Catch defective tapping screws before your customers do

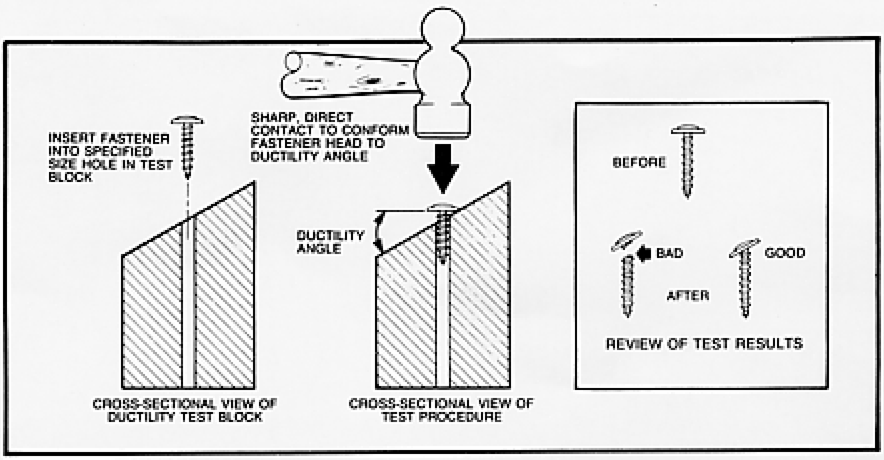
Most externally threaded fasteners in high-volume assembly are self-tapping screws. These include sheet-metal screws, commonly referred to as Types A, AB, and B; thread-cutting screws, commonly known as Types F and T or 23; thread-rolling screws; and self-drilling screws.

These various types are popular because they benefit the assembly operation by decreasing the number of components required, eliminating additional operations such as tapping or drilling, and speeding assembly.

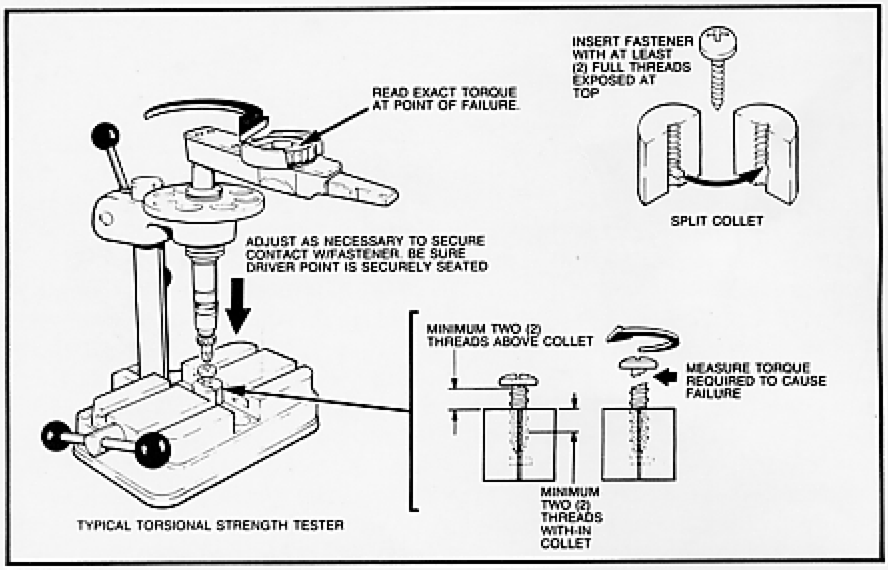
Suppliers of tapping screws should conduct four simple tests to insure that the parts they supply will perform properly for their customers at the point of assembly. With growing emphasis on just-in-time (JIT) delivery, defective screws found by the end user on the assembly line can be a major disaster. These situations can result in a great deal of frenzied effort and tremendous expense to the supplier to replace the defective parts. In the worst case, a supplier can lose a valued customer.

Four simple-to-do tests will tell the supplier if parts are too hard, too soft, or have hydrogen embrittlement:

1 Ductility.
2 Torsional strength.
3 Drive
4 Hydrogen embrittlement



Ductility test.



Torsional-strength test.

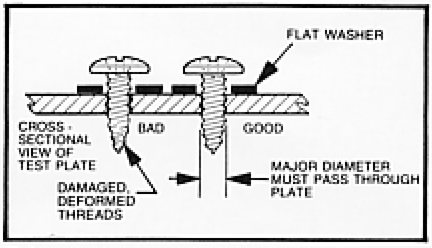
Ductility test. This is a simple test in which the operator first places a part into a specified hole in a hardened block having a 10-degree angle on its face, then strikes the part on its head with a hammer. If the head separates completely from the body, the part is either too hard in its core, the case hardness is too deep, the thread has cut the underhead radius, or the recess is too deep. Any of these problems can result in screws that break during assembly, causing lost production.

