

JIS

JAPANESE INDUSTRIAL STANDARD

**Testing methods for
thermosetting plastics**

JIS K 6911—1995

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**In the event of any doubt arising,
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JAPANESE INDUSTRIAL STANDARD

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Testing methods for thermosetting plastics

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1. Scope This Japanese Industrial Standard specifies the general methods of testing thermosetting plastics.

Remarks 1. The following standards are cited in this Standard.

JIS B 1352	Taper pins
JIS B 4410	Taper pin reamers
JIS B 7502	Micrometer callipers
JIS B 7503	Dial gauges
JIS B 7507	Vernier, dial and digital callipers
JIS B 7512	Steel tape measures
JIS B 7513	Precision surface plates
JIS B 7514	Steel straightedges
JIS B 7516	Metal rules
JIS B 7601	Trip balances
JIS B 7726	Rockwell and Rockwell superficial hardness testing machines
JIS C 1102	Electrical indicating instruments
JIS C 1302	Insulation resistance testers
JIS C 2320	Electrical insulating oils
JIS G 4051	Carbon steels for machine structural use
JIS K 8034	Acetone
JIS K 8951	Sulfuric acid
JIS R 3503	Glass apparatus for chemical analysis
JIS R 6252	Abrasive papers
JIS Z 8101	Glossary of terms used in quality control
JIS Z 8401	Rules for rounding off of numerical values
JIS Z 8801	Test sieves

2. The units and numerical values given in { } in this Standard are in accordance with the traditional unit system and appended for informative reference.

2. Definitions For the purpose of this Standard, the definitions of principal terms are as follows:

- (1) apparent density The mass of moulding material per unit volume.
- (2) bulk factor The quotient of the density of moulding product divided by the apparent density of the moulding material used for the moulding product. The bulk factor is equal to the quotient of the volume of the moulding material required for moulding divided by the volume of the moulded product.

- (3) free water content The water to be lost from a moulding material when the material is dried at room temperature.
- (4) warping rate The concave or convex deformation of material in the direction parallel to the edge, represented by the maximum warp for a length of 1000 mm in percent.
- (5) twisting rate The concave or convex deformation of material in the diagonal direction, represented by the maximum twist of a length of 1000 mm in percent.
- (6) mould shrinkage coefficient Moulding material shrinks smaller than the mould dimension when it is taken away after moulded from a mould and allowed to cool down in the air. The difference between the mould dimension and the dimension of the moulding product is called "mould shrinkage". And the percentage of the mould shrinkage to the mould dimension is the mould shrinkage coefficient.
- (7) rate of shrinkage on heating The shrinkage on heating is the difference between the dimension of the moulding product which has been moulded from a moulding material in a mould, taken out of the mould, allowed to cool down in the air (the dimension of the product in this state is termed initial dimension), and that of the product further conditioned in a thermostatic oven maintained at a specified temperature, its rate is the ratio of the shrinkage to the initial dimension in percent.
- (8) withstand voltage The property of a material such that its test piece withstands without breakdown the specified voltage (the specified potential gradient $\times$ the thickness of test piece) applied for 1 min.
- (9) flatwise withstand voltage The withstand voltage of a laminate when the voltage is applied vertically to its laminae.
- (10) edgewise withstand voltage The withstand voltage of a laminate when the voltage is applied parallel to its laminae.
- (11) dielectric breakdown strength Under the specified test conditions, the quotient of the minimum effective voltage at the breakdown of the test piece (breakdown voltage) divided by the distance between the two electrodes (thickness of test piece).
- (12) insulation resistance The quotient of the d.c. voltage applied between two electrodes divided by the total current flowing between them. It includes both the volume resistance and surface resistance of the test piece. In the case of laminates, it indicates the edgewise insulation resistance when the voltage is applied parallel to laminae.
- (13) volume resistance The quotient of the d.c. voltage applied between the two electrodes divided by the current through a unit volume of the test piece placed between the electrodes.
- (14) surface resistance The quotient of the d.c. voltage applied between two electrodes attached on one side of the test piece divided by the current flowing along the surface layer.
- (15) volume resistivity The quotient of the potential gradient parallel to the current within the test piece divided by the current density. This value equals the volume resistance between the two electrodes forming the two opposite sides of a cube with 1 cm edges.

- (16) surface resistivity The quotient of the potential gradient parallel to the current along the surface of the test piece divided by the current per unit width of the surface. This value equals the surface resistance between the two electrodes forming the opposite two sides of a square with 1 cm sides.
- (17) dielectric constant The amount of electrostatic energy stored in a unit volume of a substance in a unit electric field. It is called "dielectric constant (ϵ)" and expressed as the quotient of equivalent parallel capacitance of a capacitor employing the test piece as the dielectric (C_x) divided by that of the same capacitor when air (under the standard condition the dielectric constant of air can be taken for that of vacuum) is used as the dielectric (C_0), measured under a specified frequency.

$$\text{i.e., } \epsilon = \frac{C_x}{C_0}$$

- (18) dielectric dissipation factor Dielectric dissipation factor is the tangent of complementary angle to a dielectric phase angle ($\tan \delta$). The dielectric phase angle is the phase difference angle (θ) between the sine-wave voltage applied to the test piece and the current component having the same frequency as the applied voltage caused by the voltage application.

Remarks: The cosine of the dielectric phase angle (θ), i.e., dielectric power factor, is sometimes used in place of dielectric dissipation factor, since dielectric power factor can be regarded nearly equal to dielectric dissipation factor, if $\tan \delta < 0.1$.

- (19) arc resistance The period of time for which the test piece can withstand the exposure to arc.
- (20) Rockwell hardness A number calculated by the following equation from the net increase in the depth of impression when the load on a steel ball indenter is increased from a fixed minor load to a major load and then returned to the minor load, by employing an appropriate ball indenter specified depending on the hardness of the test piece.

$$H_R = 130 - 500h$$

where, H_R : Rockwell hardness

h : net increase in the depth of impression (mm)

In the above procedure, use a steel ball of 6.350 mm diameter for the measurement of M scale, with the minor load of 98 N {10 kgf} and major load of 980 N {100 kgf}, and use a steel ball of 12.700 mm diameter for the measurement of R scale, with the minor load of 98 N {10 kgf} and major load of 590 N {60 kgf}.

- (21) Barcol hardness The maximum reading of a Barcol impressor of Type 934-1, when the test piece is indented by applying a load on the indenter of the instrument.

