EXPERIMENT 13

DIRECT SHEAR TEST

Purpose:

This test is performed to determine the consolidated-drained shear strength of a sandy to silty soil. The shear strength is one of the most important engineering properties of a soil, because it is required whenever a structure is dependent on the soil's shearing resistance. The shear strength is needed for engineering situations such as determining the stability of slopes or cuts, finding the bearing capacity for foundations, and calculating the pressure exerted by a soil on a retaining wall.

Standard Reference:

ASTM D 3080 - Standard Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions

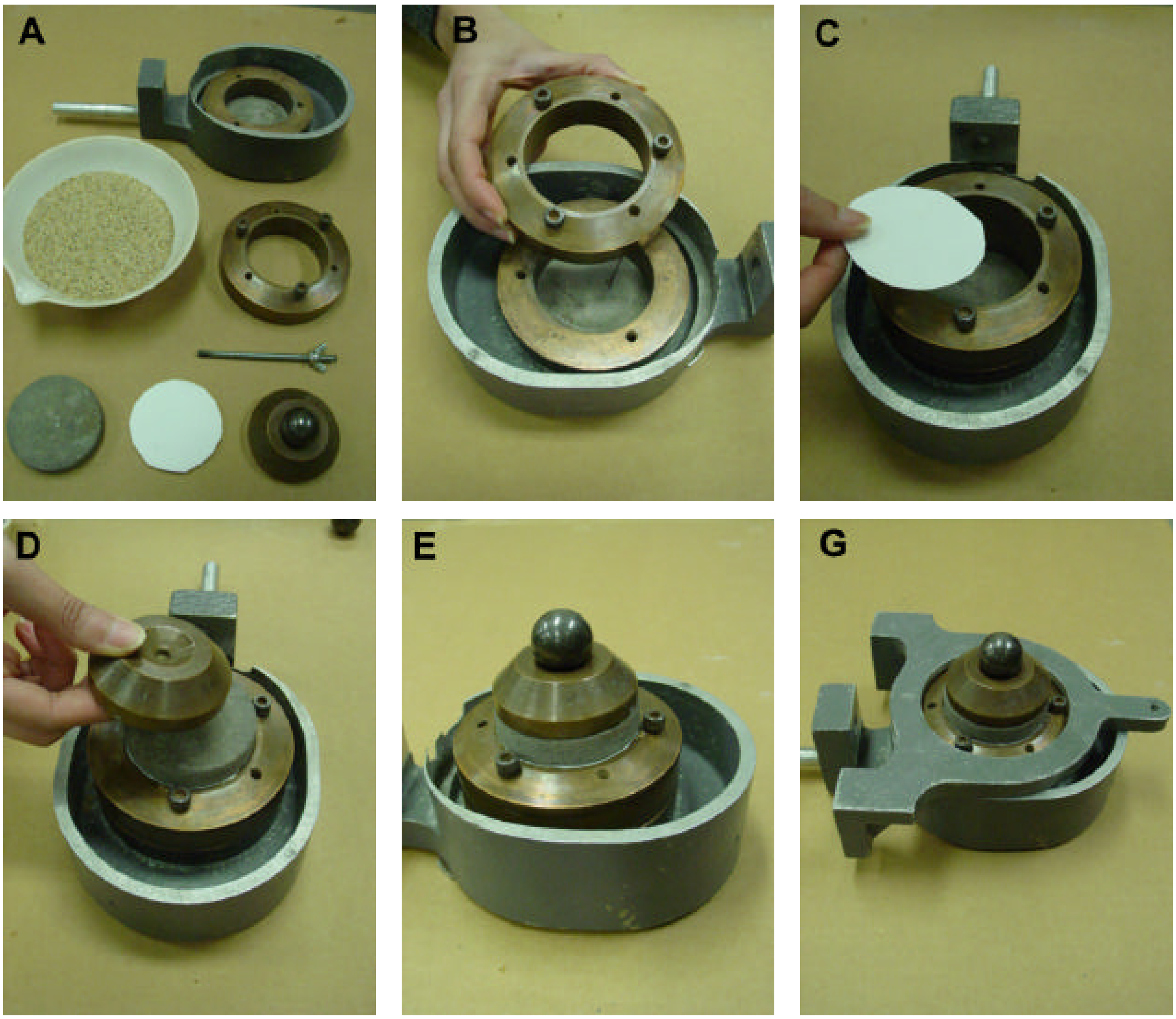
Significance:

