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Declaration & Statement of Authorship

I, bearing Registration number 103117086, agree and acknowledge that:

1. The assessment was answered by me as per the instructions applicable to each assessment and that I have not resorted to any unfair means to deliberately improve my performance.
2. I have neither persenated anyone, nor have I been impessonated by any person for the purpose of assignments.

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2. Solution,

Given:-

Axial load (P) = 1500 KN (Factored)

Major axis bending moment = 60 kNm. (M_z)

Minor axis bending moment = 30 kNm. (M_y)

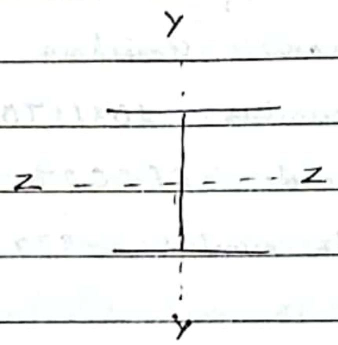
effective length = 4 m. (KL)

The section used is ISHB 350 (666.1 N/m)

The dimensions of ISHB 350 are given below.

Sectional area = 85.91 cm^2

h = 350 mm



b_f = 250 mm

t_f = 11.6 mm

t_w = 8.3 mm

r_{zz} = 14.93 cm

r_{yy} = 5.34 cm

Z_{zz} = 1094.8 cm^3 $\quad$ Z_{pz} (plastic modulus) = 1213.53 cm^3

Z_{yy} = 196.1 cm^3

The section has to satisfy both member level and section level interaction equation:

A) Section Level.

$$\frac{P}{P_{cap}} + \frac{M_y}{M_{y\,capacity}} + \frac{M_z}{M_{z\,capacity}} \leq 1.$$

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i) $P_{capacity} = \frac{f_y \times A_g}{\gamma_{mo}} = \frac{250 \times 85.91 \times 100}{1.1} = 1952.5\ kN$

ii) $M_{z,capacity}$

From table 2;

$$\frac{b}{t_f} = \frac{125}{11.6} = 10.776 \leq 15.7$$

∴ our section is semi-compact.

$$M_{z,capacity} = \frac{f_y (Z_e)_z}{\gamma_{mo}} = \frac{250 \times 1094.8 \times 10^3}{1.1} = 248.818\ kN\text{-}m$$

iii) M_y, capacity.

$$M_{y,cap} = \frac{f_y (Z_e)_y}{\gamma_{mo}} = \frac{250 \times 196.1 \times 10^3}{1.1} = 44.5682\ kN\text{-}m.$$

Checking the interaction equation for section level,

$$\frac{P}{P_{cap}} + \frac{M_y}{M_{y,cap}} + \frac{M_z}{M_{z,cap}}$$

$$= \frac{1500}{1952.5} + \frac{30}{44.5682} + \frac{80}{248.818}$$

$$= 0.7682 + 0.673 + 0.3215$$

$$= 1.763 > 1$$

∴ The member doesn't satisfy section level.

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B) Member level.

$$\frac{P}{P_{dy}} + K_y \frac{C_{my} M_y}{M_{dy}} + K_{LT} \frac{M_z}{M_{dz}} \leq 1.0$$

$$\frac{P}{P_{dz}} + 0.6 K_y \frac{C_{my} M_y}{M_{dy}} + K_z \frac{C_{mz} M_z}{M_{dz}} \leq 1.0$$

\# For P_{dy},

$$\frac{KL}{r_y} = \frac{4000}{53.4} = 74.906 \sim 80 \text{(let)}$$

f_{cd} value; First check, buckling class,

Table 10, $\frac{h}{b_f} = \frac{350}{250} = 1.4.$

$$\frac{h}{b_f} > 1.2.$$

$t_f = 11.6\text{ mm} \leq 40\text{mm},$

buckling class, y-$y \rightarrow$ 'b' buckling class,

$\therefore f_{cd} = 150 N/mm^2.$

$$P_{dy} = \frac{f_{cd} \times A}{\gamma_{mo}} = 1171.5 \text{ kN}$$

\# For, P_{dz},

$$\frac{KL}{r_z} = \frac{4000}{149.3} = 26.79 \sim 30$$

$\therefore f_{cd} = 216 N/mm^2$

$$P_{dz} = \frac{f_{cd} \times A}{\gamma_{mo}} = 1686.96 \text{ kN}$$

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For Mdz

$$M_{dz} = \beta_b Z_p f_{bd}.$$

Now,

$$\frac{KL}{r_z} = \frac{4000}{149.3} = 26.79 \sim 30$$

$$\alpha_{LT} = 0.21$$

$$\beta = 1$$

$$\frac{h}{t_f} = \frac{350}{11.6} = 30.17 \sim 30$$

From Table 14,

$$f_{cr,b} = 2,457.1 \ N/mm^2.$$

From Table 13(a)

$$f_{bd} = 227.3 \ N/mm^2$$

$$Z_p = 1213.53 \ cm^3$$

$$M_{dz} = 1 \times 1213.53 \times 10^3 \times 227.3$$

$$= 275.835 \ kN\text{-}m.$$

For K_{LT}

since both top and bottom are same $\psi = 1$.

