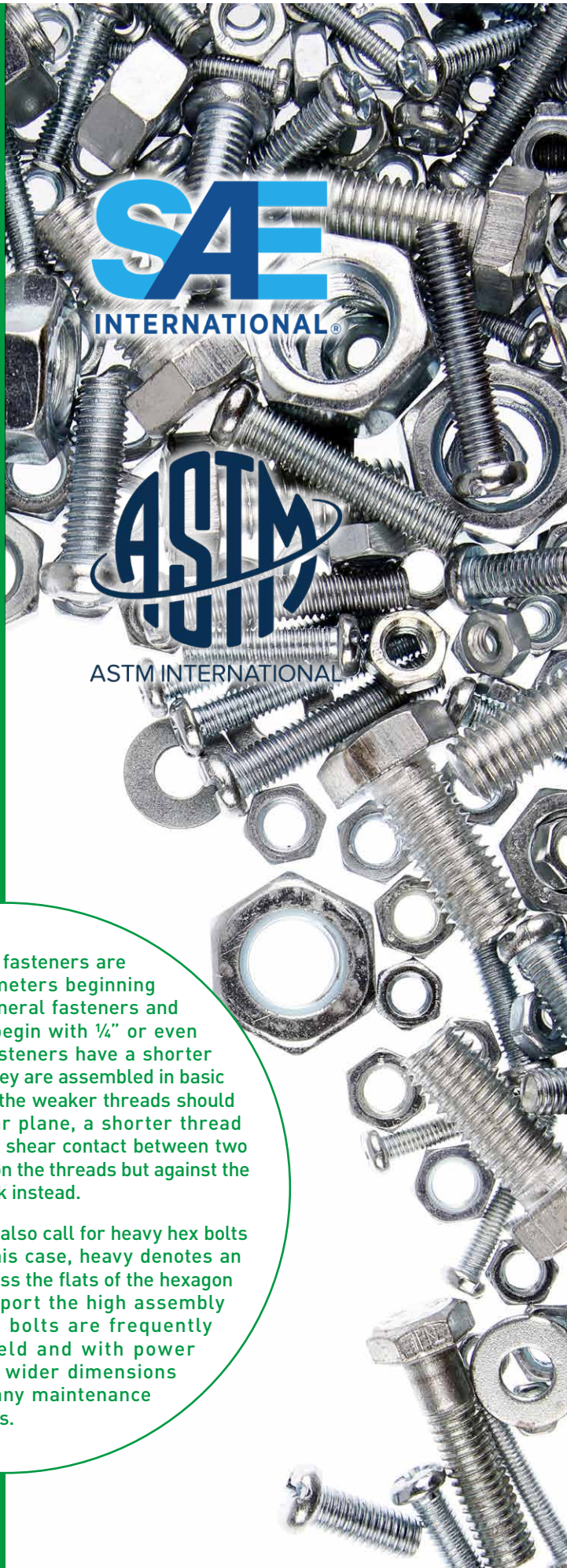
What is the Difference Between SAE Vs ASTM Fasteners?



The Society of Automotive Engineers (SAE) has been responsible for developing the mechanical and material requirements for externally threaded fasteners since 1949 in their Standard SAE J429. This is the most common Standard used for automotive, truck, bus and heavy equipment applications.

The American Society for Testing and Materials (ASTM) was founded in the early 1900's for standards to the manufacturing industry for steels and other materials and products along with test method standards for meeting quality assurance standards with the products. ASTM fasteners are primarily used in structural applications, piping, ships, bridges and industrial structures and maintenance. However, there are cross-over products with the SAE and ASTM that are used in general applications. There are also fastener product Standards in ASTM that are not found in the SAE Handbook, such as flat washers, non-ferrous fasteners and hex head products.

It wasn't until 1974 that the F16 Fastener Committee of ASTM was formed to deal specifically with fasteners. One of the first and biggest contributions to structural buildings was the development of the A325 bolt.

Structural fasteners are supplied in diameters beginning with ½", where general fasteners and SAE specifications begin with ¼" or even smaller. Structural fasteners have a shorter thread length because they are assembled in basic shear applications. Since the weaker threads should never be within the shear plane, a shorter thread length assures against any shear contact between two structural members being on the threads but against the stronger full diameter shank instead.

ASTM specifications will also call for heavy hex bolts and heavy hex nuts. In this case, heavy denotes an increase in the width across the flats of the hexagon shape, which is to support the high assembly stress as structural bolts are frequently assembled into yield and with power wrenches. These wider dimensions may benefit many maintenance general users.

The ASTM A307 is a low carbon heavy hex steel bolt that is available in two Grades. Grade A is a hex bolt for general use, non-critical applications with a tensile strength of 60,000 psi. The Grade B is a heavy hex bolt used for flanged joints in piping systems using cast iron and has a tensile strength range of 60-100,000 psi. The SAE strength equivalent is close to the Grade 2, but the fasteners are not exactly equal.

