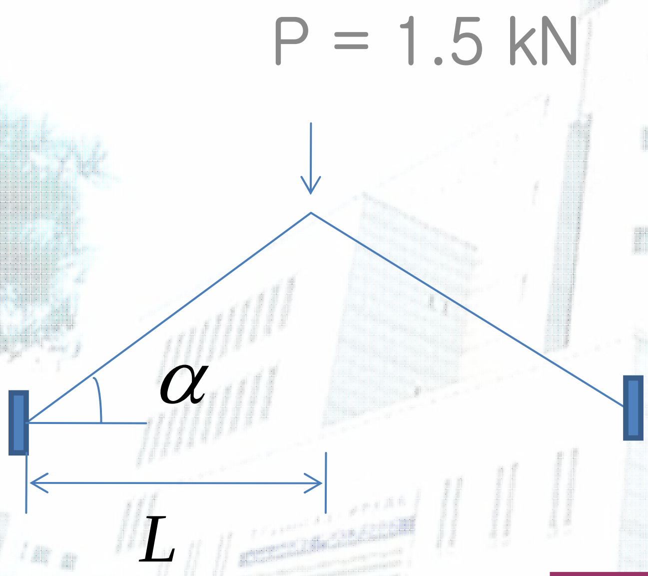
성난2인조


Optimum design of triangle mode beam
Trigon

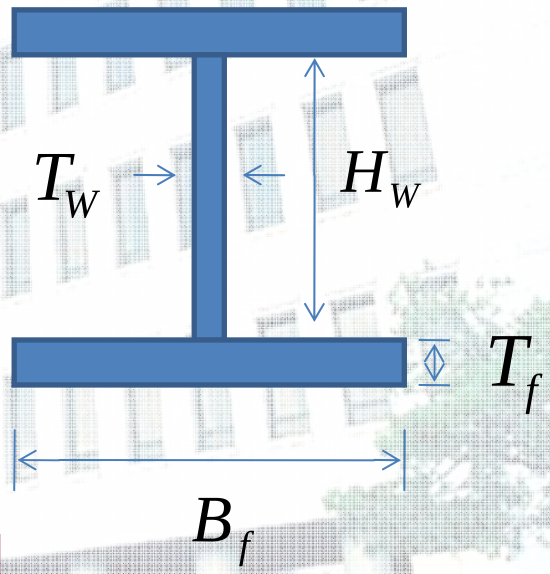
Problem Statement

- 선박의 전체 중량에서 종방향의 격벽이 차지하는 비중 약 20%
- 따라서 기존의 flat한 형태에서 Pitched structure로 대체하였을 경우 중량 감소 이득, 적재 하중 능력 향상

