlike Germany which benefits from the renewables activists. Another similar pattern is depicted by the phase out of energy inefficient heavy industry from Romania and former East Germany.

Furthermore, the decrease of gas consumption is a common outcome, although at least the short and medium term implications appear to differ. While Romania managed to reduce the share of coal in the energy mix, Germany had to increase it, especially because of the decision to phase out of the nuclear power plants.

Enerdata [8] reference scenario confirms Romania's advantage in terms of GHG emissions placing Romania in the second place among other European Member States, including Germany (Figure 17).

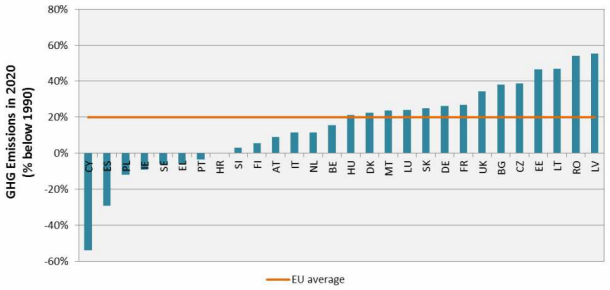


Figure 17 GHG emission reductions 2020 vs. 1990, by Member State [8]

Historical data show that the share of renewables in Romanian consumption was above the European Union average and significantly higher than in Germany (Figure 18). The 2020 outlook maintains Romania in a better position compared to Germany.

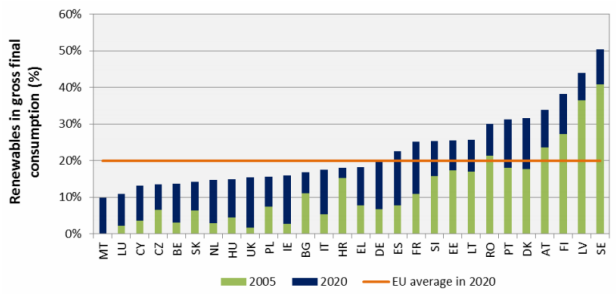


Figure 18 Romania's share of renewables in electricity production [8]

Enerdata [8] estimated that 40% reduction of greenhouse gasses by 2030 would cost Romania 430m EUR or 0.2%GDP. In percentage of respective GDP, this is similar to the estimates for Germany. Both countries would be net sellers of credits, under the considered scenario.

5. CONCLUSIONS

The power generation has a major impact on the primary energy consumption.

The power generation mix can shift from fossil fuels to renewables in the context of both developed and developing countries. A major challenge in doing so is maintaining the base load. Romania intends to continue to operate its nuclear power plant which, together with the hydro power, may allow a reduction in coal power generation. The balanced power grid places Romania in a better position compared to Germany, which needs to invest massively in the transition and distribution infrastructure to accommodate renewables, which were set to replace nuclear power on the short run and coal on a longer term.

Both countries have pioneered the energy transition and further shift towards renewables envisages comparable significant costs.

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PROTECTION OF THE HUMAN RIGHTS IN THE MARITIME LAW

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ABSTRACT

The core of the present scientific work revolves around the idea of the incidence for human rights in the maritime transport. In essence the study is organized in five chapters. The first chapter illustrates most of all the maritime international treaties and conventions which are applicable for the human rights in the maritime law. The second chapter notes the importance of the romanian naval authorities and also the international organisations in the field of the human rights, regarding their attributions and competences. The third chapter underlines the importance of the human rights in the search and rescue assistance revealed by the Tampa case. The fourth chapter evokes the obligations for the captain in case of an action stipulated by the criminal law and the human rights of the perpetrator. Finally, the fifth and last chapter points out the judgements and decisions of the European Court of Human Rights regarding the protection of the human rights in the maritime law.

Keywords: *Maritime law, human rights, conventions.*

1. INTERNATIONAL MARITIME TREATIES AND CONVENTIONS APPLICABLE IN THE FIELD OF THE HUMAN RIGHTS

The notion of human rights is not something new being statuated for millennia by Zenon in the early 300's B.C. in the romano-greek philosophy. He believed that every human being should had his elementary human rights respected: for example the human dignity and the respect for the a human person in generaly. The following list of international maritime treaties and conventions is not exhaustive:

1. The International Convention for the Safety of Life at Sea (SOLAS) adopted in London at the 1st of November 1974 had been amended massively in 1988. At first in 1914 the Convention was adopted in respose to the sinking of the RMS Titanic. It had prescribed a minimum number of lifeboats including radio watches. The 1988 version of the Convention is renewed with a whole chapter then the previous version, because it is based on the amendments of International Radio Regulations - 1987. Thus the Morse code was replaced with the Global Maritime Distress Safety System (GMDSS) and came into force beginning the 1st of February 1992. It's one of the most important maritime conventions in the human rights field because the most important human right is the right to live.

We can consider this Convention being interrelated with the article 2 (Right to live) of the European Convention of Human Rights (ECHR).

2. United Nations Convention on the Law of the Sea (UNCLOS), also called the Law of the Sea Convention or the Law of the Sea Treaty, was adopted in 1982 at Montego Bay – Jamaica. It may be considered as being a real Constitution or fundamental law of the sea because of the various democratic principles that it statuates. For example all states are guaranteed an equitable participation in the managing and exploatation of the natural resources within the seas and oceans. In this case it is obvious the reflection of the 14th article of the ECHR – the prohibition of discrimination.

3. The MARPOL or the International Convention for the Prevention of Pollution from Ships – was designed to minimize pollution of the seas and to protect the marine environment which can be interpreted as being in close relation with the 2nd article and 8th article – right to respect for private and family life from the ECHR. A lack of pollution meaning more respect for the right to live and for the family and private life.

4. The I.S.M. Code which stands for the Code of the International Standard for the Safe Management and Operation of Ships and for Pollution Prevention. The main purposes of this Code are close related with the human rights: to ensure safety at sea, to prevent human injury or loss of life and to avoid damage to the environment and the ship. Like the MARPOL, the 2nd article and the 8th article, from the ECHR can be correlated with the ISM Code.

5. The Maritime Labour Convention (MLC) is considered to be the fourth pillar of the international maritime law alongside STCW, MARPOL and SOLAS, because it sets the minimum standards to ensure satisfactory conditions of employment for the world's seafarers. In a nutshell the Convention covers the employment agreement, guaranteeing decent on-board working and living conditions, to be signed by both the seafarer and the shipowner, or a representative of the shipowner. Also the MLC guarantees the monthly payment and 14-hour work limit in any 24-hour period, 72 hours in any seven-day period. Other obligations concern the shipowner regarding: the repatriation of the seafarer in case of illness, injury, shipwreck, insolvency, sale of the ship and other similar cases. Finally the Convention states a set of obligations in relation with the living accommodation and recreational facilities – including minimum room sizes, satisfactory heating, ventilation, sanitary facilities, lighting and hospital accommodation, and an indispensable prompt medical care when on board or port. Compliance with the 2nd and 8th article from the ECHR is easy to be identified but also with the 14th article – prohibition of discrimination.

2. THE IMPORTANCE OF INTERNATIONAL AND NATIONAL MARITIME INSTITUTIONS IN THE FIELD OF THE HUMAN RIGHTS

1.1 The International Maritime Organization (IMO). The organisation came into being in 1948, the central office being located in London. It's had to imagine how the Organization would work without inherently protecting the human rights regarding the fact that the main goals are to contribute for the security of navigating, abolish restrictive practices and discriminatory measures. Thus the compliance with the 2nd, 8th and 14th article of the ECHR is assured.

1.2 The Human Rights at Sea (HRAS). Is described on its web-page as being an independent international maritime human rights organisation that was launched in London on 3rd of April 2014. Among it's objectives it is best to underline: the need to increase the global awareness and education for the protection of the human rights at sea, and also to help the development of effective, enforceable and accountable remedies for human rights abuses at sea. In correspondence with the idea that the press and the ONG's are the fourth power in the state, as a real voice of the democracy, it is best to note that in early 2015 the HRAS was a lobby group against IMO. Having in consideration the central programme, that is called „Unlocking the issue" – which is a global campaign that includes long term strategies for preventing tragedies, like the most recent ones in the Mediterranean Sea, the organisation called IMO to take actions on protecting the human rights at sea pointing out that the Maritime Labour Convention is inadequate with respect to human rights protection.

2.1 Romanian Naval Authority (RNA). Is a central authority subordinated to the Romanian Transport Ministry. It's main attributes are in the field of the safety of the navigation and the security of the ships. It is a public institution with a independent budget from the national public budget. By accomplishing it's obligations regarding the protection of the waters against the pollution from ships, it assures the respect for the 8th article of the ECHR. Also the actions for an efficient coordination centre for the search and rescue missions are in close relation with the 2nd article of the ECHR – the right to live.

2.2 Romanian Naval League. Is an non-guvernamental organisation which was established in 1928 as a patriotic and cultural entity. It is also a non profit association beyond the powers of the leading parties. It's main purposes are in close relation with observation of the respect for the human rights. The functioning of this ONG is accordingly to the 10th article of the ECHR which guarantees the freedom of expression and also the 11th article – the freedom of assembly and association. Many of the reports issued on the web address of the organisation highlight that the freight is very low in the Black Sea region. This circumstance may have a negative impact on the creditors, including the wages of the crews. According to the practice of the European Court of Human Rights, a failure in the payment of the salaries may be interpreted as a violation of the 1st article of the Protocol of the ECHR, which guarantees the protection of property (in this case the salary is considered equivalent with the notion of property).

2.3 Union of Free Seafarers. Is a professional organization which was established in december 1989. It numbers over 6000 seafarers from the romanian navigation companies and international companies. It is representative at national level for all seafarers. Among it's principles we can find the protection against discrimination as an expression for the 14th article of the ECHR.

3. THE IMPORTANCE OF THE HUMAN RIGHTS IN THE SEARCH AND RESCUE ASSISTANCE

The importance of the human rights in the search and rescue assistance I belive that is best reflected by the Tampa case. In essence, M/V Tampa was sailing between Indonesia and Australia when it came upon a fishing vessel with 430 afghan refugees on board. The imediat action was to call the australian authorities for assistance because most of the refugees needed urgent medical care. Among the refugees were children and pregnant women. Unfortunately the australian authorities refused to bring the refugees to Christmas Island – the nearest australian land and with a military ship took them to Nauru, an independent island country.

The australian administration justified it's actions by working in the limits of it's own sovereignity. Without debating whether a violation of the human rights did existed, we can conclude that the following articles of the Universal Declaration of Human Rights are applicable:

article 1 – all human beings are born free and equal in dignity and rights. They are endowed with reason and conscience and should act towards one another in a spirit of brotherhood

article 9 – no one shall be subjected to arbitrary arrest, detention or exile

article 14 paragraph 1 – everyone has the right to seek and to enjoy in other countries asylum from persecution

article 25 paragraph 1 – everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control

paragraph 2 – motherhood and childhood are entitled to special care and assistance. All children, whether born in or out of wedlock, shall enjoy the same social protection

article 28 – everyone is entitled to a social and international order in which the rights and freedoms set forth in this Declaration can be fully realized.

We can supose that the actions of the australian authorities were dictated by the need for protection their own citizens. Nevertheless the captain of MV Tampa is a good example because he managed to protect his own crew and also the refugees. In any case the captain's obligation for rendering assistance came to an end when

the same obligation was born for the australian authorities.

4. THE HUMAN RIGHTS AND THE OBLIGATIONS OF THE CAPTAIN IN CASE OF AN ACTION STIPULATED BY THE CRIMINAL LAW

Extrapolateing the captains obligations, in case someone commits a dangerous action on board the ship, he can proceed in adopting a freedom constraining measure until the perpetrator is handed over to the authorities. The master in these actions must respect the article 9 from the UDHR which state that no one shall be subjected to arbitrary arrest, detention or exile.

The detained person cannot be tortured or subjected to cruel, inhuman or degrading treatment or punishment – article 5 UDHR. This article is corresponding to the 3rd article of the ECHR – prohibition of torture: no one shall be subjected to torture or to inhuman or degrading treatment or punishment. In case the ship is in ocean pass and the perpetrator said that he had put a bomb, is debatable whether torture can be a solution for obtaining the vital information. As an ultimate solution if torture is used, according to the romanian Criminal Code I belive that the state of necessity (justitying cause – 20th article Romanian Criminal Code) is applicable therefore there will be no criminal liability.

5. EUROPEAN COURT OF HUMAN RIGHTS REVELANT LAW CASES

1. Rigopoulos againt Spain

In essence, a cargo ship was carrying cocaine in the Atlantic Ocean, towards Spain. Having known this fact, the spanish authorities boarded and searched the ship which was 3000 Nm away from the Canary Islands. The captain and crew where detained on board the ship after an exchange of fire. According to the spanish Code of Criminal Procedure at that time after 3 days of detention, the person suspected to commit a crime should either be released or be brought before the competent judicial authority. Regarding the special circumstances of the case, 12 days later when the ship arrived in the port of Las Palmas, the prisoners were presented to a judicial commission who took charge of the prisoners; later they had been transferred to Madrid by air. In Madrid the crew members where questioned in the presence of their lawyers, with interprets on hand.

In a nutshell, Captain Rigopoulos after seeing all his actions to the spanish courts dismissed, complained to the European Court of Human Rights. He thought that his human rights were violated because he expected to be brought by helicopter from the high seas to Madrid in the 3 days interval, from the moment the crew was arrested on board. Thus, in legal time he could know his accusations being assisted by his lawyer and an interpret. The ECHR found that there wasn't no violation of the the 5th article – paragraph 3, which guarantees that everyone who is arrested or detained in accordance with the provisions of paragraph 1 (c) of this article shall be brought promptly before a judge or other officer authorised by law to exercise judicial power and shall be entitled to trial within a reasonable time or to release pending trial.

The European Court contended that having in consideration the special situation, 16 days without being "brought promptly" before the investigating judge, although is not a reasonable time it is justified by wholly exceptional circumstances

In conclusion the Court considered that was materially impossible to bring the applicant physically before the investigating judge any sooner; therefore the Court had found the application inadmissible.

2. Mangouras against Spain

The European Court of Human Rights decided that a bail of 3 million euro for releasing from arrest a captain who is suspected for an environmental disaster is in proportion with the seriousness of the accident. Like in the previous law-case, the Court didn't find a violation of the 5th article – paragraph 3 from the ECHR.

3. Leray against France

The applicants, relatives of deceased seafarers in a shipwreck, invoked before the European Court of Human Rights the violation of the 2nd article and the 6th article (right to a fair trial) of the ECHR by the french authorities. In essence, the complain regarded the delay in action from the french search and rescue authorities which at first thoght that they didn't had teritorial competence, and also the long procedure followed by the french courts in solving the case.

The European Court founded no violations of the previous mentioned articles. The investigations of the french authorities were summary, but existed. Regarding the actions of the french search and rescue teams the Court highlighted that the actions existed although casualties were recorded.

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THE CHARACTERIZATION OF MARITIME PIRACY ACCORDING TO THE ROMANIAN CRIMINAL CODE

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ABSTRACT

Despite declining number of pirate attacks, seas are still far from safe as facts show. Uderstanding the phenomenon will help prevent piracy on maritime level. The main purpose of this article is explaining and giving accessible information on the maritime piracy offense according to the Romanian Criminal Code. The complex maritime piracy offense is stipulated in the special part of the Romanian Criminal Code in the 235 article. This article situated in the second title named offenses against property which includes chapter ii - robbery and piracy.

Keywords: *Maritime piracy, the Romanian Criminal Code, the piracy offense.*

1. TYPES OF MARITIME CRIMES

Marine crime is as old as this industry itself. Depending on the times that it prevailed in, the nature of maritime crime has changed a lot over the years but its implications remain just as severe. Marine crime is not only a threat to entire maritime security of goods and people in the industry, but also gives major setbacks to the entire marine industry economically.

At present, there are several maritime crimes that exist. They all differ in their execution but the end result remains the same- loss of life and property. Some of these crimes are:

a. Maritime Piracy– Maritime piracy remains one of the biggest crimes of this industry. From causing immense financial loss to causing physical harm to crew members, piracy at sea is probably the most notorious marine crime and a major threat to maritime security.

b. Unauthorized entry– For entry of any ship into a nation's marine boundary, the ship must seek permission from government of that nation. Sailing on that nation's waters without a permission is a maritime crime and punishable in all countries.

c. Smuggling Exotic plants and animals– Due to quarantine reasons mainly, it is not legal for any ship to bring in exotic plants or animals into a nation without proper permission. Doing so is a punishable offense with punishment ranging from a fine to imprisonment in some cases.

d. Drug trafficking– it is one of the most common types of maritime crime. Bringing in illicit drugs through a ship and their further distribution becomes a serious maritime crime.

e. Illegal Carrying of Weapons and artillery– due to sensitive nature of these goods, only certain ships are authorized to carry arms and weapons even for transportation purposes. Bringing in weapons on a ship not authorized to do so will make it a punishable offense. Also, a ship which is not equipped to handle such materials may be highly prone to maritime accidents along with endangering lives of others around her.

f. Tax evasion– a white collar maritime crime, this is more common than what is told. Cases of ship owners trying to evade taxes through false documentation or incorrect representation of cargo material have been increasing rapidly, posing a threat to maritime security.

g. Sailing or fishing in unauthorized areas– presence of a ship in an unauthorized spot for any purpose what so ever or fishing in areas not allotted for it is a marine crime and punishable by law. Not just that, crimes such as these can often lead to maritime accidents that can become massive very easily.

h. Discharging in Ocean Waters: Marine pollution is a serious issue and almost all countries have strict policies against ships discharging sewage or oil into their coastal waters.

i. Human Trafficking: Cases of stowaways are common in the maritime industry. Travelling to a different country without the permissions from the respective country is a grave marine crime**.**

The above mentioned crimes pose a threat to maritime security on a daily basis. Despite of all the efforts, security of waters still suffers a little. The main reason for that is this is a very broad aspect with no concrete boundaries. Lack of a coherent system with insufficient cooperation between countries is also a reason why these crimes still look marine industry in the face. Some ways through which marine crimes can be combated include:

- Better surveillance
- Use of satellite tracking
- Tighter norms and regulations
- More efficient monitoring of ships and ports
- Better quarantine services

Ships being hijacked or drugs being smuggled into the countries are news more common than what is appropriate. As such, it is important that countries realize the loopholes in their security systems and find ways to thwart them.

2. TYPES OF MARITIME PIRACY

According to the first paragraph of the mentioned article, in the standard form, the maritime piracy is defined as being the theft committed by violence or threat, by a person which is part of the crew of a ship or is one of the passengers of a ship in open sea, against assets on that ship, or on another ship. In simple words piracy is an **act of robbery** or **criminal violence at sea** through illegal use of force by non-state agents, popularly known as "Pirates". In recent years, the problem of piracy has emerged as a major threat to sea transportation in some parts of the world. According to some estimates, pirate attacks have increased by a whopping 75% in the last decade alone. As per **IMO** data, there were 489 reports of piracy and armed robbery against ships in 2010, which were 20% more in comparison to 2009. **IMB** publishes monthly, quarterly and annual piracy reports with details about names of ships attacked, position and time of attack, consequences to the crew, ship or cargo, and actions taken by the crew and coastal authorities.

The assimilated form for the standard one is statuated in the second paragraph - the act of capturing a ship located in open sea or causing, by any means, the shipwreck thereof, in order to acquire its cargo or rob the individuals on board.

The first aggravating form for this offense is provided by the third paragraph of the 235 article. It refers to the case of piracy that caused bodily harm. The second aggravating form refers to the piracy from which resulted in the victim's death, and is statuated in the 236 article.

According to the first article of the Geneva Convention adopted in 1958, the term open seas means all parts of the sea that are not included in the territorial sea or the internal waters of a State. As another spatial element, in the final paragraph of the 235 article is provided that it shall also constitute piracy when the offense was committed on aircraft or between aircraft and ships.

2. JURIDICAL OBJECT

i). The general juridical object is illustrated by the social relationships regarding the protection of the patrimony. This is the reason why for topographic reasons, the offense was placed in the Second Title, of the Special Part from the Criminal Code, entitled offenses against property.

ii). The special juridical object is on the one hand highlighted by the patrimonial relationships, and on the other hand by the relationships regarding life, the bodily integrity and freedom of the individual, as the second special juridical object.

3. MATERIAL OBJECT

As a materialization of the juridical object, the material object is given by a movable asset from another person's possession or control on a aircraft or ship, and the human body.

4. CONSTITUENT CONTENT

A. The objective side

a. The material element has a complex structure, because of the complex nature of the offense, being compose of an agent offense and a purpose offense.

i). In the standard form of the offense, the major component is given by the material element of the theft, at which is attached, adjacent, the violence or threat. By the term violence it is understandend any act of fizical or psihical constrain including by rendering the victim unconscious or unable to defend herself. By threat it is understanded the offensestatuated in the 206 article from the Romanian Criminal Code - the act of threatening an individual with the commission of an offense or of a prejudicial act against them or other individual, if this is of nature to cause a state of fear.

ii). For the assimilated form, the material element constaines in capturing a ship. In the second part of the second paragraph of 235 article, there are different nuances for the meaning of capturing a ship. Of course, this actions must be circumstanced by the purpose of taking in possession the cargo or rob the individuals on board.

We can observe an uninspired redundance of the legislator which may had been more inspirated if he had used the collocation of „illegal retain", thus avoiding reiterating a reformulated ideea. Another remark may be formulated regarding the final part of the second paragraph of the 235 article – for an elevated elegance of technical legislation, the legislator could had use the expression of taking of the cargo or the goods of the people on board.

iii). At the aggravanted form the material element consists in any of the material elements from the standard form of the offence.

b. The causative connection between the material element and the immediate effect results from the materiality of the act (ex re).

c. The immediate effect – consists in passing the mobile good from the right possession of the victim, in that of the perpetrator. In the case of the first aggravanted form, the immediate adjacent effect consists in causing a bodily harm like is defined by the 193 article from the Criminal Code – an act, which caused any of the fallowing consequences: an impairment; traumatic injuries or health impairment of an individual the healing of which required more than 90 medical care days; a serious and permanent aesthetic injury; miscarriage; endangering of an individual's life. In the case of the second aggravated form the effect is the death of the victim.

B. The subjective side – or the form of guilt, is the direct intention qualified by the purpose. Obviously the purpose is the intention of illegally taking in possession the good. The mobile of the offense does not have relevance under the constitutive content but it will be taked into consideration by the court in the customization of the sentence.

When the act had as an immediate effect the death of the victim or one of the consequences enumerated upwards, the offense is commited by an exceeded intention (praeterintention), in the way that the baddest effect is commited by guilt.

C. The subjects of the offence

a. The active subject – is qualified in the standard version, and can be only the person which is a member of the crew or a pasenger. Among the members of the crew it is best to understand all persons with or without endorsement. The passengers are the other persons that are on bord the ship. For example: the owner, the superintendent or other inspectors may be from this category.

In the case of the assimilated standard version, the active subject, may be anybody.

b. The passive subject is not qualified and may be any person which suffered a prejudice – including the owner, charterer or owner of the merchandise.

5. THE OTHER FORMS OF THE PIRACY

The preparing acts for this type of offense are possible but not incriminated. The legislator chosed to incriminate them only when they are assimilated to the attempt or consumed offence.

The attempt is punished with imprisonement with the limits between the special minimal and the special maximal imprisonment punish for each form.

The offense is consumed at the moment that the victim was disposed from the good. For the agravant forms, the offense is consumed when the worst effect happends.

As previous showned the piracy offense has a standard form, one assimilated standard form and two aggravating forms.

6. SANCTIONS

The standard form is punished with imprisonment between 3 and 15 years and a ban on the exercise of certain rights. The aggravating forms are punished by imprisonment no less than 5 and no more than 15 years of imprisonment and a ban on the exercise of certain rights, and no less than 7 and no more than 18 years of imprisonment and a ban on the exercise of certain rights, respectevly.

7. PROCESSUAL ASPECTS

The prosecutor is under an obligation to start and exercise the criminal investigation ex officio when evidence exists that shows the commission of an offense and there are no legal grounds to prevent them. The reconciliation between the victim and offencer does not removes criminal liability.

The competence for judging the piracy offense belongs in first instance to the District Court. The criminal investigation is not compulsory made by the prosecutor, and should be made by the criminal investigation bodies – 56 article 3rd paragraph per a contrario interpretated.

8. COMPARED LAW ASPECTS

Accordingly to the Moldavian Criminal Code, the piracy offense is defined as being the robbery committed for personal purposes by the crew or passengers of a vessel against persons or goods located on that ship or on another ship if the ships are in the high seas or in other places outside the jurisdiction of any state shall be punished by imprisonment for 5 to 10 years. The same action: a) committed by an organized criminal group or a criminal organization; b) committed with the use of weapons or other objects used as weapons; c) causing by imprudence the death of a person; d) causing other especially severe consequences; shall be punished by imprisonment for 8 to 15 years.

We can notice that the moldavian legislator set up a maximal limit for the imprisonment of 15 years for the aggravant form like the romanian legislator.

9. COMPARATION BETWEEN THE NEW AND OLD INCRIMINATION OF THE PIRACY OFFENCE

In the old Criminal Code, the piracy offense was incriminated in the 212 article. The standard form did had an identical content with the content provided by the Moldavian Criminal Code for this offence, but the special limits of the punishment were highter, respectively imprisonment from 3 to 18 years.

The first aggravating form in the second paragraph from the 212 article refered to the piracy which caused high body damage – as this component offense was incriminated in the 182 article from the previous Criminal Code. The punishment provided was the imprisonment from 5 to 20 years.

Finally, if the piracy produced exceptional serious consequences or the death of the victim, the punishment was imprisonment from 15 to 25 years and ban from some rights. The exceptional serious consequences included a casualty higher than 200.000 lei or a serious

pertubation of the activity of a national authority or public institution, or some other fizical or juridical person.

Remarcably the New Criminal Code preserved, as normal, from the previous Criminal Code that shall also constitute piracy when the offense was committed on aircraft or between aircraft and ships, an aspect not mentioned in the Moldovian Criminal Code.

We can observe that the limits of the punishment were higher in the previous Criminal Code then they are now. We appreciate that this can be explained by the nature of the former political party which had the power. Thus the communist regime hoped that providing severe punishments, the people would pe intimidated to commite crime.

Of course, the democratic courts chosed, through time, to apply a punishment orientated to the special minimal for the offence, as a general unwritten rule.

10. PROPOSALS FOR THE FUTURE INCRIMINATION OF PIRACY (DE LEGE FERENDA PROPOSALS)

Piracy is a type of organized crime and as such it should be dealt with in a criminal law fashion. This implies that more efforts will have to be made to track down and prosecute the key players in piracy, like the principals, the financial backers and the negotiators. For comparison:

When combating international drug trafficking, we cannot limit ourselves to tackle only the junkies, but we should especially also tackle the dealers; when combating piracy, we should not only focus on the men being caught on the high seas, but especially on their leaders. Then again this investigation and prosecution stage has its own unique issues. Although information about the pirate leaders may be available, prosecutors know that in criminal proceedings there is a big difference between any available information and evidence. The pirate leaders are usually not in the front lines, but on his mainland, or elsewhere in the world. It is a fact that a relatively small group of pirate leaders, financiers and negotiators can be held responsible for a large number of offences. This may cause quite some jurisdiction issues, for instance when a pirate leader or negotiator is involved in the hijacking of ships sailing under a Greek, Panamanian or German flag, with on board the ship a crew that is being held hostage and crew members coming from the Ukraine, the Philippines and Korea. You will understand that such investigations can only be successful if various countries join forces and cooperate closely. International treaties are highly inportaint at this point

Maritime piracy is a complex of serious crimes including hijacking, kidnapping, extortion, murder, abuse and money laundering. Without exception, all victims are innocent seamen. So when the Navy has apprehended people who can be held responsible for these crimes, it is the legislator's duty to prosecute them and end the impunity for perpetrators of piracy.

Acts of piracy threaten maritime security by endangering, in particular, the welfare of seafarers and the security of navigation and commerce. These criminal acts may result in the loss of life, physical harm or hostage-taking of seafarers, significant disruptions to commerce and navigation, financial losses to shipowners, increased insurance premiums and security costs, increased costs to consumers and producers, and damage to the marine environment. Pirate attacks can have widespread ramifications, including preventing humanitarian assistance and increasing the costs of future shipments to the affected areas.

The Division for Ocean Affairs and the Law of the Sea, as the secretariat of UNCLOS(United Nations Conventions on the Law of the Sea), has a mandate to provide information and advice on the uniform and consistent application of the provisions of UNCLOS, including those relevant to the repression of piracy. It also has a mandate to provide information on relevant developments in oceans and the law of the sea to the General Assembly, as well as to the Meeting of States Parties to UNCLOS, in the annual reports of the Secretary-General on oceans and the law of the sea. These reports provide updated information on developments in respect of piracy and other crimes at sea.

