TRADE OF
Industrial Insulation

PHASE 2

Module 5

Ductwork & Vessels

UNIT: 2

Radius Bend (Duct)
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**Introduction**

A radius bend is used in a ventilation ductwork system to change the direction of the system. Accurately measuring a radius bend requires a number of skills including sketching, measuring radii, manufacturing techniques, use of scale drawings and working to a specification.
Unit Objective

By the end of this unit *each apprentice* will be able to:

- Accurately measure a duct radius bend using the correct techniques.
- Make a freehand sketch of a radius bend.
- Accurately mark out and fabricate a 90 degree radius bend.
- Prepare, insulate and finish a radius bend for cladding.
1.0 Measuring and Sketching

Key Learning Points

1.1 Measuring – Finding the Radius of a Rectangular Duct Bend

When finding the throat radius of a radius bend we can use a number of methods such as:

- Use a flat steel square as shown and take the measurements from the square or use a tape rule or folding rule for taking the measurements.
- Use a folding rule set at 90 degrees (position the square as with the flat square) and read off the measurements.
- Position a straight edge (metal, timber etc) along one edge of the bend and take the measurements required.

Note: No extra allowances shown for flanging or ship joints.

Radius Bend – Elevation.

1.2 3D Sketching – Isometric Projection

Refer to module 2 – unit 2.

1.3 First and Third Angle Orthographic Projection

Refer to module 2 – unit 2.

1.4 Calculation of Insulation Allowances

The allowances for insulation would be the same as for any square or rectangular duct. This equals the perimeter of the rectangular bend plus eight thicknesses of insulation.

Refer to Module 5- Unit 2 – section 1.3.
1.5 Area Calculation for Sheet Size

A sample bend for calculation purposes is shown in the figure below. The size of the bend is $H = 600\text{mm}$, $W = 400\text{mm}$ and the throat radius $R = 200\text{mm}$. Note: no extra allowance shown for flanging or slip joints.

![Radius Bend – Isometric.](image)

**Area Calculation**

(a) Cheek Size (2 no. Required)

$0.6\text{m} \times 0.6\text{m} \times 2 \text{no.} = 0.72\text{m}^2$

(b) Throat Wrapper Length

Radius is 200mm so the diameter is 400mm

Circumference of throat = $(400\text{mm} \times 3.14) \div 4 = 314\text{mm}$

Area of metal for throat = $314\text{mm} \times 600\text{mm}$ or $0.314\text{m} \times 0.6\text{m} = 0.1884\text{m}^2$.

(c) Heel Wrapper Length

Radius is 600mm or diameter is 1200mm.

Circumference of throat = $(1200\text{mm} \times 3.14) \div 4 = 942\text{mm}$

Area of metal for throat = $942\text{mm} \times 600\text{mm}$ or $0.942\text{m} \times 0.6\text{m} = 0.5652\text{m}^2$.

(d) Total Area of Material Required for The Radius Bend

$0.72\text{m}^2 + 0.1884\text{m}^2 + 0.5652\text{m}^2 = 1.4736\text{m}^2$

*Note:* No allowance has been added in the calculations above for a lock-form joint.

1.6 Use of Manufacturers’ Data Sheets

Refer to module 4 – unit 5 - Glass mineral fibre and rockwool.
2.0 Marking Out and Fabrication.

**Key Learning Points**
- Notch and crimping
- Fabrication of a duct radius bend
- Neat workspace layout and professional work ethic
- Zed-bar Fabrication
- Joint weathering
- Strengthening techniques
- Tanding seams
- Cross pressing
- Force and pressure.

2.1 Marking-Out Techniques and Joint Selection for Large Radius Bends

When making large fittings or bends, layout a reduced scale drawing of the fitting to determine the seam locations, keeping in mind to utilise the full length and width of standard sheet sizes of metal available.

The choice of joints for a large duct bend would include standing seams to hold the cheeks together or the grooved seam/double seam, with the Pittsburgh Lock for corner joints and the grooved seam/double seam for the wrappings if required. For the cladding bend the standing seams or lap seam could be used to hold each section of the bend together with the corner lap seam being used on the corners. The advantage of using the Standing Seam is that it is strong, has good appearance and can be assembled and secured for a good joint. The disadvantage of using the lap seam on the cheeks – especially if it is wide – is that it tends to deflect up and down unless it is well supported underneath. The choice of joints or seams selected, will depend on the knowledge and skills of the operator.

Large radius bends are generally marked out on a sheet using a set of trammel points.

*Refer to module 1 – unit 3 – section 1.0 – Hand tools.*

2.2 Pattern Development – Parallel Line Development

*See Module 2 – Unit 3 – Parallel Line Development.*
2.3 Accurate Cutting and Forming of a Radius Bend

As the cladding bend is a large radii bend which is made in a number of sections due to its large size, care and attention to detail is important. After the joints and method of manufacture has been decided. The next thing to do is develop the patterns. This is shown in Module 2 – Unit 5 – Parallel line development.

When the patterns are developed and measurements checked, it is time to cut them out. This is done by using the guillotine, power shears and final notching with a snips.

After cutting, the various parts are folded and formed (cross breaking, rolled, swaged and crimped) before assembly.