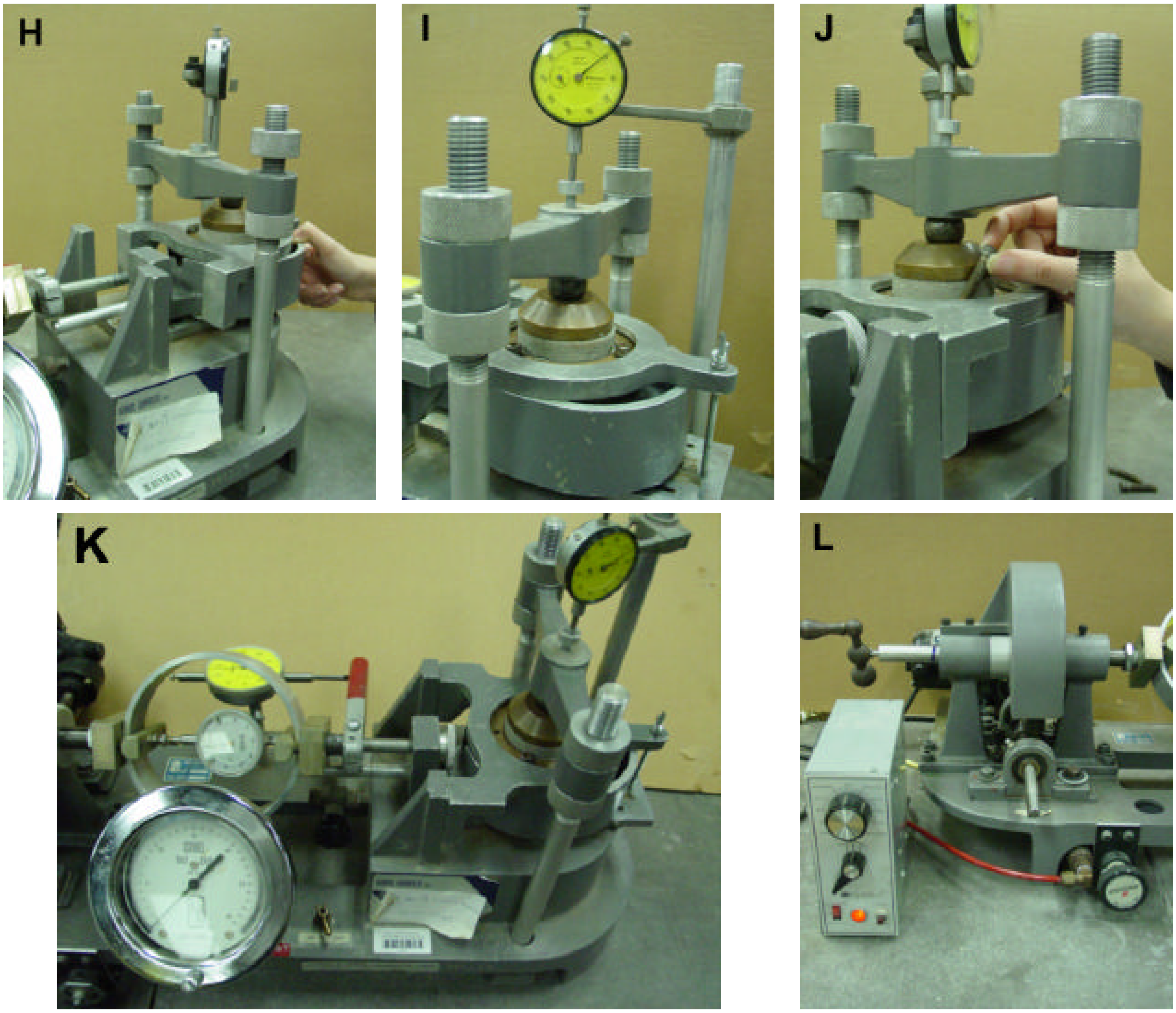
The direct shear test is one of the oldest strength tests for soils. In this laboratory, a direct shear device will be used to determine the shear strength of a cohesionless soil (i.e. angle of internal friction (f)). From the plot of the shear stress versus the horizontal displacement, the maximum shear stress is obtained for a specific vertical confining stress. After the experiment is run several times for various vertical-confining stresses, a plot of the maximum shear stresses versus the vertical (normal) confining stresses for each of the tests is produced. From the plot, a straight-line approximation of the Mohr-Coulomb failure envelope curve can be drawn, f may be determined, and, for cohesionless soils (c = 0), the shear strength can be computed from the following equation:

$$s = s \tan f$$

Equipment:

Direct shear device, Load and deformation dial gauges, Balance.




