Review on stress and strain
Review on (Strength of materials)

Types of stress :

1. Normal σ 2. Shear τ

Using Cartesian coordinate $\Rightarrow (x, y, z)$ 3D

Normal			Shear	
σ_x	σ_y	σ_z	τ_{xy}	τ_{yx}
			τ_{yz}	τ_{zy}
			τ_{xz}	τ_{zx}
	(3)		(6)	

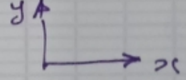
Total (9) stresses to define stress state @ a point

but $\tau_{xy} = \tau_{yx}$, $\tau_{yz} = \tau_{zy}$ & $\tau_{zx} = \tau_{xz}$
due equilibrium

$\therefore$ Only (6) stresses are needed to define stress state @ a point

$\sigma_x , \sigma_y , \sigma_z , \tau_{xy} , \tau_{yz}$ & τ_{zx}

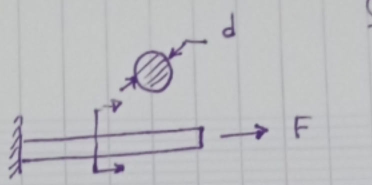
For 2D (neglect Z-direction)



only (3) Stresses needed to be defined :
σ_x , σ_y & τ_{xy}

Important: Similarly strains ϵ_x , ϵ_y & γ_{xy}

Case 1 : Rod under tension



- type of stress : is Normal σ
- direction : choose $y \lfloor \to x$ $\Rightarrow \sigma_x$
- equation : $\sigma_x = \dfrac{F}{A}$ ← force (F) ; ← x - section area (A)

$A = \frac{\pi}{4} d^2$

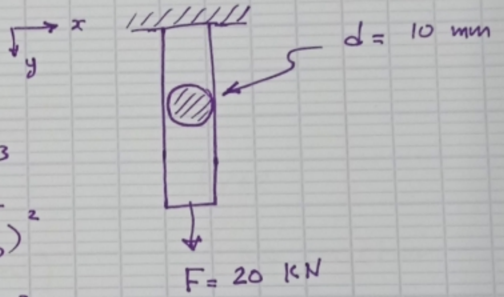
if stress is tensile ⇒ + tive

but if stress is Compressive ⇒ − tive

d : diameter of rod.

Example :

~~Case 2~~



$$\sigma_y = \frac{F}{A} = \frac{20 * 10^3}{\frac{\pi}{4}\left(\frac{10}{1000}\right)^2}$$

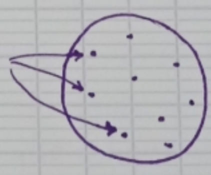
$$= \frac{20 * 10^3}{7.85 * 10^{-5}}$$

$$= 254 \text{ Mpa}$$

لاحظ

في اي نقطة من مساحة المقطع

قيمة الاجهاد هو



$\sigma_y = 254$ Mpa

اي لا تتغير قيمة الاجهاد في نقطة

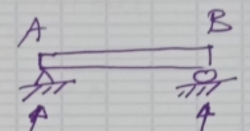
من مساحة المقطع

stress distribution is Uniform

Case (2) Beams

— Any beam should have a Support

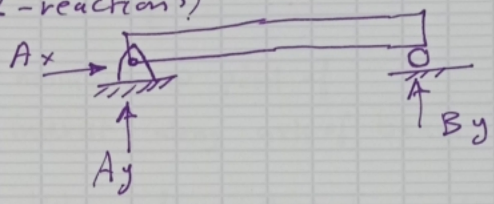
Ex 1



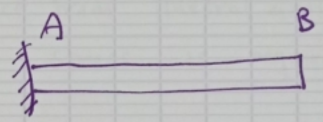
Simply Supported beam

Hinge (2-reactions)

Roller (1-reaction)

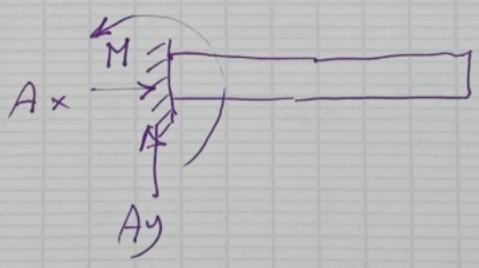


Ex 2



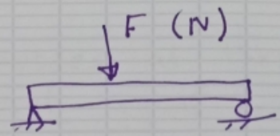
Fixed (3-reactions)

Free — No reaction



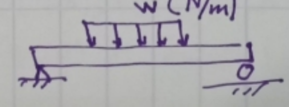
— Any beam should also have a load otherwize No stresses is generated

Ex



Concentrated load

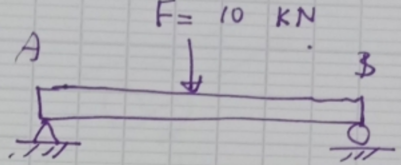
some times Combination of loads.



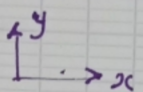
distributed load

Example
Case 2

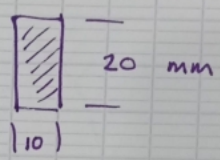
beam under Concentrated load



- type of stress : Normal
- Coordinate :



X-Section is rectangle



- equation :

$$\sigma_x = \frac{My}{I}$$

M: moment @ point of interist along axis of beam

y: distance from Nuetral axis (N.A) to point where stress is required.

I_{NA} : 2nd moment of area around N.A

Also

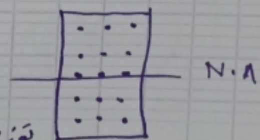
type of stress : Shear

equation :

$$\tau_{xy} = \frac{VQ}{It}$$

V : shear force
Q : 1st moment of area
I : 2nd moment of area
t : beam thickness

IMPortant : stresses at these points is not equal ,



توزيع الاجهادات العمودية من الدرجة الاولى
توزيع الاجهادات القصية من الدرجة الثانية .

Case 3: shaft under torque

- shaft is Circular

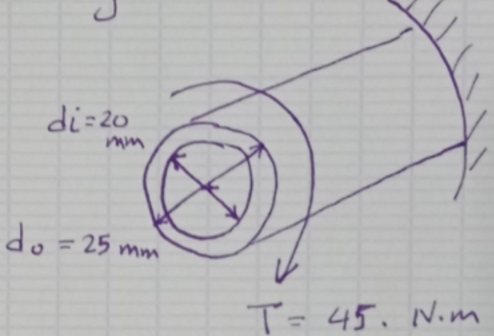
Type of stress : shear only

Equation :

$$\tau = \frac{Tr}{J}$$

Example

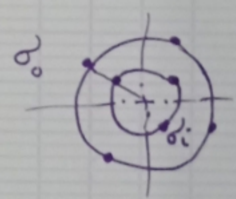
Hollow cylinder under torque



J : polar moment of area $= \frac{\pi}{32}(d_o^4 - d_i^4)$

$$J = \frac{\pi}{32}(25^4 - 20^4) = 22\ 630 \ mm^4$$

- stress at outer radius (25 mm)



$$\sigma_o = \frac{45 * (12.5) \times 10^{-3}}{22\ 630 * 10^{-12}}$$

$$= 24.8 \ Mpa$$

- stress @ inner radius (20 mm)

$$\sigma_i = \frac{45 * (10) * 10^{-3}}{22\ 630 * 10^{-12}}$$

$$= 19.88 \ Mpa$$