

INFORMATION ON FASTENER MATERIALS, GRADES, & COATINGS

General Information

Fasteners are manufactured in a wide range of materials from common steel to titanium, plastic and other exotic materials. Many materials are further separated into different grades to describe specific alloy mixtures, hardening processes, etc. In addition, some materials are available with a variety of coatings or plating to enhance the corrosion resistance, or appearance of the fastener.

Fastener material can be important when choosing a fastener due to differences between materials in strength, brittleness, corrosion resistance, galvanic corrosion properties, and of course cost.

When replacing fasteners, it is generally best to match what you are replacing. Replacing a bolt with a stronger one is not always safe. Harder bolts tend to be more brittle and may fail in specific applications. Also some equipment is designed so that the bolts will fail before more expensive or critical items are damaged. In some environments such as salt water, corrosion must also be considered if changing fastener materials.

Fastener Materials

Stainless Steel

Stainless steel is an alloy of low carbon steel and chromium for enhanced corrosion characteristics. Stainless steel is highly corrosion resistant for the price and because the anti-corrosive properties are inherent to the metal, it will not lose this resistance if scratched during installation or use.

It is a common misconception that stainless steel is stronger than regular steel. In fact, due to the low carbon content, stainless steel can not be hardened. Therefore when compared with regular steel it is slightly stronger than an un-hardened (Grade 2) steel fastener but significantly weaker than hardened steel fasteners.

Stainless steel is also much less magnetic than regular steel fasteners though some grades will be *slightly magnetic*.

18-8 Stainless

18-8 is a specific grade of stainless steel, and is the most common grade used in fasteners. For those familiar with the 300 series of stainless steel 18-8 is similar to 304 stainless.

Regular Steel

Steel is the most common fastener material. Steel fasteners are available plain as well as with various surface treatments such as zinc plating, galvanization, and chrome plating.

Steel fasteners are commonly available in 4 grades. Many other grades exist but are used far less often. The most common grades are Grade 2, Grade 5, Grade 8, and Alloy Steel. Grade 2, 5, and 8 are usually plated with a silver or yellow zinc coating or galvanized to resist corrosion.

Determining Bolt Grade

Bolts of different grades are marked on the head to show what grade bolt they are.

Grade 2

Grade 2 is a standard hardware grade steel. This is the most common grade of steel fastener and is the least expensive. Grade 2 bolts have no head marking (sometimes a manufacturer mark is present).

Grade 5

Grade 5 bolts are hardened to increase strength and are the most common bolts found in automotive applications. Grade 5 bolts have 3 evenly spaced radial lines on the head.

Grade 8

Grade 8 bolts have been hardened more than grade 5 bolts. Thus they are stronger and are used in demanding applications such as automotive suspensions. Grade 8 bolts have 6 evenly spaced radial lines on the head.

Alloy Steel

Alloy steel bolts are made from a high strength steel alloy and are further heat treated. Alloy steel bolts are typically not plated resulting in a dull black finish. Alloy steel bolts are extremely strong but very brittle.

Silicon Bronze

Silicon bronze, often referred to simply as bronze, is an alloy made mostly of copper and tin with a small amount of silicon. Bronze is used primarily in marine environments. It is preferred over stainless in wooden boat construction and re-fastening due to its superior corrosion resistance, and over brass due to its higher strength. Bronze is similar to copper in color and is also sometimes seen in fine woodworking where it is used for its appearance. The main drawback of bronze is its high cost.

Brass

Brass is an alloy of primarily copper and zinc. Brass is highly corrosion resistant and electrically conductive. However, its use as a fastener is somewhat limited due to its relative softness. It is used primarily for its appearance.

Fastener Coatings

Zinc Plating

Many steel fasteners are electro-plated with zinc for better corrosion resistance. Fasteners that have been zinc plated have a shiny silver or golden appearance referred to as clear or yellow zinc respectively. They are fairly corrosion resistant but will rust if the coating is destroyed or if exposed to a marine environment.

Hot Dip Galvanizing

Galvanizing is another coating involving the application of a layer of zinc. Hot dipped galvanizing puts the thickest possible coating on the metal resulting in superior corrosion resistance. Due to the thickness of the coating hot dipped galvanized bolts are not compatible with other nuts. Galvanized nuts are tapped slightly larger than other nuts to accommodate this coating.

Hot dipped galvanized fasteners are frequently seen in coastal environments and in pressure treated lumber where the chemicals in the lumber may corrode other fasteners.

Chrome

Chrome is used in plating fasteners for its appearance. It provides similar corrosion resistance to zinc plating. The main drawback of chrome is the extremely high cost. If more corrosion resistance is required stainless steel may be chrome plated, preventing any corrosion should the chrome be penetrated.

Guide to Fastener Materials

Note: Steel low-carbon is generally the default steel selection when no other steel grade is specified, or when no higher grade steel is required. Please check your application needs if you are not certain.

Mechanical Guidelines for Fasteners - Screws, Nuts, Bolts, Washers, Pins

| Steel Grade | Material & Treatment | Proof Load Stress | Yield Strength | Tensile Strength | Core Hardness, Rockwell |
|---------------------------|--|-----------------------------|-----------------------------|-----------------------------|-------------------------|
| | | ksi (1000 lbs/sq inch) Min. | ksi (1000 lbs/sq inch) Min. | ksi (1000 lbs/sq inch) Min. | |
| Low-carbon grade 2 | Low/medium carbon steel, cold-forged | 55 | 57 | 74 | B70-B100 |
| Grade A | Low/medium carbon steel | 90-100 | 95-105 | 60 | B69-B100 |
| Grade B | Low/medium carbon steel | 70-133 | 76-139 | 60-100 | B69-B95 |
| Grade 5 | Medium carbon steel, quenched & tempered | 74-85 | 81-82 | 105-120 | C19-C34 |
| Grade 8 | Medium carbon alloy steel, quenched & tempered | 120 | 130 | 150 | C33-C39 |
| Grade C | Medium carbon steel | 144 | 154 | N/A | B78-C38 |
| 2-H | Medium carbon steel | 144 | 154 | N/A | B78-C38 |

Strength guidelines may vary by part thickness, number of threads/inch, finish, and other design or production factors.