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Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of International Trade and Industry through deliberations at Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law:

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Fittings and joints for fibre reinforced plastic pipes

Introduction This Standard is Japanese Industrial Standard which has been established on the base of **ISO/DIS 7370** : 1996 *Glass-reinforced thermosetting plastics (GRP) pipes and fittings—Specifications for nominal sizes, diameter series, nominal pipe lengths and tolerances* and **ISO/FDIS 8483** : 1997 *Glass-reinforced thermosetting plastics (GRP) pipes and fittings—Test method to prove the design of bolted flange joints*, in which the parts (testing methods) corresponding to International Standards have been prepared without any technical modification, but the provisions of such items are supplemented, as type, performance, shape, dimensions, appearance, materials, test, inspection, marking, precautions for handling, expression of resulted figures, design plan of fibre reinforced plastic pipe fittings, and specification of fibre reinforced plastic pipe fittings for transportation of petroleum products, of which every item is not specified in corresponding International Standards.

1 Scope This Standard specifies the fittings (hereafter referred to as "pipe fittings") for standard fibre reinforced plastic pipes (hereafter referred to as "pipes") which are to be used for transportation of fluids.

The maximum working pressure shall be 2 MPa for liquid, and be 1 MPa for gas.

Remarks 1 The normative references to this Standard are as follows.

- JIS B 0151 *Iron and steel pipe fittings – Vocabulary*
- JIS B 7502 *Micrometer callipers*
- JIS B 7507 *Vernier, dial and digital callipers*
- JIS K 6900 *Plastics – Vocabulary*
- JIS K 6919 *Liquid unsaturated polyester resin for fiber reinforced plastics*
- JIS K 7010 *Vocabulary for fibre reinforced plastic*
- JIS K 7012 *Glass-fiber reinforced thermosetting resin chemical-resistant tanks*
- JIS K 7013 *Fibre reinforced plastic pipes*
- JIS K 7052 *Measuring method for fiber content of glass fiber reinforced plastics*
- JIS K 7054 *Testing method for tensile properties of glass fiber reinforced plastics*
- JIS K 7055 *Testing method for flexural properties of glass fiber reinforced plastics*
- JIS K 7060 *Testing method for barcol hardness of glass fiber reinforced plastics*
- JIS K 7070 *Testing method for chemical resistance of fiber reinforced plastics*

- JIS K 7074 *Testing methods for flexural properties of carbon fiber reinforced plastics*
- JIS K 7075 *Testing methods for carbon fiber content and void content of carbon fiber reinforced plastics*
- JIS R 3411 *Textile glass chopped strand mats*
- JIS R 3412 *Textile glass rovings*
- JIS R 3415 *Textile glass tapes*
- JIS R 3416 *Finished textile glass fabrics*
- JIS R 3417 *Woven roving glass fabrics*
- JIS R 6252 *Abrasive papers*
- JIS Z 8401 *Rules for rounding off of numerical values*

2 The International Standards corresponding to this Standard is as follows:

- ISO/DIS 7370 : 1996 *Glass-reinforced thermosetting plastics (GRP) pipes and fittings—Specifications for nominal sizes, diameter series, nominal pipe lengths and tolerances*
- ISO/FDIS 8483 : 1997 *Glass-reinforced thermosetting plastics (GRP) pipes and fittings—Test method to prove the design of bolted flange joints*

Informative reference: The mechanical performances, such as circumferential internal-pressure strength, axial tensile strength, and others, of pipe fittings can be seriously changed owing to laminating structure of materials, therefore the pipe fittings, which have various performances, other than the pipe fittings mentioned here can be manufactured. When special requirements are referred to comply with the serviceability, it is permissible to decide by the agreement between the parties concerned with delivery.

2 Definitions For the purpose of this Standard, the definitions given in **JIS B 0151**, **JIS K 6900**, **JIS K 7010**, and **JIS K 7012**, and the following definitions apply.

