

ARE YOU PROPERLY SPECIFYING MATERIALS?

Part
three in a
three-
part
series:
fastening
products

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THE MATERIALS AND PRODUCTS USED IN BUILDING DESIGN AND CONSTRUCTION ARE ALMOST UNIVERSALLY DESIGNATED by reference to an appropriate ASTM specification. This simplifies the design and construction process because all characteristics of the product specified are defined by simple reference to an approved standard. However, with dozens of ASTM specifications applicable in steel building construction alone, it is often a challenge to keep the standard designations in contract documents current. Compounding this challenge, there have been several recent additions to the roster of available ASTM specifications of which many specifiers may be unaware.

This article (Part Three) provides a summary of the common ASTM and other specifications used for fastening products in building design and construction. The usual and other applicable ASTM specifications are addressed. Parts One (January 1999 *MSC*) and Two (February 1999 *MSC*) focused on structural shapes and plate, respectively.

BOLTS

The usual material specification for conventional (heavy-hex) high-strength bolts in steel-to-steel structural connections is ASTM A325, although ASTM A490 can be specified when higher strength is desired. In either case, Type 1 is most commonly specified. When atmospheric corrosion resistance is desired, Type 3 can be specified.

For some time now, alternative-design fasteners have been specified as described in Section 2(d) of the *Research Council on Structural Connections Specification for Structural Joints Using ASTM A325 or A490 Bolts*. Recently, ASTM published its specification F1852, which formalizes the material and product requirements for these twist-off-type tension-control bolt assemblies in a strength-level that is equivalent to

ASTM A325. For convenience, the marking system for these fasteners is the more familiar A325 to avoid confusion.

While still formally permitted in the *AISC Specification for Structural Steel Buildings*, the use of other material specifications in steel-to-steel structural bolting applications has become quite uncommon. ASTM A307 is almost as uncommonly specified today as are ASTM A501 and A502 rivets, perhaps only in structurally nominal connections such as those at the ends of girts and purlins.

NUTS

The usual material specification for heavy-hex nuts is ASTM A563. The appropriate grade and finish is specified per ASTM A563 Table X1.1 according to the bolt or threaded part with which the nut will be used. For steel-to-steel structural bolting applications, the appropriate grade and finish is summarized in *RCSC Specification* Section 2(c). Although ASTM A194 is permitted as an alternative in some applications, they are generally more expensive and less available than ASTM A563 nuts.

WASHERS

The usual material specification for hardened steel washers is ASTM F436. This specification provides for both flat and beveled washers. While standard ASTM F436 washers are sufficient in most applications, there are several specific applications when special washers are required. Refer to *RCSC Specification* Sections 7(c)(6) and 7(c)(7), which outline the special washer requirements that apply when oversized and slotted holes are used in outer plies of steel-to-steel structural bolting applications. In anchor-rod and other embedment applications, hole sizes are generally larger than those for steel-to-steel structural bolting applications (see *LRFD Manual* Table 11-3 for maximum anchor-rod hole sizes). Accordingly, washers used in such applications may

Did you say rods? I say bolts. You're not from around here, are you?

"Anchor bolt" is a nearly universal term in structural steel design and construction. However, it is all too common that requirements for steel-to-steel structural bolting applications are mistakenly applied to steel-to-concrete anchorage applications. Even worse, inclusion of the word "bolt" in the term has misled many an engineer to erroneously specify the anchorage material as ASTM A325 or A490, sometimes even in applications when a hooked rod was specified. Fortunately, their friendly neighborhood fabricator knew that ASTM A449 and A354 provide the respective strength equivalents in a rod material and are available in the range of lengths that are commonly specified for anchorage devices.

To differentiate between steel-to-steel structural bolting applications and steel-to-concrete anchorage applications, AISC has changed terminology to "anchor rod". Don't worry though if you still say "anchor bolt" from time to time, we know what you mean (and we still say it sometimes too!).

require design consideration for proper force transfer, particularly when the anchorage is subject to tension.

COMPRESSIBLE-WASHER-TYPE DIRECT-TENSION INDICATORS

Four methods of installation are recognized in *RCSC Specification* Section 8(d) for high-strength bolts in pretensioned bearing joints, slip-critical joints and joints subject to tension or combined shear and tension: turn-of-nut installation, calibrated wrench installation, alternative-design-fastener installation and direct-tension-indicator installation. When the direct-tension-indicator installation method is used, ASTM F959 compressible-washer-type direct-tension indicators are specified. Type A325 is used with ASTM A325 high-strength bolts and type A490 is used with ASTM A490 high-strength bolts.

ANCHOR RODS

(SEE BOX—OPPOSITE PAGE)

The usual material specification for anchor rods is ASTM F1554, a new material specification that covers hooked, headed and threaded and nutted anchor rods in three strength grades: 36, 55 and 105. Grade 55 is most

commonly specified. The weldability supplement S1 (with the carbon equivalent formula in ASTM F1554 Section S1.5.2.1) is recommended as comparatively inexpensive insurance for a more flexible solution set should the anchor rods be placed incorrectly in the field. ASTM F1554 grades 36 and 105 are essentially the anchor-rod equivalents of the generic rod specifications ASTM A36 and A193 grade B7, respectively. ASTM F1554 grade 55, when specified with the weldability supplement, is similar to an ASTM A572 material that is intermediate between grades 50 and 60.

Although ASTM F1554 is expected to rapidly become the specification of choice for anchor rods, several other ASTM Specifications can also be used. For applications involving unheaded rods, ASTM A36, A193, A307, A354, A449, A572, A588 and A687 can be specified. For applications involving headed rods, ASTM A307, A354 and A449 can be specified.

THREADED RODS

The usual material specification for threaded rods, whether provided with plain or upset ends, is ASTM A36. Other material specifications that can be specified include ASTM A193, A307,

A354, A449, A572, A588, and A687.

FORGED STEEL STRUCTURAL HARDWARE

Forged steel structural hardware products, such as clevises, turnbuckles, eye nuts, and sleeve nuts, are occasionally used in building design and construction. These products are generally provided to AISI material specifications. AISI C-1035 material is commonly used in the manufacture of clevises and turnbuckles. AISI C-1030 material is commonly used in the manufacture of steel eye nuts and steel eye bolts. AISI C-1018 grade 2 material is commonly used in the manufacture of sleeve nuts. Other products, such as steel rod ends, steel yoke ends and pins, cotter pins and coupling nuts are commonly provided generically as "carbon steel." In any case, the dimensional and strength characteristics of these devices are fully described in the literature provided by their manufacturer.

WELD METAL

The appropriate weld metal is as summarized in ANSI/AWS D1.1-98 Table 3.1 for the various combinations of base metal specification and grade and electrode specification. Weld metal with a tensile strength $F_{EXX} = 70$ ksi is most common.

SHEAR STUD CONNECTORS

As specified in ANSI/AWS D1.1-98 Chapter 7 (Section 7.2.6 and Table 7.1), Type B shear stud connectors made from ASTM A108 material are used for the interconnection of steel and concrete elements in composite construction.

STEEL CASTINGS AND FORGINGS

Steel castings are specified as ASTM A27 grade 65-35 or ASTM A148 grade 80-35. Steel forgings are specified as ASTM A668.

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Oops!!

Please note that an error occurred in the electronic printing process for the February 1999 MSC (Are You Properly Specifying Materials?, Part II: structural plates). In several places, such as in the box on page 38 and in the text on page 39, the characters "fi" and "fl" mistakenly appear; "fi" should be "1/2" and "fl" should be "3/4".