- (22) flexural strength The maximum flexural stress in the test piece when it is supported at both ends as a both-end-supported beam and applied with a concentrated load on the upper face at the centre of span. However, for a laminated tube of not more than 100 mm inside diameter, the flexural strength is the maximum breaking stress in the test piece when it is placed between two parallel boards and uniformly loaded on the axis.
- (23) bending modulus of elasticity The resistivity of the test piece against deformation by flexural stress, in the straight portion of the load-strain curve within the elastic range. It is expressed in the flexural stress per unit strain.
- (24) tensile strength The quotient of the maximum tensile breaking load applied on the test piece divided by the minimum original cross-sectional area of the test piece, i.e., the maximum tensile stress.
- (25) compressive strength The quotient of the maximum compressive breaking load applied on the test piece divided by the compressed original cross-sectional area of the test piece, i.e., the maximum compressive stress.
- (26) Charpy impact strength The quotient of the total impact energy absorbed when the test piece is broken in a Charpy impact testing machine divided by the original cross-sectional area of the test piece under the notch.
- (27) Izod impact strength The quotient of the total impact energy absorbed when the test piece is broken in Izod impact testing machine divided by the original width of the test piece at the notch.
- (28) bonding strength The load at the break of the laminated sheet when the load is applied parallel to its laminae by using a steel ball.
- (29) deflection temperature under load The temperature of the heat-transfer medium when the deflection of the test piece at the centre of span reaches a fixed amount, when a bar-shape test piece is supported at two points, applied with a fixed load at the centre of span and is heated from outside at a constant speed.
- (30) burning resistance The grade of burning resistance and self-extinguishing property of plastics. It is expressed by the duration of burning after ignition and burning distance.
- (31) flaming The state of burning with flames.
- (32) glowing The state of red-heating without flames.
- (33) water absorption The percentage of the mass of test piece which has increased by immersion in water for 24 h to its mass before immersion.
- (34) boiling water absorption The percentage of the mass of test piece which has increased by immersion in boiling water for 1 h to its mass before immersion.
- (35) boiling water resistance The resistivity of the test piece with appearance against immersion in boiling water for 15 min.
- (36) chemical resistance The resistivity of test piece with mass and appearance against immersion in a testing solution maintained at a constant temperature for a specified period of time.

3. Method of sampling and making test pieces

3.1 Method of sampling In the case of testing the quality of product manufactured in lots ⁽¹⁾, samples ⁽²⁾ shall be taken in accordance with the following, unless otherwise specified.

- (1) Moulding material Make random sampling on a lot whose quality can be regarded as uniform so that the sample will represent the quality of the whole lot. The quantity of the sample shall be about two times as necessary for the test and the sample shall be contained in a vessel which can be closed tight.
- (2) Laminates Sample at random one piece of product as the sample from a lot of laminated sheets, rods or tubes that can be regarded as of the same quality, shape and dimensions.

Notes ⁽¹⁾ The term lot used here means, as defined in S6 (stratified sampling) of clause 3. (5) in JIS Z 8101, moulding material, laminated sheets, rods and tubes of the same quality produced at the same time under the same conditions.

⁽²⁾ The term sample used here means, as defined in S9 (cluster sampling) of clause 3. (5) in JIS Z 8101, one sampled from the same lot to be subjected to measurements and tests.

3.2 Method of making test pieces

- (1) Moulding material When making each test piece by moulding the sample, use the metal mould which meets the requirements for the respective test piece, and mould under the conditions as appropriate to the sample.
- (2) Laminated sheets Unless otherwise specified, cut the test pieces from the ends of the sample lengthwise or crosswise, with care not to produce heat by machining.
- (3) Laminated rods Unless otherwise specified, cut the test pieces from the ends of the sample, with care not to produce heat by machining.
- (4) Laminated tubes Unless otherwise specified, cut the test pieces from the ends of the sample, with care not to produce heat by machining.

Remarks: Unless otherwise specified, the tolerances on the dimensions of test piece shall be $\pm 5 \%$ of the specified dimensions.

4. Test items The test items for each type of thermosetting plastic product shall be as given in Table 1.

Table 1. Test items

Test item	Description	Appli- cable clause	Times of testing				Size of test piece mm	Preconditioning of test piece	Measured value, unit or method of expres- sion	Expres- sion of test results
			Mould- ing mate- rial	Lami- nated sheet	Lami- nated rod	Lami- nated tube				
Apparent density and bulk factor	Where pouring through funnel is possible	5.2.1	2				—	—	g/ml coeffi- cient	Mean value
	Where pouring through funnel is impossible	5.2.2	2				—	—		
Flow	Extruding method	5.3.1	2				—	—	g, s mm	Mean value
	Circular disc method	5.3.2	2				—	—		
Mouldability	—	5.4	2				—	—	—	Occurrence of defects
Free water content	—	5.33	2				—	—	%	Mean value
Dimensions	Length, width, thickness	5.5.1		2			—	A	mm, mm, 0.01 mm mm, 0.01 mm mm, 0.01 mm 0.01 mm	Mean value
	Length, diameter	5.5.2			2		—			
	Length, outside diameter, inside diameter	5.5.3				2	—			
Warping rate or twisting rate	—	5.6		2			—	A	%/ 1000 mm	Max. value
Mould shrinkage coefficient and rate of shrinkage on heating	After exposure to C-24 ± 1 h/23 ± 2°C/(50 ± 5) % RH	5.7	2				Circular disc as Fig. 8 φ 90 × 11	C-24 ± 1 h/23 ± 2°C/ (50 ± 5) % RH	%	Mean value

Table 1. (continued)

Test item	Description	Appli- cable clause	Times of testing				Size of test piece mm	Preconditioning of test piece	Measured value, unit or method of expres- sion	Expres- sion of test results
			Mould- ing mate- rial	Lami- nated sheet	Lami- nated rod	Lami- nated tube				
Withstand voltage	In oil, at specified voltage, for 1 min	5.8	2				Circular disc ϕ (60 to 100) $\times$ (2 $\pm$ 0.15)	C-90 $^{+4}_{-2}$ h/20 $\pm$ 2°C/(65 $\pm$ 5) % RH O-0.5 h/90 $\pm$ 2°C C-90 $^{+4}_{-2}$ h/20 $\pm$ 2°C/(65 $\pm$ 5) % RH		Occur- rence of frac- ture
	Flatwise withstand voltage	5.9		2			Full dia. $\times$ (2 $\pm$ 0.15)			
		5.10.1					Square plate $\square$ (70 to 100) $\times$ (2 $\pm$ 0.15)			
	For less than 200 mm inside diameter	5.10.2					Machined tube as Fig. 10, 80			
	For not less than 200 mm inside diameter						Machined piece as Fig. 11, 70 square $\times$ (2 $\pm$ 0.15)			
Edgewise withstand voltage	In 90°C oil	5.11.1		2			With electrode hole as Fig. 12, 75 $\times$ 50 $\times$ (3 to 10)	O-0.5 h/90 $\pm$ 2°C C-90 $^{+4}_{-2}$ h/20 $\pm$ 2°C/(65 $\pm$ 5) % RH		
	In oil	5.11.2					With electrode hole as Fig. 13, 40 $\times$ 20 $\times$ full thickness			
Dielectric breakdown strength	Flatwise, short-time method, in oil	5.11.3	3	3			Circular disc, ϕ (80 to 100) $\times$ 2 $\pm$ 0.15	C-90 $^{+4}_{-2}$ h/20 $\pm$ 2°C/(65 $\pm$ 5) % RH D-48 $\pm$ 2 h/50 $\pm$ 3°C C-90 $^{+4}_{-2}$ h/20 $\pm$ 2°C/(65 $\pm$ 5) % RH D-48 $\pm$ 2 h/50 $\pm$ 3°C	MV/m MV/m MV/m	Mean value
	After immersion in water		3	3			Square plate, $\square$ 100 $\times$ (0.8 to 3.0)			
	Flatwise, 1 min step-by- step method, in oil	5.11.3	3	3						
	After immersion in water		3	3						
Insulation resistance	After boiling	5.12	2	2			With electrode hole as Fig. 14 (a) (b), 40 $\times$ 20 $\times$ 10 or full thickness	C-90 $^{+4}_{-2}$ h/20 $\pm$ 2°C/(65 $\pm$ 5) % RH D-2 h/100°C + D-0.5 h/ 20 $\pm$ 10°C C-90 $^{+4}_{-2}$ h/20 $\pm$ 2°C/(65 $\pm$ 5) % RH D-2 h/100°C + D-0.5 h/ 20 $\pm$ 10°C	M Ω	Mean value
			2	2			With electrode hole as Fig. 14 (a) (b), 40 $\times$ 20 $\times$ 10 or full thickness			
	After boiling	5.12			2		With electrode hole as Fig. 14 (c), 40 $\times$ full dia. 26 or under			
					2		With electrode hole as Fig. 14 (c), 40 $\times$ full dia. 15 or under			

