CIVL 7111 - Special Modelling Project 5

Fluid Mechanics - Steady State Flow in Porous Media

Problem Statement - Consider the problem of flow in porous media in a homogeneous material. The general two-dimensional boundary-value problem is:

$$\frac{\partial}{\partial x}\left(k_x \frac{\partial h}{\partial x}\right)+\frac{\partial}{\partial y}\left(k_y \frac{\partial h}{\partial y}\right)=0 \qquad \text{in } \Omega$$

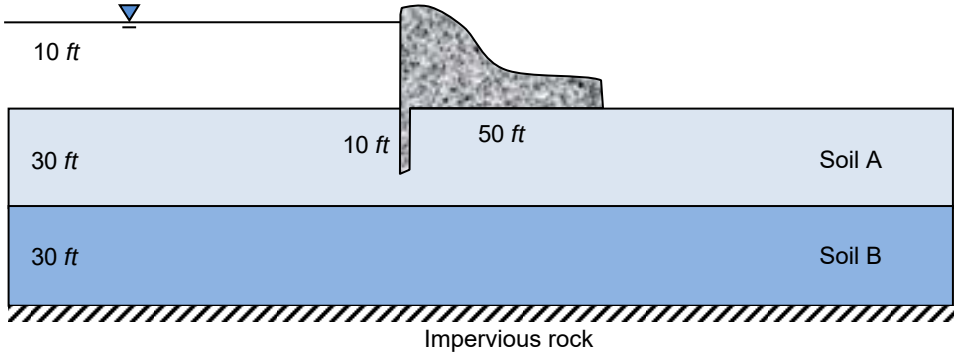
$$h = h_0 \qquad \text{on } \Gamma$$

where the dependent variable h is the pressure head, k_x and k_y are the permeabilities in the x and y directions. The stream function may be obtained by solving the following equations:

$$\frac{\partial}{\partial x}\left(\frac{1}{k_x}\frac{\partial \Psi}{\partial x}\right)+\frac{\partial}{\partial y}\left(\frac{1}{k_y}\frac{\partial \Psi}{\partial y}\right)=0 \qquad \text{in } \Omega$$

where the dependent variable Ψ is the stream function. By plotting lines of equal values of the stream functions and equal values of the pressure head a flownet may be formed.

Shown below is a concrete gravity dam with a sheet located at the base of the dam. It is desired to determine the flow under the dam and the uplift pressure acting on the dam.



The upstream and downstream boundaries should be taken as impervious. This approximation is accurate if the boundaries are far from the dam. As part of your analysis, show the effect of moving these boundaries away from the dam. Demonstrate this on the Case **I** only.

Plot the flownets for flow under the dam for the following cases:

Case	**I**		**II**		**III**	
Soil	k_x	k_y	k_x	k_y	k_x	k_y
A	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
B	0.0005	0.0005	0.0002	0.0002	0.0010	0.0010