POLYVINYL CHLORIDE INSULATED AND SHEATHED FLAT CABLES WITH FLEXIBLE CONDUCTOR FOR RATED VOLTAGES UP TO AND INCLUDING 450/750 V

(Draft Indian Standard for comments)

1 GENERAL

1.1 Scope

This standard covers general requirements of multicore flat cables with flexible annealed bare copper conductor, insulated and sheathed with polyvinyl chloride (PVC) for rated voltage 300/500 V, for use in passenger and goods lifts (elevators), and 450/750 V for general purposes and for special applications such as hoists and travelling cranes.

This standard also includes cables with improved fire performance category in FR (Flame retardant) and FR-LSH (Flame retardant low smoke and halogen) with conductor temperature not exceeding 70°C. These cables require to qualify and comply the testing as specified in the respective category.

Cables of composite construction (for instance, cables with cores of different sizes) are not specified, but conditions are given for the inclusion of telecommunication units into the cables.

Note: This standard covers the following categories of cables:

Category Code Environment Description

01 - Cables for indoor installation

FR - Cables for indoor installation with Flame retardant properties

FR-LSH - Cables for indoor installation with Flame retardant low smoke and halogen properties.

2 REFERENCES

The standards given below 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 standard indicated below:

IS No.	*Title*
1885 (Part 32) : 1993	Electrotechnical vocabulary
5831 : 1984	PVC insulation and sheath of electric cables
8130 : 2013	Conductors for insulated electric cables and flexible cords
10418 : 2024	Drums for electric cables
10810	Methods of test for cables:
(Part 0) : 1984	General
(Part 1) : 1984	Annealing test for wires used in conductors
(Part 2) : 1984	Tensile test for aluminium wires
(Part 3) : 1984	Wrapping test for aluminium wires
(Part 4) : 1984	Persulphate test of conductor
(Part 5) : 1984	Conductor resistance test
(Part 6) : 1984	Thickness of thermoplastic and elastomeric insulation and sheath
(Part 7) : 1984	Tensile strength and elongation at break of thermoplastic and elastomeric insulation and sheath
(Part 10) : 1984	Loss of mass test
(Part 11) : 1984	Thermal ageing in air
(Part 12) : 1984	Shrinkage test
(Part 14) : 1984	Heat shock test
(Part 15) : 1984	Hot deformation test
(Part 20) : 1984	Cold bend test
(Part 21) : 1984	Cold impact test
(Part 43) : 1984	Insulation resistance
(Part 44) : 1984	Spark test
(Part 45) : 1984	High voltage test
(Part 53) : 1984	Flammability test
(Part 58) : 1998	Oxygen index test
(Part 59) : 1988	Determination of the amount of halogen acid gas evolved during combustion of polymeric materials taken from cables
(Part 60) : 1988	Thermal stability of PVC insulation and sheath
(Part 64) : 2003	Measurement of temperature index
IS 13360 – part 6 sec 9	Determination of density of smoke from burning or decomposition of plastics

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 1885 (Part 32). IS 10810 (Part 0) and the following shall apply.

3.1 Polyvinyl Chloride Compound (PVC) — Combination of materials suitably selected, proportioned and treated, of which the characteristic constituent is the plastomer polyvinyl chloride or one of its copolymers. The same term also designates compounds containing both polyvinyl chloride and certain of its polymers.

3.2 Type of Compound — The category in which a compound is placed according to its properties, as determined by specific tests. The type of designation is not directly related to the composition of the compound.

3.3 Type Tests — Tests required to be made before supplying a type of cable covered by this standard ona general commercial basis in order to demonstrate satisfactory performance characteristics to meet the intended application. These tests are of such a nature that, after they have been made, they need not be repeated unless changes are made in the cable materialsor design or manufacturing process, which might change the performance characteristics.

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

3.4 Routine Tests — Tests conducted by manufactureron all finished lengths to demonstrate the integrity of the cable.

3.5 Rated Voltage — The rated voltage of a cable is the reference voltage for which the cable is designed, and which serves to define the electrical tests.

The rated voltage is expressed by the combination of two values U_o/U expressed in volts:

U_o being the rms value between any insulated conductor and the earth.

U being the rms value between any two-phase conductors of multicore cable or of a system of single-core cables.

In an alternating current system, the rated voltage of a cable shall be at least equal to the nominal voltage of the system for which it is intended.

This condition apply both to the value U_o and to the value U.

In direct current system the nominal voltage of the systems shall not be higher than 1.5 times the rated voltage of the cable.

3.6 Nominal value: The value by which a quantity is designated, and which is often used in tables. Usually,in this standard, nominal values give rise to average of values to be checked by measurements.

3.7 Nominal cross-sectional area of conductor: value that identifies a particular size of conductor but is not subject to direct measurement.

3.8 Freely suspended length: the unsupported allowed length of cable between two fixing points

3.9 Strain bearing member (sbm): metallic or non-metallic high tensile strand or bunch included in the cable construction in order to hold the cable weight.

NOTE: Each size of conductor in this standard is required to meet a maximum resistance value

4 CONDUCTOR

4.1 Material

The conductors shall consist of annealed, bare or tinned high conductivity class-5 flexible copper wires complying with IS 8130.

A separator tape made of suitable material may be applied over conductor at the discretion of the manufacturer.

4.2 Electrical Resistance

The resistance of each conductor at 20°C shall be in accordance with the requirements of IS 8130 for the given class of conductor.

Compliance shall be checked by the tests given in Table 1

In case of tinned copper conductor, the persulphatetest shall be conducted as per IS 8130 and IS 10810 (Part 4).

