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Internal Assessment Test II – Oct 2019

Sub:	Design of Machine Elements-I			Sub Code:	17ME54	Branch:	ME
Date:	15-10-2019	Duration: 90 min	Max Marks: 50	Sem / Sec:	V/A&B		OBE

Answer any TWO FULL questions

Note: Use of Machine Design data hand book is permitted.

		MARKS	CO	RBT
1(a)	Derive an expression for the impact stress due to a direct axial load.	[10]	CO2	L3
1(b)	A beam of 300 mm depth I section is resting on two supports 5 meters apart. It is loaded by a weight 5000N falling through a height ‘h’ and striking the beam at its mid point. Moment of inertia of the section is $9.6*10^7 mm^4$. $E=21*10^4 N/mm^2$. Determine the permissible value of ‘h’, if the stress is limited to 130 N/mm^2.	[15]	CO2	L3
2(a)	Determine the load carrying capacity for a joint welded as shown in fig.2(a). The allowable shear stress in 5mm size weld is 75Mpa.	[15]	CO5	L3

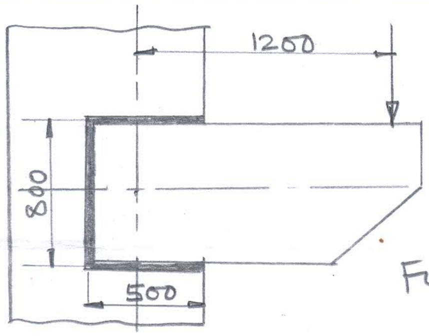


Fig. 2(a)

		MARKS	CO	RBT
2(b)	Determine the size of weld for a joint loaded as shown in fig. 2(b). The allowable stress in the weld is 105MPa.	[10]	CO5	L3

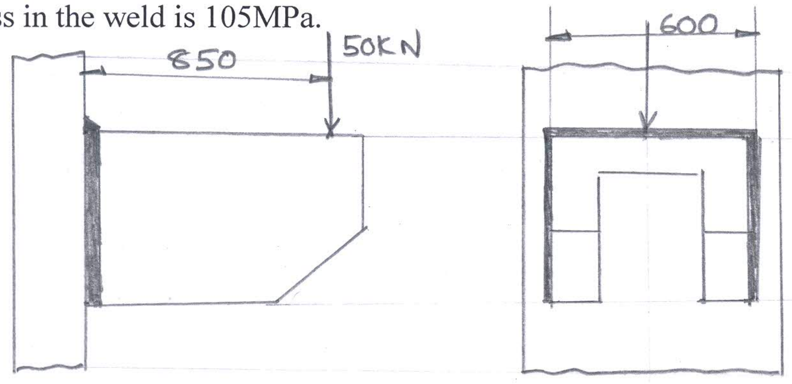


Fig. 2(b)

		MARKS	CO	RBT
3(a)	Derive an expression for the maximum efficiency of a square threaded power screw.	[10]	CO6	L3
3(b)	Refer to the C- clamp as shown in fig. 3(b). It has the following details. Thread type: ISO metric threads Nominal diameter= 12 mm Pitch= 1.75 mm (Single start) Root Diameter= 9.853 mm	[15]	CO6	L3

μ in thread= 0.12
μ in collar= 0.25
Mean collar radius=6 mm
Clamping force= 4500N
Operating force= 100N

