What is Profile Bending?

What is Metal Profile? Metal profiles and structural shapes is the constant cross-sectional shape or very unique custom designed extrusions of a straight length of material, they are metal structural members and include metals and alloys in the form of angle iron, bars, rods, channels, beams, plates, foils, and other standard shapes, also they are often called “sections”. Depending on the type of selection activity and application and with different heights and different thickness, a metal profile shape may be selected based on its material type or from specific mechanical properties relative to the service

conditions. **Important Reading:** 1. Authority! 4 Keys for the Cold Bending Process of Metal Profiles. 2. 4 Key Points Cold Bending And Hot Bending In Pipe Bending

Profile bending: Profile bending also called section bending is the curving of various lengths metal profiles (steel, aluminum, brass and various other metals) into specific profile shapes. The metal profile bending process is characterized by stretching and compression, which may cause the complex cross-section to deform and important functions to be lost. The profile bending process must ensure that this deformation is kept to a minimum and that the functionalities are retained, even in the bend. Engineers use bent and formed metal profiles for a variety of applications, from electric vehicles up to demanding design spacecraft and buildings.

Basics of profile bending

Profile bending aim to bend the workpiece in as few passes as possible, it have two approaches are asymmetrical or symmetrical bending: Fully plastic bending must be considered as asymmetrical whenever the axis of an applied bending moment is not parallel or perpendicular to an axis of symmetry of the cross-section.
Profile bending are two main processes – cold bending and hot bending (induction bending), roll bending is the most common section bending process and plate roll bending process in cold section rolling of metal profile and the hot bending includes induction bending, which applies a narrow band of heat to a profile as a bending arm pivots to make (usually) a very tight-radius bend.

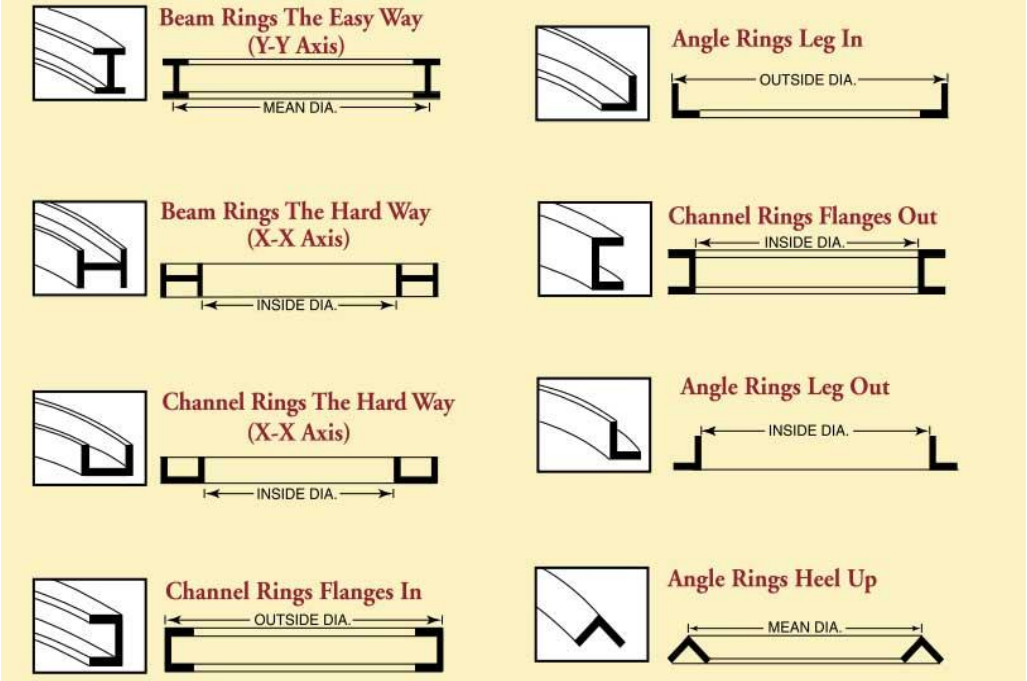
There are five typical methods of bending in the industry: **rolling, incremental bending, hot bending, rotary-draw bending, and induction bending**. Each method has its advantages. Some methods are more commonly used in the steel construction industry, while others are more common in the automobile or manufacturing industries.

