# Evaluating Stainless Steel Tapping Screws

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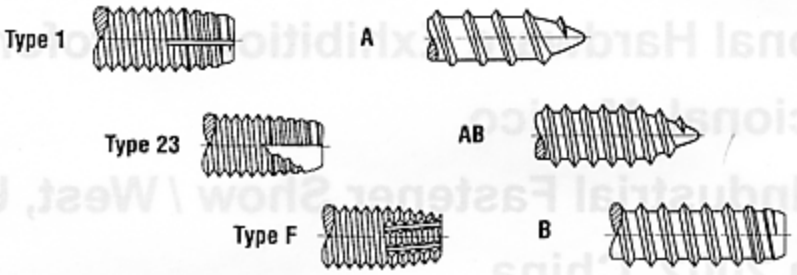


In the past I have been asked a number of times how the performance of stainless steel tapping screws should be evaluated. Earlier, I did not have an answer for those asking the question. The American Society of Mechanical Engineers (ASME) standard B18.6.4. is the tapping screw specification I most frequently referred to. This specification covers both dimensions and performance requirements for carbon steel tapping screws. Unfortunately, it makes no reference to stainless steel tapping screws.

Recently, I discovered that the Japanese Industrial Standard JIS B1055 has an Appendix 2 that is devoted to the mechanical and performance requirements for both austenitic (18-8, 300 series) and martensitic (400 series) stainless steel tapping screws. Below I will summarize the mechanical and performance requirements in this specification.

## Hardness Requirements

The following chart covers the hardness requirements for all stainless steel tapping screws.

| Hardness | Vickers hardness | Rockwell hardness |
|---|---|---|
| Surface hardness | HV 320 min. | HRC 32 min. |
| Core Hardness | HV 171 min. | HRB 85 min. |

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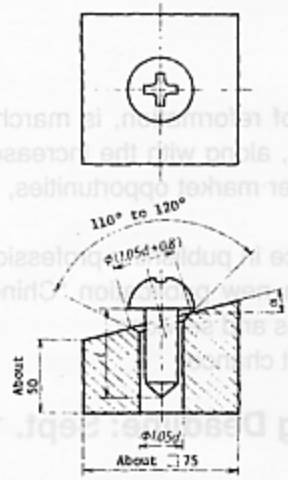
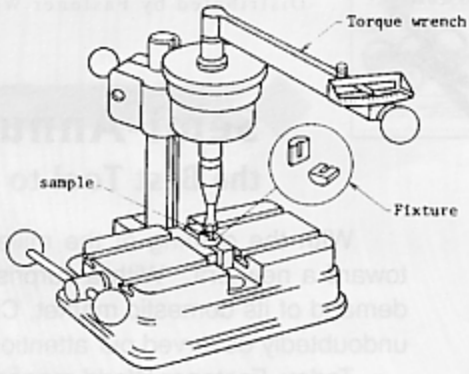
## Top Toughness (Ductility) Requirements




JIS B1055 refers to what ASME calls "ductility" as "top toughness". Top toughness requires that a screw's head can be bent a minimum number of degrees without cracking or breaking off the screw's shank. For stainless steel screws with shank lengths less than two times the screws nominal diameter (2d), the toughness angle is 15° and for screws having shank lengths equal to or greater than two nominal diameters, the toughness angle is 10°.

## Torsional Strength Requirements

Probably the most critical requirement for the evaluation of stainless steel tapping screws is the torsional strength test. Of the three required tests - hardness, top toughness, and torsional strength - the torsional strength gives the clearest indication of potential applications problems. If stainless steel screws do not meet the specified minimum torsional strength requirements, they are likely to cause failure problems during their installation.




Torsional strength is tested by clamping the screw's thread in a threaded split collet so that two or more threads are above the collet's top surface. The appropriate driving tool is engaged in the screw's recess or on its head and torque is applied with a properly calibrated torque wrench.

The torsional strength requirements for stainless steel tapping screws appear in JIS B1055, Appendix 2. Unfortunately, the only sizes covered in Appendix 2 are those made to JIS tapping screw classes 1 through 4 from the JIS dimensional specification B1007. The covered sizes and classes are in the following Table 1.

Since many stainless steel tapping screws are manufactured based on the ASME standards, the same formula is used to calculate torsional strength values for those additional sizes. The following Table 2 is provided for readers convience.

