Bending in the Right Direction

BY GEOFF WEISENBERGER

Curved steel doesn't just happen. Precision instruments and expert benders are responsible for these increasingly popular architectural and structural elements.

CLEVELAND IN WINTER ISN'T MOST PEOPLE'S IDEA OF A GOOD TIME— especially when traveling there from Chicago, where it's just as cold, as Todd Alwood, an AISC regional engineer and Secretary of AISC's Bender-Roller Committee, and I did in early March. Places like Miami, San Diego, and Las Vegas sound much more appealing when you've got an opportunity to escape the Chicago area in winter.

Luckily, the warm hospitality from the folks at Kottler Metal Products, to whom we paid a visit, made up for the weather. In fact, when I told Kottler's president, Barry Feldman, that my toothpaste was confiscated at the airport (it wasn't in the requisite plastic bag), he went into his office and found a fresh tube for me! I've been on a lot of business trips, but no one has ever given me toothpaste before.

Perhaps the hospitality can be attributed to the fact that Kottler has been family-run since its origin almost a century ago in a three-car garage in Cleveland. Nowadays, the bending and rolling company operates out of a 60,000-sq.-ft. facility in suburban Willoughby, employing approximately 30 and bending steel for projects all over the U.S. and outside of the country as well.

And business is good. Kottler's orders are split roughly in half between structural steel and tube and pipe, and these two main areas can be broken down into multiple industries. Barry credits this ability to service different markets as one of the key contributors to his company's success. "Since we cater to a multitude of industries, when one is down, another is up, keeping our labor force in balance," he says. "We have never encountered a layoff due to lack of work."

The recent demand for architectural bent steel certainly doesn't hurt. Barry explains that arches have become more and more popular in the U.S. over the last two decades, noting that using bent steel in a project only adds an incremental cost. "We're used to having box-like buildings," he says. "Arches have brought back some sense of style."

Now, I have a pretty good idea of what "bending and rolling" is, but I ask Barry the difference between the two. "Bending is rolling, but rolling is bending also," he says.

How Steel is Bent

Have you ever seen a steel beam bent in real life? If not, we've got the next best thing. These pictures show the most common bending process, which is called roll bending or pyramid bending. The rolling machine has three adjustable rolls in a pyramid configuration; a tighter roll spacing produces a tighter radius. The beam shown is a W36x135 being rolled along its weak axis, the "easy way."

The beam is placed in the rolling machine and the operator adjusts the three rolls to the proper spacing before starting the bending process.

The operator slowly begins rolling, and he frequently checks the beam for distortion of the web and flanges in these early passes.

Several additional passes are carried out, with the operator measuring the overall radius after each pass to check the beam's progress.

Bending Towards an Industry Standard

Communication issues are a key target for AISC's bender-roller committee, composed of representatives from AISC Associate Member bender-rollers.

One of the committee's goals is to set standard terminology across the board—and educate the industry—so that architects and engineers specify the proper bending information to the fabricator and there's no confusion when transferring this information to the bender.

"An industry standard, in terms of nomenclature, proper information, and quality," says AISC Bender-Roller Committee Secretary, Todd Alwood, "will allow the design team to provide proper steel drawings from the onset that will move down the line through the fabricator, bender, and finally, erector, with no mistakes."

AISC's Bender-Roller Committee

Albina Pipe Bending Company, Inc.
Bowers Fabrication
Chicago Metal Rolled Products Company
COMEQ, Inc.
Greiner Industries, Inc.
Hodgson Custom Rolling, Inc.
Kottler Metal Products, Inc.
Kubes Steel, Inc.
Marks Metal Technology
Max Weiss Company
Oakley Steel Products Company
Paramount Roll & Forming, Inc.
WhiteFab, Inc.

"In the industry, one thinks of bending as a tighter radius bend and rolling as making a larger radius bend."

It used to be that heating steel was the only way to accurately bend it. However, the advent of more advanced equipment over the last 20-30 years has allowed steel to be bent and rolled with much more accuracy in a cold condition.

Of course, there are multiple techniques for bending and rolling, depending on the overall member size, wall thickness (web and flange thickness, HSS wall thickness, etc.), radius requirement, and end application of the material. The following methods, except of course for heat induction, are all performed with steel in the cold condition.

Rotary-draw bending involves rotating a piece of steel around a solid die and pulling the material around a specified radius while internally supporting the material with a mandrel (if it's hollow).

Incremental or camber bending is a process in which pressure is applied at the third point of the member via a hydraulic ram or press. This process is often used for curving steel to very large radii.

