IS 655 (2006): Specification for Air Ducts [MED 3: Refrigeration and Air Conditioning]

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भारतीय मानक

एयर डक्ट्स — विशिष्टि

(दूसरा पुनरीक्षण)

Indian Standard

AIR DUCTS — SPECIFICATION

(Second Revision)

ICS 91.140.30

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

August 2006

Price Group 12

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Refrigeration and Air Conditioning Sectional Committee had been approved by the Mechanical Engineering Division Council.

This standard was first published in 1955 and revised in 1963 mainly to specify the values in metric system in place of fps values given in the original specification.

This revision has been taken up mainly to align the sizes with that of International Standard and also for international coordination among standards and practices being followed in other countries.

In this revision, scope has been expanded to cover different materials used in fabrication of ducts in place of metal ducts covered in earlier version. Accordingly the title has been changed and the constructional details are covered in a very detailed way.

In preparing this standard, assistance has been taken from the following:

a) ISO 7807 : 1983 Air distribution — Straight circular sheet metal ducts with a lock type spiral seam and straight rectangular sheet metal ducts — Dimensions, issued by the International Organization for Standardization

b) JIS A 4009 : 1997 Components of air ducts, issued by the Japanese Industrial Standards

The composition of the Committee responsible for the formulation of the standard is given in Annex B.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be same as that of the specified value in this standard.

Indian Standard

AIR DUCTS — SPECIFICATION

(Second Revision)

1 SCOPE

This standard covers materials and constructional requirements of air ducts used for air conditioning and ventilation system (including gas exhausting system).

2 REFERENCES

The standards listed at Annex A contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All the standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 DEFINITIONS

For the purpose of this standard, the following principal definitions shall apply.

3.1 Standard Dimensions — The dimensions which are employed as the standard in production, use, distribution, etc, extend over future.

3.2 Recommended Dimensions — The dimensions, which are tentatively specified for rationalization in production, use, distribution, etc.

3.3 Limit Pressure — The maximum pressure at which safety of duct structure is maintained in such a case that the internal pressure of duct increases temporarily due to closing of a damper in the duct. However, instantaneous pressure change due to quick closing is excluded.

4 CLASSIFICATION

4.1 Ducts are classified according to the material of duct, the shape of cross-section, the jointing method and the internal pressure of duct as given in **4.1.1** to **4.1.4**.

4.1.1 *Classification by Material of Duct*

a) Galvanized steel sheet (including PVC lined steel sheet) duct,

b) Stainless steel sheet duct,

c) Rigid polyvinyl chloride duct, and

d) Glass wool duct.

4.1.2 *Classification by Shape of Cross-Section*

a) Rectangular duct, and

b) Circular duct and circular spiral duct (circular duct with spiral seam).

4.1.3 *Classification of Rectangular Ducts of Galvanized Steel Sheet and of Stainless Steel Sheet by Method of Jointing Work*

a) Duct of angle flange technique.

b) Duct of corner bolt technique:

1) Duct of same sheet flange technique, and

2) Duct of slide-on flange technique.

4.1.4 *Classification by Internal Pressure of Duct*

a) Low pressure duct,

b) Medium pressure duct, and

c) High pressure duct.

4.2 Classification by Internal Pressure of Duct and Pressure Range

Each internal pressure class of duct and its pressure range shall be as given in Table 1. However, only low pressure duct is applicable for glass wool ducts.

Table 1 Classification by Internal Pressure of Duct and Pressure Range

Classification by Pressure	Normal Service Pressure, Pa		Limit Pressure, Pa	
	Positive Pressure, P_p	Negative Pressure, P_n	Positive Pressure	Negative Pressure
(1)	(2)	(3)	(4)	(5)
Low pressure duct	$P_p \leq +500$	$-500 \leq P_n$	+ 1 000	− 750
Medium pressure duct	$+500 < P_p \leq +1\,000$	$-500 > P_n \geq -1\,000$	+ 1 500	− 1 500
High pressure duct	$+1\,000 < P_p \leq +2\,500$	$-1\,000 > P_n \geq -2\,000$	+ 3 000	− 2 500

NOTE — Normal service pressure means the internal pressure of duct at normal running.

5 MATERIALS

5.1 Body of Duct

5.1.1 For indoor application and outdoor application (insulated), the galvanized steel sheet shall conform to Class 4 of IS 277; for outdoor application (uninsulated), the galvanized steel sheet shall conform to Class 3 of IS 277.

5.1.1.1 In case of use of pre-painted galvanized steel sheet, the requirements of painting shall be as agreed to between the supplier and the purchaser.

NOTE — In case of non-availability of Class 3 material, any other class of material may be used, subject to agreement between the supplier and the purchaser.

5.1.2 Stainless steel sheet shall conform to IS 6911.

5.1.3 Polyvinyl chloride coated steel sheet shall be manufactured by laminating or coating polyvinyl chloride (vinyl chloride resin) layer of minimum thickness of 0.2 mm on both sides or on one side of metal sheet and the base metal shall be galvanized steel sheet conforming to IS 277. The requirements on the lamination or coating of PVC shall be as agreed to between the supplier and the purchaser.

5.1.4 Rigid polyvinyl chloride plate shall conform to IS 6307.

5.1.5 Glass wool plate shall conform to IS 8183.

5.1.6 Steel products shall conform to IS 2062.

5.2 Connection and Support Materials

5.2.1 *Joint Flange*

The steel jointing flange shall conform to IS 2062.

5.2.2 *Bolts and Nuts*

Hexagon head bolts and nuts shall conform to IS 1363 (Part 1) and IS 1363 (Part 3) respectively.

5.2.3 *Rivets*

The steel rivets shall conform to IS 2998. When the duct material is stainless steel sheet or polyvinyl chloride lined steel sheet, the rivet shall be made of stainless steel or copper conforming to IS 2907. The requirements for stainless steel and copper rivets shall be as agreed to between the supplier and the purchaser.

5.2.4 *Adhesive*

The adhesive to be used for connection of glass wool duct shall conform to IS 848.

5.2.5 *Steel Bars*

Steel bars for the support material shall conform to IS 2062.

5.2.6 *Steel Flats*

Steel flats for support material shall conform to IS 2062.

5.2.7 *Light Gauge Steel Sections*

Light gauge steel sections for support material shall conform to IS 811.

5.2.8 *Steel Tubes*

Steel tubes for support material shall conform to IS 3601.

5.2.9 *Staples*

The staples for use at assembling of glass wool duct shall have shoulder width of 12 mm and a leg length of 13 mm to 15 mm.

5.2.10 *Flange Gasket*

The material shall be of fibre or rubber (*see* IS 11149) or resin system, shall not scatter and shall be durable. The gasket shall have good air tightness together with compressibility and flexibility and shall show only small air leakage.

5.2.11 *Tape for Duct*

The tape for duct shall be such that it has a resin adhesive coated on one side of aluminium foil of minimum 0.05 mm in thickness. The cloth tape shall be made by coating polyethylene on the original cloth in thin film and then coating rubber system adhesive thereon. The adhesive tape, which connects thermal insulating material of polystyrene foam, shall be of 0.2 mm thickness.

5.2.12 *Aluminium Tape for Glass Wool*

The aluminium tape for glass wool shall be used for connection of glass wool ducts and the material shall be as given below.

5.2.12.1 The tape shall be manufactured by coating an adhesive of resin system on one side of the aluminium foil of minimum 0.05 mm in thickness conforming to IS 13262 and shall have strength to withstand the static load and internal pressure. The adhesive strength shall be 5.49 N/cm. The foil so prepared shall be cut into a tape of 75 mm minimum widths for rectangular ducts and minimum 50 mm width for circular ducts.

5.2.12.2 The tape shall be manufactured by coating a hot melt adhesive (thermosetting resin adhesive) on one side of the aluminium foil of minimum 0.02 mm thickness and reinforced with glass fibre yarn. The foil so prepared shall be cut into a tape of minimum 60 mm width for rectangular ducts and minimum 50 mm width for circular ducts.

5.2.13 *Foam Soft Polyvinyl Chloride and Flexible Tube Gasket Used for Rectangular Rigid Polyvinyl Chloride Ducts*

The sealing material of polyvinyl chloride base shall be highly foamed and closed coil structure. Flexible tube gasket used for sealing shall have good sealing capacity.

5.2.14 *Sealing Material*

The sealing material for seams at duct corners shall be the material employing silicon rubber, nitryl rubber, butyl rubber, and chloroprene or modified silicon rubber as the base. The requirements shall be as agreed to between the purchaser and the supplier.

6 DIMENSIONS

6.1 Size of Duct

The size of duct refers to the internal dimensions of duct as illustrated in Fig. 1. The size of rectangular duct shall be expressed by 'lateral dimension × vertical dimension', and the size of circular duct by 'internal diameter'.

6.1.1 *Dimensions of Rectangular Duct*

The dimensions of long side and short side of rectangular duct shall be as given in Table 2.

6.1.1.1 Tolerance on both long side and short side –0, +4 mm.

6.1.2 *Internal Diameter of Circular Duct and Circular Spiral Duct*

Internal diameters of circular ducts and circular spiral ducts shall be as given below and tolerances thereon shall be as given in Table 3:

63, 80, 100, 125, 160, 200, 250, 315, 355, 400, 450, 500, 560, 630, 710, 800, 900, 1 000, 1 120 and 1 250 mm

NOTE — The internal diameter of circular duct shall not exceed 630 mm.

6.1.3 *Tolerances on External Diameters of Circular Duct, Circular Spiral Duct and Socket Joint*

Tolerances on external diameters of circular duct, circular spiral duct and socket joint shall be as given in Table 3.

6.2 Thickness of Sheet

The thickness of sheet shall be chosen based on the internal pressure of the duct.

The thickness of sheet of short side of rectangular duct shall be the same as that of long side.

6.2.1 *Rectangular Duct*

The thickness of sheet of rectangular duct, namely galvanized steel ducts, stainless steel ducts and rigid polyvinyl chloride ducts shall be as given in Tables 4, 5 and 6 respectively. Thickness of sheet for glass wool duct shall be 25 mm minimum.

6.2.2 *Circular Duct*

The thickness of sheet for galvanized steel sheet duct and for stainless steel sheet duct shall be as given in Table 7. The thickness of sheet for glass wool duct shall be 25 mm minimum.

6.2.3 *Circular Spiral Duct*

The thickness of sheet for circular spiral galvanized steel sheet duct and circular spiral stainless steel duct shall be as given in Tables 8 and 9 respectively.

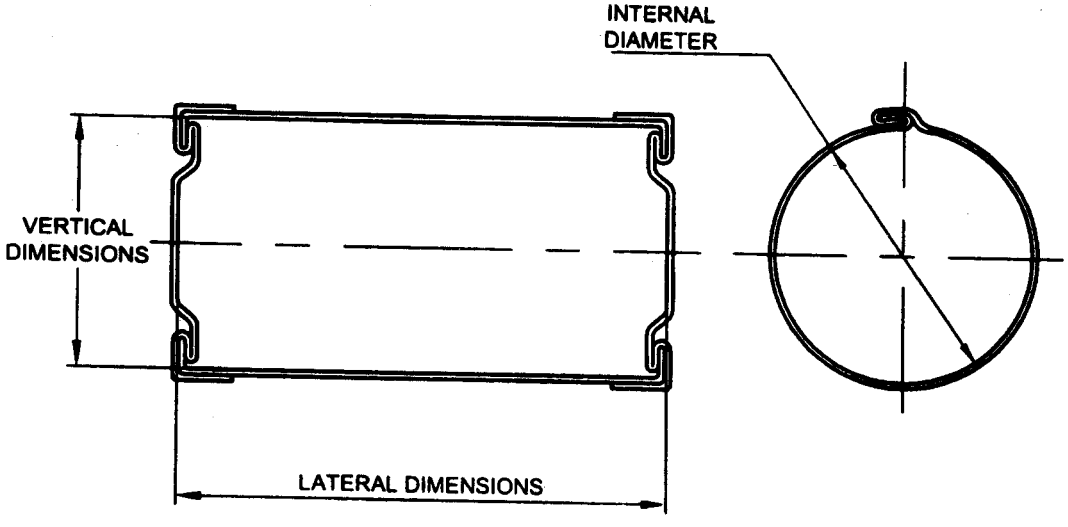

FIG. 1 SIZE OF DUCT CROSS-SECTION

Table 2 Dimensions of Long Side and Short Side of Rectangular Duct

(*Clause* 6.1.1)

SHORT SIDE \ LONG SIDE	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	2500
100		O	O	O	O		O																									
150		O	O	O	O		O		O		O																					
200			O	O	O		O		O		O		O		O																	
250				O	O		O		O		O		O		O		O															
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NOTES

1 The mark shows the standard size and inside of the thick line frame shows the recommended sizes.

2 The maximum value of the ratio of vertical dimension to lateral dimension in recommended sizes shall be 1:4.

3 The long side of duct by same sheet flange technique shali be 2 200 mm at the maximum.

Table 3 Tolerances on External Diameters of Circular Duct, Circular Spiral Duct and Socket Joint

(*Clauses* 6.1.2 *and* 6.1.3)

Internal Diameter of Duct mm	Dimensional Tolerances of Duct mm		Tolerances on External Diameter of Socket Joint mm	
	Min	*Max*	*Min*	*Max*
(1)	(2)	(3)	(4)	(5)
63	0	+0.5	−1.2	−0.7
80				
100				
125				
160		+0.6	−1.3	
200		+0.7	−1.4	
250		+0.8	−1.5	
315		+0.9	−1.6	
355		+1	−1.7	
400				
450		+1.1	−1.8	
500				
560		+ 1.2	−1.9	
630				
710		+1.6	−2	
800				
900		+2	−2.1	
1 000				
1 120		+2.5	−2.2	
1 250				

NOTE — Dimensional tolerances on cross-section of circular glass wool duct shall be ±3 mm.

6.3 Seam

6.3.1 *Configuration of Seam*

6.3.1.1 The configuration of seam in galvanized steel sheet ducts and stainless steel sheet ducts shall be as illustrated in Fig. 2, and applicable kinds of seam [(a) to (g)] for each duct shall be as given below:

Type of Duct	*Applicable Figures*
Rectangular duct	Fig. 2 (a) to Fig. 2 (d)
Circular duct (in the case of flange joint)	Fig. 2 (e)
Circular duct (in the case of socket joint)	Fig. 2 (f)
Circular spiral duct	Fig. 2 (g)

6.3.1.2 *Configuration of seam in glass wool duct*

The configuration of seam in glass wool duct shall be as follows:

a) *Seam in rectangular duct* — The connection at the corner shall be carried out in such a way that rectangular duct is formed by placing a board on the adjacent board with a minimum of 86 mm foil left at the edge, the foil is temporarily fixed by staples at intervals of 60 mm or less, and adhesive aluminum tape (with a width of minimum 75 mm) is adhered thereon by rubbing with a spatula. The staple shall have a shoulder width of 12 mm and a leg length of 18 mm to 15 mm. Typical illustration of configuration of seam are shown in Fig. 3.