Torsional-strength test. Here, the screw is held in a threaded split collet that mounts in a special fixture. The fixture is designd to hold the screw in proper relationship to a driving tool. When the tool applies torque, the screw must withstand a minimum torque value without twisting into two pieces.

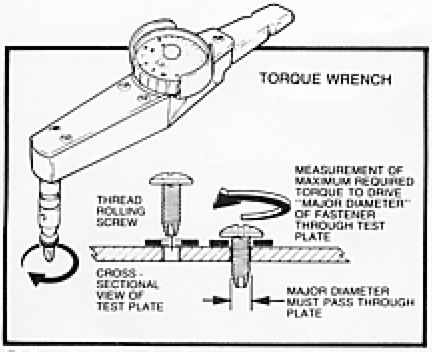
If the part fails at a value below the required value, it indicates low core hardness, low case depth, or too small a minor diameter. These problems may cause screws to twist in two at assembly, resulting in production slowdown and possible product rework.

Drive testing. This test is performed by driving tapping screws through a test plate having a hardness of Rockwell B 70 to 85, a specified thickness of ±0.002″, and a specified hole size ±0.001″. After the major diameter of the screw has passed through the plate, the threads are examined. If any deformation is obvious in the thread shape, the parts have a case hardness that is too soft or too shallow. For thread-rolling screws, the driving torque is to be recorded and compared to a given maximum driv-

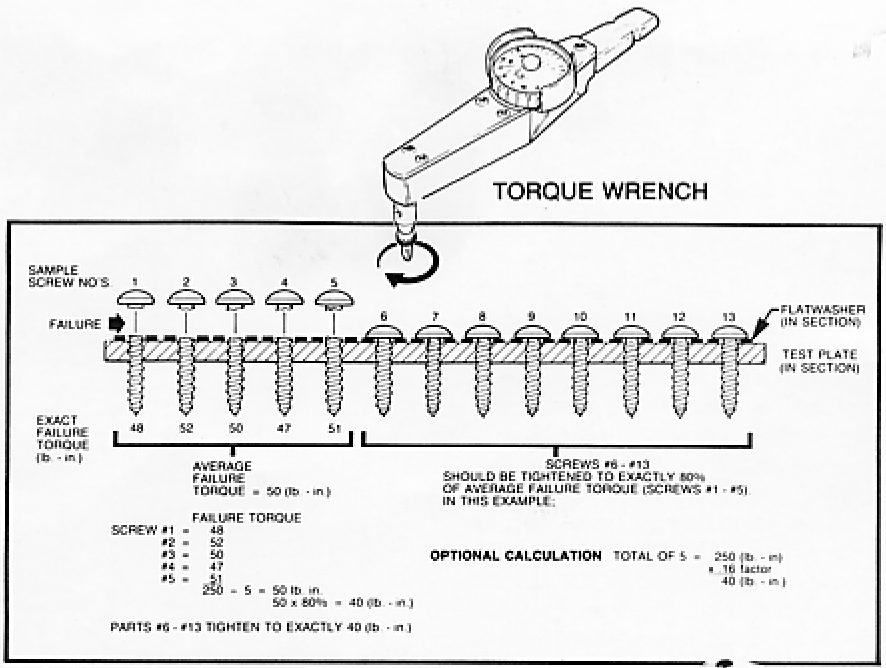
by Joe Greenslade
President
Fastener Inspection Products
Fort Worth, TX



Drive test.



Drive-torque test.



Hydrogen-embrittlement test.

ing-torque requirement. If the threads deform, or the driving torque is too high, assembly problems are likely to occur.

Hydrogen – embrittlement testing. Hydrogen-embrittlement failures are among the most frustrating and potentially costly problems with electroplated tapping screws, because the failures occur up to 24 hr after installation instead of immediately at the time of assembly.

For this test, the operator drives five tapping screws with washers into a drive test plate until they fail by stripping or breaking. He records the information and multiplies the average failure torque by 80 percent. He then sets eight or more additional screws at that calculated value and allows the parts to sit for 24 hr. Then he retightens the screws to the calculated figure. If the heads break off, hydrogen embrittlement is indicated.

