CIVL 7132 Advanced Soil Mechanics
Spring 2019 - Homework 2

1. An engineered fill 4 m thick will be constructed over the soil profile shown below. The fill material has a moist unit weight of 20.2 kN/m^3. Determine the consolidation settlement due to the weight of the engineered fill based on the following laboratory data:

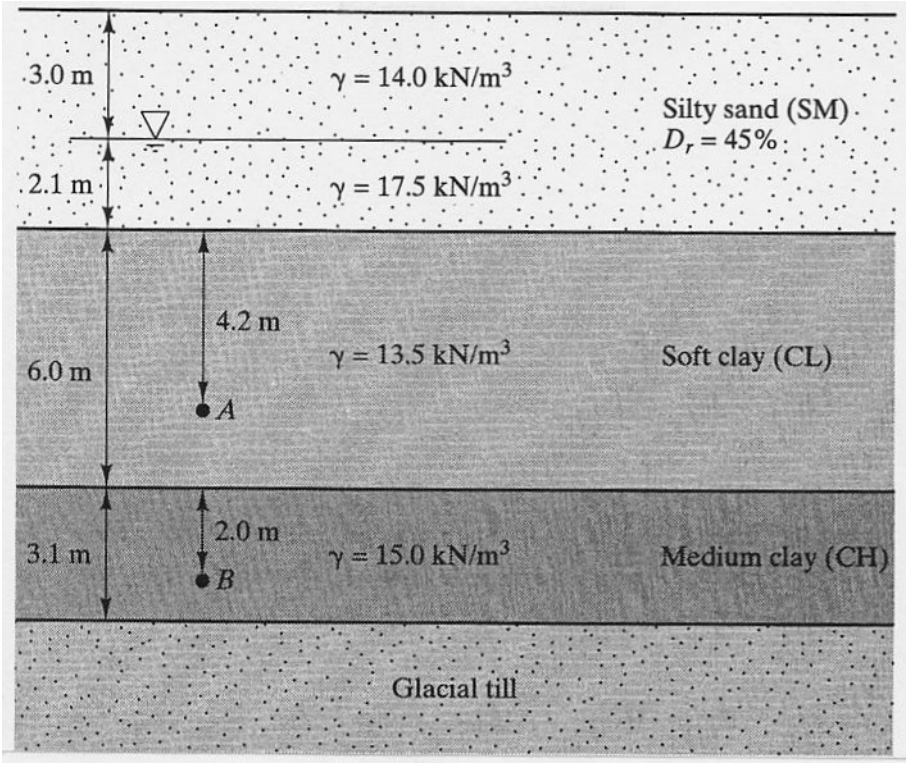
   - A consolidation test performed on a sample taken at Point A had a compression index of 0.37, a recompression index of 0.19, and an *in situ* void ratio of 1.90. Geologically, the soft clay layer is much younger than the underlying medium clay and is normally consolidated.

   - A consolidation test performed on a sample taken at Point B had a compression index of 0.59, a recompression index of 0.14, a preconsolidation stress of 120 kPa, and an *in situ* void ratio of 1.21. Overconsolidation in the stiff clay layer is likely the result of significant erosion prior to deposition of the soft clay.

   - For ease of calculation, assume that the silty sand layer is incompressible. Assume, too, that the glacial till is incompressible.

   Do the calculations (a) by hand using the mid-point stresses in each layer and (b) by hand using the closed-form integral approach. DO NOT account for the effects of submergence of the silty sand due to consolidation settlement (that's the next problem).

   NOTE: Assume that the overconsolidation margin (OCM) is constant within each layer. Below the water table, the densities shown are saturated densities; above the water table it is a moist density.



