Steel Industry Embraces A992

By Jacques Cattan

For much of the past decade, ASTM A572 Gr. 50 has been the de facto standard in the structural steel industry. The advent of the mini-mills essentially eliminated the price premium for the material compared with A36 and many designers have long since made the switch.

Now, though, the next generation de facto standard is available. A992, with a minimum strength of 50 ksi, is now available, has been incorporated into the 1999 LRFD Specification. For designers, the switch from A572 Gr. 50 to A992 should be seamless, and in fact, many designers have already been specifying the material, albeit as A572 Gr. 50 (with special requirements) as per AISC Technical Bulletin #3, March 1997. The new A992 Specification covers W shapes (rolled wide flange shapes) intended for use in building framing. ***For S, M, and HP shapes and channels, A36 or A572 Gr. 50 should still be specified. For angles and plates, A36 should still be specified (for more information, see the three-part series, "Are You Properly Specifying Materials," which appeared in the Jan.-March issues of MSC).***

The major advantage of A992 is its better material definition. It has an upper limit on yield strength of 65 ksi, a minimum tensile strength of 65 ksi, a specified maximum yield-to-tensile ratio of 0.85 and a specified maximum carbon equivalent of 0.47%.

"All of our current wide flange shapes are available in A992 today," stated James L. Wroble, Vice President/Sales & Marketing at Chaparral Steel in Midlothian, TX. "And there's no premium compared with A36 for the material on the shapes that Chaparral currently produces."

Added Robert W. Johns, Sales Manager, Nucor-Yamato Steel Company in Blytheville, AR: "We've been rolling the equivalent to A992 for 3½ years now, since even before the release of AISC Technical Bulletin #3. All of Nucor-Yamato's wide flange shapes are available in A992, though there is currently a slight price premium compared with A36 once you get above about 150 lbs. per foot."

Likewise, all wide flange sections produced by Northwestern Steel & Wire Co., as well the company's available inventory, meet the A992 Specification, according to Michael Venie, vice president of sales and marketing at Northwestern.

(Please check directly with other domestic and foreign wide flange mills concerning their policy on the new grade and its availability.)

"Also, during this transition period, there may be occasions where A992 is not readily available through service centers," explained Andy Johnson, Vice President of Marketing for AISC Marketing, Inc. "In these cases, we recommend that the engineer allow the substitution of A572 Gr. 50."

While mills and service centers are in the process of fully gearing up for A992, the steel specification has already adopted it. "The new material has already been incorporated into the latest set of revisions to the AISC specification," explained Stanley D. Lindsey Stanley D. Lindsey, president of Stanley D. Lindsey & Assoc., Ltd., in Atlanta and chairman of the AISC Committee on Specifications.

As with A572 Gr. 50, A992 presents some attractive cost benefits over A36. Since there are often no grade extras for Gr. 50 steel, most buildings will achieve a greater economy by utilizing A992 instead of A36. However, even when extras do come into play, there are typically no overall cost penalties for the frame. "This is because the weight savings provide greater benefits than the premium for the grade extra," explained Johnson. "Studies have shown this to be true even when member sizes need to be increased to meet serviceability concerns." A copy of studies showing the cost savings of using Gr. 50 instead of Gr. 36 can be obtained by faxing a request to AISC Marketing at 312/670-5403.

In addition, the entire fabricated structural steel industry will ultimately benefit from economies of scale related to moving to a single grade of steel. “The use of a single high-strength grade is expected to simplify designs for buildings and produce economies of scale for service centers, mills and fabricators,” explained H. Louis Gurthet, President of AISC.

The following page contains a brief comparison of ASTM A572 Grade 50 "Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel" and ASTM A992 "Standard Specification for Steel for Structural Shapes for Use in Building Framing". The comparison focuses on the scope, chemical composition and tensile requirements.

Like any ASTM Specification, both A572 and A992 contain a reference section, a materials and manufacture section as well as optional supplementary requirements which are not included in this comparison.

Scope:

A572 Grade 50	A992
Covers structural steel shapes, plates, piling and bars	Covers "W" shapes (rolled wide flange shapes) intended for use in building framing.
Intended for riveted, bolted or welded construction of bridges, buildings and other structures	

Chemical Composition:

A572 Grade 50		A992	
Element	**Composition %**	**Element**	**Composition %**
Carbon, max	0.23	Carbon, max	0.23
Columbium, used alone	0.005-0.05	Columbium, max	0.05
		Copper, max	0.60
Manganese, max	1.35	Manganese	0.5 to 1.50
		Manganese, min. for group 1 shapes if Manganese to Sulfur ratio > 20 to 1	0.3
		Molybdenum, max	0.15
		Nickel, max	0.45
Phosphorus, max	0.04	Phosphorus, max	0.035
Silicon, max	0.40	Silicon, max	0.40
Sulfur, max	0.05	Sulfur, max	0.045
Vanadium, used alone	0.01-0.15	Vanadium, max	0.11
Vanadium + Columbium	0.02-0.15	Vanadium + Columbium, max	0.15
Vanadium alone and Nitrogen	Vanadium to nitrogen ratio 4 to 1 min Nitrogen 0.015% max	Vanadium alone and Nitrogen	Vanadium to nitrogen ratio 4 to 1minimum if nitrogen is greater than 0.012%
		Carbon Equivalent, max	0.45% for groups 1,2 and 3 0.47% for groups 4 and 5

In addition A992 requires the reporting, for information, of the tin content. It also requires the reporting of the carbon equivalent using the following formula:

$$CE = C + (Mn)/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$$

Tensile Requirements:

A572 Grade 50		A992	
Tensile Strength, min	65 ksi	Tensile Strength, min	65 ksi
Yield Point, min	50 ksi	Yield Point	50 to 65 ksi
		Yield to tensile ratio, max	0.85
Elongation in 8 in., min	18%	Elongation in 8 in., min	18%
Elongation in 2 in., min	21%	Elongation in 2 in., min	21%

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SHAPE MATERIAL
(ASTM A572 Gr 50 with special requirements)

As announced, effective May 1, 1997, structural steel shapes will be commercially available with special requirements. Please consult your steel supplier for specifics.

