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NAME –

ROLL N –

TEST –

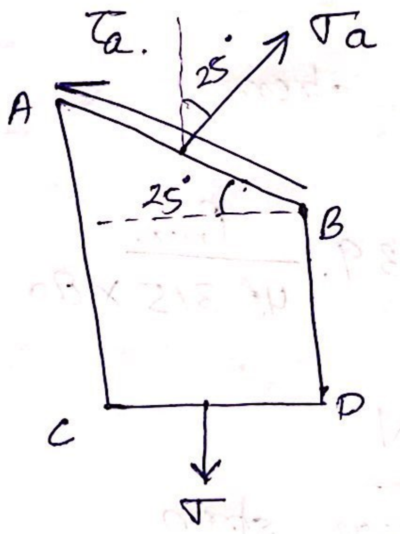
SUB – FULL SYLLABUS

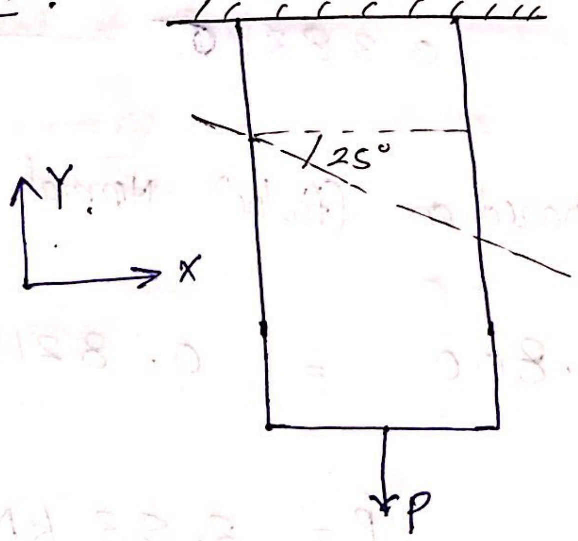
Paper- II

Total marks=234

Q-1 ⓐ

FBD of lower portion.





~~$\sigma = \frac{P}{A} = \frac{P}{50 \times 80}$ —①~~

AB = 50mm

w = 80mm

CD = AB cos25

= 45.315 mm

Balancing force in x-direction

$\sigma_a \, AB \, (\text{width}) \sin 25 - \tau_a \, AB \, (\text{width}) \cos 25 = 0$

$\sigma_a \sin 25 - \tau_a \cos 25 = 0$

$$\frac{\sigma_a}{\tau_a} = 2.1445 \quad —①$$

force balance in Y direction.

$\cos 25 \times \sigma_a \, AB \cdot w + \tau_a \, AB \cdot w \sin 25 = \sigma \cdot CB \cdot w$

$\sigma_a \cos 25 + \tau_a \sin 25 = \sigma \frac{CB}{AB}$

$0.9063 \, \sigma_a + 0.42261 \, \tau_a = 0.9063 \, \sigma$ —②

Solving ① & ②

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$\sigma_a = 0.82139\ \sigma$ —— ①

$\tau_a = 0.38300\ \tau$ —— ②

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① based on (failure) Normal stress

$$0.800 = 0.82139 \cdot \frac{P_{max.}}{45.315 \times 80}$$

$P_{max} = 3.53\ kN$

Good

② failure based on shear stress

$$0.6 = 0.3830 \frac{P_{max}}{45.315 \times 80}$$

$P_{max} = 5.679 kN$

So Max^m centric load $P_{max} = 3.53 kN$

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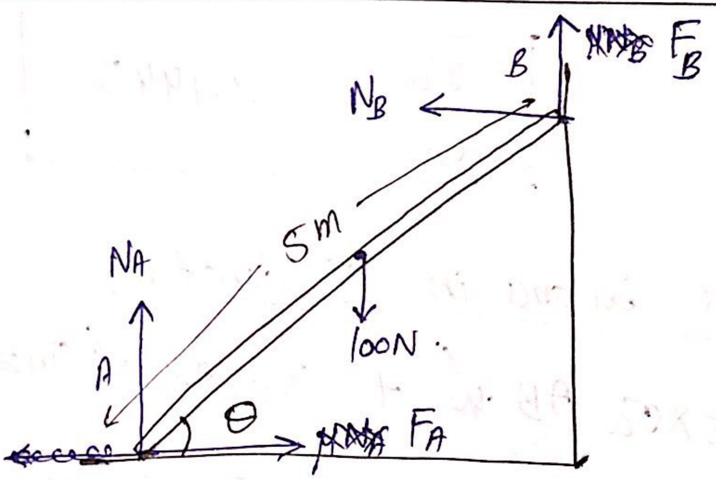
1 (b)

$W = 100 N$.

$\mu = 0.3$

$L = 5m$.



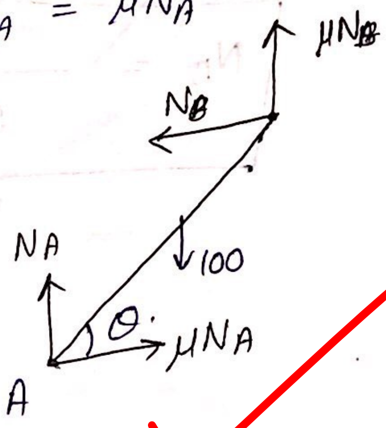
N_A & N_B → Normal force at A & B resp.

~~$\Sigma M_A = 0$~~

For θ_{min} [frictional force will be max^m]

Limiting cond.

$F_B = \mu N_B$ & $F_A = \mu N_A$



$\Sigma F_y = 0$

$100 = \mu N_B + N_A$ — ①

$\Sigma F_x = 0$

$\mu N_A = N_B$ — ②

solving ① & ② taking $\mu = 0.3$

$N_A = 91.743\ N$, $N_B = 27.523\ N$.

$\Sigma M_A = 0$

$100 \times \frac{l}{2} \cos\theta_{min} = 27.523 \times l \sin\theta_{min} + 0.3 \times 27.523 \times l \cos\theta_{min}$

$41.743 \cos\theta_{min} = 27.523 \sin\theta_{min}$

$$\boxed{\theta_{min} = 56.6^\circ}$$

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for $\theta = 45$. using eqn ① & ②

~~$\Sigma M_A = 0$~~

~~$100 \times \frac{l}{2} \cos 45 =$~~

$100 = \mu N_B + \frac{N_B}{\mu}$

$N_B = \frac{100\mu}{1+\mu^2}$

$100 \times \frac{l}{2} \cos 45 = \frac{100\mu}{1+\mu^2} l \sin 45 + \frac{100\mu^2}{1+\mu^2} l \cos 45$

$(1+\mu^2) 50 = 100(\mu^2 + \mu) = 50\mu^2 + 100\mu - 50 = 0$

$\boxed{\mu = 0.4142}$ Ans

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Q-1 (c)

(i) Cycloidal Profile in Cams :-

→ These profile are used for very high speed applications and having minimize the jerk.

→ Cycloidal velocity profile consist of cam having smooth rise and return operation.

Advantages :-

* No impact stresses so it can be used for the high speed applications

* Least Jerk at the cam which avoid the surface stresses at cam profile

Disadvantages.

* the cost of manufacturing of this profile is very high

* It require ~~proper~~ exact dimensioning (lower tolerance).

(ii) Considering the outstroke.

$$x_o = h\left[\frac{\theta}{\theta_o} - \frac{1}{2\pi}\sin\left(\frac{2\pi\theta}{\theta_o}\right)\right]$$

for velocity $\frac{dx_o}{dt} = \frac{dx_o}{d\theta}\cdot\frac{d\theta}{dt}$ ($\frac{d\theta}{dt} \to \omega$)

$$= \omega\frac{dx_o}{d\theta} = \omega \cdot h\left[\frac{1}{\theta_o} - \frac{1}{\theta_o}\cos\left(\frac{2\pi\theta}{\theta_o}\right)\right]$$

$$= \frac{\omega h}{\theta_o}\left[1 - \cos\frac{2\pi\theta}{\theta_o}\right]$$

$$= \frac{\omega h}{\theta_o}\left[2\sin^2\frac{\pi\theta}{\theta_o}\right]$$

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$$V = \frac{2\omega h}{\theta_0}\left[\sin^2 \frac{\pi\theta}{\theta_0}\right]$$

V_{max} @ $\theta = \frac{\theta_0}{2}$

$$V_{max} = \frac{2\omega h}{\theta_0}$$

for Acceleration

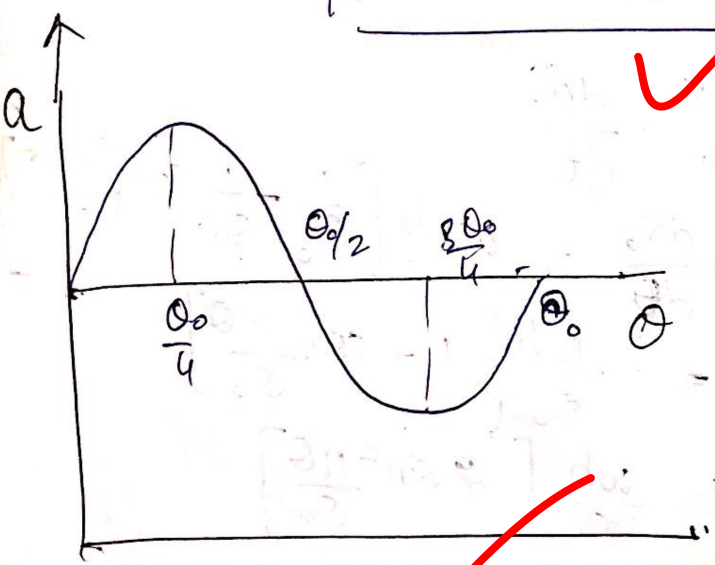
$$a = \frac{dV}{dt} = \frac{dV}{d\theta} \cdot \frac{d\theta}{dt}$$

