IS 15328 (2003): Unplasticized Non-Pressure Polyvinyl Chloride (PVC -U) Pipes for use in Underground Drainage and Sewerage Systems - [CED 50: Plastic Piping System]

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भारतीय मानक

दाब-रहित भूमिगत जल निकास एवं भवनों के बाहर मल-जल व्यवस्था में प्रयुक्त अप्लास्टिकृत पॉलीविनायल क्लोराइड (पी.वी.सी.-यू.) पाइप – विशिष्टि

Indian Standard

UNPLASTICIZED NON-PRESSURE POLYVINYL CHLORIDE (PVC-U) PIPES FOR USE IN UNDERGROUND DRAINAGE AND SEWERAGE SYSTEMS — SPECIFICATION

ICS 83.140.30; 93.030

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

July 2003 **Price Group 10**

AMENDMENT NO. 1 JANUARY 2005
TO
IS 15328 : 2003 UNPLASTICIZED NON-PRESSURE POLYVINYL CHLORIDE (PVC-U) PIPES FOR USE IN UNDERGROUND DRAINAGE AND SEWERAGE SYSTEMS — SPECIFICATION

(*Page* 6, *Table* 4, *col* 4, *title*) — Substitute 'd_{sm} *Max*' *for* '*A Min*'.

(*Page* 6, *Table* 4, *col* 5, *title*) — Substitute 'l_2 *Min*' *for* '*C Max*'.

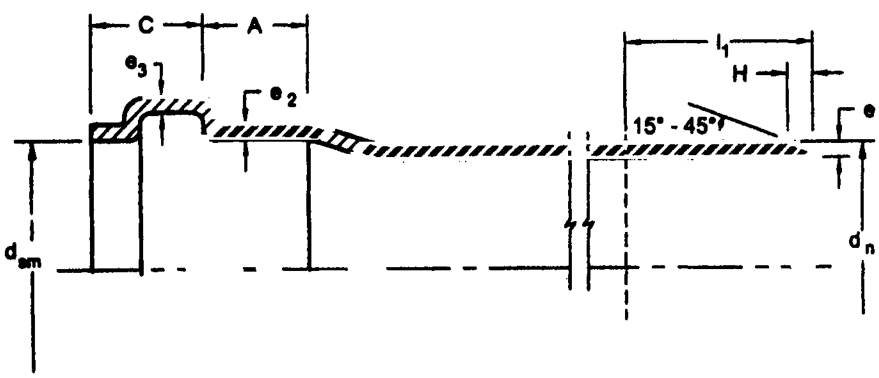
(*Page* 7, *Fig.* 5) — Substitute 'd_{sm}' *for* 'd_s'.

(CED 50)

Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 2 MAY 2005
TO
IS 15328 : 2003 UNPLASTICIZED NON-PRESSURE POLYVINYL CHLORIDE (PVC-U) PIPES FOR USE IN UNDERGROUND DRAINAGE AND SEWERAGE SYSTEMS — SPECIFICATION

(*Page* 7, *Fig.* 2) — Substitute the following for the existing figure:



BASIC DIMENSIONS OF INTEGRAL SOCKETS AND SPIGOT ENDS FOR ELASTOMETRIC SEALING RING JOINTS

[*Page* 8, *Table* 5, *Sl No.* (i), *col* 3] — Substitute '≥ 2' *for* '≤ 2'.

(CED 50)

Reprography Unit, BIS, New Delhi, India

Indian Standard

AMENDMENT NO. 3 NOVEMBER 2005
TO
IS 15328 : 2003 UNPLASTICIZED NON-PRESSURE POLYVINYL CHLORIDE (PVC-U) PIPES FOR USE IN UNDERGROUND DRAINAGE AND SEWERAGE SYSTEMS — SPECIFICATION

(*Page* 16, *Annex* C, *clause* **C-8.1**, *lines* 4 *to* 6) — Substitute the following for the existing:

$$S_a = \{0.018\,6 + 0.025\,(y_a/d_i)\}(F_a/L_a y_a)$$

$$S_b = \{0.018\,6 + 0.025\,(y_b/d_i)\}(F_b/L_b y_b)$$

$$S_c = \{0.018\,6 + 0.025\,(y_c/d_i)\}\,(F_c/L_c y_c)$$

(CED 50)

Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 4 FEBRUARY 2006
TO
IS 15328 : 2003 UNPLASTICIZED NON-PRESSURE POLYVINYL CHLORIDE (PVC-U) PIPES FOR USE IN UNDERGROUND DRAINAGE AND SEWERAGE SYSTEMS — SPECIFICATION

(*Page* 8, *Table* 6, *Note, line* 2) — Substitute,

$$p = \frac{\sigma 2e_{Min}}{(d_{em} - e_{Min})}$$ for the existing formula.

(CED 50)

Reprography Unit, BIS, New Delhi, India

AMENDMENT NO. 5 FEBRUARY 2009
TO
IS 15328 : 2003 UNPLASTICIZED NON-PRESSURE POLYVINYL CHLORIDE (PVC-U) PIPES FOR USE IN UNDERGROUND DRAINAGE AND SEWERAGE SYSTEMS — SPECIFICATION

(*Page* 1, *clause* 1, *Scope, line* 6) — Substitute '63 mm' *for* '110 mm'.

(*Page* 3, *Table* 1, *col* 1 *to* 6) — Insert the following new values in the beginning and renumber the existing Sl Nos. accordingly:

Sl No.	Nominal Outside Diameter, d_n	Mean Outside Diameter, d_{em}		Outside Diameter at Any Point, d_e	
		Min	*Max*	*Min*	*Max*
(1)	(2)	(3)	(4)	(5)	(6)
i)	63	63.0	63.3	62.2	63.8
ii)	75	75.0	75.3	74.1	75.9
iii)	90	90.0	90.3	88.9	91.2

(*Page* 4, *clause* 8.3, *line* 2) — Substitute 'IS 12235 (Part 8/Sec 1)' *for* 'IS 12235 (Part 8)'.

(*Page* 5, *Table* 2) — Insert the following new values of 'Nominal Outside Diameter' and 'Wall Thickness, *e*' before Nominal Outside Diameter, d_n of 110 mm:

Nominal Outside Diameter, d_n mm	Wall Thickness *e*, mm		
63	–	–	2.7 + 0.4[1)]
75	–	–	2.8 + 0.5[1)]
90	–	–	2.9 + 0.5[1)]

[1)] Wall thicknesses in these cases are more than what is calculated as per SDR in order to meet the stiffness requirement.

(*Page* 6, *Table* 3, *col* 1 *to* 7) — Insert the following new values in the beginning and renumber the existing Sl Nos. accordingly:

Sl No.	Nominal Diameter, d_n	Socket			Spigot End	
		d_{sm} *Min*	*A* *Min*	*C* *Max*	l_1 *Min*	$H^{1)}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	63	63.3	23	18	40	4
ii)	75	75.3	25	20	45	5
iii)	90	90.3	28	23	55	5

[*Page* 6, *Table* 4 (*see also Amendment No.* 1), *col* 1 *to* 7] — Insert the following new values in the beginning and renumber the existing Sl Nos. accordingly:

Sl No.	Nominal Diameter, d_n	Socket			Spigot End	
		d_{sm} *Min*	d_{sm} *Max*	l_2 *Min*	l_1 *Min*	$H^{1)}$
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	63	63.1	63.3	38.0	45	4
ii)	75	75.1	75.3	43.5	50	5
iii)	90	90.1	90.3	51.0	60	5

(*Page* 8, *Table* 6, *Note, last line*) — Substitute the following for the existing:

'e_{Min} = measured minimum wall thickness in millimetres of the free length of the test specimen.'

(*Page* 8, *clause* 12.3) — Substitute the following for the existing:

The colour of the marking shall be as follows:

Class of Pipe	*Colour*
SN 2	Blue
SN 4	Green
SN 8	Brown

(*Page* 12, *Table* 8, *col* 1 *to* 5) — Insert the following new values in the beginning and renumber the existing Sl Nos. accordingly:

Sl No.	Nominal Outside Diameter of Pipes, d_n, mm	Mass of Falling Weight kg	Fall Height	
			m	N.m
(1)	(2)	(3)	(4)	(5)
i)	63	0.25	2	5
ii)	75	0.25	2	5
iii)	90	0.5	2	10

(*Page* 13, *Table* 9, *col* 1 *to* 3) — Insert the following new values in the beginning and renumber the existing Sl Nos. accordingly:

Sl No.	Nominal Outside Diameter of Pipe, mm	Number of Equidistant Lines to be Drawn
(1)	(2)	(3)
i)	63	3
ii)	75	4
iii)	90	4

(*Page* 15, *Table* 11, *col* 1 *to* 3) — Insert the following new values in the beginning and renumber the existing Sl Nos. accordingly:

Sl No.	Nominal Diameter of Pipe, d_n, mm	Deflection Speed, mm/min
(1)	(2)	(3)
i)	$d_n \leq 100$	2 ± 0.4

(CED 50)

Reprography Unit, BIS, New Delhi, India

Plastic Piping System Sectional Committee, CED 50

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Plastic Piping System Sectional Committee had been approved by the Civil Engineering Division Council.

This standard has been prepared with a view to providing guidance for the manufacture and selection of PVC-U pipes for the conveyance of domestic sewage, industrial waste and surface water (other than potable water).

PVC-U pipes for conveyance of potable water are covered in IS 4985 : 2000 'Unplasticized PVC pipes for potable water supplies — Specification (*third revision*)'.

In the formulation of this standard, due weightage has been given to bring it in line with International Standards as well as market situations and practices prevailing in India and considerable assistance has been derived from the following International Standards published by International Organization for Standardization:

ISO 580 : 1990	Injection moulded unplasticized (polyvinyl chloride) (PVC-U) fittings — Oven test — Test method and basic specifications
ISO 1167 : 1996	Thermoplastics pipes for the transport of fluids — Resistance to internal pressure — Test method
ISO 3127 : 1994	Thermoplastic pipes — Determination of resistance to external blows
ISO 4065 : 1996	Thermoplastics pipes — Universal wall thickness table
ISO 4435 : 1991	Unplasticized (polyvinyl chloride) (PVC-U) pipes and fittings for buried drainage and sewerage systems — Specification
ISO 3604-1976	Fitting for unplasticized polyvinyl chloride (PVC-U) pressure pipes with elastic sealing ring type joints — Pressure test for leakproofness under conditions of external hydraulic pressure
ISO/DIS 3845-1995	Plastics piping systems — Elastomeric-sealing-ring-type socket joints for use with unplasticized (polyvinyl chloride) (PVC-U) pipes — Test method for leaktightness under internal pressure and with angular deflection
ISO/DIS 13846-1995	Plastics piping systems — End-load-bearing and non-end-load-bearing assemblies for thermoplastics pressure piping — Test method for long-term leaktightness under internal water pressure

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

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 the same as that of the specified value in this standard.

Indian Standard

UNPLASTICIZED NON-PRESSURE POLYVINYL CHLORIDE (PVC-U) PIPES FOR USE IN UNDERGROUND DRAINAGE AND SEWERAGE SYSTEMS — SPECIFICATION

1 SCOPE

This standard specifies the requirements of plain ended or equipped with integral sockets for either solvent-cement welding or for jointing with elastomeric sealing rings pipes made of unplasticized polyvinyl chloride (PVC-U) of nominal outside diameters ranging from 110 mm up to and including 630 mm, intended for underground (buried) non-pressure gravity drain and sewer applications for transportation of soil and waste discharge of domestic origin, surface water (storm water) and industrial effluent.