We suggest that in the future incrimination, the piracy will not be a separated offense but included in the aggravating form of the robbery, with it's specific elements. Finally we can't exclude the idea that in the future if a master or a person with executive attributions commits this offence, it should be more severe punished, being a personal aggravating circumstance, according to law.

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ECONOMICAL ASPECTS REGARDING COMBINED TRANSPORT IN EUROPE

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ABSTRACT

Efficient transport is the key of a developed economy. Every society searches alternatives for road transport which is polluted and with higher costs. A successful solution is combined transport, which is friendly for the environment, economy and the society as a whole. Combined transport improves the green performance of freight transport in Europe. The present study approaches the forms of combined transport and the standards for efficient combined transport services. It gives a statistical overview of European Union combined transport and it concludes on solutions to boost the efficiency in combined transport. The main objective of this paper is to highlight the effectiveness and importance that has combined transport for the transport industry, but also for the entire society. In support of this scientific approach are legislation and research studies and reports conducted by various organisations of the European Union in this area. The final purpose of the paper is to transmit the essence data about combined transport in Europe to interested parts, in order to bring a small contribution to their decision making.

Keywords: *combined transport, Europe, efficiency, rail, road, combined transport services, European Union*

1. INTRODUCTION

Transport sector is the blood of every economy of the world. Efficient transport is the "lifeblood of the European economy".[4]

As road traffic becomes more congested, more polluted and with higher costs, most European operators have tried to find an alternative to move the goods out of ports and closer to their final destinations. One efficient alternative that was introduced in order to accommodate freight without increasing road congestion was *combined transport*.

Marco Polo programme of the European Union helps reduce traffic congestion on Europe's crowded roads and promotes environmental-friendly means of transport (rail, sea and inland waterways). "Marco Polo aims at improving the green performance of European freight transport, by freeing the roads of an annual volume of 20 billion tonne-kilometres of freight, the equivalent of more than 700000 trucks a year travelling between Paris and Berlin".[4] So, Marco Polo invests in projects that bring environmental, social and economic benefits.

2. LITERATURE REVIEW

United Nations Economic Commission for Europe defines combined transport as "intermodal transport where the major part of the European journey is by rail, inland waterways or sea and any initial and/or final legs carried out by road are as short as possible."[2]

Combined transport improves the quality of life and the productivity of the entire transport chain through its benefits, like:

- Energy gains and lower CO_2 emissions;
- Fewer accidents and the reduction of road congestion;
- The best integration in the logistic chain;
- Safety and security for freight during the transport.[9]

Many studies conducted by the European Commission, interested companies in the field of transport or different authors outline the important role of combined transport for an economy. For example, Ballis and Golias sustain in their study the importance of the improvement of a combined transport chain performance, demonstrating that the time savings due to efficient terminal trans-shipment can be used effectively only in combination with advanced rail operating forms.[1]

The European Commission's White Paper "Roadmap to a single European transport area- Towards a competitive and resource-efficient transport system" (COM (2011) 144 final of 28 March 2011) sets some important targets regarding intermodal transport, especially combined transport, such as [7]:

- Shifting 30% of long-distance road tonne-kilometres to rail by 2030 and 50% by 2050;
- Reducing the oil dependency of our economies through modal shift;
- Significant diminution of GHG emissions of transport.

3. FORMS OF COMBINED TRANSPORT

Combined Transport (CT) has two forms of transport: accompanied and unaccompanied. Having in view the geographical scope, combined transport can be domestic or international. Considering the focus of transport chain, it can be continental or maritime. [10]

Accompanied CT (rolling road/motorway) means that "lorries are carried on purpose-built low-floor wagons, while drivers travel in seated accommodation or couchettes".[10] Opposite to this type of CT, unaccompanied CT supposes that intermodal loading units are transported without a truck driver on the train. Both forms of CT can be carried out in domestic (between two terminals located in a single country) or in international (cross-border) CT services. According to "Agenda 2015 for Combined Transport in Europe",

domestic CT services accounted for 72 million gross tonnes in 2005 and 145 million gross tonnes in 2015 and international CT services – 54 million gross tonnes in 2005 and 123 million gross tonnes in 2015.[15]

The segmentation of the combined transport market outlines the continental CT, where the movement of goods is sourced in/bound for a location within Europe and maritime CT, where the movement of cargo takes place between European seaports and inland destinations.

Regarding the statistical overview of combined transport in Europe, statistical data from the table below show us that the unaccompanied transport has the biggest share of the total CT volumes in the market (94.95% in 2013). We can observe the continuous growth in volume of the unaccompanied combined transport after the global economic crisis in 2009 and the decrease of accompanied combined transport volume in the analysed period.

Table 1. Evolution of total CT volumes in the period 2005-2013

Year	CT volume unaccompanied (mil. tonnes)	CT volume accompanied (mil. tonnes)	Total
2005	145,5	10,2	155,7
2007	181,5	13,6	195,1
2009	164,6	15,1	179,7
2011	191,8	14,9	206,7
2013	203,0	10,8	213,8

Source: BSL, Transport Analysis, UIRR, 2015

4. STATISTICAL OVERVIEW OF EUROPEAN UNION COMBINED TRANSPORT

Over 200 short sea and rail routes connect all major business centres in Europe. Customers are encouraged to use combined transport, because it is an environmentally-friendly transport (trains/ships for the long haul) and they can obtain flexible collection and delivery (trucks for feeder services). [17]

The European Transport Organisation "Internationale LKW-WALTER" gives seven advantages that support the use of combined transport:

- Security for the load capacities;
- Avoidance of traffic jams, driving bans and transport restrictions;
- Modern equipment;
- GPS tracking included;
- Reduction of costs by increasing loading capacities;
- High flexibility;
- Preservation of the environment and the whole society, especially reducing the greenhouse gas by 55% in CT "rail" and by 75% in CT "short sea shipping".[17]

An important project that helps the improvement of the efficiency and environmental performance of CT terminals is "EcoHubs", co-financed by the European Union and developed with the active participation of UIRR.[16]

Analysing combined transport traffic, from the data presented in table 2 we can see that on average 11% of consignments are transported by semi-trailers, 14% by rolling road and 75% by swap bodies. In 2012, it can be observed the biggest share of 82% for swap bodies. A swap body or an exchangeable container is a standard freight container for road and rail transport. This "interchangeable unit" is preferred because it can use many trailers which carry ISO containers. "The design of swap bodies and roller container is optimized to minimize empty weight, saving on trucking fuel cost and cost of built of reloading terminals".[12]

Table 2. Combined transport traffic in the period 1990-2013

-% of consignments-

Year	Semi-trailers	Rolling motorway	Swap bodies
1990	20	18	61
1995	14	19	67
2000	9	23	68
2005	7	13	80
2006	7	14	79
2007	7	13	79
2008	8	14	77
2009	8	15	77
2010	10	15	75
2011	10	14	76
2012	13	5	82
2013	14	5	81

Source:EU Transport in figures. Statistical pocketbook, 2015

Consignment = equivalent to 2.0 TEU, meaning:
-one semi-trailer;
-two swap bodies less than 8.30 m and under 16 t;
-one swap body more than 8.30 m or over 16 t;
-one vehicle on the rolling motorway.

The statistical data presented in the UIRR Report on European Road-Rail Combined Transport in 2014-2015 outlined the following:

- total number of consignments transported by UIRR member operators decreased 1,1% in 2014;
- the output (in tonne-kilometres) increased by 12,2% as compared to the previous year;
-accompanied combined transport (RoLa) developed by 12,9% in 2014;
-shorter distance combined transport decreased;
-longer distance combined transport and intercontinental combined transport recorded an 8% growth of the average distance per consignment from 722 km in 2013 to 780 km in 2014;
-unaccompanied combined transport uses the routes that connect the northwest ports area with northern Italy;
- RoLa (Rolling motorway) is focused on the Transalpine routes;
-traffic is developing on eastern relations and along the intercontinental routes.[16]

According to the same report, the best performing relations in 2014 were: Belgium-Romania (+38%), Austria-Slovenia (+37%), Hungary-Slovenia (+22%), Czech Republic-Italy (+22%). Declines have been recorded on several relations in the western part of Europe: Switzerland-Italy (-51%), Italy-Sweden (-36%), Germany-Sweden (-25%), France-Italy (-24%). A significant growth recorded in 2014 new relations, like: Croatia-Hungary (+195%), Germany-Russia (China) (+191%), Germany-Turkey (+182%).[16]

5. STANDARDS FOR EFFICIENT COMBINED TRANSPORT SERVICES

Combined transport is a competitor to long distance road haulage and if the rail efficiency and service quality rise then logistic companies will shift more traffic to rail. In order to do this, the International Union of Combined Road-Rail Transport Companies (UIRR) agrees on a few solutions, like [11]:

- Completion of rail market opening and its implementation;
- Technical harmonisation to ensure genuine interoperability;
- Fair and equal conditions for every rail actor;
- Investment in railway lines and terminals (longer and heavier trains, removal of bottlenecks).

Trains used for international combined transport should meet the following minimum standards, presented in the table below.

Table 3. Performance parameters and standards

Minimum standards	At present	Target values
Nominal minimum speed	100 km/h	120km/h
Length of train	600 metres	750 metres
Weight of train	1200 tonnes	1500 tonnes
Axle load (wagons)	20 tonnes	20 tonnes (22,5 t at 100 km/h)

Source:[3]

Trains of combined transport must have the highest priority, with a timetable settled so as to satisfy customers requests for reliable and regular transport services.

One example of requirement for efficient CT services is the short duration of door-to-door transport, high punctuality record. Other examples of requirements are: reliable and timely information on transport procedures, capability of carrying all types of standards containers and of all loading units that can be carried in international road haulage.[3]

These requirements can be achieved through various methods, such as: high transport speed, direct trains, proper equipment and infrastructure capacities, utilization of non-working hours of consignees and modern telecommunication systems.[3]

6. CONCLUSIONS

40 years ago, containerisation began in maritime transport and the International Union of Combined Road-Rail Transport Companies (UIRR) was founded. So combined transport rail-road made its first steps in this area and today it represents 1/3 of rail freight volume (in tonnes-kilometre).

Over the years there are good practice examples, like Transalpine traffic, that show the major share of rail in combined transport, if proper investments are made and framework conditions are set accordingly the goals. For example, the investments in new wagons are extremely important – small wheels and very low pocket platform (270 mm above top of the rail) for the transport of high volume mega-trailers.[11]

Standardisation is also a valuable solution to boost the efficiency in combined transport. A good practice example is „DESTINY" project, funding by Marco Polo, which aims to facilitate the deployment of existing standards, referring to EN 13044-1 (Identification of intermodal loading units), EN 13044-2+3 (Codification of swap bodies and semi-trailers; Safety-cargo securing and dangerous goods).[11]

Proliferation of ILU-Code, administered by UIRR has advanced more as 92% of consignments were found to be identifiable by the ILU or the BIC-Code at the end of 2014. This great achievement should boost the development of productivity in Combined Transport and new IT solutions.[16]

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ASPECTS OF THE INTEGRATED MARITIME POLICY OF THE EUROPEAN UNION

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ABSTRACT

The EU policies on maritime transport, industry, coastal regions, fisheries etc have been developed separately, for a long period of time. The European Parliament, through the voice of several parliamentary committees, often criticized this, with the concern of the formation of a common maritime policy aimed at integrating the internal market for maritime transport and services within the European Union. Through this article we intend to do a brief analysis on the importance of a uniform management of regional maritime policies of the European Union and its objectives, in order to promote a political leadership in international maritime affairs. This new approach aims to foster optimal development of all maritime activities in a sustainable manner in various fields such as employment in maritime sectors, fisheries, maritime and river transport, marine research in the marine sector, construction of ships, maritime surveillance, maritime and coastal tourism, coastal development and external relations in maritime affairs

Keywords: *Integrated Maritime Policy, shipping.*

1. INTRODUCTION

Europe has a 70,000 km coastal zone along two oceans (Atlantic and Arctic) and four large (Baltic, North, Mediterranean and Black Sea). EU's maritime regions account for some 40% of GDP and population. The European Union is determined to use the full potential of this area by establishing an integrated maritime policy, horizontal and cross-cutting, covering all aspects of our relationship with the oceans and seas. Exploration and potential exploitation of marine resources in consonance with concrete measures to create conditions for the conservation of exhaustible ones by applying an integrated maritime policy, The European Commission has created a management framework with objectives and instruments, which are based on the Lisbon and Gothenburg strategies.

The seas are Europe's lifeblood. Marine and coastal areas of Europe are essential to the welfare and prosperity; they are Europe's trade routes, climate regulator, sources of food, energy and resources, and a favored residence and recreation of European citizens [1].

Maritime transport has always been associated with the process of globalization. Each stage of this globalization was characterized by inventory and new technologies sea transport, containerisation as the last form of expression [2].

Our interactions with the sea are more intense, more varied, and create more value for Europe than before. However, the pressure is beginning to be felt. Our relationship with the oceans has reached a turning point.

On the one hand technology and knowledge allow us to extract more value from the sea and increasingly more people are set in coastal areas of Europe to benefit from these riches.

On the other hand, the cumulative effect of all this activity is leading to conflicts of use and to the deterioration of the marine environment that everything else depends on.

2. CHALLENGES

So far, EU policies on maritime transport, industry, coastal regions and fisheries have been developed separately.

Creating an integrated maritime policy requires a precise management framework . The Commission has created a Maritime Policy task force to analyze the interactions between the sectoral policies and coordinate them. The Commission also requested the aid OF agencies of the European Union (EU) involved in maritime affairs for the development of new policies.

In addition, the development of new maritime policies involves consultation of civil society and all stakeholders as well as comprehensive impact analysis

Europe must respond to this challenge in the context of globalization and rapid climate change, this becomes an emergency.

The European Commission has recognized this, and launched a comprehensive consultation and analysis of how Europe relates to the sea [3]. It has triggered a massive response from stakeholders, which shows enormous potential of the seas, and the scale of the challenge if we are to harness this potential in a sustainable way. The consultation process provided a wealth of ideas about how Europe can meet the challenge [4].

2.1 Concrete Actions

Scientific discoveries, rapid technological development, globalization, climate change and marine pollution can lead to the loss of real and important development opportunities [5].

Integrated maritime policy will help the European Union to confront these possible hazards and to use them to her advantage [6].

On 10 October 2007 the European Commission adopted a Communication presenting its vision for an Integrated Maritime Policy in the European Union, together with a detailed action plan which sets an ambitious work program for the coming years.

With the new integrated maritime policy we wish to change the work style, and achieve coordinated development of these sectors vital to the economy of the European Community.

Commission Communication and Action Plan are the result of an extensive consultation process which lasted about a year and gathered contributions from both the EU Member States and industry, academic and scientific, non-governmental organizations or private citizens .

The new integrated maritime policy is based on Europe's strengths in marine research, technology and innovation, will be anchored to the Lisbon strategy on increasing the number of jobs and growth, and to the EU's commitment to ensuring that economic development does not jeopardize the sustainability of the environment.

Communication and Action Plan set out a list of specific action that this Commission has proposed to carry out during the mandate.

These actions cover a wide range of issues which include maritime transport, maritime industry competitiveness, job creation, scientific research, fisheries and marine environment protection.

The most important concrete actions are:

- ✓ creating a European maritime transport area without barriers;
- ✓ achieve an European Maritime Research Strategy;
- ✓ development of national integrated maritime policies of Member States;
- ✓ the achievement of an integrated network for maritime surveillance;
- ✓ Eliminate Illegal fishing;
- ✓ promoting a European network of maritime clusters;
- ✓ review legislative exceptions that apply to naval workforce and fishing;
- ✓ the achievement of a European network of Marine Observation and Data;
- ✓ realization of a strategy to help mitigate the effects of climate change on coastal regions.

The first Action Plan initiatives have been launched since the moment it was made public, the Commission presenting a report on links between energy policy and the new EU integrated maritime policy and reviewing legislation on labor.

3. OBJECTIVES

The first objective of an integrated policy for the EU is to maximize the sustainable use of the seas and oceans, while ensuring the development of the maritime economy and coastal regions [7]. To ensure the competitiveness, safety and security sector, European Commission undertakes:

- ✓ to create a strategy to reduce the impact of climate change in coastal areas;
- ✓ to build on professional qualifications and studies in the maritime field to offer better career prospects in the sector;
- ✓ to achieve a European maritime transport area without barriers and customs administration, as well as an overall strategy for the period 2008-2018 shipping, so as to enhance the efficiency and competitiveness of maritime transport in Europe;
- ✓ to provide guidance for the implementation of environmental legislation regarding ports and propose a new policy on ports that takes into account their multiple roles;
- ✓ to encourage the formation of multi-sectoral centers and foster technological innovation in the shipbuilding and energy sector to ensure economic competitiveness without harming the environment;
- ✓ to support international efforts aimed at reducing air pollution and emissions of greenhouse gases from ships;
- ✓ to take action against the practice of discarding catches against illegal, unreported and unregulated fishing and any other destructive practices;

A second key objective is building a knowledge and innovation base for maritime policy.

Science, technology and marine research enable analysis of the effects of human activities on marine systems and offer solutions to alleviate environmental degradation and climate change. The European Commission plans:

- ✓ to present a comprehensive European strategy for marine and maritime research;
- ✓ to improve understandig of maritime affairs under the Seventh Framework Programme;
- ✓ ro support the creation of a European marine science partnership, to establish a dialogue between the scientific community, industry and policy makers.

An integrated policy is also aimed at ensuring better conditions of life in coastal and outermost regions, while reconciling economic development and environmental protection.

The Commission will therefore, in particular, plan to:

- ✓ promote coastal tourism
- ✓ prepare a database on Community funding intended for maritime projects and coastal regions;
- ✓ create a Community disaster prevention strategy in these regions;
- ✓ develop the maritime potential of outermost regions and islands.

The EU intends, moreover, to promote political leadership in international maritime affairs.

An integrated policy enables better international management of maritime affairs and the achievement of the priorities of the EU in this area. This is extremely

important given the global nature of the problems faced by the maritime sector. The Commission therefore encourages in particular:

- ✓ cooperation in maritime affairs under the European enlargement, the European Neighbourhood Policy and the Northern Dimension and structured dialogue with major partners;
- ✓ Member States to ratify and implement the appropriate tools.

The ultimate goal of this integrated policy is to improve the visibility of maritime Europe and the image of the sector's activities and professions.

To this end, the Commission proposes concrete actions and tools such as:

- ✓ the development of educational tools (Atlas of the Seas), but also the tools to promote our common maritime heritage;
- ✓ celebration of European Maritime Day since 2008.

4. THE CONSULTATION PROCESS ON EU MARITIME POLICY

The consultant on EU maritime policy has aroused an unexpected interest of parties in Maritime Affairs [8].

Contributions ask for consultation and dialogue, and to provide to those affected by maritime police with a greater volume of information. Economic actors welcome the principle of an integrated approach and hope that this will lead to a more transparent and efficient process of policy making and regulatory activity in the EU.

Regions are enthusiastic supporters of an integrated approach. They emphasize the role of host for the maritime economy of coastal regions as part of the coastal and maritime environment, and dependent on sustainable management of coastal regions.

More are expected to benefit from the link between EU action and activities on the ground in the coastal regions, and strengthening the involvement of Member State governments in the process.

Member States shall adopt the principle of integrated management of maritime issues.

They concern the proposal to develop an integrated maritime policy in the context of the interest that they have in ensuring the stable and sustainable development of their maritime economies and coastal regions. They hope for a new maritime policy to maintain well-functioning processes, acting as a catalyst for better practices.

European institutions and bodies have expressed ongoing support and make efforts to overcome sectoral constraints in the procedures they apply, to enable the formulation of a coordinated response to the Green Paper.

They are concerned by the European Maritime Policy project against the backdrop of globalization, more widespread use of oceans and seas, environmental and climate change, and given the need for full involvement of coastal and maritime communities. Some of the proposals made by the Institutions go beyond the Green Paper Citizens and civil society respond with mixed messages.

There is some concern that the EU should not take over national powers or local, but in general, the reactions offer clues about the public's concern for the marine ecosystem of the planet

Environmental NGOs ask the EU to act in respect of maritime and coastal spatial planning to ensure implementation of ecosystem management.

The integration of sectoral policies is a means to ensure the integration of environmental objectives in all sectors. Throughout the consultation, stakeholders underlines the need to be heard continuously, including during further development and implementation of EU Maritime Policy.

The launch of a consultation on Maritime Policy has also awakened the interest of those who want to inform and disclose information about our seas and oceans.

Awareness among EU citizens on coastal regions and what lies beyond this is considered as an endorsement of both the maritime economies, which depend for success, attractiveness of these regions and the marine environment, which depends, to be preserved, on the awareness among citizens.

However, there is a general consensus that the overall image of the maritime sectors should be emphasized.

Ideas abound on the organization of exchange of experience in best practice, conferences, the involvement of experts in the maritime domain, such as fishers, or small-scale development projects aimed at informing local communities having or tourists.

5. EFFECTS OF INTERNATIONAL MARITIME POLICY TRANSPOSITION INTO INTERNAL LAW OF THE EUROPEAN UNION

The incorporation of international maritime law in the European Union law is an essential process and a strategic line of the EU's integrated maritime policy in the decade 2008-2018 [10].

The Lisbon Treaty established the four fundamental principles of EU law :

- ✓ priority of EU law to the law of the Member States;
- ✓ the direct and immediate application of EU law into national law of the Member States;
- ✓ subsidiarity;
- ✓ proportionality.

Also, with the entry into force on 1 December 2009 of the Lisbon Treaty, the European Union has acquired legal personality, thus became subject of international law, with vocation to entry into major international organizations, the International Maritime Organisation included, being able to directly contribute to the development of international maritime law.

Numerous international maritime conventions transposed into European Union law illustrate the existence of a sub-branch of Union law, namely Community maritime law, that, by virtue of the principles of its seniority, will apply directly to the law of the Member States

So even if states or some of them have not ratified certain international maritime conventions the European Union has incorporated in its legal system (or some legal provisions of these conventions), they will apply directly in those Member States, as they gained through the implementing legal acts (regulation, decision, directive), the quality of Community legislation.

5.1. Romania's Position

Our interactions with the sea are more intense, more varied, and create more value for Europe than before. However, the pressure is beginning to be felt. Our relationship with the oceans has reached a turning point.

On the one hand technology and knowledge to allow us to extract more value from the sea and increasingly more people are set in coastal areas of Europe to benefit from these riches.

On the other hand, the cumulative effect of all this activity is leading to conflicts of use and to the deterioration of the marine environment that everything else depends on.

Romania, as a Black Sea littoral state, has expressed early interest in achieving an integrated maritime policy at European level and actively participated in the public consultation process that preceeded the launch of the Communication and Action Plan

Institutions working in the field have begun the process of analyzing the documents of the Commission in order to establish nationwide Steps to follow to fulfill IMP objective.

6. CONCLUSIONS

Applying the existing legal framework defined by the applicable international conventions of the IMO, to the EU's integrated maritime policy has led to the joint development of policies regarding activities of maritime sectors, sea or in coastal areas.

Necessary conditions have been created to integrate the principle of territorial cohesion, which allowed to easily overcome the difficulties caused by the global economic crisis, with its attendant effects on maritime activities and the European Union.

Eliminating differences between the legal systems of the EU countries, ensures easy identification and choice of appropriate legal instrument for the benefit of full use of growth potential in the maritime domain through the use of new cutting tools by decision makers in the field of maritime life, aimed at improving maritime economy .

It was confirmed that the Integrated Maritime Policy adopted in full conformity with UNCLOS with respect for international law, human rights, with applicable bilateral treaties etc is a very promising policy designed to strengthen the EU's role as a global player in the maritime domain.

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RIGHTS AND OBLIGATIONS OF NEUTRAL STATES DURING WAR AT SEA

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ABSTRACT

The neutrality in maritime war is the situation born from the state of war, which implies certain rights and duties for the neutral, that is a reflex towards the rights of belligerents.

Through this article we intend to do a brief analysis on the rights and obligations of neutral states in maritime war, with their capacity as subject of international law ,through the three types of neutrality - permanent neutrality, incidental and impartial. We emphasize on the particular legal situation in which the neutral states find themselves, states who during armed conflict don't take part in hostilities, but continue to maintain relations with other countries, including the belligerents.

The main legal instruments regulating the status of neutrality, which is the common law in this matter are two classic conventions adopted at the Hague Peace Conference of 1907, namely:

- The 5th Convention "relating to the rights and duties of neutral powers and persons in case of war on land" and
- The 13th Convention "relating to the rights and duties of neutral powers in case of maritime war."

At the beginning of armed conflict, the competent public authorities of the neutral state issue a statement of neutrality that shows the the advantage of clarifying relations between sovereign states, for example in the case of neutral subjects found in warring countries at the beginning of the war.

Keywords: *naval war, neutrality.*

1. INTRODUCTION

The term of neutrality derived from Medieval Latin, from Latin ne uter (neither one nor the other) was defined as the situation of states in wartime to not take part in combat, but continue to maintain peaceful relations with all states, including belligerents [1].

Neutrality means the conduct of a State towards two or more subjects of international law which are engaged in a conflict, in which the State is to refrain from any action that might prejudice the interests of any belligerents.

Neutrality is founded on the sovereignty of states. Every sovereign state has the right to remain neutral in a war between other states, at least if he is not bound by a contrary commitment [2].

The law of neutrality is a consequence of the law of war, as old as the latter, but based rather on the will to remain neutral, to avoid the effetcs of the state of war. [3]. Strictly considering, the neutrality is the operation of states not to participate at war and only begins at the outbreak of a conflict.

The main legal instruments regulating the status of neutrality are two conventions adopted at the Hague Peace Conference of 1907, namely:

- The VIIth Convention "regarding rights and duties of neutral powers and persons in case of war on land" and;
- The XIIIth Convention "on the rights and duties of neutral powers in case of maritime war."

Neutrality includes two ideas: abstention and impartiality.

The obligation to refrain occurred in the late eighteenth century and meant to prohibit a neutral country to assist any belligerent state.

Neutrality implies impartiality, strictly equal treatment to all belligerents. The Concept of benevolent neutrality is unacceptable because benevolent actions among some opponents are actions wrongdoing among others [4].

Neutrality creates rights and obligations, which usually do not exist in peacetime and stops as the end of the war or when war breks between the neutral and one of the belligerents [5].

At the beginning of armed conflict, the state competent public authorities give a statement of neutrality which has the advantage of clarifying relations between sovereign states.

2. PERMANENT, EVENTUAL AND IMPARTIAL NEUTRALITY

There have been several types of neutrality over time[6]:

- permanent neutrality (called by some authors perpetual) is where some countries have assumed the continuous obligation not to participate in any armed conflict, military-political alliances or war preparation , not to allow use of their territory for the location of foreign military bases and the obligation not to hold or produce, or experience nuclear weapons or other weapons of mass destruction. Hague Conventions (art. 7 of the Convention V and art. 7 of the Convention XIII, October 18, 1907) did not require neutral powers to prevent the export or transit of arms and ammunition for any of the belligerents. This also explains through the

interest of the great powers to do lucrative business during the war, selling war material to one or other of the belligerents or both sides ;

- eventual neutrality is the neutral attitude of a State or States to a particular war. An example of this is the Japan and Turkey's attitude towards the conflict in Israel and the Arab States in 1967

- impartial neutrality is the neutrality of a State or States to all participants in a conflict. It was governed by the Hague Conventions (1899 and 1907).

2.1 The evolution of the concept of neutrality in the event of maritime war

A significant moment in the evolution neutrality sea in wartime was the creation in 1780 at the initiative of Catherine II, Empress of Russia, of the first league of armed neutrality, an association of neutral Powers to establish a system of military neutrality for trade navigation and neutrals in time of war [7]. The League was founded on the following principles: the right of neutrals to make cabotage along the coast of belligerents; goods carried by neutral ships could not be confiscated, except the contraband of war; a blocked port could not be considered so unless the belligerent that it blocked its entry stationed manifestly dangerous warships at the entrance of the port . In 1793 Russia has abandoned these principles, in line with the British position, who, through a law proclaimed in 1781, banned neutral vessels from entering a French port

In 1780 Russia, unhappy with Britain's refusal to recognize the right of convoy initiated a second League of armed neutrality.

But the state that will decisively influence the development of naval neutrality will be Great Britain, the first country to ban its nationals to accept branded letters or hire in belligerent's armed forces.

