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| **Course Name:** CE363 | **Deadline of Report** 08/12/2014 |
| **Title of Test**  Laboratory Vane Test | |
| **Year & Section:** 3 & 2 | **Lab. Group:** 1 |
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**Table of Contents**

[**Introduction** 3](#_Toc405758029)

[**Equipment** 3](#_Toc405758030)

[**Methodology** 3](#_Toc405758031)

[Preparation 3](#_Toc405758032)

[Sample 4](#_Toc405758033)

[Procedure 4](#_Toc405758034)

[**Results** 5](#_Toc405758035)

[**Calculations** 5](#_Toc405758036)

[**Conclusion** 8](#_Toc405758037)

# **Introduction**

Laboratory Vane Test is done to determine peak and residual values of undrained shear strength of a soft clay.

# **Equipment**

* Straight edge spatula
* Miniature laboratory vane
* Chronometer

# **Methodology**

## Preparation

* The blades of the vane must be clean and undamaged.
* Measure and record dimensions (Height and Diameter) of the vane.
* The spring with the correct stiffness must be used, according to the strength of soil. Record spring number and calibration factor. If the calibration factor is not known, it can be determined by applying a known torque and measuring rotation of the spring.
* The standard rate of loading is rotating the spring by 1° per second. To match this rate easily by hand, figure out the corresponding rate of handle rotation.
* If there isn’t one already, place a mark on the vane shaft, 13mm above the top of the blades.
* Set needle indicators to zero.

## Sample

Normally this test is done on undisturbed samples. However, in this lab session, it will be done on a reconstituted sample in a Proctor mold. The rest of this section explains how the test is done on undisturbed samples.

* If you are cutting shelby tubes, then cut a section with a height that is compatible with the height of the vane from the table. Clean the upper end with spatula if necessary.
* If you are not cutting shelby tubes, then extrude a section with a height that is compatible with the height of the vane from the table. Affix it into a container that is slightly shorter in height. Trim the top with the wiresaw.
* If you are testing a block sample, you can raise the vane apparatus and reverse the direction it faces, to accommodate for the sample’s size.

## Procedure

1- Insert the vane into the sample until the mark touches the soil surface.

2- Start rotating the vane at a rate that turns the spring by about 1 degree per second. Record measurements of spring and vane rotation indicators at equal intervals of time.

3- At failure, the soil in the vane is sheared off from the rest. Take a set of measurements at that point.

4- One of the needles on the indicator records the peak value. This corresponds to the peak shear strength.

5- Rotate the vane several times.

6- Set needle indicators to zero.

7- Rotate at the testing rate until the spring measurement reaches a constant value. Record this constant value. This corresponds to the residual shear strength.

8- In a real test you would repeat steps 1 to 6 twice more at undisturbed locations of the soil surface, then take their average. Here, once is enough for instruction purposes.

9- Excavate the test location and take that soil for water content determination.

# **Results**

All measurements of the experiment and results are on the data sheet that I prepared on Excel, related graphs are at the end of the report.

|  |  |
| --- | --- |
| **Applied Mass(g)** | **Deflection(deg)** |
| 200 | 2,2 |
| 400 | 5,4 |
| 600 | 8,2 |
| 800 | 10,5 |
| 1000 | 13,1 |
| 1200 | 16,9 |
| 1400 | 20 |
| 1600 | 22,5 |
| 1800 | 25,4 |
| 2000 | 28,2 |
| 2200 | 30,1 |

Table 1: Applied Mass vs Deflection Values given by the Assistant

# **Calculations**

I have prepared an Excel file for the data sheet and in order to calculate the asked values. And I showed all values in the tables.

During the Lab Session Applied Mass (g) vs Deflection (deg) values are given by the assistant. So as to calculate Applied Torque, by using the given data I made the following calculation in order to find each Applied Torque value.

**Torque = (Applied Mass (kg)) \* (g) \* (Moment arm (cm))**

Calculation for the first row is as follows, T= (200/1000)\*9.81\*0.475=0.932, I did the same calculations for each row via Excel, and obtained the following results as shown in the Table 2.

|  |  |  |
| --- | --- | --- |
| **Applied Mass(g)** | **Applied Torque(N.cm)** | **Deflection(deg)** |
| 200 | 0,931950 | 2,2 |
| 400 | 1,863900 | 5,4 |
| 600 | 2,795850 | 8,2 |
| 800 | 3,727800 | 10,5 |
| 1000 | 4,659750 | 13,1 |
| 1200 | 5,591700 | 16,9 |
| 1400 | 6,523650 | 20 |
| 1600 | 7,455600 | 22,5 |
| 1800 | 8,387550 | 25,4 |
| 2000 | 9,319500 | 28,2 |
| 2200 | 10,251450 | 30,1 |

Table 2: Applied Torque values calculated by the formula given above

Figure 1: Spring Deflection vs Applied Torque Graph

In order to find **τave ,** we should use the provided formula in the manual which is given in Figure 2.

