TRADE OF

Industrial Insulation

PHASE 2

Module 5

Ductwork & Vessels

UNIT: 6

Hoppers (Rectangle to Rectangle)

Produced by

SOLAS

An tSeirbhís Oideachais Leanúnaigh agus Scileanna
Further Education and Training Authority

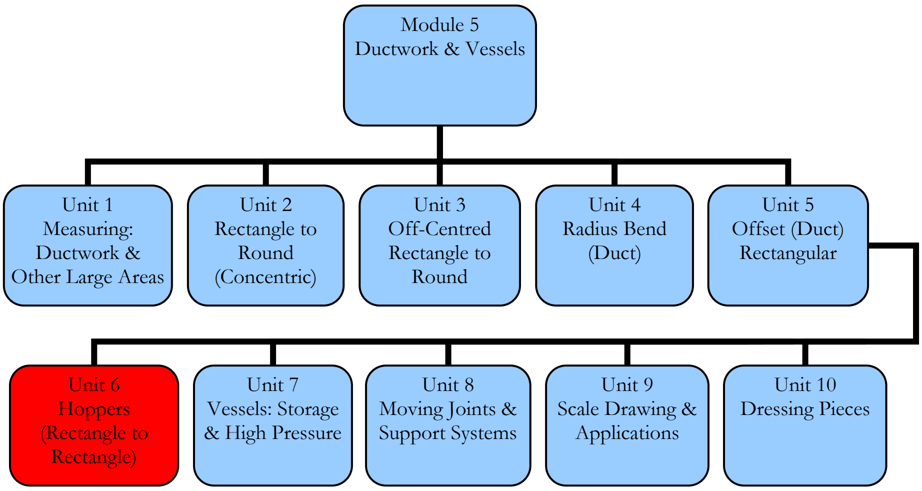
In cooperation with subject matter expert:

Michael Kelly

Table of Contents

Introduction

A hopper or rectangle to rectangle is a transition piece going from a large to a smaller size. Also known as a reducer, the hopper is used for a number of different applications, for example, reducing from one size duct to a smaller size duct and the storage of materials and liquids. Accurately measuring a hopper or rectangle to rectangle requires a number of skills including sketching, measuring centre lines, 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 and neatly sketch a hopper.
- Determine centre-lines and true length lines.
- Calculate insulation allowances, material requirements and material costs.
- Accurately mark out, fabricate, insulate and clad a hopper.

1.0 Measuring and Sketching

Key Learning Points

- Accurate measuring and centre finding
- Orthographic projection: front elevation, side elevation, plan view
- Isometric sketching of measured hoppers
- Area calculation including insulation
- Determinating vertical and true or slanted lengths
- Truncated pyramids

1.1 Measuring of a Rectangular to rectangular Hopper (On-Centre)

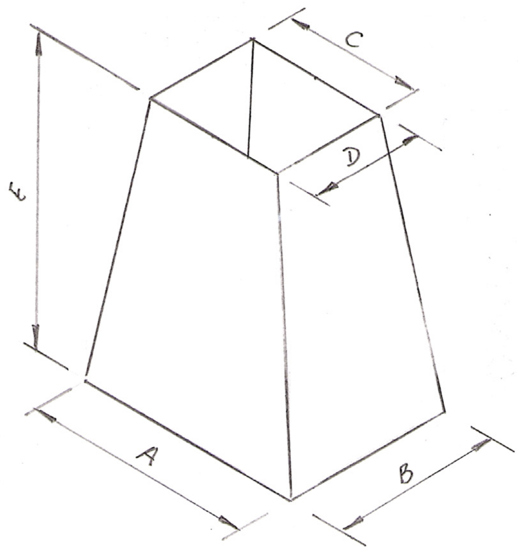
When measuring the rectangle to rectangle hopper we need the following measurements:

Bottom size = AxB

Top size = CxD

Vertical height = E.

The fact that the fitting is on-centre makes the measuring of the fitting easier as opposite panels will have the same measurements.



1.2 Calculation of Insulation Allowances and Area of Hopper

The allowances for estimating the insulation perimeter for the hopper will be the same as for a rectangular duct.

Refer to Module 5 – unit 2 – section 1.4.

Area of Hopper

The area of the hopper equates to the area of sheet 1 x 2 pieces and the area of sheet 2 x 2 pieces.

Sheet 1 is falling in or sloping by 100mm = 600mm – 400mm = 200mm ÷ 2 = 100mm.

Sheet 2 is falling in or sloping by 150mm = 800mm – 500mm = 300mm ÷ 2 = 150mm.

