Doing the *Twist*

BY TOM KLEMENS

Three things you should get straight about curved steel.

THE USE OF CURVED STEEL as an integral part of structural systems has continued to grow in recent years. Analysis tools have become more sophisticated and easier to use, as well as more affordable and accessible, making it easier for engineers to incorporate curved steel into their structural designs. And the same time, owners and other stakeholders, such as tenants and community residents, have become more aware of the possibilities curved steel offers. The desire for its aesthetic contributions also has increased.

Projects that take advantage of curved steel elements can include anywhere from a few pieces used in strategic locations to a large percentage of the project's framing. One example of the large-scale use of curved steel is the recently topped out Kauffman Center in Kansas City, Mo., where more than 20% of the structural steel is curved. (See the project article on page 24 of this issue.)

The reasons for incorporating curved steel include appearance, convenience and simply the designer's preference. For example, the trend in stadium design toward cantilevered and long-span construction to provide column-free, unobstructed views has proved to be a good application for curved steel. It also has led to requests to bend larger, more massive members to achieve these open spaces.

As more people on the design side become involved in designing with and specifying curved steel, the need for practical information also has become more widespread. AISC and others offer a good amount of reference material on the subject of curving steel (see sidebar), but with new engineers joining the market for curved steel, there always are people on the steep part of the learning curve. We recently asked three long-time professionals from the Milwaukee-based bender-roller Max Weiss Co. LLC to help clear up some common misconceptions associated with this process. Here is a summary of the information provided by president Daniel Weiss, operations manager Al Sanders, and senior estimator Dave Nader.

Common Misconception #1: It's easier to bend steel members the easy way as opposed to the hard way.

The terminology referring to bending the "easy way" and the "hard way" simply refers to the relative amount of force required to bend a member about its weak axis versus its strong axis. However, controlling the corollary effects is often what increases the difficulty of bending a given member.

For example, depending on how tight the radius is, bending a wide-flange member the hard way may result in less need to control flange distortion than would be required if it were being bent the easy way.

Although bender-rollers have developed general tables on the curvature limits for various standard sizes and shapes, the bending itself still requires a significant amount of human oversight and judgment. The operator's skill is what makes the difference between a successfully curved member and having to try again.

Common Misconception #2: Heavier material is harder to curve than lighter material.

Although it may take less force to bend a lightweight member than one that is heavier, it also requires more control and the operator's increased attention. Distortion is more difficult to control in thinner-walled material than when the material is thicker. One good example is HSS, where it also is almost always easier to keep the sides from rippling or becoming otherwise distorted when bending the hard way.

One of the reasons this is a concern is that lighter shapes often are being used for architectural effect. Where the steel will be exposed to view and appearance is important, minimizing distortion is also important. Experienced bender-rollers know how to prepare the steel and work with it to achieve the desired curvature without the undesirable side effects.

Common Misconception #3: All the bender-roller needs to know from the architect or engineer are the dimensions and orientation for each piece—a radius and a length, and whether to bend the hard way or the easy way.

On the contrary, providing the bender-roller with as much information as possible up front decreases the number of requests for information and increases the probability of problem-free projects. Often the bender-roller's experienced staff can suggest small changes in material sizing or selection that can improve the economics and the end result of bending. Trust the bender-roller to help you plan for successful results.

Finally, as in all such cooperative ventures, involve the bender-roller as early in the process as possible. Again, their experience can help you navigate the predictable twists and turns in the process of working with curved steel. MSC

Where to Learn More About Curved Steel

Many articles about curved steel have been published over the years in *MSC* and are available as free downloads at **www.modernsteel.com/backissues**. Two notable ones are "What Engineers Should Know About Bending Steel," by Todd Alwood (May 2006 *MSC*), which describes the primary methods and equipment used and includes a diagram showing the hard way and easy way curvature for various shapes; and "Bending Considerations in Steel Construction," by Russ Barnshaw (October 2009 *MSC*), which discusses some of the practical limits of bending and the mechanism by which the steel's shape is changed.

The AISC web page dedicated to bender-roller information, **www.aisc.org/benders**, includes links to information on its bender-roller members. It also links to a page where several informative publications are available as free downloads.

"Curved Steel—A Guide for Specifiers" includes clear explanations and illustrations of terminology and geometry used in specifying curved structural steel members. It also has photos of several types of special bending, such as off-axis and multiple-axis bends.

"Curved Steel—A Reference for Architects & Engineers" provides a curved steel primer, including numerous examples of its use and a series of photos showing how steel is bent.

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