Table 1. (continued)

Test item	Description	Appli- cable clause	Times of testing				Size of test piece mm	Preconditioning of test piece	Measured value, unit or method of expres- sion	Expres- sion of test results
			Mould- ing mate- rial	Lami- nated sheet	Lami- nated rod	Lami- nated tube				
Resistivity	Volume, surface, 1 min charging	5.13	2				Circular disc, $\phi 100 \times (2 \pm 0.15)$ Square plate, $\square 100 \times$ full thickness of 10 or under	C-90 $^{+4}_{-2}$ h/20 $\pm 2^{\circ}\text{C}/(65 \pm 5) \% \text{RH}$ C-90 $^{+4}_{-2}$ h/20 $\pm 2^{\circ}\text{C}/(65 \pm 5) \% \text{RH}$	M Ωcm , M Ω	Mean value
				2						
Dielectric constant and dielectric dis- sipation fac- tor	Mutual induction bridge method	5.14.1	2				Circular disc, $\phi 100 \times (3 \pm 0.15)$	C-90 $^{+4}_{-2}$ h/20 $\pm 2^{\circ}\text{C}/(65 \pm 5) \% \text{RH}$	—	Mean value
	After immersion in water		2				Circular disc, $\phi 100 \times (3 \pm 0.15)$	D-24 ± 1 h/23 $\pm 1^{\circ}\text{C}$		
	After immersion in water			2			Square plate, $\square 100 \times 3$ (full thickness)	C-90 $^{+4}_{-2}$ h/20 $\pm 2^{\circ}\text{C}/(65 \pm 5) \% \text{RH}$		
	Q-meter method	5.14.2		2			Square plate, $\square 100 \times 3$ (full thickness)	D-24 ± 1 h/23 $\pm 1^{\circ}\text{C}$		
	After immersion in water	5.14.3	2				Circular disc, $\phi 50 \times (3 \pm 0.15)$	C-90 $^{+4}_{-2}$ h/20 $\pm 2^{\circ}\text{C}/(65 \pm 5) \% \text{RH}$		
	After immersion in water		2				Circular disc, $\phi 50 \times (3 \pm 0.15)$	D-24 ± 1 h/23 $\pm 1^{\circ}\text{C}$		
Arc resis- tance	After immersion in water			2			Square plate, $\square 50 \times 3$ (full thickness)	C-90 $^{+4}_{-2}$ h/20 $\pm 2^{\circ}\text{C}/(65 \pm 5) \% \text{RH}$	s	Mean value
		5.15	2				Square plate, $\square 50 \times 3$ (full thickness)	D-24 ± 1 h/23 $\pm 1^{\circ}\text{C}$		
Hardness	Rockwell hardness	5.16.1	2				Circular disc, $\phi 100 \times (3 \pm 0.25)$	C-90 $^{+4}_{-2}$ h/20 $\pm 2^{\circ}\text{C}/(65 \pm 5) \% \text{RH}$	—	Mean value
	Barcol hardness	5.16.2	5	2	5		Circular disc, $\phi 50 \times (3 \pm 0.15)$ doubles 780 $\times 6$ (piled) 1.5 or over in thickness	A		

Table 1. (continued)

Test item	Description	Appli- cable clause	Times of testing				Size of test piece mm	Preconditioning of test piece	Measured value, unit or method of expres- sion	Expres- sion of test results
			Mould- ing mate- rial	Lami- nated sheet rod	Lami- nated rod	Lami- nated tube				
Flexural strength and bending modulus of elasticity	$L_v16 \ h \pm 0.5$	5.17.1	2				Square rod $> 80 \times (10 \pm 0.5) \times (4 \pm 0.2)$	A	MPa (kgf/ mm ²)	Mean value
	Perpendicular $L_v16 \ h \pm 0.5$ to laminae	5.17.2		2			Full thickness (1 to 3) $\times (25 \pm 0.5) \times 60$ (20 times the thickness) Full thickness (> 3 to 10) $\times (10 \pm 0.5) \times 20$ times the thickness			
				2			Full thickness (> 10 to 20) $\times (20 \pm 0.5) \times 18$ times the thickness			
				2			Full thickness (> 20 to 25) $\times (35 \pm 0.5) \times 18$ times the thickness			
	Parallel to laminae	$L_v100 \pm 0.5$		2			Full thickness (10 to 20) $\times (10 \pm 0.5) \times 120$			
	Less than 8 diameter	$L_v50 \pm 0.5$			2		Full thickness (> 20 to 25) $\times (20 \pm 0.5) \times 120$			
	8 to 15 diameter	$L_v100 \pm 0.5$			2		$< \phi 8 \times 70$			
	Thick wall tube, over 100 inside diameter	5.17.4				2	Machined wall thickness (3 to 10) $\times 10 \times 20$ times the thickness			
	Not more than 100 inside diameter					2	Full dia. (inside dia. to 0.75 times the outside dia.) $\times (15 \pm 0.7)$			

Table 1. (continued)