The A325 Type 1 is a heavy hex structural fastener that is usually furnished with a galvanized coating for extreme outdoor service conditions. Type 3 bolts are made of weathering steel to provide atmospheric corrosion resistance. Type 1 fasteners are marked with 'A325' but may also have 3 radial lines 120° apart. This is the same strength equivalent and has the same 3 radial line head marking as the SAE Grade 5.

However, the ASTM A449 is the exact equivalent of the SAE Grade 5; it specifies the same chemical and material requirements, including the 3 radial grade lines on the head. The dimensions are standard hex cap screw, the same as the SAE product.

The ASTM A354 Grade BD fasteners are the strength equivalent to the SAE Grade 8, at 150,000 psi and 120,000 psi yield strength, but with a few exceptions. Of greatest importance, all BD fastener sizes are required to be made from alloy steel. SAE has provisions for the use of non-alloy steels in certain sizes. Secondly, the Grade BD requires proof load testing, of which the results are to be included in the material test report, in addition to wedge tensile testing and hardness readings. SAE does not require the proof load testing.

The A490 is the structural version of the SAE Grade 8 and the A354, BD. However, by US standards and due to their high strength and high hardness, and that these fasteners are assembled into yield for consistency, the A490 fasteners and matching nuts are never hot dip galvanized nor electroplated to avoid hydrogen embrittlement.

The A325/A449 bolts may be quenched in water after heat treatment. However, it is required that all A490/A354BD bolts are oil quenched. This produces a refined martensitic grain structure that is very ductile at 14%, the same as the A325.

SAE does not have a specific grade for flat washers; they are either plain (fully annealed and soft) or heat treated and hardened. Hardened flat washers are available in commerce but they are also not marked to differentiate between the two types; however, the through hardened flat washers are used in all critical automotive and heavy equipment applications. The ASTM has the specification F436 which does specify the material and heat treatment hardnesses. These hardened flat washers are designed to support high yield loads without dishing or causing significant load relaxation. The flat washers are marked with 'F436' on one side.

Therefore, in non-structural and non-shear applications, an SAE Grade 5 can be substituted for an ASTM A449 or an A325 fastener. Likewise, an A354-BD may be substituted for an A490 for non-shear and non-structural applications. However, an A354-BD may be substituted for an SAE Grade 8 bolt for any application but the Grade 8 should never be used in place of the A354-BD without confirmation from the purchaser.

When a specification calls for an ASTM A193 fastener, it may never be substituted with any SAE fastener. The A193 covers high temperature alloy steel fasteners as well as stainless steels. The A193-B7, or B7 for short, is supplied in either threaded rod or heavy hex fasteners. This material is commonly used for high temperature (up to 1100°F, 593°C) and high pressure vessel applications, such as ASME SA193. The B7 threaded rods and bolts can be substituted for SAE Grade 5 but never the other way around, because the B7 is slightly stronger at 125,000 psi than the 120,000 psi tensile strength of the Grade 5. The B7 has better yield properties than the Grade 5 and is made from a 4140 series alloy steel, rather than a medium carbon steel.

Nuts are a different matter. The ASTM specifies several dimensions for structural or regular use nuts. Typical nuts are: heavy hex, hex and thick hex. These nuts are listed in the A194 standard.

A heavy hex nut has more mass; i.e., it has a larger width across the flats to provide greater support when a structural fastener is taken into yield. The ASTM A563 grade D has proof load strength of 150 ksi; DH and DH3 are 175 ksi. Compared with the regular hex dimension nuts; grade B is 120 ksi, D is 135 ksi, DH and DH3 are 150 ksi. The DH3 is made of weathering steel to mate with a Type 3 steel bolt. Therefore, a DH nut of either heavy hex or regular hex dimension may be used with a Grade 8 fastener.

All SAE nuts are the same size for different grades. For example, a 1/2" Grade 2 nut has the same dimensions as a 1/2" Grade 5 nut and the same as a 1/2" Grade 8 nut. The differences are in the heat treatments and steel chemistries. Technically, a Grade 2 nut could be used onto a Grade 8 fastener if the nut was thick enough; by at least 2 1/2 times the diameter of the fastener.

This relationship between thickness and hardness is similar to the depth and strength of a tapped hole. The old rule of thumb was that the hole only had to be as deep as the diameter of the fastener. This was derived from socket head products going into very hard tool steels. If a socket head product went into softer cold rolled steel, the hole would have to be deeper to offer more threads to carry the loads of the fastener. The softer the base materials, in relation to the hardness of the fastener, the deeper the hole must be in order to support the loads required of the fastener.

Whichever specification is used, SAE or ASTM, you can be assured of a fastener whose materials and processing treatments have been specified to provide optimum performance. ■

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