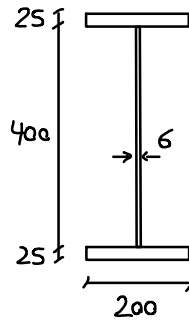
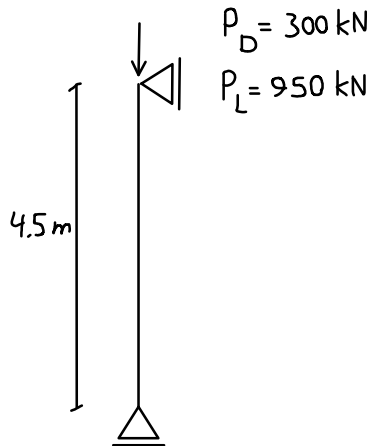


مقاومت طراحی ستون‌ها

مثال: ستون شکل زیر از ورق های فولادی S235 ساخته شده است. کفایت ستون در برابر بارهای وارده را کنترل کنید.



① مشخصات هندسی مقطع

$$A_g = 2 \times 200 \times 25 + 400 \times 6 = 124 \times 10^2 \text{ mm}^2$$

$$I_x = \frac{1}{12} \times 6 \times 400^3 + 2 \times (200 \times 25) \times 212.5^2 = 48,356 \times 10^4 \text{ mm}^4$$

$$I_y = 2 \times \frac{1}{12} \times 25 \times 200^3 = 3,333 \times 10^4 \text{ mm}^4$$

$$I_p = I_x + I_y = 51,690 \times 10^4$$

$$r_y = \sqrt{\frac{I_y}{A}} = 51.8 \text{ mm}$$

$$C_w = \frac{I_y h^2}{4} = 3,333 \times 10^4 \times \frac{425^2}{4} = 1,505,208 \times 10^6 \text{ mm}^6$$

$$J = \sum \frac{b t^3}{3} = \frac{1}{3} (2 \times 200 \times 25^3 + 400 \times 6^3) = 211.2 \times 10^4 \text{ mm}^4$$

② کنترل لاغر اجزاء

$$\lambda = \frac{h}{r_w} = \frac{400}{6} = 66.7 > \lambda_r = 1.49 \sqrt{\frac{E}{F_y}} = 35.4 \rightarrow A_e$$

$$k_c = \frac{4}{\sqrt{h_{tw}}} = \frac{4}{\sqrt{66.7}} = 0.49 \checkmark \quad 0.35 \leq 0.49 \leq 0.76$$

$$\lambda = \frac{b}{t} = \frac{100}{25} = 4 < \lambda_r = 0.54 \sqrt{\frac{k_c E}{F_y}} = 0.54 \sqrt{\frac{0.49 \times 200 \times 10^3}{355}} = 10.6 \checkmark$$

③ محاسبه F_e و F_n

$$\frac{L_c}{r_y} = \frac{4500}{51.8} = 86.9 \leq 4.71 \sqrt{\frac{E}{F_y}} = 112 \rightarrow F_e = \frac{17 \times 200 \times 10^3}{86.9^2} = 261.5 \text{ MPa} \checkmark$$

۲-۲- کافی بچتی

$$F_c = \left[\frac{\pi^4}{4500^2} \times 200 \times 10^3 \times 1,505,208 \times 10^6 + 76.9 \times 10^3 \times 211.2 \times 10^4 \right] \times \frac{1}{51,690 \times 10^4} = \underline{598 \text{ MPa}} > 261.5$$

بنابراین کافی خشی حاکم است.

۲-۲- محاسبه تنش اس F_n

$$F_n = \left[0.658 \sqrt{\frac{F_y}{F_c}} \right] F_y = \left[0.658 \sqrt{\frac{355}{598}} \right] \times 355 = \underline{201 \text{ MPa}}$$

د) محاسبه A_e

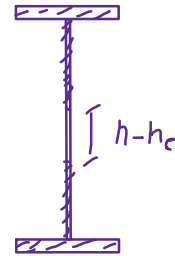
$$\lambda = 66.7 > \lambda_r \sqrt{\frac{F_y}{F_n}} = 35.4 \sqrt{\frac{355}{201}} = 47 \rightarrow h_e = h \left(1 - c_1 \sqrt{\frac{F_u}{F_n}} \right) \sqrt{\frac{F_u}{F_n}}$$

$$C_1 = 0.18, \quad C_2 = 1.31$$

$$F_{el} = \left(C_2 \frac{\lambda_r}{\lambda} \right)^2 F_y = \left(1.31 \times \frac{35.4}{66.7} \right)^2 \times 355 = \underline{171.6 \text{ MPa}}$$

$$h_e = 400 \left(1 - 0.18 \sqrt{\frac{171.6}{201}} \right) \sqrt{\frac{171.6}{201}} = 308 \text{ mm}$$

$$A_e = A_g - (h - h_e) t_w = 124 \times 10^2 - (400 - 308) \times 6 = \underline{118.5 \times 10^2 \text{ mm}^2}$$



۵) محاسبه ϕP_n و P_u

$$\phi P_n = 0.9 F_n A_e = 0.9 \times 201 \times 118.5 \times 10^2 = 2144 \text{ kN}$$

$$\phi P_n = 2144 \text{ kN}$$

$$P_u = 1.2 P_D + 1.6 P_L = 1.2 (300) + 1.6 (950) = 1880 \leq \phi P_n = 2144 \text{ kN} \quad \checkmark$$

$$\frac{P_u}{\phi P_n} = \frac{1880}{2144} = 0.88 \quad \checkmark$$