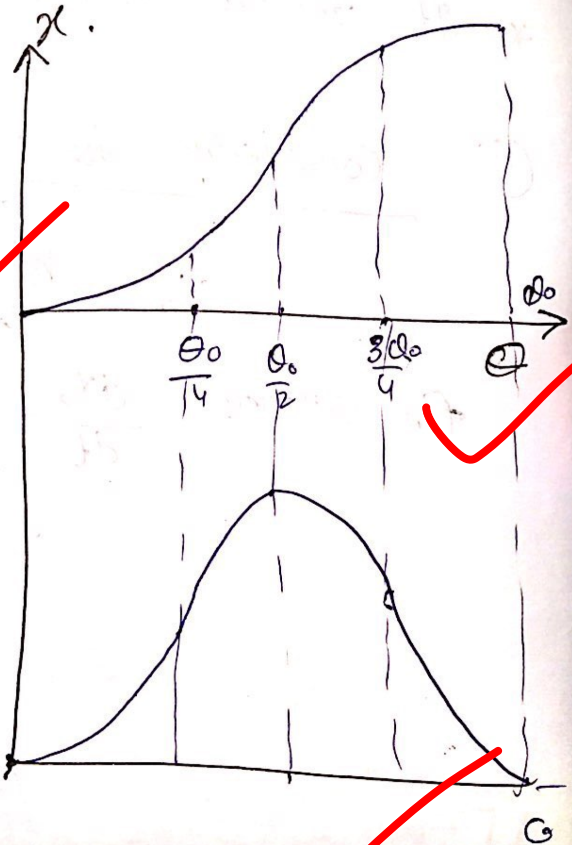
$$= \omega \cdot \frac{2\omega h}{\theta_0}\left[2\sin \frac{\pi\theta}{\theta_0} \cdot \cos\frac{\pi\theta}{\theta_0}\right]\frac{\pi}{\theta_0}$$

$$a = \frac{2\pi\,\omega^2 h}{\theta_0^2}\left[\sin\left(\frac{2\pi\theta}{\theta_0}\right)\right]$$

a_{max} @ $\theta = \theta_0/4$

$$a_{max} = \frac{2\pi\omega^2 h}{\theta_0^2}$$





Q-1 (d)

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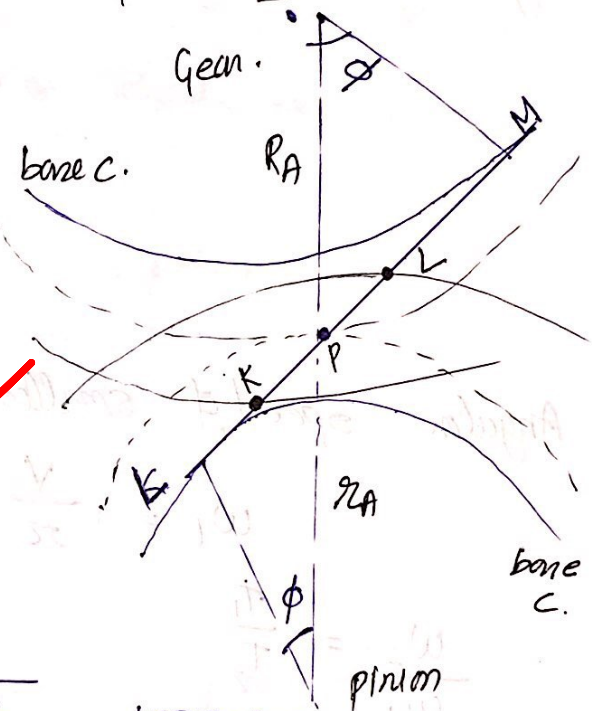
$m = 6.5\ mm$

$t = 19$ $\quad r = \frac{mt}{2} = 61.75mm$

$T = 47$ $\quad R = 152.75mm$

$\phi = 20°$

addendum $= 6.5$ $\quad [A = 1]$



path of Approach (POA)

$= \sqrt{R_A^2 + R^2\cos^2\phi} - R\sin\phi.$

$r_A = 61.75 + 6.5$

$= 68.25\ mm$

$R_A = 159.25\ mm.$

$POA = \sqrt{(159.25)^2 - (152.75)^2\cos^2 20} - 152.75\sin 20$

$= 16.73\ mm.$

Path of recen $= POR = \sqrt{r_A^2 - r^2\cos^2\phi} - r\sin\phi$

$= \sqrt{68.25^2 - 61.75^2\cos^2 20} - 61.75\sin 20$

$= 14.811\ mm$

Path of contact $= POA + POR = 16.73 + 14.811$

$= 31.5411\ mm$

Arc of contact $= \frac{POC}{\cos\phi} = \frac{31.541}{\cos 20} = 34.623\ mm.$

33.56

More variations than acceptable

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Contact Ratio = No of teeth in contact

$= \frac{AOC}{pitch} = \frac{34.629}{\pi \times 6.5}$

$= 1.6958$ 1.64

Angle Turned by Larger wheel $= \frac{AOC}{R}$

$= \frac{34.629}{152.75}$

$= 0.2267$ rad.

$= 12.99°$

Angular speed of smaller wheel ω_1

$\omega_1 = \frac{V}{r} = \frac{1.2}{0.06175} = 19.433$ rad/s.

$\frac{\omega_2}{\omega_1} = \frac{T_1}{T_2}$ $\omega_2 = 7.856$ rad/s

(i) Sliding velocity when engagement start.

$V_{s_1} = (\omega_1 + \omega_2)(K.P)$

$= (19.433 + 7.856)\ 0.01673$

$= 0.4565$ m/s

(ii) When engagement ends.

$V_{s_2} = (\omega_1 + \omega_2)\ PL$

$= (19.433 + 7.856) \times 0.014811$

$= 0.4041$ m/s

(iii) at pitch point $\therefore P = 0$ $V = 0$

Q-1-ⓔ.

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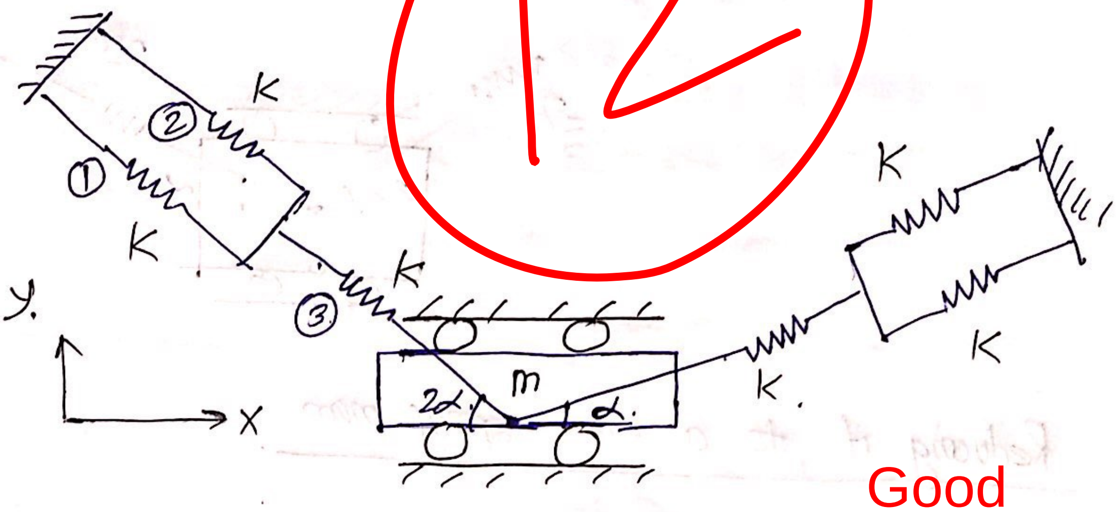

Good

$m = 5\,kg$, $K = 2\ kN/m$.

Calculation of equivalent spring stiffness.

(for) LHS spring system.

Spring 1 & spring 2 are in parallel.

for equv. of ① & ②.

