IS 9537-5 (2000): Conduits for Electrical Installations, Part 5: Pliable Conduits of Insulating Material (superseding IS:6946) [ETD 14: Electrical Wiring Accessories]

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IS 9537 (Part 5) : 2000
(Superseding IS 6946 : 1973)

भारतीय मानक

विद्युत संस्थापनों की नलिकाएँ — विशिष्टि

भाग 5 विद्युत रोधन सामग्री की अनम्य नलिकाएँ

Indian Standard

CONDUITS FOR ELECTRICAL INSTALLATIONS

PART 5 PLIABLE CONDUITS OF INSULATING MATERIAL

ICS 28.120.10

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

June 2000

Price Group 6

FOREWORD

This Indian Standard (Part 5) was adopted by the Bureau of Indian Standards, after the draft finalized by the Electrical Wiring Accessories Sectional Committee had been approved by the Electrotechnical Division Council.

The requirements of Pliable Non-Metallic conduits for electrical installations were earlier covered in IS 6946 : 1973 'Specification for pliable conduits and flexible conduits (non-metallic) for electrical installations'. However in order to bring it in line with International Standard, this standard has been prepared. The requirements of flexible conduits will be covered in a separate standard (Part 7).

Since many requirements and test methods relevant to different types of conduits are similar, these have been covered in Part 1 with the intention of covering specific requirements of individual types of conduits in subsequent parts. This standard (Part 5) is thus, one of this series.

This standard (Part 5) is to be read in conjunction with IS 9537 (Part 1) to which reference has been given regarding general requirements as well as test methods. Should however, any deviation exist between IS 9537(Part 1) and this standard, the provisions of the latter, shall apply. Sequence of clauses used in this standard is the same as in IS 9537 (Part 1) for easy reference. Wherever a particular requirement is not applicable to this type of conduits, the same has been indicated accordingly.

Any addition to the existing provision of a sub-clause of IS 9537 (Part 1) has been indicated as under:

Addition – followed by the text of the additional matter.

Clauses/Tables which are additional to those of IS 9537 (Part 1) are numbered starting from **101** and additional sub-clauses are numbered with the main clauses number followed by **101**, **102**, etc, for example **2.101**.

The Indian Standards which are necessary adjunct to this standard are given in Annex A.

The normal trade practice, while supplying conduits, is to provide one coupler with each conduit. However, for the purpose of conformity to this standard, this is not a mandatory condition of compliance.

While preparing this standard, considerable assistance has been derived from corresponding IEC Publication 614-2-3 (1990) 'Specification for conduits for electrical installation– Part 2 : Particular specification for conduits; Section 3 Pliable conduits of insulating material' issued by the International Electrotechnical Commission.

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, 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

CONDUITS FOR ELECTRICAL INSTALLATIONS

PART 5 PLIABLE CONDUITS OF INSULATING MATERIAL

1 SCOPE

This clause of Part 1 is applicable except as follows:

Addition:

This Indian Standard (Part 5) specifies requirements for pliable non-flame propagating plain and corrugated conduits of insulating material. It does not include self-recovering or flexible conduits.

This standard also applies to corrugated conduits with a smooth exterior surface.

2 DEFINITIONS

This clause of Part 1 is applicable except as follows:

Additional Sub-clause

2.101 Type Tests

Tests carried out to prove conformity with the requirements of the standards. These are intended to prove the general qualities and design of a given type of conduit.

2.102 Acceptance Tests

Tests carried out on samples taken from a lot for the purpose of acceptance of the lot.

3 GENERAL REQUIREMENTS

This clause of Part 1 is applicable.

4 GENERAL NOTES ON TESTS

This clause of Part 1 is applicable except as follows:

Replacement:

4.4 The minimum total length of conduit to be submitted for all tests is 36 m.

5 CLASSIFICATION

This clause of Part 1 is applicable except as follows:

5.1 (a), (1), **5.1** (a), (3), **5.1** (b), (1), **5.1** (d), (1), **5.1** (d), (2), **5.1** (d), (3), **5.1** (e), (2), **5.1** (f), (2), and **5.1** (g), (1) (i), not applicable.

