PROBLEM NO. 2-40 | MECHANICAL ENGINEERING DEPARTMENT | NAME Koul

DATE | SECTION

Given: Fig P2-40

Area $A = 180mm \times 150mm = 0.027 m^2$

$\tau_n \leq 140 MPa$, $\sigma_n \leq 12 MPa$

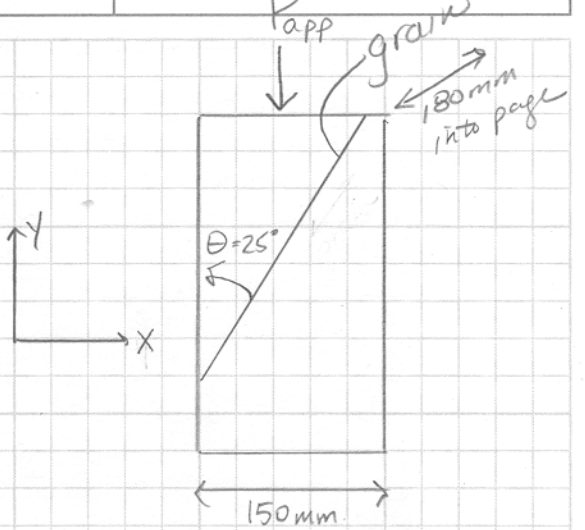
Find:

P

Relationships:

$\sigma_n = \frac{N}{A_N}$

$\tau_n = \frac{V}{A_N}$



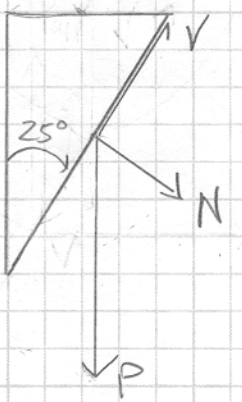
System Sketch or FBD

Solution:

Resolve P into components both ∥ + ⊥ to grain direction to get V and N on that plane

$N = P\cos 65°$

$V = P\cos 25°$



To obtain stress, determine the area of the inclined plane A_n

$A_n = \frac{A}{\cos 65°}$

$\sigma_n = \frac{N}{A_N}$

$12 MPa = \frac{P\cos^2 65}{A}$

$P \leq 98.7 kN$

$\tau_n = \frac{V}{A_N}$

$140 MPa = \frac{P\cos 25° \cos 65°}{A}$

$P \leq 1812 kN$

Therefore P must be limited to ~99 kN

PROBLEM NO. 2-50	MECHANICAL ENGINEERING DEPARTMENT	NAME KOUL
DATE		SECTION

Given: Fig P2-50

$A = 200mm \cdot 100mm = 0.02 m^2$

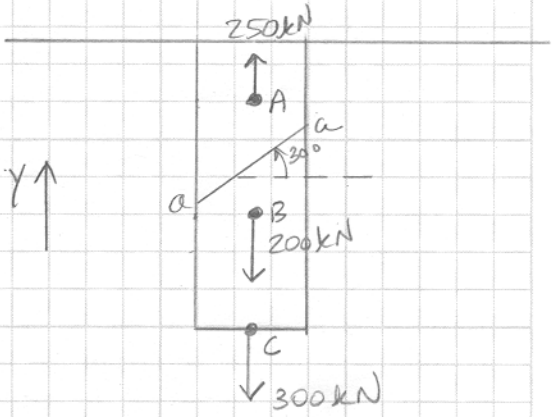
Find: (a) σ_n, τ_n on a-a

(b) σ_{max}, τ_{max} in bar

Relationships:

$\sigma_n = \frac{N}{A_n}$ $\tau_n = \frac{V}{A_n}$

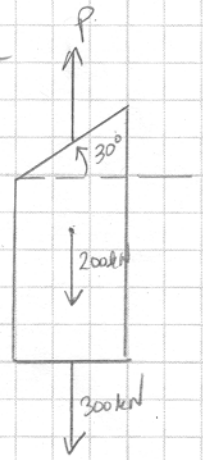
$\Sigma F_y = 0$



System Sketch or FBD

Solution:

Find internal force P at plane a-a



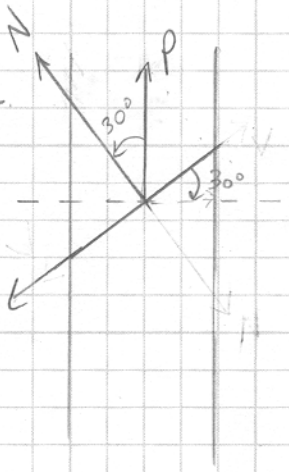
$\Sigma F_y = P - 500 = 0$

$P = 500 kN$

Resolve P into N + V on a-a

$N = P\cos 30°$

$V = P\cos 60°$



Determine area of plane a-a

$A = A_n \cos 30°$

$A_n = \frac{A}{\cos 30°}$

$\sigma_n = \frac{N}{A_n} = \frac{P\cos^2 30}{A}$

$\tau_n = \frac{V}{A_n} = \frac{P\cos 60° \cos 30°}{A}$

$\boxed{\sigma_n = 18.75 MPa}$

$\boxed{\tau_n = 10.80 MPa}$

2-50 (2)

Solution: (b) From Eq. (2-9)

$$\sigma_{max} = \frac{P}{A} = \frac{500}{0.02}$$

$$\boxed{\sigma_{max} = 25 \text{ MPa}}$$

From Eq. (2-10).

$$\tau_{max} = \frac{P}{2A} = \frac{500}{0.04} \quad (= \sigma_{max}/2)$$

$$\boxed{\tau_{max} = 12.5 \text{ MPa}}$$

PROBLEM NO. 2-65	MECHANICAL ENGINEERING DEPARTMENT	NAME KOUL
DATE		SECTION

Given: Fig P2-65

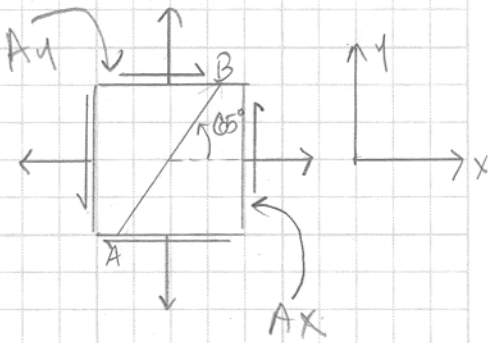
$\sigma_x = 18$ Ksi

$\sigma_y = 6$ Ksi

$\tau_{xy} = \tau_{yx} = 15$ Ksi

The applied loads result in the following plane stress state:

Find: σ_n, τ_n on plane AB



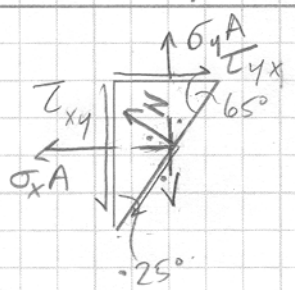
Relationships:

$P = \sigma A$

System Sketch or FBD

Solution:

Determine N, V on plane A-B



$$\Sigma F_n = N + \sigma_y A_y \cos 65° + \sigma_x A_x \cos 25° - \tau_{yx} A_y \cos 25° - \tau_{xy} A_x \cos 65° = 0$$

$$N = -2.536 A_y - 16.314 A_x + 13.595 A_y + 6.339 A_x$$

$$N = 11.059 A_y - 9.975 A_x$$

$$\Sigma F_t = V + \sigma_x A_x \cos 65° - \sigma_y A_y \cos 25° + \tau_{xy} A_x \cos 25° - \tau_{yx} A_y \cos 65° = 0$$

$$V = -7.607 A_x + 5.438 A_y - 13.595 A_x + 6.3393 A_y$$

$$V = -21.202 A_x + 11.777 A_y$$

Determine areas A_x + A_y as a function of AB area A_n

$A_y = A_n \cos 65°$ $\qquad$ $A_x = A_n \cos 25°$

$$\sigma_n = \frac{N}{A_N} = \frac{11.059 \cancel{A_n} \cos 65° - 9.975 \cancel{A_n} \cos 25°}{\cancel{A_n}}$$

$$\boxed{\sigma_n = -4.4 \text{ Ksi (opposite to drawing)}}$$

$$\tau_n = \frac{V}{A_N} = \frac{-21.202 \cancel{A_n} \cos 25° + 11.777 \cancel{A_n} \cos 65°}{\cancel{A_n}}$$

$$\boxed{\tau_n = -14.2 \text{ Ksi (opposite to drawing)}}$$