**Table 1**

| JIS Thread Class | Nominal Diameter (mm) | Pitch (mm) | Torsional Strength (Nm) | Torsional Strength (in.lb.s) |
|---|---|---|---|---|
| JIS Class 1 | 3 | 1.06 | 0.85 | 8 |
| JIS Class 1 | 3.8 | 1.41 | 1.37 | 13 |
| JIS Class 1 | 4 | 1.59 | 2.16 | 21 |
| JIS Class 1 | 4.5 | 1.81 | 2.94 | 28 |
| JIS Class 1 | 5 | 2.12 | 4.02 | 37 |
| JIS Class 1 | 6 | 2.54 | 7.36 | 68 |
| JIS Class 1 | 8 | 2.82 | 17.75 | 168 |
| | | | | |
| JIS Class 2 & 4 | 2 | 0.63 | 0.27 | 2 |
| JIS Class 2 & 4 | 2.5 | 0.91 | 0.59 | 5 |
| JIS Class 2 & 4 | 3 | 1.06 | 0.98 | 9 |
| JIS Class 2 & 4 | 3.5 | 1.27 | 1.67 | 15 |
| JIS Class 2 & 4 | 4 | 1.41 | 2.35 | 21 |
| JIS Class 2 & 4 | 4.5 | 1.59 | 3.43 | 31 |
| JIS Class 2 & 4 | 5 | 1.59 | 4.70 | 40 |
| JIS Class 2 & 4 | 6 | 1.81 | 8.53 | 73 |
| JIS Class 2 & 4 | 8 | 2.12 | 19.61 | 176 |
| | | | | |
| JIS Class 3 | 2 | 0.4 | 0.26 | 2 |
| JIS Class 3 | 2.5 | 0.45 | 0.61 | 5 |
| JIS Class 3 | 3 | 0.5 | 1.08 | 9 |
| JIS Class 3 | 3.5 | 0.6 | 1.67 | 15 |
| JIS Class 3 | 4 | 0.7 | 2.45 | 22 |
| JIS Class 3 | 4.5 | 0.75 | 3.73 | 33 |
| JIS Class 3 | 5 | 0.8 | 5.30 | 46 |
| JIS Class 3 | 6 | 1 | 8.83 | 78 |
| JIS Class 3 | 8 | 1.25 | 19.61 | 199 |

**Table 2**

| ASME Standard | Nominal Diameter | Threads Per Inch | Torsional Strength (Nm) | Torsional Strength (in.lb.s) |
|---|---|---|---|---|
| ASME B18.6.4 Types AB & B | #2 | 32 | 0.34 | 3 |
| ASME B18.6.4 Types AB & B | #3 | 28 | 0.57 | 5 |
| ASME B18.6.4 Types AB & B | #4 | 24 | 0.87 | 8 |
| ASME B18.6.4 Types AB & B | #5 | 20 | 1.17 | 10 |
| ASME B18.6.4 Types AB & B | #6 | 20 | 1.53 | 14 |
| ASME B18.6.4 Types AB & B | #7 | 19 | 2.06 | 18 |
| ASME B18.6.4 Types AB & B | #8 | 18 | 2.49 | 22 |
| ASME B18.6.4 Types AB & B | #10 | 16 | 3.92 | 35 |
| ASME B18.6.4 Types AB & B | #12 | 14 | 6.16 | 55 |
| ASME B18.6.4 Types AB & B | 1/4 | 14 | 10.07 | 89 |
| ASME B18.6.4 Types AB & B | 5/16 | 12 | 20.85 | 185 |
| | | | | |
| ASMEB18.6.4 Types C, F,1, 23 | #2 | 56 | 0.40 | 4 |
| ASMEB18.6.4 Types C, F,1, 23 | #3 | 48 | 0.61 | 5 |
| ASMEB18.6.4 Types C, F,1, 23 | #4 | 40 | 0.82 | 7 |
| ASMEB18.6.4 Types C, F,1, 23 | #5 | 40 | 1.29 | 11 |
| ASMEB18.6.4 Types C, F,1, 23 | #6 | 32 | 1.53 | 14 |
| ASMEB18.6.4 Types C, F,1, 23 | #8 | 32 | 3.09 | 27 |
| ASMEB18.6.4 Types C, F,1, 23 | #10 | 24 | 4.16 | 37 |
| ASMEB18.6.4 Types C, F,1, 23 | #10 | 32 | 5.45 | 48 |
| ASMEB18.6.4 Types C, F,1, 23 | #12 | 24 | 6.98 | 62 |
| ASMEB18.6.4 Types C, F,1, 23 | 1/4 | 20 | 10.53 | 93 |
| ASMEB18.6.4 Types C, F,1, 23 | 5/16 | 18 | 22.79 | 202 |
| | | | | |
| ASME B18.6.4, Appendix E Types A | #2 | 32 | 0.34 | 3 |
| ASME B18.6.4, Appendix E Types A | #3 | 28 | 0.57 | 5 |
| ASME B18.6.4, Appendix E Types A | #4 | 24 | 0.87 | 8 |
| ASME B18.6.4, Appendix E Types A | #5 | 20 | 1.17 | 10 |
| ASME B18.6.4, Appendix E Types A | #6 | 18 | 1.41 | 12 |
| ASME B18.6.4, Appendix E Types A | #7 | 16 | 2.00 | 18 |
| ASME B18.6.4, Appendix E Types A | #8 | 15 | 2.48 | 22 |
| ASME B18.6.4, Appendix E Types A | #10 | 12 | 3.18 | 28 |
| ASME B18.6.4, Appendix E Types A | #12 | 11 | 5.92 | 52 |
| ASME B18.6.4, Appendix E Types A | #14 | 10 | 8.97 | 79 |
| ASME B18.6.4, Appendix E Types A | #16 | 10 | 10.73 | 95 |
| ASME B18.6.4, Appendix E Types A | #18 | 9 | 14.51 | 128 |
| ASME B18.6.4, Appendix E Types A | #20 | 9 | 18.35 | 162 |
| ASME B18.6.4, Appendix E Types A | #24 | 9 | 35.65 | 316 |