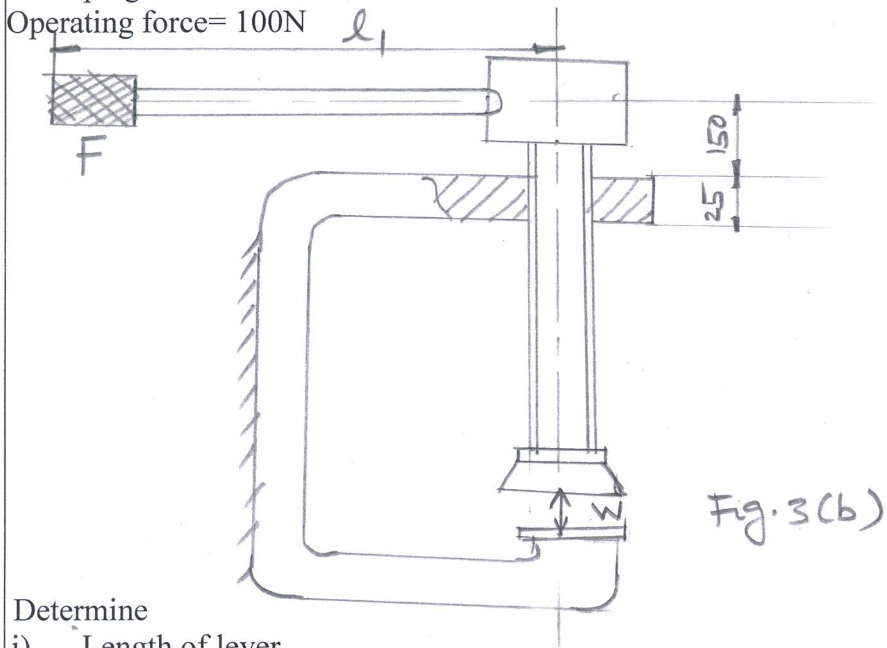


Fig. 3(b)

Determine

i) Length of lever
ii) Max. shear stress in the body of screw and its location
iii) Bearing pressure on the threads of screw.

CI	CCI	HOD

Solutions for IAT-2 (2019-20, odd sem) question paper

Sem : V

Sub : DME I

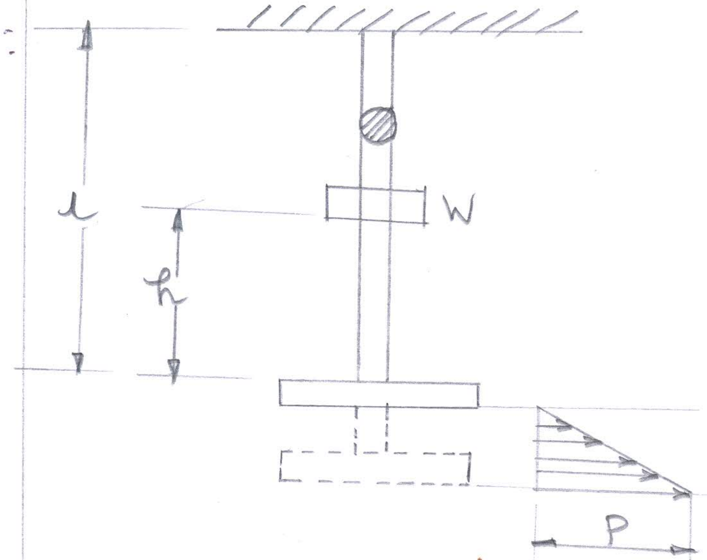
Sub code : 17ME54

Max. Marks : 50

Staff : RPR.

1(a) Derive an expression for impact stress due to a direct axial load.

Ans:



Let W = weight of falling body

A = c/s area of bar.

l = length of bar.

h = height of fall.

δ_{max} = max. instantaneous deformation.

P = static equivalent load.

σ_i = impact stress induced in the bar.

E = Young's modulus of the bar material.

Potential energy of mass = Energy absorbed by bar

P.E of mass = $mg(h + \delta_{max})$

$= W(h + \delta_{max})$ —(1).

Energy absorbed by bar = W.D by the falling body

$= \text{mean load} \times \text{deflection}$

$= \left(\frac{0+P}{2}\right) \times \delta_{max}$

$= \frac{1}{2} P \delta_{max}$ — (2)

here $P = \sigma_i A$ — (3)

$\delta_{max} = \epsilon . l$

$= \frac{\sigma_i}{E} . l$

$= \frac{\sigma_i l}{E}$ — (4)

Sub (3) & (4) in (1) & (2).

