NONLINEAR ANALYSES OF THE EMBANKMENT DAMS TO SUDDEN WATER LEVEL CHANGES IN THE RESERVOIR

ANALIZA NELINIARA A BARAJELOR DIN MATERIALE LOCALE LA VARIAȚII BRUȘTE ALE NIVELULUI APEI ÎN LAC

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Abstract. *In this paper, the effects of sudden water level changes in the reservoir on the earth dams' behavior it were studied. The water level variation in the reservoirs is a problem, which it was disregard in the past, and it was not study enough. For this reason, to put in evidence the earth dams' response in case of sudden water level changes in the reservoir, a series of numerical simulations have been done using a computer program, called Cosmos 2.6, based on the finite element method. A numerical procedure has developed on Dopca Dam and a comparison, for the model validation, it was make between numerical simulation results and timely field observations made on Dopca Dam. The problem is how the sudden rising or lowering water level of the reservoir affects the deformations of the dam. The analysis of the reservoir water level changes by the model clearly indicates that the water level variations are an important factor for the Dopca Dam structural behavior (deformation).*

Rezumat. *In acest articol este studiat efectul variatiilor bruste ale nivelului apei in lac asupra comportarii barajelor din materiale locale. Pentru a pune în evidență răspunsul barajului la aceste variații au fost realizate o serie de simulări numerice folosind programul COSMOS 2.6, bazat pe metoda elementului finit. Studiu de caz s-a realizat pentru barajul Dopca. Pentru validarea modelului s-a realizat o comparație între valorile simulate și cele măsurate. Modelarea numerică efectuată a scos în evidență că variația nivelului apei în lacul de acumulare are o deosebită importanță asupra comportării structurii barajului.*

The embankment dams are structures that need a wide foundation surface. Generally, these dams have founded on the lands that have the same properties like earth fill materials of dams. For this reason, to study the earth dams behavior it must been taken in account the earth dam-land foundation interaction. For the shear stress and strain analyses, the earth dam-reservoir interaction it is important too. Thus, it will take in account the sudden variation of the water level in reservoir. The sudden variation it is produce in the case when it is necessary a sudden drawdown of water level in reservoir or in case of a flash flood. In this paper presented the earth dams' response in case of sudden water level changes in reservoir.

MATERIAL AND METHODS

The numerical simulations for the case of sudden rise of the water level in the reservoir were done for Dopca dam, a last affluent of the Olt river, at a distance of 1,5 km upstream of the Dopca village, in the Brasov department. The Dopca dam is an earth fill dam, made of embankment from the materials extracted from the reservoir basin, with a reinforced concrete face, having a surface about 7800 m^2, made on the upstream face with the maximum height of 18,0 m and the length at the top of 175,0 m (fig. 1).

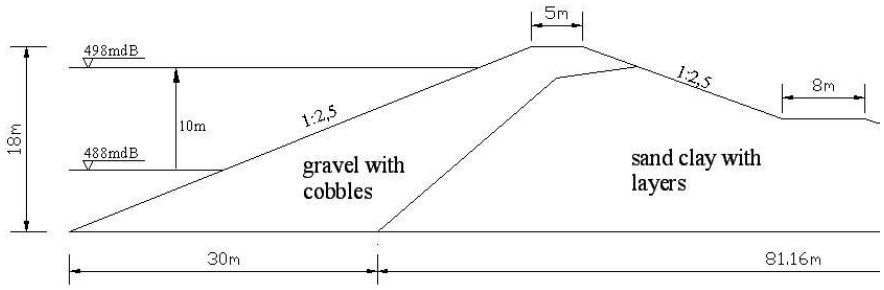

Fig.1 – Dopca dam section

Two cases it was use for the numerical simulations over the dam: sudden fill and the rapid drawdown of water in the reservoir behind dam. In case of the first simulation, it was consider a rise of water level in the reservoir about 1m/day and in the second case a rise of water level about 3m/day. Numerical analyses has made in nonlinear hypothesis of materials behavior from the body dam using finite element program with Drucker-Prager model. In both cases, the simulations have done with the help of the program of finite elements COSMOS 2.6.

The results obtained by simulation it was compare with measured data. The measured data has achieved from the reference point installed in the body dam (fig. 2).

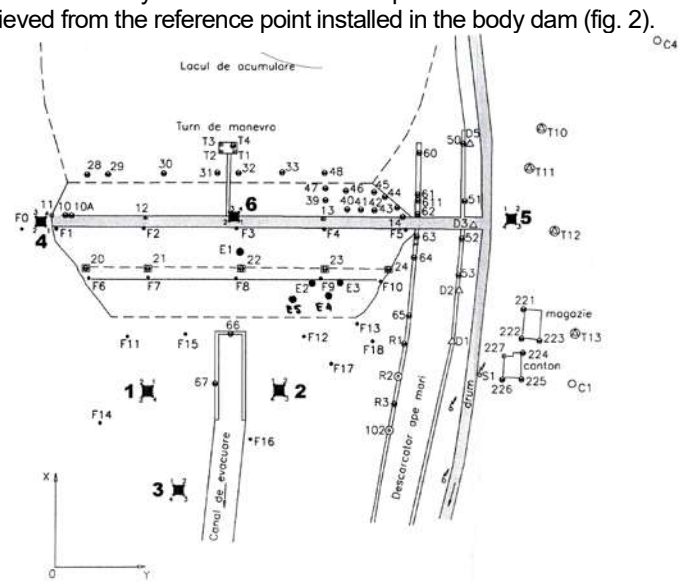

Fig.2 –The reference points position

RESULTS AND DISCUSSIONS

For the first case when the rise of level of water level was considered of 1m/day the filling had taken place in 10 days meaning 864000 seconds, and in the second case the filling had taken place in 3,33 days meaning 288000 seconds. To be sure, that the results obtained represents a behavior close to the behavior of the real dam, the results have been compared with the real behavior of the dam in time.