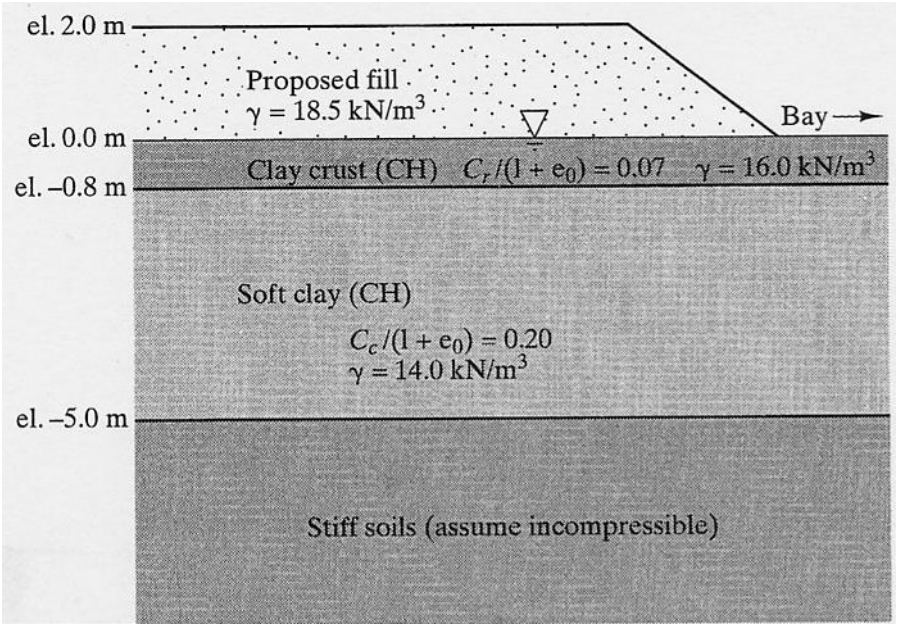
2. Repeat the previous problem but this time include the effects of submergence due to consolidation settlement. Choose one of the two methods (midpoint or closed-form) to use for this problem.

3. A cross-section through a tidal mud flat is shown below. The site is adjacent to a bay and is subject to varying water levels according to the tides. The mud flat is occasionally submerged during the rainy season when heavy runoff from nearby rivers raises the elevation of the water in the bay. A crust has formed in the upper 0.8 m of soil due to desiccation between rainy seasons and is much stiffer than the underlying soil. The proposed fill is needed to protect the site from future flooding so it can be developed into a New Urban community.

   a. Compute the expected settlement of the ground surface under 2.0 m of fill. For analysis purposes, you might simply assume the water table is always at the current ground surface. (Question: Is this a conservative or unconservative assumption? Explain.)

   b. How much additional fill do you have to place if the goal is to achieve a final elevation of 2.0 m after all of the consolidation settlement has taken place? For analysis purposes, you might want to neglect the fact that some of the fill will become submerged below the water table. (Question: Is this a conservative or unconservative assumption? Explain.)

   NOTE: To simplify the calculation, assume that the desiccated crust stays in the recompression range (so you don't need to know the preconsolidation stress in the crust) and assume $\Delta\sigma$ from the fill is constant with depth (i.e., ignore the fact that the fill ends at the water's edge).



4. An engineered fill is being constructed to level a building site for a Nissan assembly plant. On the west end of the site, the fill will be 25 feet thick. The silty sand and gravel fill, borrowed from elsewhere on the site, has a moist unit weight of 135 lb/ft3 and a saturated unit weight of 139 lb/ft3. Boring logs reveal 15 feet of medium-dense sand (with a moist unit weight of 115 lb/ft3 and a saturated unit weight of 120 lb/ft3) overlying 15 feet of normally consolidated clay (with a saturated unit weight of 105 lb/ft3). The clay sits on a thick layer of impervious clay with an OCR between 8 and 10. The water table is 5 feet below the original ground surface. Assume the impervious clay and the medium-dense sand are incompressible relative to the NC clay, which has the following geotechnical properties:

$$C_c = 0.93$$
$$e_o = 1.12$$
$$c_v = 5\times10^{-3}\ \text{cm}^2/\text{sec}$$

   a) Use the closed-form solution to estimate the total consolidation settlement. For simplicity, you can ignore the submergence of the sand resulting from consolidation settlement in the clay.

   b) Calculate and plot the settlement vs. time curve for $0 \le t \le 36$ months assuming the fill construction is for all practical purposes instantaneous.

   c) Repeat (b) assuming the fill is constructed at a more-or-less steady pace over 12 months and plot the results on the same chart.