- (1) **tees** T type pipe fittings for joining 3 pipes with shape of letter T.
- (2) **reducing fitting** Pipe fitting having 2 or more different designations of diameter.
- (3) **joining method** Method to join a pipe with other pipe, or join a pipe with an apparatus.
- (4) **taper ring** When joining pipes with steel round-type flange, reinforced plastic taper core for inserting joint into an end of pipe.
- (5) **core ring** When joining pipes with steel round-type flange, reinforced plastic core for inserting joint into the end of a pipe.
- (6) **flange with socket** Reinforced plastic flange to be used for making insertion into the end of a pipe and joining with flange.

- (7) **flange with short pipe** Reinforced plastic flange used when the end of a pipe is joined with a flange after being butt-jointed.
- (8) **reducer** Pipe fittings with which pipes with different diameter are linearly joined.
- (9) **socket** Insertion type pipe fitting for joining linearly pipes.
- (10) **solid fitting** Pipe fitting integrally molded using one mold.
- (11) **mightier fitting** Pipe fitting which has been butt-jointed after pipe was cut to make specified shape and then fabricated.

3 Classification

3.1 Classification by anticorrosive-layer thickness and test internal pressure

The pipe fittings are classified by anticorrosive-layer thickness and test internal pressure as shown in Table 3.1.

Table 3.1 Type of pipe fittings classified by anticorrosive-layer thickness and test internal pressure

Thickness of anticorrosive layer		Test internal pressure	
Division	Thickness mm	Division	Pressure MPa
Group 1	1.25	Class 1	3.0
		Class 2	4.0
		Class 3	5.0
		Class 4	6.0
		Class 5	8.0
		Class 6	10.0
		Class 7	15.0
		Class 8	20.0
Group 2	2.5	Class 1	3.0
		Class 2	4.0
		Class 3	5.0
		Class 4	6.0
		Class 5	8.0
		Class 6	10.0
		Class 7	15.0
		Class 8	20.0

Remarks 1 The standard thickness of anticorrosive layer is 1.25 mm and 2.5 mm, but thickness other than this can be adopted depending on its use.

2 The classification of fibre reinforced plastic pipe fittings for transportation of petroleum products is shown in Annex 2.

3.2 Grouping by axial tensile strength Pipe fittings are classified as shown in Table 3.2 by its axial tensile strength.

Table 3.2 Grouping by axial tensile strength of pipe fittings

Axial tensile strength MPa	50, 100, 150, 200, 250, 300
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3.3 Grouping by axial tensile elastic modulus Pipe fittings are classified as shown in table 3.3 by its axial tensile elastic modulus.

Table 3.3 Grouping by axial tensile elastic modulus of pipe fittings

Axial tensile elastic modulus MPa	5 000, 10 000, 15 000, 20 000, 25 000, 30 000
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Remarks: The tensile characteristics of pipe fittings has directionality and furthermore they show different characteristics depending on resin, reinforcing material, laminating structure, and type of moulding method, therefore, the groupings shown in Table 3.2 and Table 3.3 are respectively independent, and there is no relation between strength and elastic modulus.

4 Performance

4.1 Withstand pressure The performance of pipe fittings is grouped by its circumferential internal pressure strength carried by hydraulic pressure test, and shall be as shown in Table 4.1.

Table 4.1 Circumferential internal pressure strength

Circumferential internal pressure strength MPa	Performance value	Applicable test clause
	50, 100, 150, 200, 250, 300	9.8, 9.9, or 9.10

Remarks: The strength and elastic modulus of pipe fittings have directionality, therefore when marking strength and elastic modulus it is necessary to clearly indicate the direction of axis and circumference.

4.2 Hardness The hardness of pipe fittings is expressed by barcol hardness which has been measured by 9.5, and at least 30 in terms of Type A specified in **JIS K 7060**.

4.3 Thermal performance The thermal performance of pipe fittings is different depending of employed resin, kind of reinforcing material, and moulding method.

4.4 Chemical resistance Chemical resistance of pipe fittings shall be as follows.

- (1) The chemical resistance of pipe fittings is mainly decided by selection of material of anticorrosive layer that is shown in 3.4 of Annex 1 of **JIS K 7013**.
- (2) The chemical resistance of resin used in anticorrosive layer of pipe fittings shall conform to the following requirements when tested according to 9.7.

