Ductility Testing of Tapping Screws

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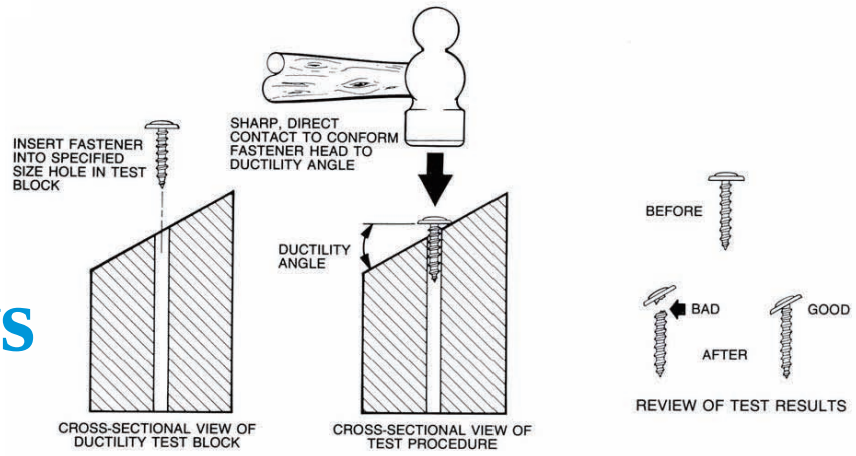

Brittle tapping screws can be problematic for end users. Brittle is describing the heat treat/material condition as unyielding, and has no relationship to Hydrogen Embrittlement. Imagine using your nut driver to install a cover onto a casting, and as soon as you seat the screw, the head snaps off. Now you have to figure out how to get that screw out when it is broken off flush with the surface of the casting. Luckily, industry experts developed tests years ago through various consensus standards that give us guidance on how to test tapping screws before such a problem occurs. Ductility testing is listed as one of the performance tests in most tapping screw standards from ASME to DIN.

Ductility can be generically defined as *a solid material's ability to deform under tensile stress*. When seating a screw head onto an uneven surface, the head will have a tendency to conform to that surface. As the head to shank junction deviates from perpendicular, one side of the shank is under compression, while the other side is in tension. It is the side in tension that will crack and cause separation if the material is not ductile enough or is found to be too brittle.

It is interesting to note that while many of the standards utilize the same language, some standards embellish more details than others. For instance ASME B18.6.3 states that ***Head separation shall be cause for rejection.*** One might wonder if "head separation" means a significant crack or complete separation from the shank. DIN 7500 goes on to better qualify the requirement by stating ***The test shall be regarded as satisfactory even if a crack appears in the first thread, provided the head does not snap off.*** As in all requirements of standards, it would be helpful to the users of those standards if the same language was always used. What we should take away is that separation means complete separation or breaking into two pieces.

So how do we test for ductility on tapping screws?

1. Determine what specification the tapping screw must conform to, as well as what kind of tapping screw it is. This will provide you with the angle of head to shank deformation that must be achieved. Most tapping screw types are required to have the heads bent to a 10 degree angle with the shank. Most Thread Rolling screws require a 7 degree angle, and most Self Drilling screws require a 5 degree angle. There are also requirements of 6 degree, and even up to 30 degrees stated in some standards. Additional requirements for the testing apparatus are:

   a. The block shall be made of hardened steel.

   b. The block shall have a hole(s) that are between .020" and .040" (for Inch sizes), and .50mm to 1.0mm (for metric sizes) larger than the given nominal major diameter of the screw.

   c. The given wedge angle of the block face should be relative to the axis of the hole in the block.

   d. The block can contain a single hole or any number of holes, and it can also have a common hole used for both inch series and metric series screws. Below is one such block created by Greenslade & Company, Inc., which contains most of the common sizes of tapping screws combining inch and metric into a single block. (Fig.1)

2. Insert the screw into the proper sized hole of the Ductility Testing Block. (Fig.2)

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

3. Strike the head of the screw with a hammer or other suitable device until it conforms to the angled surface. That is until the bearing surface of the head is flat against the angled surface. It may take more than one blow with a hammer to bend the screw head. (Fig.3 & 4)

4. Remove the screw from the Ductility Testing Block and observe the condition of the head. Note that it has been bent, and that it is **not** completely separated from the shank. Even if there is a significant crack at the head to shank junction, but the head remains attached to the shank, the test for ductility was successful. (Fig.5)

Besides Ductility Testing being a required performance test, it is also a relatively easy and inexpensive test to perform in order to ensure that the tapping screws being sold or used are good. Ductility test failures can also indicate other problems besides the core hardness being too high or the case hardness being too deep. A failure can also be a result of the recess in the head being too deep leaving very little material at the head to shank junction, or the under head fillet radius could be too small creating a high stress point at the head to shank junction. It is always important to perform all required dimensional and mechanical tests on a screw before passing it onto to the end user. A single test or check is not sufficient to provide enough information regarding the quality of the fastener.

Besides the standards referenced above, the following standards also provide details of this test along with other dimensional and performance related requirements. Some of which are FIP1000, ISO 898-1, ISO 7085, SAE J1237, SAE J78, etc. Again, be sure you are working to the correct specification before assuming all self-tapping screws have the same angular deformation requirement.