Examination of Module 4: Hydrogeology

Steady Groundwater Hydraulics (Closed Book)

Hydrology and Water Resources of WSE programme, 2011/2013

Question 1 (40%)

Two rivers located 1000 m apart fully penetrate a confined aquifer (Figure 1). The confined aquifer consists of gravels in the left part (400 m) and sand in the right part (600 m). The parameters of the aquifer are: Hydraulic conductivity: K_1 = 200 m/day; K_2 = 50 m/day; Effective porosity: n_1 = 0.25; n_2 = 0.30; Thickness of the aquifer: H = 10 m; Water level in the left river H_0 = 20 m; Water level in the right river H_L = 18 m;

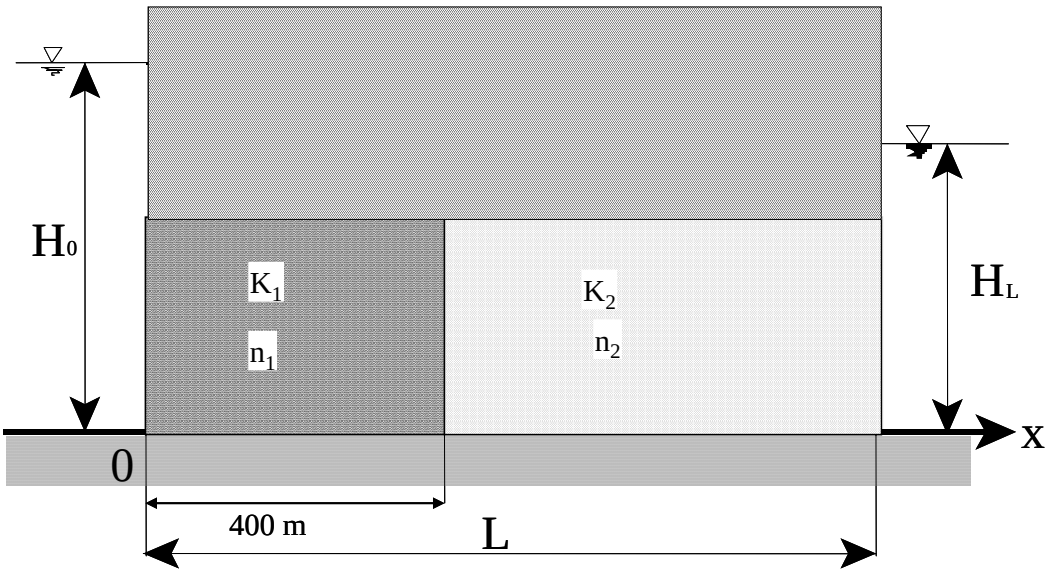

Figure 2 Groundwater flow in a confined aquifer

(1) determine the distribution of groundwater head in the left and right parts of the aquifer;

(2) calculate the velocity of groundwater in the left and right parts of the aquifer.

(3) calculate the unit width discharge through the aquifer. Is the discharge the same in two parts of the aquifer?

(4) calculate the travel time of a water particle traveling from the left river to the right river.

Question 2 (40%)

Two parallel drainage ditches were constructed to drain the excess water from a phreatic aquifer. Water levels in the two ditches will be maintained at the same level and distance between two ditches is fixed at 400m. The land surface elevation is 21 m. The hydraulic conductivity of the aquifer is 1 m/day and the uniform recharge to the aquifer is 1.5 mm/day. The general distribution of water table is described by:

$$h^2 = h_0^2 - \left(\frac{h_0^2 - h_L^2}{L} - \frac{wL}{K}\right)x - \frac{w}{K}x^2 \qquad (1)$$

Please carry out the following tasks:

(1) If the highest water table has to be controlled at 1.5 meter below the land surface for maximum agricultural production, determine the water level to be maintained in the two ditches;

(2) Calculate the drainage (water pump) capacity to maintain the required water level in the two ditches.

Question 3 (20%)

A company wishes to extract water at a discharge of Q_0 = 5000 m^3/day from a completely confined aquifer, which is bounded by a river on the left side. The hydraulic conductivity of the aquifer is 40 m/day and the thickness of the aquifer is 50m. The effective porosity of the aquifer is 0.30. In order to obtain water of optimal quality, it is desirable to have a minimum travel time from the river to the well to be 2 years.

Please determine:

(1) At what distance from the river should the well be located? The travel time formula is:

$$t = \frac{2}{3}\frac{\pi n_e H p^2}{Q_0}$$

(2) What will be the drawdown at the well when the well radius is 0.1 m?

The drawdown formula is:

$$s = \frac{Q_0}{2\pi T}\ln\left(\frac{x + p}{p - x}\right)$$