वर्गीय आवश्यकताएँ

सं:टीईसी/जीआर/टीएक्स/ ओएफसी-०२२/०२/मार्च-१७

(सं: टीईसी/जीआर/टीएक्स/ओएफसी-०२२/०१/सितम्बर २०११ को अधिक्रमित करता है)

GENERIC REQUIREMENT

No. : TEC/GR/TX/OFC-022/02/MAR-17

(Supersede No. TEC/GR/TX/OFC-022/01/SEP-11)

बिजली लाइन संरेखण के साथ बिछाने के लिए एडीएसएस ऑप्टिकल फाइबर केबल

ADSS OPTICAL FIBRE CABLE FOR LAYING ALONG POWER LINE ALIGNMENTS

दूरसंचार अभियांत्रिकी केंद्र

खुर्शीदलाल भवन, जनपथ, नई दिल्ली-110001, भारत

TELECOMMUNICATION ENGINEERING CENTRE

KHURSHIDLAL BHAWAN, JANPATH, NEW DELHI–110001, INDIA

www.tec.gov.in

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FOREWORD

Telecommunication Engineering Centre (TEC) functions under Department of Telecommunications (DOT), Government of India.

Its activities include:

- Issue of Generic Requirements (GR), Interface Requirements (IR), Service Requirements (SR) and Standards for Telecom Products and Services
- Field evaluation of products and Systems
- National Fundamental Plans
- Support to DOT on technology issues
- Testing & Certification of Telecom products

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 describes the generic requirements of All Dielectric Self Supporting (ADSS) Metal Free Optical Fibre Cables (Type-I A, Type-I B, Type-II A, Type-II B, Type-III A & Type-III B) for installation along the power line alignments. The raw material used in the cable shall meet the requirements of the GR for raw materials. The ADSS optical fibre cable shall have low weight, small volume and high flexibility.

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HISTORY SHEET

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1.	TEC/GR/TX/OFC-022/01/SEP-11	ADSS Optical Fibre Cable For laying along Power line alignments (Type-I & Type-II)	Release-1
2.	TEC/GR/TX/OFC-022/02/MAR-17	ADSS Optical Fibre Cable For laying along Power line alignments	Release-2

REFERENCES

S.No	*Document No.*	*Title/Document Name*
1.	GR/OAF-01/02. JUL 2005	Specification for Installation Accessories & Fixture for Self Supporting Metal Free ADSS Optical Fibre Cable
2.	GR/OFT-01/03. APR 2006	Specification for Tools For Installation & Operating the OFC & for Assembly of the Optical Fibre Splice Closures
3.	TEC/GR/TX/OJC-002/03/APR-2010	Specification for Optical Joint Closure
4.	TEC/GR/TX/ORM-01/04/SEP-09	Specification for Raw Material
5.	G/CBD-01/02 NOV'94	Specification for Wooden Drums
6.	IEEE 1222-2004	IEEE Standard for All Dielectric Self-Supporting Fibre Optic Cable
7.	ITU-T Rec. G. 652 D	ITU-T Recommandation
8.	GR-20 –CORE July 98	Generic Requirement for Optical Fibre cable (Telcordia document)
9.	IEC 60793-1, IEC 60793-2-50	Test method for Optical Fibres
10.	ISO 9001:2008	International Quality Management System.
11.	EIA 359-A IEC Publication 304(4)	Color Standards Color Standards
12.	EIA/TIA-455-73, EIA RS-455-37 EIA/TIA 455-81-A (B9)	Test Methods
13.	IEC 60794-1-2- E1, IEC 60794-1-2-E2, IEC 60794-1-2-E3, IEC 60794-1-2-E4,	Test Methods

	IEC 60794-1-2-E6, IEC 60794-1-2-E7, IEC 60794-1-2-E9, IEC 60794-1-2-E10, IEC 60794-1-2-E11, IEC 60794-1-2-F1, IEC 60794-1-2-F3, IEC 60794-1-2-F5, IEC 60068-2-1, IEC 61395, IEC 189	
14.	IEC 60794-4	Test Methods for Aerial Optical Fibre Cables along Electrical PowerLines
15.	ASTM D 566, ASTM D-790, ASTM D 1248, ASTM D 1693, ASTM G-53-96, ASTM D 1603, ASTM D 1693, ASTM D 638, ASTM D 817, ASTM D 3895, ASTM D 3349, ASTM D 746, ASTM G 53, ASTM D 150, ASTM D 149, ASTM D 257, ASTM D 2303-85,	
16.	FOTP-62, FOTP-98, FOTP-89	Test Methods
17.	BS 2782 Part 6 (Method 720 A & 620A-D), IS-7328-1192 Annex. B	Test Methods

CHAPTER-1

1.0 Introduction:

This document describes the generic requirements of All Dielectric Self Supporting (ADSS) Metal Free Optical Fibre Cables (Type-I A, Type-I B, Type-II A, Type-II B Type III A & Type III B) for installation along the power line alignments. ADSS cable Type-I A is Wet core cable without ice loading, Type-I B is Wet core cable with ice loading, Type II A is Semi Dry core cable without ice loading, Type-II B is Semi Dry core cable with ice loading, Type III A is Dry Dry core cable without ice loading & Type III B is Dry Dry core cable with ice loading. The optical fibre cables shall be suitably protected for the ingress of moisture by suitable water blocking material (Flooding Jelly for Type–I A & Type-I B and WS yarn & WS tape for Type-II A, Type-II B, Type III A & Type III B). The raw material used in the cable shall meet the requirements of the GR for raw materials. The ADSS optical fibre cable shall have low weight, small volume and high flexibility. The optical fibre cable shall have good mechanical protection with stable temperature performance conditions, as it will be exposed to varying environmental conditions. The ADSS cable is intended to be installed on the existing overhead power distribution network up to 33KV.

2.0 Functional Requirements:

2.1 The design and construction of ADSS metal free optical fibre cable shall be inherently robust and rigid under all conditions of installation, operation, adjustment, replacement, storage and transport. The cable shall possess good performance characteristics such as anti-impact, anti-vibration, anti-bending, prevention of thermal aging etc. All the elements consisting of ADSS cable shall be non-metallic.

2.2 The ADSS optical fibre cable shall be able to work in 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.

2.4 It shall be possible to operate and handle the ADSS optical fibre cable with tools as per GR No. GR/OFT-01/03. APR 2006 and subsequent amendment, if any. If any special tool required for operating and handling the optical fibre cable, the same shall be provided along with the cable.

2.5 It shall be possible to install the ADSS optical fibre cable with Accessories and Fixtures as per the GR No. GR/OAF-01/02. JUL 2005 and subsequent amendments, if any. If any special Accessories and Fixtures are required for installation of the ADSS optical fibre cable, the same shall be provided along with the cable. The accessories required for mounting the splice closure on towers shall also be supplied along with cable.

