



वर्गीय आवश्यकताओं के लिए मानक(DRAFT)

सं: टीईसी ८५२४०:२०२३(DRAFT)

STANDARD FOR GENERIC REQUIREMENTS(DRAFT)

TEC 85241:2023(DRAFT)

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भूमिगत इस्तेमाल के लिए मेटल फ्री रिबन ऑप्टिकल फाइबर  
केबल डबल एचडीपीई शीथ के साथ(टाइप-I एवं टाइप-II)

Metal Free Ribbon Optical Fibre Cable with Double HDPE Sheath  
for underground duct application  
(Type-I & Type-II)



ISO 9001:2015

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दूरसंचार अभियांत्रिकी केंद्र

खुर्शीदलाल भवन, जनपथ, नई दिल्ली-110001, भारत

TELECOMMUNICATION ENGINEERING CENTRE

KHURSHIDLAL BHAWAN, JANPATH, NEW DELHI-110001, INDIA

[www.tec.gov.in](http://www.tec.gov.in)

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Release 1: \_\_\_\_\_, 2023

## FOREWORD

Telecommunication Engineering Centre (TEC) is the technical arm of Department of Telecommunications (DOT), Government of India. Its activities include:

- Framing of TEC Standards for Generic Requirements for a Product/Equipment, Standards for Interface Requirements for a Product/Equipment, Standards for Service Requirements & Standard document of TEC for Telecom Products and Services
- Formulation of Essential Requirements (ERs) under Mandatory Testing and Certification of Telecom Equipment (MTCTE)
- Field evaluation of Telecom Products and Systems
- Designation of Conformity Assessment Bodies (CABs)/Testing facilities
- Testing & Certification of Telecom products
- Adoption of Standards
- Support to DoT on technical/technology issues

For the purpose of testing, four Regional Telecom Engineering Centers (RTECs) have been established which are located at New Delhi, Bangalore, Mumbai, and Kolkata.

## ABSTRACT

This document pertains to Standard for Generic Requirements of Metal Free Ribbon Optical Fibre Cable with double HDPE sheath for underground installation in ducts. Type-I is Semi Dry Core Cable and Type-II is Dry-Dry Core Cable.

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## HISTORY SHEET

<i>S. No.</i>	<i>GR No.</i>	<i>Title</i>	<i>Remarks</i>
1.	Standard No. TEC 85241:2023	Metal Free Ribbon Optical Fibre Cable with Double HDPE Sheath for underground duct application (Type-I & Type-II)	Release 1

## REFERENCES

<i>S.N.</i>	<i>Document No.</i>	<i>Title/Document Name</i>
1.	TEC 89010:2021	Standard for Generic Requirements for Raw Material for manufacturing of Optical Fibre Cable.
2.	GR No. GR/OFT- 01/03. APR 2006	Generic Requirements for Tools For Installation & Operating the Optical Fibre Cable and for assembly of the Optical Fibre Splice Closures.
3.	TEC 69370:2004	Standard for Generic Requirements for Wooden Cable Drum for Telecom Cables
4.	GR No. TEC/GR/TX/OJC-002/03/APR-2010	Generic Requirements for Splice Closure for Optical Fibre Cables
5.	GR-20 Core Issue-4 July'13	Generic Requirements for Optical Fibre cable (Telcordia document)
6.	IEC 811-5-1, IEC 60794-1-21-E1 IEC 60794-1-21-E2, IEC 60794-1-21-E3, IEC 60794-1-21-E4, IEC 60794-1-21-E7, IEC 794-1-21-E10, IEC 60794-1-21-E11, IEC 794-1-22-F1, IEC 60794-1-22-F5, IEC 60794-1-219	Test Methods for Optical Fibres
7.	IEC 304(4) EIA 598-D	Colour Standard
8.	EIA 455-104, EIA/TIA-455-181,	Test Method for Optical Fibre

	EIA/TIA-455-73	
9.	ISO 9001:2015 or latest issue	International Quality Management System
10.	FOTP-89, FOTP-181	Test Methods
11.	ASTM D-566, ASTM D-790 ASTM-1248, ASTM D-4565	Test Methods

# CHAPTER-1

## 1.0 Introduction:

This document describes the Standard for generic requirements of Metal free Ribbon Optical fibre cable with Double HDPE Sheath for underground installation in ducts. A ribbon shall have six fibres. Type-I is Semi Dry Core Cable and Type-II is Dry-Dry Core Cable. The cable shall have double HDPE jacketing with glass yarn in between as reinforcement. The cable shall be Anti-Rodent and Anti-Termite. The raw material used in the cable shall meet the requirements of the GR for raw materials (Standard No. TEC 89010:2021(or latest release) and subsequent amendments, if any).

## 2.0 Functional Requirements:

- 2.1 The design and construction of Optical fibre cable shall be inherently robust and rigid under all conditions of installation, operation, adjustment, replacement, storage and transport.
- 2.2 The Optical fibre cable shall be able to work in a saline atmosphere in coastal areas and should be protected against corrosion.
- 2.3 Life of cable shall be at least 25 years. Necessary statistical calculations shall be submitted by the manufacturer, based upon life of the fibre and other component parts of the cable. The cable shall meet the cable aging test requirement.  
Note: Each Raw Material manufacturer shall define the life and lifetime calculation of the individual raw material.
- 2.4 It shall be possible to operate and handle the Optical fibre cable with tools as per GR No. GR/OFT- 01/03.APR 2006 (latest release) and subsequent amendments,

if any. If any special tool is required for operating and handling this optical fibre cable, the same shall be provided along with the cable.

- 2.5 The Optical fibre cable supplied shall be suitable and compatible to match with the dimensions, fixing, terminating & splicing arrangement of the Splice closure. The cable supplied shall also meet other requirement of splice closure as per GR No. TEC/GR/TX/OJC-002/03/APR-2010 (latest release) and subsequent amendments, if any.
- 2.6 The manufacturer shall submit an undertaking that the optical and mechanical fibre characteristics shall not change during the lifetime of the cable against the manufacturing defects.
- 2.7 It is mandatory that the Optical fibre cable supplied in a particular route is manufactured from a single source of optical fibres.
- 2.8 The Optical fibre cable shall be manufactured so as to protect the cable from rodent and termite.

### **3.0 Technical Requirements:**

Single Mode Optical Fibre used in manufacturing optical fibre cables shall be as per ITU-T Rec. G 652 D or G.657 A1 or G.657 A2. The specifications of optical fibre are mentioned below:

#### **3.1 Type of fibre(Wavelength band optimized nominal 1310 nm):**

Single mode as per Section-I of the Standard No. TEC 89010:2021(or latest release) and subsequent amendments, if any

#### **3.2 Geometrical Characteristics of fibre:**

As per Section-I of the Standard No. TEC 89010:2021(or latest release) and subsequent amendments, if any. All the parametric values shall be as per the

Standard for GR for raw materials (Standard No. TEC 89010:2021(or latest release) and subsequent amendments, if any)

**3.3 Transmission Characteristics of fibre:**

As per Section-I of the Standard No. TEC 89010:2021(or latest release) and subsequent amendments, if any. All the parametric values shall be as per the Standard for GR for raw materials (Standard No. TEC 89010:2021(or latest release) and subsequent amendments, if any)

**3.4 Mechanical Characteristics of fibre:**

As per Section-I of the Standard No. TEC 89010:2021(or latest release) and subsequent amendments, if any. All the parametric values shall be as per the Standard for GR for raw materials (Standard No. TEC 89010:2021(or latest release) and subsequent amendments, if any)

**3.5 Material Properties of fibre:**

As per Section-I of the Standard No. TEC 89010:2021(or latest release) and subsequent amendments, if any. All the parametric values shall be as per the Standard for GR for raw materials (Standard No. TEC 89010:2021(or latest release) and subsequent amendments, if any)

**3.6 Environmental Characteristics of Fibre:**

As per Section-I of the Standard No. TEC 89010:2021(or latest release) and subsequent amendments, if any. All the parametric values shall be as per the Standard for GR for raw materials (Standard No. TEC 89010:2021(or latest release) and subsequent amendments, if any)

**3.7 Colour Qualification and Primary coating Test:**

As per Section-I of the Standard No. TEC 89010:2021(or latest release) and subsequent amendments, if any. All the parametric values shall be as per the

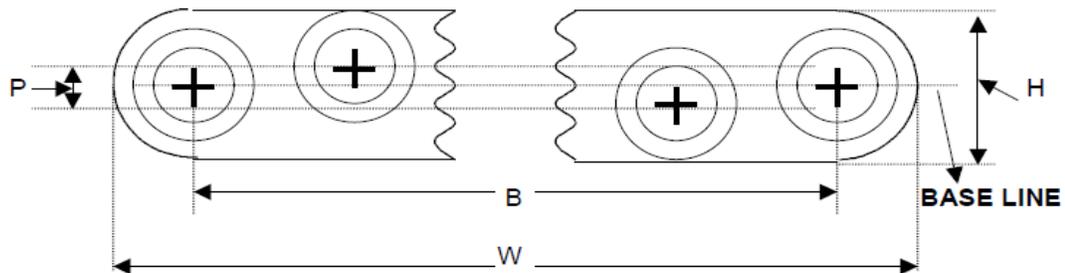
Standard for GR for raw materials (Standard No. TEC 89010:2021(or latest release) and subsequent amendments, if any)

### 3.8 Ribbon Structure:

3.8.1 Six primary coated fibres shall be arranged in ribbon structure. The fibres in the structure shall be parallel and shall not cross over each other along the entire length of the ribbon. The dimensions of 6 fibres ribbon shall be as per the sectional specification of IEC 60794-3 / Bell Core document no. GR-20-Core issue 4, 2013 (latest version) and as given below:

3.8.2 **Ribbon Dimensions:** The maximum dimensions of fibre ribbon shall be as follows and the cross section geometry of the fibre ribbon shall be as shown in the following figure:

Number of Fibres	Ribbon Width (W)	Ribbon Height (H)	Extreme Fibres (B)	Planarity (P)
6	1648 $\mu\text{m}$	360 $\mu\text{m}$	1310 $\mu\text{m}$	50 $\mu\text{m}$



Cross section of Fibre Ribbon

3.8.3 **Ribbon Material:** The ribbon shall be manufactured using single mode optical fibres coloured with UV cured resin and the ribbon shall be encapsulated with a

further layer of UV cured acrylate. The fibres and the ribbons shall confirm to the colour requirement as per clause no. 5.4 of this GR.

