Appendix D Example 21 – Continuous Pads – Individual Corbels

Refer to *Falsework Manual,* Section 8-2.04, *Continuous Pad with Single Corbel.* This example demonstrates how to analyze a continuous falsework pad with single corbels.

Given Information

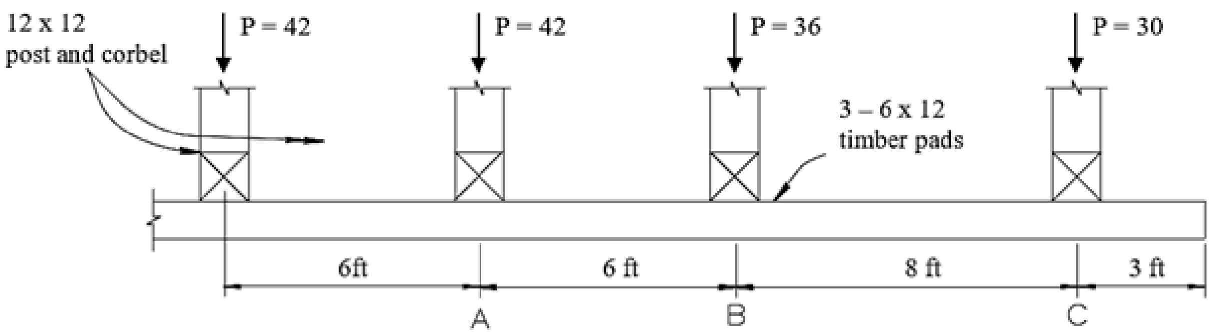

Figure D-21-1. Continuous Pad with Single Corbels

Timber pads:

Three 6 x 12 Rough Douglas Fir-Larch #2 (G=0.50)

Corbel:

12 x 12 Rough Douglas Fir-Larch #1 (G=0.50)

Post:

12 x 12 Douglas Fir-Larch #1 (G=0.50)

Allowable soil pressure = 3000 psf

Post A:

Check Pad

1. **Calculate allowable bending stress**

   Reference design value in bending F_b = 875 psi (NDS supplement table 4D)

Adjustment factors from NDS table 4.3.1:

C_D = 1.25	Duration Factor
C_M = 1.0	Wet Service Factor NDS table 4D (Assume < 19% moisture content)
C_t = 1.0	Temperature Factor NDS table 2.3.3 (Temp up to 100ºF)
C_L = 1.0	Beam Stability Factor NDS 4.4.1
C_F = 1.0	Size Factor NDS Table 4D
C_{fu} = 1.0	Flat Use Factor NDS table 4D
C_i = 1.0	Incising Factor NDS 4.3.8
C_r = 1.0	Repetitive Member Factor NDS 4.3.9

Adjusted design value Fb' = Fb $(C_D)(C_M)(C_t)(C_L)(C_F)(C_i)(C_{fu})(C_r)$ = 1094 psi

2. Calculate effective length

$$L_e = L_{SYM} = \frac{1}{12}\left(\frac{8F_b'S}{1000P} + t\right) = \frac{1}{12}\left(\frac{8(1094)(216)}{1000(42)} + 12\right) = 4.75 \text{ ft}$$

$$S = \frac{bh^2}{6} = \frac{3(12)(6)^2}{6} = 216 \text{ in}^3$$

3. Find the limiting length

Compare effective length and post spacing 4.75 ft < 6.0 ft; <u>Use effective length</u>

4. Calculate soil pressure

$$\text{Soil pressure} = \frac{P}{A} = \frac{42000}{3.0(4.75)} = 2947 \text{ psf}$$

2947 psf < 3000 psf allowable **<u>OK</u>**

5. Calculate horizontal shear stress

Reference design value in shear F_v = 170 psi (NDS supplement table 4D)

Adjustment factors from NDS table 4.3.1:

C_D = 1.25 Duration Factor

$C_M = 1.0$	Wet Service Factor NDS table 4D (Assume < 19% moisture content)
$C_t = 1.0$	Temperature Factor NDS table 2.3.3 (Temp up to 100ºF)
$C_i = 1.0$	Incising Factor NDS table 4.3.8