- (a) **Change of appearance** The appearance change of anticorrosive layer shown after each immersion test shall be Grade 1 or grade 2 or less given in Table 3, 5.3 of JIS K 7012.
- (b) **Bending strength** Retaining percentage of bending strength after one year immersion test shall be at least 60 %, and there shall be no serious change during from 180 days to one year.
- (c) **Barcol hardness** The barcol hardness after each immersion test shall be at least 15.

Remarks 1 Measure according to Type A specified in JIS K 7060.

- 2 At least 15 barcol hardness means the standard for the degree of hardening of unsaturated polyester resin and vinylester resin, which are mainly occupying the material of pipe fittings. Therefore, when other resin than these materials is used, the specification of barcol hardness follows the agreement between the parties concerned with delivery.

5. Shape and dimensions

5.1 Shape The shape of pipe fittings is as follows; solid fittings are classified into, taper socket, bend, tees, reducer, nipple, taper ring, core ring, flange with socket, flange with short pipe, etc.; and mightier fittings are classified into timer bend of 90°, 45°, and 22.5°, and mightier tees with the same diameter and different diameter; and respective shape and summary of specification are shown from Fig. 5.1 to Fig. 5.9.

The meanings of symbols used in the figures are as follows.

DN : nominal diameter

t : designed (official) thickness

t_M : reinforced thickness of timer fitting

d_i : inside diameter

d_{11} : minor bore of pipe fitting

d_{12} : major bore of pipe fitting

d_1 : minor bore of taper joining part

d_2 : major bore of taper joining part

d_{11} : minor bore of taper jointing part at small bore side, between 2 bores of pipe fitting

d_{12} : minor bore of taper jointing part at large bore side, between 2 bores of pipe fitting

d_{21} : major bore of taper jointing part at small bore side, between 2 bores of pipe fitting

d_{22} : major bore of taper jointing part at large bore side, between 2 bores of pipe fitting

D_1 : minor outside diameter of pipe fitting

D_2 : major outside diameter of pipe fitting

L : length of pipe fitting

- l : length of taper joining part or length of joining part
 l_1 : length of taper joining part of minor bore, between 2 bores of pipe fittings
 l_2 : length of taper joining part of major bore, between 2 bores of pipe fittings
 N : number of bolts for flange
 H : distance between from center to end surface excepting length of joining part (l)
 R : curvature radius of bend
 T : thickness of hub of taper ring, core ring, and flange
 C : pitch circle of bolt for flange