### **3.8.4 Ribbon Mechanical Properties:**

#### **3.8.4.1 Ribbon Macro-bend:**

Change in attenuation when wrapped on a 60 mm diameter mandrel for 100 turns at 1310 & 1550 nm. : < 0.05 dB

#### **3.8.4.2 Ribbon Compression Resistance:**

Change in attenuation when subjected to a compressive load of 500 N at 1310 nm & at 1550 nm : < 0.05 dB

#### **3.8.4.3 Ribbon Torsion Resistance**

Change in attenuation (At 1310 nm & 1550 nm) : < 0.05 dB

### **3.9 Ribbon Optical fibre Cable Construction Specifications for Semi Dry Core (Type - I):**

The cable shall be designed to the parameters mentioned in Annexure – I. The manufacturer shall submit designed calculation and the same shall be studied and checked.

### **TYPICAL STRUCTURAL DRAWING FOR 48 FIBRE OF SEMI DRY CORE CABLE**



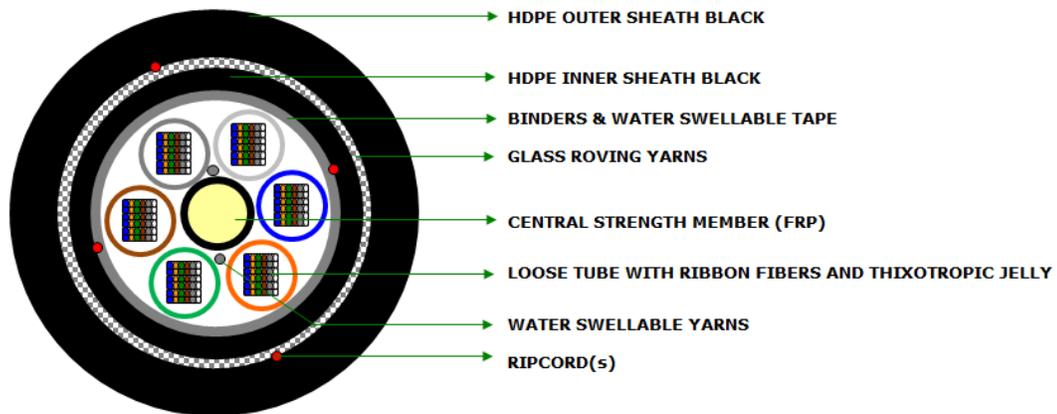
TYPICAL STRUCTURAL DRAWING FOR 96 FIBRE OF SEMI DRY CORE CABLE



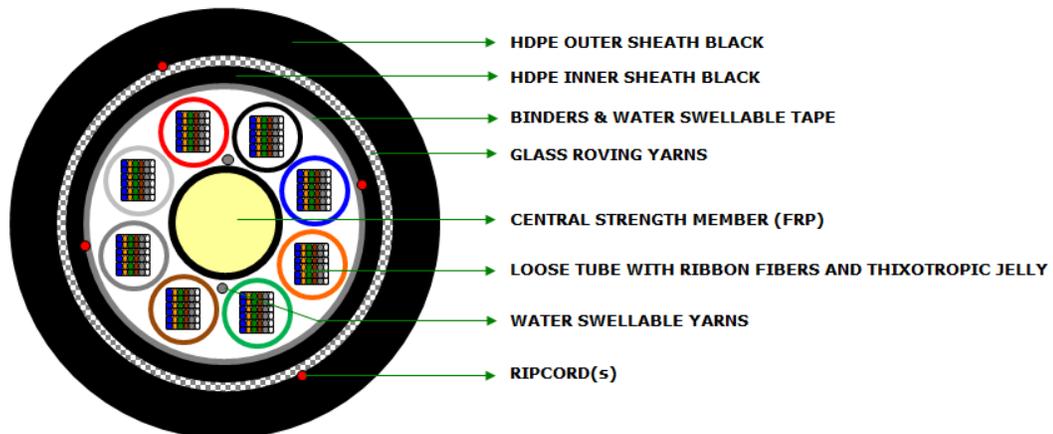
TYPICAL STRUCTURAL DRAWING FOR 144 FIBRE OF SEMI DRY CORE CABLE



## TYPICAL STRUCTURAL DRAWING FOR 216 FIBRE OF SEMI DRY CORE CABLE



## TYPICAL STRUCTURAL DRAWING FOR 288 FIBRE OF SEMI DRY CORE CABLE



**3.9.1 Secondary Protection:** The primary coated Ribbon fibres may be protected by loose packaging within tube, which shall be filled with thixotropic jelly. The dimensions of tube shall be as per Annexure – I.

**3.9.2 Number of fibres in cable:** 48, 96, 144, 216, 288

(Type Approval for a cable shall be issued depending upon the no. of fibres in the cable).

- a. Number of fibres per ribbon: Six (6) Fibres
- b. The number of ribbons per loose tube in ribbon optical fibre cable shall be as follows:

S. No	No. of Fibres	Ribbon Per Tube	Multi loose tube type
a.	48 fibres	2 ribbon per tube	4 tubes and 1 Filler
b.	96 fibres	4 ribbon per tube	4 tubes and 1 Filler
c.	144 fibres	6 ribbon per tube	4 tubes and 1 Filler
d.	216 fibres	6 ribbon per tube	6 tubes
e.	288 fibres	6 ribbon per tube	8 tubes

**3.9.3 Strength Member:** Solid FRP non - metallic strength member shall be used in the center of the cable core. The strength member in the cable shall be for strength and flexibility of the cable and shall have anti buckling properties. The FRP shall keep the fibre strain within permissible values. The size of FRP shall be as per Annexure – I.

**3.9.4 Cable Core Assembly:** Primary coated fibres in ribbon structure shall be protected inside loose tubes which are stranded together around a central strength member using helical or reverse lay techniques and form the cable core. The dimensions of FRP and stranding pitch shall be as per Annexure – I. The nylon/polyester binder thread shall be used to hold the cable core, if required.

**3.9.5 Core Wrapping:** The main cable core shall be wrapped by a layer/layers of water swellable tape. The water swellable(blocking) tape shall be as per Section-XIV of Standard No. TEC 89010:2021(or latest release) and the subsequent amendments, if any. The nylon/polyester binder thread shall be used to hold the tape, if required. The nylon/polyester binder thread shall be as per Section-IX of Standard No. TEC 89010:2021(or latest release) and the subsequent amendments, if any. The core wrapping shall not adhere to the secondary fibre coating and shall not leave any kink marks over the loose tube.

**3.9.6 Moisture barrier (protection):** The main cable core shall be protected by water swellable yarns over FRP (Central strength member). The specification of WS yarn shall be as per section XIX of Standard No. TEC 89010:2021(or latest release) and subsequent amendments issued, if any.

**3.9.7 Filling compound:** The filling compound used in the loose tube shall be compatible to fibre, secondary protection of fibre, core wrapping and other component part of the cable. The drip point shall not be lower than +70°C. The fibre movement shall not be constrained by stickiness and shall be easily removable for splicing. Reference test method to measure drop point shall be as per ASTM D 556. The thixotropic filling compound (jelly) shall be as per the Standard No. TEC 89010:2021(or latest release) and subsequent amendments issued, if any.

**3.9.8 Inner Sheath:** A non-metallic moisture barrier sheath may be applied over and above the cable core. The core shall be covered with tough weather resistant High Density Polyethylene (HDPE) sheath, black in colour (UV Stabilized). The thickness of the sheath shall be uniform and shall not be less than 0.9 mm. The sheath shall be circular, smooth, free from pin holes, joints, mended pieces and other defects. Reference test method to measure thickness shall be as per IEC 189 Para 2.2.1 and Para 2.2.2.

Note: HDPE material, black in colour, from the finished cable shall be subjected to following tests (on sample basis) and shall confirm to the requirement of the material as per Section III of Standard No. TEC 89010:2021(or latest release) and the subsequent amendments, if any:

- i) Density.
- ii) Melt Flow Index.
- iii) Oxidation Induction Time
- iv) Carbon Black Content.