Table 4 Thickness of Sheet for Galvanized Steel Sheet Duct

(*Clause* 6.2.1)

Classification of Duct by Pressure	Low Pressure Duct	Medium Pressure Duct and High Pressure Duct	Thickness of Sheet, *Min* mm
(1)	(2)	(3)	(4)
Long side of duct	$l \leq 450$	—	0.5
	$450 < l \leq 750$	—	0.6
	$750 < l \leq 1\,500$	$l \leq 450$	0.8
	$1\,500 < l \leq 2\,200$	$450 < l \leq 1\,200$	1.0
	$2\,200 < l$	$1\,200 < l$	1.2

Table 5 Thickness of Sheet for Stainless Steel Sheet Duct

(*Clause* 6.2.1)

Classification of Duct by Pressure	Low Pressure Duct	Medium Pressure Duct and High Pressure Duct	Thickness of Sheet, *Min* mm
(1)	(2)	(3)	(4)
Long side of duct	$l \leq 750$	—	0.5
	$750 < l \leq 1\,500$	—	0.6
	$1\,500 < l \leq 2\,200$	$l \leq 450$	0.8
	$2\,200 < l$	$450 < l \leq 1\,200$	1.0
	—	$1\,200 < l$	1.2

Table 6 Thickness of Sheet for Rigid Polyvinyl Chloride Duct

(*Clause* 6.2.1)

Classification of Duct by Pressure	Low Pressure Duct and Medium Pressure Duct	High Pressure Duct Pa		Thickness of Sheet, *Min* mm
	$p \leq 1\,000$	$1\,000 < p \leq 1\,500$	$1\,500 < p \leq 2\,000$	
(1)	(2)	(3)	(4)	(5)
Long side of duct	$l \leq 500$	$l \leq 500$	—	3
	$500 < l \leq 1\,000$	—	$l \leq 500$	4
	$1\,000 < l \leq 2\,000$	$500 < l \leq 2\,000$	$500 < l \leq 2\,000$	5
	$2\,000 < l$	$2\,000 < l$	$2\,000 < l$	6

Table 7 Thickness of Sheet for Galvanized Steel Sheet Duct and Stainless Steel Sheet Duct

(*Clause* 6.2.2)

Classification of Duct by Pressure	Low Pressure Duct	Medium Pressure Duct and High Pressure Duct	Thickness of Sheet, *Min* mm
(1)	(2)	(3)	(4)
Internal diameter of duct (d), mm	$d \leq 500$	—	0.5
	$500 < d \leq 630$	—	0.6
	—	$d \leq 450$	0.8
	—	$450 < d \leq 630$	1.0

Table 8 Thickness of Sheet for Circular Spiral Galvanized Steel Sheet Duct

(*Clause* 6.2.3)

Classification of Duct by Pressure	Low Pressure Duct	Medium Pressure Duct and High Pressure Duct	Thickness of Sheet, *Min* mm
(1)	(2)	(3)	(4)
Internal diameter of duct (d), mm	$d \leq 450$	$d \leq 200$	0.5
	$450 < d \leq 710$	$200 < d \leq 560$	0.6
	$710 < d \leq 1\,000$	$560 < d \leq 1\,000$	0.8
	$1\,000 < d$	$800 < d \leq 1\,000$	1.0
	—	$1\,000 < d$	1.2

Table 9 Thickness of Sheet for Circular Spiral Stainless Steel Sheet Duct

(*Clause* 6.2.3)

Classification of Duct by Pressure	Low Pressure Duct	Medium Pressure Duct and High Pressure Duct	Thickness of Sheet, *Min* mm
(1)	(2)	(3)	(4)
Internal diameter of duct (d), mm	$d \leq 560$	$d \leq 250$	0.5
	$560 < d \leq 800$	$250 < d \leq 560$	0.6
	$800 < d \leq 1\,000$	$560 < d \leq 800$	0.8
	$1\,000 < d$	$800 < d \leq 1\,000$	1.0
	—	$1\,000 < d$	1.2

b) *Seam in circular duct* — The duct shall be formed circular by coating the adhesive on the connecting parts and adhesive aluminum tape (with a width of minimum 50 mm) is adhered on the outside of seam by rubbing with a spatula. A typical illustration of configuration of seam is shown in Fig. 4.

6.3.1.3 *Configuration of seam in rigid polyvinyl chloride duct*

The straight duct is manufactured in such a way that four corners are bent, and such bent components are butt welded by hot gas at places other than bent. A typical illustration of configuration of seam is shown in Fig. 5. The edge of sheet to be welded shall be chamfered at an angle of 60° to 90° by any means such as filling, grinding, etc.

6.3.2 *Position of Seam*

6.3.2.1 *Position of longitudinal seam in rectangular duct*

a) The longitudinal seam in rectangular duct shall be positioned in any of the kinds illustrated in Fig. 6 (a) to Fig. 6 (f).

b) In the case of galvanized steel sheet ducts and stainless steel sheet ducts, the seams shall be positioned at two or more positions in general, so that the strength of duct is maintained.

c) For glass wool ducts, the positions in Fig. 6 (e) and Fig. 6 (f) shall not be used.

d) For rigid polyvinyl chloride ducts, the seam shall not be located at the corner of straight part of duct.

6.3.2.2 *Position of longitudinal seam in circular duct*

a) Longitudinal seam in circular duct shall be any of the types as given in Fig. 7.

b) For galvanized steel sheet ducts and stainless steel sheet ducts, the seam shall be as given in Fig. 7 (a).

c) For glass wool ducts, the seam shall be as given in Fig. 7 (b) or the duct shall be formed as one body.

6.3.3 *Pitch of Seam in Circular Spiral Duct*

The pitch of seam in a straight circular spiral duct shall be as given in Table 10.

Table 10 Pitch of Seam in Circular Spiral Duct

Internal Diameter (d) mm	Pitch of Seam, *Max* mm
(1)	(2)
100	125
$100 < d \leq 1\,250$	150

7 CONSTRUCTION OF JOINT

7.1 Joint of Galvanized Steel Sheet Duct and Stainless Steel Sheet Duct

7.1.1 *Joint of Rectangular Duct*

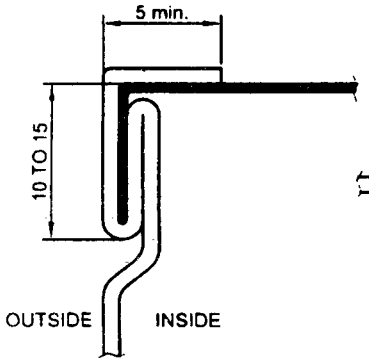
7.1.1.1 *Duct of angle flange technique*

7.1.1.1.1 In the angle flange technique, connection of ducts shall be carried out by tightening the angle flanges attached to both ends of ducts using bolts and nuts. Gasket shall be inserted between the joining faces of angle to keep air tightness. Typical configuration is given in Fig. 8.

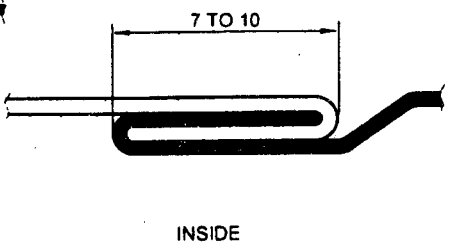
7.1.1.1.2 The angle flange shall be made in such a way that corners of four angles are welded at outside, so assembled that contacting surface of flange is flat and smooth with necessary drilling carried out.

7.1.1.1.3 The end fold of duct shall be at least 6 mm.

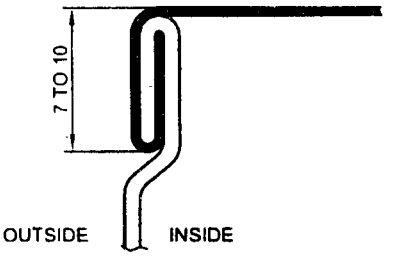
7.1.1.1.4 Joint materials for low pressure duct shall be as given in Table 11, and those for medium and high pressure ducts shall be as given in Table 12.



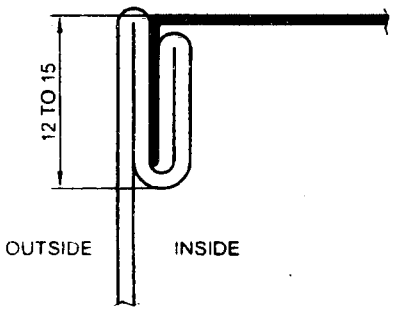
a) PITTSBURG LOCK SEAM



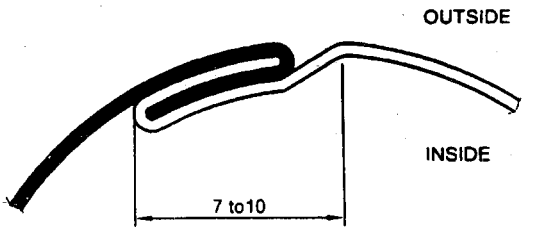
b) GROOVED LOCK SEAM



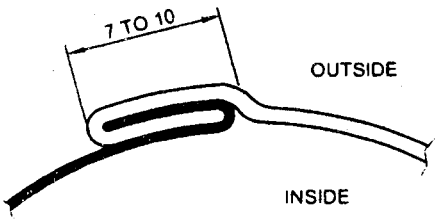
c) GROOVED CORNER LOCK SEAM



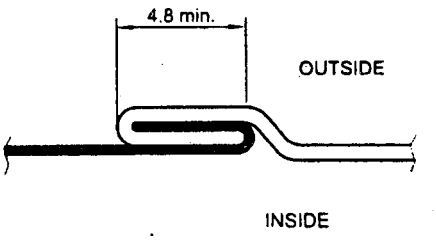
d) PITTSBURG PUNCH SNAP LOCK SEAM



e) GROOVED SEAM



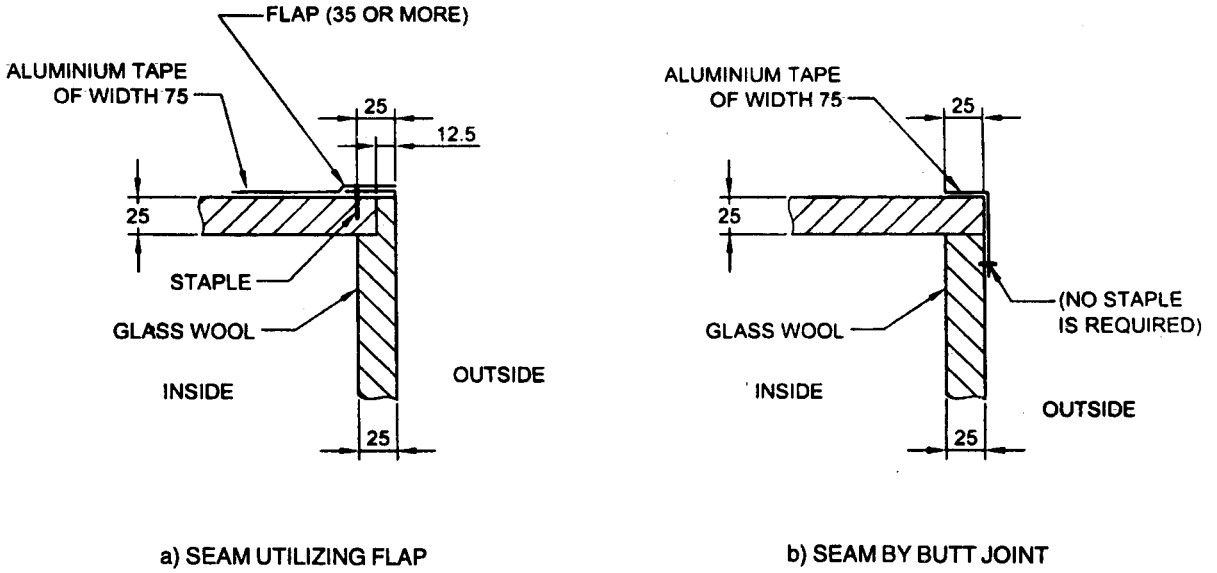
f) GROOVED SEAM



g) GROOVED SEAM

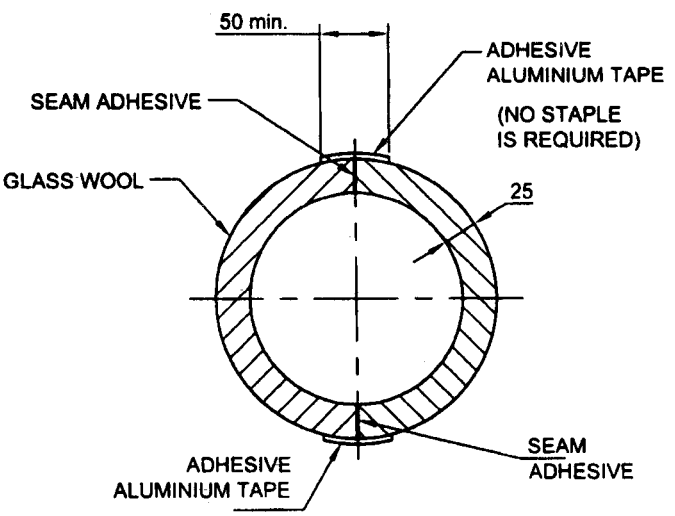
All dimensions in millimetres.

FIG. 2 CONFIGURATION OF SEAM IN DUCT



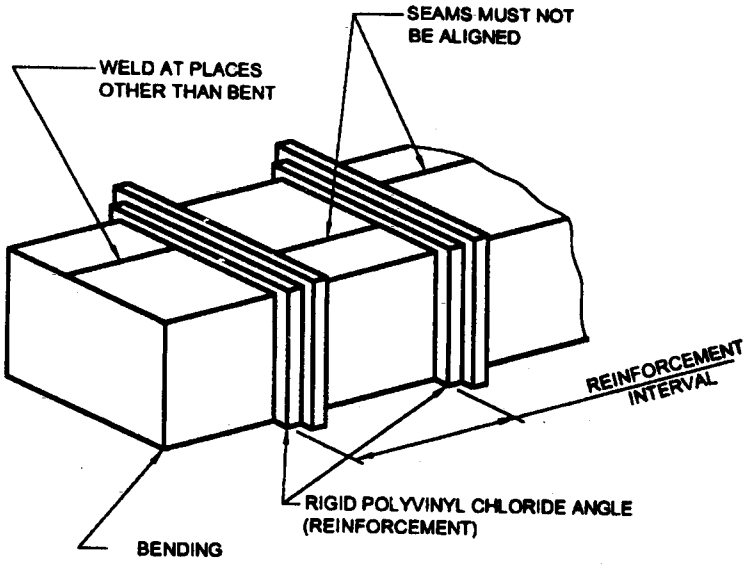
All dimensions in millimetres.

FIG. 3 EXAMPLES OF SEAM IN RECTANGULAR DUCT

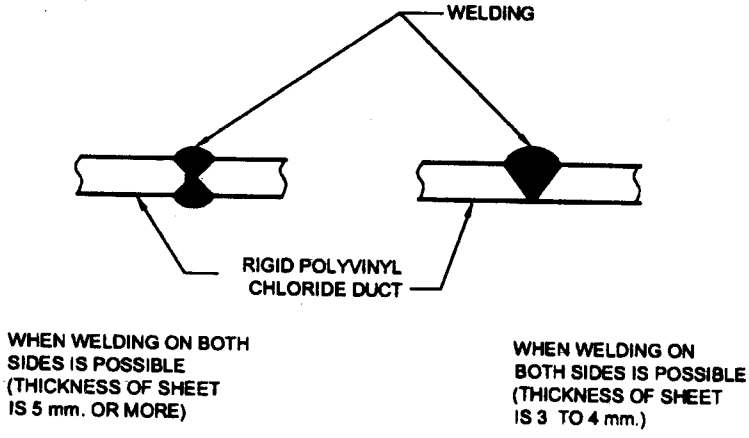


All dimensions in millimetres.

FIG. 4 EXAMPLES OF SEAM IN CIRCULAR GLASS WOOL DUCT



a) BASES OF MANUFACTURING RIGID POLYVINYL CHLORIDE DUCT



b) SEAM (BUT JOINT BY HOT GAS WELDING)

FIG. 5 EXAMPLES OF SEAM IN RIGID POLYVINYL CHLORIDE DUCT

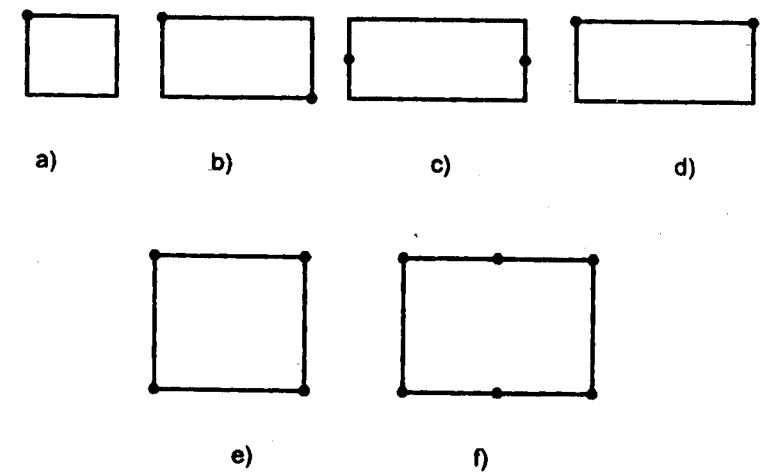


FIG. 6 POSITION AND KIND OF LONGITUDINAL SEAM IN RECTANGULAR DUCT

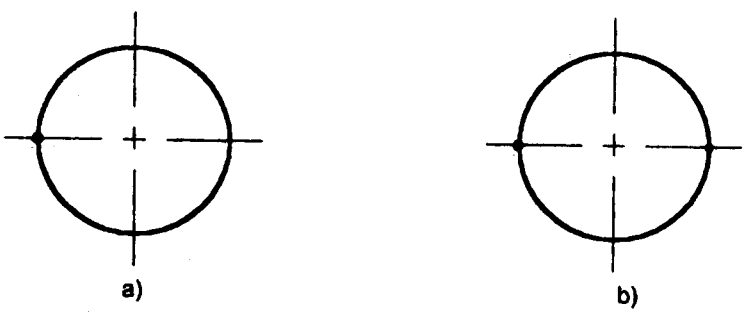


FIG. 7 POSITION OF LONGITUDINAL SEAM IN CIRCULAR DUCT

7.1.1.1.5 The dimensioning of bolt holes at the angle flange corner shall be as given in Fig. 8.

7.1.1.2 *Duct of same sheet flange technique*

7.1.1.2.1 In the same sheet flange technique, the joint is carried out by using corner metal fittings, corner bolts, same sheet flange produced by bending process of the same sheet, flange presser metal fitting (clips or the like) and gasket (*see* Table 13). Typical configuration is given in Fig. 9.

