⇒ Determine the design bending strength & shear strength of laterally unsupported beam section ISMB 300 of span 5m is unsupported laterally only @ ends. Calculate the factored UDL.

⇒ ① Properties of ISMB 300 :

$h = 300mm$

$b_f = 140mm$

$t_f = 12.4mm$

$t_w = 7.5mm$

$r_1 = 14mm$

$r_{min} = r_z = 123.7mm$

$\rightarrow Z_{p\,req} = 543.6 \times 10^3 mm^3$

$\rightarrow Z_p (provided) = 57.3.6 \times 10^3 \times 1.13$

$= 651.6 \times 10^3 mm^3$ take it (for beam)

② Classification of section:

Table ②, Pg.No 18

$b = \frac{b_f}{2} = \frac{140}{2} = 70mm.$

$d = h - 2(t_f + r_1) = 300 - 2(12.4 + 14)$

$= 247.2mm$

$\varepsilon = \sqrt{\frac{250}{f_y}} = 1.$

$\Rightarrow \frac{b}{t_f} = \frac{70}{12.4} = 5.645 < 9.4\,\varepsilon$

$\Rightarrow d/t_w = \frac{247.2}{7.75} = 32.9 < 84\varepsilon.$

So, the section is plastic

⇒ (3) Calculation of Bending strength

from pg. no 54,

$M_d = \beta_b Z_p f_{bd}$, → use the formula (or) table

~~=150.8~~

To calculate f_{bd}: Use table 13 a

pg. no 55 ⇒

To find f_{cr} → table (14) pg. no 57

$\frac{KL}{r_1} \;\&\; \frac{h}{t_f}$ ($r_1 \rightarrow r_2$)

$\frac{KL}{r} = \frac{1 \times 5000}{123.7} = 40.42$

$\frac{h}{t_f} = \frac{300}{12.4} = 24.19$

40, 1441.7

50, 951.7

$f_{cr} = 1441.7\,N/mm^2$

f_{bd} ⇒ 13(a).

2000, 227.3

1000, 209.1

$f_{bd} = 217.13\,N/mm^2$

~~$Z_{p\,req}$~~ =

$$M_d = \beta_b Z_p f_{bd}$$

$$= 1 \times 651.6 \times 10^3 \times 217.13$$

$$= 141.48 \times 10^6 \text{ Nmm}$$

④ Calculation of factored UDL based on bending strength

$$B.M = \frac{w.l^2}{8} \Rightarrow 141.48 \times 10^6 = \frac{w \times 5000^2}{8}$$

$$\boxed{w = 45.27 \text{ N/mm}}$$

⑤. Calculation of Design shear strength

$$V_d = \frac{f_y \times h_w t_w}{\sqrt{3} \times \gamma_{m0}} = \frac{250 \times 300 \times 7.5}{\sqrt{3} \times 1.1}$$

$$\boxed{V_d = 295.84 \times 10^3 \text{ N}}$$

⑥ Calculation of factored load based on shear strength:

$$V_d = \frac{wL}{2} \Rightarrow 295.24 \times 10^3 = \frac{w \times 5000}{2}$$

$$\boxed{w = 118.09 \text{ N/mm}}$$

∴ Factored UDL = least value of both the loads.

Design Factored UDL = 45.27 N/mm