(5.1.1) Solid fittings

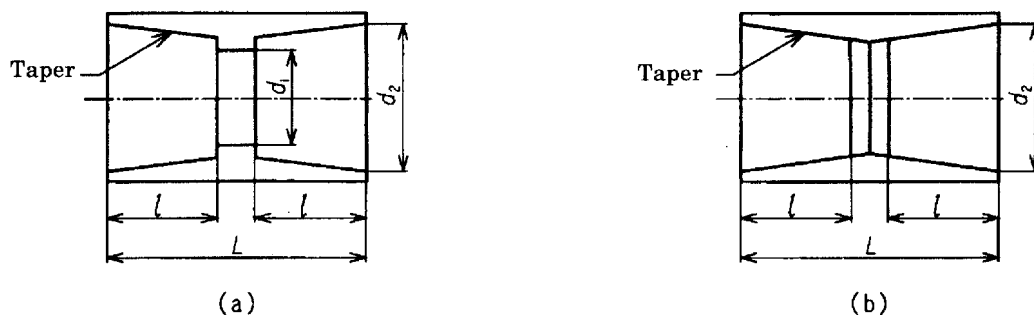


Fig. 5.1 Taper socket

Smooth bend

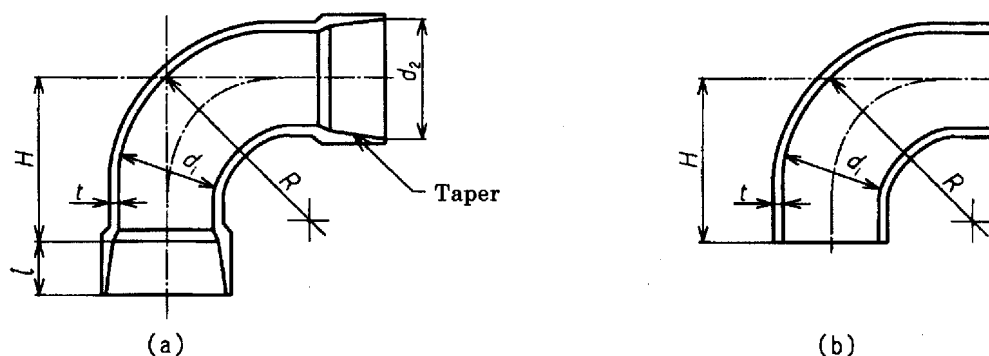


Fig. 5.2 Bend

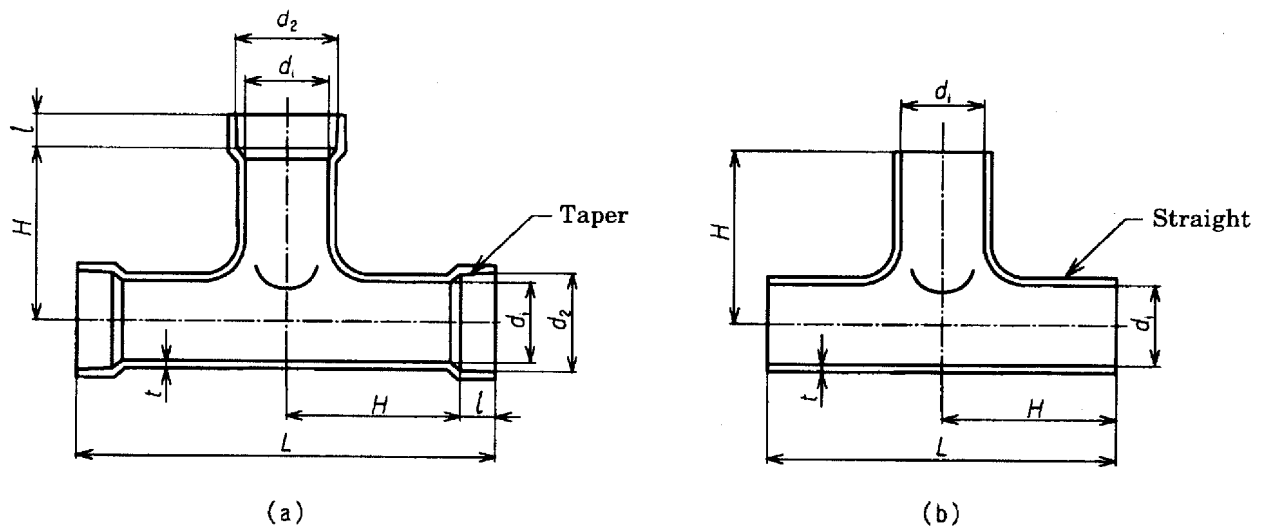


Fig. 5.3 Tees

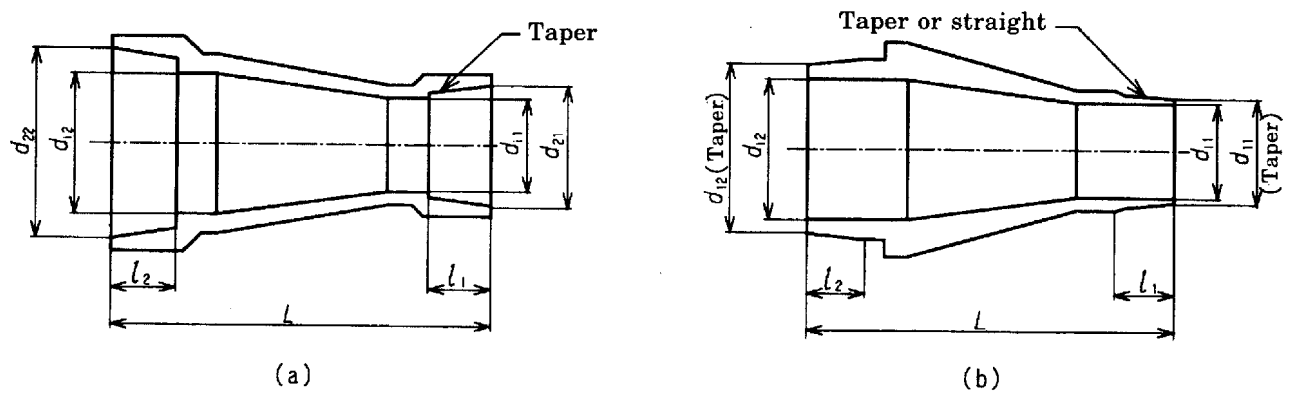


Fig. 5.4 Reducer

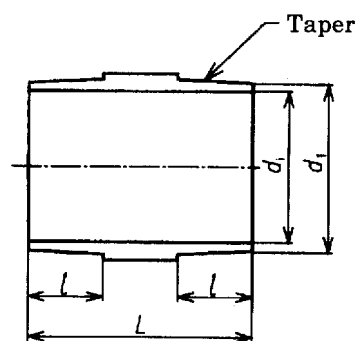


Fig. 5.5 Nipple

Taper ring and core ring shall be jointly used with steel round flange.