The presence of hydrogen embrittlement causes extremely large losses, resulting in assembly rework and possible scrap. The best-known method of preventing it in electroplated tapping screws is for the user to require that parts be baked for at least 4 hr at 400 F within 1 hr after plating.

Minium performance standards for these tests are published by the IFI, ANSI, SAE, General Motors, Fastener Inspection Products (FIP-1000.1-1000.7), etc.

Manufacturers should employ these tests whether supplying end users or distributors. Distributors should indicate the standards they can expect on their purchase orders to ensure receiving good-quality parts. They can do this simply by indicating the specification number.

There are various standards, and some are more stringent than others. For example, most imported tapping screws are made to ISO standards, which have no requirements for ductility or hydrogen-embrittlement testing. The General Motors and FIP standards are the most thorough, providing the greatest assurance of trouble-free performance.

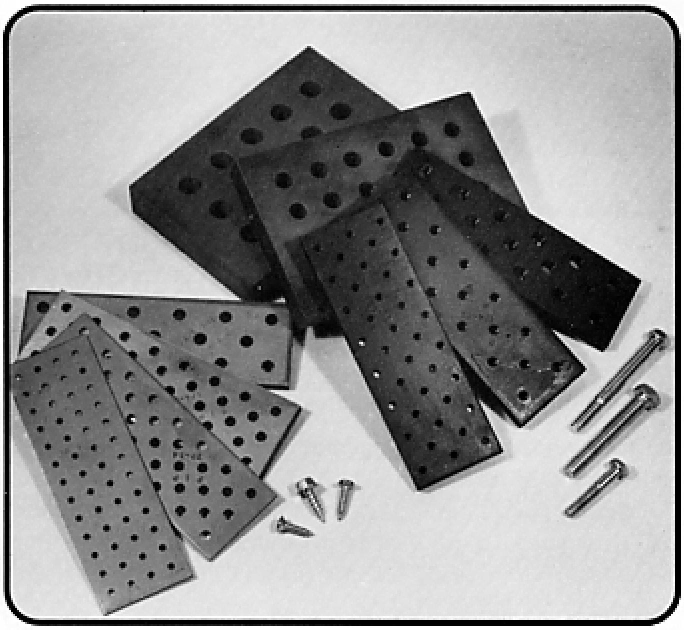
With the knowledge of the requirements of tapping-screw performance, the proper equipment, and a little time on each lot of screws, the supplier can detect and correct many potentially disruptive and aggravating problems before his customers do.

Today's US manufacturers are insisting on JIT deliveries and defect-free parts. Suppliers ready to meet these demands will prosper in the future. Those who do not will find it increasingly difficult to supply production quantity items.

Measuring crossed-recess drive systems: Wobble gage (right) determines compatibility of cross recesses in screw heads with companion screw drivers. It indicates the point where deviations in recess contours affect satisfactory driver engagement. Recess-penetration gage (left) tells whether recess is too shallow or too loose. Electronic SPC output is optional. Courtesy Fastener Inspection Products.

TEST PLATES

for
Screws and Bolts



Test plates are important inspection items. Their proper use will call attention to problems before the fasteners cause assembly or warranty problems.

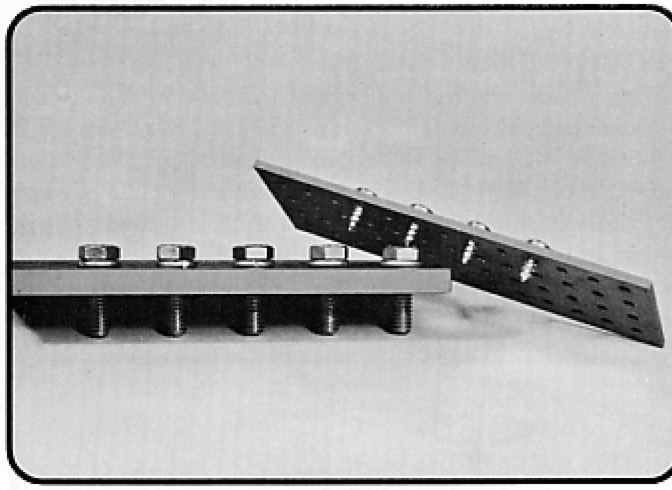
Untapped test plates are required to properly test tapping screws (Types A, AB, B, F 1, 23, TT, SF, etc.) for their ability to drive and to detect the presence of hydrogen embrittlement.

Tapped test plates are required to test machine screws and bolts which are electroplated and Rockwell C30 or harder to detect the presence of hydrogen embrittlement.