Beam subjected to distributed loads



Shape of section



Mildsteel

Minimize object function

Object function

$$W = \frac{(H_W T_W + 2B_f T_f)\rho L}{\cos\alpha}$$

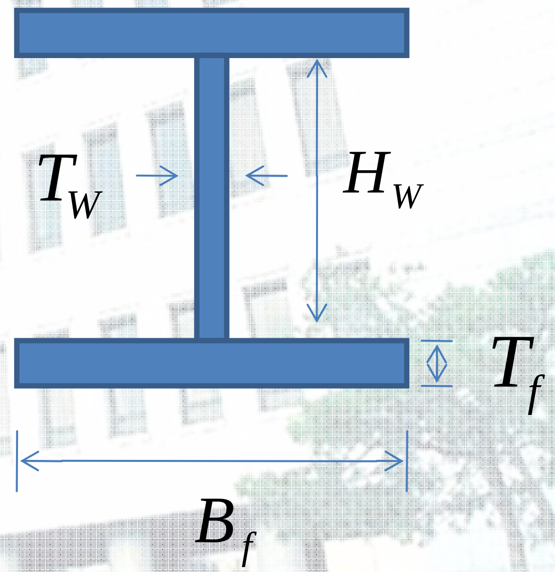
$$\rho = 7850 Kg/m^3$$

$$L = 5m$$

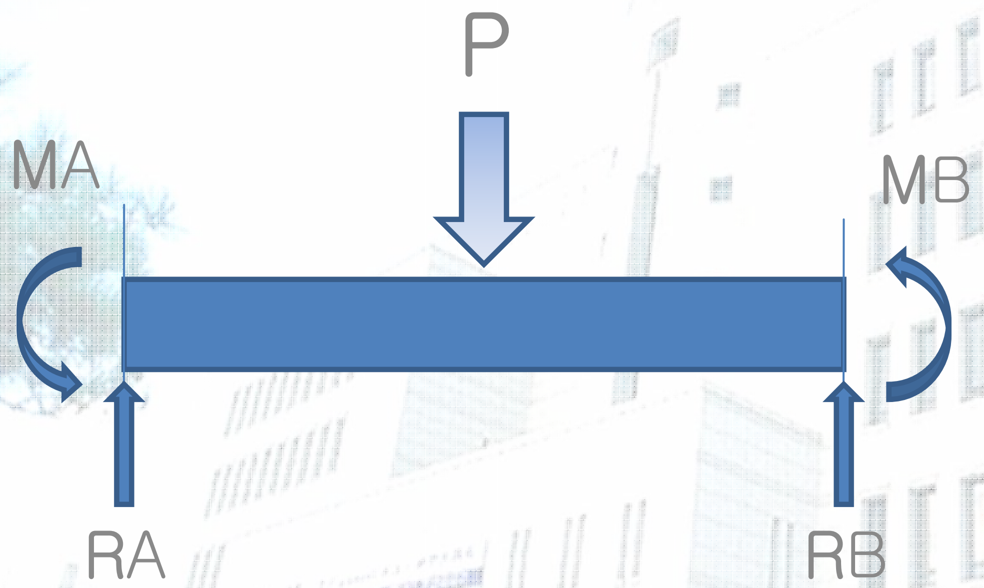
Design variable

Variable

$$\alpha\ , T_f\ , B_f\ , T_W\ , H_W$$



Method of the Calculation



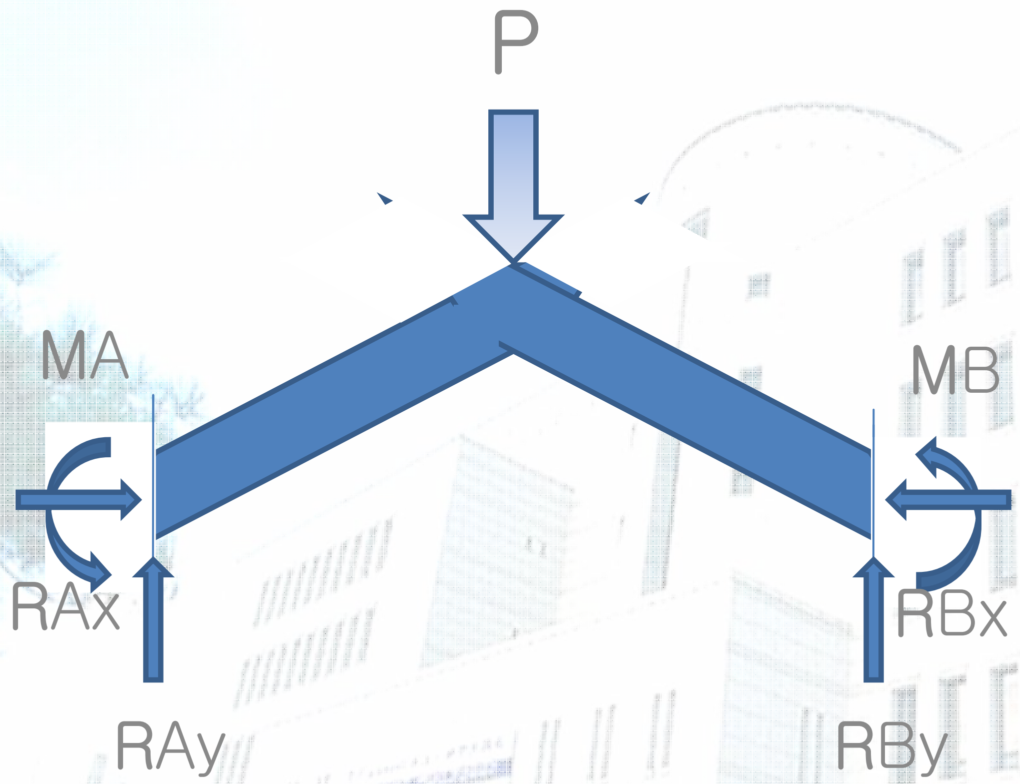
$$EI\frac{d^2y}{dx^2} = -M_A + \frac{P}{2}x$$

$$EI\frac{dy}{dx} = -M_A x + \frac{P}{4}x^2 + C_1$$

$$\begin{cases} \dfrac{dy}{dx} = 0, & at\ \ x = 0 \\ \dfrac{dy}{dx} = 0, & at\ \ x = L \end{cases}$$

$$\therefore\ M_A = \frac{PL}{4}$$

Method of the Calculation



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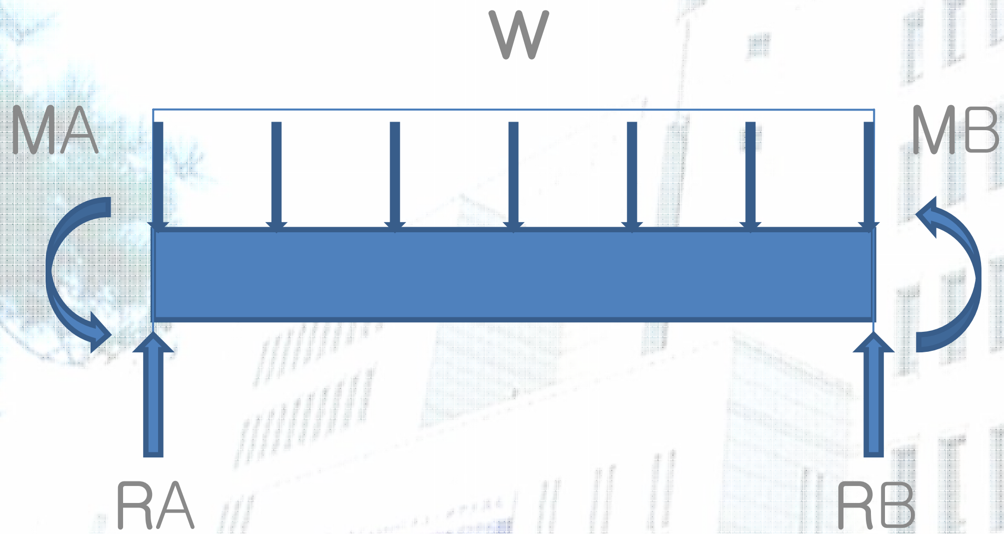
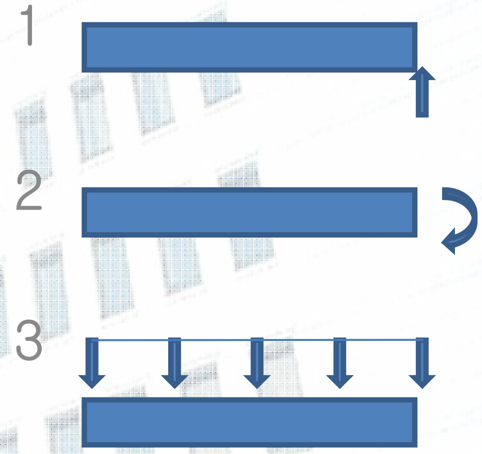
$$\left\{ \begin{array}{l} \dfrac{dy}{dx} = 0, \quad at \ \ x = 0 \\ \dfrac{dy}{dx} = 0, \quad at \ \ x = L\cos\alpha \end{array} \right\}$$

$$\therefore \ M_A = \frac{PL}{4}\cos\alpha$$

$$F = \frac{P}{2\cos\alpha}$$

Method of the Calculation



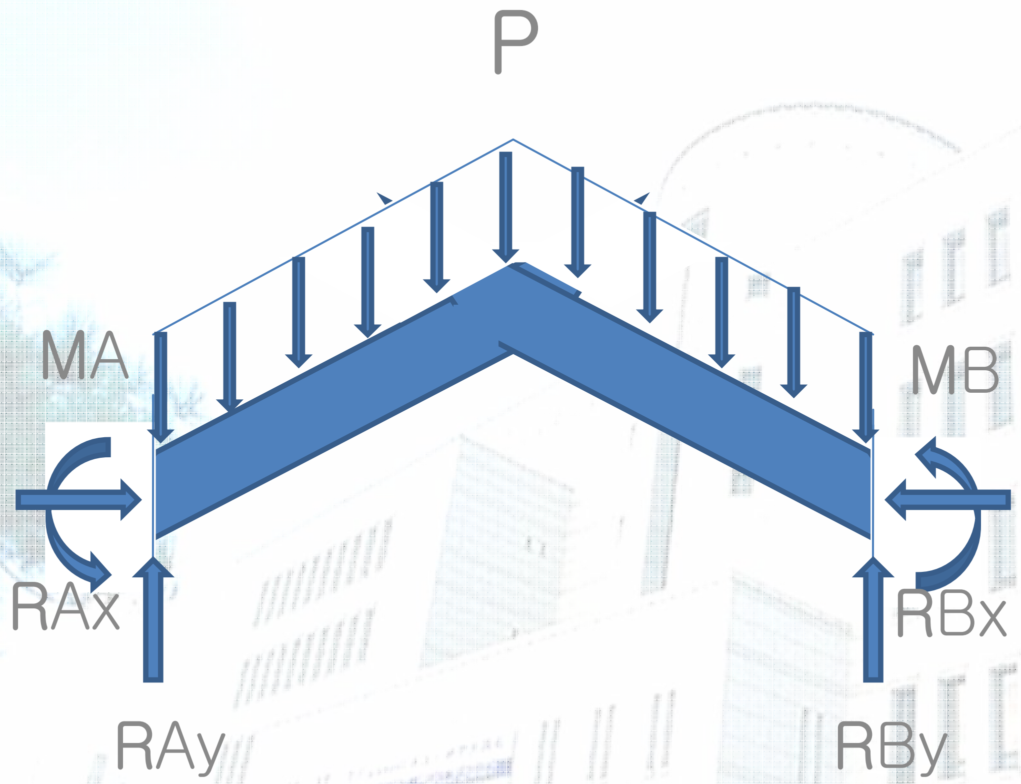


$$(y_B)_1 + (y_B)_2 + (y_B)_3 = 0$$

$$(\theta_B)_1 + (\theta_B)_2 + (\theta_B)_3 = 0$$

$$\therefore \; M_A = \frac{wL^2}{3}$$

Method of the Calculation



$$\therefore\ M_A = \frac{wL^2}{3}\cos^2\alpha$$

$$F = \frac{wL}{\cos\alpha}$$

Constraints

1. Prevent Buckling

$$\frac{H_W}{T_W} - 50 \le 0$$ ……(1)

$$\frac{T_f}{T_w} - 1.5 \le 0$$ ……(2)

$$\frac{B_f}{T_f} - 18 \le 0$$ ……(3)

Constraints

2. Cross sectional area

$$-B_f < 0 \quad \cdots\cdots(4)$$

$$-T_f < 0 \quad \cdots\cdots(5)$$

$$-T_W < 0 \quad \cdots\cdots(6)$$

$$-H_W < 0 \quad \cdots\cdots(7)$$

Constraints

3. Limit of angle

$$-\alpha \leq 0 \qquad \cdots\cdots(8)$$

$$\alpha - 20 \leq 0 \qquad \cdots\cdots(9)$$

Constraints

4. Stress

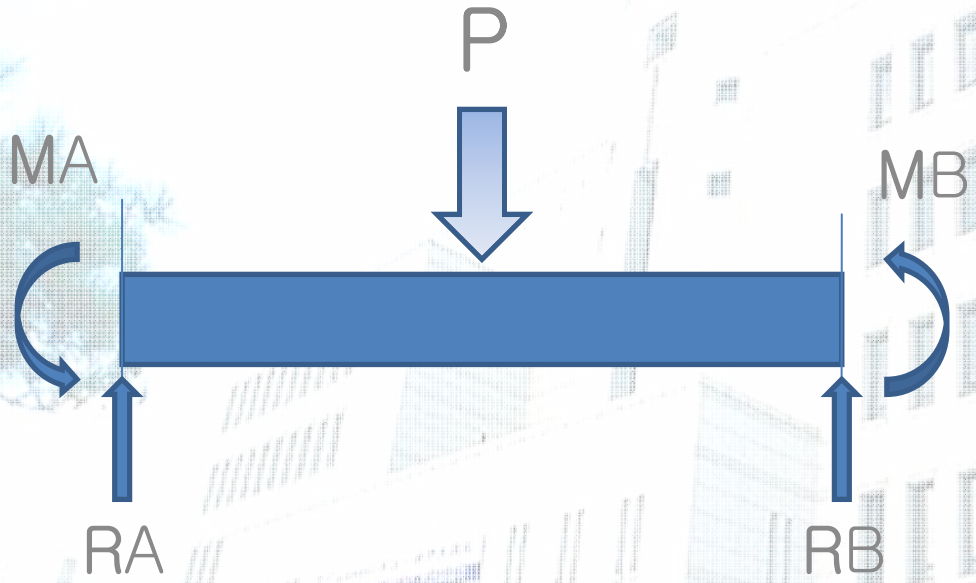
$$2(\sigma_c + \sigma_M) - \sigma_{all} \leq 0 \qquad * \; F \cdot S = 2$$

$$\left(\sigma_c = \frac{P}{A}; \qquad A = \frac{H_W T_W + 2B_f T_f}{2\cos\alpha} \right)$$

$$\left(\begin{aligned} &\sigma_M = \frac{M(H_W + 2T_f)}{2I}; \qquad M = \frac{PL}{2}\cos\alpha \\ &I = 2\left(\frac{B_f T_f^3}{12} + B_f T_f \left(\frac{H_W}{2} + \frac{T_f}{2}\right)^2\right) + \frac{T_W H_W^3}{12} \end{aligned} \right)$$

······(10)

Solve the Problem by Excel



$$EI\frac{d^2y}{dx^2} = -M_A + \frac{P}{2}x$$

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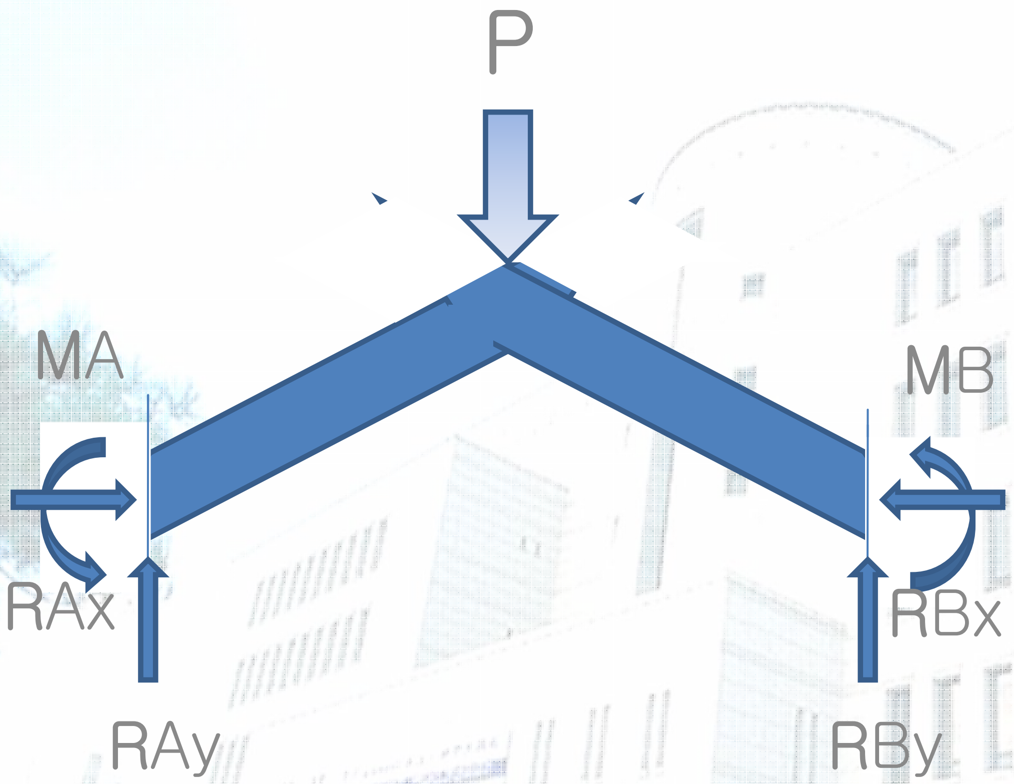

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$$\left\{ \begin{aligned} \frac{dy}{dx} &= 0, \quad at \ \ x = 0 \\ \frac{dy}{dx} &= 0, \quad at \ \ x = L\cos\alpha \end{aligned} \right\}$$

$$\therefore \ \ M_A = \frac{PL}{4}\cos\alpha$$

$$F = \frac{P}{2\cos\alpha}$$

Solve the Problem by Excel

$$\textit{Straight beam} \qquad W_1 = 21.329\ kg$$

$$\textit{Triangle beam} \qquad W_2 = 17.829\ kg, \quad at\ \alpha = 13.01°$$

$$\frac{W_1 - W_2}{W_1} \times 100 = 16.32\ \ percent$$

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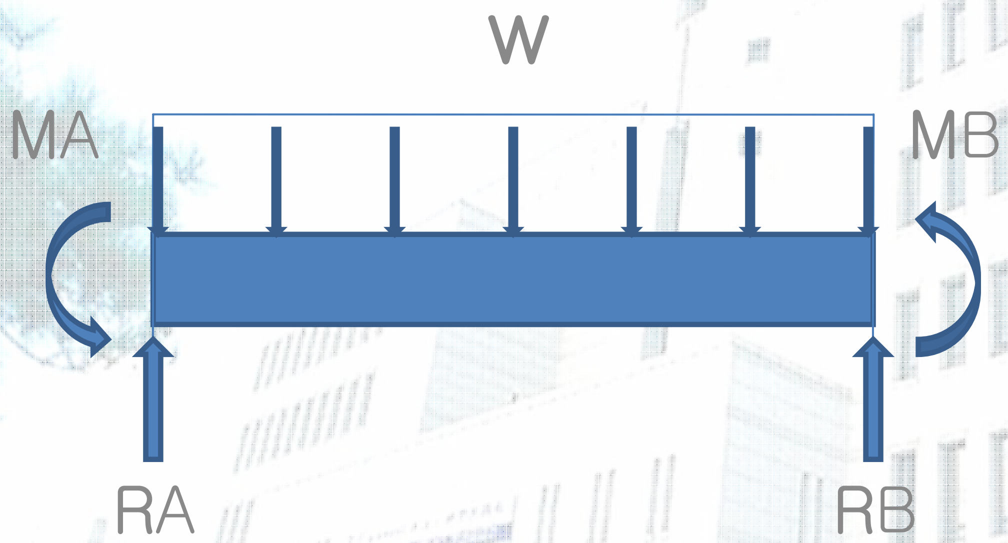

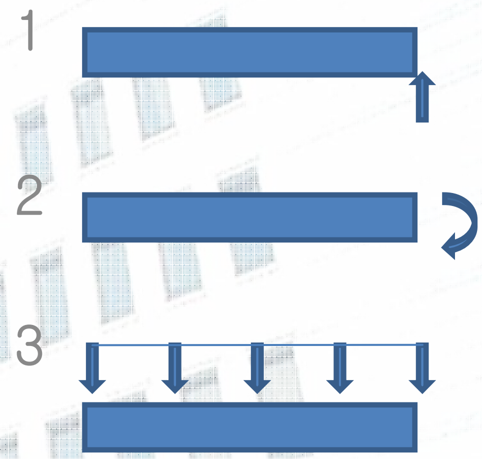

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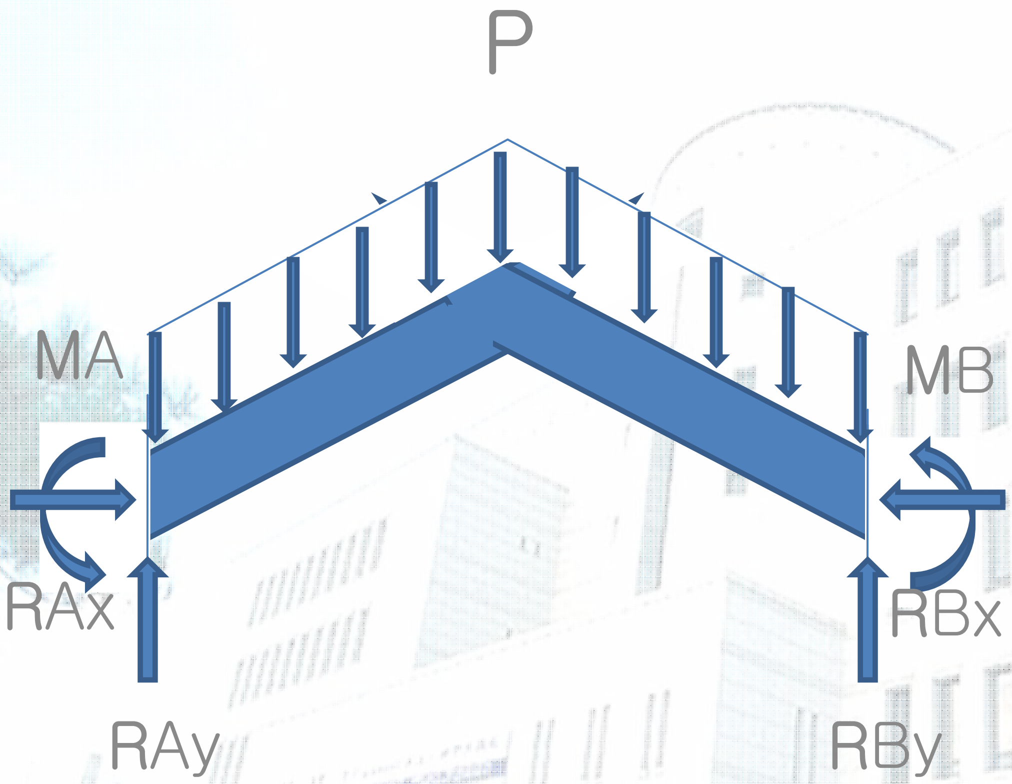

$$\therefore \; M_A = \frac{wL^2}{3}\cos^2\alpha$$

$$F = \frac{wL}{\cos\alpha}$$

Solve the Problem by Excel

$$Straight\ beam \qquad W_1 = 15.363\ kg$$

$$Triangle\ beam \qquad W_2 = 13.230\ kg, \quad at\ \alpha = 17.78°$$

$$\frac{W_1 - W_2}{W_1} \times 100 = 13.88\ \ percent$$


서울의지
인간승리 드라마