In the case of industrial effluent, chemical and temperature resistance and resistance to suspended matter have to be taken into account.

2 REFERENCES

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All 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 below:

IS No.	*Title*
4905 : 1968	Methods for random sampling
4985 : 2000	Unplasticized PVC pipes for potable water supplies — Specification (*third revision*)
5382 : 1985	Specification for rubber sealing rings for gas mains, water mains and sewers (*first revision*)
12235	Methods of test for unplasticized PVC pipes for potable water supplies:
(Part 1) : 1986	Method of measurement of outside diameter
(Part 5) : 1986	Reversion test
(Part 8) : 1986	Internal hydrostatic pressure test
14182 : 1994	Solvent cement for use with unplasticized polyvinyl chloride pipe and fittings — Specification

3 TERMINOLOGY

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

3.1 Nominal Size (***DN*** **)** — The numerical designation for the size of a pipe, other than a pipe designated by thread size, which is a convenient round number approximately equal to the manufacturing dimension in millimetres.

3.2 Nominal Outside Diameter (d_n **)** — The specified outside diameter in millimetres assigned to the nominal size.

3.3 Outside Diameter at Any Point (d_e **)** — The value of the measurement of the outside diameter of a pipe through its cross-section at any point of the pipe, rounded off to the next higher 0.1 mm.

3.4 Mean Outside Diameter (d_{em} **)** — The quotient of the outer circumference of a pipe and 3.142 (π) in any cross-section, rounded off to the next higher 0.1 mm.

3.5 Minimum Mean Outside Diameter ($d_{em,min}$ **)** — The minimum value of the mean outside diameter as specified for a given nominal size.

3.6 Maximum Mean Outside Diameter ($d_{em,max}$ **)** — The maximum value of the mean outside diameter as specified for a given nominal size.

3.7 Inside Diameter of a Socket (d_s **)** — The value of the measurement of the inside diameter of the socket at any point in any cross-section of the socket.

3.8 Mean Inside Diameter of a Socket (d_{sm} **)** — The arithmetical mean of four measurements, taken at 45° to each other, of the inside diameter of the socket in the same cross-section of the socket.

3.9 Out-of Roundness (Ovality) — The difference between the measured maximum and the measured minimum outside diameter in the same cross-section of the pipe.

3.10 Nominal Wall Thickness (e_n) — A numerical designation of the wall thickness of a component which is a convenient round number, approximately equal to the manufacturing dimension in millimetres.

3.11 Wall Thickness at Any Point (e) — The value of the measurement of wall thickness at any point around the circumference of a pipe, rounded off to the next higher 0.1 mm.

3.12 Minimum Wall Thickness at Any Point (e_{min}) — The minimum value for the wall thickness at any point around the circumference of a pipe, rounded off to the next higher 0.1 mm.

3.13 Maximum Wall Thickness at Any Point (e_{max}) — The maximum value for the wall thickness at any point round the circumference of a pipe, rounded off to the next higher 0.1 mm.

3.14 Mean Wall Thickness (e_m) — The arithmetical mean of at least four measurements regularly spaced around the circumference and in the same cross-section of a pipe, including the measured minimum and the measured maximum values of the wall thickness in that cross-section, rounded off to the next higher 0.1 mm.

3.15 Maximum Mean Wall Thickness ($e_{m, max}$) — The maximum value for the mean wall thickness around the circumference of a component, as specified.

3.16 Tolerance — The permitted variation of the specified value of a quantity, expressed as the difference between the permitted maximum and the permitted minimum value.

3.17 Standard Dimension Ratio (*SDR*) — A numerical designation of a pipe series, which is a convenient round number approximately equal to the ratio of the minimum mean outside diameter, $d_{em, min}$ and the minimum wall thickness at any point, e_{min}

$$SDR = \frac{d_{em, min}}{e_{min}}$$

3.18 Nominal Ring Stiffness (*SN*) — A numerical designation, which is a convenient round number, of the ring stiffness of a pipe or fitting, relative to the determined stiffness in kilonewtons per square metre ($kN.m^2$), indicating the minimum required ring stiffness of a pipe or fitting.

3.19 Socket-Ended Pipe — Unplasticized PVC pipes whose one end is expanded after heating for the purpose of jointing by solvent cement or jointing using an elastomeric sealing ring, to the plain ends of the pipes.

3.20 Virgin Material — Material in such form as granules or powder that has not been subjected to use or processing other than that required for its manufacture and to which no reprocessable or recyclable materials have been added.

3.21 Own Rework Material — Material prepared from rejected, unused pipes, including trimmings from the production of pipes that will be reprocessed in a manufacturer's plant by a process such as extrusion and for which the complete formulation is known.

3.22 Tests

3.22.1 *Type Tests* — Tests carried out whenever a change is made in the composition or in the size/series in order to establish the suitability and the performance capability of the pipes.

3.22.2 *Acceptance Tests* — Tests carried out on samples taken from a lot for the purpose of acceptance of the lot.

4 SYMBOLS

The following notations (symbols) shall apply in this standard:

d_n	:	Nominal outside diameter
d_e	:	Outside diameter at any point
d_{em}	:	Mean outside diameter
$d_{em, max}$	:	Maximum mean outside diameter
$d_{em, min}$	:	Minimum mean outside diameter
d_s	:	Inside diameter of socket
d_{sm}	:	Mean inside diameter of socket
DR	:	Dimension ratio
e	:	Wall thickness at any point
e_m	:	Mean wall thickness
e_{max}	:	Maximum wall thickness at any point
e_{min}	:	Minimum wall thickness at any point
$e_{m, max}$	:	Maximum mean wall thickness
A	:	Minimum depth of engagement
B	:	Length of lip
C	:	Depth of sealing zone
e_2	:	Wall thickness of the socket
e_3	:	Wall thickness of the groove
l	:	Effective length of pipe
l_1	:	Length of spigot
l_2	:	Length of solvent cement socket
H	:	Chamfer length

NOTE — The meanings of the symbols *A*, *B*, *C* and *H* are illustrated in the respective figures.

5 COMPOSITION OF THE MATERIAL

5.1 The material from which the pipe is produced shall consist substantially of polyvinyl chloride, to which may be added only those additives that are needed to facilitate the manufacture of the compound and the manufacture of sound and durable pipe of good surface finish, mechanical strength and opacity under conditions of use. None of these additives shall be used separately or together in quantities sufficient materially to impair the fabrication or welding properties of the pipe, or to impair its chemical and physical or mechanical properties (in particular long-term mechanical strength and impact strength) as defined in this standard.

5.2 The material shall contain a minimum of 0.3 percent of rutile grade titanium dioxide.

5.3 When sealing rings are retained by means of retaining devices (rings or caps), the devices may be made from polymers other than PVC-U, provided they conform to the same functional dimensions and test requirements as applied to sockets with either loose or fixed sealing rings.

5.4 The manufacturer's own rework material conforming to the requirements given in **3.21** is permissible. No other rework material shall be used.

6 DIMENSIONS

NOTE — The sketches in this standard are schematic. They are meant to demonstrate relevant dimensions. They do not necessarily represent manufactured components.

6.1 Dimension of Pipes

6.1.1 *Mean Outside Diameter*

The mean outside diameter, outside diameter at any point and tolerances shall be as given in Table 1 and shall be measured according to the method given in IS 12235 (Part 1).

6.1.2 *Wall Thickness*

The nominal wall thickness, *e*, shall be in accordance with Table 2. Tolerances in outside diameters shall be those given in IS 4985

6.1.3 *Length of Pipe*

6.1.3.1 Effective length (L_e) of pipes with sockets is considered to be the distance between ends minus the socket depth as shown in Fig. 1.

The lengths may be supplied as agreed to between the purchaser and the manufacturer.

6.1.4 *Dimensions of Integral Sockets and Spigots Ends*

The basic dimensions shall be in accordance with Tables 3 and 4, and Fig. 2, 3, 4 and 5.

6.1.4.1 *Wall Thickness of Sockets*

$$e_{2\,min} = 0.9e \text{ and } e_{3\,min} = 0.75e$$

$e_{3\,min}$ applies only to those parts of the sealing ring zone where the fluid contained within the pipe comes into contact with the fluid, that is beyond the designated ring seal point, walls thinner than e_3 are permitted.

If retaining caps or rings are provided, they can be made to other designs or from polymers other than unplasticized polyvinyl chloride, provided that the finished joint conforms to the same functional test requirements.

When a sealing ring is retained by means of a retaining ring or cap, the wall thickness of the area shall be calculated by addition of the wall thickness at the corresponding places of the socket and the retaining ring or cap (*see* Fig. 3). In all cases, the components shall meet the functional test requirements.

Table 1 Outside Diameters and Tolerances

(*Clause* 6.1.1)

All dimensions in millimetres.

Sl No.	Nominal Outside Diameter, d_n	Mean Outside Diameter, d_{em}		Outside Diameter at Any Point, d_e	
		Min	Max	Min	Max
(1)	(2)	(3)	(4)	(5)	(6)
i)	110	110.0	110.4	108.6	111.4
ii)	125	125.0	125.4	123.5	126.5
iii)	160	160.0	160.5	158.0	162.0
iv)	200	200.0	200.6	197.6	202.4
v)	250	250.0	250.8	247.0	253.0
vi)	315	315.0	316.0	311.2	318.8
vii)	400	400.0	401.2	395.2	404.8
viii)	500	500.0	501.5	494.0	506.0
ix)	630	630.0	631.9	622.4	637.6

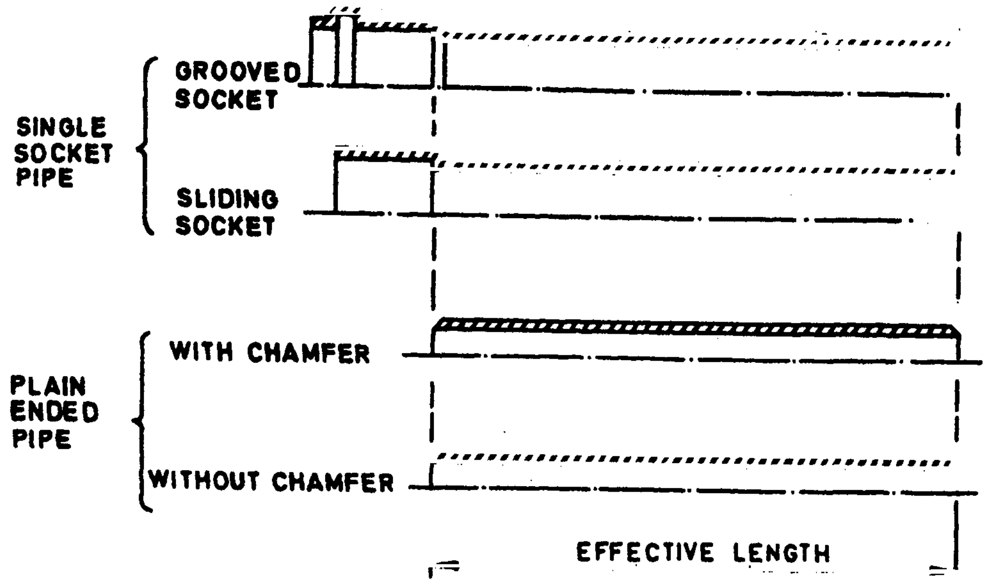


FIG. 1 EFFECTIVE LENGTH OF PIPES

7 PHYSICAL CHARACTERISTICS

7.1 Appearance

When viewed without magnification, the internal and external surfaces of the pipe shall be smooth, clean and free from grooving, blistering and any other surface irregularity, which is likely to prevent conformance of the pipe with this standard. Slight shallow longitudinal grooves or irregularities in the pipe shall be permissible, provided the wall thickness remains within permissible limits. The pipe wall shall not contain impurities or pores. The pipe ends shall be cleanly cut and reasonably square to the axis of the pipe.

