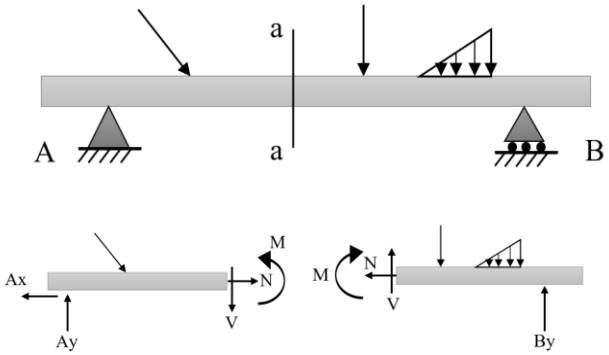
2. Axial Force, shear Force and Bending Moment Diagrams:

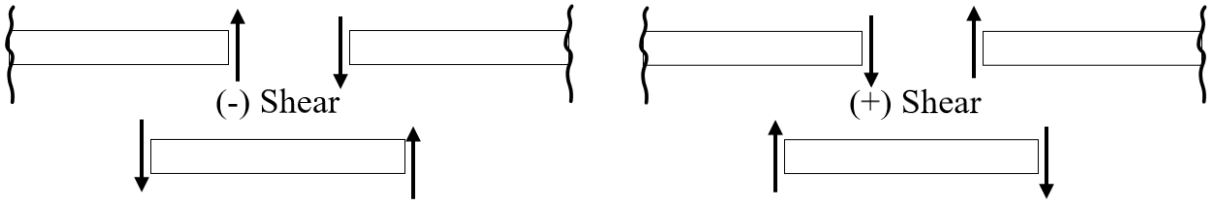
There are three interior forces are generated when any beam element was cutting:



Sign convention:

N: Axial Force (tension +ve, compression –ve).

V: Shear Force (turning structure clockwise +ve, counterclockwise –ve).

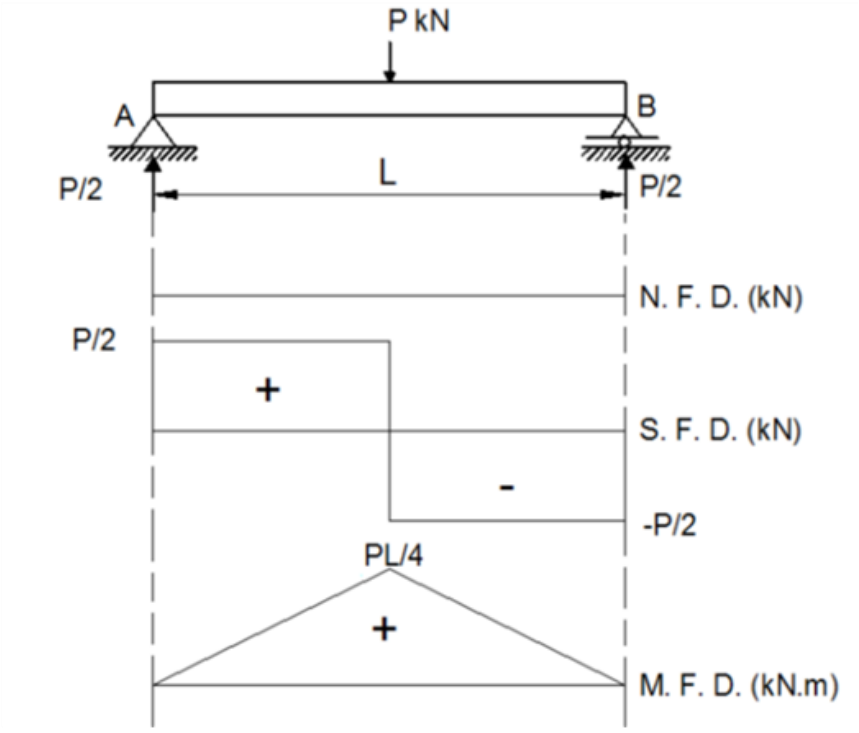


M: Bending Moment (compression outside of structure and tension inside +ve, otherwise –ve).

