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INFILTRATION MODELING THROUGH AN EARTH DAM CASE STUDY

BY

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Abstract. Seepage through the earth dam is a sensitive issue and has a significant impact on the design and exploitation. Determination of the infiltration curve is a key issue because it has a great influence in determining the stability of the slopes of the parameters used in the calculation.

Computer programs are based on these methods developed by various authors, but they have the advantage of combining them with other complementary methods (ex. Finite element method). For this reason, the results are closer to what is actually happening. When we designed the dam model, we can simulate different operating scenarios and the results are useful for designing efficient work and operation with a higher degree of safety.

Keywords: dam; seepage modeling; Geoslope; Stânca-Costeşti.

1. Introduction

Stânca-Costeşti site on Prut River is located at the border between Romania and Moldova Republic, near the Stânca village on the Romanian side

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and near the Costeşti village on the Moldova Republic bank, at 576 km from the confluence of the Prut-Danube.

The Romanian Register of Large Dams, currently a total of 247 dams, dam Stânca-Costeşti is listed 49th in order of height and No. 2 by the total volume of the reservoir 1.4 km3 (after Porțile de Fier).

In the Water Cadastre in Romania, the accumulation in listed in table main accumulation, in the Prut basin, on the position 340, with use complex

2. Content

Infiltration modeling will be made using GeoStudio Seep/W for main earth dam land zoned with the core side sloping and lateral prisms with a length of L = 740 m and the crest height H = 43 m.

2.1. Features Section

For the realization of the model were introduced in the program coordinates of the dam section, reported to the Baltic Sea. Each soil sample will be represented by a closed polygon representing a region where the characteristics of the earth are the same (Fig. 1).

These features, depending on the type of the earth, were introduced for guidance only, and will be gradually adjusted after running the program.

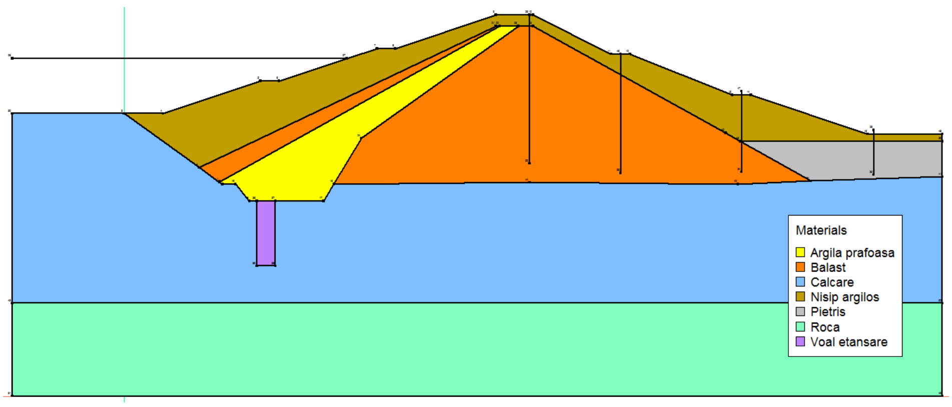

Fig. 1 – Cross-section shaped in GeoStudio Seep/W.

2.2. Setting Calculation Error

Changes in lake levels affect the level of piezometers after some time, depending by the level tendency to rise or fall. For this reason, for the same level in the lake, there will be many different values recorded in piezometers.

For example (Tabel 1) we took a value level of the lake and the piezometers readings to that date. As can be seen there is a certain amount of variation level for each piezometer, even if the water in the reservoir has the same.

Table 1
Range of Variation Levels in Piezometers for the Lake Level

Date	Water level	Trend	67	58	54	48
02-03-05	87.41	▲	63.49	63.10	62.90	62.76
28-02-06	87.41	▲	64.25	63.00	62.85	62.71
21-03-06	87.41	▼	64.29	63.31	63.11	62.97
21-08-07	87.41	▲	63.68	63.08	62.96	62.81
22-02-11	87.41	▼	64.17	63.82	63.55	63.60
Average, [m]			63.98	63.26	63.07	62.97
Range, [m]			**0.80**	**0.82**	**0.70**	**0.89**

We can see the downward trend in lake levels in piezometers the values are high, and the growth trend recorded lower values. At the same time it is found that each piezometer has a certain range of variation of the values recorded. To determine the error in modeling time will be deemed acceptable range for the half of the same level in the lake.

For example, for piezometer 67, in which the variation was 0.80 m, 0.40 m will be acceptable. That means that the value that would be generated by the computer program to be different from the measured value with ±0.20 m.

To generalize the entire field values to provide a difference calculated by the measurement of ±0.25 m.

2.3. Finite Element Meshing Model

We opted to create a network of more frequent for core elements and rare for the body of the dam. Thus, the average size of a finite element of the core clay composition is 0.4 m, and the dam body is 1.0 m. For the foundation layer we have opted for a mesh of 4.0 m (Fig. 2).