~~$\frac{1}{S_{12}} = \frac{1}{S_1} + \frac{1}{S_2}$~~ $S_{12} = K_1 + K_2$

$K_{12} = S_{12} = K_1 + K_2 = 2K$

& 3 in series

$$\frac{1}{Seq} = \frac{1}{K_{12}} + \frac{1}{K} = \frac{1}{2K} + \frac{1}{K}.$$

$$Seq = \frac{2K}{3}$$

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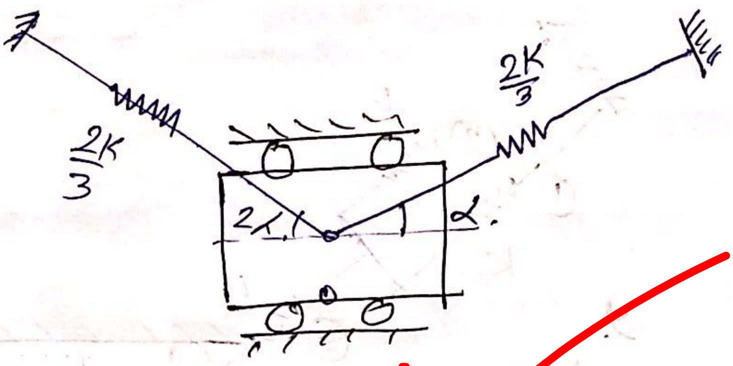
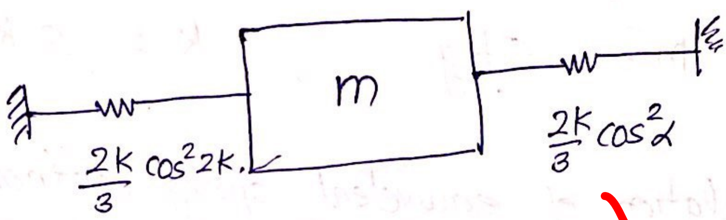
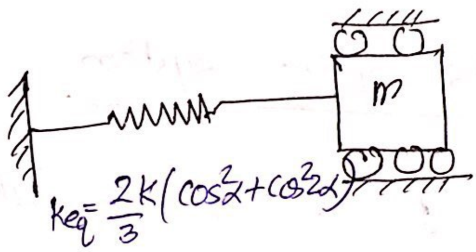
Now equivalent spring system

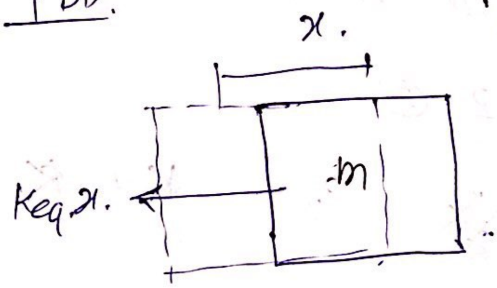


Reducing it to a single spring mass.





FBD.



Applying D'Alemberts law.

$$ma + k_{eq}\, x = 0$$

$$m\ddot{x} + \frac{2K}{3}(\cos^2\alpha + \cos^2 2\alpha)\, x = 0$$ eq^n of motion.

$$\omega_n = \sqrt{\frac{2K}{3m}(\cos^2\alpha + \cos^2 2\alpha)} = \sqrt{\cos^2\alpha + \cos^2 2\alpha} \times 16.33 \text{ rad/s}$$

$$\omega_n = 16.33\sqrt{\cos^2\alpha + \cos^2 2\alpha}$$

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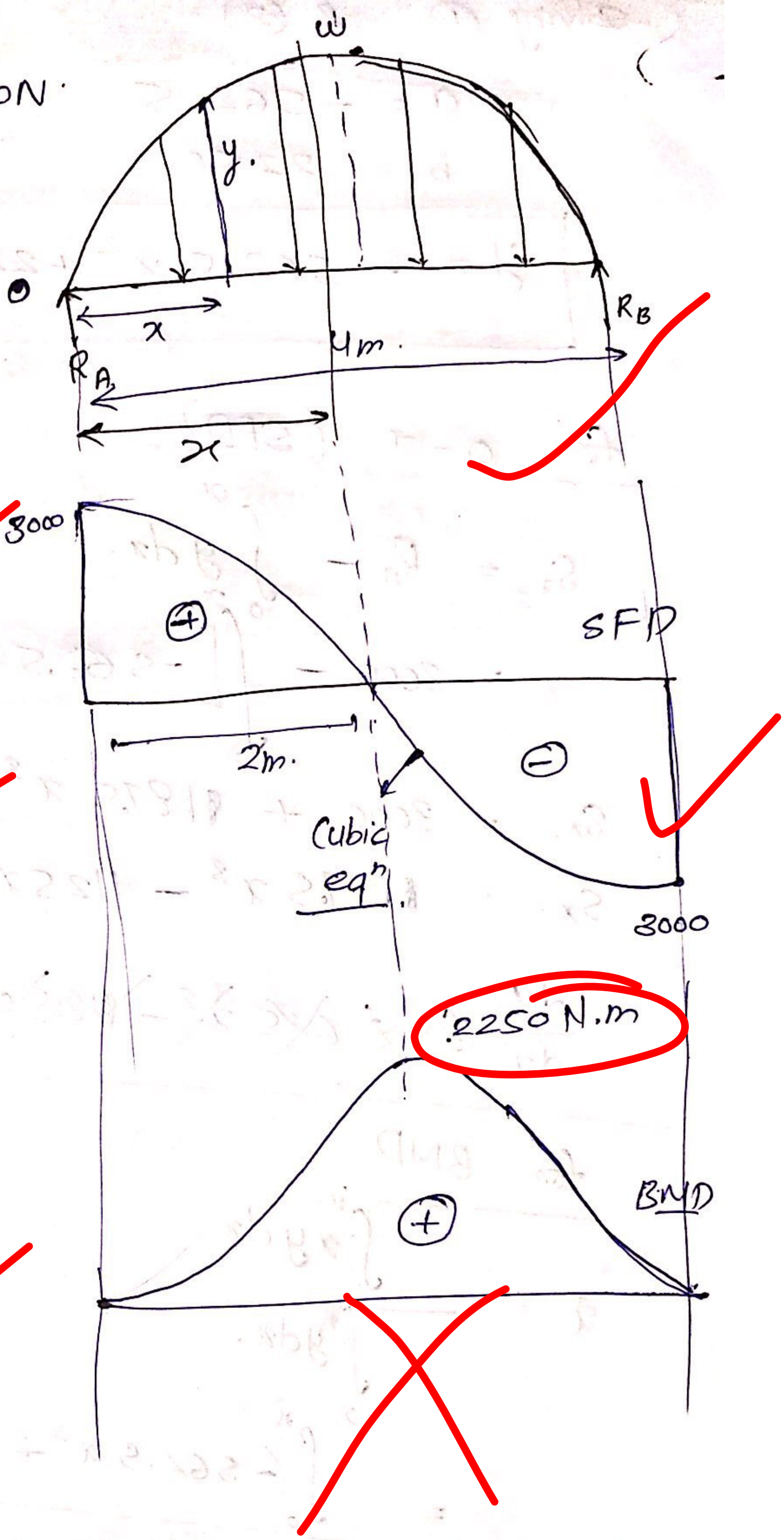
Q-2 (a)

Total load = 6000N

R_A = 3000N
R_B = 3000N
} due to symm. loading



let load intensity

$$y = ax^2 + bx + c$$

(1) at $x = 0$, $y = 0$

$\Rightarrow$ $c = 0$

$$y = ax^2 + bx$$

(2) at $x = 2$, $\frac{dy}{dx} = 0$

$$\frac{dy}{dx} = 2ax + b$$

$$0 = 2a \times 2 + b$$

$$4a + b = 0 \quad \text{— (1)}$$

(3) at $x = 4$, $y = 0$

~~$0 = 16a + 4b$~~

$$\text{Total load} = \int_0^4 y \, dx$$

$$6000 = \int_0^4 (ax^2 + bx)\, dx$$

$$6000 = a\frac{64}{3} + 8b \quad \text{— (2)}$$

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Solving ① & ②

$a = -562.5$

$b = 2250$

$$\boxed{y = -562.5x^2 + 2250x}$$

for 0 − x (SFD)

$$S_x = R_A - \int_0^x y\,dx$$

$$= 3000 - \int_0^x \left[-562.5x^2 + 2250x\right] dx$$

$$S_x = 3000 + 187.5x^3 - 1125x^2$$

$$S_x = 187.5x^3 - 1125x^2 + 3000$$

~~$\frac{dS_x}{dx} = 5.625x^2 - 2250x = 0$~~

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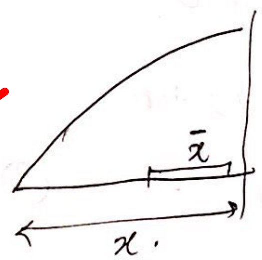
for BMD

$$\bar{x} = \frac{\int_0^x x y\,dx}{\int_0^x y\,dx}$$



$$= \frac{\int_0^x (-562.5x^3 + 2250x^2)\,dx}{\int_0^x (-562.5x^2 + 2250x)\,dx}$$

$$= \frac{-140.625x^4 + 750x^3}{-187.5x^3 + 1125x^2}$$

$$= \frac{-140.625x^2 + 750x}{-187.5x + 1125}$$

$$\bar{x} = \frac{-0.125x^2 + 0.667x}{-0.1666x + 1}$$

$$M_x = R_A \cdot x - \int_0^x (-562.5x^2 + 2250x)\,dx \cdot \bar{x}$$

$$= 3000x + (187.5x^3 - 1125x^2)\left(\frac{-0.125x^2 + 0.667x}{-0.1666x + 1}\right)$$

$$= 3000x + (-1125x^2)\left[-0.125x^2 + 0.667x\right]$$

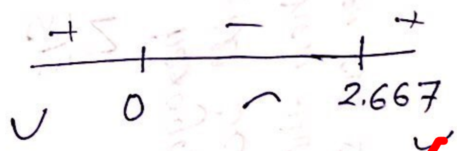
$$M_x = 140.625x^4 - 750x^3 + 3000x$$

468   375

M. max at $x = 2$

$$\frac{dM_x}{dx} = 0 \quad \text{at} \quad x = 2 \qquad M_{max} = 2250 \text{ N.m}$$

