Period #17: Soil Compressibility and Consolidation (III)

A. Review:

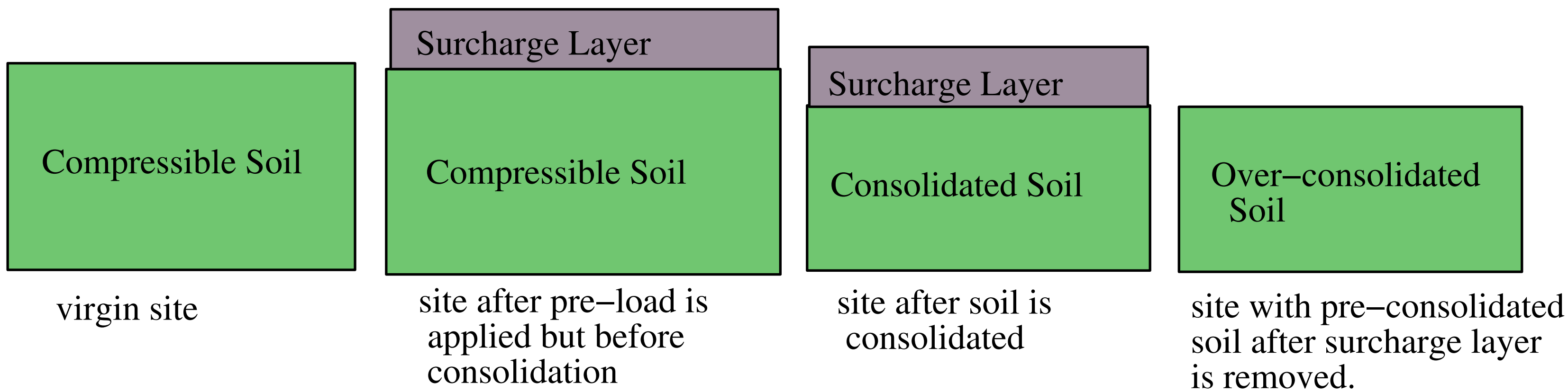
In discussing the consolidation behavior of soil deposits, we have covered the two most basic issues:

a) For given soil properties and applied loads, how much consolidation settlement will ultimately occur in the soil? and
b) On what time scale will this occur?

B. Practical Notes

In engineering and/or construction practice, it is common practice to **pre–load** construction sites with temporary fill before a structure is actually built on the site.

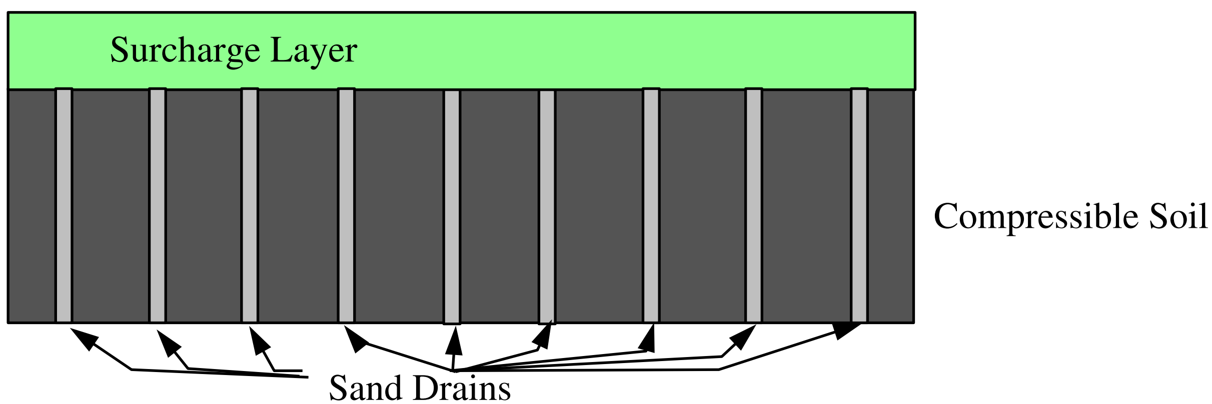
This is generally done when there are compressible silt and/or clay deposits at the site.



- If a structure is constructed on a compressible soil deposit that has been pre–loaded and allowed to partially or fully consolidate, the settlements of the structure can be significantly reduced.

- If the thickness of the compressible soil at a site is very large, then the time to achieve consolidation under pre–loading can be unacceptably large (years, decades, etc).

- In order to reduce consolidation times in these cases, the key is to reduce drainage distances H. In practice this is done using sand drains which function as shown below:

