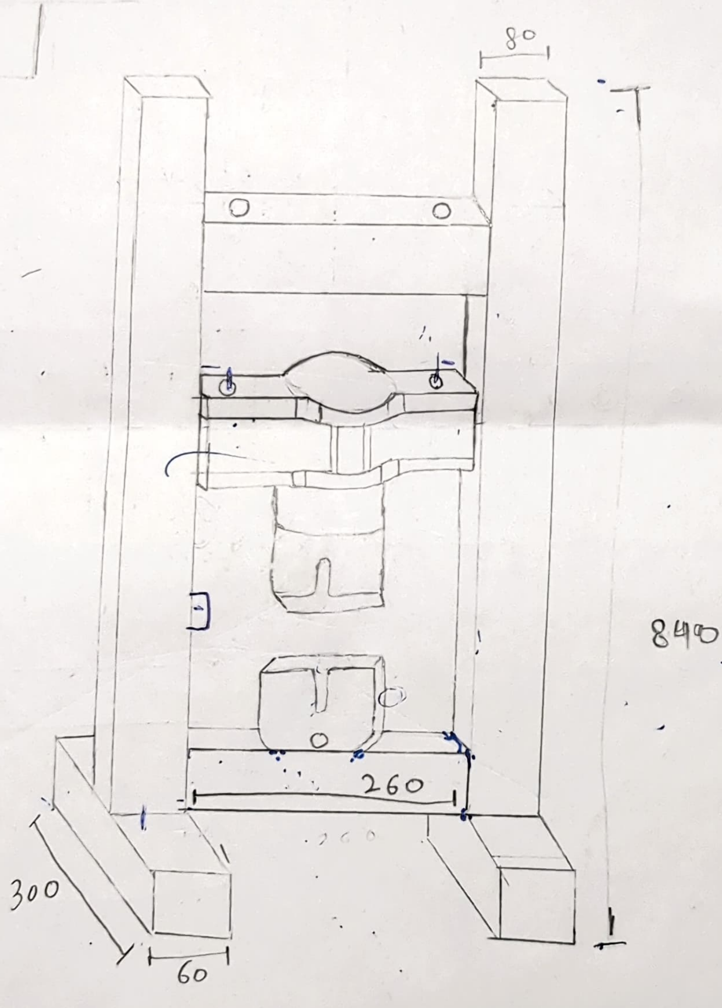
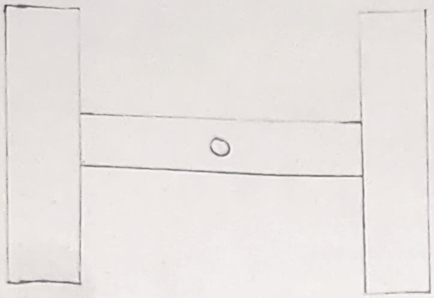
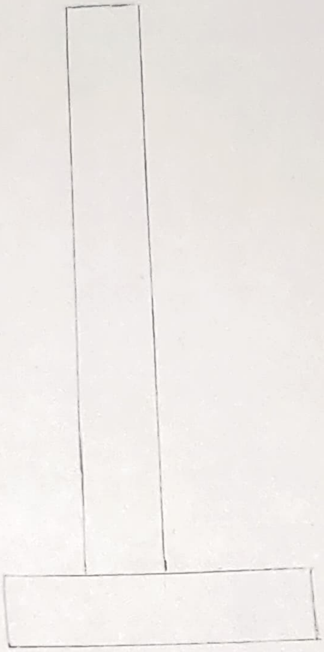