- v) Carbon Black Dispersion.
- vi) ESCR.
- vii) Moisture Content
- viii) Tensile Strength and Elongation at break
- ix) Absorption Coefficient
- x) Brittleness Temperature
- xi) UV resistance

**3.9.9 Glass Reinforcement:** Impregnated Glass Fibre Reinforcement are used to achieve the required tensile strength of the optic fibre cables over the cable inner sheath to provide peripheral reinforcement along with Solid Rigid FRP Rod in the center at cable core. These flexible strength members shall be water/Non-water blocking type. The use of Solid Rigid FRP Rod(s) is mandatory in Optical Fibre cable design. Impregnated Glass Fibre Reinforcement used shall be equally distributed over the periphery of the cable inner sheath. It shall be applied helically and shall provide full coverage to inner sheath to provide rodent protection. The quantity of the Impregnated Glass fibre Reinforcement used per km length of the cable along with its dimensions shall be as per Annexure-I. The specification of the glass roving shall be as per Section XII of Standard No. TEC 89010:2021(or latest release) and subsequent amendments issued, if any and as per other details given in the Annexure-I. Rodent protection shall be provided with Glass roving yarns around the periphery of inner sheath and these yarns shall be spread uniformly around the periphery of inner sheath.

**3.9.10 Outer Sheath:** A non-metallic moisture barrier sheath (black in colour) shall be applied over the inner sheath, which shall consist of tough weather resistant made High Density Polyethylene compound (HDPE) which is Anti-termite. The outer sheath shall be UV stabilized. The thickness of the outer sheath shall not be less than 1.5 mm. The outer sheath shall be uniform, circular, smooth, free

from pin holes, joints mended pieces and other defects. The reference test method to measure thickness shall be as per IEC 811-5-1.

**Note1:** HDPE material from finished product shall be subjected to following tests (on sample basis) and shall confirm to the requirement of the material as per Section III of Standard No. TEC 89010:2021(or latest release) and the subsequent amendments, if any:

- i) Density
- ii) Melt flow index
- iii) Oxidative Induction time
- iv) Carbon black content
- v) Carbon black dispersion
- vi) ESCR
- vii) Moisture content
- viii) Tensile strength and elongation at break
- ix) Absorption Coefficient
- x) Brittleness Temperature
- xi) UV resistance

**Note 2:** The outer jacket of HDPE shall be as to protect the sheath from attack by termites and rodents. Manufacturer shall ensure that doping material/additives used are non-toxic and non-hazardous. The surface of the sheath shall be smooth and free of defects such as cracks, blisters, etc.

**3.9.11 Cable diameter:** The finished cable diameter shall be as per Annexure-I.

**3.9.12 Cable Weight:** The nominal cable weight shall be as per Annexure – I.

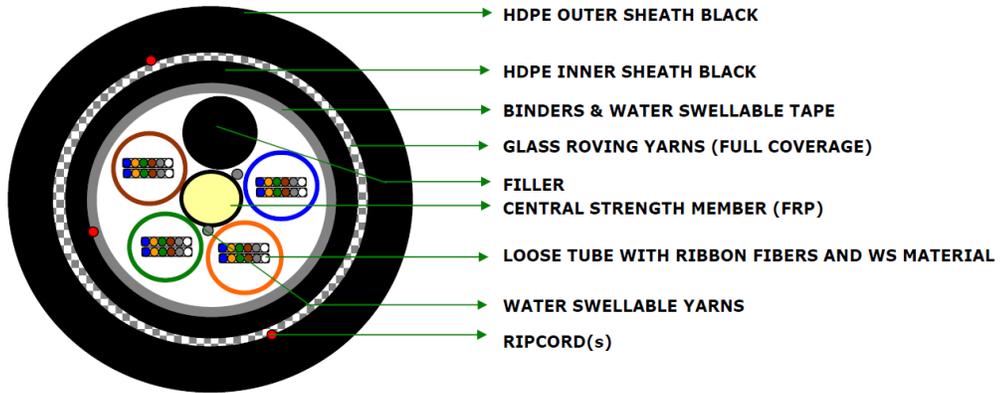
**3.9.13 RIP Cord:**

- a) Four suitable ripcords shall be provided in the cable which shall be used to open the HDPE sheath of the cable. Two rip cords shall be placed diametrically opposite to each other at below the outer Jacket and two ripcords shall be placed at below inner sheath. It shall be capable of consistently slitting the sheath without breaking for a length of 1 meter at the installation temperature. The ripcords (3ply & twisted for outer sheath and suitable ripcord for inner sheath) shall be properly waxed to avoid wicking action and shall not work as a water carrier.
  
- b) The ripcords used in the cable shall be readily distinguishable from any other components utilized in the cable construction. The rip cord shall be as per Section XVIII of Standard No. TEC 89010:2021(or latest release) and the subsequent amendments, if any

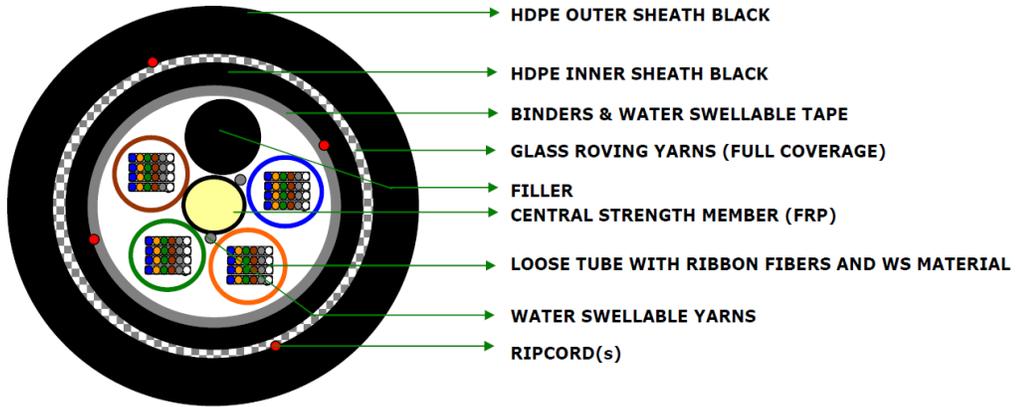
**3.10 Ribbon Optical Fibre Cable Construction Specifications for Dry-Dry core (Type – II):**

The cable shall be designed to the parameters mentioned in Annexure-II. The manufacturer shall submit designed calculations and the same shall be studied and checked.

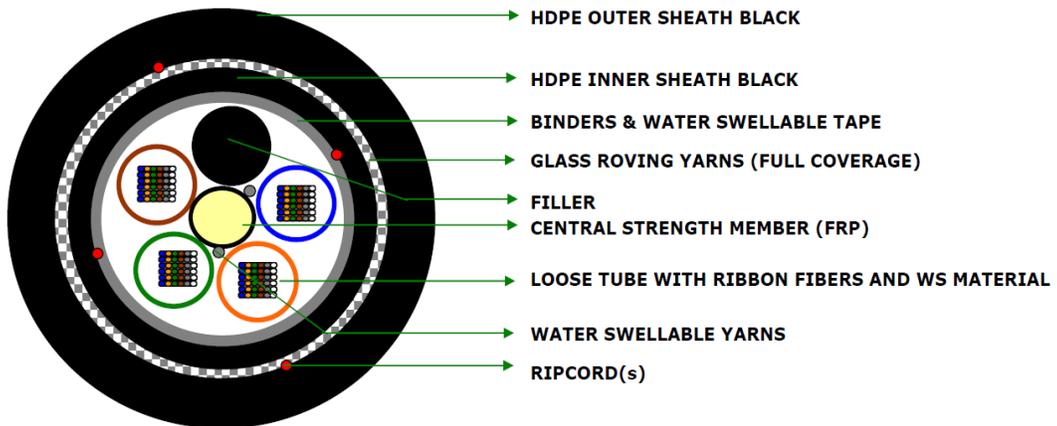
**TYPICAL STRUCTURAL DRAWING FOR 48 FIBRE OF DRY-DRY CORE  
CABLE**



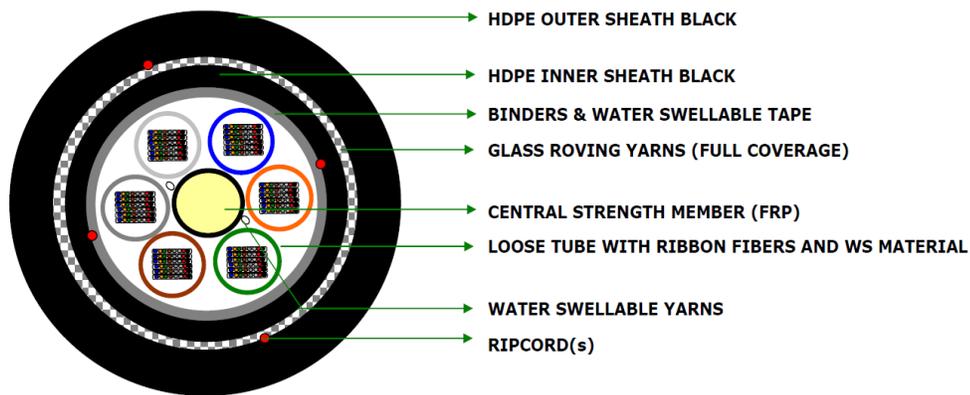
TYPICAL STRUCTURAL DRAWING FOR 96 FIBRE OF DRY-DRY CORE CABLE



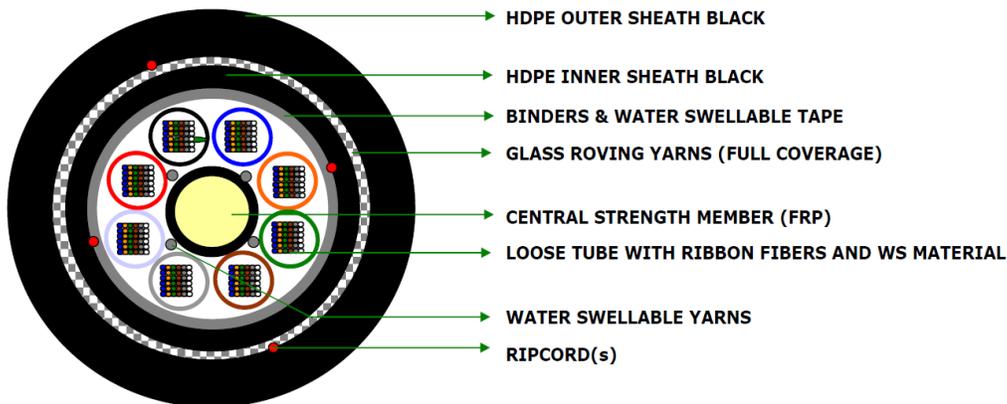
TYPICAL STRUCTURAL DRAWING FOR 144 FIBRE OF DRY-DRY CORE CABLE



TYPICAL STRUCTURAL DRAWING FOR 216 FIBRE OF DRY-DRY CORE CABLE



TYPICAL STRUCTURAL DRAWING FOR 288 FIBRE OF DRY-DRY CORE CABLE



**3.10.1 Secondary Protection:** The primary coated Ribbon fibres may be protected by loose packaging within tube which shall contain water swellable tape or water swellable yarn to prevent water ingress in loose tube. The dimensions of tube shall be as per Annexure – II.

