Base of wall at Bent 2 (joint)

1000-year no-scour case "B":

$V = 3265^k$, $P = 27{,}605^k$, $M = 181864^{'-k}$

w/1.2: $V = 3918^k$ $M = 218{,}237^{'-k}$

- Vertical (gravity) load uniformly distributed at base of wall.

Area of base: $A = 2(26 \times 9.92) + 33 \times 4 = 647.8\ ft^2$

- Assume that the longitudinal moment and shear are resisted entirely by the wall "risers". Vertical load tributary to each riser:

$P_c = 27605 \times \frac{26 \times 9.92}{647.8} = 10{,}990^k$

$M = 109{,}118^{'-k}$

$V = 1959^k$

- Take cap "width" $B_{cap} = 30'$ in the longitudinal direction

$T_c \approx 109118/9' = 12{,}124^k$

$A_{jv} = l_{ac} B_{cap} = (12 \times 12)(30 \times 12) = 51{,}840\ in^2$

$v_{jv} = 12124/51840 = 0.234\ ksi$

$A_{jh} = (9+12)(30)(144) = 90{,}720\ in^2$ (Limited by footing width: $20 \times 30 \times 144 = 86{,}400$)

↑ embedment of bars

$f_v = 10990/86400 = 0.127\ ksi$

$f_h = \frac{1959}{(30 \times 12)(144)} = 0.038\ ksi$

Principal tension:

$$p_t = \left| \left(\frac{.038+.127}{2}\right) - \sqrt{\left(\frac{.038-.127}{2}\right)^2 + (.234)^2} \right| = 0.166 \text{ Ksi} \quad \underline{OK}$$

Principal compression:

$$p_c = \left(\frac{.127+.038}{2}\right) + \sqrt{\left(\frac{.038-.127}{2}\right)^2 + (.234)^2} = 0.321 \text{ Ksi} \quad \underline{OK}$$

Principal stresses are less than $0.11\sqrt{f'_c}$. Case A in the half-scour condition has a smaller moment, but also a reduced axial load. Conservatively use that smaller axial load with the moment and shear from above and check again:

$$P_c = 16208 \times \frac{26 \times 9.92}{647.8} = 6453^k$$

$$f_v = 6453/86400 = 0.075 \text{ Ksi}$$

Principal tension:

$$p_t = \left| \left(\frac{.038+.075}{2}\right) - \sqrt{\left(\frac{.038-.075}{2}\right)^2 + (.234)^2} \right| = 0.178 \text{ Ksi} \quad \underline{OK}$$

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Project: SWB	Job No.	Sheet: of
Item: Bent 2 joint	Designer: MGL	Date: 5/12
	Checker:	Date:
		Grid: 1/10"

Also consider 2 cases of orthogonality:

① $P = 16{,}350^k$; $M_{long} = 116028^{1\text{-}k}$; $M_{trans.} = 116029^{1\text{-}k}$

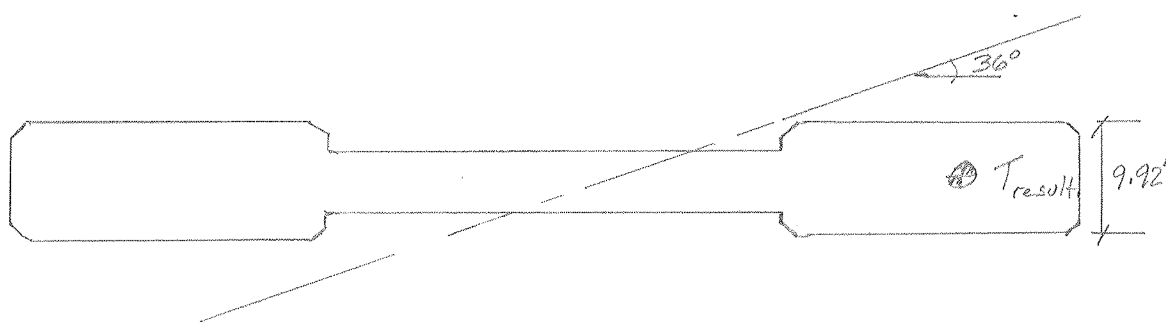
② $P = 27{,}605^k$; $M_{long} = 181864^{1\text{-}k}$; $M_{trans.} = 131614^{1\text{-}k}$

- Put these combinations into a moment-curvature analysis to determine tensile resultants to use for shear stress calcs.

Xtract output reports total tensile forces of:

① 6702^k
② 9726^k

$$\theta = \tan^{-1}\left(\frac{131614}{181864}\right) = 36^\circ$$



Assume that the "B_{cap}" term is aligned with this angle and is:

$$B_{cap} = \frac{9.92'}{\sin 36} = 16.9'$$

$$A_{jv} = (12\times12)(16.9\times12) = 29{,}203\ in^2$$

$$V_{jv} = 9726/29203 = 0.333\ Ksi$$

→ Joint shear steel is required

Transverse (volumetric) steel ratio required:

$$\rho_s = 0.40 \frac{A_{st}}{l_{ac}^2}$$

There are (134) #11 bars in each wall riser: $A_{st} = 209 in^2$

$$\rho_s = 0.40 \frac{(209)}{(12 \times 12)^2} = 0.004$$

If the (24) #5 in the wall's weak direction and the (7) #5 in the strong direction are continued into the footing:

$$\rho_s = \rho_x + \rho_y = \frac{(24 \times .31)}{(26 \times 12)s} + \frac{(7 \times .31)}{(9.92 \times 12)s} = .004$$

$$s = 10.5''$$

If the "hoops" are continued into the footing as #5 bars:

$$\rho_s = \frac{(26 \times .31)}{(26 \times 12)s} + \frac{(9 \times .31)}{(9.92 \times 12)s} = .004$$

$$s = 12.3''$$

→ Continue confinement steel into footing at 12" spacing

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Project: SWB	Job No.	Sheet: of
Item: Bent 2 joint	Designer: MGL	Date: 5/12
	Checker:	Date:
		Grid: 1/10"

Vertical steel required:

$$A_s^{jv} = 0.20 A_{st} = .2(209) = 41.8 \text{ in}^2$$

- Provide at least (42) #9 headed bars on each side of each riser. Steel to be placed within 9.9' of ℄ Bent 2 in each direction

Horizontal steel required:

$$A_s^{jh} = 0.10 A_{st} = .1(209) = 20.9 \text{ in}^2$$

- The horizontal steel shown consists of groups of 3 #5 bars placed at 1'-0" vertical spacing, with 10 such vertical placements called for.

$$A^{jh}_{s,\text{provided}} = 3 \times 3 \times .31 \times 10 \text{ plcs.} = 27.9 \text{ in}^2 \quad \underline{OK}$$

↑ 3 "clusters" of 3 bars under each riser

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Project: SWB	Job No.	Sheet: of
Item: Bent 3 joint	Designer: MGL	Date: 5/12
	Checker:	Date:
		Grid: 1/10"

- Longitudinal bending demands at the base of Bent 3 are smaller than those at Bent 2. Vertical loading and wall geometry are similar.

- Because joint shear reinforcing requirements are prescriptive, and not force-based, it is prudent to provide the same joint shear reinforcing at Bent 3 as at the more heavily loaded Bent 2 (which also has a few more #11 bars in the "A_{st}" term).

- Provide same joint shear detailing in both places