If you've ever asked yourself "why" about something related to structural steel design or construction, *Modern Steel Construction's* monthly *Steel Interchange* column is for you!

Non-Compact?

I know there are a limited number of W-shapes considered non-compact (per ASD design). Do you have a listing of the non-compact sections for F_y = 36ksi and F_y = 50ksi?

All current ASTM A6 W, S, M, C, and MC-shapes except W21×48, W14×99, W12×65, W10×12, W8×31, W8×10, W6×15, W6×9, W6×8.5, and M4×6 have compact flanges for F_y less than or equal to 50 ksi. All current ASTM A6 W, S, M, HP, C, and MC-shapes have compact webs at F_y less than or equal to 65 ksi.

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Answers to the following questions were provided by Charles J. Carter, S.E., P.E., AISC's Chief Structural Engineer.

Types of Bolts

What is the primary difference between ASTM A325 and A490 bolts, other than the difference in strength?

Strength is the main difference, from a product perspective. Some other differences include:

- ASTM A325 bolts can be galvanized, while ASTM A490 bolts can not. See ASTM A325, ASTM A490, and the commentary near Table 2.1 in the 2000 RCSC *Specification* (which is available as a free download from www.boltcouncil.org).
- Black ASTM AA325 bolts can be reused with EOR permission, while ASTM A490 bolts and galvanized ASTM A325 bolts can not. See RCSC *Specification* Section 2.3.3.
- ASTM A325 bolts have more broad applicability for use in snug-tightened joints in that they can be used in applications involving direct tension without fatigue. ASTM A490 bolts currently can not, but a research project just completed appears to indicate that this will change in a future edition of the RCSC *Specification*. See 2000 RCSC *Specification* Section 4.

There are probably some other differences you could determine by complete comparison of the details given in the ASTM A325 and ASTM A490 standard specifications.

Dimension Dilemma

Section 3.3 of the 2002 AISC *Code of Standard Practice* reads, in part, "When discrepancies exist between scale dimensions in the Design Drawings and the figures written in them, the figures shall govern." This has been interpreted to mean that if no figures exist then it is proper to scale the drawing and use the resultant dimension to build. Is this, in fact, the intent of the code?

No. The intent is to provide for the drafting convenience of changing a dimension without having to redraw the drawing. The phrase you quoted says the dimension indicated controls whatever the corresponding physical distance scales to. It does NOT allow for the elimination of dimensions and/or use of scaling of drawings.

Remember, drafting rule number one: It is never appropriate to scale drawings to determine dimensions.

Weld Metal Myth

Can weld cracking be prevented simply by specifying notch-tough weld metal?

No. It is important to distinguish that weld cracking and weld toughness are not unilaterally related. Although toughness will help solve some ills, a more holistic approach is needed than simply pursuing weld toughness.

There are three things that interrelate in an infinite number of possible combinations to influence whether something does or does not crack: flaw size, demand, and toughness level. For example, flaw size and demand could be high enough to cause cracking in tough weld metal. On the other hand, minimized flaw sizes and demand levels may be low enough to avoid cracking in weld metal of low toughness. It's a balance through the full range of combinations.

Cracking in welds is rare. Most cracks do not occur during loading but during cooling, and are the result of improper procedures, poor joint design, poor weld quality, etc. But in the end, whether the cooling demand or the loading demand is at work, it all comes down to the combination of flaw size, demand and toughness level.

Developing Welded Elements

Can a partial-joint-penetration groove weld be used when it is necessary to develop the strength of a welded element?

PJP groove welds, in some cases, can be configured with fillet-weld reinforcement to develop the strength of the base metal. This usually involves a double-sided joint. If that is the case, PJP groove welds might be perfectly acceptable instead of CJP groove welds or double-sided fillet welds, which can also be used to develop the full strength of the base metal.

Gages Gone?