Steel shapes ordered to this technical bulletin shall conform to the following:

1. Meet all requirements of ASTM A572/A572M-94c *Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel* Grade 50;

2. The steel shall be made to a practice producing nitrogen not greater than 0.012% or steel shall be made to a practice producing nitrogen not greater than 0.015% and nitrogen binding elements shall be added;

3. Chemical Requirements:

   The heat analysis shall conform to the requirements in Table 1;
   Test reports shall include the chemical analysis for tin for information. When the amount of tin is less than 0.02%, the analysis may be reported as "<0.02%";
   The carbon equivalent (CE) shall not exceed 0.50% except steel shapes not included in Groups 4 or 5 shall be supplied with a maximum of 0.45% if the carbon content is greater than 0.12%. The carbon equivalent shall be calculated using the following formula:

   $$CE = C + (Mn + Si)/6 + (Cu + Ni)/15 + (Cr + Mo + V + Cb)/5$$

   TABLE 1 Chemical Requirements

Element	Composition, %
Carbon, max	Refer to ASTM A572
Manganese	0.50 - 1.50[a]
Silicon, max	Refer to ASTM A572
Vanadium[b]	Refer to ASTM A572
Columbium[b]	Refer to ASTM A572
Phosphorous, max	0.035
Sulfur, max	0.045

Element	Composition, %
Copper, max	0.60
Nickel, max	0.45
Chromium, max	0.35
Molybdenum, max	0.15

[a] Minimum manganese for Group 1 shapes is 0.30%. The ratio of manganese to sulfur shall not be less than 20 to 1.

[b] Columbium plus vanadium is not to exceed 0.15% maximum. Nitrogen when added as a supplement to vanadium shall be reported and the minimum ratio of vanadium to nitrogen shall be 4 to 1.

4. Tensile Requirements:

Yield Point, ksi [Mpa]	50 - 65 [345 - 450]
Yield to Tensile Ratio, max	0.85

SUPPLEMENTARY REQUIREMENTS

These requirements shall not apply unless specified in the order.

Standardized supplementary requirements for use at the option of the purchaser are listed in Specification A6/A6M. Those that are considered suitable for use with this specification are listed by title:

S1. Vacuum Treatment

S2. Product Analysis

S5. Charpy V-Notch Impact Test

S8. Ultrasonic Examination

S14. Bend Test

ADDED SUPPLEMENTARY REQUIREMENTS

In addition, the following optional supplementary requirements are also suitable for use with this specification.

S79. Maximum Tensile Strength
S79.1 The maximum tensile strength shall be 90 ksi [620 Mpa].

S91. Fine Austenitic Grain Size
S91.1 The steel shall be killed with a fine austenitic grain size.

SX3. Charpy V-Notch Impact Test for Group 4 and 5 Structural Shapes

SX3.1 When Group 4 and 5 structural shapes are used as members subject to primary tensile stress and when such members are spliced using full penetration welds, the steel shall be impact tested in accordance with Specification ASTM A6, supplementary requirement S5, modified in accordance with SX3.2.

SX3.2 Charpy V-Notch impact tests shall be conducted in accordance with Specification ASTM A673/A673M with the following exceptions for Group 4 and 5 rolled shapes:

The center longitudinal axis of the specimens shall be located as near as practical to midway between the inner flange surface and the center of the flange thickness at the intersection with the web mid-thickness (see Fig. 1).

SX3.3 The frequency of testing shall be Frequency P in Specification ASTM A673/A673M with the following exception for rolled shapes produced from ingots:

Tests shall be conducted from a location representing the top of each ingot or part of an ingot used to produce the product represented by these tests.

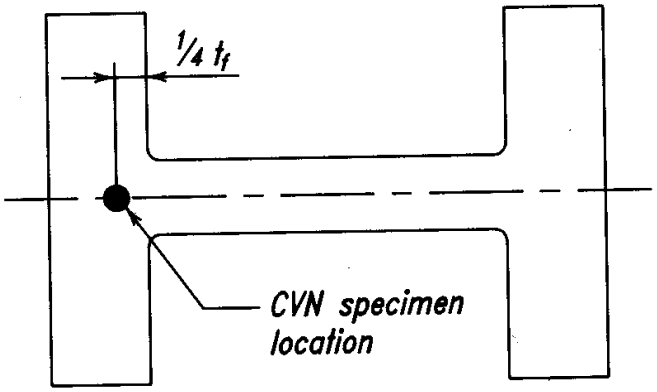

Fig. 1 Location from which Charpy impact specimen shall be taken for Group 4 and 5 structural shapes.

SX3.4 The test result shall meet a minimum average value of 20 ft-lb [27J] absorbed energy at +70°F [+21°C] if the steel is intended for ordinary use in buildings such as static loading. For unusual applications such as dynamic loading, highly restrained connections, low temperature or any combination of these conditions, the purchaser should consider more restrictive Charpy V-notch requirements for specification in the contract documents.