H
I
J
K
L

Test Procedure:

(1) Weigh the initial mass of soil in the pan.

(2) Measure the diameter and height of the shear box. Compute 15% of the diameter in millimeters.

(3) Carefully assemble the shear box and place it in the direct shear device. Then place a porous stone and a filter paper in the shear box.

(4) Place the sand into the shear box and level off the top. Place a filter paper, a porous stone, and a top plate (with ball) on top of the sand

(5) Remove the large alignment screws from the shear box! Open the gap between the shear box halves to approximately 0.025 in. using the gap screws, and then back out the gap screws.

(6) Weigh the pan of soil again and compute the mass of soil used.

(7) Complete the assembly of the direct shear device and initialize the three gauges (Horizontal displacement gage, vertical displacement gage and shear load gage) to zero.

(8) Set the vertical load (or pressure) to a predetermined value, and then close bleeder valve and apply the load to the soil specimen by raising the toggle switch.

(9) Start the motor with selected speed so that the rate of shearing is at a selected constant rate, and take the horizontal displacement gauge, vertical

displacement gage and shear load gage readings. Record the readings on the data sheet. (Note: Record the vertical displacement gage readings, if needed).

(10) Continue taking readings until the horizontal shear load peaks and then falls, or the horizontal displacement reaches 15% of the diameter.

Analysis:

(1) Calculate the density of the soil sample from the mass of soil and volume of the shear box.

(2) Convert the dial readings to the appropriate length and load units and enter the values on the data sheet in the correct locations. Compute the sample area A, and the vertical (Normal) stress s_v.

$$s_v = \frac{N_v}{A}$$

Where: N_v = normal vertical force, and s_v = normal vertical stress

(3) Calculate shear stress (τ) using $t = \frac{F_h}{A}$

Where F_h= shear stress (measured with shear load gage)

(4) Plot the horizontal shear stress (τ) versus horizontal (lateral) displacement ?H.

(5) Calculate the maximum shear stress for each test.

(6) Plot the value of the maximum shear stress versus the corresponding vertical stress for each test, and determine the angle of internal friction (f) from the slope of the approximated Mohr-Coulomb failure envelope.

DIRECT SHEAR TEST
DATA SHEET

Date Tested: **August 30, 2002**

Tested By: **CEMM315 Class, Group A**

Project Name: **CEMM315 Lab**

Sample Number: **K-3,AU-10, 2'-4'**

Visual Classification: **Brown uniform sand**

Shear Box Inside Diameter: **6.3 cm**
Area (A): **31.17 cm^2 = 4.83 in^2**
Shear Box Height: **4.9 cm**
Soil Volume: **119.9 cm^3**
Initial mass of soil and pan: **1000. g**
Final mass of soil and pan: **720.82 cm**
Mass of soil: **279.18 g**
Density of soil (?) **:** **1.65 g/cm^3**

Direct Shear Test Data

Displacement rate: ______
Normal stress: **2.27 psi**

Horizontal Dial Reading (0.001 in)	Horizontal Displacement (in)	Load Dial Reading	Horizontal Shear Force (lb)	Shear Stress (psi)
0	0	0	0	0
10	0.01	4	5.142	1.064
19	0.019	4.3	5.231	1.082
29	0.029	4.8	5.379	1.113
36	0.036	5	5.439	1.126
44	0.044	7	6.033	1.248
51	0.051	8	6.33	1.31
57	0.057	13.5	7.963	1.648
63	0.063	15	8.409	1.740
70	0.07	17	9.002	1.863
76	0.076	19	9.597	1.986
84	0.084	20	9.893	2.047
91	0.091	22	10.488	2.170
100	0.1	22.5	10.636	2.201
107	0.107	23	10.785	2.232
114	0.144	23.5	10.933	2.262
121.5	0.1215	25	11.379	2.355
129	0.129	25.5	11.527	2.385
137	0.137	26	11.675	2.416
145	0.145	27	11.973	2.478
152	0.152	27.5	12.121	2.508
160	0.16	28	12.270	2.539
179	0.179	25	11.379	2.355

