

BUREAU OF INDIAN STANDARDS
DRAFT FOR COMMENTS ONLY

(Not to be reproduced without the permission of BIS or used as a standard)

Draft Indian Standard

Aerial bunched cables for working Voltages up to and including 1 100 volts —Specification

(First Revision)

Power Cables Sectional
Committee, ETD 09

Last date for comments-04 08 2024

FOREWORD

(Formal Clause will be added)

This draft Indian Standard (First Revision) will be adopted by the Bureau of Indian Standards on the recommendation of the Power Cables Sectional Committee and approval of the Electrotechnical Division Council.

This standard was originally published in 1995 covering the requirement of Polyethylene/crosslinked polyethylene insulated cables with aluminium conductors twisted over a central bare/Insulated aluminium alloy messenger wire for use as overhead distribution feeders for rated voltages up to and including 1 100 V.

This Indian Standard is revised to meet the various constructions of Aerial Bunched Cables in demand.

The changes and additions made in this standard are -

- a) Cable sizes up to 185 sq. mm covered.
- b) Thickness of insulation for insulated Al alloy messenger is defined
- c) For weather resistance of insulation, carbon content is defined and test method as per IS: 10810 (Part 32) included.
- d) Sampling plan for acceptance test is revised.
- e) Revision of marking including printing/embossing etc. as per current practice.

The composition of the Committee, responsible for the formulation of this standard is given at Annex B.

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: 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Draft Indian Standard

**AERIAL BUNCHED CABLES FOR WORKING VOLTAGES UP TO AND INCLUDING
1 100 VOLTS — SPECIFICATION**
(First Revision)

SECTION 1 GENERAL

1 SCOPE

1.1 This standards Covers the requirements of polyethylene/ cross linked polyethylene insulated cables with Aluminum conductors twisted over a central bare / insulated aluminum alloy messenger wire for use as overhead distribution feeders.

1.2 The cables covered in this standard are suitable for use on single phase and three phase ac (earthed or unearthed) system for rated voltage up to and including 1 100 V of following types.

1. Single insulated phase conductor, one insulated neutral conductor (if required) and an insulated street light conductor (if required) twisted around bare or insulated aluminium alloy messenger conductor.
2. Three insulated phase conductors, one insulated neutral conductor (if required) and an insulated street light conductor (if required) twisted around bare or insulated aluminium alloy messenger conductor.

NOTE — The cable conforming to this standard may be operating continuously at a power frequency voltage 10 percent higher than the rated voltage.

1.3 The cables covered in this standard are suitable for use where the combination of ambient temperature and temperature rise due to load, including temperature on exposure to direct sun light results in conductor temperature not exceeding the following;

Type of Insulation	Normal Continuous Operation	Short Circuit Operation
Polyethylene	70 °C	160 °C
Cross linked polyethylene	90 °C	250 °C

2. REFERENCES

2.1 The following Indian Standards (with latest amendments) are necessary adjuncts to this standard:

<i>IS NO.</i>	<i>Title</i>
IS 398 (Part 4): 1994	Aluminium Conductors for overhead transmission purposes : Part 4 Aluminium alloy stranded conductors (Aluminium-Magnesium- Silicon type) (Second Revision)
IS 1885 (Part 32) : 2019	Electrochemical vocabulary: Part 32 Electric Cables (First Revision)
IS 8130: 2013	Conductors for insulated electric cables and flexible cords (first Revision)
IS 10810 (series)	Methods of test for cables. (The relevant part numbers are given in Column 4 of 10.1
IS 4905 : 2015	Random sampling and randomization procedures (First Revision)

3 TERMINOLOGY

For the purpose of this standard the following definition, in addition to those given in IS 1885 (Part 32) shall apply.

3.1 Routine Test:

Test made by the manufactures on all finished cable lengths to demonstrate the integrity of the cables.

3.2 Type Test:

Test required to be made before supply on a general commercial basis on a type of cable in order to demonstrate satisfactory performance characteristics to the intended application.

