Applied Geomechanics. Hometask 1

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1 Pre-processing data

Table 1: Input data for this hometask

σ_3, MPa	σ_F, MPa
5	95.33
10	118.53
15	135.16
20	149.13

where

$\sigma_2 = \sigma_3 = P_c$ – confining pressure;

$\sigma_1 - \sigma_3 = P_c$ – differential Stress;

σ_F - differential stress at the moment of sample failure.

By definition we can assume that

$$\sigma_1 = \sigma_F + \sigma_3$$

And according to the lecture material we can calculate the center and the radius of Mohr circle:

$$\text{Center} = \frac{\sigma_1 + \sigma_3}{2}$$

$$\text{Radius} = \frac{\sigma_1 - \sigma_3}{2}$$

And we can calculate this table in Pandas library in Python.

Table 2: Data after the calculations on python

σ_3, MPa	σ_F, MPa	σ_1, MPa	Circle center	Circle radius
5	95.33	100.33	52.665	47.665
10	118.53	128.53	69.265	59.265
15	135.16	150.16	82.580	67.580
20	149.13	169.13	94.565	74.565

Therefore we can calculate Mohr-Coulomb criterion which called "Failure Envolope" according the formula from the lecture:

$$\tau_f = \sigma_n \cdot \tan\phi + c$$

where c - tensile cutoff.
And according this statements, we got this figure as results:

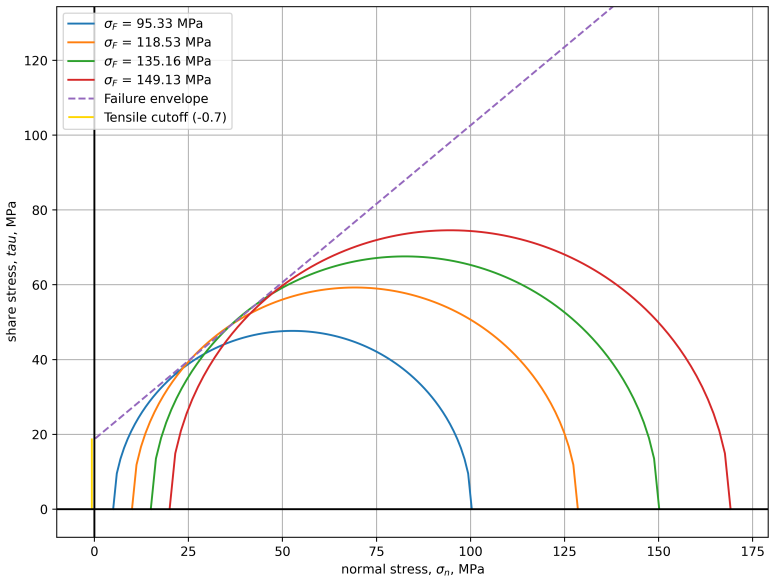

Figure 1: Mohr-Coulomb diagram for 4 samples

2 Answers to Questions

2.1 What is the Slope of Mohr-Coulomb Envelope?

Using visual diagram analysis and brute force way to evaluation two parameters, we find that Failure envelope line.

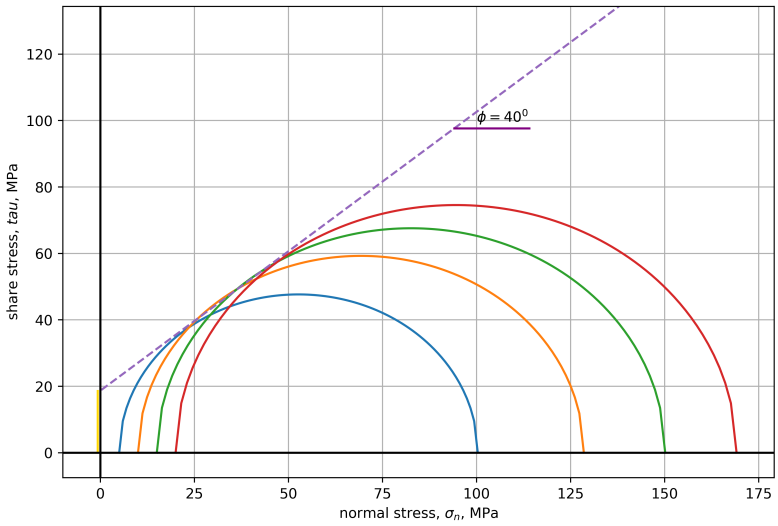

Figure 2: Mohr-Coulomb diagram for 4 samples with labeled *phi*

Slope value equal 40°.
Answer: 40°.

