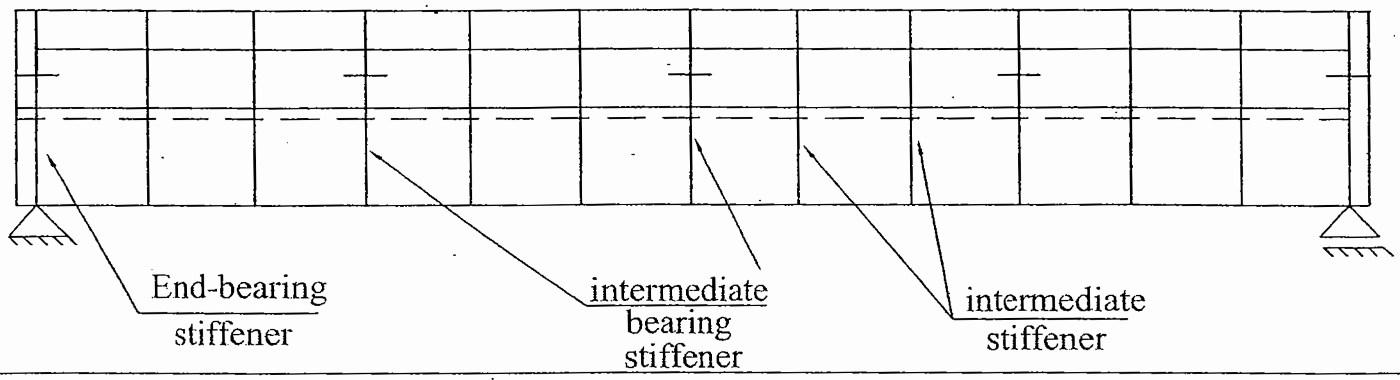
steel رابعة أشغال
٢/المودة [7]

design of web stiffeners



stiffeners type:

- transverse stiffeners (vertical)

  1-End bearing stiffener : (at the bearing)

  -Function : resist high reaction of the main girder (Q d+L+I).

  -Shape : 2 T-sec from the both sides of the web, connected to (X.G)

  2-Intermediate bearing stiffener : (at the intermediate (X.G 'S).

  -Function : transmit the X.G reaction to (M.G) or prevent buckling (Cs).

  -Shape : T- sec also (to make connection with (X.G).

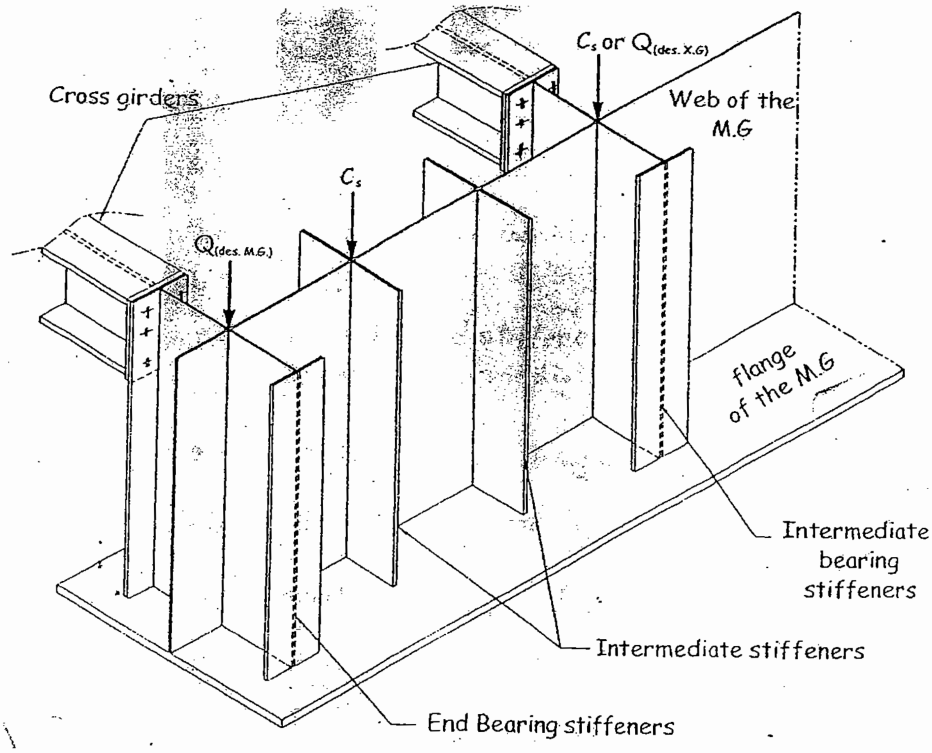
  3- Intermediate stiffeners : located in the spacing between (X.G'S) each (1.5-1.8m)

  -Function : resist buckling force (Cs).