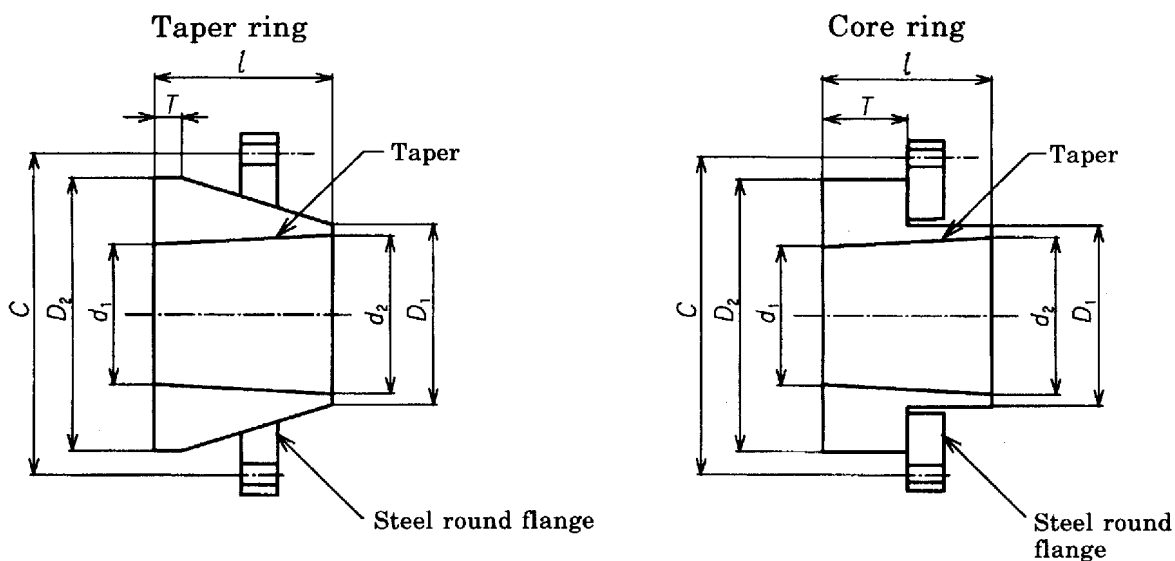


Fig. 5.6 Taper ring, core ring