Greenslade Fastener Test Plates are stocked for immediate shipment. They meet the following requirements:

- ANSI B18.6.4, B18.6.5M
- DIN 7500-1, 7513, 7516
- FIP-1000.1 – .7
- Ford ES-M1A160-A, ES-20003-S1000
- GM 6010M, 617M, 6171M
- ISO 2702
- JIS 1055
- SAE J81, J478a, J993, J1237

All test plates come with Certificates of Quality at no extra charge.



Untapped Test Plate Specifications

HARDNESS: RB 70–85 HOLE SIZE: +/- .001
LENGTH: 6 inches WIDTH: 2 inches

SHEET METAL SCREWS (TYPES A, AB, and B)

SIZE	THICKNESS	HOLE SIZE	#HOLES	NEW #
2	.050–.046	.076	52	TP-02
3	.050–.046	.081	52	TP-03
4	.050–.046	.086	52	TP-04
5	.050–.046	.1065	52	TP-05
6	.077–.073	.116	52	TP-06
7	.077–.073	.1285	52	TP-07
8	.077–.073	.136	52	TP-08
9	.077–.073	.149	52	TP-09
10	.127–.123	.159	52	TP-10
12	.127–.123	.1875	38	TP-12
14	.127–.123	.2165	38	TP-14
1/4	.1905–.1845	.2165	38	TP-25
5/16	.1905–.1845	.272	17	TP-31
3/8	.1905–.1845	.328	17	TP-37

THREAD CUTTING SCREWS (TYPES F, 1, and 23)

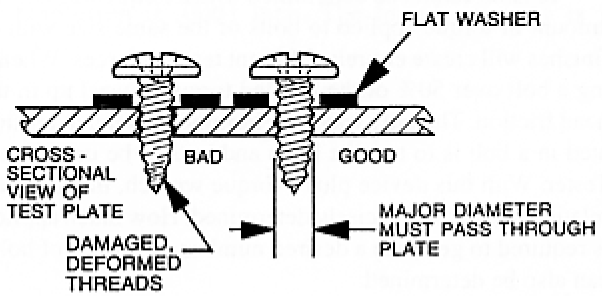
SIZE	THICKNESS	HOLE SIZE	#HOLES	NEW #
2–56	.080–.076	.073	52	TPT-0256
3–48	.096–.092	.081	52	TPT-0348
4–40	.111–.107	.096	52	TPT-0440
5–40	.111–.107	.101	52	TPT-0540
6–32	.1425–.1385	.120	52	TPT-0632
8–32	.1425–.1385	.147	52	TPT-0832
10–24	.1905–.1845	.173	52	TPT-1024
10–32	.1905–.1845	.177	52	TPT-1032
12–24	.1905–.1845	.199	38	TPT-1224
1/4–20	.253–.247	.228	38	TPT-2520
1/4–28	.253–.247	.234	38	TPT-2528
5/16–18	.3155–.3095	.290	17	TPT-3118
5/16–24	.3155–.3095	.295	17	TPT-3124
3/8–16	.378–.372	.358	17	TPT-3716
3/8–24	.378–.372	.358	17	TPT-3724
M2	.080–.076	.0669	52	TPT-M02
M2.5	.096–.092	.0827	52	TPT-M02.5
M3	.111–.107	.1024	52	TPT-M03
M3.5	.1425–.138	.1220	52	TPT-M03.5
M4	.1425–.138	.1378	52	TPT-M04
M5	.1905–.184	.1772	52	TPT-M05
M6	.253–.247	.2126	38	TPT-M06
M8	.3157–.3094	.2913	17	TPT-M08
M10	.3779–.3717	.3661	17	TPT-M10

Test Plates

Untapped Test Plate Specifications

THREAD ROLLING SCREWS (TYPES TT, SF, ETC.)

SIZE	THICKNESS	HOLE SIZE	#HOLES	NEW #
2-56	.127-.123	.075	52	TPR-0256
3-48	.127-.123	.087	52	TPR-0348
4-40	.127-.123	.098	52	TPR-0440
5-40	.127-.123	.110	52	TPR-0540
6-32	.127-.123	.120	52	TPR-0632
8-32	.1905-.1845	.147	52	TPR-0832
10-24	.1905-.1845	.166	52	TPR-1024
10-32	.1905-.1845	.172	52	TPR-1032
12-24	.1905-.1845	.191	38	TPR-1224
1/4-20	.254-.246	.219	38	TPR-2520
1/4-28	.254-.246	.228	38	TPR-2528
5/16-18	.3175-.3075	.277	17	TPR-3118
5/16-24	.3175-.3075	.290	17	TPR-3124
3/8-16	.380-.370	.339	17	TPR-3716
7/16-14	.4425-.4325	.394	17	TPR-4314
1/2-13	.505-.495	.456	17	TPR-5013
M2	.133-.118	.0697	52	TPR-M02
M2.5	.133-.118	.0886	52	TPR-M02.5
M3	.133-.118	.1063	52	TPR-M03
M3.5	.133-.118	.1240	52	TPR-M03.5
M4	.2165-.1969	.1417	52	TPR-M04
M5	.2165-.1969	.1791	52	TPR-M05
M6	.2559-.2362	.2126	38	TPR-M06
M8	.338-.315	.2874	17	TPR-M08
M10	.4210-.3937	.3622	17	TPR-M10
M12	.500-.4724	.4331	17	TPR-M12



Hydrogen Embrittlement Test Plates for Bolts and Machine Screws

TAPPED AND HARDENED TEST PLATE SPECIFICATIONS

SIZE	DIMENSIONS	#HOLES	NEW PART #
2-56	2x6x 3/16	38	TPHE-0256
4-40	2x6x 3/16	38	TPHE-0440
6-32	2x6x 1/4	38	TPHE-0632
8-32	2x6x 1/4	38	TPHE-0832
10-24	2x6x 5/16	38	TPHE-1024
10-32	2x6x 5/16	38	TPHE-1032
12-24	2x6x 5/16	17	TPHE-1224
1/4-20	2x6x 3/8	17	TPHE-2520
1/4-28	2x6x 3/8	17	TPHE-2528
5/16-18	2x6x 3/8	17	TPHE-3118
5/16-24	2x6x 3/8	17	TPHE-3124
3/8-16	2x6x 3/8	17	TPHE-3716
3/8-24	2x6x 3/8	17	TPHE-3724
7/16-14	4x6x 3/4	24	TPHE-4314
7/16-20	4x6x 3/4	24	TPHE-4320
1/2-13	4x6x 3/4	24	TPHE-5013
1/2-20	4x6x 3/4	24	TPHE-5020
9/16-12	4x6x 1"	15	TPHE-5612
9/16-18	4x6x 1"	15	TPHE-5618
5/8-11	4x6x 1"	15	TPHE-6211
5/8-18	4x6x 1"	15	TPHE-6218
3/4-10	4x6x 1-1/4	15	TPHE-7510
3/4-16	4x6x 1-1/4	15	TPHE-7516

METRIC TAPPED TEST PLATE SPECIFICATIONS

SIZE	DIMENSIONS	#HOLES	NEW PART #
M2.5x0.45	2x6x 3/16	38	TPHE-M02504
M3x0.5	2x6x 1/4	38	TPHE-M0305
M3.5x0.6	2x6x 1/4	38	TPHE-M03506
M4x0.7	2x6x 1/4	38	TPHE-M0407
M5x0.8	2x6x 5/16	17	TPHE-M0508
M6x1.0	2x6x 3/8	17	TPHE-M0610
M8x1.0	2x6x 3/8	17	TPHE-M0810
M8x1.25	2x6x 3/8	17	TPHE-M08125
M10x1.25	4x6x 3/4	24	TPHE-M10125
M10x1.5	4x6x 3/4	24	TPHE-M1015
M12x1.25	4x6x 3/4	24	TPHE-M12125
M12x1.75	4x6x 3/4	24	TPHE-M12175
M14x1.5	4x6x 1"	15	TPHE-M1415
M14x2.0	4x6x 1"	15	TPHE-M1420
M16x1.5	4x6x 1-1/4	15	TPHE-M1615
M16x2.0	4x6x 1-1/4	15	TPHE-M1620
M18x1.5	4x6x 1-1/4	15	TPHE-M1815
M18x2.0	4x6x 1-1/4	15	TPHE-M1820

Answers To Frequently Asked Questions About...

Testing and Inspecting High Performance Thread Rolling Screws

By Joe Greenslade

High performance thread rolling screws began to be marketed about twenty years ago. They were developed to improve the performance and increase the versatility of the self tapping screws used in industry up until that time. The original self tapping screws were Types A, AB, B and C for thread forming and Types 1, 23 and 25 for thread cutting.

A common characteristic of high performance thread rolling screws is that they all form their mating threads similarly to the Types A, AB, B and C except that they were designed for multiple thread engagement in metal, unlike their predecessors. Types A. B, and AB usually used a single thread engagement in metal. Previously, self tapping fasteners used for multiple thread engagement in metal were Types 1 and 23 which cut their mating threads instead of forming them.