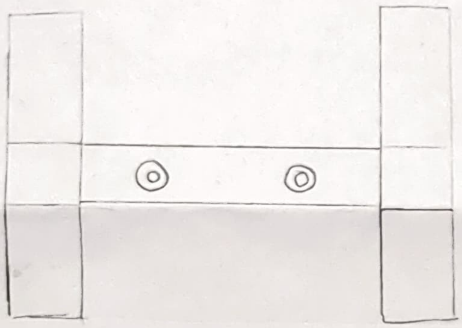
80
840
260
300
60



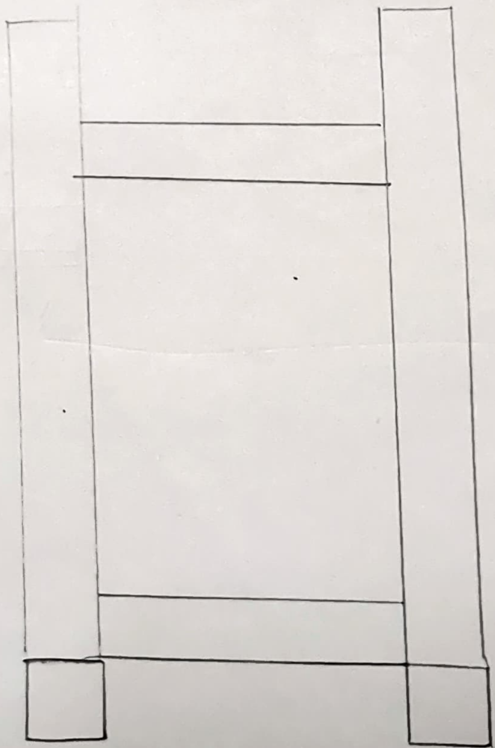
B·V



S·V



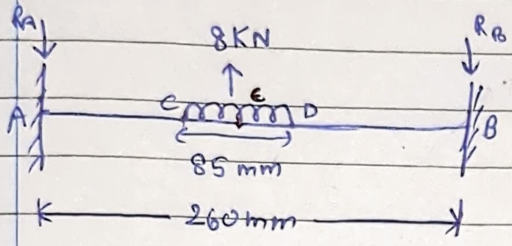
T·V



FV

Design and Devlopment of Portable Universal Testing Machine for Miniature Testing ...

→ Lower Crosshead



$R_A + R_B = 8000N$ — (I)

$\Sigma M_A = 0$ — (II)

From (II), $-R_B \times (0.26) + 8 \times 10^3 \times (0.13) = 0$

$\Rightarrow \boxed{R_B = 4 \times 10^3 N}$ — (III)

From (I) & (III), $R_A + 4 \times 10^3 N = 8 \times 10^3 N$

$\Rightarrow \boxed{R_A = 4 \times 10^3 N}$

BM at B = 0

BM at D = $R_B \times (0.0875) = 4000 \times 0.0875$

$= 350$ Nm

BM at C = $R_B \times (0.1725) - 8 \times 10^3 \times (0.0425)$

$= 350$ Nm

BM at A = $R_B \times (0.260) - 8 \times 10^3 \times (0.130)$

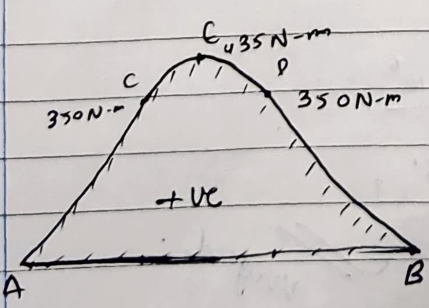
$= 0$

BM at mid point of UDL (say E):

$= R_B \times (0.130) - \frac{8 \times 10^3}{2} \times (0.02125)$

$= 435$ Nm

BMD



Date / /

Shear Force at B = -4 kN

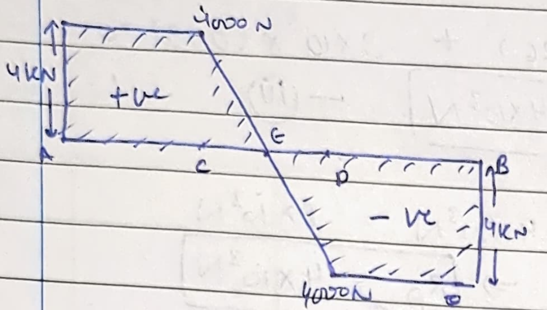
at D = -4 kN

at C = -4 + 8 kN

= +4 kN

at A = +4 kN

SFD



$$\boxed{SF_{max} = 4000\,N}$$

at E, BM is extreme

$(BM)_E = 435$ N-m

So, $\boxed{BM_{max} = 435 \text{ N-m}}$

Assumptions

(i) $b = d$

(ii) FOS = 3

Data

$\sigma_{ys} = 800$ MPa

Using Tresca's Theory / Max^m Shear Stress Theory of failure

$$\sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2} = \frac{\sigma_{ys}}{2 \times FOS}$$

