Rockwell Hardness Testing of Fasteners

By Joe Greenslade

The Rockwell hardness test is the most common test performed on fasteners. This is because most fasteners have some type of hardness requirement in their governing specification.

Hardness testing is determining a material's amount of resistance to being permanently deformed by a precisely shaped indenter under a precise amount of weight. See Figure 1. Softer materials indent more than harder materials. This is very obvious when looking at the indentation in a Grade 2 bolt verses a Grade 8 bolt.

The Rockwell hardness testing machine actually measures the depth of the indentation made in the material and converts that to a reading on what is called a Rockwell Hardness Scale which is shown on the tester's indicator at the conclusion of a test. The most commonly used scales in testing fasteners are the Rockwell "C" scale (about 95% of the time), and the Rockwell "B" scale (about 5% of the time).

The Rockwell "C" Scale is measured using a diamond penetrator under a 150 kilogram load. This involves a simple three step process. A prepared specimen (described in detail below) is placed in the Rockwell machine and a preliminary load, called the minor load, is applied to the specimen. Next the test load, called the major load, is applied to the specimen. Finally the major load is removed from the specimen and the number exhibited on the tester's indicator is the specimen's Rockwell hardness. Each hardness test, excluding preparation, only takes between 5 and 10 seconds to perform.

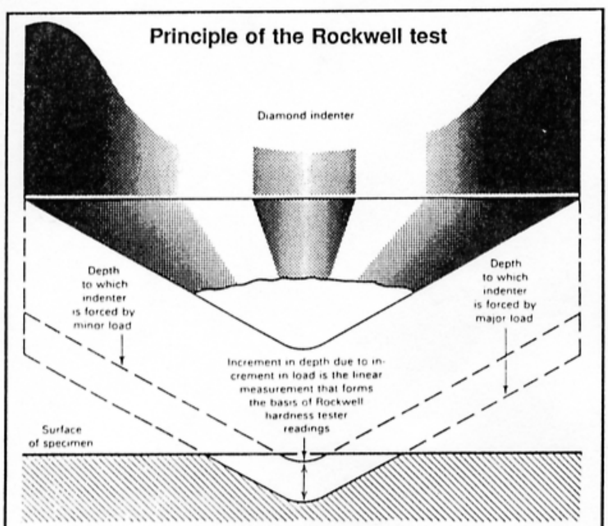

Figure 1.

Two other types of hardness tests requiring different types of testers are also performed on fasteners. These are Superficial Rockwell Hardness and Microhardness testing. Superficial testing is used sometimes to test surface hardness of fasteners or to test very thin sections of materials such as washers. The most common hardness scales are called 15N, 30N, and 45N. Here again the depth of the indentation is the relative measurement being made.

Microhardness testing is a much more complex testing procedure requiring very extensive and precise specimen preparation. The specimen is subjected to light loads compared to the Rockwell tests. The resulting indentations are then measured under a microscope. The surface area displacement and not the indentation depth is the determinant of the microhardness reading. Microhardness is measured on the Knoop and Vickers scales, with the Knoop being much more common. Microhardness testing is used most commonly to measure the hardness and depth of the case on tapping screws and the depth of decarburization on the surface of through hardened fasteners such as graded bolts.

Decarburization is a soft outer layer of a fastener that occurs when the atmosphere in a heat treat furnace is not properly controlled and the carbon on the fastener's surface is depleted. If this layer is too deep threads are weak and may strip when subjected to service loads.

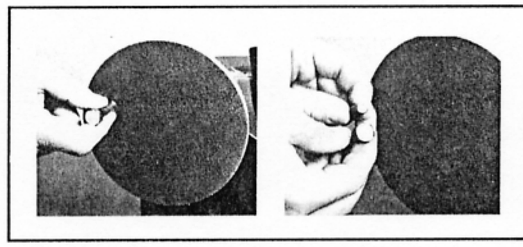

Figure 2.