Since high performance thread rolling screws formed their mating threads and provided a multiple thread engagement they opened the realm of self tapping applications immensely where previous designs either stripped out too easily, required too much driving force and/or could not be used because the presence of chips in the final assembly was unacceptable.

The best known of these high performance thread rolling screws are the "Swageform" screws developed by Parker-Kalon, now a division of Black and Decker, and the "Taptite" screws developed by Research Engineering and Manufacturing Companv, formerly a part of the Continental Screw Company. These products have gained particularly wide acceptance in the automotive, appliance, electronics, and telecommunications equipment industries.

This article will cover frequently asked questions about the testing, inspecting and applying of these products.

Question — What specifications should be used in ordering and/or inspecting high performance thread rolling screws?

Answer — The specification which should be referred to unless otherwise designated is S.A.E.-J81 (June 79). Prior to the publication of this specification the I.F.I.-112 was the most widely used. This specification was withdrawn after the S.A.E.-J81 was issued. Other applicable specifications are GM 6171M and Ford Motor ES-20003-5100. We produced the FIP-1000 in 1987 to provide clearer explanations of the test procedures. This is a composite of the other specifications with many helpful illustrations.

Question — Do all of these specifications agree with one another?

Answer — No. They are very similar but some are more thorough than others. They require a little more testing, which we feel is important.

Question — What are the common test requirements for these types of types of fasteners?

Answer — The most common tests are:

1. Ductility
2. Torsional Strength
3. Drive and Drive Torque
4. Tensile Strength
5. Hydrogen Embrittlement

The S.A.E and Ford Motor specifications additionally requires that hex and hex washer head screws be tested for Proof Torque, and Torque-To-Clamp Load.

Continued on page 16

H.P. Thread Rolling Screws

(Continued from page 15)

Question — What do each of these tests tell you about these fasteners and how are the tests done?

Answer — The tests tell you several things about the fasteners as follows:

Ductility

This test tells you that if the parts pass, you will probably not experience heads popping off at the time of assembly due to the case hardness being too deep, the core hardness too high, the recess too deep, or the thread too close to the head.

The test is simple and Figure 1. provides a graphic illustration. It is easy to interpret and should be the first to be performed. If the parts fail this test they should be rejected and no more tests are needed. To test for ductility, parts are placed into a hole slightly larger than the thread diameter with an angle of 5, 7, or 10 degrees on the top of the test block, depending on which specification you follow. Our experience has led us to recommend that a 10 degree angle be used all the time. After the screw is placed in the angled test block it is struck firmly on the top of its head with a hammer until the underside of the screw head conforms to the test block angle.

Interpretation is easy. If the screw head comes off completely it should be rejected. If it stays intact and even if a crack is visible the parts are acceptable. Eight randomly selected samples from a homogenous lot of up to 250,000 pieces are usually sufficient to detect a problem.

Torsional Strength

If the parts pass, this test tells you that the core hardness is sufficient to provide the screw with adequate strength to resist twisting in two during screw installation in the application.

This test (see Figure 2.) is performed by clamping the screw.s threads into a split threaded collet which in turn is held in a screw torsional testing fixture. A driving tool is then engaged with the screw's head and the screw is twisted with a torque wrench. If the torque required to twist the screw in two is greater than the listed minimum torsional strength the parts pass.

Eight randomly selected parts from a homogenous lot of up to 250,000 pieces are usually sufficient for testing.

Two common testing problems which frequently result in incorrect test results are (1) when the threads are clamped in a vise instead of threaded split collets, tearing the threads and (2) not using the correct testing fixture when testing Phillips, slotted and other recessed head designs. If suppliers and users do not use the same testing apparatus disagreements about test results can and do occur.

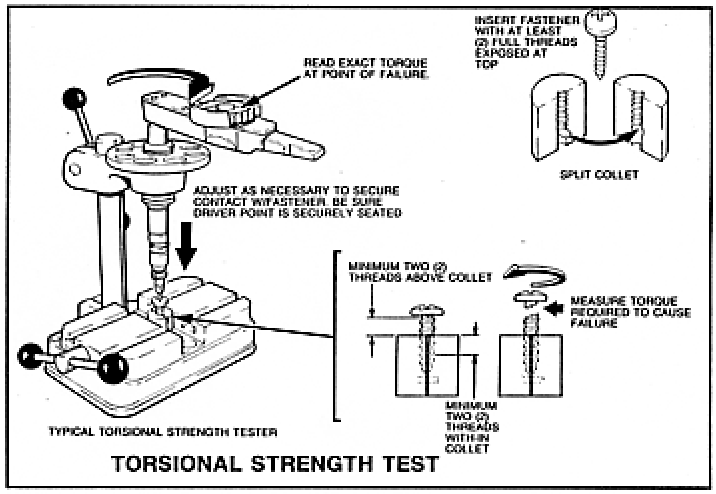


Figure 2.

