
British Standard

Flexible insulating sleeving for electrical purposes

Part 2. Methods of test

[IEC title: Specification for flexible insulating sleeving Part 2: Methods of test]

Gaines isolants souples à usages électrotechniques
Partie 2. Méthodes d'essai

Flexible Isolierschläuche für die Elektrotechnik
Teil 2. Prüfverfahren

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National foreword

This Part of BS 6893 has been prepared under the direction of the General Electrotechnical Engineering Standards Committee. It is identical with IEC Publication 684-2 : 1984 'Specification for flexible insulating sleeving, Part 2 : Methods of test', published by the International Electrotechnical Commission (IEC).

This Part of BS 6893 together with Part 1 supersedes the general and test clauses of BS 2848 : 1973 which will be deleted by amendment in due course. No decision has yet been taken concerning possible implementation of IEC Publication 684-3 as a British Standard.

The individual sheets of IEC Publication 684-3 'Specification requirements for individual types of sleeving' will be available on publication from BSI Sales Department, Linford Wood, Milton Keynes MK14 6LE.

Terminology and conventions. The text of the international standard has been approved as suitable for publication as a British Standard without deviation. Some terminology and certain conventions are not identical with those used in British Standards; attention is drawn especially to the following.

Wherever page numbers are quoted, they are IEC page numbers.

In figures 1, 4 and 10, the comma has been used as a decimal marker. In British Standards it is current practice to use a full point on the baseline as the decimal marker.

In clause 25 reference is made to a contractual agreement which should not form part of a specification and would normally appear in British Standards as a note to the text. The item so indicated does not constitute a requirement in this method of test.

Cross-references

International standard*	Corresponding British Standard
IEC 68-2-10 : 1984	BS 2011 Basic environmental testing procedures Part 2.1J : 1985 Test J. Mould growth (Identical)
IEC 68-2-20 : 1979	Part 2.1T : 1981 Test T. Soldering (Identical)
IEC 93 : 1980	BS 6233 : 1982 Methods of test for volume resistivity and surface resistivity of solid electrical insulating materials (Identical)
IEC 212 : 1971	BS 2844 : 1972 Memorandum on conditioning of solid electrical insulating materials prior to and during testing (Technically equivalent)
IEC 216-1 : 1974	BS 5691 Guide for the determination of thermal endurance properties of electrical insulating materials Part 1 : 1979 General procedures for the determination of thermal endurance properties, temperature indices and thermal endurance profiles (Identical)
IEC 216-2 : 1974	Part 2 : 1979 List of materials and available tests (Identical)
IEC 426 : 1973	BS 5735 : 1979 Test methods for determining electrolytic corrosion with electrical insulating materials (Identical)
IEC 587 : 1977	BS 5604 : 1978 Methods for evaluating resistance to tracking and erosion of electrical insulating materials used under severe ambient conditions (Identical)
IEC 589 : 1977	BS 5591 : 1978 Methods of test for determination of ionic impurities in electrical insulating materials by extraction with liquids (Identical)
ISO 5-1974 †	BS 1384 : 1947 Photographic density measurements (Technically equivalent)
ISO/R 182-1970	BS 2782 Methods of testing plastics Method 130A : 1976 Determination of the thermal stability of polyvinyl chloride by the Congo red method (Technically equivalent)

*Undated in the text.

†ISO 5 has recently been revised in four Parts; BS 1384 : Parts 1 to 4 are identical with those Parts.

International standard*	Corresponding British Standard
ISO 1431/1-1980	BS 903 Methods of testing vulcanized rubber Part A43 : 1982 Determination of resistance to ozone cracking (static strain test) (Identical)
ISO 4589-1984 †	BS 2782 Methods of testing plastics Method 141 : 1986 Determination of flammability by oxygen index (Identical)

The Technical Committee has reviewed the provisions of IEC 216-3 : 1980, IEC 243 : 1967, IEC 250 : 1969, IEC 304 : 1982, ISO 37-1977, ISO 105/B-1978, and ISO 974-1980 to which reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard.

Related British Standards to those mentioned in the previous paragraph are:

IEC 243 : 1967	BS 2918 : 1957 Determination of electric strength of solid insulating materials at power frequencies (Obsolescent)
IEC 250 : 1969	BS 2067 : 1953 Determination of power-factor and permittivity of insulating materials Hartshorn & Ward method) (Obsolescent)
	BS 2782 Methods of testing plastics. Methods 240A and 240B : 1982
	BS 903 : Part C3 : 1982 Determination of loss tangent and permittivity at power and audio frequencies
	BS 4542 : 1970 Method for determination of loss tangent and permittivity of electrical insulating materials in sheet form (Lynch method)
IEC 304 : 1982	BS 6746C : 1969 Colour chart for PVC insulation and sheath of electric cables (Agrees with CENELEC HD 402)
ISO 37-1977	BS 903 Methods of testing vulcanized rubber Part A2 : 1971 Determination of tensile stress-strain properties ‡

There are no British Standards relating to the subjects covered by ISO 105/B and ISO 974.

Additional information. Line 2 of 10.4 contains a typographical error which has been notified to the IEC Secretariat. It should read 'except that the sleeving sample and the plug gauge therein shall be replaced by the test specimen'.

Paragraph 3 of 13.3 and paragraph 2 of 14.2 require visual examination of the specimen without magnification. This should be taken to permit visual examination with normally corrected vision.

Clause 25 refers to Method A of IEC Publication 587 : 1977. The 1977 edition of that standard has been superseded by the 1984 edition but reference should still be made to the 1977 edition for the purposes of this standard.

The last paragraph of 34.2 refers to the use of a good north light. It should be noted that this is appropriate only at European latitudes. Alternative arrangements will have to be made if colour comparisons are to be made elsewhere.

35.3 requires examination using normal eyesight. This should be taken to permit examination with normally corrected vision.

Figure 10 is not intended to serve as a manufacturing drawing. However, burners constructed using the nominal dimensions given should produce the flame dimensions required by the test.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

*Undated in the text.

†Referred to in the text as ISO DIS 4589.

‡BS 903 Part A2 : 1971 is technically equivalent to the superseded ISO 37-1968.

British Standard

Flexible insulating sleeving for electrical purposes

Part 2. Methods of test

INTRODUCTION

This standard is one of a series which deals with flexible insulating sleeving for electrical purposes. It consists of three parts:

- Part 1: Definitions and General Requirements (IEC Publication 684-1);
- Part 2: Methods of Test (IEC Publication 684-2);
- Part 3: Specification Requirements for Individual Types of Sleeving (IEC Publication 684-3).

1. Scope

This part of the standard gives methods of test for flexible insulating sleeving, including heat shrinkable sleeving, intended primarily for insulating electrical conductors and connections of electrical apparatus.

The tests specified are designed to control the quality of the sleeving but it is recognized that they do not completely establish the suitability of sleeving for impregnation or encapsulation processes or for other specialized applications. Where necessary, the test requirements in this part will require to be supplemented by appropriate impregnation or compatibility tests to suit the individual circumstances.

2. Test conditions

Unless otherwise specified, all tests shall be made under standard ambient conditions according to IEC Publication 212: Standard Conditions for Use prior to and during the Testing of Solid Electrical Insulating Materials, i.e. at a temperature between 15 °C and 35 °C and a relative humidity between 45% and 75%.

When heating at elevated temperature is specified for a test procedure, the specimen shall be maintained in a uniformly heated oven for the prescribed period.

3. Measurements of bore and wall thickness

Suitable methods are detailed in Sub-clauses 3.1, 3.2 and 3.3.

3.1 Bore

The bore shall be determined with a plug gauge of length at least three times the bore diameter or 20 mm, whichever is the greater. The gauge shall enter the bore without the use of undue pressure. A lubricant in powder form will assist when some types of sleeving are being measured.

An alternative method for measurement of the bore of textile sleeveings is to use gauges such as shown in Figure 1, page 68, having the diameter C increasing in steps of 0.01 mm.

To determine the bore of a textile sleeving, a gauge of the dimensions shown in Figure 1 is inserted into a specimen of sleeving longer than dimension A . The sleeving is held vertically with the gauge at the bottom and with the point of support sufficiently above the end of the gauge to avoid pressing the specimen on to it.

If the gauge falls out freely, the gauge with the next larger diameter is tried, and so on until a gauge is found which just fails to fall out freely.

The bore of the specimen is the diameter of the largest gauge to fall out freely.

3.2 *Wall thickness*

A plug gauge or mandrel shall be inserted so that it enters freely but has a diameter not less than 80% of the bore. The overall dimension shall then be measured using a micrometer having flat anvils of approximately 6 mm diameter. In making this measurement, the pressure applied by the micrometer shall be just sufficient to close the sleeving on to the inserted plug gauge or mandrel. For heat shrinkable sleeving, the measurement is made after unrestricted recovery. The wall thickness shall be calculated by halving the difference between the plug gauge or mandrel diameter and the overall dimension. The result shall be reported as the wall thickness.

3.3 *Minimum and maximum wall thickness*

This part does not give mandatory methods for making this measurement. For heat-shrinkable sleeving, the measurement shall be made after unrestricted recovery.

Note. — The following methods of measurement have proved suitable: optical profile projector, optical comparator, a suitable micrometer.

4. **Density**

Any method may be used which can ensure an accuracy of 0.01 g/cm^3 at $23 \pm 2^\circ\text{C}$.

5. **Resistance to splitting after heating**

5.1 *Number of test specimens*

Three specimens shall be tested.

5.2 *Form of test specimen*

The specimens shall be produced by cutting rings whose cut length equals the wall thickness. Precautions shall be taken to ensure that the cut is clean since imperfections can affect the result.

5.3 *Procedure*

The specimens shall be tested using a mandrel tapered sufficiently at one end to enter the bore. The specimens shall be maintained for a period of $168 \pm 2 \text{ h}$ at a temperature of

70 ± 2 °C or another temperature specified in Part 3, and then allowed to cool to 23 ± 5 °C. They shall then be rolled up the mandrel so that they are extended by an amount equal to the percentage of nominal bore diameter specified in Part 3. The specimens shall be kept in that position and at a temperature of 23 ± 5 °C for 24 ± 1 h and then examined for signs of splitting.

6. Resistance to heat

A length of approximately 75 mm of sleeving shall be heated for $4 \text{ h} \pm 10 \text{ min}$ in an oven at the temperature specified in Part 3. The sleeving shall be allowed to cool to room temperature and then examined for any signs of dripping, cracking, flowing or change in colour. In addition, when so specified in Part 3, the specimen shall be tested for elongation at break in accordance with Clause 19. In this case, the specimen subjected to heating shall be of the dimensions required for the test for elongation.

7. Resistance to soldering heat

7.1 Number of test specimens

Three specimens shall be tested.

7.2 Form of test specimen

60 mm of sleeving shall be used and approximately 150 mm of tinned copper wire, of a diameter which permits a sliding fit in the sleeving.

The wire shall be bent through 90° at its middle point round a mandrel of diameter three times the nominal bore of the sleeving.

The sleeving shall be slipped over the wire and worked round the bend so that it covers a length of the straight part of the wire which will be vertical during the test, equal to 1.5 times the nominal bore of the sleeving but with a minimum length of 1 mm (see Figure 2, page 69). The wire shall be cut off on the part to be vertical during the test 20 mm beyond the sleeving.

The wire shall be cut off on the part to be horizontal during the test at the end of the sleeving. Not less than 5 min after the wire has been bent, a high grade flux* consisting of 25% by weight of colophony in 75% by weight of 2-propanol (isopropanol) or of ethyl alcohol shall be applied to the lower 6 mm of the protruding part of the wire.

7.3 Procedure

With the sleeving at a temperature of 23 ± 5 °C, the test shall be started within 60 min of the application of the flux. The horizontal part shall be held at the end remote from the bend and at least 25 mm from the bend. The vertical portion shall be immersed in the centre of a bath of molten solder so that 6 mm of the wire is immersed; a convenient way to achieve this is to mark the wire beforehand. The wire shall be held in this position for 15 ± 1 s or as specified in Part 3. The solder bath shall be not less than 25 mm in diameter and 12 mm deep and the temperature of the solder shall be maintained at 260 ± 5 °C during the test. To pass the test, no specimen shall split or widen considerably, slight melting being permissible (see Figure 3, page 69).

* Non-activated colophony only, the acid value of which shall be not less than 155 mg KOH/g. A full specification is given in Appendix C of IEC Publication 68-2-20: Basic Environmental Testing Procedures, Part 2: Tests Test T: Soldering.

8. Loss in mass on heating of uncoated textile glass sleeving

8.1 *Number and mass of test specimens*

Three specimens shall be tested, each consisting of a sufficient length to provide 5 ± 1 g.

8.2 *Procedure*

The specimens shall be conditioned by heating at 105 ± 2 °C for 1 h and then allowed to cool in a desiccator to room temperature. They shall then be weighed to the nearest 0.0002 g (m_1) and then heated in a ventilated furnace at 600 ± 10 °C for 60 min to 75 min. After cooling to room temperature in a desiccator, the specimens shall be re-weighed (m_2).

8.3 *Result*

The percentage loss in mass of each test shall be calculated as:

$$\frac{m_1 - m_2}{m_1} \times 100$$

The percentage loss in mass on heating is the central value of the three determinations, the other two values are also reported.

9. Longitudinal change

9.1 *Number of test specimens*

Three specimens shall be tested.

9.2 *Form of test specimen*

A specimen of sleeving 100 mm long is cut cleanly at right angles to its length and measured to within an accuracy of 0.5 mm.

9.3 *Procedure*

The specimen shall be supported horizontally on a medium on which it can recover freely. The supported specimen shall be maintained in an oven for the time and temperature specified in Part 3.

The sleeving shall be allowed to cool to room temperature and then re-measured.

9.4 *Result*

The result of each determination shall be expressed as the percentage change calculated on the original length.

The test result is the central value of the three determinations, the other two values are reported.

10. Resistance to pressure at elevated temperature

10.1 Number of test specimens

Three specimens shall be tested.

The tests shall be carried out not less than 16 h after the extrusion of the sleeving.

10.2 Form of test specimen

The test specimen shall be formed by slitting the sleeving along its length and then cutting from the sleeving a section approximately 10 mm × 5 mm (or the full circumference of the sleeving if this is less than 5 mm), so that the long axis of the specimen is parallel to the length of the sleeving.

10.3 Apparatus

The apparatus consists of an instrument capable of measurement to ± 0.01 mm with a rectangular indenter blade with an edge 0.70 ± 0.01 mm which applies a load to the specimen of 1.2 ± 0.05 N, unless otherwise specified in Part 3. The specimen is placed on a metal mandrel 6.00 ± 0.1 mm in diameter which is supported on a V block. The essential features of this arrangement are shown in Figure 4, page 70.

The assembly shall be placed in a uniformly heated air oven maintained at $110 \pm 2^\circ\text{C}$ during the heating period, unless another temperature is specified in Part 3. To minimize vibration a gravity-circulated oven, mounted on suitable damping pads, shall be used.

10.4 Procedure

The wall thickness of the test specimen shall be measured by the method of Sub-clause 3.2, except that the plug gauge and sleeving sample therein shall be replaced by the test specimen resting on the mandrel. The wall thickness shall be the measured difference between the mandrel diameter and the overall dimensions.

The assembly with mandrel but without the test specimen shall be conditioned for at least 2 h before the test in the oven at $110 \pm 2^\circ\text{C}$, unless another temperature is specified in Part 3.

The indenter blade shall be raised, the test specimen placed on the mandrel with its long axis parallel to the mandrel and the indenter gently lowered on to the surface of the test specimen.*

The assembly and test specimen shall then remain in the oven at the specified temperature for 60 ± 5 min.

The position of the indenter blade shall then be recorded. Remove the specimen, allow the indenter to rest directly on the mandrel and again record the position. Subtract the difference between these two readings from the original measured wall thickness to give the indentation.

Differences between any two of the three values for the position of the indenter resting directly on the mandrel shall be not more than 0.02 mm.

* With small bore sleeveings the manipulation of the test specimen may cause difficulty. In such cases it is recommended that the test specimen be flattened under a 1 kg weight for approximately 10 min at room temperature before placing it on the mandrel.

10.5 *Result*

The indentation of the specimen shall be expressed as a percentage of the initial wall thickness.

The percentage indentation shall be taken as the central value of the three determinations, the other two values are also reported.

11. **Thermal stability of p.v.c sleeving**

11.1 *Principle*

This method determines the time taken for hydrogen chloride to be evolved from polyvinyl chloride (p.v.c.), its copolymers or compounds or products based on them, when heated.

The evolution of hydrogen chloride is detected either by the use of Congo red paper (Method A) or by the change in pH of a potassium chloride solution contained in a measuring cell (Method B).

Methods A and B are both in accordance with those contained in ISO Recommendation R 182.

11.2 *Form of test specimen*

Method A

The specimen shall be sufficient to fill two of the specified test tubes to a depth of 50 mm and is formed by cutting the sleeving into pieces of maximum dimension 6 mm, slitting where necessary. The pieces of sleeving shall not be deliberately compacted in the test tubes.

Method B

To prepare specimens, cut pieces of sleeving approximately 5 mm² to 6 mm² in size and weigh 1.0 g into each test tube.

11.3 *Procedure*

The test shall be carried out in accordance with either Method A or Method B of ISO Recommendation R 182. The relevant specification sheet of Part 3 will specify which test is to be used, the test temperature and, in the case of Method B, if a moving gas medium other than air is to be employed.

12. **Volatile content of silicone sleeving**

12.1 *Number and mass of test specimens*

Three specimens shall be tested, each consisting of a sufficient length to provide 10 ± 1 g.

12.2 *Procedure*

The specimens shall be weighed to the nearest 0.01 g (m_1) and then heated in a ventilated oven at 200 ± 3 °C for 24 ± 1 h. A convenient way to achieve this is to suspend the test pieces over a wire that is thermally insulated from the metalwork of the oven.

After cooling in a desiccator, the specimens shall be re-weighed (m_2).

12.3 *Result*

The percentage loss in mass of each test specimen shall be calculated as:

$$\frac{m_1 - m_2}{m_1} \times 100$$

The result is the central value of the three determinations, the other two values are also reported.

13. **Bending after heating**

13.1 *Number of test specimens*

Three specimens shall be tested, each of length sufficient to wind conveniently round a mandrel of the size specified in Part 3 for the sleeving under test.

13.2 *Form of test specimen*

When the nominal bore does not exceed 2 mm, a length of wire which is a sliding fit in the sleeving shall be inserted in the bore of the specimen.

When the nominal bore exceeds 2 mm but does not exceed 15 mm (or other value as specified in Part 3 for a particular type of sleeving), the specimen shall be filled by any suitable means (e.g. a number of wires) to prevent undue collapse of the sleeving during winding.

When the nominal bore exceeds 15 mm (or other value as specified in Part 3 for a particular type of sleeving), the specimen shall consist of a strip of sleeving 6 mm wide cut parallel to the longitudinal axis of the sleeving.

13.3 *Procedure*

The specimen, filled as described in the previous sub-clause, shall be suspended for 48 ± 1 h in a uniformly heated air oven maintained at the temperature specified in Part 3. It shall then be removed from the oven and allowed to cool to room temperature.

It shall then be wound without jerking for one complete turn in a close helix round a mandrel of the diameter specified in Part 3. For cut strips, the inside surface shall be in contact with the mandrel. The time to achieve one complete turn shall be not greater than 5 s. The specimen shall be held in this position for 5 min.

It shall then be visually examined without magnification while still on the mandrel for signs of cracking, detachment of coating, delamination or change of colour.

Detection of cracking in sleeving up to 15 mm bore by application of voltage using a method described in Clause 21 may be specified in Part 3.

14. Bending at low temperature

14.1 *Number and form of test specimens*

The number and form of test specimens shall be as in Clause 13, except that, when the nominal bore exceeds 8 mm (instead of 15 mm), the specimen shall consist of a strip of sleeving 6 mm wide cut parallel to the longitudinal axis of the sleeving.

Alternatively, where so specified in Part 3, specimens of nominal bore up to and including 8 mm shall be tested unfilled.

14.2 *Procedure*

The specimen, filled as described in the previous sub-clause, shall be suspended for 60 ± 10 min in a chamber maintained at the temperature specified in Part 3 and, while still at that temperature, shall be wound without jerking for one complete turn in a close helix round a mandrel at the same temperature and having the diameter specified in Part 3. For cut strips, the inside surface shall be in contact with the mandrel. The time to achieve one complete turn shall be not greater than 5 s. The specimen shall be held in this position and at the low temperature for 5 min. It shall then be allowed to regain room temperature.

The specimen shall then be visually examined without magnification while still on the mandrel for signs of cracking, detachment of varnish or delamination.

15. Brittleness temperature

The test is made in accordance with ISO Standard 974 using specimens prepared as follows:

For sleeving of nominal bore up to 4 mm diameter, specimens shall be cut in full section 40 mm long. For sleeving of bore larger than 4 mm, specimens shall be 6 mm wide and 40 mm long, with the longer dimension parallel to the longitudinal axis. The strip specimens shall be mounted so that the hammer strikes the convex side of the specimen.

16. Dimensional stability on storage

(Applicable to heat-shrinkable sleeving only.)

16.1 *Number and length of test specimens*

Three specimens shall be tested, each approximately 100 mm long.

16.2 *Procedure*

The internal diameter of the sleeving shall be measured in the expanded state as delivered. The sleeving shall then be stored in a ventilated oven for 336 ± 2 h at a temperature of 40 ± 3 °C. It shall then be removed from the oven, allowed to cool to ambient temperature and the internal diameter re-measured.

16.3 *Result*

The dimensional stability is expressed as the percentage change in diameter related to the original diameter and the result is the central value of the three determinations.

17. Hydrolysis of coating

17.1 *Number of test specimens*

Three specimens shall be tested.

17.2 *Form of test specimen*

Each specimen of the sleeving shall be cut into lengths of 40 mm to 50 mm, which shall be wrapped in filter paper to form a bundle of a diameter to give a push fit into a 125 mm × 12 mm borosilicate glass test tube*. Where the size of the sleeving requires it, specimens may be cut along their length to enable them to be rolled up before insertion in the test tube.

The sleeving shall be pushed to the bottom of the test tube, and 2 ml of distilled water added. A short length of copper wire, of approximately 0.6 mm diameter, shall then be inserted, the end nearest to the sleeving being bent into a somewhat circular shape at right angles to the length. The length of wire shall be such that it is totally within the test tube after sealing, with the formed end above the water level when the tube is inverted. The wire acts as a stop to prevent the sleeving from slipping down into the water.

The end of the test tube shall then be sealed. This is done conveniently by drawing it out in a flame.

17.3 *Procedure*

The test tube shall then be held vertically, with the sealed end downwards, and maintained at 100 ± 2 °C for 72 ± 1 h.

Report any running of the coating, any adherence between sleeving and paper, between the pieces of sleeving, and any sign of discolouration of the paper.

18. Flexibility

18.1 *Number and length of test specimens*

Three specimens shall be tested, each 150 mm long.

18.2 *Conditioning*

The test specimen shall be left loose on a flat surface in an ambient temperature of 23 ± 5 °C for approximately 24 h. Thereafter, the specimen should be handled as little as possible to avoid increasing its temperature.

18.3 *Apparatus*

Apparatus of the type shown in Figure 5, page 71, shall be used.

A length of sewing thread** shall be attached to the mandrel and passed through the sleeving. The specimen shall be attached to the mandrel by a screw clamp as shown in Figure 5.

* It is essential that "heavy" wall thickness test tubes are used for this test to minimize the risk of explosion and injury to personnel. As a further safety precaution, it is recommended that the test tubes are placed behind a screen protecting the observer.

** A polyethylene terephthalate sewing thread is suitable for this purpose; but for 0.5 mm bore sleeving, it may be necessary to use suction or a pull-through to get the thread through the sleeving.

The mandrel shall be provided with a means of rotating it through 270°. The weight shall be attached to the thread. The weight to be attached is specified in Part 3 for the particular type of sleeving relative to the bore size.

The thread below the sleeving shall pass and almost touch a scale of deflection in millimetres. A plumbline shall be used to ensure that the zero of the scale is directly below the side of the mandrel.

18.4 *Test temperature*

The test shall be made with the sleeving and the apparatus at 23 ± 2 °C.

18.5 *Procedure*

The mandrel shall be rotated so that the screw clamp used to anchor the sleeving is above the zero mark on the deflection scale. The weight shall be applied with the mandrel in this position and the mandrel shall immediately be rotated smoothly through 270°, at such a rate that it reaches the position shown in Figure 5, page 71, in about 10 s*. The deflection shall be recorded 30 ± 5 s after completion of the rotation. If there is any curvature, the test shall be carried out with the curvature and not against it. The true deflection is obtained by subtracting the wall thickness of the sleeving under test from the deflection recorded.

18.6 *Result*

The result is the central value of the three determinations, the other two values are also reported.

19. **Tensile strength, elongation at break and secant modulus at 2% or 100% elongation**

Specification sheets in Part 3 may stipulate some of the following tests according to the type of sleeving. In some cases, more than one of the tests given below can be carried out in the same operation:

- Tensile strength and elongation at break of full section sleeving.
- Tensile strength and elongation at break of dumb bell specimens.
- Tensile strength and elongation at break of uncoated textile glass sleeving.
- Secant modulus at 2% elongation.
- Secant modulus at 100% elongation.
- Secant modulus at 100% elongation and at elevated temperature.

Note. In all these tests appropriate jaws should be used. Specimens should be protected to avoid failure at the jaws.

19.1 *Tensile strength and elongation at break for full section sleeving*

19.1.1 *Number of test specimens*

Five specimens shall be tested.

* It may be necessary to use a guide to ensure that the sleeving remains in a vertical plane.

19.1.2 *Form of test specimen*

The test specimen shall be a length of sleeving sufficient to allow 100 mm between the clamps of the testing machine and shall be marked with two parallel reference lines 50 mm apart, approximately mid-way between the jaws. The marking medium shall have no detrimental effect on the material and the marks shall be as narrow as possible. The use of a marker with parallel printing blades is recommended.

19.1.3 *Conditioning*

Unless otherwise specified in Part 3, the test specimen shall be kept at an ambient temperature of $23 \pm 2^\circ\text{C}$ for 1 h immediately before testing, or for a longer time to enable the specimen to reach a temperature of $23 \pm 2^\circ\text{C}$.

19.1.4 *Test temperature*

The test shall be made at a temperature of $23 \pm 2^\circ\text{C}$.

19.1.5 *Procedure*

The cross-sectional area of the test specimen shall be calculated from measurements of bore and wall thickness made in accordance with Clause 3.

The specimen shall be mounted in the tensile test machine in axial alignment with the direction of pull. The jaws shall be separated at the uniform rate specified in Part 3 for a particular material. The range of the testing machine shall be such that the maximum load is between 15% and 85% of the maximum scale reading.

The distance between the reference lines at break may conveniently be measured by means of a ruler lightly attached to the specimen or by an extensometer.

The maximum load shall be measured to the nearest 2%. The distance between the reference lines at break shall be measured to within 2 mm.

If the test specimen breaks outside the reference lines the result shall be discarded and a further test made using another specimen.

19.1.6 *Result*

The tensile strength shall be calculated from the maximum load and the original area of cross-section and the result expressed in megapascals (MPa).

The elongation at break shall be expressed as a percentage of the original distance between the reference lines, i.e.:

$$\text{elongation at break (\%)} = \frac{L - L_0}{L_0} \times 100$$

where:

L = measured distance between the two marks on the stretched specimen
 L_0 = the original distance between the marks

For tensile strength and elongation at break the test result is the central value of the five determinations of each property. The highest and lowest values are reported.

19.2 *Tensile strength and elongation at break on dumb-bell specimens*

The test shall be carried out exactly as in Sub-clause 19.1 but with the following changes: