SOIL MECHANICS
CONSOLIDATION

References:

1. Rajapakse, Ruwan. Geotechnical Engineering Calculations and Rules of Thumb.
2. Schroeder, W.L., Dickenson, S.E, Warrington, Don, C. Soils in Construction. Fifth Edition. Upper Saddle River, New Jersey; Prentice Hall, 2004.

Learning objectives:

1. What is Primary and secondary consolidation.
2. What is the difference of normally consolidated and overconsolidated clays

We will discuss settlement in shallow foundation in that section. This section will just highlight the theory behind fine grained soil consolidation.

Learning objective #1:

Concept of consolidation:

- Primary consolidation is the settlement due to water being squeezed out of the soil caused by the change in vertical stress being applied by a load. When all the water in the soil is squeezed out, the primary consolidation has been achieved.

- In reality, it would not be feasibility to wait for all the water to be squeezed out in clay. Usually 90% consolidation is taken as the end of the process. Primary consolidation in clay can take a very long time, which is why for geotechnical engineering is usually the main concern for design purposes.

- Secondary consolidation occurs during primary consolidation, but usually the practice is to compute the secondary compression after the primary consolidation is complete. This phenomenon is due to the fact that soil particles start to rearrange their orientation after the water is removed into a more stable consolidated formation.

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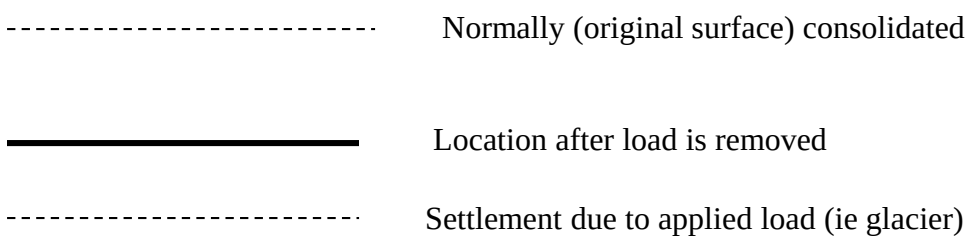
Learning objective #2:

Normally Consolidated Clays

- Clay soil usually originate from bodies of water (slow moving rivers, lakes, and ocean floors). The clay layer was normally only subject to the load due to the body of water. These clays are the normally consolidated clays.

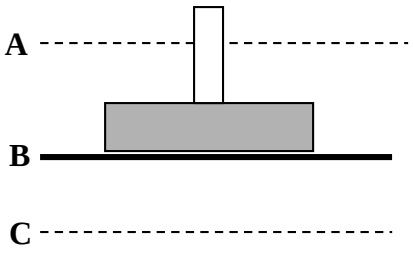
Over Consolidated Clays

- Due to the changing earths environment, a lot of the clay have been over consolidated because of a number of reasons, a few examples that could over consolidated clay in the past are glaciers, landslides, volcanoes. Below is an example of what end states of consolidated soil before the load is applied, during loading, and then what happens to the clay when the load is removed.



Over Consolidated Clays

- Now this is where it gets interesting. Lets put a footing on the clay surface.

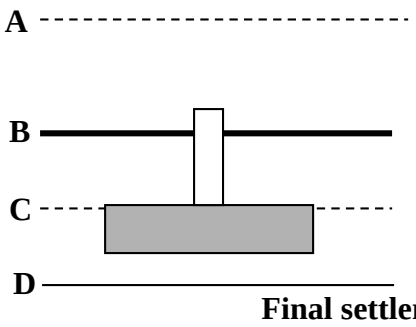


Normally (original surface) consolidated

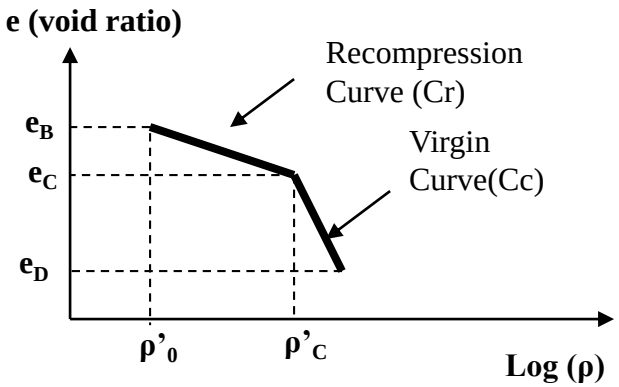
Location after load is removed

Settlement due to applied load (ie glacier)

- It is pretty intuitive that the stress applied to the soil (weight of the footing and the load the foot distributes) depends on the rates and distance of settlement. However, it is important to note that the decrease void ratio vs stress applied depends on if the footing is in the overconsolidated region or in a virgin area where the clay soil has never been consolidated there before. Review the diagram below for an example.



Final settlement



e_B = Void ratio of clay after rebounded
e_C = Void ratio of clay during initial loading event
e_D = Void ratio of clay after settlement due to footing load.

-The gradient of the virgin curve is steeper than the recompression curve.

-The gradient of the recompression curve is usually denoted by Cr and the gradient of the virgin curve is denoted by Cc

- The stress prior to placement of the footing is usually denoted by ρ'_0. The pressure at point C is known as the preconsolidation pressure and is denoted by ρ'_C.

- **For example problems and equation for settlement distance and time review the shallow foundation section in Geotechnical Engineering.**