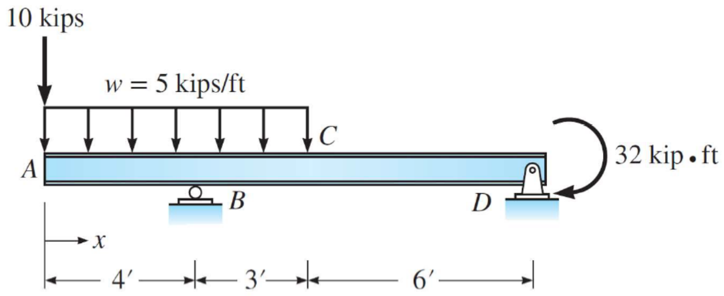
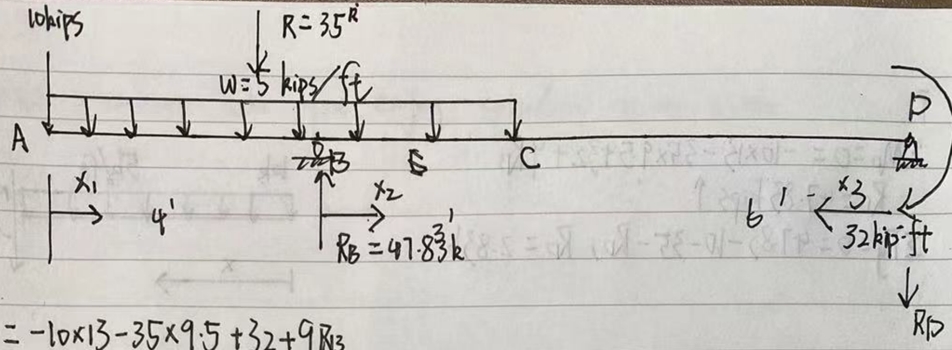
Problem 1. Write the equations for shear and moment using the origin shown in the figure. Draw the corresponding diagrams. Evaluate the shear and moment at C.



P1.