5 INSULATION

5.1 Material

The insulation shall be of polyvinyl chloride compound of Type D confirming to IS 5831 further to the requirement specified in this standard.

5.2 Application to the Conductor

The insulation shall be so applied that it fits closely on the conductor. It shall be possible to remove it without damage to the insulation itself, to the conductor or to the tin coating, if any.

5.3 Thickness

The mean value of the thickness of insulation shall be not less than the specified values for each type and size of cable as given in Table 3

The smallest of the measured values of thickness of insulation (t_i) shall not fall below the nominal value (t_i) specified in Table 3 by more than (0.1 mm+0.1 t_i).

6. SHEATH

6.1 Material

The sheath shall be of polyvinyl chloride compound of Type ST3 confirming to IS 5831.

For the cables with improved fire performance category FR and FR-LSH, sheathing compound shall satisfy the relevantspecial FR/FR-LSH properties.

6.2 Application

The sheath shall be extruded in a single layer on the assembly of cores.

The sheath shall not adhere to the cores.

In certain cases, the sheath may penetrate the spaces between the cores, thus forming a filling, without sticking to cores.

6.3 Thickness

The mean value of the thickness shall not be less than the specified value for each type and size of cable shownin Table 1. However, the thicknessof PVC sheath determined by taking average of numberof measurements, shall be not less than nominal value (t_s) specified in relevant tables and smallest of themeasured value shall not fall below the nominal value (t_s) specified by more than (0.2 mm + 0.2 t_s).

Compliance with **t**he dimensional requirements specified in Section 3 andas per test method given in IS 10810 (Part 6).

7 OVERALL DIMENSIONS

The mean overall dimensions of the cables shall be within the limits specified in the Table 3 & Table 6.

8 TESTS

The testing on the cables will be conducted as given in Table for each category of the cable listed under scope.

8.1 High Voltage Test (Water Immersion Test)

The core shall be carefully removed from a sample minimum 3 m long from the finished multi core cable. In case of single core cable, the cores should be selected from the coil. They shall be so immersed in a water bath, with water of less hardness (preferably potable water) at 60 ± 3°C that their ends protrude at least 200 mm above the water level. After 24 h, voltage of 3 kV (rms) shall be applied between conductors and water. This voltage shall be raised to 6 kV (rms) within10 s and held constant at this value for 5 min. If the sample fails in this test, one more sample shall be subjected to this test, which should pass.

The cores which have passed the preliminary test given in **10.1** shall be subsequently tested with a dc voltage of 1.2 kV in the same water-bath, with water of less hardness (preferably potable water) at the same temperature.

The conductor shall be connected to the negative pole and water to the positive pole of dc supply by meansof copper electrode. The core shall withstand this dc voltage test for total 240 h without breakdown.

8.2 High Voltage Test (at Room Temperature)

In case of multi core cables and cords, the same shall withstand without breakdown an ac voltage of 3 kV (r**m**s) or a d**c v**oltage of 7.2 kV applied for a period of5 min for **ea**ch test connection.
Single c**o**re cables shall be immersed in water at am**bi**en**t** temperature 1 h before the testing and the test **volta**ge shall be applied between conductor and water, (with less hardness - preferably potable water) for a period of 5 minutes

8.3 Spark Test

Spark test may be carried out as an alternate to high voltage as per IS 10810 (Part 44) on single core unsheathed cables. The voltage shall be as specified below:

Thickness of Insulation mm	*Test Voltage* kV (rms)
Up to and including 1.0	6
Above 1.0 and up to and including 1.5	10
Above 1.5 and up to and including 2.0	15
Above 2.0 and up to and including 2.5	20
Above 2.5	25

8.4 Flammability Test

The testing is conducted in accordance with IS 10810 (Part 53).

The period of burning after removal of flame shall not exceed 60 s and the unaffected portion from the lower edgeof the top clamp shall be at least 50 mm.

8.5 Oxygen Index Test

The test shall be conducted as per IS 10810 (Part 58) on samples at 27 ± 2°C. The oxygen index shall not beless than 29 percent.

8.6 Test for Halogen Acid Gas Evolution

The test shall be conducted as per IS 10810 (Part 59). The level of halogen acid gas evolved shall not exceed 20 percent by weight.

8.7 Test for Temperature Index

The test shall be conducted as per IS 10810 (Part 64). The minimum measured value of temperature index shall be 21 percent at a temperature of 250°C

8.8 Smoke Density Rating

The test shall be conducted as per IS 13360 (Part 6 / Section 9):2001 and Maximum Smoke density rating shall be 60 %.

8.9 Persulphate Test

This test is conducted for the tinned copper conductor as per method specified in IS 10810 (Part 4) and the requirements are as per **6.1.1** of IS 8130.

8.10 Flexing Test

The test shall be conducted as per Annex D

During the test with 30 000 cycles, i.e. 60 000 single movements, neither interruption of the current, short circuit between the conductors nor short circuit between the cables and pulleys (the flexing apparatus) shall occur.

After the required number of cycles the sheath of the cable shall be removed. The cores shall then withstand the high voltage test carried out in accordance with Cl. No. 8.2

In the case of a cable with strain bearing member (sbm), after completion of the test, there shall be no short circuit between the sbm and an adjacent core, and the

tensile strength of the sbm shall still be higher than 75 % of the initial value.