7.1.1.2.2 Joint materials shall be as given in Table 13.

7.1.1.2.3 The same sheet flange shall be formed by bending the end of duct and shall have the same thickness of sheet as that of duct.

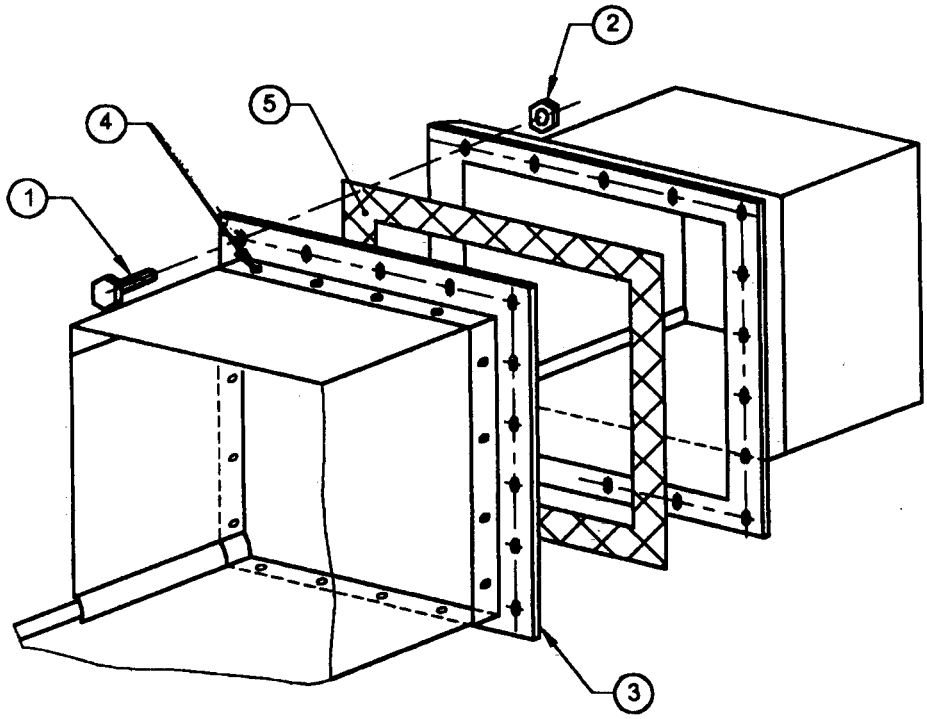
7.1.1.2.4 In addition to the bolts, the flanges shall be tightened with flange presser metal fittings (clip or the like). The flange may be reinforced with mounting fittings with bolts.

7.1.1.2.5 The flange presser metal fittings shall have a width of 150 mm or more, be located within 150 mm from the duct edge and the spacing between metal fittings shall be within 200 mm.

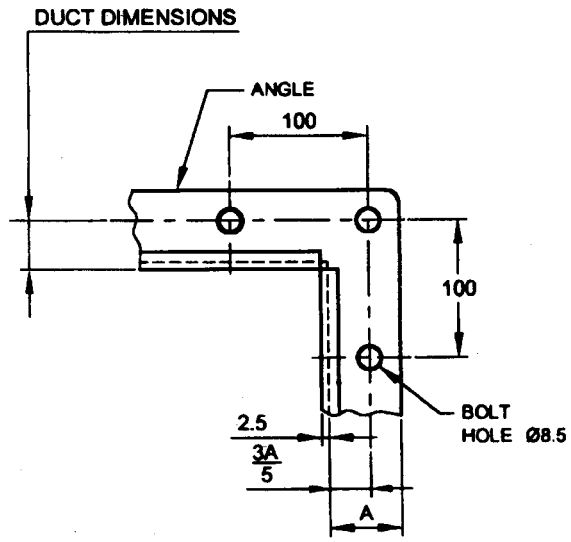
7.1.1.2.6 The height and width of flange, the thickness of sheet of corner metal fittings and flange presser metal fittings, etc, shall be as given in Table 13.

7.1.1.3 *Duct of slide-on flange technique*

7.1.1.3.1 In the slide-on flange technique, the joint is carried out by using corner metal fittings, corner bolts, sliding type flange, flange presser metal fittings (nuts, clamps, etc) and gasket. Typical configuration is given in Fig. 10.

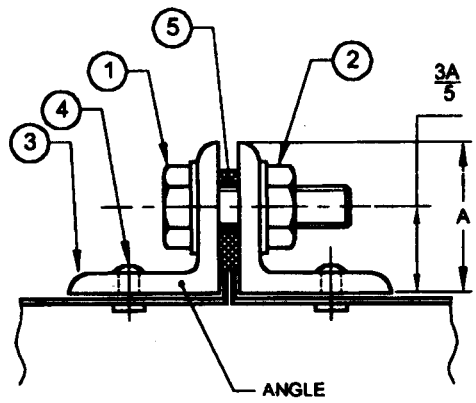


a) STRUCTURAL DRAWING



A - DIMENSIONS OF ANGLE
BOLT HOLE Ø8.5

c) MAXIMUM SPACING OF
BOLT HOLES AT CORNER



b) SECTIONAL VIEW OF FLANGE

1. BOLT (FULL THREADED)
2. NUT
3. ANGLE FLANGE
4. RIVET (FULL CIRCUMFERENCE)
5. GASKET

All dimensions in millimetres.

FIG. 8 STRUCTURE OF JOINT BY ANGLE FLANGE TECHNIQUE

Table 11 Material for Joint of Low Pressure Duct by Angle Flange Technique

(*Clause* 7.1.1.1.4)

Long Side of Duct (*l*) mm	Joint Flange		Flange Mounting Rivet		Connecting Bolt		
	Angle Minimum Size mm	Maximum Spacing mm	Minimum Nominal Diameter mm	Maximum Spacing of Rivets mm	Minimum Nominal Diameter mm	Maximum Spacing	
						Corner mm	Other Than Corner mm
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$l < 750$	25 × 25 × 3	3 640	4.5	65	M8	100	150
$750 < l \leq 1\,500$	30 × 30 × 3	2 730	4.5	65	M8	100	150
$1\,500 < l \leq 2\,200$	40 × 40 × 3	1 820	4.5	65	M8	100	150
$2\,200 < l$	40 × 40 × 5	1 820	4.5	65	M8	100	150

NOTES

1 The bolts shall be located symmetrically at the central portion of flange.

2 Electrical spot welding may be employed other than rivetting. The spacing shall be within 100 mm.

3 The diameter of connecting bolt shall not exceed a certain diameter which ensures enough edge distance of flange.

Table 12 Materials for Joint of Medium Pressure Ducts by Angle Flange Technique

(*Clause* 7.1.1.1.4)

Long Side of Duct (*l*) mm	Joint Flange		Flange Mounting Rivet		Connecting Bolt		
	Angle Minimum Size mm	Maximum Spacing mm	Minimum Nominal Diameter mm	Maximum Spacing of Rivets mm	Minimum Nominal Diameter mm	Maximum Spacing	
						Corner mm	Other Than Corner mm
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$l < 750$	25 × 25 × 3	1 820	4.5	65	M8	100	100
$750 < l \leq 1\,500$	30 × 30 × 3	1 820	4.5	65	M8	100	100
$1\,500 < l \leq 2\,200$	40 × 40 × 3	1 820	4.5	65	M8	100	100
$2\,200 < l$	40 × 40 × 5	1 820	4.5	65	M8	100	100

NOTES

1 The bolts shall be located symmetrically at the central portion of flange.

2 Electrical spot welding may be employed other than rivetting. The spacing shall be within 100 mm.

3 The diameter of connecting bolt shall not exceed a certain diameter which ensure enough edge distance of flange.

7.1.1.3.2 The flange shall be double folded and formed steel sheet, the thickness of sheet shall be at least 0.6 mm, the height of flange shall be 19 mm, 20 mm, 30 mm, or 40 mm and the flange shall be as given in Table 14.

7.1.1.3.3 The thickness of sheet of corner metal fittings shall be adequate to the material to be used for the flange. The thickness of sheet shall be as given in Table 15.

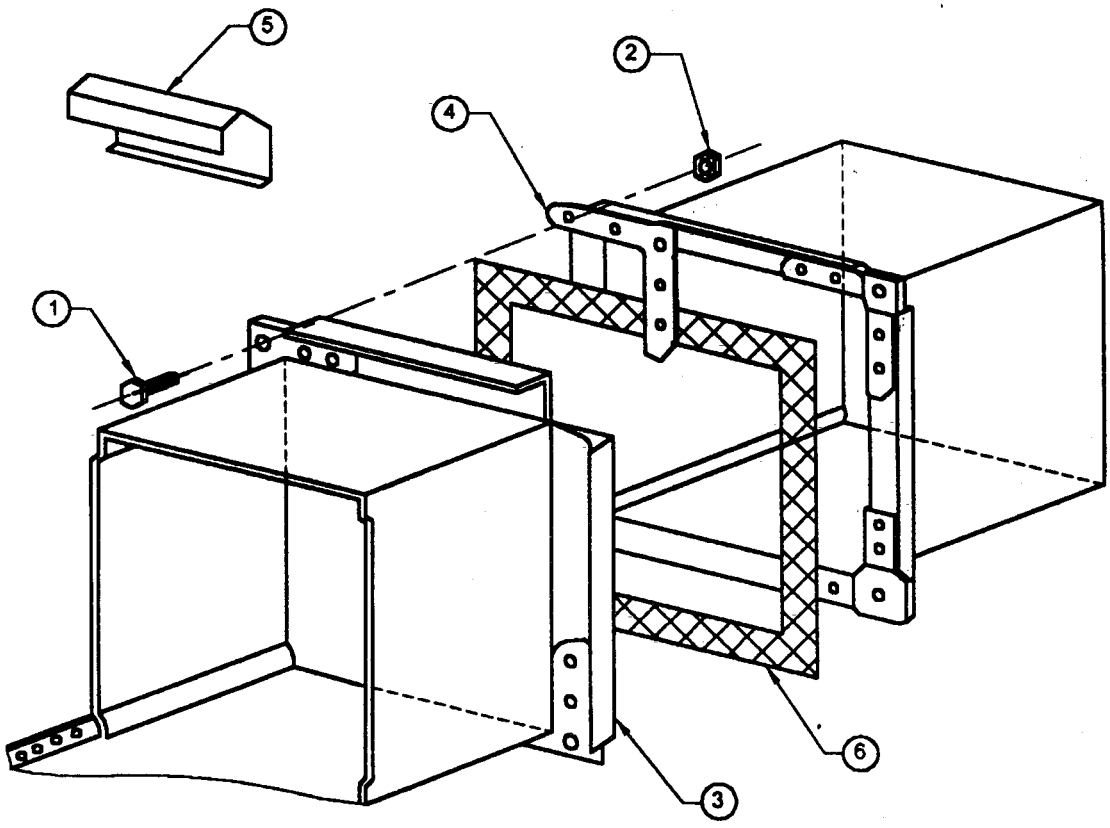
7.1.1.3.4 In addition to the bolts, flanges shall be fixed with flange presser metal fittings (nuts, clamps, etc). The fixing spacing and number of fittings shall be as given in Table 16.

7.1.1.3.5 The flange shall be mounted to the duct by electric spot welding. Spacing of spot weldings shall be within 100 mm.

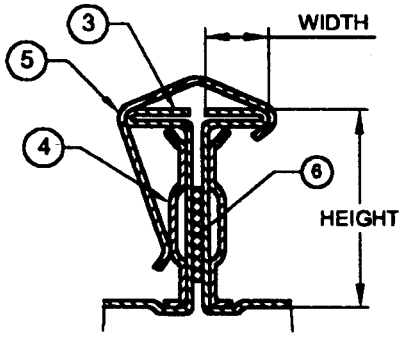
7.1.2 *Joints of Circular Duct and Circular Spiral Duct*

7.1.2.1 *Connection by socket joint*

The connecting method shall be such that the joint is coated with a sealing compound at external surface, inserted into the straight duct, connected



a) STRUCTURAL DRAWING



1. BOLT (FOUR CORNERS ONLY)
2. NUTS (FOUR CORNERS ONLY)
3. SAME SHEET FLANGE
4. CORNER METAL FITTING (CORNER PIECES)
5. FLANGE PRESSURE METAL FITTINGS (CLIPS OR THE LIKE)
6. GASKET

b) SECTION VIEW OF FLANGE

FIG. 9 EXAMPLE OF CONFIGURATION OF JOINT BY SAME SHEET FLANGE TECHNIQUE

Table 13 Material for Joint by Same Sheet Flange Technique

(*Clauses* 7.1.1.2.2 *and* 7.1.1.2.6)

Long Side of Duct (*l*)	Minimum Size of Same Sheet Flange mm				Minimum Size of Corner Metal Flange mm			Minimum Thickness of Sheet of Flange Presser Metal Fittings mm		Maximum Spacing of Joints mm	
	Height	Width	Thickness of Sheet (Thickness of Duct Sheet)		Thickness of Sheet		Nominal Diameter of Bolt	Low Pressure	High Pressure, Medium Pressure	Low Pressure	High Pressure, Medium Pressure
			Low Pressure	High Pressure, Medium Pressure	Low Pressure	High Pressure, Medium Pressure					
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$l \leq 450$	30	10	0.5	0.8	1.2	1.6	M8	1.0	1.2	3 480	2 610
$450 < l \leq 750$	30	10	0.6	1.0	1.2	1.6	M8	1.0	1.2	3 480	1 740
$750 < l \leq 1\,200$	30	10	0.8	1.0	1.2	1.6	M8	1.0	1.2	2 610	1 740
$1\,200 < l \leq 1\,500$	30	10	0.8	1.2	1.6	1.6	M8	1.0	1.2	2 610	1 740
$1\,500 < l \leq 2\,200$	30	10	1.0	1.2	1.6	1.6	M8	1.2	1.2	1 740	1 740

NOTE — The diameter of bolts for corner metal fitting shall not exceed a certain diameter which ensures enough edge distance of flange.

with duct at the periphery by means of steel machine screws of a number not less than that shown in Table 19, and the engaged part is wound with tape for duct in two layers for finishing. Typical configuration is given in Fig. 11. The thickness of sheet for socket joint, the length of insertion and the number of machine screws at the joint are given in Table 17, Table 18 and Table 19, respectively.

7.1.2.2 *Connection by flange joint*

Typical illustration of connecting method is given in Fig. 12. The connecting materials, the number of flange bolts, and dimensional positioning of flange bolt holes are given in Table 20, Table 21 and Fig. 13, respectively.

7.2 Joint of Glass Wool Duct

7.2.1 Structure of joint in rectangular or circular duct is classified into two types namely, halving joint and butt joint as given in Fig. 14.

7.2.2 In both of halving connection and butt connection, adhesive shall be coated on the cut surfaces; (adhesive) aluminum tape (with a width of minimum 75 mm for rectangular duct, or of minimum 50 mm for circular duct) is applied to the junction and adhered by rubbing with a spatula for sealing.

7.2.3 The length of insertion in the halving connection shall be 25 mm for rectangular ducts and 50 mm for circular ducts.