7.2 Colour

The colour of the pipes shall be dark (any shade of brown). The pipe shall be uniformly coloured throughout the entire wall. Slight variations in the appearance of the colour are permitted.

7.3 Vicat Softening Temperature

The Vicat softening temperature, when determined according to Annex A, shall not be less than 79°C.

7.4 Longitudinal Reversion

The longitudinal reversion, when tested according to the method prescribed in IS 12235 (Part 5), shall not exceed ± 5 percent. In the case of socket ended pipe, this test shall be carried out on the plain portion of the pipe taken at least 100 mm away from the root of the socket. The pipe shall not exhibit any blisters, bubbles or cracks on completion of the test.

8 MECHANICAL CHARACTERISTICS

8.1 Resistance to External Blows at 0°C

When tested according to the method prescribed in Annex B, the pipe shall have a true impact rate of not more than 10 percent. In case of socket-ended pipes, this test shall be carried out on the plain portion of the pipe taken at least 100 mm away from the root of the socket.

8.2 Ring Stiffness

When tested according to the method described in Annex C, the ring stiffness of the pipe shall be as stated in Table 5.

8.3 Resistance to Internal Hydrostatic Pressure (Type Test)

When tested according to the method described in IS 12235 (Part 8) the pipe shall not fail (seep, crack, bulge or burst) during the prescribed test duration of the test and shall meet the requirements given in Table 6.

9 JOINTS

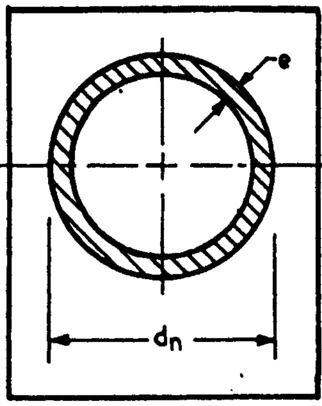
9.1 Elastomeric Sealing Rings

Elastomeric sealing rings shall be free from substances (for example, plasticizers) that can have a detrimental effect on the polyvinyl chloride of the pipes or fittings used in conjunction with the pipes.

The design of the profile and dimensions of the sealing ring is left to the manufacturer, as long as the pipe with the sealing ring meets the requirements of this standard. Where the design of the socket is such that the sealing ring is not firmly fixed in position, the housing for the ring shall be so designed as to minimize the possibility of the ring being dislodged during insertion of the pipe (or spigot of a fitting) to complete the joint.

Table 2 Wall Thickness and Tolerances

(*Clause* 6.1.2)



Nominal Ring Stiffness, *SN* kN/m²	2	4	8
Dimension Ratio (*SDR*)	51	41	34
Pipe Series	S 25	S 20	S 16.5
Nominal Outside Diameter, d_n, mm	Wall Thickness, *e*, mm		
110	—	—	3.2+0.5
125	—	3.2+0.5	3.7+0.7
160	3.2 +0.5	4.0+0.6	4.7+0.7
200	3.9+0.6	4.9+0.7	5.9+0.8
250	4.9+0.7	6.2+0.8	7.3+1.0
315	6.2+0.8	7.7+1.0	9.2+1.2
400	7.9+1.0	9.8+1.2	11.7+1.4
500	9.8+1.2	12.3+1.4	14.6+1.7
630	12.3+1.2	15.4+1.7	18.4+1.9

NOTES

1 $SDR = 2S + 1$

2 The tolerances for nominal diameter and the wall thickness have been calculated as per 7.1.1.1 and 7.1.2.1 respectively of IS 4985.

Elastomeric sealing rings shall be in accordance with one of the types (Type 1 to Type 6) of IS 5382. The manufacturer has to, however, specify the type of sealing ring (namely Type 1, 2, 3, 4, 5 or 6) that is being offered.

NOTE — A test report or conformity certificate may be obtained from the manufacturer of the sealing ring for conformity to IS 5382. The frequency of this certificate shall be once in three months or whenever source of supply is changed.

9.2 Solvent Cement

The solvent cement used shall conform to the requirements laid down in IS 14182.

10 PERFORMANCE REQUIREMENTS

10.1 Elastomeric Sealing Ring Joints

10.1.1 *Internal Hydrostatic Pressure*

When tested according to the method described in Annex D, the joint, when assembled according to the manufacturer's instructions and subjected to an angular deflection, α, of minimum 2° as well as a diametric deflection (distortion) of 5 percent of the outer diameter, shall withstand an internal pressure of up to and including 0.05 MPa (0.5 bar) for a minimum of 15 min without leakage.

10.1.2 *Internal Negative Hydrostatic Pressure (Internal Vacuum)*

When tested according to the method described in Annex E, the joint, when assembled according to the manufacturer's instructions and subjected to an angular deflection, α, of minimum 2° as well as a diametric deflection (distortion) of 5 percent of the outer diameter, shall withstand an internal negative pressure (internal vacuum) of up to and including 0.03 MPa (0.3 bar) for a minimum of 15 min without leakage.

10.2 Solvent Cemented Joints

10.2.1 *Internal Hydrostatic Pressure*

When assembled according to the manufacturer's instructions, the joint shall withstand an internal pressure of up to and including 0.05 MPa (0.5 bar) for a minimum period of 15 min without leakage.

10.2.2 *Internal Negative Hydrostatic Pressure (Internal Vacuum)*

When assembled according to the manufacturer's instructions, the joint shall withstand an internal negative pressure (internal vacuum) of up to and including 0.03 MPa (0.3 bar) for a minimum period of 15 min without leakage.

NOTE — Deflection and distortion shall not apply to solvent cemented joints.

11 SAMPLING AND CRITERIA FOR CONFORMITY

The sampling procedure and criteria for conformity shall be as given in Annex F.

Table 3 Dimensions of Elastomeric Sealing Ring Sockets and Spigot Ends

(*Clause* 6.1.4)

All dimensions in millimetres.

Sl No.	Nominal Diameter d_n	Socket			Spigot End	
		d_{sm} *Min*	*A* *Min*	*C* *Max*	l_1 *Min*	H [1)]
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	110	110.4	32	26	60	6
ii)	125	125.4	35	26	67	6
iii)	160	160.5	42	32	81	7
iv)	200	200.6	50	40	99	9
v)	250	250.8	55	70	125	9
vi)	315	316.0	62	70	132	12
vii)	400	401.2	70	80	150	15
viii)	500	501.5	80	—	160	18
ix)	630	631.9	93	—	188	23

NOTES

1 A_{min} for $d_n \leq 200$ mm, shall be $0.2\ d_n + 10$ mm

2 A_{min} for $d_n \geq 250$ mm, shall be $0.1\ d_n + 30$ mm

3 Values for *B* may be smaller for constructions with sealing rings firmly fixed in the groove of the socket. Where sealing rings are firmly fixed and have multiple sealing zones, the dimensions A_{min} and C_{max} should be measured to the effective sealing point as specified by the manufacturer (*see* Fig. 4).

[1)] Approximate values, when a chamfer is applied.

Table 4 Dimensions of Sockets and Spigot Ends for Solvent-Cemented Joints

(*Clause* 6.1.4)

All dimensions in millimetres.

Sl No.	Nominal Diameter d_n	Socket			Spigot End	
		d_{sm} *Min*	*A* *Min*	*C* *Max*	l_1 *Min*	H [1)]
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	110	110.1	110.4	61.0	67	6
ii)	125	125.1	125.4	68.5	78	6
iii)	160	160.2	160.4	86.0	100	7
iv)	200	200.3	200.6	106.0	134	9

NOTE — For solvent cement sockets, the manufacturer shall declare whether the socket is designed tapered or parallel. If they are parallel, or near parallel, the mean outside diameter of the socket, d_{sm}, shall apply over the entire length of the socket. If the socket is tapered, then the limits for d_{sm} apply at the mid point of the socket with a maximum taper of 0° 30'.

[1)] Approximate values, when a chamfer is applied.

