

Equal Legs Angle (hinged) Beam's End Support: Plastic Check



A short stub of equal legs angle is welded to the column, then the beam is laid on it, if needed welded also horizontally to stand some horizontal force

$\sigma_u := 2600 \cdot \frac{\text{kgf}}{\text{cm}^2}$

$E := 2100000 \cdot \frac{\text{kgf}}{\text{cm}^2}$

$R_v := 9 \cdot \text{ton}$

$R_h := 4 \cdot \text{ton}$

factored reactions

Beam data

$b_f := 15 \cdot \text{cm}$

$t_f := 1.07 \cdot \text{cm}$

$h := 30 \cdot \text{cm}$

$t_w := 0.71 \cdot \text{cm}$

$r := 1.5 \cdot \text{cm}$

fillet radius

$s_w := 1.5 \cdot \text{cm}$

- maximum distance of end face of beam to column flange external face
- result is distinctly sensitive to s and so precision in beam length, distances between columns and placement is required

Angle Data

$b := 9 \cdot \text{cm}$

$t := 1 \cdot \text{cm}$

width := 15·cm

$r_{\text{angle}} := 1.1 \cdot \text{cm}$

$a := 4 \cdot \text{mm}$

throat at corner of angle fillet weld, for the full width

$a_h := 5 \cdot \text{mm}$

throat of weld to stand horizontal reaction (both sides)



$k := t_f + r$

$F_{yw} := \frac{\sigma_u}{\sqrt{3}}$

$\phi := 0.75$ for web crippling

$d := 3 \cdot \text{cm}$ unwarranted guess for half bearing length

Given

$$R_v = \min \left[\begin{array}{l} \phi \cdot \text{ksi} \cdot \left[68 \cdot t_w^2 \cdot \left[1 + 3 \cdot \frac{2 \cdot d}{h} \cdot \left(\frac{t_w}{t_f} \right)^{1.5} \right] \cdot \sqrt{\frac{F_{yw}}{\text{ksi}} \cdot \frac{t_f}{t_w}} \text{ if } \frac{2 \cdot d}{h} \leq 0.2 \right. \\ \left. 68 \cdot t_w^2 \cdot \left[1 + \left(4 \cdot \frac{2 \cdot d}{h} - 0.2 \right) \cdot \left(\frac{t_w}{t_f} \right)^{1.5} \right] \cdot \sqrt{\frac{F_{yw}}{\text{ksi}} \cdot \frac{t_f}{t_w}} \text{ otherwise} \right] \\ (2.5 \cdot k + 2 \cdot d) \cdot F_{yw} \cdot t_w \end{array} \right]$$

this evaluation cares for web crippling and web yielding

$s_w := \text{Find}(d)$

$d = 1.01 \text{ cm}$

$$\text{ecc} := s + d \qquad \text{ecc} = 2.51 \text{ cm}$$

$$\text{Frontal}_{\text{force}} := \sqrt{{R_v}^2 + {R_h}^2}$$

$$\text{Ratio}_{\text{Weld}} := \frac{\text{Frontal}_{\text{force}}}{(\text{width} - 2 \cdot a) \cdot a \cdot 0.85 \cdot \sigma_u} \qquad \text{Ratio}_{\text{Weld}} = 0.78 \qquad \text{limit for frontal weld strength}$$

In this case our check will be simplified due to assumption of acceptability of full non reduced plastic moments till concurrent shears $0.55F_y$

$$M(x) := R_v \cdot (\text{ecc} - t - x) + R_h \cdot \frac{t}{2}$$

$$\text{th}(x) := \left| \begin{array}{ll} t & \text{if } x > r_{\text{angle}} \\ t + r_{\text{angle}} - \sqrt{{r_{\text{angle}}}^2 - (x - r_{\text{angle}})^2} & \text{otherwise} \end{array} \right.$$

$$W_p(x) := \text{width} \cdot \frac{\text{th}(x)^2}{4} \qquad \sigma(x) := \frac{M(x)}{W_p(x)}$$

$$\tau(x) := \frac{R_v}{\text{width} \cdot \text{th}(x)}$$

and we test N_x intervals for stations between resultant and inner face of angular and N_y intervals for heights at each station for Von Mises

$$N_x := 100$$

$$j := 1 \dots N_X + 1$$

$$xx_j := (j - 1) \cdot \frac{ecc - t}{N_X}$$

$$\mathbf{tt}_j := \mathbf{th}(\mathbf{xx}_j)$$

$$\mathbf{M}\mathbf{M}_j := \mathbf{M}(\mathbf{x}\mathbf{x}_j)$$

$$\sigma\sigma_j := \sigma(\mathbf{xx}_j) \qquad \tau\tau_j := \tau(\mathbf{xx}_j)$$

$$\text{Ratio}_{\sigma_{S_j}} := \frac{\sigma_{S_j}}{\sigma_u} \qquad \text{Ratio}_{\tau_{S_j}} := \frac{\tau_{S_j}}{0.55 \cdot \sigma_u}$$

$$\text{Ratio}\sigma := \max(\text{Ratio}_{\sigma_S}) \qquad \text{Ratio}\tau := \max(\text{Ratio}_{\tau_S})$$

$$L_h := \frac{b}{2} \quad \text{unwarranted guess}$$

Given

$$R_h = 2 \cdot a_h \cdot (L_h - 2 \cdot a_h) \cdot 0.75 \cdot \sigma_u$$

$$\mathbf{L}_h := \text{Find}(\mathbf{L}_h)$$

$$\text{Ratio}_{\text{Weld}} = 0.78$$

ratio to limit strength of the frontal weld at corner

$$\text{Ratio}_{\sigma} = 0.83$$

ratio of the maximum longitudinal tension to σ_u

the three must be less than 1 for OK

$$\text{Ratio}_{\tau} = 0.42$$

ratio of the maximum shear tension to $0.55 \cdot \sigma_u$

$$L_h = 3.05 \text{ cm}$$

required length of each lateral weld to safely pass horizontal reaction

$$b - s \geq 2 \cdot d = 1$$

must be 1 to have enough support on the angle