<u>Direct Shear Test Data</u>

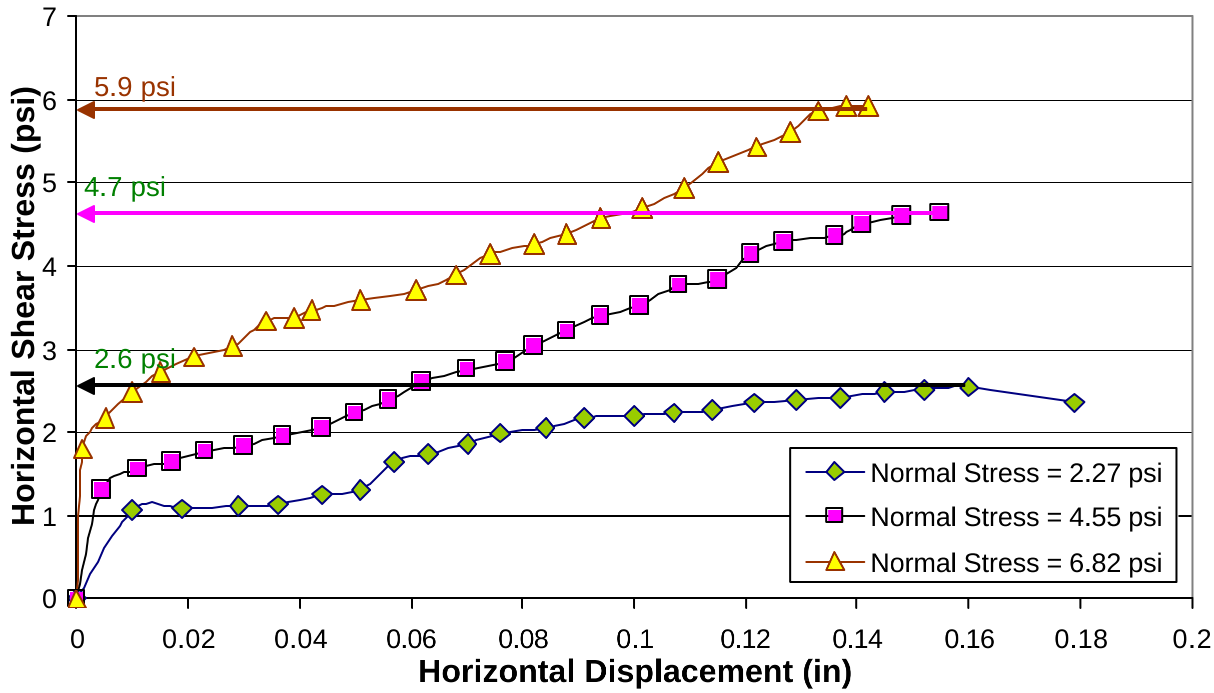
Normal stress: **<u>4.55 psi</u>**

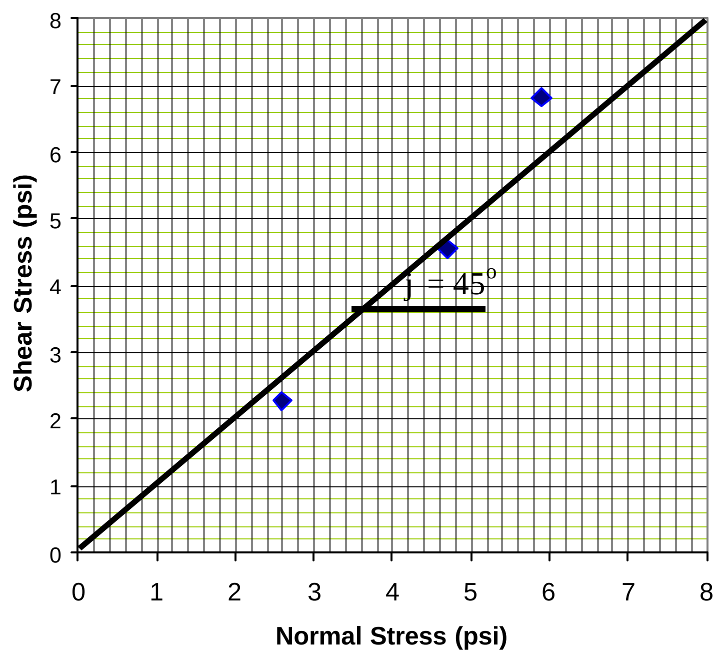
Horizontal Dial Reading (0.001 in)	Horizontal Displacement (in)	Load Dial Reading	Horizontal Shear Force (lb)	Shear Stress (psi)
0	0	0	0	0
4.5	0.0045	8	6.330	1.31
11	0.011	12	7.517	1.556
17	0.017	13.5	7.963	1.648
23	0.023	15.5	8.557	1.77
30	0.030	16.5	8.854	1.832
37	0.037	18.5	9.448	1.955
44	0.044	20	9.894	2.047
50	0.05	23	10.785	2.232
56	0.056	25.5	11.527	2.385
62	0.062	29	12.567	2.60
70	0.07	31.5	13.309	2.754
77	0.077	33	13.755	2.846
82	0.082	36	14.646	3.031
88	0.088	39	15.537	3.215
94	0.094	42	16.428	3.4
101	0.101	44	17.022	3.522
108	0.108	48	18.210	3.768
115	0.115	49	18.507	3.83
121	0.121	54	19.991	4.13
127	0.127	56.5	20.734	4.291
136	0.136	57.5	21.031	4.352
141	0.141	60	21.774	4.506
148	0.148	61.5	22.219	4.599
155	0.155	62	22.368	4.62

Direct Shear Test Data

Normal stress: **6.82 psi**

Horizontal Dial Reading (0.001 in)	Horizontal Displacement (in)	Load dial Reading	Horizontal Shear Force (lb)	Shear Stress (psi)
0	0	0	0	0
1	0.001	16	8.706	1.801
5	0.005	22	10.488	2.170
10	0.01	27	11.972	2.478
15	0.015	31	13.16	2.723
21	0.021	34	14.052	2.908
28	0.028	36	14.646	3.031