Why did AISC stop publishing the usual gage dimension for W-shapes in the properties table? What was the basis for these values when they appeared in earlier editions (pre 9th edition ASD)?

They were eliminated because people were *requiring* those gages, even when others were permissible. In hindsight, we recognized that was a mistake, since the information there is often needed as a guide. To rectify this situation, we have reintroduced those values as "workable gages" in the 3rd Edition AISC *LRFD Manual*. The term *workable* is explained as being

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useful as is, and adjustable within the limits of entering/tightening clearance and edge distance requirements.

Sleeve Nuts

Page 4-150 of the 9th Edition of AISC *ASD Manual* has a table of sleeve nuts and it states "Strengths are greater than the corresponding rod when same material is used." What is the ASTM designation of these sleeve nuts?

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Refer to the article on proper material specification in the January 2004 issue of *Modern Steel Construction*. It is on the AISC web site at www.modernsteel.com. The text that will help you on sleeve nuts follows:

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 commonly is used in the manufacture of clevises and turnbuckles. AISI C-1030 material commonly is used in the manufacture of steel eye nuts and steel eye bolts. AISI C-1018 grade 2 material commonly is used in the manufacture of sleeve nuts. Other products, such as steel rod ends, steel yoke ends and pins, cotter pins and coupling nuts commonly are provided generically as "carbon steel." The dimensional and strength characteristics of these devices are described in the literature provided by their manufacturer. Note that such information usually is provided as a safe working load and based upon a factor of safety as high as 5, assuming that the product will be used in rigging or similar applications subject to dynamic loading. If so, the tabular value might be overly conservative for permanent installations and similar applications subject to static loading only. In these applications, a factor of safety of 3 typically is used.

Buckling Restraint

What is the force required to restrain a compression member from buckling laterally?

The 4th Edition of the *Guide to Stability Design Criteria for Metal Structures* (p. 55) indicates that the required bracing strength is based upon the initial out-of-plumbness of the column, the ideal and actual stiffnesses of the member, and the number of points of bracing along the length of the member. If the initial lean is 1 in 500, the ratio of ideal stiffness to actual stiffness is 0.5, and the number of braces is 1, the bracing force is 0.8 percent of $P_{critical}$. If the number of braces approaches infinity, the bracing force is 1.6 percent of $P_{critical}$. To cover the full range, and to account for the uncertainties in this derivation, the 2-percent strength rule was born as a usual conservative practice.

However, today's structures look very little like those that were considered in establishing the above derivation, which was done by Winter circa 1960. As a result, one should return to the basic assumption behind it—that sufficent strength and stiffness are *both* needed to provide proper bracing.

In old-style construction, the stiffness was usually there and one could simply assess the bracing by the 2-percent strength rule. If you know what you are doing, you can still probably do this. But you have to know what you are doing.

Modern approaches to stability bracing design provide for assessment of both strength and stiffness. These provisions are included in detail in the AISC *Specification*, Chapter C3. It's a free download at www.aisc.org if you don't already have it.

Seeing is Believing

Why is visual inspection so important in welding?

Visual inspection before, during and after welding is critical to the success and quality of welding. It's a lot like grilling a great steak. You can't walk up to a steak that's on the grill and tell it's medium rare just by looking at the outside. You have to have been there to ensure the grill temperature was high at the start, know what time the steak went on that grill, when to stop searing the steak and reduce the heat for the longer cooking phase, when to flip it, how long to leave it, etc. (Giving proper credit: Duane Miller of Lincoln Electric Company gave me the steak analogy).

Steel Interchange is an open forum for *Modern Steel Construction* readers to exchange useful and practical professional ideas and information on all phases of steel building and bridge construction. Opinions and suggestions are welcome on any subject covered in this magazine.

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If you have a question or problem that your fellow readers might help you to solve, please forward it to us. At the same time, feel free to respond to any of the questions that you have read here. Contact *Steel Interchange* via AISC's Steel Solutions Center:

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