Test item	Description	Applicable clause	Times of testing				Size of test piece mm	Preconditioning of test piece	Measured value, unit or method of expression	Expression of test results
			Moulding material	Laminated sheet	Laminated rod	Laminated tube				
Flexural strength under heat	Vertical to $L_v16 h \pm 0.5$ laminae	5.34		2			Full thickness (1 to 3) × 25 ± 0.5 × 60 (20 times the thickness)	A	MPa (kgf/mm ²)	Mean value
				2			Full thickness (> 3 to 10) × (10 ± 0.5) × 20 times the thickness			
				2			Full thickness (> 10 to 20) × (20 ± 0.5) × 18 times the thickness			
				2			Full thickness (> 20 to 25) × (35 ± 0.5) × 18 times the thickness			
				2			Full thickness (10 to 20) × (10 ± 0.5) × 120			
				2			Full thickness (> 20 to 25) × (20 ± 0.5) × 120			
Tensile strength	—	5.18.1	2				Moulded pieces as Fig. 30 110 × 45 × 6.5	A	MPa (kgf/mm ²)	Mean value
		5.18.2		2			Machined pieces as Fig. 31 Full thickness (0.5 to 10) × 20 × 175 For sample over 10 mm in thickness, machine to 10 mm thickness			

Table 1. (continued)

Test item	Description	Appli- cable clause	Times of testing				Size of test piece mm	Preconditioning of test piece	Measured value, unit or method of expres- sion	Expres- sion of test results
			Mould- ing mate- rial	Lami- nated sheet	Lami- nated rod	Lami- nated tube				
Compressive strength	Loading at right angles to direction of moulding pressure	5.19.1	4				Moulded pieces as Fig. 33 (c) □ (12.7 ± 0.3) × (25.0 ± 0.3)	A	MPa (kgf/mm ²)	Mean value
	Loading perpendicular to laminae	5.19.2	2	2			Machined pieces as fig. 33 (a), piled			
	Loading parallel to laminae	5.19.3	2	2			Machined pieces as Fig. 33 (b) □ (13 ± 0.5) × (25 ± 0.3)			
	10 to 20 diameter				2		Machined pieces, full dia. × (25 ± 0.3)			
	Over 20 diameter				2		Machined to φ 20 concentric circles × (25 ± 0.3)			
Charpy im- pact strength	Not less than 10 outside dia., not less than 6 inside dia., not less than 2 wall thickness					2	Full dia. (wall thickness 2, machined to concentric circles) × (25 ± 0.3)	A	kJ/m ² (kgf·cm/cm ²) J/m (kgf·cm/cm)	Mean value
	Tubes of thick wall					2	Machined pieces as Fig. 34 □ (13 ± 0.3) × (25 ± 0.3)			
	Loading at right angles to direction of moulding pressure	5.20	2				Fig. 36, with U-notch			
	Parallel to laminae	5.21		2			Fig. 38, with V-notch in lami- nae showing side			
Bonding strength	Perpendicular to laminae			2			Fig. 38, with V-notch in face side	A	N (kgf)	Mean value
	φ10 steel ball	5.22		2			Fig. 40, thickness (13 ± 0.1) × □ 25			

Table 1. (continued)

Test item	Description	Applicable clause	Times of testing				Size of test piece mm	Preconditioning of test piece	Measured value, unit or method of expression	Expression of test results
			Moulding material	Laminated sheet	Laminated rod	Laminated tube				
Appearance after heating	Heating for 2 h	5.23	2				Circular disc, $\phi (50 \pm 1) \times (3 \pm 0.2)$	A	—	Occurrence of remarkable change
	Heating for 2 h			2			Full thickness $\times \square (50 \pm 1)$			
	Heating for 2 h				2		Full dia. $\times (50 \pm 1)$			
	Heating for 2 h					2	Full dia. $\times (50 \pm 1)$			
Deflection temperature under load	—	5.35	2				$(6.4 \pm 0.2) \times (12.7 \pm 0.2) \times 110 \text{ min.}$ $(6.4 \pm 0.2) \times (12.7 \pm 0.2) \times 110 \text{ min.}$	A	°C	Mean value
Thermal expansion	Perpendicular to laminae Parallel to laminae	5.25	2	2			$120 \times 10 \times 10$ Full thickness $\times 10 \times 10$ $120 \times 10 \times 10$	A	1°C	Mean value
Burning resistance	Method A	5.24.1	2	2			$127 \times 12.7 \times 12.7$ Full thickness $\times 12.7 \times 12$	A	—	Division of burning resistance
	Method B	5.24.5	5				$0.8 \times (12.7^{+0.5}_0) \times 127$	A	—	Class
			5	5			$0.8 \times (12.7^{+0.5}_0) \times 127$ Full thickness $\times (12.7^{+0.5}_0) \times 127$			
				5			Full thickness $\times (12.7^{+0.5}_0) \times 127$	E-168 h/70 $\pm 1^\circ\text{C}$ A E-168 h/70 $\pm 1^\circ\text{C}$		
Method C		5.24.3	3				$0.8 \text{ or over} \times (12.7^{+0.5}_0) \times 127$	A	—	Class
							Full thickness $\times (12.7^{+0.5}_0) \times 127$			

Table 1. (continued)

Test item	Description	Appli- cable clause	Times of testing				Size of test piece mm	Preconditioning of test piece	Measured value, unit or method of expres- sion	Expres- sion of test results
			Mould- ing mate- rial	Lami- nated sheet	Lami- nated rod	Lami- nated tube				
Water ab- sorption	—	5.26.1	2				$\phi (50 \pm 1) \times (3 \pm 0.2)$	E-24 ± 1 h/50 $\pm 2^\circ\text{C}$ + des	%	Mean value
		5.26.2		2			Full thickness $\square 50 \pm 1$			
		5.26.3			2		Full dia. $\times (50 \pm 1)$			
		5.26.4				2	Full dia. $\times (50 \pm 1)$ or Fig. 44			
Boiling water absorption	Boiling for 1 h	5.27	2				$\phi 50 \pm 1 \times 3 \pm 0.2$	E-24 ± 1 h/50 $\pm 2^\circ\text{C}$ + des	%	Mean value
Specific grav- ity	—	5.28	1	1	1	1	Suitable shape, dimensions (1 g to 5 g mass) Cut faces to be smooth	A	—	Mean value
Resistance to acetone	Applied to phenol resin	5.29	2	2	2	2	20 $\times$ 20 $\times$ 20 or suitable di- mensions	A	—	Occurrence of remarkable change in appearance
Resistance to boiling water	—	5.30	2				$\phi (50 \pm 1) \times (3 \pm 0.2)$	A	—	Occurrence of change in ap- pearance and coloration of water
Resistance to sulfuric acid	Applied to melamine resin 0.8 $\pm$ 0.05 % sulfuric acid	5.31	2				$\phi (50 \pm 1) \times (3 \pm 0.2)$	A	—	Extent of change in appearance and dis- coloration
Chemical re- sistance	Changing rate of mass	5.32	2				$\phi (50 \pm 1) \times (3 \pm 0.2)$	E-24 ± 1 h/50 $\pm 2^\circ\text{C}$	%	Mean value

Remarks: The symbols for preconditioning are as follows:

A is for as furnished condition, C for constant temperature and humidity, E for constant temperature air, D for immersion in distilled water and O for treatment in oil, and des shows the condition having been allowed to cool in a desiccator containing desiccant.

