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ID : 7900

Section: A

Subject: MOS 2

Submitted to: Sir Usama

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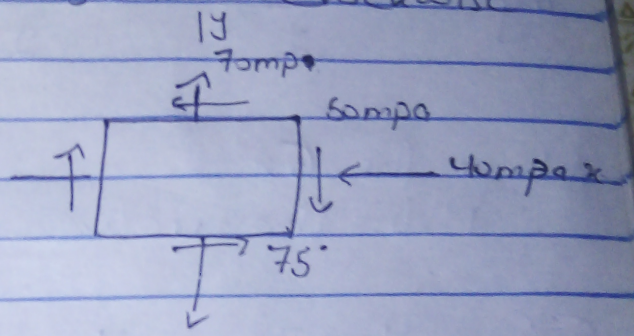
(1)

Question

The state of stress at point is shown by element of a beam shown in fig below

Determine state of stress at point rotated 15° in clockwise direction



Sol:-

Data:-

$\sigma x = -40mpa$

$\sigma y = 70mpa$

$\tau xy = 50 mpa$

Find Stress at point of rotated 15° in clockwise direction.

$\sigma' x = ?$

$\sigma' y = ?$

$\tau' xy = ?$

Now we derived the following Equation

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Equations- (2)

$$\sigma_{x'} = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2} \cos 2\theta + \tau_{xy} \sin 2\theta$$

$$\sigma_{y'} = -\frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2} \cos 2\theta - \tau_{xy} \sin 2\theta$$

$$\tau_{x'y'} = \frac{\sigma_x - \sigma_y}{2} \sin 2\theta + \tau_{xy} \cos 2\theta$$

Now for $\sigma_{x'}$

put the value in equation

$$\sigma_{x'} = \sigma_x + \sigma_y/2 + \sigma_x - \sigma_y/2 \cos 2\theta + \tau_{xy} \sin 2\theta$$

$$\sigma_{x'} = \frac{-40 + 70}{2} + (-40 - 70) \cos 2(-15) + (-50) \sin 2(-15)$$

$$\sigma_{x'} = -7.63 \text{ MPa}$$

Now for $\sigma_{y'}$

putting value in equation

$$\sigma_{y'} = -40 + 70 - (-40 - 70) \cos 2(-15) - (50) \sin 2(-15)$$

$$\sigma_{y'} = 37.63 \text{ MPa}.$$

$$\tau_{x'y'} = -(\sigma_x - \sigma_y) \sin 2\theta + \tau_{xy} \cos 2\theta$$

Put value

$$\tau_{x'y'} = \frac{-(-40 - 70)}{2} \sin 2(15^\circ) + (-50) \cos(-15)$$

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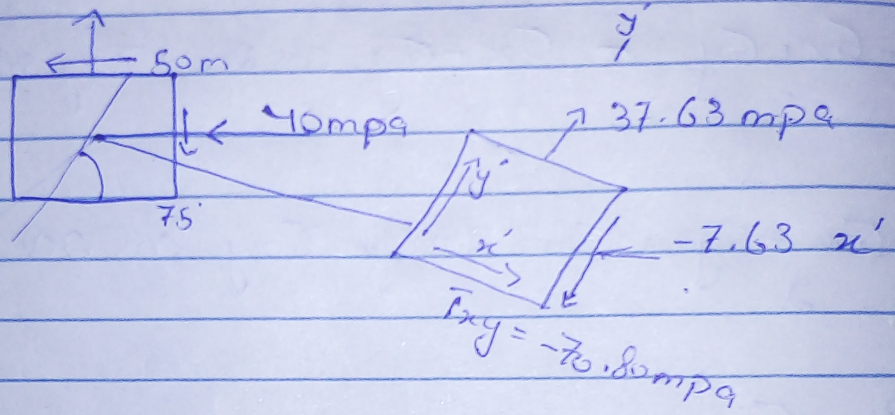
$\tau_{x'y'} = -70.80$ MPa



Ques

sho

(a)

(b)

Sol:-

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Question :- 2

for the element of a beam shown in Q1, find the following

(a) Principal plane and principal stress

(b) Maximum in plane shear stress and shear plane.

Sol:-

First we find principal plane

$$\tan 2\theta = \frac{2\tau_{xy}}{\sigma_x - \sigma_y}$$

$$\tan 2\theta_p = \frac{2(-50)}{-40 - 70}$$

$$\tan * 2\theta_p = 0.9091$$

$$2\theta_{p1} = \tan^{-1}(0.9091) = 42.27$$

$$\theta_{p2} = 21.14^\circ \text{ (for x-axis)}$$

Also

$$2\theta_{p2} = 42.27 + 180$$

$$\theta_{p2} = \frac{222.27}{2} = \theta_{p1} = 111.135 \text{ (for y-axis)}$$

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Now we find principal stress as:

$$\sigma_1 = \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$\sigma_1 = \frac{-40 + 70}{2} + \sqrt{\left(\frac{-40 - 70}{2}\right) + (-50)^2}$$

$$\sigma_1 = 89.33 \text{ Mpa}$$

$$\sigma_2 = \frac{\sigma_x + \sigma_y}{2} - \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right) + (\tau_{xy})^2}$$

$$\sigma_2 = \frac{-40 + 70}{2} \sqrt{\left(\frac{-40 - 70}{2}\right)^2 + (50)^2}$$

$$\sigma_2 = -59.33 \text{ Mpa}$$

we must check which angle goes with Principal stress

$$\sigma_{x1} = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2} \cos 2\theta + \tau_{xy} \sin 2\theta$$

$$\sigma_{x1} = \frac{-40 + 70}{2} + \frac{(-40 - 70)}{2} \cos 2(21.14) + (50) \sin(21.14)$$

$$\sigma_x = 59.33 \text{ Mpa}$$

Hence
$\sigma_1 =$
$\sigma_2 =$

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Hence

$\sigma_1 = 89.33$ Mpa with $\theta_{p1} = 111.135$

$\sigma_2 = -59.33$ Mpa with $\theta_{p2} = 21.14°$

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Part b)

(7)

Given data

The state of stress which are given

$\sigma_x = 40mpa$

$\sigma_y = 70mpa$

$\tau_{xy} = -50mpa$

Required

Maximum In-plane shear stress= ?

Maximum shear plane?

Solution

first we find max in plane shear stress

$$\tau_{max\ in\ plane} = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}}$$

$$= \sqrt{\left(\frac{-40-70}{2}\right)^2 + (50)^2}$$

$\tau_{max\ in\ plane} = 74.3mpa$

$$\tau_{xy1} = \frac{\sigma_x + \sigma_y}{2} = \frac{40+70}{2}$$

$\tau_{xy} = 15$

Now have to find Max Shear plan

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$$\tan 2\theta_s = \frac{(\sigma_x - \sigma_y)/2}{\tau_{xy}}$$

$$= \frac{(40 - 70)/2}{-50}$$

$$\tan 2\theta_s = -1.1$$

$$\theta_s = \frac{1}{2} \tan^{-1}(-1.1)$$

$$\theta_s = -23.90^\circ \text{ Ans.}$$