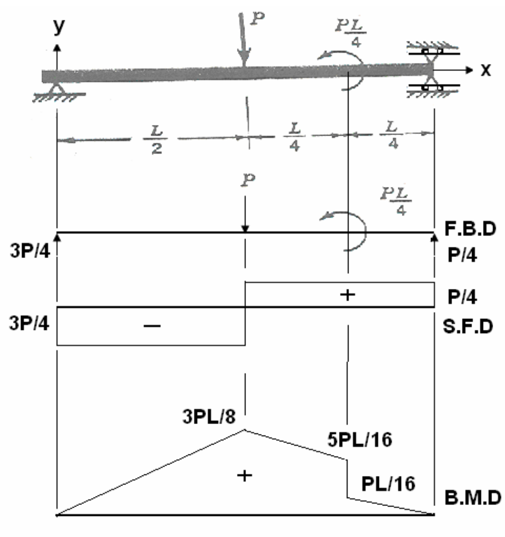
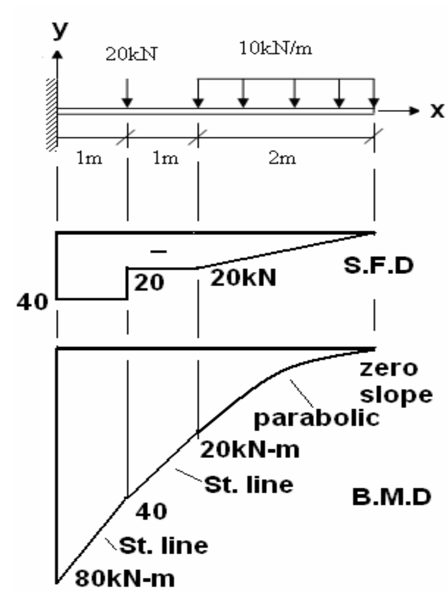
ESO 202A/204: Mechanics of Solids (2016-17 II Semester)
Solution of Assignment No. 6

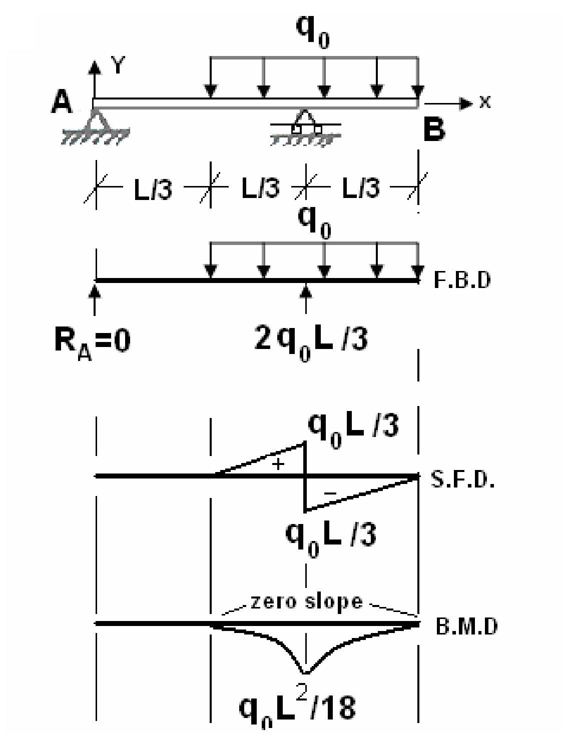
6.1



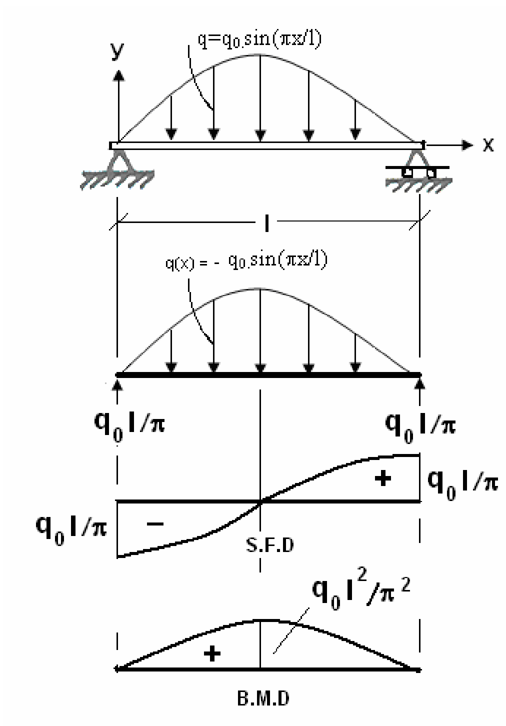
6.2



6.3



6.4



$q(x) = -q_0\sin(\pi x/l)$

$$\left.\begin{aligned} \frac{dV}{dx} + q(x) = 0 \\ \frac{dM}{dx} + V(x) = 0 \end{aligned}\right\} \quad \text{M=0 at x=0, l}$$

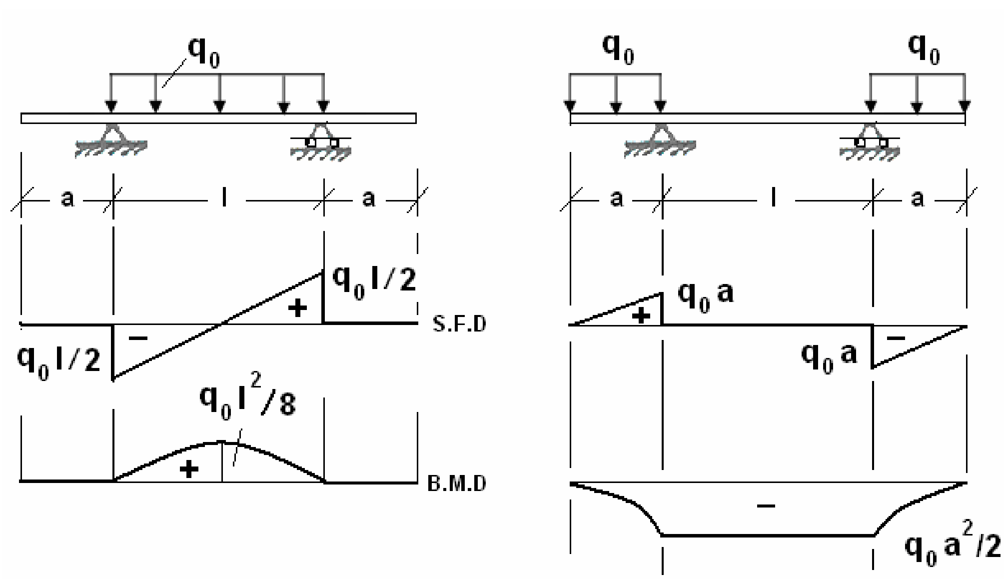
$V = -q_0(l/\pi)\cos(\pi x/l) + C_1$

$M = q_0(l^2/\pi^2)\sin(\pi x/l) - C_1x + C_2$

Using B.C we find that $C_1 = C_2 = 0$

6.5

Let us use superposition of loads.

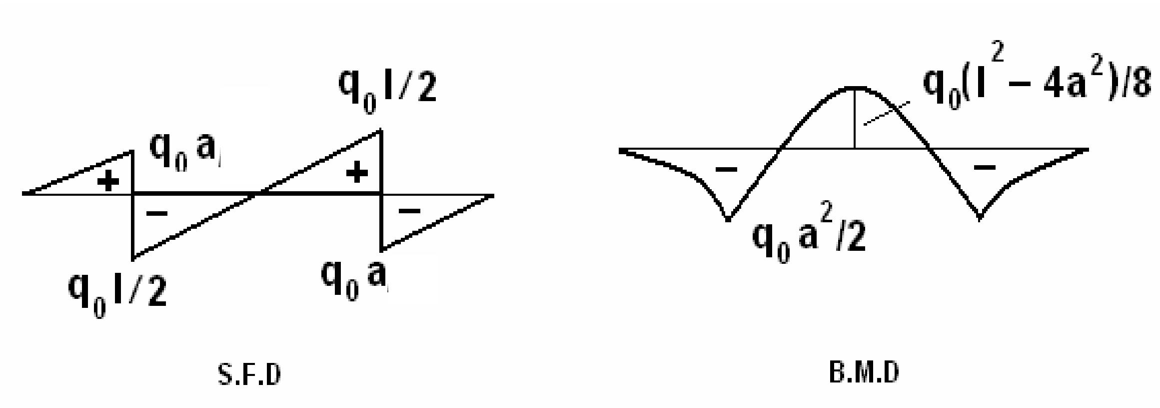


Note: Net B.M.D will be superposition of two diagrams.

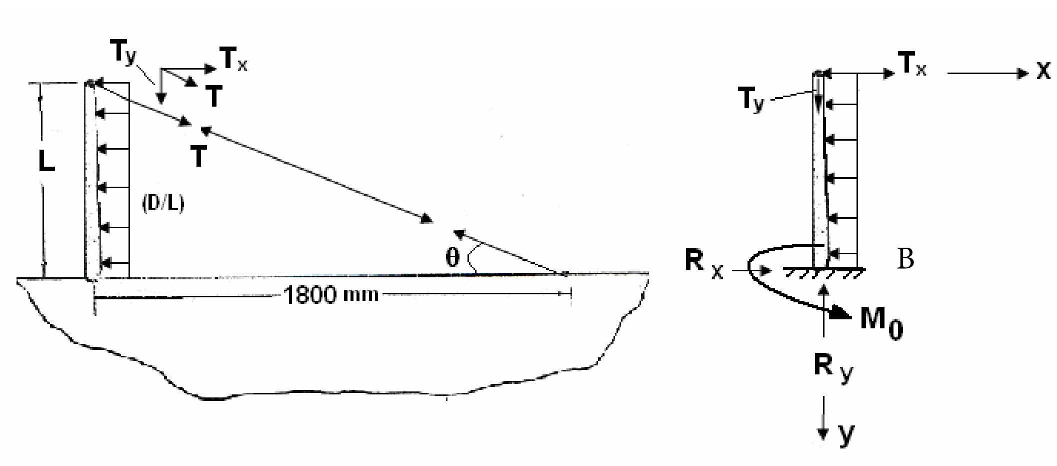
(i) For no +ve B.M in the beam: $q_o l^2/8 \le q_0 a^2/2$ i.e. $a \ge l/2$

(ii) For Max. + ve B.M = Max. - ve B.M:
Net + ve B.M = $(q_o l^2/8 - q_0 a^2/2)$

Therefore,
$(q_o l^2/8 - q_0 a^2/2) = q_0 a^2/2$
Or, $l^2/8 = a^2$ or, $a = l/(2\sqrt{2})$
For $a < l/2$, the SFD & BMD are:



6.6



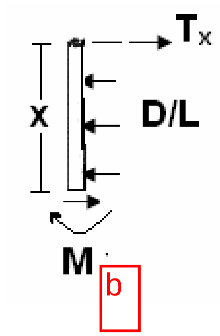
Total drag = D $\tan\theta = (540/1800)$ gives, $\theta^0 = 16.7^0$

Drag per unit length = D/L   L = 540mm

$\sum F_x = 0$ gives, $R_x + T_x = D$ which gives, $R_x = (D - T_x)$
$\sum F_y = 0$ gives, $R_y = T_y$

$\sum M_B = 0$ gives, $T_x.L\text{-}D.(L/2)\text{-}M_0 = 0$,
which gives, $M_0 = (T_xL\text{-}DL/2)$ = moment at the base of antenna (which is negative B.M. and is maximum)

Now, the bending moment at a section x is:



$M_b = -T_x.x + Dx^2/(2L)$ (which is positive B.M.)

For this moment to be maximum,

$$\frac{dM_b}{dx} = 0 \text{ gives, } -T_x + Dx/(L) = 0, \text{ gives, } x/L = T_x/D$$

$M_b(\max) = -T_x^2.L/D + T_x^2.L/2D = -T_x^2.L/2D$

For maximum moment to be minimized, we must have,
$T_x.L - DL/2 = -T_x^2.L/2D$
or, $T_x^2 + 2D.T_x - D^2 = 0$ or, $T_x = 0.414D$

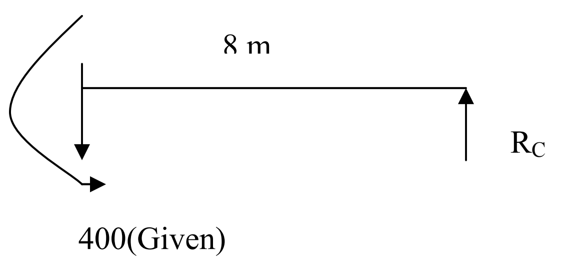
$T_x = T\cos\theta = 0.9578T$ hence, $T = 0.432D$

6.7

Horizontal reaction at A will be zero.

$\sum F_y = 0$ gives $R_A + R_B + R_C = 8\text{x}100$ (1)
$\sum M_A = 0$ gives $8R_B + 16R_C = 100\text{x}8\text{x}4$ (2)

Consider a section at B, given that $M_B = -400$ KNm.



Therefore,
$8R_C + 400 = 0$
$R_C = -50$ KN.
From 1 and 2,
$R_B = 500$ KN $R_A = 350$ KN

One can now draw the SFD and BMD

BM where SF is zero, i.e at 3.5 m from support A = R_A x 3.5 - $\frac{100x3.5x3.5}{2}$ = 612.5KNm

To find X (Where BM is zero):

$R_A.X - \frac{100}{2}.X^2 = 0$ or $350X - 50X^2 = 0$,

X = 7m