Curved Steel: Means and Methods

By Erin J. Gachne Conaway, P.E., LEED AP and Jacinda L. Collins, P.E.

Every piece of structural steel experiences some form of bending during its life. Straightening, cambering, and curving of structural shapes are all representative of bending. W-shapes are straightened at the mill to a curvature that is within the tolerances as specified in ASTM Specification A6/A6M. Camber, or curvature, is often fabricated into structural steel beams to compensate for deflection. But it is the third reason for bending structural steel that is often misunderstood or just unknown.

What is "curved steel"? The use of curved steel in building projects is a growing trend that can benefit any type of project. Curved steel is used to increase visibility and provide more architectural freedom in aesthetics and functionality. But as curved steel has increased in popularity, so have the questions about it. "Who curves steel?" and "How is it curved?" are two common questions that many design professionals have.

Bending/Rolling is carried out by a "Bender", who is typically a specialty subcontractor of the fabricator. Curved steel is readily available for most projects, as there are many qualified bender-rollers located across the US. Many different bending techniques exist, and each process has its advantages and specific characteristics. The six most widely used bending processes in the industry are included in *Table 1*, listed in order based on prevalence of use in the industry.

It is important for design professionals to recognize that different levels of quality and consistency are associated with each bending process, tooling and material size/thickness. Benders, if included early in a project, can help provide assistance on what is and isn't feasible concerning a design, and can help save time and money as a project moves forward. In all cases, a qualified bending company is going to know what process is necessary to meet the design and quality requirements. Curved steel can provide many readily available options to benefit all project types – big or small – if properly understood and specified.

Do you have more questions about bending? Detailed questions regarding the visual appearance of a specific member with a specific bend and cost implications for a given configuration are best handled by contacting an AISC member bender-roller. For a list of AISC member bender-rollers and other bending information, visit **www.aisc.org/benders**.▪

Table 1: Bending process.

Bending Process	Process Description	Process Distinction(s)	Mainly used for:	Steel Shapes
Rotary Draw / Compression Bending	Structural member is bent by rotating it around a die. The member is clamped into a form and then is drawn through the machine until the bend is formed.	Produces very tight radii (typically limited to 180 degree of bend)	Complicated bends in the machine and parts industry	Medium to smaller sections of round, rectangular, and square HSS, or pipe
Rolling or Cold Bending (a.k.a. "Pyramid Rolling")	Structural member is placed in a machine and curved between three rolls. Also called "Pyramid Bending" because of the three rolls' pyramid arrangement. Bending occurs when the distance between the rolls is manipulated before each successive pass.	The typical method of curving steel for construction Usually the most economical for rolling members with tighter radii Typically bent to larger radii than the rotary draw/ compression bending	Profile rolls for bending in the 8D and above range (capable of 360 degree of bend)	Angles, flat bars, channels, W-shapes, WT-shapes, HSS (all shapes), pipe, and rails
Point Bending / Gag Pressing	Structural member is bent by applying a minimal number of point loads with a hydraulic ram or press at selected points.	This is the typical method used for cambering beams Good for larger sections bent to larger radii	Cambering and curving to very large radii	W-shapes, channels, HSS and pipe
Synchronized Incremental Cold Bending	Structural member is bent by applying pressure in a highly synchronized fashion at several locations on the section. This method employs external restraint and internal support at the bend point.	A patented process performed by only one bender in the US Typically this method allows for tighter radii with better levels of distortion control when compared to Point Bending / Gag Pressing	Situations where tight radii with minimal distortion is desired	HSS,W-shapes, channels and pipe
Hot (Heat) Bending	Structural member is heated directly and then bent. The heat source could be a direct flame or furnace. The application of bend pressure is performed in numerous ways; by bending around pins or forms or by short increment pushes or pulls with bending at the fulcrum point.	Expensive and rarely used as an initial bending method unless other methods cannot be used Allows for members to be bent very tight with low levels of distortion	Repair applications	All shapes
Induction Bending	Structural member is heated over a short section with an electric coil drawn through a process similar to rotary-draw and cooled with water directly after bending.	Not commonly used and can be expensive Produces curved steel with little distortion Applies principles of both Rotary draw and Heat Bending, but allows the bending of larger members to very tight radii	Situations that require larger diameter shapes with heavy wall thicknesses to have a smaller, tighter radius	Large shapes with heavy wall thicknesses

Erin J. Gachne Conaway, P.E., LEED AP is the Intermountain West Regional Engineer with the American Institute of Steel Construction. Erin may be contacted at ***conaway@aisc.org****.*

Jacinda L. Collins, P.E. is an AISC Steel Solutions Center advisor. Jacinda may be contacted at ***collins@aisc.org****.*

References

The references below provide more information and guidance. Detailed questions regarding the visual appearance of a specific member with a specific bend and cost implications for a given configuration are best handled by contacting an AISC member bender-roller early in the process. For a list of AISC member bender-rollers and other bending information, visit **www.aisc.org/benders** or contact AISC's Steel Solutions Center at 866.ASK.AISC or **solutions@aisc.org**.

ASTM International. *ASTM A6/A6M—08: Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling*, 2008.

American Institute of Steel Construction. *Code of Standard Practice for Steel Buildings and Bridges*, 2005.

Bjorhovde, Reidar "Cold Bending of Wide-Flange Shapes for Construction". *Engineering Journal*, fourth quarter, 2006.

Alwood, Todd A. "What Engineers Should Know About Bending Steel." *Modern Steel Construction*, May 2006.

Smith, Brian and Geoff Weisenberger. "A Conversation with a Bender." *Modern Steel Construction*, July 2008.

Barnshaw, Russ. "Bending Considerations in Steel Construction." *Modern Steel Construction*, October 2009.