The nineteenth century was called "the golden age of neutrality" He started with the creation of the institution of permanent neutrality (in Switzerland in 1815, Belgium in 1839, Luxembourg in 1867) and total or partial neutralization of territories. Earlier in this century the "European balance" was created, that allowed neutral states to defend their rights, especially since the United States have entered in their ranks . Also, in the shadow of economic liberalism, which imposed a distinction between public and private sectors, neutrals found fertile ground to assert claims not to be hindered in carrying out their trade. Military unions of states develop at the same time with commercial and sailing unions, although with different goals. The first sought mastery of the seas and destruction of enemy merchant ships and termination of its trade, while the others development of safe, peaceful activities .In this context, the strong current pacifist in the second half of the century, which began with the creation of the International Red Cross in 1863 and the Paris Declaration regarding naval warfare of 1856 and continued with lectures coding (1864 - Geneva, 1874 - Brussels) and peace (1899 - Hague), 'has given greater status neutral powers, including the role of moderator in conflicts between belligerents. From here to the codifying general rules of maritime neutrality there was only a step, and it was made at the Second Hague Peace Conference of 1907 .

3. RIGHTS AND OBLIGATIONS OF NEUTRAL STATES

Maritime Neutrality has its roots in a series of international treaties, of which the most important is the Convention XIII of the 1907 Hague of rights and obligations of neutral powers in maritime war and other various customs [8]. These obligations impose neutral states restraint and tolerance and give them certain rights - the right to pursue relations with other countries and the right to respect their territorial integrity .

In substance, maritime neutrality in war is governed by the following principles :

With regard to neutral :

a) freedom of navigation and trade;

b) the obligation to observe a strict equality of treatment of all belligerent parties;

c) failure to intervene in the conduct of war.

In regard of the belligerents:

a) prohibition of committing acts of hostility in neutral waters and ports;

b) the obligation to observe internal regulations of neutral and international provisions on neutrality regulations.

Much more complex than similar issues regarding land warfare, maritime neutrality in war is based on the same symmetrical principles. .Thus, while duties of belligerents are expressed in two norms of behavior - refusing to commit acts of hostility in neutral waters and the obligation to comply with internal and international regulations concerning the stay of belligerent warships in neutral waters and ports, correlative duties of neutrals are based on two rules of behavior all expressing the idea of abstention and impartiality.

Compliance to follow these rules has a quite complex character, due primarily to the specificity of maritime war, whose main theater of war is the high seas, that is exactly the space where non-participating states operate and secondly that the neutral states territorial sea, which is governed by the principle of freedom of innocent passage of vessels of all states, including belligerent, constitutes a ground clash of interests [9]. Another source of difficulties is the ownership and persons regime in the sea war, either because the criteria for determining the neutrality of vessels, goods and people, or especially because of frequent abuses perpetrated under the shield [10].

3.1 The duties and rights of warring States

The duties and rights of belligerent states, are based on, as mentioned, two principles: the inviolability of neutral states waters and respect of domestic and international regulations on the protection of neutrality [11].

a) Maritime territorial inviolability of neutral states, with all its component parts, constitutes a general obligation of warring parties. Belligerents – as shown in Article 1 of the Convention XIII Hague - are bound to respect the sovereign rights of neutral Powers and to

abstain, territory or neutral waters, from any act that would constitute a departure from the their neutrality .

Among the acts prohibited are the capture and visit a belligerent in neutral waters; establishment of tribunals on neutral territory or on a ship which would be in neutral waters; use neutral ports and waters as a base of operations against enemy shipping, installation of telegraphic stations or means of communication with belligerent land or naval forces.

It is forbidden to a neutral country to deliver to a belligerent warships, ammunition and any material that would help in conducting its military operations and belligerent aircraft flying over the territorial waters of neutral states

Convention tends, as seen, to prohibit any acts of war in the waters of neutral states.

b) Capturing an enemy ship by a belligerent in the territorial waters of a neutral State is expressly prohibited by the Convention.

This prohibition covers both warships and merchant vessels of belligerent power and other neutral vessels liable to be confiscated for contraband of war, hostile assistance, forcing the blockade etc who managed to flee to neutral waters.

For the above-mentioned facts to be considered a belligerent crime, the Convention imposes two conditions:

- to have happend in neutral waters in the sense of international humanitarian law and
- the neutral to protest against their commission.

Compliance with the first condition has raised many controversies in the past, as some neutral states had a width of three miles of territorial sea, some 12 miles, with the latter belligerentparts refusing to recognize them.

Today the problem seems solved since the last postwar regulations recognize to states the right to have a width of the territorial sea up to 12 nautical miles.

The issue is however with the other components of marine space - special areas and exclusive economic zone - where States exercise their sovereign rights.

With regard to tlehe latter condition, the neutral has the following obligations:

- if the capture is still under their jurisdiction, he must use all means available to have the catch and the crew freed or to have the crew stationed at shore;

- if the capture is outside their jurisdiction, the neutral nas the obligation to intervene with the captor's government to release the capture; if belligerents carry loot within neutral's territorrial sea, the neutral must release both loot and crew.

c) Crossing of belligerent warships and prey through neutral territorial waters does not, under Article 10 of the Convention, constitute an offense.

This rule is based on rules of international law relating to the right of " innocent passage ' of trade and war ships of all States in the territorial sea . This rule was laid down in the 1958 Geneva Convention on the Territorial Sea and Contiguous Zone and reiterated in that of Montego Bay 1982 ; to the latter many countries, particularly of the non-aligned and developing ones, have made reservations for the purposes of avoiding the passage of ships of war if not with express notice.

Since states have the right to prohibit temporarily, in certain circumstances, the passage of foreign vessels, especially those of war through their territorial waters, a neutral state is entitled, a fortiori, to exercise such a right in relation to warships the warring parties, without being obliged to do so.

If a neutral grant right of passage of warships of belligerents, this must not be used to gain a military advantage, such as, for example, to escape the pursuing enemy or evade an attack.

d) In the war on land, any violation of the neutral territory of a State constitutes a violation of neutrality. In maritime warfare, passing and staying of ships through neutral waters may in certain circumstances be permitted

Regulated since the eighteenth century by domestic laws and treaties of commerce and navigation and peace treaties, issue of the right of passage and stay of warring parties ships in neutral waters has been enshrined in international law at the beginning of the twentieth century by the he thirteenth Convention of the Hague, governed by two main principles:

1) The exclusive competence of the neutral state to admit belligerent vessels access to ports and territorial waters;

2) Equal treatment for all warring parties.

3.2. Rights and duties of neutral states

International humanitarian law applicable to maritime war rules two neutral states rights - the right to trade and the right to navigate.

The citizens of neutral states have the right to trade between them and third parties and to continue to trade with belligerent subject to certain conditions . In practice, the issue takes a very complex turn, which is determined by the specificity of maritime war (high seas, where neutral Powers exercise this right, are the main theater of operations with private property not being here inviolable) and opposite interests of neutrals and belligerents (first want to enjoy full freedom of trade and navigation, while recent seek to discontinue any way of their opponents to connect with the world in order to weaken their economic and military potential).

The complexity of the problem results from the fact that if the issue of trade relations between the citizens of neutral states is relatively simple, that of trade between belligerants and neutrals questions the base of neutrality which is impartiality; The Particular of the neutral state can not be impartial in business and the affected belligerent has the right to retaliate. From the point of view of humanitarian law, the neutral state is not liable for acts committed by its citizens contrary to neutrality individually. This disclaimer seems to create an advantage for the neutral, a rupture of balance between the rights and obligations of belligerents and neutrals. In reality, the imbalance is in reverse. Belligerents have more extensive rights and those of neutrals are rather limited.

International humanitarian law applicable in maritime war grants belligerents in exchange of lack of accountability of neutral states, a "compensation": the right to take action against citizens of neutral states who would try to help the enemy. The right to control and

prevent neutrals trade was considered a right of "self-defense" by the belligerent state.

3.3 Restrictions on the rights of neutral

Freedom of trade and navigation of neutrals is carried out under the control of belligerents, subject to certain restrictions . Neutral are not allowed: to carry on what one party considers contraband of war, to enter or leave a belligerant's port when those ports are blocked.

One restriction is to prohibit the smuggling of war, which constitute an essential element of maritime neutrality.

The term "contraband of war" means objects and merchandise which, because of their usefulness for military operations, if being supplied to opponent, belligerent prohibits, the penalty is confiscation of the vessels that are they transported on. So, smuggling involves a trade prohibited by international humanitarian law norms

The regime of belligerent merchant ships is governed by two rules;

1. Freedom of access and freedom of anchor ;
2. The Right of neutral states to commandeer them for the public interest

Freedom of anchor of merchant ships is not limited in time, provided it does not violate the neutrality of the state.

4. CONCLUSIONS

The Status of neutrality creates rights and obligations which usually do not exist in peacetime and that come to an end at the end of the war or when war breaks between the neutral state and one of the belligerents.

Assuming the rights and obligations of neutral states in maritime warfare does not, however, exclude the right of the neutral state, in compliance with art. 51 of the Charter of UNO, of self-defense, to maintain armed forces, take any measures necessary to protect the national territory against aggression, to seek help and be helped if attacked by another state.

The state has also the right to permanent recognizing and guaranteeing his international personality and the right to fully participate in international life as any other state. Crew members of the merchant marine of the parties in conflict not receiving favored treatment by virtue of the law of war, have the status of prisoner of war.

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FREE PORTS

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ABSTRACT

Through this article we try to emphasize the economic importance of a free port with jurisdiction more relaxed compared to the country where it is located: exemption from customs duties and a special customs regime with favorable customs regulations. We emphasized the legal definition of free port in binding with another institution, the free economic zone which together play an important role in the global economy.

Free ports or "Porto Franco" have a millenary existence, whose first origins were in China and Greece. At the end of the century, the great port cities were equipped with Zona Franca, in order to attract cargo, ship owners, merchants, to develop the local economy. Through continual adaptation to new needs, this concept has its origins in the Middle Ages and is not yet obsolete. Free port development was particularly significant during the last decades.

Keywords: *Free port, free zone, port operators.*

1. INTRODUCTION

Territories with a free state or a certain degree of liberalization suffered big changes and transformations . Thus, these territories called customs zones, duty-free zones, zones of free enterprise, free trade zones etc. have gained widespread use in virtually all countries Initially free zones were known as free ports. The first free port is considered Carthage, founded in 1814 BC, and then other free ports in the Mediterranean, on the west coast of Africa and Phoenicia were founded.

A free port is a port declared by a state as not being regulated by their customs laws, in a wide sense, a free port is a port where there is a „free zone" [1].

In another sense the free port means a territory (port city, a neighborhood in port) neutralized in terms of customs, where all ships, irrespective of nationality, have free access and where all the goods of whatever nature and their origin can be landed, handled, processed, processed and exported without any restrictions and without paying any customs duty only if they fall within the country.

Free ports enjoyed another very important favor: they were exempt from any tax on imports and all foreign goods consumed within.

Porto Franco regime was applied for the first time in Italian ports, where trade center has shifted to the west and north-west Europe [2].

So were established free ports Livorno in 1547, Genoa in 1595, Naples in 1633, Venice in 1661 Ancona and Messina in 1732 [3]. The positive results obtained by these ports in their commercial traffic led Colbert to introduce in France the Porto Franco regime as a corrective of his protectionism.

So he declared free ports Marseille (1669), Dunkirk, Lorient and Bayonne, further development of these ports fully confirming the great French minister hopes, that period being considered "the most brilliant era" of French maritime trade.

In 1719 Fiume and Triest, under Austrian administration, were invested with the privilege of Porto Franco.

Along the commercial function, free ports fulfilled an industrial function. Thus, some industries could emerge and develop inside their zone, benefiting from the existence of raw materials inside the port without being subject to customs duties.

The prosperity and use of free ports were possible along with the conditions that put them into existence [4].

At the time, however, when elsewhere free ports regime had fallen into disuse, here, in the first half of the nineteenth century, free ports were not only possible, but also entirely necessary.

On the river Danube, one of the first free ports was Galati. Nicolae Iorga, in one large documentary study marking some of the city's most important moments of the Danube, included that of setting up a free port regime, by royal charter in October 1836, declaring Galati a free port [5].

The territory of the free port is separated from the customs area by a fence with gates under customs control [6].

1.1. The proposal definition of free port

In order to define the free port we need to present the main characteristics that define the notion itself.

At first, free port semantics designate, by default, a port.

If the port remains a vague notion of positive law, one agrees to emphasize that managing the flow of goods characterizes it, as a testimony to the notions of import, export or re-export.

Secondly, it represents, per se, an interface between the transport streams. according to Dr. R. Rezenthel statements, the notion of port exceeds the restrictive space of traffic management arranged for sea or inland waterway, but designates, more pertinently a

multimodal facility t: „(...) port is the point of convergence of all modes of land transport (routes, rivers, railways) and sea transport. Therefore, the port is in this way defined as a multimodal transport interface, designed to handle the transition of logistics flows nationally and internationally. But if the free port inherently presents the characteristics of a classic seaport, it has a singularity that makes the difference: extraterritoriality. American doctrine analyzed this feature, giving free port the role of a "buffer tool," meaning "storage area in which the sender can discharge cargo, can rest and decide what to do later" . Finally, the specificity of extraterritoriality gives free port functions which, by their nature, are more complex and elaborate than those of a simple commercial port .

According to the doctrine, the open port can be defined as a multimodal interface defined most often closed, managed under a multimodal interfaces defined, most often closed, managed under an economic regime especially like "duty free" through which extended logistic services such as general contracting, assembly, processing of products are supplied under a customs extraterritoriality.

Therefore, the free port is free of all border barriers, in order to bring added value logistics operations and supply chain.

As an interface, it can receive various implantation sites: in the center or close to a commercial port, a dry port, a river port or an airport. It is designed to transit international logistics flows under a special economic status, meaning outside the customs territory and outside of the country of destination systematically control, thus avoiding physical and administrative obstacles - tax and customs – due when border crossing.

2. FREE COMMERCIAL ZONES

Commercial free zones - the oldest and simplest form of territorial organization (sec. XVII-XVIII), is a title awarded to the first generation of areas. This group following forms: a free zone, customs warehouse, free port, port works, free airports, transit areas, export processing zones, and not the last commercial free zones, which are most widespread.

Such areas shall be established in international transport hubs (river and sea ports, railway hubs, airports) to facilitate penetration in the country of foreign currency through external commerce intensification. Such areas are usually approved and supervised by customs. Inside these zones duty-free goods can be stored, packaged, and marketed transhipped. Commercial free zones exist virtually in all countries.

A variant of the free trade area is the network of shops "Duty Free Shop" (detailed marketing for individuals) [8].

2.1 Porto Franco: Addressing an uncertain notion

Inside Free ports one can carry out loading unloading ,can store goods brought from abroad, and then re-export either manufactured or in the state in which they were brought, can perform commercial and industrial transactions, duty-free import or export [7].

Import duties are paid only for goods out of the ports to domestic consumption.

The existence of free ports is determined by the need to create optimum conditions for the traffic of goods destined for other countries.

With the exception of Australia, free ports are found on all continents, the meeting points of the roads ocean ports are free: Hong Kong, Singapore, Cologne etc.; free ports in Europe are: Constanta, Hamburg, Bremen, Bremerhaven, Cuxhaven, Emden and Kiel, Stockholm, Göteborg, Malmö, Copenhagen etc.

The notion of Porto Franco remains as cloudy as at the beginning of XXI century. The notion of Porto Franco is subject to different definitions of a state or the other, not forgetting many related concepts, such as free zones, coming to complicate understanding of positive law [9].

2.2 The concept of free port in positive law

Free port, free zone, free zone port logistics free zone, industrial free zone, urban free zone, free exports zone ... are extremely imaginative practitioners regarding the terminology used to describe these specific facilities whose importance is enshrined the Incoterms © 2010, but equally by the recent creation of an international organization dedicated to: World Free Zones Organization As notions of port or terminal, subject to various denominations and definitions, we would be tempted to say that this is, without doubt, a shortcoming quite common port facilities.

No international convention actually does define the notion of Porto Franco and the Geneva Convention and Statute on the international regime of maritime ports in 1923 doesn't fill the gap .

At European level, the proposal for a regulation on market access to port services on May 25, 2013 defines in a general manner, the notion of port „an area of dry land and water made up of works and equipment allowing essentially penetration ships, loading and unloading, storage of goods, the receipt and delivery and embarking and disembarking passengers, and any such infrastructure which carriers need in the port area ”. By allowing the incorporation of large parts of the port infrastructure, this general definition does not refer to the characteristics of the free port .

The only express reference to this notion is found in the old customs provisions on free zones and enterprises of works from the "old free port of Hamburg", defining it as "the Parts of Community customs territory separated from the rest where the non-Community goods which are introduced are considered for the purpose of import duties and commercial policy import measures, as contained in the customs territory of the Community (...)”. If this definition does not clarify on what can be a free port, it classifies the free port in the category of free zones and gives it the principle of customs extraterritoriality apart from the commercial "classic"port. This extraterritoriality of free zones is equally confirmed in the Protocol amending the 1973

Kyoto Convention on the Simplification and Harmonization of Customs Procedures.

On the positive law of customs, although France was a territory that has sheltered the free port until the revolution abolished their privileged status, even if there remained modest reminiscences in Verdun, the great seaport Bordeaux, Saint-Martin and Saint -Barthelemy the concept of port zone remains ignored in seaports Code.

3. EXPLOITATION OF FREE PORTS REGIME

While lawyers are familiar with operating regimes of seaports and their governance model, those of free ports remain confidential because they are still little studied .

Free ports operating regimes are very different as far as each state defines the legal framework applicable in a unilateral manner. Meanwhile, free ports are characterized by common principles, notably customs, unified under the aegis of the World Customs Organization.

3.1. The particular characteristics

As in the case of the commercial port, creating a free port reveals an administrative authority, the state in general, authorizing location and infrastructure development in the legal area. This decision affects the equal status of "free" of that installation. generally formalized by a law, the establishment and activity of free port are strictly regulated, with the possibility of repealing or evolution of certain provisions during existence through a law amending, as a law in finance, as It has been the case several times to Tanger-Med port in Morocco

Regardless of their diversity, the legal framework applicable to free ports is structured in a manner similar to the provisions that can be classified into seven categories, of which the most significant are:

- ✓ Free port functions,
- ✓ Geographical delimitation and,
- ✓ Access, authorized activities,
- ✓ Tax incentives,
- ✓ Operators and organization of the port .

In this way, the public authority defines the functions exercised by the free port authorities expressly authorized for knowledge products and services,

The text stipulates in this respect the conditions of delivery, suspension and withdrawal of licenses for companies operating in the free port, without omitting reference to facing checks .

In principle, all ships goods without discrimination based on the flag, can penetrate the free port, subject to security and safety rules

Regarding the actors in the free port, they are the regulator, operators and sometimes developers

If the regulator is coordinator or facilitator zone, operators are forwarding agents, shipping agents, handling companies, enterprises or logistics etc.

The various tax incentive schemes come to complete the legal framework of the free port, presenting favorable regimes in terms of duties and taxes proposed by these operators.

3.2. The ways for operating the free port

Free port has a specific operating system that overlaps their governance arrangements.

This system, which is uniform, is justified by its extraterritorial character which gives it a special status. As if free zone, free port is in fact a "territorial enclave", outside the jurisdiction of the customs of the country of residence. That transit goods are viewed, therefore, as not being on the customs territory, in particular the implementation of liabilities related to customs and taxes. Accordingly, free ports are equipped for operating a regime of exceptions and derogations on the application of the common customs law. At European level, in terms of free zones, free ports belong to the default "private arrangements" of Title VII of the Customs Code of the Union. The principle of "One Country, Two Systems" characterize the free port with a very attractive tax regime for operators or foreign investors. In a more precise manner, if free port offers the same benefits as a seaport "classic" on the handling and transit, it is instead dedicated his work mainly internationally.

This commitment to international Mundus is in contact with the freedom of maritime trade and the free movement of goods

This principle of free movement, supported by extraterritoriality customs entails the corollary of a series of prohibitions to state that the free port is located in, especially in terms of control of origin and possession of the goods, the nature, quality and quantity, subject to use and finally destination.

The second major difference compared to classic commercial port operations is that "mundane" loading, unloading, transhipment and storage must be previously authorized in the Act establishing the free port, while this is true for the handling and transformation of goods , but these operations are carried out by the exemption of customs duties for both raw materials and production equipment used for. Outside mere warehousing functions, it could be assembly, labeling or refurbishment, carried out under the inward processing regime.

4. FREE PORTS IN A GLOBALIZED WORLD

Today's globalized world is characterized by the free movement of persons, goods, services and information. It's an interconnected world where actions in one place can have implications elsewhere on the planet [14].

Maritime transport is an important aspect for world trade and access to global markets. Globalization has introduced also new Maritime actors .

Free ports such as: Galati, Malta, Cuba, Isle Maurice, United Arab Emirates, Panama, Madagascar, Morocco, Latvia and China, are located invariably in states of medium size and large size, port facilities of free ports fall within globalized context of the world economy.

In this way, regardless of whether they are secular, modern free port will never be the same level as at the beginning of XX century, as proof of their omnipresence in countries located close to the strategic axes of world trade, such as Suez, Gibraltar, Panama Malacca.

Meanwhile, beyond their dynamism and presence around the world, these plants are poorly understood by lawyers from the harbor and sea . in respect of installations on land, maritime law is not intended to regulate them as well as the International Maritime Organization (IMO), which tends to incorporate progressively ports in its body of rules, as with the ISPS Code on ship and port facility security.

5. CONCLUSIONS

We are in the period in which the world economy increasingly globalized, entering a new phase. Pretty interesting

In this context, the notion of the free zone and customs duty suspension arrangement offered by this are becoming increasingly interesting for international affairs.

National economic and social context have changed much in Romania in the last 25 years. From progress to regress, from growth to decline, from year with profit to years with losses, about that we can say that free zones and free ports in Romania have not disappeared and still seek solutions on the path of evolution and their development towards economical growth.

Galati Free Zone can become a pole of commercial interests on the eastern border of Romania and the European Union, the reasons are: China already insists on a commercialand logistitic gigantic project [15] of restoration of the old Silk Road [16] and it seems that already the first steps of the project take shape

Tense political conditions and latest developments of the Middle East crisis bring more interest to the project of restoring this ancient trade routes - proposed and supported by the Chinese.

Located at the east gate of Romania and the European Union, specifically the border with the former Soviet space, Galati city and Galati Free Zone [17] more pronouncedly become increasingly important for business people interested in economic exchanges between East and West.

In its positive aspects, free port allows attracting investment, especially foreign investment, the growth rate of freight traffic and hence the creation of jobs. In its negative aspects, an open port creates revenue for the benefit of recipient countries for operations carried out directly within it.

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STUDY OF THE ECONOMICAL EFFECTS OF THE BIO-INVASIONS

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ABSTRACT

This paper aims to examine the economical effects of the bio-invasive phenomenon, begining with global considerations in this respect, and ending with proposing legal and scientifical measures, for prevent the undesirable effects of this phenomenon. As an example, it is analised the Black Sea ecosystem problem.

Keywords: *invasion, Black Sea, industry,legislation , biodiversity.*

1. INTRODUCTION

After developing global metal transport vessels, massive changes occur in the structure of the marine ecosystems.The ships were carrying ballast water in their hold from the latest port, which was discharged in the first port, without any caution.

This way, an extremely wide range of marine organisms larval stages plankton that were able to withstand confinement shorter or longer, managed to reach areas where, naturally, would have had no chance to reach .

2. GLOBAL CONSIDERATIONS

Experts in biology and marine ecology began to signal mostly alien (invasive) species: in Europe began to appear in the interwar period, species of Indo-Pacific or North American, first transported in large ports British, French, German or Dutch; in the US ports, eastern European species occured; on the west coast of North America species were emerging from the Far East Asia and in Australia and New Zealand, also in some Pacific islands, are reported European and North American species.

This way, the situation in large areas near major ports on all continents reached soon to show a mix of joint species, where the aliens started to dominate – that is exactly the antropochori immigrants.

Such species have produced also an economic damage: for example, when was registed the penetration of the Chinese crab, *Eriocheir sinensis*, in Europe (adults custom of digging shelters in the bank of the freshwater, where they are developping, endangered a series of dams in the seaside Netherlands and German in the 1920's and led to taking appropriate action against them), or the American *Crepidula fornicator* gastropods impact upon the indigenous populations of *Haliotis*, on the French coast, used by the local population for direct consumption.

The real disaster, both ecologically and economically, occurred when, in a marine basin, unique in its own way, as the Black Sea, recently formed, with specific fauna and flora, has appeared a predator ctenophor from the north Atlantic waters of America - *Mnemiopsis leidyi*(Skolka, 2004).

Without natural enemies and no effective competition to food from the native species, *Mnemiopsis* enormous populations have grown throughout the Black Sea, in a very short time, and have caused general collapse of the main pelagic species populations and the entire Black Sea basin.

As a direct consequence of this, the fishing industry, based on the exploitation of the native species, has experienced a formidable setback from which has not recovered even after *Mnemiopsis* diminished its populations.

The Black Sea example became for the specialists a veritable "case study", of what can happen in a marine basin when entrying an invasive species. Today, between the dominant species in the Black Sea basin, of a particular ecological importance there are just some non-indigenous species - immigrants antropochori:
Mnemiopsis leidyi in the pelagic ecosystems, the *Mya arenaria* bivalves (North American) and *Scapharca inaequivalvis* (from the Far East) on the sandy shallow bottoms, also the crustacean ciriped *Balanus improvisus* (of Asian origin), on the bottoms rocky shallow bottoms, the east Asian predator gastropod *Rapana venosa*, in the same habitats, where he managed to exterminate almost entirely the oyster banks (today, simple remember the great masses of valves on some beaches or sediments) (Skolka, 2004).

Introducing new species in the fresh water, by humans, had also serious effects upon the ecosystems. Often man practiced the introducing of the fish species for economic or sporting interest, without realizing what might result from such actions. One of the most unfortunate cases, introducing a species for acclimatization and commerce, was the *Lates niloticus* species - species that can reach two meters in length and 200 kg - in Victoria Lake, in America, during 1950's. Following the acclimation of this species, 200 endemic fish species have disappeared, so this was the most important phenomenon of extinction of vertebrate indigenous species recorded from the late glacial period (Kolar, Lodge, 2001).

Taking account of the important damages sometimes that the immigrant species have produced in the invaded habitats (eg. the Baltic Sea marine basin, with a number of special characteristics, today can be described as a "high species imvazive" considering the large number of the naturalized exotic species and the

native species drastic reduction in the staff), the specialists even tried to quantify the invasive phenomenon itself. It was proposed an "exotic index" or "invasive index" (Branch, 1994), to characterize the different taxonomic groups.

This index can be calculated as following:

$$E_i = E \times \frac{100}{N}, \quad (1)$$

The E_i index is the exotic index;
- E represents the number of alien species in a particular taxonomic group, in a given area;
- N is the number of native species in the same taxonomic group; when in the area there is no domestic species, it will take the value of N + 1.

Calculating the index for some groups in the Black Sea:

• For molluscs, the value is 3.22 (Zaitsev, Ozturk, 2001);
• For *Mnemiopsis leidyi* the value is 300;

2. THE BLACK SEA PHENOMENON

An example in this respect is the great comb jelly *Mnemiopsis* invasion, still existing in the Black Sea and also its aftermath economic and ecological.

The invasion occurred in 1987-1988, when the *Mnemiopsis* predatory ctenophor came into the Black Sea, from the ballast water of merchant ships. The lack of the adequate normative regulating for discharging the ballast water under controlled conditions, in the specially designated areas, in order to purify them, and the lack of legislation to regulate the periodic inspection of the fauna territorial waters, led to the migration of a very large populations of *Mnemiopsis leidyi*, from the North American waters in the Black Sea.

In competition with the indigenous forms, it has defeated and eliminated the competitors, at the basic trophic chain. *Mnemiopsis* caused severe disruption and directly in the pelagic or even bental shore. The populations of fish, especially anchovy, and other species, have been deeply affected, registering a real collapse in the period of the explosive growth of the ctenophor, not merely because *Mnemiopsis* feeds on their larvae and juveniles, but also because this new immigrant is a strong competitor on the food fishes. (Skolka, 2004).

The lack of the preventive measures against the introduction of the invasive species into the Black Sea is partially justified by the fact that, until this invasion, it had been produced no major environmental changes due to the ingress of a invasive species in the Black Sea.

2.1 Economical effects of the bio-invasion in the Black Sea ecosystem

As a result of entering this predatory species in the Black Sea basin is the drastic collapse of many fish populations whose juveniles were both competing to food and consumed by this new immigrant. Sometimes, a number of economic interest species flocks fell close to zero, as was the case of *Engraulis encrasicolus*, on the right Romanian seaside.(Niermann, 1993)

In the present, this ctenophor became the dominant species in the Black Sea macro-zooplankton, even if its workforce no longer reach the same values as in the exponential growth of its population.(Skolka, 2004) *Mnemiopsis* attacked the food source for some very important fishes for the fishing industry, such as anchovy. This, combined with overfishing in that time, almost led to the extinction of the anchovy species in the Black Sea.

If it would had been made a fishing plan, rationally based on the results of scientific research, this certainly would not have happened.