9. IDENTIFICATION

The manufacturer shall be identified throughout the length of the cable by the manufacturer's name or trademark being printed, indented or embossed on thecable. In case none of these methods can be employed,or if the purchaser so desires, color identification threads in accordance with the scheme to be approved by Bureau of Indian Standards shall be employed. The printing, indentation or embossing shall be done onthe insulation in case of unsheathed cables and on the sheath in case of sheathed cables. The distance betweenany two consecutive printing, indentation or embossingshall not be more than 1 m

9.1 Durability

In the case of printed marking, it should be durable and compliant with the requirements. The compliance with requirement shall be checked by trying to remove the marking of manufacturer's name or trademark andthe colours of cores or numerals by rubbing lightly ten times with a piece of cotton wool or cloth soaked in water.

9.2 Legibility

All markings shall be clear and legible. The colours of the identification threads shall be easy to recognize or easily made recognizable, if necessary, by cleaning **w**it**h** petrol or other suitable solvent.

9. CORE IDENTIFICATION

Each core shall be identified as follows:

a) One core Green/Yellow & all other cores black with numbering

b) One core Green/Yellow & all other cores white with numbering

c) As agreed between the manufacturer and the purchaser

The insulation of the cores shall be of the same colour and numbered sequentially, except for the core coloured green-yellow, if one is included. The numbering shall start by number 1 in the inner layer. The numbers shall be printed in Arabic numerals on the outer surfaces of the cores. All the numbers shall be of the same colour, which shall contrast with the colour of the insulation. The numerals shall be legible.

10.1 Preferred Arrangement of Marking

The numbers shall be repeated, at regular intervals along the core, consecutive numbers being inverted in relation to each other.

When the number is a single numeral, a dash shall be placed underneath it. If the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral. The spacingbetween consecutive numbers shall not exceed 50 mm

The arrangement of the marks is shown in Fig. 1.

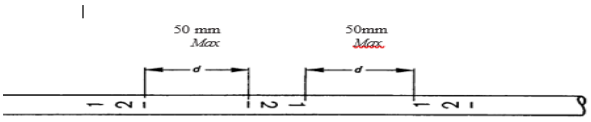


FIG. 1 PREFERRED ARRANGEMENT OF MARKING

Printed numerals shall be durable. Compliance with this requirement shall be checked by the test givenin **11.1**.

11 TELECOMMUNICATION UNITS

It shall be permitted to introduce telecommunication units into the cable construction.

1) units shall be chosen from copper pairs or copper coaxial or optical fibres;

NOTE Two pairs may alternatively be included as a quad.

2) units shall have a diameter equal or very close to the diameter of insulated cores;

3) preferably the number of telecommunication units in a cable shall not exceed three;

4) the position of units shall be central and symmetrical;

5) thickness of the cable sheath, where measured over telecommunication units, shall comply with the requirements for minimum thickness but shall not be taken into account when calculating the mean value;

6) the colour or identification of the outer sheath over units shall not conflict with that of the cores. However, no restriction shall be placed on colours used for insulations under an outer sheath.

12 CABLE CODE

The following code shall be used fo**r de**signatin**g** t**he** cable

Constituent	Code Letter
PVC Insulation	Y
PVC Sheath	Y
With SBM	S
PVC with FR properties	FR
PVC with FR-LSH properties	FR-LSH
PVc with RoHS properties	RoHS

NOTES

1 No code letter is required when the conductor material is copper.

2 The abbreviation FR or FR- LSH to be used after the cable code, that is for example YY (FR) or YY (FR-LSH)

13 SAMPLING OF CABLES

See Annex A.

14 PACKING AND MARKING

13.1 The cable shall be either wound on drums (*see* IS 10418) or reels or supplied in coils packed.

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

a) Reference to this Indian Standard

b) Manufacturer's name, brand name or trade-mark;

c) Type of cable and voltage grade;

d) In cases of flame retardant PVC the word 'FR'and in case of flame retardant low smoke and Halogen type the word 'FR-LSH' to be used;

e) Number of cores;

f) Nominal cross-sectional area of conductor;

g) In case of tinned copper conductor the word ATC' to be used;

h) Cable code;

i) Length of cable on the reel, drum or coil

j) Number of lengths on the reel, drum or coil if more than one

k) Direction of rotation of drums (by means of arrow) in case packed in drums

l) Approximate gross mass.

m) Country of manufacture.