$P.E \text{ of mass} = W\left(h + \frac{\sigma_i l}{E}\right)$ — (5)

$\text{Energy absorbed} = \frac{1}{2}(\sigma_i A).\left(\frac{\sigma_i l}{E}\right)$ — (6)

Equating (5) & (6)

$$\frac{\sigma_i^2 A l}{2E} = \frac{\sigma_i W l}{E} + Wh.$$

$$\left(\frac{Al}{2E}\right)\sigma_i^2 - \left(\frac{Wl}{E}\right)\sigma_i - Wh = 0$$

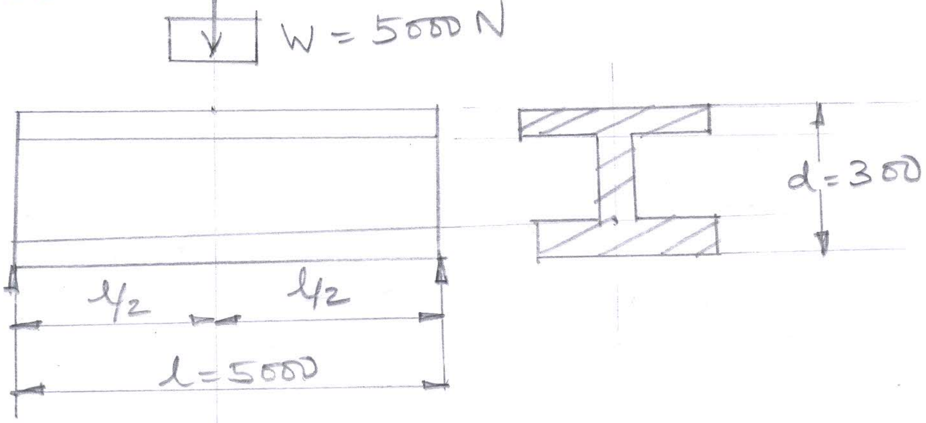
$$\sigma_i = \frac{\frac{Wl}{E} \pm \sqrt{\left(\frac{Wl}{E}\right)^2 - 4\left(\frac{Al}{2E}\right)(-Wh)}}{2\left(\frac{Al}{2E}\right)}$$

$$= \frac{\frac{Wl}{E} + \frac{Wl}{E}\left[\sqrt{1 + 2Ah\left(\frac{E}{Wl}\right)}\right]}{\left(\frac{Al}{E}\right)}$$

$$= \frac{W}{A} \pm \frac{W}{A}\left[\sqrt{1+\frac{2hAE}{Wl}}\right]$$

$$= \frac{W}{A}\left[1+\sqrt{1+\frac{2hAE}{Wl}}\right]$$

1(b) A beam of 300 mm depth I section is resting on two supports 5 metres apart. It is loaded by a weight 5000 N falling through a height 'h' striking the beam at its midpoint. M.I of the section is 9.6×10^7 mm^4. E = 21×10^4 N/mm^2. Determine the permissible value of 'h' if the stress is limited to 130 N/mm^2.



<u>data</u>

$d = 300$ mm

$l = 5000$ mm

$W = 5000$ N.

$I = 9.6 \times 10^7$ mm^4

$E = 21 \times 10^4$ N/mm^2

$\sigma_{bi} = 130$ N/mm^2

<u>to find</u> $h = ?$

$$\sigma_{bi} = (\sigma_b)_{st}\left[1+\sqrt{1+\frac{2h}{\delta_{st}}}\right] \quad -(1)$$

$$(\sigma_b)_{st} = \frac{M_b \cdot c}{I}$$

where $M_b = \frac{Fl}{4}$.

$c = \frac{d}{2}$.

& $I = 9.6\times10^7 \text{ mm}^4$ (given).

$$\therefore (\sigma_b)_{st} = \frac{Fl}{4}\times\frac{d}{2}\times\frac{1}{9.6\times10^7}$$

$$= 9.76 \text{ N/mm}^2$$

$$\delta_{st} = \frac{Wl^3}{48EI} = 0.645 \text{ mm}$$

Sub in (1)

$$130 = 9.76\left[1+\sqrt{1+\frac{2h}{0.645}}\right]$$

$$\Rightarrow h = 48.62 \text{ mm}$$

2(a) Det. the load carrying capacity for a joint welded as shown in fig 2(a). The allws. shear stress in 5mm size weld is 75MPa.