2.6 The ADSS optical Fibre Cable shall be suitable and compatible with the dimensions, fixing, terminating and splicing arrangement of the splice closure supplied along with the cable & vice versa. The manufacture shall indicate the type, make and the model no. of the splice closure to be supplied along with cable. The cable supplied shall also meet other requirement of the splice closure GR No. TEC/GR/TX/OJC-002/03/APR-2010 & subsequent amendments, if any.

2.7 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.

2.8 The Self Supporting Metal Free ADSS Optical Fibre cable shall be designed and manufactured to meet the following conditions of operation, installation and storage:

For Type-I A, Type-II A & Type III A

a) Maximum Span length : 100 meters

b) Maximum ice loading : 0 Kg per meter

c) Operational wind velocity : 100 Kms per hour

d) Sag of the span length :
   i) Maximum sag allowed without excess load : 1 % of the span length
   ii) Maximum sag allowed with excess load : 2 % of the span length

e) Operating Temperature : - 40°C to + 70° C

f) Tensile force design parameter : 9.81 x 4.0 x W
   (**Note:** W is the mass of 1 Km length of the cable in Kg)

g) Minimum bending Radius : 10D (D-dia of cable)

h) Minimum distance of cable from Phase conductor on 33 KV line: 1.5 meters

For Type-I B & Type II B & Type III B

a) Maximum Span length : 100 meters

b) Maximum ice loading : 1 Kg per meter

c) Operational wind velocity : 100 Kms per hour

d) Sag of the span length :

i) Maximum sag allowed without excess load : 1 % of the span length

ii) Maximum sag allowed with excess load : 2 % of the span length

e) Operating Temperature : - 40°C to + 70° C

f) Tensile force design parameter : 9.81 x 6.0 x W

(**Note:** W is the mass of 1 Km length of the cable in Kg)

g) Minimum bending Radius : 10D (D-dia of cable)

h) Minimum distance of cable from Phase conductor on 33 KV line: 1.5 meters

3.0 Technical Requirements:

Single Mode Optical Fibre used in manufacturing optical Fibre Cables shall be as per ITU-T Rec. G 652 D. The specification of optical fibres shall be as per Section-I (Type-III) of GR No. TEC/GR/TX/ORM-01/04-SEP-09 or subsequent amendments if any.

3.1 Type of fibre: Single mode (Section-I of the GR No.TEC/GR/TX/ORM-01/04 SEP-09 & subsequent amendments,if any)

3.2 Geometrical Characteristics:

3.2.1 MFD : 8.8-9.8µm

3.2.2 Cladding Diameter : 125 µm ± 1.0 µm

3.2.3 Cladding Non-circularity : $\leq$ 1%

3.2.4 Core Clad concentricity error : $\leq$ 0.6 µm

3.2.5 Diameter over primary coated with double UV cured acrylate. : 245 µm ± 10 µm

(Shall be measured on un coloured fibre)

Note: The thickness of colour coating may be over and above the values specified above, if the manufacturer adopts separate UV cured colouring process (to colour the un coloured fibres) other than the on line integrated colouring process (of secondary layer of primary coating) of the fibres, during fibre manufacturing.

3.2.6 Coating / Cladding Concentricity : $\leq$ 12 µm

3.3 Transmission Characteristics:

3.3.1 Attenuation:

a) Fibre attenuation before Cabling

i) At 1310 nm : $\leq$ 0.34 dB/Km

ii) Between 1285 to 1380 nm : $\leq$ 0.37 dB/Km

iii) Between 1390 to 1525 nm : $\leq$ Value at 1310nm

iv) At 1550 nm : $\leq$ 0.21 dB/Km

v) Between 1525 to 1625 nm : $\leq$ 0.24 dB/Km

b) Water Peak Attenuation before cabling

Between 1380-1390 nm : ≤ Value at 1310nm

Note:

1. Attenuation in the band 1380-1390nm shall be checked at every 2nm after Hydrogen ageing as per IEC 60793-2-50. Hydrogen ageing test is to be carried out by CACT, Bangalore or any other recognized laboratory for type test.
2. Sudden irregularity in attenuation shall be less than 0.1 dB
3. The spectral attenuation shall be measured on un-cabled fibre.
4. The Spectral attenuation in the 1250 nm–1625 nm band shall be measured at an interval of 10nm and the test results shall be submitted.

c) Fibre attenuation after cabling

i) At 1310 nm : ≤ 0.36 dB/km

ii) At 1550 nm : ≤ 0.23 dB/Km

iii) At 1625 nm : ≤ 0.26 dB/Km

d) Water Peak Attenuation after cabling

At 1383nm ± 3nm : ≤ Value at 1310 nm

3.3.2 Dispersion:

a) Total Dispersion

i) In 1285-1330 nm band : ≤ 3.5 ps/nm.km

ii) In 1270-1340 nm band : ≤ 5.3 ps/nm. Km

iii) At 1550 nm. : ≤ 18.0 ps/nm. Km

iv) At 1625 nm : ≤ 22.0 ps/nm. Km

Note: The dispersion in the 1250 nm–1625 nm band shall be measured at an interval of 10nm and the test results shall be submitted.

b) Polarization mode dispersion at 1310 & 1550 nm.

i) Fibre : $\leq$ 0.2 ps/$\sqrt{}$ km

ii) Cabled Fibre : $\leq$ 0.3 ps/$\sqrt{}$ 'km

Note : Measurement on un-cabled fibre may be used to generate cabled fiber statistics and correlation established.

c) Zero Dispersion Slope : $\leq$ 0.092 ps/(nm ^{2} Km)

d) Zero dispersion wave length range : 1300 -1324 nm

3.3.3 Cut off wavelength for fibres used in cables : 1320 nm Max.

Note - The above cut off wavelength is w.r.t. 2M sample length of fibre.

3.3.4 Cable Cut off wavelength : 1260nm Max.

Note - The above cut off wavelength is w.r.t. 22M sample length of fibre.

3.4 Colour Qualification and Primary coating Test

3.4.1 Colour Qualification Test:

a) MEK Rub Test (Methyle Ethyl Ketone):

To be tested by using soaked (Solvent) tissue paper for ten strokes unidirectional on 10 cm length of fibre. No colour traces shall be observed on the tissue paper after testing.

b) **Water immersion Test (Type Test):**

To be tested for coloured fiber for 30 days. After the test Colour qualification, Attenuation measurement & Strippability test are to be taken.

3.4.2 Primary coating Test (Type Test):

a) **Fourier Transform Infrared Spectroscopy (FTIR) Test:**

To be tested to check the curing level of coating on the surface of natural fibre. The curing level shall be better than 90%.

b) **Adhesion Test:**

To be tested by using soaked (Solvent) tissue paper for ten strokes unidirectional on 10 cm length of fibre. No coating shall be observed on the tissue paper after testing.

