HWRS 582 – Groundwater modeling

HM1 - Challenge

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Abstract

The report presents the preliminary answers to the challenge, using just the background knowledge about the topic. The goal of this report is to define our baseline to quantify the improvement gotten through the ideas developed in the Tuesday class.

Development

1. Show, based on the flux with depth, that the model is steady-state. Repeat this for a homogeneous and for a heterogeneous column.

Answer: In the steady stage, the change in storage is zero for each grid element in the vertical column. That means the inflow and outflow must the same and constant at each element as presented in Figure 1 and 2.

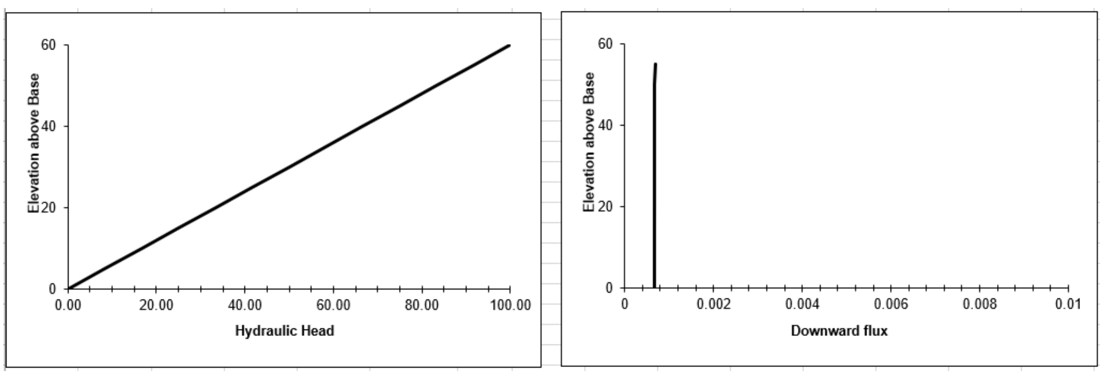

Figure ***¡Error! No hay texto con el estilo especificado en el documento.****1 Homogeneous column. K=4e-4*

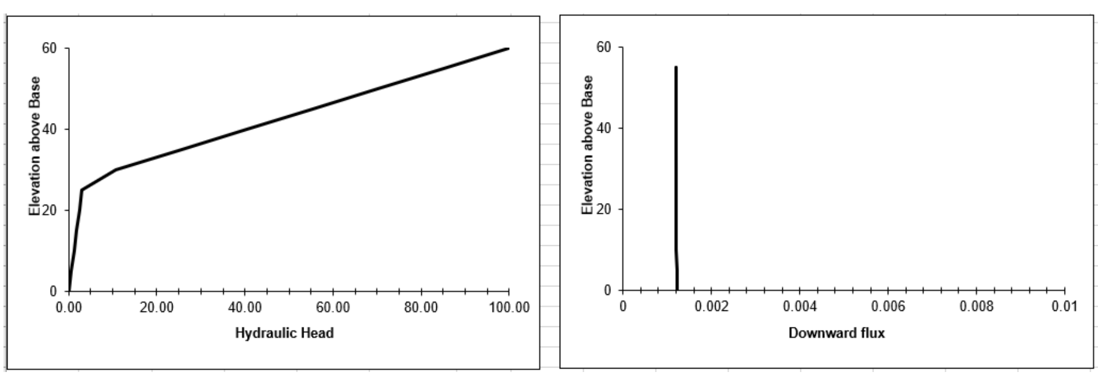

Figure 2 Heterogeneous column. 2 Layers, K1=4e-4 & K2=1e-2

2. Show that the steady-state flux agrees with the direct calculation based on the harmonic mean average K. Write the equation defining the direct calculation of the flux.

Answer: Given that the flux crosses perpendicular to each layer, the lost energy is the sum of the loss of each layer.

$$\Delta H_t = \Delta H_1 + \Delta H_2$$

$$q = K * \frac{\Delta H}{\Delta L}, Applying\ Darcy\ law$$

$$\frac{q * \Delta L_t}{K_{eq}} = \frac{q * \Delta L_1}{K_1} + \frac{q * \Delta L_2}{K_2}, Contant\ and\ equal\ flux\ per\ layer$$

$$\frac{\Delta L_t}{K_{eq}} = \frac{\Delta L_1}{K_1} + \frac{\Delta L_2}{K_2}$$

In the case of figure 2, the flux calculated is q=0.00119 which is consistent with the use of the K_{eq} using the previous equation.

$$\frac{60}{K_{eq}} = \frac{32.5}{0.0004} + \frac{27.5}{0.01}$$

$$K_{eq} = 0.000714$$

$$q = 0.000714 * \frac{100}{60} = 0.00119$$

3. Show the steady-state head profile for a column with approximately equal-thickness layers that have different K values.

Answer: For that, I considered the first layer with K1 between 42.5-60, a second layer with K2 between 22.5-42.5, and K3 between 0-22.5. The head profile is presented in figure 3.

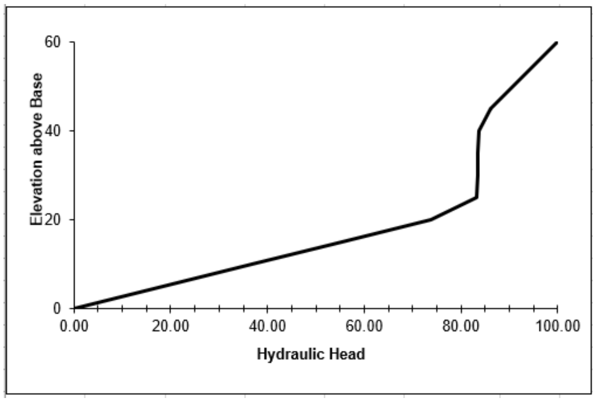

Figure 3 Head profile for a heterogeneous column with 3 Layers, K1=4e-4, K2=1e-2 & K3=1e-4

4. Use the head profile to explain WHY the equivalent hydraulic conductivity, Keq, is closer to the lower of the two K values.

Answer: The K_{eq} (2.22e-4) is closer to K_3 (1.0e-4) because the layer with lower K is where more energy is lost in the process. Figure 3 shows that more than 80 units of energy are lost in this layer, where the total energy is 100 units, therefore K_{eq} must be close to K3.