7.2.4 The maximum spacing of joints shall be 3 000 mm.

7.3 Joint of Rigid Polyvinyl Chloride Duct

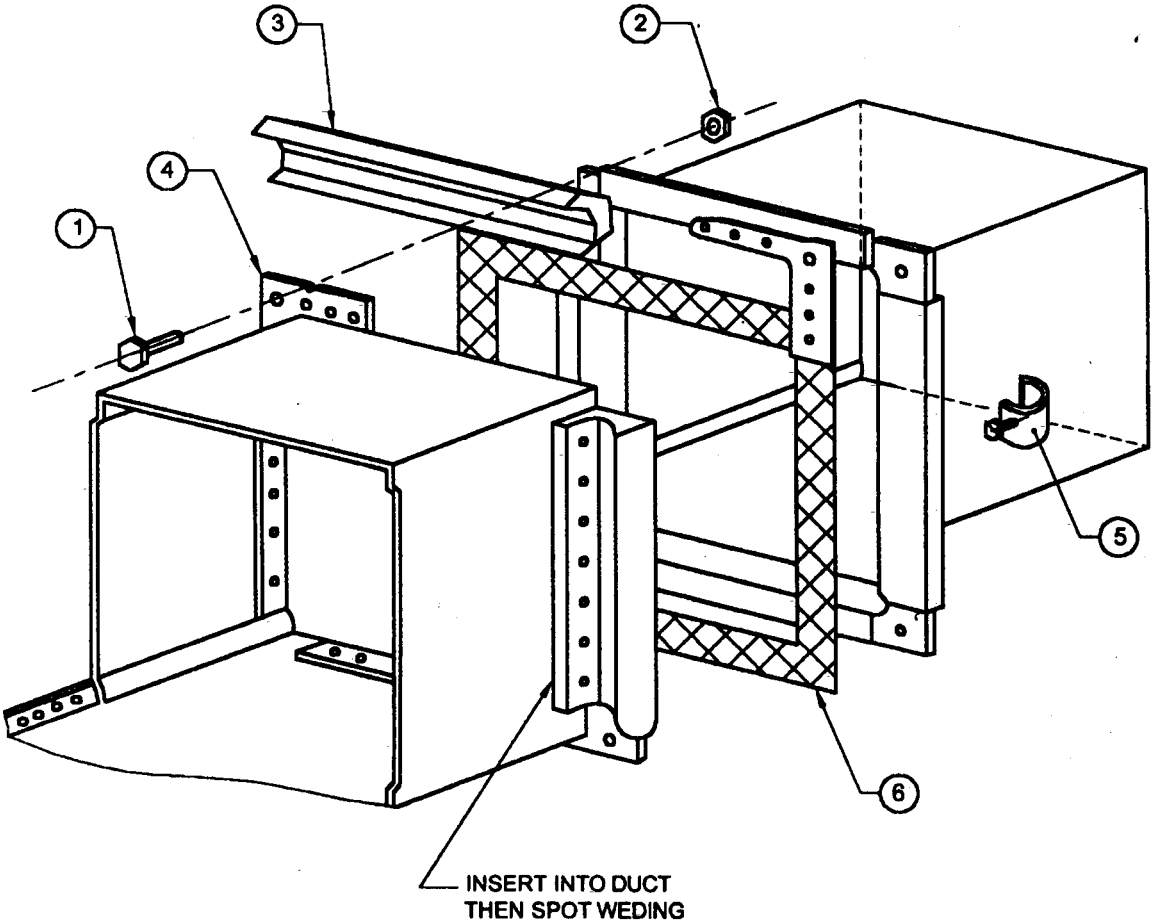
7.3.1 *Joint of Rectangular Duct*

7.3.1.1 The connection shall be carried out by tightening rigid polyvinyl chloride angles attached to the ends of both ducts by means of bolts and nuts. Gasket shall be inserted between the engaging faces of angles.

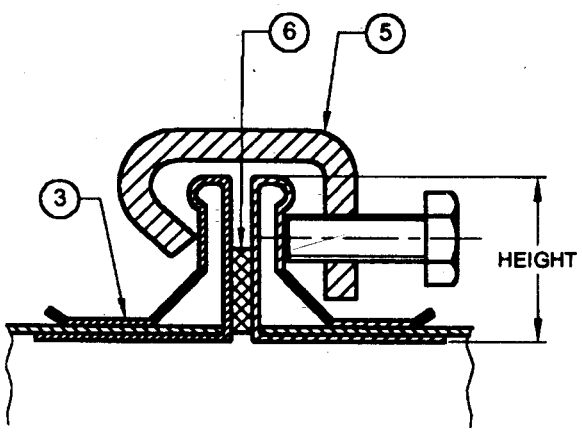
7.3.1.2 Typical configuration of joint for rectangular rigid polyvinyl chloride ducts given in Fig. 15 and joint flange in Table 22.

8 REINFORCEMENT OF DUCT

8.0 The direction of reinforcement made perpendicular to longitudinal direction of duct is called lateral direction, and that made parallel to longitudinal direction of duct is called longitudinal direction, provided that the circular spiral duct is exempted from the reinforcement.



a) STRUCTURAL DRAWING



1. BOLT (FOUR CORNERS ONLY)
2. NUTS (FOUR CORNERS ONLY)
3. SLIDE-FLANGE
4. CORNER METAL FITTING (CORNER PIECES)
5. FLANGE PRESSURE METAL FITTINGS (NUTS, CLAMPS, etc.)
6. GASKET

b) SECTION VIEW OF FLANGE

FIG. 10 EXAMPLE OF CONFIGURATION OF JOINT BY SLIDE-ON FLANGE TECHNIQUE

Table 14 Joint Flange of Slide-on Flange Technique

(*Clause* 7.1.1.3.2)

Long Side of Duct (l) mm	Minimum Size of Joint Flange						Maximum Spacing
	Low Pressure Duct		Medium Pressure Duct		High Pressure Duct		
	Height mm	Thickness of Sheet mm	Height mm	Thickness of Sheet mm	Height mm	Thickness of Sheet mm	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$l < 450$	19	0.6	20	0.9	30	1.2	3 680
$450 < l \leq 750$	20	0.9	20	0.9	30	1.2	3 680
$750 < l \leq 1\,500$	20	0.9	30	1.2	30	1.2	2 760
$1\,500 < l \leq 2\,200$	30	1.2	30	1.2	40	1.5	1 840
$2\,200 < l$	30	1.2	40	1.5	40	1.5	1 840

Table 15 Minimum Values of Thickness of Sheet for Corner Metal Fittings and Diameter of Bolt

(*Clause* 7.1.1.3.3)

Long Side of Duct (l) mm	Low Pressure Duct		Medium Pressure Duct		High Pressure Duct	
	Thickness of Sheet mm	Nominal Diameter of Bolt mm	Thickness of Sheet mm	Nominal Diameter of Bolt mm	Thickness of Sheet mm	Nominal Diameter of Bolt mm
(1)	(2)	(3)	(4)	(5)	(6)	(7)
$l \leq 450$	2.0	M8	2.3	M8	3.2	M10
$450 < l \leq 750$	2.3	M8	2.3	M8	3.2	M10
$750 < l \leq 1\,500$	2.3	M8	3.2	M10	3.2	M10
$1\,500 < l \leq 2\,200$	3.2	M10	3.2	M10	4.0	M12
$2\,200 < l$	3.2	M10	3.2	M12	4.0	M12

NOTE — The diameter of bolts for corner metal fitting shall not exceed certain diameter, which ensures enough edge distance of flange.

Table 16 Fixing Spacing and Number of Flange Pressure Metal Fittings (with Bolt) Size of Joint Flange

(*Clause* 7.1.1.3.4)

Long Side of Duct (l) mm	Low Pressure Duct		Medium Pressure Duct		High Pressure Duct	
	Number of Pieces	Maximum Spacing mm	Number of Pieces	Maximum Spacing mm	Number of Pieces	Maximum Spacing mm
(1)	(2)	(3)	(4)	(5)	(6)	(7)
$l \leq 450$	0	—	0	—	0	—
$450 < l \leq 1\,000$	0	—	1	700	1	650
$1\,000 < l \leq 1\,300$	1	1 000	1	700	1	650
$1\,300 < l \leq 1\,400$	1	1 000	1	700	2	670
$1\,400 < l \leq 2\,000$	1	1 000	2	700	2	670
$2\,000 < l$	2	1 000	3	800	3	700

Table 17 Thickness of Sheet for Socket Joint

(*Clause* 7.1.2.1)

Internal Diameter of Duct (*d*) mm	Minimum Thickness mm
(1)	(2)
$d \leq 315$	0.6
$315 < d \leq 710$	0.8
$710 < d \leq 1\,000$	1.0
$1\,000 < d \leq 1\,250$	1.2

Table 18 Length of Insertion for Socket Joint

(*Clause* 7.1.2.1)

Internal Diameter of Duct (*d*) mm	Minimum Length mm
(1)	(2)
$d \leq 315$	25
$315 < d \leq 800$	50
$800 < d \leq 1\,250$	100

Table 19 Number of Machine Screws at Engaged Part of Socket Joint

(*Clause* 7.1.2.1)

Internal Diameter of Duct (*d*) mm	Minimum Number of Bolts at One Side
(1)	(2)
$d \leq 355$	4
$355 < d \leq 560$	6
$560 < d \leq 800$	8
$800 < d \leq 1\,250$	12

8.1 Reinforcement of Galvanized Steel Duct

8.1.1 *Reinforcement of Low Pressure Duct*

8.1.1.1 *Lateral reinforcement*

The spacing of lateral reinforcement depending on joint technique is given in Table 23. The flange junction made in duct of angle flange technique, duct of same sheet flange technique and duct of slide-on flange technique is considered as the lateral reinforcement.

8.1.1.2 *Longitudinal reinforcement*

For ducts of the sizes given in Table 24 in addition the lateral reinforcement given in Table 23 is performed and longitudinal reinforcement shall also be carried out.

8.1.2 *Reinforcement of Medium and High Pressure Duct*

8.1.2.1 *Lateral reinforcement*

The spacing of lateral reinforcement shall be as given in Table 25. The flange junction made in duct of angle flange technique, duct of same sheet flange technique and duct of slide-on flange technique is considered as the lateral reinforcement.

8.1.2.2 *Longitudinal reinforcement*

For ducts of the sizes given in Table 26, in addition to the lateral reinforcement given in Table 26, longitudinal reinforcement shall also be carried out.

8.2 Reinforcement of Stainless Steel Sheet Duct

8.2.1 *Reinforcement of Low Pressure Duct*

Reinforcement of low pressure duct shall be as given in Table 27.

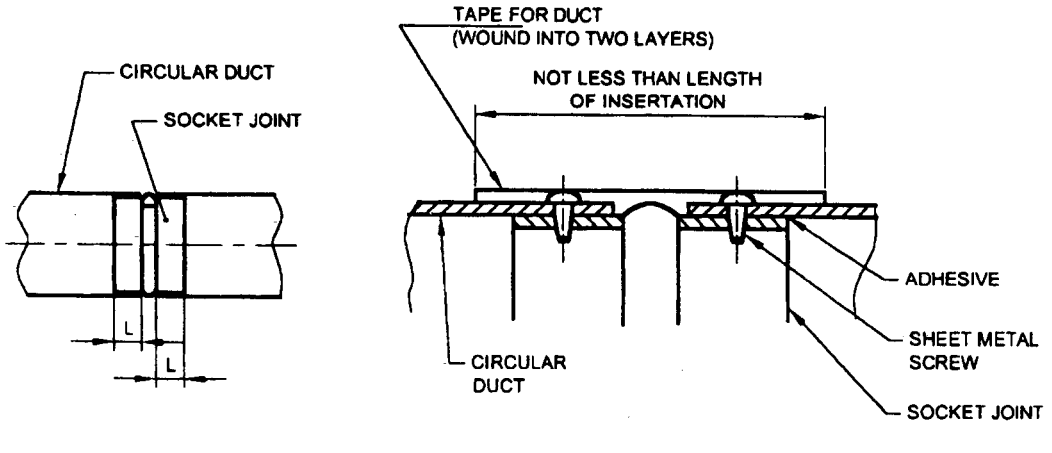


FIG. 11 EXAMPLE OF CONNECTION BY SOCKET JOINT

Table 20 Connecting Materials for Flange Joint

(*Clause* 7.1.2.2)

Internal Diameter of Duct (d) mm	Joint Flange		Flange Mounting Rivet		Connecting Bolt	
	Minimum Size of Angle mm	Maximum Spacing mm	Minimum Nominal Diameter mm	Maximum Spacing mm	Minimum Nominal Diameter mm	Maximum Spacing mm
(1)	(2)	(3)	(4)	(5)	(6)	(7)
$d \leq 710$	25×25×3	1 820	4.5	65	M8	100
$710 < d \leq 1\,000$	30×30×3	1 820	4.5	65	M8	100
$1\,000 < d \leq 1\,260$	40×40×3	1 820	4.5	65	M8	100

NOTE — The diameter of connecting bolt shall not exceed a certain diameter which ensures enough edge distance of flange.

Table 21 Number of Flange Connecting Bolts

(*Clause* 7.1.2.2)

Internal Diameter of Duct (d) mm	Minimum Number of Bolts
(1)	(2)
$d \leq 160$	6
$160 < d \leq 250$	8
$250 < d \leq 355$	12
$355 < d \leq 500$	16
$500 < d \leq 630$	20
$630 < d \leq 710$	24
$710 < d \leq 1\,000$	32
$1\,000 < d \leq 1\,250$	40

8.2.2 *Reinforcement of Medium and High Pressure Duct*

Reinforcement of high pressure duct shall be as given in **8.1.2**.

NOTES

1 The sections shall be of stainless steel or of steel.

2 Mounting of the sections shall be made by riveting or electric spot welding.

3 The rivet shall be that of stainless steel with a nominal diameter not less than 5.0 mm and the pitch shall not exceed 100 mm.

4 For ducts not thermally insulated with a long side exceeding 450 mm, brake or reinforcement rib with a pitch not exceeding 300 mm be mounted.

5 The longitudinal reinforcement shall be evenly spaced on the side of duct so that the specified number of reinforcements is obtained.

8.3 Reinforcement by Tie Rod

8.3.1 When both of steel angle and tie rod is used in a rectangular duct the following requirements shall be satisfied (*see* Fig. 16, 17 and 18).

8.3.2 For ducts of slide-on flange technique or of same sheet flange technique having a length of side as given in Tables 28 and 29, reinforcement shall be made by means of both of steel angle and tie rod.

8.3.3 The tie rod shall be located at a position where the lateral reinforcement and the longitudinal reinforcement intersect or in the vicinity thereof.

8.3.4 The nominal diameter of tie rod shall be minimum 9 mm when the rod is one in each side, and 12 mm minimum when the rods are two or more in one or both sides.

8.3.5 In the case of the long side of duct of slide-on flange technique utilizing tie rod and steel angle exceeds 2 200 mm, the size of steel angle 40 mm × 40 mm × 5 mm may be replaced by 40 mm × 40 mm × 3 mm.

8.4 Reinforcement of Circular Galvanized Steel Sheet or Stainless Steel Sheet Duct

The reinforcement of circular galvanized steel sheet or stainless steel sheet duct shall be carried out by means of steel angles as given in Table 30.

8.5 Reinforcement of Glass Wool Duct

8.5.0 There are two methods for reinforcement of rectangular glass wool duct that is the method by material employing light gauge steel sections as the base metal (light gauge steel substrate) and the method by tie rod.

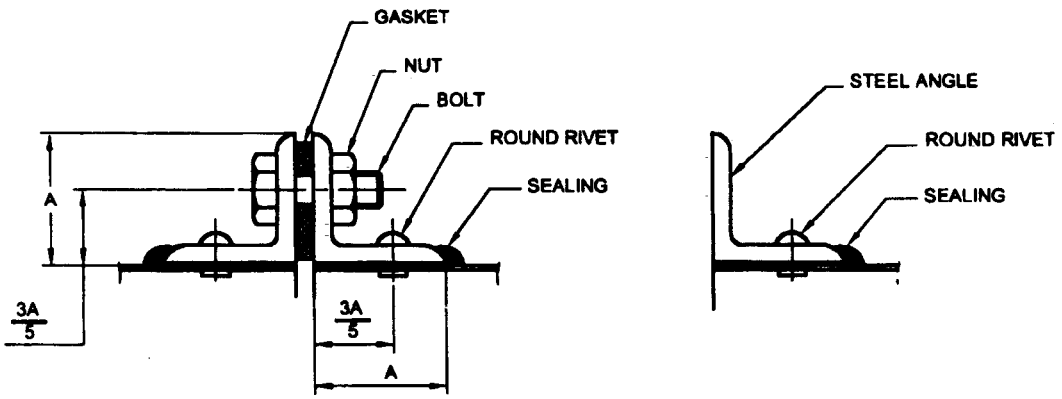
However, circular ducts need not be reinforced.

8.5.1 *Reinforcement by Light Gauge Section Substrate*

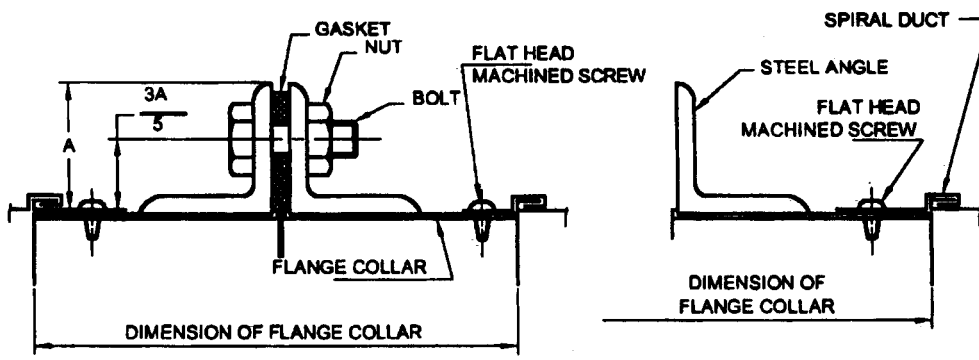
8.5.1.1 *Reinforcement of horizontal duct positively pressurized*

The reinforcement of horizontal duct positively pressurized shall be as given below, in addition to compliance with Table 31.

