

SUPPLEMENT NO. 1

TO THE LOAD AND RESISTANCE FACTOR DESIGN SPECIFICATION FOR STRUCTURAL STEEL BUILDINGS

(ADOPTED SEPTEMBER 1, 1986)

Effective January 1, 1989



**AMERICAN INSTITUTE
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Supplement No. 1

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SECTION A3.1a HEAVY SECTIONS

For ASTM A6 Group 4 and 5 rolled shapes to be used as members subject to primary tensile stresses due to tension or flexure, toughness need not be specified if splices are made by bolting. If such members are spliced using full penetration welds, the steel shall be specified in the contract documents to be supplied with Charpy V-Notch testing in accordance with ASTM A6, Supplementary Requirement S5. The impact test shall meet a minimum average value of 20 ft-lbs. absorbed energy at +70°F. and shall be conducted in accordance with ASTM A673 with the following exceptions:

- a. 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.
- b. 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.

For plates exceeding 2-in. thick used for built-up members with bolted splices and subject to primary tensile stresses due to tension or flexure, material toughness need not be specified. If such members are spliced using full penetration welds, the steel shall be specified in the contract documents to be supplied with Charpy V-Notch testing in accordance with ASTM A6, Supplementary Requirement S5. The impact test shall be conducted in accordance with ASTM A673, Frequency P, and shall meet a minimum average value of 20 ft-lbs. absorbed energy at +70°F.

The above supplementary toughness requirements shall also be considered for welded full-penetration joints other than splices in heavy rolled and built-up members subject to primary tensile stresses.

Additional requirements for joints in heavy rolled and built-up members are given in Sections J1.10, J1.11, J2.7, J2.8 and M2.2.

SECTION J1.10 SPLICES IN HEAVY SECTIONS

This paragraph applies to ASTM A6 Group 4 and 5 rolled shapes, or shapes built-up by welding plates more than 2-in. thick together to form the cross section,* and where the cross section is to be spliced and subject to primary tensile stresses due to tension or flexure. When tensile forces in these sections are to be transmitted through splices by full-penetration groove welds, material notch-toughness requirements as given in Sect. A3.1a, weld access hole details as given in J1.11, welding preheat requirements as given in J2.7 and thermal-cut surface preparation and inspection requirements as given in M2.2 apply.

At tension splices in Group 4 and 5 shapes and built-up members of material more than 2-in. thick, weld tabs and backing shall be removed and the surfaces ground smooth.

When splicing ASTM A6 Group 4 and 5 rolled shapes or shapes built-up by welding plates more than 2-in. thick to form a cross section, and where the section is to be used as a primary compression member, all weld access holes required to facilitate groove welding operations shall satisfy the provisions of J1.11.

Alternatively, splicing of such members subject to compression, including members which are subject to tension due to wind or seismic loads, may be accomplished using splice details which do not induce large weld shrinkage strains such as partial penetration flange groove welds with fillet-welded surface lap plate splices on the web or with bolted or combination bolted/fillet-welded lap plate splices.

SECTION J1.11 BEAM COPES AND WELD ACCESS HOLES

All weld access holes required to facilitate welding operations shall have a length from the toe of the weld preparation not less than $1\frac{1}{2}$ times the thickness of the material in which the hole is made. The height of the access hole shall be adequate for deposition of sound weld metal in the adjacent plates and provide clearance for weld tabs for the weld in the material in which the hole is made but not less than the thickness of the material. In hot-rolled shapes and built-up shapes, all beam copes and weld access holes shall be shaped free of notches or sharp reentrant corners except when fillet web-to-flange welds are used in built-up shapes, access holes are permitted to terminate perpendicular to the flange.

For Group 4 and 5 shapes and built-up shapes of material more than 2-in. thick, the thermally cut surfaces of beam copes and weld access holes shall be ground to bright metal and inspected by either magnetic particle or dye penetrant methods. If the curved transition portion of weld access holes and beam copes are formed by predrilled or sawed holes, that portion of the access hole or cope need not be ground. Weld access holes and beam copes in other shapes need not be ground nor inspected by dye penetrant or magnetic particle.

SECTION M2.2 THERMAL CUTTING

Thermally cut free edges which will be subject to substantial tensile stress shall be free of gouges greater than $\frac{3}{16}$ -in. deep and sharp notches; gouges greater than $\frac{3}{16}$ -in. deep and sharp notches shall be removed by grinding or repaired by welding. Thermally cut edges which are to have weld deposited upon them, shall be reasonably free of notches or gouges.

All reentrant corners shall be shaped to a smooth transition. If specific contour is required it must be shown on the contract documents.