Positive (+) Negative (-)

Notes:

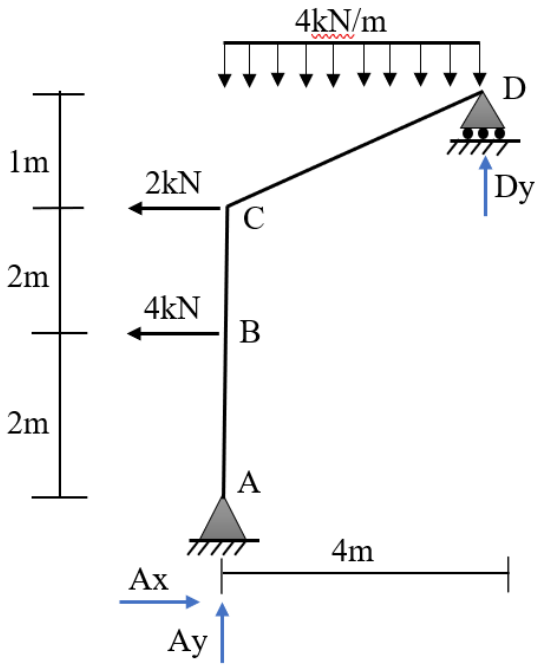
- Axial, shear and bending moment diagrams are usually started from the left side.
- The value of the interior force (axial, shear or moment) at any location is equal to the cumulative area under the corresponding force diagram from (x = 0) to the considered location.
- Any concentrated load (force or moment) causes a jump in the corresponding diagram.



Shear and Bending moment diagram for a simply supported beam with a concentrated load at mid-span.

Example 1:

Sketch the axial, shear force and bending moment diagrams for the frame shown.



Sol.

$\sum F_x = 0$

$A_x - 2 - 4 = 0 \longrightarrow A_x = 6$ kN

$\sum M_A = 0$

$4 \times 4 \times 2 - d_y (4) - 2 \times 4 - 4 \times 2 = 0$

$d_y = 4$ kN

$\sum F_y = 0$

$- 4 \times 4 + 4 + Ay = 0 \longrightarrow Ay = 12$ kN

$\sum F_x = 0$

$6 + V - 4 = 0 \longrightarrow V = -2 = 2$ kN

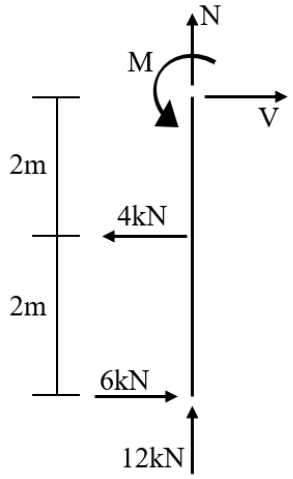
$\sum F_y = 0$

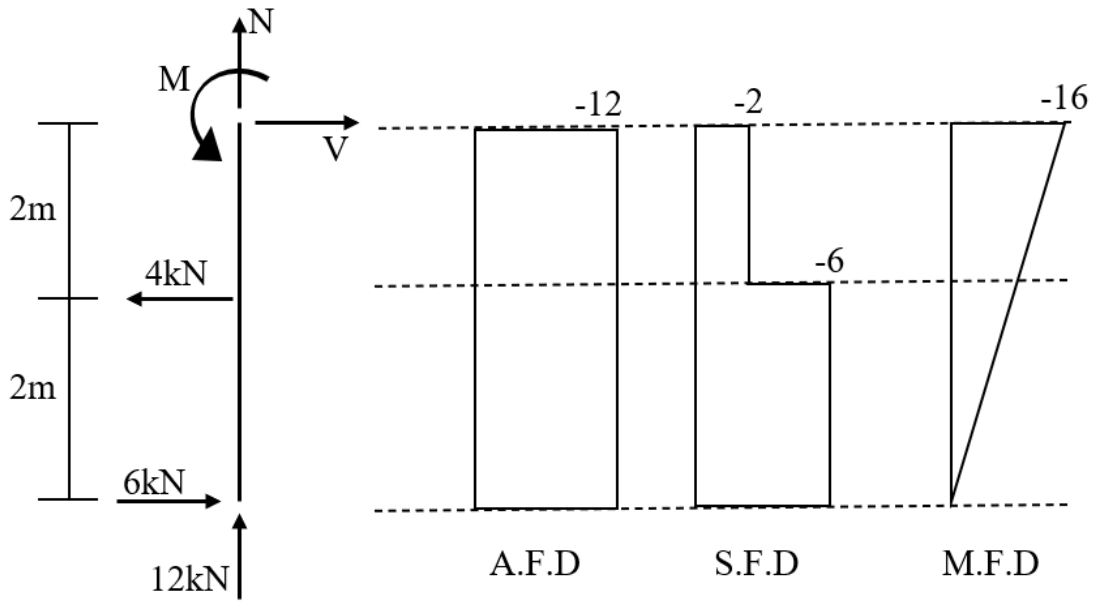
$12 + N = 0 \longrightarrow N = -12 = 12$ kN

