Homework 3 – challenge, discussion and glossary

Challenge questions

1. The values are not constant at all points along the y axis because of the center low K inclusion. Since we have a constant flux boundary (type 1), the only thing that can give with a fixed K is the flux, and the flux changes to accommodate the different K values further on in the grid.

The flow distributions are the same on the left and right because we have a steady state, and symmetrical model. Steady state means that each flux column across the grid can differ in distribution, but must be the same flux overall. Couple this with the fact that we have model symmetry over the center, we see identical flux plots at each of the boundary points.

1. We can glean that the head gradients must be more extreme in this center region of flux, due to the increased change in flux near the cube. This makes sense, with a lower K inclusion layer, we would expect the head gradient to increase to compensate for this lower conductivity in order to maintain the same flux.
2. \*See figures for calculations and plots\*
3. It’s hard for me to draw a succinct conclusion here. It almost seems like using the flux to calculate K eff is more accurate when you have the lower K inclusions. The harmonic seems to really skew towards the smaller q layer, when I doubt, in reality, that the K eff would lower that significantly. Like we talked about last week, the students flowing through the room would simply walk around the obstruction. They aren’t all limited like they would be in there was an entire column of low K that all flux had to pass through. I would very much like to discuss this aspect in class.

Discussion questions

1. I think that the equipotentials depend on the absolute K values. I say this because of how the model is calculated. Everything is resolved at the grid cell scale, where each calculation only “sees” over a singe grid cell boundary to find the gradient. I wouldn’t know how I can test this using the model though. Perhaps one could find a way to calculate Keff using data from the python code, and see how that compares to our own calculation using the exact grid layout.
2. It means that for any type 1 steady state condition, there is a type 2 boundary condition that will produce the same equipotential profiles. It means that you can run the same type of model, but tailor it to the particular types of conditions that you have. For example, you might not be able to justify a constant head boundary for a particular groundwater system, but a constant flux boundary might be more suitable.
3. If we altered our model for unconfined conditions, we would potentially have to account for water’s ability to flow out of the top and bottom of our grid, not just our boundary conditions. I’m not sure if that is how mudflow behaves in unconfined conditions, but this makes sense to me. There are different flow restrictions in each case that need to be considered.

Glossary

1. FloPy is a python code package created specifically to run MODFLOW’s suite of modules. MODFLOW is the executable that actually runs the model, and is simply compiled by FloPy, while FloPy is a python code that is used to create and manipulate the input files used by the MODFLOW executable. FloPy has the advantage of being able to easily manipulate the input files and create plots of your new data. It also makes making changes to the system significantly faster for the user. The disadvantage of using FloPy is you lose some sense of control of what’s going on. Code can also be quite challenging to debug at times.
2. It means that your model is limited strictly to the resolution of your grid. Each grid cell itself is a single K value, when in reality this isn’t the case. Each grid cell if translated to the real world would be akin to square homogenous zones next to other homogenous cells. The system only becomes heterogenous when enough of these cells come together. Resolution is important to factor into the decision making process because grid cells that are too big may not accurately capture what is really going on in your system. At the same time, you could also have an unnecessarily complex grid system with a resolution that no longer adds any meaningful impact to your model.
3. For a groundwater model to be unconfined, it means that the water isn’t strictly confined to your grid. In an unconfined system water could flow out or into the top and bottom of your models. Confined implies the opposite, you only have flow through your type 1 or 2 boundaries. This gives you more control over how the water moves through your model. This also simplifies your groundwater flux, in that you don’t have to consider things like drainage or change in storage.