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Preseone Los Bordes “Squash the Bumps”

There's a simple way to install bolts that's better than any other way. Here it is:

Put a Direct Tension Indicating washer (called a DTI, on the bolt, and “squash the bumps,” or in Spanish, “preseone los bordes.”

DTI's, often called “load indicators,” or “loads” by some distributors, don't have to be handled gently. They don't have to be compressed just so far and no more, as was thought at one time, and as some specifying authorities still think.

Typical DTI instructions, like those shown in Figures 1 and 2, show the DTI compressed only just so far. Nowadays, however, steel erectors like those shown in Figure 3, assembling connections like those shown in Figures 4 and 5, first “snug” the connection getting all the steel plies together, and then they “squash the bumps.” And if they squash the DTI bumps so that there is absolutely no gap remaining, that's the easiest thing for them to do. And it's OK with us, the DTI manufacturer, too.

The good news is, it's also OK for the connection, and there's research to

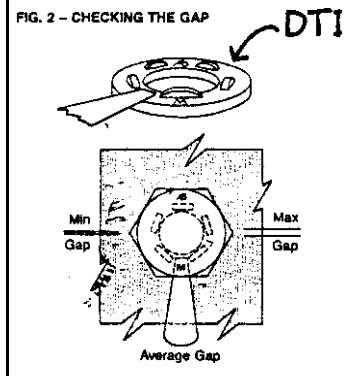
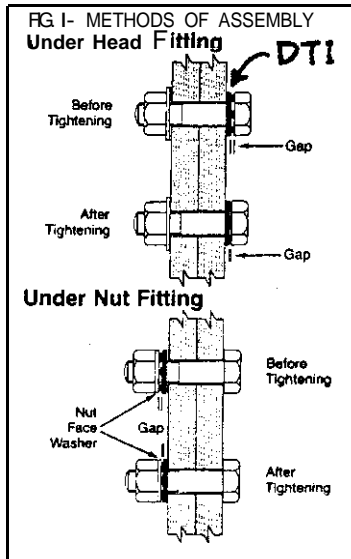


FIGURE 3 - ERECTORS

prove it, done by the Department of Civil Engineering at the University of Idaho¹. With the permission of Dr. Schmeckpeper and Dr. Nielsen, the work is summarized here. Note that their work goes on today, and another final version of the entire paper will be prepared for distribution in the Summer of 1997.

This is the situation which precipitated the research:

The Idaho Department of Transportation, while constructing the Lawyer's Canyon Bridge in 1993, noted that the steel erector “flattened” some of the DTI's. He did not always leave a residual gap (See Figure 2 “Min. Gap”). Engineering officials from IDOT asked Dr. S. and Dr. N. to test whether leaving the DTI's in the “completely flattened” condition was acceptable structurally.

This is what they did:

They went out into the marketplace and procured some DTI's and bolts, assembled them in a Skidmore, and measured the DTI gap with feeler gages as the bolt preload was increased and as the DTI gap went to zero (see Figure 6). But they didn't stop there. They continued tightening the bolt 360 degrees of nut rotation past the “dead flat” DTI position (that's ONE FULL TURN OF THE NUT PAST FLAT). Then, not to leave any possibility untested, they advanced the nuts on the tested bolts ANOTHER 360 DEGREES. That's TWO

FULL TURNS PAST DEAD FLAT ON THE DTI. Many bolts will not take this much turn of the nut before break-

ing, but the presence of a DTI on the bolt enables more nut rotation before fracture compared to a bolt without a DTI. DTI's on the bolt are said to "soften" the bolt tension/turn response, and to make it more forgiving to abuse like this.

For these three conditions (flat DTI, flat plus one nut turn, flat plus two nut turns) Dr. S. and Dr. N. tested the ultimate strength of the bolts in shear, and found that it was unchanged (see Figure 7).

They were then able to report to IDOT that they did not have to worry about their contractor getting overly vigorous about going too far past flat on the DTI - the bolts were still doing their job of holding the connection together and resisting ultimate shear loads.

(The writer points out that there is an additional advantage in going to a flat DTI, for coated DTI's, either mechanically galvanized or galvanized and epoxy coated, because it removes any possibility of a crevice acting as a corrosion initiator, since the coating on the flattened DTI gets mushed around under the bolt head and seals up any crevice. If field paint is applied to the assembly, so much the better.)

From this work, IDOT concluded that they could allow

DTI's to be left installed in the "flat" condition, although they encourage the bolt installers not to rotate the nut too much past the flat position of the DTI. But if they do

so, they're not concerned about the shear capacity of the connection. They suggest simply selecting a few of the bolts where the DTI has been flattened, remove them, and check if the nut can run down the bolt to the root of the thread. If it can, the bolt has not been stretched too muchⁱⁱ, and is acceptable. Then they caution the erector to go a little easier in the future. 0

ⁱ "Effects of Bolt Over-tightening on Bolted Connections," Schneckpeper, Edwin R., et al, Proceedings of the ASCE Structures Congress, 1994, ISBN: 0-87262-952-X

ⁱⁱ This does not mean that the opposite is not acceptable. Satisfactorily tightened structural bolts can be stretched to the point where they begin to "neck down" a bit in the first few threads, and therefore the nut might not run easily right down to the bottom of the thread. If this occurs, the FHWA

"Installation Verification Procedure" might be run with the bolts and DTI's together, and the bolt tension at "flat" compared with the bolt's Rotational Capacity tension value. If the former is 0.95 of the latter, or less it's OK. The tried and true rule of thumb that "...If the bolt has not broken on installation, it's OK..." is actually true, at least for structural bolts installed in virtually all applications.

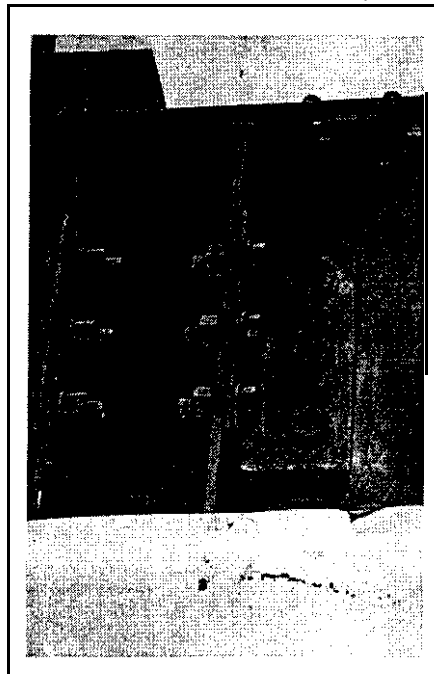


FIGURE 4 -CONNECTION

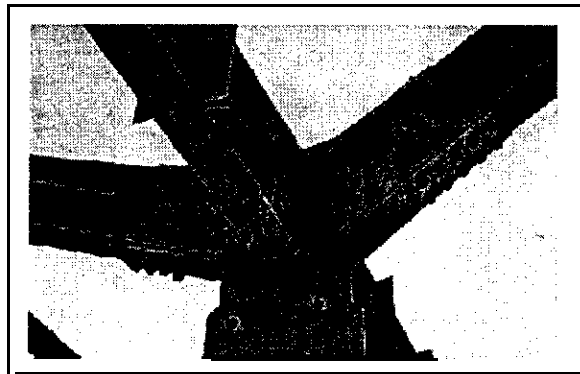


FIGURE 5 -CONNECTION

