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The KoolDuct System Design Guide

KoolDuct® ...... No Worries

Kingspan®
INDUSTRIAL INSULATION

The KoolDuct System Design Guide

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1 KOOLDUCT COMPLETE SYSTEM TECHNOLOGY

The Heating, Ventilation, and Air Conditioning (HVAC) industry is in the midst of a dynamic era. However, air ducting, a critical component of HVAC systems, has remained virtually unchanged since the early 1900's. Several factors and recent innovations have introduced the need to revolutionise air ducting. Building materials and insulating products have dramatically improved. Requirements for clean air are becoming increasingly stringent. Energy costs have continued to escalate. Changing fire and smoke regulations have raised the standards for compliance.

Kingspan Industrial Insulation is pleased to present a revolutionary approach to insulated ductwork. The KoolDuct System is like no other insulated ducting. It is the most advanced and innovative System of pre-insulated air distribution ductwork available in the UK and Ireland.
The KoolDuct System of pre-insulated ducting is a proven, easy, innovative product providing a new perspective in the field of air distribution.

This third generation System virtually eliminates all the problems of traditional metal ductwork while at the same time offering extra advantages to both the consulting engineer and the fabricator / installer. The System is the clear leader in the new generation of insulated prefabricated ducting and has already proved itself in the highly competitive global marketplace.

What's different about the KoolDuct System. Traditionally, ducting is made of sheet metal which is installed first and then lagged with insulation as a second operation. The KoolDuct System offers pre-insulated ducting with aluminium surfaces in a single fix.

The KoolDuct System comprises duct sections fabricated from phenolic insulation panels and joined together with proprietary jointing systems.

2 THE KOOLDUCT SYSTEM – DESIGN THEORY

2.1 APPLICATION LIMITATIONS

This document sets out the minimum requirements for the manufacture and installation of the KoolDuct System for air distribution operating within the allowable range of limits and applications designated below.

The nature of the material imposes certain limitations on its application, and it should not be used for the passage of solids or where it could potentially be damaged. It can be installed in an aggressive atmosphere provided that appropriate protective coatings are applied and certain precautions are followed. Kingspan Industrial Insulation should always be consulted for such applications.

While the material exhibits excellent fire and smoke performance, the material should not be used adjacent to high temperature sources or where the failure of the control equipment may give rise to high temperatures. It is also important that combustible matter is not allowed to collect within the ductwork system, and accordingly, it is not recommended that the material be used in conjunction with kitchen extract and fume exhaust systems.

This design and construction guide does not apply to ductwork systems used in the following applications:

- kitchen extract ducting;
- conveyance of solids;
- chemical or fume exhaust systems;
- with equipment of any type that does not include automatic maximum temperature controls;
- adjacent to any mechanical / electrical source of extreme heat;
- in high pressure systems, as defined in section 2.2 below.

Although the material has excellent erosion resistant characteristics, there may be a certain amount of phenolic dust due to particles remaining within the duct resulting from the cutting and grooving operations during assembly. It is therefore a procedural recommendation that the system is blown out prior to start-up. Nevertheless, care must be taken to ensure that the ductwork is cleaned to the appropriate level of cleanliness, particularly for applications in sensitive areas where a dust free environment is required such as operating theatres, clean rooms, hospitals, food manufacturing facilities, pharmaceuticals, etc.

It is recommended that KoolDuct System ducting be used for operation within the following limits:

Mean Air Velocity:	15 m / s maximum.
Total Pressure:	1,000 Pa maximum (positive or negative).
Temperature:	maximum internal air temperature of 70°C during continuous operation.
Size:	unlimited (provided that recommended KoolDuct System techniques and procedures are strictly observed).

2.2 PRESSURE CLASSIFICATION

Pressure, rather than velocity, is the main basis for classification for the lower velocity ductwork systems for which the KoolDuct System is recommended. Air leakage and phenolic insulation panel deflection for low velocity systems are almost entirely a function of pressure (static pressure), and not velocity (dynamic pressure). It is therefore common practice in the HVAC industry to approximate static pressure as total pressure, and ignore the relatively minor contribution of dynamic pressure for this class of ductwork. This specification is based on the pressure classes set out in Table 2.2.1.

Duct Pressure Class	Static Pressure Limit (Pa) Positive	Static Pressure Limit (Pa) Negative	Mean Air Velocity (Maximum) (m / s)	Air Leakage
Low	500	500	10	Class A
Medium	1,000	750	15	Class B
High	2,000	750	20	Class C

Table 2.2.1

Note that 'mean air velocity' refers to the design air flow rate related to the cross sectional area of the ductwork. Also, ductwork pressure relates to the actual static pressure of the relevant section of ductwork, and not the fan static pressure.