Drive and Drive Torque Test

These are actually two tests in one procedure. First it shows that the parts can be driven into an application without the requirement of excessive installation torque and second, that the hardening is adequate to form threads in a mating part without the screw threads being deformed.

The procedure (see Figure 3. on page 00) is to drive the screws into a specific test plate having the hole size, thickness, and hardness designated in the specifications. The highest torque required to drive them into the plate must not exceed the specification's maximum allowable value and the threads must not show signs of breakdown or deformation after having penetrated the plate.

To obtain accurate drive torque results when testing slotted, Phillips, and other recessed head screws you must use the torsional strength testing fixture with a test plate holding adaptor. Otherwise the driving tool can not be kept engaged properly in the screw's recess to accurately measure the drive torque.

If the screws are "plain finish" it is generally acceptable to apply a light oil to the screws for lubricity before testing to simulate the finish to be applied. Otherwise, it is very common for the threads to collapse due strictly to the friction created in driving.

Eight randomly selected screws from a homogenous lot of up to 250,000 pieces is usually an adequate test lot size.

Tensile Strength

This test indicates if a part has the ability to hold a minimum axial load in it's intended application. S.A.E. and Ford Motor only require this test on hex and hex washer head screws which are the longer of either 1/2 inch or 3 times the basic diameter. General Motors requires it on all screws 3 times the basic diameter and longer.

The parts are to be assembled in tooling in a tensile testing machine with 6 threads exposed. The axial load is to be applied at a free crosshead speed not to exceed 1 inch per minute until the part fails. Its ultimate tensile strength must exceed the minimum value listed in the specifications.

Hydrogen Embrittlement

This test should be performed on all high performance thread rolling screws which are electroplated. This test will provide confidence that delayed failures will probably not occur. There are many misunderstandings about these failures. Frequently people assume that failures at the time of assembly are related to hydrogen embrittlement. This is not the case. These failures are generally problems of the screw's hardness resulting in brittleness or softness or very frequently it is actually a problem of an incorrect mating part hole size.

Hydrogen embrittlement failures are always associated with "after assembly"

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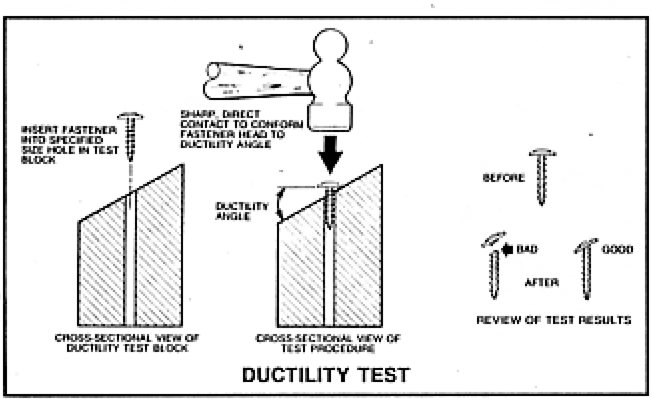

Figure 1.

H.P. Thread Rolling Screws

(Continued from page 16)

failures. These can show up as soon as 5 minutes after assembly up to 24 hours later. Some cases have occurred after an even longer period of time, but most failures result within 24 hours after assembly.

There are two common procedures:

1. Seat screws in a pretapped hardened test plate at minimum values specified in the specification. Let the parts set 24 hours and retighten them to the specified values. If any heads break off the parts fail.
2. Drive the parts into untapped test plates. This is actually a continuation of the "Drive and Drive Torque" tests. Drive five parts to complete failure. Average the five values and seat eight more parts at 80% of that average failure value. Let the parts sit 24 hours and retighten to that previously calculated seating value. Any failure should be considered a reject.

We recommend the second test procedure because it compensates for the differences in lubricity, thread size, hole size etc. for the particular lot of screws tested and since it is a continuation of other tests it makes testing more efficient. Figure 4. provides further clarification and specifications.