Additional Sub-clause

5.101 According to temperatures, given as follows:

Temperature Classification	Temperatures not Normally Less Than		Permanent Application Temperature Range
	Storage and Transport	Use and Installation	
	°C	°C	°C
– 45	– 45	– 15	– 15 to + 60
– 25	– 25	– 15	– 15 to + 60
– 5	– 5	– 5	– 5 to + 60
+ 90	– 5	– 5	– 5 to + 60[1]
+ 90/-25	– 25	– 15	– 15 to + 60[1]

[1] These types, for use in prefabricated concrete, will temporarily withstand temperatures up to +90°C.

NOTE — Conduits of insulating materials for temperatures up to 200°C are under consideration.

6 MARKING

This clause of Part 1 is applicable except as follows:

Additional Sub-clauses

6.101 Conduits shall be marked with a classification code in accordance with **C-1**.

6.102 The conduits may also be marked with Standard Mark.

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

7 DIMENSIONS

This clause of Part 1 is applicable except as follows:

7.1 Replacement

The minimum outside diameter of the conduit shall be checked by means of the gauge in accordance with Fig.101 and shall comply with Fig. 102.

Compliance is checked by means of the gauge according to Fig.103. It shall be possible to pass the appropriate gauge through the sample in the vertical position, under its own weight and without any initial speed.

Additional Sub-clause

7.101 Checking the Uniformity of the Material Thickness

In case of doubt with regard to the uniformity of the material thickness of conduits, three samples, each taken from different lengths or from place separated by approximately 3 m, are cut along a plane perpendicular to the axis. The thickness at each cut edge is measured at four places as far as possible equally spaced around the circumference, one of the measurements being made at the thinnest place.

In no case shall the difference between the value measured and the average of the twelve values obtained from the three samples exceed 0.1 mm + 10 percent of the average value.

8 CONSTRUCTION

This clause of Part 1 is applicable.

9 MECHANICAL PROPERTIES

This clause of Part 1 is applicable except as follows:

9.2 Bending Test

Replacement:

9.2.1 Conduits shall be subjected to a bending test by means of a device as shown in Fig. 104.

9.2.2 The test is made on six samples of conduit, the length of each sample being at least

- 30 times the nominal diameter for plain conduits;
- 12 times the nominal diameter for corrugated conduits.

Three of the samples are tested at room temperature, the other three samples are tested at low temperature.

For the test at room temperature, the samples are clamped vertically in the bending apparatus according to Fig. 104, and are bent by hand to the left through approximately 90°, back to the vertical position, to the right through approximately 90°, and back to the vertical position, a rest period of 15 s being allowed between each of the four bending operations in each sequence.

This sequence of operation is made four times, except that, finally, the sample is not bent back to the vertical position. The sample shall be maintained for 5 min in the bent position, after which the sample is placed in such a position that the straight portions are at 45° to the vertical, one end of the sample pointing upwards and the other downwards. It shall then be possible to pass the appropriate gauge according to Fig. 105 through the sample, under its own weight and without any initial speed.

The test at low temperature is made in a cold chamber, in the same way as described before, after the bending apparatus together with the samples have been kept for 2 h in the cold chamber at a temperature of:

– 5°C ± 1°C for conduits of type – 5 and +90;

– 15°C ± 1°C for conduits of type – 25, –45 and + 90/ –25.

After the test, the samples shall show no cracks visible to normal or corrected vision, without additonal magnification.

9.3 Compression Test

9.3.3 *Para 2*–The difference between the nominal diameter and the diameter of the flattened sample shall not exceed 25 percent of the nominal diameter while the compression force is still applied.

9.5 Callapse Test

Replacement

9.5.1 Samples of the conduit shall be subjected to a collapse test, the length of the samples being at least

- 30 times the nominal diameter for plain conduits;
- 12 times the nominal diameter for corrugated conduits.

The samples are bent, using the apparatus shown in Fig. 104, at room temperature, once through approximately 90°, back to the vertical position and then through approximately 90° in the opposite direction. They are then fixed to a rigid support as shown in Fig. 3 of IS 9537 (Part 1) and having a radius in accordance with Fig.104 of this standard.