2.2 Studies, researches, reglementations upon the invasive phenomenon of Black Sea

Understanding that the Black Sea ecosystem is threatened by increasingly more dangers, Institute of Biology of the southern seas of Sevastopol, together with the Institute of Oceanography and Fisheries in Kerch, Ukraine, have conducted research and regular expeditions until 1993 to monitor changes in this ecosystem. Data gathered from these researches have been crucial in understanding the mechanism of the *Mnemiopsis leidyi* invasion and were the main source for numerous and specialized studies which were conducted later in this respect.

The main authors of these studies (Lebedeva, Shushkina, 1994) showed how the attack was carried by *Mnemiopsis* species upon the native species and the effects which have been produced (Drăgoescu, 2012)

To build a complete defense system is necessary to analyze these data for forecasting composition changes of the ecosystem structure, since the introduction of the disruptive factor. In this case, *Mnemiopsis* is the disturbing factor.

Many researchers in fields such as oceanography, chemistry, biology, even biophysics, biomathematics, stressed the importance of such forecasts.

Starting from some basic elements, namely: the total phytoplankton, protozoa, *Mnemiopsis* and dissolved organic matter, without taking into account fish populations, it can be assessed, over a period of time, the changes that may occur in the marine ecosystem (Drăgoescu, 2011).

Currently, Romanian law foundations are introducing invasive species phenomenon into a legal framework, because of treaties, international agreements to which Romania has joined, and some others internal regulations (Skolka, 2004).

2.3 "Solving" the problem

However, the law did not protect the Black Sea Mnemiopsis's invasion, but other invasive species introduction in the late 90's, *Beroe ovata* i.e. whose main source of food is the lobate *Mnemiopsis leidyi* in this case (Skolka, 2004). Although this event had the effect of halting the invasion of Mnemiopsis's and the pelagic start rebuilding herds, long-term consequences of these changes in the ecosystem are unknown. In the absence of

a close monitoring of the Black Sea ecosystem, it can collapse any time due to a variety of causes.

Mnemiopsis site was not destroyed by *Beroe ovata* and it is possible that when two populations will stay a while longer separated from one another (because of the sea currents, for example), the population of *Beroe ovata* disappear(for lack of food) and *Mnemiopsis* restart the invasion in the Black Sea ecosystem.

According to the author, let us consider, the exclusive model of the competition between two species. Research results led to a representation like this: (Figure 1)

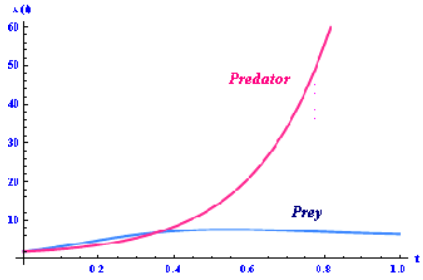

Figure 1 Optimal trajectory (in the first year), for the exclusivist competition(Drăgoescu, pp. 64, 2011)

After about 25 years, biologists have verified that there are still Mnemiopsis in the Black Sea ecosystem, So the two populations, both invasive predators, coexist, even if they had the same trend, and even if they annihilate each other, even if not in the same proportion and recent data can be presented as it follows: (Figure 2)

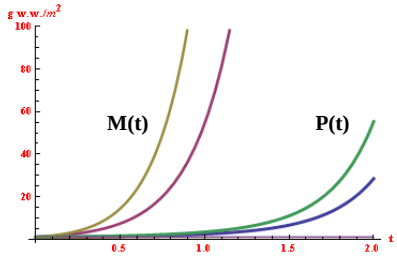

Figure 2 The predators, P(t) (green and blue) have an upward trajectory, slowly at first, but after two years, rising to become significant. The prey, M(t), *Mnemiopsis*, has brown and red components, and develops parallel to the predator, although more slowly. (Drăgoescu, pp. 103, 2011)

as in the maximum period of development, in which case, a realistic trend, supported by theoretical studies

We believe, therefore, that the emergence of species *Beroe ovata* in the Black Sea has a positive role in combating the *Mnemiopsis* invasion, but as the literature has shown, the presence of both species in the Black Sea can only worsen the global aspect of its biodiversity. (Skolka, 2004)

It can be said, more literary, that a "bad" was stopped by introducing another "bad", but at what cost, we are asking ourselves? Long-term effects of this are unknown and the lack of interest in legislation on the issue of the invasive species places the Black Sea ecosystem in a great danger.

3. THE IMPACT OF THE INVASIVE SPECIES EFFECTS (Tabel 1)

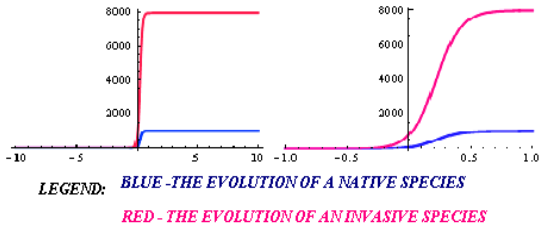

Figure 3 The different evolutions of the native and the invasive species(Drăgoescu, pp. 96, 2011)

The impact of the invasive species on the ecosystems has been studied by the researchers based on particular characteristics such as: fecundity, competitive ability in exploiting the ecological niches, rapid maturation, so on. These observations led to the use of a so-called "impact index" calculated according to the recorded characteristics of invasive species. The biggest such index for the marine invasive species, was 7,96- recorded by *Mnemiopsis.*(Skolka, pp. 147, 2004)

Analysing the evolution of the invasive species compared with the native species, during different periods, we are led to the result represented in Figure 3.

SWOT analysis of the effects of the existence of such species leads to the following:

Table 1. Swot analyse for the invasive species economical effects(Skolka, 2004)-revised

WEAKNESSES	STRONG POINTS
Effects of species from fouling on underwater constructions require expensive cleaning procedures and the application of some preventive measures (antifouling paints);	Expanding the fishing season;
Negative effects for tourism - accumulation of dead organisms or algae on the shores;	The emergence of new economically and exploitable fishery resources (eg. the *Mya arenaria* bivalve is eatable);
Losses in the total quantity of the commercially exploited species populations;	Sometimes, the increasing number of jobs;
Losses in aquaculture;	-
The increase in the cost of the marine products due to the cost of chemicals used to control or eradication;	-

3. CONCLUSIONS

This study wants to be a foundation, as well as a motivation for a set of economic measures, supported by legislative regulations, in order to minimize the effects of the phenomenon of bio-invasions in the Black Sea and even, to try to stop it. These measures will have to achieve both environmental economic sector and macroeconomics, highlighting here the importance of an existing idea in literature, which is a cost-benefit analysis of the introduction of any alien species in the existing ecosystems. For long term, it would be beneficial to analyze from the macroeconomic point of view, two different scenarios, and balance the incomes and the payments, in each of these two situations:

a) no measures for treatment of the discharged ballast water, with all the consequences deriving from it.

b) installing a ballast water treatment equipment, which operation will be supported by fees from the ships with ballast water discharges.

This study, although only of a theoretical importance, tries to be a true warning signal about the presented issue.

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COMMENT ON THE IMPLEMENTATION OF "0 – 1" TEST FOR TINKERBELL MAP

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ABSTRACT

Recently, Gottwald and Melbourne proposed a new technique for characterization the regular or chaotic nature of dynamical orbits. Their "0 – 1 test for chaos" takes as input a scalar time series of observations and returns the value unity in the presence of chaos, and zero otherwise. Since its appearance in 2004, the test has undergone several modifications which aimed to increase its reliability. The purpose of this paper is to check how these refinements have improved the test's performances and to highlight the role played by the main parameters. To achieve this we generate data that we use from the 2D Tinkerbell map, known for its rich dynamical behaviour. Our findings show that the last variant of the test succeeds even better to give the right answer on the type of the investigated orbit.

Keywords: *Tinkerbell map, 0 – 1 test, ordered and chaotic orbits, time series analysis.*

1. INTRODUCTION

Determining the chaotic or regular nature of the orbits in deterministic dynamical systems continues to be an important issue of nonlinear science. It is more difficult to solve as we have less information on the internal dynamics. For those systems whose evolution in time is described by ordinary/ partial differential equations or maps there are an impressive set of methods for distinguishing chaos from order, including Lyapunov characteristic exponents, the Smaller Alignment Index, the Fast Lyapunov Indicator, the Generalized Alignment Index, the Mean Exponential Growth factor of Nearby Orbits, and the Dynamic Lyapunov Indicator [1 - 10]. If our knowledge on the dynamical system concerns only its observed outputs, then our maneuvering space is severely limited to only a few tools, including "0 – 1 test", Asymmetry Coefficients or Fast Norm Vector Indicator [11 – 15].

The "0 – 1 test for chaos" was introduced in 2004 by Gottwald and Melbourne as a means of separating robustly periodic and low-dimensional chaotic dynamics. The test has successfully been applied to several flows and maps, to noisy numerical data, experimental data, quasi-periodically forced systems and strange non-chaotic attractors, Hamiltonian systems, and so on [16 – 20]. The main advantage of the test consists in its binary output. More precisely, for an infinite amount of data taken as input the test returns the value unity in the presence of chaos, and zero otherwise. Other important strong points of the test are (a) the dimensionality of the vector field has not practical limitations, (b) the equations of the underlying dynamics do not need to be known, (c) the test does not require phase space reconstruction, and (d) the computational effort is low cost, both in terms of programming effort and in terms of computational time. In the next section we briefly describe the steps for the implementation of the "0 – 1 test", following [17].

2. IMPLEMENTATION OF THE 0 – 1 TEST

Briefly, the test takes as input a scalar time series of observations $\Phi(j)$, for $j = 1,2,...,N$, and returns a single scalar value usually in the range [0, 1]. To obtain it, the following sequence of steps must be covered:

Step 1: For a fixed real parameter $c \in (0, 2\pi)$, arbitrarily chosen, one construct *the translation variables:*

$$p_c(n) = \sum_{j=1}^{n} \Phi(j)\cos jc \ , \quad q_c(n) = \sum_{j=1}^{n} \Phi(j)\sin jc \quad (1)$$

for $n = 1,2,...,N$. These variables are bounded if the dynamics generating Φ is ordered (i.e periodic or quasi-periodic). Contrary, if the underlying dynamics is chaotic, then p_c and q_c are unbounded and, more than that, they behave asymptotically like a Brownian motion.

Step 2: The growth of p_c and q_c is described by *the mean square displacement* (MSD), defined as

$$M_c(n) = \frac{1}{N - n_{cut}} \sum_{j=1}^{N-n_{cut}} \left\{ [p_c(j+n) - p_c(j)]^2 + [q_c(j+n) - q_c(j)]^2 \right\} \quad (2)$$

for $n \le n_{cut} = N/10 << N$. The definition (2) shows us that the test needs a relatively large number of data points to work properly. The theory behind the test assures that if the underlying dynamics of Φ is deterministic chaos then $M_c(n) \propto n$, while the MCD of a (quasi) periodic dynamics will grow much slower than the number *n* of data points.

For removing a persistent artificial oscillation in M_c, appeared because of p_c and q_c, it was proposed *the smoothed mean square displacement*

$$D_c(n) = M_c(n) - \frac{1 - \cos nc}{1 - \cos c} \left(\frac{1}{N} \sum_{j=1}^{N} \Phi(j) \right)^2 \quad (3)$$

The subtraction of the oscillatory term (the second term in right hand side of (3)) regularizes the linear behavior of M_c in the chaotic case and improves the convergence properties.

Step 3: Compute *the asymptotic growth rate,* K_c, of the mean square displacement. K_c is defined in the first version of the 0 – 1 test as

$$K_c = \lim_{n\to\infty} \frac{\log M_c(n)}{\log n}. \quad (4)$$

From numerical point of view, K_c may be determined by linear regression of $\log M_c(n)$ versus $\log n$, so

$$\log M_c(n) = A\cdot \log n + B,\ K_c = A. \quad (5)$$

Theoretically, the value returned for K_c is close to unity in the case of deterministic chaos, and to zero otherwise. An alternative definition of K_c utilizes the modified mean square displacement D_c:

$$K_c = \lim_{n\to\infty} \frac{\log \tilde{D}_c(n)}{\log n}, \quad (6)$$

where

$$\tilde{D}_c(n) = D_c(n) - \min_{n=1,2,\ldots,n_{cut}} D_c(n). \quad (7)$$

In the most recent version of 0 – 1 test, it was suggested another definition of K_c, more precisely

$$K_c = corr(\xi, \Delta) = \frac{\mathrm{cov}(\xi,\Delta)}{\sqrt{\mathrm{cov}(\xi,\xi)\cdot \mathrm{cov}(\Delta,\Delta)}}, \quad (8)$$

where $\xi = 1,2,\ldots,n_{cut}$, $\Delta = M_c(1), M_c(2),\ldots,M_c(n_{cut})$, and $\mathrm{cov}(x,y)$ denotes the usual covariance sum

$$\mathrm{cov}(x,y) = \frac{\sum_{i=1}^{N}(x(i)-\bar{x})(y(i)-\bar{y})}{N},\ \bar{y} = \frac{\sum_{i=1}^{N} y(i)}{N}. \quad (9)$$

The two approaches are called *regression method* and *correlation method*, respectively.

Step 4: The 0 – 1 test fails to work properly if *c* is a resonant frequency of the analyzed dynamical system. In this case, $M_c(n) \propto n^2$ so $K_c \cong 2$, irrespective of whether the dynamic is regular or chaotic. To avoid this, the steps 1 to 3 must be performed for other values of *c* equally spaced or randomly chosen in the interval $[0.1, 2\pi - 0.1]$ (there exist resonances for $c \in \{0, 2\pi\}$). For practical purposes, $N_c = 100$ values for *c* are sufficient.

Step 5: Compute the binary diagnostic value

$$K = median(K_c). \quad (10)$$

It will have values close to zero for a non-chaotic dynamics and close to one in the presence of deterministic chaos.

3. APPLICATION OF THE 0 – 1 TEST FOR TINKERBELL MAP

In this section, we investigate the capability of the 0 – 1 test to detect the presence or not of chaos in time series obtained by iteration of the Tinkerbell map, a discrete – time dynamical system given by the difference equations

$$x_{n+1} = x_n^2 - y_n^2 + a\,x_n + b\,y_n \quad (11a)$$

$$y_{n+1} = 2\,x_n\,y_n + \bar{c}\,x_n + d\,y_n \quad (11b)$$

where $a, b, \bar{c}$, and d are real parameters. The map exhibits interesting dynamical behaviors, including suddenly appearing and disappearing chaos, interior crisis, symmetry – breaking of periodic orbits, coexisting chaotic sets or invariant circles, absence of an obvious road to chaos by period-doubling bifurcations, and so on [21]. Part of these patterns may be obtained by varying $\bar{c}$ in the range [1.5, 2.0] and fixing $a = 0.9, b = -0.6$, and $d = 0.5$. The associated bifurcation diagram in the $(\bar{c}, x)$ plane is given in Figure 1, together with its local amplification for $\bar{c} \in [1.6, 1.7]$. For the sake of comparison, Figure 2 displays the behavior of the maximum Lyapunov exponent corresponding to Figure 1 [22]. From the diagrams, one can easily see a great abundance of periodic windows separated by large chaotic regions.

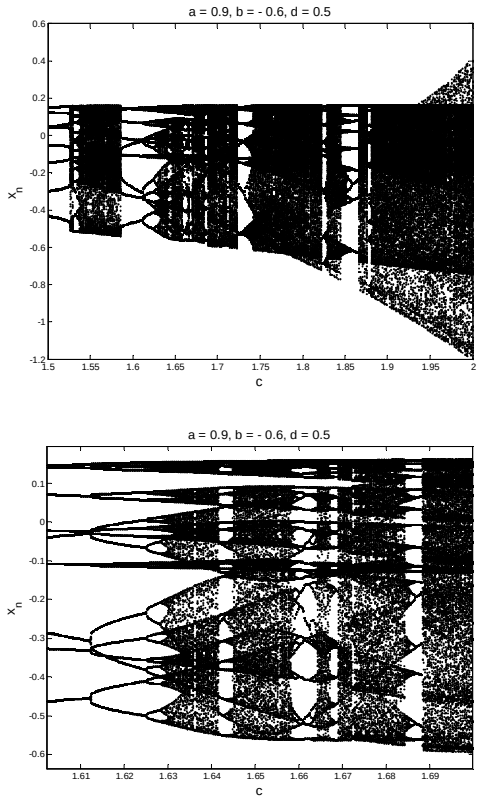


Figure 1 *Up*: Bifurcation diagram of Tinkerbell map for $a = 0.9$, $b = -0.6$, $\bar{c} \in [1.5, 2.0]$, and $d = 0.5$.
Down: Local amplification for $\bar{c} \in [1.6, 1.7]$.

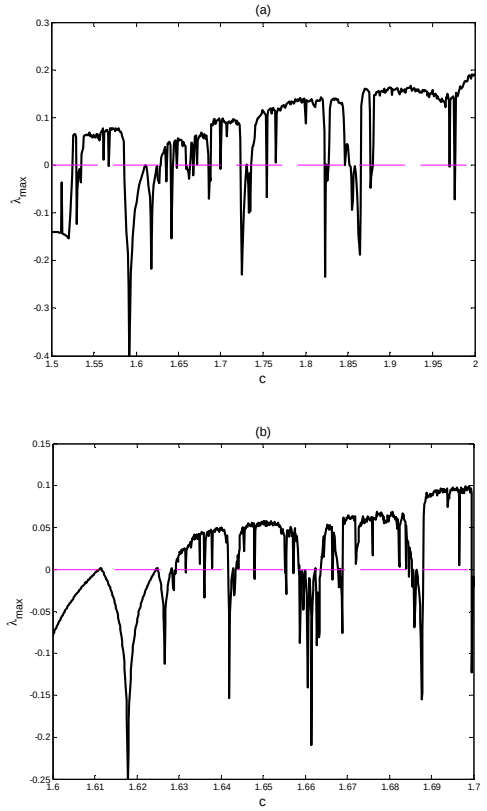
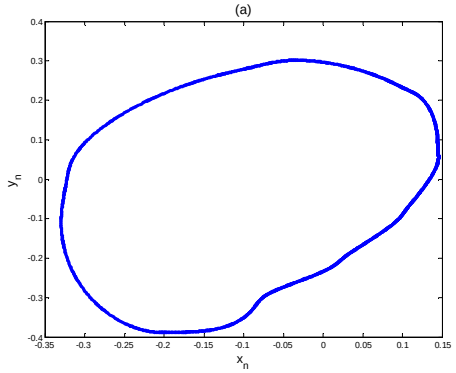


Figure 2 *a)* Maximum Lyapunov exponent of Tinkerbell map for $a = 0.9,\ b = -0.6,\ \bar{c} \in [1.5, 2.0],$ and $d = 0.5$. *b)* Local amplification for $\bar{c} \in [1.6, 1.7]$.

For our purpose of applying "0 -1 test" we selected first a number of four different patterns which are presented in Figure 3.



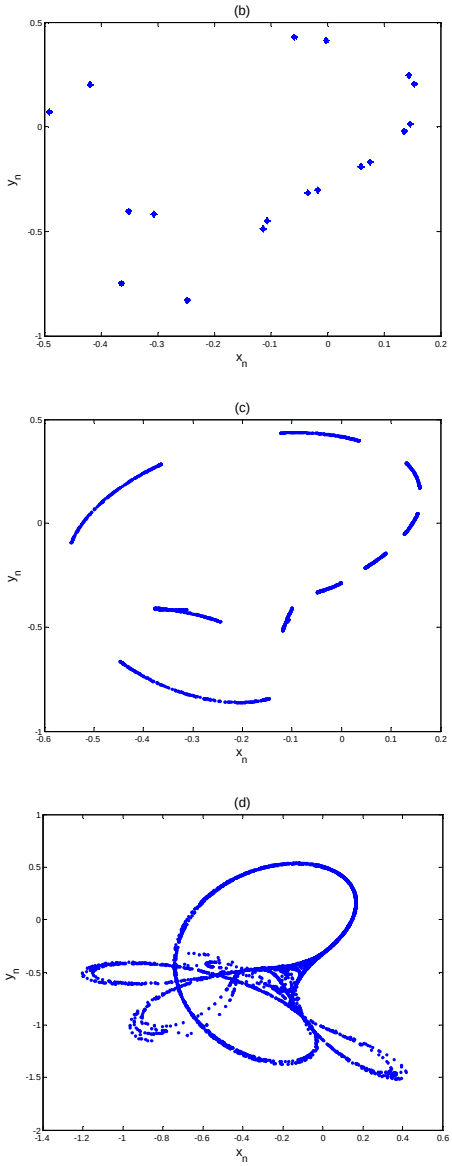
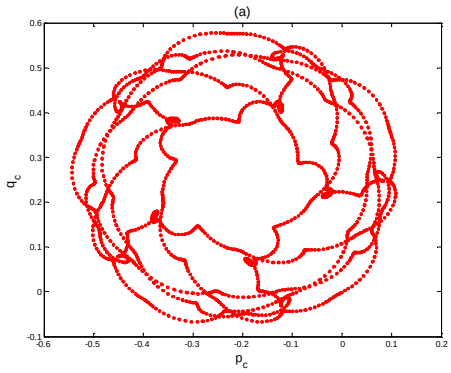


Figure 3 Phase portraits of Tinkerbell map for $a = 0.9,\ b = -0.6,\ d = 0.5$, and various values of $\bar{c}$: *a)* $\bar{c}$ = 1.2 (invariant circle); b) $\bar{c}$ = 1.62 (period – 18 orbit); c) $\bar{c}$ = 1.64 (coexisting chaotic sets); d) $\bar{c}$ = 2.0 (chaotic set).



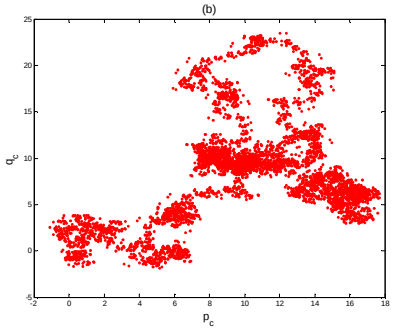
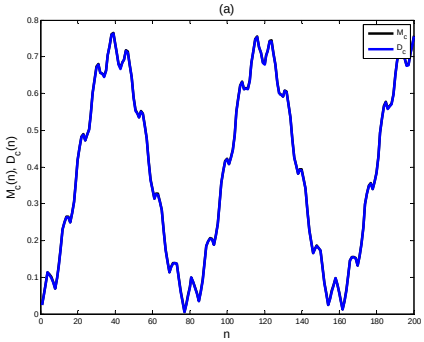


Figure 4 Plots of q_c versus p_c for the Tinkerbell map with $a = 0.9,\ b = -0.6,\ d = 0.5$, and: a) $\bar{c} = 1.2$; b) $\bar{c} = 2.0$.

The next step was to fix $c = 1.55$ and determine the translation variables p_c and q_c for $\Phi(j) = x_j$, $j = 1,2,...,N$, with N = 5000. Plots of q_c versus p_c, only for $\bar{c} \in \{1.2, 2.0\}$, are shown in Figure 4. The bounded nature of the set $\{(p_c(n), q_c(n)), n = 1,2,...,N\}$ for $\bar{c} = 1.2$, as well as its Brownian behavior for $\bar{c} = 2.0$, is more than obvious.

The "0 – 1 test" for chaos is based on the growth rate of M_c or D_c, defined in (2) and (3), as functions of *n*. First, in Figure 5 we plotted the dependence of M_c, respective D_c, with *n* for the same values of parameter $\bar{c}$ used in Figure 4. A notable difference between M_c and D_c is observed only in the chaotic case $\bar{c} = 2.0$. As is mentioned in [17], the disappearance of the oscillatory behavior in the graph of D_c is a consequence of the subtraction which made the difference between M_c and D_c. Then, as a part of regression method, we represented in Figure 6 $\log M_c(n)$ and $\log \tilde{D}_c(n)$ versus $\log n$ and observed that it is desirable to eliminate in the determination of the asymptotic growth rate, K_c, those points corresponding to small *n*, because they contribute to an overestimation of $|K_c|$ in a least square fit (at least for ordered orbits). Each time the regression method has been applied, the first 10% points of the graph have been ignored.



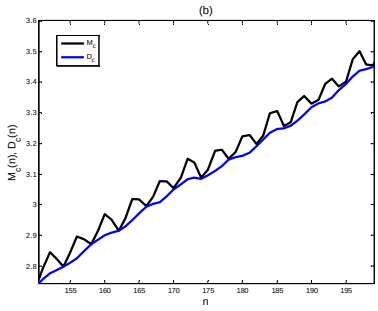


Figure 5 Plots of M_c and D_c versus *n* for the Tinkerbell map with $a = 0.9,\ b = -0.6,\ d = 0.5$, and: a) $\bar{c} = 1.2$; b) $\bar{c} = 2.0$.

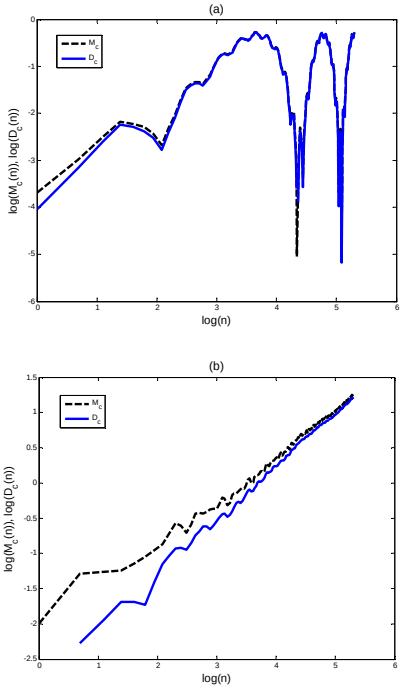


Figure 6 Plots of $\log M_c(n)$ and $\log \tilde{D}_c(n)$ versus $\log n$ for the Tinkerbell map with $a = 0.9,\ b = -0.6,\ d = 0.5$, and: a) $\bar{c} = 1.2$; b) $\bar{c} = 2.0$.

The correlation coefficient K_c was determined both by regression and correlation method. To estimate the influence of time series' length on K_c, we considered two values for n_{cut}, namely $n_{cut} = 200$ and $n_{cut} = 500$. The results are summarized in Tables 1 and 2.

Table 1. Values of K_c for the Tinkerbell map with $a = 0.9,\ b = -0.6,\ d = 0.5$, different $\bar{c}$, and two time series lengths. The computation of K_c was based on M_c.

$\bar{c}$	**Regression method**		**Correlation method**	
	$n_{cut} = 200$	$n_{cut} = 500$	$n_{cut} = 200$	$n_{cut} = 500$
1.2	0.1352	0.0278	0.0551	- 0.0567
1.62	- 0.1360	- 0.0782	0.0263	- 0.0312
1.64	0.2793	0.4713	0.5491	0.8464
2.0	0.6545	0.6403	0.9927	0.9874

Table 2. Values of K_c for the Tinkerbell map with $a = 0.9,\ b = -0.6,\ d = 0.5$, different $\bar{c}$, and two time series lengths. The computation of K_c was based on $\tilde{D}_c$.

$\bar{c}$	**Regression method**		**Correlation method**	
	$n_{cut} = 200$	$n_{cut} = 500$	$n_{cut} = 200$	$n_{cut} = 500$
1.2	0.1174	0.0247	0.0551	- 0.0565
1.62	- 0.0972	- 0.0457	0.0269	- 0.0308
1.64	0.3325	0.5346	0.5502	0.8469
2.0	0.7285	0.7584	0.9931	0.9880

At least for the analyzed cases, the values obtained for K_c by using correlation method practically do not change by replacing M_c with $\tilde{D}_c$, while the same modification leads to greatly improved values for K_c when the regression method is used instead. As expected, the K_c approach asymptotic values 0 or 1 if the amount of data is increased (especially for chaotic orbits).

As mentioned in Section 2, to avoid the possibility that c to be a resonant point, one must to perform the above steps for other values of it.

Choosing 100 equally spaced values of c in the interval $[0.1, 2\pi - 0.1]$ and computing K either as $K = mean(K_c)$ or $K = median(K_c)$, we found the values summarized in Tables 3 and 4. We have now another proof that the correlation method works almost identically for M_c and D_c, and that an increased number of data for the observable Φ is desirable. The definition $K = median(K_c)$ turns out to be more effective than that using the mean of the computed values of K_c, especially for ordered orbits.