3.5 ADSS Optical Fibre Cable Construction Specifications for Wet core (Type-I A & Type-I B):

The cable shall be designed to the parameters mentioned in Annexure-I for Type I A and Annexure II for Type I B. The manufacturer shall submit designed calculation and the same shall be studied and checked.

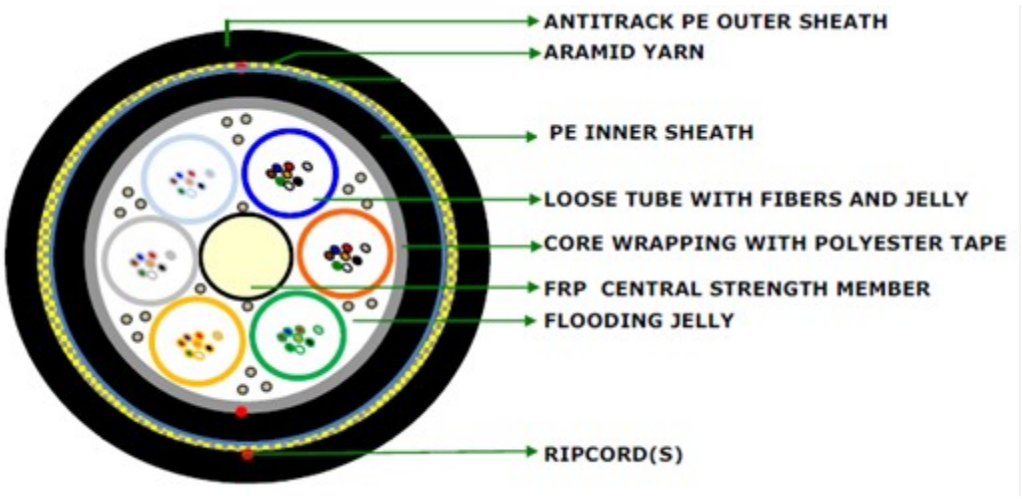


Figure 1: TYPICAL STRUCTURAL DRAWING FOR 48 FIBRE OF CABLE

3.5.1 **Secondary Protection**: The primary coated fibres may be protected by loose packaging within a tube or tubes which shall be filled with thixotropic jelly.

3.5.2 **Number of fibres**: 12, 24, 48 and 96

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

3.5.3 **Strength Member:** Solid FRP non - metallic strength member in the centre of the cable core shall be provided. The strength member in the cable shall be for strength and flexibility of the cable and shall have anti buckling properties. This shall also keep the fibre strain within permissible values.

3.5.4 **Cable Core Assembly:** Primary coated fibres in loose tubes, stranded together around a central strength member (using helical or reverse lay techniques), shall form the cable core.

3.5.5 **Core Wrapping:** The main cable core containing fibres shall be wrapped by layer/layers of Polyester foil/tape. The nylon/polyester binder tape or thread shall be used to hold the tape, if required.

3.5.6 **Moisture barrier (protection):** The main cable core (containing Tube/FRP & Core wrapping) shall be protected by thixotrophic flooding compound (Jelly) having properties of non hygroscopic dielectric material.

3.5.7 **Filling compound:** The filling compound used in the loose tube and in the cable core shall be compatible to fibre, secondary protection of fibre, core wrapping etc. The drip point shall not be lower than +70º C. The fibre movement shall not be constrained by stickiness and shall be easily removable for splicing. The test method to measure drop point shall be as per ASTM D 566. The filling and the flooding jelly compound shall be as per the GR No. TEC/GR/TX/ORM-01/04 SEP-09 and the subsequent amendments, if any.

3.5.8 **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. Thickness of the sheath shall be uniform and shall not be less than 1.0mm 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 (in black colour) from the finished cable, shall be subjected to following tests (on sample basis) and shall conform to the requirement of the material as per the GR No. TEC/GR/TX/ORM-01/04 SEP-09 (Section-III)

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

3.5.9 **Reinforcement:** The ADSS optical fibre cable shall be helically reinforced with Aramid Yarn in the periphery over the inner sheath. The Aramid Yarn shall be uniformly and equally distributed on the entire periphery (circumference) of the cable. The quantity of the Aramid Yarn used per kilometer length of the cable shall be as per requirement in Annexure I for Type I A and Annexure II for Type I B. The Aramid Yarn shall be as per the GR No. TEC/GR/TX/ORM-01/04 SEP.09 (Section XVII) and the subsequent amendments, if any.

3.5.10 **Outer Jacket:** A circular and uniform tough weather resistant polyethylene compound Antitrack Polyethylene material sheath/Jacket, black in colour, (UV Stabilised) shall be provided over and above the reinforcement of Aramid Yarn. The thickness of the outer sheath/Jacket shall not be less than 1.8mm. The sheath shall be free from pinholes, joints, scratches, mended pieces and other defects etc. and it shall have smooth finish.

Note: Antitrack PE material (in black colour) from the finished cable, shall be subjected to following tests (on sample basis) and shall conform to the requirement of the material as per the GR No. TEC/GR/TX/ORM-01/04 SEP.09 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

3.5.11 Cable diameter: The manufacturer shall define the cable diameter. The finished cable diameter shall be as per Annexure I for Type I A and Annexure II for Type I B.

3.5.12 RIP Cord:

a) The suitable water blocking ripcords (two each for Inner & Outer sheath) shall be provided which shall be used to open the inner and outer sheath of the cable. It shall be capable of consistently slitting the sheath without breaking for a length of 1 meter at the installation temperature. The rip cord(s) shall be properly waxed to avoid wicking action and shall not work as a water carrier.

b) The ripcord used in the cable shall be readily distinguishable from any other components (e.g. Aramid Yarn etc.) utilized in the cable construction.

3.6 ADSS Optical Fibre Cable Construction Specifications for Semi Dry core (Type-II A & Type-II B):

The cable shall be designed to the parameters mentioned in Annexure–III for Type II A and Annexure IV for Type II B. The manufacturer shall submit designed calculation and the same shall be studied and checked.

