

Investigation into the Stability of Plate Girders with Diagonal Stiffeners

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Abstract

In this research, web stability of plate girders with diagonal stiffeners has been studied. For theoretical study of stability of plate girders with diagonal stiffeners same rules has been employed which are implied in studying the web stability of plate girders with vertical stiffeners. For obtaining the buckling factor k , Lusas software has been used. With regard to obtained formulas and tests results, it has been found that where diagonal stiffeners are used, the shear post-buckling strength of web which in turn is a result of the existing tension field action is higher than the case where vertical stiffeners are used. Thus by using diagonal stiffeners, the thickness of plate girder's web can be reduced which will cause economy. It should be noted that in this case, the force in diagonal stiffeners will be higher than that of vertical stiffeners, but the increase in weight of stiffeners is less than decrease of the weight of web plate due to employment of diagonal stiffeners.

Key words: Plate girders, Diagonal stiffeners, Buckling, Stability

[4]

[1]

0.3 2.1*10⁶ kg/cm²

μ E

Archive of SID

h

a

[5]

$$\tau_{cr} = k \frac{\pi^2 E}{12(1 - \mu^2)(h/t)^2}$$

()

μ

E

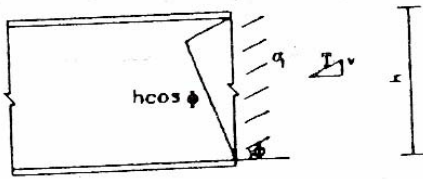
k

t

[4]

k

(



[1]

$$a/h \leq 1 \rightarrow k = 4 + \frac{5.34}{(a/h)^2} \quad ()$$

$$a/h > 1 \rightarrow k = 5.34 + \frac{4}{(a/h)^2}$$

C_v
:[4]

$$C_v = \frac{3287434k}{F_y \cdot (h/t)^2} \quad ()$$

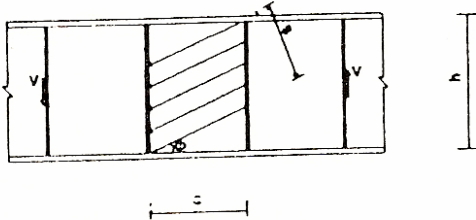
:[4]

C_v

$$C_v = \frac{1621}{(h/t)} \sqrt{\frac{k}{F_y}} \quad ()$$

()

s



()

$\sigma_t s t$

(Tension field action)

σ_t

$$\Delta V_{yf} = \sigma_t s t \cdot \sin \phi \quad ()$$

()

()

T

$$s = h \cdot \cos \phi - a \cdot \sin \phi \quad ()$$

$$T = \sigma_t h t \cdot \cos \phi \quad ()$$

V

$$\Delta V_{yf} = \sigma_t t \left(\frac{h}{2} \cdot \sin 2\phi - a \cdot \sin^2 \phi \right) \quad ()$$

$$V = T \cdot \sin \phi = (\sigma_t h t \cdot \sin 2\phi) / 2 \quad ()$$

$$\Delta V_{yf} = \dots$$

$$\text{tg } 2\phi = \frac{1}{a/h} \quad ()$$

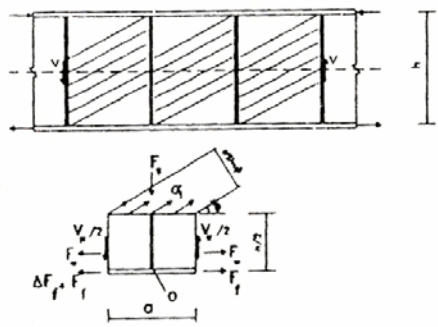
$$V_u = V_{cr} + V_{yf} \quad ()$$

$$V_u = F_y h t \left[\frac{C_v}{\sqrt{3}} + \frac{1 - C_v}{2\sqrt{1 + (a/h)^2}} \right] \quad ()$$

$$\text{Sin } 2\phi = \frac{1}{\sqrt{1 + (a/h)^2}} \quad ()$$

()

$$\text{Sin}^2 \phi = \frac{1}{2} \left[1 - \frac{a/h}{\sqrt{1 + (a/h)^2}} \right] \quad ()$$



$$V_{yf} = \frac{\sigma_t h t}{2} \left(\frac{1}{\sqrt{1 + (a/h)^2}} \right) \quad ()$$