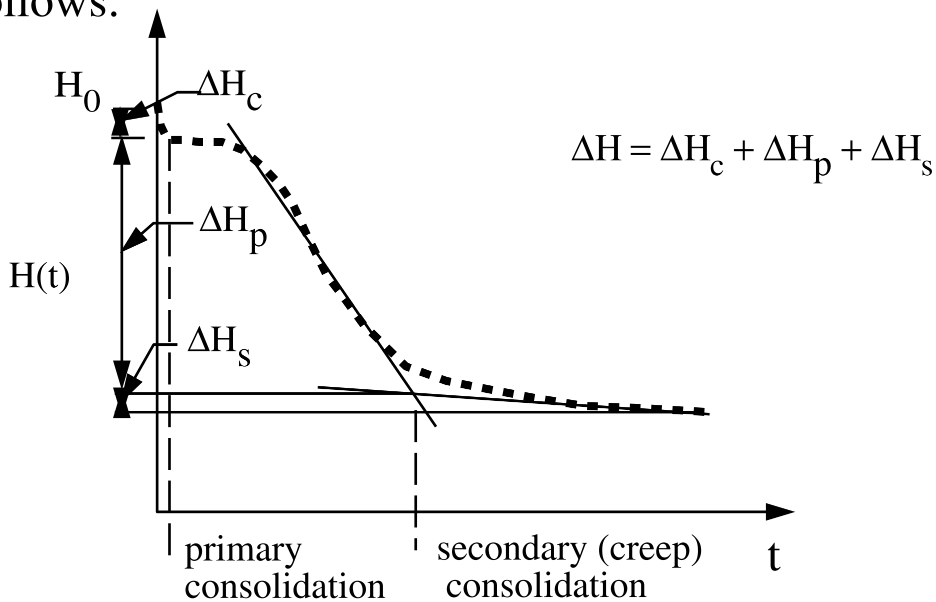


- With sand drains, the water in the compressible soil can flows to the nearest sand drain and then up into the surcharge layer. Since this greatly reduces the drainage distance through the impermeable compressible soil, it significantly reduces consolidation times.

C. Finer Points of Soil Compressibility/Consolidation

- To this point, we have made three major assumptions in discussing the compressibility of soils:
  - The volumetric compression of soils is due entirely to reduction of the void volume rather than volume of the soil grains;
  - The pore fluid (water) is incompressible; and
  - Time dependence in compression response is due to the time it takes for fluid to escape (drain) from the soil.
- While these assumptions are *fairly realistic* and help to simplify things in engineering practice, they are not *entirely realistic*, since:
  - the soil grains are slightly compressible;
  - the pore fluid is also slightly compressible; and
  - there are other mechanisms that can cause time−dependence in soil compression other than pore−fluid drainage.
- The net effect of the inaccuracies in the assumptions outlined above is usually but not always small.

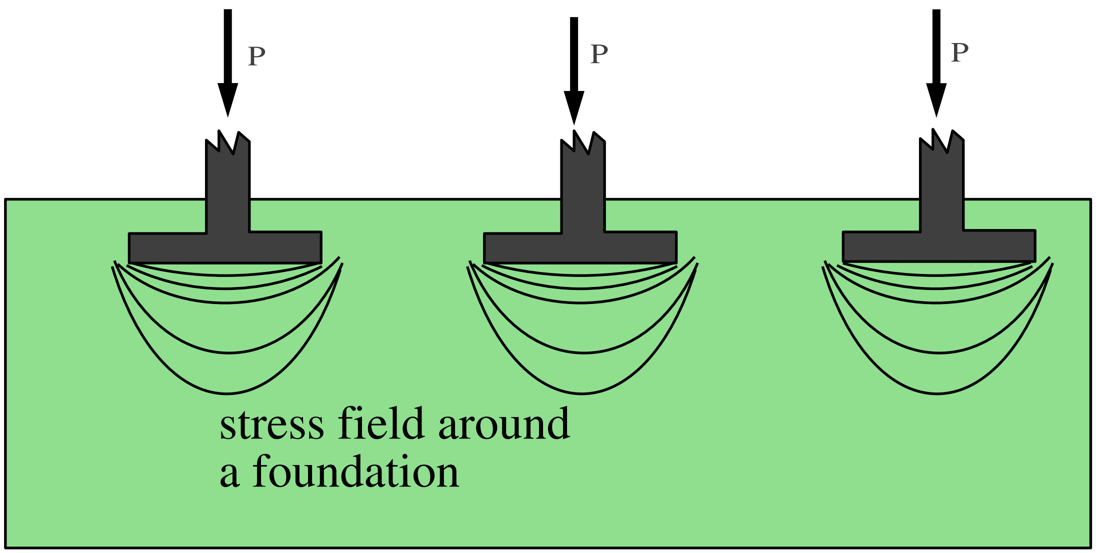
- For example, assume that a load is applied to a soil layer very quickly. We might then observe a change in height of the soil layer over time as follows:



- The overall change in height of the specimen could be broken into three distinct contributions:
  - ΔH_c : A relatively instantaneous ΔH due to compressibility of soil grains and water.
  - ΔH_p : The change of height during discharge of water and collapse of voids. This is called primary consolidation.
  - ΔH_s : Change in height due to viscoelastic or viscoplastic creep of the soil skeleton. This is called secondary consolidation.
- Methods for computing all three types of consolidation settlements are presented in the textbook.

- To this point we've discussed one–dimensional consolidation of soils. Strictly speaking, this applies when loads are applied uniformly to soils over wide areas.

- In reality, loads are often applied to soils over relatively small areas such as the foundations of structures. In this case, the stress field is not uniform beneath the load as shown below, and a two– or three–dimensional consolidation model should be used.



- Chapter 9 teaches how to compute the stresses in soils under general loadings, including foundations such as those shown.

- We will then briefly return to the idea of consolidation to estimate settlements in soils under foundation loads.