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CONSOLIDATION TEST

# Purpose of the Test

In the light of this experiment, compressive stress-volumetric strain-time relation characteristics of soil are obtained under 1-D loading conditions. This experiment enables students to analyse an undisturbed saturated, cohesive soil, the relationship between the effective pressure and void ratio and the time-settlement characteristics.

# Theory

Consolidation is the gradual reduction in volume of a fully saturated soil of low permeability due to drainage of some of the pore water, the process continuing until the excess pore water pressure set up by an increase in total stress has completely dissipated. In the nature all soil samples contains some air entrapped in their structure. Moreover, some water in these pores. When an additional pressure affects this sample consolidation occurs because of this pore water pressure and pores that contains air. But consolidation totally occurs because of water that cannot easily dissipates through soil because of soil’s low permeability property (fine soils such as clay). In this test we are going to use a clay sample which has fine particle property. Cohesive forces in the structure of clay become very attractive after contact with water. Thus, clay sample can stay as a rigid body during test.

# Equipment

Test equipment is as followings taken from CE363 web site.

* Cutting ring
* Oedometer cell (retaining ring, top cap, pedestal, drainage lines)
* Porous stones
* Filter papers
* Oedometer load frame
* Displacement measurement device (LVDT & data acquisition system)

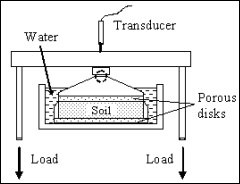


Figure 1: Oedometer

# General Rules

* During the transportation of the prepared specimen, one must hold it such a position that is parallel to the ground.
* Unless the specimen will be placed into the test cell immediately, one must seal it in a humid chamber
* It is occasionally better to check the spirit level on the loading arm as the test goes on. Adjustment should be done from the top screw if it is off.

# Calibration

* The loading mechanism should be understood and it should be figured out what load on the specimen corresponds to what load on the hanger
* One must be sure whether the data acquisition system works or not. If not, take a precaution before the experiment.
* The dimensions of the cutting ring should be measured.
* Make sure that the loading lever is horizontal without any load. If not, adjustment should be done by organizing the location of the cylindrical counterweight at the back of the setup.

# Preparation

* GS should be determined
* The inner surface of retaining ring and cutting ring should be greased.
* A specimen should be obtained by using the cutting ring, but since it is a long and complicated procedure it is skipped in this lab session for simplicity, and the assistant brings as pre-made reconstituted specimen already in the cutting ring.)
* Weight of the cutting ring and the soil specimen should be measured.
* Filter papers should be placed on the surface of the specimen.
* Align the retaining and cutting ring and transfer the specimen to the retaining ring by pushing it with the top cap ad porous stones.
* Bring the screw-knob under the loading lever in contact with the lever, to prevent any unintentional load application.
* Water should be filled the base.
* Placement of soil with ring and bottom stone should be done.
* Place top porous stone and top cap on top of the specimen, under the loading crossbar.
* Application of a tiny seating load should be done.
* The LVDT on top should be attached. Moreover, ensure that it is on the correct side of its range. Record zero reading.

# Calculation

All calculations are attached to the end of the report

The coefficient of consolidation is calculated by

Cv=0.196\*H2/t50

where Cv= coefficient of consolidation

H=half of the average height

T50=time where 50% of the consolidation takes place(obtained from graph)

coefficient of volume change can be found by

mv=(e0-e1)/(100(1+ e0))

where mv= coefficient of volume change

e0=initial void ratio= 1.57

e1=final void ratio= 1.3

mv= 4.6\*10 -6 m2/kN

The following graphs show the calculated values in part 1

|  |  |
| --- | --- |
| Diameter of Ring (cm) | 6.35 |
| **Area of Ring (cm2)** | **31.67** |
| Initial Height of Specimen (i.e. Height of ring), 2H1 (cm) | 1.88 |

|  |  |
| --- | --- |
| Mass of Ring (gram) | 68.81 |
| Mass of Ring + Wet Soil (gram) | 167.65 |
| Mass of Ring + Dry Soil (gram) | 130.58 |
| **Initial Moisture Content, m1 (%)** | **60.03** |
| Final Water Content (after unloading), m2 (%) | 30.00 |
| Specific Gravity, GS | 2.76 |

|  |  |
| --- | --- |
| **Volume of Sample (volume of ring), V (cm3)** | **201.10** |
| **Volume of Solids, VS= mass of solids/(GS\*ɣw) (cm3) (where ɣw=1gram/cm3)** | **22.38** |
| **Volume of Voids, Vv=V-Vs (cm3)** | **178.72** |
| **Void Ratio, e=Vv/Vs** | **7.99** |
| **Degree of Saturation, Sr=Vwater/Vvoids = (mwater/ɣwater)/Vv (%)** | **0.21** |
| **Equivalent Height of Solids, 2H0=Vs/Area of Specimen (cm)** | **0.71** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Consolidation Pressure (kPa)** | **Change in Height of Specimen\*, H (mm)** | **Height of Specimen, (2H=2H1-H) (mm)** | **Equivalent Height of Voids, (=2H-2H0) (mm)** | **Void Ratio, e=(2H-2H0)/2H0** |
|
| 0 | 0 | 18.8 | 11.7 | 1.647887324 |
| 20 | 0 | 18.8 | 11.7 | 1.647887324 |
| 40 | 0.172 | 18.628 | 11.528 | 1.623661972 |
| 80 | 0.384 | 18.416 | 11.316 | 1.593802817 |
| 160 | 0.749 | 18.051 | 10.951 | 1.542394366 |
| 320 | 2.002 | 16.798 | 9.698 | 1.365915493 |
| 480 | **3.2** | 15.6 | 8.5 | 1.197183099 |
| 640 | 4.343 | 14.457 | 7.357 | 1.036197183 |
| 1280 | 7.156 | 11.644 | 4.544 | 0.64 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Consolidation Pressure (kPa)** | **Average Pressure on the Sample (kPa)** | **t50 (seconds)** | **Height of specimen, 2H (mm)** | **Cv (mm2/sec)** |
|
| 40 |  | 3250 | 18.628 | 0.005231728 |
| 80 | 60 | 3380 | 18.416 | 0.004916658 |
| 160 | 120 | 3540 | 18.051 | 0.004510195 |
| 320 | 240 | 3920 | 16.798 | 0.00352716 |
| 480 | 400 | **4200** | 15.6 | 0.0028392 |
| 640 | 560 | 4340 | 14.457 | 0.002359732 |
| 1280 | 960 | 4410 | 11.644 | 0.001506475 |

# Discussion of Result

The consolidation test is carried out on undisturbed clay. It is seen in the test that as the applied pressure increases, the void ratio decreases.

In this test, the characteristics of a soil during one dimensional consolidation or swelling can be determined by means of oedometer test. The personal factor in this test is very important since it affects directly the results obtained from the test. A misreading of the values, a carelessness or improper application of the test may yield totally wrong results. Also the equipment limit the accuracy of the test since the values are read from dials and the human eye can not determine exactly the values but rather approximate values are obtained. Instead of these equipment electronic, data processors with high accuracy(if available) could be used.

The results obtained from this test can be used when we are dealing with problems such as construction of structures when we are dealing with settlements and is useful since it provides us with such data. Graphs are as followings.