ϕ

()

()

()

σ_t

[3]

$$\sigma_t \text{ Sin}^2 \phi \quad () \quad V_{yf}/2 \quad (\tau_{cr})$$

τ_{cr}

(σ_t)

$$F_s = \frac{F_y (1 - C_v) a t}{2} \left[1 - \frac{a/h}{\sqrt{1 + (a/h)^2}} \right] \quad ()$$

)

45°

(45°

[6]

()

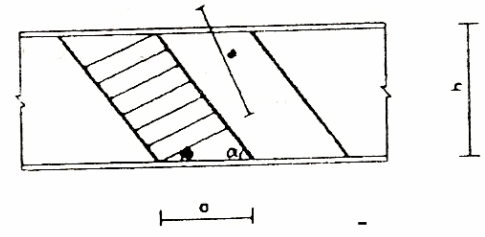
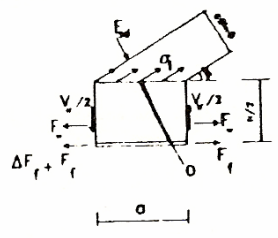
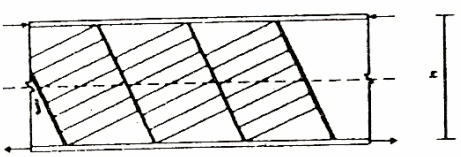
K

$$\sigma_t = F_y (1 - C_v) \quad ()$$

$$V_u = F_y h t \left[\frac{C_v}{\sqrt{3}} + \frac{(1 - C_v)}{2\sqrt{1 + (a/h - \text{Cotg}\alpha)^2}} \right] \quad ()$$

Lusas

C_v



$$\sin^2 \phi \quad \sigma_t \quad ()$$

$$F_s = \frac{F_y (1 - C_v) a t}{2 \cdot \text{Sin}\alpha} \left[1 - \frac{a/h - \text{Cotg}\alpha}{\sqrt{1 + (a/h - \text{Cotg}\alpha)^2}} \right] \quad ()$$

$$s = h \cdot \text{Cos}\phi - (a - h \cdot \text{Cotg}\sigma) \cdot \text{Sin}\phi \quad ()$$

Lusas

C_v

$$\text{tg}2\phi = \frac{1}{a/h - \text{Cotg}\alpha} \quad ()$$

$$\text{Sin}2\phi = \frac{1}{\sqrt{1 + (a/h - \text{Cotg}\alpha)^2}} \quad ()$$

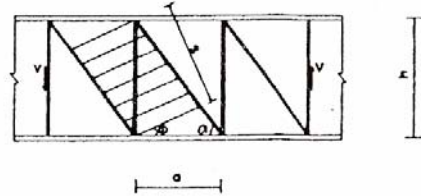
$$\text{Sin}^2\phi = \frac{1}{2} \left[1 - \frac{a/h}{\sqrt{1 + (a/h - \text{Cotg}\alpha)^2}} \right] \quad ()$$

$$F_{sd} \cdot \sin \alpha + F_{sv} = \sigma_t a \sin^2 \phi \quad () \quad () \quad ()$$

$\alpha \quad a/h$

$$\frac{F_{sv}}{F_{sd}} \quad \frac{F_{sv}}{F_{sd}}$$

$$s = h \cdot \cos \phi \quad ()$$



() ()

() ()

90°

α

$\cot \alpha$

() ()

() ()

a/h

$\phi = 45^\circ$

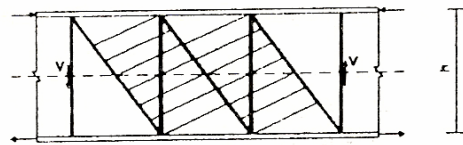
$$V_u = F_y h t \left(\frac{C_v}{\sqrt{3}} + \frac{1 - C_v}{2} \right) \quad ()$$