The finite element discretization of the dam section has presented in fig.3. For the calculus, we have considered the nodes number 1, 9 and 18 (fig.4). For example are presented the results for node number 9 that coincide with the reference point number 39 (fig.2).

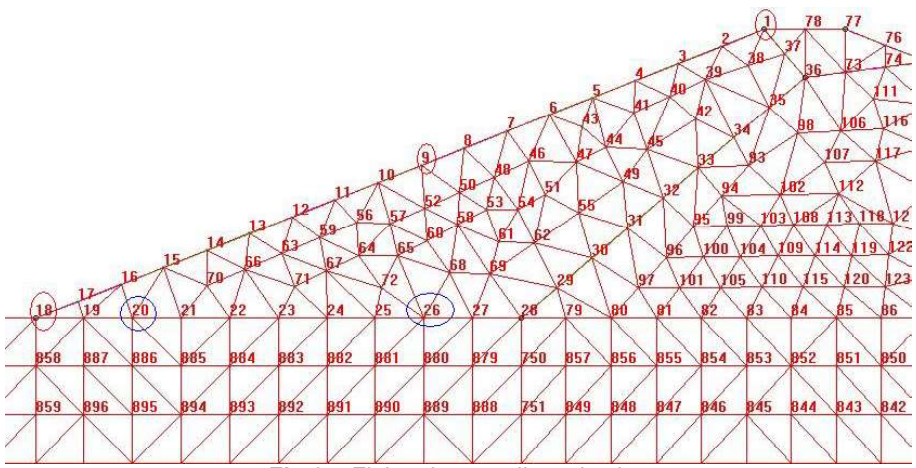

Fig.3 – Finite element discretization

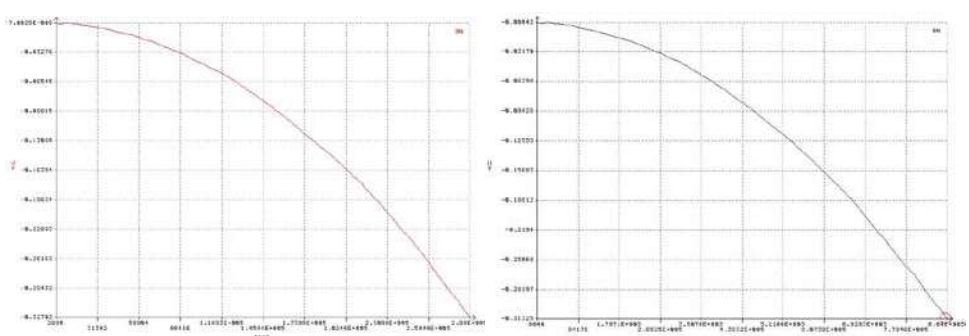

Fig. 4 - The settlement variation on the y direction in node 9 in the case of sudden variation –left and the case of slow variation – right (cm)

The total settlements value on y direction in the case of sudden variation is 3.29mm (for the 9 node). At the 39 reference point was measured a value of

3.27mm. In the fig. 5 the differences between the settlement obtained by the calculation and the settlement obtained by the measurement for the rest of point (41 and 46) are presented.

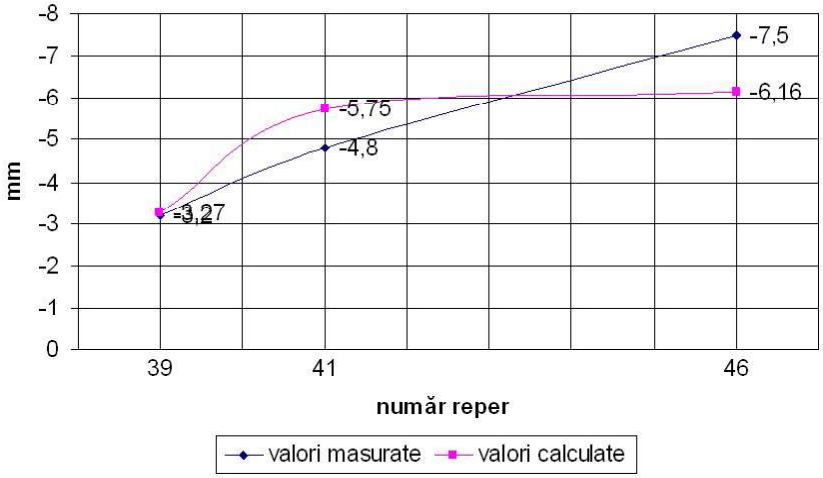

Fig.3 – Comparesing between measured data and observed data

In this graphic, the x axes represent the references point number and the y axe represents the total settlement measured and simulated.

CONCLUSIONS

The methods used to simulate the earth dam behavior offers good results. We note that the differences between the settlement measured and simulated are very small (min. 0.02mm and maximum 1.34mm).

Following the comparing value of the results in the two cases, we can se that the influence of sudden variation of the water level over the results is very important. The differences of the displacement on the y (vertical) direction are very small, but we calculated also the settlement on the horizontal direction. The differences on the x (horizontal) direction are important and could not be ignore.

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