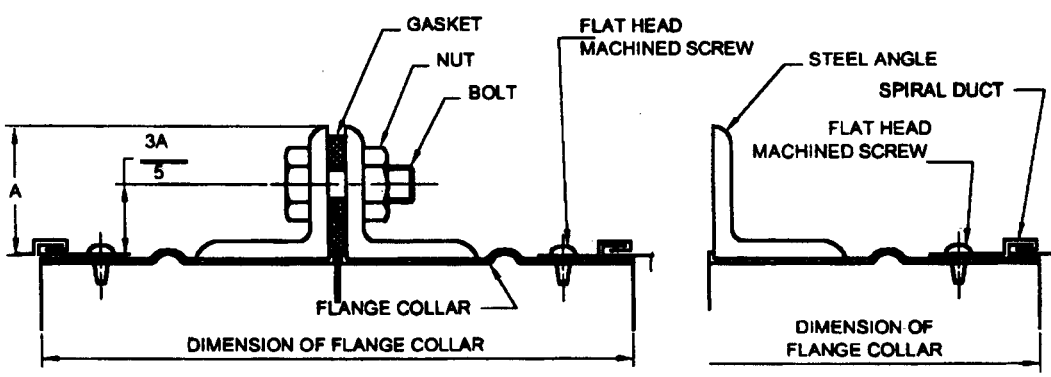
a) The washers and tie rods shall be mounted to the positions which divide the side evenly.



a) FLANGE JOINT IN CIRCULAR DUCT



b) EXAMPLE 1 OF FLANGE JOINT IN SPIRAL DUCT



c) EXAMPLE 2 OF FLANGE JOINT IN SPIRAL DUCT

A : DIMENSION OF STEEL ANGLE

FIG. 12 EXAMPLE OF JUNCTION BY FLANGE JOINT IN CIRCULAR DUCT AND CIRCULAR SPIRAL DUCT

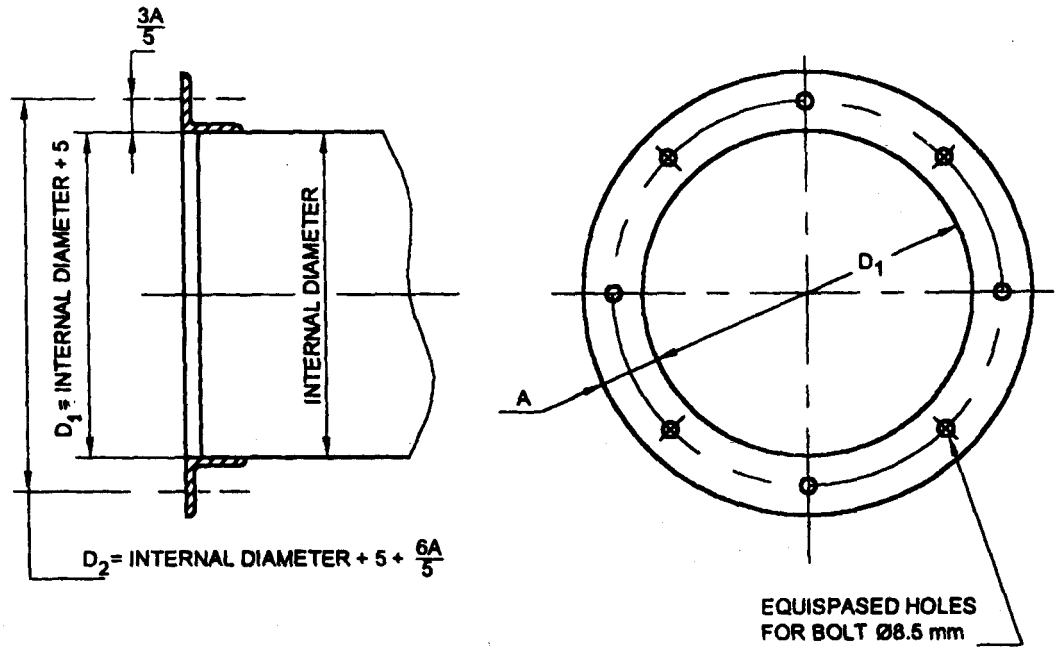


FIG. 13 DIMENSIONAL POSITIONING OF FLANGE JOINT BOLT HOLES

b) Typical illustration of reinforcement by light gauge steel furring is given in Fig. 19.

8.5.1.2 *Reinforcement of positively pressurized vertical duct (air supply vertical duct)*

The reinforcement of positively pressurized vertical duct shall be as given below, in addition to compliance with Table 32.

a) The washers and tie rods shall be mounted to the positions which divide the side evenly.

b) Typical illustration of reinforcement by light gauge steel furrings is given in Fig. 20 (common to air inlet and air return).

8.5.1.3 *Reinforcement of negatively pressurized duct*

The reinforcement of duct negatively pressurized shall be as given below in addition to compliance with Table 33.

a) The washers and tie rods shall be mounted to the positions which divide the side evenly.

b) Typical illustration of reinforcement by light gauge steel furrings is given in Fig. 21 (common to air inlet and air return).

8.5.2 *Reinforcement by Tie Rods (Common to Air Supply Duct and Air Return Duct)*

8.5.2.1 The reinforcement by tie rods shall be as given below, in addition to compliance with Table 34.

a) Tie rods shall be mounted to the positions which divide the side evenly.

b) Typical illustration of reinforcement by tie rods is shown in Fig. 22.

8.6 Reinforcement of Polyvinyl Chloride Duct

The rigid polyvinyl chloride angle used for reinforcement of polyvinyl chloride duct shall be attached to the duct by hot gas welding, and the reinforcing steel flats shall be attached to rigid polyvinyl chloride angle with stainless steel bolts.

8.6.1 *Lateral Reinforcement Between Joints of Rectangular Duct*

The lateral reinforcement between joints of rectangular duct shall be as given in Table 35.

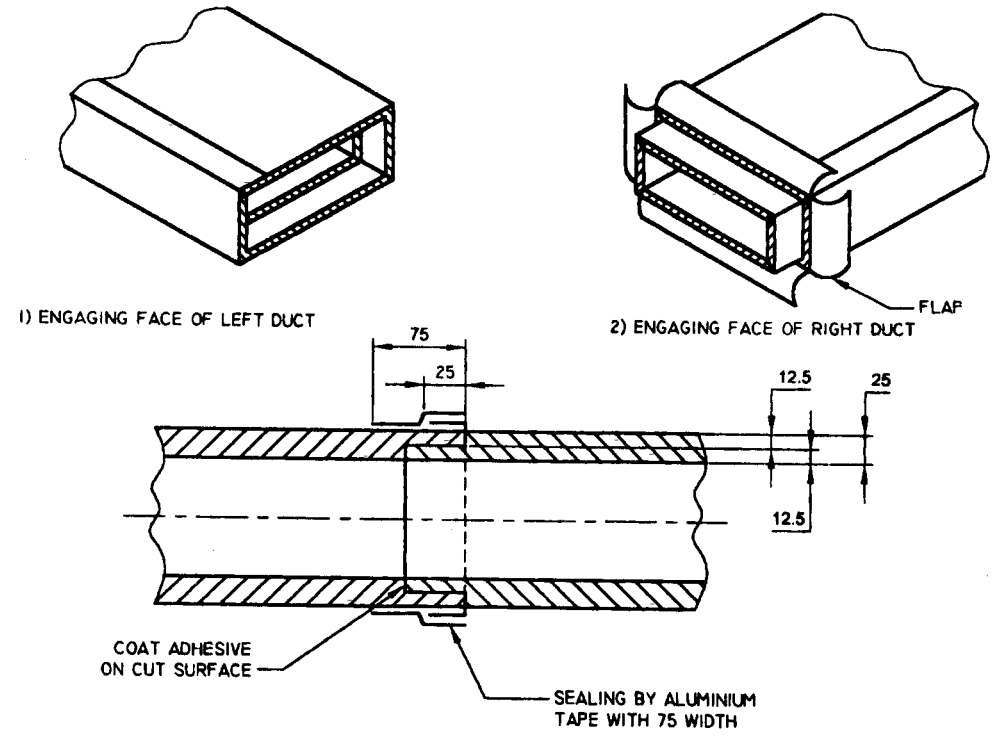
Typical illustration of the lateral reinforcement is given in Fig. 23.

8.6.2 *Longitudinal Reinforcement of Rectangular Duct*

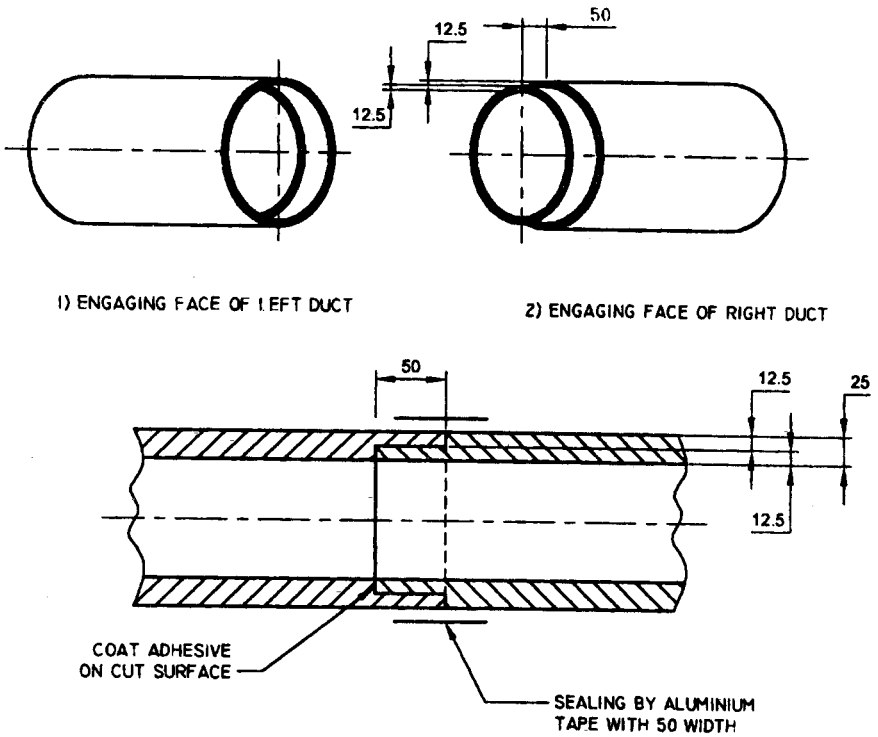
The longitudinal reinforcement of rectangular duct shall be as given in Table 36.

9 SEAL OF DUCT

9.0 N seal, A seal, B seal and C seal shall be applied to the duct according to the positions in the duct, to maintain the internal pressure and to limit the air leakage.



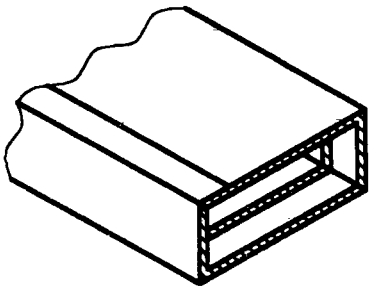
a) HALVING JOINT OF RECTANGULAR DUCT



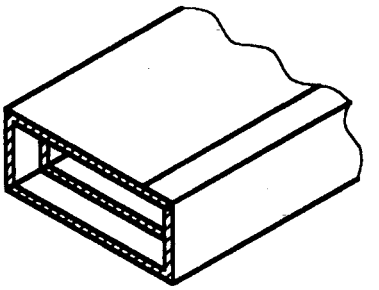
b) HALVING JOINT OF CIRCULAR DUCT

All dimensions in millimetres.

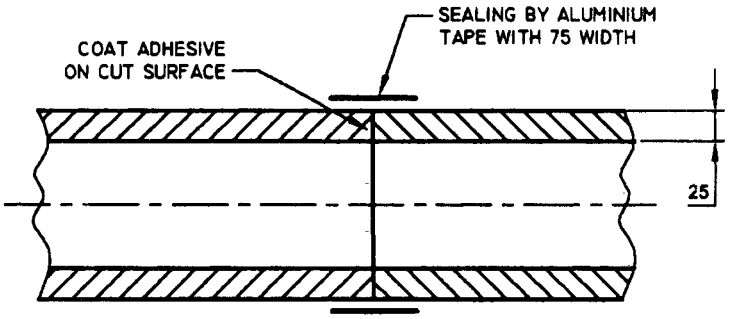
FIG. 14 EXAMPLE OF JOINT STRUCTURE IN GLASS WOOL DUCT — *Continued*



1) ENGAGING FACE OF LEFT DUCT

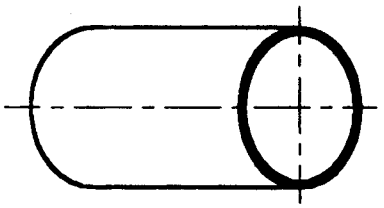


2) ENGAGING FACE OF RIGHT DUCT

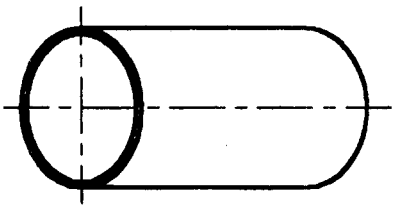


3) DETAIL SECTION OF ENGAGING FACE

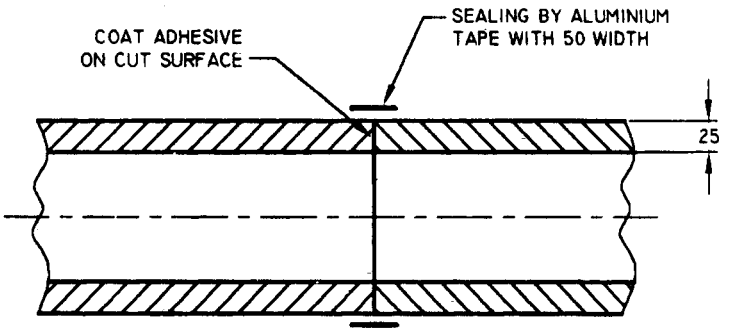
c) BULTT JOINT OF RECTANGULAR DUCT



1) ENGAGING FACE OF LEFT DUCT



2) ENGAGING FACE OF RIGHT DUCT



3) DETAIL SECTION OF ENGAGING FACE

d) BUTT JOINT OF CIRCULAR DUCT

All dimensions in millimetres.

FIG. 14 EXAMPLE OF JOINT STRUCTURE IN GLASS WOOL DUCT

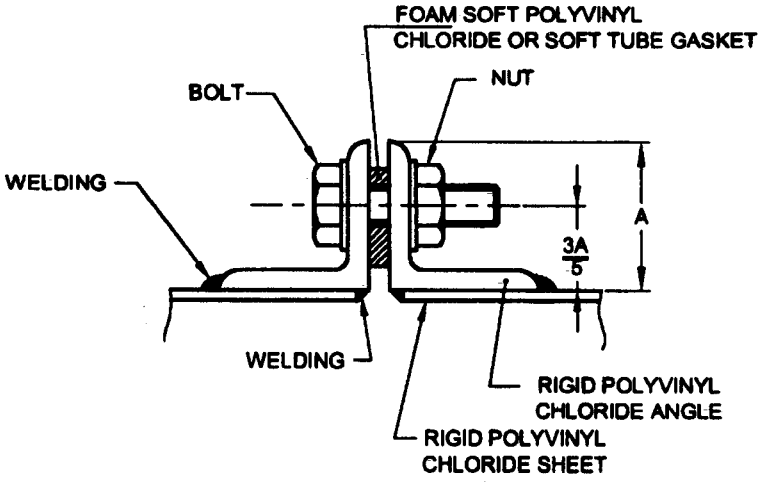


FIG. 15 EXAMPLE OF CONFIGURATION OF JOINT FOR RECTANGULAR RIGID POLYVINYL CHLORIDE DUCT

Table 22 Joint Flange for Rectangular Rigid Polyvinyl Chloride Duct

(*Clause* 7.3.1.2)

Long Side of Duct (l) mm	Joint Flange			
	Minimum Size of Rigid Polyvinyl Chloride Angle mm	Maximum Spacing mm	Connecting Bolt	
			Minimum Nominal Diameter mm	Maximum Spacing mm
(1)	(2)	(3)	(4)	(5)
$l \leq 500$	50 × 50 × 6	4 000	M8 (M10)	100 (75)
$500 < l \leq 1\,000$	60 × 60 × 7	4 000	M8 (M12)	100 (75)
$1\,000 < l \leq 1\,500$	60 × 60 × 7	3 000	M8 (M12)	100 (75)
$1\,500 < l \leq 2\,000$	60 × 60 × 7	3 000	M8	100
$2\,000 < l \leq 3\,000$	60 × 60 × 7	2 000	M8	100

NOTES

1 The connecting bolts and nuts shall be made of stainless steel or rigid polyvinyl chloride.

2 The values given in parenthesis in the column of connecting bolt show the values when rigid polyvinyl chloride bolt is used.

3 Foam soft polyvinyl chloride or soft tube gasket with the same width as that of flange and a thickness of 3 mm or more shall be used for connection of flanges and the flanges shall be tightened airtight by means of bolts.