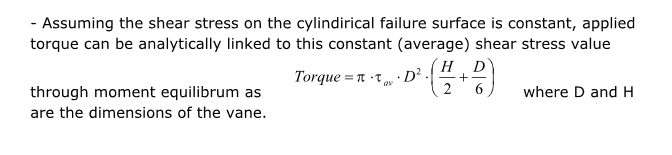


Figure 2: Provided formula to find Average Shear Stress

D and H values in the formula were both given by the assistant as 1.25 cm. And also diameter was given as 9.5 mm. This means radius is 0.475 cm.

As shown in the Figure 1, I obtained a best-line via Excel. The equation of the line is y=0.3267\*x+0.172. By applying this formula we can obtain corresponding torque values. In this formula, x represents the spring deflection and y represents the torque value.

At t =10 sec, deflection value is 1.5

So by substituting corresponding values i.e. deflection value, y=0,3267\*1,5+0,172 = 0,662 N.cm. I did the same for each row with the help of the Excel I obtained all Torque values. After that, with the formula provided in Figure 2 I calculated the average shear stress.

τ= Torque/(π\*D2\*((H/2)+(D/6))) . At time t=10 τ=1,618 kPa by applying this formula. Again I did the same calculations for each row via Excel and they are shown in Table 3.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Time(sec)** | **Spring Deflection** |  | **Torque(N.cm)** | **Vane Rotation** |  | **τ(kPa)** |
|  | **Reading** | **Deflection** |  | **Reading** | **Deflection** |  |
| 0 | 9,0 | 0,0 | 0,172 | 4,5 | 0,0 | 0,420 |
| 10 | 10,5 | 1,5 | 0,662 | 5,0 | 0,5 | 1,618 |
| 20 | 12,0 | 3,0 | 1,152 | 5,5 | 1,0 | 2,816 |
| 30 | 15,0 | 6,0 | 2,132 | 6,0 | 1,5 | 5,212 |
| 40 | 17,5 | 8,5 | 2,949 | 7,0 | 2,5 | 7,209 |
| 50 | 19,5 | 10,5 | 3,602 | 8,0 | 3,5 | 8,806 |
| 60 | 21,0 | 12,0 | 4,092 | 10,0 | 5,5 | 10,004 |
| 70 | 22,0 | 13,0 | 4,419 | 11,0 | 6,5 | 10,803 |
| 80 | 23,5 | 14,5 | 4,909 | 13,0 | 8,5 | 12,001 |
| 90 | 24,5 | 15,5 | 5,236 | 15,0 | 10,5 | 12,800 |
| 100 | 25,0 | 16,0 | 5,399 | 17,0 | 12,5 | 13,199 |
| 110 | 25,0 | 16,0 | 5,399 | 20,0 | 15,5 | 13,199 |
| 120 | 25,0 | 16,0 | 5,399 | 24,0 | 19,5 | **13,199** |
| t=0 | 10,0 | 0,0 | 0,172 | 5,0 | 0,0 | 0,420 |
|  | 13,0 | 3,0 | 1,152 | 5,0 | 0,0 | 2,816 |
|  | 15,0 | 5,0 | 1,806 | 7,0 | 2,0 | 4,414 |
|  | 15,0 | 5,0 | 1,806 | 9,0 | 4,0 | 4,414 |
|  | 15,0 | 5,0 | 1,806 | 12,0 | 7,0 | **4,414** |

Table 3: Data Sheet with recorded and calculated values

* The ratio of peak to residual shear strength is called ‘sensitivity’.

So as to calculate sensitivity I used the bolded data from Table 3. Peak Value is 13,199 kPa, and residual value is 4,414 kPa. So, sensitivity is 13,199/4,414 = **3,1534**

# **Conclusion**

In this experiment, our purpose was to determine the peak and residual shear strength of a soft clay. We obtained data by using vane apparatus which is run with a torque application. We did not measure the torque values because the data which shows torque vs deflection values was given by the assistant. By using given data, I obtain an equation to calculate the torque value for the given deflection. We measured the deflections with respect to the time during the lab session. By using measured deflection values, I calculate the applied torque by using the equation I obtained and mentioned in calculations part. By using applied torque and calibration factors I calculate the average shear strength of the soft clay. After making necessary calculations I obtained the Average Shear Stress vs Vane Rotation graph as shown in the Figure 3.

Figure 3: Average Shear Stress vs Rotation Graph

With the help of the graph, we can say that residual shear strength of soft clay is lower than the undisturbed sample as expected.

To sum up, via Laboratory Vane Test we examine the shear strength characteristics of a soft clay. Of course, there might be some errors in our results, because we used the previously disturbed soil sample. This means, actually our sample was disturbed for the other groups’ experiments.