

About the Author/WAYNE WALLACE

Wayne Wallace is the president of Applied Bolting Technology Products. The company provides bolting consulting services and manufactures direct tension indicating washers from its base in Ludlow, Vermont. Wallace is a member of the Research Council on Structural Connections, a director of the Bolting Technology Council, and author of numerous papers on the practical aspects of quality assurance in structural bolting. He can be reached by fax at 802-228-7204 - or e-mail at wallace@appliedbolting.com



Bolting Failures I Have Seen

I am sometimes asked to describe the types of bolting failures I have seen. I don't keep a list, and I may be forgetting some, but here are some of the most frequently encountered ones. These are the common everyday kind — not the spectacular failures like the long engagement and/or thread failure of an MD-80 tail plane jack screw. Not the technically complex failures like stress corrosion cracking or delayed fracture caused by hydrogen embrittlement. Not the really obvious failures like stripping of bolt threads or bolts loosening because they were never really tensioned in the first place.

The failures I'm talking about are the ordinary day-to-day kind that gets bolting all screwed up and costs money needlessly. The kind that never should happen. We see them on construction projects from sophisticated California processing plants to the paper mills of the Northeast US forest wilderness, and from the cities of Europe to the remote jungles of Southeast Asia.

I can't tell you how many project sites I have visited where there was no sign of the specifications. Nobody knew for sure what they were supposed to do.

We see them as contractors are driven by them toward using DTI's. It's true, our DTI's help get the bolting straight, but even DTI's aren't foolproof. We still (occasionally) see DTI's installed with the bumps upside down — that is against the steelwork (DTI's are harder than steel plate so the bumps dig in rather than get compressed like they would if the bumps were against the bolt head or a hard flat washer). And just the other day a bolting foreman from a major American EPC company told us he only uses one washer, a DTI (good), and he always puts it directly under the nut (bad!). Our instructions clearly state the DTI bumps must be separated from the turning element by a hard flat washer, but apparently he didn't know that.

Which brings me to perhaps the most common failure of bolting: Not reading and understanding the bolting instructions. Or not having instructions in the first place. Speaking from the DTI side, our standard DTI Installation sheet has big pictures, and lots of small print on the back. But we know that doesn't get read thoroughly. So we've just come up with an "all picture" DTI Installation Sheet, in an attempt to get everybody to look at it, even if they don't want to read. The new one has almost no words, just pictures (see Fig. 1). I got the idea from trying to follow the assembly instructions for a Thule roof rack in the parking lot of the store where I bought it, in a cold rain and drizzle. On one of the dozen or so sheets of instructions, for many models of cars, in many languages, I found a few sequential pictures, and in desperation I followed the pictures. It worked fine.

This is also why we developed the "squirter" DTI. Bolt installers don't want to hear about feeler gage instructions — where to try to put it, how many times you can't get it in, etc. That's OK for inspectors, but installers just drove the bolt until the DTI was flat, which is OK for most situations. With "squirters", it's pretty obvious what to do — drive the bolt until the orange silicone squirts out, then stop.

I can't tell you how many project sites I have visited where there was no sign of the specifications. Nobody knew for sure what they were supposed to do. If the primary specifications were there, often the reference documents were not. No RCSC spec., no AISC spec., no approved bolting procedure. But it never seems to stop the workers from going ahead anyway, somehow. Maybe the same way they did it on the last job. And that's usually trouble.

The second most common failure is not understanding that TENSION is needed, not TORQUE. Visiting project sites, it's rare for us to encounter bolting professionals who understand what level of tension or stretch is needed in the bolts. They're still used to torque. We also see this from the many visitors to our website, who, several times each and every day, ask:

1. What tension do I need?
2. Approximately what torque does that mean?

We put answers to these most frequently asked questions on the front page of our website (www.appliedbolting.com), where we show a link to a table of minimum tensions. To answer their torque question, we link to the old $T=Pkd$ formula, and show a table of suggested installation torque ranges and recommended wrench sizes. In case they want to get into a lot more detail, we even provide a dedicated search engine called "Atomizer", which searches the entire website using the term they're looking for, right down to the bottom of the downloadable text articles, and puts the search results up in the form of links just like Yahoo! or Metacrawler would do. Clicking on any of these search results puts them face-to-face with the information they need, and in the right context.