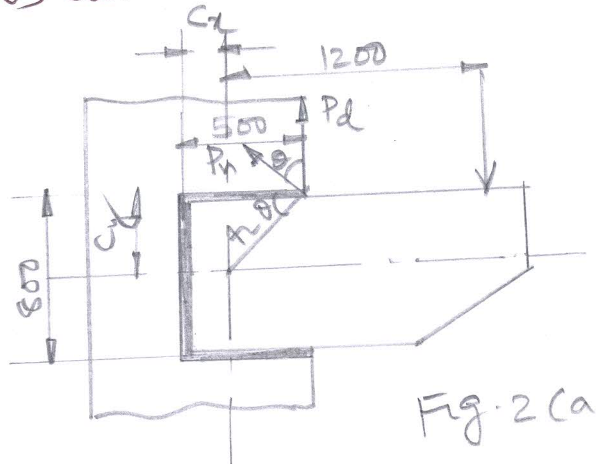


Fig. 2(a)

data

$\omega = 5\,mm$, $b = 500\,mm$

$\tau = 75\,MPa$. $d = 800\,mm$

to find

$P = ?$

1. C.G. of weld configuration

$C_x = 400\,mm$

$$C_y = \frac{b^2}{2b+d} = 139\,mm.$$

2. Direct shear stress (τ_d)

$$\tau_d = \frac{P}{0.707\,w\,l}$$

$$= (1.571 \times 10^{-4}\,P)\ N/mm^2.$$

3. sec. shear stress (τ_n)

$$\tau_n = \frac{M_t \times r}{J} = \frac{(P \times e)\,r}{J_w \times (0.707\,w)}$$

$e = 1200 - C_y$

$= 1061\,mm.$

$$r = \sqrt{(500-139)^2 + 400^2}$$

$= 539\,mm.$

$$J_w = \frac{(2b+d)^3}{12} - \frac{b^2(b+d)^2}{(2b+d)}$$

$= 251.28 \times 10^6\ mm^3.$

$$\Rightarrow \tau_n = (6.43 \times 10^{-4} P)\ N/mm^2.$$

4. Load carrying capacity

$$\tau_{max} = \sqrt{\tau_d^2 + \tau_n^2 + 2\tau_d \tau_n \cos\theta}.$$

$$\cos\theta = \frac{(500-139)}{539}$$

$$= 0.67.$$

$$\therefore \tau_{max} = 7.573 \times 10^{-4} P.$$

ie $75 = 7.573 \times 10^{-4} P$

$$\Rightarrow P = 99.037\ kN.$$

2(b) Det. the size of weld for a joint loaded as shown in fig. 2(b). The allow. stress in the weld is 105 MPa.

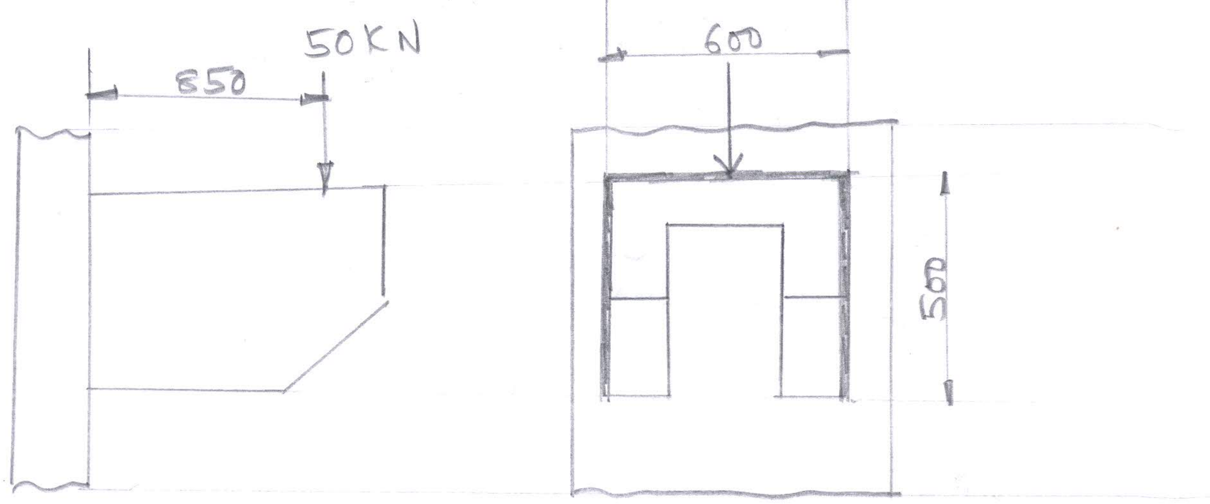


Fig. 2(b)

Ans: data

$b = 600\ mm$

$d = 500\ mm$

$\tau_{max} = 105\ N/mm^2$

to find

$\omega = ?$

1) Direct shear stress (τ_d)

$$\tau_d = \frac{P}{(0.707 w l)}$$

where $l = (2 \times 500) + 600$
$= 1600\ mm$.

$$\tau_d = \frac{50 \times 10^3}{0.707 w \times 1600}$$

$$= \left(\frac{44.2}{w}\right) N/mm^2$$

2) Bending stress due to BM

$$\sigma_b = \frac{Pe}{Z_w (0.707 w)}.$$

where $$Z_w = \frac{d^2(2b+d)}{3(b+d)}.$$
$= 128.78 \times 10^3\ mm^2$.

$$\therefore \sigma_b = \frac{50 \times 10^3 \times 850}{128.78 \times 10^3 \times 0.707 \times w}$$

$$= \left(\frac{466.78}{w}\right) N/mm^2.$$

3) Size of weld

$$\sigma_{max} = \frac{\sigma_b}{2} + \sqrt{\left(\frac{\sigma_b}{2}\right)^2 + \tau^2}$$

$$105 = \frac{466.78}{2w} + \sqrt{\left(\frac{466.78}{2w}\right)^2 + \left(\frac{44.2}{w}\right)^2}$$

$\Rightarrow w = 4.48\ mm$.

Select $w = 4.5\ mm$.

3(a) Derive an expression for the max: effeciency of a square threaded power screw. (8)

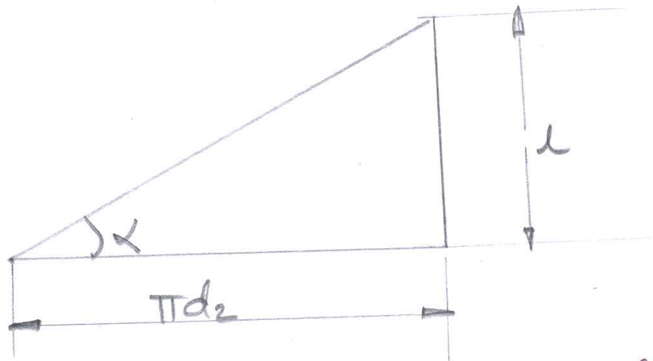


Fig: Development of the thread of a screw.

Fig 3(a)

with reference to fig. 3(a),

The work output for one turn $= Wl$.

The work input for one turn $= P(\pi d_2)$

$$\therefore \text{effeciency} (\eta) = \frac{\text{output work}}{\text{Input work}}$$

$$= \frac{Wl}{\pi d_2} = \frac{W}{P} \cdot \frac{l}{\pi d_2}$$

$$= \frac{W}{P} \tan\alpha.$$

But $P = W \tan(\phi + \alpha)$.

$$\therefore \quad \eta = \frac{\cancel{W} \tan\alpha}{\cancel{W} \tan(\phi+\alpha)}$$

$$= \frac{\sin\alpha / \cos\alpha}{\sin(\phi+\alpha) / \cos(\phi+\alpha)}$$

$$= \frac{\sin\alpha \cdot \cos(\phi+\alpha)}{\cos\alpha \cdot \sin(\phi+\alpha)}$$

$$= \frac{2\sin\alpha \cdot \cos(\phi+\alpha)}{2\cos\alpha \cdot \sin(\phi+\alpha)}$$

$$\Rightarrow \eta = \frac{\sin(\alpha+\alpha+\phi) + \sin(\alpha-(\alpha+\phi))}{\sin(\alpha+\alpha+\phi) - \sin(\alpha-(\alpha+\phi))}$$

$$= \frac{\sin(2\alpha+\phi) + \sin(-\phi)}{\sin(2\alpha+\phi) - \sin(-\phi)}$$

$$= \frac{\sin(2\alpha+\phi) - \sin\phi}{\sin(2\alpha+\phi) + \sin\phi}.$$

The only variable in the above expression is α.

$\therefore$ For η to be maximum, $\sin(2\alpha+\phi)$ should be maximum which is equal to 1.

$$\therefore \eta_{max} = \frac{1 - \sin\phi}{1+\sin\phi}.$$

3(b) Refer to the c-clamp shown in fig. 3(b). It has the following details.

Thread type : ISO metric threads

Nominal diameter = 12 mm.

Pitch = 1.75 mm (single start)

Root diameter = 9.853 mm.

μ in thread = 0.12.

μ in collar = 0.25.

Mean collar radius = 6 mm.

clamping force = 4500 N.

operating force = 100 N.

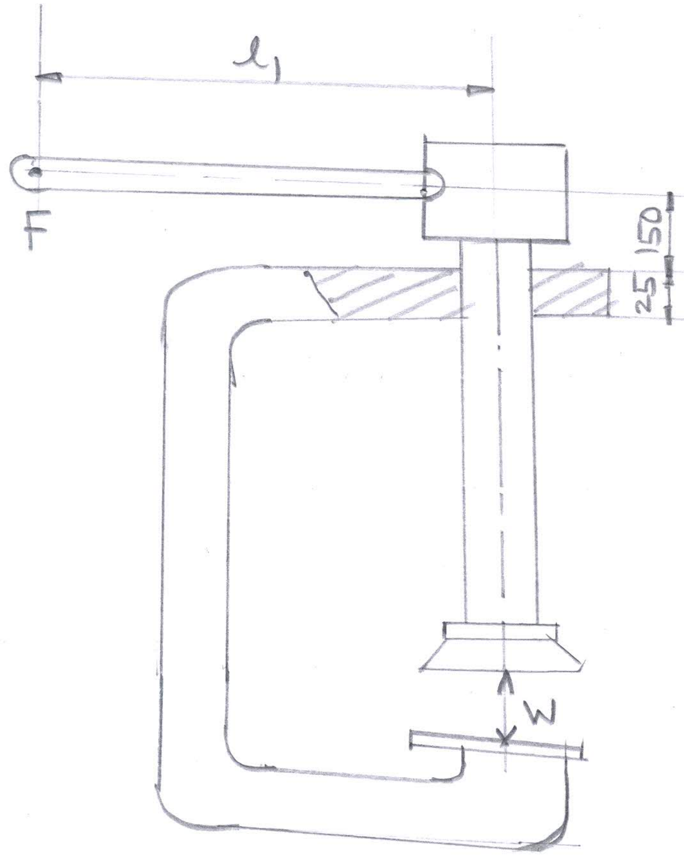


Fig. 3 (b)

Determine

i) length of lever

ii) Max. shear stress in the body of screw and its location

iii) Bearing pressure in the threads of screw.

Ans: data

ISO metric threads

$2\theta = 60^\circ$

$\Rightarrow \theta = 30^\circ$.

$d = 12mm$.

$P = 1.75mm$.

$i = 1$.

$d_1 = 9.853mm$.

$A_1 = 76.25mm^2$.

(11)

$\mu = 0.12$

$\mu_c = 0.25$

$r_c = 6\,mm$

$d_c = 12\,mm$

$W = 4500\,N$

$F = 100\,N$

$l_h = 25\,mm$

<u>to find</u>

1) l

2) τ_{max}