34	0.034	41	16.131	3.338
39	0.039	41.5	16.279	3.37
42	0.042	43	16.725	3.461
51	0.051	45	17.319	3.584
61	0.061	47	17.913	3.707
68	0.068	50	18.804	3.891
74	0.074	54	19.99	4.13
82	0.082	56	20.586	4.26
88	0.088	58	21.18	4.383
94	0.094	61	22.071	4.568
101.5	0.1015	63	22.665	4.690
109	0.109	67	23.85	4.937
115	0.115	72	25.337	5.244
122	0.122	75	26.228	5.428
128	0.128	78	27.119	5.612
133	0.133	82	28.307	5.858
138	0.138	83	28.605	5.92
142	0.142	83	28.60	5.92


5.9 psi
4.7 psi
2.6 psi
Horizontal Shear Stress (psi)
Horizontal Displacement (in)
Normal Stress = 2.27 psi
Normal Stress = 4.55 psi
Normal Stress = 6.82 psi
0
1
2
3
4
5
6
7
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2


Shear Stress (psi)
Normal Stress (psi)
0
1
2
3
4
5
6
7
8

BLANK DATA SHEETS

DIRECT SHEAR TEST
DATA SHEET

Date Tested:

Tested By:

Project Name:

Sample Number:

Visual Classification:

Shear Box Inside Diameter:
Area (A):
Shear Box Height:
Soil Volume:
Initial mass of soil and pan:
Final mass of soil and pan:
Mass of soil:
Density of soil (?) **:**

Direct Shear Test Data

Displacement rate: ______
Normal stress: ________psi

Horizontal Dial Reading (0.001 in)	Horizontal Displacement (in)	Load Dial Reading	Horizontal Shear Force (lb)	Shear Stress (psi)