Aluminum vs. Steel Profing Bending

The aluminium bending process is near identical as mild steel sections;The difference is that Aluminium extrusions requires higher levels of accuracy and control because of the different properties of the metals.
When bending aluminium, it has a tendency to work-harden and crack if do not use the correct methods. Aluminium comes in several grades and tempers.
Read More: Profile Bending Machine: 5 Things Before Buy, 6 Steps to Bending

Two confusing concepts about profile bending

Profile bending vs. profile rolling: The profile bending process(section rolling) can be implemented in many ways. The section rolling process/profile rolling process can only be realized by a section roller. The principle of roll bending is to form a circle at three points. The commonly used model is a three-roll section rolling machine.
Roll bending vs. Roll forming: The **cold roll bending process** (section rolling process/profile rolling process) is a suitable technique for curving (rolling) structural steel sections, pipes and tubes, and flanges where very tight radius bends or ‘elbows’ are generally not required. The **cold roll forming process** is accomplished by passing the steel member back and forth between sets of rolls. The point load applied by the central roller is sufficient to take the steel past its yield point and introduce a permanent set.



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Three Common Terminology of Profile Bending

- “Easy way” is bending a member around its weak axis, and “hard way” is bending around the strong axis;
- “Flanges in” or “flanges out” refers to the direction of the flanges on channels, angles, and tees;
- When an angle is curved on its diagonal, is the heel (the intersection of each leg) oriented in, out, or up.
  Pertaining to steel structures profile bending(beams, Channels, Tees, Rails, Angles, and Tubing) camber applies to the curve about the strong axis, and sweep applies to the curve about the weaker axis of the member.

  The bend angle irons have 9 orientations: leg in, leg out, short leg in, short leg out, long leg in, long leg out, heel in, heel out and heel up. Leg-out rolled angle rings resemble an old-time straw hat (minus the top) where the leg out would be the brim. Heel-in rolled angle rings look like, and can function as, pulleys. The most difficult orientation in angle bending is leg in. When not done correctly, there will be distortion in the horizontal leg (the leg in) that looks like an off-set. With the proper methods and tooling, this distortion will be avoided.

Cold Bending Process of Profile Bending

Cold bending, as the name suggests, bends the workpiece in a cold state. **Read More:** 4 Key Points Cold Bending And Hot Bending In Pipe Bending

5 Common Cold Bending Profile Methods

Because the cross section of metal profile is not symmetric, the profile bending process can be unpredictable. The cost of the special metal profiles is greater due to the complexity of the profile bending process, which makes ensuring effective bending practices even more important. The following provides you with the 5 common metal profiles bending process methods in the market：

Hydraulic Rotary Draw Bending pROCESS
Roll Bending Process
Stretch Forming Process

- **Ram or push bending**, as the name implies, uses a ram to force the extruded metal piece on a bending die.
- **Hydraulic rotary draw bending** process, place extruded aluminum onto a bender and hold it in place with a stationary or sliding pressure die and clamping block. The round bending die, powered by hydraulics, is rotated up to 90 degrees, bending the extrusion as it rotates.
- **Electric rotary draw bending** uses the same process as the hydraulic method, but allows faster setup.
- **Roll bending:** Three-roll bending pushes an extrusion around three different rolls placed in a triangular shape.
- **Stretch forming**, an extrusion is placed along a rounded, fixed bending die and clamped in place on each end. The machine begins to swing the clamped ends downward to angles up to 180 degrees, and the extrusion is bent around the die to reach the desired form.

Read More: 5 Common Bending And Forming Methods For Aluminum Profiles

Three Tips To Choose Right Bending Process And Equipment

The test bending and trial and error is a good place to start. For any profile bending methods, the goal is to cover and stabilize the part to ensure the best possible bend, but this is especially true for geometric profiles. The best way to ensure feasibility is through test bending and trial and error. Working with bend experts and machine OEMs can help fabricators determine whether a project will be possible and cost-effective.

- The basic information for a profile tube is much more extensive than that of a round tube or box profile, which generally has only an outer shape, outer diameter, wall thickness, and radius. A special profile has many additional dimensions to consider, especially as the radius changes throughout the cross section. There needs to be clear

communication between the supplier of the job and customer about the exact dimensions and features required.

- The better a machine can control and cover the springback effect of the materials, the twisting effect of the material while bending, the better the part will turn out.
- A bending machine that can repeatedly control many axes, which are affecting the result of the part, will be more beneficial than a machine that can only control one or two axes, which cannot work against the twisting of material during the process."

This is why trial and error is so important. Getting a sense of the machine's capabilities for these applications will give fabricators a better understanding of the nature of the variables during the bend process.