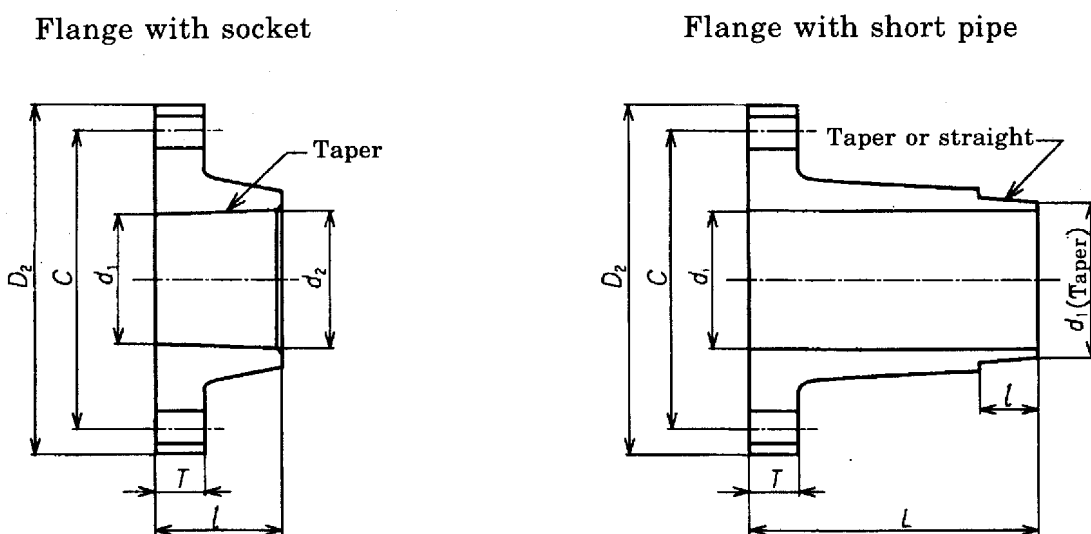
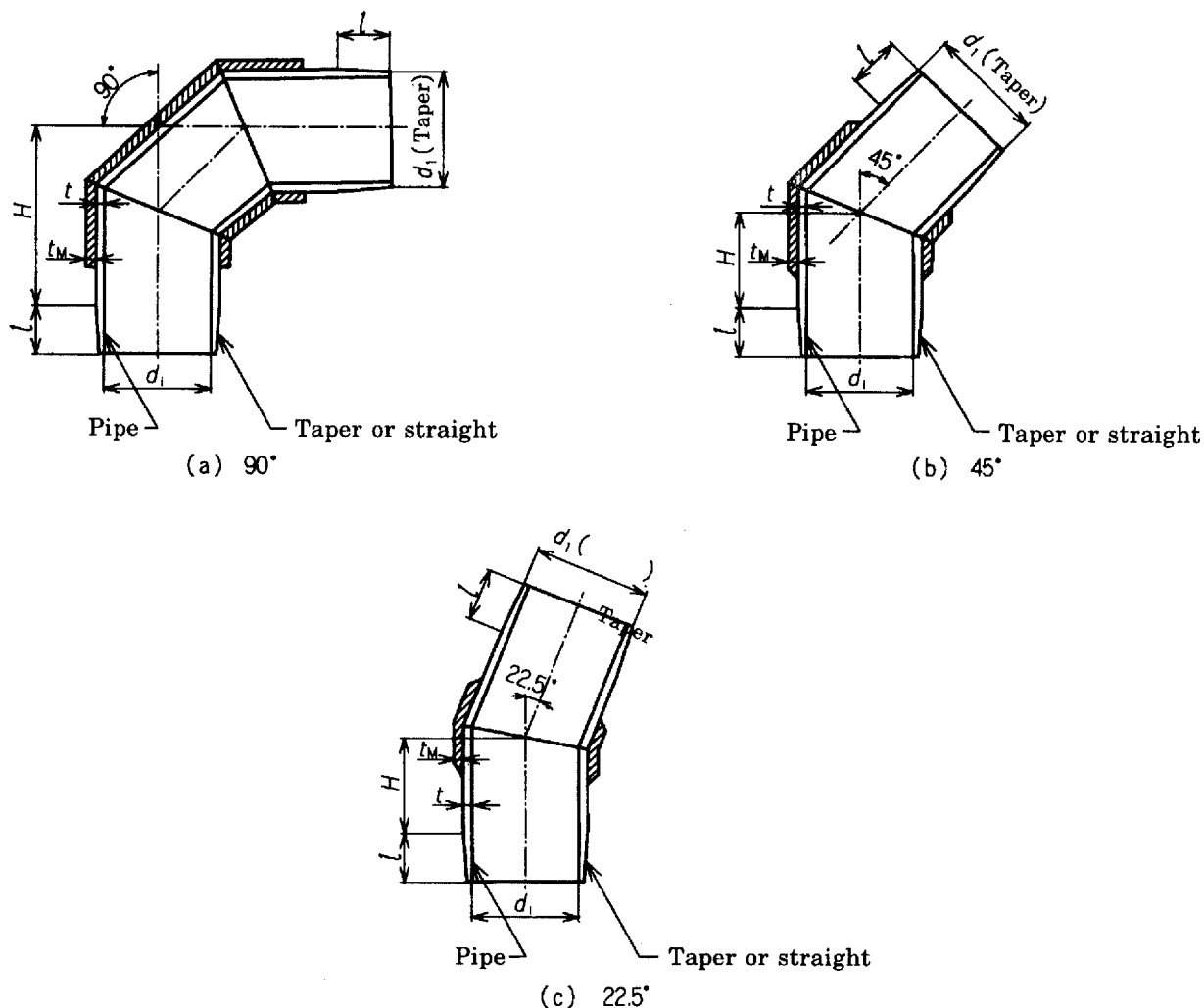


