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Comparative Study on the Results of Analytical and Experimental Analysis of a Steel Taintor (Radial) Gate

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Summary

The main load of a hydraulic gate is the water pressure, especially for the submerged gates. A good accuracy of the computation methods leads to a more secure structure.

The paper presents a comparison between different computation methods of this type of structures. A radial gate was analyzed. The size of the submerged outlet is 4,0 x 4,0 m and the water depth is 20,0 m

The following methods were used in the analysis:

- *The finite elements method, using a mesh of the structure of the gate.*
- *Model studies. An 1:4 scale model was built in order to perform this study. The model was subjected to water pressure. In several points of this model, strain measuring devices were installed and the strains were measured at several water pressure magnitudes.*

The results of the first two computation methods are compared in some points of the structure. With the aid of the second method, the strains were computed in order to compare them with the strains measured on the model.

These comparative studies try to establish the accuracy of each of the methods presented above.

KEYWORDS: radial gate, water pressure; experimental study

1. STUDY'S OBJECT

In this paper it is analyzed a depth radial gate, which have the dimensions 4,00x4,00m, located on 20,00m depth. The structure of radial gate is presented in figure 1.

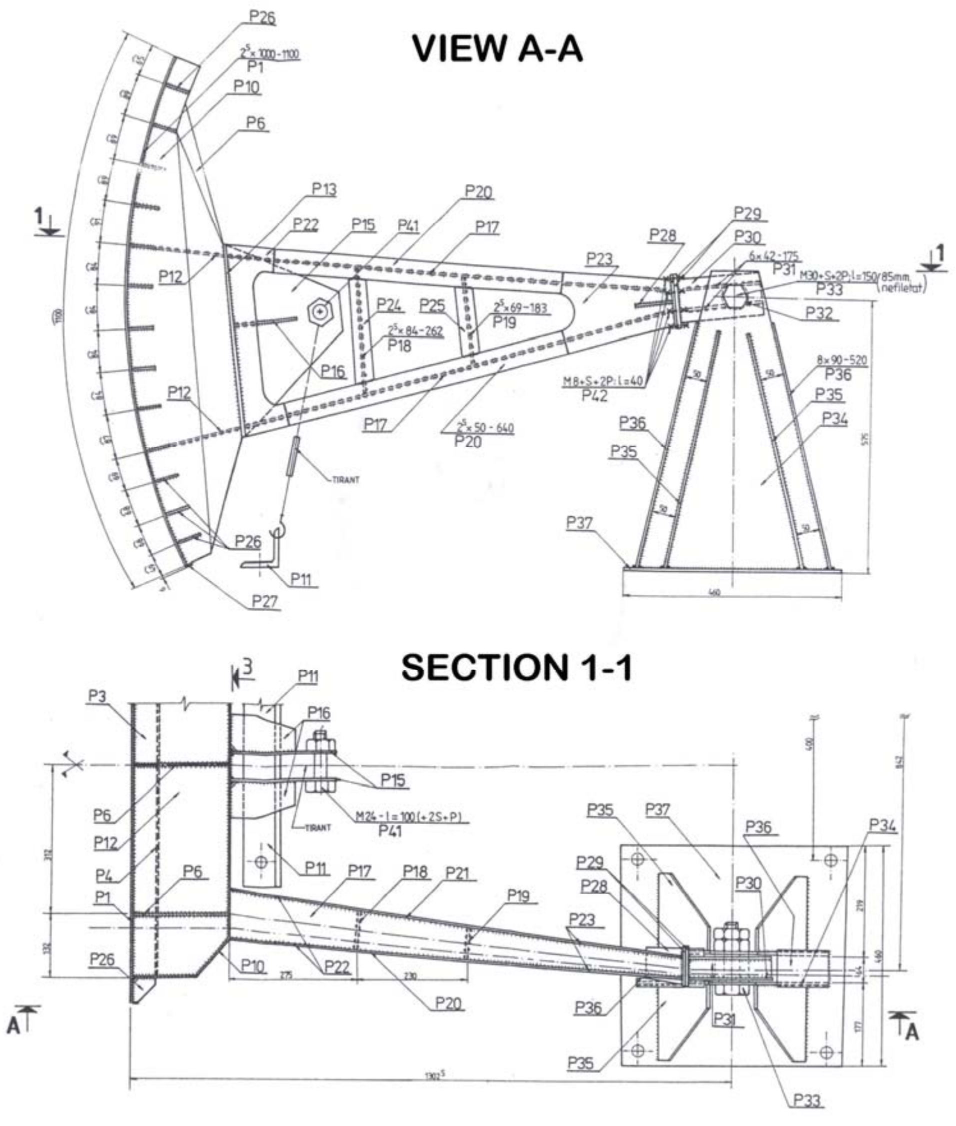

Figure 1. The structure of analyzed radial gate

The main dimensions of the 1:4 scale model are:

- the outlet dimensions Lxh = 1050x1000 mm;
- the plate radius is 1300 mm;
- the plate thickness is 2,5 mm, in order to be 1:4 by the thickness of the gate's plate (10 mm);

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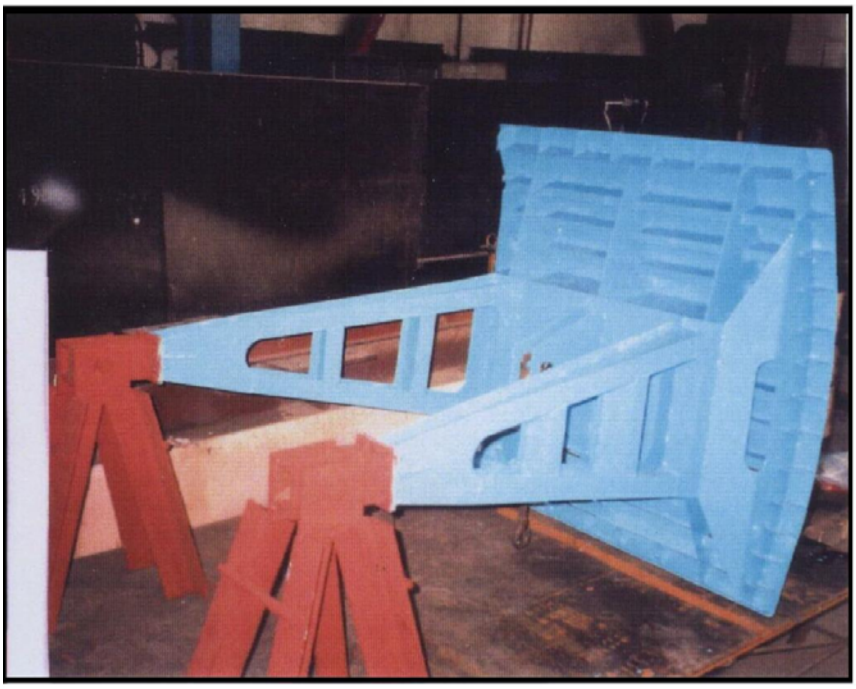

Fig 2 Assembling the scale model

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2. THE HYDRAULIC PRESSURE TEST OF THE SCALE MODEL

In order to apply water pressure on the model, a steel tank was built such as the model would fit on one of the tank's lateral faces. The tank was made out of 6 mm thickness sheet, which was stiffened with angle steel shapes.

