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MODELLING OF DRAINAGE OUT OF SLAG AND ASH WASTE DUMP

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ABSTRACT
This paper deals with investigation of conditions for the dam construction at thermal plant for slag and ash waste dump. Analysis of functioning of designed solutions of drainage system within the body of the dam, were carried out for given filtration characteristics of materials out of which body of the dam and drainage system were constructed. Calculation was carried out at the model consisting of 863 nodes and 788 quadrilateral elements by application ADINA R&D 8.3.program. Circulation or water filtration are presented by equipotential lines. Performed analysis had confirmed the correctness of established drainage system conception.
Key words: slag and ash waste dump, drainage, drainage system, modelling, coefficient of filtration

1. INTRODUCTION
By combustion of the coal in the boiler fire-box in thermal power plant, slag and ash, whose characteristics depends on type of used coal, are being created in considerable volume. Disposal of the slag and ash appears as one of the most important problems, taking into account environmental aspect as well as a security of the waste dump dam. Results obtained by investigation of functionality of the water drainage system within the dam and waste dumps for water that appears due to hydraulic transportation of the slag from the power plant, are presented in the paper. slag and ash are being mixing with a water in appropriate relations and is transported by pipelines, when the slag and ash sedimentation develop in a natural way, while clarified water is being conducting away through spillway channels and drainage system. The dam is of filled up type, constructed out of sand with drainage diaphragm in the dam base along with appropriate drainage system. The aim of modelling was to check functionality of the drainage system. Calculation of the water flow through the dam was performed by finite elements method for stationary water flow.

2. MATHEMATICAL DESCRIPTION OF PROBLEM
Stationary water flow through the porous medium is given by the following differential equation:

$$\frac{\partial}{\partial x}\left(K_x \frac{\partial \overline{u}}{\partial x}\right)+\frac{\partial}{\partial y}\left(K_y \frac{\partial \overline{u}}{\partial y}\right)+\frac{\partial}{\partial z}\left(K_z \frac{\partial \overline{u}}{\partial z}\right)=0$$

where: K_x, K_y, K_z are water permeability coefficient in direction of x, y, and z axis.

$\overline{u}=\frac{u}{\gamma_w}+z$ - elevation of water or potential

u- pore pressure

γ_w - unit volume weight of water

z- elevation

If the soil is isotropic ($K_x = Kx = K_z$), the equation may be written in a form:

$$\nabla^2 \overline{u} = 0$$

where ∇^2 Laplace's operator , or $\nabla^2 \equiv \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$

For two-dimensional third member of above equation is being neglected. Depending on boundary conditions, this problem may be classified into categories, out of which one may be considered as a water flow through earth dams (Figure 1.).

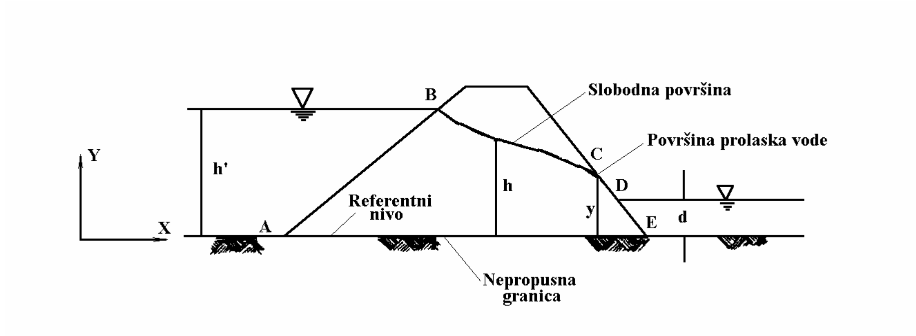

Figure 1. Water flow through earth dam

Water flow through earth dam was modelled by a grid 2D finite elements. Model is non-homogenous, and in this analysis is treated as isotropic, consists of 863 nodes with 788 quadrilateral elements. Calculation was carried out by utilisation the program ADINA R&D 8.3, and the calculation results are given by equipotential lines.

3. CALCULATION RESULTS

Body of the dam toe should be constructed out from broken stone of appropriate granulation, which was spread into separate layers with prior compaction. Filter-drainage layer beneath and in front of the stone toe is designed to be made of compacted gravel-sandy materials. Dual-filter , at the upstream dam slopes, bodies of partition embankments, and vertical drains within the dam base, are also made of gravel-sandy materials. The dam core is made of sand with appropriate compactness. Conveyance of drained water will be performed by reinforced concrete pipes.
Coefficients of filtration in the calculations were as follows:

- material 1.- drainage systems within the dam: k = $2x10^{-2}$ cm/s
- material 2.- dam core: k= $1x10^{-6}$ cm/s
- material 3. – separated slag and ash = k= $1x10^{-6}$ cm/s

Several calculation was performed, for each phase separately, and in the paper are
presented calculation results for the completed dam. The first case, that was considered, was when the dam is with only horizontal drain at the contact of the base and filled in part (Figure2.)

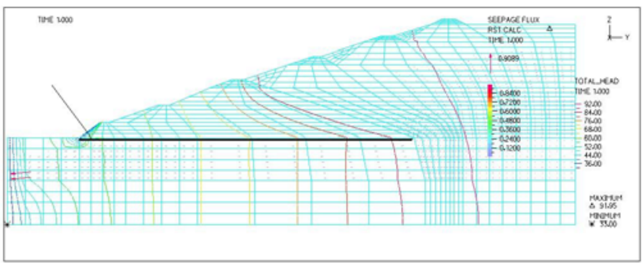

Figure 2. Dam model without drainage system

The second considered case was when the dam is with completed vertical and horizontal drainage system. (Figure 3.)

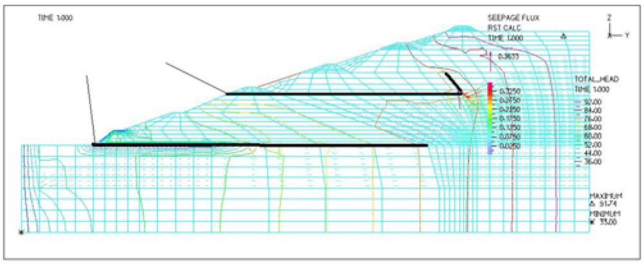

Figure 3. Dam model with drainage system

From the Figure 2. it may be seen that just horizontal drainage is nit sufficient, and it cannot fulfil a function of accepting all drained waters. Figure 3. shows that elements of the drainage system contribute to lowering free water level within the dam core and fulfil all requirements pertaining the drainage. It can be also noticed that the dam can function without vertical drain, which may serve in the case of extreme water inflow, and as such presents an useful solution.

4. CONCLUSION

Construction of the slag and ash waste dump for a need of the thermal power plants presents urban, environmental, and at the same time the technical problem. Besides the fact that these waste dumps require huge space, as close as possible to the thermal power plant, these have to meet environmental standards, and complex analysis on influence on the environment must be performed, especially influence on the ground water. Results of calculation of the drainage system for high dam for ash and slag are published in the paper. Calculation was performed by utilisation of the program ADINA R&D 8.3. for a dam with an incomplete drainage system, and for the dam with completed drainage system. Water flow was presented by equipotential lines, which shows that only completely constructed drainage system provides conveyance of drained waters out the dam core.

5. REFERENCES

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