Important Five Mechanical Properties in Profile Bending

These include tensile strength, yield strength, elongation, and tensile modulus.

- Tensile strength or ultimate tensile strength (UTS) at break is the maximum amount of stress (force per unit area) required from stretching or pulling to fail (necking) or break the material under tension-loading test conditions. It is an intensive property and therefore does not depend on size, but is affected by surface defects and the temperature of the environment. This property is primarily used in the design of brittle members where breakage of a material from stretching is a concern.
- Yield strength (YS) is the maximum amount of stress (force per unit area) required to deform or impart permanent plastic deformation (typically of 0.2%) in the material under tension-loading test conditions. The yield point occurs when elastic (linear) stress-strain behavior changes to plastic (non-linear) behavior. Ductile materials typically deviate from Hooke's law or linear behavior at some higher stress level. Knowledge of the yield point is vital when designing a component since it generally represents an upper limit to the load that can be applied.
- Elongation is the percent amount of deformation that occurs during a tensile test or other mechanical test. Ductile materials will be more inclined to deform than to break. Designs that require metal parts to fit and maintain a fixed shape under stress should consider the part's elongation properties.
- Tensile modulus or Young's modulus is a material constant that indicates the variation in strain produced under an applied tensile load. Materials with a higher modulus of elasticity have higher stiffness or rigidity.

It is important to consider the testing conditions under which the properties of a material have been found. Operating conditions that differ from the testing environment may have adverse effects on a material's properties.

Profile Bending Process for 9 Types Metal Profile Section

- **Type 1# – Bent Tube Profiles;** Bent tube is used for numerous applications, from agricultural equipment to roof trusses. Section bending can bent round, square, or rectangular tubes in all sizes and materials
- **Type 2# -Bent Pipe Profiles**: Cold section bending process can bend pipe profiles with a diameter of fewer than 20 inches, work with most grades of carbon steel pipe and aluminum pipe, and can create custom profiles from both full and half pipe.
- **Type 3# -Bent Bar Profiles:** Can create custom-bent profiles from bars in all sizes and shapes: round, half-round, square, hexagonal, and rectangular. Section rolling process can custom-bend metal bars the “easy way” (on the y-y axis) and the “hard way” (x-x axis) with equal precision.
- **Type 4# -Bent Beam Profiles:** Using the section rolling process can produce custom bent beam profiles of any size, creating even the largest bent beams with superior precision and repeatability. Section rolling processes are “the hard way” and “the easy way” bending methods.
- **Type 5# -Bent Channel Profiles:** the section bending process can bent channels with flanges out, flanges in, or “the hard way.”
- **Type 6# -Bent Tee Profiles:** Bent tee profiles “stem in,” “stem out,” or “stem up,” with minimal distortion, Its section rolling process is similar to ring rolling angle.
- **Type 7# -Bent Angle Iron Profiles:** The section rolling process can be ring rolling in nine orientations to custom-bent angle profiles with minimal distortion.
- **Type 8# -Bent Steel Section Profiles:** Complete section bending services, custom-bent profiles from standard mill shapes, and more.
- **Type 9# -Custom Profiles from Rolled Plate:** Accurately roll steel and aluminum plates into full cylinders, full cones, and cylinder cone segments, as designs require.

Profile Bending 101

- Profile bending aim to bend the workpiece in as few passes as possible. Usually profile bending operators will choose asymmetrical or symmetrical bends.
- Mandrels similar to those used in rotational stretch bending cannot be performed a second time in the same bending operation with 3-roll profile bending machine, lest they become permanently stuck inside the workpiece.
- The selection of the nature of metal profiles is also very important, such as aluminum profiles: Bending of T6 materials will easily cause breakage.
- Profile bending machine must choose a correctly sized machine, one with sufficient forming tonnage and adequate grip lengths—enough to provide the needed leverage to reduce distortion, but not so long that they will require an excessively long sacrificial straight section.

:: Read More: Glossary of common bending-rolling terms, taken from Design Guide 33.

12 Applications of Profile Bending process

4 Roll Plate Rolling Machine

The applications for bent metal profiles are varied. Cover a broad spectrum of industry, including; building, tunnels, bridges, civil excavations, architectural features, pipe and mechanical works for materials handling and storage, machinery, etc.