4 The diameter of connecting bolt shall not exceed a certain diameter which ensures enough edge distance of flange.

Table 23 Lateral Reinforcement of Low Pressure Duct

(*Clause* 8.1.1.1)

Long Side of Duct (l) mm	Type and Spacing of Reinforcement			
	Minimum Size of Steel Angle Reinforcement mm	Maximum Spacing		
		Angle Flange Technique mm	Slide-on Flange Technique mm	Same Sheet Flange Technique mm
(1)	(2)	(3)	(4)	(5)
$250 < l \leq 750$	25 × 25 × 3	1 840	1 840	1 840
$750 < l \leq 1\,500$	30 × 30 × 3	925	925	925
$1\,500 < l \leq 2\,200$	40 × 40 × 3	925	925	925 + Tie rod
$2\,200 < l$	40 × 40 × 5 (3)	925	925 + Tie rod	—

NOTE — The value given in parenthesis shows that when tie rods are also used.

Table 24 Longitudinal Reinforcement of Low Pressure Duct

(*Clause* 8.1.1.2)

Long Side of Duct (l) mm (1)	Minimum Size of Steel Angle mm (2)	Position of Reinforcement (3)
$1\,500 < l \leq 2\,200$	$40 \times 40 \times 3$	One point or more
$2\,200 < l$	$40 \times 40 \times 5$ (3)	Two points or more

NOTES

1 The value given in parenthesis shows that when tie rods are also used.

2 Angle reinforcement may be outside or inside of the duct.

Table 25 Lateral Reinforcement of Medium and High Pressure Duct

(*Clause* 8.1.2.1)

Long Side of Duct (l) mm (1)	Spacing of Reinforcement			
	Minimum Size of Steel Angle Reinforcement mm (2)	Maximum Spacing		
		Angle Flange Technique mm (3)	Slide-on Flange Technique mm (4)	Same Sheet Flange Technique mm (5)
$250 < l \leq 750$	$25 \times 25 \times 3$	925	925	925
$750 < l \leq 1\,200$	$30 \times 30 \times 3$	925	925	925
$1\,200 < l \leq 2\,200$	$40 \times 40 \times 3$	925	925 + Tie rod	925 + Tie rod
$2\,200 < l$	$40 \times 40 \times 5$ (3)	925	925 + Tie rod	—

NOTE — The value given in parenthesis shows that when tie rods are also used.

Table 26 Longitudinal Reinforcement of Medium and High Pressure Duct

(*Clause* 8.1.2.2)

Long Side of Duct (l) mm (1)	Minimum Size of Steel Angle mm (2)	Position of Reinforcement (3)
$1\,200 < l \leq 2\,200$	$40 \times 40 \times 3$	One point or more
$2\,200 < l$	$40 \times 40 \times 5$ (3)	Two points or more

NOTES

1 The value given in parenthesis shows that when tie rods are also used.

2 The mounting of steel angle shall be made by rivets of nominal diameter not less than 4.5 mm or electrical spot welding and the spacing between welding shall not exceed 100 mm.

3 For ducts not thermally insulated with a long side exceeding 450 mm, diamond brake or reinforcement rib with a pitch not exceeding 300 mm shall be mounted.

4 The longitudinal reinforcement shall be evenly spaced on the side of duct so that the specified number of reinforcements is obtained.

5 Angle reinforcement may be outside or inside of the duct.

Table 27 Reinforcement of Low Pressure Duct

(*Clause* 8.2.1)

Classification	Long Side of Duct (l) mm	Reinforcement by Steel Angle	
		Minimum Size of Steel Angle mm	Maximum Spacing mm
Lateral reinforcement	$300 < l \leq 750$	25 × 25 × 3	2 000
	$750 < l \leq 1\,500$	30 × 30 × 3	1 000
	$1\,500 < l \leq 2\,200$	40 × 40 × 3	1 000
	$2\,200 < l$	40 × 40 × 3	1 000
Longitudinal reinforcement	$1500 < l \leq 2\,200$	40 × 40 × 3	One point or more at central part
	$2\,200 < l$	40 × 40 × 3	Two points or more at central part

Table 28 Mounting Position and Nominal Diameter of Tie Rod in Low Pressure Duct (Common to Slide-on Flange Technique and Same Sheet Flange Technique)

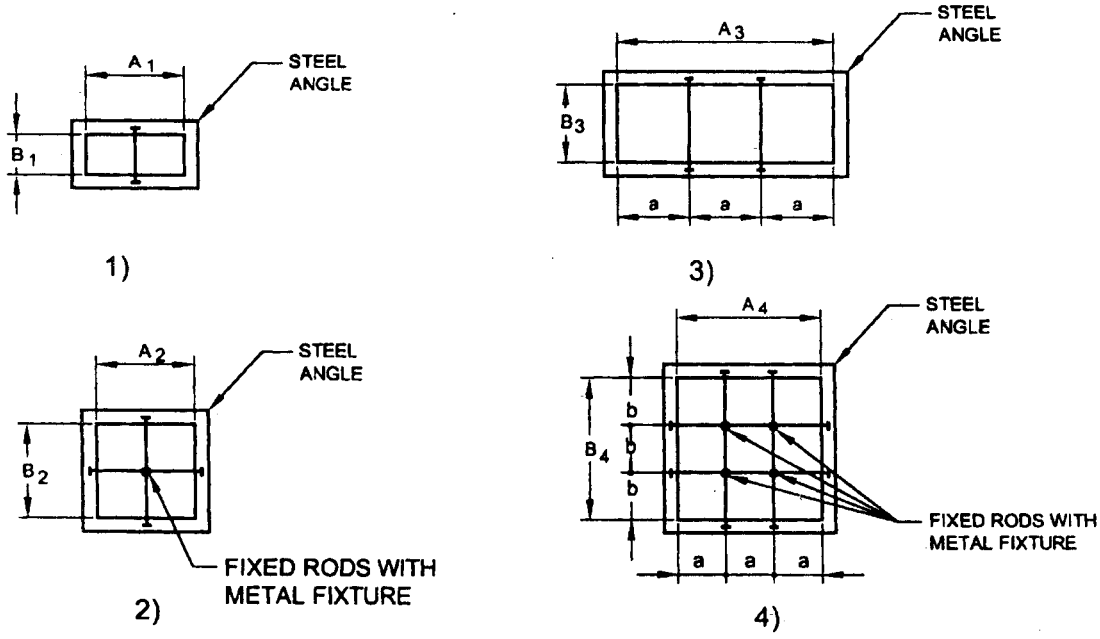
(*Clause* 8.3.2)

Title of Figure	Dimension of Duct		Spacing of Tie Rod Mounting	Minimum Nominal Diameter of Steel Bar for Tie Rod mm
	Dimension A mm	Dimension B mm		
(1)	(2)	(3)	(4)	(5)
1)	$1\,500 < A_1 \leq 2\,200$	$1\,500 \geq B_1$	One centre of side A_1	9
2)	$1\,500 < A_2 \leq 2\,200$	$1\,500 < B_2 \leq 2\,200$	One in each side (two in total)	9
3)	$2\,200 < A_3$	$1500 \geq B_3$	a: 1 100, *Max*	12
4)	$2\,200 < A_4$	$2\,200 < B_4$	a: 1 100, *Max* b: 1 100, *Max*	12

Table 29 Intermediate Reinforcement by Tie Rod and Its Size in Medium Pressure Duct or High Pressure Duct (Common to Slide-on Flange Technique and Same Sheet Flange Technique)

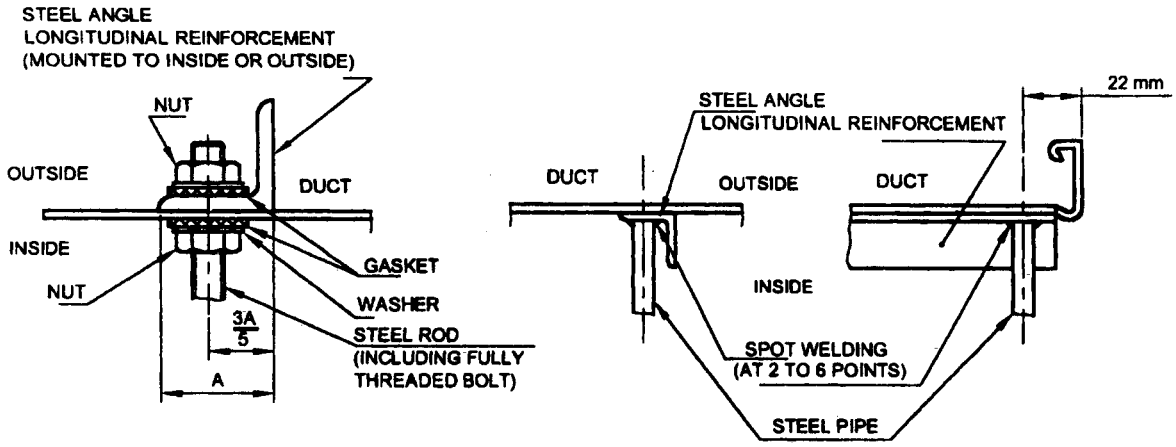
(*Clause* 8.3.2)

Title of Figure	Dimensions of Duct		Spacing of Tie Rod	Minimum Nominal Diameter of Steel Bar for Tie Rod mm
	Dimension A mm	Dimension B mm		
(1)	(2)	(3)	(4)	(5)
1)	$1\,200 < A_1 \leq 1\,800$	$1200 \geq B_1$	One at centre of side A_1	12
2)	$1\,200 < A_2 \leq 1\,800$	$1\,200 < B_2 \leq 1\,800$	One in each side (two in total)	12
3)	$1\,800 < A_3$	$1200 \geq B_3$	a: 900, *Max*	12
4)	$1\,800 < A_4$	$1\,800 < B_4$	a: 900, *Max* b: 900, *Max*	12



REMARKS:-
A_1 TO A_4 INDICATE LONG SIDE OF THE DUCT
B_1 TO B_4 INDICATE SHORT SIDE OF THE DUCT

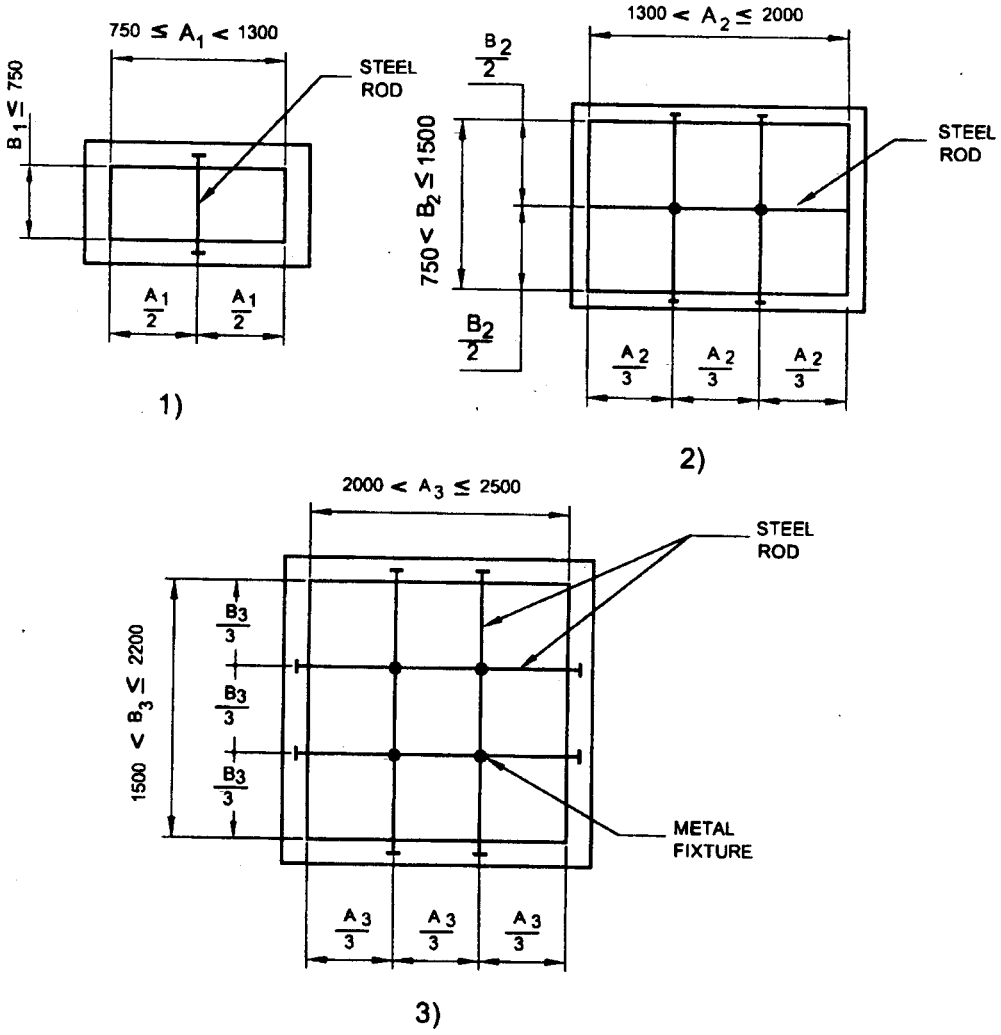
a) MOUNTING POSITION OF TIE ROD ON RECTANGULAR DUCT



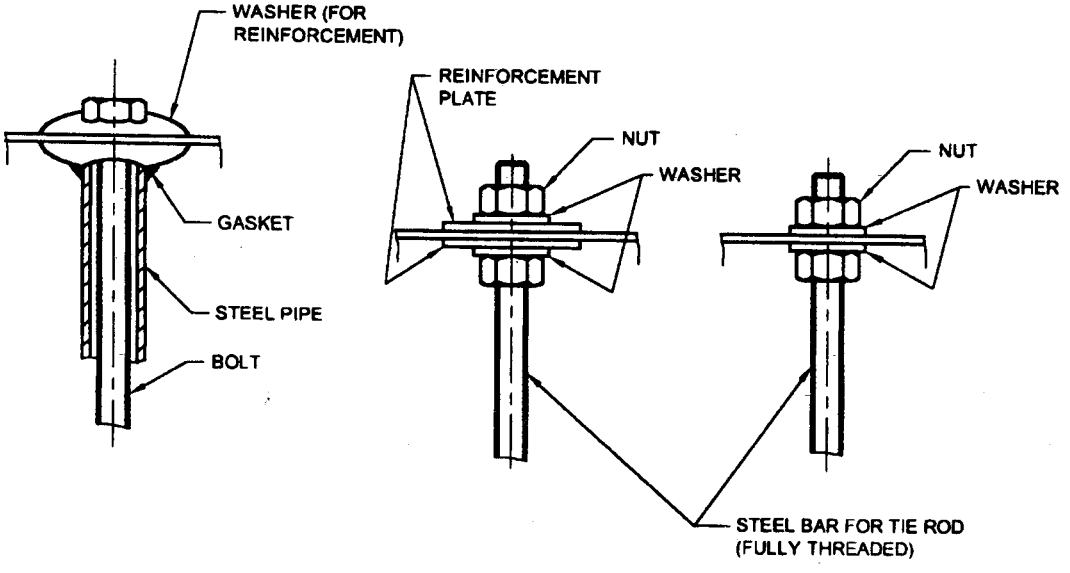
REMARKS:- THE NOMINAL DIAMETER OF STEEL ROD SHALL BE AS SPECFIED IN TABLES 29 AND 30

b) EXAMPLE OF DETAIL DRAWING FOR MOUNTING OF TIE RODS

FIG. 16 REINFORCEMENT BY STEEL ANGLE AND TIE ROD

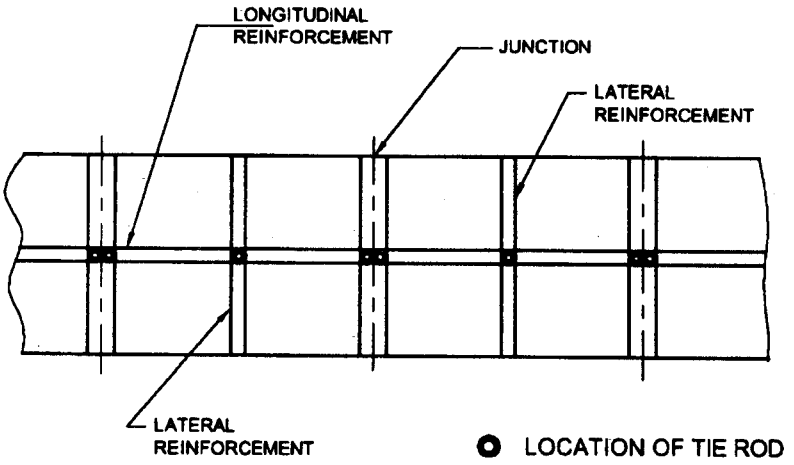


a) MOUNTING POSITION OF THE TIE ROD ON RECTANGULAR DUCT

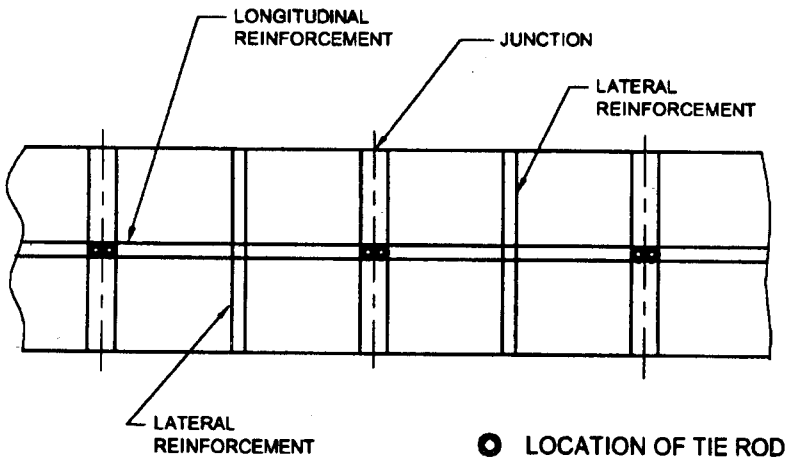


b) EXAMPLE OF DETAIL DRAWING FOR MOUNTING INTERMEDIATE REINFORCEMENT BY ROD

FIG. 17 INTERMEDIATE REINFORCEMENT BY TIE ROD



a) LOCATION OF REINFORCEMENT AND TIE ROD IN SAME SHEET TECHNIQUE



b) LOCATION OF REINFORCEMENT AND TIE ROD IN SLIDE TECHNIQUE

FIG. 18 EXAMPLE OF TIE ROD LOCATION IN DUCT OF CORNER BOLT TECHNIQUE (EXAMPLE OF ONE POSITION AT CENTRE)