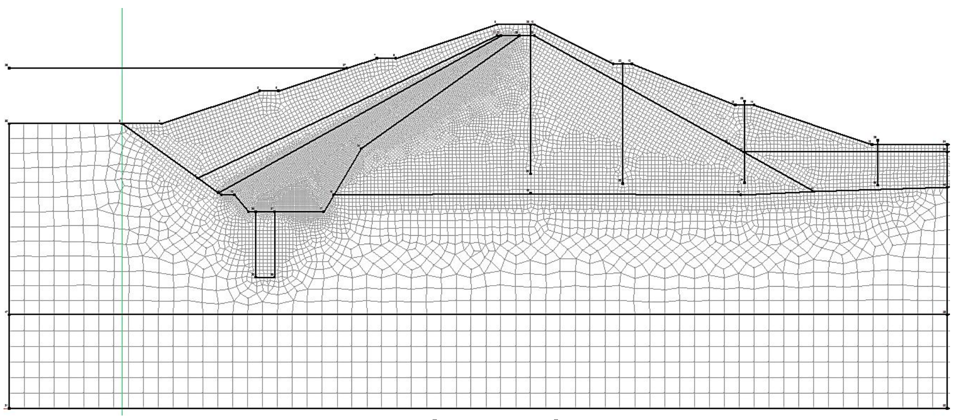

Fig. 2 – Finite element meshing section.

2.4. The Boundary Conditions

Or submitted section for the analysis, the two boundary conditions are imposed: upstream and downstream.

For the **upstream**, constraint is given by the water level in the accumulation depending on the time. We will use data from an average year, where there are levels below and above the NNR. For this reason it will be taken as the base year, 2013, and the lake level variation is shown in Fig. 3.

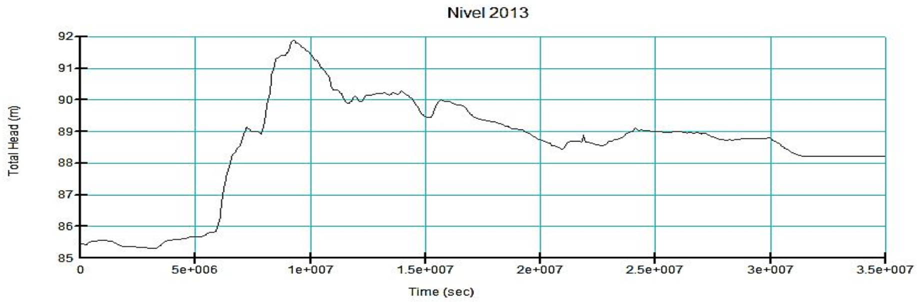

Fig. 3 – Change in lake levels in 2013.

For the **downstream**, the condition is given by the drainage system existing at the site.

2.5. Model Calibration

The program does not allow the condition of edge water level in piezometers. For this reason, model calibration requires that the program generated piezometric coincides with piezometric levels measured, allowing for a deviation of 0.25 m from the level measured.

Given the known input data (boundary conditions), and known output data (the water level in the piezometers), the calibration will modify the characteristics of soils, in particular the permeability coefficient k.

Every running program has made one change the whole model. This way it can see if the change has made a positive or negative direction calibration model.

2.6. Results After Calibration

After repeated runs of the program and gradual adjustment of the coefficients, we obtained some results for each piezometer. The analysis of these values is compared with the data measured and analyzed within the tolerance if required. Measured and modeled data are shown graphically in Fig. 4.

