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Ebene nichtstationäre Grundwasserabflüsse mit freier Oberfläche

VON DER

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Themistocles Dracos

dipl. Bauingenieur ETH

Griechischer Staatsangehöriger

Referent: Herr Prof. G. Schnitter

Korreferent: Herr Prof. Dr. E. Stiefel

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Summary

The preceding investigation is concerned with a 2-dimensional, non-steady, free surface groundwater-flow-problem.

A computation procedure is desired which starts with the conditions rising from a slope stability analysis and which accurately predicts the motion of the free water surface near the embankment. The existing procedures are insufficient as they do not relate the conditions in the embankment. A revision of the entire theory was therefore necessary. It was found:

The non-steady groundwaterflow originates from the propagation of disturbances.

In other words the non-steady groundwaterflow leads to wave problems with large frictional effects. To compute the motion of the free water surface a knowledge of the distubance is necessary. The disturbance which in this causes motion is the position of the outcrop point of the seepage line along the embankment as a function of the tailwater elevation. This motion of the outcrop point of the seepage line can be found and is given in eqs. (III. 10) and (III. 34). The wave equation can now be solved by the method of characteristics and the motin of the free water surface determined.

With a digital computer this method of solution is quite simple. The variables, length, thickness, slope (when small) of the aquifer and slope of embankment and their changes can easily be considered with this method.

To make a solution by the method of characteristics economically feasible a similarity study was carried out. Factors were thus isolated which were important in the model study of the free-surface groundwaterflow problem as well as in the digital computer analysis. The upper limit of the region, in which the Froude number has no influence on the motion, is of spesial interest. In this investigation this limit was not determined as it meant going to great amounts of work in computing and in the model study. To choose this limit as the object of a further investigation seems desirable.

As the proposed computation method is based on the equation of motion and of continuity the acceleration terms can easily be considered. This was also done in the computed example.

For an approximation of the free surface water line the equations (III. 36) and (IV. 08) give the position respectively of the outcrop point of the seepage

line and the wave front. The tangent to the free surface line at the outcrop point of the seepage line is also known through the slope of the embankment. With some experiance the approximated free surface line can now readily be drawn.

The results of the computation agree well with the ones obtained from the Hele-Shaw analogy model. The errors inherent in the computer method and in the analogy model are seemingly of the same order. The determination of the permeability constant gives rise to a considerable error due to the inhomogenity of the soil. Thus the accuracy seems satisfactory. This method can also be applied when a transverse isotropy exists (see appendix).