Example: C-90 ± 4 h/20 $\pm 2^\circ\text{C}$ /(65 ± 5) % RH means to place the test piece in the air of a constant temperature and relative humidity of 20 $\pm 2^\circ\text{C}$ and (65 ± 5) % for 90 ± 4 h.

5. Test method

5.1 General conditions for tests The general conditions for tests shall be as follows:

- (1) Atmosphere of testing place Tests shall, as a rule, be carried out in a room of $23 \pm 2^{\circ}\text{C}$ temperature and $(50 \pm 5) \%$ relative humidity. When the tests have been carried out under other temperature and humidity than the above, the temperature and humidity shall be noted in addition to the test results. However, for withstand voltage, dielectric breakdown strength, insulation resistance, resistivity, dielectric constant, dielectric dissipation factor and arc-resistance, the tests shall be carried out in a room of $20 \pm 2^{\circ}\text{C}$ temperature and $(65 \pm 5) \%$ relative humidity.
- (2) Maintaining accuracy of apparatus Testing machines and measuring instruments shall be maintained in such a state that tests are reproducible with required accuracies.
- (3) Tolerances The tolerances on the numerical values prescribed shall comply with the requirements for the items as appropriate. Unless otherwise specified, the tolerances shall be $\pm 5 \%$ of the numerical values.
- (4) Numerical values of test results Determine the numerical values to the place next below the specified, and round them off in accordance with JIS Z 8401.

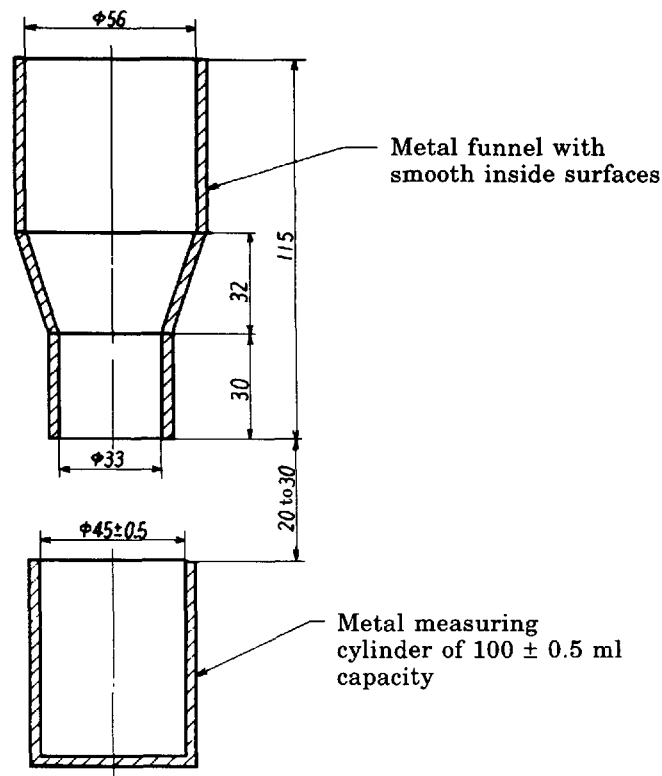
5.2 Apparent density and bulk factor

5.2.1 Moulding material (where pouring through funnel is possible) To be carried out as follows:

- (1) Apparatus
 - (1.1) Trip balance The balance specified in JIS B 7601 with precision of 0.5 g reciprocal sensibility or better.
 - (1.2) Apparent density measuring apparatus Metal ones of the shapes and dimensions as shown in Fig. 1.

Fig. 1. Apparent density measuring apparatus
(where pouring through funnel is possible)

Unit: mm



- (2) Procedure Measure the mass of the measuring cylinder to the nearest 0.5 g. Close the bottom of the funnel with a flat metal panel, and pour in it 110 ml to 120 ml of well mixed sample. Next, remove the metal panel under the funnel to let the sample freely fall into the measuring cylinder below.

Where the sample is in clods and adhering to the funnel, break them in pieces with a glass stick. Scrape off the part of the sample heaping above the measuring cylinder by moving a straightedge crosswise on the top edge of the cylinder, and measure the mass of the cylinder with the sample in it to the nearest 0.5 g.

- (3) Calculation Calculate the apparent density and bulk factor by the following equations:

$$A_1 = \frac{B - C}{D}$$

$$A_2 = \frac{E}{A_1}$$

where, A_1 : apparent density [g/ml (kg/l)]

A_2 : bulk factor

B : mass of measuring cylinder with sample in it (g)

- C : mass of measuring cylinder (g)
 D : capacity of measuring cylinder (ml)
 E : density of moulding product [g/ml (kg/l)]

The density of moulding product is the numerical value of specific gravity measured by the method specified in 5.28.

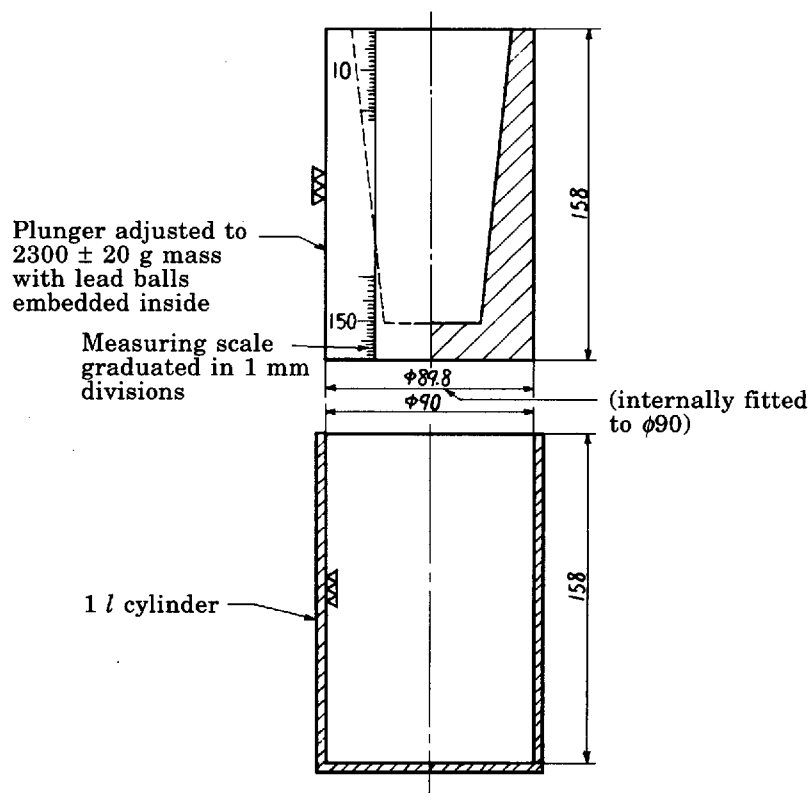
5.2.2 Moulding material (where pouring through funnel is impossible) To be carried out as follows:

(1) Apparatus

- (1.1) Trip balance The balance specified in 5.2.1 (1.1).
 (1.2) Apparent density measuring instrument Metal instrument of the shapes and dimensions as shown in Fig. 2, the plunger being graduated outside in 1 mm divisions from the top to the bottom, and adjusted to 2300 ± 20 g with lead balls.

