CONSIDERATIONS REGARDING THE USE OF DISTORSIONAL SIMULATION FOR STUDYING LONG BREAKE-WATERS

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ABSTRACT

In the paper we propose to use the FLUENT to calculate the water current action on the break-waters. This calculation is made on models at one and two scales. The results are converting into reality using the similarity criterions. We also calculated the action of the current on the break-waters in the nature.

We are interesting about the correspondence between the values in the nature and the values obtained using the similarity at one scale and two scales.

Keywords: *break-water, distorsional simulation, current action.*

1. INTRODUCTION

It is difficult to achieve a model for experimenting. Also it is difficult to calculate the phenomena in the nature scale using the FLUENT. So we calculated the physical parameters, using FLUENT, on the model and we pass them, with the similitude criteria help, in the nature.

The results obtained using the single scale similitude method are very close to the nature. The main idea is that FLUENT can be used as an experimental stand.

Some problems, especially related to the long objects (conduit, break-waters, etc.) can be solved using two geometrical scales (one for length and one, smaller, for diameter). By applying the formulas for distortional similitude, we can pass from the model to the nature.

2. THE MODEL OF A BREAK-WATER UNDER CURRENT ACTION

2.1 One scale model

We consider the case of a break-water designated to protect the harbour area, situated perpendicularly on the current velocity direction of a river.

The dimensions of the underwater part are: L = 200 m; l = 2,5 m; h = 12,5 m.

The velocity of the water current: v = 2 m/s.

The model, built at the scale 1:25, will have the dimensions:

L' = 8 m; l' = 0.1 m; h' = 0.5 m.

By applying Froude similitude we'll obtain **v' = 0.4 m/s:**

$$\frac{v^2}{gl} = \frac{v'^2}{g'l'} \qquad (1)$$

We have noted with ' the model magnitudes.

Taking into account that g = g', it results:

$$k_v = \sqrt{k_l} = 5, \qquad (2)$$

and v' = v/5 =0.4 m/s.

We establish the forces scale using the formula $F = \gamma V$, where γ is the specific gravity of the water. Having the same fluid in the nature and on the model, we conclude:

$$k_F = k_l^3. \qquad (3)$$

In the Figure 1 we have the construction in GAMBIT programme of the model:

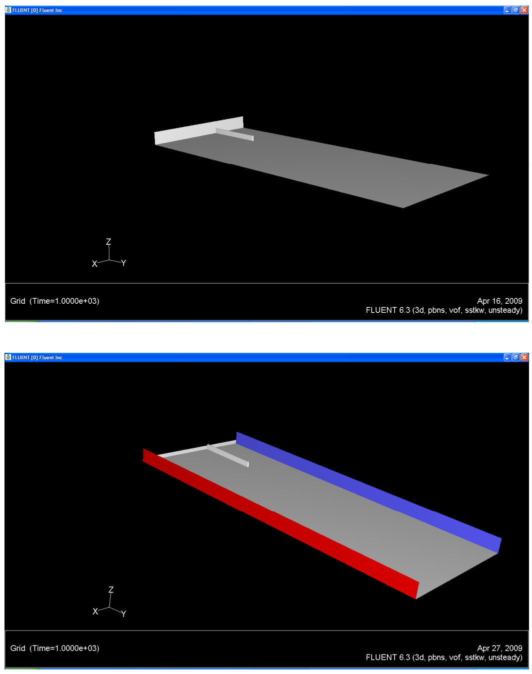

Figure 1 The model construction

To solve the problem, using FLUENT programme, we'll make the conditions:

- implicit formulation;
- 3 D;
- unsteady movement;
- turbulence model: k-omega.

We'll consider the biphasic flow, with free surface and with contact between air and water. The calculation begins from an entrance velocity, Ox positive direction: v' = 0.4 m/s.

After iterations (300 steps), we observed the linearization of the solution for C_D – the resistance coefficient, the three components of the velocity, k and omega.

After linearization of the solutions we can see the contour of the static pressure and the velocity vectors in various sections (Figure 2).

The forces acting on the break-water is presented in the Table 1.

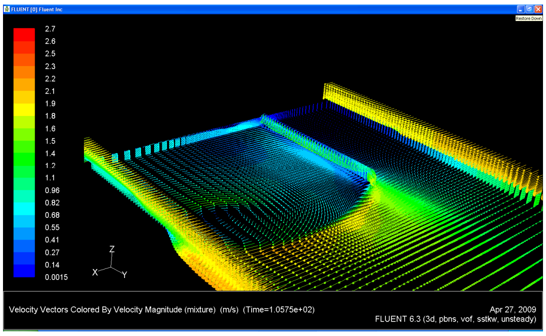

Figure 2 The velocity vectors

Table 1

Force vector: (1 0 0)

zone name	pressure force n	viscous force n	total force n	pressure coefficient	viscous coefficient	total coefficient
fundul-apei	0	1803.9548	1803.9548	0	1.2026366	1.2026
mal	0	-2.540731	-2.540731	0	-0.00169382	-0.00169
dig	8681.01	0.10	**8681.11**	5.7873457	7.0015152e-05	5.787
mal.2	0	0.18278292	0.1827829	0	0.00012185	0.000121855
net	8681.01	1801.7019	10482.72	5.7873457	1.2011346	6.98

To calculate the force in the nature, we apply the relation (3):

F = F' x k_F = 8681 x 25 x 25 x 25 = **135 660 625 N = =13 566 x 10^3 daN.** (4)

2.2 Two scales model

We'll take the two scales as follows:

$$k_x = k_z = 25; k_y = 200.$$

The distorsional rate will be:

$$k_1 = \frac{k_y}{k_x} = 8. \tag{5}$$

The model, built at two scales, will have the dimensions:

L' = 1 m; l' = 0.1 m; h' = 0.5 m.