2.3 AIR LEAKAGE STANDARDS

The permitted air leakage limit for each standard of air-tightness, as defined by DW 144, is set out in Table 2.3.1 below:

Duct Pressure Class	Air Leakage Requirement	Leakage Limit (litre / sec / m^2*)
Low	Class A	$0.027 \times p^{0.65}$**
Medium	Class B	$0.009 \times p^{0.65}$
High	Class C	$0.003 \times p^{0.65}$

Table 2-3-1

* surface area computed based internal duct dimensions
** p is the pressure differential in Pascals

As can be seen from Table 2.3.1, the higher the duct pressure class, the more stringent the leakage limits. Therefore, when classifying ductwork, economic advantage can be attained by matching the duct pressure classification to the duct distribution static pressure. For example, in certain installations where the supply ductwork is designated as Class B, the terminal outlets might possibly be classified as Class A.

2.3.1 Leakage at Various Pressures

Based on the limits set out in Table 2.3.1, the maximum allowable air leakage for each pressure class over a range of pressures from 0 to 2,000 Pascals is plotted in Figure 2.3.1. The leakage figures are given in litres of air per second per square metre of internally measured ductwork against a static pressure differential ranging from 100 Pa to 2,000 Pa.

2.3.2 Testing for Air Leakage

Testing of ductwork to establish conformity with the leakage limits specified in Table 2.3.1 is generally only required for high pressure applications (i.e., Class C). Therefore, testing for air leakage of ductwork operating within low and medium ranges of pressure is not necessary unless explicitly called for in the job specification.

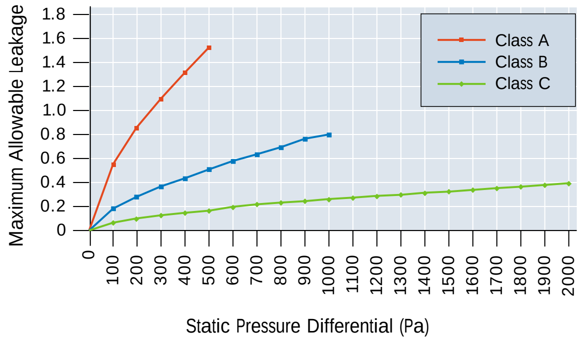


Figure 2.3.1
Allowable Leakage Per Pressure Class

Notes:

- leakage expressed in litre per second per square metre;
- pressure expressed in Pascals (Pa);
- low pressure region defined as 0-500 Pa;
- medium pressure region defined as 500-1,000 Pa;
- high pressure region defined as above 1,000 Pa.

2.4 ECONOMY OF DUCT DESIGN

Although the same general design rules apply as to sheet metal ductwork, it is important to recognise that the user should be aware of the need to plan optimum material usage in order to achieve economy of fabrication. Off-cuts have little or no scrap value.

The ductwork system comprises a substantial portion of the overall cost of a buildings HVAC system - potentially in excess of one-third of the total cost. Careful and attentive planning during the design stage of the ductwork system can yield significant reduction of the overall cost of the system. There are two factors in particular that can have a considerable impact:

- the total number of special pieces (pieces other than straight sections); and
- the aspect ratio of the duct segments.

Special pieces such as elbows, reducers, and offsets, etc. require considerably more labour (and material to a certain extent) to construct than straight segments. While all ductwork systems will require a certain amount of special fittings, their usage should be minimised. Ideally, the system should follow the straightest route possible.

The other point which is less intuitively obvious is the aspect ratio of the duct segments. This ratio is defined as the duct's larger side divided by its smaller side. As the aspect ratio increases, the corresponding surface area dramatically increases. Table 2.4.1 illustrates this relationship for six duct sizes of identical cross sectional areas with different aspect areas. In addition, higher aspect ratio ducts also exhibit increased frictional resistance and noise. As can be seen, a square aspect ratio is the most economical (1:1). However, while smaller aspect ratios are more desirable from a material requirements and aerodynamic standpoint, the trade-off is in space requirements, as small aspect ratio ducts require more clearance for installation. Based on all of these considerations, it is not recommended that aspect ratios exceed 4:1.

