product expert series

# BENDING TO THE NEW RULES

Notes on curving HSS made to the new ASTM A1085 Specification.

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**THIS PAST SPRING,** ASTM A1085-13 *Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections* was released, offering several improvements to the requirements of ASTM A500 for the production of HSS.

Where approved by the authority having jurisdiction, an engineer might choose to use this new material. If so, there are some things to think about if ASTM A1085 HSS are to be curved. Although the material is too new to have been curved by any bender-rollers yet, this article shares some thoughts based upon our experience with bending a variety of materials.

In general, anything that improves the performance of steel in construction and simplifies design should be welcomed, and HSS is now being manufactured to ASTM A1085. But what should we expect when curving steel to the new spec? The new product has at least four characteristics that may affect bending it to a given radius:

**More stringent wall tolerances and a mass tolerance.** These should result in less variation from HSS to HSS, and less variation should result in more consistency and repeatability in curving HSS. Once an operator develops the machine settings, he or she should be able to produce quality parts more quickly.

**More stringent corner radius tolerances.** To curve square and rectangular HSS effectively, machine tooling should match the corner radii. Once again, if we start with HSS with more consistent corner radii and we match our tooling to those radii, we should have more consistent corner radii on the finished product. And the resultant corner radius on the curved HSS should be closer to that on the raw material.

**Limited yield stresses ranging from 50 ksi to 70 ksi.** Limiting yield stresses to a smaller range should also have a positive effect in curving HSS. Again, less variation should result in a bender-roller's ability to produce quality parts more quickly. The higher yield strength is not an issue for most bender-rollers.

**A minimum toughness value.** The toughness, as represented in a minimum Charpy V-notch value, should not affect the process of curving steel. Having HSS perform well in dynamically loaded applications will create more opportunities to incorporate curved HSS in bridges and seismic applications, among others.

## Looking Back to Look Forward

There are countless examples using high-quality curved HSS to make signature, dynamic projects. Looking back at some of the ones my company has done, it's interesting to consider how using ASTM A1085 HSS might have improved these projects had it been available at the time, and how future similar projects might benefit from it. Below are a few examples.


The retractable roof of the University of Phoenix Stadium uses 402 tons of 12-in. square HSS.

1) Careful curving of 10-in. square HSS for the lenticular trusses supporting the roof of the University of Phoenix Stadium (in Glendale, Ariz.) allowed a near-net use of raw material; 52 ft of arc was made from 54 ft of material. Critical to this process was eliminating


The Kimmel Center for the Performing Arts features a curved steel barrel vault that measures 350 ft by 174 ft in plan.

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The expansion of the Mineta San Jose International Airport Terminal B and Concourse used 420 tons of curved steel.


The Seminole County pedestrian bridge.

any deformation that might occur from where the rolling begins and ends. The likelihood of such deformation should be decreased with material meeting A1085 specifications because the machine operator will have reduced dimensional variation in the HSS sections to work with.

2) The corner radius of the 5-in. HSS for the half-barrel vault of Philadelphia's Kimmel Center required special attention. Rolled 45° off-axis, it was critical to maintain the corner radii because of how the glass panels fit in the curtain wall. And the rolling tolerance for putting the radius in the curved tubes was +/- 1/16 in. Again, more consistent cross-sectional dimensions and a more limited range in yield values in the raw material should lead to more consistent rolling, which, in turn, should produce curved sections more quickly and with greater quality.

3) Located in a heavily populated and highly seismic area, San Jose (Calif.) International Airport had to be designed to withstand potentially devastating earthquakes (the design incorporated slides to allow the structure to move some 14 in. during a seismic event). With its limited steel stresses and defined toughness, ASTM A1085, had it been available, would have made the curving easier and more consistent.

4) These conclusions also apply to pedestrian bridges such as Florida's curvy Seminole County pedestrian bridge, where 14-in. square HSS (70 ft long) was rolled with both camber and sweep.

Moving forward, greater consistency in the ASTM A1085 *Specification* should lead to increased productivity and improved quality from the bending-rolling process. And the more difficult the project, the more valuable these benefits will become. MSC

**Better HSS**

A1085 was released to meet the goals of increasing the performance of HSS and simplifying its design, thereby making it a more desirable option for clients. Benefits include:

**Tighter material tolerances and a single minimum yield stress of 50 ksi.** More stringent wall tolerances and the addition of a mass tolerance mean the full nominal wall thickness can be used for design of HSS. This means no longer needing to reduce the nominal wall thickness by 0.93 as prescribed in the AISC *Steel Construction Manual* for both member selection and connection design. And more area available for design and a higher minimum yield mean that HSS will become a more economical and efficient design option.

**Maximum specified yield stress of 70 ksi.** This increased maximum yield will result in a lower expected yield strength and reduce capacity design requirements and column-required strengths in seismic designs. ASTM A1085 is the only specification used in North America or Europe that limits the maximum yield stress.

**Standard requirement for Charpy notch toughness.** The specification will require all HSS to meet a minimum CVN value of 25 ft-lb at 40 °F, which corresponds to AASHTO Zone 2. Having the minimum CVN required makes HSS more suitable for use in dynamically loaded structures.

*For more on ASTM A1085, see "Hollow Product, Solid Benefit" (09/2013) at* ***www.modernsteel.com****.*