NOTE — These tests are of such a nature that after they have made, they need not be repeated unless changes are made in the cable material or design which might change the performances characteristics.

3.3 Acceptance Test:

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

3.4 Optional Test:

Special test to be carried out, when required by agreement between the purchaser and supplier

3.5 Earthed System:

An electric system which fulfills any of the following conditions:

- a) The neutral point or midpoint connection is earthed in such a manner that even under fault condition, The maximum voltage that can occur between any conductor and earth does not exceed 80 percent of the nominal system voltage:
- b) The neutral point or midpoint connection is not earthed but a protective device is installed which automatically cut out any part of the system which accidentally becomes earthed;
OR
- c) In case of ac system only, the neutral point is earthed through an arc suppression coil with arrangement for isolation within 1 hour of occurrences of the fault provided that total of such periods in a year does not exceed 125 hour

3.6 Un Earthed System:

An electric system which does not fulfill the requirements of earthed system (*see 3.5*)

SECTION 2 MATERIALS

4. CONDUCTOR

4.1 Phase/Street Lighting Conductor

The conductor shall be of H2 or H4 grade aluminium complying with the requirement of IS 8130.

4.2 Messenger (Neutral conductor or otherwise)

The conductor shall be of heat treated aluminium – magnesium – silicon alloy having a composition appropriate to the mechanical and electrical properties specified in Table 3.

5 INSULATION

5.1 The insulation shall be either of cross-linked polyethylene compound or of polyethylene compound, confirming to requirement given in Table 1 and 2 respectively.

Table 1
Properties of XLPE Insulation
(*Clause 5.1*)

Sl. No.	Test	Requirement
(1)	(2)	(3)
1.	Tensile Strength	12.5 N/mm ² , Min
2.	Elongation at break	200% , Min

3.	Ageing in air oven		
	a) Treatment	Temperature	135 ± 3 °C
		Duration	7 days
	b) Tensile strength variation		± 25% , Max
c) Elongation variation		± 25% , Max	
4.	Hot set		
	a) Treatment	Temperature	200 ± 3 °C
		Time under load	15 min
		Mechanical stress	20 N/ cm ²
	b) Elongation under load		175 % max
c) Permanent elongation (set) after cooling		15 % max	
5.	Carbon Black Content		2.5 ± 0.5 %
6.	Shrinkage		
	a) Treatment	Temperature	130 ± 3 °C
		Duration	1 Hour
b) Shrinkage:		4% , max	
7.	Water Absorption (Gravimetric)		
	a) Treatment	Temperature	85 ± 2 °C
		Duration	14 days
b) Water Absorbed		1 mg/cm ² , Max	
8.	Volume Resistivity		
	a) at 27 °C		1 × 10 ¹³ Ω – cm, <i>Min</i>
	b) at 70 °C		1 × 10 ¹¹ Ω – cm, <i>Min</i>

Table 2
Properties of PE Insulation
(Clause 5.1)

SI No.	Property	Requirements
1.	Volume Resistivity	
	a) at 27 °C	1 × 10 ¹⁴ Ω – cm, <i>Min</i>

	b) at 70 °C	$1 \times 10^{12} \Omega - \text{cm}, \text{Min}$
2.	Tensile Strength	10 N/ mm ² , Min
3.	Elongation at break	300 % , Min
4.	Melt Flow index	3, Max
5.	Vicat Softening Point	85 ° C, Min
6.	Carbon Black Content	2.5 ± 0.5 %
7.	Environmental Stress Cracking	No Crack Shall be visible to naked eye

SECTION 3 CONSTRUCTIONS

6 CONDUCTOR

6.1 The Power/neutral/street lighting conductor shall conform to flexibility class 2 of IS 8130.

6.2 The Messenger (Neutral Conductor) or Otherwise shall be either stranded circular or compacted circular type and shall have minimum strands as per Table 3. The surface of conductors shall be smooth.