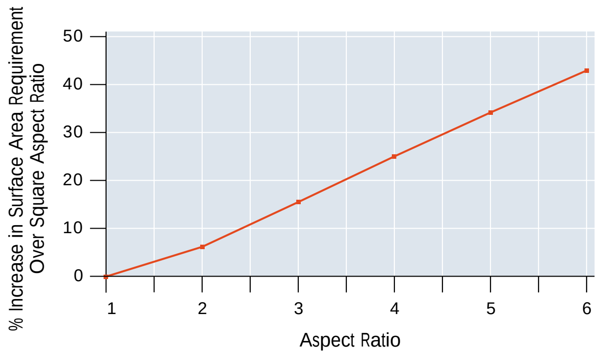


Figure 2.4.1
Duct Aspect Ratio

3 THE KOOLDUCT SYSTEM – PRACTICAL DESIGN GUIDE

3.1 FABRICATION OF DUCTWORK

All personnel responsible for the fabrication and construction of ductwork systems shall, prior to being engaged in the work, have successfully completed the specialised KoolDuct System training course and shall be familiar with all aspects of the fabrication techniques necessary for the manufacture of the complete system. All trainees who successfully complete the training course are awarded a KoolDuct System certificate of competency.

The KoolDuct System offers a complete product line providing all tools, accessories and components necessary to fabricate ductwork. Each item has been rigorously tested in the laboratory and the field to the highest of standards in a variety of applications. Under no circumstance are any substitute components to be used in place of approved KoolDuct System products.

3.1.1 Procedure

The construction of a duct is accomplished by following a standardised procedure. The process is the same regardless of the shape of the duct element:

- tracing;
- cutting;
- gluing;
- folding;
- taping;
- flanging & reinforcement; and
- sealing.

Although each of the above operations is described in general below, this design guide is by no means intended to serve as an instruction manual to replace the training course. Note that when properly constructed, the finished duct will have no exposed phenolic insulation - internally or externally.

3.1.2 Tracing

The tracing of the duct outline onto the phenolic insulation panel is the first step of the process. This is accomplished by utilising the Teflon "pencils" supplied in each tool box which scribe a line as opposed to marking a line. Note that all measurements specified on drawings of duct systems refer to a duct's internal dimension. This corresponds to the cross-sectional area of the air passage necessary to satisfy design requirements. It is therefore recommended that the fabricator adopt the convention of internal measurements during plotting. Accordingly, all tracing and plotting will take place on the internal side of the duct.

3.1.3 Cutting

This operation involves cutting 45° mitre cuts along each edge of the duct. These 'V' grooves made by the 45° Jack Plane enable the phenolic insulation panel to be folded into shape. The 'V' groove is also optimal for the subsequent gluing operation as it provides maximum bonded surface area. The material that is discarded as a result of this operation must have been accounted for during the previous tracing. There are also several other special purpose Jack Planes available including the 22.5°, and the Adjustable.

3.1.4 Gluing

The glue must be well shaken prior to use in order to assure uniform consistency. Glue is applied evenly to mitred surfaces utilising a Pneumatic Glue Spreader, and should cover all exposed phenolic material. Note that the 'V' groove should first be swept clean of any remaining phenolic dust. Depending on the temperature and relative humidity, the adhesive requires approximately 10 to 20 minutes to cure during which time the solvents evaporate. This operation should be performed in a well ventilated area and the precautions recommended on the COSHH datasheet sheet should be observed. The curing period is complete when the glue is dry to the touch.

3.1.5 Folding

Following the curing phase, the sides are folded at right angles to each other (90°) and the duct shape is formed. Note that when two open sides of a duct are joined together, the aluminium foil edge of the mitre cut on the internal surface should be used for aligning purposes. When a duct is comprised of several individual pieces, the joining process should always be initiated from the same end so that the subsequent trimming operation of any excess length is required at the opposite end only. The black hard spatulas should then be used to firmly crease along the edges of the duct to ensure maximum adhesion in the 'V' grooves.

3.1.6 Taping

Special reinforced aluminium self adhesive tape is provided. The tape has been double cured for increased pliability, and contains 2.5 times as much glue as standard tapes to ensure maximum adhesion. The taping of the duct serves four purposes:

- it re-establishes the vapour barrier within the mitred cuts;
- external seams are taped to improve the duct's aesthetic appearance;
- tape is used to repair and cover any damage to the phenolic insulation panel, both externally and internally; and
- it seals and isolates the phenolic material from the surroundings.

Prior to applying the tape, ensure that all surfaces are dry, and free of dirt, oil, silicone, and grease. If the surface can not be thoroughly cleaned, then a simple solution is to apply a light coat of glue on the surface where the tape is to be placed (note that the glue must be allowed to cure first, as discussed within section 3.1.4 above). The tape should ideally be applied in temperatures above 10°C in order to assure a satisfactory bond. The tape should not be applied to the duct's surface when the temperature is below 0°C due to the potential entrapment of ice crystals.