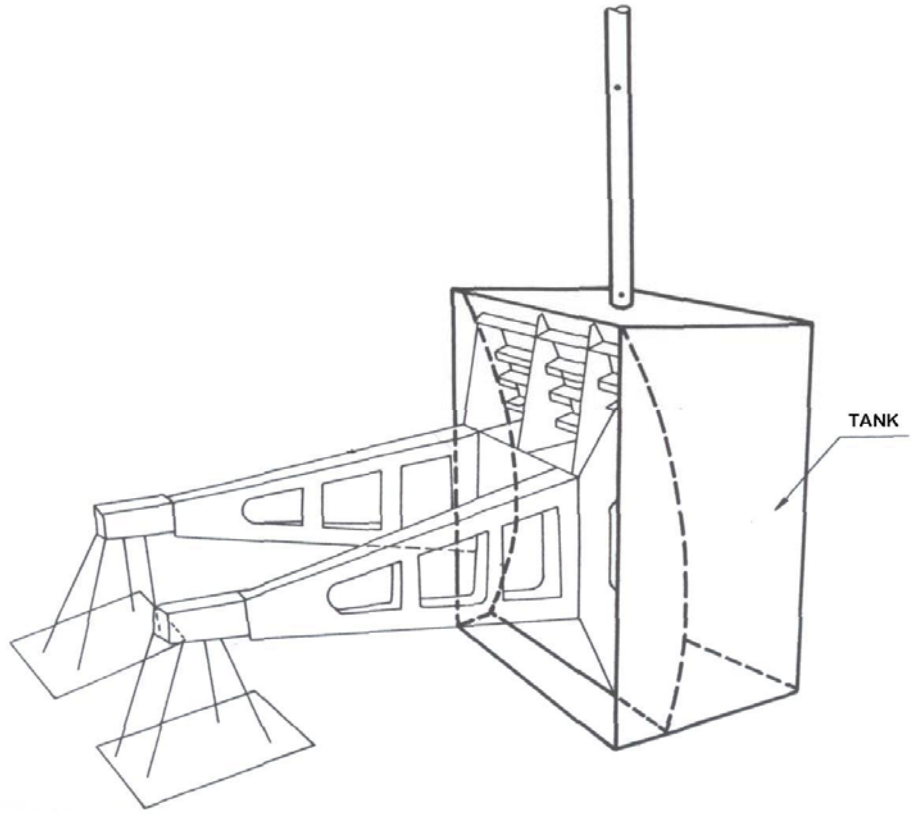

Fig. 3. The scheme of the hydraulic pressure test

The sealing between the model and the tank was made using siliconic sealant with good elastic properties, in order to allow the displacements between the tank and the model.

The boundary conditions were made similar to the real ones, when the gate is closed.

A vertical pipe was attached to the top face of the tank. This pipe allows the increase of water pressure in 1 m steps, the maximum pressure being 6 m above the tank.

ISSN 1582-3024

The deflections of the model were measured in 6 load steps; the water pressure was increased with 1 m in each step.

The deflections of the model in the upstream - downstream direction were measured with the aid of some measuring devices with 1/100 mm precision. The points in which these measuring devices were placed are shown in fig. 4 and 5. In pts 1 and 2 (where the displacements should be 0) two measuring devices were installed in order to correct the other measured deflections.