The support, with the sample in position, is then kept for 24 h in a heating cabinet with an atmosphere having the composition and pressure of the ambient air and ventilated by natural circulation, at a homogeneous temperature of 60°C ± 2°C.

After this period, with the support in such a position that the straight portions of the sample are at 45° to the vertical, one end of the sample pointing upwards and the other downwards, it shall be possible to pass the appropriate gauge, according to Fig. 105, through the conduit fixed to the support, under its own weight and without any initial speed.

10 RESISTANCE TO HEAT

This clause of Part 1 is applicable except as follows:

Additional Subclauses:

10.101 Compliance is checked by the test given in **10.102** which shall be made in a heating cabinet as described in **9.5.1** at a temperature of

60°C ± 2°C for conduits of type – 5, – 25 and – 45;

90°C ± 2°C for conduits of type +90, and + 90/ –25.

10.102 Each of the samples, each approximately 100 mm long, together with the test apparatus, is kept for 4 h in the heating cabinet at the temperature given above.

After this period, each sample is loaded for 24 h in an apparatus as shown in Fig. 106, with an appropriate mass so that the sample is subjected to a total mass including the mass of the rod, as shown in Table 101, placed in the middle of the sample:

Table 101 Load for Heating Test

(*Clause* 10.102)

Conduits	Mass kg
Very light	0.5
Light	1.0
Medium	2.0
Heavy	4.0
Very heavy	8.0

The load is applied through a steel rod 6 mm in diameter, disposed as far as possible at right angles to the axis of the conduit as shown in Fig. 106. The temperature specified in **10.101** is maintained while the sample is under compression.

The sample under load is then removed from the heating cabinet and allowed to cool to approximately room temperature. The load is then removed and it shall be possible to pass the appropriate gauge according to Fig.105 through the sample in the vertical position under its own weight and without any initial speed.

NOTE — Care should be taken that in removing the sample and apparatus from the cabinet, the operation shall be made in such a way as not to influence the result of the test.

11 RESISTANCE TO BURNING

This clause of Part 1 is applicable except as follows:

11.3 Addition

Duration of exposure of the sample to the flame shall be as given in Table 102.

12 ELECTRICAL CHARACTERISTICS

This clause of Part 1 is applicable.

13 EXTERNAL INFLUENCES

This clause of Part 1 is applicable except as follows:

Table 102 Durations of Exposure of the Sample to the Flame

(*Clause* 11.3)

Material Thickness mm		Flame Application Duration s
Over	Up to	
–	–	15
0.5	1.0	20
1.0	1.5	25
1.5	2.0	35
2.0	2.5	45
2.5	3.0	55
3.0	3.5	65
3.5	4.0	75
4.0	4.5	85
4.5	5.0	130
5.0	5.5	200
5.5	6.0	300
6.0	6.5	500

13.4 Not Applicable

101 CLASSIFICATION OF TESTS

101.1 Type Tests

The following shall constitute the type tests:

a) Checking of dimensions (**7**),
b) Bending test (**9.2**),
c) Compression test (**9.3**),
d) Impact test (**9.4**),
e) Collapse test (**9.5**),
f) Resistance to heat (**10**),
g) Resistance to burning (**11**),
h) Electrical characteristics (**12**), and
j) External influences (**13**).

101.2 Acceptance Tests

The following shall constitute the acceptance tests:

a) Checking of dimensions (**7**),
b) Bending test (at room temperature only) (**9.2**),
c) Compression test (**9.3**),
d) Collapse test (**9.5**),
e) Resistance to burning (**11**), and
f) Electrical characteristics (**12**).

101.2.1 A recommended sampling plan for acceptance tests is given in Annex B.

ANNEX A

(Foreword)

LIST OF INDIAN STANDARDS

IS No.	*Title*	*IS No.*	*Title*
9537 (Part 1) : 1980	Specification for conduits for electrical installations : Part 1 General requirements	2500 (Part 1) : 1992	Sampling inspection procedure : Part 1 Attribute sampling plan indexed by acceptable quality level (AQL) for lot by lot inspection (*second revision*)

ANNEX B

(Clause 101.2.1)

SAMPLING AND CRITERIA FOR CONFORMITY

B-1 LOT

B-1.1 In any consignment, all the manufactured lengths of conduits of the same type and size manufactured by the same factory during the same period shall be grouped together to constitute a lot.