Tape is only applied to seams where the external surface of the aluminium foil has been cut. On sides where the phenolic insulation panel has been simply folded, as opposed to joined, no tape is required. The tape-marker is used to scribe a line on the phenolic insulation panel which serves as reference during application of the tape. The soft spatula is brushed firmly along the surface of the tape during application to ensure maximum adhesion and to expel any air trapped underneath. When taping reducers or elbows, the tape must always be applied to the curved or creased surface (not the flat surface), and the supplemental directions within the respective sections should be observed.

3.1.7 Aluminium Profile and Reinforcement

There are a variety of aluminium profiles available to suit various installation requirements. A full discussion of each, complete with instruction, is provided in section 3.10.

Depending on both the system pressure and the duct's dimensions, the installation of reinforcement bar may be necessary. Section 3.7 provides a complete guide to its usage.

3.1.8 Sealing

Following assembly of the duct segment, all internal joints must be sealed with silicone. In addition to imparting greater strength and rigidity, the primary function of the silicone is to hermetically seal the internal surface of the duct and prevent any phenolic particles from entering the air stream. It is recommended that after the silicone bead has been applied, a radiused tool (or alternatively a wet finger) is gently run along the entire length of the bead to further spread the sealant along the sides of the duct wall. Proper application is crucial in order to achieve "clean air" performance and minimise leakage.

3.2 RECTANGULAR DUCTS

For purposes of clarity, the following convention will be adopted, where w refers to internal duct width, h refers to internal duct height, and l refers to duct length:

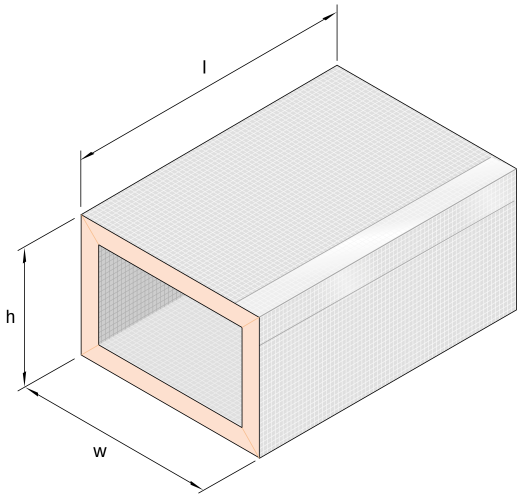


Figure 3.2.1

KoolDuct System phenolic insulation panels are supplied in one size only: 2,950 mm x 1,200 mm x 22 mm. Ducts may be constructed by cutting 'V' grooves along the length or the width of the phenolic insulation panel. The methods for cutting rectangular ducts are divided into four general classes, and the selection of the appropriate technique is governed by the dimensions of the duct. The correct choice will minimise both material usage and fabrication time. Table 3.2.1 specifies the limiting dimensions of a duct for each method, and sections 3.2.1-3.2.4 describe the procedure. Dual Duct design is presented separately in section 3.8.

Method	Duct Side Dimensions (mm)	Maximum Length of Duct Segment (metres)
1	2 x (w+h) <1040 the sum of 4 sides	2.95
2a	(h+w+h) <1080 the sum of any 3 sides	2.95
2b	(w+h) <1120 the sum of 2 sides	2.95
2c	w and h <1160 any single side	2.95
3a, 3b	(h+w+h) <2830 the sum of any 3 sides	3.56
4	w and h <2910 any single side	1.2
Dual Ducts	unlimited see section 3.8	2.95

Figure 3.2.1
Rectangular Straight Duct Construction

3.2.1 Rectangular Ducts – Method 1

This method is utilised when the perimeter of a duct is less than or equal to 1,040 mm.
The advantages are simplicity and strength in that the entire duct can be constructed from a single phenolic insulation panel. The figure of 1,040 mm is derived from subtracting the combined length of the off-cuts of the mitre grooves (equivalent to 20+40+40+40+20 = 160 mm) from the phenolic insulation panel width: 1,200–160 = 1,040 mm. The 'V' grooves are cut in the lengthways direction, and the duct is constructed as shown below in Figure 3.2.2. Aluminium flanges should be fitted on both ends of the duct segment.