()

[5]

$$F_{cr} = \frac{1898000k}{(h/t)^2}$$

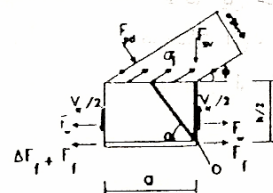
()



k

[2]

()



$$F_{cr} = \frac{69201111}{(h/t)^2}$$

()

() ()

$\phi \quad \sigma_t$

() : $\frac{h}{t}$

Lusas k $\frac{h}{t} \cong \frac{8300}{\sqrt{F_{cr}}}$ ()

() $\frac{8300}{\sqrt{F_{cr}}}$ $\frac{h}{t}$

()

[4]

[4]

$F_u = F_{cr} [1.0 - 0.0005 \frac{A_w}{A_f} (\frac{h}{t} - \frac{8300}{\sqrt{F_{cr}}})]$ ()

$\frac{h}{t} \leq \frac{984200}{\sqrt{F_y(F_y + 1160)}}$ ()

()

k

a/h

Lusas

[4]

$a/h \leq 1.5 \rightarrow \frac{h}{t} \leq \frac{16770}{\sqrt{F_y}}$ ()

()

$\frac{h}{t}$

$\frac{h}{t}$

($F_y = 2400$)

$\frac{h}{t} = \frac{1378\sqrt{k}}{\sqrt{F_{cr}}}$ ()

$\frac{h}{t} \leq \frac{984200}{\sqrt{F_y(F_y + 1160)}} = 337$ ()

$\frac{h}{t}$

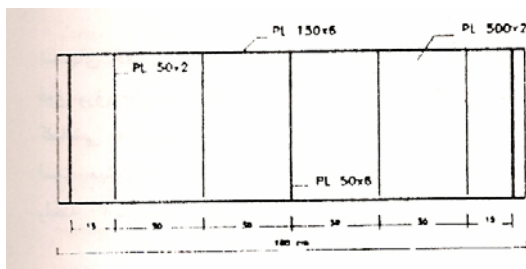
$\frac{h}{t}$

$\frac{h}{t} \leq \frac{16770}{\sqrt{F_y}} = 342$ ()

$F_u = F_{cr} [1.0 - 0.0005 \frac{A_w}{A_f} (\frac{h}{t} - \frac{1378\sqrt{k}}{\sqrt{F_{cr}}})]$ ()

h/t
()

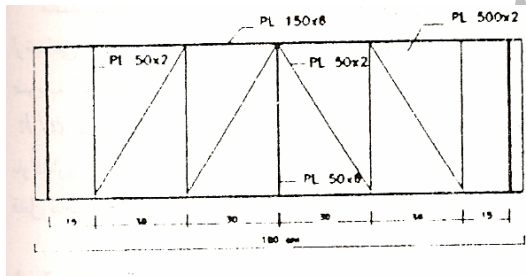
() ()



h/t

()

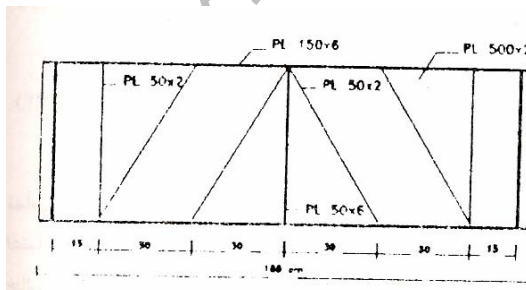
45.1 kg



48.6 kg

1.5^m

0.5^m



h/t

2^{mm}

47.1 kg

()

(ton)			
	17.5	30.1	24.1
	23.5	25.71	25.44
	25.5	17.08	5.3

[1] Basler, K. 1963 . Strength of Plate Girders in Shear. Transactions, ASCE, 128, Part II, 683-719.

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[3] Gaylord, E.H. & Gaylord, C.N. & Stallmeyer, J.E. 1992. Desing of Steel Structures. McGrow-Hill International Book Company.

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[5] Timoshonko, S.P. & Gere, J.M. 1961. Theory of Elastic Stability. McGrow-Hill International Book Company.

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