Conversion charts exist to compare the readings made on Rockwell scales, Superficial Rockwell scales, Knoop and Vickers scales. The industrial specifications covering the Rockwell hardness testing of fasteners are ASTM F606, ASTM E18, SAE J429, and SAE J995.

Rockwell Hardness Testing Procedure:

1. Specimen Preparation

It is extremely important that test specimens be prepared properly before doing a hardness test. This preparation consists of sanding or grinding two opposite surfaces of the fastener so that they are smooth and parallel. The surface should be removed to a depth so that all plating and any slight depth of surface decarburization are removed. See Figure 2.

Rockwell Hardness Tester.

If surfaces are not clean, smooth, and parallel, the hardness readings obtained will indicate lower hardnesses than the parts actually have.

Bolts can be tested by preparing both extreme ends of the parts or by preparing two

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Mr. Greenslade is an Associate Member of the Industrial Fastener Institute (IFI) serving on several technical subcommittees relative to fastener quality. He is also a Member of the American Society of Mechanical Engineers serving on the ANSI/ASME B1 Thread Subcommittees and is an alternate member of the ANSI/ASME B18 Fastener Supplier Accreditation Subcommittee.

Mr. Greenslade is the author of over 40 fastener technology related articles, and is the inventor of several innovative patented fastener inspection devices. He is one of the industry's most frequent speakers on fastener quality subjects.

Testing

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opposite flats of a hex. Nuts should always be tested on their face and never across flats. If nuts are measured across their flats they may flex inward causing an erroneously low hardness reading.

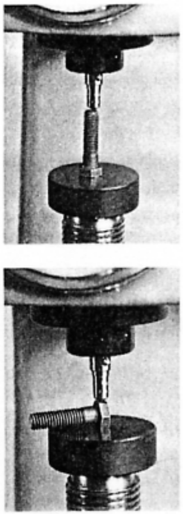

Figure 3

According to ASTM F606, it is permissible to simply sand the top of the head and the point end as preparation for routine inspections. If a dispute arises over hardness results the end of the bolt must be cut off at least one diameter's length from the end of the part and tests performed in that area. When using this procedure bolts should be cut carefully with an abrasive saw under

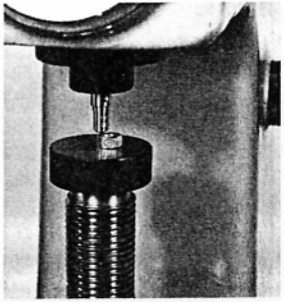

Figure 4.

coolant to avoid heating the part. If a part shows any discoloration after cutting, it has probably become too hot. If a part becomes discolored during sanding or cutting it will distort its hardness readings.

2. Taking Hardness Readings:

The recorded hardness reading on a fastener should be the average of 2 to 4 readings taken at different places on the same part.

Bolts

On bolts 3/8" diameter and larger the hardness readings should be taken at 4 places 90 degrees from one another about half way between the center of the part and its outer edge. See Figure 3. The average of these four readings should be recorded as the part's hardness.

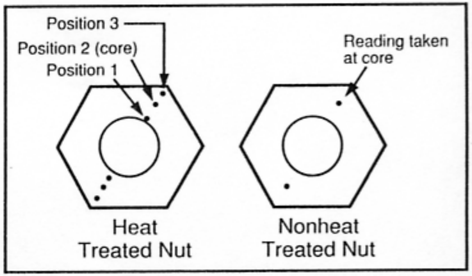

Figure 5.

Nuts

Nonheat-treated nuts are to be tested at two positions 180 degrees apart midway between a corner of the hex and the inside diameter of the nut on the face or bearing surface. See Figure 4. The average of these two readings is the hardness to be recorded.

Heat-treated nuts are to be tested with six indentations, three on each side as shown in Figure 5. Position #l is as close as possible to the inside diameter. Position #2 is midway between the inside diameter and the outer corner. Position #3 is as near to the corner as possible. The average of these six readings is the hardness value to record. ❑