n) Year of manufacture

Table 1 Tests

Sl No.	Test	Category	Requirements, Ref to IS No./ Clause of this Standard	Method of Test, Ref to Part of IS 10810
(1)	(2)	(3)	(4)	(5)
	i) *Routine tests*:			
a)	Conductor resistance test	01, FR and FR-LSH	IS 8130	5
b)	High voltage test or Spark test	01, FR and FR-LSH	8.2 or 8.3	45 or 44
	ii) *Acceptance tests*:			
a)	Annealing test (for copper)	01, FR and FR-LSH	IS 8130	1
b)	Tensile test (for aluminium)	01, FR and FR-LSH	IS 8130	2
c)	Wrapping test (for aluminium)	01, FR & FR-LSH	IS 8130	3
d)	Conductor resistance test	01, FR and FR-LSH	IS 8130	5
e)	Test for thickness of insulation & sheath	01, FR and FR-LSH	As per relevant tables-Tables 3 to 10	6
f)	Tensile strength and elongation at break of insulation and sheath	01, FR and FR-LSH	IS 5831	7
g)	Insulation resistance test	01, FR and FR-LSH	IS 5831	43
h)	High voltage test or spark test	01, FR and FR-LSH	8.2 or 8.3	45 or 44
J)	Flammability test	01, FR and FR-LSH	8.4	53
k)	Oxygen index test	FR and FR-LSH	8.5	58
m)	Test for temperature index	FR and FR-LSH	8.7	64
n)	Test for halogen acid gas evaluation	FR-LSH	8.6	59
p)	Test for smoke density rating	FR-LSH	8.8	-
q)	Persulphate test (for tinned copper conductor cable only)	01, FR and F**R**-LSH	8.11	4
	iii) *Type tests*:			
a)	Tests on conductor:			
	1) Annealing test (for copper)	01, **F**R **a**nd FR-LSH	IS 8130	1
	2) Tensile test (for aluminium)	01, **FR** and FR-L**SH**	IS 8130	2
	3) Wrapping test (for aluminium)	01, **F**R and F**R-LSH**	IS 8130	3
	4) Conductor resistance test	0**1**, FR and F**R-LS**H	IS 8130	5
	5) Persulphate test (for tinned copper conductor cable only)	**01**, FR and **FR**-LSH	8.11 and 6.1.1 of IS 8130	4
b)	Test for overall dimensions and thickness **o**f insulation /sheath		As per relevant tables—Tables 3 to 10	6
c)	Physical tests for insulation:			
	1) Tensile strength and elongation at break	01, FR and FR-LSH	IS 5831	7
	2) Loss of mass test	01, FR and FR-LSH	IS 5831	10
	3) Ageing in air oven	01, FR and FR-LSH	IS 5831	11
	4) Shrinkage test	01 , FR and FR-LSH	IS 5831	12
	5) Heat shock test	01, FR and FR-LSH	IS 5831	14
	6) Hot deformation	01, FR and FR-LSH	IS 5831	15
	7) Thermal stability	01, FR and FR-LSH	IS 5831	60
	8) Flammability test	01, FR and FR-LSH	8.4	53
	9) Oxygen index test	FR and FR-LSH	8.5	58
	10) Test for temperature index	FR and FR-LSH	8.7	64
	11) Test for halogen acid gas evaluation	FR-LSH	8.6	59
	12) Test for smoke density rating	FR-LSH	8.8	-
d)	Physical tests for sheath (removed from the finished cable):			
	1) Tensile strength and elongation at break	01, FR and FR-LSH	IS 5831	7
	2) Loss of mass test	01, FR and FR-LSH	IS 5831	10
	3) Ageing in air oven	01, FR and FR-LSH	IS 5831	11
	4) Shrinkage test	01, FR and FR-LSH	IS 5831	12
	5) Heat shock test	01, FR and FR-LSH	IS 5831	14
	6) Hot deformation	01, FR and FR-LSH	IS 5831	15
	7) Thermal stability	01, FR and FR-LSH	IS 5831	60
	8) Oxygen index test	FR and FR-LSH	8.5	58
	9) Test for temperature index	FR and FR-LSH	8.7	64
	10) Test for halogen acid gas evaluation	FR-LSH	8.6	59
	11) Test for smoke density rating	FR-LSH	8.8	IS 13360 (Part 6 / Section 9) : 2001

e) Test on Complete cable			
1) High Voltage test (water immersion)	01, FR, FR-LSH	8.1	45
2) Insulation Resistance test	01, FR, FR-LSH	IS 5831	43
3) High Voltage test	01, FR, FR-LSH	8.2	45
4) Flammability Test	01, FR, FR-LSH	8.4	53
5) Flexing Test	01, FR, FR-LSH	8.10	Annex D
6) Static flexibility test	01, FR, FR-LSH	Annex C	Annex C
7) Unrolling test	01, FR, FR-LSH	Annex B	Annex B
8) Adherence test between cores & sheath	01, FR, FR-LSH	Annex G	Annex G
f) Test on strength bearing member(s) (SBM)			
1) Tensile strength for cable with sbm	cables with sbm	Annex E	Annex E
2) Adherence test on sbm	cables with sbm	Annex F	Annex F
iv) Optional tests:			
1) Cold bend test	–	IS 5831	20
2) Cold impact test	--	IS 5831	21

NOTE — The properties/testing for FR /FR-LSH mentioned in table above is applicable only for the cables covered in this standard.

15. PVC insulated & sheathed Flat flexible cables for rated voltage 300/500 V

15.1 Code designation

Without strain bearing members: YY05-F
With strain bearing members: YY05S-F

15.2 Rated Voltage

300/500 V

15.3 Construction

15.3.1 Conductor

Material: copper or Tinned copper

Table 2 Combination of construction

Nominal cross-sectional area Sq.mm	Number of cores
0.50, 0.75, 1	3,4,5,6,9,12,16,18,20,24

The conductors shall be in accordance with the requirements of Class 5 given in IS 8130

15.3.2 Insulation

The insulation shall be PVC compound Type D as per IS 5831 applied around each conductor.