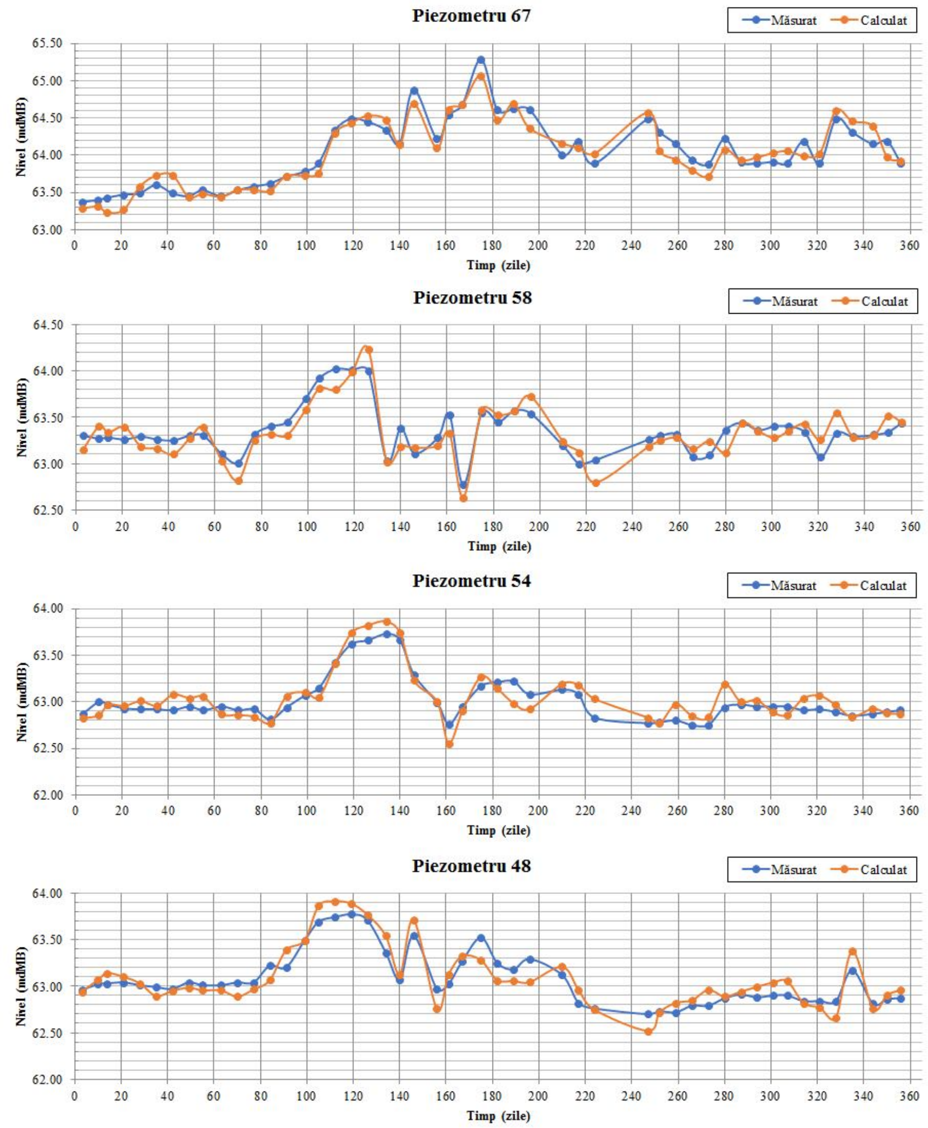

Fig. 4 – Graphic representation of the measured and the modeled level.

By analyzing the diagrams of Fig. 4, it is found that the data calculated dash chart is similar to the measured data.

In Fig. 5 shows the infiltration curve shape generated on the created model, as well as the hydrodynamic pressure spectrum.

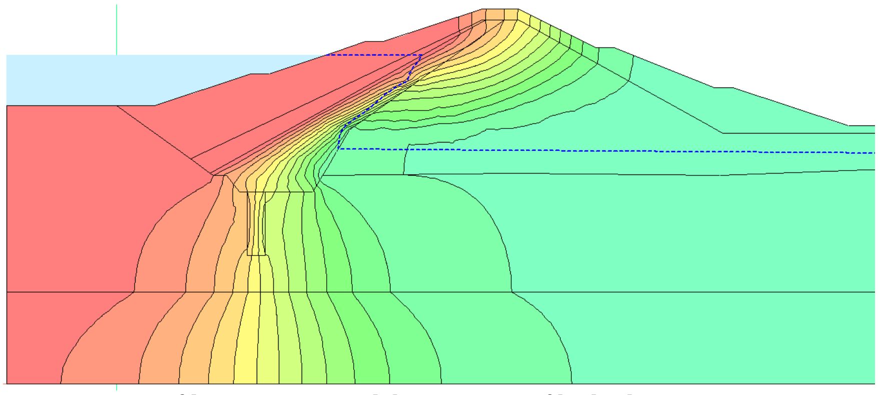

Fig. 5 – Infiltration curve and the spectrum of hydrodynamic pressure.

3. Conclusions

With this calculation model, it can be created different scenarios related to the safe operation of the dam. However, to validate this model, it can be simulated the most important floods recorded in the history of exploitation of Hydrotechnical Node Stânca-Costeşti. Thus it will be seen if there are atypical phenomena related to water infiltration and how they can influence the reliability of the dam exploitation.

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MODELAREA INFILTRAȚIILOR PRINTR-UN BARAJ DE PĂMÂNT
Studiu de caz

(Rezumat)

Infiltrațiile printr-un baraj de pământ reprezintă o problemă sensibilă şi au un impact semnificativ pentru proiectarea şi exploatarea acestuia. Stabilirea curbei de infiltrație reprezintă un aspect principal deoarece are o influență mare în stabilirea parametrilor utilizați în calculul stabilității taluzelor.

Programele pentru calculul infiltrațiilor sunt bazate pe aceste metode dezvoltate de diverşi autori, dar ele prezintă avantajul îmbinării acestora cu alte metode complementare (ex. metoda elementului finit). Din acest motiv, rezultatele obținute vor fi mai apropiate de ceea ce se întâmplă în realitate.

În momentul în care avem creat modelul unui baraj, putem să simulăm diferite scenarii de exploatare, iar rezultatele obținute sunt utile pentru proiectarea eficientă a lucrării şi exploatarea cu un grad de siguranță mai ridicat.