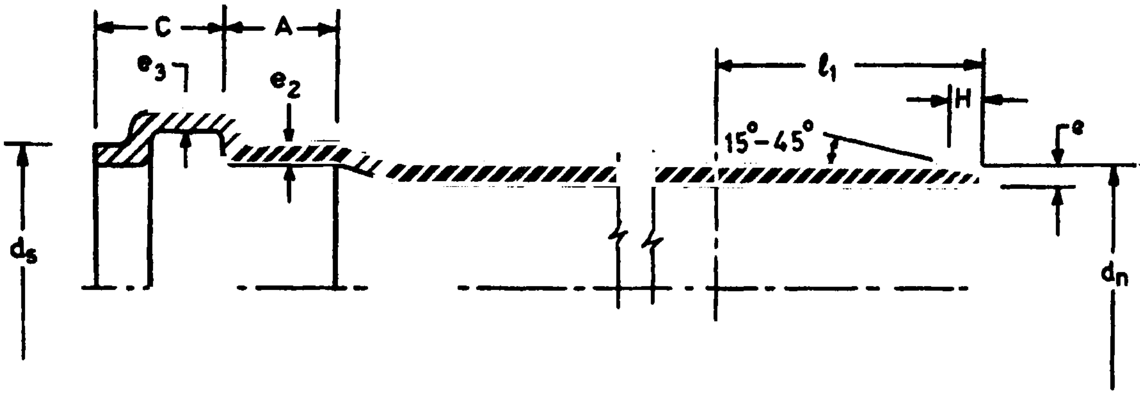


FIG. 2 BASIC DIMENSIONS OF INTEGRAL SOCKETS AND SPIGOT ENDS FOR ELASTOMERIC SEALING RING JOINTS

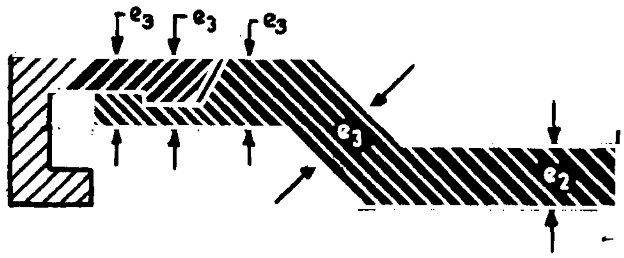


FIG. 3 EXAMPLE OF A SEAL RETAINING CAP AND CALCULATION OF THE WALL THICKNESS OF SOCKETS

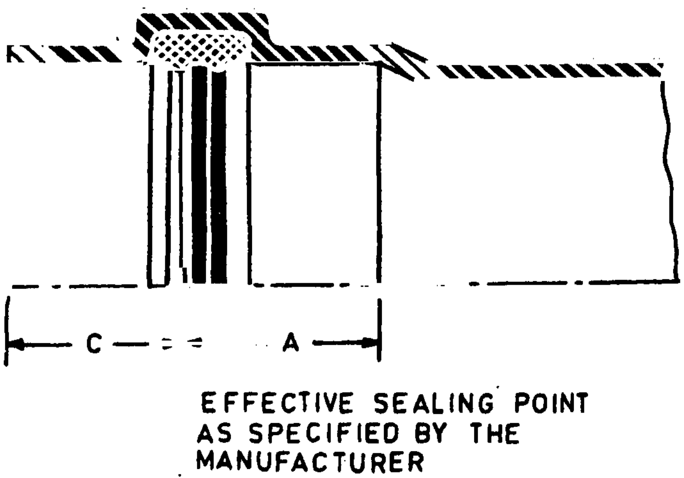


FIG. 4 EXAMPLE FOR MEASURING THE EFFECTIVE SEALING POINT

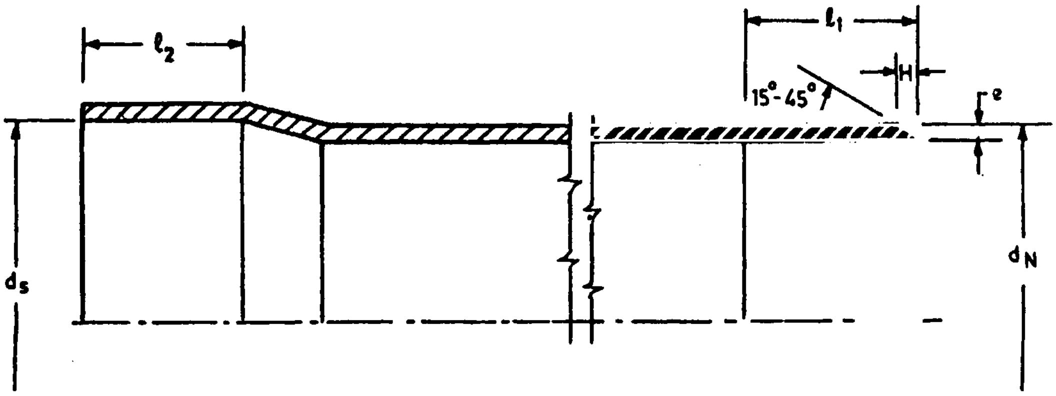


FIG. 5 BASIC DIMENSIONS FOR INTEGRAL SOCKETS AND SPIGOTS FOR SOLVENT-CEMENTED JOINTS

Table 5 Ring Stiffness of Pipes

(*Clause* 8.2)

Sl No.	*SDR*/ Stiffness Class	Ring Stiffness kN.m^{-2}
(1)	(2)	(3)
i)	51/SN 2	≤ 2
ii)	41/SN 4	≥ 4
iii)	34/SN 8	≥ 8

12 MARKING

12.1 Each pipe shall be clearly and indelibly marked in ink / paint or hot embossed on white base at intervals of not more than 3 m, but at least once per pipe, in the colour indicated in 12.3. The marking shall be legible without magnification. The marking shall not initiate cracks or other types of defects which adversely influence the performance of the pipe. Marking by indentation reducing the wall thickness not more than 0.15 mm shall be deemed to conform to this clause without infringing the requirements for the wall thickness given in 6.1.2.

12.2 The marking shall show the following:

a) Identification of the source of manufacture,

b) Outside diameter,

c) Stiffness class, and

d) Batch or Lot number.

12.3 The colour of the marking shall be such that it differs from the basic colour of the pipe.

12.4 BIS Certification Marking

12.4.1 Each pipe may also be marked with the Standard Mark.

12.4.1.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 1986 and the rules and regulations made thereunder. Details of conditions under which a license for the use of the Standard Mark may be granted to the manufacturers or the producers may be obtained from the Bureau of Indian Standards.

Table 6 Requirements of Pipes for Internal Hydrostatic Pressure Test

(*Clause* 8.3)

Sl No.	Test	Test Temperature °C	Test Duration (Minimum Holding Time) h	Circumferencial Hoop Stress, *Min* MPa	Requirements
(1)	(2)	(3)	(4)	(5)	(6)
i)	Acceptance test	27	1	36	No seepage cracking, bursting
ii)	Type test	60	1 000	10	

NOTE — Required internal test pressure in MPa, can be calculated as follows:

$$p = \frac{10\,\sigma\,.\,2.e_{min}}{d_{em} - e_{min}}$$

where

σ = hoop stress, in MPa;

d_{em} = measured mean outside diameter, in mm; and

e_{min} = measured mean wall thickness of free length of test specimen.

ANNEX A

(*Clause* 7.3)

DETERMINATION OF VICAT SOFTENING TEMPERATURE

A-1 SCOPE

This Annex provides a method for the determination of the Vicat softening temperature for PVC-U pipes.

A-2 PRINCIPLE

Determination of the temperature at which a standard indenter penetrates 1 mm into the surface of the test specimen, cut from the wall of a pipe or fitting, under a test load of 50 N ± 1 N. During the test, the temperature is raised at a uniform rate.

The temperature at 1 mm penetration is quoted as the vicat softening temperature (VST) in °C.

A-3 APPARATUS

A-3.1 Rod — Provided with a load carrying plate, held in a rigid metal frame so that it can move freely in the vertical direction, the base of the frame serving to support the test specimen under the indenting tip at the end of the rod (*see* Fig. 6).

A-3.2 Indenting Tip — Preferably of hardened steel, 3 mm long, of circular cross-section, and area 1.000 ± 0.015 mm^2, fixed at the bottom of the rod. The lower surface of the indenting tip shall be plane and perpendicular to the axis of the rod and be free from burrs.

A-3.3 Micrometer Dial Gauge — Graduated in divisions of 0.01 mm, to measure the penetration of the indenting tip into the test specimen. The thrust of the dial gauge, which contributes to the thrust on the test specimen, shall be known and shall comply with the requirements of **A-3.4**.

A-3.4 Load-Carrying Plate — Fitted to the rod, and suitable weights adjusted centrally so that the total thrust applied to the test specimen can be made up to 50 N ± 1 N (5.097 ± 0.1 kgf). The combined masses of the rod, indenting tip and load-carrying plate shall not exceed 1 N (100 g).

NOTE — If the rod and the components of the frame do not have the same linear coefficient of expansion, their differential change in length introduces an error into the readings. A blank test shall be carried out for each apparatus using a test specimen of rigid metal of low coefficient of thermal expansion. This test shall cover the whole range of service temperatures and a correction term shall be determined for each temperature. If the correction term is greater than or equal to 0.02 mm, its algebraic sign shall be noted and the correction shall be applied to each test by adding it to the value observed for apparent penetration. It is recommended that the apparatus be constructed using an alloy with a low coefficient of thermal expansion.

A-3.5 Heating Bath — Containing a suitable liquid (*see* Notes 2 and 3) in which the apparatus is placed so that the specimen is at least 35 mm below the surface of the liquid. An efficient stirrer shall be provided. The heating bath shall be equipped with a means of control so that the temperature can be raised at a uniform rate of 50 ± 5°C/h (*see* Note 4). This heating rate shall be considered to be met if, over every 5 min interval during the test, the temperature change is within the specified limits.

NOTES

1 Liquid paraffin, transformer oil, glycerol and silicone oils may be suitable liquid heat-transfer media, but other liquids may be used. In all cases, it shall be established that the liquid chosen is stable at the temperature used and does not affect the material under test.

2 If no suitable liquid can be found for use as a heat-transfer medium as defined in Note 1, some different heating arrangement, for example, air, may be used. If air is used as the heat-transfer medium, it should be noted that errors in the quoted softening point may arise, unless care is taken to correct for possible differences in temperature between the air and the specimen.

3 A uniform rate of temperature rise can be obtained by controlling the heat input either manually or automatically, although the latter is strongly recommended. One method of operation found to be satisfactory is to provide an immersion heater adjusted to give the correct rate of temperature rise at the starting temperature of the test, and then to increase the power input (either in the same heater or in a subsidiary heater) by adjustment of a rheostat or a variable transformer.

4 It is desirable to have a cooling coil in the liquid bath in order to reduce the time required to lower the temperature between determinations. This must be removed or drained before starting a test, as boiling of coolant can affect temperature rise.

A-3.6 Thermometer or Any Other Accurate Temperature-Measuring Device — Of appropriate range, and with graduations at least at each 0.5°C. The scale error at any reading shall not exceed 0.5°C. If a mercury-in-glass thermometer is used, it should be calibrated for the depth of immersion as required under **A-5.4**.

A-4 TEST SPECIMENS

A-4.1 Preparation

A-4.1.1 Two test specimens shall be used for each sample. The test specimen shall consist of segments of rings removed from pipes, limited by cross-sections and having the following dimensions:

a) *Length* — approximately 50 mm measured along the circumference of the ring, and

b) *Width* — between 10 mm and 20 mm.

A-4.1.2 If the wall thickness of the pipe is greater than 6 mm, reduce it to 4 mm by machining the outer surface only of the pipe, by a suitable technique.

A-4.1.3 Test specimens of thickness between 2 mm, 4 mm and 6 mm shall be tested as they are.

A-4.1.4 If the wall thickness of the pipe or fitting is less than 2.4 mm, each test specimen shall comprise three ring segments superimposed so as to obtain an overall thickness of at least 2.4 mm. The lower segments, which will serve as the base, shall be flattened by heating them to 140°C for 15 min, while resting a thin metal plate on them.

A-4.1.5 Use two test pieces for each test, but provide additional test pieces, in case the difference between the results is too great.

A-4.2 Conditioning

Condition the test specimens for 5 min at a temperature about 50°C lower than the expected VST of the product under test.

A-5 PROCEDURE

A-5.1 A schematic arrangement of the apparatus is given in Fig. 6.

A-5.2 Bring the heating bath to a temperature about 50°C lower than that expected for the VST of the product under test (*see* A-3.5, Note 4). Maintain this temperate constant.

A-5.3 Mount the test specimen horizontally under the indenting tip (*see* A-3.2) of the unloaded rod (*see* A-3.1), which shall rest on the concave surface of the test specimen. In the case of pipes with a wall thickness of less than 2.4 mm, the indenting tip shall rest on the concave surface of the non-flattened segment, the latter being placed on the flattened segment.

The indenting tip shall at no point be less than 3 mm from the edge of the test specimen.