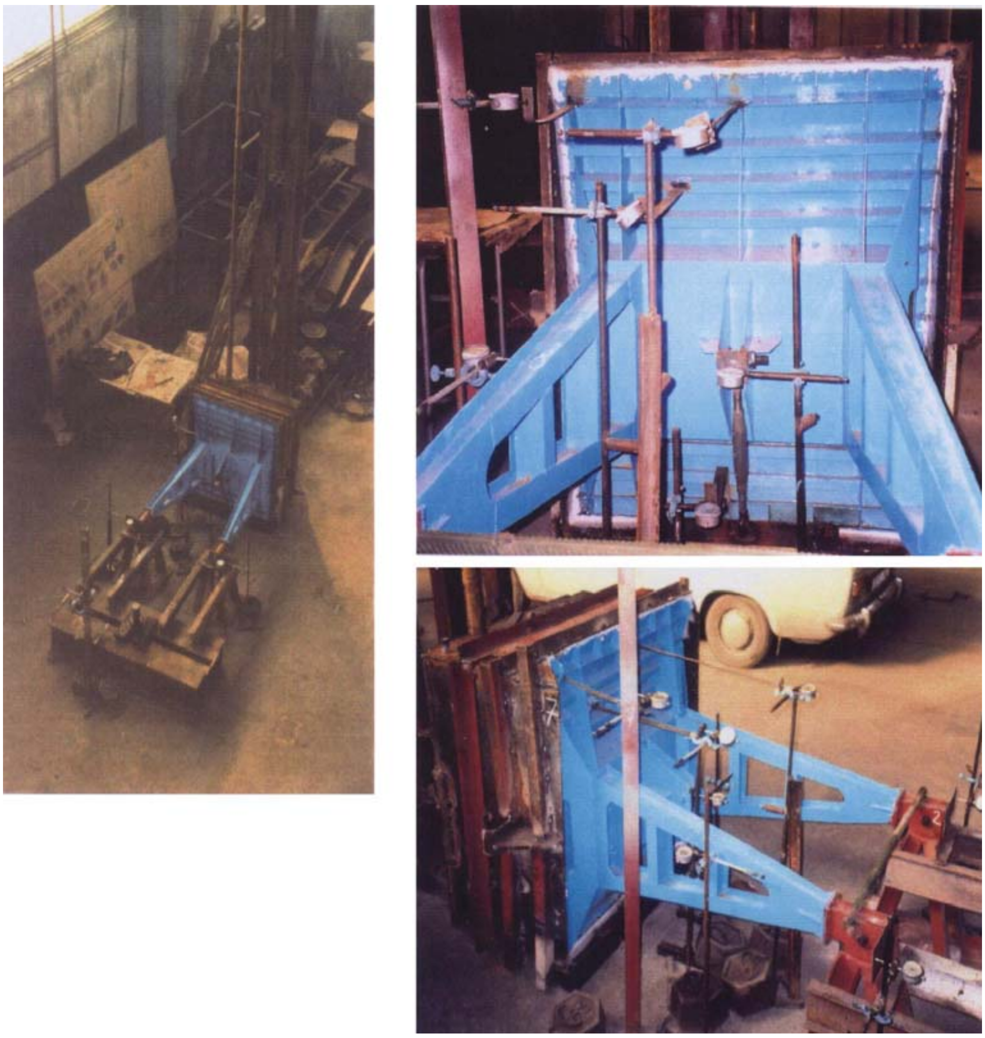

Fig. 4. Aspects during the test

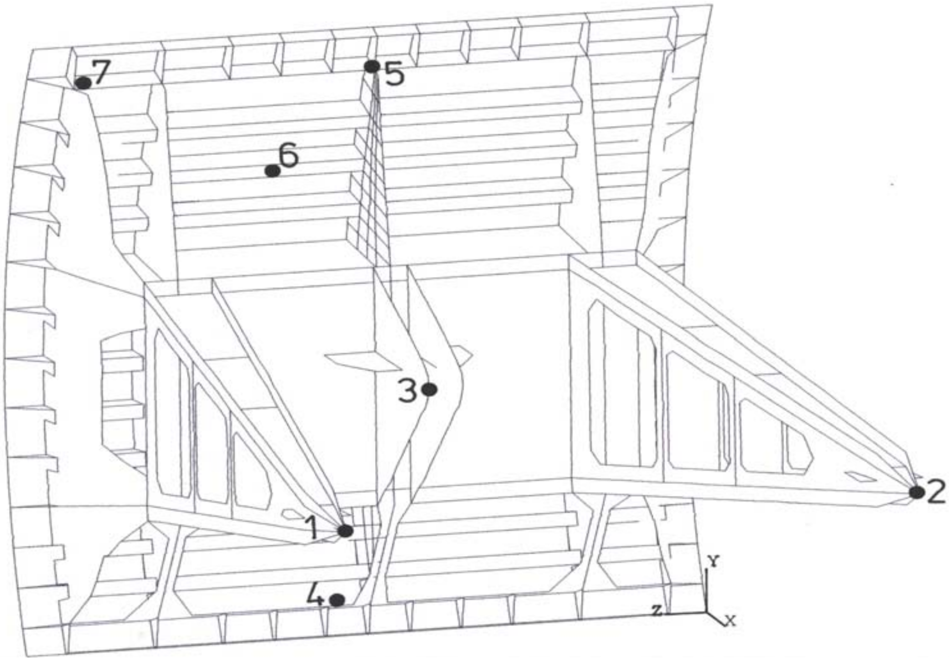

Fig. 5. The points where the measuring devices were installed

The corrected deflections in points 3 to 7 are shown in fig. 6. The corrections were made using the deflections measured in points 1 and 2 (which are the bearings where, theoretically, the displacement is null)

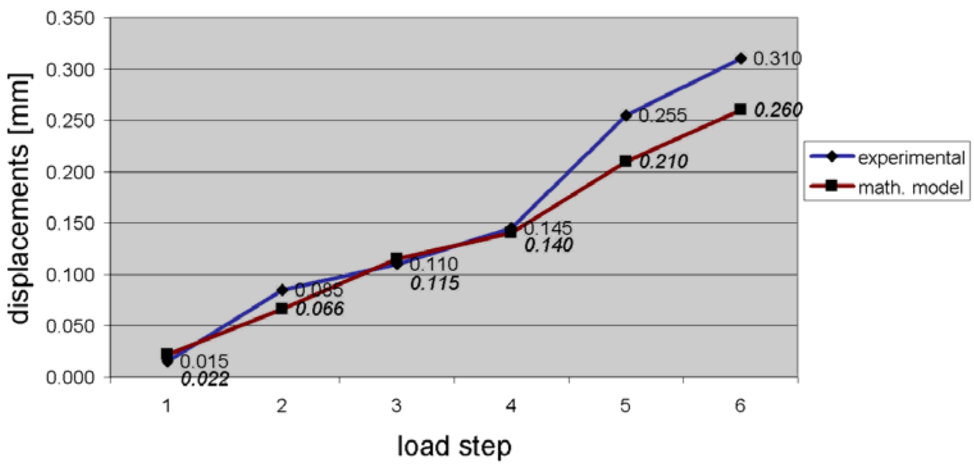

Figura 6. The corrected deflections in points 3 to 7.

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3. COMPARRISON BETWEEN THE RESULTS OF THE TEST AND THOSE OBTAINED BY COMPUTATIONS

A finite elements model was build, having the same characteristics as the scale model. The load steps were similar to the ones from the test.

The graphs in fig. 7, 8 and 9 shows comparisons between the displacements obtained in the test and in the computations.

One can notice a good match between the results obtained using the two methods, especially in the first four loading steps.