The mean value of the thickness of insulation shall be not less than the specified value for each type and size of cable as in below table 3

Table 3 Dimensions of PVC insulated & sheathed Flat flexible cables

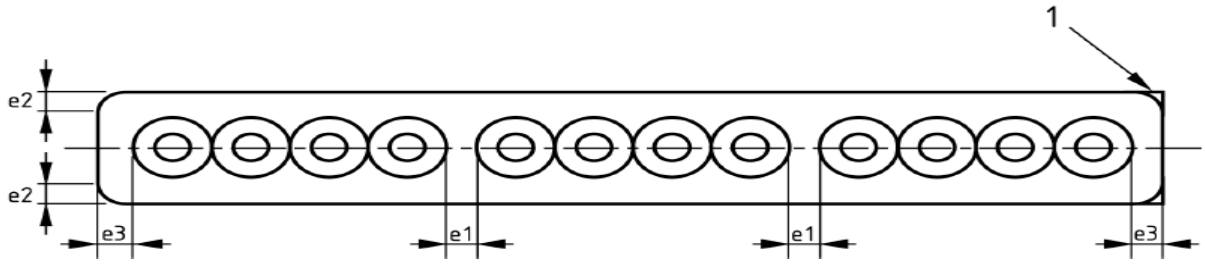
No of cores	Nominal size	Insulation thickness (Nominal)	Thickness of sheath and clearances		
Nos	Sq.mm	mm	e1 (Minimum)	e2 (Nominal)	e3 (Nominal)
3	0.5	0.6	0.5	0.8	1.2
4	0.5	0.6	0.5	0.8	1.2
5	0.5	0.6	0.5	0.8	1.2
6	0.5	0.6	0.5	0.8	1.2
12	0.5	0.6	0.5	0.8	1.2
16	0.5	0.6	0.5	0.8	1.2
18	0.5	0.6	0.5	0.8	1.2
20	0.5	0.6	0.5	0.8	1.2
24	0.5	0.6	0.5	0.8	1.2
3	0.75	0.6	0.5	0.8	1.2
4	0.75	0.6	0.5	0.8	1.2
5	0.75	0.6	0.5	0.8	1.2
6	0.75	0.6	0.5	0.8	1.2

12	0.75	0.6	0.5	0.8	1.2
16	0.75	0.6	0.5	0.8	1.2
18	0.75	0.6	0.5	0.8	1.2
20	0.75	0.6	0.5	0.8	1.2
24	0.75	0.6	0.5	0.8	1.2
3	1	0.6	0.5	0.8	1.2
4	1	0.6	0.5	0.8	1.2
5	1	0.6	0.5	0.8	1.2
6	1	0.6	0.5	0.8	1.2
12	1	0.6	0.5	0.8	1.2
16	1	0.6	0.5	0.8	1.2
18	1	0.6	0.5	0.8	1.2
20	1	0.6	0.5	0.8	1.2
24	1	0.6	0.5	0.8	1.2

Value for 9 cores ?

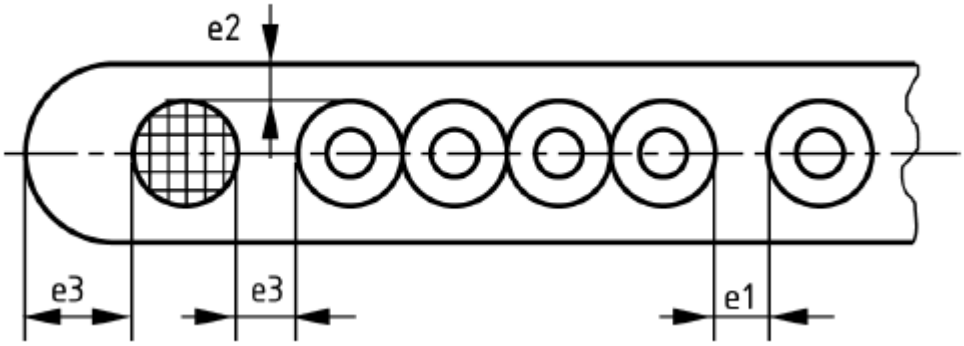
e1, e2 , e3 are as in figure 2

Figure 2 – Cable without strain bearing member.



1 Alternative edge shaping

Figure 3 – Cable with strain bearing member



15.3.3 Assembly of core

The cores shall be laid parallel and covered with the sheath.
The cores shall be grouped, lying closely side by side in groups of 2 to 5 cores.

For cables having the preferred number of cores, the grouping shall comply with Table 2 up to 5 cores, no grouping is recommended.

Table 4 – Grouping of cores

Number of cores	6	9	12	16	18	20	24
Number of groups x number of cores in group	2 x 3	3 x 3	3 x 4	4 x 4	2 x 4 + 2 x 5	5 x 4	6 x 4

A tearing thread (rip cord) may be added inside each core group. It shall be possible to separate the cores without damage to the insulation.
The green-and-yellow core, if any, shall be placed inside one of the inner core groups, and preferably next to either core number 7 or 8. For cables with fewer than 8 cores, the green-and-yellow core shall be placed as centrally as possible.
It shall be possible to separate the cores without damage to the insulation.

15.3.4 Strain bearing member (sbm)
A strain bearing member (or members) either of textile material or of metal may be included in the cable but shall be separated from the core groups.

NOTE It is permitted to apply a protective surface coating to the sbm

The sbm shall preferably be located on the edges of the cable in a symmetrical position and shall be easily separable from the cable, without damage to the cores, when separate terminations of the sbm are necessary.

15.3.5 Sheath

The sheath shall be PVC compound of type ST 3 to IS 5831 applied to substantially avoid the formation of cavities. The sheath shall not stick to the cores.

Thickness of web gap and sheath shall be as in Table 3
Measurements for e1, e2 and e3 shall be taken as follows (see Figures 2 and 3):

e1 the clearance separating groups of cores shall not at any place be less than the value specified in Table 3;

e2 the thickness on both flat sides shall be measured in each core group at the place where the sheath is thinnest ; the opposite thickness at the same core shall also be measured. The mean value of measurements above shall not be less than that specified in Table 3. The minimum value of e2 at any place shall not be less than the specified value by more than 0.2 mm + 0.2 ts of the specified value.

e3 the thickness at the edge and the separation between sbm, if any, and cores shall be measured at both edges of the cable, along the major axis of the cross section. The mean value of measurements above shall not be less than that specified in Table 3. The minimum value of e3 at any place shall not be less than the specified value by more than 0.2 mm + 0.2 ts of the specified value.