Fig. 5.7 Flange

(5.1.2) Mightier fittings

Mightier bend



Mightier tees

Fig. 5.8 Bend

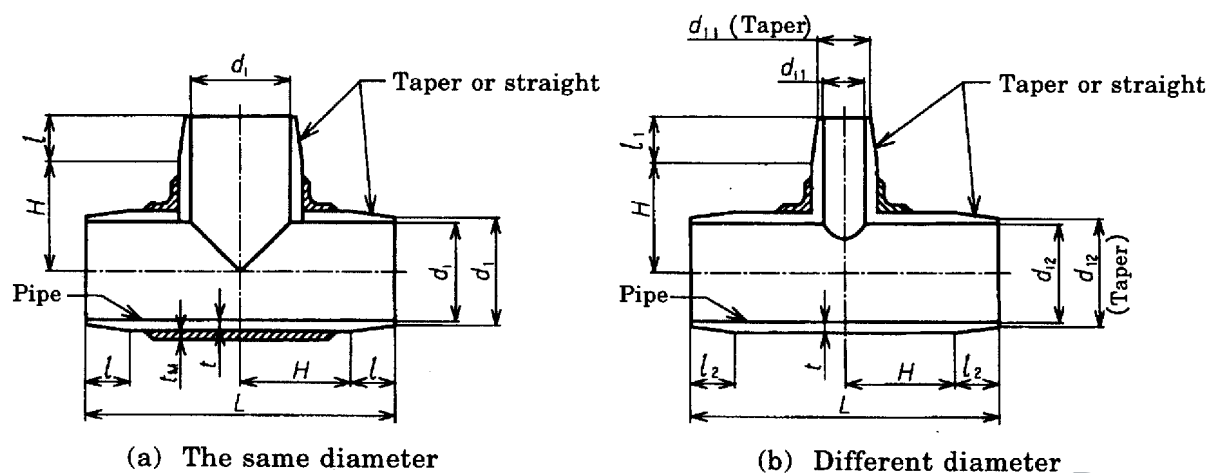


Fig. 5.9 Tees

5.2 Dimensions Dimensions shall be as follows.

- (1) **Inside diameter** The inside diameters of pipe fittings are as shown in Table 5.2.

Table 5.2 Dimensions of pipe fittings

Nominal diameter <i>DN</i>	Inside diameter mm
25A	25
40A	40
50A	50
65A	65
75A	75
80A	80
100A	100
125A	125
150A	150
200A	200
250A	250
300A	300

Remarks 1 Nominal diameter 40A contains 36 mm and 38 mm in addition to inside diameter 40 mm.

- 2 The inside diameter of pipe fittings, corresponding to the pipe that is based on outside diameter, shall be the agreement between the parties concerned with delivery.

- (2) **Thickness and length** The thickness of pipe fittings is 3 mm or more, and expressed with 0.5 mm unit. In case of mightier fittings, thickness is measured at reinforced part. The length is not specially specified.

- (3) **Tolerance on dimension** Tolerance on dimension shall be as follows.