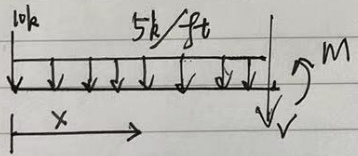


$\Sigma M_D = 0 = -10\times13 - 35\times9.5 + 32 + 9R_B$

$R_B = 47.83$ kips ↑

$\Sigma F_y = 0 = 47.83 - 10 - 35 - R_D$; $R_D = 2.83^k$

Segment AB: $0 \le x_1 \le 4$

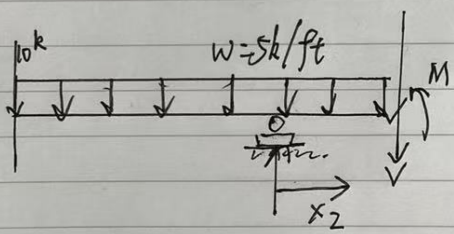


$\Sigma F_y = 0 = -10 - 5x_1 - V$ $\quad \therefore V = -10 - 5x_1$

$\Sigma M_x = 0 = 10x_1 + 5x_1 \cdot \frac{x_1}{2} + M$

$M = -10x_1 - \frac{5}{2}x_1^2$

Segment BC: $0 \le x_2 \le 3$



$\Sigma F_y = 0 = -10 - (4+x_2)5 + 47.83 - V$

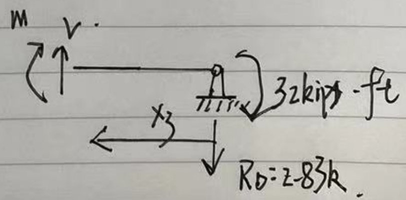
$V = -30 - 5x_2 + 47.83$

$V = 17.83 - 5x_2$

$\Sigma M_B = 0 = -M - 10(4+x_2) - 5\left(\frac{4+x_2}{2}\right)^2 + 47.83x_2$

$M = -40 + 37.83x_2 - \frac{5}{2}(4+x_2)^2$

Segment DC: $0 \le x_3 \le 6'$



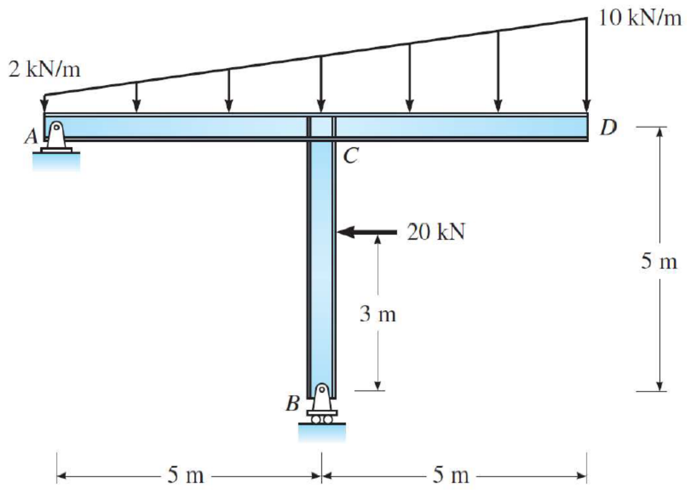
$\Sigma F_y = 0 \quad V_c - 2.83^k = 0$; $V_c = 2.83^k$

$\Sigma M_z = 0 \quad M + 32\text{ ft}\cdot k + 2.83x_3 = 0$

$M = -32^{\text{ft}\cdot k} - 2.83x_3$

$M_c(x_3 = 6') = -49\text{ ft}\cdot k$

Problem 2. Draw the shear and moment diagrams for each member of the frame in the figure below. Sketch the deflected shape.

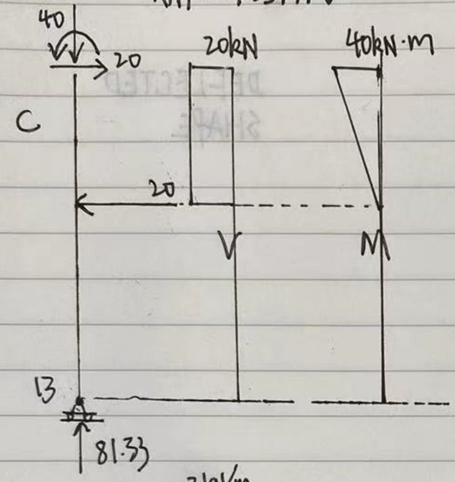


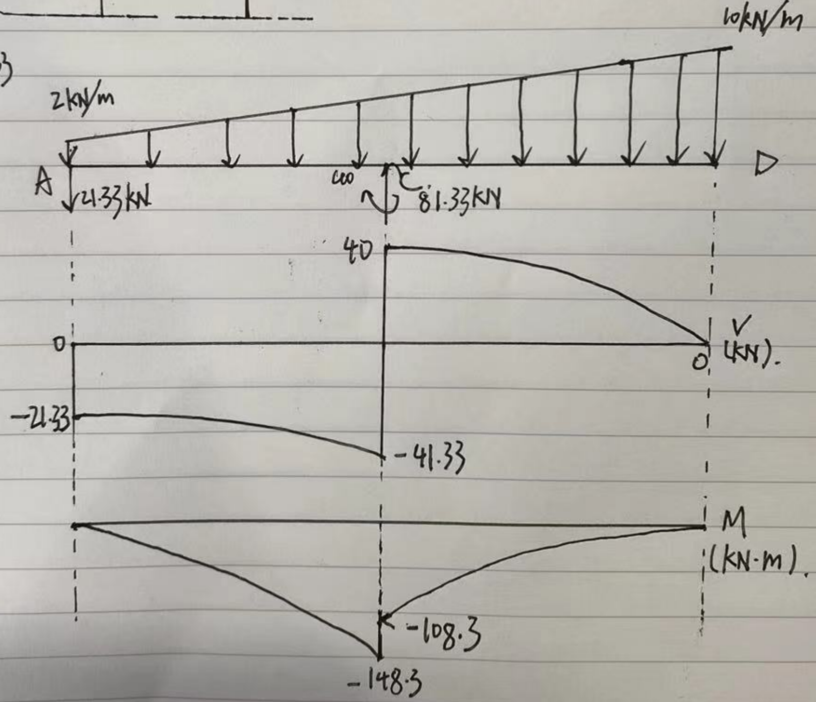
P2. $\Sigma M_A = 0;\quad 20(5m) + 40\left(\frac{20}{3}\right) - 5R_B + 20(2m) = 0$

