Structural Steel Materials Update

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Are you specifying the latest in structural steel materials? This update from AISC's Steel Solutions Center summarizes the latest standards.

NEW MATERIAL STANDARDS AND INNOVATIONS HAVE BEEN DEVELOPING AT A FAIRLY RAPID PACE OVER THE PAST SEVERAL YEARS. While it may be difficult to keep track of the latest material offerings, have no fear! After reading this article, you'll be up to date on current material specifications.

Steel Shapes and Sections

All open, hot-rolled shapes approved by the 2005 AISC specification fall under the ASTM A6 standard. New shapes are added or eliminated as the standard is updated every few years. That is why it's important to use the 13th edition *Steel Construction Manual*, which lists shapes found in the latest ASTM A6-05 standard. If you're stilling using the old green book (9th edition AISC manual), you are likely to encounter shapes that no longer exist.

The latest version of ASTM A6 has added many heavier hot-rolled shapes. Visit **www.aisc.org/availability** for the latest open shape and hollow structural section (HSS) availability, which also includes pipe. Contact information for shape mills and steel service centers, including the various states that they serve, is conveniently listed.

In terms of wide-flange shapes, ASTM A992 is the preferred material standard. Although ASTM A992 also addresses M, S, C, MC, and L shapes, that is not an indication of availability. In fact, we found only three shape mills offering channels and angles in ASTM A992. As such, use caution in specifying ASTM A992 for non-W-shapes unless availability is confirmed ahead of time.

If your interest lies in tubular sections, it is important to remember that there are four ASTM standards for HSS (ASTM A500, A501, A618, and A847). Of those four standards, only ASTM A500 material is produced. Although the other standards exist, mills are not producing HSS to ASTM A501, A618, and A847.

Most rounds are ASTM A53 Grade B pipe or round ASTM A500 HSS that have not been pressure tested. You may receive round ASTM A500 instead of ASTM A53 Grade B for two reasons: ASTM A500 has a greater yield strength than ASTM A53 Grade B, and it is manufactured to the same dimensions as ASTM A53 pipe. It is interesting to note that HSS producers produce pipe-like cross sections in ASTM A500, but due to the overlap in the two standards, such round tubular sections are offered as ASTM A53 Grade B without pressure testing. They are essentially ASTM A500 products that have been downgraded and sold as ASTM A53 Grade B pipe!

ASTM A500 is either an electric-resistance-welded (ERW) or seamless, cold-rolled material with a maximum perimeter of 64 in. If larger perimeters are required, the designer should investigate submerged-arc-welded (SAW) HSS or even very large API pipe. Note that SAW HSS does not fall under any ASTM Standard; hence, it is not referenced in Section A3 of the 2005 AISC specification as an approved material.

Structural Steel Shapes and Sections

Shape/ Section	Preferred ASTM Material Standard	Other Applicable ASTM Material Standards
W	A992	A242 Grade 42[c], 46[b], 50[a] A529 Grade 50[a], 55[c] A572 Grade 42, 50, 55, 60[c], 65[c] A588 Grade 50 A913 Grade 50, 60, 65, 70
HP	A572 Grade 50	A36 Grade 36 A242 Grade 46[b], 50[a] A529 Grade 50[a], 55[c] A572 Grade 42, 55, 60[c], 65[c] A588 Grade 50 A913 Grade 50, 60, 65, 70 A992
M, S, C, MC	A36	A242 Grade 50[a] A529 Grade 50[a], 55[c] A572 Grade 42, 50, 55, 60[c], 65[c] A588 Grade 50 A913 Grade 50, 60, 65, 70 A992 – confirmation required
L	A36	A242 Grade 46[b], 50[a] A529 Grade 50[a], 55[c] A572 Grade 42, 50, 55, 60[c], 65[c] A588 Grade 50 A913 Grade 50, 60, 65, 70 A992 – confirmation required
HSS	A500 Grade B	A500 Grade C A501 Grade 36 A618 Grade I, II and III A847 Grade 50
Pipe	A53 Grade B	N/A

Material Type	Applicable ASTM Standard(s)
Carbon	A36, A53, A500, A501, A529
High-Strength, Low-Alloy	A572, A618, A913, A992
Corrosion-Resistant, High-Strength, Low-Alloy	A242, A588, 847

[a]For shapes with a flange thickness ≤ 1½ in.
[b]For shapes with a flange thickness > 1½ in., but ≤ 2 in.
[c]For shapes with a flange thickness > 2 in.