$C_{mLT} = 0.6 + 0.4(1) = 1.0 \geq 0.4$ okay,

$C_{my} = C_{mL} = 1.0$

$$n_y = \frac{P}{P_y} = 1.28$$

$$\lambda_{LT} = \sqrt{\frac{f_y}{f_{cr,b}}} = 0.319$$

$K_{LT} = 1 - \left(\frac{0.1 \lambda_{LT} n_y}{C_{mLT} - 0.25}\right) = 0.9455 > 0.83$ so okay!!!

$$1 - \frac{0.1 n_y}{C_{mLT} - 0.25} = 0.83$$

$\therefore K_{LT} = 0.9455$

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$n_z = \frac{P}{P_z} = 0.889$

For kz

$$K_z = 1 + (\lambda_z - 0.2) n_z \leq 1 + 0.8 n_z$$

$$\lambda_z = \sqrt{\frac{f_y}{f_{cc}}} = \sqrt{\frac{f_y \left(\frac{KL}{r}\right)^2}{\pi^2 E}} = \sqrt{\frac{250 \times 30^2}{\pi^2 \times E}} = 0.3376$$

$$\therefore K_z = 1 + (0.3376 - 0.2) \times 0.889 = 1.122 < 1.7112 \text{ okay!!}$$

For ky.

$$k_y = 1 + (\lambda_y - 0.2) n_y \qquad n_y = \frac{P}{P_y} = 1.28$$

$$\lambda_y = \sqrt{\frac{f_y \left(\frac{KL}{r_y}\right)^2}{\pi^2 E}} = 0.9 \quad \cancel{< 2.024 \text{ okay!!}}$$

$$k_y = 1.896 < 2.024$$

Interaction equations

$$\cancel{\frac{P}{P_{dy}}}^{1.28} + k_y \frac{C_{my} M_y}{M_{dy}} + K_{LT} \frac{M_z}{M_{dz}} \geq 1 \therefore$$

=

$\therefore$ Member is not ~~suscept~~ acceptable.

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Solution,

1. Truss configuration : Let the inclination of the roof with the horizontal be 'α'.

$\tan\alpha = 2/5$

$\therefore \alpha = 21.8^\circ$

Length of rafter $= \sqrt{5^2+2^2} = 5.38m$

Length of each panel $= \frac{5.38}{2} = 2.69m$

Loads on panel points

Dead load:

Dead load of G.I sheets with fixings $= 200 N/m^2$

self weight of truss $= 60N/m^2$

self weight of purlin $= 70N/m^2 = 70 \times 3 =$

$= 210N$

panel length $= 2.69m$

Now,

Load on each intermediate node because of the dead load is given as,

$= (200+60) \times (3 \times 2.69) + 210$

$= 2308.2 N = 2.308kN$

Load on the end panel points of the rafter $= \frac{2308.2}{2} = 1154.1 = 1.154kN$

Load on intermediate purlin $= (200+60+70) \times 2.69 = 887.7N = 0.887 kN/m$

Load on the end purlin $= \frac{0.887}{2} = 0.4435 kN/m.$

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3. ~~For the analysis of truss~~.

$$W_x \text{ (purlin)} = 0.867 \cdot \cos 21.8^\circ$$
$$= 0.82 \text{ kN/m.}$$

$$w_y \text{ (purlin)} = 0.887 \ \cancel{\cos}\ \sin 21.8^\circ.$$
$$= 0.33 \text{ kN/m.}$$

Now, for the moment,

$$M_z = \frac{0.82 \times 3^2}{8} = \cancel{92.25\,k}\ 0.9225 \text{ kN-m}$$

$$M_y = \frac{0.33 \times 3^2}{8} = 0.37125 \text{ kN-m.}$$

Now,

\# ~~A~~ Live load.

$$L.L = 300 \text{ N/m}^2$$

$\therefore$ L.L on intermediate panel $= 300 \times 3 \times 2.69 = 2421 \text{ N} = 2.421 \text{ kN.}$

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2. Wind load calculations.

→ The given location is tricky and building location has large openings.

Therefor, the basic speed is,

$Vb = 47 m/s$.

The terrain and topography of location are open with well scattered obstructions and therfore,

span of building = 5 years.

wind load = $(Cpe - Cpi) \times A \times Pd$

The roof angle = $\tan^{-1}(2/5)$

$= 21.8°$.

∴ The design wind speed $(V_3) = k_1 \times k_2 \times k_3 \times Vb$

k_1 - a/c to Table 1 (IS 875 part-3)

for 5 years and basic speed of 47 m/s,

$k_1 = 0.71$

$k_2 = 1$ (For terrain category of 2)

For flat land, $k_3 = 1$

The design wind speed $= k_1 \times k_2 \times k_3 \times 47$

or, $Vd = 1 \times 0.71 \times 1 \times 47$

∴ $Vd = 33.37 m/s$.

Design wind pressure $(Pd) = 0.6 (Vd)^2$

$= 0.6 \times (33.37)^2$

$= 668.134 N/m^2$

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Now,

Wind pressure coefficient

→ Assuming building with large openings (greater than 20% area)

$C_{pi} = \pm 0.7$

since our $h = 5$, $w = 10$

$\therefore h/w = 0.5 \leq 1/2 (0.5)$

i) From Table 6, of wind angle as 0°

or,

C_{pe} for 20° = −0.4 (on windward direction)

= −0.4 (on leeward direction)

For,

C_{pe} 30°, C_{pe} = 0 (for windward)

= −0.4 (for leeward)

Doing interpolation,

For 21.8°,

or, C_{pe} for windward = −0.32

C_{pe} for leeward = −0.4.

ii) For wind angle = 20°,

C_{pe} for 20° = −0.7 (windward)

= −0.6 (leeward)

C_{pe} for 30° = −0.7 (windward)

= −0.6 (leeward)

Using interpolation for 21.8°,

C_{pe} (windward) = −0.7

C_{pe} (leeward) = −0.6

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