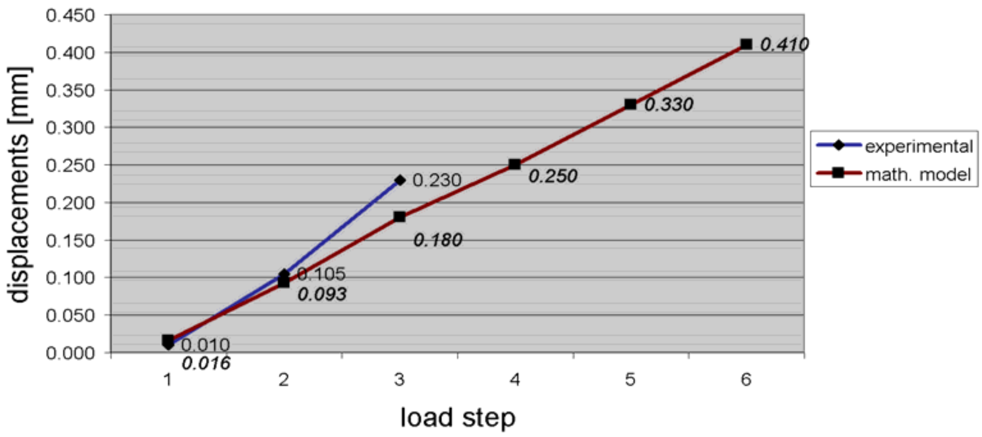

Fig 7. Displacements in point 3

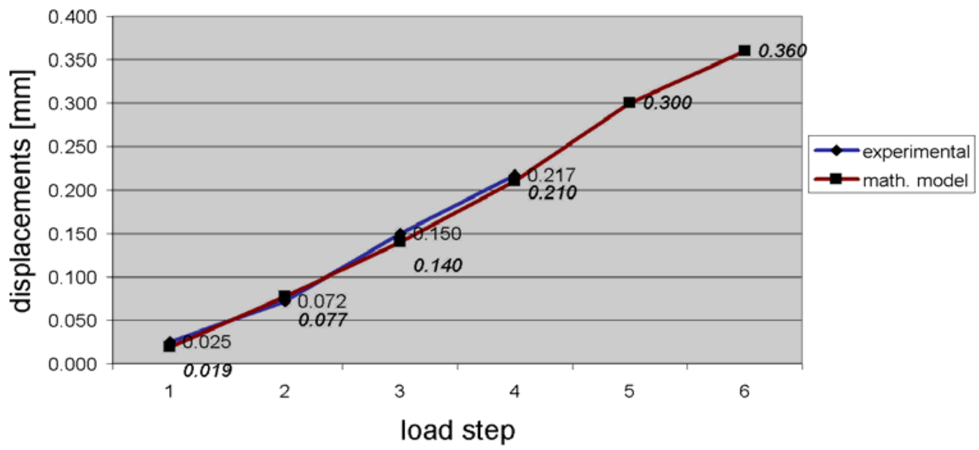

Fig 8. Displacements in point 6

ISSN 1582-3024

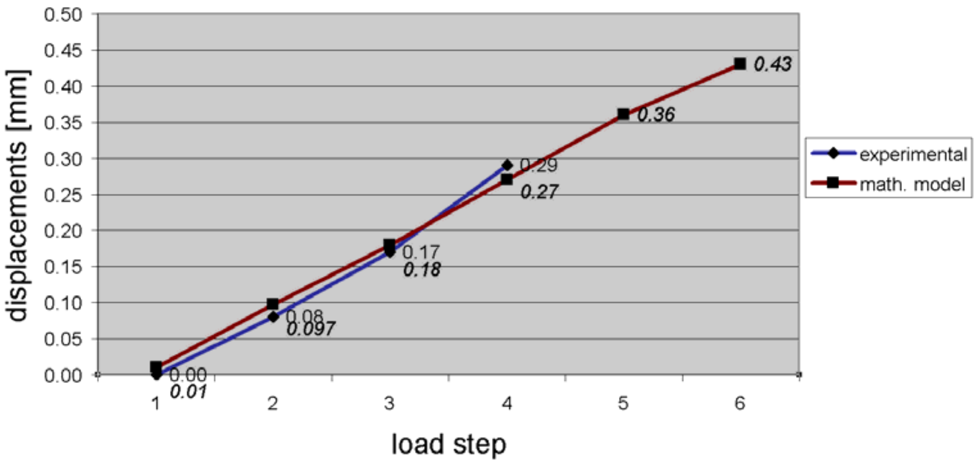

Fig 9. Displacements in point 7

In points 3 and 6, situated in areas of the structure having rather big stiffness, one can see the results are very close, the maximum differences being of about 19 % for point 3 and about 26% in point 6.

As a conclusion, the closeness between the results confirms the reliability of the finite element method, if the mesh is appropriate and sufficiently detailed.

References

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