Fig. 2. Apparent density measuring instrument
(where pouring through funnel is impossible)

Unit: mm



- (2) Procedure Fill 60 ± 0.2 g of the sample in the measuring cylinder making the surface of the sample horizontal. Next, put the plunger into the cylinder and allow it to stand for 1 min, then measure the level of the sample by the scale outside the plunger to the nearest 1 mm.

- (3) Calculation Calculate the apparent density and bulk factor by the following equations:

$$A_1 = \frac{60}{B \times C}$$

$$A_2 = \frac{E}{A_1}$$

where, A_1 : apparent density [g/ml (kg/l)]

A_2 : bulk factor

B : cross-sectional area of measuring cylinder (cm²)

C : height of sample in measuring cylinder (cm)

E : density of moulding product [g/ml (kg/l)]

In the above, the density of moulding product is the numerical value of the specific gravity as measured by the method specified in 5.28.

5.3 Flow

5.3.1 Moulding material (flow by extruding method) To be tested as follows:

(1) Apparatus

(1.1) Trip balance The balance specified in 5.2.1 (1.1).

(1.2) Thermometer A thermometer graduated up to 360°C in 1°C divisions.

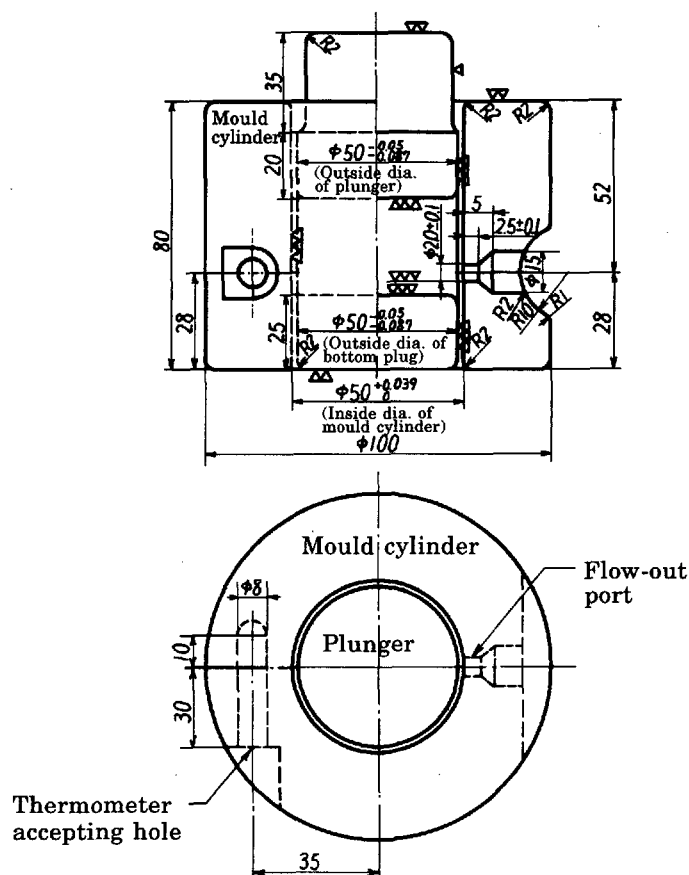
(1.3) Stopwatch Stopwatch graduated in 0.2 s divisions.

(1.4) Compression moulding machine A moulding machine capable of keeping the metal mould shown in Fig. 3 under the conditions of temperature and pressure given in Table 2.

(1.5) Metal mould for testing flow by extruding method A mould with the shapes and dimensions shown in Fig. 3.

Fig. 3. Metal mould for testing flow by extruding method

Unit: mm



Remarks: The material of each part of the mould shall, in accordance with the provisions of JIS G 4051, be as follows:

Plunger : S50C Mould cylinder : S55C
Bottom plug : S50C

- (2) Procedure Charge the specified mass of the sample in the mould cylinder maintained at the specified temperature, put the plunger into the cylinder within 30 s, apply the specified pressure on the sample and measure the mass of the sample extruded from the flow-out port in the cylinder to the nearest 1 g to represent the flow-out mass (g), and measure the time from the start of pressing to the finish of the flow-out to the nearest 1 s to represent flow-out time (s).

In the above, the charging mass, temperature of metal mould and pressure shall, as a rule, be as given in Table 2.

Where the test was made under other conditions than those in Table 2, they shall be clearly noted in addition to the results.

Table 2. Charging mass, temperature of metal mould
and pressure in testing flow by extruding method

Condition Kind	Charging mass g	Temperature of metal mould °C	Pressure ⁽³⁾ MPa {kgf/cm ² }
Phenol resin	40	160 ± 3	A: 9.80 {100} B: 29.0 {300}
Urea resin	35	140 ± 3	20.0 {200}
Melamine resin	35	150 ± 3	20.0 {200}
Diallyl phthalate resin	40	160 ± 3	A: 9.80 {100} B: 20.0 {200}

Notes ⁽³⁾ A : for material of good fluidity

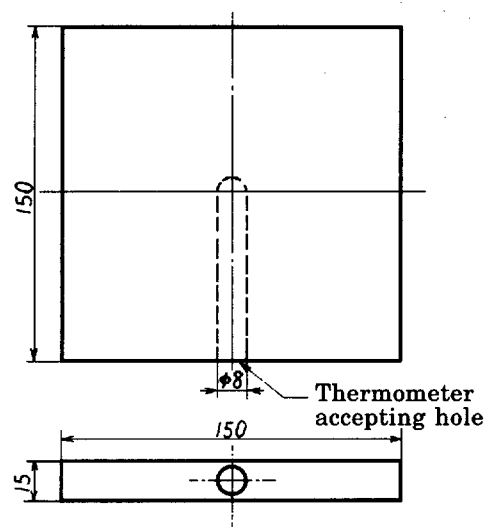
B : for material of little fluidity

5.3.2 Moulding material (flow by circular disc method) To be tested as follows:(1) Apparatus(1.1) Dimension measuring instrument Graduated in 1 mm divisions.(1.2) Thermometer The thermometer specified in 5.3.1 (1.2).(1.3) Compression moulding machine A moulding machine capable of maintaining the metal panels shown in Fig. 4 under the conditions of temperature and load given in Table 3.(1.4) Metal panels A set of two panels of hard steel, with their faces hard-chrome plated, with shape and dimensions shown in Fig. 4.(1.5) Metal cylinder A cylinder approximately 50 mm in inside diameter and approximately 10 mm in height.(2) Procedure Put 5 g of the sample on the metal panel maintained at the temperature specified in Table 3, nearly at the centre, using the metal cylinder so as the sample forms a cone, and within 15 s, press-form it under the load and pressing time specified in Table 3. However, where the test was made under other conditions than those in Table 3, they shall be clearly noted.