- (a) The tolerance of pipe-fitting length (L) shall be ± 3.5 mm or less.
- (b) The tolerance of pipe-fitting inside diameter (d_i) shall be larger one either ± 1 mm or ± 0.6 % of nominal diameter.
- (c) The minimum thickness ($t_{\min}$) of reinforced layer of pipe-fitting shall be at least 80 % of thickness designed for reinforced layer.
- (d) The averaged thickness of pipe-fitting shall be designed thickness (t) or more.
- (e) The tolerance on the rectangularity between cut pipe-fitting end and axial line shall be ± 3.5 mm or less (See Fig. 5.10).

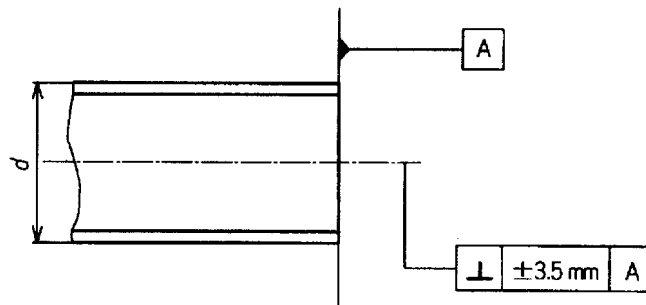


Fig. 5.10 Rectangularity of the end of pipe fitting

(f) The tolerance on angle of bends and tees shall be 1° or less.

6 Appearance Appearance shall be as follows.

- (1) **Inside surface** Inside surface shall be free from cracking, fissure, and inferior impregnation. Inside surface shall be smooth, and have no pit with 3 mm or larger diameter and 0.5 mm or more depth. Additionally, there shall be averagely 2 pits or less per 300 mm² each of whose size is less than 3 mm in diameter and less than 0.5 mm in depth, and the fibre on the surface shall be completely covered with resin from exposure. Bubbles shall be scarce enough to be used satisfactorily under corrosive surroundings.
- (2) **Outside surface** Outside surface shall be smooth, and free from exposed fibre or sharp projections.

7 Material

7.1 Resin The thermosetting resin, which is to be used for manufacturing of pipe fittings, shall be mainly unsaturated polyester series resin or epoxy resin specified in **JIS K 6919**, but other thermosetting resins can be included. Additionally, the thermosetting resins to be used for improving anticorrosiveness of anticorrosive layer and weather resistance of outer-surface coated layer, are included.

- (1) **Resins for reinforced layer** Resins for reinforced layer shall be as follows.
 - (a) Isophthalic acid series unsaturated polyester resin
 - (b) Bisphenol series unsaturated polyester resin
 - (c) Novolac type vinyl ester resin
 - (d) Bisphenol type vinyl ester resin
 - (e) Epoxy resin
 - (f) Other thermosetting resins
- (2) **Resin for anticorrosive layer** Resin for anticorrosive layer shall be as follows.
 - (a) Isophthalic acid series unsaturated polyester resin
 - (b) Bisphenol series unsaturated polyester resin

- (c) Novolac type vinyl ester resin
- (d) Bisphenol type vinyl ester resin
- (e) Epoxy resin
- (f) Phenol resin
- (g) Furan resin
- (h) Thermoplastic resins

7.2 Fibre reinforcing material The fibre reinforcing material for manufacturing of pipe fittings shall be the material conforming to **JIS R 3411, JIS R 3412, JIS R 3415, JIS R 3416, and JIS R 3417**, otherwise glass fibre equal to or superior to this, or carbon fibre or organic fibre.

7.3 Additives Filling material or pigments can be added for the purpose to improve appearance, workability, performance, but they shall not impair the anticorrosiveness or strength.

8 Manufacturing method

8.1 Solid fittings The solid fittings specified in (5.1.1) are manufactured by, hand-lay up molding, filament winding molding, press molding, resin injection (resin transfer) molding, or other molding method.

8.2 Mightier fittings The mightier fittings specified in (5.1.2) are manufactured by hand-lay up molding after butt joining of fibre reinforced plastic pipe that was cut to specified form.

9 Test

9.1 Test piece The shape and preparation method of test piece and its number shall be as shown in Table 9.1. Test piece shall be prepared by either cutting out from pipe fitting, or by cutting out from the dummy part which has been additionally produced when moulding. When above both are impossible, however, laminated plate which was manufactured by the same composition and the same moulding method, can be available.