steelwise

# A QUICK LOOK AT PRYING

There's no need to fear prying checks, and a new paper can help guide you through the process.

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**THE PRYING CHECK PROCEDURE** can be intimidating for first-time users.

There are many variables and equations in the procedure, which is presented in Part 9 of the 14th Edition of the AISC *Steel Construction Manual*, and the controlling limit state may not always be obvious.

For those that have struggled with this procedure, a paper has been posted on AISC's website that presents a different way to view the prying checks in the *Manual*. You can view the complete paper at **www.aisc.org/pryingcheck**. But for a summary of what it discusses, read on.

### Increasing Strength

Prying may mistakenly be viewed as a flaw in a connection, a limit state that weakens the connection when the opposite can be true. As stated on page 9-11 of the *Manual*: "Alternatively, it is usually possible to determine a lesser required thickness by designing the connecting element and bolted joint for the actual effects of prying action with $q$ greater than zero." One should view prying as a way to increase the strength of a connection. It is analogous to the post-buckling strength gained in plate girders from tension-field action.

Often, different models can be used in design with each producing an acceptable result. Simple models are often more conservative than more complex models. A simple, statically determinate model is shown in Figure 1.

In this model, the angle to the right of the bolt line is neglected. The moment is resisted through bending in the angle near the junction between the two legs. It is assumed that the capacity of the system has been reached when a single hinge is formed.

However, it must be recognized that a second hinge can form at the bolt line. A model that considers only the strength from this hinge is shown in Figure 2.

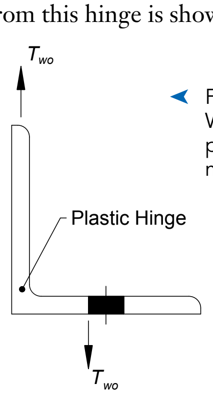



Figure 1. Without prying model.

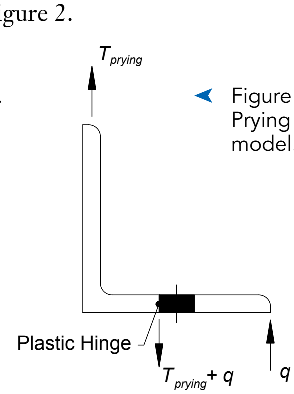
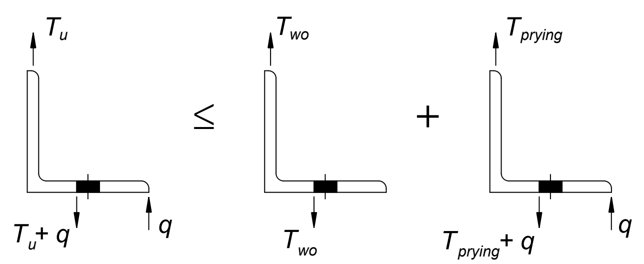



Figure 2. Prying model.

Essentially, additional restraint is added to the system when prying is considered, and adding restraint cannot weaken the system. (This is, in fact, a corollary to the lower bound theorem.)

To determine the available strength of an angle for prying, these two models can be superimposed as shown in Figure 3. Note that while this approach is shown for a single angle, it can easily be adapted to WT and wide-flange sections.




$$T_u \leq T_{wo} + T_{prying}$$

Figure 3. Breakdown of prying check.

Where:
$T_{wo}$ = Connection Strength without Considering Prying
$T_{prying}$ = Additional Connection Strength due to Prying
$q$ = Prying Force

The load that can be carried based on the first model is the lesser of the moment that causes the first hinge or the strength of the bolt, $B$. If the model is limited by the bolt strength, then no additional strength can be gained from considering prying.

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$$T_{wo} = \frac{\phi M_{wo}}{b'} = \frac{\phi F_u Z}{b'} = \frac{\phi F_u \left(\frac{p\,t^2}{4}\right)}{b'} \le B$$

If the first model is not sufficient to transfer the load, then prying can be considered. The additional strength that can be added to $T_{wo}$ can be calculated as follows:

The load that can be carried based on the formation of the second hinge is calculated.

$$T_{prying\_flexure} = \frac{\phi M_{prying}}{b'} = \frac{\phi F_u \left(\frac{(p-(d'))t^2}{4}\right)}{b'}$$

The strength of bolt must also be considered:

$$T_{prying\_bolt} = \frac{B-T_{wo}}{\left(1+\frac{b'}{a'}\right)}$$

The available strength gained by considering prying is the lesser of the bolt strength and the angle strength:

$$T_{prying} = min\begin{cases} T_{prying\_flexure} \\ T_{prying\_bolt} \end{cases}$$

The total available strength of the connection is the sum of these:

$$T_{total} = T_{wo} + T_{prying}$$

where:
$d'$ = width of the hole along the length of the fitting, in.
$p$ = tributary length, in.
$B$ = the available strength per bolt, kips.

Note that if $T_u$ is less than $T_{wo}$, prying does not need to be considered. The connection is sufficient considering only one hinge.

The checks are summarized in Figure 4.

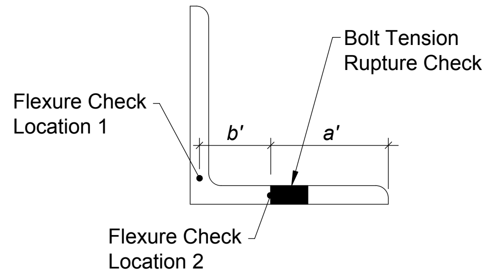


Figure 4. Limit states being checked.

The paper posted online goes into greater detail about this approach and provides a few examples. View the complete paper at **www.aisc.org/pryingcheck**.