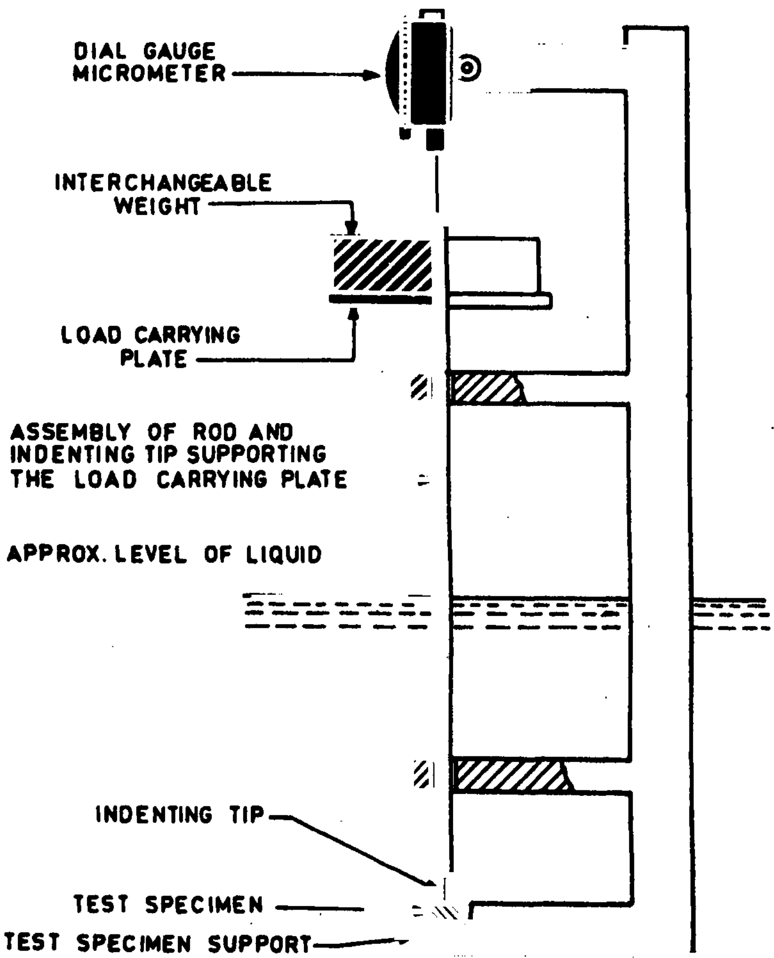


FIG. 6 SCHEMATIC DIAGRAM OF APPARATUS FOR DETERMINING VICAT SOFTENING TEMPERATURE

A-5.4 Immerse the apparatus in the heating bath. The bulb of the thermometer or the sensing portion of the temperature measuring device shall be at the same level as and as close as possible to the test specimen.

A-5.5 Position the indenting tip and, after 5 min, add to the load carrying plate the weight required so that the total thrust on the test specimen is 50 ± 1 N. Record the reading on the micrometer dial gauge or other indentation-measuring instrument, and set the instrument to zero.

A-5.6 Raise the temperature of the bath at a uniform rate of 50 ± 5°C per hour. Stir the liquid well during the test.

A-5.7 Record the temperature of the bath at which the indenting tip has penetrated into the test specimen by 1 ± 0.01 mm relative to its starting position, and record the value as the VST of the test specimen.

A-5.8 Record the arithmetic mean of the VST of the two test specimens as the VST of the pipe under test, and express the result in °C.

A-5.9 If the individual results differ by more than 2°C, report them in the test report and repeat the test using a new set of at least two test specimens.

ANNEX B

(*Clause* 8.1)

RESISTANCE TO EXTERNAL BLOWS AT 0°C (ROUND-THE-CLOCK METHOD)

B-1 SCOPE

This Annex specifies a method for the determination of the resistance to external blows of thermoplastics pipes, including unplasticized PVC pipes.

This method is applicable to isolated batches of pipe tested at 0°C.

B-2 DEFINITIONS

For the purposes of this Annex, the following definitions apply.

B-2.1 True Impact Rate (TIR) — The total number of failures divided by the total number of blows, as a percentage, as if the whole batch had been tested.

NOTE — In practice, test specimens are drawn at random from the batch and the result is only an estimate of the TIR for that batch.

B-2.2 Failure — Shattering or any crack or split on the inside of the pipe that was caused by the impact and that can be seen by the naked eye (lighting devices may be used to assist in examining the specimens).

Indentation of the test specimen is not considered a failure.

B-3 PRINCIPLE

Test pieces are subjected to blows from a falling striker, of specified mass and shape, dropped from a known height onto specified positions around the circumference of the test specimen. The true impact rate (TIR) of the batch, or production run from an extruder, is estimated.

The severity of this test method can be adjusted by changing the mass of the striker and/or by changing the drop height. It is not technically correct to vary the severity of the test by choosing values of the TIR other than those specified.

The maximum acceptable values for the TIR is taken to be 10 percent.

NOTE — It should be appreciated that a completely definitive result can be reached only by testing the whole batch. But in practice, a balance is necessary between the statistical possibility of a definitive result and the cost of further testing.

B-4 APPARATUS

B-4.1 Falling Weight Testing Machine — Incorporating the following basic components (*see* Fig. 7).

B-4.1.1 *Main Frame* — With guide rails or tube, which can be fixed in the true vertical position, to accommodate a striker (*see* **B-4.1.2**) and release mechanism to release the striker to fall vertically and freely.

B-4.1.2 *Striker* — Having a nose comprising all or part of a hemisphere, combined with a stem at least 10 mm long, and having dimensions conforming to Fig. 8 and Table 7. The mass of the striker, including any associated weights, shall be selected from the values given in Table 8. Below the stem, the nose shall be of solid steel, polished and free of flats,

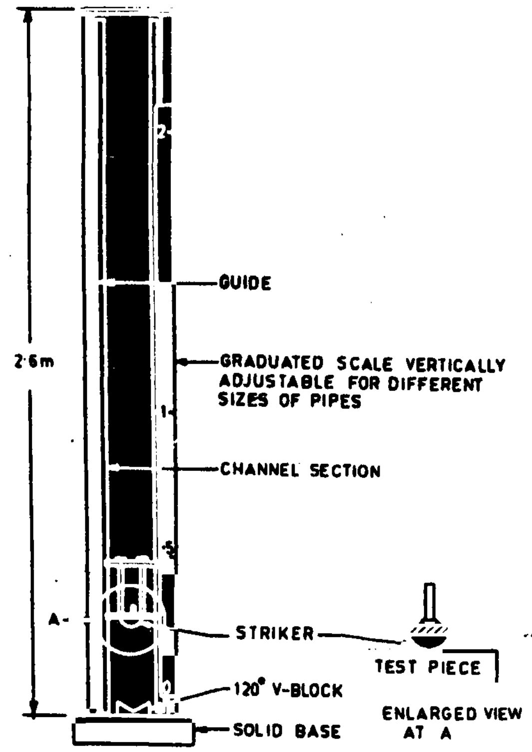
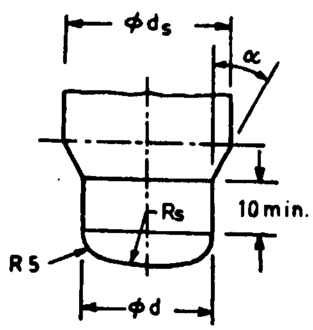
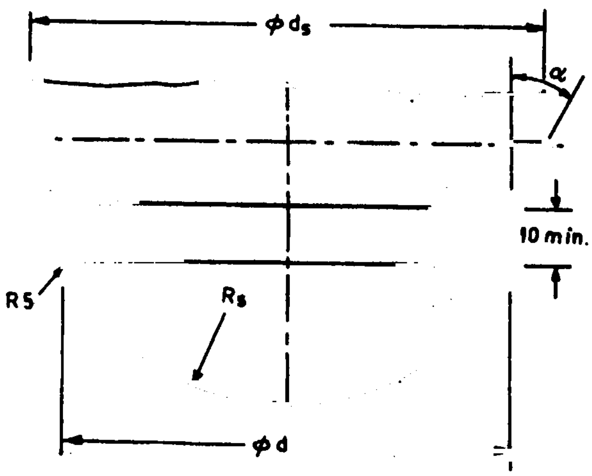


FIG. 7 IMPACT TESTING MACHINE



8A Type d_{25} (for Strikers of Mass 0.5 kg and 0.8 kg)



8B Type d_{90} (for Strikers of Mass ≥ 1 kg)

FIG. 8 NOSES OF STRIKERS

indentations or other imperfections, which may influence the result.

Table 7 Dimensions of the Nose of the Striker

(*Clause* B-4.1.2)

All dimensions in millimetres.

Sl No.	Type	R_s	d	d_s	$\alpha°$
(1)	(2)	(3)	(4)	(5)	(6)
i)	d_{25}	50	25 ± 1	Free	Free
ii)	d_{90}	50	90 ± 1	Free	Free

Table 8 Classified Striker Mass and Drop Height Conditions for the Falling Weight Impact Test

(*Clause* B-4.1.2)

Sl No.	Normal Outside Diameter of Pipes, d_n mm	Mass of Falling Weight kg	Fall Height	
			m	N.m
(1)	(2)	(3)	(4)	(5)
i)	110	1.6	2	32
ii)	125	2.5	2	50
iii)	160	3.2	2	64
iv)	200	4	2	80
v)	250	5	2	100
vi)	≥ 315	6.3	2	125

B-4.1.3 *Rigid Specimen Support* — Consisting of a 120° *V*-Block at least 200 mm long positioned so that the vertical projection of the point of impact of the falling striker is within 2.5 mm of the axis of the *V*-block (*see* Fig. 7)

B-4.1.4 *Release Mechanism* — Such that the striker can fall from a variable height which can be adjusted to any height up to at least 2 m, measured from the top surface of the test specimen, with an accuracy of ± 10 mm.

B-5 TEST SPECIMENS

Test specimens of length 200 ± 10 mm shall be cut from pipe selected at random from the batch, or the production run from an extruder.

The cut ends shall be square to the axis of the pipe, clean and free from damage.

For pipes with outside diameters greater than 40 mm, a straight line shall be drawn along the length of each test specimen at a random position. Further lines shall be drawn at equal distances around the pipe piece so that each test specimen has a number of lines given in Table 9. The number of blows required is given in B-6. For pipes with outside diameters less than or equal to 40 mm, only one blow per test specimen shall be made.

Table 9 Number of Equidistant Lines to be Drawn on Test Specimens

(*Clause* B-5)

Sl No.	Nominal Outside Diameter of Pipe mm	Number of Equidistant Lines to be Drawn
(1)	(2)	(3)
i)	110	6
ii)	125	6
iii)	140	8
iv)	160	8
v)	180	8
vi)	200	12
vii)	225	12
viii)	250	12
ix)	280	16
x)	≥ 315	16

NOTE — Initially, a minimum of 25 blows shall be made. In case no failure occurs, the lot is deemed to have passed. In case of 4 or more failures, the lot is treated as rejected. In case 1, 2 or 3 failures occur at this stage (after 25 blows), the test has to be continued further till the results fall into either Region *A* or Region *C*, before arriving at a decision of acceptance or rejection respectively.

B-6 SAMPLING TO CONFIRM VALUE OF TIR ON ISOLATED BATCHES

If the number of failures from a sample falls into Region *A* of Fig. 9 (for a TIR of less than or equal to 10 percent), then reasonable confirmation is obtained that the batch has a TIR less than or equal to the specified level.

If the number of failures falls into the Region *C* of Fig. 9, the batch can be judged to have a TIR greater than the specified value.