$\sum M = 0$

$M + 6 \times 4 - 4 \times 2 = 0$

$M = -16 = 16$ kN.m





$\sum F_y = 0$

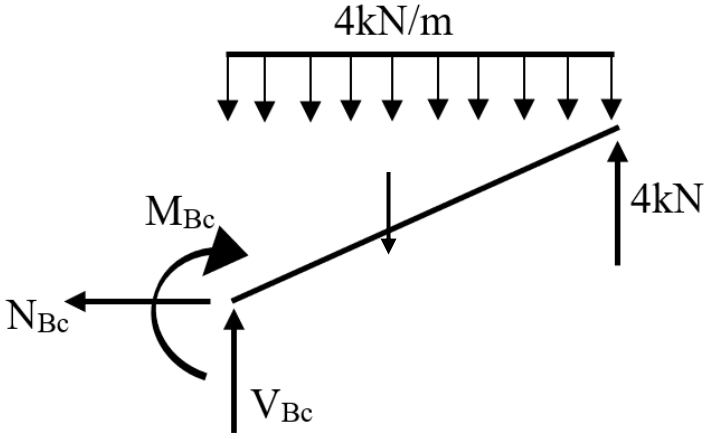
$V_{Bc} + 4 - 4 \times 2 = 0$

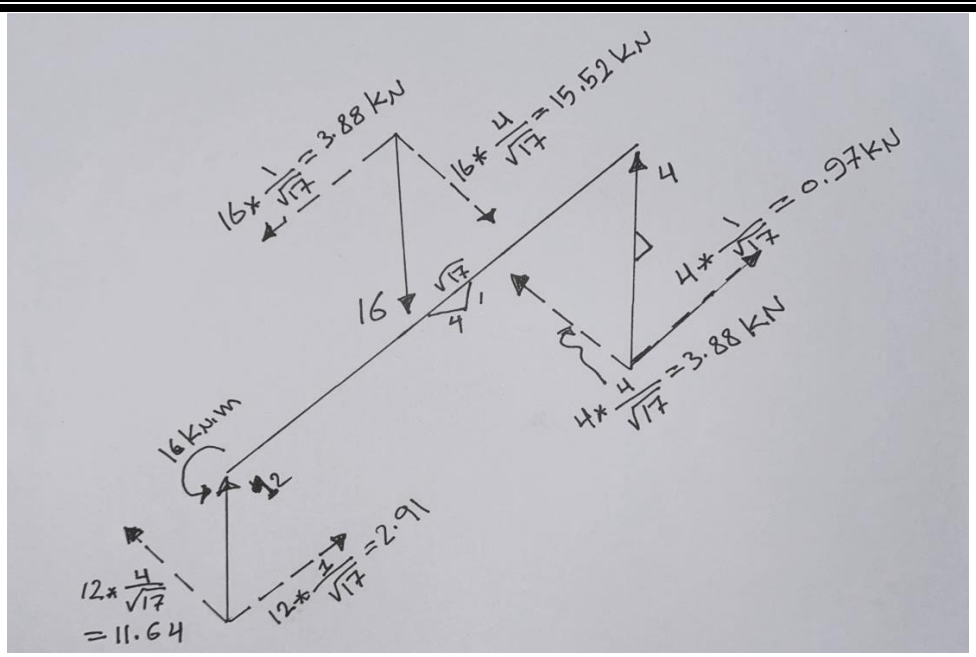
$V = 12$ kN

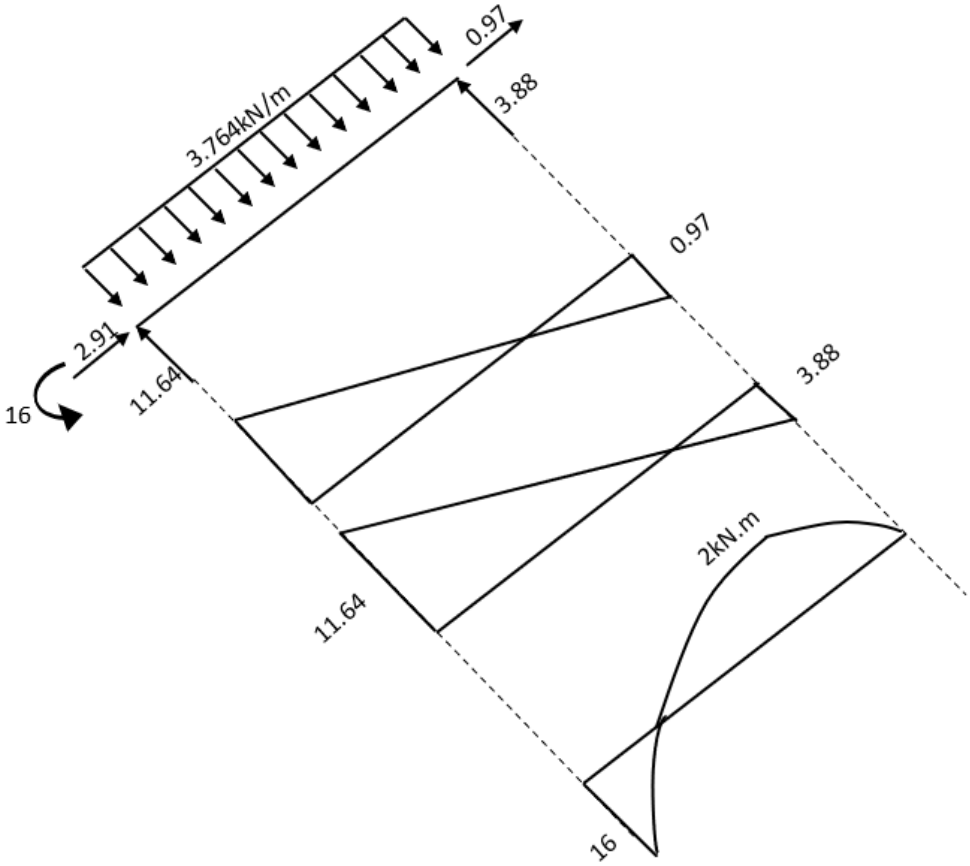
$\sum M_C = 0$

$M_C + 4 \times 4 \times 2 - 4 \times 4 = 0$

$M_C = -16 = 16$ kN.m