In all cases washers should be used under the heads of the screws to eliminate the possibility of damaging the screw's head to shank radius which will result in erroneous failures. This approach also simulates the actual use of the parts. Any washer will do as long as all of the washers used in one test are the same type but because split lock washers are hardened we recommend their use in most cases.

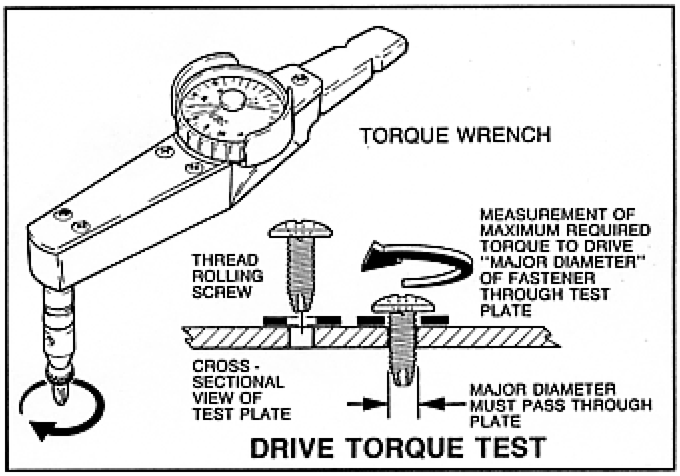

Figure 3

Question — Are the test plate hole sizes those recommended for use in applications?

Answer — Absolutely not! The test plate hole sizes in the specifications represent extremely severe applications. If parts pass the tests with these plates they provide assurance of performance in the intended application.

The sales literature of various manufacturers of these fasteners provides guidance for application hole sizes. You have to be careful in this area to check recommended hole sizes before specifying the hole size in the application and take care before substituting one thread rolling screw design for another, because different screw designs recommend the use of different hole sizes.

Thread Rolling Screws

— Inch —

SIZE	DUCTILITY min. degrees	MINIMUM TORSIONAL STRENGTH lb.-in.	TEST PLATES (RB 70-85) Thickness +/− .002	TEST PLATES (RB 70-85) Hole Size +/− .001	DRIVE TORQUE Phos & Oil Cad lb.-in.	DRIVE TORQUE Zinc lb.-in.	HYDROGEN EMBRITTLEMENT TORQUE lb.-in.
2-56	10	6	.125	.075	4.5	6	SEE NOTE BELOW
3-48	10	10	.125	.087	7.5	9.5	
4-40	10	14	.125	.098	9	13	
5-40	10	22	.125	.110	12	16	
6-32	10	24	.125	.120	14	20	
8-32	10	48	.1875	.147	25	32	
10-24	10	65	.1875	.166	35	52	
10-32	10	74	.1875	.172	35	52	
1/4-20	10	156	.250	.219	90	120	
5/16-18	10	330	.312	.277	180	240	
3/8-16	10	600	.375	.339	240	300	
Minimum Sample Size	8 pc	4 pc			4 pc	4 pc	13 pc

Hydrogen Embrittlement Test

(All Electroplated Tapping Screws)

1. Seat 5 screws with flat washers under head into the correct test plate to screw failure and record all 5 torque values.
2. Add the 5 values and multiply the sum by .16 (16%0 to determine the "Test Tightening Torque."
3. Using 8 more screws from the same lot, seat them with flat washers under head into the same test plate to the "Test Tightening Torque" and allow to sit 24 hours.
4. After 24 hours retighten to same value as in Step #3. If any parts fail during the 24 hour period or when retightening the lot is rejectable.

Material and Heat Treat

Material	Case Hardness	Core Hardness	Case Depth
Cold Heading Quality Killed Steel Wire 0.13%-0.27% Carbon 0.64%-1.71% Manganese	RC 45 min.	RC 28-38	#2 through #6 .002-.007 #7 through #12 .004-.009 1/4 and larger .006-.011

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Figure 4.

Question — Are there recommended seating values for high performance thread rolling screws in various assembly applications?

Answer — No. Many users erroneously confuse testing torque values with applications values. Each application is a little different than another. Each application should be tested to determine suitable tightening torque values.

This can be done by experimenting with the hole size in the actual assembly components. You should drill a series of progressively larger sizes to find the size which results in the greatest total difference in torque values between the value required to drive the screws into the assembly and the minimum torque value required to fail the assembly in any way. This simple procedure will help you find the best hole size. After determining that best hole size, you can establish the recommended tightening value at approximately 60% to 70% of that minimum failure value. The only thing to be careful of is to make sure that the value always exceeds the highest driving torque you observed when driving into that hole size to insure that all fasteners will be seated.

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