Measure the major and minor diameters of the glossy part of the formed circular disc by the measuring instrument to the nearest 1 mm, and calculate the average value of the measurements for the elongation (mm) of sample.

Fig. 4. Metal panels for testing flow
by circular disc method

Unit: mm

Table 3. Temperature of panels, load and pressing time
for testing flow by circular disc method

Kind	Condition	Temperature of metal panel °C	Load kN (kgf)	Pressing time min
Phenol resin		160 ± 3	24.50 {2500}	1
Urea resin		140 ± 3	19.60 {2000}	2
Melamine resin		150 ± 3	19.60 {2000}	2
Diallyl phthalate resin		160 ± 3	24.50 {2500}	1

5.4 Mouldability (moulding material) To be tested as follows:(1) Apparatus

(1.1) Compression moulding machine A moulding machine capable of maintaining the temperature and the pressure on the metal mould specified in (1.2) as agreed between the parties concerned.

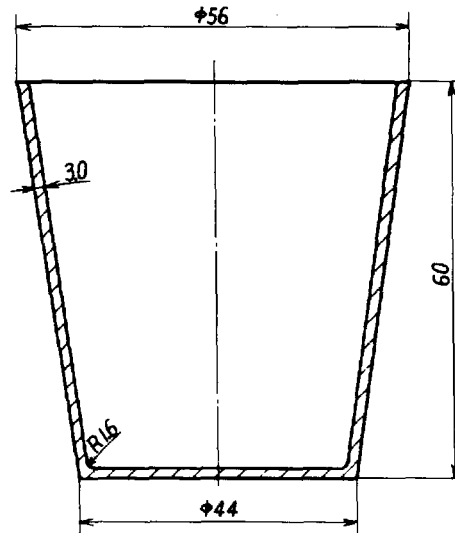
(1.2) Metal mould A metal mould capable of moulding the sample, as a rule, to the shape and dimensions shown in Fig. 5.

(2) Procedure Examine the product moulded in the metal mould from the sample to the shape and dimensions shown in Fig. 5, for easiness of separation from the metal mould, the smoothness in appearance, deformation, wrinkles, spots, etc.

The temperature of metal mould, pressure and pressing time shall be as agreed between the parties concerned.

Fig. 5. Dimensions of moulding product
in mouldability test

Unit: mm



5.5 Dimensions

5.5.1 Laminated sheets To be measured as follows:

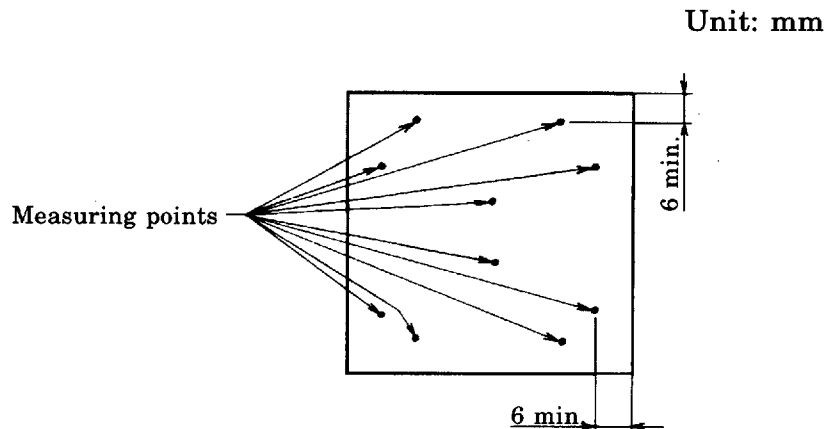
(1) Length and width

- (1.1) Apparatus Use the steel tape measure of Class 1 (graduated in 1 mm divisions) specified in JIS B 7512 or one with an accuracy at least equivalent.
- (1.2) Procedure Hold the laminated sheet vertical or horizontal and measure, in parallel to the periphery of the sheet, lengthwise and widthwise to the nearest 1 mm.

(2) Thickness

- (2.1) Apparatus Use the micrometer calliper for external measurement specified in JIS B 7502 or at least equivalent provided with a yoke of sufficient size and rigidity to permit accurate measurement of the thickness of the laminated sheet in the centre.
- (2.2) Procedure Hold the laminated sheet vertical or horizontal, measure the thickness at 10 points as shown in Fig. 6 — two along each edge, not less than 6 mm inwards, (thus eight with all boundaries) and two in the middle — to the nearest 0.01 mm. Make two measurements for one point and take their average as the thickness at the point.

Fig. 6. Measuring points for thickness of laminated sheet



5.5.2 Laminated rod To be measured as follows:

(1) Length

(1.1) Apparatus Use the steel tape measure of Class 1 (graduated in 1 mm divisions) specified in JIS B 7512 or one with an accuracy at least equivalent.

(1.2) Procedure Hold the laminated rod vertical or horizontal, measure the length in four positions spaced at 90° round the circumference to the nearest 1 mm, and take the average of the measurements as the length.

(2) Diameter

(2.1) Apparatus The micrometer calliper for external measurement specified in JIS B 7502, the vernier calliper of the minimum reading value of 0.02 mm specified in JIS B 7507 or one with an accuracy at least equivalent.

(2.2) Procedure Hold the laminated rod vertical or horizontal, measure the diameters at both ends and in the middle, in four positions spaced at 45°, with the micrometer calliper to the nearest 0.01 mm, and take the average of the measurements as the diameter.

They may be measured with the vernier calliper to the nearest 0.02 mm.

5.5.3 Laminated tube To be measured as follows:

(1) Length

(1.1) Apparatus The dimension measuring apparatus used shall be the steel tape measure of Class 1 (graduated in 1 mm divisions) specified in JIS B 7512 or one with an accuracy at least equivalent.

(1.2) Procedure Hold the laminated tube vertical or horizontal, measure the length in four positions spaced at 90° round the circumference to the nearest 1 mm, and take the average of the measurements as the length.

(2) Outside diameter

(2.1) Apparatus

(2.1.1) Micrometer calliper The micrometer calliper for external measurement specified in JIS B 7502 or one with an accuracy at least equivalent.

- (2.1.2) Vernier calliper The vernier calliper the minimum reading value 0.02 mm specified in JIS B 7507 or one with an accuracy at least equivalent.
- (2.1.3) Steel tape measure The steel tape measure of Class 1 specified in JIS B 7512 or one with an accuracy at least equivalent.
- (2.2) Procedure Hold the laminated tube vertical or horizontal, measure the outside diameters at both ends and in the middle in four directions spaced at 45° by the micrometer calliper to the nearest 0.01 mm and take the average of the measurements as the outside diameter.