Method 1: w+h+w+h<1,040 mm

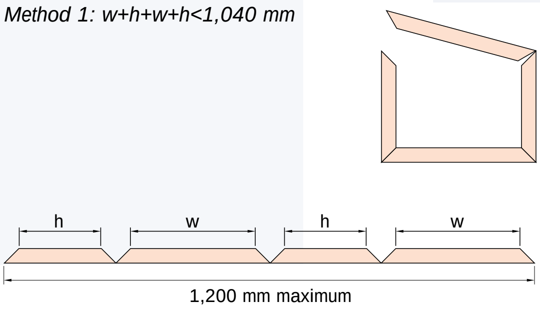


Figure 3.2.2

3.2.2 Rectangular Ducts – Method 2

This method is utilised for larger ducts that are still 3 metres in length, but constructed of separate phenolic insulation panels that are subsequently joined. The dimensions of the duct dictate whether or not the individual pieces are symmetrical (method 2b), or asymmetrical (method 2a).

When the duct cannot be constructed according to Figure 3-2-2, and the sum of three of the sides is less than or equal to 1,080 mm, then method 2a applies. The duct is constructed as illustrated in Figure 3-2-3 by using a U shaped piece and a cover. The ‘V’ grooves are still cut in the lengthways direction.

Method 2a: w+h+w<1,080 mm

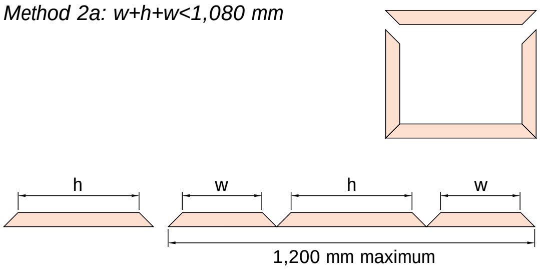


Figure 3.2.3

If the duct is larger still, and the sum of two sides is less than or equal to 1,120 mm, then method 2b applies. In this case, the duct will be constructed of two symmetrical pieces, each consisting of two full sides. The ‘V’ grooves are again cut in the lengthways direction, and is illustrated in Figure 3.2.4.

Method 2b: w+h<1,120 mm

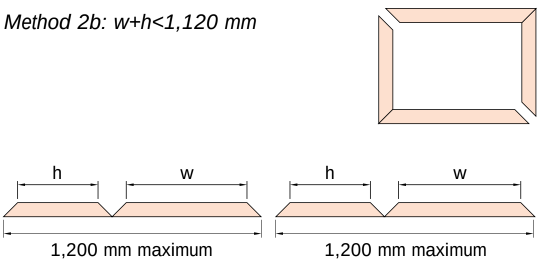


Figure 3.2.4

A larger duct can also be constructed by utilising an individual phenolic insulation panel for each side of the duct, as prescribed by method 2c, illustrated in Figure 3.2.5. The side dimension of such a duct would be limited to the size of the KoolDuct System phenolic insulation panel corrected for the mitre cuts, 1,160 mm (1,200 – 20 – 20). The length of the duct segment is again limited to the length of the phenolic insulation panel, 3 m.

Method 2c: w and h<1,160 mm

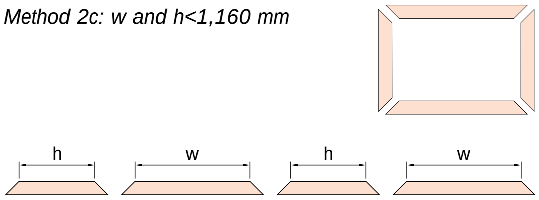


Figure 3.2.5

Aluminium flanges should be fitted on both ends of the duct segment, for each of the methods covered in Class 2 ducts.

3.2.3 Rectangular Ducts – Method 3

This method is employed for larger ducts still. The ‘V’ grooves are now cut along the widthways direction of the phenolic insulation panel which means that each individual module is limited to 1,180 mm in length (computed as the 1,200 mm phenolic insulation panel width less the 20 mm mitre cut).

When constructing rectangular ducts utilising the third family of techniques, it is permissible to join up to three individual modules together with male-female jointing alone, provided that the following precautions are observed. First, the cover must be carefully positioned such that the joints are staggered, thus adding an additional degree of strength and stability. The edge of the cover must never, under any circumstance, be allowed to coincide with the male-female joints of the three duct modules.

In addition, the direction of the male-female joints must be consistent with the direction of the air flow. Figure 3.2.6 below demonstrates the proper application. All male-female joints must be glued and then taped on both sides. Finally, aluminium flanges shall not exceed 3.6 metres in distance apart (three duct modules) when using this method of construction.

