DESIGN OF STEEL BEAMS...

Exmples

A simply supported beam has an effective span of 7m and carries a uniformly distributed load of 50 kN/m (i.e DL = 25kN/m and LL = 25 kN/m). Taking f_y = 250 N/mm² and E = 2 x 10 ⁵ N/mm², design the beam, if it is laterally supported.

Example....

STEP 1:

Factored Load = 1.5 x 50 = 75 kN/m (Table 4)

STEP 2:

Design Bending Moment = wl²/8 = 459.375 kN.m

Design shear force = wl/2 = 262.5kN

- **STEP 3:**

Plastic Section modulus reqd., $Z_p = M \times \gamma_{mo} / f_y$

(cl. 8.2.1.2)

$= 459.375 \times 10^6 \times 1.1/250$ (Table 5)

$= 2021.25 \times 10^3 \text{ mm}^3$

Example....

- Z_p/Z_e is conservatively assumed to be 1.15

$Z_{e,\ reqd} = 2021.25 \times 10^3/1.15 = 1757.61 \times 10^3 \text{ mm}^3$

Choose ISMB 500

Depth, h = 500 mm ;

width of flange, b = 172 mm ;

Thickness of flange, $t_f = 17.2$ mm ;

Thickness of web, $t_w = 10.2$ mm ;

Depth of web, $d = h - 2(t_f+R) = 500 - 2(17.2+17) = 431.6$ mm

$I_{zz} = 45218.3 \times 10^4 \text{ mm}^4$; $Z_e = 1808.7 \times 10^3 \text{ mm}^3$

Weight of the section = 86.9 kg/m

- **STEP 4**

Section Classification (Table 2)

$\varepsilon = \sqrt{250/fy} = 1$

$b/t_f = 172/17.2 = 10 < 10.5\varepsilon \rightarrow$ compact

$d/t_w = 431.6/10.2 = 42.31 < 84\varepsilon \rightarrow$ plastic

Hence section is **compact**

- **STEP 5**

Check for adequacy of section

Factored self weight = 1.5 x 86.9 x 9.81/1000

= 1.279 kN/m

Total factored load = 75 + 1.279 = 76.279 kN/m

Example....

- $M_{max} = wl^2/8 = 467.21$ kN.m

Z_p(reqd.) = 467.21 x 10^6 x 1.1/250

= 2055.72 x 10^3 mm^3 < 2080 x 10^3 mm^3

Hence provided section is adequate

- **STEP 6**

Design Shear Force , V = wl/2

= 76.279 x 7/2 = 266.98 kN

Example....

- **STEP 7**

Design Shear Strength , $V_d = V_n/\gamma_{mo}$

$= h \times t_w \times f_{yw}/(1.1 \times \sqrt{3})$

$= 500 \times 10.2 \times 250 /(1.1 \times \sqrt{3})$

$= 669.201$ kN > 266.98 kN

Hence OK

Also $V < 0.6V_d$

- **STEP 8**

Check for Design Capacity

$d/t_w = 42.31 < 67\varepsilon$ (cl 8.2.1.1)

$M_d = \beta_b Z_p \times f_y/\gamma_{mo} = 1 \times 2080 \times 10^3 \times 250/1.1$

$= 472.7273$ kN.m $< 1.2 \times Z_e \times f_y /\gamma_{mo}$ (cl 8.2.1.2)

$<$ 493.28 kN.m

Hence satisfied

- **STEP 9**

Check for Deflection (Use unfactored imposed load)

$\delta = 5wl^4/384 = 8.64$mm $< l/300$ (Table 6)

< 23.33mm

Hence safe

- In the previous problem the bearing length was assumed to be adequate.
- Suppose a bearing length of 75mm is provided.
- We should check the safety of the web in bearing and buckling