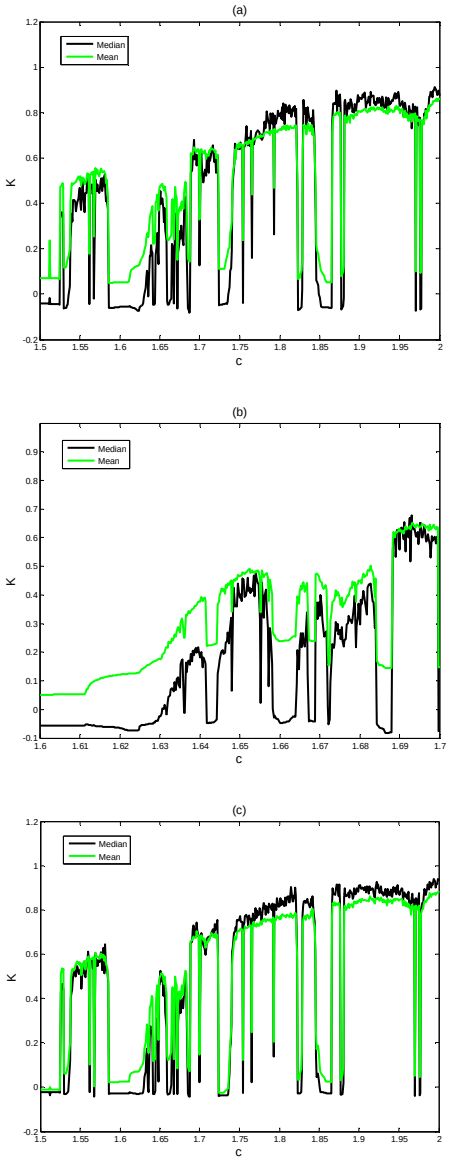
Table 3. Values of K for the Tinkerbell map with $a = 0.9,\ b = -0.6,\ d = 0.5$, different $\bar{c}$, and two time series lengths. The computation of K_c was based on M_c and correlation method.

$\bar{c}$	$n_{cut} = 200$		$n_{cut} = 500$	
	$mean(K_c)$	$median(K_c)$	$mean(K_c)$	$median(K_c)$
1.2	0.1315	0.0216	0.0695	0.0007
1.62	0.1258	0.0172	0.0585	0.00002
1.64	0.4938	0.4155	0.5411	0.5972
2.0	0.9543	0.9954	0.9591	0.9971

Table 4. Values of K for the Tinkerbell map with $a = 0.9,\ b = -0.6,\ d = 0.5$, different $\bar{c}$, and two time series lengths. The computation of K_c was based on D_c and correlation method

$\bar{c}$	$n_{cut} = 200$		$n_{cut} = 500$	
	$mean(K_c)$	$median(K_c)$	$mean(K_c)$	$median(K_c)$
1.2	0.1290	0.0170	0.0705	0.0019
1.62	0.1248	0.0172	0.0594	0.0035
1.64	0.4958	0.4159	0.5566	0.6003
2.0	0.9543	0.9954	0.9912	0.9977

In order to present the effectiveness of the "0 – 1" test in detecting regions of order and chaos, we extended our study by computing K for the same parameters' values as those utilized in Figures 1 and 2. First, we compared the results given by $K = median(K_c)$ with those provided by $K = mean(K_c)$, both for the regression method and the correlation method. Our findings are shown in Figures 7 and 8. We used 100 equally spaced values for c and the mean square displacement M_c. Even a superficial analysis of the above-mentioned figures shows that the correlation method greatly outperforms the regression method and the median provides better results than the mean of the computed values of K_c.



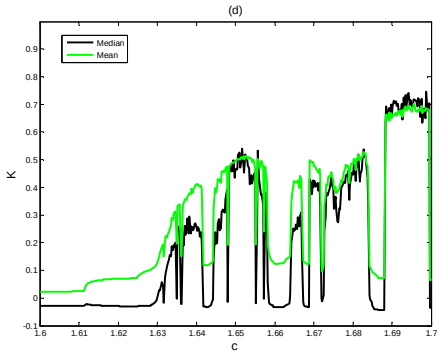


Figure 7 "0 – 1" test results for Tinkerbell map with $a = 0.9,\ b = -0.6,\ d = 0.5$, and: a) $\bar{c} \in [1.5, 2.0]$, $N = 2000$; b) $\bar{c} \in [1.6, 1.7]$, $N = 2000$; c) $\bar{c} \in [1.5, 2.0]$, $N = 5000$; d) $\bar{c} \in [1.6, 1.7]$, $N = 5000$.
We used the regression method.

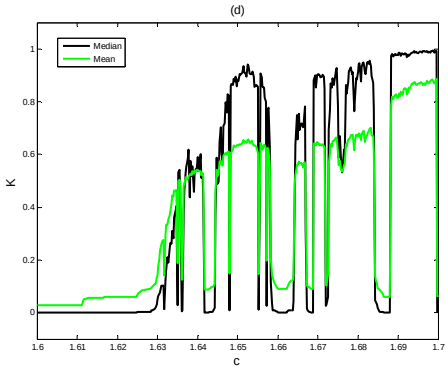
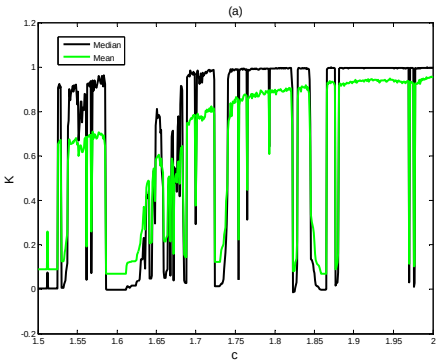
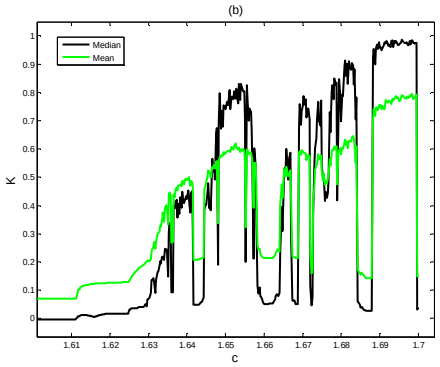
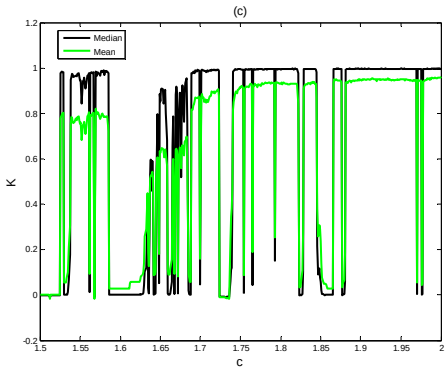


Figure 8 "0 – 1" test results for Tinkerbell map with $a = 0.9,\ b = -0.6,\ d = 0.5$, and: a) $\bar{c} \in [1.5, 2.0]$, $N = 2000$; b) $\bar{c} \in [1.6, 1.7]$, $N = 2000$; c) $\bar{c} \in [1.5, 2.0]$, $N = 5000$; d) $\bar{c} \in [1.6, 1.7]$, $N = 5000$.
We used the correlation method.

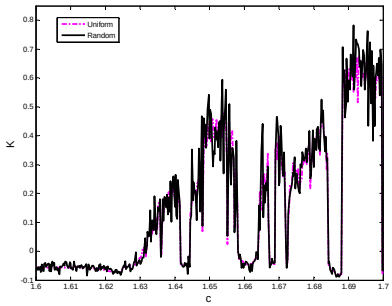






However, regardless of the used definition of *K* or the applied method, the verdict on the orbit's type given by the "0 – 1 test" is in full compliance with Lyapunov coefficient's values. The only differences occurred near the edge of chaos, where the "0 – 1 test" needs more iterations to distinguish between regular and chaotic orbits.

Second, our further numerical investigation has proposed to analyze the effect on *K* of a choice of randomly sampled values of *c* instead of an evenly distributed set. The results, displayed in Figures 9 and 10, indicate that for ordered orbits the selection mode of *c* is less important for the test, both methods providing values of *K* close to 0. On the other hand, for chaotic orbits the two ways of choosing *c* produce significantly different results, but the convergence tendency towards the asymptotic value $K = 1$ is not affected at all. Somewhat surprisingly, the regression method indicates smaller differences between the results than the correlation method. We worked with M_c, $N = 2000$ and median of K_c values.



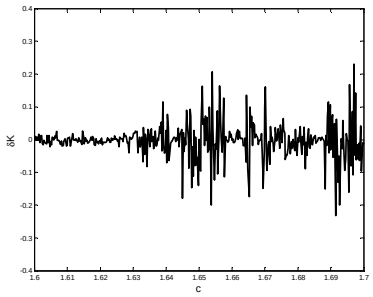


Figure 9 "0 – 1" test results for randomly and equally spaced values of *c*. The regression method was used. *Up*: Plot of *K* versus *c*; *Down*: Difference between the *K* values showed upward versus *c*.

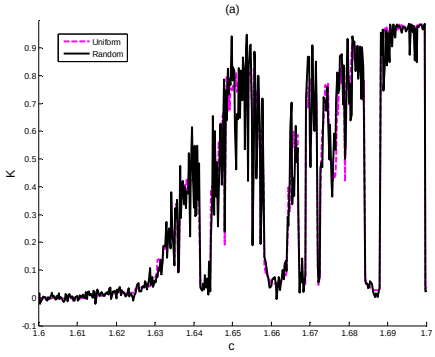


Figure 10 "0 – 1" test results for randomly and equally spaced values of *c*. The correlation method was used. *Up*: Plot of *K* versus *c*; *Down*: Difference between the *K* values showed upward versus *c*.

Finally, we wanted to answer the question: *How many different values of c to consider?* Figures 11 and 12 present a comparison between the *K* values obtained with 10, 100 and 200 values of *c*. As pointed out in [17], is no measurable gain in increasing number of *c* values above 100, irrespective of the used method. However, at least for the chaotic orbits, by choosing 10 values instead of 100 we get better results. This occurred rather by chance, because for a small number of *c* values the binary diagnostic value *K* shows sudden and large changes, as illustrated in Figure 13. Starting with $N_c = 50$, the dependence of *K* with N_c for a well-defined orbit is almost negligible.

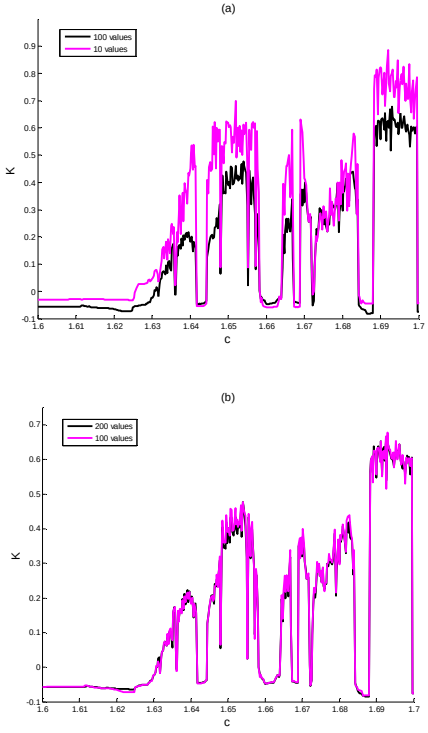


Figure 11 "0 – 1" test results for different values of *c*. The regression method was used.
a) 10 versus 100 values; b) 100 versus 200 values.

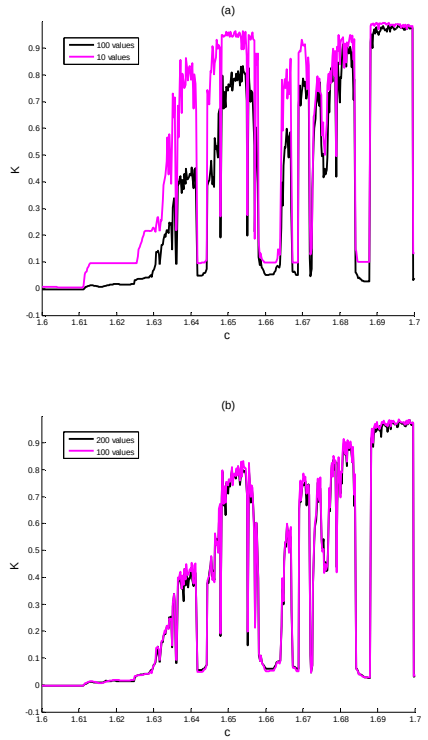


Figure 12 "0 – 1" test results for different values of *c*. The correlation method was used.
a) 10 versus 100 values; b) 100 versus 200 values.

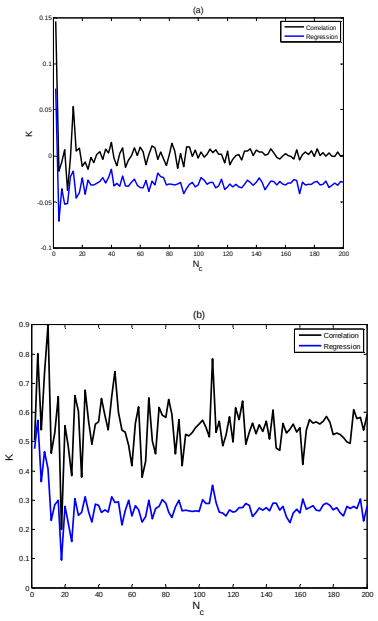


Figure 13 The dependence of binary diagnostic value K on number N_c of c values for Tinkerbell map with $a = 0.9,\ b = -0.6,\ d = 0.5$, and: a) $\bar{c} = 1.62$ (periodic orbit); b) $\bar{c} = 1.64$ (chaotic orbit)

4. CONCLUSIONS

In the paper, we have illustrated the capability of the "0 – 1 test" in distinguishing between order and chaos in Tinkerbell map system. At the same time, we have presented a comparison between the initial version of the test (based on the regression method) and the improved one (based on the correlation method). Generally, we have found that last version of the test greatly outperforms the first one and we have concluded that it represents a valuable numerical diagnostic tool for nonlinear deterministic time series analysis.

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MODELLING THE GROWTH OF WIND-INDUCED OSCILLATIONS IN OVERHEAD LINES. NON-RESONANT CASE

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ABSTRACT

Galloping is a high amplitude periodic oscillation of both single and bundle conductors due to aerodynamic instability hitting high voltage overhead lines, with a single or a few loops of standing waves per span. The inability to control galloping can lead to severe disruptions in the electrical power supply.

In the paper, a simplified two-dimensional nonlinear discrete model of an iced suspended cable, excited by uniform wind velocity, is developed in quasi-static regime. The equations of motion are coupled through cubic terms and the ratio of the associated linear frequencies is not close to a ratio of two positive integers (so we speak about the non-resonant case). The Krylov-Bogoliubov method is employed to obtain a set of four amplitude modulation equations, which provides us the steady state solutions. Analytical results are compared with direct numerical integration results of discrete nonlinear equations and conclusions are presented.

Keywords: *Galloping in overhead lines, non-resonant case, approximate solution.*

1. INTRODUCTION

Probably no other large structure has so much of its mass in such a highly flexible form, and so continuously exposed to the forces of wind, as does the modern transmission lines. This makes the line susceptible to the development of sustained, cyclic conductor motions. These motions may take the form of Aeolian vibration, conductor galloping, or wake-induced oscillations. In all of them, incremental amounts of mechanical power are repeatedly absorbed from the wind into the line.

Galloping is a high amplitude periodic oscillation of both single and bundle conductors due to aerodynamic instability hitting high voltage overhead lines, with a single or a few loops of standing waves per span. This instability is always caused by moderately strong, steady crosswind acting upon on asymmetrically-iced conductor surface. The large amplitudes are generally (but not always) in a vertical plane, and range typically from ± 0.1 to ± 1.0 times the sag of the span. Frequencies often vary between 0.15 Hz and 10 Hz, depending on the type of line construction and the oscillation mode excited. The inability to control galloping can lead to severe disruptions in the electrical power supply. Further, galloping can cause wear and fatigue damage to conductors, insulator strings, and support hardware and tower components.

Galloping has been documented since the 1930 [1] and, despite extensive analytical and experimental investigations, has not been resolved satisfactorily. Den Hartog (1932) introduced a criterion for vertical galloping that specifies under what aerodynamic load conditions a conductor will gallop. There has been extensive investigation of the galloping phenomenon since then, including static and dynamic laboratory tests of a variety of cross-sectional shapes to determine their propensity to gallop [e.g. Cheers (1950), Parkinson (1965), Novak (1972), Nigol and Clarke (1974)] and theoretical models of galloping to analyze the motion and to determine a relationship between the wind speed and the galloping amplitude [e.g. Richardson (1965), Novak (1969), Blevins and Iwan (1974), van Horssen (1989), Yu, Shah and Popplewell (1992), Luongo (1996), van Oudheusden (2000), Deleanu (2009)] [2 – 14]. This paper proposes a non-linear, two-degree-of-freedom model of conductor galloping that describes galloping line motion in both the transient and steady state cases. Special attention is allowed to the case in which the ratio of the two natural frequencies is not close to a ratio of two positive integers, so that we speak about the non-resonance case.

2. THE KRYLOV-BOGOLIUBOV MEHOD. BASIC IDEA

The motion of an *n*-degree-of-freedom system is described by

$$\ddot{\eta}_i + \omega_i^2 \eta_i = \varepsilon f_i\left(\nu\tau, \eta_j, \dot{\eta}_j\right), i, j = \overline{1,n} \qquad (1)$$

where the dots indicate differentiation with respect to normalized time τ and η_i, ω_i are the *i*th normalized co-ordinate and eigenvalue, respectively, of the corresponding linear system ($\varepsilon = 0$). The f_i is the analogous normalized force, including all the non-linear terms as well as the damping terms and ν is the frequency of the external forcing function. The parameter $\varepsilon << 1$ represents a week non-linearity. When $\varepsilon = 0$, a response can be written in the form

$$\eta_i(\tau) = X_i \cos(\omega_i \tau + \phi_i), \; i = \overline{1,n} \qquad (2)$$

where constants X_i and ϕ_i, respectively, represent the *i*th component's amplitude and phase, which are determined from the initial conditions [15]. The solution for $\varepsilon \neq 0$ can be considered to be a perturbation of solution (2) and, therefore, may be expressed by

$$\eta_i(\tau) = X_i(\tau)\cos(\omega_i \tau + \phi_i), \; i = \overline{1,n} \qquad (3)$$

with $X_i(\tau)$ and $\phi_i(\tau)$ "slowly varying variables"

2.1. Non-resonance case

This case implies that a ratio of any two natural frequencies is not close to a ratio of two positive integers. By differentiating equation (3) with respect to τ and letting the amplitudes and phases be chosen such that

$$\dot{X}_i(\tau)\cos(\omega_i\tau+\phi_i(\tau))-X_i(\tau)\dot{\phi}_i(\tau)\sin(\omega_i\tau+\phi_i(\tau))=0$$

we find that

$$\dot{\eta}_i(\tau)=-X_i(\tau)\,\omega_i\sin(\omega_i\tau+\phi_i(\tau)) \qquad (4)$$

Differentiate equation (4) with respect to τ and substitute the resulting equation into (1), yields

$$\dot{X}_i(\tau)\sin(\omega_i\tau+\phi_i(\tau))+X_i(\tau)\dot{\phi}_i(\tau)\cos(\omega_i\tau+\phi_i(\tau))=$$

$$=-\frac{\varepsilon}{\omega_i}f_i(X_i\cos(\omega_i\tau+\phi_i(\tau)),-\omega_i X_i\sin(\omega_i\tau+\phi_i(\tau))) \qquad (5)$$

Solving eqs. (4) and (5) for $\dot{X}_i$ and $\dot{\phi}_i$ and employing time-averaging leads to

$$\dot{X}_i=-\frac{\varepsilon}{\omega_i}\cdot\lim_{T\to\infty}\frac{1}{T}\int_0^T\sin(\omega_i\tau+\phi_i(\tau))\cdot$$

$$\cdot f_i(X_i\cos(\omega_i\tau+\phi_i(\tau)),-\omega_i X_i\sin(\omega_i\tau+\phi_i(\tau)))\,d\tau \qquad (6)$$

$$\dot{\phi}_i=-\frac{\varepsilon}{\omega_i X_i}\cdot\lim_{T\to\infty}\frac{1}{T}\int_0^T\cos(\omega_i\tau+\phi_i(\tau))\cdot$$

$$\cdot f_i(X_i\cos(\omega_i\tau+\phi_i(\tau)),-\omega_i X_i\sin(\omega_i\tau+\phi_i(\tau)))\,d\tau$$

The amplitude of the steady state solution, X_i, is determined by setting $\dot{X}_i=0$ in eqs. (6). This yields:

$$\lim_{T\to\infty}\frac{1}{T}\int_0^T\sin(\tilde{\omega}_i\tau)\,f_i(X_i\cos(\tilde{\omega}_i\tau),-\omega_i X_i\sin(\tilde{\omega}_i\tau))d\tau=0 \qquad (7)$$

where $\tilde{\omega}_i=\omega_i+\dot{\phi}_i,\ i=\overline{1,n}$.

Equation (7) contains *n* independent, non-linear algebraic equations which can be used to solve the *n* independent variables X_i because the ω_i are known (the solution may not be unique). Having found X_i, the corresponding frequency, $\tilde{\omega}_i$, is determined from (6):

$$\tilde{\omega}_i=\omega_i-\frac{\varepsilon}{\omega_i X_i}\lim_{n\to\infty}\frac{1}{T}\int_0^T\cos(\omega_i\tau+\phi_i(\tau))\cdot$$

$$\cdot f_i(X_i\cos(\omega_i\tau+\phi_i(\tau)),-\omega_i X_i\sin(\omega_i\tau+\phi_i(\tau)))\,d\tau \qquad (8)$$

A stability analysis can be performed on the Jacobian matrix of equation (6). If all the eigenvalues, evaluated on the steady state solution, have negative real parts, then the solution is stable. Otherwise, the solution is unstable.

3. MODEL PRESENTATION

Assume a one-dimensional body having a cross-section of an arbitrarily shape in a horizontal wind field $\vec{V}_\infty$. The body is reported to a Cartesian system with *y* axis perpendicular to the wind direction. The two-degrees-of-freedom are the vertical plunge *y* and the torsional angle θ around the elastic axis (see Figure 1).

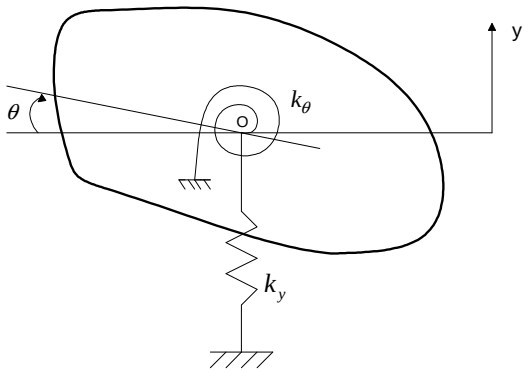

Figure 1 Two-degree-of-freedom model for galloping

Mass per unit length is *m* and momentum of inertia J_0. k_y and k_θ are the vertical and torsional stiffness and c_y, c_θ are corresponding viscous dampers (unrepresented on the figure). The equations describing the motion of a two-degree-of-freedom model are:

$$m\ddot{y}+c_y\dot{y}+k_y y=F_y \qquad (9)$$

$$J_0\ddot{\theta}+c_\theta\dot{\theta}+k_\theta\theta=M \qquad (10)$$

F_y and *M* represent the vertical aerodynamic force and the aerodynamic momentum, respectively. They are functions of the angle of attack α, and can be expressed by

$$F_y=\frac{1}{2}\rho_a V_\infty^2 d\,C_y(\alpha)\ ,\ M=\frac{1}{2}\rho_a V_\infty^2 d^2 C_M(\alpha) \qquad (11)$$

where ρ_a is air density, *d* is a suitable reference length of cross-section and C_y, C_M dimensionless aerodynamic coefficients (obtained from measurements). They are relatively smooth continuous functions of α and may be approximated by cubic polynomial (Blevins, 1974)

$$C_y=a_1\alpha+a_3\alpha^3,\ C_M=b_1\alpha+b_3\alpha^3 \qquad (12)$$

The angle α can be approximated by

$$\alpha\cong\theta-\frac{\dot{y}}{V_\infty}-R_1\frac{\dot{\theta}}{V_\infty} \qquad (13)$$

where R_1 is a reference length of cross-section (we will consider that $R_1=\frac{l}{2}$). In conclusion, the motion of proposed model is governed by the following equations:

$$\ddot{y}+\omega_y^2\cdot y=-\frac{c_y}{m}\dot{y}+\frac{\rho_a V_\infty^2 d}{2m}\left(a_1\alpha+a_3\alpha^3\right) \quad (14)$$

$$\ddot{\theta}+\omega_\theta^2\cdot\theta=-\frac{c_\theta}{J_0}\dot{\theta}+\frac{\rho_a V_\infty^2 d^2}{2J_0}\left(b_1\alpha+b_3\alpha^3\right) \quad (15)$$

where $\omega_y^2=\frac{k_y}{m},\omega_\theta^2=\frac{k_\theta}{J_0}$ represent the associated natural frequencies.

4. THE GOVERNING BIFURCATION EQUATIONS

The terms involved in the right-side of eqs. (14, 15) are usually order ε, $0<\varepsilon\le 1$, compared to unit order terms in left-side of mentioned equations:

$$c_y=\varepsilon\hat{c}_y,\ c_\theta=\varepsilon\hat{c}_\theta,\ a_i=\varepsilon\hat{a}_i,\ b_i=\varepsilon\hat{b}_i,i=\overline{1,3} \quad (16)$$

Hence, the dynamic equilibrium equations (17) can be considered to be weakly nonlinear and a perturbation technique, like Krylov - Bogoliubov method, can be applied to approximate a dynamical motion.

$$\ddot{y}+\omega_y^2\cdot y=\varepsilon f_y\left(y,\theta,\dot{y},\dot{\theta}\right),\ \ddot{\theta}+\omega_\theta^2\cdot\theta=\varepsilon f_\theta\left(y,\theta,\dot{y},\dot{\theta}\right) \quad (17)$$

$$f_y=-\frac{\hat{c}_y}{m}\dot{y}+\frac{\rho_a V_\infty^2 d}{2m}\left[\hat{a}_1\left(\theta-\frac{\dot{y}}{V_\infty}-R_1\frac{\dot{\theta}}{V_\infty}\right)+\hat{a}_3\left(\theta-\frac{\dot{y}}{V_\infty}-R_1\frac{\dot{\theta}}{V_\infty}\right)^3\right]$$

$$f_\theta=-\frac{\hat{c}_\theta}{J_0}\dot{\theta}+\frac{\rho_a V_\infty^2 d^2}{2J_0}\left[\hat{b}_1\left(\theta-\frac{\dot{y}}{V_\infty}-R_1\frac{\dot{\theta}}{V_\infty}\right)+\hat{b}_3\left(\theta-\frac{\dot{y}}{V_\infty}-R_1\frac{\dot{\theta}}{V_\infty}\right)^3\right]$$

By following the procedure outlined in Section 2, the periodic or quasi-periodic solutions of eqs. (17) are assumed to take the form

$$y(t)=Y(t)\cos\left(\omega_y t+\phi_y(t)\right),\ \theta(t)=\Theta(t)\cos\left(\omega_\theta t+\phi_\theta(t)\right) \quad (18)$$

where amplitudes Y,Θ and phases ϕ_y,ϕ_θ are given by

$$\dot{Y}=-\frac{\varepsilon}{\omega_y}\cdot\lim_{T\to\infty}\frac{1}{T}\int_0^T\sin\left(\omega_y\tau+\phi_y(\tau)\right)\cdot$$

$$\cdot f_y\left(Y(\tau)\cos\left(\omega_y\tau+\phi_y(\tau)\right),\Theta(\tau)\cos\left(\omega_\theta\tau+\phi_\theta(\tau)\right),\right.$$

$$\left.-\omega_y Y(\tau)\sin\left(\omega_y\tau+\phi_y(\tau)\right),-\omega_\theta\Theta(\tau)\sin\left(\omega_\theta\tau+\phi_\theta(\tau)\right)\right)d\tau$$

$$\dot{\Theta}=-\frac{\varepsilon}{\omega_\theta}\cdot\lim_{T\to\infty}\frac{1}{T}\int_0^T\sin\left(\omega_\theta\tau+\phi_\theta(\tau)\right)\cdot$$

$$\cdot f_\theta\left(Y(\tau)\cos\left(\omega_y\tau+\phi_y(\tau)\right),\Theta(\tau)\cos\left(\omega_\theta\tau+\phi_\theta(\tau)\right),\right.$$

$$\left.-\omega_y Y(\tau)\sin\left(\omega_y\tau+\phi_y(\tau)\right),-\omega_\theta\Theta(\tau)\sin\left(\omega_\theta\tau+\phi_\theta(\tau)\right)\right)d\tau$$

$$\dot{\phi}_y=-\frac{\varepsilon}{\omega_y Y}\cdot\lim_{T\to\infty}\frac{1}{T}\int_0^T\cos\left(\omega_y\tau+\phi_y(\tau)\right)\cdot \quad (19)$$

$$\cdot f_y\left(Y(\tau)\cos\left(\omega_y\tau+\phi_y(\tau)\right),\Theta(\tau)\cos\left(\omega_\theta\tau+\phi_\theta(\tau)\right),\right.$$

$$\left.-\omega_y Y(\tau)\sin\left(\omega_y\tau+\phi_y(\tau)\right),-\omega_\theta\Theta(\tau)\sin\left(\omega_\theta\tau+\phi_\theta(\tau)\right)\right)d\tau$$

$$\dot{\phi}_\theta=-\frac{\varepsilon}{\omega_\theta\Theta}\cdot\lim_{T\to\infty}\frac{1}{T}\int_0^T\cos\left(\omega_\theta\tau+\phi_\theta(\tau)\right)\cdot$$

$$\cdot f_\theta\left(Y(\tau)\cos\left(\omega_y\tau+\phi_y(\tau)\right),\Theta(\tau)\cos\left(\omega_\theta\tau+\phi_\theta(\tau)\right),\right.$$

$$\left.-\omega_y Y(\tau)\sin\left(\omega_y\tau+\phi_y(\tau)\right),-\omega_\theta\Theta(\tau)\sin\left(\omega_\theta\tau+\phi_\theta(\tau)\right)\right)d\tau$$

With notations

$$\bar{Y}=\frac{Y}{d},U=\frac{V_\infty}{\omega_y d},\tau=\omega_y t,\eta_y=\frac{\rho_a d^2}{2m},\eta_\theta=\frac{\rho_a d^4}{2J_0},$$

$$\xi_y=\frac{c_y}{2m\omega_y},\ \xi_\theta=\frac{c_\theta}{2J_0\omega_\theta},r=\frac{\omega_\theta}{\omega_y},\bar{R}_1=\frac{R_1}{d} \quad (20)$$

the integration of (19) produces the following non-dimensionalized governing bifurcation equations

$$\frac{d\bar{Y}}{d\tau}=-\left(\xi_y+\frac{\eta_y U}{2}a_1\right)\bar{Y}-\frac{3a_3}{4}\left[\frac{\eta_y}{2U}\bar{Y}^2+\right.$$

$$\left.+\left(\eta_y U+\frac{\eta_y r^2\bar{R}_1^2}{U}\right)\Theta^2\right]\bar{Y},\frac{d\Theta}{d\tau}=-\left(r\xi_\theta+\frac{\eta_\theta U\bar{R}_1 b_1}{2}\right)\Theta$$

$$-\frac{3b_3}{4}\left[\frac{\eta_\theta\bar{R}_1}{U}\bar{Y}^2+\frac{\eta_\theta\bar{R}_1}{2}\left(U+\frac{\bar{R}_1^2 r^2}{U}\right)\Theta^2\right]\Theta \quad (21)$$

$$\frac{d\phi_y}{d\tau}=0$$

$$\frac{d\phi_\theta}{d\tau}=-\frac{\eta_\theta U^2 b_1}{2r}-\frac{3b_3}{4}\left[\frac{\eta_\theta}{r}\bar{Y}^2+\frac{\eta_\theta U^2}{2r}\left(1+\frac{\bar{R}_1^2 r^2}{U^2}\right)\Theta^2\right].$$

5. THE INITIATION OF GALLOPING AND STABILITY ANALYSIS

The steady-state solutions can be obtained from (21) by setting $\frac{d\bar{Y}}{d\tau}=\frac{d\Theta}{d\tau}=0$. They are listed below and represent the initial equilibrium solution, the Hopf bifurcation solution corresponding to a periodic plunge vibration, the Hopf bifurcation solution corresponding to a periodic torsional vibration, and a motion on a two-dimensional torus, respectively [16 -17].

