Appendix D Example 22 – Continuous Pads – Two or More Corbels

Refer to *Falsework Manual,* Section 8-2.05, *Continuous Pad with Two or More Corbels.* This example demonstrates how to analyze a continuous falsework pad with multiple corbels.

Given Information

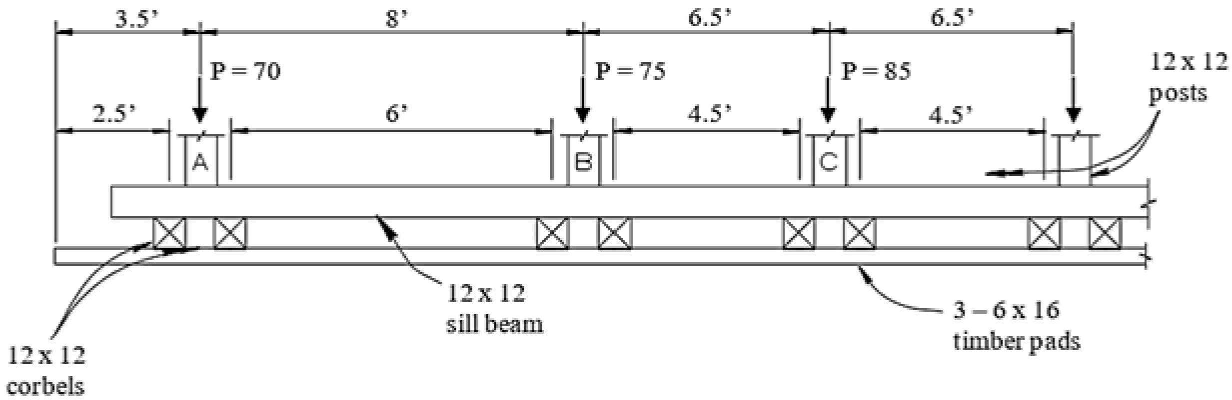


Figure D-22-1. Continuous Pad with Two Corbels

Timber pads:

Three 6 x 16 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 = 4000 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 $F_b' = F_b (C_D)(C_M)(C_t)(C_L)(C_F)(C_i)(C_{fu})(C_r) = 1094$ psi

2. Calculate effective length of pad

$$L_e = L_{SYM} = \frac{1}{12}\left(\frac{8F_b' S}{1000P} + t\right) = \frac{1}{12}\left(\frac{8(1094)(288)}{1000(70)} + 12\right) = 4.00 \text{ ft}$$

$$S = \frac{bh^2}{6} = \frac{3(16)(6)^2}{6} = 288 \text{ in}^3$$

3. Find limiting length of outside of post

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

$$\frac{1}{2}(4.0) = 2.00 \text{ ft}$$

Edge distance = 2.50 ft

L_1 = 2 ft (min. from above)

4. Find limiting length on inside of post

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

$$\frac{1}{2} L_e = \frac{1}{2}(4.0) = 2.00 \text{ ft}$$

$\frac{1}{2}$ (corbel spacing) = $\frac{1}{2}$ (6.0) = 3.00 ft

L_2 = 2.00 ft (min. from above)

5. Calculate soil pressure

Bearing length = L_1 + m + L_2 = 2.00 + 2.00 + 2.00 = 6.00 ft

Soil pressure = $\frac{P}{A} = \frac{70000}{4(6.0)} = 2917$ psf

2917 < 4000 allowable **OK**

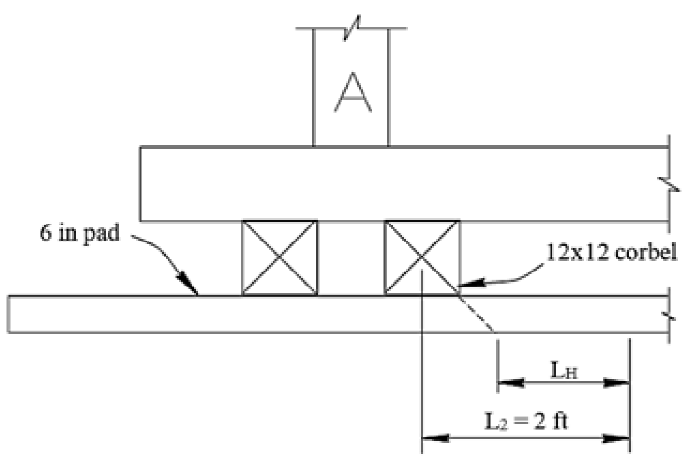
6. Calculate horizontal shear on long side of pad