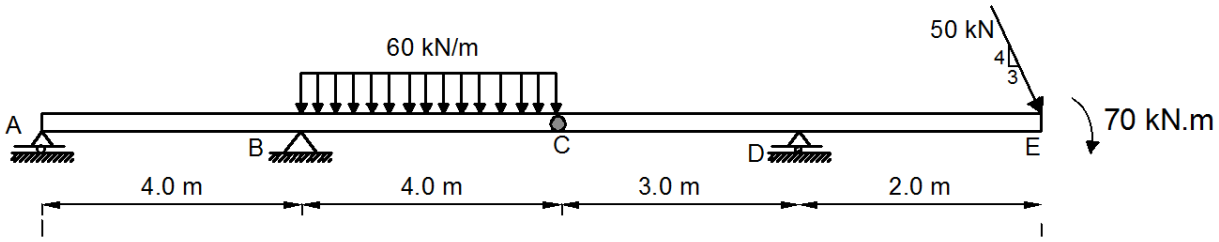



16*1/√17 = 3.88 kN
16*4/√17 = 15.52 kN
16
√17
4
1
4
4*1/√17 = 0.97kN
4*4/√17 = 3.88 kN
16kN.m
12
12*4/√17 = 11.64
12*1/√17 = 2.91


3.764kN/m
0.97
3.88
0.97
2.91
16
11.64
3.88
2kN.m
11.64
16

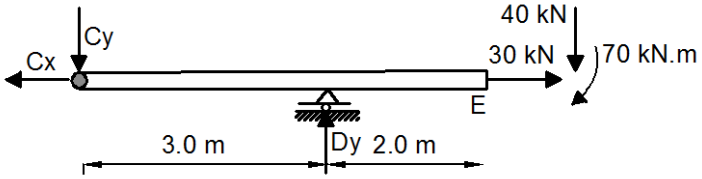
Example 2:

Draw axial, shear and bending moment diagram for the figure shown.



Sol.

$\sum M_C = 0$



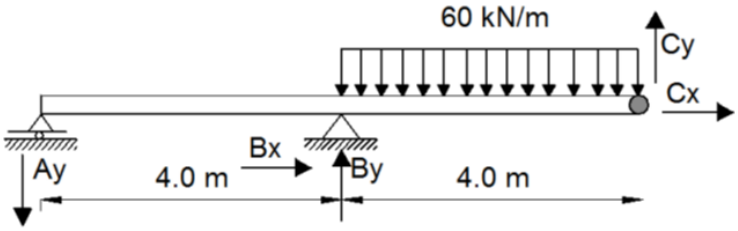
$70 + 40 \times 5 - D_y \times 3 = 0$

$D_y = 90$

$\sum F_y = 0$

$90 - 40 - C_y = 0 \longrightarrow C_y = 50$ kN

$\sum M_A = 0$

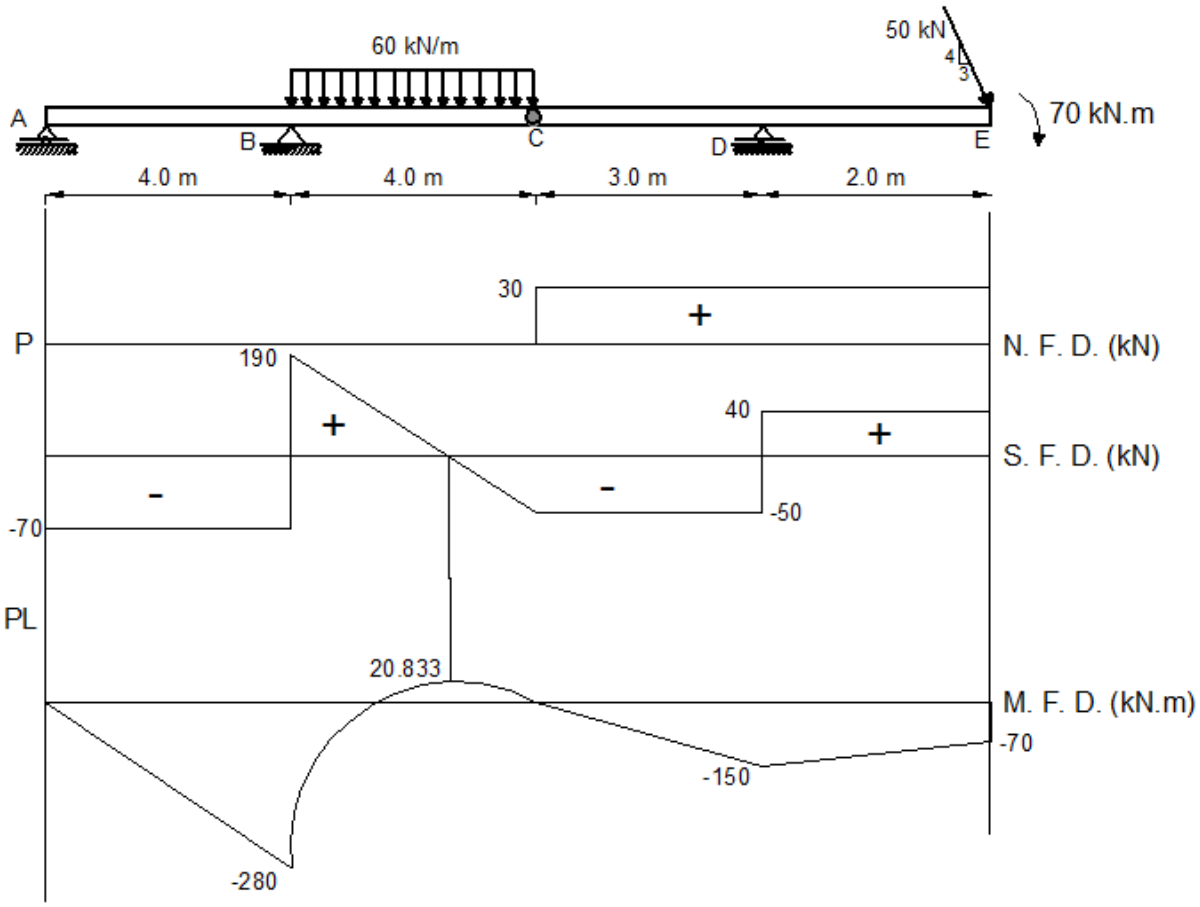


$-50 \times 8 + 240 \times 6 - B_y \times 4 = 0$

$B_y = 260$ kN.m

$\sum F_y = 0$

$260 - 240 - A_y + 50 = 0 \longrightarrow A_y = 70$ kN


60 kN/m
50 kN
4
3
70 kN.m
A
B
C
D
E
4.0 m
4.0 m
3.0 m
2.0 m
P
30
+
N. F. D. (kN)
190
+
40
+
S. F. D. (kN)
-
-
-70
-50
PL
20.833
M. F. D. (kN.m)
-70
-150
-280