- Metal joinery
- Construction metallers
- Metal construction
- Metal furniture manufacturing
- Equipment for industrial facilities (chemical, petrochemical, pharmaceutical, food, etc.)
- Manufacture of agricultural machinery
- Equipment for railway, naval, military, nuclear, and energy sectors
- Equipment parts for agricultural machinery,
- rail, naval, military, nuclear, and energy sectors
- Manufacture of parts for gates and fences
- Manufacture of protective equipment parts such as rails, fences, handrails, bumpers, etc …
- Manufacturing of urban furniture parts

Read More: 4 Key Points Cold Bending And Hot Bending

Hot Section Bending Process of Profile Bending

induction bending H beam

Hot bending generally refers to different types of induction bending. Hot bending is highly effective at bending pipes because they are fast, precise, and makes few errors.

The induction bending process, also known as high-frequency bending, incremental bending, or hot bending, uses inductors to locally heat steel by induction. This results in a narrow heat band in the shape to be bent. The shape is firmly held by a clamp at the desired radius, which is mounted on a free-pivoting arm. The shape is pushed through the inductor by an accurate drive system which causes the hot section to form the induction bend at the set radius. The best part is then cooled by water, forced or still air to fix the bent shape.

Hot bending process of the section bending

Hot bending is generally only referring to different types of induction bending.

Induction bending is a highly effective way of section bending, as it is fast, precise, and with few errors. The induction bending process is performed by heating a certain point of the section up where it then can be bent without much effort. It doesn’t require any filler material and the result of the bending tends to keep distortion to a minimum. Many induction benders have also chosen this type of bending because of its energy sufficiency. After the heating process has been done, the bending doesn’t take a lot of time at all.

Features of the hot section bending process

Induction bending is a very effective method of section bending because it is fast, accurate, and almost error-free. The induction bending process is performed by heating a certain point of the metal profiles, which can then be bent effortlessly. It does not require any filling material, and the result of bending tends to keep deformation to a minimum. Many induction bending machines also choose this type of bending because of its sufficient energy. The heating process is the most time-consuming element of the process, after the heating process is completed, bending does not require much time at all.

Advantages of the hot section bending process

The hot section bending process has the incomparable adaptability of cold bending.

- For example, the straight line distance between two adjacent elbows on a pipe can be kept small, and even continuous bending can be carried out without leaving straight pipe sections;
- Can process materials with poor cold ductility into elbows;
- It can process elbows that require a lot of mechanical energy during cold bending and can bend brittle materials that are easy to break during cold bending. Hot bending can be bent into a small radius elbow on the pipe.
- For carbon steel pipes and most alloy steel pipes, the bending radius of hot bending is much smaller than that of cold bending, and the bending radius can be as small as 0.7 to 1.5 times the outer diameter of the pipe.

Disadvantages of hot section bending

- The downside of hot section bending may be that the material must be cooled later, increasing the time spent on each pipe, and the machines tend to be more expensive than cold section bending machines.
- The negative aspects of hot section bending can be that the material does have to cool off afterward, adding to the time spent on each pipe and that the machines tend to be more expensive than cold section bending appliances.
- The equipment is complex, the processing cost is high, the production efficiency is low, and the surface finish is poor.
- For copper pipes, the cold section bending process is used, which eliminates the possibility of “hydrogen disease” due to the elimination of high-temperature heating.

Induction metal profile bending

Hot bending or induction bending:
While there are slight variances to different hot section bending methods, nearly all are a form of induction bending. This method precisely heats the metal profiles using an induction heating coil before applying pressure to make the intended bend. It requires much less physical force than cold bending methods and can produce bends of similar or higher quality with no filler materials, mandrils, or other additions used to avoid distortion.

What Is Induction Bending?

Induction Bending is a precisely controlled and efficient section bending technique. Local heating using high frequency induced electrical power is applied during the induction bending process. Pipes, tubes, and even structural shapes (channels, W & H sections) can be bent efficiently in an induction bending machine. Induction bending is also known as hot bending, incremental bending, or high-frequency bending. For bigger pipe diameters, when cold bending methods are limited, Induction bending is the most preferable option. Around the pipe to be bent, an induction coil is placed that heats the pipe circumference in the range of 850 – 1100 degrees Celsius.

Induction Bending Metal

The induction bending technology allows the bending of an almost unlimited variety of materials. The only requirement is that they can be heated by induction. Common material groups are:

CARBON STEELS

- Low alloyed steels
- High alloyed steels
- Fine-grain steels

STAINLESS STEELS

- Austenitic
- Martensitic
- Ferritic
- Duplex

OTHER

- Special alloys
- Clad pipe
- Aluminum
- Titanium