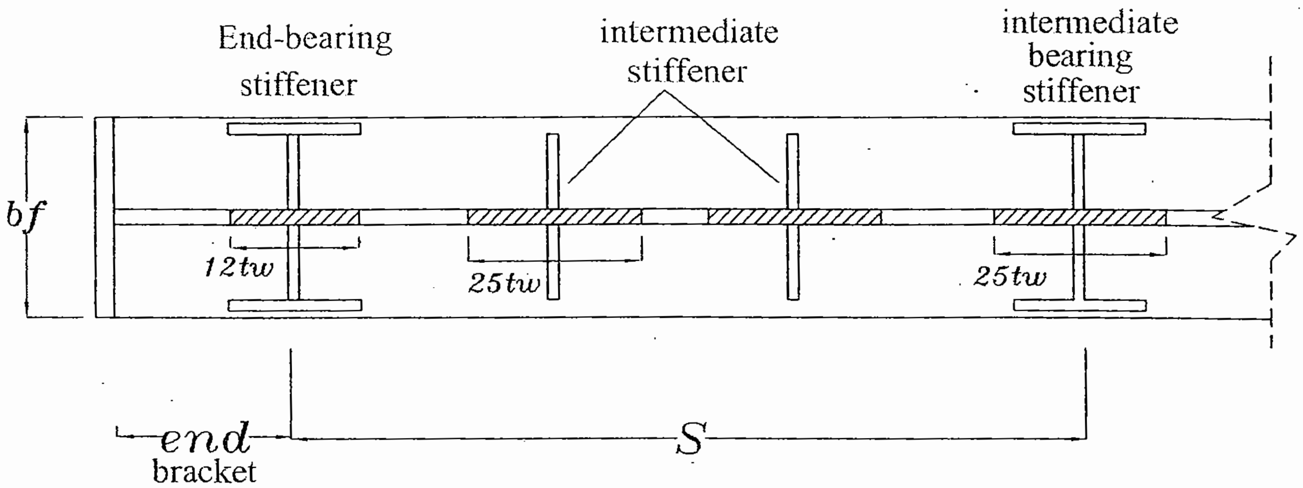
  -Shape : 2-plates welded to (M.G) web (no T-sec as no (X.G) to connect).

- longitudinal stiffeners (horizontal).

  -Function : placed at hw/5 and hw/2 to support the hw(M.G).



IMP notes in design of transverse stiffeners (vertical):



these members will be designed as acomp. members (B.U.S) so:

our general equation : $f = \frac{\text{force}}{\text{area}}$

1st : area of each member :
area of each stiffener = (area of plates + area of part of web)

the part of web for
- 1-End bearing stiffener (12tw x tw)
- 2-Intermediate bearing stiffener (25tw x tw)
- 3- Intermediate stiffeners (25tw x tw)

2nd : Force affecting each stiffener :

1-End bearing stiffener : Q(d+L+I) of (M.G).

2-Intermediate bearing stiffener: resist greater of
- Q(des) of (X.G).
- Cs (buckling force).

3- Intermediate stiffeners —— Cs (buckling force).

