Unconsolidated Undrained Strength Test

Lecture Notes # 10
Definitions, Objectives and Applications

Objective
To determine the shear strength of the soil by Unconsolidated Undrained test

Significance and Applications
• A quick test to obtain the shear strength parameters of both fine and coarse grained soils either in undisturbed or remolded state
• The test is not applicable when the rate of construction is slow allowing consolidation of soil
• The test is different from the UCS test in a way that the confinement from the surrounding soil in side the ground can be simulated by applying water. Remember that UCS is unconfined
• Hence the test is representative of soils in construction sites where the rate of construction is very fast and the pore waters do not have enough time to dissipate
• Total stress parameters are obtained as portion of load applied is also received by the water
• Quick results. Economical testing. The designs using UU parameters are mostly conservative

Some useful terminology in triaxial testing
Total stress: \( \sigma = \gamma \cdot H \)
Pore water pressure: \( u = \gamma_w \cdot H \)
Effective stress: \( \sigma' = \sigma - u \)
Confining pressure: \( \sigma_3 \)
Deviatoric stress: \( \sigma_d \)
Axial stress: \( \sigma_1 = \sigma_d + \sigma_3 \)
Equipment

- Triaxial Machine
- Specimen preparation equipment
- Sample extruder
- Balance

Test Procedure

- Remolded specimens are prepared in the laboratory depending on the proctors data at the required molding water content
  http://geotech.uta.edu/lab/Main/index.htm (look for UU test in the menu)
- If testing undisturbed specimens retrieved from the ground by various sampling techniques, trim the samples into regular triaxial specimen dimensions (2.8” x 5.6”)
- There will be a significant variation in strength of undisturbed and remolded samples
- Measure the diameter and length of the specimen to be tested
- If curing the sample (treated soils), wrap the samples in a geotextile and then a zip bag. Place the sample in a humidity room maintained at a relative humidity of 90%
- Prior to testing, avoid any moisture loss in the sample, place on a triaxial base (acrylic). The ends of the sample are assumed to be frictionless
- The triaxial cell is placed above the sample and required confinement is applied simulating the effect of surrounding soil at that depth
- The rate of strain is maintained at 1.2700 mm/min as per ASTM specifications
- The data acquisition system collects real time data and the test is stopped when there is a drop observed in the strain versus load plot
Triaxial Setup

Placing the specimen

Placing the triaxial cell

Apply confinement

Adjust the drainage and inlet valves as shown

Real time data from data acquisition system (DAS)
Interpretation of data for UU test

The test results are saved as an EXCEL sheet and contain the load (in kg-force) and strain in (mm). This section explains how to apply the area correction and interpret the test results

Axial strain, \( \varepsilon_a = \left( \frac{\Delta H}{H_o} \right) \times 100 \)

Stress, \( \sigma = \frac{F}{A_c} \) where, \( A_c = \frac{A_i}{1 - \varepsilon} \)

\( A_i \) is the initial area of the specimen (\( \pi r_i^2 \))

Sample Data sheet from the test

<table>
<thead>
<tr>
<th>Load, ( F ) (kg-f)</th>
<th>Deformation (mm)</th>
<th>Load Tarred</th>
<th>( \Delta H ) (mm)</th>
<th>( \Delta H ) (inches)</th>
<th>Load, ( F ) (lb)</th>
<th>vertical strain = ( \frac{\Delta H}{H_o} )</th>
<th>Corrected area, ( A_c )</th>
<th>Stress (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>6.28</td>
<td>0</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.000</td>
<td>3.1400</td>
<td>0.0000</td>
</tr>
<tr>
<td>6</td>
<td>6.28</td>
<td>0</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.000</td>
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<td>6</td>
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<td>0.0000</td>
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<td>0.0000</td>
<td>0.000</td>
<td>3.1400</td>
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<tr>
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<tr>
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<td>0.0000</td>
<td>8.813</td>
<td>0.000</td>
<td>3.1400</td>
<td>2.8084</td>
</tr>
<tr>
<td>10</td>
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<td>4</td>
<td>0.0000</td>
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</table>

Area correction is applied in the interpretation of the results as the cross section of the sample doesn’t remain constant as the load is increased. There will be an observed bulge at the middle of the specimen due to which it is almost presumptive to consider uniform stress through out the specimen length. However, the volume of the specimen is assumed constant.

Columns 1 and 2 are obtained from the test results
Column 3 = \{Column 1 – 6 kg-f\}, (Tarring the load and making it start from zero)
Column 4 = \{Column 2 – 6.28 m\}, (Tarring the deformation and starting it from zero)
Column 5 = \( \Delta H \) in inches
Column 6 = Load in lb
Column 7 = Strain calculated from \( H_o \)
Column 8 = Area correction from the above equation
Column 9 = \( F/A_c \)

Plot column 7 (on x-axis) against column 9 (y axis)