(I) $\bar{Y}=\Theta=0$ (22)

$$\textbf{(II)}\ \bar{Y}^2=-\frac{4U}{3a_3}\left(\frac{2\xi_y}{\eta_y}+U a_1\right),\ \Theta=0 \tag{23}$$

$$\textbf{(III)}\ \bar{Y}=0,\Theta^2=-\frac{4}{3\bar{R}_1 b_3}\frac{\frac{2r\xi_\theta}{\eta_\theta}+U\bar{R}_1 b_1}{U+\frac{\bar{R}_1^2 r^2}{U}} \tag{24}$$

$$\textbf{(IV)}\ \bar{Y}^2=\frac{A_2C_1-A_1C_2}{B_1C_2-B_2C_1},\ \Theta^2=\frac{A_1B_2-A_2B_1}{B_1C_2-B_2C_1} \tag{25}$$

where $A_1=-\left(\xi_y+\frac{\eta_y U a_1}{2}\right)$, $A_2=-\left(r\xi_\theta+\frac{\eta_\theta U\bar{R}_1 b_1}{2}\right)$

$$B_1=-\frac{3a_3\eta_y}{8U},\ C_1=-\frac{3a_3\eta_y}{4}\left(U+\frac{\bar{R}_1^2 r^2}{U}\right),$$

$$B_2=-\frac{3b_3\eta_\theta\bar{R}_1}{4U},\ C_2=-\frac{3b_3\eta_\theta\bar{R}_1}{8}\left(U+\frac{\bar{R}_1^2 r^2}{U}\right).$$

To study the stability conditions for these solutions we consider the Jacobian matrix

$$J=\begin{pmatrix}A_1+3B_1\bar{Y}^2+C_1\Theta^2 & 2C_1\bar{Y}\Theta\\ 2b_2\bar{Y}\Theta & A_2+B_2\bar{Y}^2+3C_2\Theta^2\end{pmatrix} \tag{26}$$

For brevity, we will consider next only the first three solutions. A comprehensive study will be done in another paper. By substituting eqs. (22-24) into (26), and searching for sign of the real parts of the eigenvalues of *J*, one finds the results summarized in Appendix (see Table 1). There, we are used the non-dimensionalized quantities:

$$U_y=\frac{\eta_y U a_1}{2\xi_y},\ U_\theta=\frac{\eta_\theta U\bar{R}_1 b_1}{2r\xi_\theta} \tag{27}$$

Finally, it is worth noting that the frequency for the purely plunge vibration (II) remain unchanged (equal to ω_y) whereas the frequency of torsional vibration (III) becomes $\omega_2=\omega_\theta\left(1+\frac{U\xi_\theta}{r\bar{R}_1}\right)$.

6. NUMERICAL RESULTS

The theory developed in the paper was applied to a typical angle section model considered in detail by Modi et al. [5]. The aerodynamic lift and moment coefficients of the model were measured from wind tunnel tests. The structural and aerodynamic properties of the angle section are well documented in reference [5], and they are used to yield

$$a_1=-0.656, a_3=7.83, b_1=-0.105, b_3=9.37, \xi_y=0.0041,$$

$$\xi_\theta=0.00513, \eta_\theta=0.01952, r=2.92, \bar{R}_1=0.5.$$

The normalized wind speed U was chosen as a parameter. The initial equilibrium (I) was found to be stable for $U<4.2273$. Indeed, for $U=2$ we get $U_y=-0.4731, U_\theta=-0.0684$. Figure 2 reveals the vanishing of an initial excitation $\left(\bar{Y}_0,\Theta_0\right)=(0.3,0.25)$.

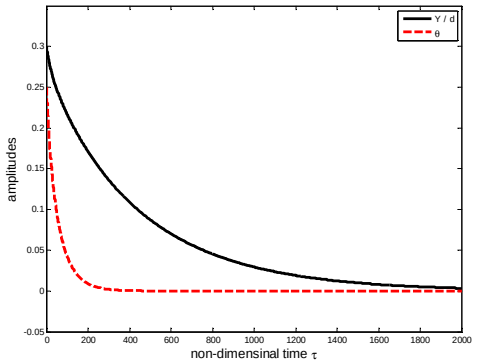

Figure 2 Stability of solution (I) for $U=2$

If the normalized wind speed is increased at $U=6.0$, then $U_y=-1.4193$, $U_\theta=-0.2052$. That means the solution (I) becomes unstable and a Hopf bifurcation to solution (II) appears. It corresponds to a periodic plunge vibration with amplitude $\bar{Y}=1.0891$ (see Figure 3). The basin of attraction for this solution is the set $\left\{\left(\bar{Y}_0,\Phi_0\right),\bar{Y}_0\neq 0\right\}$.

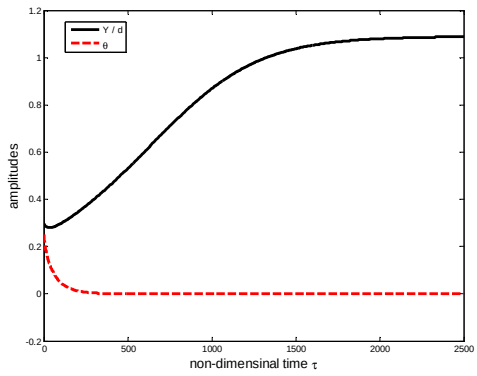

Figure 3 Periodic plunge vibration for $U=6.0$

If the initial condition is selected from this basin, then the solution (I) will remain stable, irrespective of the normalized wind speed $U>4.2273$. Because the linear part in (23) is dominant with respect to the quadratic one, the amplitude of the plunge motion will increase almost linear with U (see Figure 4). The time required for the wind – induced oscillation to converge to one of the steady states (I) or (II) is considerably larger in the area adjacent to the bifurcation value $U=4.2273$, as shown in Figure 5.

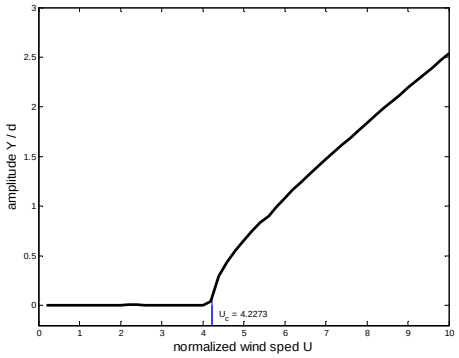

Figure 4 The Hopf bifurcation from the equilibrium solution to a periodic plunge oscillation

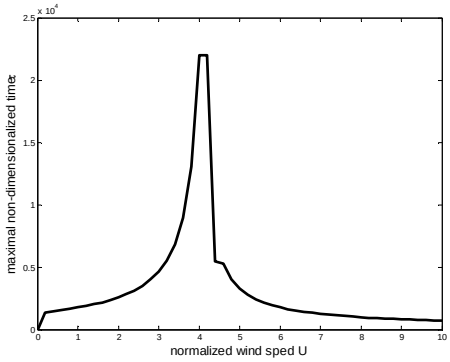

Figure 5 The convergence time to the steady – states (I) and (II) versus normalized wind speed

If the initial condition $\left(\overline{Y}_0, \Theta_0\right)$ is characterized by $\overline{Y}_0 = 0$, then the equilibrium solution (I) becomes unstable starting with $U = 29.2372$ and a periodic torsional oscillation bifurcates from it. As an example, for $U = 32$ we get $U_y = -0.7265, U_\theta = -2.1432 < -1$. The Hopf bifurcation from solution (I) to solution (III) corresponds to a periodic torsional vibration with amplitude $\Theta = 0.036$ (see Figure 6).

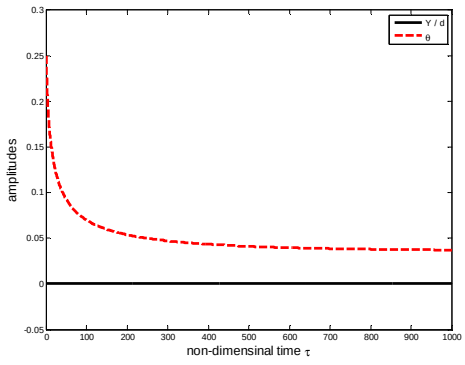

Figure 6 Periodic torsional vibration for $U = 32$

This time, the quadratic part of (24) is much better represented in the amplitude curve, as presented in Figure 7. This solution preserves its stability too, regardless the magnitude of normalized wind speed.

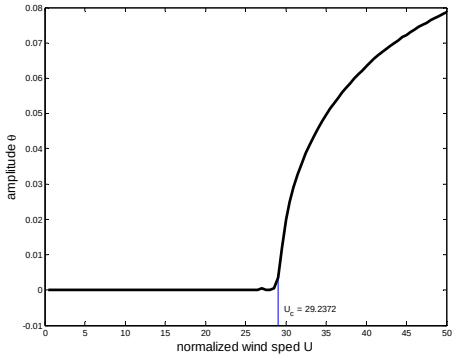

Figure 7 The Hopf bifurcation from the equilibrium solution to a periodic torsional oscillation

7. CONCLUSIONS

In this paper, a two-degrees-of-freedom model of an iced suspended cable in non-resonance condition, excited by a transversal wind flow, has been analysed by means of a time averaging procedure, namely the Krylov – Bogoliubov method. The degrees-of-freedom are the vertical plunge and the torsional angle around the elastic axis. The procedure furnishes a set of four modulation equations which provides us the amplitudes and the phases of the motion, in the transition period as well as in the steady state conditions. They can be either an equilibrium state, a periodic plunge oscillation, a periodic torsional vibration, or a motion on a two-dimensional torus. Using a *D*-section transmission line and the mean wind speed as a control parameter, the existence of periodic motions is proved, both analytically and numerically. The number of such motions and their stability depends on the mean wind speed. Initial conditions are very important in steady motion's selection.

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APPENDIX

Table 1. Existence and stability conditions

Solution	Existence conditions	Stability conditions	Bifurcation solution
(I)	-	$U_y > -1$	(II)
		$U_\theta > -1$	(III)
(II)	$a_3(1+U_y) < 0$	$1+U_y < 0$, $2\frac{a_1}{a_3}\frac{b_3}{b_1}\frac{U_\theta(1+U_y)}{U_y(1+U_\theta)} < 1$	(IV)
(III)	$b_3(1+U_\theta) < 0$	$1+U_\theta < 0$, $\frac{a_1}{a_3}\frac{b_3}{b_1}\frac{U_\theta(1+U_y)}{U_y(1+U_\theta)} > 2$	(IV)

INFLUENCE OF EMOTIONAL INTELLIGENCE ON THE WORK PERFORMANCE OF SEAFARERS

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ABSTRACT

Maritime Transportation process is a complex and closed system in which human factor has arisen as an important concept. Seafarers try to adopt themselves to the vessel environment and perform their tasks while creating new social interactions with each other. These social interactions can be directly shaped by the trait emotional intelligence of the seafarers. Accordingly in this study, it is aimed to understand the relationship between the trait emotional intelligence of the seafarers and the job performances of them during a maritime transportation process. Through our study, it is seen that the seamen with high emotional intelligence show high performances as well. Furthermore positive relation has been monitored between ages, years of employment, level of education and duty on ship, and emotional intelligence as a result of correlations established with demographic features.

Keywords: *maritime transportation, human factor, emotional intelligence, work performance.*

1. INTRODUCTION

About 90% of the world trade is carried by sea. This state clearly reveals the significance of maritime transportation. When examined maritime accidents with lots of life casualties such as Valdez and Titanic, Torrey Canyon put forth that a great majority of those accidents were caused by human factor. For that reason International Maritime Organization (IMO) has introduced regulations in order to make maritime business efficient by arranging rules and take precautions necessary with regards to minimizing the accidents and maintaining the security of navigation on seas.

In examination of human-related accidents, one can see standing out deficiencies in individuals' process of comprehending, processing and making decisions in the presence of emerging problematic conditions. Cognitive skill may be defined as the ability to acquire comprehend and process information and make decisions, and consists of four main capacities. These capacities are learning, perceiving information, adaptation to unfamiliar conditions, and structuring information for future conditions.

Vessels have complicated structures as they are closed environments, and their environmental conditions and psychological states show variance. This structure may well affect cognitive process during navigations a cargo is transported from a dock to another. In fact, researches carried out have determined that sensitivities in process management may vary for individuals in the same environment [1]. In examination of the causes of differences among individuals, emotional intelligence appears as a cause within the scope of abilities to keep feelings under control and adapt them under changing conditions [2, 3]. Emotional intelligence relates to individual skills and is open to improvement through experience [4].

The main purpose of this study is to reveal the relationship between the trait emotional intelligence and performance of the seafarers and to explain interactions of them through structural equity model.

2. LITERATURE OVERVIEW

2.1 Background on emotional intelligence and its history

When we approach the definition emotional intelligence from the perspective of linguistics, it is clear that the first components would be the terms "Emotion" and "Intelligence". Emotions are impulses that make us take action. When we examine the word emotion, we learn that its roots are in the word "motere" meaning "move" in Latin. Goleman stated that the word's meaning turned into "move away" and this meant emotions' capacity to direct towards movement if added "-e" suffix to the verb "move" in Lation.

Emotion in English means a strong feeling or strong feelings in general. Salovey and Mayer in their definitions argued that emotion not only defined perception but also included setting in motion [5].The word intelligence has roots in the Latin word "intelligentia" such like the word emotion, and finally took this form in English. The word intelligence is defined as the ability to gain and apply information and skills in Oxford English dictionary.

The persons defined as intelligent were only those with achievements in the academic field through the history, particularly before industrialization. In the early 20th century, researchers tended to investigate intelligence terms of people, and strived to measure individuals' intelligence, and comprehend how clever one was and classify them based on those results. Many different thoughts were set forth for those classifications and many methods of different intelligence identification were developed. During those days, the term "Cognitive Intelligence (IQ)" with an academic background was introduced for classification of intelligent persons, and those persons were classified accordingly.

It was soon discovered that those approaches were limited. Those who were incredibly successful in fields such as reading, writing, and arithmetics in academic means were observed to be not that skillful in fields of controlling human behaviours and getting on with others

at times. A new perspective was needed as a result of this condition.

American researcher and psychologist Edward Lee Thorndike of Colombia Univeristy developed a concept other than the cognitive intelligence concept and set forth the idea that merely IQ would not suffice for success in the 1920s. Coining the term "Social Intelligence" in the literature apart from the cognitive intelligence concept, Thorndike defined social intelligence as "to understand, direct people and act wisely in human relations" [6].

This definition has the roots of the term" Emotional Intelligence" we use today. This new concept decreasingly continued especially until 1980s even though it was accepted rapidly among the public in the earlier stages.

After passage through the information age, Researcher Howard Gardner pointed out the non-cognitive aspect of intelligence, and succeeded in getting significance of social intelligence popular again by revealing its importance for human relations in the 1980s. In his book titled "Frames of Mind", Gardner wrote that there would not be a certain type of intelligence to be evaluated in terms of success in life, and types of intelligence could be handled through examination in a wider framework [7].

Consequently, losing popularity since the 1920s, intelligence classification has gained popularity again with studies conducted for evaluation of cognitive and non-cognitive skills since the 1980s. Thus, social and emotional structures too were considered for evaluation but the researches conducted on the role social intelligence factors became clearer after the 1990s. For example, Hakkak et al. investigated the effects of emotional intelligence on social-mental factors of the human resource [8].

2.2 Emotional intelligence models

2.2.1 Mayer and salovey model

Psychologist John Mayer of New Hampshire University and psychologist Peter Salovey of Yale University were first to coin the term "Emotional Intelligent" in 1990. According to Mayer and Salovey, emotional intelligence is another kind of social intelligence. Within this context, they defined emotional intelligence as "individual's ability to monitor emotions in relation to oneself and others, differentiate between those moods and use as a guide for himself or herself the information gained through evaluation" [5].

Mayer and Salovey discussed the emotional intelligence concept in 4 titles. These are;

i. *Emotional perception and expression:* This article emphasizes individuals' being aware of their own feelings. The important thing is individuals' being able to be aware of what they feel in a certain state or at that moment. Above all, one needs to be aware of his or her own feelings. This fact could be considered as base. Those who are familiar with his or her own feelings are aware of their moods, and can make healthier decisions on matters requiring their personal decisions when they accurately analyze their moods; they are certain of their states and can look on the bright side of life.

ii. *Use of emotions:* Another important factor is individuals' being able to deal with their emotions in a proper way. This feature is defined as individuals' ability to save oneself from intense anxiety, sensitivity and pessimism, and comfort oneself. This feature, if deficient or poor, forces individuals to struggle against uneasiness constantly, however those strong in terms of this feature can pull themselves together more easily after coming across with unexpected events or mishaps.

iii. *Emotional understanding*: This connotes one's being aware of what their feelings mean. Emotions do not form by chance. Affected by current conditions, emotions vary and there may be a lot of underlying causes within this framework. We can express this as one's understanding these conditions as well. This information gathered on emotions occurs as a result of the reflection of the ability to carry out an "if-then" analysis and the words used by the individual while expressing feelings.

iv. *Emotional management*: Emotions carry information and affect our thinking. For that reason, individuals need to evaluate their emotions through their reason, approach to problems, judgments and behaviors. The means to overcome this lies on the ability to open to any kind of emotions, either positive or negative, and select strategies containing feelings as well [5].

2.2.2 Goleman model

Business life was reshaped in consequence of rapidly developing computers and information technologies through the end of the last quarter of the 20th century. Considering 1990s, we can say that a breakthrough was experienced that could be named "information age". The technological revolution going on at a great pace revealed the necessity for a new understanding.

Even though Mayer and Salovey were the first to set forth and define the emotional intelligence concept, it is possible to name Daniel Goleman, psychologist and columnist in the paper New York Times well, as the most important reason for its popularity. Taking advantage of the media power as well, Goleman took emotional intelligence concept beyond a phenomenon discussed only in academic circles and caused it to spread thanks to his publishing the book title "Emotional Intelligence – why it can matter more than IQ" in 1995 and expressing it in his newspaper articles. This book by Goleman ranked up to the first in "bestsellers list" and managed to attract attention from the whole world [9]. Goleman in his book wrote that EQ, standing for emotional quotient, appeared unexpectedly even in comic strips by Roz Chast in New Yorker and cartoons such as "Dilbert and The Pinhead Zippy" which were published and very popular at that time.

Goleman defines emotional intelligence as "individuals' ability to recognize owns emotions and the emotions of others, motivate one, and accurately manage emotions in one and in relations with other individuals. According to Goleman, emotional intelligence is a set consisting of learned ability and competencies [9,10].

Goleman's emotional intelligence model consists of 5 domains. These are;

i. Emotional self-awareness: Priority in this model, just like in Mayer and Salovey's emotional intelligence model, is one's ability to be aware of their own emotions. Emotional self-awareness is individual's making progress in describing and identifying their emotions, understanding the causes of their feelings in a more accurate way, and differentiating between feelings and actions.

ii. Emotional management: Emotional management includes individual's managing their own emotions. Emotions may appear in a lot of different ways. What is meant by emotional management is not trying to overcome emotions by suppressing them. Because, attempts to suppress emotions only leads to covering them and causes them to reappear again in a much stronger form. For this reason, emotional management is to accept the current mood, and avoid spontaneous reactions caused by emotions at that moment.

iii. Efficient use of emotions: This means individual's ability to use their emotions efficiently and effectively in their behaviors. What is meant by the efficient use emotions is that individuals' paying further attention and focusing on their work due to their increasing responsibility, and reacting based on further self-regulation by making less impulsive decisions in terms of their behaviors and decisions.

iv. Empathy: Empathy is individual's ability to put themselves in the other's shoes, and predict the other's current mood and frame of mind. The other's point of view could be better comprehended, sensitivity could be developed against others' feelings, and others could be better listened thanks to empathy.

v. Managing relations: Managing relations is individual's ability to determine the most proper behavior by making correct observations in their interactions with those around them. This connotes characteristics such as individual's ability to analyze and comprehend their relations, settle and resolve disputes, solve the problems in relations, be skillful in communication, be sought by those around, be concerned and thoughtful, be in cooperation with those around, and be helpful and democratic [9].

2.2.3 Bar-On model

Another scientist conducting research on emotional intelligence is American academician and psychologist Reuven Bar-On. Bar-On defined emotional intelligence as a set of emotions and abilities in communication with the environment in that period. Presenting this defined intelligence as "Emotional- Social Intelligence (ESI)", Bar-On evaluated it in association with characteristic features in particular [11].

Bar-On suggested that it would be lacking to limit the intelligence concept that could be defined out of academic intelligence only within emotional intelligence, it was necessary to put forth social intelligence as a different type of intelligence, yet social intelligence and emotional intelligence were two different but inseparable concepts.

The researcher identified the set forth definition under five main competency domains as follows [2,11].

i. One's capacity for emotional ability: This defines individual's will. This is one's ability to understand how well the individual knows themselves, whether they are aware of their emotions, the state of being at peace with oneself through understanding their emotions, what actions make them feel well or what feels well.

ii. Interpersonal relations: This describes the individual's ability to understand the other's thoughts and emotions by putting oneself in the other's shoes, be on good terms with those around and feel socially responsible.

iii. Adaptation ability: This describes the ability to solve problems and meet the demands by those around by acting flexibly in problematic events, differentiate between situation's reality and a situation assessed relatively for an individual, and bring sufficient flexibility by reviewing their emotions against changing situations.

iv. Stress management: This describes the ability to be resistant even under difficult situations and intense pressure, overcome this process, regulate and control their emotions in this kind of situations, and stand out against pressure.

v. General mood: This relates to individual's ability to be aware of their mood and modulate their thoughts and emotions to an extent to enjoy and get satisfied with life. Within this context, this is individual's ability to be happy and optimistic. Happiness is individual's ability to be at peace with oneself and others and enjoy life, and optimism is the ability to take up a positive position by looking on the bright side of events no matter how negative their mood or actual situation is, and maintain this even under difficult situations.

According to Bar-On, those individuals with specified abilities also have high emotional intelligence. It is this type of people who succeed in their business life.

2.3 Emotional intelligence scales

Popularized emotional intelligence, academicians then conducted studies on how to measure emotional intelligence. Investigations were continuously carried out for that purpose; various diccussions and researches were made on how to measure emotional intelligence, and whether it could be measured by a scale or examination of behavior and mood. Nevertheless, it was agreed that emotional intelligence could be evaluated using scales as a result of examinations carried out.

Present below are general information and clarifications related to significant emotional intelligence scales commonly accepted in academic circles.

2.3.1 Mayer and salovey multifactor emotional intelligence scale (MEIS) and mayer-salovey-caruso emotional intelligence test (MSCEIT)

Mayer and Salovey suggested that emotional intelligence could be developed or improved through experience and learning, and it included the capacity of emotion and emotional awareess. For that reason, they

developed MEIS (Multifactor Emotional Intelligence Test) for the purpose of evaluating emotional abilities in 1998.

This developed scale is a very detailed one. Arranged in a mixed order and aiming to increase validity and reliability with reverse questions, this scale contains 401 articles in total and 4 subscales. These are Identifying, Using, Understanding and Managing emotions.

However, Mayer, Salovey and Caruso updated this scale and developed a newer version as a result of recent research and due to the presence of too many questions. This scale is called Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT). Overall emotional intelligent and lower branch points are determined in the scale. These branches are perceiving emotions, facilitating emotions, understanding emotions and managing emotions. This updated scale comes with more subtests for each branch, examines their reliability, and allows additionally for understanding facial expressions, understanding and being aware of emotional changes, and solving problems in communication and evaluating them in the light of information gathered for emotions.

2.3.2 Goleman and boyatzis emotional competence inventory test (ECI)

Being the leading actor in popularizing emotional intelligence concept and make tremendous impact worldwide, Goleman and Boyatzis developed "Emotional Competence Inventory" test (ECI) for the purpose of assessing emotional intelligence. This presented scale aims to evaluate individual's emotional abilities and behaviors [10].

Emotional Competence Inventory test consists of 110 articles in total. This scale measures 4 subbranches in a similar way to MSCEIT. These are individual awareness, social awareness, selfmanagement and social skills.

2.3.2 Bar-On emotional quotient inventory (Bar-On EQ-I)

Developed by Reuven Bar-On in 1997, this scale consists of 133 articles. It was developed for the purpose of determining individuals' emotional intelligence leves and consists of 5 main domains. These domains are matters related to one's own, one's interpersonal relations, coherence, general mood and stress management [2].

2.3.3 Schutte emotional intelligence scale

This scale was developed by Schutte et al. in 1998. When first designed, the scale consisted of 33 artiles [12]. Updated by Austin then in 2004, this scale contained up to 41 articles in its final form. The update within this framework arranged some articles of the scale introduced in 1998 in reverse question form and added several new questions.

The scale is presented with 3 main factors. These are Optimism/Regulating Mood, Using Emotions and Evaluating Emotions. Consisting of 41 articles in total, Schutte Emotional Intelligence Scale was adapted into Turkish by Tatar, Tok and Saltukoglu. Our study makes use of the Schutte Emotional Intelligence Scale adapted into Turkish by Tatar et al. in 2001 [13].

3. WORK PERFORMANCE

Performance has always been a leading factor since the industrial revolution in the early 20th century and rapidly increasing industrialization.

