5. Approximate Method of Analysis:

During preliminary design and analysis, the actual member dimensions are not usually known. Approximate analysis is useful in determining (approximately) the forces and moments in the different members and in coming up with preliminary designs. Based on the preliminary design, a more detailed analysis can be conducted and then the design can be refined. Approximate analysis is conducted by making realistic assumptions about the behavior of the structure. Before applying approximate methods, it is necessary to reduce the given indeterminate structure to a determinate structure by suitable assumptions.

❖ Approximate Method of Frame Structures with vertical loads:
Consider a building frame subjected to vertical loads as shown in Fig. (1). Any typical beam, in this building frame is subjected to axial force, bending moment and shear force. Hence each beam is statically indeterminate to third degree and hence 3 assumptions are required to reduce this beam to determinate beam.

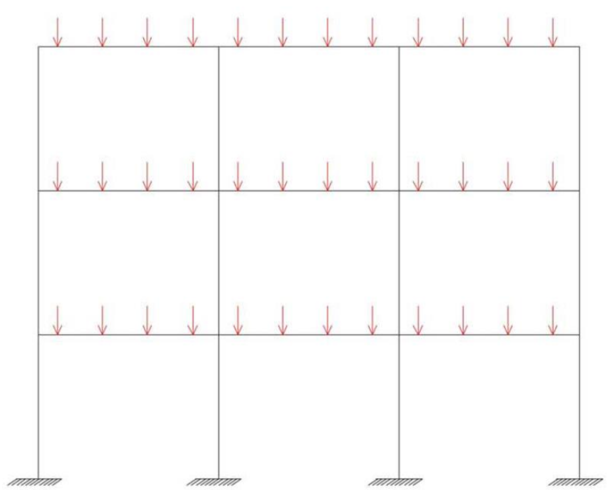


Figure (1)

For a simply supported beam the point of zero moment or point of inflexion occurs at the supports themselves, figure (2). At a fixed-fixed beam the point of zero moment or point of inflexion occurs at 0.21L from both ends of the support, figure (3).

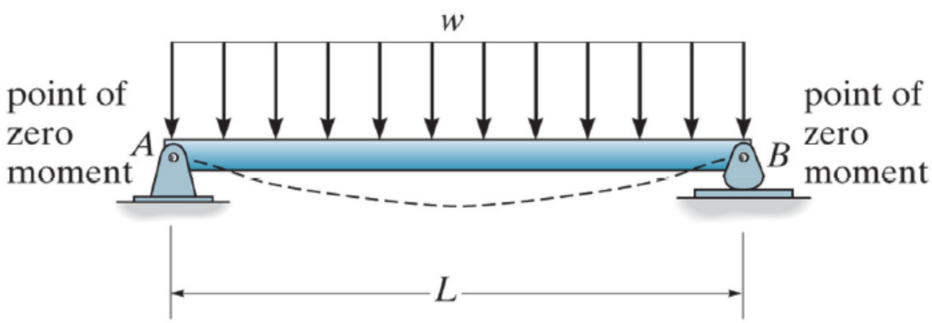


Figure (2)

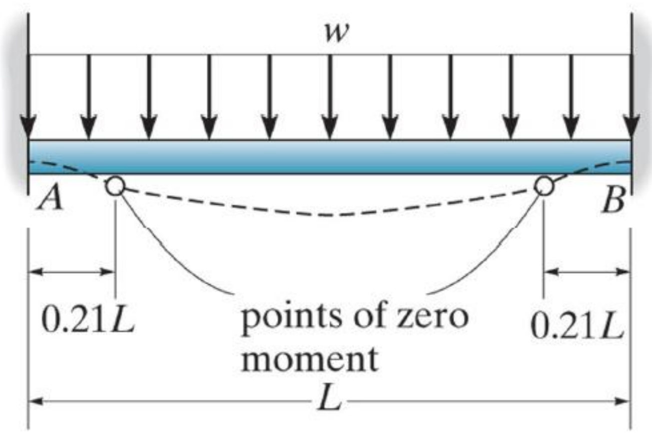


Figure (3)

In a case the support provided by the columns is neither fixed nor simply supported, figure (4). For the purpose of approximate analysis, the inflexion points or point of zero moment is assumed to occur at 0.1L from the supports.
In reality the point of zero moment varies depending on the actual rigidity provided by the columns thus the beam is approximated for the analysis.

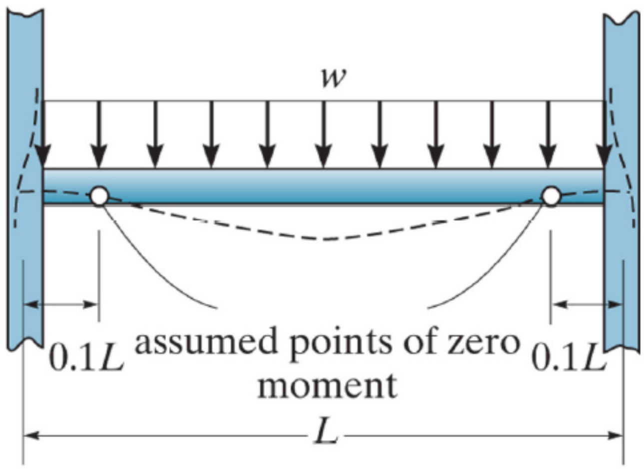
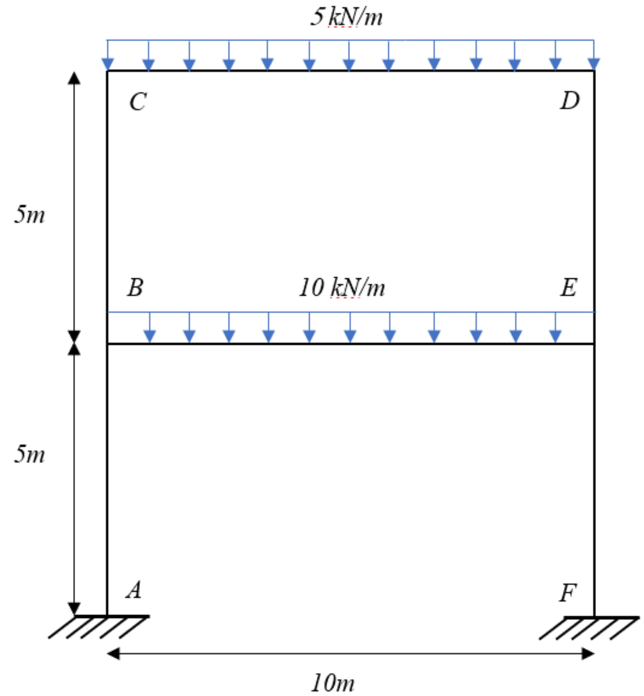


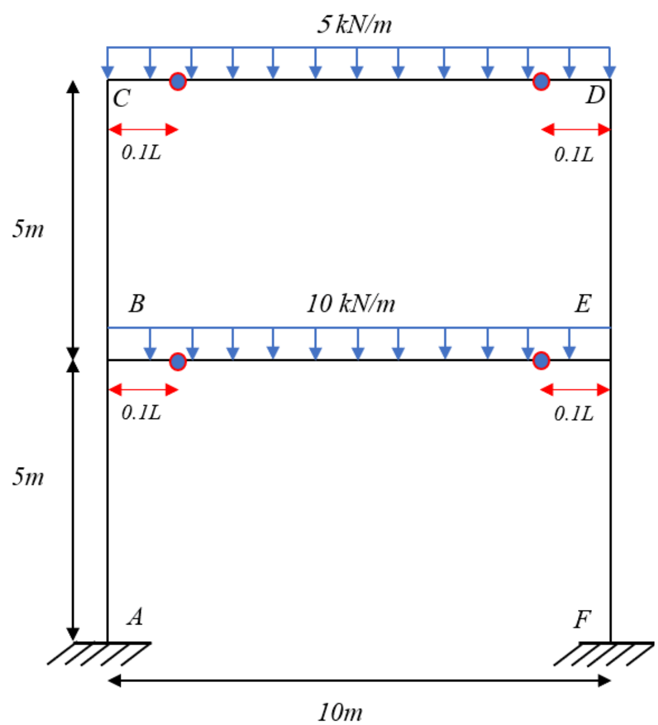
Figure (4)

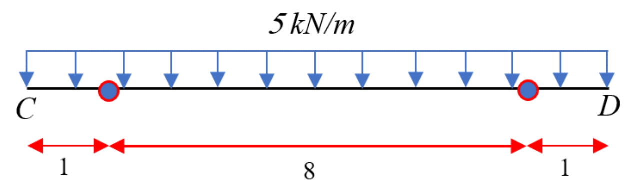
The third assumption is that axial force in the beams is zero. With these three assumptions one could analyse this frame for vertical loads.

Example:



Sol.





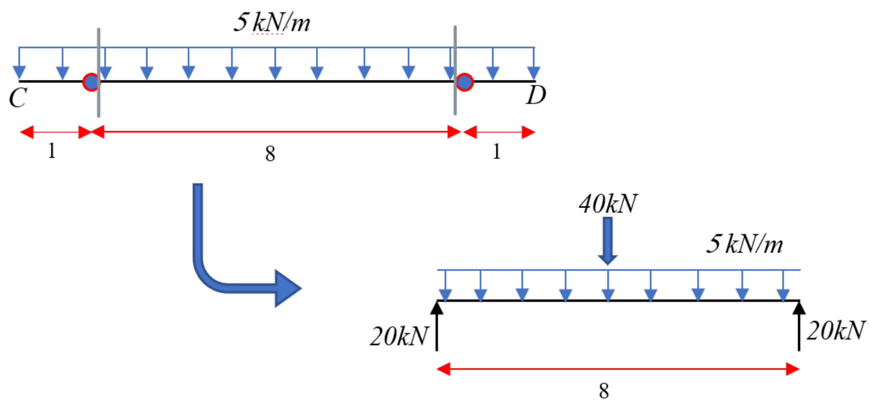
Member CD

Member (CD)

$\sum M_1 = 0$ +↻

$40(4) - V_2(8) = 0$

$V_2 = 20\ kN$



$\sum F_y = 0$ ↑+

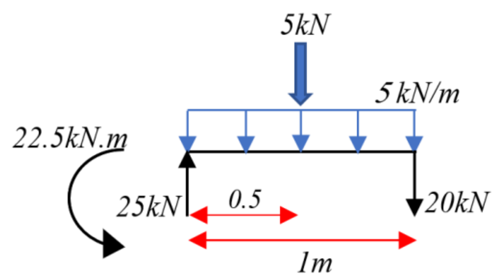
$V_1 - 40 + 20 = 0$

$V_1 = 20\ kN$

$\sum F_y = 0$ ↑+

$V_C - 5 - 20 = 0$

$V_C = 25\ kN$

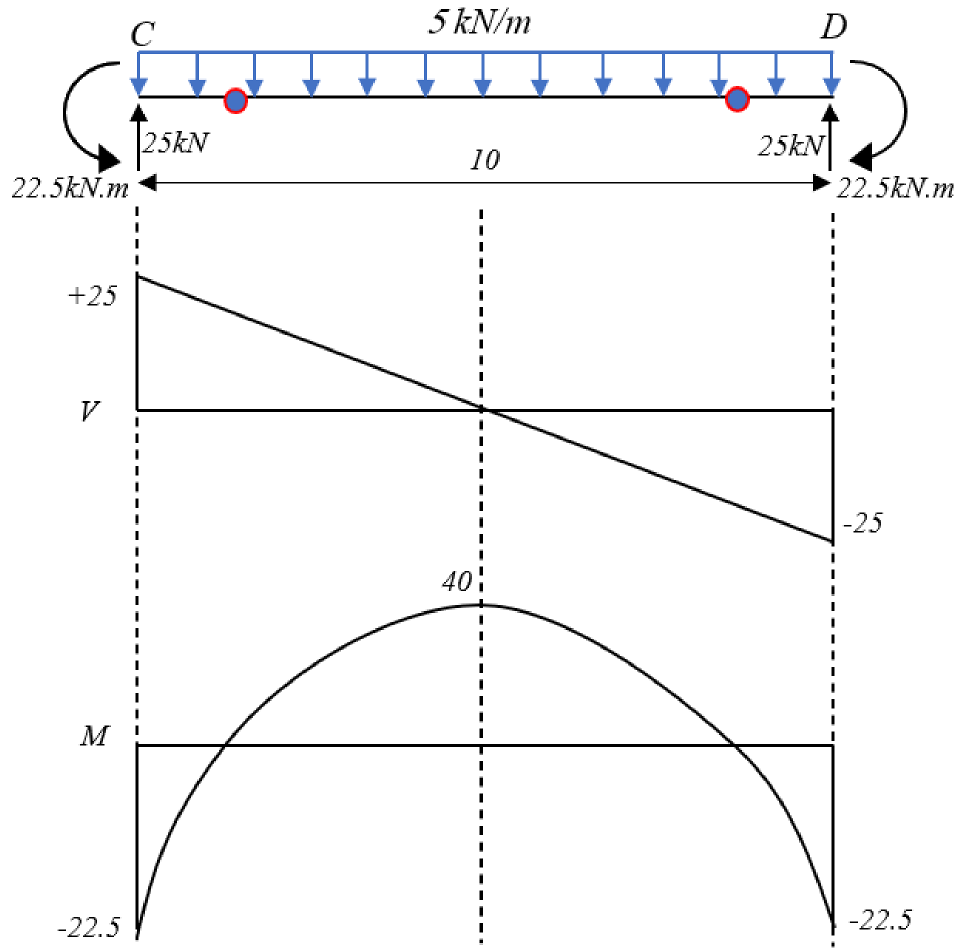


$\sum M = 0$ +↻

$M + 5(0.5) + 20(1) = 0$

$M = -22.5\ kN.m = 22.5\ kN.m$ ↺

Follow the same steps to calculate (*V*, *M*) for the other side.



Member (BE)

$\sum M_1 = 0 \; +\curvearrowright$

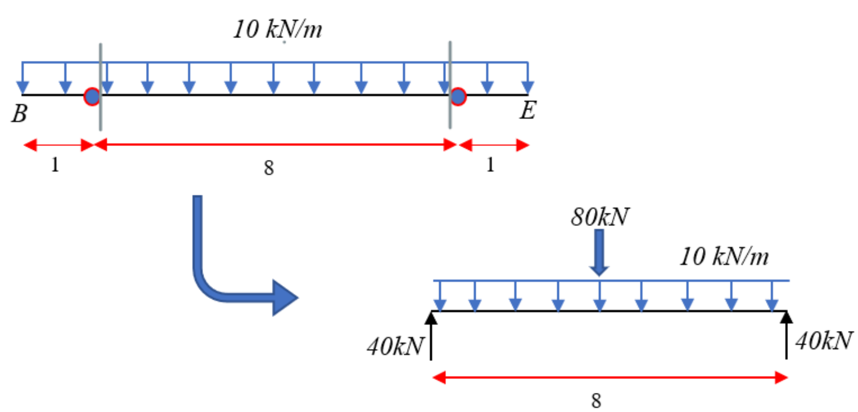
$80(4) - V_2(8) = 0$

$V_2 = 40 \text{ kN}$

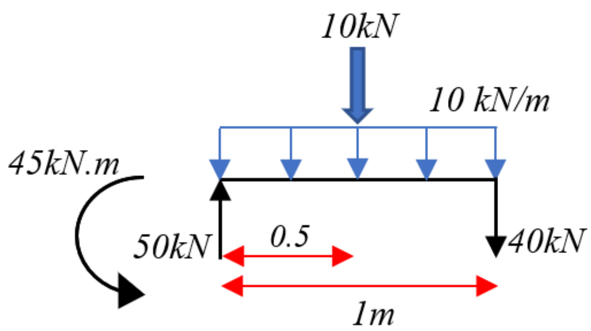
$\sum F_y = 0 \; \uparrow +$

$V_1 - 80 + 40 = 0$

$V_1 = 40 \text{ kN}$

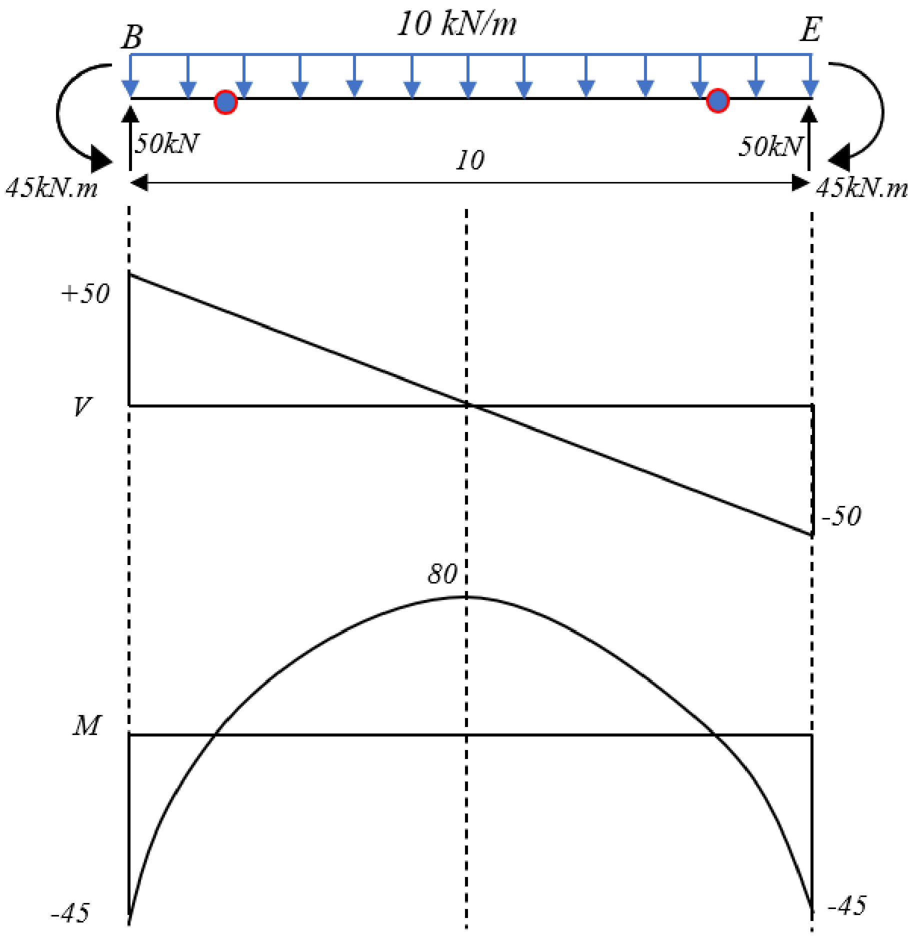


$F_y = 0$ ↑+
$V_B - 10 - 40 = 0$
$V_B = 50\ kN$

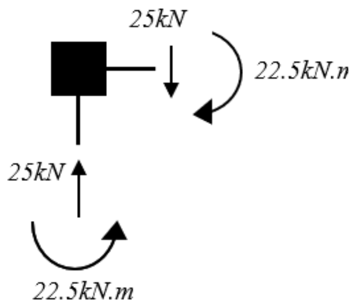


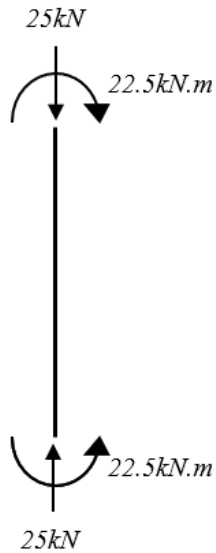
$\sum M = 0$ +↻
$M + 10(0.5) + 40(1) = 0$
$M = -45\ kN.m = 45\ kN.m$ ↺

Follow the same steps to calculate (*V*, *M*) for the other side.



Joint C





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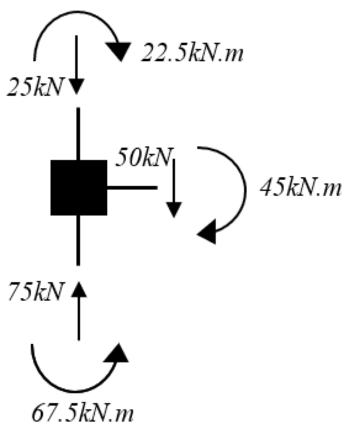
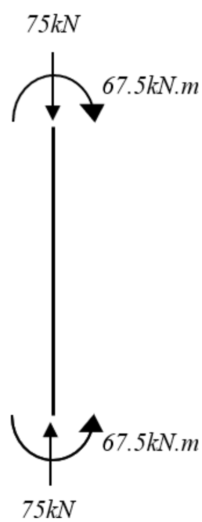
Column CB

Joint B





Column BA

Joint A