How to Make the Perfect Cone

Tips and tricks revealed in 7 steps
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Dear reader,

Creating cones from metal plates is in our opinion one of the most exciting things to do. Nothing is more exciting than bending plates of steel, stainless steel or aluminium into cones that fit perfectly in a construction.

But how to produce a cone? And how to make sure the cone meets the required measurements?

We would like to share our knowledge in this white paper and to reveal tips and tricks for making the perfect cone!

Enjoy reading!

With kind regards,

Kersten Europe

Bart Simonse
Deputy director
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What is a cone?

This white paper is about cones of metal. For example cones of carbon steel S235, S355 or stronger kinds of steel such as S460 and S690. As well as cones of stainless steel and aluminium.

There are non-truncated cones and truncated cones. A truncated cone is a geometric shape with *two different diameters*.

Cones can be found in many different applications. For example for *architectural purposes*; such as cones in art objects, in bridges and in building complexes. Cones are used in architecture often mainly as an aesthetic feature of a construction.

Cones for the *offshore wind industry, oil&gas* and *industrial equipment* typically have a more functional purpose. They play an important role in a construction.
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Tips and tricks revealed in 7 steps

Types of cones

There are two major types of truncated cones. Most cones are *concentric*. The center of the small diameter is perpendicular to the center of the large diameter.

An *eccentric* cone is also conical shaped however the center of the small diameter is not perpendicular to the center of the large diameter.
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Tips and tricks revealed in 7 steps

Producing a cone in 7 steps

1. Defining cone requirements
2. Making workshop drawing
3. Cutting cone template
4. Bending by rolling or press braking
5. Welding the cone
6. Calibrating after welding
7. Cutting to length with/without 3D contour
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Tips and tricks revealed in 7 steps

1. Define cone requirements

There is a lot involved in the production of cones. Whether it is just one single cone or a complete series of cones, it is very important to define the specifications and requirements.

The information that is necessary:

- Large diameter (inside or outside)
- Small diameter
- Concentric or eccentric
- Vertical height / slant height
- Tolerance allowance
- Material type
- Plate thickness
- Tack-welding or welding

Optional:

- Weld edges longitudinal seam (for example a v-seam or x-seam)
- Weld edges circumferential seams
- 3D cut contour

It is recommended to ask a specialist about the most efficient production method. The dimensions of the cone are determinant for the unfolded cone template.

Tip

Consult a specialist in cones about the possibilities of bending technology in an early stage.

If the project involves multiple cones you can save on material and handling costs by getting the most optimal nested layouts.

A specialist knows how to cut the most cone templates out of one plate. This helps cutting down waste material, time and labor.

Below: Optimal nested layout of nine cone templates out of a 2x12m plate
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2. Make a workshop drawing

It is important to put all the available information and dimensions in a workshop drawing prior to production. Make sure that all the measurements and tolerance allowances are noted. A small deviation in the given measurements (for example the inside or outside diameter) can lead to a large deviation in the final product.

Take into account that you might need overlength on the longitudinal and circumferential seams. How much overlength you need depends on the bending method, the material type and thickness.

If a plate is bent by a three or four roller bending machine there is often no overlength required on the longitudinal seam, unless the plate is thicker than 40mm. There is an overlength required on the circumferential seam of the small diameter because this part of the plate scratches against the machine during the bending process. This causes thickening of the material.

If a plate is bent by a press braker there is always an overlength required on the longitudinal seam, unless a very large diameter is required. An overlength on the circumferential seams is not needed since this bending method won’t cause thickening the plate.

Consult a specialist about the most suitable bending method and find out how much overlength is required.
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Tips and tricks revealed in 7 steps

3. Cut the cone template

After all the preparations are done the production process can start. First step is to cut the cone patterns out of the metal plate.
Place the plate on the cutting table. The type of material, plate thickness and required weld edge shape determine the cutting method.

Up to a plate thickness of 40mm a plate is cut by plasma cutting technology. Modern CNC-controlled plasma cutting machines are equipped with a rotating 3D bevel head. In just one single movement, this advanced cutting tool cuts the plate and provides the cone templates with a tapering or a V-seam for the weld edges.

Plates thicker than 40mm are cut by oxy fuel cutting technology, with or without a 3-burner unit. A 3-burner unit has three adjustable oxy fuel torches to cut a plate and provide the template with complex weld edges in just one single move. Complex weld edges such as V-seam, X-seam and Y-seam can easily be cut with such a 3-burner unit.

Tip
Save time and money by cutting the cone templates with weld edge preparation in one single movement.

Above and left below: Cutting cone template out of a steel plate with a 3-burner unit
Right below: Cut plate patterns with weld edge preparation (X-seam)
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4. Bending by rolling or press braking

The flat cone templates can be bent either by *rolling* the plate with a three roller bending machine or by *press braking* on a power press. The most suitable bending method depends on the material, plate thickness and the circumference of the small diameter.