Organizations are supposed to constantly struggle with environmental factors in a rapidly changing and incrasing competitive environment. Organizations aim to escalate its or employees' performance in their short or long-term plans. The performance of an organization might be evaluated thorugh its increasing production or increasing quality.

Every organization has a quality policy, a mission and vision in our day. Organization form performance management system for the purpose of achieving them and reaching intended success levels. The purpose in this system is to constitute a performance evaluation system in the organization, reward and promote successful personnel, take precautions aimed at raising performance of those with low performance, including in organization the personnel thought to bring more benefit in achieving the organizatin's targets instead of those personnel failing to reach intended levels [14].

Anyone can think of several definitions upon hearing performance. Anyone has a comment to make on this subject. For example, a definition of performance suggests it is an employee's fulfilling a designated work with success while another one claims it is amount of work completed at the end of a certain time [15].

To exemplify the subject, one can evaluate the performance of a factory manufacturing anything through increase in its production or income gained with production, etc. However, performance could be presented with service quality in some industries.

Performance could be evaluated under performance service main heading in maritime industry. In its simplest form, performance cannot be defined through a cargo carried in the event that a vessel transports a cargo loaded from a harbor to another one. Because vessel's load capacity, speed and route legs are definite. Amount of cargo carried or vessel's speed cannot be altered with an increase in performance. Nevertheless, performance is presented in the process of transportation. Factors affecting performance in maritime business may include carrying a load without any damage during its transportation, vessel's not having any technical breakdown or not postponing its estimated time of arrival (ETA) by removing the breakdown as soon as possible, carrying the load in a proper way, professionalism during loading-unloading procedures, safe navigation of vessel between departurearrival harbors, recovering any failure to emerge on vessel by detecting as early as possible with efforts and awareness of the whole personnel, and how important the emerging failure is and coordination necessary to be applied in order to recover that failure. Performance is the level of fulfilling current tasks as individuals or teams in the direction of reaching the organization's target. Therefore

it is the evaluation of the whole effort made for the purpose of fulfilling the organization's targets.

Performance is a result not only presented as individually but also as a team. Mathis and Jackson define performance as those carried out by employees and those not carried done by them [16].

Work performance is perhaps the most significant variable of organizational psychology. Business establishment have focused on measuring their employees' performance for the purpose of raising their effectiveness [17]. Greguras et al. defined work performance in 1996 as individuals' determining and performing their own targets in the direction of organization's targets [18].

According to Keller on the other hand, only if an organization expects and asks the best from individuals, employees can show their best [19].

Success and efficiency of human management in an organization might be presented through examining and following its employees' performances. For that reason, organizations resort to assess and evaluate performances as per their selected criteria.

Employees from each level in successful organizations are put to performance evaluation. The purpose here is to take the employees being obstacles for success in organizations out of the system and obtain more efficiency and performance from employees.

Organization has short, medium and long-term plans in order to reach success. Within this context, they evaluate the performances of their employees in intervals such as 6-month or 3-month periods. This period may vary between organizations. Organizations are generally evaluated by comparing what they are expected to do at the end of a year or within a determined time period to what they have produced.

4. METHODOLOGY

4.1 Empirical Analysis

The seafarer were applied 2 surveys in order to measure their emotional intelligence levels and performances, and the questions asked were included in emotional intelligence scale for the purpose of determining demographic features.

All the seafarer were applied emotional intelligence scale in survey practices conducted. It was considered that the personnel could not evaluate their own performance in a sufficiently unbiased way and only the sea captains and those in higher positions took the performance survey applied as the second survey for that reason.

"Schutte Emotinal Intelligence Scale", developed by Schutte in 1998 and revised by Austin et al. in 2004, was applied in order to measure emotional intelligence level during the data collection phase. Schutte Emotional Intelligence Scale has a 41-article 5 point likert type rating adapted into Turkish and tested for validity and reliability by Tatar et al. The scale consists of 3 factors. These are Optimism/Regulating Mood, Using Emotions and Evaluating Emotions. The scale measures these three factors and emotional intelligence level as a whole [12].

Participants in the scale are asked to choose one of the "Definitely", "I Disagree", "I Have No Idea", and "I Definitely Agree" options for each of the 41 articles presented in the emotional intelligence scale. These answers are respectively scored 1, 2, 3, 4 and 5 while calculating the scale point. The scale contains 21 reverse-directed questions in total in order to increase reliability. These are taken into consideration in evaluation phase. Total score shows whether emotional intelligence is high or low.

Performance evaluation survey was organized for the purpose of evaluating seafarer's performances. The performance evaluation forms present in maritime corporations were examined for the survey, and factors thought to be useful in investigating performances aimed at maritime industry were compiled and presented. Above-mentioned survey consists of 41 articles in total. This survey was taken by the personnel employed in sea captain or chief mate positions for the purpose of evaluating their employees.

4.2 Participants

The population of this research is comprised by seafarer. The sample of the research was comprised by 182 seafarer in total who deal in inner-city passenger transportation and international tanker transportation. The participants were given 2 different surveys; emotional intelligence scale and performance survey, and asked questions related to demographic features within the emotional intelligence scale. We applied by entering the vessels on harbors they were moored, or had them applied through the agency of liaison personnel on vessels dealing in international transportation when they were harbored.

4.3 Results

4.3.1 Reliability analysis of the survey

The most commonly used ones of realiability tests may be listed as Cronbach Alpha, Split, Parallel, and Strict Parallel. A Cronbach Alpha value over 60% is indicator of survey's success. Some researchers select values over 75% as baseline. Other criteria exceeding 70% show that internal consistency of a survey is ensured and implications could be relied on. As seen in Table 1, percentage values intended and specified in each of 4 tests exceed reliability criteria. Conclusions of the sample are found to be reliable and consistent with high reliability values.

Table 1. Reliability test results for the survey

	Reliability Test Results for the Survey.
Cronbach_Alpha	0.967
Split	0.932-0.972
Parallel	0.970
Strict	0.969

4.3.2 Data analysis

Frequency distribution tables related to demographic questions and scale articles of the survey were obtained and interpreted in the first phase Table 2.

Table 2. Frequency distribution for demographic features

		Frequency	**Percentage**
Sex	Male	180	98,9
	Female	2	1,1
Total		**182**	**100**
Marital Status	Married	128	70,3
	Single	54	29,7
Total		**182**	**100**
Age	20-25	30	16,5
	25-30	30	16,5
	30-40	78	42,9
	Over 40	44	24,2
Total		**182**	**100**
Number of Children	None	78	42,9
	1	50	27,5
	2	40	22
	3	6	3,3
	4	8	4,4
Total		**182**	**100**
Years of Employment at Business Establishment	0-1	40	22
	1-3	16	8,8
	3-5	26	14,3
	5-10	62	34,1
	Over 10	38	20,9
Total		**182**	**100**
Duty on Ship	Officer	64	35,2
	Other	118	64,8
Total		**182**	**100**
Education	Primary School	30	16,5
	Secondary School	36	19,8
	High School	56	30,8
	University	60	33
Total		**182**	**100**

Explanatory factor analysis and confirmatory factor analysis (DFA) were implemented in orderto test the scale's construcy validity. The data were investigated using Kaiser-Meyer-Olkin (KMO) coefficient and Bartlett's sphericity test on whether they were appropriate for factor analysis before moving on to factory analysis. Factor analysis was initiated after testing whether the data set was appropriate for factor analysis (tested for normality).

Structural equation modeling was established depending on confirmatory factor analysis, and the obtained factors' coefficient and impact on performance were calculated. To what extent the articles present in the scale exemplify similar behaviors was determined by calculating the relation between scores obtained and total score of the scale (article-test correlation). The relation between the score obtained from the performance survey and emotional intelligence score was analyzed and interpreted in the final phase. The data were analyzed on computer environment using SPSS 16.00 and AMOS 18.0 bundle software.

Several tests were performed in order to determine the suitability of factory analysis in the first phase of application. Bartlett's Test of Sphericity tests the hypothesis "correlation matrix equals to unit matrix". Rejecting the hypothesis means the presence of a correlation among variables and applicability of factor analysis on variables comes into question. In this study, main mass correlation matrix was found not to be unit matrix with respect to Bartlett's test and sphericity criteria was met ($p<0.05$). Kaiser-Meyer-Olkin (KMO) value provides information on whether factor analysis is appropriate. Lower KMO values concludes that application of factor analysis will not be appropriate. Regarding KMO criteria; sample size, observed correlation coefficienct size and partial correlation coefficients were found to be consistent for factor analysis (see KMO=0.959) in Table 3.

Table 3. KMO and Bartlett's test results

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.959
Bartlett's Test of Sphericity	Approx. Chi-Square	6332.11
	df	66
	Sig.	.000

The total varience percentages that are found for the first, second and third factor is 0.47, 0.11, 0,10 respectively. The highest weight is equal to the first factor. Principal factor analysis and varimax rotation method have been analysed for Mean explanatory factor analysis in Figure 1. The results have been consistent with the factorial structure of Austin et al. [20].

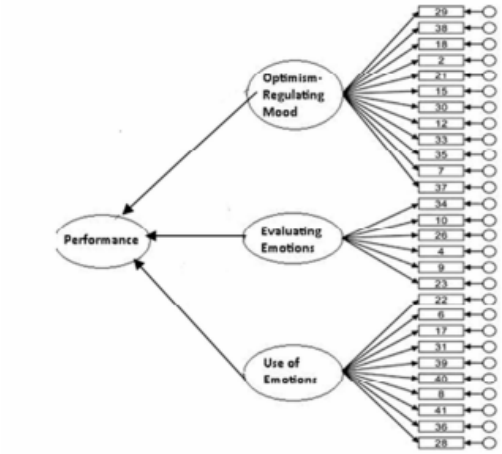

Figure 1. Mean explanatory factor analysis

Indicating normal distribution with by Kolmogorov Smirnov and Shapiro-Wilk test as $p>0.05$ both for three factors, H0 hypothesis was accepted.. In this condition, it is possible to apply confirmatory factor analysis and structural equation modeling practice.

The construct presented with three factors in the study by Austin et al. (2004) for the 41-article form was tested for validity of confirmatory structure [20]. Suitability of the data obtained in this study to the presented model was tested with Confirmatory Factor Analysis (CFA) using AMOS computer statistics software version 18.0. This study uses three-factor progressive model and takes factors as relative to each other.

Confirmatory factor analysis and structural equation modeling practice Confirmatory factor analysis is a strong statistical method used to analyse a hypothetical framework and frequently resorted to in adapting a scale developed in a certain culture to another. For that reason, confirmatory factor analysis method was applied in construct validity practicve of the Goodness of fit indices belonging to the model show sufficiency in order to consider confirmatory factor analysis results valid. Even though it was stated that chi-square, CFI and RMSEA should be found coherent for sufficiency of the model all the indices was checked in adaptation practice [21].

Table 4 gives the goodness of fit index values for confirmatory factor analysis. It is indicated for goodness of fit indices that GFI, NFI, RFI, CFI and IFI indices at values over .90 show sufficient level of fit; values getting closer to 0 show bad fit, and getting closer to 1 show perfect fit; SRMR and RMSEA under .05 is a good value, and falling under .08 shows an acceptable goodnees of fit; the rate of chisquare value to degree of freedom under 5 shows good fit [22, 23, 24, 25].

Table 4. Goodness of fit index values for confirmatory factor analysis

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	,972	,980	,958	0,923	,988
Saturated model	1,000		1,000		1,000
Independence model	,000	,000	,000	,000	,000
RMSEA					
Model	RMSEA	LO 90	HI 90	PCLOSE	
Default model	,042	,014	,111	,205	
Independence model	,303	,277	,329	,000	
HOELTER					
Model	HOELTER 05	HOELTER 01			
Default model	102	80			
Independence model	13	15			

A structural equation modeling was established following confirmatory factor analysis to measure the relation of emotional intelligence with work performance. It is tried to understand if three factors that have been obtained by the emotional intelligence scale have any effect on the work performance, figured out in Figure 2. Model fit indices have been also shown in Table 5.

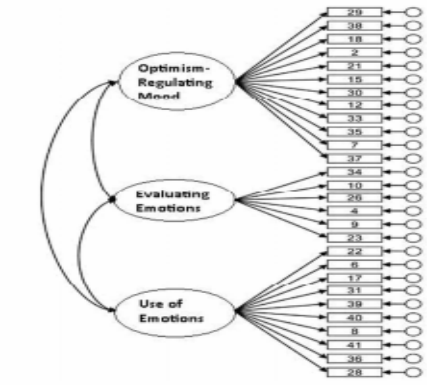

Figure 2. Mean explanatory factor analysis

Table 5. Model fit indices

Model Fit Indices	**Values**
X^2 (Chi_Square)	129,38
P (Level of Significance)	0,0000
Degree of Freedom (sd)	81
X^2 / sd	1,59
Adjusted Goodness of Fit Index (AGFI)	0,91
Goodness of Fit Index (GFI)	0,94
Comperative Fit Index (CFI)	0,99
Normed Fit Index (NFI)	0,96
Relative Fit Index (RFI)	0,95
Root Mean Square Error of Approximation (RMSEA)	0,04

Conformity of all the criterias in structural equity model has been reseulted with high level. Thus, model is suitable for interpretation. The results of structural equity model gas been given in Table 6.

Table 6. Results of structural equity model

	Estimate	**S.E.**	**C.R.**	**p**
performance ← optimism	,873	,057	15,191	***
performance ← use of emotions	,833	,047	17,830	***
performance ← evaluating emotions	,899	,050	18,155	***

As seen on model outputs of Amos version 18.0, each of the 3 factors has significant effects on performance ($p<0.05$). Each of the 3 factors has positive directional, that is, increasing effect on performance. In examination of coefficients, “Evaluating Emotions” (0.899) has the highest effect, “Optimism” the second most important effect (0.873), and “Use of Emotions” (0.833) the third most important effect.

5. DISCUSSIONS

Our study investigates emotional intelli-gence’s effect on work performance of seafarer. Our research is handled within two dimensions. The first is to determine emotional intelligence of seafarer, and the other one is detect whether there is a significant relation between emotional intelligence and work performance by evaluating work performance. First of all, “Schutte Emotinal Intelligence Scale”, developed by Schutte in 1998 [12] and revised by Austin et al. in 2004 [20], was applied in order to measure emotional intelligence level during the data collection phase. Adapted into Turkish [13], Schutte Emotional Intelligence Scale was tested for validity and reliability by revising for seafarer [12].

Our study evaluates findings and results of the survey applied on totally 182 seafarer employed in corporations dealing in international tanker business and inter-city passenger transportation. It was found out that performance value increased with incrasing emotional intelligence. Based on the research conducted by Bachmann et al., [25], Bar-On [2], Dulewicz and Higgs [26] and Jonavics and Christiansen [27]; emotional intelligence at a workplace raised performance and effectiveness in certain situations, and our study reached conclusions in parallel to these research. From this point of view, it is an expected result that increasing level of emotional intelligence raises performance.

Maritime occupation has a lot of differences and involves a lot of factors to be taken into account compared to other occupations. Those factors are not only records to be kept or maintenance activities to be

performed. One of the most basic requirements of maritime business is competent personnel. Seafarers are the most significant actors of maritime industry possessing the biggest transportation capacity worldwide.

Our study conducted reveals that the seafarer with high emotional intelligence show high performances as well. Consequently, it is known that seafarer working on difficult and troublesome duties need to have high emotional intelligence considering navigations they endure for long periods on covered environments such as vessels, and all the hardshps they face during those navigations. We hope this study helps us be aware of the significance of emotional intelligence for seafarer and leads other studies on this subject.

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IMPROVING ORGANIZATIONAL PERFORMANCE THROUGH THE APPLICATION OF INTEGRATED MANAGEMENT SYSTEMS IN MAINTENANCE ACTIVITIES IN THE SHIPYARDS

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ABSTRACT

Shipyards must act for ships maintenance cost reduction by new strategies based on performance indicators analysis (achieved firm bookings percentage of their submitted bids number; repair costs percentage reduction; ships docking period improving by acting for less days for ships staying on docking; number of delay days at delivery of the ships; percentage of the technical inspections repetition for final scope of works settlement) and so, through corrective actions taken, may not be alliterated the shipyards basic objectives: their docks capacities and available manpower constant time loading, collaboration with traditional customers and opening new collaboration opportunities for customer portfolio extending. This work paper purpose is for the author's original contributions and research results presentation concerning integrated management systems application into the shipyards, aiming systems performance indicators and organizational strategies applied for ships maintenance shipyards presenting and analyzing.

Keywords: *shipyard; maintenance; performance indicators; variability in operation; Balanced Scorecard.*

1. INTRODUCTION

The ship-repairs shipyards by integrated management systems implementing managed to reassess their policies so as to provide products and services to customer expectations regarding quality, safety, performance and environmental protection during their operation. At this moment, the ship-repairs shipyards are permanently concerned of any subject to ensure that their delivered products and services are as agreed deadlines and complying with legal requirements and manufacturing international standards and practices, customer satisfaction is regularly monitored, aiming for optimizing work from the design stage through to the vessel delivery, including the warranty period.

The authors need to highlight the current state and trends of vessel maintenance and the maintenance peculiarities in the shipbuilding industry (maintenance management systems on board ships, shipyards role in maintenance management systems), conducted for a wide bibliography represented by books, studies and foreign articles consulting, therefore as mentioned here [6], [7], [9], [10], [14], [16], [17].

The documentation was supplemented with Romanian authors [5], [13], [15], [18] as well as domain-specific databases, such as [20], [23] and an extensive collection of journals [25].

The ships maintenance outlook, as per the authors performed documentation, is that maintenance developing is based on computer system for operational maintenance implementing; better consideration of maintenance at design stages, equipment procurement and installation; transfer for called level one maintenance workers to a directly productive level whose training will be higher; supervision development of maintenance systems that will lead to the application of conditional or preventive maintenance; cooperation in maintenance, which will develop the scientific foundation, and control for a good management.

The shipyards management, through its planning, organization and training - coordination functions improvement will establish performance targets choosing their strategies and policies paths to reach and develop for bidding processes, contracting, implementation for works on board ships preparation and carrying out, the ship handing over, by maintained equipment and systems proving and testing , "the works completion reports" and the "final invoice" drafting and approving.

This paper work originality consists of presenting a ship-repairs shipyard organizational chart and the variability in operational and organizational functions illustrating for the ships maintenance works execution (laid on berth and in-docking), highlighting performance indicators and scoreboard model proposing for a ship-repairs shipyard.

2. GENERAL ISSUES

A shipyard is "a place where ships are built or repaired, properly equipped and placed in a maritime or inland harbour aquatorium or in their vicinity (shipyards include: ships reinforcement, large, medium and small ships building, old ship dismantling, ships, river and/or sea boats repair) "[1].

A shipyard is a complex organization undertaking construction and/or repair ships including: workshops, path, docks, piers and berths and other numerous facilities and technical means capable of carrying out the entire process of planning, implementation and evidence needed to build and launch new building ships and ships repairing.

The shipyards location is usually in maritime or inland ports aquatorium, or nearby, so that path

construction, workshops, docks and all technical installations involved for modern shipbuilding on the space shore to allow their installation and water depth and expansion its surface can allow also new building ships to be safely launched.

A shipyard operational structure include work spaces and equipment for all processes running. In terms of functionality, the ships are complex floating constructions, self-propelled, towed or stationary intended to perform a maritime and/or water in-land function in respect of transportation and other activities [11].

The shipbuilding diversity and complexity goals, derived from the multitude serviced, make it difficult to complete a classification of ships, which can be addressed from various viewpoints. According to the Equasis [20] statistical database, the most widely used world-wide commercial fleet vessels currently are tankers; bulk carriers; container ships.

The „United Nations Conference on Trade and Development - Review of Maritime Transport 2013" presents the period 2006 – 2013 overall international seaborne trade expressed in billion tons of goods transported, which allowed the authors the graph presentation as per Figure 1.

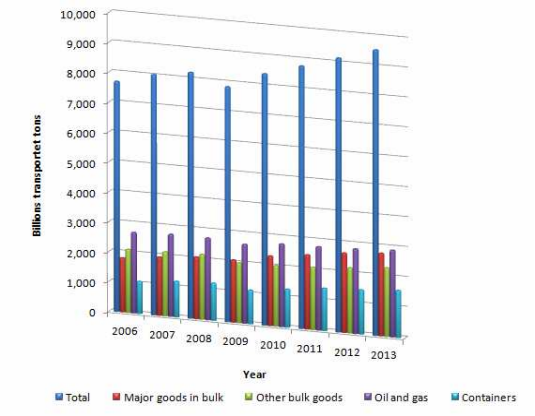

Figure 1 2006-2013 Overall international seaborne trade

A shipyard is a complex organization where main objectives include: ships design and construction execution; maintenance and repair works execution on board of the ships as per ships dry-docking management systems implemented onboard.

For the works execution on board ships a complex structure consisting off workshops, path, docks, piers and berths and other numerous facilities and technical means is required to conduct the entire process of planning, implementation and evidence needed for new building ships construction, launching and equipment and systems mounting on board and for maintenance and repair works as per maintenance management systems requirements on board of the existing ships, also.

Marine shipyards main activity can be categorized as follows: new building ships construction only, where the designing activity can be done by own resources or outsourced by specialized companies sub-contracting; repair works execution on board of the ships only, as per the ships dry-docking management systems implemented onboard; both activities for new building ships construction and for repair works execution on board of the ships.

In the EU, there are shipyards operating in 16 countries providing a total of 50-55 000 employees (average 2007-2011). The proportion, which holds the EU on the world market, is about 35%, which proves that this is a strategic sector for Europe. This position should be maintained and even improved to ensure a high level of safety in shipping and establish rigorous standards of environmental and energy efficiency [12].

Repair works carried out on board of the ships, as per the ships dry-docking management systems implemented onboard are as follows: dry docking works such as: external hull treatment, external hull and various structures below the waterline steel plates replacement, tail shaft and propeller, rudder and rudder blade, sea chest and valves, anchors and anchors chains; with the ship afloat alongside berth where pending by the ship age and the Classification Society inspection type requirements repair works such as: various steel structures replacements, ballast and cargo tanks treatment, piping systems replacement or repairing, mechanical and electrical equipment and systems overhauling and repairing, accommodation systems repair works.

The ship is designed and built such as in terms of technical performance and economic efficiency, specific functionality to be ensured.

The naval architects and shipbuilders engineers responsibility is for design methodologies and construction technologies developing so that by the natural environment actions exhibited on ships enabling her technical and economic appropriate operation, performing according to her construction type and purpose.

The ship can be certified by the Classification Society if, the maintenance of the ship's structure, systems installations and related equipment is in accordance with its requirements and rules, evidenced by the outcome of periodic or non-periodic classification society inspections where the Classification Society objective is for checking the ship's structure and key parties under hull and its appendix integrity and propulsion systems, governance, power generators and other systems and equipment proper operation onboard.

The ships onboard maintenance presents some challenges due to the ships locations changing in operation technical systems redundancy and working parameters must be permanently ensured, the waiting equipment (stand-by) must be ready to work at any time; there are no service stations in the open sea, so that maintenance activities planning and conducting is being critically necessary and vitally important to be executed accordingly by the crew, consisting of specialized personnel, to ensure goods and ship safe arrival at her destination.

The maintenance and repairs works required as per ships' maintenance management systems cannot be fully achieved without applying to a shipyard for the ship dry-

docking as a result of the requirements and standards imposed for the maintenance and repair works completing or as a result of collisions/accidents in the ship operation where consequently the integrity of the ship's submerged hull including structures and installations, equipment related to that area have been affected.

The ship generally applied maintenance systems to carry out scheduled dry-docking in a shipyard are: as required maintenance (corrective maintenance); preventive maintenance.

The maintenance system as required (corrective maintenance) are applicable for the hull outer shell plating and the internal tanks structures anticorrosion protection.

It is also applicable for steel plates replacements for the hull structures where their thickness became below acceptable standards limits or for deformed steel plates structures as a result of collision or grounding damage.

The preventive maintenance system is applicable to those underwater hull systems and structures that cannot be normally inspected during ships' operation.

3. ANALYSIS AND POSSIBLE SOLUTION

3.1 The ship-repairs organizationally structure

Repair works carried out on board of the ships, as per the ships dry-docking management systems implemented onboard are as follows: dry docking works such as: external hull treatment, external hull and various structures below the waterline steel plates replacement, tail shaft and propeller, rudder and rudder blade, sea chest and valves, anchors and anchors chains; with the ship afloat alongside berth where pending by the ship age and the Classification Society inspection type requirements repair works such as: various steel structures replacements, ballast and cargo tanks treatment, piping systems replacement or repairing, mechanical and electrical equipment and systems overhauling and repairing, accommodation systems repair works.

A shipyard providing ships dry-docking repair and maintenance works, is performing the activities based on processes developing, as illustrated in Figure 2.

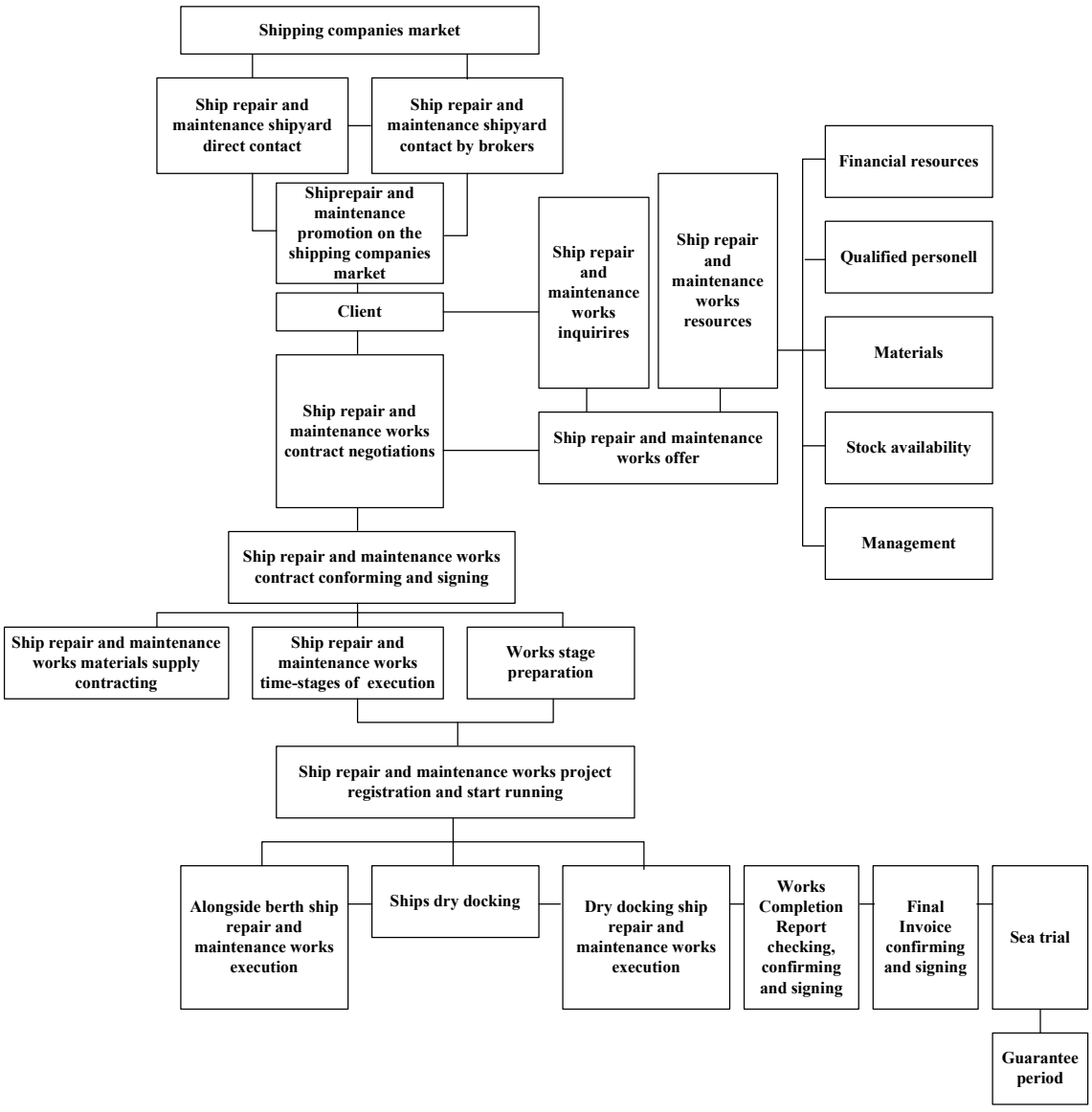

Figure 2 The ship-repairs shipyard processes developing scheme

The dedicated ship repair and maintenance works shipyard functionality envisages that the operating state, quality in respect of achieved specific functions measurement is every time as a part and the whole life time variable dependent upon followings, according Figure 3 presentation: the "inputs" condition (ships traffic in the geographic area in which shipyard is positioned, shipyard collaborative relationships with shipping companies having ships trading in the area through direct contact or through intermediaries (brokers/agents), shipping market developments depending on the area, regional and global economy levels developments; technical capacities of the shipyard operational structures and shipyard available human resources); the "outputs" condition (numbers and type of ships booked for maintenance works performing during a certain period of time, customer type: new customer or traditional one - long term potential customer, with large number of ships trading regularly in the area, effectiveness expressed by the degree of maximum possible loading of the technical capacities of the operational structures and human resources realization, efficiency, expressed by maintenance works performing profit during a certain period of time determined by the incomes reported to the performed maintenance works costs.