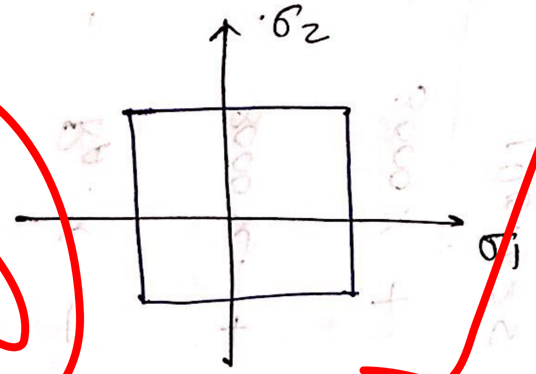
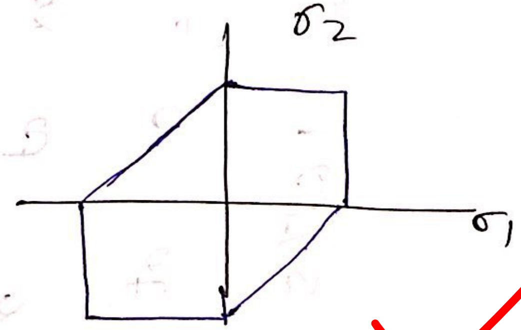
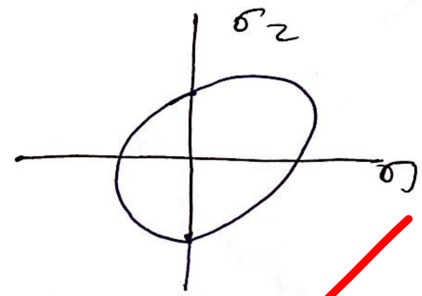
$$\frac{d^2M}{dx^2} = 1687.5x^2 - 4500x.$$



$$M_{x=1} = 140.625 - 750 + 3000$$

Q-2 (b) (i)

MPST :

MPST	MSST	MDET
		
This theory gives good Result for materials which do not yield.	It is a conservative theory used for material which shows yielding	It is the economical theory used for ductile material.
$\sigma_1 \leq \frac{S_{yt}}{N}$	$\frac{(\sigma_1 - \sigma_2)}{2} \leq \frac{S_{ys}}{N}$	$\sqrt{\sigma_1^2 + \sigma_2^2 + \sigma_1\sigma_2} \leq \frac{S_{yt}}{N}$
the Graph will always from a square for various values of σ_1 and σ_2	the Graph is hexagon & design will be more safer when the principle stresses are same in nature.	* It is not applicable for a material which is under the hydrostatic state of stress.

Q-2(b) $\sigma_{yt} = 380\ N/mm^2$

$\sigma_x = 100\ N/mm^2$, $\sigma_y = 40\ N/mm^2$, $\tau_{xy} = 80\ N/mm^2$

① for max^m principal stress theory :-

$$\sigma_{1/2} = \frac{\sigma_x+\sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x-\sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$= 70 \pm \sqrt{(30)^2 + 80^2}$$

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$\sigma_1 = 155.44\ MPa.$

$\sigma_2 = -15.44\ MPa.$

$\sigma_1 \leq \sigma_{yt}$

$155.44 \leq \frac{380}{N}$ $N = 2.444$

as per the MPST the material will not fail.

② Maximum shear stress theory :

$$[\tau_{max}]_{absolute} = Max^m\ of \left[\frac{\sigma_1-\sigma_2}{2}, \frac{\sigma_1}{2}, \frac{\sigma_2}{2}\right]$$

$$= \frac{155.44 + 15.44}{2}$$

$= 85.44\ MPa.$

$\tau_{ys} = \frac{S_{ys}}{2} = \frac{380}{2} = 190$

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$$85.44 = \frac{190}{N}$$

$$\boxed{N = 2.2237}$$

design is safe.

③ Max^m Distortion Energy theory :

$$\sigma_1^2 + \sigma_2^2 - \sigma_1 \sigma_2 \leq \left(\frac{S_{yt}}{N}\right)^2$$

$$155.44^2 + 15.44^2 + 155.44 \times 15.44 \leq \left(\frac{380}{N}\right)^2$$

$$\boxed{N = 2.3212}$$

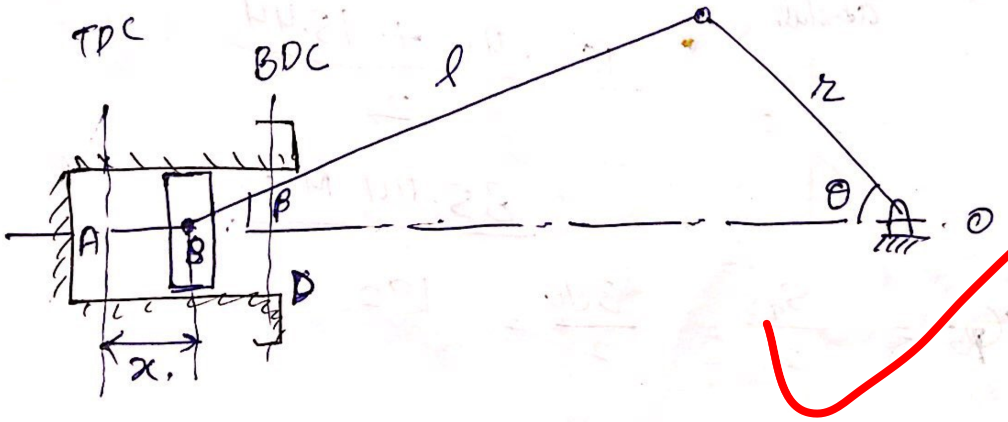
$$\boxed{N_{MSST} > N_{DET} > N_{MSST}}$$

2 (c) $r = 50mm = 0.05m$

C.R length $l = 175mm = 0.175m$

$N = 400 rpm$

$n = \frac{l}{r}$



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from the given figure shown.

displacement $x = OA - OB$

$OA = l + r$

$OB = r\cos\theta + l\cos\beta$

$x = l + r - l\cos\beta - r\cos\theta$ ——— ①

$\sin\beta = \frac{\sin\theta}{n}$

$\cos\beta = \sqrt{1 - \sin^2\beta} = \frac{\sqrt{n^2 - \sin^2\theta}}{n}$

putting in eqⁿ ①

$x = l + r - \frac{l\sqrt{n^2 - \sin^2\theta}}{n} - r\cos\theta$

$$x = r\left[(1-\cos\theta) + \left(n - \sqrt{n^2 - \sin^2\theta}\right)\right]$$

Velocity $= \frac{dx}{dt} = \frac{dx}{d\theta}\cdot\frac{d\theta}{dt} = \omega\frac{dx}{d\theta}$

$= \omega r\left[\sin\theta - \frac{-2\sin\theta\cdot\cos\theta}{2\sqrt{n^2 - \sin^2\theta}}\right]$

$$V = \omega r\left[\sin\theta + \frac{\sin 2\theta}{2\sqrt{n^2 - \sin^2\theta}}\right]$$

assuming $n^2 - \sin^2\theta \longrightarrow n^2$

Acceleration $a = \frac{dv}{dt} = \frac{dv}{d\theta}\cdot\frac{d\theta}{dt} = \omega\frac{dv}{d\theta}$

$= \omega^2 r\left[\cos\theta + \frac{2\cos 2\theta}{2n}\right]$

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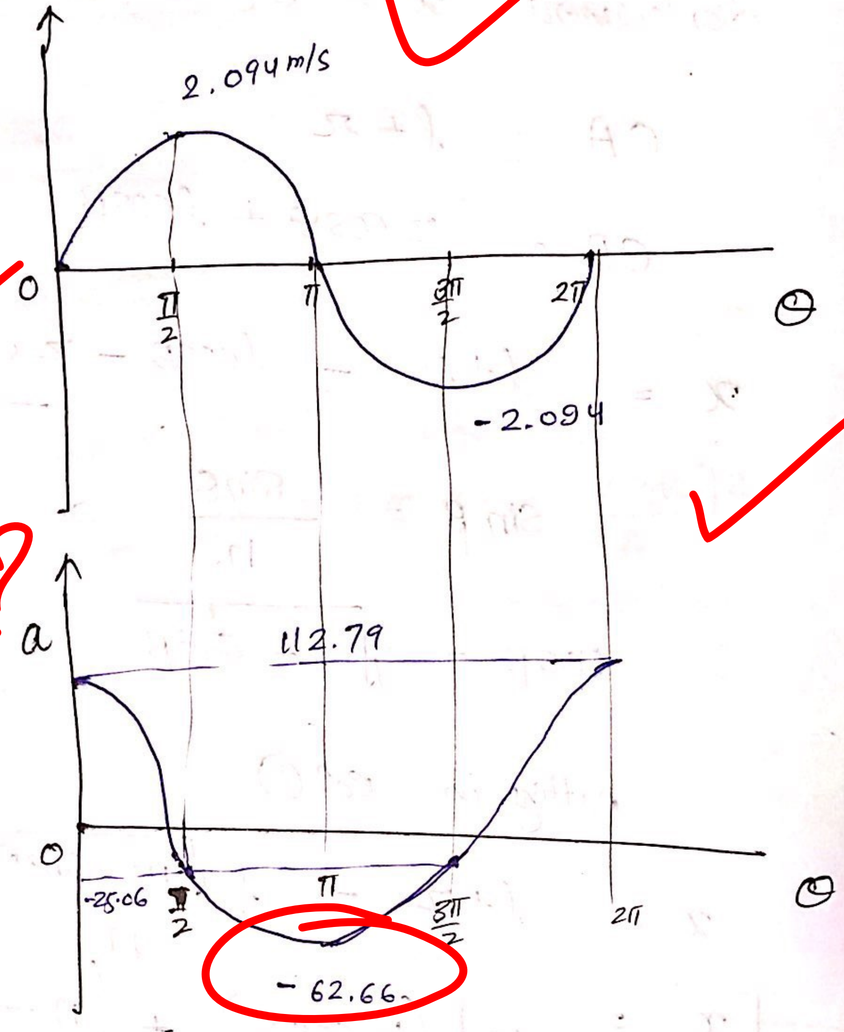
$$a = \omega^2 r \left[\cos\theta + \frac{\cos 2\theta}{n} \right]$$



$V_{at\,\theta=0} = 0$

$V_{at\,\theta=\frac{\pi}{2}} = \omega r$

$= \frac{400\pi}{30} \times 0.05$?