6.3 The size of messenger conductor for single phase and three phase cables, breaking load, number of minimum wires and max. d.c. resistance shall be as per Table 3.

6.4 There shall be no joints in any wire of the messenger conductor except those made in the base rod or wires before final drawing. The direction of outer layer of wire in messenger conductor shall be right hand.

6.5 The size of street lighting conductor shall be 16 mm².

6.6 A protective barrier may be applied between the conductor and insulation, if required. Such barrier, when used, shall be compatible with insulating materials and suitable for the operating temperature of the cable.

7 INSULATION

7.1 The conductor (with protective barrier, wherever applied) shall be provided with cross linked polyethylene or polyethylene insulation applied by extrusion.

Table 3
Size and Requirements of Messenger Conductor
(Clauses 6.3)

SI No.	Nominal Cross Section Area of Phase Conductor	Messenger Conductor			
		Cross Section Area	Maximum DC Resistance at 20 °C	Minimum Breaking Load	Min. no of wires `
(1)	(2)	(3)	(4)	(5)	(6)
1	16	25	1.38	7.0	7
2	25	25	1.38	7.0	7
3	35	25	1.38	7.0	7
4	50	35	0.986	9.8	7
5	70	50	0.689	14.0	7
6	95	70	0.492	19.7	7
7	120	95	0.339	29.26	7
8	150	120	0.2735	36.64	19
9	185	150	0.2290	43.50	19

Note — Higher size of messenger conductor is permitted, as agreed between purchaser and supplier.

7.2 Thickness of insulation

The average thickness of insulation shall not be less than the nominal value (t_i) specified in Table 4.

Table 4
Thickness of insulation
(Clause 7.2)

Sl. No.	Nominal area of conductor	Nominal insulation thickness for Al Conductor (t_i)	Cross section area of messenger	Nominal insulation thickness for Al Alloy Messenger Conductor (t_i)
(1)	(2)	(3)	(4)	(5)
1.	16	1.2	25	1.2
2.	25	1.2	25	1.2
3.	35	1.2	25	1.2

4.	50	1.5	35	1.2
5.	70	1.5	50	1.5
6.	95	1.5	70	1.5
7.	120	1.8	95	1.5
8.	150	1.8	120	1.8
9.	185	2.0	150	1.8

7.3 Tolerance on thickness of insulation

The smallest of measured value of thickness of insulation shall not fall below the nominal value (t_i) specified in Table 4 by more than $0.1 \text{ mm} + 0.1(t_i)$.

7.4 Application of insulation

The insulation shall be so applied that it fits closely on the conductor (on barrier if any) and it shall be possible to remove without damage the conductor

7.5 The color of insulation shall be black.

8 CORE IDENTIFICATION

8.1 The phase conductor shall be provided with one, two and three ‘ridges’ and neutral insulated conductor, if provided, shall have four ‘ridges’ as shown in fig 1 for quick identification. The street light conductor & messenger conductor (if insulated) shall not have any identification mark.

The Single phase conductor shall be provided with one ridge and if neutral insulated conductor is provided shall have four ridges as shown in **figure 1** for quick identification. The street light conductor and messenger conductor (if insulated) shall not have any identification mark.

8.2 Identification by other mean as agreed between the supplier & purchaser is also permissible.

9 ASSEMBLY (LAYING UP)

9.1 Single insulated phase conductor or Three insulated phase conductor, one insulated neutral conductor (if required) and a street lighting conductor (if required) shall be laid up along with the bare (or insulated) messenger conductor without filler with a lay not exceed 35 times the diameter of the insulated phase conductor.

9.2 The direction of lay shall be right hand.

Insulated Phase Conductor



Insulated Neutral Conductor

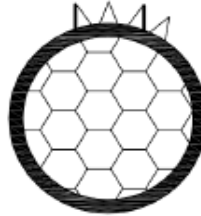


Fig. 1 Core Identification

SECTION 4 TESTS

10 CLASIFICATIONS OF TESTS

10.1 Type Tests

The following shall constitute type test:

SI No.	Test	Requirements	Test Method (Ref to part No. of IS 10810)
1.	Tests on phase / street light conductor		
	a) Tensile test	see IS 8130	2
	b) Wrapping test	do	3
	c) Resistance test	do	5
2.	Test on Messenger Conductor		
	a) Breaking Load	see Table 3	2

	b) Elongation test	<i>see</i> 11.3	11.3
	c) Resistance Test	<i>see</i> Table 3	5
3.	Physical test for XLPE insulation		
	a) Tensile strength and elongation at break	<i>see</i> Table 1	7
	b) Ageing in air oven	do	11
	c) Hot set test	do	30
	d) Shrinkage test	do	12
	e) Water absorption (Gravimetric)	do	33
	f) Carbon black content	do	32
4.	Physical test for PE insulation		
	a) Tensile strength and elongation at break	<i>see</i> Table 2	7
	b) Melt flow index	do	23
	c) Carbon black content	do	32
	d) Vicat softening Point	do	22
	e) Environmental Stress Cracking	do	29
5.	Test For Thickness Insulation	<i>see</i> Table 4	8
6.	Insulation resistance test (Volume Resistivity)Test	<i>see</i> Table 1 and 2	43
7.	High Voltage Test	<i>see</i> 11.2	45

10.2 Acceptance test

The following shall constitute acceptance test:

- a) Tensile test (for phase /street light conductor),
- b) Wrapping Test (for phase /street light conductor),
- c) Breaking load test for messenger conductor,
- d) Elongation test for messenger conductor,
- e) Conductor resistance test,
- f) Test for thickness of insulation,
- g) Tensile strength and elongation at break test of Insulation,
- h) Hot set test for XLPE,
- i) Carbon black content,
- j) Insulation resistance test, and
- k) High voltage test.

10.2.1 A recommended sampling plan for acceptance test is given in Annex A.

10.3 Routine Tests

The following shall constitute routine test:

- a) Conductor resistance test and
- b) High voltage test.

10.4 Optional Test

The following shall constitute Optional test:

- a) Bending Test

11 DETAIL OF TEST

11.1 General

Unless otherwise started in the standard the test shall be carried out in accordance with appropriate parts of IS 10810 taking into account additional information given in the standard.

11.2 High voltage test

High voltage test at room temperature (Type, Acceptance and Routine test):

The cable shall withstand a voltage of 3kV a.c (rms) at frequency of 40 to 60 Hz or dc voltage of 7.2 kv between conductors for 5 minutes.

11.3 Elongation Test on messenger Conductor

Test shall be carried out on wires before stranding. The specimen shall be straightened by hand and an original gauge length of 200 mm shall be marked on the wire. A tensile load shall be applied by means of suitable tensile testing machine. The load shall be applied gradually and the rate of separation of jaws of the testing machine shall be not less than 25 mm per minute and not greater than 100 mm per minute. The elongation shall be measured after the fracture ends have been fitted together. If the fracture occurs outside the gauge marks, or within 25 mm of either mark, or the required elongation is not obtained, the test shall be disregarded and another test shall be made.

The elongation of the specimen shall not be less than 4 percent on a gauge length of 200 mm.

11.4 Bending Test on the Complete Cable

The test shall be performed on a sample of complete cable. The sample shall be bent around a test mandrel at room temperature for at least one complete turn. It shall then be unwound and the process shall be repeated after turning the sample around its axis by 180 degrees.

The cycle of these operations shall then be repeated twice. The diameter of the mandrel shall be:

$$10 (D + d)$$

Where

D = actual diameter of the cable, for example,
Minimum circumscribing diameter, mm; and
d = actual diameter of the phase conductor, mm
Requirement: No cracks visible to the naked eye are allowed

SECTION 5 IDENTIFICATION, PACKING AND MARKING

12 IDENTIFICATION

12.1 Manufacturer's Identification

The manufacturer shall be identified throughout the length of the cable by means of printed tape or printing on the insulation or Indenting or Embossing on insulation bearing the manufacturers name or trade-mark and year of manufacture. In case the above method cannot be employed, or if the purchaser so desires, colour identification threads in accordance with a scheme to be approved by Bureau Of Indian Standards (BIS) shall be employed.