Structural Plates and Bars

As was the case for hot-rolled shapes, plates and bars are also included in the ASTM A6 Standard. However, unlike the shape listings found in ASTM A6 that establish dimensions, such listings

do not exist for plates and bars. As such, to determine which dimensions are rolled, it is best to contact the plate mills or a steel service center. Many service centers will cut stocked plates and bars to the customer's dimensional requirements, as well as provide additional services.

ASTM A36 is the preferred material standard for plates and bars. Note that ASTM A572 grade 50 is quite common for gusset plates, built-up shapes, and other details with plates thicker than ¾ in. Check with a fabricator for guidance. There has not been as much change over the years in terms of material selection for plates and bars, as has been the case with hot-rolled shapes. An important fact about plate and bar is that as thickness increases, the number of applicable ASTM standards and grades decreases. Also, material over 8 in. thick is only available in ASTM A36, but with a minimum specified yield strength of 32 ksi.

Structural Fasteners

There is currently a myriad of structural fasteners available, each developed for specific applications. For structural applications where only snug-tightened bolted joints are required, low-strength ASTM A307 bolts are permitted, but typically considered only for secondary members or low-load applications. High-strength bolts such as ASTM A325 and A490 are the more common choice.

There are four pretensioning methods of bolt installation sanctioned by the RCSC specification (available at **www.boltcouncil.org**): turn-of-the-nut, calibrated wrench, twist-off-type tension-control bolt, and direct-tension-indicator. For pretensioned and slip-critical bolted joints, one will need to consider ASTM A325 and A490 high-strength bolts, or alternatively, F1852 and F2280 tension-control bolt assemblies.

If ASTM A325 or A490 high-strength bolts are used in pretensioned and slip-critical joints, one can choose turn-of-the-nut or calibrated wrench, or decide to use ASTM F959 direct-tension-indicator washers to determine that the minimum level of installation pretension has been provided. In all cases, the pre-installation verification requirements of the RCSC specification must be followed. The newest addition to the structural bolting family is ASTM F2280, which is a tension-control bolt with a material strength equivalent to an ASTM A490 high-strength bolt.

One should never confuse structural bolts with anchor rods, or improperly use one when the other is required. AISC changed the term "anchor bolt" to "anchor rod" about 17 years ago to highlight the differences between bolts used in steel-to-steel connections and those used in anchoring steel-to-concrete. The design and installation parameters are quite different for each. Structural bolt lengths are usually available in lengths of 8 in. or less, which is typically insufficient for proper embedment development length as an anchor rod.

When thinking about column anchorage, one should remember that ASTM F1554 Grade 36 is the preferred material specification for anchor rods. It contains the same chemical and structural properties as ASTM A36 rod, but includes two important aspects: color coding and inclusion in the ASTM F1554 anchor rod standard. ASTM F1554 is an "umbrella" anchor rod standard, as it establishes the process, threading, coatings, dimensions, and tolerances for anchor rods. No other ASTM Standard for rod material

Structural Plates and Bars		
Thickness	**Preferred ASTM Standard**	**Other Applicable ASTM Standards**
to 0.75 in.	A36[d]	A242 Grade 50 A514 Grade 100 A529 Grade 50, 55 A572 Grade 42, 50, 55, 60, 65 A588 Grade 50 A852[b] Grade 70
greater than 0.75 in. up to 1.25 in.	A36[d]	A242 Grade 46 A514 Grade 100 A529 Grade 50[a], 55[a] A572 Grade 42, 50, 55, 60, 65 A588 Grade 50 A852[b] Grade 70
greater than 1.25 in. up to 1.5 in.	A36[d]	A242 Grade 46 A514 Grade 100 A529 Grade 50[a], 55[a] A572 Grade 42, 50, 55 A588 Grade 50 A852[b] Grade 70
greater than 1.5 in. up to 2 in.	A36[d]	A242 Grade 42 A514 Grade 100 A529 Grade 50[a] A572 Grade 42, 50, 55 A588 Grade 50 A852[b] Grade 70
greater than 2 in. up to 2.5 in.	A36[d]	A242 Grade 42 A514 Grade 100 A529 Grade 50[a] A572 Grade 42, 50 A588 Grade 50 A852[b] Grade 70
greater than 2.5 in. up to 4 in.	A36[d]	A242 Grade 42 A514 Grade 90 A572 Grade 42, 50 A588 Grade 50 A852[b] Grade 70
greater than 4 in. up to 5 in.	A36	A514 Grade 90 A572 Grade 42 A588 Grade 46
greater than 5 in. up to 6 in.	A36	A514 Grade 90 A572 Grade 42 A588 Grade 42
greater than 6 in. up to 8 in.	A36	A588 Grade 42
greater than 8 in.	A36[c]	N/A