Table 30 Reinforcement of Circular Galvanized Steel Sheet or Stainless Steel Sheet Duct

(*Clause* 8.4)

Thickness of Sheet mm	Minimum Size of Steel Angle mm	Maximum Spacing mm	Mounting Rivet	
			Minimum Nominal Diameter mm	Maximum Spacing of Rivet mm
(1)	(2)	(3)	(4)	(5)
0.6	25 × 25 × 3	2 400	4.5	100
0.8	30 × 30 × 3	1 800	4.5	100
1.0	40 × 40 × 3	1 800	4.5	100
1.2	40 × 40 × 5	1 200	4.5	100

Table 31 Reinforcement of Positive Pressure Horizontal Glass Wool Duct

(*Clause* 8.5.1.1)

Static Pressure (p) Pa	Long Side of Duct (l) mm	Maximum Spacing mm	Internal Surface of Duct	
			Number of Mounted Washers	Number of Mounted Tie Rods
(1)	(2)	(3)	(4)	(5)
$p \leq 125$	$l \leq 800$	—	—	1
	$800 < l \leq 2\,000$	600	3	1
	$2\,000 < l \leq 2400$	400	3	1
$125 < p \leq 250$	$l \leq 600$	—	—	1
	$600 < l \leq 1\,700$	600	3	1
	$1\,700 < l \leq 2\,400$	400	3	1
$250 < p \leq 500$	$l \leq 400$	—	—	1
	$400 < l \leq 1\,700$	400	2	1
	$1\,700 < l \leq 2\,400$	400	3	1

NOTES

1 At least C50 × 25 × 5 × 0.5 shall be used for the light gauge steel furrings.

2 In a duct with a side length 1 200 mm or more, a washer (at least galvanized steel sheet of 75 mm × 75 mm × 0.5 mm or Ø75 mm × 0.5 mm) is applied to the inside surface of duct at the centre of the upper reinforcement and the duct is fixed to the reinforcement by means of a sheet-metal screw at a pitch not exceeding 600 mm.

3 The minimum nominal diameter of tie rod shall be 8 mm.

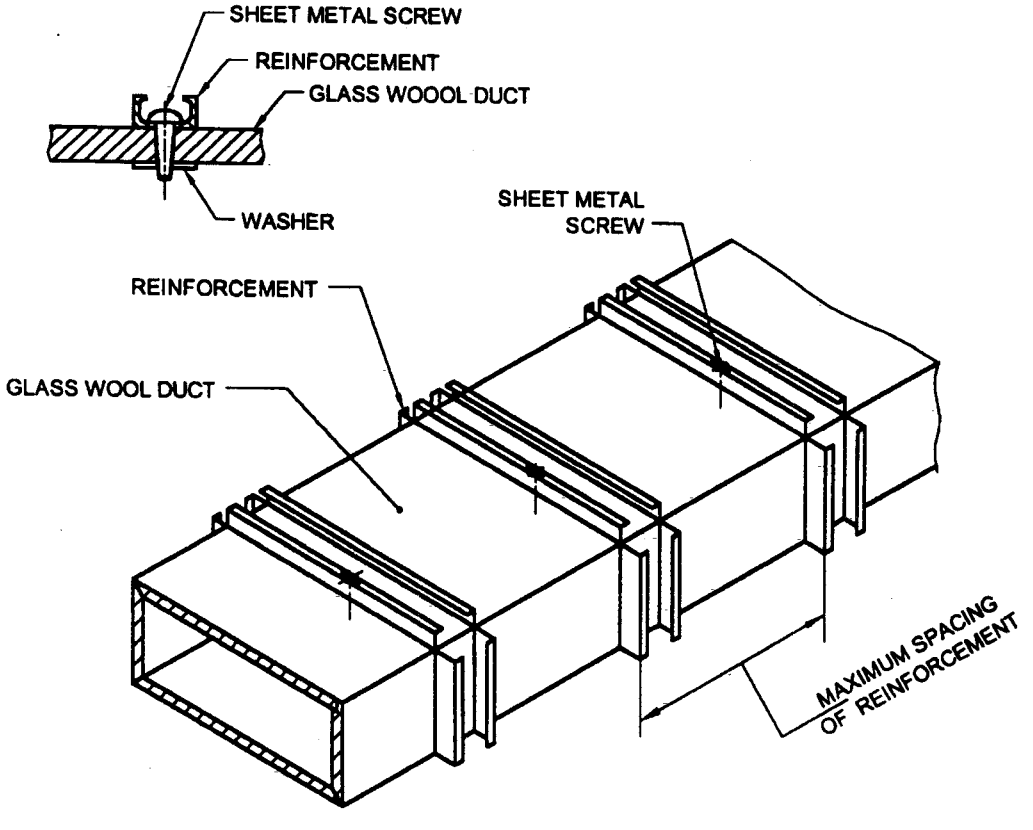


FIG. 19 EXAMPLE OF REINFORCEMENT OF POSITIVE PRESSURE HORIZONTAL GLASS WOOL DUCT

Table 32 Reinforcement of Positive Pressure Vertical Glass Wool Duct

(*Clause* 8.5.1.2)

Static Pressure (p) Pa (1)	Long Side of Duct (l) mm (2)	Maximum Spacing mm (3)	Number of Tie Rods Mounted to Inside Surface of Duct (4)
$p \leq 125$	$l \leq 800$	—	—
	$800 < l \leq 2\,000$	600	—
	$2\,000 < l \leq 2\,400$	400	—
$125 < p \leq 250$	$l < 600$	—	—
	$600 < l \leq 1\,700$	600	—
	$1\,700 < l \leq 2\,400$	400	—
$250 < p \leq 500$	$l \leq 400$	—	—
	$400 < l \leq 1\,700$	400	—
	$1\,700 < l \leq 2\,400$	400	1

NOTES

1 At least C 50 × 50 × 5 × 0.5 shall be used for light gauge steel furring.

2 The minimum nominal diameter of steel bar for tie rod shall be 8 mm.

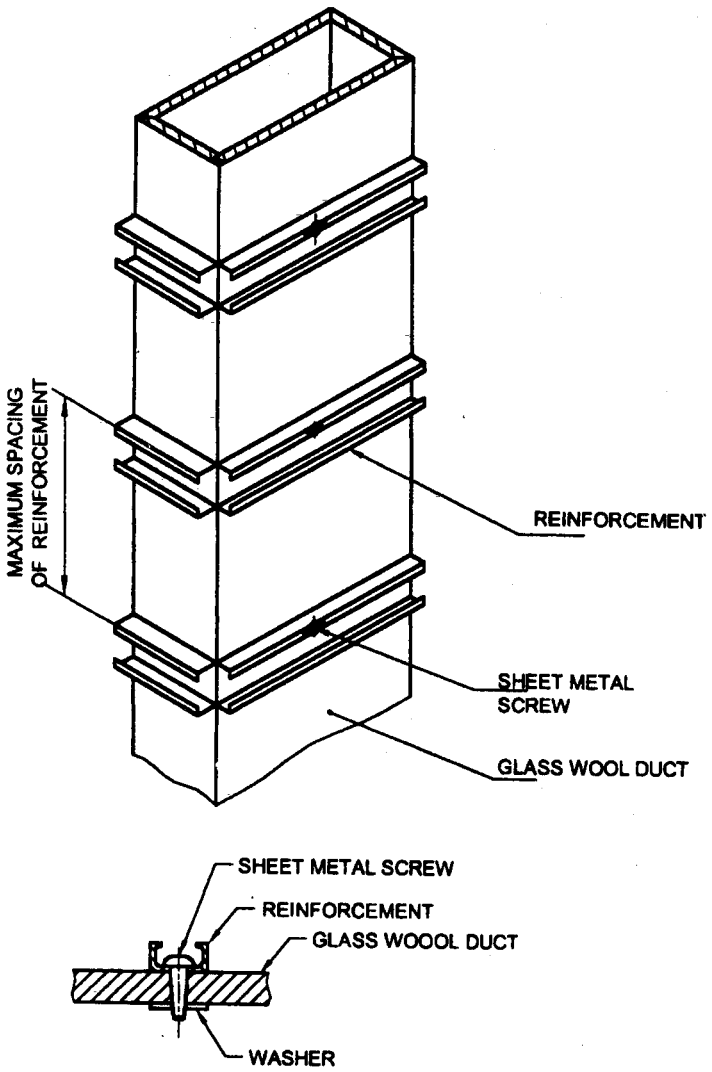


FIG. 20 EXAMPLE OF REINFORCEMENT OF POSITIVE PRESSURE VERTICAL GLASS WOOL DUCT

Table 33 Reinforcement of Negative Pressure Glass Wool Duct

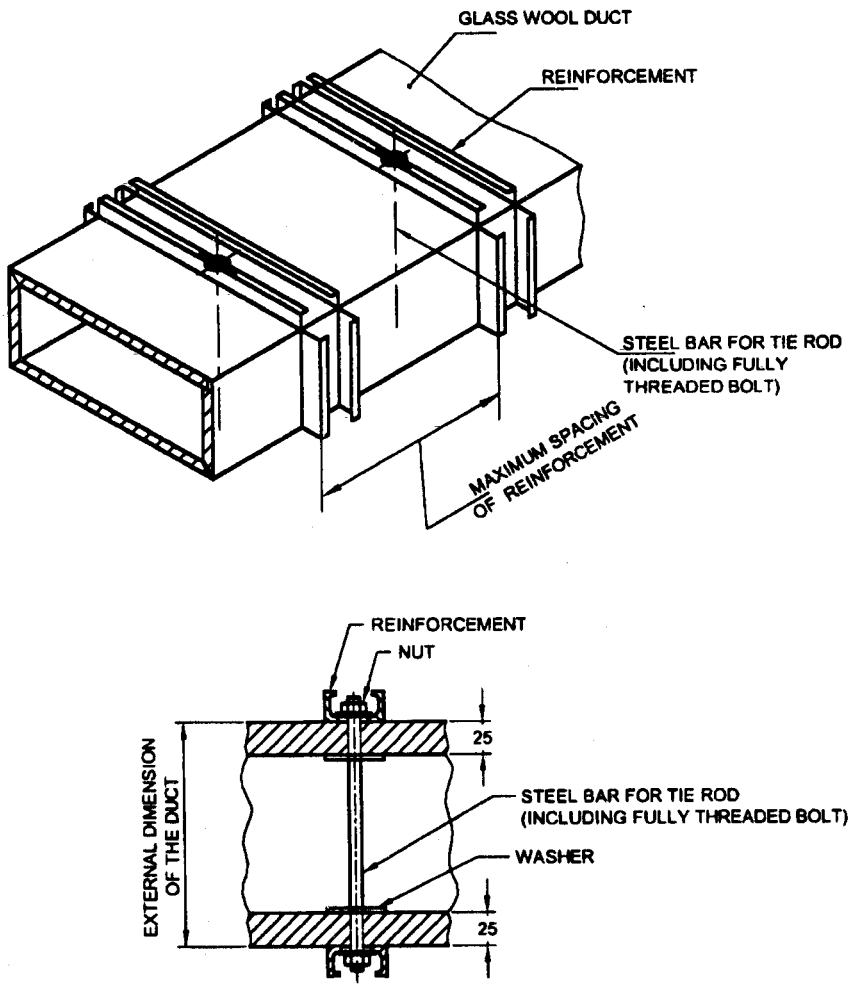
(*Clause* 8.5.1.3)

Static Pressure (*p*) Pa (1)	Long Side of Duct (*l*) mm (2)	Maximum Spacing mm (3)	Internal Surface of Duct	
			Number of Mounted Washers (4)	Number of Mounted Tie Rods (5)
$p \leq 125$	$l \leq 800$	—	—	
	$800 < l \leq 2\,000$	600	3	—
	$2\,000 < l \leq 2\,400$	400	5	—
$125 < p \leq 250$	$l \leq 600$	—	—	—
	$600 < l \leq 1\,700$	600	3	—
	$1\,700 < l \leq 2\,400$	400	5	—
$250 < p \leq 500$	$l \leq 400$	—	—	—
	$400 < l \leq 900$	600	2	—
	$900 < l \leq 1\,400$	400	2	1
	$1\,400 < l \leq 2\,400$	300	3	2

NOTES

1 At least C 50 × 50 × 5 × 0.5 shall be used for light gauge steel furrings.

2 The minimum nominal diameter of steel bar for tie rod shall be 8 mm.



All dimensions millimetres.

FIG. 21 EXAMPLE OF REINFORCEMENT OF NEGATIVE PRESSURE GLASS WOOL DUCT (EXAMPLE WHEN TIE ROD IS USED)

Table 34 Reinforcement of Glass Wool Duct by Tie Rods (Common to Air Supply Duct and Air Return Duct)

(*Clause* 8.5.2.1)

Static Pressure (*p*) Pa (1)	Long Side of Duct (*l*) mm (2)	Mounting Spacing mm (3)	Number of Rods Necessary for One Side (4)
$p \leq 125$	$l \leq 800$	—	—
	$800 < l \leq 1\,200$	600	2
	$1\,200 < l \leq 1\,600$	600	3
	$1\,600 < l \leq 2\,000$	600	4
	$2\,000 < l \leq 2\,400$	600	5
$125 < p \leq 250$	$l \leq 600$	—	—
	$600 < l \leq 800$	600	1
	$800 < l \leq 1\,200$	600	2
	$1\,200 < l \leq 1\,600$	600	3
	$1\,600 < l \leq 2\,000$	600	4
	$2\,000 < l \leq 2\,400$	600	5
$250 < p \leq 500$	$l \leq 400$	—	—
	$400 < l \leq 600$	600	1
	$600 < l \leq 800$	400	1
	$800 < l \leq 1\,200$	400	2
	$1\,200 < l \leq 1\,600$	400	3
	$1\,600 < l \leq 2\,000$	400	4
	$2\,000 < l \leq 2\,400$	400	5

NOTES

1 The dimension of long side of duct 800 mm at a static pressure 125 Pa or below shall be understood as 700 mm in the case of air return duct since the inside pressure of duct becomes negative pressure.

2 The minimum nominal diameter of steel bar for tie rod shall be 8 mm.

9.1 Types of Seal

a) *N seal* — This seals four corners of duct junction where duct is folded. The illustration is given in Fig. 24.

b) *A seal* — This seals longitudinal seam of duct. The illustration is given in Fig. 25.

c) *B seal* — This seals the junction of duct. The illustration is given in Fig. 26.

d) *C seal* — This seals the position of duct where such components of duct assembling material, reinforcement, etc as rivets, bolts, tie rods penetrate the duct. The illustration is given in Fig. 27.

10 MARKING

10.1 The following information shall be marked on the duct by an adequate method:

a) Manufacturer's name, identification or trademark;

b) Size of duct, in mm;

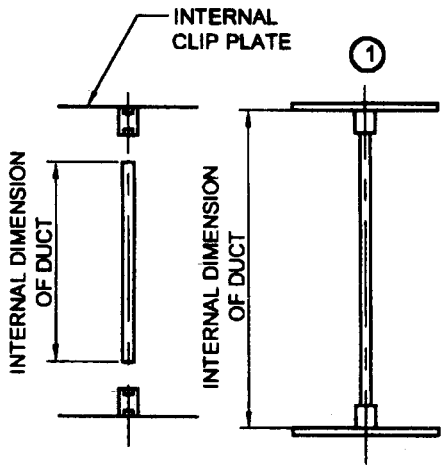
c) Duct material, and type of jointing technique; and

d) Year of manufacture.