12.2 Cable Identification

Cables with cross-linked polyethylene insulation shall be identified throughout the length of the cable by the legend 'XLPE 90', year of manufacture and cable description i.e. number of phases and size, size of neutral (if provided), size of street light (if provided), size of messenger conductor and any other additional information as agreed between supplier and purchaser by a printed tape or printing on the insulation or indenting or embossing on insulation. No identification is required for polyethylene insulation

The recommended sequence for conductor sizes as Phase conductor + Neutral conductor (If applicable) + Messenger Conductor + Street Light conductor as applicable e.g. $3C \times 95 + 95 + 80 + 16$ Sq. mm.

NOTES

1 Single tape bearing manufacturer's name or trademark and the cable identification, that is, XLPE 90, if provided, shall be acceptable against the requirement of **12.1** and **12.2**.

2 Identification required in 12.1 and 12.2 may be given on any one of the insulated conductor of cables.

13 PACKING AND MARKING

13.1 The cable shall be wound on Wooden or Steel drums of suitable size and packed. The ends of the cable (phase conductors, neutral conductor, street light conductor and insulated messenger) shall be sealed individually by non – hygroscopic material to prevent ingress of moisture / water and tied suitably.

13.2 The cable shall carry the following information. Either stenciled on the drum or contained in a label attached to it:

- a) Reference to this Indian standard , for example, Ref IS 14255;
- b) Manufacture's name or trade-mark;
- c) Type of cable and voltage grade ;
- d) Nominal cross-sectional area of Phase, Neutral, Street light & messenger conductor ;
- e) Length of cable on the drum;
- f) Number of lengths on the drum (if more than one);
- g) Direction of rotation of drum (by mean of an arrow);
- h) Gross mass ;
- i) Country of manufacture ; and
- j) Year of manufacture ;

13.2.1 The cable (drum or label) may also be marked with the Standard Mark

The use of Standard Mark is governed by the provision of *Bureau of Indian Standard Act , 2016* and the Rules and Regulations made there under .The details of conditions under which the license for the of Standard Mark may be granted to manufacturers or producer may be obtained from Bureau of Indian Standard .

ANNEX A
(Clause 10.2 .1)

A-1 LOT:

A-1.1 In any consignment the cables of the same size manufactured under essentially similar conditions of production shall be grouped together to constitute a lot.

A-2 SCALE OF SAMPLING

A-2.1 Samples shall be taken and tested from each lot for ascertaining the conformity of the lot to the requirements of the specification.

A-2.2 The number of drums (n) to be selected from the lot of drums (N) of consignment of cables shall be in accordance with col 2 and 1 of Table 5 respectively. These samples shall be taken at random.

A-2.2.1 In order to ensure the randomness of selection, random number tables shall be used (*see* IS 4905 Methods of random sampling).

A-3 NUMBER OF TESTS AND CRITERION FOR CONFORMITY

A-3.1 Suitable length of test sample shall be taken from each of the drums selected. These test samples shall be subjected to each of the acceptance tests (*see* 10.2). A test sample is called defective if it fails in any of the acceptance tests. If the number of defectives is less than or equal to the corresponding permissible number (a) given in col 3 of Table 5 the lot shall be declared as conforming to the requirements of acceptance test , otherwise not.

Table 5
Number of drum to be selected for sampling and permissible number of defectives
(Clause A.3.1)

Number of Drums in the Lot	Number of Drums to be Taken as sample	Permissible Number of Defectives
(1)	(2)	(3)
N	n	a
Up to 25	3	0
26 to 50	5	0
51 to 100	8	0
101 to 300	13	1
301 and above	20	1

ANNEX B

(Foreword)

COMMITTEE COMPOSITION

Power Cables Sectional Committee- ETD 09