Using Pythagoras' theorem, we can find the length of the sloping sheets 1 and 2.

Sheet 1

The vertical height = 1100mm

The sloping length = 100mm

Pythagoras' theorem = $a^2 + b^2 = c^2$

$$c = \sqrt{a^2 + b^2}$$

$$c = \sqrt{100^2 + 1100^2}$$

$$c = 1104.5\text{mm}$$

Sheet 2

The vertical height = 1100mm

The sloping length = 150mm

Pythagoras' theorem = $a^2 + b^2 = c^2$

$$c = \sqrt{a^2 + b^2}$$

$$c = \sqrt{150^2 + 1100^2}$$

$$c = 1110.2\text{mm}$$

Area of Sheet 1

Area of trapezium = (a + b) h ÷ 2.

= (.5mt + .8mt) 1.105mt ÷ 2

= .718mt^2

We have 2 sides = .718mt x 2 = 1.4365mt^2

Area of Sheet 2

Area of trapezium = (a + b) h ÷ 2.

= (.4mt +.6mt) 1.110mt ÷ 2

= .555mt^2

We have 2 sides = .555mt x 2 = 1.11mt^2

Total area of hopper = 1.11mt^2 + 1.4365mt^2 = 2.5465mt^2

Answer = 2.5465mt^2

1.3 3D Sketching - Isometric Projection, First and Third Angle Projection

Refer to Module 2 – Unit 2 – Orthographic Projections.

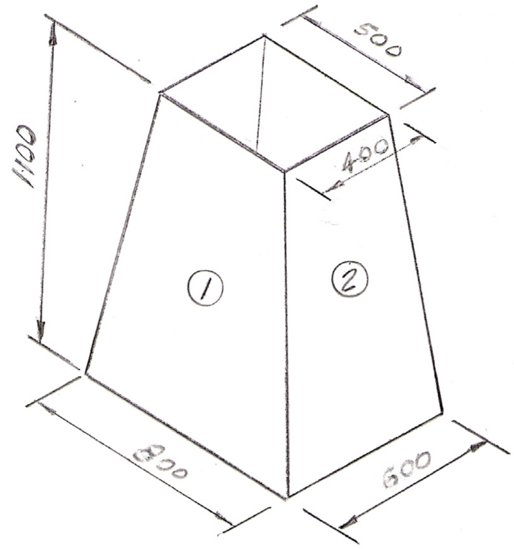
1.4 Truncated Pyramids

Refer to Module 2 – Unit 5 – Cones and pyramids.

1.5 Accurate Measuring and Centre Finding

Mistakes caused by poor or inaccurate measurements can be a very costly exercise to a company both in time and money. Measuring of ductwork and centre line measuring can be straight forward enough, but accuracy and attention to detail is required in order to gets things right.

Refer to Module 5 – Unit 1 – section 1.7.



2.0 Marking Out, Fabrication, and Fitting of Insulation and Cladding

Key Learning Points

- Drawing and development
- Use of numbering and lettering in surface development
- Problems encountered with insulation allowances
- Support systems for large scale hoppers
- Job planning , sequencing and costing
- Estimation and prediction of production time
- Corner angle finding and cross checking
- Assembly and finishing techniques
- Selection of insulation and cladding materials
- Application of insulation and cladding materials

2.1 Marking out Techniques for an On-Centre Hopper

The main things we need to know before we start marking out the hopper are:

- Size of top and bottom of the hopper = AxB
- Sloping length of sheet 1.
- Sloping length of sheet 2.
- Vertical height.

Once the measurements are known, it is developed as shown in ***Module 2 – Unit 3 – parallel line development***. The sizes of the cladding for the hopper include the thickness of the insulation all-round plus an extra allowance of 10mm or 1cm to make the fitting of the hopper easier on site.

Before a pattern can be developed, it must be decided on how it is going to be made, for example the type of joint to be used, position of joints and whether sheets of material will need to be joined to fabricate the hopper panels.

2.2 Pattern Development – Parallel Line / Triangulation

Refer to module 2 – unit 3 (parallel line development) and unit 8 (triangulation).

2.3 Use of Numbering and Lettering in Surface Development

Refer to module 2 – unit 3 – Parallel line development.

2.4 Determination of Vertical and True Slant Lengths

Refer to module 2 – unit 5 – Cones and pyramids (truncated pyramids).