Of course the failure to understand the difference between torque and tension in a bolt is critical to making the bolting work go smoothly, and that leads inevitably to all kinds of related failures.

Here's our hit list of what can (and often does) go wrong:

1. They insist on referring to torque tables. When you tell them they were deleted from the North American specs in the '50's, they produce wrench manufacture capacity charts. "See?" they say. "It says right here this wrench is good for 1" A490 bolts." And they go on hammering away for 30 or 40 seconds on a 1" A325 DTI and still can't squash the DTI bumps. "There's

something wrong with these (expletive deleted) DTI's!" they say. We get out the bolt lubricant, and away they go.

2. They set up their "calibrated wrench" procedures using new bolts out of the keg, but wonder why they can't tighten bolts up in the steelwork which have been out in the weather for a few weeks, don't have hard flat washers under the nut, or both.

3. When all else fails, they get out their torque wrench and measure the torque on all the bolts. If it's not high enough, they wait a few days and measure it again. And guess what? The torque gets higher every day that the bolts are exposed.

4. Sometimes the inspector declares that there's too much torque on the bolts, or if he has a way of testing, too much tension.

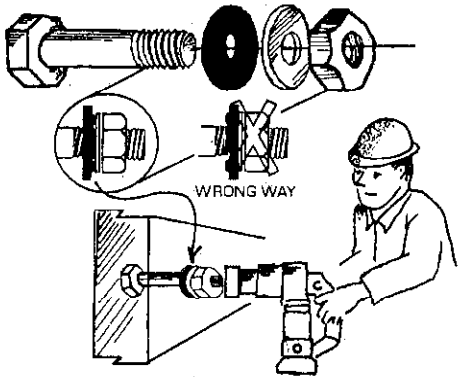
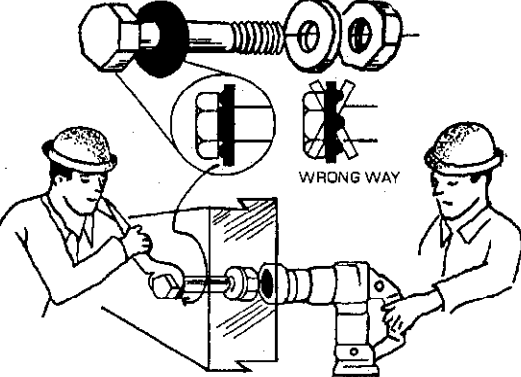
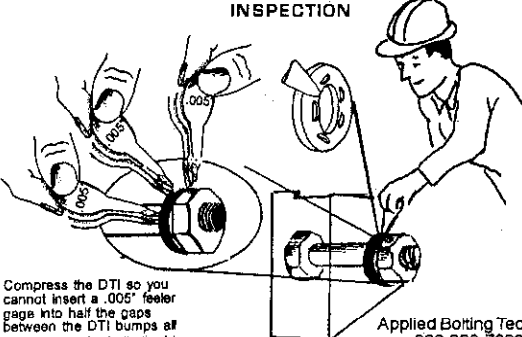
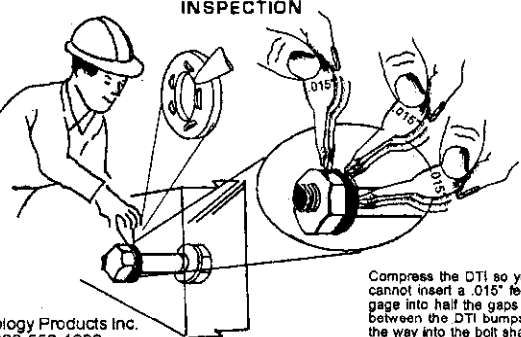
5. Most project sites don't have a Skidmore bolt tension calibrator available. When you ask them if they should have one available, they don't know what you're talking about.

