Appendix D Example 15 – Diagonal Bracing of Single Tier Framed Bent – Bolted Connections

Refer to *Falsework Manual,* Section 6-3, *Diagonal Bracing* and Section 5-3, *Timber Fasteners*. This example demonstrates how to determine if the bracing system of a single tier framed bent is adequate. All connections are bolted.

Given Information

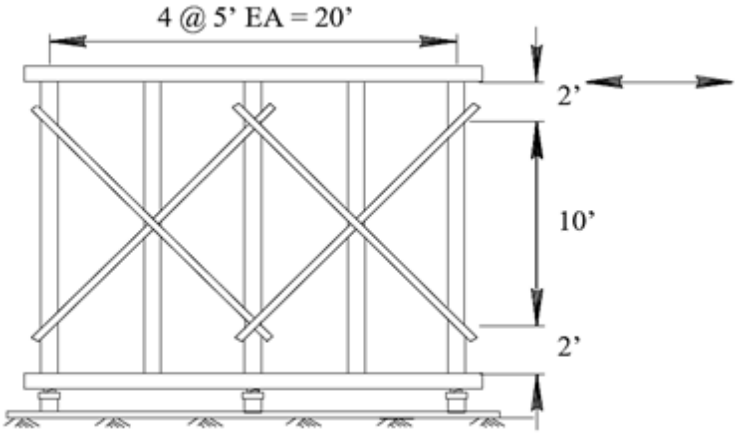


Figure D-15-1. Single Tier Framed Bent with Multiple Diagonal Bracing

2% Dead Load = 4200 lb
Wind Load = 4100 lb

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

Diagonal Braces:
2x8 Douglas Fir-Larch #2 (G=0.50)

Connectors:
End of brace to post: ¾ ″ Ø Bolt
Center of brace to post: ¾ ″ Ø Bolt
(All bolts in single shear)

Determine if the Bracing System is Adequate

1. **Determine the strength of the bolted connection between brace and post:**

   (See Example Problem #10 for additional information)

   Adjusted connection capacity (Z') = 1530 lb

2. **Determine strength of diagonal braces in tension:**

Reference design value in tension F_t = 575 psi (NDS supplement table 4A)

Adjustment factors from NDS table 4.3.1:

C_D = 1.25 *Duration Factor for 2% lateral loading*
C_M = 1.0 *Wet Service Factor NDS table 4A (Assume < 19% moisture content)*
C_t = 1.0 *Temperature Factor NDS table 2.3.3 (Temp up to 100ºF)*
C_F = 1.2 *Size Factor NDS Table 4A*
C_i = 1.0 *Incising Factor NDS 4.3.8*

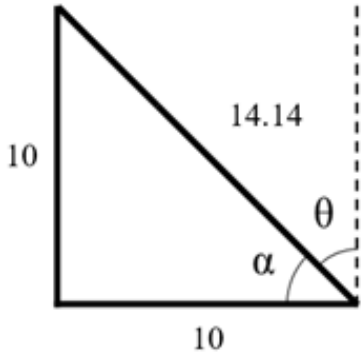
Adjusted design value Ft' = Ft (CD)(CM)(Ct)(CF)(Ci) = 863 psi

Tension capacity = 863 psi (1.5")(7.25") = 9385 lb

3. **Determine strength value of the tension members:**

   9385 lb > 1530 lb ∴ Connection controls tension

4. **Calculate the horizontal component of the strength value for tension members:**



$$T = 1530\ \text{lb}\left(\frac{10}{14.14}\right) = 1082\ \text{lb}$$

Figure D-15-2. Geometric Components of Tension Strength Value

5. **Determine the capacity of diagonal brace in compression:**

   Determine connection capacity of diagonal brace in compression:

   Connection capacity = 1530 lb (from step 1 above.)

   Determine the capacity of diagonal brace in compression:

Reference design value in compression F_c = 1350 psi (NDS supplement table 4A)

Adjustment factors from NDS table 4.3.1:

C_D = 1.25 *Duration Factor for 2% lateral loading*

C_M = 1.0 *Wet Service Factor NDS table 4A (Assume < 19% moisture content)*

C_t = 1.0 *Temperature Factor NDS table 2.3.3 (Temp up to 100ºF)*

C_F = 1.05 *Size Factor NDS Table 4A*

C_i = 1.0 *Incising Factor NDS 4.3.8*

C_P = 0.083 *Column Stability Factor NDS 3.7.1 (unsupported length* = $\frac{14.14}{2}$ = 7.07’*)*

Adjusted design compression value $F_c' = F_c\ (C_D)(C_M)(C_t)(C_F)(C_i)(C_P)$ = 147 psi