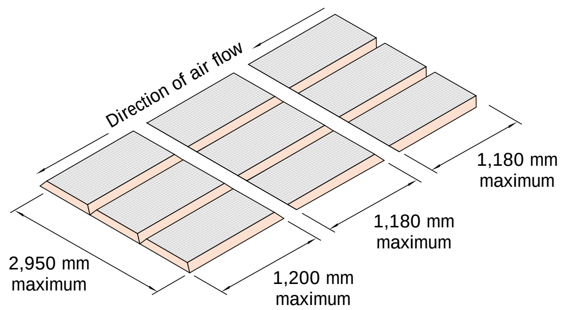


Figure 3.2.6

When the dimensions of the duct exceed the limits set forth in the previous two classes, and the sum of three sides is less than or equal to 2,830 mm, then both methods 3a and 3b can be utilised. The determining factor for selecting the proper technique is the width of the cover. If the cover width is less than or equal to 1,160 mm, then method 3a applies, as shown in Figure 3.2.7. Note that the orientation of the cover is lengthways (2,950 mm) which would mean that a supplementary piece of roughly 630 mm in length would be necessary to complete the cover for a duct that is composed of three modules (3.6 metres long) as is the case in Figure 3.2.7.

Method 3a: w+h+w<1,080 mm

- 3 U-shaped segments joined together using male/female
- maximum combined length of 3.56 m (3 modules)
- the sum of three sides equal to or less than 2,830 mm (internally)
- cover width equal to or less than 1,160 mm (internally)

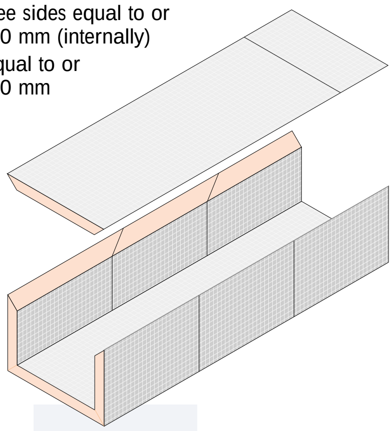


Figure 3.2.7

If the cover width exceeds 1,160 mm, then method 3b would be applicable. The difference is that the orientation of the phenolic insulation panel strips used for the cover is in the widthways direction. Accordingly, each are 1,200 mm long. Again, care should be taken to ensure that the seams of the cover do not coincide with the male-female joints of the duct body. Figure 3.2.8 provides an example.

Method 3b: w+h+w<1,080 mm

- 3 U-shaped segments joined together using male/female
- maximum combined length of 3.56 m (3 modules)
- the sum of three sides equal to or less than 2,830 mm (internally)
- cover width equal to or less than 1,160 mm (internally)

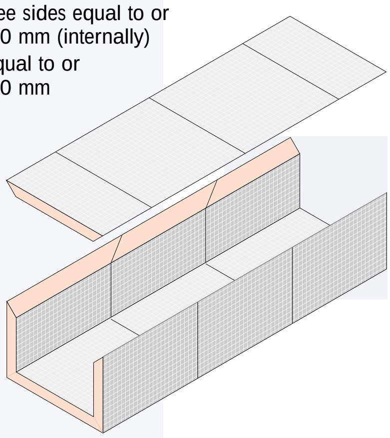


Figure 3.2.8

3.2.4 Rectangular Ducts – Method 4

This method is reserved for the largest of duct sizes. The 'V' grooves are cut along the widthways direction of the phenolic insulation panel, and duct segments are manufactured in lengths of 1.2 metres, flanged at each end. An entire phenolic insulation panel can be used for a single side, which enables a maximum side width or height of 2,910 mm. Reinforcement of method 4 ducts is almost a certainty, and the schedules in section 3.7 should be referenced.

Depending on the air pressure and velocity, it might be advisable, and more economical, to manufacture according to the Dual Duct methodology outlined in section 3.8. Beyond resulting in a more rigid duct, less stiffening bars would be required, and the ducts could also be manufactured in 3m lengths.

3.2.5 End Caps

Sometimes it may be necessary to cap the end of a duct. The end of the duct should then be cut in a 45° female mitre utilising the Small Jack Plane. The cap is cut male, and then checked for a good fit. It is recommended that both the cap and duct are marked while held in place in order to assure the proper orientation is attained. All mitred cuts should then be glued, allowed to cure, the cap fitted, and the external seams taped. The internal seams should be sealed with silicone, either through an access door or prior to installation of the end cap. Figure 3.2.9 below illustrates the fitting.