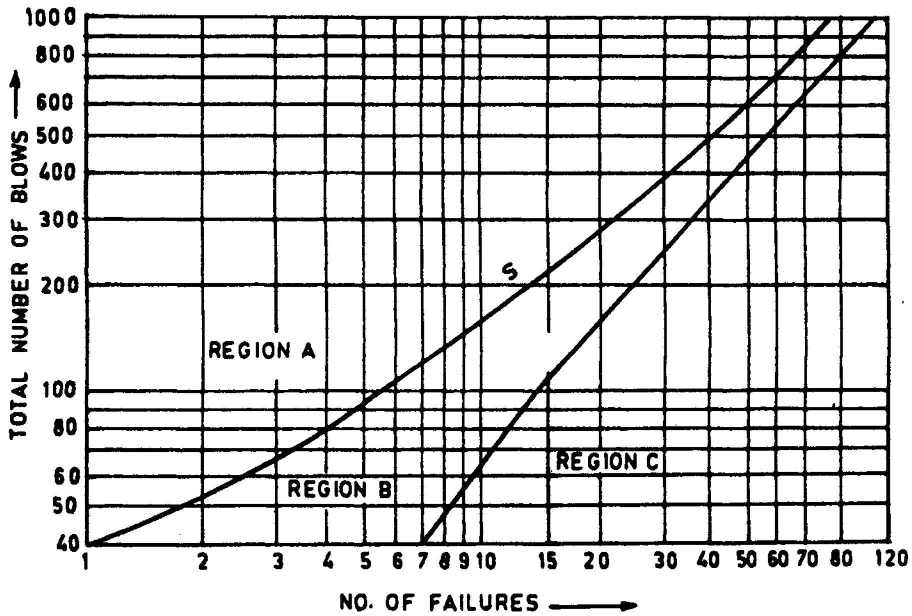
If the number of failures falls into the Region *B* of Fig. 9, in general further test specimens should be taken so that a decision can be arrived at.

The decision shall be made by using the cumulative result of all the test specimens examined from the batch under consideration.

NOTE — The graph is provided only to indicate the principal of the test method and is only a guideline. Evaluation of the test results shall be made based on Table 3. If the number of blows exceeds 124, *see* Fig. 9 for assessment of results.

B-7 CONDITIONING

B-7.1 The test specimens shall be conditioned in a



Boundaries between regions are calculated using the following equations:

$S_{A/B} = np - 0.5 + \mu\,[\,np\,(\,1 - p\,)\,]^{-0.5}$

$S_{B/C} = np + 0.5 + \mu\,[\,(\,np\,(\,1 - p\,)\,]^{-0.5}$

where

μ = 1.282,

p = 0.10 (TIR), and

n = Number of blows.

FIG. 9 NUMBER OF TEST PIECES FOR 10 PERCENT TIR (AT 90 PERCENT CONFIDENCE LEVEL) liquid bath or in air at a temperature of 0 ± 1°C for at least the period given in Table 10.

In case of disputes over the results, a liquid bath shall be used.

B-7.2 Test specimens with wall thickness up to 8.6 mm shall be tested within 10 s of their removal from air conditioning, or within 20 s of their removal from liquid conditioning, as applicable.

Test specimens with wall thickness greater than 8.6 mm shall be tested within 20 s of their removal from air conditioning or within 30 s of their removal from liquid conditioning, as applicable.

If this interval is exceeded, the test specimen shall be returned immediately to the unit for re-conditioning for a further period of at least 10 min.

Table 10 Conditioning Period

(*Clauses* B-7.1 *and* 8.1)

Sl No.	Wall Thickness, *e* mm	Conditioning Period, *Min*	
		Liquid Bath	Air
(1)	(2)	(3)	(4)
i)	< 8.6	15	60
ii)	8.6 to 14.1	30	120
iii)	Above 14.1	60	240

B-7.3 For pipes with smooth inside and outside surfaces, the wall thickness of the pipe to be tested shall be the total wall through the pipe section.

B-7.4 For pipes which are corrugated or ribbed externally, the wall thickness is the thickest wall of the pipe cross-section.

B-8 PROCEDURE

B-8.1 The mass of the falling striker and the drop height appropriate to the pipe shall be as specified in Table 10.

B-8.2 For pipes of outside diameter 40 mm or less, subject the test specimen to only single blow.

B-8.3 For pipes of outside diameter greater than 40 mm, subject the test specimen to a blow by allowing the striker to fall on one of the marked lines. If the test specimen passes the test, rotate it in the *V*-block to the next marked line and again subject it to a blow from the falling striker, after re-conditioning if necessary (*see* **B-7**).

B-8.4 Continue this procedure until the test specimen fails the test, or until all the marked lines have been struck one blow.

B-8.5 If required, carry out the test on subsequent test specimens, subjecting each one to the required number of blows.

B-9 TEST REPORT

The result shall be expressed as *A*, *B* or *C* for the batch or the production run from an extruder, as follows:

a) *A* — If the TIR is below 10 percent;
b) *B* — If no decision can be made on the basis of the number of test specimens used (*see* **10.3**); and
c) *C* — If the TIR is greater than 10 percent.

NOTE — The number of failed test specimens, as compared to the total number of blows, should not be expressed as a percentage, to avoid confusion with the TIR, of which the percentage is only an estimate.

ANNEX C

(*Clause* 8.2)

DETERMINATION OF RING STIFFNESS OF THERMOPLASTICS PIPE

C-1 SCOPE

This Annex covers the method for the determination of the ring stiffness of thermoplastics pipes, including unplasticized polyvinyl chloride (PVC-U) pipes having a circular cross-section, under parallel-plate loading

C-2 PRINCIPLE

The ring stiffness is determined by measuring the force and the deflection while deflecting the pipe at a constant rate. A length of pipe supported horizontally is compressed vertically between two parallel plates moved at a constant speed, which is dependent of the diameter of the pipe. The ring stiffness is calculated as a function of the force necessary to produce a deflection of 3 percent diametrically across the pipe.

C-3 DEFINITIONS

C-3.1 Initial Internal Diameter (d_i) — The average of the inside diameters of the test specimen expressed in metres (m).

C-3.2 Vertical Deflection (y) — Measured change of the inside diameter in the directon of the load application expressed in metres (m).

C-3.3 Percentage Deflection (P) — The ratio of the reduction in pipe inside diameter to the pipe initial diameter expressed as a percentage of the initial inside diameter.

C-3.4 Load (F) — The load applied to the pipe to produce a given percentage deflection, expressed in kilonewtons (kN).

A-3.5 Length (L) — The average length of the test specimen expressed in metres (m).

C-3.6 Ring Stiffness (S) — The value obtained by dividing the force per unit length of specimen by the resulting deflection in the same units at the prescribed percentage deflection and multiplied by a factor, expressed in kilonewtons per square metre (kN/m^2).

C-4 APPARATUS

C-4.1 Testing Machine — A properly calibrated compression-testing machine of the constant-rate-of-crosshead-movement type, shall be used for the tests. The rate of head movement shall be in accordance with Table 11, with sufficient force and travel to produce the specified deflection through the parallel plates.

Table 11 Deflection Speeds

(*Clauses* C-4.1 *and* C-7.4)

Sl No.	Nominal Diameter of Pipe, d_n mm	Deflection Speed mm/*min*
(1)	(2)	(3)
i)	$100 < d_n \leq 200$	5 ± 1
ii)	$200 < d_n \leq 400$	10 ± 2
iii)	$400 < d_n \leq 1\ 000$	20 ± 2

C-4.2 Loading Plates — The load shall be applied to the specimens through two parallel steel bearing plates. The plates shall be flat, smooth and clean. The thickness of the plates shall be sufficient so that no bending or deformation occurs during the test, but it shall not be less than 6.0 mm. The plate length shall equal or exceed the specimen length and the plate width shall not be less than the pipe contact width at maximum pipe deflection plus 25 mm.

C-4.3 Deformation (Deflection) Indicator — The change in the inside diameter or deformation parallel to the direction of loading, shall be measured with a suitable instrument accurate to the nearest 0.25 mm. The instrument shall not support the pipe test specimen or the plate, or in any way affect the load deflection measurements. Changes in diameter may be measured during loading by continuously recording plate travel.

C-4.4 Measuring Devices — The measuring devices shall be capable of measuring the following:

a) Length of the test specimen to within 1 mm;
b) Internal diameter of the test specimen to within 0.5 percent; and
c) Change in inside diameter of the test specimen in the direction of loading; and with an accuracy of 0.1 mm, or 1 percent of the deflection, which ever is greater.

C-4.5 Force-measuring device capable of determining to within 2 percent the force necessary to produce a 1 percent to 4 percent deflection of the test specimen diametrically across the test specimen.

C-5 TEST SPECIMENS

C-5.1 Marking

The pipe from which the specimens are to be cut shall be marked on the outside along its full length with a line parallel to the pipe axis. Three test specimens, marked *a*, *b*, and *c*, shall be tested for each sample of pipe. The ends of the test specimens shall be reasonably square to the axis of the pipe, free of burrs and jagged ends and the lengths shall conform to C-5.2.

C-5.2 Length

C-5.2.1 The length of the test specimen shall be determined by calculating the arithmetic mean of n length measurements, made to within 1 mm, equally spaced around the circumference of the pipe in conformation with Table 12. For each individual test specimen, the smallest of the length measurements shall not be less than 0.9 times the largest.

Table 12 Number of Length Measurements

(*Clause* C-5.2.1)

Sl No.	Nominal Diameter of Pipe, d_n	Number of Length Measurements, n
(1)	(2)	(3)
i)	$d_n \leq 200$	3
ii)	$200 < d_n \leq 500$	4
iii)	$d_n \geq 500$	6

C-5.2.2 For pipes with nominal diameter less than or equal to 1 500 mm, the average length of each test specimen shall 300 ± 10 mm.

C-5.2.3 For pipes that have a nominal diameter, d_n, greater than 1 500 mm, the average length of each test specimen shall be 0.2 d_n.

C-5.3 Inside Diameter

Determine inside diameter, d_{ia}, d_{ib}, d_{ic}, of each test specimen as the arithmetic mean of four measurements made at 45° intervals along one cross-section of the test specimen. Finally, calculate the average internal diameter, d_i, of all three test specimens using the following equation:

$$d_i = (d_{ia} + d_{ib} + d_{ic}) / 3$$

C-5.4 Average Outside Diameter

Measure the average outside diameter of each test specimen in accordance with IS 12235 (Part 1).

C-5.5 Wall Thickness

Measure the wall thickness in accordance with IS 12235 (Part 1) at eight evenly spaced points along the perimeter of each test specimen. Note the maximum and minimum values and calculate the average. Mark the point of minimum wall thickness, if any, on each test specimen.

C-6 CONDITIONING

The test specimens shall be at least 24 h old. For type testing and in cases of dispute, the age of the test shall be 21 ± 2 days.

C-6.1 Condition the pipe samples for at least 24 h in air, at a temperature of 27 ± 2°C, and conduct the test at the same temperature.

C-6.2 In case of dispute, the specimens shall be conditioned at a temperature of 23 ± 2°C and a relative humidity of 50 ± 5 percent for 40 h and the test conducted under the same conditions.

C-7 PROCEDURE

C-7.1 Locate the pipe specimen with its longitudinal axis parallel to the bearing plates and centre it laterally in the testing machine.

C-7.2 If an orientation of minimum wall thickness has been found, place the first specimen with the thinnest portion on top. Rotate each successive specimen 35° and 70°. If no minimum wall thickness has been found, use any base line.

C-7.3 With the deflection indicator in place, bring the upper plate in contact with no more load than necessary to hold it in place. This establishes the beginning point for the measurement of subsequent deflections.

C-7.4 Compress the specimen at a constant speed specified in Table 11, while continuously recording the force and deflection.

C-7.5 If the load/deflection plot, which is typically a smooth curve, indicates that the zero point may be incorrect (*see* Fig. 10), extrapolate back the initial straight-line portion of the curve and use the intersect with the horizontal axis as the (0,0) point (origin).

C-8 CALCULATIONS

C-8.1 Calculate the ring stiffness, S_a, S_b, S_c, of each of the three test specimens using the following equations:

$$S_a = 0.0186 + 0.025\, y_a/d_i . F_a / L_a y_a$$

$$S_b = 0.0186 + 0.025\, y_b/d_i . F_b / L_b y_b$$

$$S_c = 0.0186 + 0.025\, y_c/d_i . F_c / L_c y_c$$

where

F = force, in kilonewtons, corresponding to 3.0 percent pipe deflection;

L = length, in m, of the test specimen; and

y = deflection, in m, corresponding to 3.0 percent deflection, that is, $y/d_i = 0.03$.

Calculate the ring stiffness of the pipe, in kilonewtons per square metre, as the mean of these three values, using the following equation:

$$S = (S_a + S_b + S_c) / 3$$

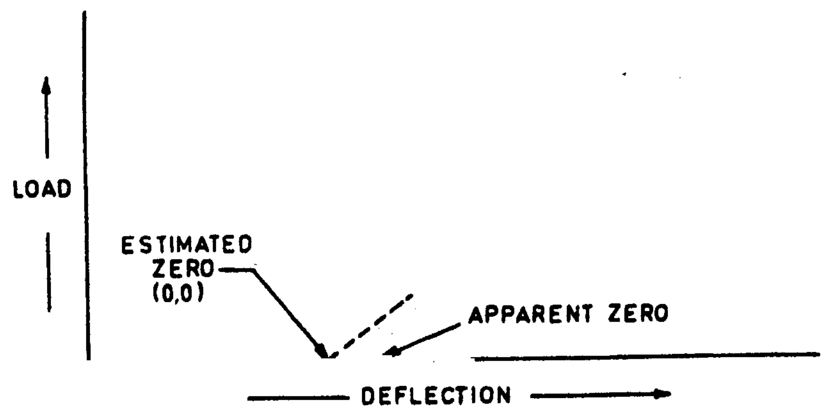


Fig. 10 Load Deflection Curve

C-9 TEST REPORT

Test report shall contain the following information:

a) Complete identification of the samples tested;
b) All dimensions of each specimen;
c) Conditioning time, temperature and environment;
d) Testing temperature and environment;
e) The calculated values of S_a, S_b and S_c of the ring stiffness of each test specimen, to three decimal places;
f) The calculated value of the ring stiffness S, to two decimal places;
g) If required, a force/deflection plot for each test specimen;
h) Any factors which may affect the results; and
j) Date of report.

ANNEX D

(*Clause* 10.1.1)

TEST METHOD FOR LEAKTIGHTNESS OF ELASTOMERIC SEALING RING TYPE SOCKET JOINTS UNDER POSITIVE INTERNAL PRESSURE AND WITH ANGULAR DEFLECTION

D-1 SCOPE

This Annex specifies a method of testing the leaktightness under positive pressure of assemblies of polyvinyl chloride (PVC-U) pipes with elastomeric sealing ring type socket joints including the following:

a) Single sockets of pipes;
b) Double sockets; and
c) Sockets of fittings.

It also applies to elastomeric sealing ring type sockets made of ductile iron for use with PVC-U pressure piping.

D-2 PRINCIPLE

A joint assembly as a test specimen consisting of a PVC-U pipe mounted into a PVC-U socket is exposed, within a specified temperature range, to a specified internal pressure regime for a specified time while the pipe is subject to an angular deflection in the socket. While under pressure the test piece is monitored for signs of leakage.

NOTE — It is assumed that the following test parameters are set by the standard making the reference to this standard:

a) Test pressure, and
b) Number of test specimens to be used.

D-3 APPARATUS

D-3.1 Framework — Comprising of at least two fixing devices, one of which is movable to allow angular deflection, vertical or horizontal, to be applied within the socket. A typical arrangement is shown in Fig. 11.

D-3.2 A pressure control device connected to the test specimen and capable of applying and maintaining a variable internal hydrostatic pressure of the PVC-U pipe section mounted into the socket of the component to be tested.

D-3.3 The assembly shall be carried out in accordance with the socket manufacturer's instructions.

D-3.4 A pipe of the same nominal pressure as that of the socket shall be used for the test.

D-3.5 The length of the pipe section shall be such that the free length, L, between the socket and the end-seal is equal to five times the normal outside diameter, d_n, of the pipe with a minimum of 500 mm and a maximum of 1 500 mm.

NOTE — The mean outside diameter, d_{em}, of the pipe should preferably conform to the minimum specified value, and the socket dimensions (mean inside diameter, d_{im}, and the diameter of the groove for housing the sealing ring) should preferably conform to the maximum values stated by the manufacturer, in order to have dimensions as close to the extreme limits of the relevant tolerances.

D-4 PROCEDURE

D-4.1 Secure the socket, without any deformation, to the solid framework and align the pipe section with the axis of the socket.

D-4.2 Incline the pipe in the test apparatus, determine the free angle of deflection, α, which the joint can tolerate without application of force.

If $\alpha \geq 2°$, firmly anchor the pipe to maintain the deflected pipe in this position for the remainder of the test.

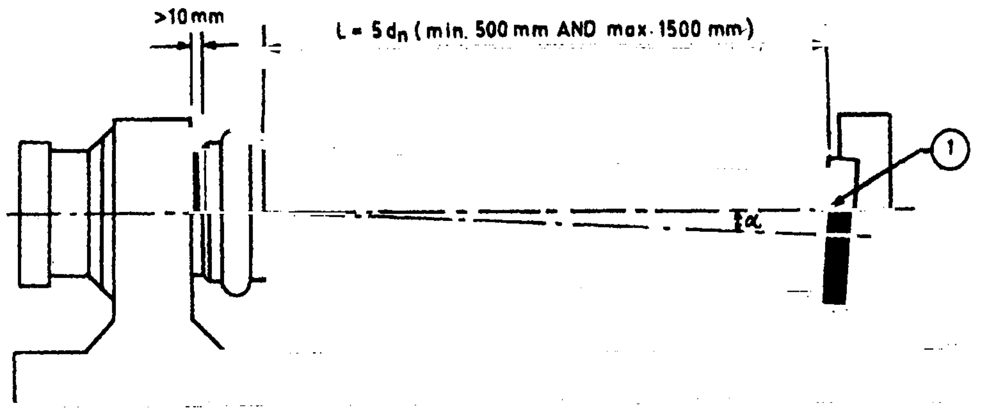


FIG. 11 TYPICAL ARRANGEMENT OF FRAMEWORK

If α < 2°, carry out the test at a deflection of 2° by forcing the pipe to that degree of deflection.

D-4.3 Measure the mean outside diameter at a point 0.5 d_n away from the mouth of the socket. Calculate the amount of distortion required and tighten the bolts of the distortion clamp until the required distortion is achieved.

D-4.4 Fill the test specimen with water at a temperature of 27 ± 5°C and release any trapped air.

D-4.5 Condition the test specimen assembly for a period of at least 20 min to ensure equalization of temperature.

D-4.6 While testing in accordance with 5.7:

a) Maintain the ambient temperature within ± 5°C of any temperature between 20 and 32°C; and
b) Examine the joint during the whole test cycle and record any sign of leakage.

D-4.7 Apply and raise the hydrostatic pressure slowly over a period of not less than 15 min to a minimum of 0.05 MPa (0.5 bar). Maintain the pressure at this value for a minimum of 15 min.

D-5 TEST REPORT

The test report shall include the following information:

a) Nominal pressure class of the PVC-U pipe and socket used for the test;
b) Angle of deflection, α, used for the test;
c) Ambient temperature during the test;
d) Information of the leaktightness of the joint;
e) Any factors which may have affected the results, such as, any incidents or any operating details not specified in this standard; and
f) Date of the test.

ANNEX E

(*Clause* 10.1.2)

TEST METHOD FOR LEAKTIGHTNESS OF ELASTOMERIC SEALING RING TYPE SOCKET JOINTS UNDER NEGATIVE INTERNAL PRESSURE AND WITH ANGULAR DEFLECTION

E-1 SCOPE

This Annex specifies a method of testing the leaktightness under negative pressure of assemblies of polyvinyl chloride (PVC-U) pipes with elastomeric sealing ring type socket joints including:

a) Single sockets of pipes;
b) Double sockets; and
c) Sockets of fittings.

It also applies to elastomeric sealing ring type sockets made of ductile iron for use with PVC-U pressure piping.

E-2 PRINCIPLE

A joint assembly as a test specimen consisting of a PVC-U pipe mounted into a PVC-U socket is exposed, within a specified temperature range, to a specified negative pressure for a specified time while the pipe is subject to an angular deflection in the socket. While under vacuum the test piece is monitored for signs of leakage.

NOTE — It is assumed that the following test parameters are set by the standard making the reference to this standard:

a) Test pressure, and

b) Number of test specimens to be used.

E-3 APPARATUS

E-3.1 Framework — Comprising of at least two fixing devices, one of which is movable to allow angular deflection, vertical or horizontal, to be applied within the socket. A typical arrangement is shown in Fig. 12.

E-3.2 Vacuum Pump and Control Device — Connected to the test specimen, preferably at the immovable end of the apparatus, and capable of applying and maintaining two required levels of negative pressure of the PVC-U pipe section mounted into the socket of the component to be tested.

E-3.3 An isolation valve between the test piece and the vacuum pump.

E-3.4 The assembly shall be carried out in accordance with the socket manufacturer's instructions.

E-3.5 A pipe of the same nominal pressure as that of the socket shall be used for the test.

E-3.6 The length of the pipe section shall be such that the free length, L, between the socket and the end-seal is equal to five times the normal outside diameter, d_n, of the pipe with a minimum of 500 mm and a maximum of 1 500 mm.

NOTE — The mean outside diameter, d_{em}, of the pipe should preferably conform to the minimum specified value, and the socket dimensions (mean inside diameter, d_{sm}, and the diameter of the groove for housing the sealing ring) should preferably conform to the maximum values stated by the manufacturer, in order to have dimensions as close to the extreme limits of the relevant tolerances.

E-4 PROCEDURE

E-4.1 Secure the socket, without any deformation, to the immovable portion of the framework and align the pipe section with the axis of the socket.

E-4.2 Incline the pipe in the test apparatus, determine the free angle of deflection, α, which the joint can tolerate without application of force.

If $\alpha \geq 2°$, firmly anchor the pipe to maintain the deflected pipe in this position for the remainder of the test.

If $\alpha < 2°$, carry out the test at a deflection of 2° by forcing the pipe to that degree of deflection.

E-4.3 Measure the mean outside diameter at a point 0.5 d_n away from the mouth of the socket. Calculate the amount of distortion required and tighten the bolts of the distortion clamp until the required distortion is achieved.

E-4.4 While testing, maintain the ambient temperature within ± 5°C of any temperature between 20 and 32°C.

E-4.5 Apply a negative pressure (vacuum) to the test piece until a constant gauge pressure of – 0.03 Mpa (– 0.3 bar) is achieved.

E-4.6 Isolate the vacuum pump from the test piece, but not from the control device. Record the change in the negative pressure for 15 min. During this period, the variation in negative pressure should not be more than ± 10 percent of the required test pressure.

E-4.7 Again, isolate the vacuum pump from the test piece, monitor the pressure for a further 15 min and record any change in the negative pressure.

