Week #11 - excavation of a trench

We will model in Optum G2 the step-wise excavation of a trench with a diaphragm wall as support. We sketch the configuration in figure 1 with its different excavation phases.

1 Mesh and initial stresses

We will let you create the mesh for the problem given in figure 1. In order to compare side by side different constitutive model, create a single mesh with 1000 elements, and with the following features: i) a mesh fan at the bottom of the diaphragm wall, 2) enforce a mesh size of 0.1 along the lowest part of the diaphragm wall. In what follows, always use the 6-nodes element in the analysis.

The constitutive relation for the soil will change troughout the exercice. Note that for this, you need to use different type materials for every stage (recommended). The initial water table is given in figure 1 but will eventually change following the excavation.

Soil properties Use the default elastic and weight properties for the Mohr-Coulomb (MC) and Modified Cam-Clay (MCC). Use the following strength properties for the MC and MCC:

$$c = 5\text{kPa} \qquad \phi = 25^\circ$$

Also use the following for the initial earth coefficient and over-consolidation ratio:

$$K_o = 0.5 \qquad OCR = 1$$

2 Excavation analysis: Comparing Mohr-Coulomb and Cam-Clay

Perform the following steps once with Soil 1 = Soil 2 = MC and once with the Soil 1 = Soil 2 = MCC. In a first stage calculate the initial stresses. Use this as the input for the analysis of the excavation of phase 1. The following excavation steps will always take the previous step as initial condition. For step 2 simply excavate half of the phase 2 and 3 soil and perform the same for step 3. Stages 4 and 5 are similar to 2 and 3 but incorporate a simultaneous lowering of the water table. You should finish with having an initial and 5 excavation stages.

2.1 Mohr-Coulomb

2.2 Modified Cam-Clay

You can see that for this material parameters the diaphragm wall will fail when advancing the last excavation step. Note that it is a plastic rupture of the soil associated with large displacements whereas the diaphragm still behaves as a rigid body. You can prevent this and achieve reasonable deformations when putting a strut (fixed end anchor in Optum) at the point (18,15) from excavation step 2 on.

3 Consolidation analysis

For the MCC material we want to get the long term settlements of the excavation. These can be obtained from optum by using a consolidation analysis. Perform this analysis with a target time of 200 days by performing 30 steps.

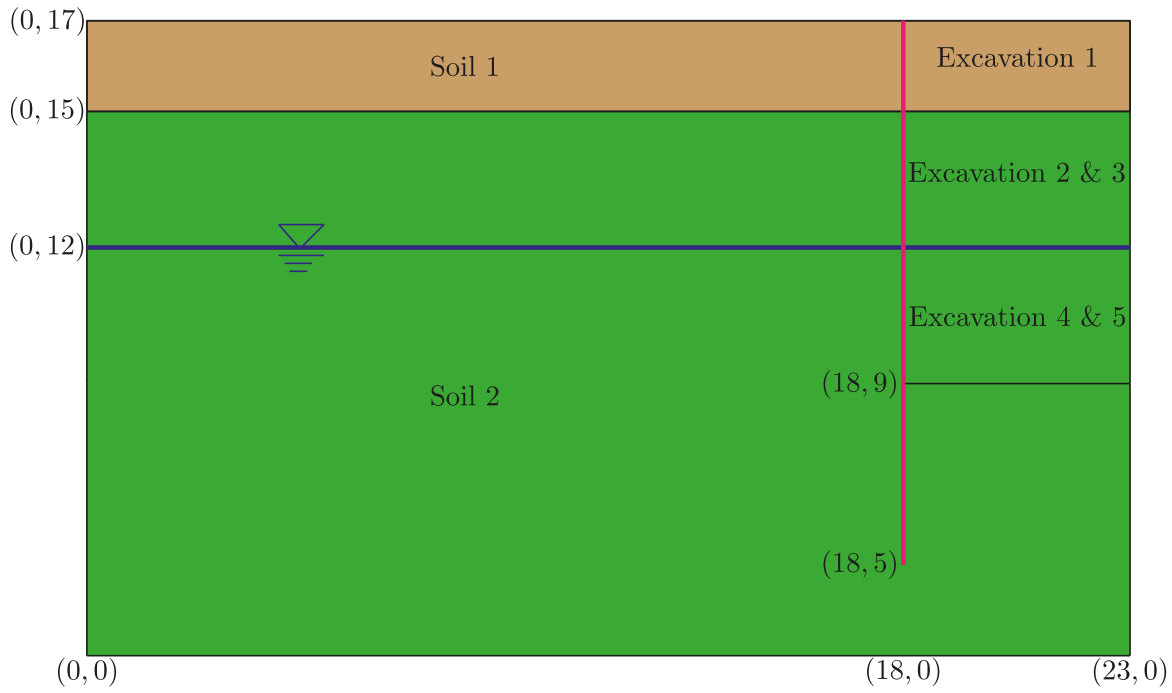

Figure 1: Geometry of the excavation. The affiliations of the two soils will change troughout the exercise. The blue line is the initial water table, the red line corresponds to a diaphragm wall (in Optum modeled with plates where the plus needs to be on the side of the active soil).