6. When they do pre-installation testing in a Skidmore and the bolt/nut/washer assembly fails, they sometimes stop doing it. Just stop. Like that.

7. Hardware certifications are usually not available on site, so no one is sure that the bolts and nuts (and DTI's) they actually have are up to specification and usable together. Lot control is not understood. "I got

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SHORT FORM DTI INSTALLATION & INSPECTION SHEET

<p style="text-align: center;">ONE MAN DTI INSTALLATION</p> 	<p style="text-align: center;">TWO MAN DTI INSTALLATION</p> 
<p style="text-align: center;">INSPECTION</p>  <p style="font-size: small;">Compress the DTI so you cannot insert a .005" feeler gage into half the gaps between the DTI bumps all the way into the bolt shank!</p>	<p style="text-align: center;">INSPECTION</p>  <p style="font-size: small;">Compress the DTI so you cannot insert a .015" feeler gage into half the gaps between the DTI bumps all the way into the bolt shank!</p>

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The instructions above are simplified and may have to be modified for galvanized bolts and DTI's. Consult our detailed installation sheet packed in every bag of DTI's or which is available on our website at http://www.appliedbolting.com/line_print.html and at http://www.appliedbolting.com/pdf/inst_orig.pdf

Figure 1

them A325 nuts with the bolts!" they say. "They should work."

8. The galvanized bolts, nuts and flat washers have not been shipped in the same container, and there's no evidence of them ever having been RC tested together. Some components might have different types of galvanizing, which isn't allowed.

9. There's two grades of bolts of the same diameter on site. Count on confusion about which bolts go into which holes, or which nuts are to be used with which grade of bolts.

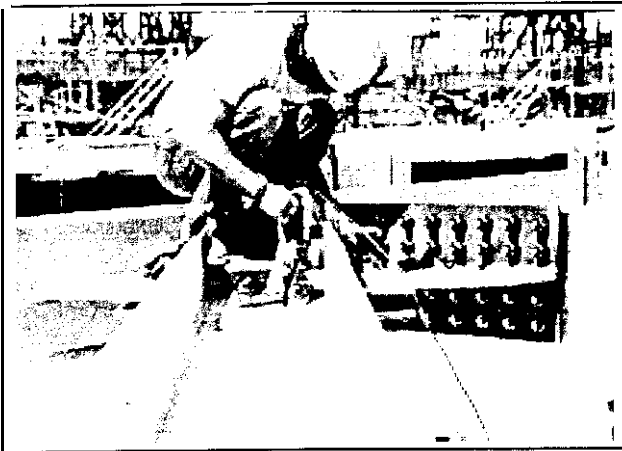


Figure 2

10. Near the end of the job, they might be a few kegs of bolts short, so they get whatever bolts they can find and stick them into the holes. Even some A490's sent out to be galvanized to match the other A325 galvanized bolts.

11. If all the TC bolts won't test OK in the inspector's Skidmore, they start spraying all the TC bolts with WD-40 from aerosol cans. Have a look at Fig. 2. I'm not kidding.

12. When fit-up is bad, the snug pass (meant to get the steel plies together) is just not done, because, they say, if they did it, the bolts would break. So they stuff bolts in the holes and use a turn-of-nut procedure or a turn-of-chuck procedure and hope the inspector is going to return to high school soon.

13. When the bolts are too long for turn-of-nut, say a 7/8" x 11", they use the method called "Let's guess the turn needed to make the bolt sound OK" method of tightening. When the bolts are really short, say a 3/4" x 1 1/4", they go ahead and put on a full one-third turn, add a bit for good measure, and snap the bolts.

14. And the best one of all -- "I install all my bolts by putting on the correct amount of turn in the Skidmore, measure the torque. then go out and put that torque on all the bolts. It's worked for 30 years, and I guess it'll work now."

Until I heard that one, I thought I'd heard them all.