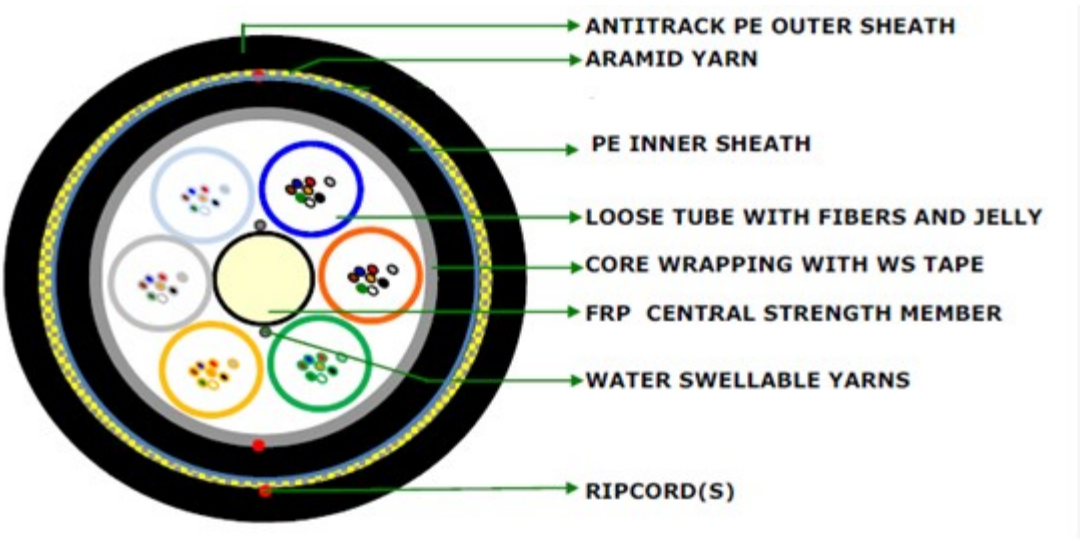


Figure 2: TYPICAL STRUCTURAL DRAWING FOR 48 FIBRE OF CABLE

3.6.1 Secondary Protection:

The primary coated fibres may be protected by loose packaging within a tube or tubes which shall be filled with thixotropic jelly.

3.6.2 Number of fibres: 12, 24, 48 and 96
(Type approval for a cable shall be issued depending upon the no. of fibres in the cable)

3.6.3 Strength Member: Solid FRP non - metallic strength member in the centre of the cable core shall be provided. The strength member in the cable shall be for strength and flexibility of the cable and shall have anti buckling properties. This shall also keep the fibre strain within permissible values.

3.6.4 Cable Core Assembly: Primary coated fibres in loose tubes, stranded together around a central strength member (using helical or reverse lay techniques), shall form the cable core.

3.6.5 **Core Wrapping:** The main cable core containing fibres shall be wrapped by layer/layers of water swellable tape & binder (as per Section IX of TEC/GR/TX/ORM-01/04/Sep-09).

3.6.6 **Moisture barrier (protection):** The main cable core (containing Tube/FRP & Core wrapping) shall be protected by water swellable yarn as per section XIX of GR TEC/GR/TX/ORM-01/04 SEP.09.

3.6.7 **Filling compound:** The filling compound used in the loose tube shall be compatible to fibre, secondary protection of fibre, core wrapping etc. The drip point shall not be lower than +70º C. The fibre movement shall not be constrained by stickiness and shall be easily removable for splicing. The test method to measure drop point shall be as per ASTM D 566. The filling jelly shall be as per the GR No. TEC/GR/TX/ORM-01/04 SEP.09 and the subsequent amendments, if any.

3.6.8 **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. Thickness of the sheath shall be uniform and shall not be less than 1.0mmThe 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 (in black colour) from the finished cable, shall be subjected to following tests (on sample basis) and shall conform to the requirement of the material as per the GR No. TEC/GR/TX/ORM-01/04 SEP-09 (Section-III)

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

3.6.9 **Reinforcement:** The ADSS optical fibre cable shall be helically reinforced with Aramid Yarn in the periphery over the inner sheath. The Aramid Yarn shall be uniformly and equally distributed on the entire periphery (circumference) of the cable. The quantity of the Aramid Yarn used per kilometer length of the cable shall be as per requirement in Annexure III for Type II A and Annexure IV for Type II B. The Aramid Yarn shall be as per the GR No. TEC/GR/TX/ORM-01/04 SEP.09 (Section XVII) and the subsequent amendments, if any.

3.6.10 **Outer Jacket:** A circular and uniform tough weather resistant polyethylene compound Antitrack Polyethylene material sheath/Jacket, black in colour, (UV Stabilised) shall be provided over and above the reinforcement of Aramid Yarn. The thickness of the outer sheath/Jacket shall not be less than 1.8mm. The sheath shall be free from pin holes, joints, scratches, mended pieces and other defects etc. and it shall have smooth finish.

Note: Antitrack PE material (in black colour) from the finished cable, shall be subjected to following tests (on sample basis) and shall conform to the requirement of the material as per GR No. TEC/GR/TX/ORM-01/04 SEP.09 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

3.6.11 Cable diameter: The manufacturer shall define the cable diameter. The finished cable diameter shall be as per Annexure-III for Type II A and Annexure IV for Type II B.

3.6.12 RIP Cord:

a) The suitable water blocking ripcords (two each for Inner & Outer sheath) shall be provided which shall be used to open the inner and outer sheath of the cable. It shall be capable of consistently slitting the sheath without breaking for a length of 1 meter at the installation temperature. The rip cord(s) shall be properly waxed to avoid wicking action and shall not work as a water carrier.

b) The ripcord used in the cable shall be readily distinguishable from any other components (e.g. Aramid Yarn etc.) utilized in the cable construction.

3.7 ADSS Optical Fibre Cable Construction Specifications for Dry-Dry Core (Type III A & Type III B)

The cable shall be designed to the parameters mentioned in Annexure–V for Type III A and Annexure VI for Type III B. The manufacturer shall submit designed calculation and the same shall be studied and checked.