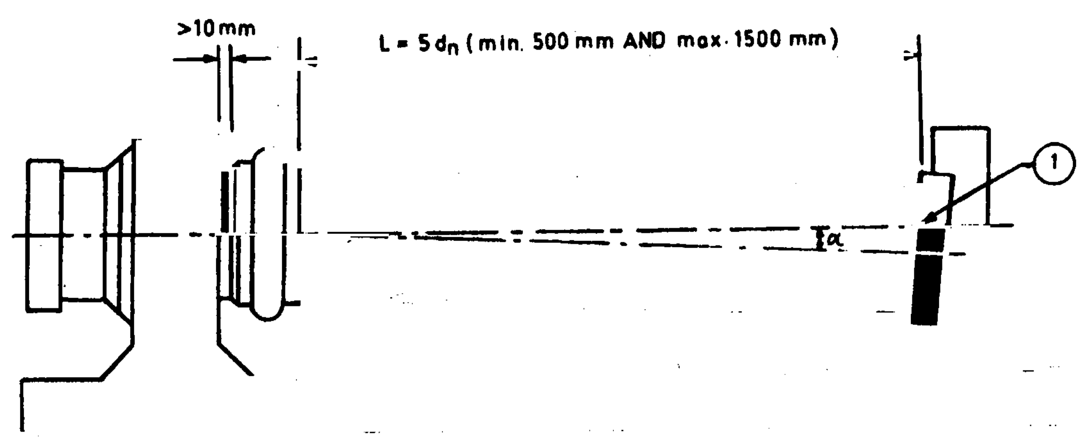


FIG. 12 TYPICAL ARRANGEMENT OF FRAMEWORK

E-5 TEST REPORT

The test report shall include the following information:

a) Nominal pressure class of the PVC-U pipe and socket used for the test;

b) Angle of deflection, α, used for the test;

c) Ambient temperature during the test;

d) Information of the leaktightness of the joint;

e) Any factors which may have affected the results, such as, any incidents or any operating details not specified in this standard; and

f) Date of the test.

ANNEX F

(*Clause* 11)

SAMPLING AND CRITERIA FOR CONFORMITY

F-1 ACCEPTANCE TESTS

F-1.1 Acceptance tests are carried out on samples selected from a lot for the purpose of acceptance of the lot.

F-1.2 All PVC pipes in a single consignment of the same class, same size and manufactured under essentially similar conditions shall constitute a lot.

F-1.3 For ascertaining the conformity of the lot to the requirements of the standard, samples shall be tested from each lot separately.

F-1.4 Visual and Dimensional Requirements

F-1.4.1 The number of test samples taken from a lot shall depend on the size of the lot and the outside diameter of the pipes, and shall be in accordance with Table 13.

F-1.4.2 These pipes shall be selected at random from the lot and in order to ensure the randomness of the selection, a random number table shall be used. For guidance and use of random number tables, IS 4905 may be referred to. In the absence of a random number table, the following procedure may be adopted:

> Starting from any pipe in the lot, count 1, 2, 3 ... and so on up to *r*, where *r* is the integral part of *N/n*, *N* being the number of pipes in the lot, and *n* the number of pipes in the sample. Every *r*th pipe so counted shall be withdrawn so as to constitute the required sample size.

F-1.4.3 The number of pipes given for the first sample in col 4 of Table 13, shall be taken from the lot and examined for visual and dimensional requirements given in 6, 7.1 and 7.2. A pipe failing to satisfy any of these requirements shall be considered defective. The lot shall be deemed to have satisfied these requirements, if the number of defectives found in the first sample is less than or equal to the corresponding acceptance number given in col 6 of Table 13. The lot shall be deemed not to have met these requirements, if the number of defectives found in the first sample is greater than or equal to the corresponding rejection number given in col 7 of Table 13. If, however, the number of defectives found in the first sample lies between the corresponding acceptance or rejection numbers given in col 6 and 7, a second sample of the size given in col 4 shall be taken and examined for these requirements. The lot shall be considered to have satisfied these requirements if the cumulative sample is less than or equal to the corresponding acceptance number given in col 6, otherwise not.

F-1.5 Reversion Test

F-1.5.1 The lot, having satisfied visual and dimensional requirements, shall be tested for reversion.

F-1.5.2 For this purpose, the number of pipes given for the first sample in col 3 of Table 14 shall be taken from the lot. The sample pipe failing in reversion shall be considered to be defective. The lot shall be deemed to have met the requirements given in this standard for the reversion test if the number of defectives found in the first sample is less than or equal to the corresponding acceptance number given in col 5. The lot shall be deemed not to have met the requirements, if the number of defectives found in the first sample is greater than or equal to the corresponding rejection number given in col 6. If, however, the number of defectives in the first sample lies between the corresponding acceptance and rejection numbers given in col 5 and 7, a second sample of the size given in col 3 shall be taken and examined for the requirement. The lot shall be deemed to have satisfied the requirements, if the number of defectives found in the cumulative sample is less than or equal to the corresponding acceptance number given in col 6, otherwise not.

F-1.6 Vicat Softening Temperature

F-1.6.1 The lot, having satisfied the visual and

Table 13 Scale of Sampling for Visual Appearance and Dimensional Requirements

(*Clauses* F-1.4.1 *and* F-1.4.3)

Sl No.	Number of Pipes in the Lot	Sample Number	Sample Size	Cumulative Sample Size	Acceptance Number	Rejection Number
(1)	(2)	(3)	(4)	(5)	(6)	(7)
i)	Up to 1 000	First	13	13	0	2
		Second	13	26	1	2
ii)	1 001 to 3 000	First	20	20	0	2
		Second	20	40	1	2
iii)	3 001 to 10 000	First	32	32	0	3
		Second	32	64	3	4
iv)	10 001 and above	First	50	50	1	4
		Second	50	100	4	5

Table 14 Scale of Sampling for Reversion and Vicat Softening Temperature Tests

(*Clauses* F-1.5.2 *and* F-1.6.2)

Number of Pipes in the Lot	Sample Number	Sample Size	Cumulative Sample Size	Acceptance Number	Rejection Number
(1)	(2)	(3)	(4)	(5)	(6)
For nominal diameters up to and including 110 mm					
Up to 1 000	First	5	5	0	2
	Second	5	10	1	2
1 001 to 3 000	First	8	8	0	2
	Second	8	16	1	2
3 001 to 10 000	First	13	13	0	2
	Second	13	26	1	2
10 001 and above	First	20	20	0	3
	Second	20	40	3	4
For nominal diameters above 110 mm					
Up to 3 000	First	3	3	0	2
	Second	3	6	1	2
3 001 to 10 000	First	5	5	0	2
	Second	5	10	1	2
10 000 and above	First	8	8	0	2
	Second	8	16	1	2

dimensional requirements, shall be tested for Vicat softening temperature.

F-1.6.2 For this purpose, the procedure adopted for sampling and criteria for conformity shall be the same as given in **F-1.5**, using Table 14.

F-1.7 Resistance to External Blows at 0°C

F-1.7.1 The lot, having been found satisfactory according to **F-1.4**, **F-1.5** and **F-1.6**, shall be tested for resistance to external blows at 0°C.

F-1.7.2 For this purpose, the procedure adopted for sampling and criteria for conformity shall be as specified in Table 15.

F-2 TYPE TESTS

F-2.1 Type tests are intended to prove the suitability and performance of a new composition or a new size of pipe. Such tests, therefore, need to be applied only when a change is made in polymer composition or when a new size is to be introduced.

F-2.1.1 *Resistance to Internal Hydrostatic Pressure (Type Test)*

F-2.1.1.1 For this test, the manufacturer or the supplier shall supply furnish to the testing authority, three samples of pipes of different diameters and different classes, selected preferably from a regular production lot.

Table 15 Scale of Sampling for Resistance to External Blows

(*Clause* F-1.7.2)

Number of Pipes in the Lot	Sample Number	Sample Size	Cumulative Sample Size	Acceptance Number	Rejection Number
(1)	(2)	(3)	(4)	(5)	(6)
For all sizes					
Up to 3 000	First	3	3	0	2
	Second	3	6	1	2
3 001 to 10 000	First	5	5	0	2
	Second	5	10	1	2
10 001 and above	First	8	8	0	2
	Second	8	16	1	2

NOTE — The numbers mentioned in col 3 to 6 in the table represent the number of times the test is to be carried out and do not represent either the number of pipe samples or the number of blows or the number of failures.

F-2.1.1.2 Three samples so selected shall be tested for compliance with the requirements of the type test given in Table 6.

F-2.1.1.3 If all the three samples pass the requirements of the quality test, the type of pipe under consideration shall be considered to be eligible for type approval, which shall be normally valid for a period of one year.

F-2.1.1.4 In case any of the samples fail in this test, the testing authority, at its discretion, may call for fresh samples not exceeding the original number and subject them to the type test. If, in the repeat test, no single failure occurs, type of pipe shall be considered for type approval. If any of the samples fails in the repeat tests, the type of pipe shall not be approved. The manufacturer or the supplier may be asked to improve the design and resubmit the product for type approval.

F-2.1.1.5 At the end of the validity period (normally one year) or earlier, if necessary, the testing authority may call for fresh samples for type test for the purpose of type approval.

ANNEX G

(*Foreword*)

COMMITTEE COMPOSITION

Plastic Piping System Sectional Committee, CED 50

Organization	*Representative(s)*
Engineer-in-Chief's Branch, Army Headquarters, New Delhi	SHRI K. PRABHAKAR RAO (***Chairman***)
Ahmedabad Municipal Corporation, Ahmedabad	SHRI N. P. PATEL SHRI V. B. PARMAR (*Alternate*)
Brihanmumbai Mahanagar Palika, Mumbai	HYDRAULIC ENGINEER DEPUTY HYDRAULIC ENGINEER (*Alternate*)
Building Materials and Technology Promotion Council, New Delhi	SHRI J. SEN GUPTA
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Carbon Everflow Limited, Nashik	MS SEEMA VAIDYA SHRI B. M. VALASKAR (*Alternate*)
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Central Public Health Environment Engineering Organization, New Delhi	ADVISER (PHE) ASSISTANT ADVISER (PHE) (*Alternate*)
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Housing and Urban Development Corporation Limited, New Delhi	SHRI K. SUBRAMANIAN SHRI P. R. SRIVASTAVA (*Alternate*)
Institute of Co-operative Management, Ahmedabad	DR S. M. PATEL DR M. K. PANDEY (*Alternate*)
Jain Irrigation System Limited, Jalgaon	DR H. C. MRUTHYUNJAYA SHRI S. NARAYANASWAMY (*Alternate*)

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Organization	*Representative(s)*
Kerala Water Authority, Thiruvananthapuram	DEPUTY CHIEF ENGINEER (MTRL MOT UNIT)
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Public Health Engineering, Roorkee	SHRI SUDESH KUMAR SHARMA
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Public Health Engineering Department, Bangalore	SHRI GULAM AHMED
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Vinplex India Private Limited, Chennai	SHRI G. K. SRINIVASAN SHRI P. SAI VENKATA PRASAD (*Alternate*)
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Member Secretaries
SHRI J. K. PRASAD
Director (CED), BIS

SHRI R. K. GUPTA
Joint Director (CED), BIS

(*Continued on page 25*)

(Continued from page 24)

PVC and ABS Piping System Subcommittee, CED 50 : 3

Organization	*Representative(s)*
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Department of Telecommunications, New Delhi	SHRI V. L. VENKATARAMAN SHRI P. ADINARAYANA (*Alternate*)
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