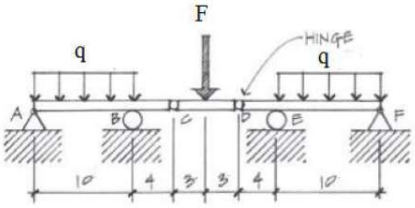
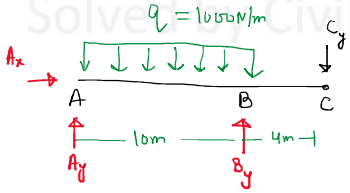
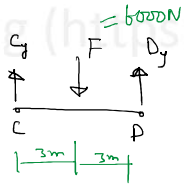
Shear and Moment Diagrams:

5. A compound beam with internal hinges is loaded as shown. Draw the load, shear, and moment diagrams of the figure show. F=6000N, q=1000N/m.

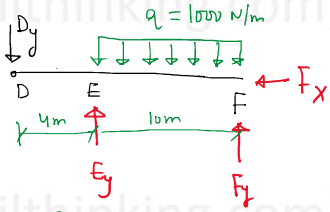




Part-1



Part-2



Part-3

Part-3 and part-1 are similar

$F_x = A_x = 0$

$F_y = A_y = 8000\ N$

$E_y = B_y = 9200\ N$

$\curvearrowleft \Sigma F_x = 0 \Rightarrow A_x = 0$

$\curvearrowleft \Sigma M_A = 0$:

$-(C_y \times 14) + (B_y \times 10) - \left(q \times \frac{10^2}{2}\right) = 0$ (q = 1000 N/m)

$C_y = 30000\ N$

$\Rightarrow -(30000 \times 14) + (B_y \times 10) - \left(1000 \times \frac{100}{2}\right) = 0$

$\Rightarrow B_y = (1000 \times 50) + (30000 \times 14) = 9200\ N$

$\Rightarrow B_y = 9200\ N$

CD is Symmetric

$\Rightarrow C_y = D_y = \frac{F}{2} = \frac{6000\ N}{2}$

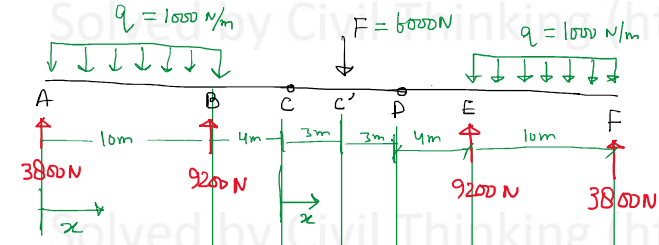
$\Rightarrow C_y = D_y = 3000\ N$

$\curvearrowleft +\uparrow \Sigma F_y = 0$:

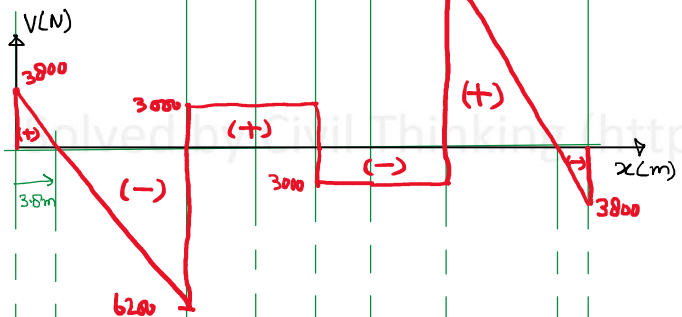
$A_y + B_y - (10q) - C_y = 0$ (B_y = 9200 N, 10q: q = 1000 N/m, C_y = 30000 N)

$\Rightarrow A_y = (10 \times 1000) - 9200 + 30000\ N$

$\Rightarrow A_y = 3800\ N$



Shear Diagram:



Shear Forces:

- $V_A = 38000$
- $V_{B^-} = 38000 - (10000 \times 10) = -62000$

Zero Shear Force location between A and B:

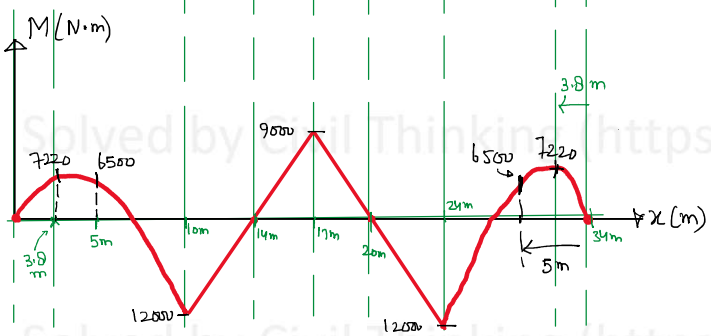
$V_x = 0$:

$\Rightarrow 38000 - 10000x = 0 \Rightarrow x = 3.8\,m$

- $V_{B^+} = V_{B^-} + 92000 = -62000 + 92000 = 30000\,N$
- $V_C = V_{B^+} = 30000N$
- $V_{C'} = V_C - 60000 = 30000 - 60000 = -30000$
- $V_D = -30000$; $V_E = 62000$; $V_F = -38000$

[∵ D, E, F are mirror images of C, B, A respectively]

Moment Diagram:



Moments:

- $M_A = M_F = 0$ [Hinge supports]
- $M_C = M_D = 0$ [internal Hinges]
- In AB:

$$M_x = 38000 \times x - \left(q \frac{x^2}{2}\right) \quad \text{[parabolic]}$$

$$\Rightarrow M_{5m} = 38000 \times 5m - \left(10000 \times \frac{5^2}{2}\right) = 65000\,Nm$$

$$\Rightarrow M_{3.8m} = 38000 \times 3.8 - \left(10000 \times \frac{3.8^2}{2}\right) = 72200\,Nm$$

- In BC:

$$M_B = (38000N \times 10m) - \left(q \times 10m \times \frac{10m}{2}\right) = -120000\,Nm \quad (q = 10000\,N/m)$$

$$M_C = 38000 \times (10+4) - \left(q \times 10 \times \left(\frac{10}{2}+4\right)\right) + (92000 \times 4) = 0 \quad (q = 10000\,N/m)$$

- In CD:

$$M_{max} = \frac{FL}{4} = \frac{60000 \times 6}{4} = 90000\,N.m$$

- In EF:

Same as AB because EF and AB are symmetric.