**3.10.2 Number of fibres in cable:** 48, 96, 144, 216, 288

(Type Approval for a cable shall be issued depending upon the no. of fibres in the cable).

- a. Number of fibres per ribbon: Six (6) Fibres.
- b. The number of ribbons per loose tube in ribbon optical fibre cable shall be as follows:

S. No	No. of Fibres	Ribbon Per Tube	Multi loose tube type
a.	48 fibres	2 ribbon per tube	4 tubes and 1 Filler
b.	96 fibres	4 ribbon per tube	4 tubes and 1 Filler
c.	144 fibres	6 ribbon per tube	4 tubes and 1 Filler
d.	216 fibres	6 ribbon per tube	6 tubes
e.	288 fibres	6 ribbon per tube	8 tubes

**3.10.3 Strength Member:** Solid FRP non-metallic strength member shall be used in the center of the cable core. The strength member in the cable shall be for strength and flexibility of the cable and shall have anti buckling properties. The FRP shall keep the fibre strain within permissible values. The size of FRP shall be as per Annexure - II.

**3.10.4 Cable Core Assembly:** Primary coated fibres in ribbon structure shall be protected inside loose tubes which are stranded together around a central strength member using helical or reverse lay techniques and form the cable core. The dimensions of FRP and stranding pitch shall be as per Annexure - II. The nylon/polyester binder thread shall be used to hold the cable core, if required.

**3.10.5 Core Wrapping:** The main cable core shall be wrapped by a layer/layers of water swellable tape. The water swellable(blocking) tape shall be as per Section-XIV of Standard No. TEC 89010:2021(or latest release) and the subsequent amendments, if any. The nylon/polyester binder thread shall be used to hold the tape, if required. The nylon/polyester binder thread shall be as per Section-IX of

Standard No. TEC 89010:2021(or latest release) and the subsequent amendments, if any. The core wrapping shall not adhere to the secondary fibre coating and shall not leave any kink marks over the loose tube.

**3.10.6 Moisture barrier (protection):** The main cable core shall be protected by water swellable yarns over FRP (Central strength member). The specification of WS yarn shall be as per section XIX of Standard No. TEC 89010:2021(or latest release) and subsequent amendments issued, if any.

**3.10.7 Inner Sheath:** A non-metallic moisture barrier sheath may be applied over and above the cable core. The core shall be covered with tough weather resistant High Density Polyethylene (HDPE) sheath, black in colour (UV Stabilized). Thickness of the sheath shall be uniform & shall not be less than 0.9 mm. The sheath shall be circular, smooth, free from pin holes, joints, mended pieces and other defects. Reference test method to measure thickness shall be as per IEC 189 para 2.2.1 and para 2.2.2.

**Note:** HDPE material, black in colour, from the finished cable shall be subjected to following tests (on sample basis) and shall confirm to the requirement of the material as per Section III of Standard No. TEC 89010:2021(or latest release) and the subsequent amendments, if any:

- i) Density
- ii) Melt flow index
- iii) Oxidative Induction time
- iv) Carbon black content
- v) Carbon black dispersion
- vi) ESCR
- vii) Moisture content
- viii) Tensile strength and elongation at break
- ix) Absorption Coefficient

- x) Brittleness Temperature
- xi) UV resistance

**3.9.8 Glass Reinforcement:** Impregnated Glass Fibre Reinforcement are used to achieve the required tensile strength of the optic fibre cables over the cable inner sheath to provide peripheral reinforcement along with Solid Rigid FRP Rod in the centre at cable core. These flexible strength members shall be water/Non-water blocking type. The use of Solid Rigid FRP Rod(s) is mandatory in Optical Fibre cable design. Impregnated Glass Fibre Reinforcement used shall be equally distributed over the periphery of the cable inner sheath. It shall be applied helically and shall provide full coverage to inner sheath to provide rodent protection. The quantity of the Impregnated Glass fibre Reinforcement used per km length of the cable along with its dimensions shall be as per Annexure-II. The specification of the glass roving shall be as per Section XII of Standard No. TEC 89010:2021(or latest release) and subsequent amendments issued, if any and as per other details given in the Annexure–II. Rodent protection shall be provided with Glass roving yarns around the periphery of inner sheath and these yarns shall be spread uniformly around the periphery of inner sheath.

**3.10.8 Outer Sheath:** A non-metallic moisture barrier sheath (black in colour) shall be applied over the inner sheath, which shall consist of tough weather resistant made High Density Polyethylene compound (HDPE) which is Anti-termite and Anti rodent. The outer sheath shall be UV stabilized. The thickness of the outer sheath shall not be less than 1.5 mm. The outer sheath shall be uniform, circular, smooth, free from pin holes, joints mended pieces and other defects. The reference test method to measure thickness shall be as per IEC 811-5-1.

**Note 1:** HDPE material from finished product shall be subjected to following tests (on sample basis) and shall confirm to the requirement of the material as per

Section III of Standard No. TEC 89010:2021(or latest release) and the subsequent amendments, if any:

- i) Density
- ii) Melt flow index
- iii) Oxidative Induction time
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- v) Carbon black dispersion
- vi) ESCR
- vii) Moisture content
- viii) Tensile strength and elongation at break
- ix) Absorption Coefficient
- x) Brittleness Temperature
- xi) UV resistance

**Note2:** The outer jacket of HDPE shall be as to protect the sheath from attack by termites and rodents. Manufacturer shall ensure that doping material/additives used are non-toxic and non-hazardous. The surface of the sheath shall be smooth and free of defects such as cracks, blisters, etc.

**3.10.9 Cable diameter:** The finished cable diameter shall be as per Annexure – II.

**3.10.10 Cable Weight:** The nominal cable weight shall be as per Annexure – II.

**3.10.11 RIP Cord:**

- a) Four suitable rip cords shall be provided in the cable which shall be used to open the HDPE sheath of the cable. Two rip cords shall be placed diametrically opposite to each other at below the outer Jacket & two ripcords shall be placed at below inner sheath. It shall be capable of consistently slitting the sheath without breaking for a length of 1 meter at the installation temperature. The rip

cords (3ply & twisted for outer sheath and suitable ripcord for inner sheath) shall be properly waxed to avoid wicking action and shall not work as a water carrier.

- b) The ripcords used in the cable shall be readily distinguishable from any other components utilized in the cable construction. The rip cord shall be as per Section XVIII of Standard No. TEC 89010:2021(or latest release) and the subsequent amendments, if any.

#### 4.0 Mechanical Characteristics and Tests on Optical Fibre Cable:

(Note: All observations are to be taken at 1310nm and 1550nm wavelengths)

##### 4.1 Tensile strength Test:

**Objective:** This measuring method applies to optical fibre cables which are tested at a particular tensile strength in order to examine the behaviour of the attenuation as a function of the load on a cable which may occur during installation.

**Method:** IEC 60794-1-21-E1.

**Test Specs.:** The cable shall have sufficient strength to withstand a load of value  $T(N) = 9.81 \times 2.5 W$  Newton or 2670 N whichever is higher (Where W-mass of 1 Km of cable in Kg). The load shall be sustained for 10 minutes and the strain of the fibre monitored.

**Requirement:** The load shall not produce a strain exceeding 0.25% in the fibre and shall not cause any permanent physical and optical damage to any component of the cable. The attenuation shall be noted before strain and after the release of strain. The change in attenuation of

each fibre after the test shall be  $\leq 0.05$  dB both for 1310 nm and 1550 nm wavelength.

#### 4.2 Abrasion Test:

**Objective:** To test the abrasion resistance of the sheath and the marking printed on the surface of the cable.

**Method:** IEC-60794-1-21-E2

**Test Specs.:** The cable surface shall be abraded with needle (wt. 150 gm) having diameter of 1 mm with 500 grams weight (Total weight more than equal 650 gms.)

No. of cycles : 100

Duration : One minute (Nominal)

**Requirement:** There shall be no perforation & loss of eligibility of the marking on the sheath.

#### 4.3 Crush Test (Compressive Test):

**Objective:** The purpose of this test is to determine the ability of an optical fibre cable to withstand crushing.

**Method:** IEC 60794-1-21-E3.

**Test Specs.:** The fibres and component parts of the cable shall not suffer permanent damage when subjected to a compressive load of 2000 Newton applied between the plates of dimension 100 x 100 mm. The load shall be applied for 60 Secs. The attenuation shall be

noted before and after the completion of the test.