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



$L_H = 2.00 - \frac{12/12}{2} - \frac{6}{12} = 1.00$ ft

V = (2916)(1.0)(4.00) = 11667 lb

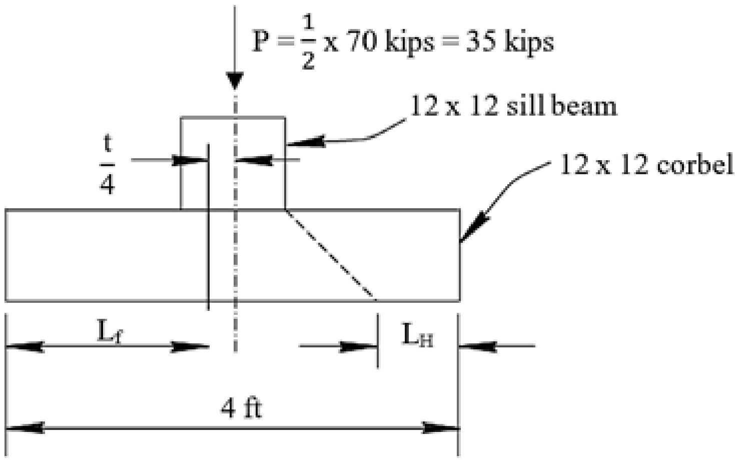
$f_v = \frac{3V}{2A} = \frac{3(11667)}{2(6)(16)(3)} = 61$ psi

61 psi < 213 psi allowable **OK**

Figure D-22-2. Exterior Post A Continuous Pad Shear Dimension

Check Corbels

Assume total vertical load is distributed equally to the two corbels.



$W = \frac{35000}{4} = 8750$ plf

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

$L_f = \frac{4.0}{2} - \frac{12/12}{4} = 1.75$ ft

$L_H = \frac{4.0}{2} - \frac{12/12}{2} - \frac{12}{12} = 0.5$ ft

Figure D-22-3. Post A Timber Corbel Flexure and Shear Dimensions

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

$F_c = \frac{P}{A} = \frac{35000}{12(12)} = 243$ psi

243 psi < 625 psi allow **OK**

2. Calculate horizontal shear stress in corbel

V = 0.5(8750) = 4375 lb

$f_v = \frac{3V}{2A} - \frac{3(4375)}{2(144)}$ = 46 psi

46 psi < 213 psi allow **OK**

3. Calculate bending stress

$M = \frac{WL^2}{2} = \frac{(8750)(1.75)^2}{2}$ = 13398 ft-lb

$f_b = \frac{M}{S} = \frac{(13398)(12)}{288}$ = 558 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)

558 psi < 1688 psi allowable **OK**

Post B:

Check Pad

1. Calculate effective length of pad

$L_e = L_{SYM} = \frac{1}{12}(\frac{8F_b'S}{1000P} + t) = \frac{1}{12}(\frac{8(1094)(288)}{1000(75)} + 12)$ = 3.80 ft

$S = \frac{bh^2}{6} = \frac{3(16)(6)^2}{6}$ = 288 in^3

2. Find limiting length of short (right) side

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

$\frac{1}{2}(3.80)$ =1.90 ft

$\frac{1}{2}$ (corbel spacing) = $\frac{1}{2}$ (4.50) = 2.25 ft

L_1 = 1.90 ft (min. from above)

3. Find limiting length on long side

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

$\frac{1}{2}$ (3.80) = 1.90 ft

$\frac{1}{2}$ (corbel spacing) = $\frac{1}{2}$ (6.00) = 3.00 ft

L_2 = 1.90 ft (min. from above)