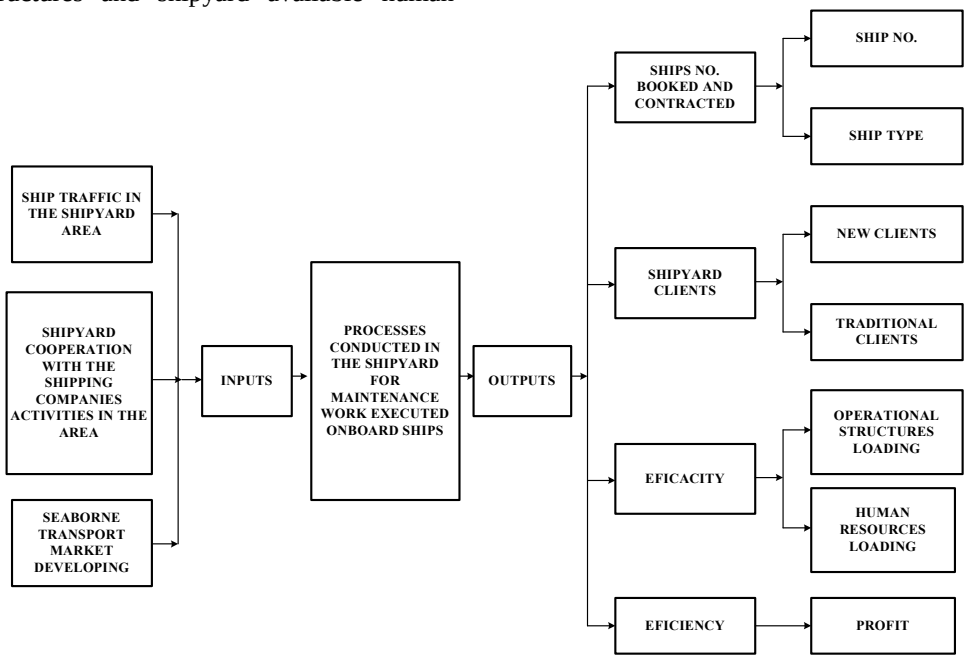

Figure 3 The ship repair and maintenance works shipyard variability in operation

The organization functioning generally means, the specific organization process carrying out, a process which is first expressing the organization ability to correlate dynamic resources (human and extra-human) for the assumed order [3].

Organizing process includes the activities necessary to fulfill objectives determination as well clearly specifying their tasks and arranging them in a decision-making framework o [21].

The organization functionality is considering the organization's operating status, quality in respect of achieved specific functions measurement is every time as a part and the whole life time of the organization.

The organization functionality is variable, being dependent on the "inputs" and "outputs" conditions and the nature of internal organizational processes.

The organization functionality condition indicates the "organizational health" condition. At the limits, organizations can be "healthy" or "sick" [6].

The organization functions means of homogenous groups of activities that achieves its organizational purpose [17]. These are, as follows: Research & Development function - sometimes considered as part of the marketing function; Marketing function - including the commercial also; Production function; Financial and accounting function; Human resources/personnel function.

The role of each in relation to other functions of the organization but also in relation to the organization itself, has developed over time, as the marketing concept has evolved from production orientation to customer orientation.

In the open systems, self-organized, function is the element contribution to system it belongs requirements satisfying and developing.

The top management developed strategies and policies have a paramount important role for designing and reasoning organizations activities.

The strategies and policies, as forecast materialization key, pegging the each organization development, often efficacy of over-systems interface decisive depending on their content which includes the extent to which they maintain and amplify occupied market segment and obtained profitability.

The functions in an organization such as a ship repair and maintenance works shipyard (with ship floating alongside berth and dry- docked) are those

homogenous groups of activities that achieves its organizational purpose and are described in Table 1.

3.2. Performance indicators used in a shipyard

Performance measurement can provide additional information about what happens in a system or process based on indicators which do not include the causes evidence that has produced results and not displayed digits indicating which is the best way to react [8].

For an organization to effectively use information obtained by performance measurement, has to make transition from the measuring range to analysis and decision actions, which represents performance management, thus offering the possibility that by performance indicators analysis, the different terms major objectives of organization and main ways of achieving, together with the allocated resources to achieve a competitive advantage, to be identified and defined.

Table 1. The functions in an organization such as a ship repair and maintenance works shipyard (with ship floating alongside berth and dry- docked)

FUNCTION TIPE	DESCRIPTION AND CHARACTERISTICS
RESEARCH AND DEVELOPMENT	All activities that are conceived and implemented scientific and technical progress, consisting of: upgrading works for workspaces and their logistic systems and utilities (electric power, oxygen, compressed air stations, propane tankers, sea and fresh water systems); upgrading works for necessary equipments such as: cranes, automatic steel plates and profiles blasting and painting stations, cutting machines, automatic and semi-automatic welding equipments; endowment of basic and auxiliary sections with latest generation tools and devices, in order to reduce the consumption of manpower consumption to achieve different types of required works to be performed
MARKETING (commercial included)	Marketing activity consists of the group of activities related to: internal and external market analysis; client needs and behavior acknowledgement in way of the most adequate ship repair and maintenance services (ship alongside and dry docked) increasing for clients satisfaction
	The trade activity consists of assembly processes of knowledge of supply and demand markets for procurement of raw materials and production equipment necessary to conduct the production process shipyard
PRODUCTION	As a matter of objectives and processes targeted, in a shiprepair an maintenance shipyard production activity can be classified as following: production starting / launching; production programming and analysis; works execution; works quality control; equipments maintenance and repair; auxiliary production consisting of electric power, oxygen, compressed air stations, propane tankers, sea and fresh water systems; general responsibilities could be exists sometimes as an expression for the managements of activities listed above, such as: organization for use in a greatest possible way the production capacity, specific consumption minimizing, health and occupational safety regulations applying
FINANCIAL ACCOUNTING	all activities which provide the financial resources required to carry out repair and maintenance works on ship, from conducting market research, tendering, negotiation and contracting trough the ship to delivery to client after sea trial completion, and the obvious value of movement of the entire shipyard patrimony.
HOUMAN RESOURCES	assembly processes that ensure necessary human resources and the use, development and motivating them

The performance indicators can be strategic, operational or managerial depending on the strategy and strategic goals, three components being measured (business, profitability and productivity) by monitoring results, the activities carried out and the costs constituting the measurement benchmark that allows to examine and emphasize sustainability strategies for those objectives achieving [2].

The shiprepair and maintenance shipyard performance parameters characteristics toward the literature consulted overview could be those recommended in Table 2 by the authors.

The organizational performance common used measurement instrument is "the balanced scorecard" - BSC which is grouping a set financial and non-financial indicators of the organization highlighting the performance by balancing and inter-compliance of four perspectives (financial perspective, customer perspective; perspective of internal processes, learning and development perspective), using a cut-based organization processes and activities [4].

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Balanced Scorecard have been used mainly as improved performance measurement systems and organizations have created models of management balanced scorecards for more comprehensive view regarding performance indicators from the four perspectives point view providing.

The classic model has now been replaced by a strategy map that is at the center of a balanced scorecard - BSC [15]. A strategy map places the four perspectives in relation one with the other, to show that the objectives are mutually supportive [2].

Balanced Scorecards are a visual representation of a list of demands and objectives where the needs and objectives are be immediately identified as visible and managed by "action plans."

Exemplifying to a ship-repair and maintenance shipyard is as per Table 3 presentation.

Table 2. The ship-repair and maintenance shipyard performance indicators –characteristics

Objectives		Performance indicators	Content	
			Financial	Non - Financial
Economical	Strategically	Risk and Opportunity	Clients financial situation	Invoices delayed for payment by customer types
			The amount of uncollected bills	
		Market share		Total enrolling customers direct shipyard relations
				Total enrolling customers relationships by brokers
				Potential enrolling new customers
	Managerial	Availability of resources		Docks
				Dock cycle by ship types
				Number of days delayed in delivery of ships
		Costs	Production costs Backgrounds / ship	The percentage reduction of costs production / ship
			Expenses directly related to sales/allocated expenses (indirect)	
			Costs related to storage	
	Operational	Activities		Number of visits to the customers
				The number of customers lost
				Orders productivity / day
				The number of suppliers / alternatives number
				The number of pollution incidents / ship
				The number of work accidents / ship
		Product		The percentage of defective works
				The percentage of defective materials
				Percentage of late arrived materials
		Procedures		The percentage of repeat inspections for technical failures / ship
		Efficiency		Efficiency of visits to the customers = the number of obtained contracts / number of visits
				Efficiency of contracting related to the number of offers submitted to customers
				Consumption of energy, water, gas / ship
				The effectiveness of maintenance works carried for workspaces and equipment
				The percentage of investigated faults

Table 3. The ship repair and maintenance shipyard Balanced Scorecards – Example

BALANCED SCORECARD PERSPECTIVE	OBJECTIVES	INDICATORS	REQUIRED ACTIONS
Financial	10% increased incomes	1. total revenues 2. dry dock and manpower availability in the extra season period	1. price list and payment terms condition revision 2. additional facilities offered for the clients booking in the extra season
Clients	Increased requires for the shipyard services	1. customers satisfaction 2. dry docks and manpower loading	1. Marketing Department actions program 2. selection plan for the shipyard collaborators and subcontractors
Internal processes	Ships repair and maintenance quality works to be carried out	1. ships type docking period 2. delayed days at ship delivery	1. reviewing and streamlining processes for conducting repair and maintenance works on ships 2. restructuring plan
Organizational development	Motivation and professional recognition	1. employee satisfaction	1. plan for employee training courses 2. evaluating employee performance

4. CONCLUSIONS

Currently, the organizations performance is fundamental in the context of tighter market competition, so that the survival chance considerably increases in this competition for those organizations who finds and minimize very quickly their vulnerabilities and, moreover implements performance management tool that facilitates detection, explaining and solving various shortcomings within the management activities, the main objective being the increase of competitiveness. The specific global economy new elements, economic liberalization, globalization, intense competition, the transition from industrial economy to knowledge economy and information, social and environmental challenges to the sustainable development needs, recent global financial crisis has led to organizations changing requirements and diversify their responsibilities directed by to all holders of interests categories, to society as a whole so that they do not can discuss an organization viability in a competitive environment, unstable and turbulent, without no performance, world economy currently imposing new performance standards that go beyond economics. The mentioned macroeconomic developments impose that ignoring social and environmental aspects can result in losses that may result in market share in lower turnover diminishing, reducing the customers number, in diverse ecological costs, in acquisition consumer confidence campaigns and in products and services. The financial crisis has affected world seaborne market as a matter of economic uncertainties, the shipping applications decrease, in excess seaborne transport capacities existence and banks and financial institutions available funds decreasing so that, shipping companies for survival were forced to adopt unconventional strategies such as "slow steaming" and transport services re- alignment, withdrawing vessels from routes become unprofitable. In these adverse market conditions for shipping companies, became imperative necessary maintenance lowering cost strategies implementation referring to: lowering associated deviation costs from the last discharging port up to the repair shipyard for ship repair and maintenance works commencement; contracting ship repair and maintenance works at affordable prices for shipping companies; ship daily fixed costs decreasing during ongoing ship repair and maintenance works requiring time period reducing by booking the shipyard that quote the shorter repairing period frame for ship repair and maintenance works performance as per quality, environment, health and security standards terms. Based on the shipping companies maintenance lowering cost update targets, the ship repair and maintenance works shipyards for competitiveness and efficiency economic conditions maintaining may will analyze their performance indicators related to: contracting percentage versus offers submitted number; the reduction percentage of production costs / ship; docking period time per ships and types ; the days of delays in the ships delivery; percentage of technical re-inspections /ship. The adopted corrective measures seeks out the basic objectives not be affected: the docking capacities constant ships loading; all permanent employees manpower force constant loading; long-term collaboration with shipping companies registered as traditional customers portfolio companies; the possibility co-operation starting with new shipping companies expanding the customers portfolio. Performances indicators for the quoting activity are indicated by: number of quotations sent to the clients and the number of gained bookings related to the: geographical area, ships type (tankers, bulkers, container ships) and ships

dimensions; the accepted number of tenders for maintenance works execution contracting where the a final invoice has been under "The Maintenance and Repair Works related to the Ship Maintenance Quotation" initially estimated budget based on "The Maintenance Works Technical Specification" prepared by the Ship-owners/Technical managers: the customer profile consisting of by their fleets number of vessels, geographical location etc; the amount and type of canceled works related to: docking, ships surfaces treatment and painting, structures steel plates and piping's replacement, mechanical and electrical repairs etc. For the planning and scheduling activity the performance indicators could refer to: the tenders undelivered number due to lack of docking slot availability for the ship-owners required time periods: the customer profile consisting of by their fleets number of vessels, geographical location, the types and dimensions of required in docking ships (tankers, bulk carriers, container ships), the required time for ships docking slot availability for the ship-owners; the contracted vessels delaying days encountered according to: the delayed days amount; the types and dimensions of delayed ships (tankers, bulk carriers, container ships) and the maintenance and repairs type works hat led to overflows deadline: docking, ships surfaces treatment and painting, structures steel plates and piping's replacement , mechanical and electrical repairs etc.; the booked ships which delayed their arrival into the shipyard for the maintenance and repairs works starting.

The Maintenance and Repairs Shipyard tendering ,planning and programming activities are resulting as a fixed dates estimations subject to a wide range of variables conditions and limits such as: the seaborne trading markets; the geographical shipyard location weather seasons; the ships type, capacity and age; final works volume differences toward initial estimation due to the ships systems, installations and equipment technical conditions established after overhauling and repair works starting.

The authors conclusion for future studies is that should be necessary the efforts focused on two areas: the significant variable number identification and their interrelation in the maintenance and repair works shipyard tendering and planning programming activities for the ships total repair and in docking period time estimation required for the execution of the listed works by the Owners/Technical Managers Ships Technical Specification; a mathematical model developing to estimate ships total repair and indocking period time required for the execution of the listed works by the Owners/Technical Managers Ships Technical Specification.

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COSTS ANALYSIS IN MULTIMODAL TRANSPORT

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ABSTRACT

It is well known that multimodal transport refers to the transportation of goods by using more than one mode of transport. The purpose of this paper is to determine the best transport solution in terms of transport costs, taking into account the combinations of transport modes that can be used to transport the freight, the transport distances for each segment and also the handling and transport costs involved on each segment.

Keywords: *Multimodal transport, cost, ITU, TIET.*

1. INTRODUCTION

Taking into consideration the complexity and importance of transport as an essential component of the global economy, we can say that the debate on aspects of this broad field can be always considered current.

International transport generally involves the use of variable transport ways, each connection corresponding to a transfer, storage or a transport operation that takes place either in the country of origin, a transit country or the country of final destination. The development of 'door to door' transport imposed also the development of multimodal transport because this allows combining in the most advantageous way all the benefits of each mode of transport.

For realizing this study we assume that we will transport 3,000 tons of fertilizer from expedition point Targu Mures, Romania to destination point Rotterdam, Netherlands.

Figure 1 The localization of the expedition and destination point of the cargo
Source: www.maps.google.ro

2. ANALYSIS OF POSSIBLE TRANSPORT ROUTES

2. 1. Rail transport

The first transport route that can be used to transport the 3,000 tons of fertilizers may consist in a direct route, using the rail transport. The route on which the freight will be transported will cross four countries: Germany, Austria, Hungary and Romania, from Târgu Mureş to Rotterdam (Târgu Mure□- Simeria- Arad- Curtici- Szolnok- Budapesta- Gyor- Sopron- Viena- Linz- Salzburg-Munchen- Stuttgard- Koln- Venlo- Dordecht- Rotterdam).

The shortest rail distance between Targu Mures and Rotterdam is about 2,000 km. Fertilizers in bags belong to general palletized cargo category, with high volume that requires protection against atmospheric agents. In order to transport this type of cargo by rail we will use Gas wagons. Given the transport capacity of a train we will have:

- 3000 tons: 50 tons/wagon = 60 wagons
- A complete train has 30 wagons, so we will need two complete trains to transport goods.

In order to determine the transport costs we will need: freight name, transport distance, dispatch weight and other requirements provided by this type of transport and its costs.

For the rail transport of this freight, we will need to use the Tariffs of import, export and transit of CFR Marfa that takes into consideration whether the expeditions are made of complete wagons or of Intermodal Transport Units (ITU).

If the transport distance exceeds 1,200 km, the transport cost is determined as follows:

a) It is established the distance that exceeds 1,200 km;

b) From the distance of 1,200 km we subtract the distance resulting from point a);

c) We determine the transport costs for the distance resulting from point b);

d) We determine the difference between the transport cost obtained for the distance of 1,200 km and the one obtained at point c);

e) The transport cost is obtained by adding the transport cost for the distance of 1,200 km and the one that resulted at point d).

Costs determination

According to the table on fares for wagons expeditions from TIET (Tariff of import, export and transit of CFR Marfa), for a distance between 1,151-1,200 km, the price is 209.76 lei/ton.

- Loading operations cost:

Approximately 2.00 Euro/ton => Loading cost= 3,000 tons × 2.00 Euro/ton = 6,000 Euro

- Rail transport cost:

Due to the fact that the transport distance exceeds 1,200 km, the transport price is determined as follows:

a) 2,000km - 1200km= 800 km

b) 1,200km - 800km= 400km
c) According to TIET for a distance of 381- 400 km the price is 85.50 lei/ton.
d) Price difference= 209.76 lei/ton– 85.50 lei/ton = 124.24 lei/ton
e) Transport cost= 209.76 lei/ton + 124.24 lei/ton =334 lei/ton

Transport cost= 75.90 Euro ≅ 76 Euro (1 Euro= 4.4 lei)

So, the rail transport cost for 3,000 tons will be:
3,000 tons × 76 Euro/ton=228,000 Euro

- Unloading operations cost:

Approximately 2.25 Euro/ton: Unloading cost= 2.25 Euro/ton x 3000 tons = 6750 Euro

Total costs for rail transport on the route Targu Mures- Rotterdam: 6,000 Euro + 228,000 Euro + 6,750 Euro = 240,750 Euro

2. 2. Rail transport followed by river transport

A second route taken into consideration for transporting the 3000 tons of cargo can be a combined route, rail transport from Targu Mures to the river port Drobeta Turnu Severin, where the cargo will be transhipped onto a river ship for transiting the river section up to the port of Rotterdam.

a) The distance Targu Mures- Drobeta Turnu Severin will be realised by rail transport. The cargo will be transported same as in the first scenario, during two complete train expeditions of 30 wagons each, on 4 axles type Gas covered wagons.
b) The ship used for river transport can be a cargo type ship with a loading capacity allowing the transport of 3000 tons and a maximum draft enabling the river transport without restrictions.

Costs determination

In this case the distances are divided as follows:

- The rail distance form Târgu Mureş to Drobeta Turnu Severin is of 453 km.
- The river distance between Drobeta Turnu Severin and Rotterdam is of 2,678 km.

- Wagons loading operations cost:

Approximately 2.00 Euro/ton => Loading cost= 3,000 tons × 2.00 Euro/ton = 6,000 Euro

- Rail transport cost:

The amount of freight =3,000 tons of fertilizer
Rail distance= 453 km
According to TIET for a distance between 431- 460 km the price is of 94.43 lei/ton.
Rail transport cost= 94.43 lei/ton × 3,000 tons = 283,290 lei ≅ 64,384 Euro

- Transhipment costs:

The transhipment costs charged by CFR for this type of freight (fertilizers in bags), is of 4.11 Euro/ton.
Transhipment costs= 4.11 Euro/ton × 3,000 tons =12,330 Euro

- River transport cost:

The amount of freight =3,000 tons of fertilizer
Approximately 20 Euro/ton => River transport costs= 20 Euro/ton × 3,000 tons= 60,000 Euro

- Unloading operations cost:

Approximately 2.25 Euro/ton: Unloading cost= 3000 tone × 2.25 Euro/ton= 6,750 Euro

Total costs for rail- river transport route, Targu Mures- Rotterdam: 6,000 Euro + 64,384 Euro + 12,330 Euro + 60,000 Euro + 6,750 Euro = 149,464 Euro

2.3. Road transport followed by river transport

A third transport route considered for transporting the 3,000 tons of fertilizer can be a combined route, road transport from Targu Mures to the river port Drobeta Turnu Severin, where the cargo will be transhipped onto a river ship for transiting the river section up to the port of Rotterdam.

The distance between Târgu Mure and the river port Drobeta Turnu Severin is of 453 km. The suitable mean of transport is the covered truck, which has a maximum speed of 90 km/h. The maximum load capacity of a truck is 24 tons, which means that in order to transport the 3,000 tons of fertilizer packed in bags of 40 kg, we will need 125 trucks (125 trucks x 24 tons = 3,000 tons).

Costs determination

- Trucks loading operations cost:

Approximately 2.00 Euro/ton => Loading cost= 3,000 tons × 2.00 Euro/ton= 6,000 Euro

- Road transport cost:

The amount of freight =3,000 tons of fertilizer
Road distance= 453 km
Transport cost: approximately 3 lei/km for a truck of 24 tons.
Road transport cost/truck= 3 lei/km x 435 km x 1.24 (VAT) = 1,618.2 lei/truck
Road transport cost= 125 trucks x 1,618.2 lei/truck= 202,275 lei ≅ 45,971.6 Euro

- Transhipment costs:

Approximately 2.75 Euro/ton => Transhipment cost= 2.75 Euro/ton x 3,000 tons = 8,250 Euro

- River transport cost:

The amount of freight =3,000 tons of fertilizer
Approximately 20 Euro/ton => River transport costs= 20 Euro/ton × 3,000 tons= 60,000 Euro

- Unloading operations cost:

Approximately 2.25 Euro/ton: Unloading cost= 3000 tone × 2.25 Euro/ton= 6,750 Euro

Total costs for road- river transport route, Targu Mures-Rotterdam: 6,000 Euro + 45,971.6 Euro + 8,250 Euro + 60,000 Euro + 6,750 Euro = 126,971.6 Euro

2.4. Rail transport followed by maritime transport

The fourth transport route considered for transporting the 3,000 tons can be a combined route, rail transport from Targu Mures to the maritime port of Constanta, where the cargo will be transhipped onto a ship for maritime transport to the port of Rotterdam.

a) The distance Targu Mures- Drobeta Turnu Severin will be realised by rail transport. The cargo will be transported same as in the first scenario, during two complete train expeditions of 30 wagons each, on 4 axles type Gas covered wagons.
b) The distance between port of Constanta and port of Rotterdam is of 3,340 nautical miles, approximately 1,804 km. The ship used for maritime transport can be a cargo type ship with a loading capacity allowing the transport of 3000 tons.

Costs determination

- Loading operations cost:

Approximately 2.00 Euro/ton => Loading cost= 3,000 tons × 2.00 Euro/ton = 6,000 Euro

- Rail transport cost:

The amount of freight =3,000 tons of fertilizer
Rail distance= 642 km
According to TIET for a distance of 642 km the price is of 127.20 lei/ton.
Rail transport cost= 127.20 lei/ton × 3,000 tons =

381,600 lei ≅ 86,727.3 Euro

- Transhipment costs:

The transhipment costs charged by CFR for this type of freight (fertilizers in bags), is of 4.11 Euro/ton.
Transhipment costs= 4.11 Euro/ton × 3,000 tons =12,330 Euro

- Maritime transport cost:

The amount of freight =3,000 tons of fertilizer
Maritime distance= 3,340 nautical miles= 1,804 km
Approximately 30 Euro/ton => Maritime transport costs= 30 Euro/ton x 3,000 tons= 90,000 Euro

- Unloading operations cost:

Approximately 2.25 Euro/ton: Unloading cost= 3000 tone × 2.25 Euro/ton= 6,750 Euro

Total costs for rail- maritime transport route, Targu Mures-Rotterdam: 6,000 Euro + 86,727.3 Euro + 12,330 Euro + 90,000 Euro + 6,750 Euro = 201,807.3 Euro

2.5. Road transport followed by maritime transport

The fifth transport route considered for transporting the 3,000 tons of fertilizer can be a combined route, road transport from Targu Mures to the maritime port of Constanta, where the cargo will be transhipped onto a ship for maritime transport to the port of Rotterdam.

Costs determination

- Loading operations cost:

Approximately 2.00 Euro/ton => Loading cost= 3,000 tons × 2.00 Euro/ton = 6,000 Euro

- Road transport cost:

The amount of freight =3,000 tons of fertilizer
Road distance= 642 km
Transport cost: approximately 3 lei/km for a truck of 24 tons.
Road transport cost/truck= 3 lei/km x 642 km x 1.24 (VAT) = 2,388.24 lei/truck
Road transport cost= 125 trucks x 2,388.24 lei/truck=

298,530 lei ≅67,847.7 Euro

- Transhipment costs:

Approximately 2.75 Euro/ton => Transhipment cost= 2.75 Euro/ton x 3,000 tons = 8,250 Euro

- Maritime transport cost:

The amount of freight =3,000 tons of fertilizer
Maritime distance= 3,340 nautical miles= 1,804 km
Approximately 30 Euro/ton => Maritime transport costs= 30 Euro/ton x 3,000 tons= 90,000 Euro

- Unloading operations cost:

Approximately 2.25 Euro/ton: Unloading cost= 3,000 tone × 2.25 Euro/ton= 6,750 Euro

Total costs for road- maritime transport route, Targu Mures-Rotterdam: 6,000 Euro + 67,847.7 Euro + 8,250 Euro + 90,000 Euro + 6,750 Euro = 178,847.7 Euro

2.6. Road transport

The sixth transport route that can be used to transport the 3,000 tons of fertilizers may consist in a direct route, using the road transport, from Târgu Mureş to the port of Rotterdam. The transport distance in this case will be 1,962 km.

Costs determination

- Loading operations cost:

Approximately 2.00 Euro/ton => Loading cost= 3,000 tons × 2.00 Euro/ton = 6,000 Euro

- Road transport cost:

The amount of freight =3,000 tons of fertilizer
Road distance= 1,962 km
Transport cost: approximately 3 lei/km for a truck of 24 tons.
Road transport cost/truck= 3 lei/km x 1,962 km x 1.24 (VAT) = 7,298.64 lei/truck
Road transport cost= 125 trucks x 7,298.64 lei/truck=

912,330 lei ≅ 207,347.7 Euro

- Unloading operations cost:

Approximately 2.25 Euro/ton: Unloading cost= 3,000 tone × 2.25 Euro/ton= 6,750 Euro

Total costs for road transport route, Targu Mures-Rotterdam: 6,000 Euro + 207,347.7 Euro + 6,750 Euro = 220,097.7 Euro

3. CONCLUSIONS

In order to choose the most efficient route as per cargo transport and handling costs implied, six scenarios have been analysed taking into consideration all restrictions met on different routes selected.

Total costs for each route considered are shown in the figure below, for a better perception of the cheapest route.

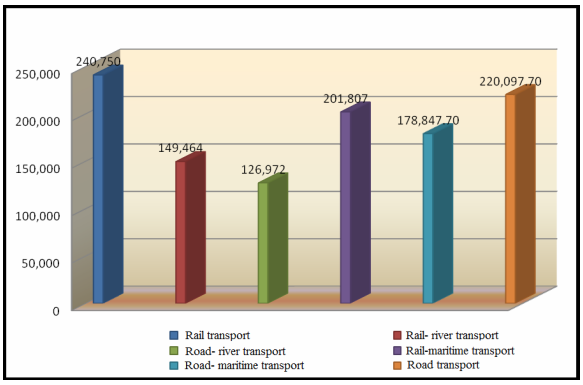

Figure 2 Total costs related to each analysed route

According to the figure above, the most efficient route is the one that use the combined road-river route: Targu Mures- Drobeta Turnu Severin- Rotterdam; but we should consider two important elements: the number of trucks used for the transport of goods and the possibility that the cargo will not arrive at river terminal in time for transhipment.

Although the transport cost is lower using the combined road- river route, the most efficient is the combined rail- river route, because it requires only two expeditions. By using rail transport the goods will reach the transhipment point all in the same time.

So the best option in terms of costs but also benefits is represented by the combined rail-river route with a transport cost 149,464 Euro.

As stated before and considering our study, we can see that multimodal transport is considered a safe alternative for the future, due to the fact that it meets the demands regarding environmental protection (due to the use of means of transport less polluting), energy conservation and traffic congestions.

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