Direct Shear Test Data

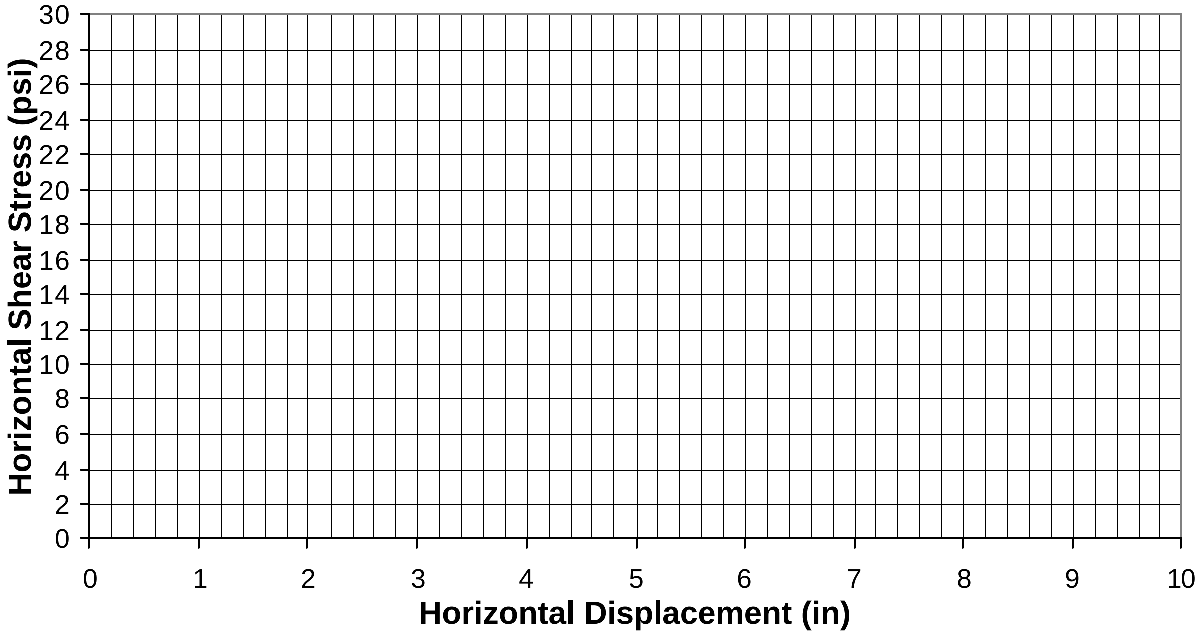
Normal stress: ________ **psi**

Horizontal Dial Reading (0.001 in)	**Horizontal Displacement (in)**	**Load Dial Reading**	**Horizontal Shear Force (lb)**	**Shear Stress (psi)**

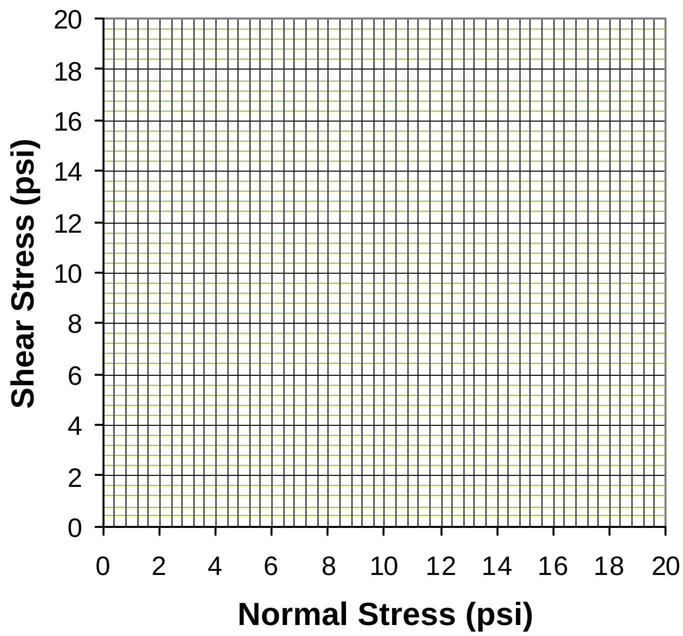
Direct Shear Test Data

Normal stress: _______**psi**

Horizontal Dial Reading (0.001 in)	Horizontal Displacement (in)	Load dial Reading	Horizontal Shear Force (lb)	Shear Stress (psi)



Horizontal Shear Stress (psi)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
0
1
2
3
4
5
6
7
8
9
10
Horizontal Displacement (in)



Shear Stress (psi)
20
18
16
14
12
10
8
6
4
2
0
0
2
4
6
8
10
12
14
16
18
20
Normal Stress (psi)