They may be measured by the vernier calliper to the nearest 0.02 mm.

With a laminated tube with specially large diameter, the outside diameter may be calculated by the following equation, from the circumferential length measured with the steel tape measure wound around the tube to the nearest 1 mm.

$$D = \frac{L}{\pi} - 2t$$

where, D : outside diameter (mm)
 π : ratio of the circumference of a circle to its
 diameter = 3.14
 L : circumference of laminated tube (mm)
 t : thickness of steel tape measure (mm)

(3) Inside diameter

(3.1) Apparatus

- (3.1.1) Dimension measuring instrument The bar-shaped micrometer calliper for internal measurement specified in JIS B 7502 or one with an accuracy at least equivalent, bar-shaped micrometer calliper for internal measurement (extension rod type, 0.01 mm in scale), calliper type micrometer for internal measurement (graduated in 0.01 mm division) or small hole gauge (0.01 mm in scale).
- (3.1.2) Vernier calliper The vernier calliper of the minimum reading value 0.02 mm specified in JIS B 7507 or one with an accuracy at least equivalent.
- (3.2) Procedure For a laminated tube with not less than 50 mm inside diameter, hold it vertical or horizontal, measure the inside diameters in each end plane, in four directions at 45° intervals, with a single unit or extension rod type internal micrometer, to the nearest 0.01 mm, and take the average of the measurements as the inside diameter.

They may be measured with a vernier calliper to the nearest 0.02 mm.

For a laminated tube with not less than 3 mm but less than 50 mm inside diameter, measure the diameters in the same way as that for the laminated tube with not less than 50 mm inside diameter, with a calliper type internal micrometer or small hole gauge.

For a laminated tube with specially large wall thickness, the inside diameter may be calculated by subtracting a length equal to twice the measured wall thickness from the outside diameter.

(4) Wall thickness and its variation(4.1) Apparatus(4.1.1) Micrometer calliper A micrometer calliper with convex anvil for pipe thickness measurement (graduated in 0.01 mm divisions).(4.1.2) Dial gauge The dial gauge of 0.01 mm in scale interval specified in JIS B 7503.(4.1.3) Surface plate The Class 2 surface plate specified in JIS B 7513 or one with an accuracy at least equivalent.(4.2) Procedure The wall thickness is the numerical value equal to $\frac{1}{2}$ the difference between the outside and inside diameters measured by (2.2) and (3.2). However, when direct measurement of wall thicknesses of a laminated tube with not less than 6 mm inside diameter is particularly desired, measure the thicknesses with the micrometer calliper with convex anvil for pipe thickness measurement, in each end plane, in eight directions at 45° intervals, to the nearest 0.01 mm, and take the average of the measurements as the wall thickness.

When measuring those of a laminated tube with less than 6 mm inside diameter, place the laminated tube on the surface plate, fit a stick with a diameter slightly smaller than the inside diameter of the tube into it, measure the difference between the outside diameters of the stick and the laminated tube, in eight directions round the circumference at 45° intervals, with the dial gauge to the nearest 0.01 mm, and take the $\frac{1}{2}$ of the average of measurements as the wall thickness.

The variation of the wall thickness of laminated tube is the numerical value of the difference between the maximum and minimum wall thicknesses.

5.6 Warping rate or twisting rate (laminated sheets)5.6.1 Apparatus Use those as follows:(1) Straightedge The Class B straightedge specified in JIS B 7514 (with rectangular cross section) with an effective length not less than 1.5 m.(2) Rule The Class 1 rule (graduated in 1 mm divisions) specified in JIS B 7516 or one with an accuracy at least equivalent.5.6.2 Test piece Use full size laminated sheets.5.6.3 Procedure Hang the laminated sheet vertical by the centre of one edge as shown in Fig. 7 (a) and apply the straightedge parallel to the edge. Apply the straightedge on the concave side of the sheet and measure the maximum clearance between the straightedge and the sheet with the metal rule to the nearest 1 mm.

Repeat similar measurements with other edges and take the maximum clearance as the maximum warping of the laminated sheet.

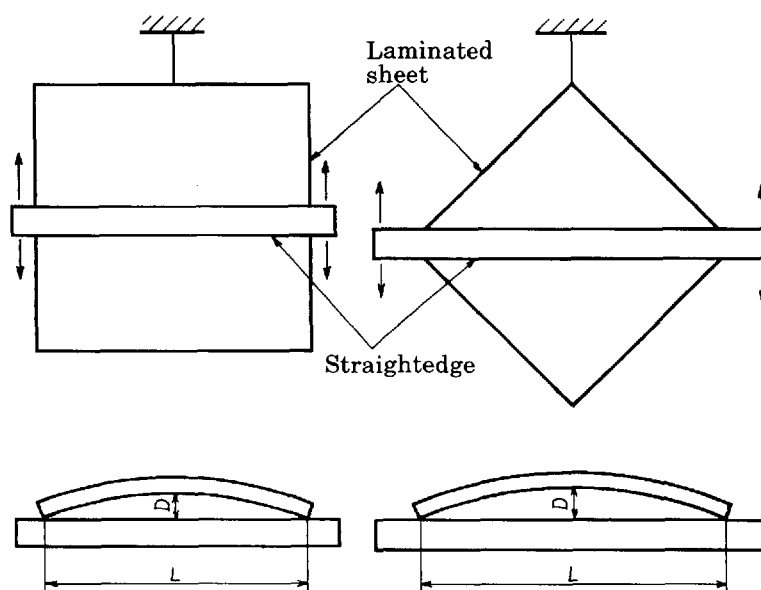
Hang the laminated sheet vertical by one corner as shown in Fig. 7 (b), apply the straightedge on the horizontal diagonal of the sheet, determine the maximum clearance similarly to the case of maximum warping, and take it as the maximum twisting of the laminated sheet.

In the case of a laminated sheet not less than 3 mm in thickness, make the measurement with the sheet stood vertical.

Fig. 7. Measuring procedure for warping or twisting of laminated sheets

(a) Measurement of warping

(b) Measurement of twisting



5.6.4 Calculation Calculate warping or twisting rate W_{1000} (%) by the following equation:

$$W_{1000} = \frac{D_{1000}}{1000} \times 100$$

where, W_{1000} : warping or twisting rate (%)

D_{1000} : warping or twisting on 1000 mm (mm)

$$D_{1000} = \frac{D}{L^2} \times 1000^2$$

where, D : maximum warping or twisting (mm)

L : span of laminated sheet applied with straightedge (mm)

5.7 Mould shrinkage coefficient and rate of shrinkage on heating (moulding material)

5.7.1 Apparatus Use those as follows: