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Indian Standard

(Reaffirmed 2001)

METHODS OF TEST FOR CABLES

PART 7 TENSILE STRENGTH AND ELONGATION AT BREAK OF THERMOPLASTIC AND ELASTOMERIC INSULATION AND SHEATH

Power Cables Sectional Committee, ETDC 59; Panel for Methods of Tests for Cables, ETDC 59/P1 [Ref : Doc : ETDC 59 (2240)]

1. Scope — Covers the method to determine the tensile strength and elongation at break of thermoplastic and elastomeric insulation and sheath of electric cables.

2. Significance — During the process of manufacture and during installation electric cables are unavoidably subjected to mechanical stresses; particularly bending. Thermoplastic or elastomeric insulation and/or sheath in the cable are also subjected to these stresses and strains. This test is carried out to ensure that the insulation and/or sheath have requisite tensile strength and elongation to withstand the same.

3. Terminology

3.1 *Gauge Length* — The original length of that portion of the specimen over which strain or change of length is determined.

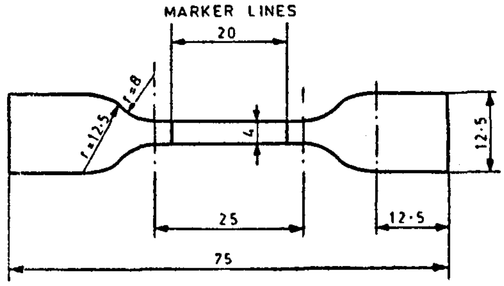
3.2 *Elongation at Break* — The increase in gauge length of a tensile test specimen measured at the moment of break and expressed as a percentage of the original gauge length.

3.3 *Breaking Load* — The load at which the test specimen breaks.

3.4 *Tensile Strength at Break* — Tensile strength is computed from the measurements of breaking load and cross-sectional area of the test specimen.

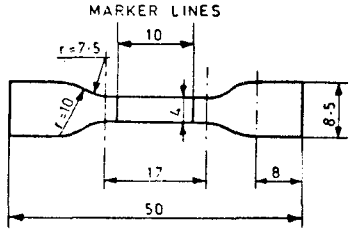
4. Apparatus

4.1 *Die* — The shape and dimensions of dumb-bell punching die for preparing dumb-bell test specimens shall be as shown in Fig. 1 and 2. The die shall be sharp and free from nicks in order to prevent ragged edges on the specimens.



All dimensions in millimetres.

FIG. 1 STANDARD DUMB-BELL TEST PIECE



All dimensions in millimetres.

FIG. 2 SMALL DUMB-BELL TEST PIECE

Adopted 14 March 1984

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4.2 *Tensile Testing Machine* — The machine shall be automatic. It shall have the capacity to meet the requirement of this test and shall have the rate of separation of jaws as specified in **8.3**. The grips shall firmly hold the test specimen. The elongation may be measured manually or with an automatic device.

4.3 *Analytical Weighing Balance* — Sensitivity 0·1 mg.

4.4 *Mechanical/Optical Instruments* — For measuring dimensions of test specimen to an accuracy not worse than 0·01 mm.

5. Material — No material other than the test specimen is required for performing this test.

6. Test Specimen

6.1 The specimen shall be prepared from a piece of insulated conductor/sheathed cable taken not less than 300 mm from the end of cable.

6.2 *Type of Test Specimen* — The test specimen may be of two types, dumb-bell or tubular. Whenever possible, dumb-bell type test specimens shall be used. Tubular test specimens shall be used only when the insulated conductor/sheathed cable is of such a small size that it is not possible to prepare the dumb-bell test pieces from them.

6.3 *Number of Test Specimens* — Four in each case of insulation or sheath.

6.4 *Preparation of Test Specimens*

6.4.1 *Tubular test speimens* — A tube of insulation/sheath not less than 100 mm long shall be obtained by carefully removing other components of the insulated conductor/sheathed cable piece without damaging the insulation/sheath.

6.4.2 *Dumb-bell test specimens*

6.4.2.1 The insulation/sheath shall be cut open length-wise and the other components of the insulated conductor/sheathed cable which are not to be part of this test specimen shall be removed carefully without causing damage to insulation/sheath.

6.4.2.2 Semi-conducting layers, if any, adhering to the insulation inside or outside shall be removed carefully without damaging the insulation.

6.4.2.3 It shall be permissible to grind or cut the insulation/sheath, by a method which does not over-heat or distort it, so as to obtain two parallel surfaces between the marker lines. It is not normally necessary to remove by grinding the webs formed between the wires of a stranded conductor, but in case of dispute this should be done. After grinding or cutting, the thickness of test pieces shall be not less than 0·8 mm and not more than 2·0 mm.

6.4.2.4 From test pieces of insulation/sheath prepared as above, dumb-bell test specimen shall be punched in accordance with Fig. 1. If possible, two dumb-bell test specimens shall be punched side by side. When the diameter of the insulated conductor/sheathed cable is too small, the dumb-bell test specimen shall be punched in accordance with Fig. 2.

6.5 *Determination of Cross-Sectional Area of Test Specimen*

6.5.1 *Cross-sectional area (mm^2) of tubular test specimen* — Shall be determined either by dimensional measurements or by computation from density, mass and length measurement.

6.5.2 *Cross-sectional area (mm^2) of the dumb-bell test specimen* — Shall be determined by one of the following methods.

6.5.2.1 *Method A — From the dimensional measurements* — The cross-sectional area of each of the dumb-bell test specimen shall be arrived at from the measurements of width and thickness at three points between the marker lines (that is gauge marks), on both surface of the test specimen taking the mean of the two values for the calculation of the cross-section. The smallest of the three cross-sections thus found shall be used for the calculation of the tensile strength. The measurements shall be made using a suitable mechanical/optical instrument to an accuracy of 0·01mm. If mechanical instrument is used care shall be taken to keep the contact pressure as small as possible.

6.5.2.2 *Method B — From the density, the mass and the length* — The mean cross-sectional area of the gauged portion (that is portion between the marker lines) of dumb-bell test specimen shall be determined after the tensile test. For this purpose, the specimen after test shall be cut accurately and squarely along the middle of each gauge mark and weighed to give the mass of the gauge length to an accuracy of 0·001 g. The mean cross-sectional area is then calculated from this mass, gauge length and density.

7. Conditioning — All the test specimens shall be kept at a temperature of 27 ± 2°C for a period of not less than 3 h prior to testing.

8. Procedure

8.1 The test shall be made within 5 min of removing the specimen from the conditioning cabinet and specimen shall receive minimum handling.

8.2 Immediately before the tensile test, the respective gauge length shall be marked by two lines centrally on each specimen. The gauge length shall be 20 mm for tubular specimen and in accordance with Fig. 1 in case of dumb-bell specimen. For the small dumb-bell specimen of Fig. 2, the gauge length shall be 10 mm.

8.3 The rate of separation of the jaws (grips) shall be 250 ± 50 mm/min in all cases. However, in case of doubt or dispute, the separation of the grips shall be such that the relative rate of elongation of the test specimen between the marker lines, that is, gauge length, is about 600 percent/min.

8.4 The tensile strength and elongation at break shall be determined simultaneously on the same test specimen. During the test the distance between the marker lines shall be closely followed and the elongation shall be determined by measuring the distance between the two marker lines at the instant of break, that is, the separation of the gauge marks at break. This distance is used to calculate the percentage elongation at break based on the original gauge length. The breaking load at which the test specimen breaks is also recorded for each test piece.

An unsatisfactory result due to any test specimen breaking due to damage in or at the grips shall be ignored and the test shall be made on a new test specimen. At least four valid results shall be obtained in order to calculate the tensile strength and elongation at break; otherwise the test shall be repeated.

8.5 The tensile strength shall be calculated on the original mean cross-sectional area and the percentage elongation shall be based on the original gauge length.

9. Tabulation of Observations

Description	*Symbol*	*Unit*	*Observed Values for Specimen*			
			1	2	3	4
Mean value of outer diameter of tubular test specimen	D	mm				
Mean value of width of dumb-bell test specimen within gauge length	W	mm				
Mean vaule of thickness of test specimen	t	mm				
Mass of relevant length of test specimen	m	g				
Relevant length of test specimen	l	mm				
Load at break	F	N				
Original gauge length	G_1	mm				
Separation of gauge marks at break	G_2	mm				

10. Calculation

10.1 *Calculation for Individual Specimen*

10.1.1 *Area*

a) For tubular test specimen:

$$A = \pi (D - t) t$$

OR

$$A = \frac{1\,000\, m}{s \times l}$$

b) For dumb-bell test specimen

$$A = W \times t$$

OR

$$A = \frac{1\,000\, m}{s \times l}$$

where

A is area of the specimen, mm^2; and

s is the density of material, g/cm^3.

10.1.2 Tensile strength, N/mm^2 $= \frac{F}{A}$.

10.1.3 Elongation at break, percent $= \frac{G_2 - G_1}{G_1} \times 100$.

10.2 The maximum and the minimum values of the tensile strength and elongation from the calculated values are discarded and the average of the remaining two is considered as the test result.

11. Report

11.1 *Test for Tensile Strength and Elongation at Break of Insulation/Sheath of Material*

Cable Type

Batch No./Lot No.

Cable No./Drum No.

11.2 *Results*

Reference Specification ______________________________

Property	*Observed Value*	*Specified Value*
Tensile strength at break, N/mm^2		
Elongation at break, percent		

11.3 *Conclusion* — Specimen meets/does not meet the requirements of the specification.