

CE 3213 Structural Analysis & Design –II

Lecture: 3 hrs/week

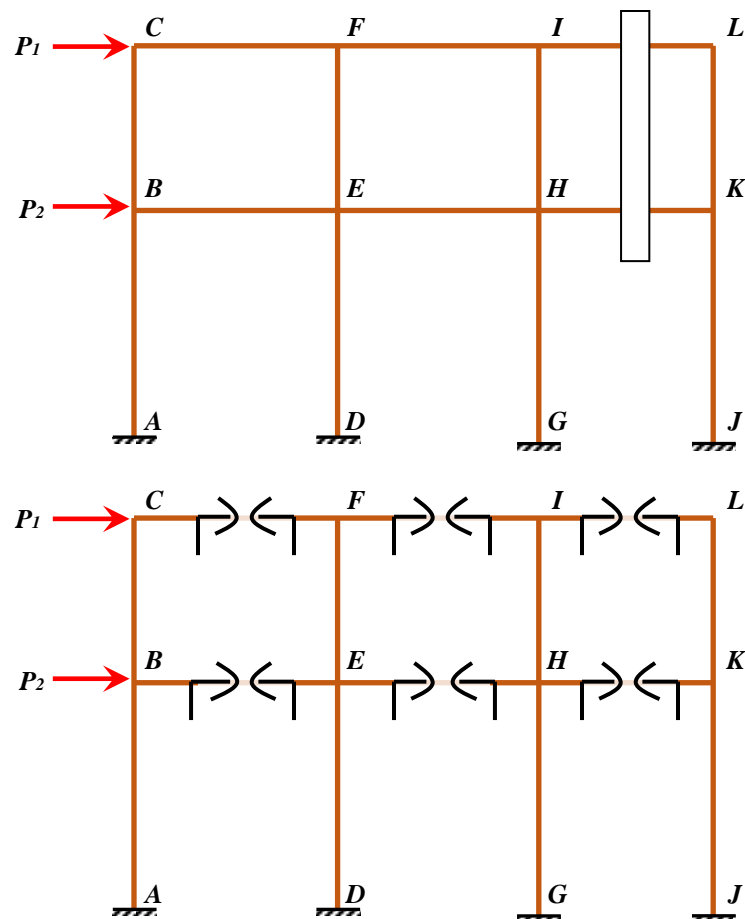
Credits: 3.00

Prereq. CE 3111

Approximate analysis of statically indeterminate structures, deflection of beams, frames and trusses by virtual work method, two hinged arches, influence line for indeterminate structures, wind and earth-quake analysis. composite structures.

Approximate analysis of statically indeterminate structures

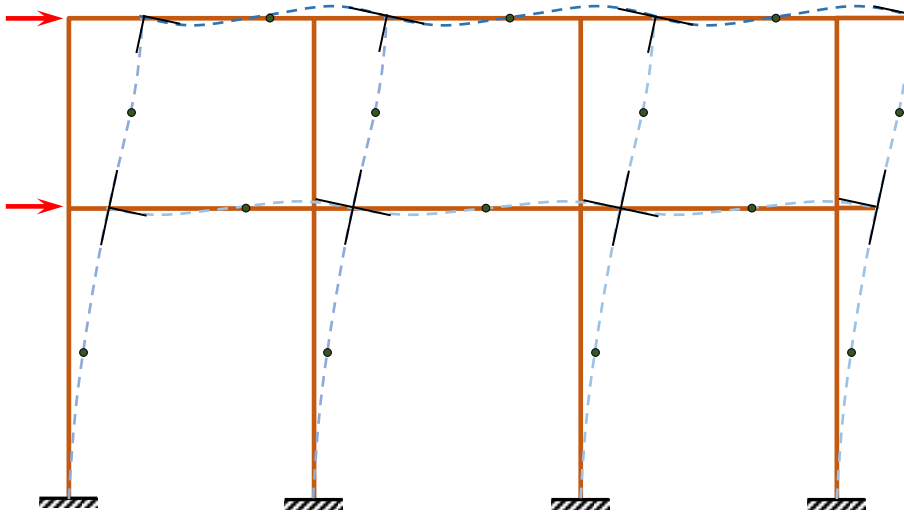
1. Approximate analysis due to vertical load
2. Cantilever Method



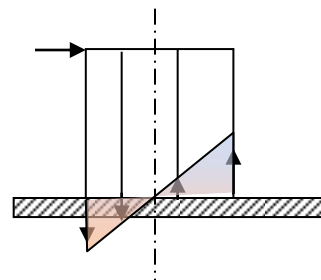
For each cut, three pairs of unknown,

Assumptions for Lateral Load Analysis

1. The amount of side sway increases rather fast from the lower toward the upper stories; all joint rotations are clockwise for later loading coming from the left.
2. All column end moments are counter-clockwise, producing horizontal shears from right to left at lower ends; there is one point of inflection in each column.
3. All beam end moments are clockwise, producing vertical shears downward at the left end and upward at the right end; there is one point of inflection in each beam.

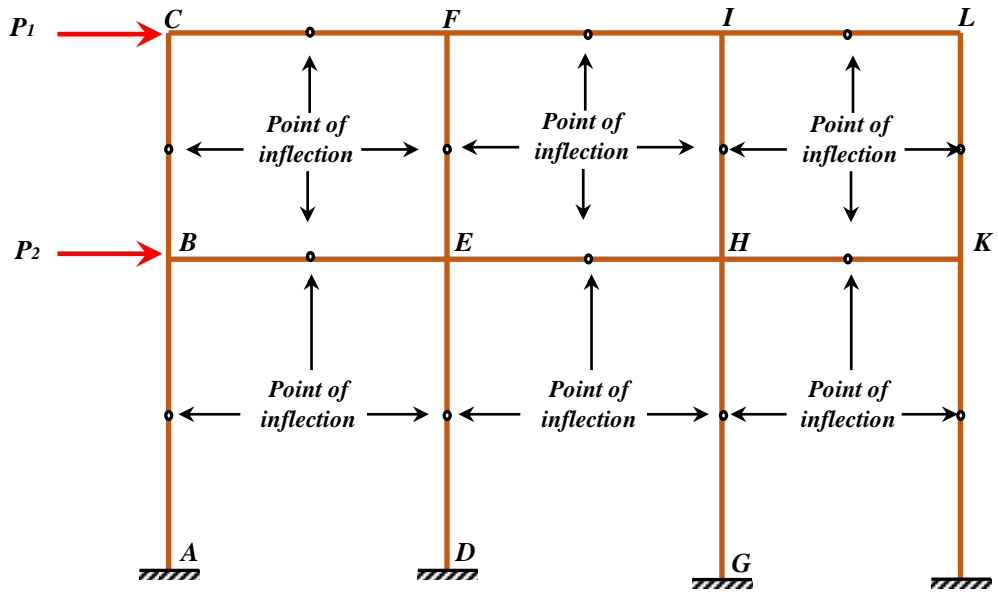


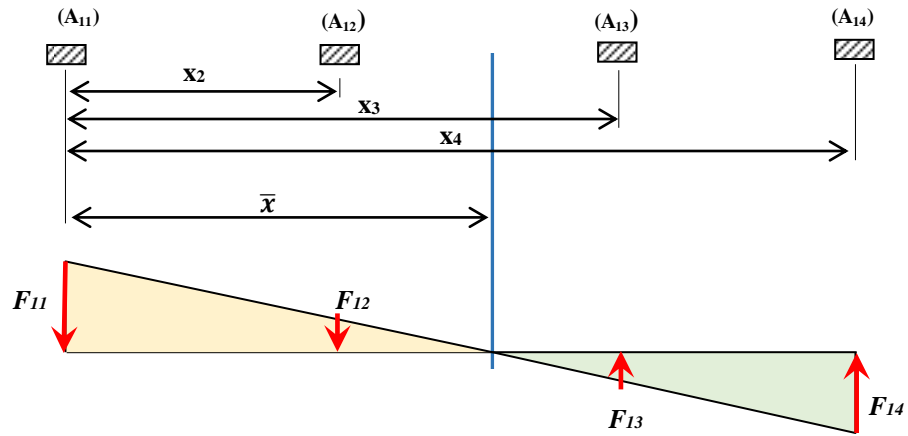
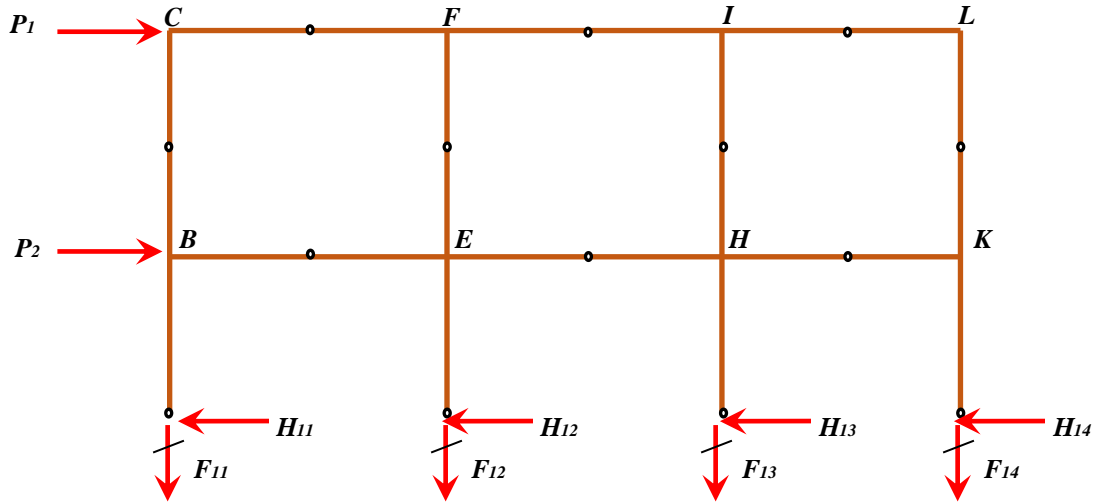
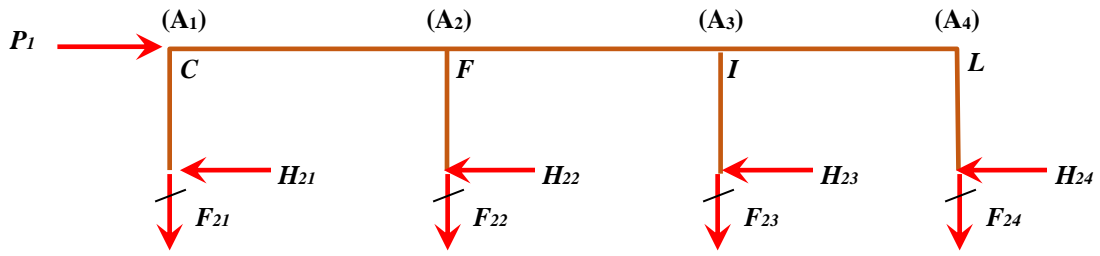
Response of frame subjected lateral loads.



Cantilever Method

1. There is a point of inflection at the center of each girder.
2. There is a point of inflection at the center of each column.
3. The intensity of axial stress in each column of a story is proportional to the horizontal distance of that column from the center of gravity of all the columns of the story in consideration.





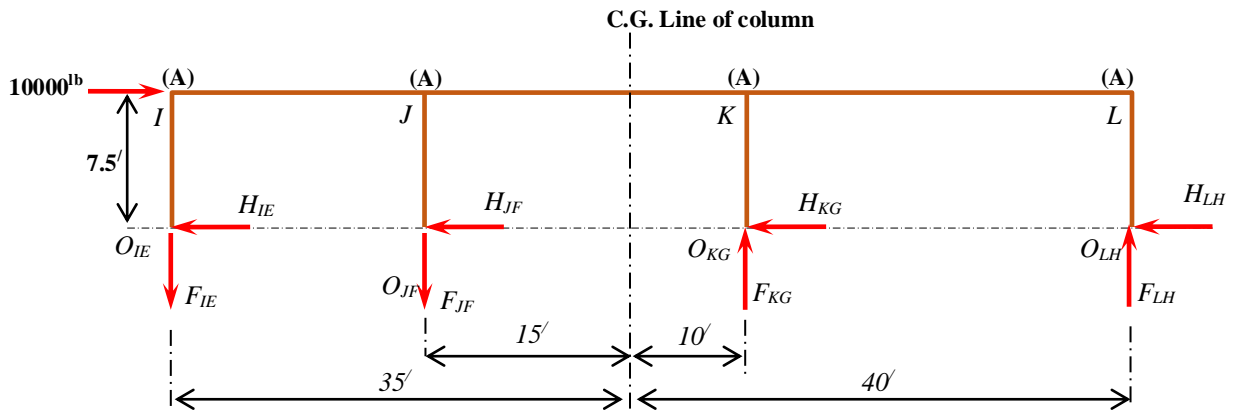
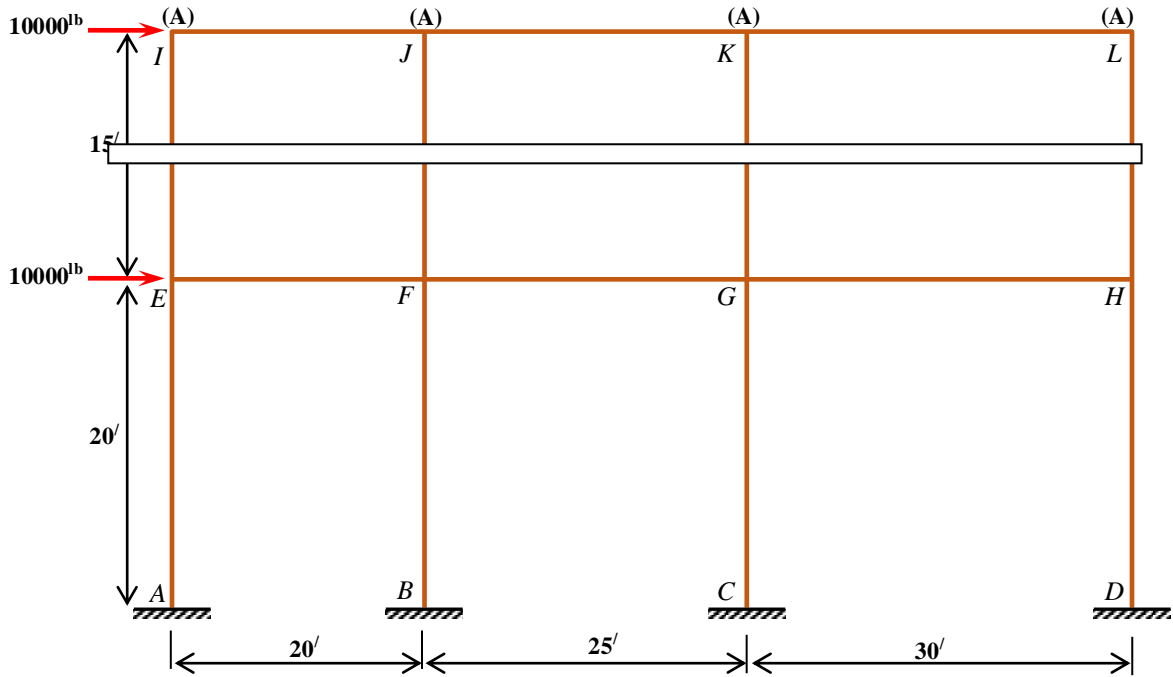
$$f_{11} = \frac{F_{11}}{A_{11}}; \quad f_{12} = \frac{F_{12}}{A_{12}}; \quad f_{13} = \frac{F_{13}}{A_{13}}; \quad f_{14} = \frac{F_{14}}{A_{14}}$$

$$\frac{f_{11}}{\bar{x}} = \frac{f_{12}}{(\bar{x} - x_2)}; \quad f_{12} = \frac{(\bar{x} - x_2)}{\bar{x}} f_{11}; \quad \frac{F_{12}}{A_{12}} = \frac{(\bar{x} - x_2)}{\bar{x}} \frac{F_{11}}{A_{11}}; \quad F_{12} = \frac{(\bar{x} - x_2)}{\bar{x}} * \frac{A_{12}}{A_{11}} * F_{11}$$

$$F_{13} = \frac{(\bar{x} - x_3)}{\bar{x}} * \frac{A_{13}}{A_{11}} * F_{11}$$

$$F_{14} = \frac{(\bar{x} - x_4)}{\bar{x}} * \frac{A_{14}}{A_{11}} * F_{11}$$

$$\bar{x} = \frac{A_{11} * x_{11} + A_{12} * x_{12} + A_{13} * x_{13} + A_{14} * x_{14}}{(A_{11} + A_{12} + A_{13} + A_{14})}$$



$$\bar{x} = \frac{A * 20 + A * 45 + A * 75}{(A + A + A + A)} = 35'$$

$$F_{JF} = -\frac{(\bar{x} - x_2) * A_{JF} * F_{IE}}{\bar{x}} = -\frac{(35 - 20) * A * F_{IE}}{35} = -\frac{15}{35} F_{IE}$$

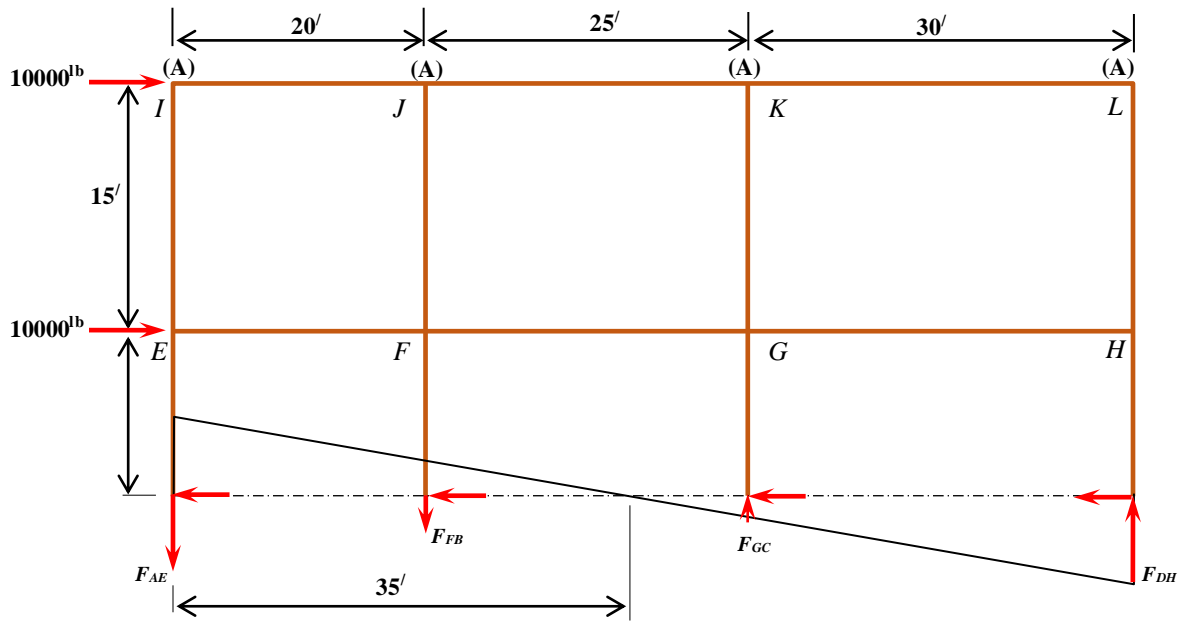
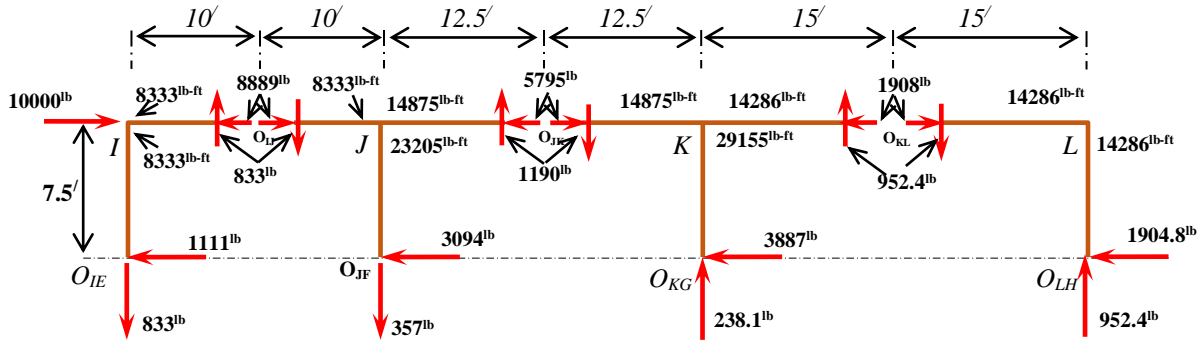
$$F_{KG} = -\frac{(\bar{x} - x_3) * A_{KG} * F_{IE}}{\bar{x}} = -\frac{(35 - 45) * A * F_{IE}}{35} = \frac{10}{35} F_{IE}$$

$$F_{LH} = -\frac{(\bar{x} - x_4) * A_{LH} * F_{IE}}{\bar{x}} = -\frac{(35 - 75) * A * F_{IE}}{35} = \frac{40}{35} F_{IE}$$

$$\sum M_{O_{IE}} = 10000 * 7.5 + F_{JF} * 20 - F_{KG} * 45 - F_{LH} * 75 = 0$$

$$10000 * 7.5 + \frac{15}{35} F_{IE} * 20 - \frac{10}{35} F_{IE} * 45 - \frac{40}{35} F_{IE} * 75 = 0$$

$$F_{IE} = 833.33 \text{ lb}; \quad F_{IE} = 357.14 \text{ lb} \quad F_{KG} = 238.10 \text{ lb} \quad F_{LH} = 952.38 \text{ lb}$$



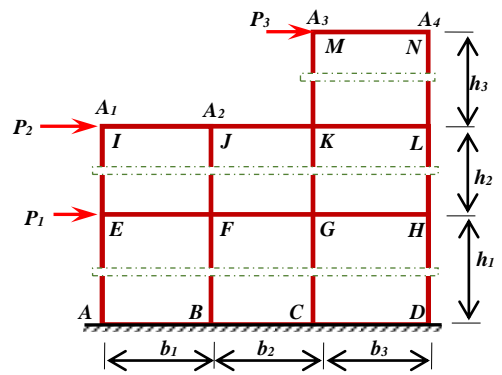
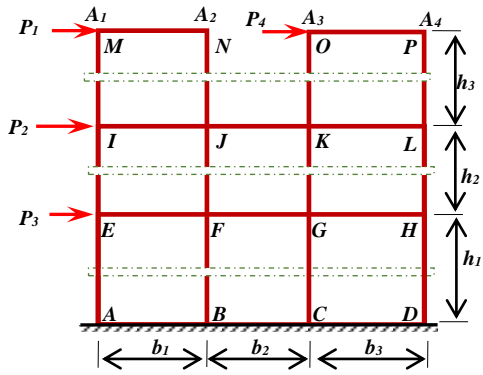
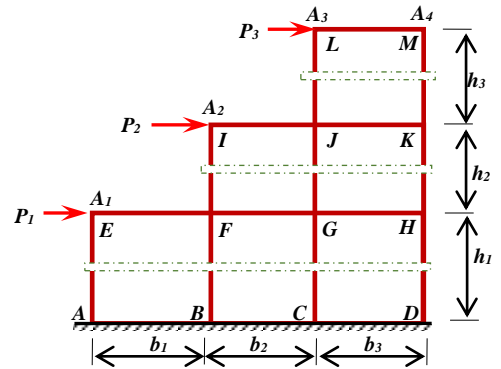
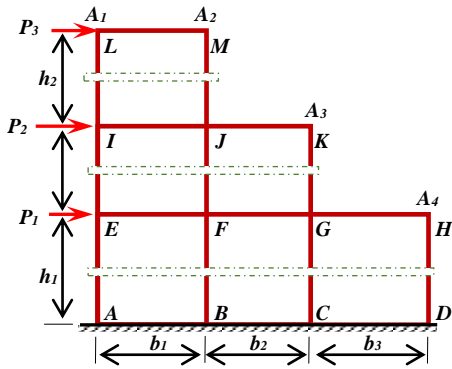
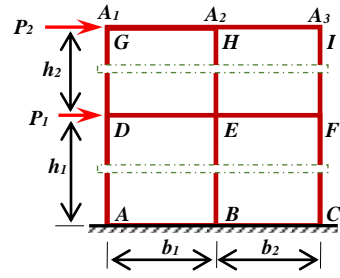
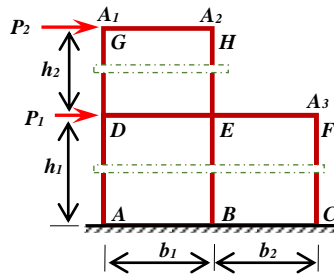
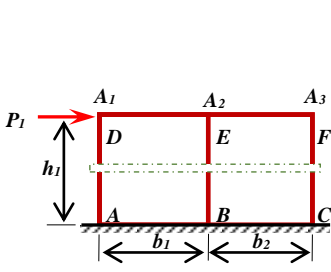
$$\bar{x} = \frac{A * 20 + A * 45 + A * 75}{(A + A + A + A)} = 35'$$

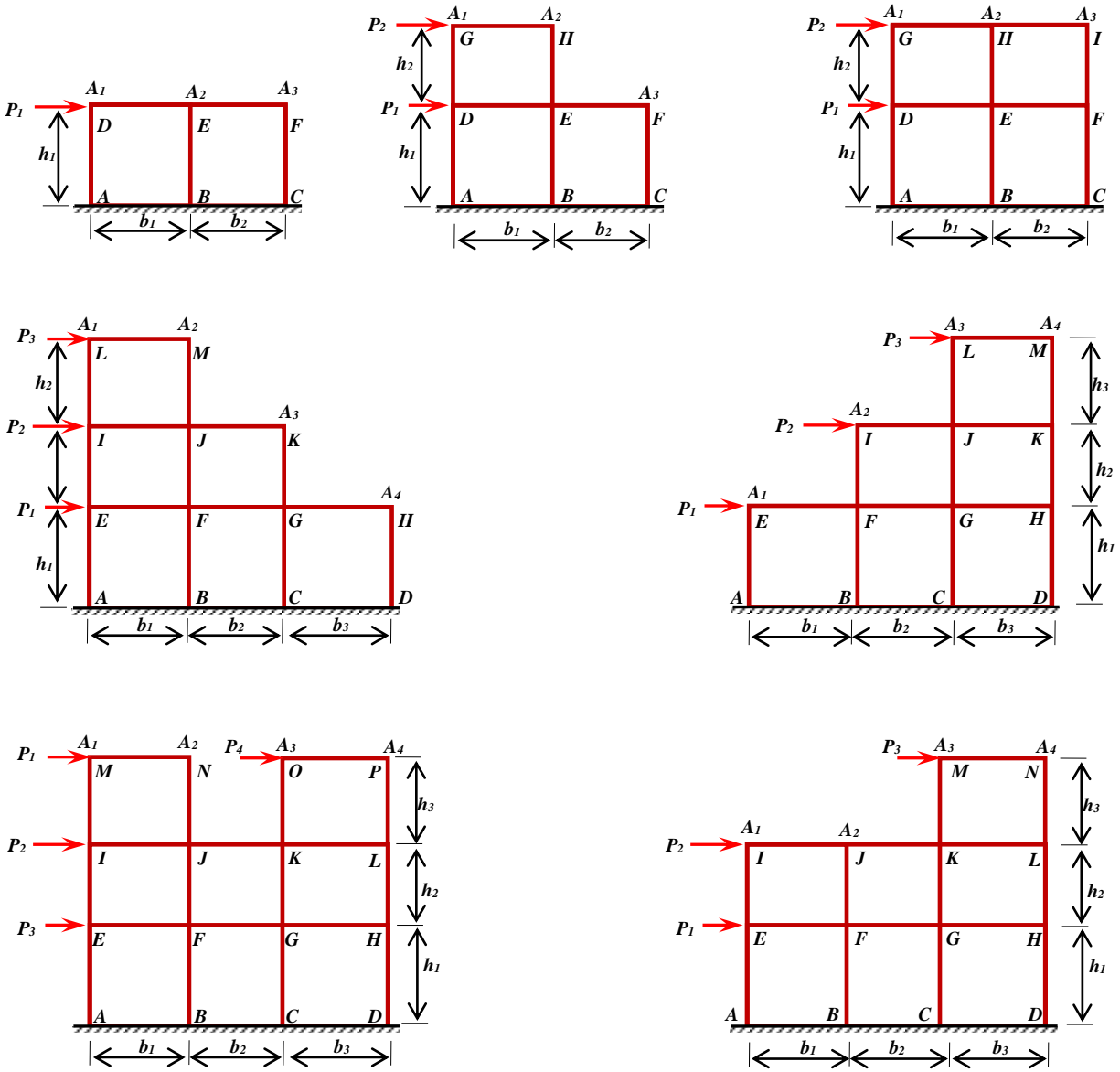
$$F_{FB} = -\frac{15}{35} F_{AE} ; \quad F_{CG} = \frac{10}{35} F_{AE} ; \quad F_{DH} = \frac{40}{35} F_{AE}$$

$$\sum M_{O_{AE}} = 10000 * 25 + 10000 * 10 + F_{FB} * 20 - F_{CG} * 45 - F_{DH} * 75 = 0$$

$$10000 * 25 + 10000 * 10 + \frac{15}{35} F_{AE} * 20 - \frac{10}{35} F_{AE} * 45 - \frac{40}{35} F_{AE} * 75 = 0$$

$$F_{AE} = 3888.89 \text{ lb}(\downarrow); \quad F_{FB} = 1666.67 \text{ lb}(\downarrow) \quad F_{CG} = 1111.11 \text{ lb}(\uparrow); \quad F_{AE} = 4444.45 \text{ lb}(\uparrow);$$





Roll No 1-60

$h_1 = 12 + (0.05 \cdot \text{Last 3 digits of Roll No.})$ in ft

$h_2 = h_3 = 10 + (0.05 \cdot \text{Last 3 digits of Roll No.})$ in ft

$P_1 = 3 + (0.05 \cdot \text{Last 3 digits of Roll No.})$ kips

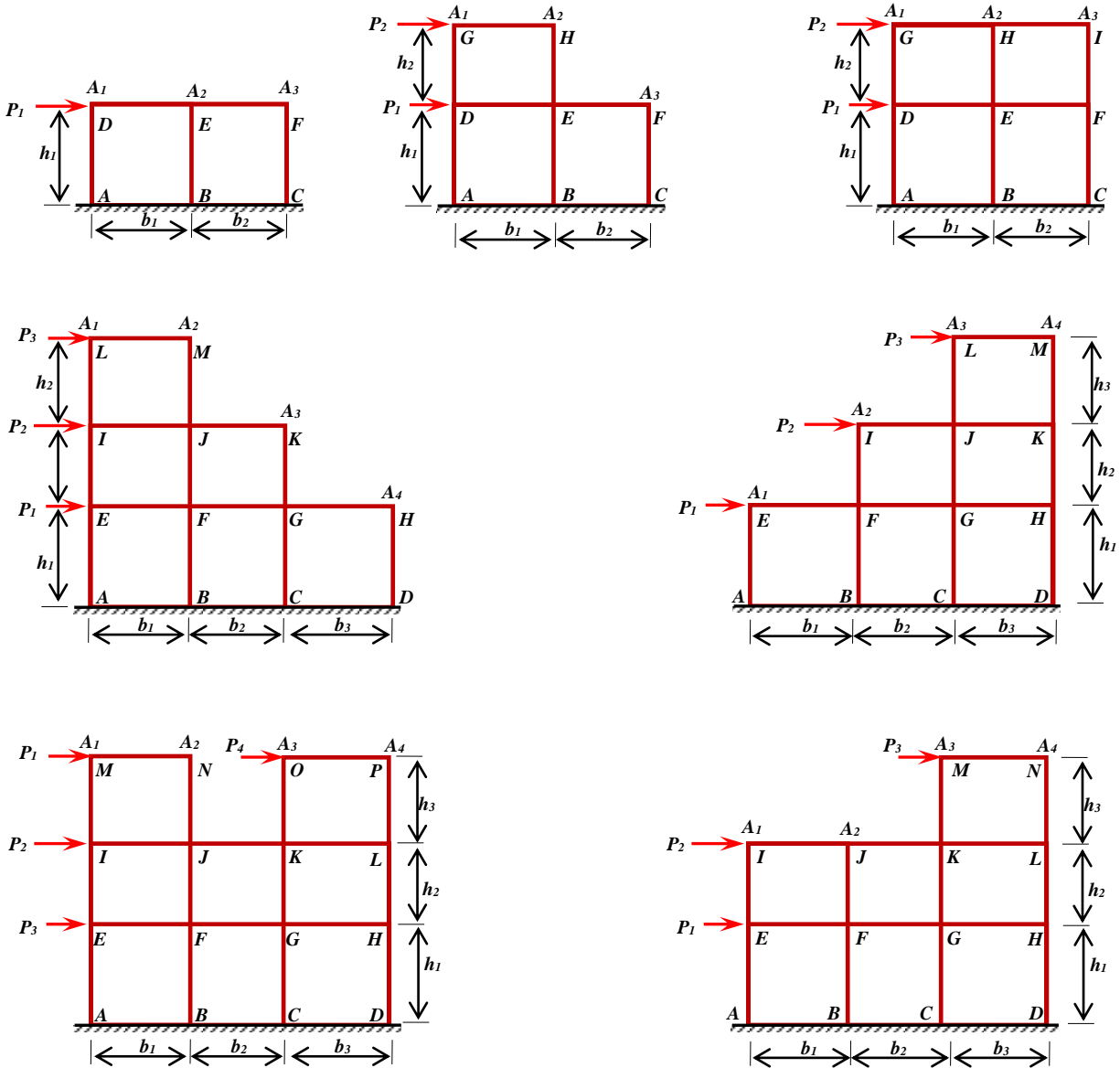
$P_2 = 5.0 + (0.05 \cdot \text{Last 3 digits of Roll No.})$ kips