$V_{at\,\theta=\pi} = 0$

$(a_{x=0})_{max} = \omega^2 r \left[1 + \frac{1}{n} \right]$

$= 112.79\ m/s^2$

$n = \frac{175}{50}$

$= 3.5$

$a_{\theta=\frac{\pi}{2}} = -25.06\ m/s^2$

$a_{\theta=\pi} = -62.66\ m/s^2$

$a_{\theta=\frac{3\pi}{2}} = -25.06\ m/s^2$

$a_{2\pi} = 112.79\ m/s^2$

for acceleration to be zero

$$\cos\theta + \frac{\cos 2\theta}{n} = 0$$

$$\cos\theta + \frac{2\cos^2\theta - 1}{3.5} = 0$$

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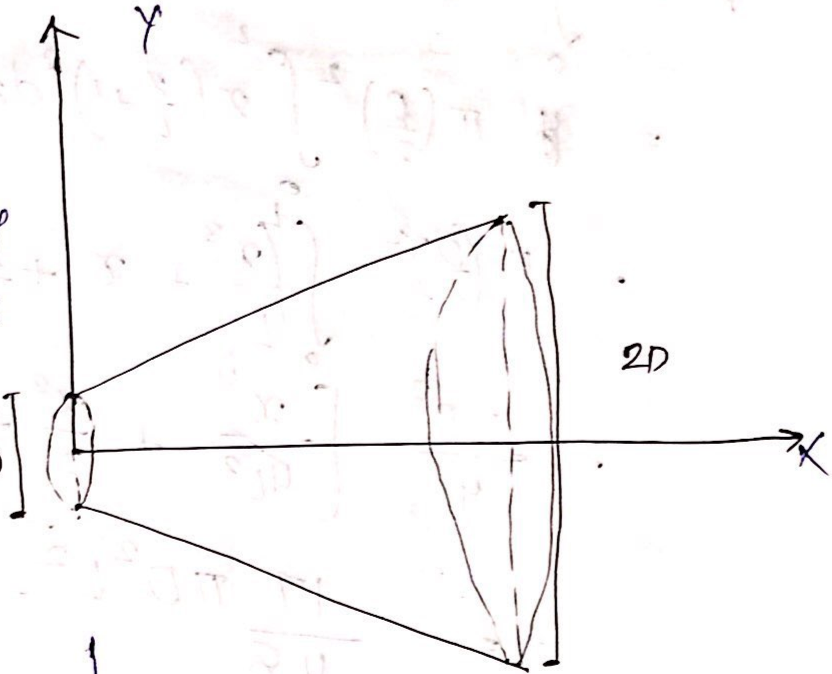
$$2\cos^2\theta + 3.5\cos\theta - 1 = 0$$

$$\cos\theta = \frac{1}{4} \quad , \quad \cos\theta = -2 \ \times$$

$$\boxed{\theta = 75.52^\circ} \ , \ \boxed{284.47^\circ} \quad \text{Ans}$$

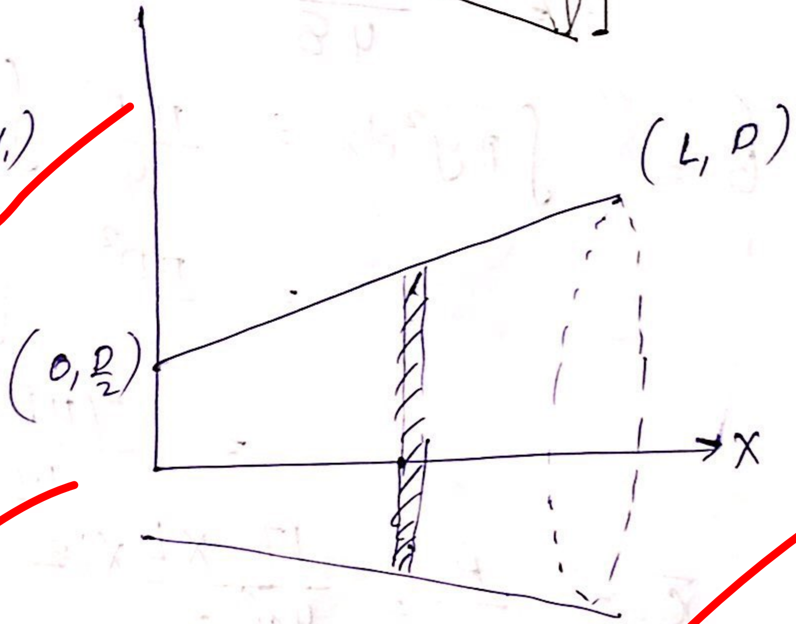
Q - 4(a)

This shape can be Generated by revolving a line about X Axis.



For the eq^n of line.

$$y - y_1 = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1)$$



$$y - \frac{D}{2} = \frac{D/2}{L}(x)$$

$$\boxed{y = \frac{D}{2}\left[\frac{x}{L} + 1\right]}$$

↳ eq^n of line.

if this line Revolves about X-Axis

$$\bar{x} = \frac{\int \pi y^2 . x \, dx = A}{\int \pi y^2 \, dx = B.}$$ Let

$$A = \int_0^L \pi y^2 x . dx.$$

$$= \pi \left(\frac{D}{2}\right)^2 \int_0^L x \left(\frac{x}{L}+1\right)^2 dx.$$

$$= \pi \left(\frac{D}{2}\right)^2 \int_0^L \left(\frac{x^3}{L^2} + x + \frac{2x^2}{L}\right) dx.$$

$$= \frac{\pi D^2}{4} \left[\frac{x^4}{4L^2} + \frac{x^2}{2} + \frac{2x^3}{3L}\right]_0^L$$

$$= \frac{17}{48} \pi D^2 L^2$$

$$B = \int \pi y^2 dx = \frac{\pi D^2}{4} \int_0^L \left(1+\frac{x}{L}\right)^2 dx.$$

$$= \frac{\pi D^2}{4} \left[x + \frac{x^3}{3L^2} + \frac{x^2}{L}\right]_0^L$$

$$= \frac{7\pi D^2 L}{12}$$

$$\bar{x} = \frac{A}{B} = \frac{17 \times L \times 12}{48 \times 7} = \frac{17}{28} L$$ Ans

$$\bar{x} = 0.6071 L$$

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Q-4 (b)

$P = 7.5\ kW$
@ 360 rpm

$D_1 = 250\ mm$

$D_2 = 500\ mm$

$M_1 = 10\ kg$

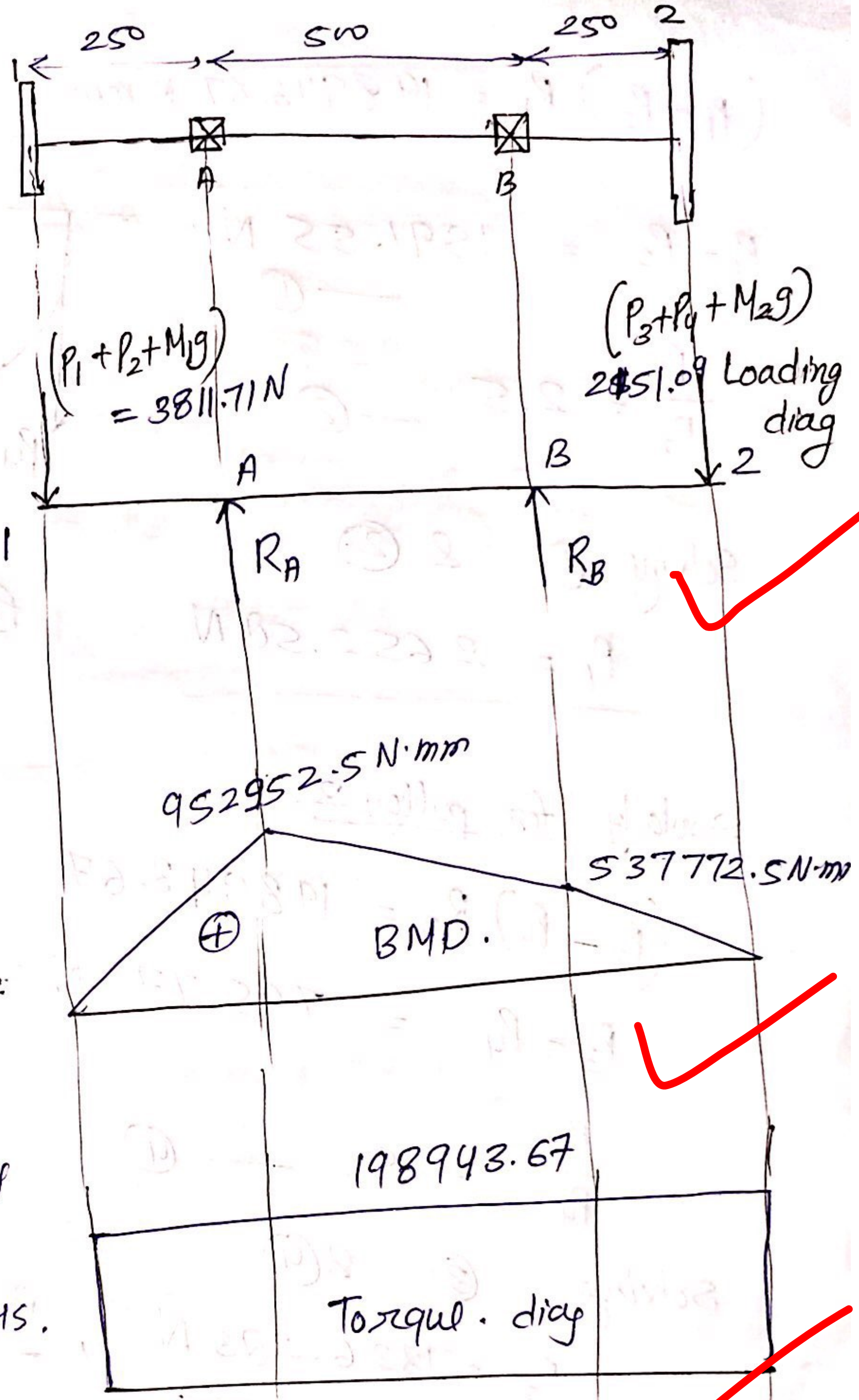
$M_2 = 30\ kg$

$\sigma_{yt} = 380$

$FOS = 3$

$\theta = 0.5°$

$G = 79300\ N/mm^2$



Assuming shaft rotating in ACW direction when viewed from LHS.