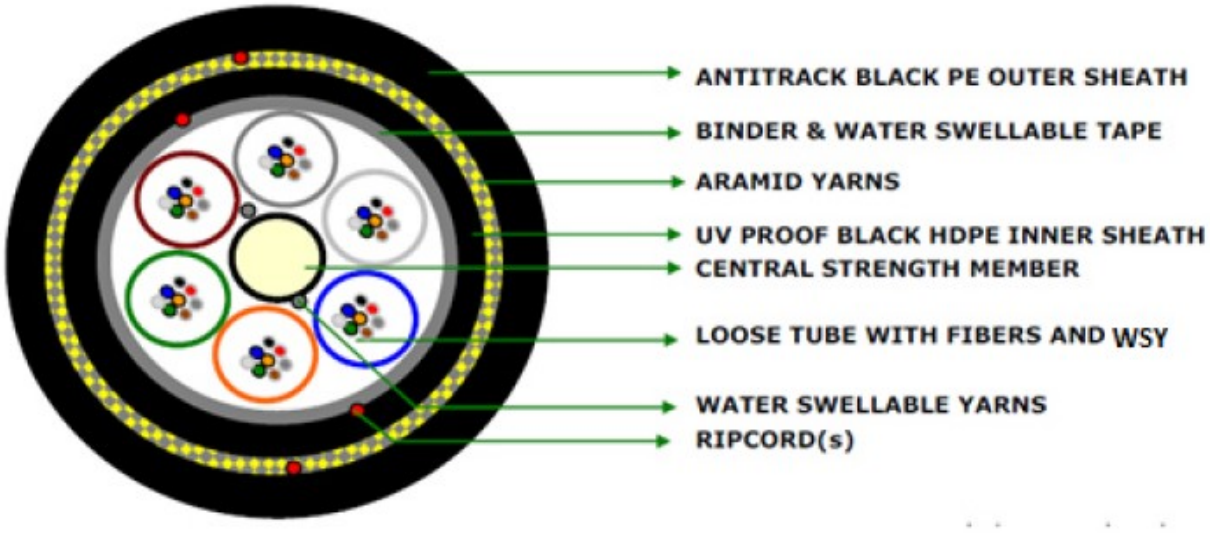


Figure 3: TYPICAL STRUCTURAL DRAWING FOR 48 FIBRE OF CABLE

3.7.1 Secondary Protection:

The primary coated fibres may be protected by loose packaging within a tube or tubes which shall contain water swellable yarn to prevent water ingress in loose tube.

3.7.2 Number of fibres: 12, 24, 48 and 96

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

3.7.3 Strength Member: Solid FRP non - metallic strength member in the centre of the cable core shall be provided. The strength member in the cable shall be for strength and flexibility of the cable and shall have anti buckling properties. This shall also keep the fibre strain within permissible values.

3.7.4 Cable Core Assembly: Primary coated fibres in loose tubes, stranded together around a central strength member (using helical or reverse lay techniques), shall

form the cable core.

3.7.5 **Core Wrapping:** The main cable core containing fibres shall be wrapped by layer/layers of water swellable tape & binder (as per Section IX of TEC/GR/TX/ORM-01/04/Sep-09).

3.7.6 **Moisture barrier (protection):** The main cable core (containing Tube/FRP & Core wrapping) shall be protected by water swellable yarn as per section XIX of GR TEC/GR/TX/ORM-01/04 SEP.09.

3.7.7 **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. Thickness of the sheath shall be uniform and shall not be less than 1.0mm. 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 (in black colour) from the finished cable, shall be subjected to following tests (on sample basis) and shall conform to the requirement of the material as per the GR No. TEC/GR/TX/ORM-01/04 SEP-09 (Section-III)

ix) Density
x) Melt flow index
xi) Oxidative Induction time
xii) Carbon black content
xiii) Carbon black dispersion
xiv) ESCR
xv) Moisture content
xvi) Tensile strength and elongation at break

3.7.8 **Reinforcement:** The ADSS optical fibre cable shall be helically reinforced with Aramid Yarn in the periphery over the inner sheath. The Aramid Yarn shall be uniformly and equally distributed on the entire periphery (circumference) of the cable. The quantity of the Aramid Yarn used per kilometer length of the cable shall be as per requirement in Annexure V for Type III A and Annexure VI for Type III B. The Aramid Yarn shall be as per the GR No. TEC/GR/TX/ORM-01/04 SEP.09 (Section XVII) and the subsequent amendments, if any.

3.7.9 **Outer Jacket:** A circular and uniform tough weather resistant polyethylene compound Antitrack Polyethylene material sheath/Jacket, black in colour, (UV Stabilised) shall be provided over and above the reinforcement of Aramid Yarn. The thickness of the outer sheath/Jacket shall not be less than 1.8mm. The sheath shall be free from pin holes, joints, scratches, mended pieces and other defects etc. and it shall have smooth finish.

Note: Antitrack PE material (in black colour) from the finished cable, shall be subjected to following tests (on sample basis) and shall conform to the requirement of the material as per GR No. TEC/GR/TX/ORM-01/04 SEP.09 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

3.7.10 **Cable diameter:** The manufacturer shall define the cable diameter. The finished cable diameter shall be as per Annexure- V for Type III A and Annexure VI for Type III B.

3.7.11 **RIP Cord:**

a) The suitable water blocking ripcords (two each for Inner & Outer sheath) shall be provided which shall be used to open the inner and outer sheath of the cable. It shall be capable of consistently slitting the sheath without breaking for a length of 1 meter at the installation temperature. The rip cord(s) shall be properly waxed to avoid wicking action and shall not work as a water carrier.

b) The ripcord used in the cable shall be readily distinguishable from any other components (e.g. Aramid Yarn etc.) utilized in the cable construction.

4.0 Mechanical Characteristics and Tests on Optical Fibre Cable:

4.1 Tensile strength Test:

Objective:

To test the tensile strength of Self Supporting Metal Free ADSS Optical Fibre Cable, in order to examine the behavior of the attenuation as a function of the load on a cable. This load occurs during installation, while the ADSS optical fibre cable encounters the excess ice loading and the winds at high speed.

Test Method:

IEC 60794-1-2-E1

Test Specs. :

The cable shall have sufficient strength to withstand a load of value T(N) = 9.81 x

4 W Newtons for ADSS cable without ice loading & T(N) = 9.81 x 6 W Newtons for ADSS cable with ice loading(where – W is the mass of 1 Km of cable in Kg.). The load shall be sustained for 10 minutes and the strain on the fibre and the attenuation shall be monitored.

Requirement:

The load shall not produce a strain exceeding 0.25 % in the fibre and shall not cause any permanent physical or 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 wavelengths.

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-60794-1-2-E2

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 and loss of legibility 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.

Test Method:

IEC 60794-1-2-E3

Test Specs. :

The fibres and component parts of the cable shall not suffer permanent damage when subjected to a compressive load of 2200 Newtons applied, between the plates of dimension 100 x 100 mm. The load shall be applied for 10 minutes. The attenuation shall e 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 for1310nm and 1550nm wavelengths.

4.4 Impact Test:

Object:

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

Method:

IEC 60794-1-2-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. Ten 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 wavelengths.

4.5 Repeated Bending /Cable cyclic flexing:

Objective:

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

Method:

IEC-60794-1-2-E6/ IEEE - 1222

Test Specs. :

The cable sample shall be of sufficient length (5m minimum) to permit radiant power measurements as required by this test. Longer lengths may be used, if required. The sheave diameter shall be maximum of 20 times the cable outside diameter. The cable shall be flexed at 30 cycle/minute for 25 cycles.

Parameters:

Weight	: 5 Kg
Minimum distance from Pulley centre to holding device	: 216 mm
Minimum distance from Wt. to Pulley centre	: 457 mm

Pulley Diameter	: 20D(D– cable diameter)
Angle of Turning	: 90°
No. of cycles	: 30
Time Required for 30 cycles	: 1 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 wavelengths.

4.6 Torsion Test/Cable twist:

Object:

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

Method:

IEC 60794-1-2-E7 /IEEE - 1222

Test Specs. :

The length of the specimen under test 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 clockwise 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 ten 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 ports 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 wavelengths.