Another process is heat induction bending, where steel is heated and bent in increments and pulled to the designated radius. It's a slow and expensive process, Barry says.

And then there's rotoform bending, a specialized extrusion process in which the material is extruded from the straight condition into a bend. This bending technique is the most flexible in terms of radius parameters.

Finally, there's roll bending, which involves curving a piece of steel between three or more rolls. The member is rolled

The operator confirms the beam's final radius (14′-4$\frac{3}{16}$″ in this case), completing the bending process.

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5 The curved beam is lifted out of the rolling machine and moved to another area of the shop where the member's geometry is checked one final time.

back and forth on multiple passes until the designated radius is achieved.

When it comes to structural steel, members can be bent two ways: the easy way involves bending a member along its weak axis, and the hard way means bending it along its strong axis.

Todd explains that it's difficult to find a bender that performs every single type of bending/rolling process. "Everyone can do several of them, but not all of them. Everyone has different strengths and weaknesses." For example, Kottler performs all of the aforementioned processes except for heat induction.

Standing Out

While Todd and Barry agree that many bending outfits have similar capabilities, they also note that each has its own proprietary techniques, and this is what differentiates companies from one another. For example, Barry says, pointing to a piece of bending equipment as we tour his facility, everyone has this particular machine, but each bender develops their own processes and manipulates their machines to do their own thing different and better than everyone else.

"Much of rolling and bending is an art and not a form—one company's ability to use a certain machine in a certain method," he says. Much in the same way that handing the same guitar to Jimi Hendrix and Eddie Van Halen would produce masterful—but completely different—guitar solos.

"No matter how good the machine is, you need a skilled operator in order to achieve a quality bend," Barry explains. "The bend is a byproduct of the machine and the material, as well as the operator. You can't just put it in, push a button and say there it goes, because on many of these jobs, especially for architectural applications, you may have 100 pieces, but they may have different radii and different degrees."

I ask Barry if the bending staff operates multiple machines. The answer is no; the same operator generally uses the same machine every day. This allows them to become experts on their machine; they know the machine, the materials it bends, and all its nuances. Benders start on smaller machines, and then move up to larger machines, which equals more responsibility and higher wages.

Of course, people like "big," and this provides another opportunity for benders to stand out from the competition. Kottler's facility can bend up to 40-in. channel beams and I-beams both the easy and hard way. "That gives us one of the largest structural capacities in the country," says Barry. The longest member the facility has bent was 87 ft., and they literally cut holes on both sides of the building to accommodate this job.

In the end, for Kottler at least, reputation ends up being the ultimate selling point. "We only have an internal sales force, so it's mainly word of mouth and referals from satisfied customers, which is our best mode of advertising," Barry says.

So what's the most difficult bending job? Barry is ready with the answer: Apply a hard-way bend to light material to a tight radius, "because then you have every variable working against you—the material, the thickness, and the radius."

Higher Standards

While Barry explains that bending and rolling equipment has been slow to change in recent years, one thing that has changed is that the industry has become much more demanding when it comes to the quality of a bend for architecturally exposed steel. "Even as recent as 10 years ago, you were able to bend a piece of tube or pipe or rectangular tube and have much distortion and concavity in it, and it would be acceptable in the industry," says Barry. "Today, with better equipment as well as better techniques, the industry has raised the baseline, insisting that we put out a better quality product. This is possible to do right now with new techniques that we've developed, as well as excellent equipment that's available in the marketplace."

All Kottler bending is performed to AESS standards outlined in AISC's *Code of Standard Practice* (**www.aisc.org/code**). Kottler inspects the segments to the AESS tolerance and desired degree bend to assure that the segments are correct prior to the end user receiving the goods. If an error is made, the segment is replaced with a new, quality piece so that the customer never has to see a faulty product. "Ultimately, when it leaves the shop, it's got to be right," says Barry.

When customers provide the material, it is critical that they work with the bender to determine the required length. Two factors affect the length required:

- The finished arc length is greater than the member span.
- Depending on the bending process used, varying amounts of extra material are required at one or both ends of the member to initiate the process.

If insufficient material length is originally supplied, the customer may have to add splices to comply with the bender's requirements.

Precision, not Primate

I left Kottler and Cleveland with a much greater understanding and appreciation of the steel bending process. The only disappointing part of our visit was that my theory of a giant King Kong-like gorilla chained to a wall—bending member after member with his bare hands, occasionally snapping one in half and pounding his chest and snarling in fury—turned out to be wrong. But that's probably a good thing. MSC