$$T_1 = \frac{P}{\omega} = \frac{7.5\times10^6}{\frac{2\pi\times360}{60}}$$

$$= 198943.67\ N\cdot mm.$$

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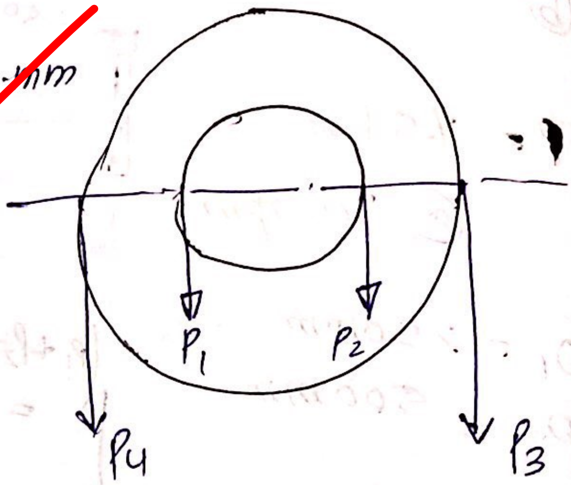
$(P_1 - P_2) R_1 = 198943.67$ N-mm



$P_1 - P_2 = 1591.55$ N — ①

$\frac{P_1}{P_2} = 2.5$ — ②

Solving ① & ②

$P_1 = 2652.58$ N $P_2 = 1061.03$ N

Similarly for pulley 2.

$(P_3 - P_4) R_2 = 198943.67$

$P_3 - P_4 = 795.77$ N — ③

$\frac{P_3}{P_4} = 2.5$ — ④

Solving ③ & ④

$P_3 = 1326.283$ N , $P_4 = 530.51$ N

Total force at 1

$F_1 = P_1 + P_2 + M_1 g = 2652.58 + 1061.03 + 10 \times 9.81$

$= 3811.71$ N.

$F_2 = P_3 + P_4 + M_2 g = 1326.283 + 530.51 + 30 \times 9.81$

$= 2151.09$ N.

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$R_A + R_B = F_1 + F_2$

$R_A + R_B = 3811.71 + 2151.09$

$R_A + R_B = 5962.8 N$

$\Sigma M_A = 0$

$F_1 \times 2500 + R_B \times 500 = F_2 \times 750$

$3811.71 \times 250 + R_B \times 500 = 2151.09 \times 750$

$R_B = 1320.78 N$

$R_A = 4642.02 N$

~~Bending Moment~~ Usig Rigidity Criterion

$\theta_{max} = \frac{TL}{GJ}$

$\frac{0.5 \times \pi}{180} = \frac{198943.67 \times 1000}{79300 \times \frac{\pi}{32} d^4}$

$d = 41.366 \text{ mm}$

Selecting shaft diameter → next higher number in the series of 5.

$d = 45 mm$

Bending Moment at critical crossection (at A)

$M = 952952.5 \text{ N.mm}$

$T = 198943.67 \text{ N-mm}$

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Using MDET.

$$M_e = \sqrt{M^2 + \frac{3}{4} T^2}$$

$$= \sqrt{952952.5^2 + \frac{3}{4} \times 198943.67^2}$$

$$= 968401.98 \text{ N·mm}$$

$$\sigma_{induced} = \frac{32 M_e}{\pi d^3} = \frac{32 \times 968401.98}{\pi \times 45^3}$$

$$= 108.247 \text{ N}$$

$$\sigma_{per} = \frac{380}{3} = 126.66 \text{ N}.$$

$$\boxed{\sigma_{induced} < \sigma_{per}}$$

Hence design is safe.

$$\boxed{d = 45 \text{mm}}$$

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Q-4 ©

$M = 250\ kg$

piston mass $m_p = 3.75\ kg$

stroke $L = 150\ mm$

crank. Rad. $r = L/2 = 75mm$

Transmitted load $(F_T)_{max} = 500N$

$N = 750\ rpm$

$\omega = \frac{750 \times 2\pi}{60} = 78.54\ rad/s$

unbalance force due to recip mass

$(F_0)_{max} = m r \omega^2$

$= 3.75 \times 0.075 \times (78.54)^2$

$= 1734.9\ N$

as per question.

$$\frac{F_T}{F_0} = \frac{1}{\sqrt{(1-\gamma^2)^2}}, \quad \gamma = \frac{\omega}{\omega_n}$$

$\xi = 0$

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$$\frac{500}{1734.9} = \frac{1}{\pm(1-\gamma^2)}$$

$$\gamma^2 - 1 = \frac{1734.9}{500}$$

$\gamma^2 = 3.47 + 1$

$\boxed{\gamma = 2.114}$

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$$2.114 = \frac{\omega}{\omega_n} = \frac{78.54}{\omega_n}$$

$$\boxed{\omega_n = 37.1523 \text{ rad/s}}$$

$$37.1523 = \sqrt{\frac{s}{250}}$$

stiffness $s = 345.073$ kN/m

(i) at $N = 800$ rpm

$\omega = 83.775$ rad/s.

$$F_0 = m r \omega^2 = 3.75 \times 0.075 \times 83.775^2$$

$$= 1973.88.$$

Amplitude $A = \dfrac{F_0/s}{\left(\frac{\omega}{\omega_n}\right)^2 - 1} = \dfrac{\frac{1973.88}{345.073}}{\left(\frac{83.775}{37.1523}\right)^2 - 1}$

$$\boxed{A = 1.4 \text{ mm}}$$

(ii) below 750 rpm

$$\frac{500}{3.75 \times 0.075\, \omega^2} = \frac{1}{1 - \left(\frac{\omega}{37.1523}\right)^2}$$

by solving $\omega = 27.875$ rad/s.

$$\boxed{N = 266.18 \text{ rpm}}$$

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Q-5 (a)

Function of Flux Coating

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① **Deoxidisers.**

flux coating may work as deoxidisers & prevent the oxidisation.

Eg: Graphite, Silicon, ferro silicon. etc.

② **Arc stabalizers**

Arc stabalisers are added in the flux coating which help to stablise arc and high speeds and at different ~~at~~ ~~dir~~ orientation of welding

Eg: Ferrous oxide, silicon oxide, potacium silicate etc.

③ **Slag forming Agents.**

these are added to the flux coating & they form slag & prevent molten metal to come in contact with atmospheric gases.

Eg: ferrous oxide, Titanium oxide, CaF_2 etc.

④ **Alloying element.**

Some time allowing element is added in the coating they inhances the quality of weld, small ~~ie~~ amount of alloy impurity can strengthen the welded joint

Eg: Ni, Cr, Co.

⑤ **Gas forming Compounds**

Gas forming compounds are added that converts into gas & protect weld pool.

Eg Cellulose, $CaCO_3$.

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Q-5 (b)

① Titanium Alloys.

→ Titanium alloys having very good strength and having approximately half weight compared to Iron so they are used widely

→ their carbides are used in cutting tool material Tic having 3100 VHN hardness.

Limitation

- Machinability of Titanium & its alloys are very poor

→ costly.

Application

- Used in Aircrafts

→ cutting tool material.

② Refractory Materials

- Refractory materials are those, which can withstand at elevated Temperature.

→ they do not lose their Mechanical properties at the elevated Temp.

Eg: Al_2O_3, Graphite.

Limitations.

Every material have certain Temp beyond which they can't withstand

Application:

→ Used in furnance lining

→ Crucibles. (Annanio)

→ Metal casting dies.

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Super Alloys :

these are Generally Ni based Alloy in which more than 10% Alloying is done to inhance the properties at different working conditions

Eg: Monel, Nimonic, Invar.

Limitations :

* They are costly compared to other Alloys
* more alloy contect can cause more distortion within Material.

Applications

bike muffler, Turbine blades.

Noble Metals

Metal which possess Ideal behaviour are called Noble metals ____ ?