B-1.2 The number of conduits to be selected from each lot shall depend upon the size of the lot and shall be in accordance with col 1 and 3 of Table 103.

B-1.2.1 These conduits shall be selected from the lot at random. In order to ensure the randomness of selection, procedure given in IS 2500 (Part 1) may be followed.

B-2 NUMBER OF TESTS AND CRITERIA FOR CONFORMITY

B-2.1 All the conduits selected in the first sample at random according to col 1 and 3 of Table 103 shall be examined for dimensional requirements. A conduit failing to satisfy any of these requirements shall be termed as 'defective'. The lot shall be considered as conforming to these requirements if the number of defectives found in the first sample is less than or equal to the corresponding acceptance number (*see* col 4 of table 103). If the number of defectives is greater than or equal to the corresponding rejection number (*see* col 5 of Table 103), the lot shall be deemed as not

Table 103 Sample Size, Acceptance and Rejection Number

(Clauses B.1.2, B-2.1 *and* B-2.2)

Lot Size	Stage of Sample	For Dimensional Requirements			For Other Acceptance Tests		
		Sample Size	Acceptance Number	Rejection Number	Sample Size	Acceptance Number	Rejection Number
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Up to 300	First	8	0	2	3	0	2
	Second	8	1	2	3	1	2
301 to 500	First	13	0	2	5	0	2
	Second	13	1	2	5	1	2
501 to 1 000	First	20	0	3	8	0	2
	Second	20	3	4	8	1	2
1 001 and above	First	32	1	5	13	0	3
	Second	32	4	4	13	3	4

conforming to the requirements. If the number of defectives is greater than the acceptance number but less than the rejection number, a second sample of the same size as the first shall be taken to determine the conformity or otherwise of the lot. The number of defectives found in the first and second samples shall be combined and if the combined number of defectives is less than or equal to the corresponding acceptance number of the second sample, the lot shall be declared as conforming to these requirements; otherwise not.

B-2.2 The lot which is found conforming to the dimensional requirements, shall then be tested for other acceptance tests. For this purpose, sample size, acceptance number and rejection number are given in col 6, 7 and 8 of Table 103 respectively.

B-2.3 The lot shall be considered as conforming to the requirements of acceptance tests if **B-2.1** and **B-2.2** are satisfied.

ANNEX C

(*Clause* 6.101)

CONDUIT MARKING CLASSIFICATION CODES

C-1 MANDATORY MARKING CODE

Metal conduit shall be marked with a single digit code denoting mechanical properties.

Insulating and composite conduits shall be marked with a three-digit code, the first digit shall denote mechanical properties, the second and third digits shall denote temperature classification.

The code shall be in accordance with the following Table:

First digit—Mechanical properties

Very light mechanical stresses.....1

Light mechanical stresses.....2

Medium mechanical stresses.....3

Heavy mechanical stresses.....4

Very heavy mechanical stresses.....5

Second and third digits by—Temperature Classification

– 5	conduits	05
– 25	conduits	25
– 45	conduits	45
+ 90	conduits	90
+ 90/–25	conduits	95
+ 90/–5	conduits	99

C-2 ADDITIONAL MARKING CODE

Conduits may be marked with an additional code denoting properties other than mechanical or temperature classification. The additional code, if used, shall follow immediately after the code marking required by **B-1** and shall be separated from it by an oblique stroke(/).

The additional code shall consist of seven digits; if code markings in respect of any of the additional properties are not required, they shall be replaced by zeros in the seven digit sequence.

The code shall be in accordance with the following:

First additional digit—Suitability with the following:

Rigid conduits.....1

Pliable conduits.....2

Self-recovering conduits.....3

Flexible conduits.....4

Second additional digit — electrical properties
Conduits with electrical continuity.....1

Conduits suitable for use as supplementary insulation.....2

Conduits with electrical continuity, and suitable for use as supplementary insulation.....3

Conduits suitable for use as a protective conductor 4

Third additional digit—Resistance to ingress of water

Conduits giving protection against dripping water.....2

Conduits giving protection against spraying water.....3

Conduits giving protection against splashing water 4

Conduits giving protection against water jets.....5

Conduits giving protection against heavy seas 6

Conduits giving protection against the effects of immersion.....7

Conduits giving protection against the effects of submersion.....8

Fourth additional digit—Resistance to ingress of solid objects

Conduits giving protection against solid objects greater than 12.5 mm.....2

Conduits giving protection against solid objects greater than 2.5 mm.....3

Conduits giving protection against solid objects greater than 1 mm.....4

Conduits giving protection against dust.....5

Dust-tight conduits.....6

Fifth additional digit—Resistance to corrosion

Conduits with low protection outside and inside....1

Conduits with medium protection outside, low protection inside.....2

Conduits with medium protection outside, and inside.....3

Conduits with high protection outside, low protection inside.....4

Conduits with high protection outside, medium protection inside.....5

Conduits with high protection outside and inside 6

Sixth additional digit—Resistance to solar radition conduits with low protection.....1

Conduits with medium protection.....2

Conduits with high protection.....3

Seventh additional digit—Suitability to support a suspended load.

The seventh additional digit is not applicable.

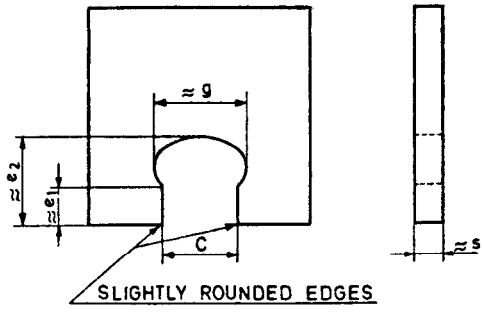
C-3 EXAMPLE OF CODE MARKING

A marking of 3 denotes a metal conduit suitable for medium mechanical stress, no other property being claimed.

A marking of 225 denotes an insulating or composite conduit suitable for light mechanical stress, with a temperature classification of –25, no other property being claimed.

A marking of 4/1000600 denotes a rigid metal conduit suitable for heavy mechanical stress, with high protection against corrosion both outside and inside.

A marking of 390/2255030 denotes a pliable insulating or composite conduit suitable for medium mechanical stress, with a temperature classification of +90, suitable for use as supplementary insulation, giving protection against water jets and dust, and with high protection against solar radiation.