2.5 Accurate Cutting, Folding and Assembly of Hopper

When the patterns have been developed and joint allowances added, the patterns are ready for cutting on the guillotine. After cutting, the patterns are then notched using the snips. Panels are then punched for assembly. Folding and stiffening of the four panels by cross-breaking can take place on the box and pan folding machine. The hopper is then swaged and assembled using self-tapping screws.

2.6 Finding Angle of Corners and Cross Checking

The correct angle of the corner folds can b simply found by checking that the folded corners are 90º on the top and bottom of the folded edge, as shown in the diagram below. If the actual folding angle between the sheet and the folded edge has to be found, we need to find the 'dihedral angle'. This is the angle between two planes as measured in the plane normal to their line of intersection. It is a much more complicated method of finding the folded angle than the workshop method as shown.

Refer to module 5 – unit 4 – section 2.8 – cross checking.

2.7 Selection, Cutting and Fitting of Insulation Using Appropriate Fixings

Refer to module 4 for a selection of materials.

Refer to module 5 – unit 4 – section 2.6 – cutting and fitting of insulation using appropriate fixings.

2.8 Support Systems for Large Scale Hoppers

Depending on the size of the hopper, support systems can be as simple as 'Z-bar' sections or more robust as in supports needed for insulation and cladding of vessels. These vessels can include small and large rectangular, cylindrical and irregular pieces of equipment, large hoppers and storage tanks for example.

Refer to module 5 – unit 7 – Vessels (storage and high pressure).

2.9 Calculation of Insulation and Costs

The allowances for estimating the insulation length is the same as estimating for a length of square or rectangular duct, taking into consideration that the slant length of the hopper may differ considerably from the vertical height.. This equates to the perimeter of the rectangle to rectangle hopper plus eight thicknesses of insulation. Once the squared meterage of insulation has been calculated, a rate or unit cost is applied to the square meterage to achieve an overall cost. The rate per square metre will depend on a number of factors within the company:

- Cost of material per square metre.
- Cost per hour for labour.
- Cost per hour for overheads (heat, light, office staff, equipment etc).
- Percentage added for profit.

It is important to note that the unit cost per square metre is sometimes governed by industry rates.

2.10 Estimating Production Times

Estimating production and fabrication times can be a fine art. Experience and skill are required to accurately measure the time required to manufacture a specific fitting or piece of cladding. There are a number of factors to take into account when estimating production and fabrication times:

- The level of automation within the workshop.
- The number of fabricators and their level of experience.
- The complexity of the pieces to be manufactured.
- The level of planning and sequencing applied to the job.
- Delivery times – different parts of the job may take priority.
- Availability of materials and financing of the job.

3.0 Health and Safety

Key Learning Points

- Removal of sharp edges, safe disposal of waste/recycling.

3.1 A Professional Approach to House-Keeping and Presentation

Good house-keeping should not just be another chore for the worker. It is an important element in accident prevention and overall efficiency on the job. Good house-keeping begins with planning ahead. Storage areas should be planned to allow for ease of access to materials without blocking up walk ways. Materials should be neatly stockpiled. Access areas and walkways should be kept clear at all times, waste materials, tools and equipment should not be left in the walkways.

Off-cuts of insulation, cladding and packaging materials should be disposed of correctly. Recycling bins should be available on site for different types of materials.

It is the responsibility of each worker to maintain their work area in a neat and orderly manner. Keeping areas clean and tidy shows a professional attitude towards safety.

It is the responsibility of each worker to make sure that each job, whether in the workshop or on site, is finished off to the highest possibly standards. This would include:

- The overall job is free from marks, scratches and dents.
- All joints are properly sealed.
- Adequate support brackets are in place and are plumb and true.
- All sharp edges and burrs have been removed.
- Work area is left clean and tidy.

Refer to module 1 – unit 3 – measuring, marking and cutting out.

Summary

Accurate measuring, the use of centre lines, obstacle identification and related knowledge are all required when measuring, marking out and fabricating a hopper or rectangle to rectangle transition.

Insulation is applied to ductwork and pipe work to maintain the temperature integrity of a system. Cladding is applied over the insulation to protect the insulation from corrosion, damage and protect personnel from injury due to high temperatures.

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.

It is the responsibility of each worker to make sure that each job, whether in the workshop or on site, is finished off to the highest possibly standards. This would include removing all sharp edges and burrs, ensuring that all brackets are plumb and in line and leaving the work area tidy when finished.

SOLAS
An tSeirbhís Oideachais Leanúnaigh agus Scileanna
Further Education and Training Authority

Castleforbes House
Castleforbes Road
Dublin 1