$P_3 = P_4 = 2.5 + (0.05 \cdot \text{Last 3 digits of Roll No.})$ kips

$b_1 = 10 + (0.02 \cdot \text{Last 3 digits of Roll No.})$ in ft

$h_2 = 12 + (0.02 \cdot \text{Last 3 digits of Roll No.})$ in ft

$h_3 = 12 + (0.02 \cdot \text{Last 3 digits of Roll No.})$ in ft



Roll No 60-120

$h_1 = 4 + (0.02 * \text{Last 3 digits of Roll No.})$ in m

$h_2 = h_3 = 3 + (0.02 * \text{Last 3 digits of Roll No.})$ in m

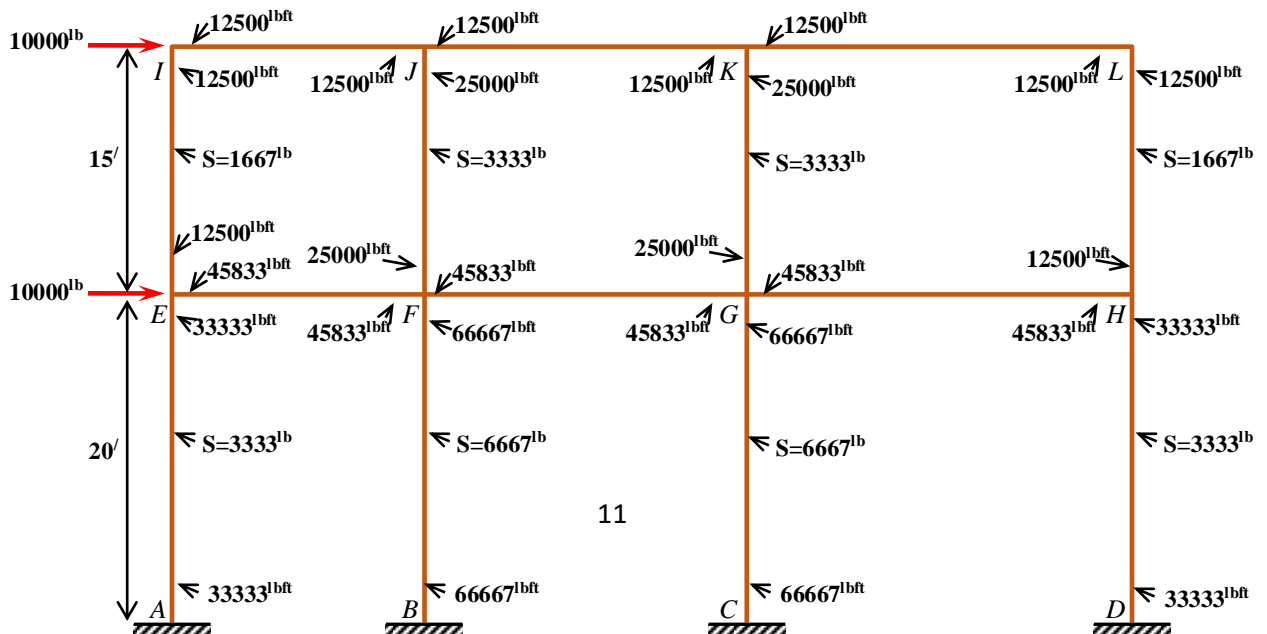
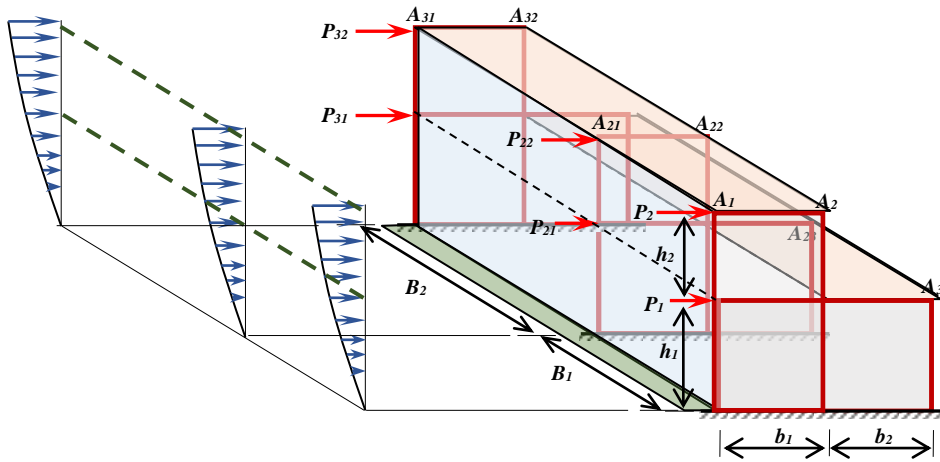
$P_1 = 14 + (0.05 * \text{Last 3 digits of Roll No.})$ kN

$P_2 = 20 + (0.05 * \text{Last 3 digits of Roll No.})$ kN

$P_3 = P_4 = 10 + (0.05 * \text{Last 3 digits of Roll No.})$ kN

$b_1 = 3 + (0.02 * \text{Last 3 digits of Roll No.})$ in m

$b_2 = 4 + (0.02 * \text{Last 3 digits of Roll No.})$ in m



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The approx. analysis of a statically determinate structure dose not depend on the elastic properties of its members. For

Approximate analysis due to vertical load

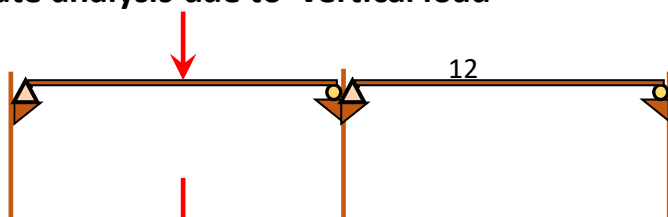
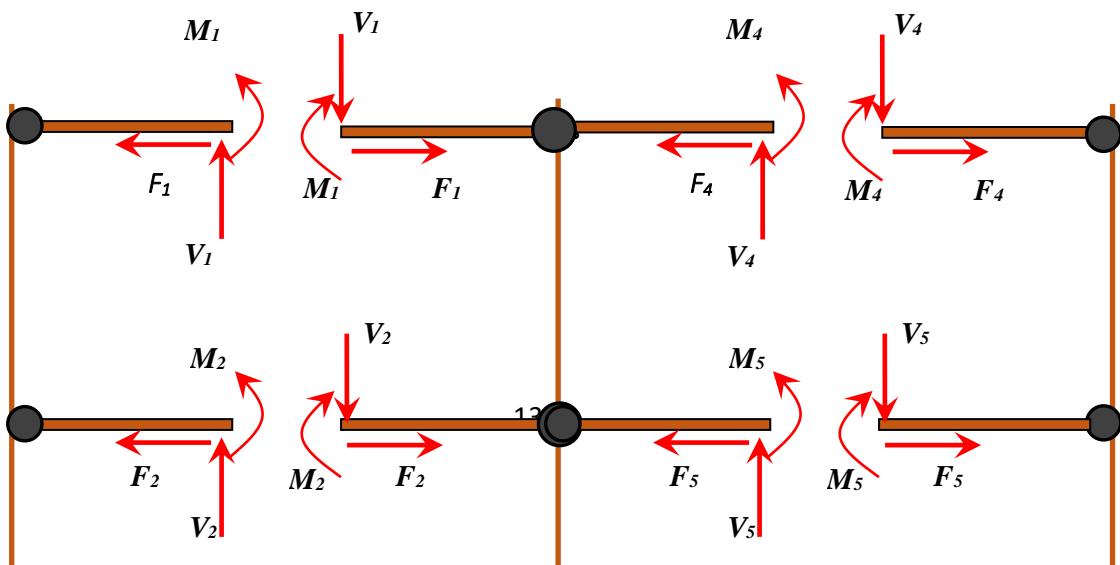


Fig. b

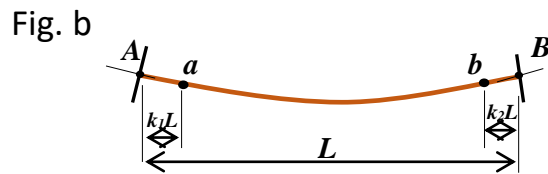
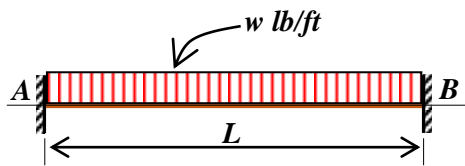
Rigid Frame in which the girders are rigidly connected to the columns so that all members can carry bending moment, shear force, and axial force.

$$\text{DOI} = (3M+R)-3j = (3*15+3*3)-3(12) = 18$$

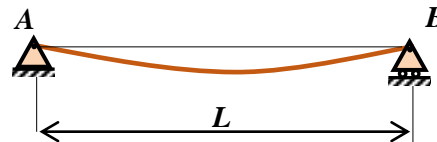
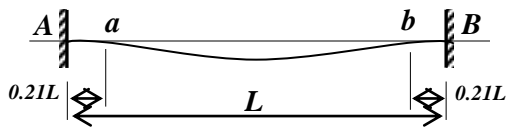


Fully Clamped

semi



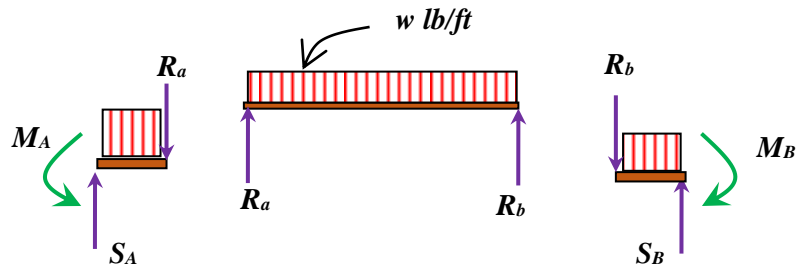
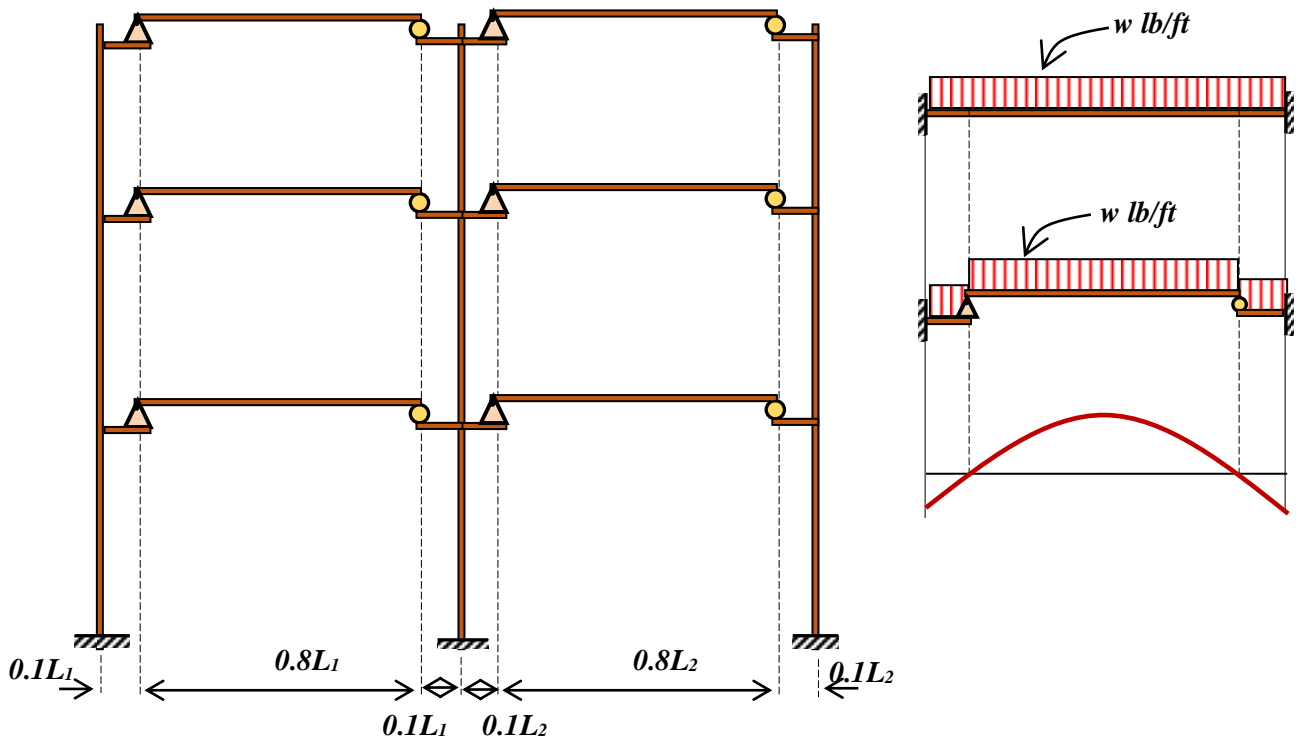
If the girder subjected to UDL w lb/ft, both the joints A and B will rotate as shown above.

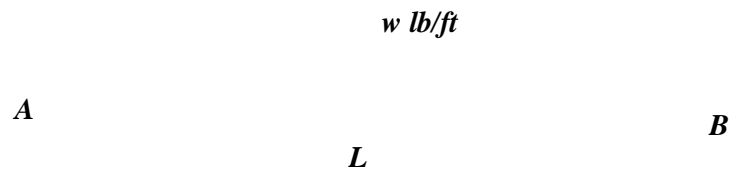


Points of inflection are at points a and b .

Assumptions

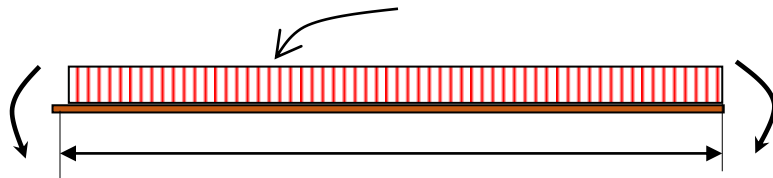
- i. The axial force in the girder zero.
- ii. A point of inflection occurs at the one-tenth point measure along the span from the left support.
- iii. A point of inflection occurs at the one-tenth point measure along the span from the right support.

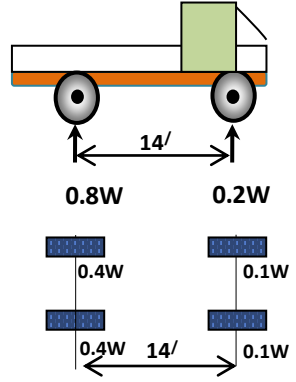
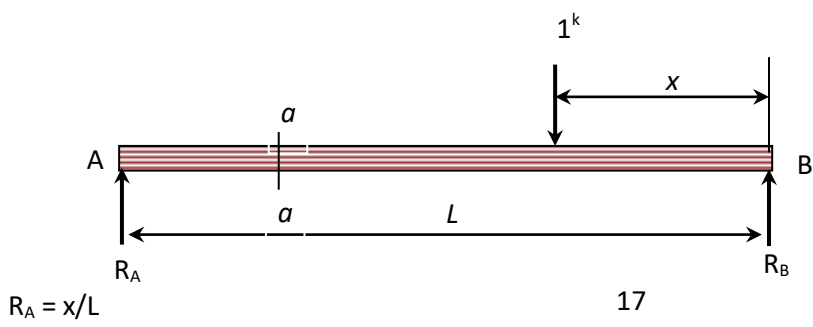
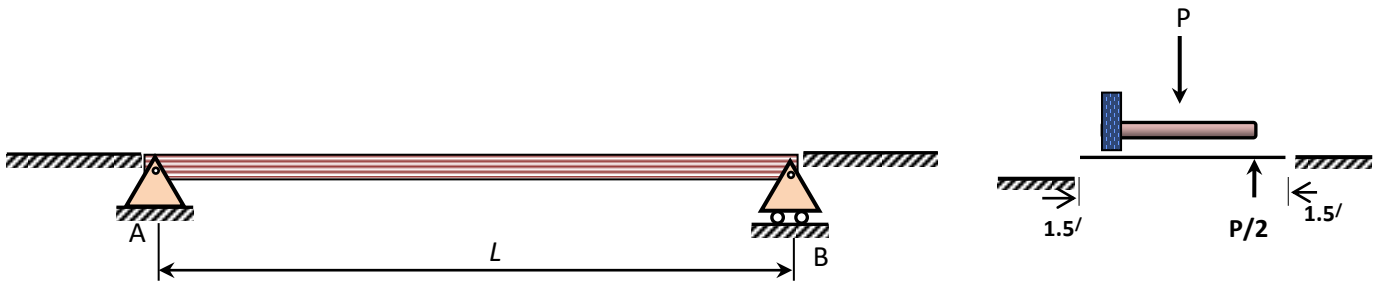
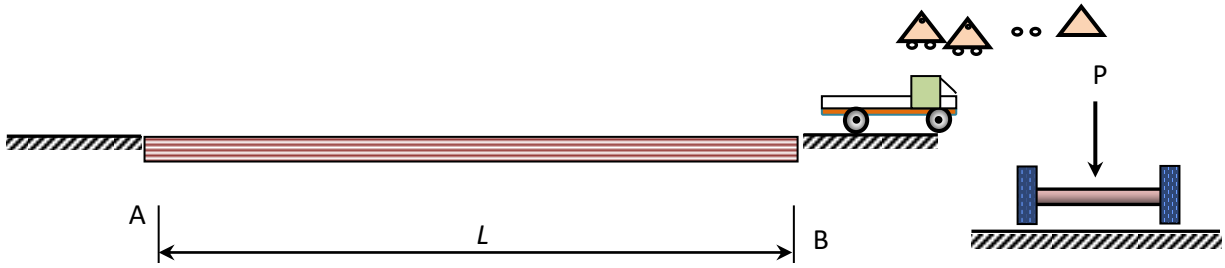




Determine points of inflection.

$$M_{FEM} = wl^2/12$$





$R_A = x/L$