Beam copes and weld access holes shall meet the geometrical requirements of J2.7. For beam copes and weld access holes in ASTM A6 Group 4 and 5 shapes and welded built-up shapes with material thickness greater than 2-in., a preheat temperature of not less than 150°F shall be applied prior to thermal cutting.

*When the individual elements of the cross section are spliced prior to being joined to form the cross section in accordance with AWS D1.1, Article 3.4.6, the applicable provisions of AWS D1.1 apply in lieu of the requirements of this Section.

SECTION J2.7 MIXED WELD METAL

When notch-toughness is specified, the process consumables for all weld metal, tack welds, root pass and subsequent passes, deposited in a joint shall be compatible to assure notch-tough composite weld metal.

SECTION J2.8 PREHEAT FOR HEAVY SHAPES

For ASTM A6 Group 4 and 5 shapes and welded built-up members made of plates more than 2-in. thick, a preheat equal to or greater than 350°F. shall be used when making groove-weld splices.

COMMENTARY

SECTION A3.1a HEAVY SECTIONS

The web-to-flange intersection and the web center of the heavy hot-rolled shapes as well as the interior portions of heavy plates may contain a coarser grain structure and/or lower toughness than other areas of these products. This is probably caused by ingot segregation, as well as somewhat less deformation during hot rolling, higher finishing temperature and a slower cooling rate after rolling for these heavy sections. This characteristic is not detrimental to suitability for service as compression members or other non-welded members. When heavy sections are fabricated using full-penetration welds, tensile strains induced by weld shrinkage may result in cracking. For critical applications such as primary tension members, material should be produced to provide adequate toughness at service temperatures. Because of differences in the strain rate between the Charpy V-Notch (CVN) impact test and the strain rate experienced in actual structures, the CVN test is conducted at a temperature higher than the anticipated service temperature for the structure. The location of the CVN test is shown in Fig. C-A3.1

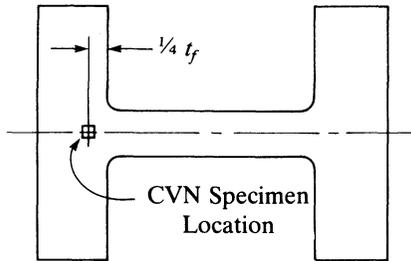


Fig. C-A3.1. Location from which Charpy impact specimen shall be taken

The toughness requirements of A3.1a are intended only to provide material of reasonable toughness for ordinary service application. For unusual applications and/or low temperature service, more restrictive requirements and/or toughness requirements for other section sizes and thickness may be appropriate.

To minimize the potential for fracture, the notch toughness requirements of A3.1a must be used in conjunction with good design and fabrication procedures. Specific requirements are given in J1.10, J1.11, J2.7, J2.8 and M2.2.

SECTION J1.10 SPLICES IN HEAVY SECTIONS

Solidified but still-hot weld metal contracts significantly as it cools to ambient temperature. Shrinkage of large welds between elements which are not free to move to accommodate the shrinkage causes strains in the material adjacent to the weld that can exceed the yield point strain. In thick material, the weld shrinkage is restrained in the thickness direction as well as in the width and length directions causing triaxial stresses to develop that may inhibit the ability of ductile steel to deform in a ductile manner. Under these conditions, the possibility of brittle fracture increases.

When splicing ASTM A6 Group 4 and 5 rolled sections or heavy welded built-up members, the potentially harmful weld shrinkage strains can be avoided by using bolted splices or fillet-welded lap splices or a splice using a combination welded and bolted detail (see Fig. C-J1.2). Details and techniques that perform well for materials of modest thickness usually must be changed or supplemented by more demanding requirements when welding thick material. Also, the provisions of Structural Welding Code, AWS D1.1, are minimum requirements that apply to most structural welding situations; however, when designing and fabricating welded splices of Group 4 and 5 shapes and similar built-up cross sections, special consideration must be given to all aspects of the welded splice detail.

- Notch-tough requirements should be specified for tension members. See Commentary A3.1a.
- Generously sized weld access holes, Fig. C-J1.3, are required to provide increased relief from concentrated weld shrinkage strains, to avoid close juncture of welds in orthogonal directions, and to provide adequate clearance for the exercise of high quality workmanship in hole preparation, welding and ease of inspection.
- Preheating for thermal cutting is required to minimize the formation of a hard surface layer.
- Grinding to bright metal and inspection using magnetic particle or dye-penetrant methods is required to remove the hard surface layer and to assure smooth transitions free of notches or cracks.

In addition to tension splices of truss chord members and tension flanges of flexural members other joints fabricated of heavy sections subject to tension should be given special consideration during design and fabrication.