By applying Froude similitude (1) we'll obtain also **v' = 0.4 m/s.**

In this case the force scale will be:

$$F = \gamma V \Rightarrow k_F = k_\gamma k_x^2 k_y \tag{6}$$

and taking into account that $k_\gamma = 1$, it results:

$$k_F = k_x^2 k_y . \tag{7}$$

In the Figure 3 we have the distortional model of the break-water:

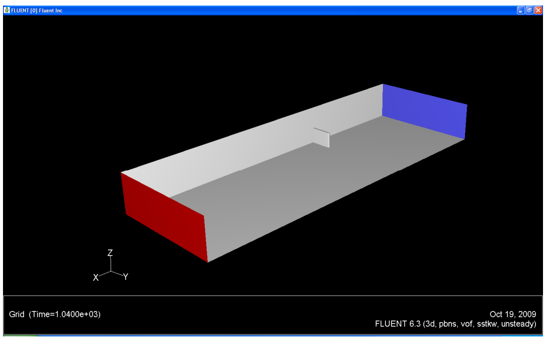

Figure 3 The distortional model

Using FLUENT programme we calculated the force acting on the distortional break-water model (Table 2).

Table 2

Force vector: (1 0 0)

zone name	pressure force n	viscous force n	total force n	pressure coefficient	viscous coefficient	total coefficient
fundul-apei	0	380.88428	380.88428	0	0.25392285	0.25392285
mal	0	-2.4170322	-2.4170322	0	-0.001611354	-0.001611354
dig	1207.32	0.002225	1207.3285	0.804884	1.4837e-06	0.8048856
mal.2	0	0.95656317	0.95656317	0	0.00063770	0.000637708
net	**1207.32**	379.42603	1586.7523	0.804884	0.25295069	1.0578349

To obtain the force acting on the real break-water we apply the relation (7):

$$F = 1207 \times 25^2 \times 200 = 150\ 875\ 000\ N = =15\ 087{,}5 \times 10^3\ daN \quad (8)$$

3. THE BREAK-WATER IN THE NATURE

The break-water is designated to protect the harbour area and it is situated perpendicularly on the current velocity direction of a river.

It is necessary to remember the dimensions of the underwater part: L = 200 m; l = 2,5 m; h = 12,5 m. The velocity of the water current: v = 2 m/s.

The general conditions to solve the problem are the same as presented in the previous chapter.

After calculation we obtained the following spectrum for the velocity (Figure 4).

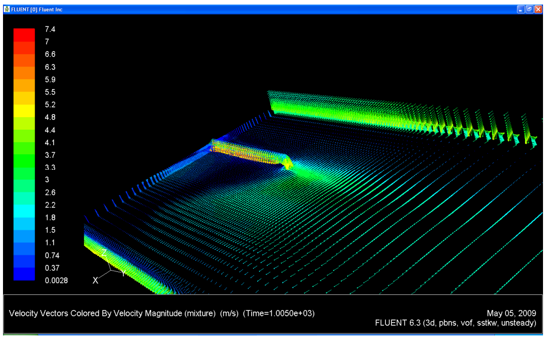

Figure 4 The velocity vectors for the brake-water in the nature

Also, we obtained the forces acting on the brake-water (Table 3).

Table 3

zone name	pressure force n	viscous force n	total force n	pressure coefficient	viscous coefficient	total coefficient
fundul-apei	0	1320574.3	1320574.3	0	880.38283	880.38283
mal	0	-3526.4692	-3526.4692	0	-2.3509795	-2.3509795
dig	1.189e+08	149.354	1.18915e+08	79277	0.099569478	79277
mal.2	0	127.4361	127.43618	0	0.084957453	0.08495
net	1.189e+08	1317324.6	1.20232e+08	79277	878.21638	80155.31

$$F = 118\ 900\ 000\ N = 11\ 890 \times 10^3\ daN. \quad (9)$$

4. CONCLUSIONS

The comparative analysis can be made in different way:

- between the values obtained using the similarity at one scale and two scales;
- between the values in the nature and the values obtained using the similarity at one scale and two scales.

If we refer only to the force of the current acting on the break-water, we notice that the difference of the total value is 26% between the “nature” and the “model” at two scales. The difference between the “nature” and the “model” at one scale is only 11%.

However, we consider that the two scales similarity method mustn’t be eliminate because it is more suggestive in the simulation of phenomena and, in a “virtual stand”, with exotic liquids, the conclusions can be different.

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