15.4 Tests

Compliance with the requirements of **15.3** shall bechecked by inspection and by the tests given in Table 1., whichever is applicable.

16. **PVC insulated & sheathed Flat flexible cables for rated voltage 450/750 V**

16.1 Code designation

Without strain bearing members: YY07-F
With strain bearing members: YY07S-F

16.2 Rated Voltage

450/750 V

16.3 Construction
16.3.1 Conductor
Material: copper or Tinned copper

Table 5 Combination of construction

Nominal cross-sectional area Sq.mm	Number of cores
1.5 & 2.5	3,4,5,6,9,12,16,18

4,6,10,16 & 25	4 & 5

The conductors shall be in accordance with the requirements of Class 5 given in IS 8130

16.3.2 Insulation

The insulation shall be PVC compound of Type D as IS 5831 applied around each conductor.
The mean value of the thickness of insulation shall be not less than the specified value for each type and size of cable shown in Table 6

Table 6 Dimensions of PVC insulated & sheathed Flat flexible cables for rated voltage 450/750 V

Nominal cross section area of conductor	**Thickness of insulation**	**Thickness of sheath and clearance**		
mm²	**mm**	**e1 (Minimum)**	**e2 (Nominal)**	**e3 (Nominal)**
		mm	**mm**	**mm**
1.5	0.7	1	1	1.4
2.5	0.8	1.2	1	1.6
4	0.8	1.5	1.2	1.8
6	0.8	1.5	1.2	1.8
10	1	1.5	1.4	1.8
16	1	1.5	1.5	2.0
25	1.2	--	1.6	2.0

e1, e2, e3 are as in figure 2 & 3

16.3.3 Assembly of cores
The cores shall be laid parallel and covered with the sheath
The cores shall be grouped, lying closely side by side in groups of 2 to 5 cores

For cables having the preferred number of cores, the grouping shall comply with Table 4 up to 5 cores no grouping is recommended.

Table 7 – Grouping of cores

Number of cores	6	9	12
Number of groups x number of cores in group	2 x 3	3 x 3	3 x 4

A tearing thread (rip cord) may be added inside each core group. It shall be possible to separate the cores without damage to the insulation.

The green-and-yellow core, if any, shall be placed inside one of the inner core groups, and preferably next to either core number 7 or 8. For cables with fewer than 8 cores, the green-and-yellow core shall be placed as centrally as possible.

It shall be possible to separate the cores without damage to the insulation.

16.3.4 Strain bearing member (sbm)
A strain bearing member (or members) either of textile material or of metal may be included in the cable, but shall be separated from the core groups.

NOTE It is permitted to apply a protective surface coating to the sbm

The sbm shall preferably be located on the edges of the cable in a symmetrical position and shall be easily separable from the cable, without damage to the cores, when separate terminations of the sbm are necessary.

16.3.5 Sheath

The sheath shall be PVC compound of type ST 3 as per IS 5831 applied to substantially avoid the formation of cavities. The sheath shall not stick to the cores.

Thickness of clearance and sheath shall be as in Table 6
Measurements for e1, e2 and e3 shall be taken as follows (see Figures 2 and 3):

e1 the clearance separating groups of cores shall not at any place be less than the value specified in Table 6;

e2 the thickness on both flat sides shall be measured in each core group at the place where the sheath is thinnest ; the opposite thickness at the same core shall also be measured. The mean value of measurements above shall not be less than that specified in Table 6. The minimum value of e2 at any place shall not be less than the specified value by more than 0.2 mm + 0.2 ts of the specified value.

e3 the thickness at the edge and the separation between sbm, if any, and cores shall be measured at both edges of the cable, along the major axis of the cross section. The mean value of measurements above shall not be less than that specified in Table 6. The minimum value of e3 at any place shall not be less than the specified value by more than 0.2 mm + 0.2 ts of the specified value.

16.4 Tests

Compliance with the requirements of **15.3** shall bechecked by inspection and by the tests given in Table 1., whichever is applicable.

ANNEX A
(*Clause* 13)

SAMPLING OF CABLES

A-1 LOT

In any consignment the cables of the same size and type 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 requirement of the specification.

A-2.2 The number of samples to be selected shall depend on col 1 and col 2 of table 11. These samples shall be taken at random.

A-2.2.1 In order to ensure the randomness of selection, procedure given in IS 4905 may be followed.

A-3 NUMBER OF TESTS AND CRITERION FOR CONFORMITY

From each of the drum/coils/reels selected according to col 1 and col 2 of Table 11, suitable lengths of test samples shall be taken. These test samples shall be subjected to each of the acceptance tests. A test sample is called defective, if it fails in any one of the acceptance tests. If the number of defectives is less than or equal to the corresponding permissible number given in col 3 of Table 11, the lot shall be declared as conforming to the requirements of the acceptance tests; otherwise not.