**Requirement:** The change in attenuation of the fibre after the test shall be  $\leq 0.05$  dB both for 1310 nm and 1550 nm wavelength.

#### 4.4 Impact Test:

**Objective:** The purpose of this test is to determine the ability of an optical fibre cable to withstand impact.

**Method:** IEC 60794-1-21-E4.

**Test Specs:** The cable shall have sufficient strength to withstand an impact caused by a mass weight of 50 Newton, when falls freely from a height of 0.5 meters. The radius R of the surface causing impact shall be 300 mm. 10 such impacts shall be applied at the same place. The attenuation shall be noted before and after the completion of the test.

**Requirement:** The change in attenuation of the fibre after the test shall be  $\leq 0.05$ dB both for 1310 nm and 1550 nm wavelength.

#### 4.5 Repeated Bending Test:

**Objective:** The purpose of this test is to determine the ability of an optical fibre cable to withstand repeated bending.

**Method:** EIA-455-104.

**Test Specs.:** The cable sample shall be of sufficient length (5 m minimum) to

permit radiant power measurements as required by this test.  
Longer lengths may be used if required.

**Parameters:**

Length of Cable sample	:	5m (minimum)
Weight	:	5 Kg
Minimum distance from Pulley centre to holding device	:	216mm
Minimum distance from Wt. to Pulley centre	:	457mm
Pulley Diameter (D - cable diameter)	:	20 D
Angle of Turning	:	90°
No. of cycles	:	30
Time Required for 30 cycles	:	2 min

**Requirement:** During the test no fibre shall break and The attenuation shall be noted before and after the completion of the test. The change in attenuation of the fibre after the test shall be  $\leq 0.05$  dB both for 1310 nm and 1550 nm wavelength.

#### 4.6 Torsion Test:

**Objective:** The purpose of this test is to determine the ability of an optical fibre cable to withstand torsion.

**Method:** IEC 60794-1-21-E7.

**Test Specs.:** The length of the specimen under rest shall be 2 meters and the load shall be 100 N. The sample shall be mounted in the test

apparatus with cable clamped in the fixed clamp sufficiently tight to prevent the movement of cable sheath during the test. One end of the cable shall be fixed to the rotating clamp which shall be rotated in a clock wise direction for one turn. The sample shall then be returned to the starting position and then rotated in an anti-clock wise direction for one turn and returned to the starting position. This complete movement constitutes one cycle. The cable shall withstand 10 such complete cycles. The attenuation shall be noted before and after the completion of the test.

**Requirement:**The cable shall be examined physically for any cracks tearing on the outer sheath and for the damage to other component parts of the cable. The twist mark shall not be taken as damage. The change in attenuation of the fibre after the test shall be  $\leq 0.05$  dB both for 1310 nm and 1550 nm wavelength.

#### 4.7 Kink Test:

**Objective:**The purpose of this test is to verify whether kinking of an optical fibre cable results in breakage of any fibre, when a loop is formed of dimension small enough to induce a kink on the sheath.

**Method:** IEC 794-1-21-E10.

**Test Specs.:** The sample length shall be 10 times the minimum bending radius of the cable The sample is held in both hands, a loop is made of a bigger diameter and by stretching both the ends of the cable in opposite direction, the loop is made to the minimum bend radius so that no kink shall form. After the cable comes in normal condition, the attenuation reading is taken.

**Requirement:**The kink should disappear after the cable comes in normal condition. The change in attenuation of the fibre after test shall be  $\leq$  0.05 dB both for 1310 nm & 1550 nm wavelength.

#### 4.8 Cable Bend Test:

**Objective:** The purpose of this test is to determine the ability of an optical fibre cable to withstand repeated flexing. The procedure is designed to measure optical transmittance changes and requires an assessment of any damage occurring to other cable components.

**Method:** IEC 60794-1-21-E11 (Procedure-I).

**Test Specs.:** The fibre and the component parts of the cable shall not suffer permanent damage when the cable is repeatedly wrapped and unwrapped 4 complete turns of 10 complete cycles around a mandrel of 20 D, where D is the diameter of the cable. The attenuation shall be noted before and after the completion of the test.

**Requirement:** The change in attenuation of the fibre after the test shall be  $\leq$  0.05 dB both for 1310 nm and 1550 nm wavelength. Sheath shall not show any cracks visible to the naked eye when examined whilst still wrapped on the mandrel

#### 4.9 Test of Figure of 8 (Eight) on the cable (Type Test):

**Objective:** Check of easiness in formation of figure of 8 of the cable during installation in the field.

**Test Method:** 1000 meter (approximate) of the cable shall be uncoiled from the cable reel and shall be arranged in figure of 8 (eight). The diameter of each loop of the figure of 8 shall be maximum 2 meters.

**Requirement:** It shall be possible to make figure of 8 of minimum 1000-meter length of the cable uncoiled from the cable reel, without any difficulty. No visible damage shall occur.

#### 4.10 Temperature Cycling (Type Test):

**Objective:** To determine the stability behaviour of the attenuation of a cable subjected to temperature changes which may occur during storage, transportation and usage.

**Method:** IEC 794-1-22-F1 (To be tested on Standard cable length & drum i.e 2Km.  $\pm$  5%)

**Test Specs.:** The permissible temperature range for storage and operation will be from  $-20^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$ . The rate of change of temperature during the test shall be  $1^{\circ}\text{C}$  per minute approx. The cable shall be subjected to temperature cycling for 12 Hrs. at each temperature as given below:

TA2 temp.	:	$-20^{\circ}\text{C}$
TA1 temp.	:	$-10^{\circ}\text{C}$ .
TB1 temp.	:	$+60^{\circ}\text{C}$ .
TB2 temp.	:	$+70^{\circ}\text{C}$ .

The test shall be conducted for 2 cycles at the above temperatures.

**Requirement:**The change in attenuation of the fibre under test shall be  $\leq 0.05$  dB for 1310 nm and 1550 nm wave length respectively for the entire range of temperature.

#### 4.11 Cable aging Test (Type Test):

**Objective:** To check the cable material change dimensionally as the cable ages.

**Method:** At the completion of temperature cycle test, the test cable shall be exposed to  $85 \pm 2$  degree C for 168 hours. The attenuation measurement at 1310 & 1550 nm wave length to be made after stabilization of the test cable at ambient temperature for 24 hours.

**Requirement:**The increase in attenuation shall be  $\leq 0.05$  dB at 1310 and 1550 nm.

**Note:** The attenuation changes are to be calculated with respect to the base line attenuation values measured at room temperature before temperature cycling.

#### 4.12 Water Penetration Test (Type Test):

**Objective:** The aim of this test is to ensure that installed jelly filled Optical Fibre cable will not allow water passage along its length.

**Method:** IEC 60794-1-22-F5

**Test Specs.:**A circumferential portion of the cable end shall face the water head.

The water tight sleeve shall be applied over the cable. The cable shall be supported horizontally and two meter head of water, containing a sufficient quantity of water soluble fluorescent dye for the detection of seepage, shall be applied on the inner HDPE sheath of the cable for a period of 7 days at ambient temperature. No other coloured dye is permitted.

**Requirement:**No dye shall be detected when the end of the 3m length of the cable is examined with ultraviolet light detector. The cable sample under test shall be ripped open after the test and then it shall be examined for seepage of water into the cable and the distance to be noted. It shall not be more than 20 cm.For Semi Dry core cable it shall not be more than 1 meter.

#### 4.13 Flexural Rigidity Test on the optical fibre cable (Type Test):

**Objective:** To check the Flexural Rigidity of the metal free optical fibre cable.

**Method:** To be tested as per ASTM D –790

**Test Specs:** The fibre and the component parts of the cable shall not suffer permanent damage in the cable subjected to Flexural Rigidity Test as per the above method. The attenuation shall be noted after and before the completion of the test.

**Requirement:** The change in attenuation of the fibre after the test shall be < 0.05 dB at 1310, 1550 nm and 1625nm wavelengths. The sheath shall not show any cracks visible to the naked eye.

#### 4.14 Static Bend test (Type Test):

**Objective:** To check the cable under Static bend.

**Method:** As per the clause no 4.8 of the GR alternatively as per ASTM D790.

**Test Specs:** The cable shall be subjected to static bend test. The optical fibre cable shall be bend on a mandrel having a Diameter of 10 D (D is diameter of the cable).

**Requirement:** The change in attenuation of the fibre after the test shall be <0.05 dB for 1310, 1550 nm and 1625nm wavelengths. Sheath shall not show any cracks visible to the naked eye when examined whilst still wrapped on the mandrel.

#### 4.15 Cable Jacket Yield Strength And Ultimate Elongation:

**Objective:** To determine the yield strength and elongation of the polyethylene (HDPE) cable sheath (jacket).

**Test Method:**FOTP-89 or ASTM 1248 Type III class

**Test Condition:** 1. Sample shall be taken from a completed cable. The aged sample shall be conditioned at  $100 \pm 2^{\circ}\text{C}$  for 120 hours before testing. 2. The cross-head speed shall be 50 mm per minute.

**Requirement:**

Jacket Material	Minimum Yield Strength		Minimum Elongation (%)
	(MPa)	(psi)	
HDPE un-aged	16.5	2400	400

HDPE aged	12.4	1800	375

#### 4.16 Ribbon Dimension Measurements test: (Type Test)

**Objective:** To Check the fibres in ribbon structure, fibre cross over and fibre identity to ensure the transmission performance and the mechanical service life of the fibre in the ribbon structure.