3rd : alowable stresses : (Fc) :

these are compressive members there allowable is (Fc) depends on λ

$\lambda = \frac{lb}{r\,x}$ & $lb = 0.8hw$ so

$Fc = 1.6 - 8.5\times10^{-5}\lambda^2$ ST.44

$Fc = 2.1 - 13.5\times10^{-5}\lambda^2$ ST.52

- design End-bearing stiffener

1st:dimensions:

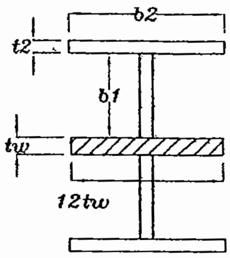
1.3 t/cm^2 (st 44.)
1.6 t/cm^2 (st 52.)

$$f = \frac{force}{area}$$

force = Q(d+L+I) M.G

area = $2.b_2.t_2+2.b_1.t_1+12.tw^2$. area = ...$cm^2$

take:
- b1 = hw/30 + 5cm. & t1 = tw.
- b2 = 20(t2)
  - b2=....> 16cm=6Ø+t1 (Ø: use bolt M22)
  - t2 =....> tw (even no.)



End-bearing stiffener

checks:

a-non-compact:

- $\frac{c}{t_f} = \frac{b2/2}{t_2} < \frac{21}{\sqrt{f_y}}$
- $\frac{hw}{t_w} = \frac{b1}{t_1} < \frac{64}{\sqrt{f_y}}$

b-check buckling:

$$\lambda = \frac{lb}{r\,x} = \frac{0.8\,hw}{r\,x} \ngtr 110$$

$$r\,x = \sqrt{\frac{Ix}{A}}$$

$$Ix = \left[\frac{t1\,.\,b1^3}{12} + t1\,.\,b1x\left(\frac{b1+tw}{2}\right)^2\right] x\,2 + 2xb2\,x\,t2\left(\frac{t2}{2} + b1 + \frac{tw}{2}\right)^2$$

$$A = 2.b\,.t + 2.b\,.t + 12.tw^2$$

c-check stresses:

$$f = \frac{force}{area} = ...\ t/cm^2 \ngtr Fc$$

- $Fc = 1.6 - 8.5x10^{-5}\lambda^2$ ST.44
- $Fc = 2.1 - 13.5x10^{-5}\lambda^2$ ST.52

d- size of weld:

Q(M.G) = (0.2 Fu) x (4xsxL)

note : L = hw

Smin = 6mm

- Intermediate-bearing stiffener

1st:dimensions:

$1.3\ t/cm^2$ (st 44.)

$1.6\ t/cm^2$ (st 52.)

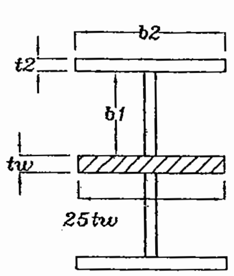
$$f = \frac{force}{area}$$

$$Force = \text{big. of} \begin{cases} Cs = 0.65\left(\frac{0.35\ Fy}{qb} - 1\right) Q(act) \\ Q(d+L+I)\ X.G \end{cases}$$

$qb = 0.25\ Fy$

$area = 2.b_2.t_2 + 2.b_1.t_1 + 25.tw^2$ area = ...cm^2

take:
- $b1 = hw/30 + 5cm.$ & $t1 = tw.$
- $b2 = 20(t2)$
  - $b2 = ... > 16cm = 6\phi + t1$
  - $t2 = ... > tw$ (even no.)



Intermediate-bearing stiffener

Note: we design stiff at (S) from support

checks:

a-non-compact:

- $\frac{c}{t_f} = \frac{b2/2}{t_2} < \frac{21}{\sqrt{f_y}}$
- $\frac{hw}{t_w} = \frac{b1}{t_1} < \frac{64}{\sqrt{f_y}}$

b-check buckling:

$$\lambda = \frac{lb}{r\,x} = \frac{0.8\ hw}{r\,x} \ngtr 110$$

$$r\,x = \sqrt{\frac{Ix}{A}}$$

$$Ix = \left[\frac{t1 . b1^3}{12} + t1 . b1 x \left(\frac{b1+tw}{2}\right)^2\right] x\,2 + 2 x b2 x t2 \left(\frac{t2}{2} + b1 + \frac{tw}{2}\right)^2$$

$$A = 2.b_2.t_2 + 2.b_1.t_1 + 25.tw^2$$

c-check stresses:

$$f = \frac{force}{area} = ...\ t/cm^2 \ngtr Fc$$

- $Fc = 1.6 - 8.5x10^{-5}\lambda^2$ ST.44
- $Fc = 2.1 - 13.5x10^{-5}\lambda^2$ ST.52

d- size of weld:

Q(x.g) or (Cs) = (0.2 Fu) x (4xsxL)

note : L = hw/3

Smin = 6mm

- Intermediate- stiffener

1st:dimensions:

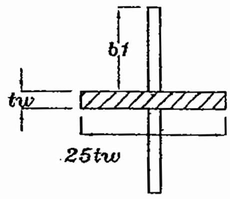
1.3 t/cm² [st 44.] / 1.6 t/cm² [st 52.] $\Big\rangle\ f = \dfrac{\text{force}}{\text{area}}$

Force = $Cs = 0.65\left(\dfrac{0.35\,Fy}{qb} - 1\right) Q(act)$

$qb = 0.25\ Fy$

$area = 2.b_1.t_1 + 25.tw^2$ area = ...cm^2

take ——— $b1 = hw/30 + 5cm.$ then get $t1 = ...\ cm > 1cm.$



Intermediate-stiffener

Note: we design nearest stiff. to support.

checks:

a-non-compact:

$$\frac{hw}{t_w} = \frac{b1}{t_1} < \frac{64}{\sqrt{f_y}}$$

b-check buckling:

$$\lambda = \frac{lb}{r\,x} = \frac{0.8\,hw}{r\,x} \not> 110$$

$$r\,x = \sqrt{\frac{Ix}{A}}$$

$$Ix = \left[\frac{t1\,.\,b1^3}{12} + t1\,.\,b1\,x\left(\frac{b1+tw}{2}\right)^2\right] x\,2$$

$$A = 2.b_1.t_1 + 25.tw^2$$

c-check stresses:

$$f = \frac{\text{force}}{\text{area}} = ...\ t/cm^2 \not> Fc$$

$Fc = 1.6 - 8.5x10^{-5}\lambda^2$ ST.44

$Fc = 2.1 - 13.5x10^{-5}\lambda^2$ ST.52

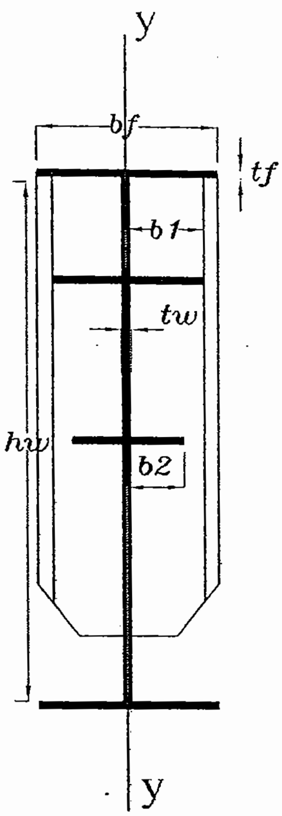
d- size of weld:

$(Cs) = (0.2\ Fu)\ x\ (4xsxL)$

note : $L = hw/3$

$Smin = 6mm$

• longitudinal stiffener :



design stiffener at , hw / 5

assume

$b1 = hw/30 + 5cm.$ $t1 = tw$

design stiffener at , hw / 2

assume

$b2 = 10\ cm.$ $t2 = tw$

then calculate : (Iy)

stiff at hw/5

$$Iy = 2\left[\frac{b1^3 \times t1}{12} + b1 \times t1 \times \left(\frac{b1 + tw}{2}\right)^2\right] \quad \text{If } > 4.hw.tw^3 \quad \text{O.K}$$