Compression brace capacity = 147 psi(1.5”)(7.25”) = 1599 lb

6. Determine the strength value of the compression members

1599 lb > 1530 lb ∴ connection controls compression

Limit to ½ theoretical strength for compression values: See section 6-3.02 *Wood Cross Bracing.*

Reduced compression brace capacity = $\frac{1530\ \text{lb}}{2}$ = 765 lb

7. Calculate the horizontal component of the strength value for the compression member

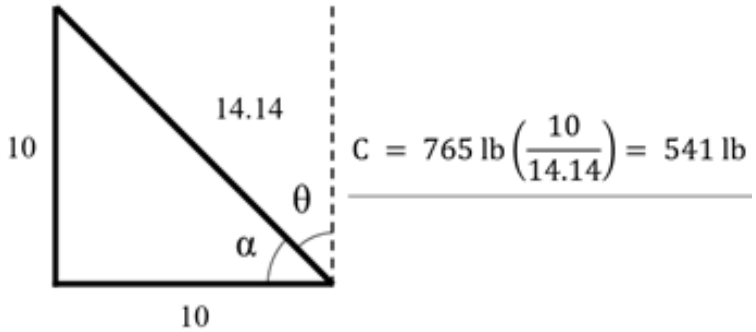


Figure D-15-3. Geometric Components of Compression Strength Value

8. Calculate the total resisting capacity of the diagonal bracing system:

Summarize Result for 2% Dead Load

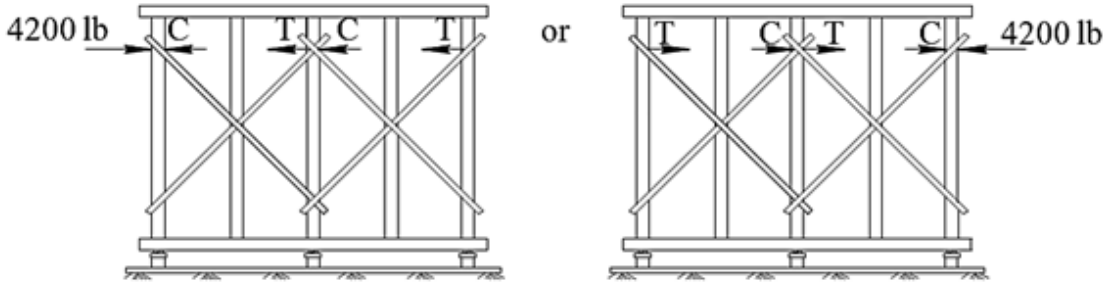


Figure D-15-4. Total Resisting Capacity for 2% Dead Load

Total resisting capacity $= \Sigma(C + T) =$ 541 + 1082 + 541 + 1082 = 3246 lb

Resisting capacity = 3246 lb < Horizontal demand force = 4200 lb

Bracing system is inadequate for 2% Dead Load

Summarize Result for Wind Load

Repeat above process for wind load to calculate the Resisting Capacity, using C_D = 1.6 rather than 1.25. All other factors are the same.

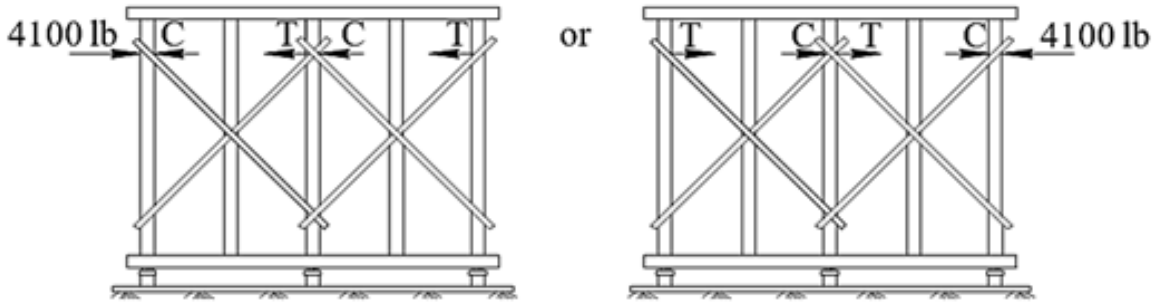


Figure D-15-5. Total Resisting Capacity for Wind Load

The Resisting Capacity for wind load can also be derived by multiplying the resisting capacity for 2% Dead Load (above table) by the ratio $\frac{C_D \text{ wind}}{C_D \text{ 2\%}} = \frac{1.6}{1.25}$

Resisting Capacity = 3246 lb $\left(\frac{1.6}{1.25}\right)$ = 4155 lb > Horizontal Demand Force = 4100 lb

Bracing system is adequate for Wind Load

Bracing system does not have enough capacity to resist both 2% Dead Load and Wind Load.

Bracing system is inadequate.