$\sigma_x = 0$, $\sigma_y = \sigma_{b_{max}}$

$\tau = \dfrac{SF_{max}}{bd} = \dfrac{4 \times 10^3 N}{b^2}$

So, $$\frac{\sigma_y^2}{4} + \left(\frac{4000}{b^2}\right)^2 = \left(\frac{\sigma_{ys}}{2 \times 3}\right)^2$$

$$\Rightarrow \frac{\sigma_b^2}{4} = \frac{(800 \times 10^6)^2}{36} - \frac{(4000)^2}{b^4}$$

$4 \times 16 \times 10^6 \times$

$$\sigma_b^2 = \frac{64 \times 4 \times 10^{16}}{\cancel{36}\,9} - \frac{4 \times 16 \times 10^6}{b^4}$$

$$\sigma_b^2 = \frac{64 \times 10^{16}\, b^4 - 64 \times 10^6 \times 9}{9 b^4}$$

verified.

$$\frac{-8000}{12(0.26)^2}\left[0.1725^3(1.04-0.5175)-0.0875^3(1.04-\cancel{\ }0.2625)\right]$$

$$0.00268 - 0.00052$$
$$0.00216$$

$M_{FAB} = -21.313\ Nm = M_A$

$M_C = M_A +$ SFD area from A to C

$= -21.313 + (4000 \times 0.0875) =$

328.687

M_E (centre of beam) $= M_C +$ Area from C to E

$= 328.687 + (0.0425 \times 4000)$

$= \boxed{498.687\ Nm}$

$$9 \times (498.687)^2 \times 144 = 256 \times 10^{16} \times b^6 - 256 \times 9 \times 10^6 b^2$$

$$322.3 \times 10^6 = 256 \times 10^{16}\, b^6 - 2304 \times 10^6\, b^2$$

Let $b^2 = x$

$$322.3 \times 10^6 = 256 \times 10^{16}\, x^3 - 2304 \times 10^6\, x$$

$$256 \times 10^{16}\, x^3 - 2304 \times 10^6\, x - 322.3 \times 10^6 = 0$$

$x_1 = 5.0179 \times 10^{-4}\ m$

$b = 0.0224\ m$

$\boxed{b = 2.24\ cm} = \boxed{22.4\ mm}$

$V = b^2 \times 320$

~~$V = 160457.6\ mm^3$~~

$V = 160563.2\ mm^3$

$= 160.5632\ cm^3$

$\rho = 7.75\ g/cm^3$

$= 7.8\ g/cm^3$

mass ~~weight~~ $= 1.252\ kg$

II) Lead Screw Design

$$\sigma_x = \frac{4000}{\frac{\pi}{4}d^2} + \frac{(wt/2)}{\frac{\pi}{4}d^2}$$

$$\frac{4}{\pi d^2}\left(4000 + \frac{49.354}{2}\right) = \sigma_x$$

$$\frac{1.27}{d^2}(4024.67) = \sigma_x$$

$$\left[\sigma_x = \frac{5124.37}{d^2}\right]$$

$$\sqrt{\left(\frac{\sigma_x}{2}\right)^2} = \frac{\sigma_{ys}}{2 \times FOS}$$

$$\frac{2562.185}{d^2} = \frac{800 \times 10^6}{2 \times 3}$$

$$d^2 = 19.21 \times 10^{-6}\ m$$

$$\boxed{\begin{aligned} d &= 4.38 \times 10^{-3}\ m \\ d &= 4.38\ mm \\ d &= 0.438\ cm \end{aligned}}$$

Weight of Cross head?

$V = (5)^2 \times 25.8 = 645\ cm^3$

$\rho = 7.8\ g/cm^3$

$m = V \times \rho = 5031\ gm$

$= 5.031\ Kg$

$Wt = mg = 5.031 \times 9.81$

$\boxed{Wt. = 49.354\ N}$

$$\sigma_1 = \frac{\sigma_{et}}{FOS}$$

$$\sigma_1 - \nu(\sigma_2 + \cancel{\sigma_3}\ 0) = \frac{\sigma_{et}}{FOS}$$

$$(\sigma_1\ ,\ \sigma_2)$$

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

σ_2