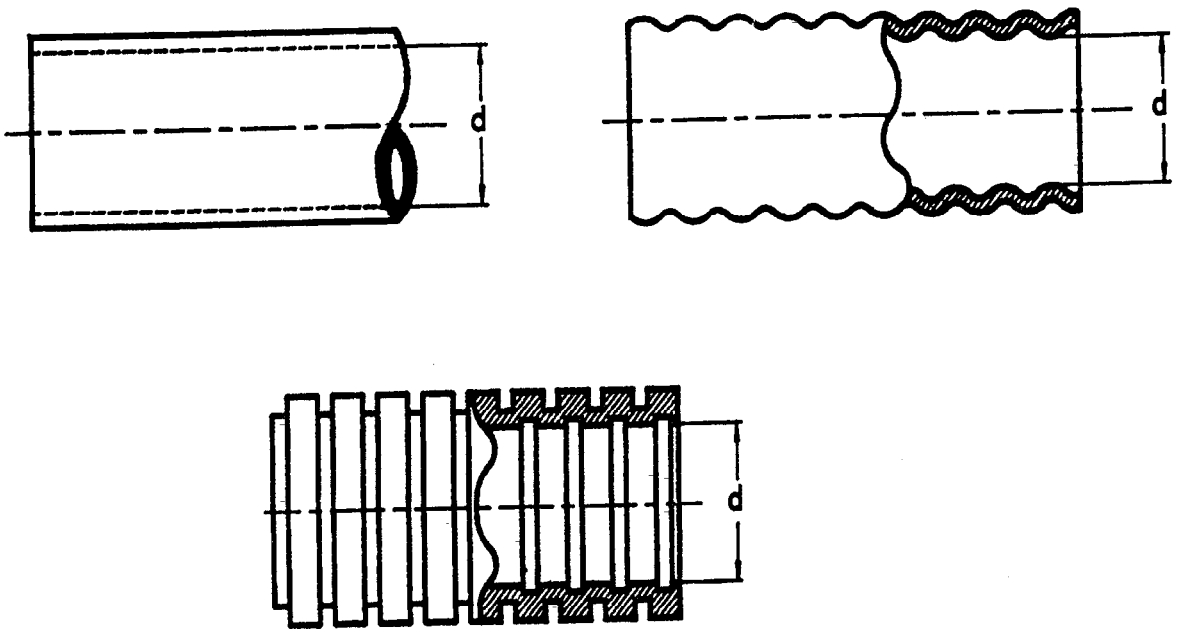


Material: steel

It shall not be possible to pass the gauge over the conduit, in any position, without undue force. If the profile of the conduit is not truly circular, it is permitted to reshape it by hand when checking with this gauge.

Size	C	Manufacturing Tolerances	Admissible Wear	e_1	e_2	g	s
	mm	mm	mm	mm	mm	mm	mm
16	15.700	0 − 0.018	+ 0.018 0	8	17	18	8
20	19.700	0 − 0.022	+ 0.022 0	10	23	27	9
25	24.600	0 − 0.022	+ 0.022 0	10	23	27	9
32	31.600	0 − 0.025	+ 0.025 0	12	29	34	10
40	39.600	0 − 0.030	+ 0.030 0	14	35	42	10
50	49.500	0 − 0.030	+ 0.030 0	16	42	52	12
63	62.400	0 − 0.030	+ 0.030 0	18	49	65	12

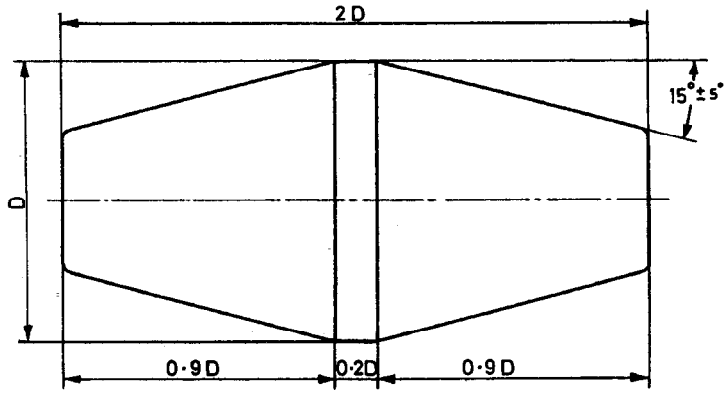
FIG. 101 GAUGE FOR CHECKING MINIMUM OUTSIDE DIAMETER OF CONDUITS



Size	Minimum Inside Diameter, *d* mm	Preferred Lengths When Delivered as Coils m
16 20	10.7 14.1	50 and 100
25 32 40	18.3 24.3 31.2	50
50 63	39.6 50.6	00

The figures are not intended to govern design except as regards the dimensions shown.