Adjusted design value $F_v' = F_v (C_D)(C_M)(C_t)(C_i) = 213$ psi

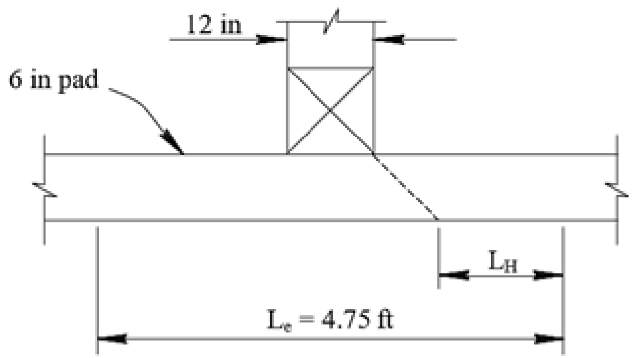

Figure D-21-2. Post A Continuous Pad Shear Dimension

$$L_H = \frac{4.75}{2} - \frac{12/12}{2} - \frac{6}{12} = 1.38 \text{ ft}$$

$$V = (2947)(1.38)(3.0) = 12201 \text{ lbs}$$

$$f_v = \frac{3V}{2A} = \frac{3(12201)}{2(6)(12)(3)} = 85 \text{ psi}$$

85 psi < 213 psi allowable **<u>OK</u>**

<u>Check corbel</u>

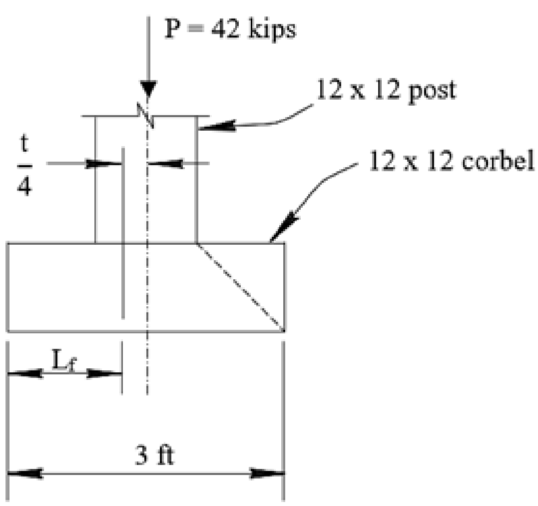

Figure D-21-3. Post A Timber Corbel Flexure and Shear Dimensions

$$W = \frac{42000}{3} = 14000 \text{ plf}$$

$$S = \frac{bh^2}{b} = \frac{12(12)^2}{6} = 288 \text{ in}^3$$

$$A = bh = 12(12) = 144 \text{ in}^2$$

$$L_f = \frac{3.0}{2} - \frac{12/12}{4} = 1.25 \text{ ft}$$

$$L_H = \frac{3.0}{2} - \frac{12/12}{2} - \frac{12}{12} = 0 \text{ ft}$$

1. Calculate compression perpendicular to grain

Reference design value $F_{c\perp} = 625$ psi

Adjustment factors from NDS table 4.3.1:

C_M = 1.0	Wet Service Factor NDS table 4D (Assume < 19% moisture content)
C_t = 1.0	Temperature Factor NDS table 2.3.3 (Temp up to 100ºF)
C_i = 1.0	Incising Factor NDS table 4.3.8
C_b = 1.0	Bearing Area Factor NDS 3.10.4

Adjusted design value $F_{c\perp}' = F_{c\perp}(C_M)(C_t)(C_i)(C_b)$ = 625 psi

$$f_c = \frac{P}{A} = \frac{42000}{144} = 292 \text{ psi}$$

292 psi < 625 psi allowable **OK**

2. Calculate horizontal shear stress

V = 0(14000) = 0 lbs.

$$f_v = \frac{3V}{2A} = 0 \text{ psi} \quad < 213 \text{ psi}$$ **OK**

3. Calculate bending stress

$$M = \frac{WL^2}{2} = \frac{(14000)(1.25)^2}{2} = 10938 \text{ ft-lbs}$$

$$f_b = \frac{M}{S} = \frac{10938(12)}{288} = 456 \text{ psi}$$

Reference design value in bending F_b = 1350 psi (NDS supplement table 4D)

Adjusted design value $F_b' = F_b(C_D)(C_M)(C_t)(C_L)(C_F)(C_i)(C_{fu})(C_r)$ = 1688 psi (see "Pad Check" step 1 for adjustment factors)

f_b = 456 psi < F_b = 1688 psi allowable **OK**

Post B:

Check Pad

1. Calculate effective length of pad short side

$$L_{SYM} = \frac{1}{12}\left(\frac{8F_b'S}{1000P} + t\right) = \frac{1}{12}\left(\frac{8(1094)(216)}{1000(36)} + 12\right) = 5.38 \text{ ft}$$

$S = \frac{bh^2}{6} = \frac{3(12)(6)^2}{6} = 216 \text{ in}^3$

2. Find limiting length on short side

Compare $\frac{1}{2}$ of effective length and $\frac{1}{2}$ post spacing

$\frac{1}{2}$ (5.38 ft) = 2.69 ft

$\frac{\text{post spacing}}{2} = \frac{6.00}{2} = 3.00$

L_1 = 2.69 ft (min. from above)

3. Find limiting length on long side

Compare $\frac{1}{2}$ of effective length and $\frac{1}{2}$ post spacing

$\frac{1}{2}$ (5.38) = 2.69 ft

$\frac{\text{post spacing}}{2} = \frac{8.0}{2} = 4.00$ ft

L_2 = 2.69 ft (min. from above)

4. Calculate soil pressure

Bearing length = $L_1 + L_2$ = 2.69 + 2.69 = 5.38 ft

Soil pressure = $\frac{P}{A} = \frac{36000}{3(5.38)}$ = 2230 psf

2230 psf < 3000 allowable **OK**

5. Calculate horizontal shear in pad on long side

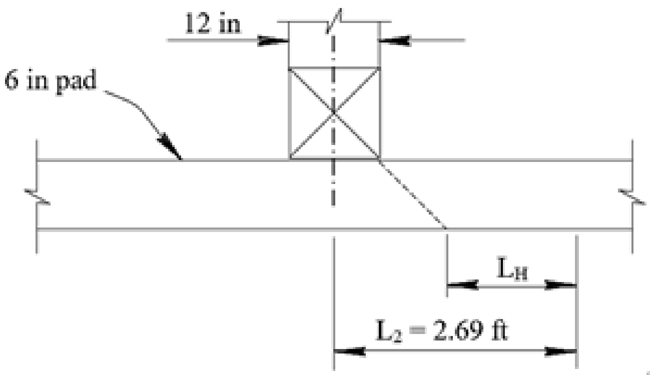

Figure D-21-4. Post B Continuous Pad Shear Dimension

$L_H = 2.69 – 0.5 – 0.5 = 1.69$ ft

V = (2230)(1.69)(3.0) = 11306 lbs.

$f_v = \frac{3V}{2A} = \frac{3(11306)}{2(6)(12)(3)} = 79$ psi < 213 psi **<u>OK</u>**

<u>Check Corbel</u>

Corbel is **<u>OK</u>** by inspection (Post load at B < post load at A)

<u>Post C:</u>

<u>Check Pad</u>

1. **Calculate effective length of pad**

$$L_{SYM} = \frac{1}{12}\left(\frac{8F'_bS}{1000P} + t\right) = \frac{1}{12}\left(\frac{8(1094)(216)}{1000(30)} + 12\right) = 6.25 \text{ ft}$$

2. **Find limiting length on outside of post**

Compare $\frac{1}{2}$ of effective length and edge distance

$\frac{1}{2}(6.25) = 3.13$ ft

Edge distance = 3.00 ft

$L_1 = 3.0$ ft (min. from above)

3. **Find limiting length on inside of post**

Compare $\frac{1}{2}$ of effective length and $\frac{1}{2}$ post spacing

$\frac{1}{2}(6.25) = 3.13$ ft

$\frac{\text{post spacing}}{2} = \frac{8.00}{2}$ = 4.00 ft

L_2 = 3.13 ft (min. from above)

4. **Calculate soil pressure**

Bearing length = $L_1 + L_2$ = 3.00 + 3.13 = 6.13 ft

Soil pressure = $\frac{P}{A} = \frac{30000}{3(6.13)}$ = 1631 psf

1631 psf < 3000 psf allowable **OK**

5. **Calculate horizontal shear stress on long side**

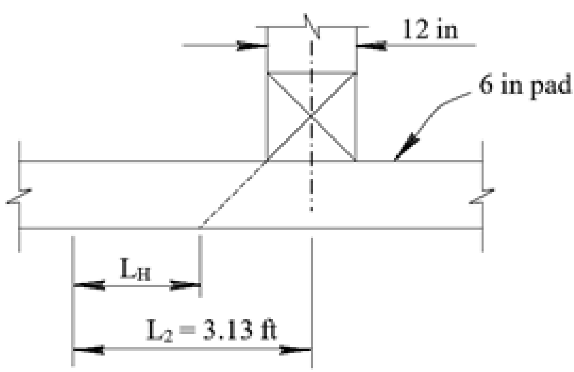

Figure D-21-5. Post C Continuous Pad Shear Dimension

$L_H = 3.13 - \frac{12/12}{2} - \frac{6}{12}$ = 2.13 ft

V = (1631)(2.13)(3.00) = 10422 lbs

$f_v = \frac{3V}{2A} = \frac{3(10422)}{2(6)(12)(3)}$ = 72 psi

72 psi < 213 psi allowable **OK**

Check Corbel

Corbel is **OK** by inspection (Post load at C < post load at A)