---

5 (c) $h = d$

$25 \times 25 \times 5 \ cm^3$

$a = 0.1, \ b = 0.03, \ c = 1$

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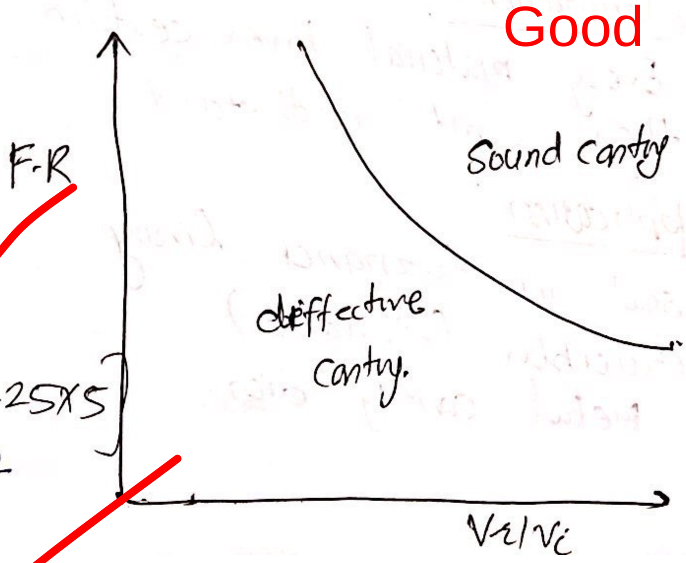
Good

$$F.R = \frac{(A/V)_{casting}}{(A/V)_{r}}$$



For Casting.

$A = 2[25 \times 25 + 25 \times 5 + 25 \times 5]$

$= 1750 \ cm^2$

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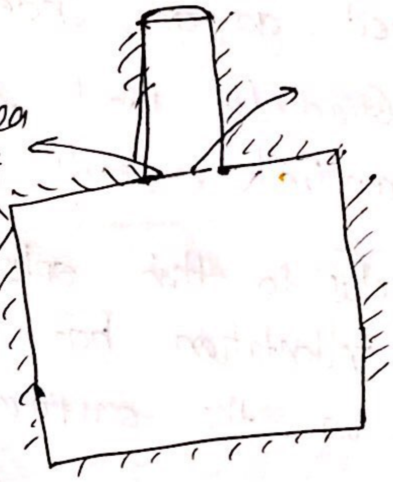
$$V = 25 \times 25 \times 5 = 3125 \text{ cm}^2$$

$$(A/V)_c = \frac{1750}{3125} = \frac{14}{25}$$

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

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

$$= \frac{5\pi}{4} d^2$$



$$V = \frac{\pi}{4} d^2 . h = \frac{\pi}{4} d^3$$

$$\frac{A}{V} = \frac{5 \frac{\pi}{4} d^2}{\frac{\pi}{4} d^3} = \frac{5}{d.}$$

$$x = F.R = \frac{\frac{14}{25}}{\frac{5}{d.}} = \frac{14d}{125}$$

$$\frac{V_r}{V_c} = \frac{\frac{\pi}{4} d^3}{3125} = \frac{\pi d^3}{12500}$$

$$X = \frac{a}{y-b} + c$$

$$\frac{14d}{125} = \frac{0.1}{\frac{\pi d^3}{12500} - 0.03} + 1$$

$$\boxed{d = 11.478 \text{ cm} \quad \therefore = h}$$

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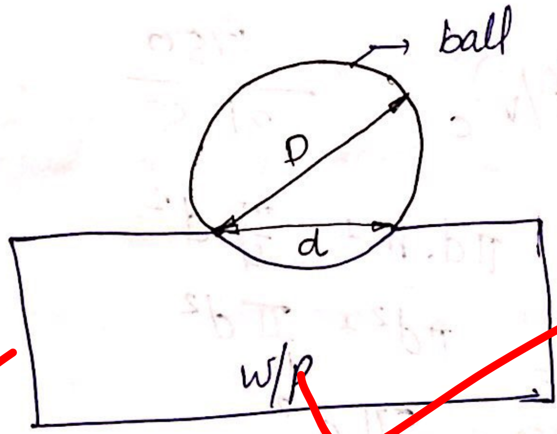
Q-5 (e)

Brinell Hardness Test :



- It consist of a ball used as an Indentor
- Gradially load is applied on ball Indentor.
- due to this spherical Indentation has been occured on the surface of WP.
- by measuring the dimension of Indentation BHN No is calculated.

P → force applied on indentor (kgf)

D → diam. of ball (2mm, 5mm, 10mm)

d → Indented diameter.

t → time of application of load (20-30 sec)

$$BHN = \frac{P}{\frac{\pi D}{2}\left[D - \sqrt{D^2 - d^2}\right]}$$

D = 10mm. d = 1.62mm.

P = 500 kgf

$$BHN = \frac{500}{\frac{\pi \times 10}{2}\left[10 - \sqrt{10^2 - 1.62^2}\right]}$$

BHN = 240.97 HB.

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6 (a)

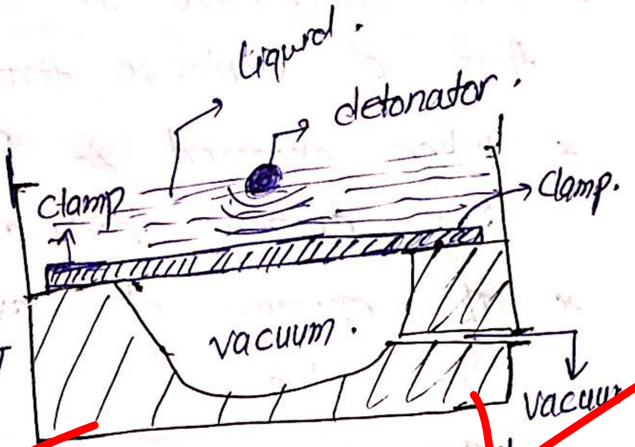
① Explosive forming.

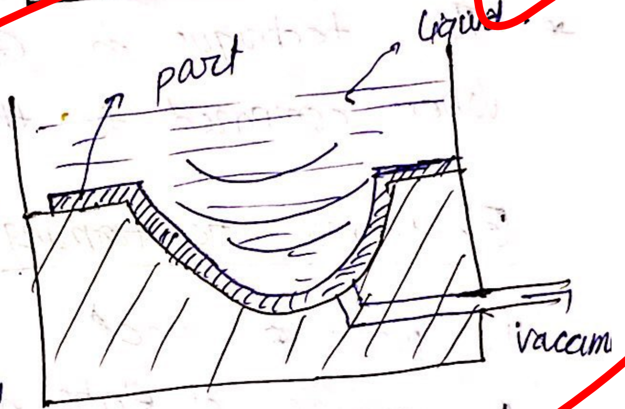
* Shockwave is Generated in a water medium by explosive

* with the use of ~~EA~~ TNT or dynamite this explosive wave is Generated.

* this high energy shock wave force the work piece to form into die.

* vacuum pump ~~for~~ provided to ease of forming can be done.





* this Technique is used for thick sections

* these parts are Generally used in Aircrafts.

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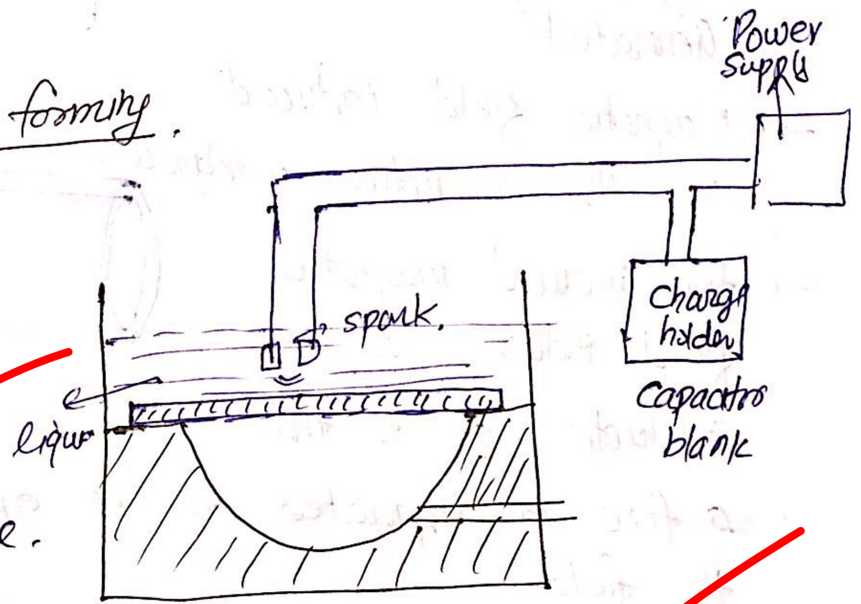
② Electrohydraulic forming.

* In Electrohydraulic forming the charge is Generated b/w the electrods

* due to this charge.



Please see solution for better figures

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high energy shock wave is produced.

* this shockwave is Generally consist less power than that of Explosive forming

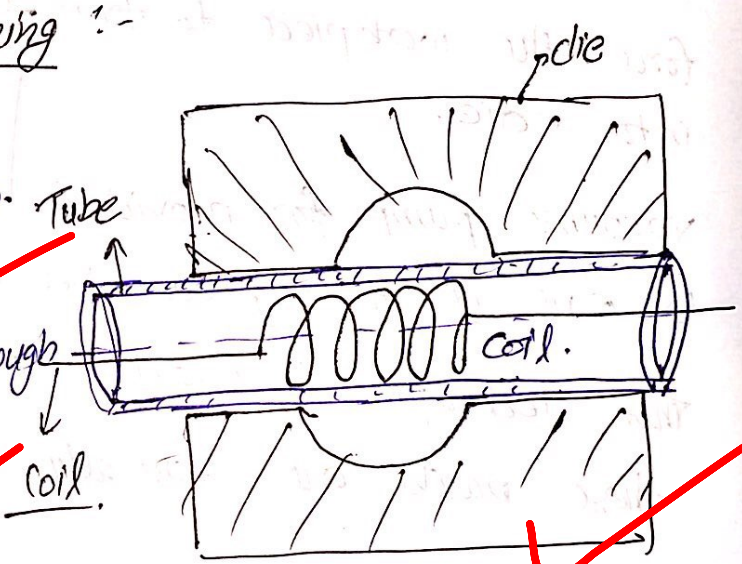
* When charged is Released from the charge blank High energy shockwave is Generated.