4.7 Kink Test:

Object:

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 60794-1-2-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 is brought to normal position. The change in attenuation of the fibre after test shall be $\leq$ 0.05 dB, both for 1310 nm & 1550 nm wavelengths.

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 60794-1-2-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 having diameter 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 wavelengths. Sheath shall not show any cracks visible to the naked eye, when examined whilst still wrapped on the mandrel.

4.9 Snatch Test (Type Test):

Object:

This test is to determine the ability of the cable to withstand a sudden snatch load.

Method:

IEC 60794-1-2-E9

Test Specs.

The sample is terminated in a manner that the fibres, sheathing and any strength member/ members are clamped together firmly. A hook has a shaft capable of bearing variable loads applied to it. The cable of 4.5 meters length is taken and firmly clamped at the two ends so that a sag of 300 mm., is formed . The attenuation is then measured.

Testing load shall be 300 N and the radius of impacting surface of the crown of the hook shall be 12.5 mm. The hook with the mass attached, is held or supported over the cable so that the crown of the hook is centered over the lowest point of the cable at a height of 100 mm. The hook is then released so as to catch the cable after dropping from the height of 100 mm. It shall be repeated ten times. The load is then removed from the cable and attenuation is noted.

Requirement:

There shall be no permanent physical damage to the cable and the change in attenuation of the fibre after the test shall be $\leq$ 0.05 dB, both for 1310 and 1550 nm wavelengths.

4.10 Cable bend Test at High & Low Temp (Type Test):

Object :

To determine the ability of a optical fibre cable to withstand bending at low and high temperatures, which might be encountered during cable placement.

Method :

EIA RS-455-37.

Test Specs. :

Test Temperature	:	- 40° to + 70° C
Mandrel Diameter	:	20D (D- Diameter of cable).
No. of turns	:	4
Conditioning Time Duration	:	24 hours at each temperature.
Acceptance	:	Visual test for the damage of the sheath.

Requirement :

The change in attenuation of the fibre after the test, shall be $\leq$ 0.05 dB both for 1310 nm & 1550 nm wave lengths. The attenuation shall be noted before and after the completion of the cycle.

4.11 Temperature Cycling(Type Test):

Objective :

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

Method :

IEC 60794-1-2-F1/ IEEE – 1222 (Annexure E)

(To be tested on Standard cable length of drum i.e. 2Km + 5 %)

Test Specs. :

The permissible temperature range of the cable for storage shall be from -50°C to +70°C and for operation -40°C to +70°C. The rate of change of temperature during the test shall be 1° per minute approx. The cable shall be subjected to temperature cycling for 24 hrs at each temperature as given below:

TA2 temp. : - 40°C

TA1 temp. : - 10°C.

TB1 temp. : + 60°C.

TB2 temp. : + 70°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, both for 1310 nm and 1550 nm wavelengths for the entire range of temperature.

4.12 Cable Aging test (Type Test):

Objective:

To check the cable material change dimensionally as the cable ages.

Method : IEEE –1222 (Annexure F)

Test Specs. :

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 allowed is $\leq$ 0.05dB at 1310nm & 1550nm

Note:

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

4.13 Cable Freezing Test(Type Test):

Objective:

To determine that installed optical fibre cable jacket shall not show the evidence of cracking or splitting.

Test Method:

FOTP - 98.

Requirement:

The attenuation change shall be $\leq$ 0.05dB at 1310nm & 1550nm. The magnitude of the maximum attenuation change of each individual fibre shall not be greater than 0.15dB and cable shall not show the evidence of cracking or splitting.

4.14 Water Penetration/Blocking Test (Type Test):

Objective:

The aim of this test is to ensure that installed optical fibre cable will not allow water passage in the cable.

Method:

IEC 60794-1-2-F5 (Fig. B) 1999

Test Specs. :

A circumferential portion of the cable end shall face the water head. The water tight sleeve shall be applied over the core of cable. The cable shall be supported horizontally and two meter water head, containing sufficient quantity of water soluble fluorescent dye for the detection of seepage, shall be applied over the inner sheath of cable for seven days, at ambient temperature. No other colored

dye is permitted.

Requirement:

No dye shall be detected when the end of the 3m length 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 and Dry Dry cable, it shall not be more than 1 meter.

Note: For bulk testing, test should be conducted for 24 hours.

4.15 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) length 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.

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

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

Method: 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 $\leq$ 0.05 dB at both 1310 nm and 1550 nm wavelengths. The sheath shall not show any cracks visible to the naked eye.

4.17 Static Bend test (Type Test):

Objective: To check the cable under Static bend.

Method: ASTM D 790.

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 $\leq$0.05 dB for both 1310 nm and 1550 nm wavelengths. Sheath shall not show any cracks visible to the naked eye when examined whilst still wrapped on the mandrel.

4.18 Cable Jacket Yield Strength And Ultimate Elongation(Type Test):

Objective:

To check the yield strength and elongation of polyethylene (HDPE) cable sheath.

Test Method :

FOTP-89 or ASTM D 1248 Type III Class.

Test Condition:

1) Sample shall be taken from a completed cable. The aged sample shall be conditioned at 100 $\pm$ 2^0 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 unaged	16.5	2400	400
HDPE aged	12.4	1800	375

4.19 Drip Test on the cable (Seepage of filling/flooding compound Test):

Objective :

The purpose of this test is to determine the ability of jelly in the Optical Fibre cable to withstand a temperature of 70°C.

Test Method:

TIA/EIA-455-81-A-1992 [B9]

Method :

Take a sample of 30 cm length of the cable with one end sealed by the end cap. Remove outer jacket, 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 over for dripping of the jelly after 24 hours.

Requirement :

There should be no jelly drip or oil impression on the paper.

Note: The test is applicable for only Wet Core and Semi Dry cable.

4.20 ESCR (Environmental Stress Cracking Resistance) Test(Type Test):

Objective:

The outer sheath of the ADSS optical fibre cable shall be checked and tested for ECSR.

Test Method:

ASTM D 1693

Requirement :

There should not be any visible cracks on the surface of the outer sheath, when examined with the help of a magnifying glass at the end of 1000 hours for Type Test in a 10% Igepal solution.

4.21 UV radiation Test (Type Test)

Objective :

To check the effect of UV radiation on the following:

i) On the Outer Sheath material (ATPE).

ii) On the meter and other legend markings.

Test Method :

IEC 60068-2-1/ASTM G-154-12a

Type of Lamp :

40 Watt UV-B lamp with a peak emission at 313nm.

Duration :

1000 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.

4.22 Check of the quality of the loose tube (containing optical fibre) (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.

Test 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:

$Lo > 100 \times \sqrt{(D^2 + d^2)} / 4$

Where Lo = Length of tube under test.

