steel quiz

This month's Steel Quiz looks at the use of design tables in the AISC *Steel Construction Manual*.

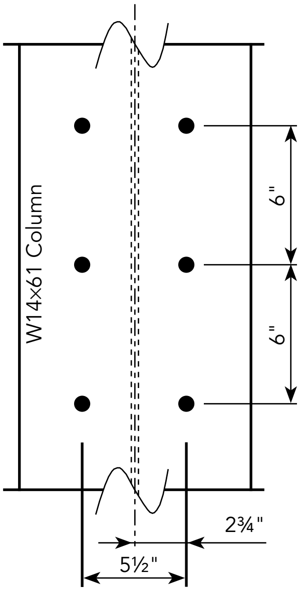


Figure 1

1 What is the tributary length, p, for checking prying on the column flange shown in Figure 1?

2 True or False: If the thickness of the column flange shown in Figure 1 is greater than t_{min}, calculated using Equation 9-20a or 9-20b given in the 14th Edition AISC *Manual*, then the prying force per bolt, q, due to the column flange would be equal to 0 kips.

3 True or False: If the thickness of the column flange shown in Figure 1 is greater than t_{min}, a flexural yielding check of the column flange is not required.

4 For the connection angle shown in Figure 2, the required strength, T_u, is 16 kips and the prying force, q, calculated from Equation 9-28, is equal to 7.3 kips. Assume $\alpha' > 1$ and Q, calculated per Equation 9-34, equals 0.49. The available tension per bolt, $B = \phi r_n$, is equal to 29.8 kips. The total force on the bolt is equal to $T_u + q$ = 16 kips + 7.3 kips = 23.3 kips < 29.8 kips.

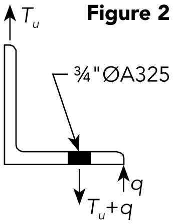


Figure 2

True or False: The connection is adequate for prying action without any further consideration.

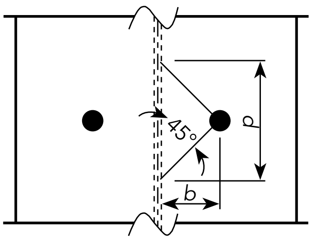
5 Does the prying force, q, need to be determined when checking prying action?

6 Assume the connection to the column shown in Figure 1 is a slip-critical joint, and the thickness of the column flange is such that a prying force on the bolt, q, exists.

True or False: This force, q, will result in a reduction in the slip resistance of the slip-critical connection (per AISC *Specification* Equation J3-5a or J3-5b).

TURN PAGE FOR ANSWERS

Figure 3



1 p = 5⅛". The column web thickness for a W14×61 is equal to ⅜". Therefore, b (see Figure 3) is equal to 2¾"−$^3/_{16}$"=2$^9/_{16}$". Per the recommended design procedure in Part 9 of the 14th Edition AISC *Manual*, $p = 2b \leq s$, where s = 6". It should be noted that the *Manual* explicitly allows other methods, which could allow a larger tributary length to be used. One alternative is presented in "A Yield Line Component Method for Bolted Flange Connections" (Dowswell, *Engineering Journal* 2nd Quarter 2011).

2 True. As stated in the explanation of these equations in Part 9 of the 14th Edition *Manual*, "When the fitting thickness, t, is greater than or equal to t_{min}, no further check of prying action is necessary. In this solution, the additional force in the bolt due to prying, q, is essentially zero."

3 True. Equation 9-22a and 9-22b are used to select a preliminary fitting thickness, and they do so based upon checking flexural yielding. Solve for t and the following expression results (LRFD shown, ASD similar).

$$t = \sqrt{\frac{2Tb}{\varnothing pF_u}}$$

Compare this to equation 9-20a and one should realize that selecting a thickness that eliminates prying action will also satisfy flexural yielding.

4 False. When $\alpha' > 1$, the fitting has insufficient strength to develop the full bolt available tensile strength which is 29.8 kips in this case. The available strength, $T_{u\text{-}avail}$, can be determined using Equation 9-31 and equals $B \times Q$ = 29.8 kips × 0.49 = 14.6 kips < 16 kips. Therefore, the connection is not adequate. Stated more directly, the significance of $\alpha' > 1$ is that the strength of the fitting is governed by the flexural strength of the angle.

5 No for statically loaded applications, yes for fatigue applications. The procedure shown in Part 9 of the *Manual* contains a formula to calculate the magnitude of the prying force, q. But in reality, designers rarely need to determine the prying force directly since its magnitude is only required for fatigue calculations. In statically loaded applications, the calculation process integrates the effects of q in the calculations without the need to calculate it.

6 False. The prying force, q, also acts in compression along the flange tip. Therefore, there would be no change in the slip resistance of the connection.