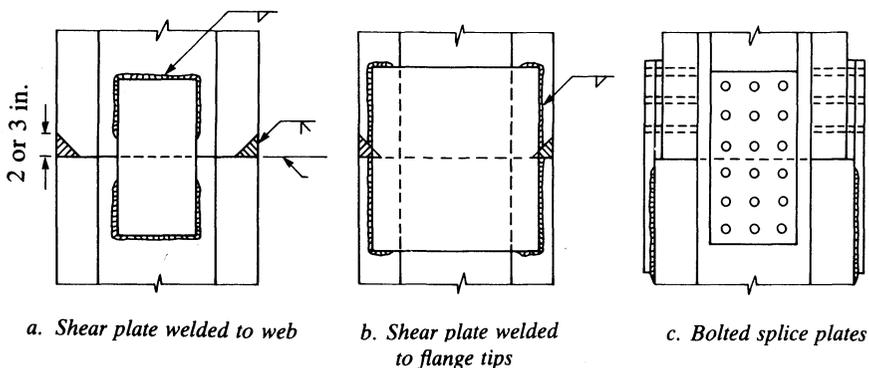


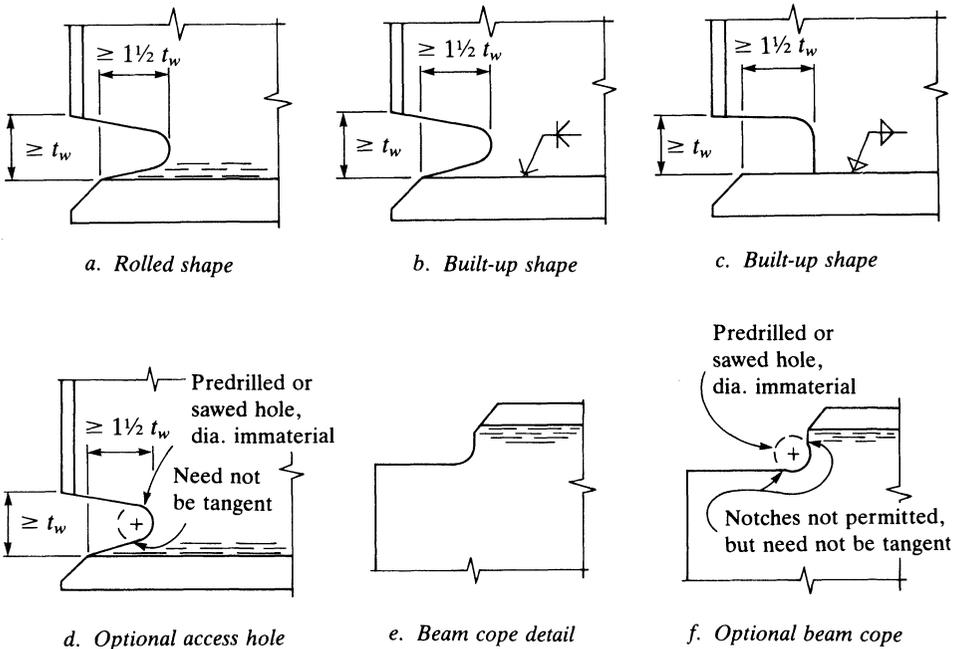
Fig. C-J1.2. Alternative splices that minimize weld restraint tensile stresses

SECTION J2.7 MIXED WELD METAL

Instances have been reported* in which tack welds deposited using a self shielded process with aluminum deoxidizers (which by itself provided notch-tough weld metal) were subsequently covered by weld passes using a submerged arc process (which by itself provided notch-tough weld metal) resulted in composite weld metal with low notch-toughness.

SECTION M2.2 THERMAL CUTTING

Thermal cutting shall be done preferably by machine. The requirement for a positive preheat of 150°F minimum when thermal cutting beam copes and weld access holes in ASTM A6 Group 4 and 5 shapes and in built-up shapes made of material more than 2-in. thick tends to minimize the hard surface layer and the initiation of cracks.



Note: For Group 4 and 5 shapes and welded built-up members made of material more than 2-in. thick, preheat prior to thermal cutting, grind and inspect thermally cut edges using magnetic particle or dye penetrant methods.

Fig. C-J1.3. Weld access hole and beam cope geometry

* Terashima, H. and P. H. M. Hart Effect of Aluminum on Carbon, Manganese, Niobium Steel Submerged-arc Weld Metal Properties *Welding Journal*, Vol. 63, June 1984.
 Kotecki, D. S. and R. A., Moll A Toughness Study of Steel Weld Metal From Self-shielded, Flux-cored Electrodes, Part 1, *Welding Journal* Vol. 49, April 1970.
 Kotecki, D. S. and R. A., Moll A Toughness Study of Steel Weld Metal From Self-shielded, Flux-cored Electrodes, Part 2, *Welding Journal*, Vol. 51, March 1972.