Both methods will be explained below.

**Plate rolling** is the process in which a cone template is being rolled into the required conical shape by moving it through a three or four roller bending machine.

The flat template is placed between the three rolls of the machine. The rolls turn independently from each other and guide the plate through the machine. Hydraulic power enables the two side rolls to press against the plate. The *combination of power and rotation* bends the plate gradually until it reaches the desired round shape.

This cold bending method is often used for the production of cylinders but is also very suitable for the production of cones. In comparison with cylinders, rolling a cone is more complex and *special machine settings* and *real craftsmanship* are required.

The machines’ two side rolls should be positioned lower on the large diameter side. The small radius is supposed to go through the machine slower than the large radius to reach a conical shape. The machine operator needs to adjust the machine settings constantly. He uses a radius template to check the radii.
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**Tips and tricks revealed in 7 steps**

**Press braking** is a bending method to bend plates into cones by a press braker or power press. It is a very suitable bending method for thick steel plates such as carbon steel S235 and S355 as well as stronger types such as S460 and S690. With a pressing accuracy of 1/100mm it is a very accurate.

The flat cone template is placed on the V-block of the machine. A heavy stamp/knife presses on the plate to bend the plate.

The production process of press braking a cone is as followed:

1. **Set the V-block**
   - To create a difference in diameter (conical shape) the V-block of the press braker should be set unparallel.

2. **Place the cone template**
   - Place the plate on the V-block. You can save overlength by placing the cone template uncentered of the V-block.

3. **Press braking**
   - The knife presses on the plate and bends the plate.

4. **Level**
   - Since the V-block is set unparalell there is more power required at the small radius. By levelling the hydraulic units of the machine you can adjust the pressing power of the knife.

5. **Check the radius**
   - Check the radii of both sides of the plate. You need two radius templates for measuring both radii. If the plate doesn’t meet the shape of the radius template, revise the press braking process.

6. **Move and repeat**
   - After the required radius is reached, move the plate in the machine and repeat step 3 till 6 of the process until the complete plate is bent in the required conical shape.

7. **Remove overlength**
   - Remove overlength on the longitudinal seam with a cutting robot (plasma or oxy fuel)
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*Tips and tricks revealed in 7 steps*

5. Welding

A cone can consist of just one piece or of multiple parts if it requires a very large diameter.

For example; two 180° cone shells can be welded together on the longitudinal seam to form one big cone.

A cone can also consist of multiple cones. For example an offshore ‘Bellmouth’ in which the small diameter of the largest cone is welded on the large diameter of the next cone. These cones are welded on the longitudinal seam and the circumferential seam.

Save time by cutting weld edges in the same process as cutting the cone template and/or removing the overlength.

Before the seams are welded together the seams are tack-welded by hand right after removing the cone from the bending machine.

The welding method depends on the material specifications and requirements.

UP-welding is often used for heavy industrial applications.

Tip

Under powder fluxed-core arc welding and TWIN welding increases productivity.

Welding can be executed with *stick welding* or *fluxed-core arc welding*.

Stick welding is the most common welding method. However, fluxed-core arc welding is, especially with long and deep welds, more accurate and faster. It requires an additional welding certification.

Standard welding occurs with a single wire, but production time can be faster when a double wire is used. This is called *TWIN-welding*. It requires an *additional welding qualification*. 
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*Tips and tricks revealed in 7 steps*

6. Calibration after welding

The heat of the welding process causes tension on the material which results in strong deformation of the surface at the welding seam.

This deformation is relatively easy to repair by calibrating the longitudinal seam on a three roller bending machine after the welding process.

You can *save on costs for transport and handling* by having the bending company taking care of the welding work too instead of moving the cone back and forward between the bending company and the welder.

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**Tip**

Save transportation costs by contracting the bending work and the welding work to the same company.
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### 7. Cutting to length (with 3D contour)

Advanced CNC robot cutting technology is used for cutting the cone to size. A cutting robot cuts the cone in just one single movement:

- Cut to length
- Add tapering / weld edges
- Provide a 3D cut contour

A 3D-cut contour is applied when a cone makes part of a construction with a tube-to-tube connection, or -in this case- a cone-to-tube connection or cone-to-cone connection.

3D-contour cutting requires highly advanced robot cutting technology.

This very accurate process guarantees *significant cost saving* in comparison with conventional methods.

Flexible machining options and modern software make that robotised cutting is suitable for *small, medium and large series.*
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Need help with the production of cones?

Contact us for more information without any obligations.

We are specialised in bending technology and we take care of the entire process from engineering up to on-site delivery of complete conical semi-finished products.

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