D = Outside dia of loose tube.

d = Inside dia of loose tube.

Example:-

Fibre optic tube, D = 5mm, d = 3mm

$Lo > 100 \times \sqrt{(5^2 + 3^2)} / 4 = 100 \times 5.83/4 = 145.8$

Test Method:

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 ink should appear on the tube up to the safe bend dia 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**

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.

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 dia 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.

4.23 Drainage Test for loose Tube (Type Test):

Sample Size: 30 cm tube length.

Test Method:

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.
4. Leave the filled tube in a horizontal position at an ambient temperature for 24 hrs.

5. 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.
6. 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 the tube has PASSED the drainage test.
2. If there is gel or oil in the beaker the tube has FAILED the drainage test.

Note: This test is applicable for only Wet Core and Semi Dry cable.

4.24 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.

Test Method:

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.

4.25 Check of the effect of aggressive media on the cable (Type Test) :

Test Method:

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 600mm 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.

4.26 Electrical Test (Type Test) :

Objective:

The objective of this test is to demonstrate the resistance of the cable sheath to erosion and tracking under combined electrical and mechanical stresses.

Test Method:

IEEE Std 1222-2003 (Annexure A)

Requirement:

Tracking on the outside of sheath shall not result in erosion at any point of sheath.

4.27 Aeolian Vibration Test (Type Test) :

Objective:

The objective of this test is to assess the fatigue performance of ADSS cable and the optical characteristics of the fibers under typical Aeolian vibrations.

Test Method:

IEC 60794-1-2 (E19) / IEEE Std 1222-2003 (Annexure B)

Test Specs.:

The cable test set up is as shown in Figure B.1of IEEE Std 1222-2003 (Annexure B). The cable shall be subjected to a minimum of 100 million vibration cycles. The frequency of the test span shall be equal to and maintained at the nearest resonant frequency produced by a 16.1 km/hr wind (i.e., frequency = 82.92, diameter of cable in centimeters). The free loop peak-to-peak antinode amplitude shall be maintained at a level equal to one-half the diameter of the cable.

In the initial stages, the test span requires continuous attention and recordings shall be taken approximately every 15 minutes until the test span has stabilized. After the span has stabilized, readings shall be taken a minimum of two times per day, typically at the start and end of the working day. The test shall be performed on a minimum 95 meter sample of ADSS cable. About 45 meter section of the cable is placed in a test span at a 2 deg static sag angle with the use of ADSS dead ends and suspension clamps.

Requirement:

The change in attenuation of the fibre after the test shall be $\leq$ 0.05 dB measured at both 1310 nm & 1550 nm wavelengths. The cable shall be examined physically for any cracks, tearing of the outer sheath and for the damage to other component parts of the cable.

4.28 Galloping Test (Type Test):

Objective:

The objective of this test is to assess the fatigue performance of ADSS cable and the optical characteristics of the fibers under typical galloping motions.

Test Method:

IEEE Std 1222-2003 (Annexure C)

Test Specs. :

The cable test set up is as shown in Figure C.1of IEEE Std 1222-2003 (Annexure C). The cable shall be subjected to a minimum of 100000 galloping cycles. The test frequency shall be the single-loop resonant frequency. The minimum peak-to-peak antinode amplitude/loop length ratio shall be maintained at a value of 1/25, as measured in the active span.

Mechanical and optical data shall be read and recorded approximately every 2000 cycles.

The optical power meters shall be continuously monitored beginning at least one hour before the test and ending at least two hours after the test.

Requirement:

The change in attenuation of the fibre after the test shall be $\leq$ 0.05 dB measured at both 1310 nm & 1550 nm wavelengths. The cable shall be examined physically for any cracks, tearing of the outer sheath and for the damage to other component parts of the cable.

4.29 Sheave Test(Type Test):

Objective :

The objective of this test is to verify that the installation of the ADSS cable will not damage or degrade their performance.

Test Method:

IEC 60794 –1-2 (E9) / IEEE Std 1222-2003 (Annexure D)

Test Specs.:

The cable test set up is as shown in Figure D.1of IEEE Std 1222-2003 (Annexure D). A 2m minimum length of the ADSS test sample shall be pulled 120 times forward and backward through the sheave (60 times in each direction).

The 120 passes shall be distributed as mentioned below:

Angle of Pull (Degrees) -- 70

Number of passes -- 120

The diameter of the sheave for the angle of pull shall be determined by the ADSS cable manufacturer. Before the first pull, the beginning, midpoint, and end of this length shall be marked. Micrometer readings of the diameter shall be taken and recorded before the first pass through the sheave and thereafter every tenth cycle. The output of the optical power meter shall be monitored continuously during the test. After the test is completed, the ADSS cable shall be removed in the test section and the cable shall be visually examined for any surface damage. The ADSS cable shall be dissected to observe for any signs of damage to the inner structure.

Requirement:

The change in attenuation of the fibre after the test shall be $\leq$ 0.05 dB measured at both 1310 nm & 1550 nm wavelengths. The cable shall be examined

physically for any cracks, tearing of the outer sheath and for the damage to other component parts of the cable.

4.30 Creep Test(Type Test):

Test Method:

IEC 61395

Test Specs. :

A creep test shall be performed on an ADSS sample approximately 10 m long. The cable shall be terminated at each end, and a tension of at least 50% of the maximum rated cable loads shall be applied and sustained for duration of at least 1000 hrs. The elongation of the cable versus time shall be measured at suitable intervals and recorded.

Requirement:

The change in attenuation of the fibre after the test shall be $\leq$ 0.05 dB measured at both 1310 nm & 1550 nm wavelengths. The cable shall be examined physically for any cracks, tearing of the outer sheath and for the damage to other component parts of the cable.

4.31 Tracking & Erosion Test(Type Test):

Test Method:

ASTM D 2303-97

Note: Type test is conducted during product approval and Bulk test are conducted during Bulk production.

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 ATPE Sheath (jacket) and shall be done 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
d) Number of Fibres
e) Type of cable –ADSS (Type IA, IB -Wet Core / Type IIA, IIB -Semi Dry Core/Type IIIA, IIIB- Dry Dry Core)
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 (conforming to GR No. G/CBD-01/02 NOV 94 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. The diameter of the cable shall also be marked on the cable drum.

5.2.2 An Anti-twist device (Free head hook) shall be provided attached to the both end 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 ± 5 % / 4Km ± 5% / 8Km ± 5% / 10Km ± 5% and shall be supplied as per the order. The variation in length of optical fibre cable, as specified above (in each drum), shall be acceptable.

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 - ADSS (Type IA, IB -Wet Core / Type IIA, IIB -Semi Dry Core/ Type IIIA, IIIB –Dry Dry Core)
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.
j) Purchase Order No.
k) Cable ID

5.4 Colour coding in the OF Cable:

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 (For EIA standard EIA-598C) and also IEC Publication 304 (4).

