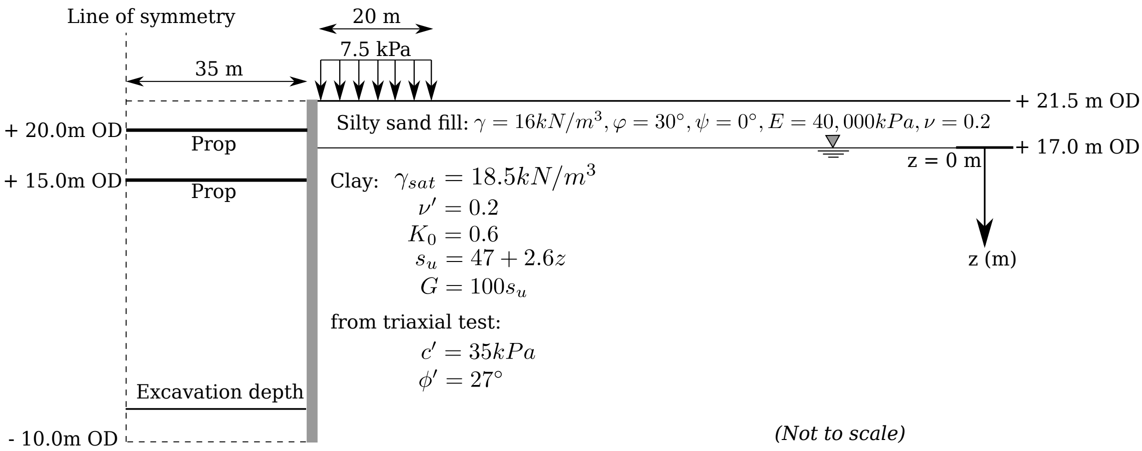
Project 1: Finite Element modeling of a propped excavation in clay
Assigned: 1st April 2019
Due: 19th April 2019

You may obtain access to Plaxis through a Virtual Desktop. Information about gaining access can be found at `http://caee.utexas.edu/students/itss/43-students/it/386-virtualdesktops`.

A 70 m wide excavation is to be dug in uniform stages through 4.5 m of silty-sand fill into normally consolidated clay that extends to a great depth. The excavation will be supported by a diaphragm wall from the ground surface (21.5 m OD) to a base elevation of −10.0 m OD and two rows of props at an elevation of 20 m OD and 14.5 m OD. During excavation, a pressure load of 5 kPa will act at the ground surface within 25 m of the wall. The geometry and material parameters for the problem are presented below:



Wall Parameters: EA = 7.5×10^6 kN/m; EI = 0.12×10^6 kN/m^2/m; equivalent thickness d = 0.35m; w = 8.3 kN/m/m; ν=0.15
Prop Parameters: EA=2.5×10^6 kN/m; $L_{spacing} = 4$ m.

1. Perform a plane strain finite element analysis in PLAXIS using the Mohr–Coulomb model without dilation and total stress method. Model the wall using beam and interface elements and the prop using a fixed end anchor. Assume the wall and props are perfectly elastic.

   Hint: Perform a "drained" analysis with no water, but specify undrained material parameters in the clay (note that the Poisson's Ratio cannot be set to ν=0.5 so use ν=0.495 instead).

   (a) Determine the excavation depth at which some material points will begin to exceed the Mohr–Coulomb strength criterion in the clay.

   (b) Determine the maximum excavation depth at which the horizontal wall movements will not exceed 100mm.

   (c) When the excavation depth reaches +7.5m:

i. Plot the total displacement and mean total (or effective) stress contours,
ii. Plot horizontal displacement and bending moment along the wall,
iii. Record the prop forces.

(d) Determine the maximum excavation depth at which the system will collapse. Plot the plastic points at this depth and identify the failure mechanism.

2. Repeat part 1(a – c) using the effective stress method and the parameters determined from triaxial testing.

3. Repeat part 1(a – c) using the effective stress method and equivalent Mohr Coulomb parameters derived from the shear strength profile.

   Hint: Determine effective stress parameters from the shear strength profile by constructing Mohr's Circles.

4. Discuss the role of tension cut-off in finite element simulations and give an example of a situation where this might be important. Does tension cut–off play an important role for this propped excavation?

5. Compare and contrast the three different analysis methods, paying particular attention to the prop forces and depth–displacement curves. What are the advantages and disadvantages of each method?

6. Pore pressures can only be generated using effective stress methods. Are the pore pressures computed using Mohr–Coulomb reasonable? How might the computed pore pressures (and shear strengths) be different if a more advanced soil model was used?