## No drive test or hydrogen embrittlement test requirements in JIS B1055, Appendix 2

The hardness of stainless steel tapping screws is only slightly higher than the hardness of the drive test plates required for testing carbon steel tapping screws. Due to this small difference in hardness, most stainless steel tapping screw threads collapse when driven into the steel test plates. Since stainless steel tapping screws should only be used in soft materials such as aluminum, plastic, and wood, trying to drive them into steel test plates is inappropriate. The JIS B1055, Appendix 2 does NOT require any type of drive test for stainless steel tapping screws.

JIS B1055, Appendix 2 does NOT require stainless steel tapping screws to be tested for hydrogen embrittlement. This is appropriate for stainless steel tapping screws that are NOT electroplated. However, in some applications the end user orders 410 stainless steel tapping screws that they want bright-hardened or case hardened and electroplated. In such cases, it is strongly recommended that the screws be tested for hydrogen embrittlement because hydrogen embrittlement can occur in these types of parts.

If the supplier wants to perform a hydrogen embrittlement test on hardened, electroplated stain-

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less steel screws, a slightly modified test procedure can be effectively used. The procedure is as follows:

1. Drive a minimum of 13 carbon steel tapping screws of the same size as the stainless steel screws to be tested into the standard carbon steel test plate until they generate a thread in the plate. Stop driving before the screws seat in the plate.
2. Remove the carbon steel screws and replace them with the stainless steel screws. Hardened steel washers must be placed on each screw so that a washer thickness equal to or greater than two thread pitch lengths is used (more than one washer may have to be used on each screw to obtain this required minimum thickness).
3. Drive the first five stainless steel screws to failure and record the highest value observed in each of the five tests.
4. Average the five values obtained above and multiply that average by 80%. This calculated value is the test value to which the next eight or more screws are tightened to perform the hydrogen embrittlement test.
5. Seat the next eight or more screws to the calculated test value and allow the parts to sit for at least 24 hours. After 24 or more hours, re-apply the same calculated test torque value to all screws by applying torque in the clockwise (tightening) direction.
6. If any of the parts break during the waiting period or while the re-tightening is being performed, the parts have hydrogen embrittlement and should not be used.

When fastener suppliers provide stainless steel tapping screws, I suggest they use JIS B1055, Appendix 2 with guidance for mechanical and performance test requirements. Conducting the hardness, top toughness test, and torsional strength test required in this specification will provide suppliers and users with much great assurance that the stainless steel tapping screws will perform as intended when used in their final application.

END