2.4 Zed-Bar Fabrication

Z-bar sections are fitted to ductwork to support and fix the metal cladding. They are made to match the insulation thickness and are fabricated from 0.6mm thick material. They are cut and folded to suit the outside dimensions of the insulated duct and are secured with pop rivets or self-tapping screws.

2.5 Bends Strengthened by Cross Breaking/Pressing

Stiffening of a duct bend is carried out to strengthen the metal (cheeks and wrappers) and to reduce or stop drumming in the bend and ductwork. This helps to reduce noise in the system. For cladding, it helps to strengthen the metal and enhance the overall appearance of the job.

2.6 Standing Seams

The standing seams used on ductwork should be a good close fit and be secured with pop rivets or bolts. For cladding, the standing seam should also be a close fit and should be secured with pop rivets. Seams should be finished with a sealant to stop penetration of moisture into the seams and the insulation underneath.

2.7 Joint Weathering

Joints on the cladding should be weathered correctly, close fitting and finished with a sealant to stop moisture penetration.
2.8 Pressure and Force

Pressure depends on two things:

- The Force (in Newton’s) and,
- The Area it’s pressing on (in square metres).

We work this out using: \( \text{PRESSURE} = \frac{\text{FORCE}}{\text{AREA}} \).

Pressure is measured in Pascals (Pa for short).

1 Pascal means 1 Newton per square metre.

Example

A block of steel sitting on bench has a mass of 8kg. The Weight of the block is 80 Newtons (that’s the force on the bench). If the block of steel has a surface area of 2m², then we can work out the pressure of the block of steel on the bench:

Pressure on the bench = Force ÷ Area.

\[ \text{Pressure on the bench} = 80 \text{ Newtons} ÷ 2\text{m}² \]
\[ = 40 \text{ Pascals.} \]
3.0 Fitting of Insulation and Cladding

Key Learning Points
- Selection of appropriate insulation and supply form
- Insulating with slabs
- Application of insulation
- Vapour barrier integrity
- Professional approach to material use and finish

3.1 Select Appropriate Type of Insulation
Refer to module 4 for information on insulation types and fitting techniques.

3.2 Apply Insulation to Existing Bend Using Appropriate Fixings
The insulation of specified thickness is cut, fitted and secured to the existing bend by the suitable adhesive and/or self-adhesive stick pins, applied in accordance with the manufacturers’ recommendations. The pins and washers are necessary to avoid sagging of the insulation, particularly on the underside of ducts and large areas. Slab type insulation such as fibreglass is ideal for insulating square surfaces such as ventilation ducts as it is easy to install, gives square corners for the cladding and is available in a number of sizes and thicknesses.

All joints should be securely butted together and covered with 75mm/100mm wide plain soft aluminium foil self-adhesive tape. If the self adhesive pins puncture the class ‘O’ facing, they should be sealed with the aluminium foil tape to maintain the vapour barrier/control layer of the insulation system.

3.3 Vapour Barrier
As mentioned in section 2.6 the vapour barriers’ integrity is maintained by sealing all joints and covering the stick pins with the aluminium foil self-adhesive tape.

3.4 Cladding an Existing Radius Bend
As the existing radius duct bend is a large bend, the zed bars will be fitted to the bend to support the cladding. As the bend is large, they will need to be fitted for support and to stop movement or sagging of the metal. The types of joints to be used will depend on the preferences of the operator. The cheeks can be held together with standing seams as there are a number of pieces making up the cheeks or lap joints swaged for strength and finish/appearance. The wrappers (heel and throat of the cladding bend) can be held together with a corner joint either riveted or screwed. The cladding can then be finished with a sealant to stop moisture penetration.
3.5 Professional Approach to Material Use and Finish

It is very important that a job is well planned so that materials are not wasted. This is done by studying the job, looking at the machinery available, the skills of the staff/workers as well as the way the job is going to be made. This is especially true when the job is a large one as in the radius bend.

When the details of manufacture have been decided, the bend is then developed and laid out on the sheets of metal. It is very important that the patterns are “nested” properly, so that the minimum amount of sheets are used for the job. It is also very important to make sure that all measurements and angles are checked twice before cutting.

To maintain a professional finish on the job, the sheets should be free from work marks and scratches, so as to maintain a quality finish.
Summary

A radius bend is used in a ventilation ductwork system to change the direction of the system. Accurately measuring a radius bend requires the use of a number of tools including a flat steel square, a tape rule or folding rule and a straight edge.

When measuring a radius bend on site, it is important to make a detailed sketch of the bend including such measurements and the radius of the throat, the width and depth of the bend and any obstacles which may cause problems during installation. Also if the radius bend is positioned outside, joint location and the sealing of joints must be taken into consideration.

When making large fittings or bends, layout a reduced scale drawing of the fitting to determine the seam locations, keeping in mind to utilise the full length and width of standard sheet sizes of metal available. The choice of joints for a large duct bend would include standing seams to hold the cheeks together or the grooved seam/double seam, with the Pittsburgh Lock for corner joints and the grooved seam/double seam for the wrappings if required.

Good house-keeping and a professional attitude is essential in accident prevention and the overall efficiency of the job. Work areas should be kept clean and tidy at all times. Waste materials should be disposed of correctly and recycled where possible.