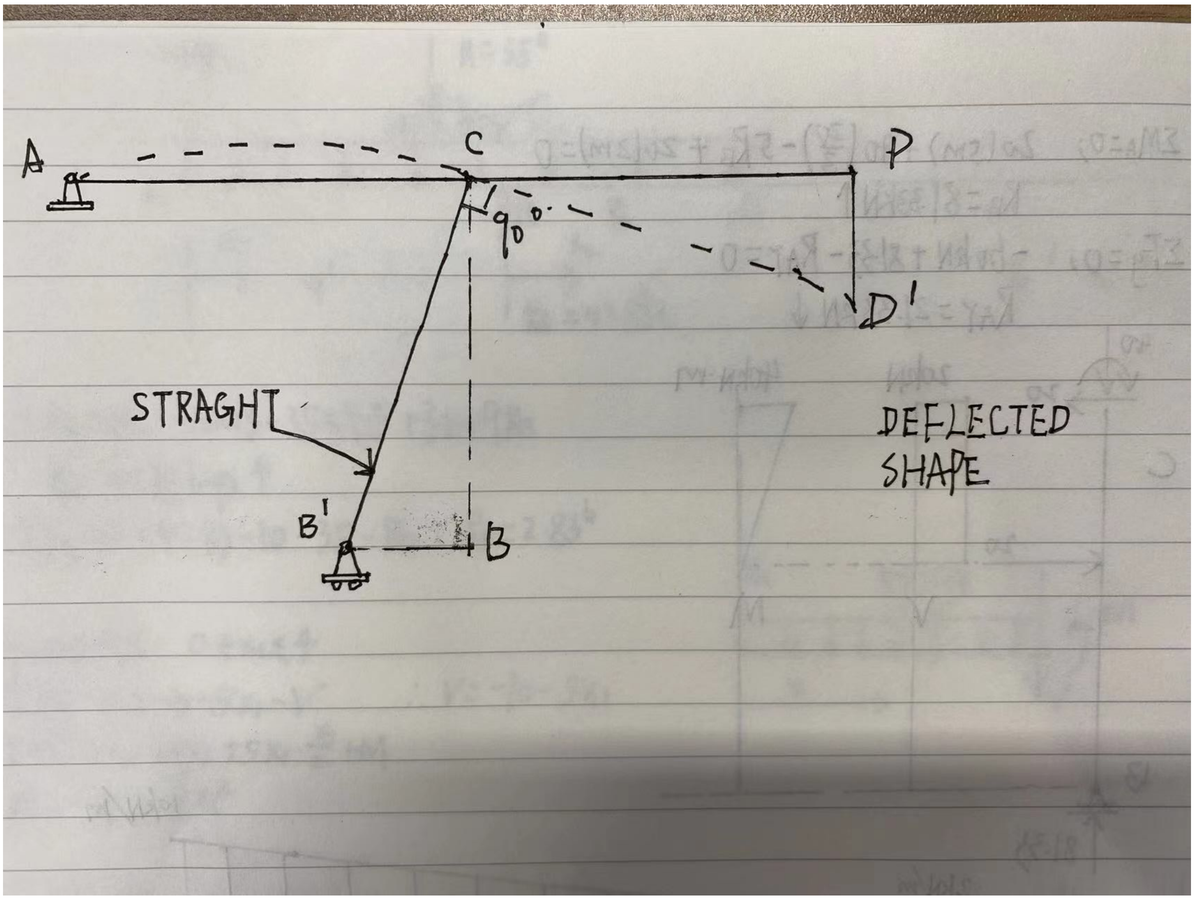
$R_B = 81.33\,kN \uparrow$

$\Sigma F_y = 0;\quad -60kN + 81.33 - R_{AY} = 0$

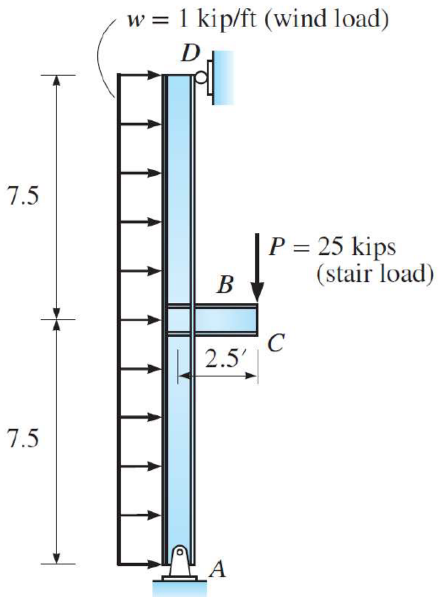
$R_{AY} = 21.33\,kN \downarrow$





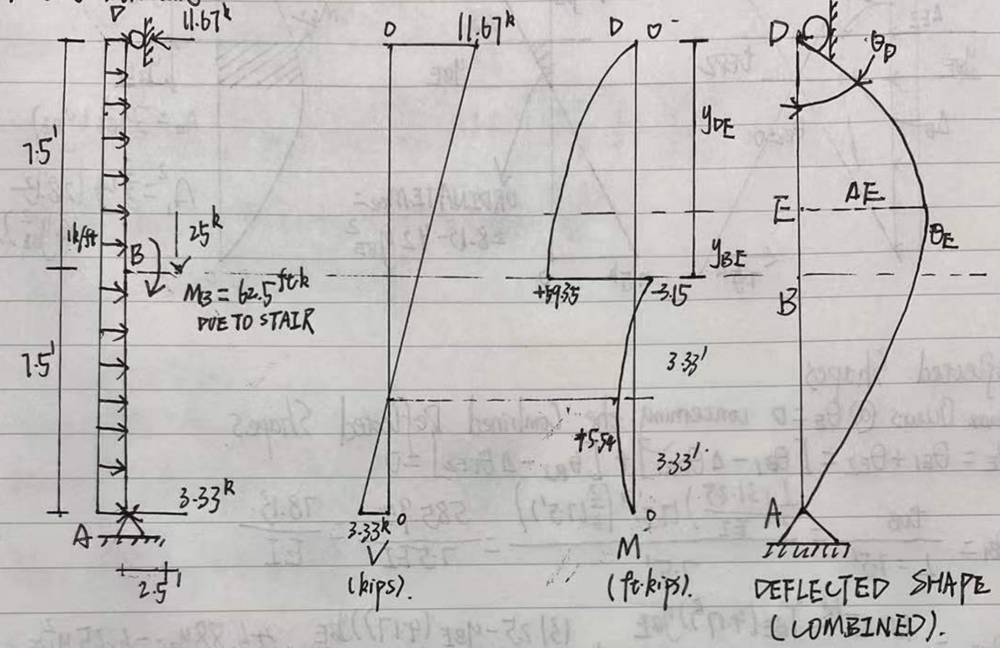


Problem 3. The load acting on a column that supports a stair and exterior veneer is shown in the figure below. Determine the required moment of inertia for the column such that the maximum lateral deflection of AD does not exceed $1/4\ \mathrm{in}$, a criterion set by the veneer manufacturer. Use $E = 29,000\ \mathrm{kips/in^2}$.

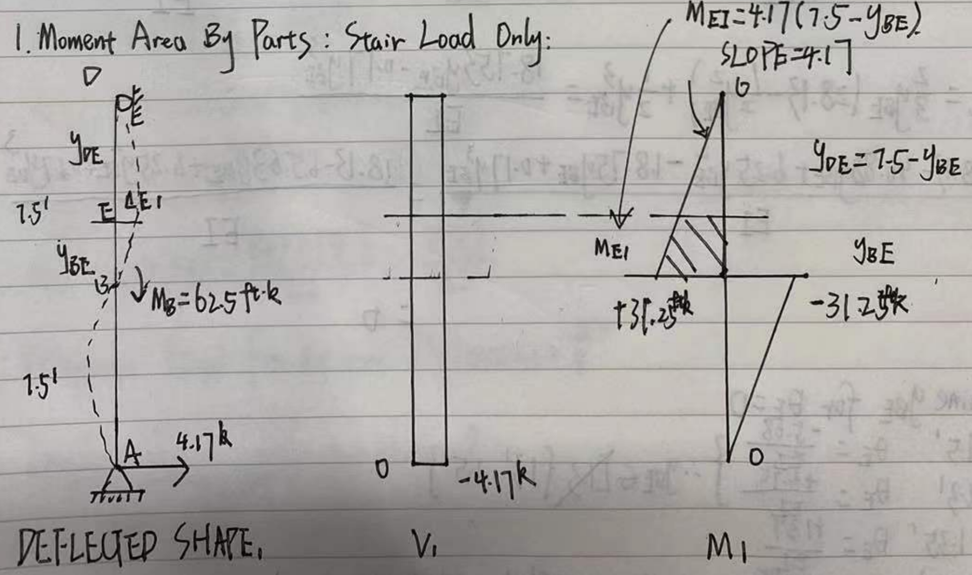


P3. Max lateral deflection occurs where $\theta_E = 0$, which occurs between max positive deflections caused by stair & wind loads independently.

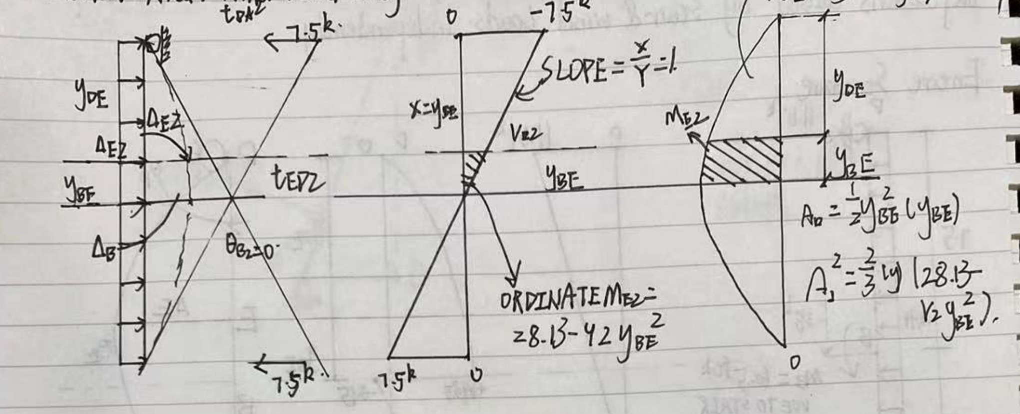
Entire Structure



1. Moment Area By Parts: Stair Load Only:



2. Moment-Area: Wind Load Only:



Deflected Shapes

Δ_{max} Occurs @ $\theta_E=0$ concerning the Combined Deflected Shapes.

$$\theta_E=\theta_{E1}+\theta_{E2}=[\theta_{B1}-\Delta\theta_{BE1}]+[\theta_{B2}-\Delta\theta_{BE2}]=0$$

$$\theta_{B1}=\frac{t_{DB}}{L=7.5'}=\frac{\frac{1}{2}\left(\frac{31.25}{EI}\right)(7.5')\left(\frac{2}{3}(7.5')\right)}{7.5'}=\frac{585.94}{7.5EI}=\frac{78.13}{EI}$$

$$\Delta\theta_{BE1}=\frac{(31.25^{1k}-y_{BE}(4.17^k))y_{BE}}{2EI}+\frac{(31.25-y_{BE}(4.17))y_{BE}}{EI}=\frac{46.88y_{BE}-6.25y_{BE}^2}{EI}$$

$$\Delta\theta_{BE2}=\frac{2}{3}y_{BE}\left(28.13-\frac{1}{2}y_{BE}^2\right)+\frac{1}{2}y_{BE}^3=\frac{18.753y_{BE}-0.17y_{BE}^3}{EI}$$

$$\theta_E=\frac{78.13-46.88y_{BE}+6.25y_{BE}^2-18.75y_{BE}+0.17y_{BE}^3}{EI}=\frac{78.13-65.63y_{BE}+6.25y_{BE}^2+0.17y_{BE}^3}{EI}$$

$=0$

Determine y_{BE} for $\theta_E=0$

$y_{BE}=1.5'$ $\quad\theta_E=\frac{-5.68}{EI}$

$y_{BE}=1.3'$ $\quad\theta_E=\frac{+3.75}{EI}$ $\Big\}\therefore y_{BE}\in\{1.3',1.5'\}$

$y_{BE}=1.35'$ $\quad\theta_E=\frac{+1.39}{EI}$

$y_{BE}=1.37'$ $\quad\theta_E=\frac{+0.385}{EI}$ $\rightarrow y_{BE}=1.378'$ $\quad y_{DE}=7.5'-y_{BE}=6.12'$

Determine $\Delta_E = \Delta_{E1} + \Delta_{E2}$

$\Delta_{E1} = EE_1' - t_{ED1}$

Where $EE_1' = \theta_{D1} \cdot y_{DE}$

$$\theta_{D1} = \frac{t_{AD1}}{L} = \frac{\left[\left(\frac{31.25}{2EI}\right)7.5'(10'-5')\right]}{15'} = \frac{39.1}{EI}$$

$$t_{ED1} = \frac{1}{2}M_{E1}(y_{DE})\left[\frac{1}{3}(y_{DE})\right] = \left[\frac{1}{2}\left(\frac{25.52}{EI}\right)(6.12)\right]\left[\frac{6.12'}{3}\right] = \frac{159.3}{EI}$$

M_{E1} = Ordinate on M_1 curve $= 4.17(7.5 - y_{BE}) = \frac{25.52}{EI}$

Thus $\Delta_{E1} = \frac{39.1(6.12') - 159.3}{EI} = \frac{80}{EI}$

$\Delta_{E2} = EE_2' - t_{ED2}$

Where $EE_2' = \theta_{D2} \cdot y_{DE}$

$$\theta_{D2} = \frac{t_{AD2}}{L} = \frac{2}{3}\left(\frac{28.13}{EI}\right)\frac{(15')(7.5')}{(15')} = \frac{140.65}{EI}$$

$$EE_2' = \left(\frac{140.65}{EI}\right)6.12' = \frac{860.8}{EI}$$

$$t_{ED2} = \left(\frac{2}{3}M_{E2} \cdot y_{DE}\right)\frac{1}{3}y_{DE}$$

$$M_{E2} = 28.13 - \frac{1}{2}y_{BE}^2 = \frac{27.18}{EI}$$

$$t_{ED2} = \frac{2}{3}(27.18)(6.12')\frac{1}{3}(6.12') = \frac{226.2}{EI}$$

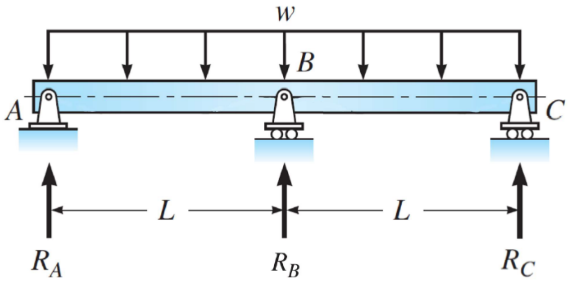
Thus $\Delta_{E2} = \frac{860.8 - 226.2}{EI} = \frac{634.7}{EI}$

$$\Delta_E = \Delta_{E1} + \Delta_{E2} = \frac{80 + 634.7}{EI} = \frac{714.7}{EI}$$

Determine I_{Reqd} for Δ_E max. Deflection $= \frac{1}{4}''$

$$I_{Reqd} = \frac{714.7(1728)}{29000(1/4'')} = 170.4\ in^4$$

Problem 4. Determine the reactions of the continuous beam in the figure below (EI is constant). Draw the shear and moment diagram, and sketch the deflected shape.



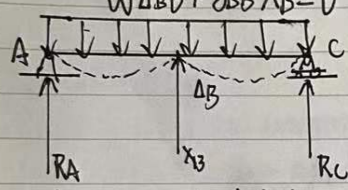
P4. The beam is indeterminate 1° 4 reactions 3 equations of statics.

We select the reaction at B as the redundant.
The released structure loaded by the specified loads and the redundant X_B is shown in figure below.
Since the roller prevents vertical deflection at B,
the ~~geometrical~~ geometric equation ~~Static~~ is

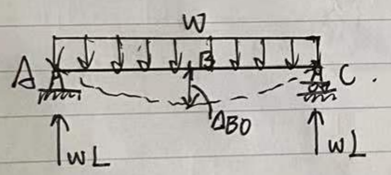
$$\Delta_B = 0 \qquad (1)$$

Expressing ~~Equatio~~ Equation 1 in terms of external load and a unit value of the redundant multiplied by the magnitude of the redundant X_B.

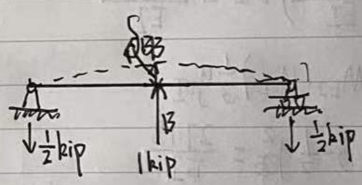
$$w\Delta_{B0} + \delta_{BB} X_B = 0 \qquad (2)$$



released structure loaded by external load and redundant



released structure with external load



released structure loaded by redundant

Using figure above, we compute the displacement at B.

$$\Delta_{B0} = -\frac{5w(2L)^4}{384EI} \qquad \delta_{BB} = \frac{1\cdot(2L)^3}{48EI}$$

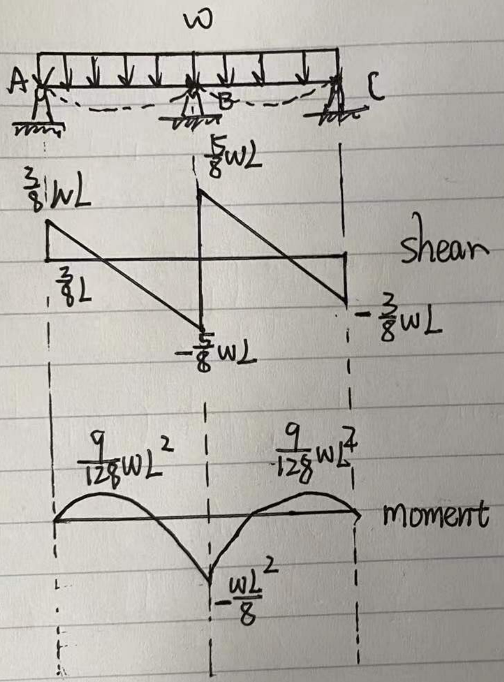
Substituting Δ_{B0} and δ_{BB} into Equation (2) to solve X_B:

$$R_B = X_B = 1.25wL$$

We compute the balance of the reactions by adding.

$$R_A = wL - \frac{1}{2}\times 1.25wL = \frac{3}{8}wL$$

$$R_C = wL - \frac{1}{2}\times 1.25wL = \frac{3}{8}wL$$



DEFLECTED SHAPE