5. PLATE GIRDERS

- Economic depth of the girder

$$D = 1.1\sqrt{\frac{M}{\sigma_{bt} \times t_w}}$$

- A self weight may be assumed to begin with the design

$$w = \frac{W}{300}\ kN/m$$

DESIGN OF WEB

- Average shear stress in the web $\tau_{va,cal} = \frac{V}{d_w \times t_w} \not> $ permissible average shear stress, τ_{va}

WEB STIFFENERS

- IS : 800-1984 recommends the provision of web stiffeners as follows:

(i) $\frac{d_1}{t_w} \le$ lesser of $\frac{816}{\sqrt{\tau_{va,cal}}}$ and $\frac{1344}{\sqrt{f_y}}$ and 85. No stiffener is required.

(ii) $\frac{d_2}{t_w} \le$ lesser of $\frac{3200}{\sqrt{f_y}}$ and 200. Vertical stiffeners are provided.

(iii) $\frac{d_2}{t_w} \le$ lesser of $\frac{4000}{\sqrt{f_y}}$ and 250.

Vertical stiffeners and one horizontal stiffener at a distance from the compression flange equal to two-fifths of the distance from the compression flange to the neutral axis are provided.

(iv) $\frac{d_2}{t_w} \le$ lesser of $\frac{6400}{\sqrt{f_y}}$ or 400.

where d_2 = 2 × clear distance from compression flange angles or plate or tongue plate to the neutral axis.

- In no case should the greater clear dimension of a web panel should exceed $270t_w$ nor the lesser clear dimension of the same panel should exceed $180t_w$.

- The term $\left(A_f + \frac{A_w}{6}\right)$ is called the effective flange area.

PERMISSIBLE BENDING STRESS

- The maximum compressive stress $\sigma_{bc,cal}$ is calculated on gross flange area, i.e.,

$\sigma_{bc,cal} = \frac{M \times D/2}{I_{gross}} \not> $ permissible bending stress in compression, σ_{bc}.

- The maximum tensile stress $\sigma_{bt,cal}$ is calculated on the net flange area i.e.,

$\sigma_{bt,cal} = \frac{M \times D/2}{I_{gross}} \times \frac{\text{gross flange area}}{\text{net flange area}} \not> $ permissible bending stress in tension, σ_{bt}

CURTAILMENT OF FLANGE PLATES

- Length of the plate to be curtailed

$$l_n = l\sqrt{\frac{A_1 + A_2 + A_3 + ... + A_n}{A_f + A_{we}}}$$

Where, l = span
n = no. of plates to be curtailed counting 1, 2, 3,... from outer plate.
A_{we} = effective web area

WEB STIFFENERS

- Unless the outer edge of each stiffener is continuously stiffened, the outstand of all stiffeners from the web should not be more than $\frac{256 \times t}{\sqrt{f_y}}$ (=16t for steel sections and 12t for flats where t is the thickness of the section or flat.
- Where vertical stiffeners are required, they should be provided throughout the length of the girder at a distance not greater than $1.5d_1$ and not less than $0.33\ d_1$.
- When horizontal stiffeners area provided d_1 should be taken as the clear distance between the horizontal stiffener and tension flange (farthest flange) ignoring fillets.
- The moment of inertia I of a pair of vertical stiffener about the centre of web or a single stiffener about the face of the web should be,

$$I \ge \frac{1.5 \times d_1^3 \times t^3}{c^2}$$

where, t = the min. required thickness of web.
c = the max. permitted clear distance between vertical stiffener for thickness t.

- Sometimes vertical stiffeners are subjected to external forces and therefore the moment of inertia of the stiffener should be increased as described below.

  (a) Bending moment on stiffener due to eccentricity of vertical loading with respect to vertical axis of the web.

  Increase of $\boxed{I = \frac{150M \times D^2}{E \times t_w} cm^4}$

  (b) Lateral loading on stiffener:

  Increase of $\boxed{I = \frac{0.3V \times D^3}{E \times t_w} cm^4}$

- For first horizontal stiffener at 2/5th of the distance between compression flange and neutral axis, from the compression flange:

$$\boxed{I \geq 4C \times t^3}$$

Where I = moment of inertia of a pair of horizontal stiffeners about the centre of the web or a single stiffener about the face of the web

t = the minimum thickness of web required

c = actual distance between vertical stiffeners

- For second horizontal stiffener at the neutral axis,

$$\boxed{I \geq d_2 \times t^3}$$

Stiffeners are connected to web to withstand a shearing force not less than $\frac{125 \times t_w^2}{h}$ kN/m, where h = outstand of stiffener in mm.

LOAD BEARING STIFFENERS

- Bearing stiffeners are provided at the points of concentrated loads and at supports.
- Where these stiffeners are to provide restraint against torsion of the plate girder at the ends,

$$\boxed{I \not< \frac{D^3 \times T}{250} \times \frac{R}{W}}$$