Table 8 Sampling of Cables
(*Clauses* A-2.2 *and* A-3)

Number of Drums/Coils/ Reels in the Lot	Number of Drums/Coils/Reels to be Taken as Sample	Permissible Number of Defectives
(*N*)	(*n*)	(*a*)
(1)	(2)	(3)
Up to 50	3	0
51-100	5	0
101-300	8	0
301 and above	13	1

ANNEX B
(Table 1)

Method for Unrolling test

A sample with a length of (2,00 ± 0,05) m shall be wound at room temperature, to form an annular coil with an inner diameter of 200 mm.
The coil of cable shall be tied and put into a cold room for at least six hours at the specified temperature of (20 ± 1) °C.
The coil shall be brought out of the cold room and within five seconds it shall be hung vertically by its outer end and untied to allow it to unroll freely under its own weight.
60 s after untying, the coil must have unrolled so that the inner end of the cable coil is clearly free from the remainder.

ANNEX C
(Table 1)

Method for Static flexibility test

This test shall be applied to all cables. The test method shall be as given in IS 10810 (Part-54) with the following requirements:
Before the test, the cable shall be conditioned at (20 ± 5) °C for 24 h in a vertical position.
The sample shall be mounted in the one clamp with the flat side towards the other clamp.
The mean of the two values of L., as measured between two plumb lines, shall not exceed 0,7 m.

NOTE If the results of the test are unfavourable, the sample shall be pre-conditioned by winding it twice on and off a reel with a diameter approximately 20 times the lower dimension of the cable with a flat side against the reel. In this case, the sample shall be turned each time through 180°. After this pre-conditioning, the sample shall be subjected to the test described above and shall meet the specified requirements.

ANNEX D
(Table 1)

Method for Flexing test

This test shall be carried out with the same procedure and apparatus as described in Is 10810 (Part-57), except for the following modifications:
1) pulleys with flat grooves and appropriate guides shall be used;
2) the weights shall be 10 times the weight of 1 m length of the flat cable;
3) diameter of pulleys shall be between 25 and 30 times the specified maximum overall thickness of the flat cable;
4) each conductor shall be loaded with a current of 0,1 A (a metallic sbm shall be considered as a conductor for this purpose);
5) an a.c. voltage of (400 ± 40) V rms shall be applied between all even conductors connected and all odd conductors connected. The green and yellow conductor, if any, is included in this count;
6) the number of flexing cycles is 30 000 (60 000 single strokes).
During the test with 30 000 cycles, i.e. 60 000 single movements, neither interruption of the current, short circuit between the conductors nor short circuit between the cables and pulleys (the flexing apparatus) shall occur.
After the required number of cycles the sheath of the cable, if any, shall be removed. The cores shall then withstand the high voltage test carried out in accordance with IS 10810 (Part-45)
In the case of a cable with strain bearing member (sbm), after completion of the test, there shall be no short circuit between the sbm and an adjacent core, and the tensile strength of the sbm shall still be higher than 75 % of the initial value specified in **ANNEX D** below.

ANNEX E
(Table 1)

Method for Tensile strength for cable with strain bearing member (sbm)

The tensile strength at break of each sbm shall be higher than the following specified value:
f = (*weight of freely suspended length/number of sbm) * 4*
The elongation under a load half the value of f above shall be less than 2 % (initial distance between mark: 1 000 mm).
The test shall be carried out with a tensile strength machine at an elongation speed of (50 ± 10) mm/min.

NOTE See definition of the freely suspended length in 3.4.

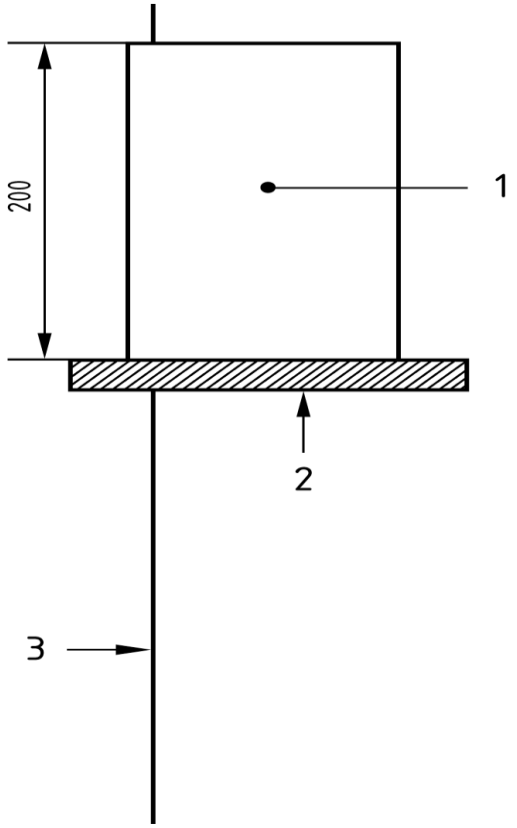
ANNEX F
(Table 1)

Method for Adherence test on sbm

Two testing methods can be applied according to the type of support. For both methods a tensile strength machine (dynamometer) capable of using a clamping device for flat cables shall be used.

Method 1 (for cable supported only by the sbm)
A sample of the complete cable 1 m long shall be weighed. Coverings and cores shall be removed to leave only 200 mm of cable and the sbm (Figure F.1).
The stripped part of the sbm shall be inserted through the hole of a steel device properly designed to be tightened in the clamp of a tensile strength machine (Figure F.1).
Then, a force shall be applied between the free end of the stripped sbm and the steel device until the sbm slides out of the cable, the cable being maintained in a vertical position.
The sliding force of each sbm must be higher than the weight of 1 m of complete cable.