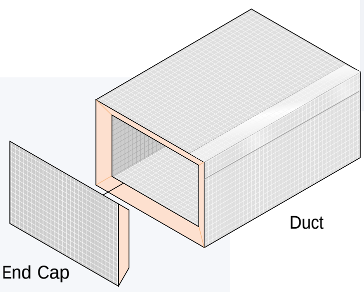
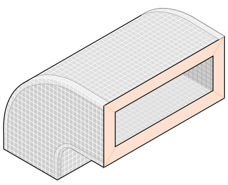


Figure 3.2.9
End-Cap Construction

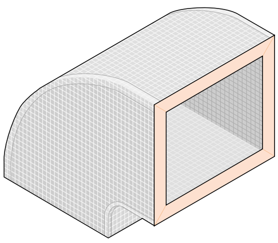
3.3 ELBOWS

Elbows are the most common fitting in the ducting system. Prior to discussing construction techniques, it is necessary to define some basic terminology.

First, bends are classified as “hard” or “easy.” A hard bend signifies that rotation occurs in the plane of the longer side of the duct’s cross section. That is, w is less than h. An easy bend signifies that rotation occurs in the plane of the shorter side of the duct’s cross section. That is, w is greater than h. An example is illustrated in Figure 3.3.1 below.



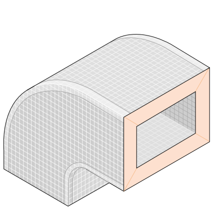
Easy Elbow



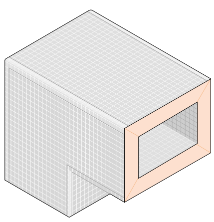
Hard Elbow

Figure 3.3.1

Bends are also classified as “radiused” or “square.” A radiused bend is a smooth elbow where the air changes direction along a radiused path. This type of design assures the continuance of laminar flow and therefore minimises both noise and drag. A square bend has no radius and the abrupt change in air direction requires the use of turning vanes. Examples of each are shown in Figure 3.3.2 below.



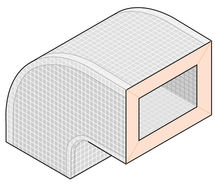
Radiused Elbow



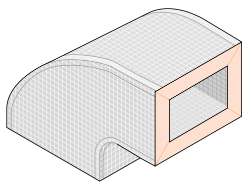
Square Elbow

Figure 3.3.2

Finally, bends are also classified as symmetric, or asymmetric. A symmetric elbow has an inlet and an outlet of identical dimensions. Accordingly, the outlet on an asymmetric elbow is not the same size as the inlet. Figure 3.3.3 demonstrates the difference.



Symmetric Elbow



A Symmetric Elbow

Figure 3.3.3

Figure 3.3.4 details the components of the elbow which will be repeatedly cited in the following instruction on fabrication of elbows.

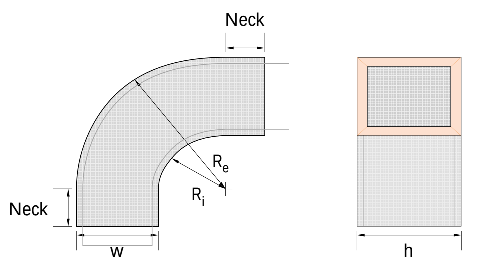


Figure 3.3.4

3.3.1 Elbow Construction

As illustrated in Figure 3.3.5, elbows are generally constructed from four separate pieces: the two sides, and the inner and outer strips.

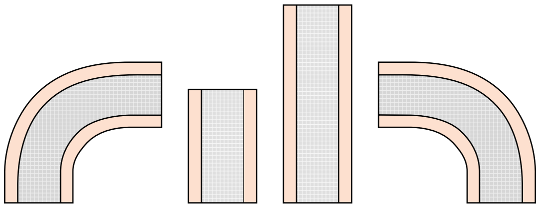


Figure 3.3.5
Components of an Elbow

In order to properly construct an elbow, the following information should ideally be supplied:

- dimensions of inlet;
- dimensions of outlet;
- internal radius (or external radius);
- lengths of inlet and outlet neck.

When designing an elbow to be made of phenolic insulation panels, it is essential to observe the following recommendations:

- the minimum length of any neck shall be 200 mm;
- the internal radius shall not be less than 200 mm;
- the distances between the creases on the internal and external strips shall not be less than 50 mm apart.