10.2 BIS Certification Marking

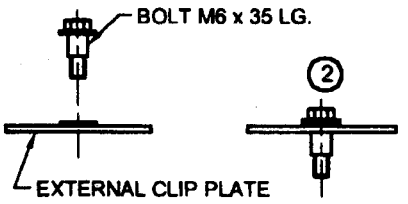
Every 2 m length of ducting may be marked with the Standard Mark.

10.2.1 The use of the Standard Mark is governed by the provisions of *Bureau of Indian Standards Act*, 1986 and the Rules and Regulations made thereunder. The details of conditions under which a licence to the use of the Standard Mark may be granted to the manufacturers or producers may be obtained from the Bureau of Indian Standards.



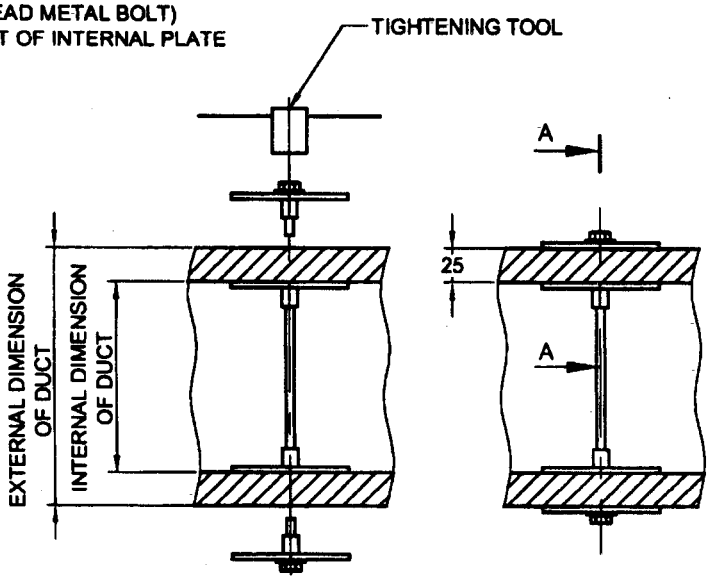
a) TIE ROD PROCEDURE 1

(INSERT STEEL BAR FOR TIE ROD
EXAMPLE M8 THREAD METAL BOLT)
INTO THREAD PART OF INTERNAL PLATE



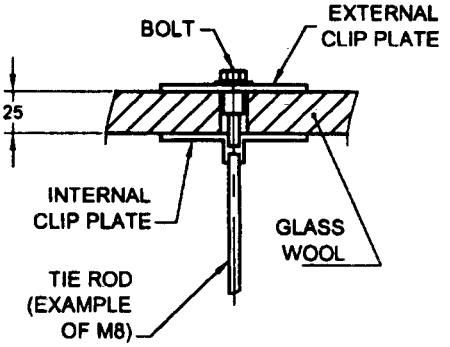
b) TIE ROD PROCEDURE 2

(INSERT THE BOLT INTO
EXTERNAL CLIP PLATE)



c) TIE ROD PROCEDURE 3

(INSERT (1) TO THE PRESCRIBED POSITION
AND SCREW IN (2) WITH TIGHTENING TOOL)



DETAIL SECTIONAL VIEW
OF TIE ROD MOUNTING
A-A

All dimensions in millimetres.

FIG. 22 EXAMPLE OF REINFORCEMENT OF GLASS WOOL DUCT BY TIE RODS

Table 35 Lateral Reinforcement Between Joints of Rectangular Duct

(*Clause* 8.6.1)

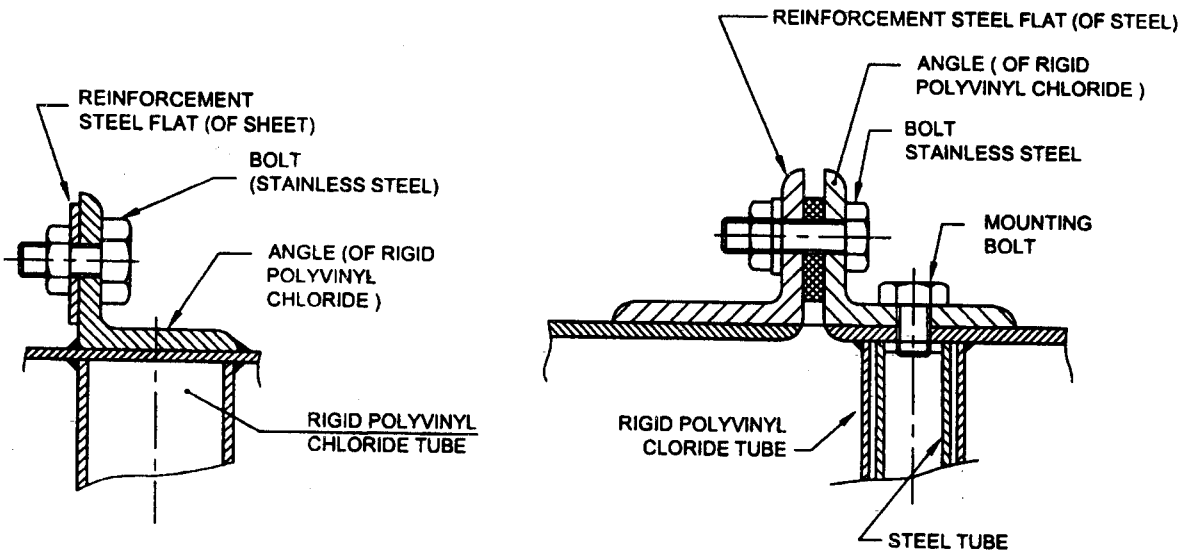
Long Side of Duct (l) mm	External Reinforcement			Mounting Bolt		Internal Reinforcement by Strut
	Minimum Size of Rigid Polyvinyl Chloride Angle mm	Minimum Size of Steel Flat mm	Maximum Spacing mm	Minimum Nominal Diameter mm	Maximum Spacing mm	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
$l \leq 500$	50 × 50 × 6	—	—	—	—	—
$500 < l \leq 1\,000$	60 × 60 × 7	(50 × 4)	1 000	(M8)	(150)	—
$1\,000 < l \leq 1\,500$	60 × 60 × 7	50 × 4	1 000	M8	150	One position
$1500 < l \leq 2\,000$	60 × 60 × 7	50 × 4	1 000	M8	150	One position
$2\,000 < l \leq 3\,000$	60 × 60 × 7	50 × 4	1 000	M8	150	Two positions

NOTES

1 The values given in parenthesis show those when the normal service pressure exceeds 1 500 Pa but not exceeds 2 000 Pa.

2 The steel flats shall be of steel or stainless steel.

3 The diameter of mounting bolt shall not exceed a certain diameter which ensures enough edge distance of flange.



a) EXAMPLE OF REINFORCEMENT 1

b) EXAMPLE OF REINFORCEMENT 2

FIG. 23 EXAMPLE OF EXTERNAL REINFORCEMENT AND INTERNAL REINFORCEMENT BY STRUT OF POLYVINYL CHLORIDE DUCT

Table 36 Longitudinal Reinforcement Between Joints of Rectangular Duct

(*Clause* 8.6.2)

Width of Duct (w)	External Reinforcement		Mounting Position	Mounting Bolt	
	Minimum Size of Rigid Polyvinyl Chloride Angle mm	Minimum Size of Steel Flat mm		Minimum Nominal Diameter mm	Maximum Spacing mm
(1)	(2)	(3)	(4)	(5)	(6)
$2\,000 < w \leq 2\,500$	$60 \times 60 \times 7$	50×4	One position	M 8	150

NOTE — The diameter of mounting bolt shall not exceed a certain diameter which ensures enough edge distance of flange.

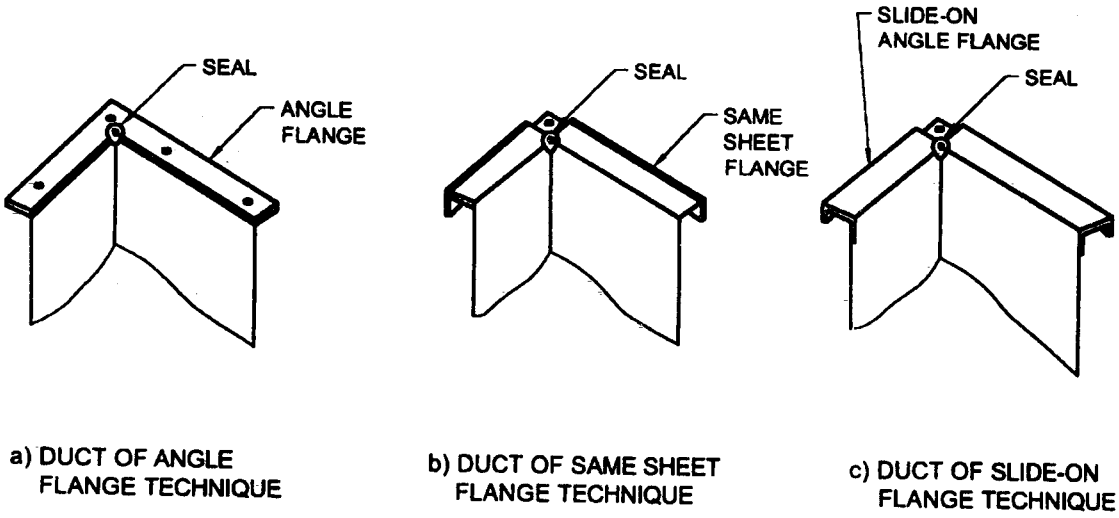


FIG. 24 EXAMPLE OF 'N' SEAL POSITION

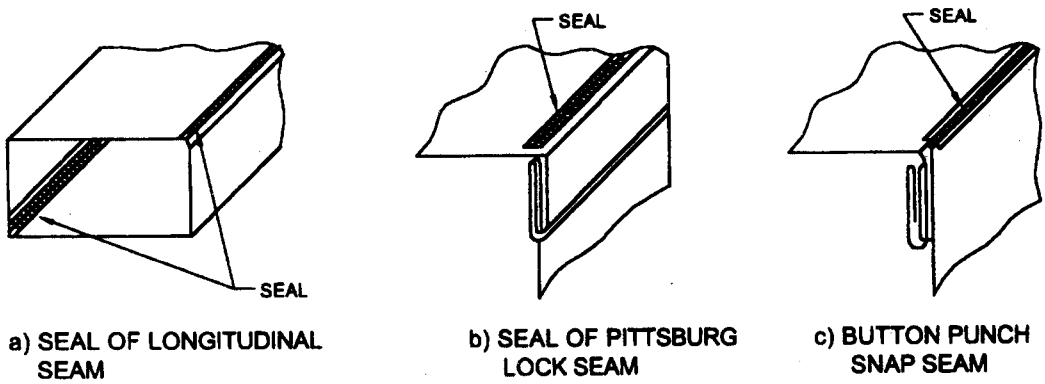


FIG. 25 EXAMPLE OF 'A' SEAL POSITION

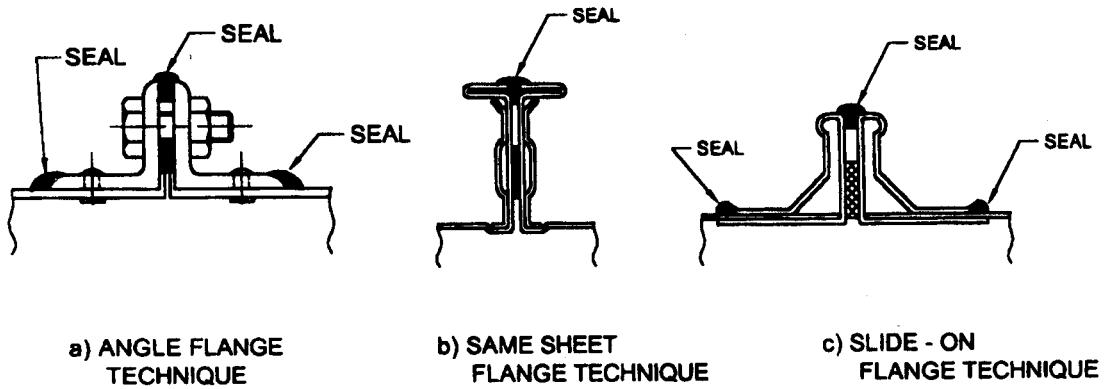


FIG. 26 EXAMPLE OF 'B' SEAL POSITION

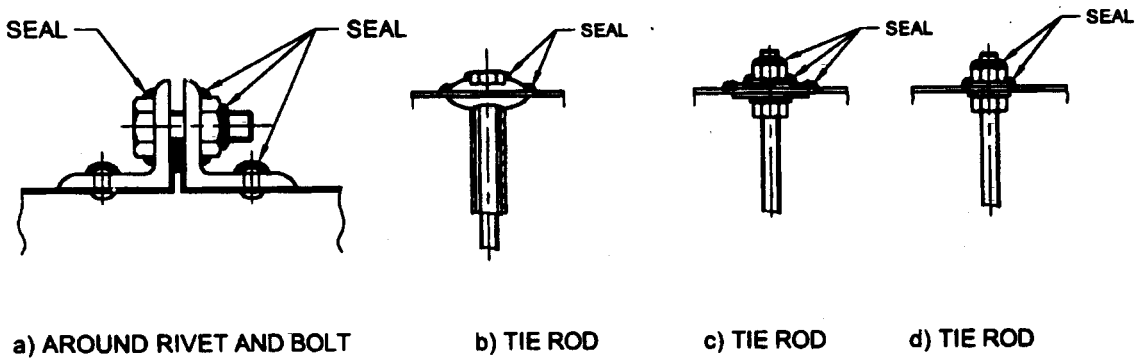


FIG. 27 EXAMPLE OF 'C' SEAL POSITION

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*	*IS No.*	*Title*
277 : 2003	Galvanized steel sheets (plain and corrugated) — Specification (*fifth revision*)	2907 : 1998	Non-ferrous rivets — Specification (*first revision*)
811 : 1987	Cold formed tight gauge structural steel sections (*revised*)	2998 : 1982	Cold forged steel rivets for cold closing (1 to 16 mm diameter) (*first revision*)
848 : 1974	Synthetic resin adhesives for plywood (phenolic and amino plastic) (*first revision*)	3601 : 1984	Steel tubes for mechanical and general engineering purposes (*first revision*)
1363	Hexagon head bolts, screws and nuts of product grade C:	6307 : 1985	Rigid PVC sheets (*first revision*)
(Part 1) : 2002	Hexagon head bolts (size range M5 to M64) (*fourth revision*)	6911 : 1992	Stainless steel plate, sheet and strip (*first revision*)
(Part 3) : 1992	Hexagon nuts (size range M5 to M64) (*fourth revision*)	8183 : 1993	Bonded mineral wool (*first revision*)
2062 : 1999	Steel for general structural purposes — Specification (*fifth revision*)	11149 : 1984	Rubber gaskets
		13262 : 1992	Pressure sensitive adhesive tapes with plastic base

ANNEX B

(Foreword)

COMMITTEE COMPOSITION

Refrigeration and Air Conditioning Sectional Committee, ME 03

Organization	*Representative(s)*
Indian Institute of Technology, Mumbai	PROF K. G. NARAYANKHEDKAR (***Chairman***)
All India Air-Conditioning and Refrigeration Association, New Delhi	DR R. K. MALHOTRA SHRI A. P. KHURANA (*Alternate*)
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Indian Society of Heat, Refrigeration Air-Conditioning Engineers, New Delhi	SHRI MANOJ CHAKRAVORTY
Intercool Western Refrigeration (India) Pvt Ltd, District Thane	SHRI ASHUTOSH KULKARNI
Kirloskar Copeland Ltd, Pune	SHRI V. G. SARDESAI SHRI N. M. INGLE (*Alternate*)
Kirloskar Pneumatic Co Ltd, Pune	SHRI V. D. MANE SHRI ADITYA KOWSHIK (*Alternate*)
Lawkim Motors Ltd, District Satarthane	SHRI KISHORE M. JOSHI SHRI RASIK P. KHAVANEKAR (*Alternate*)
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Universal Comfort Products Pvt Ltd, Dadra	SHRI NILESH PATIL
Videocon Appliances Ltd, Aurangabad	SHRI SETHURAMAN SHRI V. SRINIVASAN (*Alternate*)
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Voltas Ltd (White Goods), Hyderabad	SHRI AJAY KUMAR SOMANI SHRI L.V. RAMPRASAD (*Alternate*)
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Whirlpool of India Ltd, District Pune	SHRI AMIT VERMA SHRI N. B. PANTH (*Alternate*)
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Member Secretary
SHRI P. V. RAO
Director (MED), BIS

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