2.2 What is the Intercept of Mohr-Coulomb Envelope?

According to the previous question and the figure 2, we can take value which was used for plotting this Failure envelope line.
Answer: 18.7°.

2.3 What is the inclination of the fault, created in the sample?

We know that teoretically it can be calculated by the next formula:

$$\alpha = 45 + \frac{\phi}{2} = 45 + \frac{40}{2} = 65^{\circ}$$

Answer: 65°.

2.4 Figure 4 represents Mohr-Coloumn failure criterion: true or false?

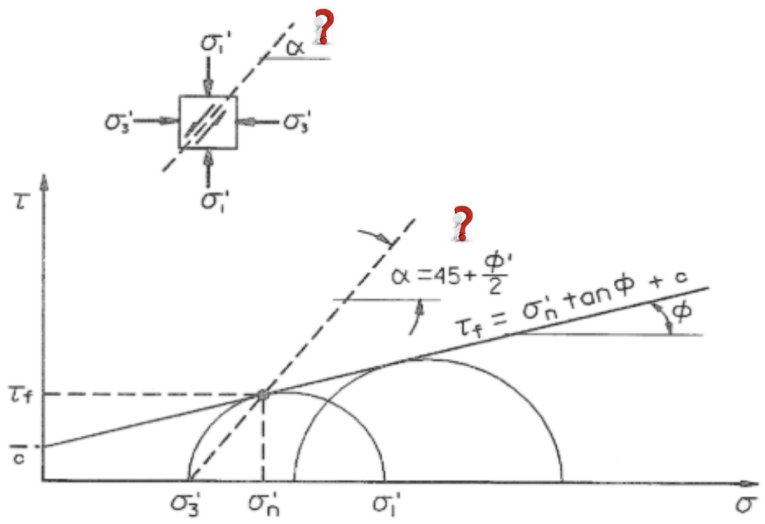

Figure 3: Theoretical diagram, which needs to checked

It is possible to check this statement with simple logic method: we need to plot line from σ_3 to the point of intersection of the Failure envelope line and one of the circles, for example, the last.

For finding intersection point we need to solve simple system of equations:

$$\begin{cases} (x - 99.565)^2 + y^2 = 74.565^2 \\ y = k(x - x_0) + b \end{cases}$$

where x_0 is the point of intersection with the x-axis, i.e. σ_3 for this circle.

And our desired angle will be equal to the arcsine of the angle coefficient of the line.

If we draw a line with an angle of 65 degrees, we get the same picture.

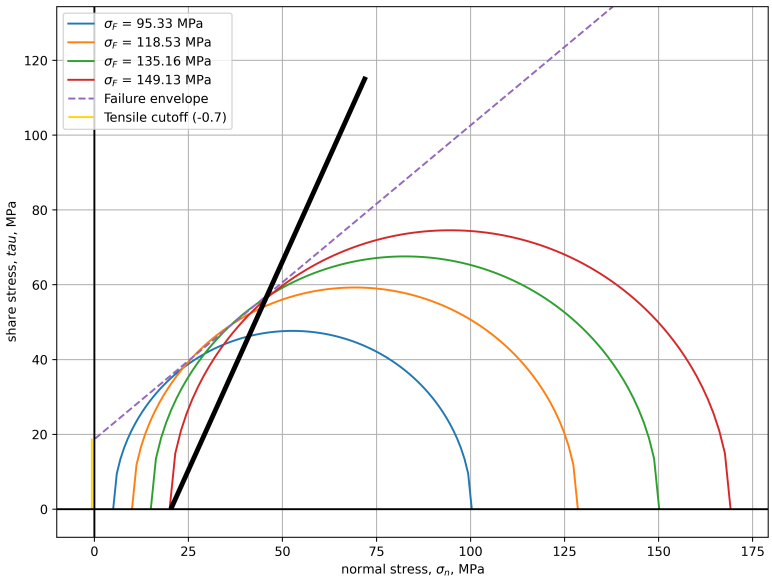

Figure 4: Diagram with checked line

Answer: True.