As with rectangular ducts, all measuring should be performed on the internal side of the duct. The sides of the elbow are cut using the Small Jack Plane with a 45° cutter. The second side of the elbow can be traced by simply turning the previously cut first side upside down onto a new phenolic insulation panel and scribing a line along the internal edge. The lengths of the strips are obtained by bending the flexible ruler along the curved perimeter of the sides. A nominal amount should be added to compensate for the subsequent creasing process. The excess length can be trimmed following complete assembly.

Parallel scribe lines should be marked on both strips in preparation for the bending machine. Note that the bending of the internal strip is performed on the outer surface, and the bending of the external strip is performed on the inner surface. The gluing process is as described in section 3.1.4.

The fitting process begins by placing the external strip onto the table. Both sides are joined to the external strip simultaneously starting at the end of the neck, taking care to ensure that the *inner* edges of the aluminium foil are properly aligned. The process continues along the external radius until the three pieces are joined together.
The fourth side is then fitted, starting at the same end of the duct as previously. The black, stiff spatulas are then used to gently crease along the edges to ensure maximum adhesion in the 'V' grooves. The procedure is illustrated in Figure 3.3.6 below.

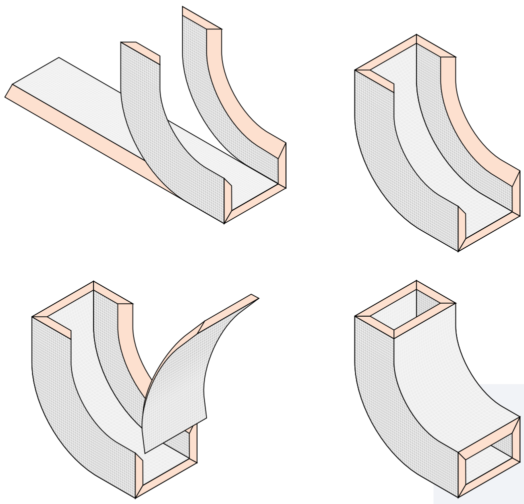


Figure 3.3.6
Elbow Fitting Procedure

The taping and sealing process is as described in sections 3.1.6 and 3.1.8. Note that the tape is always first applied to the strips (the side with the creases), not the elbow's sides. In addition, because the surface to be taped is curved, the edge of the tape to be folded over should be slit intermittently in order to prevent wrinkling, the entrapment of air, and a poor application as a result. Again, the soft spatula should always be used. Finally, both ends of all elbows shall be fitted with aluminium profiles.

3.3.2 Splitters

Splitters are inserted in radiused elbows in order to reduce turbulence in the air stream and the associated pressure drop. No splitters are required in elbows that have a turning radius of at least 200 mm with a width, w, of less than 600 mm. Elbows of widths greater than 600 mm but less than 900 mm will require a single splitter positioned one third of the width dimension away from the internal curvature. Elbows over 900 mm but less than 1,200 mm will require two splitters placed equally between the internal and external curvature. Elbows over 1,200 mm will require three splitters placed equally apart. Splitters can be constructed of KoolDuct System phenolic insulation panels and should be glued and sealed in position.

When using KoolDuct System phenolic insulation panels as splitters, they run parallel to the inner and outer strips of the elbow with a neck on either end. The front end of the splitter on the inlet side is cut in a 'V' shaped manner to ensure minimal disruption to the air stream and taped to seal all insulation surfaces. Note that splitters are not a substitute for positive pressure reinforcement.

3.3.3 Turning Vanes

Square elbows are employed when space is limited or when explicitly specified. All square elbows shall be fitted with turning vanes secured at both ends. Aerodynamically designed aluminium turning vanes, also known as double skin, are recommended. Turning vanes should be fitted as illustrated in figure 3.3.7, and fastened to externally mounted bayonet strips with 35 mm aluminium rivets. A bead of silicone sealant spread along the turning vane track can be used to further secure the vane assembly to the duct. Note that turning vanes are not a substitute for proper reinforcement.

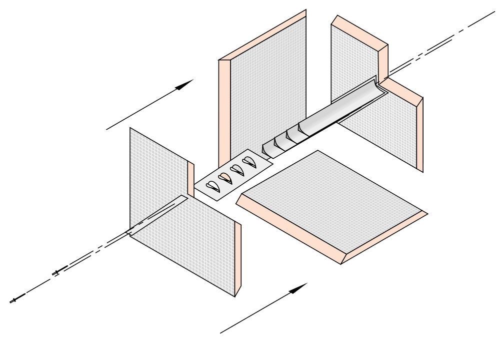


Figure 3.3.7
Square Elbow and Turning Vane Assembly