ASSIGNMENT REGARDING

SHEAR STRENGTH OF SOILS

PART-1:

RESOLVE THREE EXAMPLES REGARDING USE OF MOHR CIRCLE TO DETERMINE THE STRESS WITHIN SOIL MASS

PART-II:

SOLVE QUESTION 1-10

▶ **Example 1**

Given. Figure E 1.1

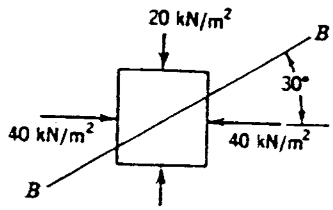

Fig. E 1.1

Find. Stresses on plane *B–B*.

Solution. Use Fig. E 1.2

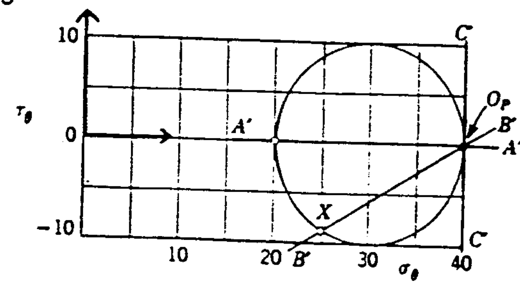

Fig. E 1.2

1. Locate points with co-ordinates (40, 0) and (20, 0).
2. Draw circle, using these points to define diameter.
3. Draw line $A'A'$ through point (20, 0) and parallel to plane on which stress (20, 0) acts.
4. Intersection of $A'A'$ with Mohr circle at point (40, 0) is the origin of planes.
5. Draw line $B'B'$ through O_P parallel to BB.
6. Read coordinates of point X where $B'B'$ intersects Mohr circle.

Answer. See Fig. E 1.3

$$\text{on } BB \quad \begin{cases} \sigma = 25 \text{ kN/m}^2 \\ \tau = -8.7 \text{ kN/m}^2 \end{cases}$$

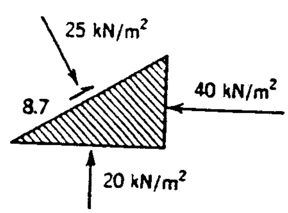

Fig. E1.3

Alternate Solution. Steps 1 and 2 same as above.

3. Draw line $C'C'$ through (40, 0) parallel to plane on which stress (40, 0) acts. $C'C'$ is vertical.

4. $C'C'$ intersects Mohr circle only at (40, 0), so this point is O_P. Steps 5 and 6 same as above.

Solution Using Eqs. 1 and 2

$$\sigma_1 = 40 \text{ kN/m}^2 \quad \sigma_3 = 20 \text{ kN/m}^2 \quad \theta = 120°$$

$$\sigma_\theta = \frac{40 + 20}{2} + \frac{40 - 20}{2} \cos 240° = 30 - 10 \cos 60° = 25 \text{ kN/m}^2$$

$$\tau_\theta = \frac{40 - 20}{2} \sin 240° = -10 \sin 60° = -8.66 \text{ kN/m}^2$$

◀

(*Questions for student.* Why is $\theta = 120°$? Would result be different if $\theta = 300°$?)

▶ **Example 2**

Given. Figure E 2.1

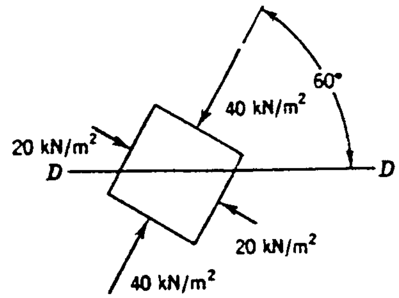

Fig. E 2.1

Find. Stresses on horizontal plane DD.

Solution.

1. Locate points (40, 0) and (20, 0) on Mohr diagram (Fig. E 2.2).

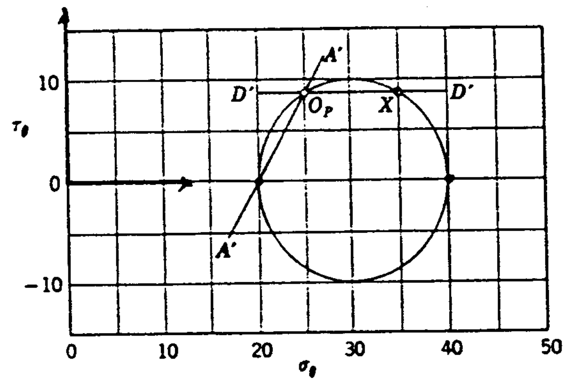

Fig. E 2.2

2. Draw Mohr circle.
3. Draw line $A'A'$ through (20, 0) parallel to plane upon which stress (20, 0) acts.
4. Intersection of $A'A'$ with Mohr circle gives O_P.
5. Draw line $D'D'$ parallel to plane DD.
6. Intersection X gives desired stresses

Answer. See Fig. E 2.3

$$\text{on } DD \quad \begin{cases} \sigma = 35 \text{ kN/m}^2 \\ \tau = 8.7 \text{ kN/m}^2 \end{cases}$$

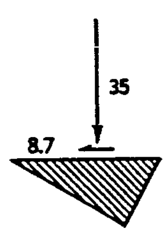

Fig. E 2.3 ◀

Example 3

Given. Figure E 3.1

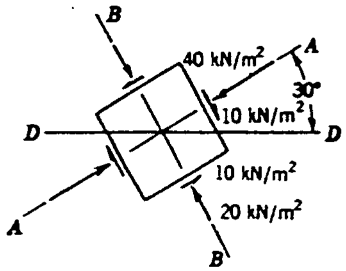

Fig. E 3.

Find. Magnitude and direction of the principal stresses.
Solution. Use Fig. E 3.2

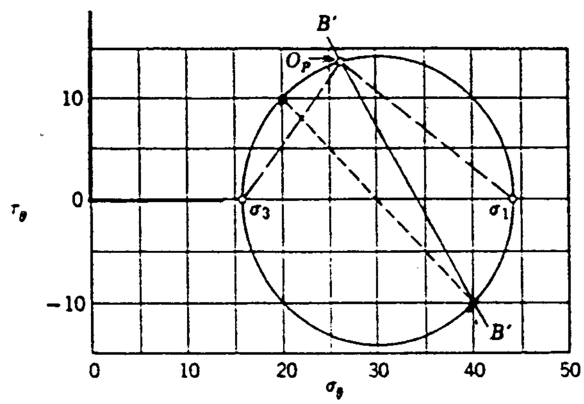

Fig. E 3.2

1. Locate points (40, −10) and (20, 10).
2. Erect diameter and draw Mohr circle.
3. Draw $B'B'$ through (40, −10) parallel to BB.
4. Intersection of $B'B'$ with circle gives O_P.
5. Read σ_1 and σ_3 from graph.
6. Line through O_P and σ_1 gives plane on which σ_1 acts, etc. (see Fig. E 3.3).

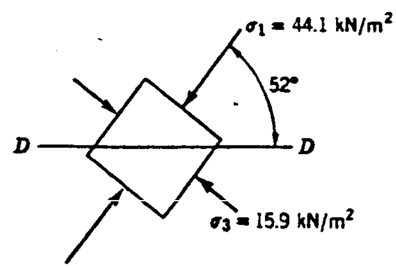

Fig. E 3.3

Solution by Equations.
1. First make use of fact that sum of normal stresses is a constant:

$$\frac{\sigma_1 + \sigma_3}{2} = \frac{\Sigma\sigma_\theta}{2} = \frac{40 + 20}{2} = 30 \text{ kN/m}^2$$

<u>Assignment (Shear Strength of Soil)</u>

Q-1: The results shown in the following table were obtained at failure in a series of triaxial tests on specimens of saturated clay. Determine the shear strength parameters w.r.t (a) total stress and (b) effective stress.

Type of test	Cell pressure, kPa	Deviator stress, kPa
UU	200	120
	400	122
	600	119
CD	200	150
	400	180
	600	205

Q-2: The results shown in the following table were obtained in a series of consolidated undrained triaxial tests, with pore water pressure measurement on specimens of saturated clay. Determine the shear strength parameters w.r.t (a) total stress and (b) effective stress.

Cell pressure, kPa	Deviator stress, kPa	Pore water pressure, kPa
150	192	80
300	341	154
450	504	222

Q-3:
A direct shear test was conducted on a specimen of dry sand with normal stress of 200 kPa. Failure occurred at shear stress of 175 kPa. The size of the specimen tested was 75x75x30 mm. Determine the angle of internal friction, ϕ. For a normal stress of 150 kPa, what shear force would be required to cause failure in the specimen.

Q-4:
The size of a sand specimen in a direct shear test was 50x50x30 mm. It is known that, for this sand $\tan\phi = 0.65/e$ (where e is void ratio) and the specific gravity, $G_s = 2.68$. During the test, a normal stress of 150 kPa was applied. Failure occurred at a shear stress of 110 kPa. What was the mass of the dry sand specimen packed in the shear box?

Q-5:
The equation of the effective stress failure envelope for a loose sandy soil was obtained from a direct shear test as $\tau_f = \tan 30^o$. A drained triaxial test was conducted with the same soil at a chamber pressure of 70 kPa. Determine

(a) Deviator stress at failure
(b) Angle that the failure plane makes with the major principal plane.
(c) The normal and shear stress at failure on a plane which makes an angle of 30 degree with major principal plane. Also explain why the specimen did not fail along this plane during the test.

Q-6:

For a normally consolidated clay, it is given that ϕ'=24 degree. In a drained triaxial test, the specimen failed at a deviator stress of 175 kPa. What was the chamber confining pressure?

Q-7:

A soil has an effective angle of shearing resistance ϕ' of 20 degree and effective cohecion c' of 20 kPa. What value of vertical stress at failure is expected on top of the specimen in a drained triaxial compression test with cell pressure of 250 kPa?

Q-8:

In an unconfined compression test, the value of unconfined compression strength is 200 kPa. Determine

(A) The undrained shear strength parameters of the soil.

(B) The undrained shear strength of the soil

Q-9:

A sample of dry cohesionless soil is known to have the angle of internal friction of 30 degree. If in a CD triaxial test, the cell pressure is 100 kPa. At what value of maximum deviator stress, major principal stress and the normal stress is the sample likely to fail?

Q-10

A vane shear test performed in a saturated soft clay gives the maximum value of Torque of 50 N-m. The vane is 160 mm long and has a diameter of 60 mm, compute the undrained shear strength of the soil.