John Hubbell

2/2/22

HWRS 482

Homework Two Discussion

Challenge

1. Create a conceptual model of the homogenous MODFLOW model: This should be an illustration that shows the locations and values of constant head boundaries, the number of grid cells and their spacing as well as any other model properties. You should also include in here a cross section with your predicted head gradient and direction of flow. You can draw this by hand if you would like.

- I drew mine by hand and believe I did a fairly successful job at showing a conceptual model. The key features to show were the head goes from 15 to 10 and is constant at 15 and ten. Also that the grid is 25 x 25. One thing I did not include that I should of is that dx=100 and dy= 100 and labeled some x and y values.

2. Show, based on the flux with horizontal distance from a constant head boundary, that the model is steady state. Repeat this for a homogenous and a heterogenous cases where you place different K values in series in the direction of flow (Note: to modify the K values you should change the .bcf file, just be careful because spacing matters! Note 2: see the excel sheet for an example calculating flux. Keep in mind that that heads are calculated at the center of a cell and the K values are defined across the entirety of a cell)

- It is important that it can be seen that the model is in steady state because we know inputs are equal to the outputs.

3. Show the steady state head contour in plan view for the homogeneous and heterogeneous (zones in series) condition. Use this plot to defend a contention that flow is 1D. Then, drawing on your first assignment, use the results to explain WHY the equivalent hydraulic conductivity, Keq, is closer to the lower of the two K values.

- My excel model was slightly messed up and didn't read the values correctly for some cells. You can see that flow is 1D because we have a steady state system and the model is only 1D. Using the correct answers posted you can see that the head contour starts at 15 and ends at 10 for both the homogeneous and heterogeneous models. Also you can see that the head is decreasing to the right for both constant for the homogeneous and for the heterogeneous you can see where the rate of change differs do to different k values and then goes back to the same.

4. Build a model based on a homogeneous domain with a square region of lower K in the middle of the domain. What can you learn based on your explanation of what controls the

effective K for a 1D flow system now that you are applying it to a 2D system? What do you think the Keq of this entire system would be compared to the high and low K values? Explain why it is much more difficult to develop a direct solution for this 2D system than it was for a 1D system (including the zones placed in series).

5.

- That it changes things around the box area drastically and the model slowly recovers and goes back to normal. This is because inputs must equal outputs so if k decreases the head (dh/dl) must increase or vice versa.

6. For steady state conditions, there are equivalent Type I and Type II boundary conditions. What would the Type II boundary condition be that would result in the same equipotentials for the first model? What is the value of the constant flux? What about the second model? What are the values of the constant flux on the left and right boundaries? What is fundamentally different about the equivalent Type II boundary for the third model compared to the first two?

- The boundary conditions show inputs must equal outputs and that the head at the beginning is equal to 15 and goes down to 10 for all the models. The way it changes for the third model is different for the third model.

Glossary Questions:

1. What is MODFLOW? What is a MODFLOW package (provide at least 2 examples)? What are the inputs to a MODFLOW model?

- MODFLOW is the USGS's modular hydrologic model and is considered the standard for simulating and predicting groundwater conditions. A MODFLOW package is something that allows for a model to run a certain way or use certain parameters / properties. An example is WEL the well package and RCH Recharge Package. The inputs to a MODFLOW model are hydraulic conductivities and the elevation of the top and bottom of the aquifer.

2. What is the relationship between head gradients and hydraulic conductivity in steady state systems?

- As hydraulic conductivity decreases the head must increase or vise versa because inputs must equal outputs.

3. What is a model node? A model cell? Use a simple diagram to show the relationship between heads defined at nodes and properties defined in cells.

- A node is a point of intersection or connection within a network. A model cell is a placeholder for a value.

4. What is the difference between TypeI and Type II boundary conditions and under what conditions might you use each? Provide at least 2 examples for locations where we might use Type I or Type II boundaries to represent a feature in the real world.

- A boundary type one is specified head, a boundary type two is specified fluxes. You would use a boundary type specified head when you know you have a steady state system or constant head. You would use a type two for when you have known fluxes or steady fluxes. You could use them when you want a ballpark idea of what's going to happen.