

MV-103 Anejo 5 Bolted Connections



2. Eccentric but in-plane shear

2.1 NC Columns of equal ordinary bolts or rivets subject to eccentric shear

$F_y := 105 \cdot \text{ksi}$ of bolt or rivet $NPS := 1$ number of planes in shear

$V_{uy} := 124 \cdot \text{kip}$ eccentric factored shear (no concurrent tensile load is assumed)

$V_{ux} := 52 \cdot \text{kip}$

$\alpha := \text{atan}\left(\frac{V_{ux}}{V_{uy}}\right)$ $\alpha = 22.75 \text{ deg}$

$V_u := \sqrt{V_{ux}^2 + V_{uy}^2}$ $V_u = 134.46 \text{ kip}$

$e := \frac{149 \cdot \text{ft} \cdot \text{kip}}{V_u}$ V_u force acts with this eccentricity respect the cog of the bolt group

$d := 1.25 \cdot \text{in}$ probing diameter

$NC := 2$ $NR := 4$ number of columns and rows of bolts vary mainly these parameters till the check is OK

$SBC := 1.25 \cdot \text{ft}$ $SBR := 1 \cdot \text{ft}$ separation between columns and rows of bolts

$v_n := \frac{F_y}{\sqrt{3}}$ conservatively $v_n = 417.98 \text{ MPa}$

$r := 1 \dots NR$ $c := 1 \dots NC$

$$x_{l_{r,c}} := -\frac{(NC-1) \cdot SBC}{2} + (c-1) \cdot SBC$$

$$y_{l_{r,c}} := -\frac{(NR-1) \cdot SBR}{2} + (r-1) \cdot SBR$$

$$n_{bolts} := NR \cdot NC$$

$$n_{bolts} = 8$$

$$x_{r,c} := x_{l_{r,c}} \cdot \cos(\alpha) + y_{l_{r,c}} \cdot \sin(\alpha)$$

$$y_{r,c} := -x_{l_{r,c}} \cdot \sin(\alpha) + y_{l_{r,c}} \cdot \cos(\alpha)$$

coordinates in the rotated axes of
the centers of bolts

$$r_{m_{r,c}} := \sqrt{\left(x_{r,c}\right)^2 + \left(y_{r,c}\right)^2}$$

vector radius (from origin) length

$$X_i := \frac{\sum_r \sum_c \left(r_{m_{r,c}}\right)^2}{e \cdot n_{bolts}}$$

abscissa of instantaneous center of rotation, from cog of
bolts in the rotated axes

$$r_{im_{r,c}} := \sqrt{\left(x_{r,c} + X_i\right)^2 + \left(y_{r,c}\right)^2}$$

vector radius (from instantaneous center of rotation) length

$$R_{m_{r,c}} := V_u \cdot e \cdot \frac{r_{im_{r,c}}}{\sum_r \sum_c \left(r_{m_{r,c}}\right)^2}$$

$$R_{max} := \max\left(R_m\right)$$

$$Ratio := \frac{R_{max}}{\pi \cdot \frac{d^2}{4} \cdot v_n \cdot NPS}$$

$$\text{Ratio} = 0.44$$

the connection is OK respect Bolt
shear capacity when the value at left is
equal to or less than 1

$$R_{\max} = 14.8 \text{ ton}$$

maximum shear force (metric tons) in a single bolt
to distribute between the specified number of
shear planes

$$R_{\max} = 32621.11 \text{ lbf}$$

$$R_{\max} = 32.62 \text{ kip}$$

at the most solicited bolt