* This energy shockwave force workpiece to form into die

* This technique is Generally used for small parts when compared to that of explosive forming.

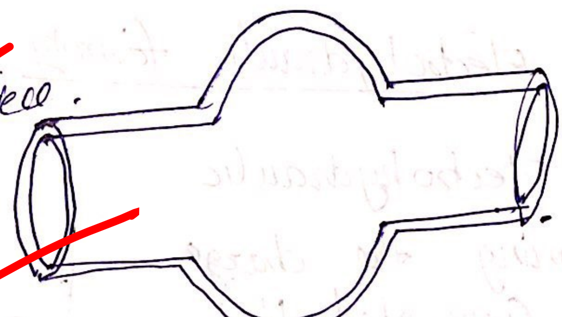
Electromagnetic forming :-

– this process used the principle of electro-Magnetic force



→ Current is passed through coil. due to this Magnetic field is Generated

→ Magnetic field induced in the conductive workpiece.



→ this induced magnetic field induce current on conductor. due to this a force is Generated in the opposite direction of the field

* this force Lead to formation of the w/p

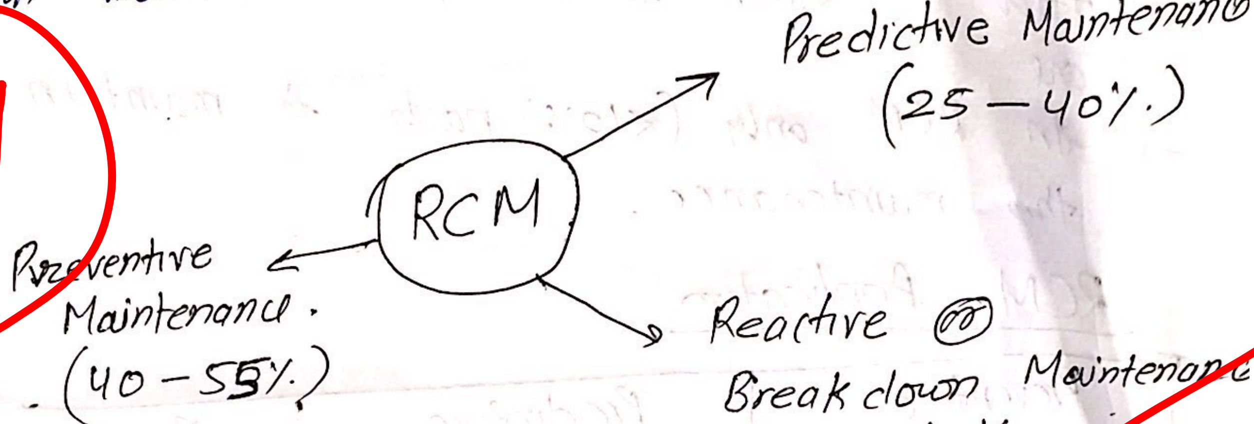
* Material (w/p) should be conductive for Electromagnetic forming.

Q-6(b)

Reliability centred Maintenance

→ Reliability Centred Maintenance is used to determine the requrement of ~~an~~ maintenance of any physical system.

→ this maintenance is based on preventive maintenance.



① Preventive Maintenance

→ Preventive maintenance consist of Routine maintenance or scheduled maintenance.
→ Maintenance is done after fixed period of time
→ It may sometime leads to occur unneeded Maintenance
→ for a physical system in Reliability centred Maintenance about 40–55% of the components consist of this type of Maintenance.

② Predictive maintenance

→ the life of certain physical equipment is predicted and maintenance is done based on that.
→ It is having less cost, since failure is predicted means no extra unneeded maintenance are required.
→ this is done for critical component
→ It is done 25–40% of physical system in RCM.

Reactive or Breakdown Maintenance

- Reactive ~~or~~ breakdown maintenance is done for Non critical parts in physical system
- In this type of maintenance ~~uses~~ the component is used until it gets failure
→ After the failure it is replaced by the new one
→ In RCM only (<10%) parts is maintain by this maintenance.

Primary principal missing ?

RCM Application

Preventive	Predictive	Reactive
- done for equipment subjected to Gradual wear. → done for the system whose failure is pattern is known → No catastrophic failure.	→ Equipment with Random failure → Critical equipment → these are not subjected to wear → Some time they can ~~can~~ cause catastrophic failure.	→ done for very small No of product → Non critical product. → equipment are unlikely to fail → small parts

Please refer solution

Advantages

→ It is one of most efficient maintenance Technique
→ It reduces the unnecessary maintenance
→ Increase the reliability of physical system
→ Minimizing complete checkup time.

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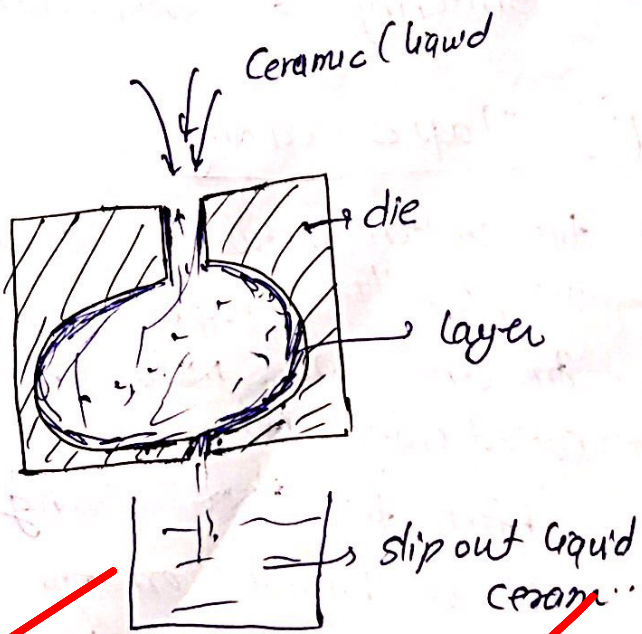
6 (c)

① **Sintering :**

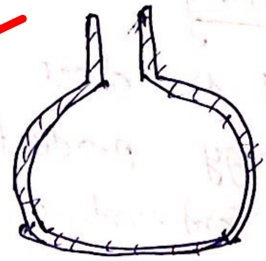
- Sintering is done after the compaction of the powder mettalurgy product.
- → the Temperature of the compacted powder metallurgy product is increase upto $\frac{3}{4}$ times ~~th~~ of its melting Temperature.
- → due to this particles fuse together & diffusion is taken place.
- → Recrystalization occurs and grain growth is also take place.
- → After the sintering approximately 90 - 95% of density is achieved
- → strength increase, hardness increases, brittleness decrease
- → porosity ~~&~~ decrease. & Toughness increase of the product.

② **Slip casting :**



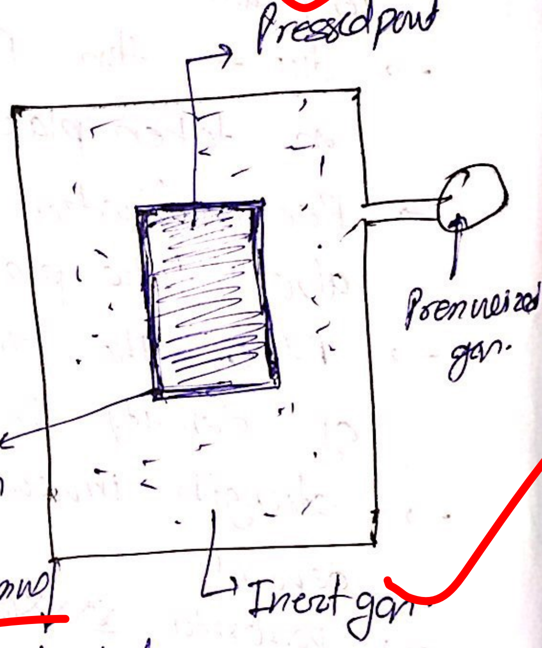
- this Technique is used for making complex shape of potteries
- → Liquid ceramic added to the die & it flow ~~layer~~ & slip over the die & a layer is produced.

extra fluid is gone above from below opening & this layer is now taken out & used as a end product.



③ Hot isostatic Pressing

~~the ceramic part powder~~
Sintered part



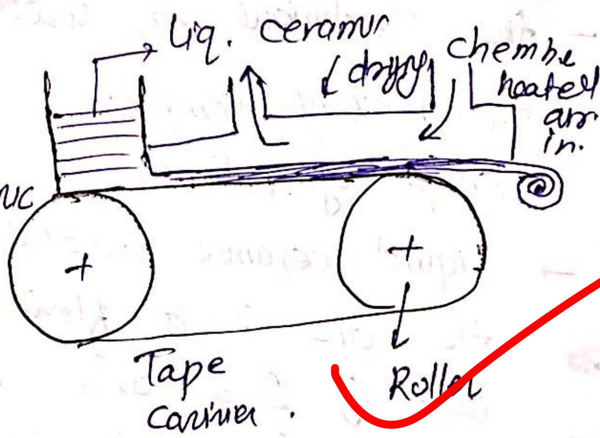
→ the metal is kept under steel can

→ high Temp & pressure is applied

→ Inert gas (Eg. Argon) apply pressure on can

→ Sintering & compaction is done simultaneously.

④ Tape casting



- the molten metal is carried away by the Tape carrier

→ In drier zone, ~~metal~~ ceramic cooled using Air.

* After the drying it is bundled on the Roller so it can be used.