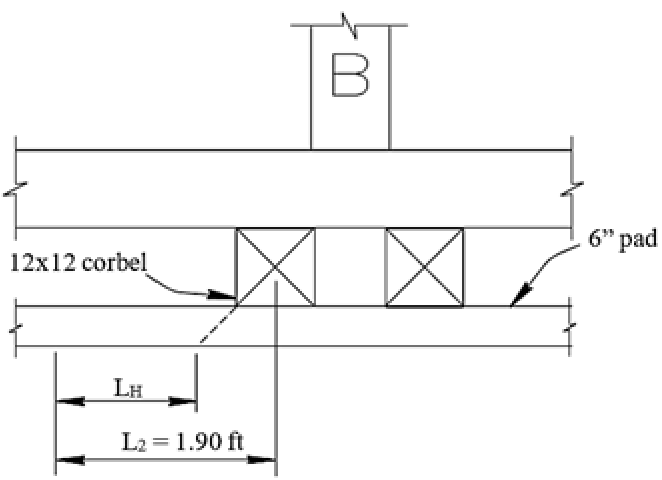
4. Calculate soil pressure

Bearing length = L_1 + m + L_2 = 1.90 + 2.00 + 1.90 = 5.80 ft

Soil pressure= $\frac{P}{A} = \frac{75000}{4(5.80)}$ = 3233 psf

3233 psf < 4000 psf allowable **OK**

5. Calculate horizontal shear stress on long side of pad



L_H = 1.90 – $\frac{12/12}{2}$ – $\frac{6}{12}$ = 0.90 ft

V = 4(3233)(0.90) = 11639 lb

f_v = $\frac{3V}{2A} = \frac{3(11639)}{2(6)(16)(3)}$ = 61 psi

61 psi < 213 psi allowable **OK**

Figure D-22-4. Interior Post B Continuous Pad Shear Dimension

Check Corbels

Post B corbel is same as Post A corbel; therefore, stress is proportional to the applied load.

$f_c = \frac{75}{70}(243)$ = 260 psi < 625 psi allowable

$f_v = \frac{75}{70}(46)$ = 49 psi < 213 psi allowable

$f_b = \frac{75}{70}(558)$ = 598 psi < 1688 psi allowable **OK**

Post C:

Check Pad

1. **Calculate effective length of pad**

$L_e = L_{SYM} = \frac{1}{12}\left(\frac{8F_b^{\prime}S}{1000P} + t\right) = \frac{1}{12}\left(\frac{8(1094)(288)}{1000(85)} + 12\right)$ = 3.47 ft

2. **Find limiting length**

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

$\frac{1}{2}(3.47)$ = 1.74 ft

$\frac{1}{2}$ (corbel spacing) = $\frac{1}{2}(4.5)$ = 2.25 ft

$L_1 = L_2$ = 1.74 ft (min. from above)

3. **Calculate soil pressure**

Bearing length = $L_1 + m + L_2$ = 1.74 + 2.00 + 1.74 = 5.48 ft

Soil pressure = $\frac{P}{A} = \frac{85000}{4(5.48)} =$ 3878 psf

3878 psf < 4000 psf allowable **OK**

4. **Calculate horizontal shear stress**

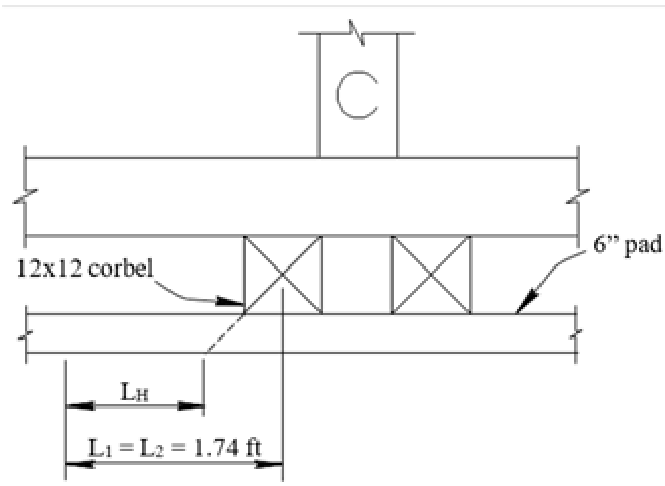


Figure D-22-5. Interior Post C Continuous Pad Shear Dimension

$$L_H = 1.74 - \frac{12/12}{2} - \frac{6}{12} = 0.74 \text{ ft}$$

$$V = 4(3878)(0.74) = 11479 \text{ lb}$$

$$f_v = \frac{3V}{2A} = \frac{3(11479)}{2(6)(16)(3)} = 60 \text{ psi}$$

60 psi < 213 psi allowable **OK**

Check Corbels

Post C corbel is same as Post A corbel; therefore, stress is proportional to the applied load.

$$f_c = \frac{85}{70}(243) = 295 \text{ psi} < 625 \text{ psi allowable}$$

$$f_v = \frac{85}{70}(46) = 56 \text{ psi} < 213 \text{ psi allowable}$$

$$f_b = \frac{85}{70}(558) = 678 \text{ psi} < 1688 \text{ psi allowable}$$ **OK**