**Test method:** FOTP-123 (Video Gray Scale Analysis (VGSA) or Microscopic method).

**Requirement:** It shall meet the dimensional requirements given in clause no. 3.8.2 of this GR. The fibres in the entire length of the ribbon shall not cross over at any point.

#### 4.17 Ribbon Resistance to Twist (Robustness) test: (Type Test)

**Objective:** To check the robustness of the fibre ribbons to withstand the twist in installed conditions and to check the structural integrity of the ribbon over the deployed length for mid-span entry, maintenance purposes, consideration in rearrangements and housekeeping.

**Test method:** FOTP-141.

**Requirement:** The un-aged and aged (at 85 + 2 degree C with uncontrolled humidity for a period of 30 days) completed ribbon shall not show any separation of individual fibres from the ribbon structure after

completion of the twist test when observed under 5X magnification.

#### 4.18 Ribbon Residual Twist (Flatness) Test: (Type Test)

**Objective:** To check the dimensional integrity of the ribbon without twisting to allow rearrangements and to limit the potential attenuation increases due to a macro-bending caused by twisting of the fibre ribbon.

**Test Method:** FOTP-131.

**Requirement:** The aged (at 85° + 2° C with uncontrolled humidity for a period of 30 days) ribbon residual twist (if any) shall have a pitch: > 400 mm.

#### 4.19 Ribbon Separation Test:

**Objective:** (a) To check the separation of individual fibres, separation of sub-unit of fibres and mid span separation from a fibre ribbon.

(b) To check the retention of sufficient colorant for identification for any 2.5 cm length of fibre after separation for individual and sub-unit of fibres.

**Test to be conducted for:**

- (a) Separation of any single fibre or a multi-fibre subgroup by a tool or by hand from a ribbon for a length of 1 meter. Mid span separation from a 2 meter sample, separated close to middle for at least 0.5 meter (both single fibre and the six fibre sub – units) for un-aged ribbon.

**Requirement:** The un-aged ribbon of minimum length of a 0.3 meter (1.0 foot) of an individual fibre and a sub group of six fibres shall be separated from the ribbon without breaking the fibres or damaging the fibre coating. The force required to perform separation shall not exceed 4.4 N. The area at the separation shall not show any damage to the fibre coating when examined under 5X magnification.

(b) **Retention of the Colour and Fibre Identification after separation.**

**Requirement:** Individual fibre colour identification shall be maintained after the separation test. It shall retain sufficient colorant that any 2.5 cm length is readily identifiable.

(c) **Removal of Ribbon matrix material to access individual fibres.**

**Requirement:** No damage shall occur either to fibre coating or the fibres. The coating shall not sustain any swelling self-stripping, cracking or splitting when examined under 5X magnification.

Note: The manufacturer shall recommend the procedure for the removal of ribbon matrix.

#### 4.20 Ribbon Stripability Test:

**Objective:** Check of removal of the matrix material and the fibres protective coating mechanically with commercial stripping tools from un-aged and aged ribbons.

**Test Method:** GR-20-CORE issue 4, 2013

**Pre Conditioning:**

- a. **Aged samples:** The humidity of aged ribbons shall be soaked at  $85 \pm 2$  degree C and a non-condensing humidity of  $85 \pm 5\%$  for a period of 30 days.
- b. **Water aged samples:** The water aged ribbons shall be soaked in de-ionized or distilled water at a temperature of  $23 \pm 5$  degree for a period of 14 days.

The fibre ribbon strip-ability testing shall be conducted at standard atmospheric conditions. The un-aged, humidity – aged, and water aged ribbons shall be tested within eight hours after aging.

**Requirement:** There shall be no fibre breakage, and any coating residue shall be removable with a single isopropyl alcohol wipe when at least 25 mm of the matrix material and the fibre Protective coating is mechanically removed with commercial stripping tools from un-aged and aged ribbons.

#### 4.21 Ribbon Macro-Bend Performance

**Objective:** To check the macro-bend performance of a ribbon.

**Method:** One hundred turns of ribbon are wound around a 60 mm diameter ribbon and the loss increase at 1310 nm & 1550 nm shall be measured.

**Requirement:** The change in attenuation of the fibre shall be  $< 0.05$  dB, for 1310 nm and 1550 nm wave lengths.

#### 4.22 Torsion Resistance of the ribbon (Type test):

**Objective:** To check the torsion resistance of the ribbon.

**Method:** One-meter length of ribbon is twisted to through five revolutions of 360° and measurement is taken.

**Requirement:** The change in attenuation of the fibre shall be  $< 0.05$  dB, for 1310 nm and 1550 nm wave lengths.

#### 4.23 Crush Resistance of Ribbon (Type Test):

**Objective:** To check the crush resistance of the ribbon.

**Method:** A 50 mm<sup>2</sup> sample is subjected to a load of 500 N and the attenuation measurement taken for both 1310 nm & 1550 nm wave lengths.

**Requirement:** The change in attenuation of the fibre shall be  $< 0.05$  dB, for 1310 nm and 1550 nm wave lengths.

#### 4.24 Check of the quality of the loose tube (containing optical fibre ribbon) (Type Test):

##### a. Embrittlement Test of Loose Tube

This test method is based on bending by compression and reflects embrittlement much better than the other tensile tests. This test is independent of wall thickness of the loose tube.

**Sample:** The minimum length of the test sample depends on the outside diameter of the loose tube and should be 85 mm for tubes up to 2.5 mm outside dia. The length of the bigger tubes should be calculated by using the following equation:

$$L_o > \frac{100 \times \sqrt{(D^2 + d^2)}}{4}, \text{ Where}$$

$L_o$  = Length of tube under test.

$D$  = Outside dia of loose tube.

$d$  = Inside dia of loose tube.

**Procedure:** Both the ends of a buffer tube test sample may be mounted in a tool, which is clamped in jaws of a tensile machine which exerts a constant rate of movement. The movable jaw may move at a rate of 50 mm per minute toward the fixed jaw. Under load, the tube will bend so that it is subjected to tensile and compressive stresses. The fixture for holding the tube should be designed in a manner that the tube might bend in all directions without further loading.

**Requirement:** The tube should not get embrittled. No kink should appear on the tube up to the safe bend diameter of tube (15 D), where D is the outside diameter of the loose tube. There should also not be any physical damage or mark on the tube surface.

#### b. Kink Resistance Test on the Loose Tube

**Objective:** To safeguard the delicate optical fibres, the quality of the loose tube material should be such that no kink or damage to the tube occur while it is being handled during installation and in splicing operations.

**Procedure:** To check the kink resistance of the loose tube, a longer length of the loose tube is taken (with fibre and gel), a loop is made and loop is reduced to the minimum bend radius of loose tube i.e. 15 D (where D is the outside diameter of the loose tube). This test is to be repeated 4 times on the same sample length of the loose tube.

**Requirement:** No damage or kink should appear on the surface of the tube.

#### 4.25 Drainage Test for Loose Tube and Drip test on the cable (Type Test):

##### a. Drainage Test for loose tube

**Sample Size:** 30 cm tube length.

**Test procedure:**

1. Cut the tube length to 40 cm.
2. Fill the tube with the tube filling gel ensuring that there are no air bubbles and the tube is completely full.
3. Place the filled tube in a horizontal position on a clean worktop and cut 5 cm from either end so that the finished length of the sample is 30 cm.

Leave the filled tube in a horizontal position at an ambient temperature for 24 hrs. (This is necessary because the gel has been sheared and the viscosity has been reduced during the filling process).

4. The sample tube is then suspended vertically in an environment heat oven over a weighed beaker. It is left in the oven at a temperature of 70° C for a period of 24 Hrs.
5. At the end of the 24 hrs period the beaker is checked and weighed to see if there is any gel in the beaker.

**Requirement:**

1. If there is no gel or oil in the beaker, then tube has PASSED the drainage test.
2. If there is gel or oil in the beaker, then tube has FAILED the drainage test.

**b. Drip test on the cable**

**Objective:** The purpose of this test is to determine the ability of jelly in the O.F. cable to withstand a temperature of 70-degree C.

**Method:** Take a sample of 30 cm. length of the cable with one end sealed by end cap. Remove outer black sheath, binder tapes for 5 cm from open end of the sample. Clean the jelly. Then the sample is kept vertically with open end downwards in the oven for 24 hours at 70° C with a paper under the sample.

**Test Specs:** Examine the paper placed below the cable inside the oven for dripping of the jelly after 24 hours. There should be no jelly drip or oily impression on the paper.

**4.26 Check of easy removal of sheath:**

**Objective:** Check of the easy removal of sheath of the optical fibre cable by using normal sheath removal tool.

**Procedure:** To check easy removal, the sheath shall be cut in circular way and the about 300 mm length of the sheath should be removed in one operation. It should be observed during sheath removal process that no undue extra force is applied and no component part of the cable is damaged. One should be able to remove the sheath easily.

**Note:** - Easy removal of both the outer jacket and the inner sheath shall be checked separately.

**4.27 Check of the effect of aggressive media on the cable (Acidic and Alkaline Behaviour) (Type Test):**

**Procedure:** To check the effect of aggressive media, solution of PH4 and PH10 shall be made. The two test samples of the finished cable, each of 600 mm in length, are taken and the ends of the samples are sealed. These test samples are put in the PH4 and PH10 solutions separately. After 30 days these samples are taken out from the solutions and examined for any corrosion etc on the sheath and other markings of the cables. (Test method no. ISO175).

**Requirement:** The sample should not show any effect of these solution on the sheath and other marking of the cable.

**4.28 UV Radiation Test(Type Test)**

**Objective:** To check the effect of UV radiation on the following:

- (i) On the Outer Sheath material(HDPE)
- (ii) On the meter and other legend markings.

**Test Method:** IEC 60068-2-1/ASTM G-154-12a ASTM G-53-96(ASTM G 154)

Type of Lamp: 40 Watt UV-B lamp with a peak emission at 313nm.

**Duration:** 2000 hours

**Test procedure:** Four test samples of the finished cable of the required length(as per the test chamber specifications) are to be prepared and 2 samples are to be kept inside. These test samples are to be compared after test with the other 2 samples kept outside.

**Requirement:** There should not be any fading or change in the colour of the markings and that of sheath.

#### **4.29 Termite & Rodent Test (Type Test):**

The uniformity of application of glass roving yarns around the periphery of inner sheath shall be checked. Termite & Rodent test shall be carried out at any recognized lab or institute on finished cable samples. The reports shall be submitted by the manufacturers. The manufacturer shall specify anti-termite and anti-rodent additives and submit the detail characteristics of the material and additives used to make it termite and rodent proof. The cable shall be tested for the presence of Anti-termite and Anti-rodent additives/dopants by recognized lab. The following minimum parametric tests on Anti-termite/Anti-rodent dopants shall be carried out at recognized lab or institute:

- (i) Non-toxicity
- (ii) Thermal Stability
- (iii) Long life span/half life
- (iv) Compatibility
- (v) Efficacy

#### **5.0 Engineering Requirements:**

##### **5.1 Cable Marking:**

5.1.1 A long lasting suitable marking shall be applied in order to identify this cable from other cables. The cable marking shall be imprinted (indented). The marking on the cable shall be indelible of durable quality and at regular intervals of one meter length. The accuracy of the sequential marking must be within -0.25% to +0.5%

of the actual measured length. The sequential length markings must not rub off during normal installation and in life time of optical fibre cable. The total length of the cable supplied shall not be in negative tolerance.

5.1.2 The marking shall be in contrast colour over the black HDPE Sheath (jacket) and shall be one by hot foil indentation method. The colour used must withstand the environmental influences experienced in the field. The marking on the cable shall be permanent, insoluble in water and shall be legible for duration of cable life.

5.1.3 The type of legend marking on O.F. cable shall be as follows:

- a) Company Legend
- b) Legend containing telephone mark & international acceptable Laser symbol
- c) Type of Fibre– G.652 D / G.657 A1/ G.657 A2
- d) Number of Fibres
- e) Type of cable
- f) Year of manufacture
- g) Sequential length marking
- h) User's Identification
- i) Cable ID

## 5.2 Cable Ends:

5.2.1 Both cable ends (the beginning end and end of the cable reel) shall be sealed and readily accessible. Minimum 5 meter of the cable of the beginning end of the reel shall accessible for testing. Both ends of the cable shall be kept inside the drums and shall be located so as to be easily accessible for the test. The drum (confirming to Standard No. TEC 69370:2004(latest release) and subsequent amendments, if any) should be marked to identify the direction of rotation of the drum. Both ends of cable shall be provided with cable pulling (grip) stocking and the anti twist device (free head hook). The wooden drums shall be properly

treated against termites and other insects during transportation and storage. The manufacturer shall submit the methodology used for the same

5.2.2 An anti twist device (Free head hook) shall be provided, attached to the both the ends of the cable pulling arrangement. The arrangement of the pulling eye and its coupling system along with the anti twist system shall withstand the prescribed tensile load applicable to the cable.

### **5.3 The nominal drum length:**

5.3.1 Length of OF Cable in each drum shall be 2 Km / 4Km / 8Km / 10Km shall be supplied as per the order. The variation in length of optical fibre cable in each drum shall be  $\pm 5\%$  or  $\pm 10\%$ , as decided by the purchaser.

5.3.2 The fibres in cable length shall not have any joint.

5.3.3 The drum shall be marked with arrows to indicate the direction of rotation.

5.3.4 Packing list supplied with each drum shall have at least the following information:

- a) Drum No.
- b) Type of cables
- c) Physical Cable length
- d) No. of fibres
- e) Length of each fibre as measured by OTDR
- f) The Cable factor - ratio of fibre/cable length
- g) Attenuation per Km. of each fibre at 1310 & 1550 nm
- h) Users / Consignee's Name
- i) Manufacturers Name, Month, Year and Batch No.
- j) Group refractive index of fibre.
- k) Purchase Order No.

l) Cable ID

**5.4 Colour coding and Ribbon identification in O.F. Cables:**

5.4.1 The colorant applied to individual fibres shall be readily identifiable throughout the life time of the cable and shall match and conform to the MUNSELL color standards (EIA- 598D) and also IEC Publication 304(4).

**5.4.2 Colour Coding Scheme:**

When the loose tubes are placed in circular format, the marking to indicate the loose tube no. "1" shall be in blue colour followed by loose tube no.2 of orange and so on for other tubes as per the colour scheme given below at Table-1 and complete the circular format by placing the dummy /fillers at the end.

**Table -1 : Colour Coding scheme of Loose tube**

Loose tube No./Sequence	Loose tube identification
1	Blue
2	Orange
3	Green
4	Brown
5	Slate
6	White
7	Red
8	Black
9	Yellow
10	Violet
11	Rose/Pink
12	Aqua

Depending upon the number of fibres in a Ribbon (which depends on the cable capacity), the fibres within each Ribbon are serially chosen starting from blue colour as per the colour scheme given below at Table-2.

**Table-2: Colour Coding scheme of the Optical Fibre within Ribbon**

Fiber No./Sequence within Ribbon	Fibre Identification
1	Blue
2	Orange
3	Green
4	Brown
5	Slate
6	White
7	Red
8	Black
9	Yellow
10	Violet
11	Pink
12	Aqua

**5.4.3 Identification of Ribbon:**

No. of fibre in a Cable	No. of Tubes	No. of Ribbon per Tube	Fiber Per Ribbon	Marking on Ribbon
48 Fibres	4 Tubes 1 Filler	2	6	Individual Ribbon shall be printed with respective number as 1, 2.

96 Fibres	4 Tubes 1 Filler	4	6	Individual Ribbon shall be printed with respective number as 1, 2, 3, 4.
144 Fibres	4 Tubes 1 Filler	6	6	Individual Ribbon shall be printed with respective number as 1, 2, 3, 4, 5, 6.
216 Fibres	6 Tubes	6	6	Individual Ribbon shall be printed with respective number as 1, 2, 3, 4, 5, 6.
288 Fibres	8 Tubes	6	6	Individual Ribbon shall be printed with respective number as 1, 2, 3, 4, 5, 6.

Note: The individual number marking shall be at regular interval of every 300 mm or lesser on natural color ribbon and shall be legible. The printing on the ribbon shall also be of durable quality and shall be compatible with coating of the ribbon and Thixotropic Jelly (filled in the loose tube of the cable).

## 6.0 Quality Requirements:

6.1 The cable shall be manufactured in accordance with the international quality standards ISO 9001-2015 or latest issue for which the manufacturer should be duly accredited. The Quality Manual shall be submitted by the manufacturer.

## 6.2 Raw Material:

6.2.1 The cable shall use the raw materials approved against the Standard No. TEC 89010:2021(or latest release) and the subsequent amendment issued, if any.

- 6.2.2 Any other material used shall be clearly indicated by the manufacturer. The detailed technical specifications of such raw materials used shall be furnished by the manufacturer at the time of evaluation/testing.
- 6.2.3 The raw materials used from multiple sources is permitted and the source / sources of raw materials (Type and grade) from where these have been procured shall be submitted by the manufacturer.
- 6.2.4 The manufacturer can change the raw material from one approved source to other approved source with the approval of QA wing of purchaser. The change of source/grade of SM optical Fibre and/or design of cable shall call for fresh approval/certification
- 6.2.5 Impregnated Glass Fibre Reinforcement used shall be equally distributed over the periphery of the cable inner sheath. It shall be applied helically and shall provide full coverage to inner sheath to provide rodent protection.
- 6.2.6 The raw material used (HDPE black in colour) for outer sheath shall protect the cable from attack by termite & rodent. The cable shall also be tested for its termite & rodent proof-ness by recognised laboratory or institute. The manufacturer shall specify anti-termite and anti-rodent additives and submit the detail characteristics of the material and additives used to make it termite & rodent proof. The cable shall be tested for the presence of Anti termites & Anti rodent additives by recognised laboratory or institute. The additives/dopants shall be non-toxic and non-hazardous. The non-toxicity, thermal stability, half-life, efficacy etc. of additives/dopants shall be tested by recognized laboratory or institute.
- 6.2.7 The HDPE black in colour used for sheath shall be UV stabilised.

**Note:** A test certificate from a recognised laboratory or institute may be acceptable for the UV stability of the HDPE sheath material

6.2.8 The material used in optical fibre cable must not evolve hydrogen that will affect the characteristics of optical fibres.

**Note:** A test certificate from a recognised laboratory or institute may be acceptable.

### 6.3 Cable Material Compatibility:

Optical fibre, buffers/core tubes, and other core components shall meet the requirements of the compatibility with buffer/core tube filling material(s) and/or water-blocking materials that are in direct contact with identified components within the cable structure (This shall be tested as per clause no. 6.3.4 of Telecordia document GR-20-CORE issue 4, July 2013 or as per IEC 60794-1-219).

**Note:** The tests may be conducted in house (if facility exist) or may be conducted at CACT or any other recognized laboratory. The test certificate may be accepted and the tests may not be repeated subsequently, in next type approvals, if the raw material used is of same make and grade.

### 7.0 Safety Requirements:

7.1 The material used in the manufacturing of the Optical fibre cables shall be non-toxic and dermatologically safe in its life time and shall not be hazardous to health. The manufacturer shall submit MSDS (Material safety Data Sheet) for all the material used in manufacturing of OF Cable to substantiate the statement.

Note: Latest issue of the Standards mentioned in the GR, may be referred.

## CHAPTER- 2

### 8.0 Documentation:

8.1 Complete technical literature in English with detailed cable construction diagram of various sub-components with dimensions, weight & test data and other details of the cable shall be provided.

8.2 All aspects of installation, operation, maintenance and fibre splicing shall also be covered in the handbook. The pictorial diagrams of the accessories (with model no. and manufacturer name) supplied along with the cable as package shall be also be submitted. A hard as well as soft copy of the manuals shall be provided.

### 9.0 Information for the Procurer of product:

9.1 Purchaser may ask for following types of cables as per their requirements:

- i) Type-I is Semi Dry Core cable
- ii) Type II is Dry-Dry Core cable

9.2 It is suggested that the Optical fibre cable supplied in a particular route is manufactured from a single source of optical fibres.

### 10.0 Procedures for the issue of Approval certificate for Lower Fibre Count Cables:

The manufacturer may seek approval certificate for Lower Fibre Count of Metal Free Double HDPE Ribbon Optical Fibre Cables against this Standard for GR without conducting the actual tests on the cables only when he is having valid approval certificate for higher fibre count of cable against this GR.

The manufacturer seeking approval certificate for the Lower Fibre Count cable shall apply afresh and submit the documents as per the prescribed approval procedure along with

- List of Raw Materials used, the make and grade of the raw material and the certificate of source approval issued by CACT or any other govt. recognized laboratory along with the details of the raw materials used in the manufacturing of the higher fibre count cable for which he is holding valid approval certificate. Both the raw materials shall be compared and are required to be of same make and grade.
- Samples of at least 5 cable reels (2 Kms each approx.) for each lower fibre count cable.

Any additional information as required may be sought from the manufacturer and the manufactured cable may be inspected at the manufacturer's premises. After all the above requirements are met, the approval certificate may be issued to the lower fibre count of the cable based upon the test results and other details submitted by the manufacturer. The tariff in each case shall be as applicable for category – II.

The following shall be mentioned in the remarks column of the Approval Certificate to be issued for the lower fibre count of the cable:

“This certificate is issued on the basis of certificate No. \_\_\_\_\_ dated \_\_\_\_\_ for \_\_\_\_\_ fibre count cable”.

The validity of the certificate for lower fibre count cables shall be coterminous to the validity of approval certificate of higher fibre count cable.

The above procedure shall be applicable only for the approval of Optical Fibre Cable against this standard for GR and subsequent amendments, if any.

## ABBREVIATIONS

ASTM	-	American Society for Testing and Materials
BIS	-	Bureau of Indian Standards
CACT	-	Component Approval Centre For Telecommunications
dB	-	Decible
EIA	-	Electronic Industries Association
ESCR	-	Environmental Stree Cracking Resistance
FRP	-	Fibre Reinforced Plastic
FOTP	-	Fibre Optic Test Procedure
HDPE	-	High Density Polyethylene
IEC	-	International Electro -Technical Commission
IS	-	Indian Standard
ISO	-	International Standard Organisations
ITU-T	-	International Telecommunication Union –Telecommunication Standardisation Sector
MFD	-	Mode Field Diameter
MSDS	-	Material Safety Data Sheet
Nm	-	Nanometer
QA	-	Quality Assurance
SM	-	Single Mode
UV	-	Ultra Violet
µm	-	Micrometer
°C	-	Degree Celsius

## Annexure - I

(Semi Dry Core Design: Type-I)

The following parameters of the component parts of the cable are to be taken in to account while designing and manufacturing the optical fibre cables of the required fibre count. These parameters shall be checked during evaluation of the OF cables.

SN	Parameter	Unit	48F Ribbon Fibre cable	96F Ribbon Fibre cable	144F Ribbon Fibre Cable	216F Ribbon Fibre Cable	288F Ribbon Fibre Cable
1	FRP Rod EAA Coated	mm	2.5+0.1/- 0.0	3.0+0.1/- 0.0	3.0+0.1/- 0.0	3.5+0.1/- 0.0	3.5+0.1/- 0.0
2	FRP Up-coating thickness	mm	0	0	0	0.5 ± 0.1	2.0 ± 0.1
3	Tube ID (min)	mm	2.6	3.0	3.3	3.3	3.3
4	Tube OD	mm	3.4 ± 0.2	4.0±0.2	4.5 ± 0.2	4.5 ± 0.2	4.5 ± 0.2
5	No of fibre / ribbon	No	6	6	6	6	6
6	No of Ribbon in a tube	No	2	4	6	6	6
7	Color of fibre per Ribbon		BL,OR, GR, BR,SL,W H	BL,OR, GR, BR, SL, WH	BL,OR, GR, BR, SL, WH	BL,OR, GR, BR, SL, WH	BL,OR, GR, BR, SL, WH
8	No of loose tubes	No	4 with 2 Ribbons	4 with 4 Ribbons	4 with 6 Ribbons	6 with 6 Ribbons	8 with 6 Ribbons
9	Colour of loose tubes		BL,OR, GR, BR	BL,OR, GR, BR	BL,OR, GR, BR	BL,OR, GR, BR, SL, WH	BL,OR,G R,BR,SL, WH, RD, BK

10	No of dummy cord	No	1	1	1	0	0
11	Tube stranding lay over length	mm	> 200	>400	>400	>400	>500
12	Inner Sheath Thickness (min)	mm	0.9	0.9	0.9	0.9	0.9
13	Qty. of Impregnated Glass roving (min.)	Kg	27	27	29	29	29
14	Outer Sheath Thickness(min)	mm	1.5	1.5	1.5	1.5	1.5
15	Cable diameter	mm	16.0 +1.0	17.8 ± 1.0	19.0 ± 1.0	20 ± 1.0	23 ± 1.0
16	Cable weight	Kg/k m	185 ± 10%	230 ± 10%	260 ± 10%	285 ± 10%	385 ± 10%
17	Cable to be designed to Fibre strain value of.	%	0.1	0.1	0.1	0.1	0.1
18	Cable to be tested at defined load for fibre strain value of	%	0.25	0.25	0.25	0.25	0.25

Note: The manufacturer shall submit the design calculations which shall be cross checked.

## Annexure-II

(Dry-Dry Core Design: Type-II)

The following parameters of the component parts of the cable are to be taken in to account while designing and manufacturing the optical fibre cables of the required fibre count. These parameters shall be checked during evaluation of the OF cables.

SN	Parameter	Unit	48F Ribbon Fibre cable	96F Ribbon Fibre cable	144F Ribbon Fibre Cable	216F Ribbon Fibre Cable	288F Ribbon Fibre Cable
1	FRP Rod EAA Coated	mm	2.5+0.1/- 0.0	3.0+0.1/- 0.0	3.0+0.1/- 0.0	3.5+0.1/- 0.0	3.5+0.1/- 0.0
2	FRP Up-coating thickness	mm	0	0	0	0.5 ± 0.1	2.0 ± 0.1
3	Tube ID (min)	mm	2.6	3.0	3.3	3.3	3.3
4	Tube OD	mm	3.4 ± 0.2	4.0±0.2	4.5 ± 0.2	4.5 ± 0.2	4.5 ± 0.2
5	No of fibre / ribbon	No	6	6	6	6	6
6	No of Ribbon in a tube	No	2	4	6	6	6
7	Color of fibre per Ribbon		BL, OR,GR, BR,SL,W H	BL, OR,GR, BR, SL,WH	BL, OR,GR, BR, SL,WH	BL, OR,GR, BR, SL,WH	BL, OR,GR, BR, SL,WH
8	No of loose tubes	No	4 with 2 Ribbons	4 with 4 Ribbons	4 with 6 Ribbons	6 with 6 Ribbons	8 with 6 Ribbons
9	Colour of loose tubes		BL,OR, GR, BR	BL,OR, GR, BR	BL,OR, GR, BR	BL,OR, GR, BR, SL, WH	BL,OR,G R,BR,SL, WH, RD,BK

10	No of dummy cord	No	1	1	1	0	0
11	Tube stranding lay over length	mm	> 200	>400	>400	>400	>500
12	Inner sheath thickness (min)	mm	0.9	0.9	0.9	0.9	0.9
13	Qty. of Impregnated Glass roving (min.)	Kg	27	27	29	29	29
14	Outer Sheath Thickness(min)	mm	1.5	1.5	1.5	1.5	1.5
15	Cable diameter	mm	16.0 +1.0	17.8 ± 1.0	19.0 ± 1.0	20.0 ± 1.0	23 ± 1.0
16	Cable weight	Kg/k m	170 ± 8%	210 ± 8%	230 ± 8%	260 ± 8%	330 ± 8%
17	Cable to be designed to Fibre strain value of.	%	0.1	0.1	0.1	0.1	0.1
18	Cable to be tested at defined load for fibre strain value of	%	0.25	0.25	0.25	0.25	0.25

Note: The manufacturer shall submit the design calculations which shall be cross checked.