Optimal numerical models selection for flood embankment pore pressure data

Monika Chuchro, Maciej Dwornik, Kamil Szostek, Andrzej Leśniak
{chuchro, kamil.szostek, lesniak} @agh.edu.pl dwornik@geol.agh.edu.pl
AGH University of Science and Technology, Department of Geoinformatics and Applied Computer Science

Introduction

One of the greatest natural hazards occurring in our country are floods. In order to understand the mechanism of formation of the floods in the river bed and evaluation of the stability of flood embankment, research within the project ISMOP are carried out.

The aim of this project is to study processes occurring in the earthen flood embankments under the changes in water level in river bed. Water filtration, changes in pore pressure and temperature in the embankment. The main goal of ISMOP project is to develop a system of continuous monitoring of flood embankment stability. Real-size earthen flood embankment with built-in sensors was built in Czernichow. While conducting various experiments, the parameters are measured with a time step of 15 minutes.

Numerical modelling

Numerical modeling was performed using Isasca Flac 2D 7.0 software. This software used finite-difference method to simulate water filtration or heat transfer in geological medium.

In this case, squared grid size model was used. The size of model is 92.4x7.5m (924745 cells) with 20m horizontal offset and 3m of depth. Value of geomechanical parameters was presented in table 1. Air temperature and water level inside reservoir was updated with 1h steps. These parameters and initial water saturation inside levee was obtained from measurements recorded during real experiment. (fig.3).

<table>
<thead>
<tr>
<th>Table1. Geomechanical parameters</th>
<th>Source: Borecka et al.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density (t/m³)</td>
<td>1.96</td>
</tr>
<tr>
<td>Cohesion (kPa)</td>
<td>12.5</td>
</tr>
<tr>
<td>Friction angle (°)</td>
<td>32.0</td>
</tr>
<tr>
<td>Compaction factor (kPa)</td>
<td>6.0</td>
</tr>
<tr>
<td>Modelled pore pressure (kPa)</td>
<td>0.5</td>
</tr>
<tr>
<td>Initial water saturation (%)</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Performed test includes comparison of three numerical models with real data from experiment of water column raising to 3 meters from NW half section, with different initial parameters. In the first step using a Mean Square Error (MSE), a comparison of the experimental data with both numerical models is conducted. Dissimilarity metric (MSE) for numerical modeling 1 (Fig 6) range from 212 for UT6 to 259 for UT6 sensor, which is consistent with the graphic representation (Fig 6.). For the numerical modelling 2, the MSE exceed 300, for numerical modelling 3, the smallest value of MSE exceed 350.

Conclusions

The chosen method allowed to select an appropriate numerical model for the experiment conducted on a flood embankment. The most important problem to be solved is to find the suitable critical values for the selected algorithms. The biggest differences in the analyzed data are related to temperature. In further tests, the analysis of its impact on the algorithm’s results should be performed. What is more, the assessment whether better results could be obtained for the temperature gradients should be done.

BIBLIOGRAPHY


Acknowledgments. This work was partially supported by the National Centre for Research and Development (NCBiR) under Grant No. PBŚ1/B9/18/2013 and by the AGH grant no. 11.11.140.630.