Material Type	Applicable ASTM Standard(s)
Mild Carbon	A36, A529
High-Strength, Low-Alloy	A572
Corrosion-Resistant, High-Strength, Low-Alloy	A242, A588
Quenched and Tempered Alloy	A514
Quenched and Tempered, Low-Alloy	A852

[a]Applicable to bars > 1 in. thick.
[b]Available only as plate.
[c]Produced to a minimum specified yield strength of 32 ksi.
[d]ASTM A572 grade 50 is common for gusset plates, built-up shapes, and other details with plates thicker than ¾ in.

Structural Fasteners		
Fastener Type	**Preferred ASTM Material Standard**	**Other Applicable ASTM Material Standards**
High-Strength, Conventional Bolts[c]	A325 A490	A449[a]
High-Strength, Twist-Off-Type Tension-Control Bolts	F1852 F2280[b]	N/A
Common Bolts	A307 Grade B	N/A
Nuts	A563	A194 Grade 2H
Washers	F436[d]	N/A
Direct-Tension-Indicator Washers	F959[e]	N/A
Threaded Rods	A36	A193 Grade B7 A307 Grade C A354 Grade BD A449 A572 Grade 42, 50, 55, 60, 65
Shear Stud Connectors	A108	N/A
Anchor Rods	F1554 Grade 36	A36 A193 Grade B7 A307 Grade C A354 Grade BD A449 A572 Grade 42, 50, 55, 60, 65 A588 A687 F1554 Grade 55, 105

[a]Refer to 2005 AISC specification for limitations on use.
[b]Adoption into AISC specification is pending.
[c]SAE bolts are not approved by AISC specification.
[d]Special washer requirements may apply per RCSC specification.
[e]Washers that express colored dyes when compressed are not covered by ASTM F959.

establishes these important requirements. ASTM F1554 includes a Grade 55, which can be ordered to Supplementary Requirement S1, which ensures weldability. There is also a Grade 105 for high-strength applications, which is a heat-treated material; hence, it cannot be ordered to Supplementary Requirement S1 to ensure weldability.

It should be noted that threaded rods are typically used for tension-only bracing or when tension hangers are required. Such threaded rods may also be used as anchor rod, although are not very common. Per ASTM F1554, A563 heavy-hex or hex nuts are typically used with anchor rods, depending on the anchor rod nominal diameter and whether zinc coating has been applied. Heavy-hex ASTM A563 nuts are used with structural steel bolts, such as ASTM A325 and A490, as outlined in the RCSC specification.

Service Centers

The majority of structural steel in the U.S. is obtained directly through steel service centers rather than through structural rolling mills. The most obvious benefit is sequential and just-in-time delivery, which carries the advantage of significantly reducing the yard storage and the finding costs for the fabricator.

Additional benefits include minimization of material price volatility, efficient purchasing by way of exact quantities, and the ability of the fabricator to improve cash flow management by invoicing materials as they are delivered on an as-needed basis. Service centers are also becoming more service-oriented, many offering services such as cutting to length, miter cutting, cambering, tee splitting, plate shearing, forming, and shape burning.

The premium associated with these benefits and services ranges from 10 to 15 percent above rolling mill pricing. It follows that customers with very large tonnage jobs, or jobs involving a significant number of repetitive shapes, will still benefit the most from purchasing directly from the rolling mills. In terms of balancing economy and benefits, it should be noted that the majority of service center customers are involved in jobs less than 1,000 tons in the under-five-story building market. For a list of steel service centers and the states that they service, visit **www.aisc.org/servicecenter**. MSC

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