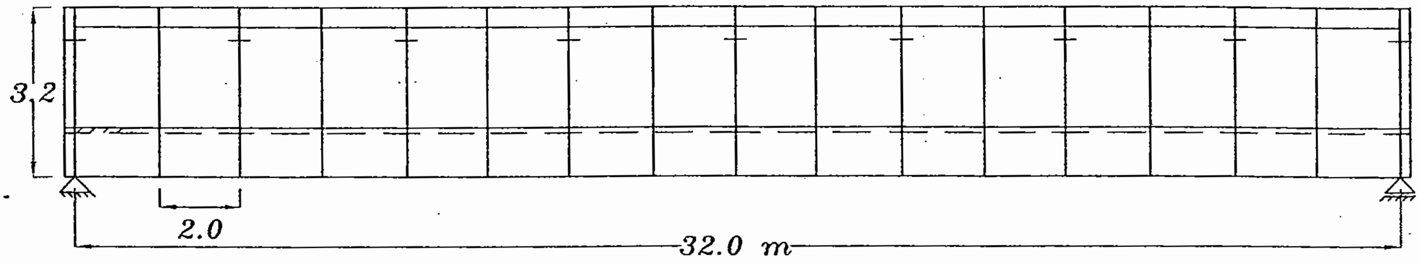
stiff at hw/2

$$Iy = 2\left[\frac{b2^3 \times t2}{12} + b1 \times t1 \times \left(\frac{b2 + tw}{2}\right)^2\right] \quad \text{If } > .hw.tw^3 \quad \text{O.K}$$

if unsafe increase (t)

• Example :

for the shown main-girder its required to design all-transverse and Long. stiff.



Given That :

1- Main-girder of flange (64x4) & (320 x 1.6).

2- for the Main-gorder : Qd=106 t. , Q(L+I)= 111.72 t.

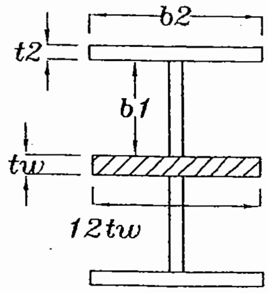
3- for the (X.G): Q(d+L+I) = 86.4 t.

4- sT. 44.

- <u>design End-bearing stiffener</u>

$$f = \frac{force}{area} = \frac{217.72}{area} \longrightarrow area = 167.5\ CM^2$$

f → $1.3\ t/cm^2$ [st 44.]



End-bearing stiffener

take $b1 = hw/30 + 5cm. = 320/30 + 5 = 15.67 = 16$ cm.

$t1 = tw = 1.6$cm

$$area = 2.b_2.t_2 + 2.b_1.t_1 + 12.tw^2 = (2xb2xt2 + 2x16x1.6 + 12(1.6)^2) = 167.5$$

$b2 \times t2 = 42.8$ assume $b2 = 20\ t2 \longrightarrow t2 = 1.46 = 1.6$ cm.

$b2 = 27$ cm.

checks:

<u>a-non-compact:</u>

- $$\frac{c}{t_f} = \frac{b2/2}{t_2} = \frac{27/2}{1.6} < \frac{21}{\sqrt{f_y}}$$

- $$\frac{hw}{t_w} = \frac{b1}{t_1} = \frac{16}{1.6} < \frac{64}{\sqrt{f_y}}$$

<u>b-check buckling:</u>

$$Ix = \left[\frac{t1\ .\ b1^3}{12} + t1\ .\ b1x\left(\frac{b1 + tw}{2}\right)^2\right] x\ 2 + 2xb2\ x\ t2\left(\frac{t2}{2} + b1 + \frac{tw}{2}\right)^2$$

$$\left[\frac{1.6x16^3}{12} + 1.6x16x\left(\frac{16 + 1.6}{2}\right)^2\right] x\ 2 + 2x27\ x\ 1.6\left(\frac{1.6}{2} + 16 + \frac{1.6}{2}\right)^2 = 31820.5\ cm^4$$

$$A = 2.b\ .t + 2.b\ .t + 12.tw^2 = 168.32\ cm^2$$

$$r\,x = \sqrt{\frac{Ix}{A}} = 13.75 \qquad \lambda = \frac{lb}{r\,x} = \frac{0.8\,hw}{r\,x} = \frac{0.8\,(320)}{13.75} = 18.6 \not> 110$$

$$Fc = 1.6 - 8.5\times10^{-5}\lambda^{2} = 1.57\ t/cm^{2}$$

c-check stresses:

$$f = \frac{force}{area} = \frac{217.72}{168.32} = 1.29\ t/cm^{2}$$

d- size of weld:

Q(M.G) = (0.2 Fu) x (4xsxL)

note : L = hw

217.72 = (0.2 (4.4)) x (4xsx320)

s= 0.19 cm ------ take s= 0.6cm