Dimensions in millimetres

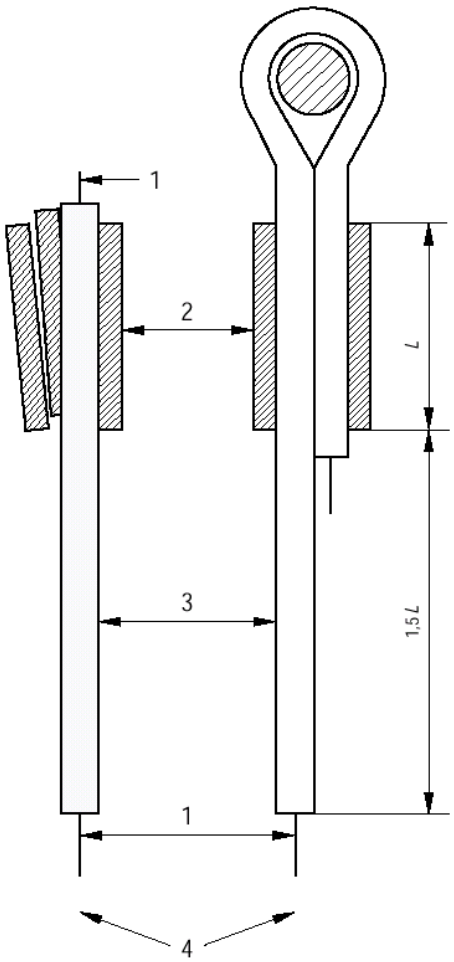


Key
1 Flat cable
2 Steel device (fixed support)
3 Stripped s.b.m.

Figure F.1 - Adherence test for strain bearing member (method 1)

Method 2 (when clamping is applied to the complete cable)
The test shall be carried out with the clamping device designed by the manufacturer, or with a similar device taking into consideration the same design parameters after agreement between customer and manufacturer. Examples are shown in Figure F.2.
All coverings and cores shall be removed beyond a distance from the clamping device which is 1,5 times the length of the clamping device.
The sliding force of the sbm inside the cable must be higher than the following specified value:

$f = (weight\ of\ freely\ suspended\ length/number\ of\ sbm) * 2$



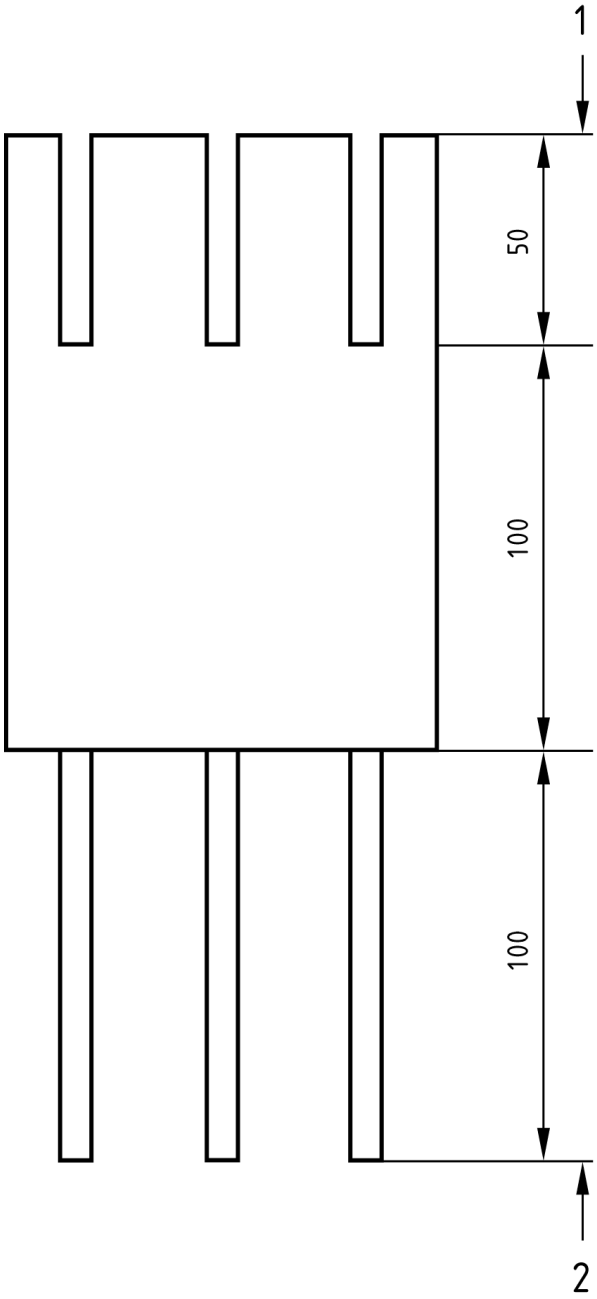
Key
1 Stripped s.b.m.
2 Clamping device (proprietary)
3 Flat cable
4 Load

Figure F.2 - Adherence test for strain bearing member (method 2, showing two examples of clamping device)

ANNEX G
(Table 1)

Method Adherence test between cores and sheath (for cables according to Clause 15)
The test shall be carried out on a cable sample of 250 mm.
The coverings and cores shall be removed over 100 mm to keep only one core in each core group (bottom of sample). At the opposite end of the sample the cores to be tested shall be carefully cut out over 50 mm (top of sample) (Figure G.1).
The top 50 mm shall be clamped in a tensile strength machine and a force shall be applied, in turn, to each of the cores to be tested until the core slides out of the cable.
The sliding force on each core shall be more than 3 N.

NOTE Higher values for the sliding force may be requested in connection with special mounting and/or operating conditions.



Dimensions in millimetres

Key

1 Top

2 Bottom

Figure G.1 - Adherence between cores and sheath