HEB 450

$d = 450mm$, $t_f = 26mm$ → $h_w = d - t_f = 424mm$

$S_x = 5551 \times 10^3 mm^3$, $I = 1160.5 \times 10^6 mm^4$

$I_y = 11720 \times 10^4 mm^4$, $C_w = 5258 \times 10^9 mm^6$

$r_y = 75.3mm$, $Z_x = 3982 \times 10^3 mm^3$

$L_p = 1.76 \times (11.3) \times \left(\frac{200000}{355}\right)^{1/2} = 3062mm$

$L_p = 3.06m$, $L_b = 2.5m$

$L_b < L_p \rightarrow M_n = M_p = Z_x \cdot \sigma_y$

$\phi M_n = \{0.9 \times 3982 \times 10^3 \times 355\} \times 10^{-6} = 1272.25 kN.m$

$\phi M_n = 1272.25 > M_{max} = 1200 kN.m \rightarrow$ safe

check for deflection

$L = 10m = 10000mm$

$P = 225 kN \rightarrow$ service live load

$E = 200 GPa$

$I_x = 79890 \times 10^4 mm^4$

$\frac{L}{800} = 12.5mm$

$\Delta = \frac{225 \times (10000)^3}{48 \times 200 \times (79890 \times 10^4)} = 29.34mm$

$\Delta > \frac{L}{800} \rightarrow$ excessive deformation

$\frac{10000}{800} > \frac{225 \times (10000)^3}{48 \times 200 \times I} \rightarrow I_x > 1875 \times 10^6 mm^4 = 187500 cm^4$

Choose HEB 650 → $I_x = 210600 cm^4 > 187500 cm^4$

HEB 650

$r_y = 69.9mm \rightarrow L_p = 1.76 \times (69.9) \times \left(\frac{200000}{355}\right)^{0.5} = 2920mm = 2.92m$

$L_b = 2.5m < L_p \rightarrow M_n = M_p = Z_x \cdot \sigma_y$

$Z_x = 7320 \times 10^3 mm$

$\phi M_n = [7320 \times 10^3 \times 355 \times 0.9] \times 10^{-6} = 2338.74 kN.m > M_{max} = 1200 kN.m$ → safe

choose HEB650 → lightest section

check assumption

$t_f = 31mm$, $b_f = 300mm$ → $\frac{b_f/2}{t_f} = 4.84$, $\lambda_p = 0.38\sqrt{\frac{2 \times 10^5}{355}} = 9.02$ → $4.84 < \lambda_p$

$h = 588mm$, $t_w = 16mm$ → $\frac{h}{t_w} = 36.75$, $\lambda_p = 3.76\sqrt{\frac{E}{f_y}} = 89.25$ → $36.75 < \lambda_p$

compact section.

assumption is true!