FIG. 102 PLIABLE CONDUITS



Size	Diameter *D*, mm
16	10.0
20	14.0
25	18.0
32	24.0
40	30.0
50	39.0
63	50.0

Material: steel, hardened and polished, edges slightly rounded

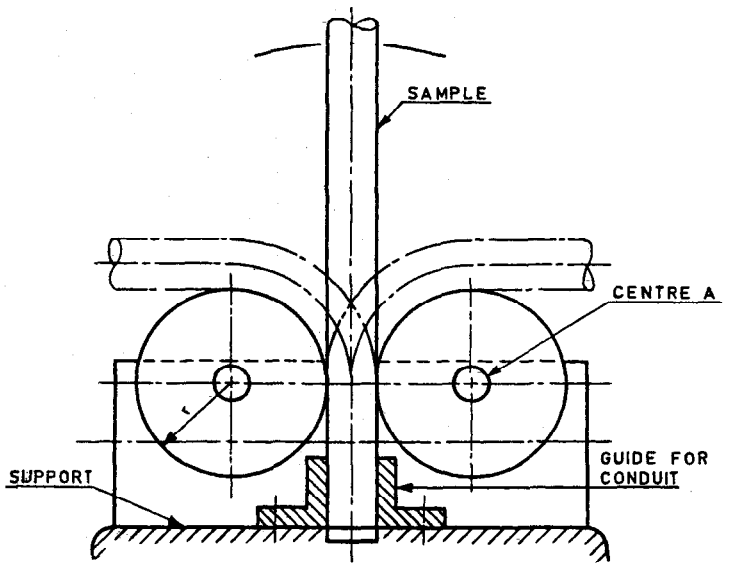
Manufacturing tolerance: $^{+\ 0.05}_{0\ \text{mm}}$

Tolerance on axial dimension: ± 0.2 mm

Admissible wear: 0.01 mm

If the profile of the conduit is not truly circular, it is permitted to reshape it by hand when checking with this gauge.

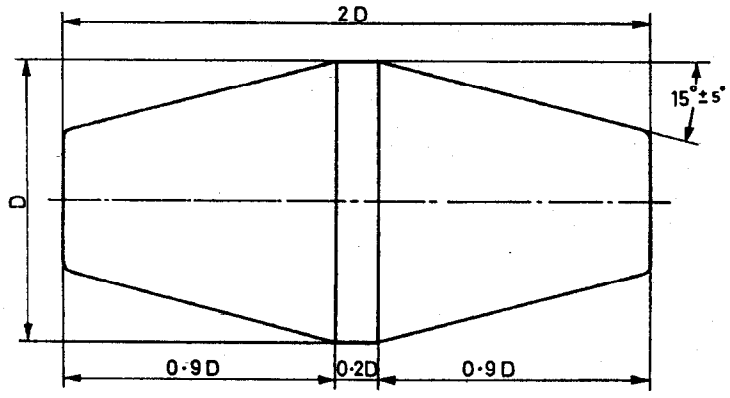
FIG. 103 GAUGE FOR CHECKING MINIMUM INSIDE DIAMETER OF CONDUITS IN THE STRAIGHT CONDITION



Size	Radius *r* mm	
	Plain Conduits	Corrugated Conduits
16	96	48
20	120	60
25	150	75
32	192	96
40	300	160
50	480	200
63	600	252

To pass the gauge according to Fig.105 while the sample is still bent, it shall be possible to rotate the apparatus round centre A, and the bisecting line of the bending angle on the centre A shall be in the horizontal position.

FIG. 104 APPARATUS FOR BENDING TEST



Size	Diameter *D* mm
16	8.0
20	11.0
25	14.0
32	19.0
40	25.0
50	31.0
63	40.0

Material: steel, hardened and polished, edges slightly rounded

Manufacturing tolerance: $^{+\ 0.05}_{0\ \text{mm}}$

Tolerance on axial dimension: ± 0.2 mm

Admissible wear: 0.01 mm

If the profile of the conduit is not truly circular, it is permitted to reshape it by hand when checking with this gauge.

FIG. 105 GAUGE FOR CHECKING MINIMUM INSIDE DIAMETER OF CONDUITS IN THE BENT CONDITION

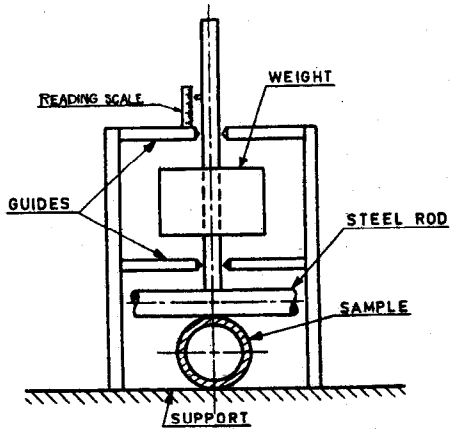


FIG. 106 APPARATUS FOR RESISTANCE TO HEAT TEST

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act,* 1986 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Handbook' and 'Standards: Monthly Additions'.

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