Design a S.S.B of span 5m to carry a factored UDL of 47KN/m. Use ISMB section & take beam as laterally supported. The depth of the beam shouldn't exceed 350 mm.

S.S.B, $l = 5m$

Factored Load = 47 KN/m

ISMB, laterally supported beam

depth $\ngtr$ 350 mm.

Step 1: Load Calculation:

T.L (given) = 47KN/m

(if not assume)

Step 2: B.M Calculation:

$$\text{Max B.M (S.S.B)} = \frac{wl^2}{8} = \frac{47 \times 5^2}{8}$$

$$= 146.875 \text{ KNm} = 146.875 \times 10^6$$

Step 3: S.F. Calculation (V):

$$V (S.S.B) = \frac{WL}{2} = \frac{47 \times 5}{2} = 115 KN.$$

Step 4: Calculation of section Modulus (Z_p):

$$Z_p = \frac{M \gamma_{mo}}{f_y}$$

$$= \frac{146.875 \times 10^6 \times 1.1}{250}$$

$$\boxed{Z_p (\text{required}) = 646250 \text{ mm}^2}$$

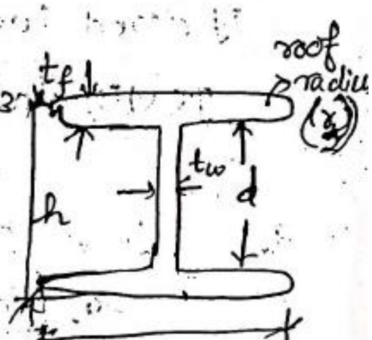
Step 5: Selection I-section:

In given problem, depth of section shouldn't exceed 350mm & ISMB section.

ISMB 350 (pg.no 2 → steel table)

$Z_e = 778.9 \times 10^3 \, mm^3$

$Z_p = 1.136 \times Z_p = 884.83 \times 10^3 \, mm^3$



$h = 350 \, mm$

$b_f = 140 \, mm.$

$t_f = 14.2 \, mm$ $\quad b = \frac{b_f}{2}$

$t_w = 8.1 \, mm.$ $\quad r_1 = 14 \, mm.$

$I_z = 136303 \times 10^4 \, mm^4$

Where, b → outstand of flange (or) compression flange.

pg.no-18

$b = \frac{140}{2} = 70 \, mm,$

↓ Table (2)

Step 6: Classification of section:

Rolled steel section → b/b_f; neutral axis @ mid-depth → d/t_w

	b/b_f	d/t_w
→ Plastic	9.4 ε	84 ε
→ Compact	10.5 ε	105 ε
→ Semi-compact	15.7 ε	126 ε.

i) $b = 70 \, mm \Rightarrow \frac{b}{t_f} = \frac{70}{14.2} = 4.93 < 9.4\varepsilon$

ii) $d = h - 2(t_f + r_1) = 350 - 2(14.2 + 14)$ $\quad \varepsilon = 1$

$= 293.6 \, mm$

d

$= 293.6$

Step 7 : Check for Shear.

The given prblm is laterally supported beam

So, $V \leq V_d$.

[pg. no. 59, 8.4] $V_d = \frac{f_y \times h \times t_w}{\gamma_{m0} \times \sqrt{3}} = \frac{250 \times 350 \times 8.1}{1.1 \times \sqrt{3}}$

$= 372.99$ KN

$V = 117.5$ KN (from step ①).

$V < V_d$ ⇒ So, check for shear is satisfied.

Step 8 : Check for Moment carrying capacity:

The given section is plastic & laterally supported

$V = 117.5 \times 10^3$ N. ① ($V \leq 0.6 V_d$)

$0.6 \times V_d = 0.6 \times (372.99)$

$= 223.794$

($V < V_d$). Hence safe.

② M_d (8.2.1.2 - pg no 53)

$$M_d = \frac{\beta_b Z_p f_y}{\gamma_{m0}} < \frac{1.2 Z_e f_y}{\gamma_{m0}}$$

$\beta_b = 1$ (plastic section)

⇒ $M_d = \frac{1 \times 884.8 \times 10^3 \times 250}{1.1}$

$= 201.0909 \times 10^6$ Nmm

⇒ $\frac{1.2 Z_e f_y}{\gamma_{m0}} = \frac{1.2 \times 778.9 \times 10^5 \times 250}{1.1} = 21242.7 \times$

Step 9 : Check for Deflection :

$$\delta < \frac{l}{300}$$

$$\rightarrow \delta_{(S.S.B)} = \frac{5wL^4}{384EI} = \frac{5 \times 47 \times (5000)^4}{384 \times 2 \times 10^5 \times 13130.3 \times 10}$$

$$\boxed{\delta = 14.03 \text{ mm}}$$ from steel table.

$$\rightarrow \frac{l}{300} = \frac{5000}{300} = 16.67 \text{ mm}$$

14.03 < 16.67. Hence, check for deflection is satisfied.