5.4.2 Colour Coding Scheme:

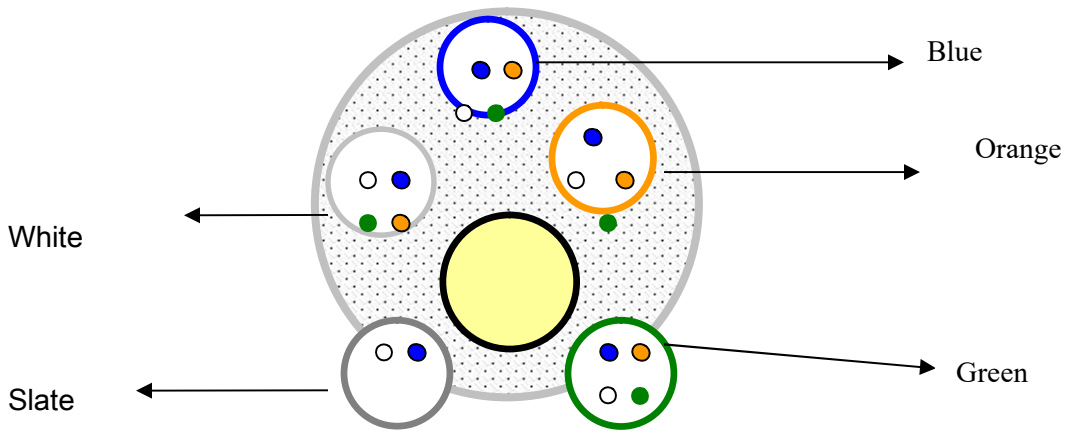
When the loose tubes are placed in circular format, the marking to indicate the loose tube no. "1" shall be in blue colour followed by loose tube no.2 of orange and so on for other tubes as per the colour scheme given below and complete the circular format by placing the dummy /fillers at the end.

Depending upon the number of fibres in a loose tube (which depends on the cable capacity), the fibres are serially chosen from the column no. II of the table-1. Last fibre in a tube shall be of natural color, while the rest of fibres are colored.

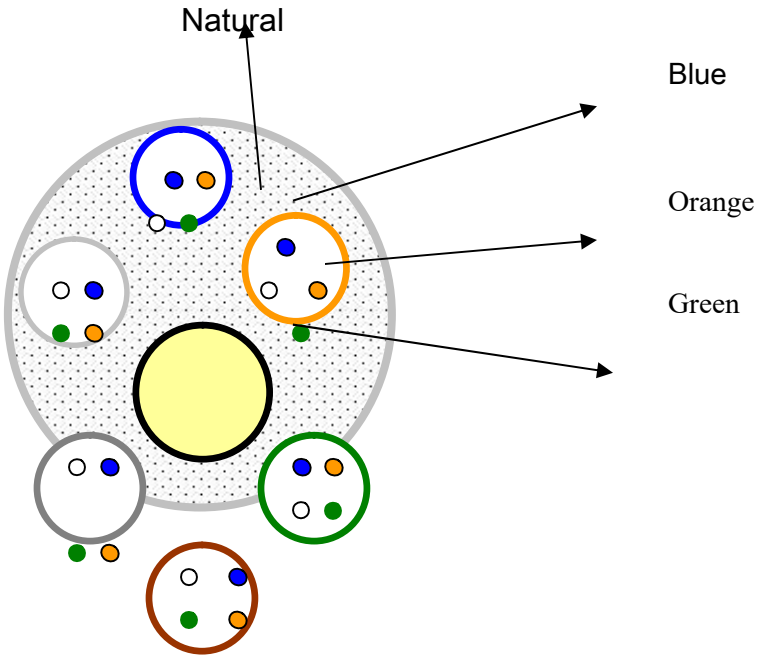
Table-1 Colour Coding scheme of the Optical Fibres & Loose tube

No.of Fibers/Buffer tube I	Fiber identification II	Loose tube identification III
1	Blue	Blue
2	Orange	Orange
3	Green	Green
4	Brown	Brown
5	Slate	Slate
6	White	White
7	Red	Red
8	Black	Black
9	Yellow	Yellow
10	Violet	Violet
11	Rose/Pink	Rose/Pink
12	Natural	Aqua

Color coding of Loose Tubes for 24 fibres (Refer Table 1)



(Loose Tube Colour: Blue, Orange, Green, Brown, Slate, White)



(Fiber Colour : Blue , Orange, Green, Natural)

Figure 4: Color coding of 24 Fibres within Loose Tubes (Refer Table 1)

6.0 Quality Requirements:

6.1 The cable shall be manufactured in accordance with the international quality standards ISO 9001-2008 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 GR No. TEC/GR/TX/ORM-01/04 SEP-09 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. In case of change of source/grade of SM Optical Fibre, the call for fresh evaluation/testing shall be decided by QA wing of purchaser.

6.2.5 The ATPE Black in colour used for outer sheath shall be UV stabilized and shall withstand UV test for 2000 hrs (minimum).

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

6.2.6 The material used in optical fibre cable must not evolve hydrogen that will affect the fibre loss.

Note: Test certificate from a recognized 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 Telcordia document GR-20-CORE issue 2, July 1998).

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 Requirement:

The material used in the manufacturing of the ADSS 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.

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 Guidelines for Purchaser

1. Field trial for Dry Dry core cable(Type IIIA, Type IIIB) shall be conducted by purchaser before bulk procurement. Duration for field trial may be decided by the purchaser.

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

Procedures for the issue of Evaluation/Testing certificate for ADSS Optical Fibre Cable for Laying along power lines alignments against GR No. TEC/GR/TX/OFC-22/02/MAR-17

For the issue of Evaluation/Testing certificate for low fibre count of ADSS Optical Fibre Cables against GR No. TEC/GR/TX/OFC-22/02/MAR-17 to the manufactures having valid Evaluation/ Testing certificate for higher fibre count of ADSS Optical Fibre cables against this GR without conducting the actual tests on the cable, following is stated.

i) The manufacturer may seek Evaluation/Testing certificate of ADSS Optical Fibre Cables against GR No. TEC/GR/TX/OFC-22/02/MAR-17 for the respective fibre count of 24, 48 & 96 fibres.

ii) The ADSS Optical Fibre Cables against GR (GR No. TEC/GR/TX/OFC-22/02/MAR-17) are grouped into following two groups:

a) Group no. I Fibre cables of 96, 48, & 24, 12 Fibres.

b) Group no. II Fibre cables have 48 & 24, 12 Fibres.

iii) The manufacturer may seek Evaluation/Testing certificate of **Lower Fibre Count Cable** mentioned in the respective group. To qualify, the manufacturer must have **certificate** for highest fibre count cable in the particular group.

Note: The group approval for lower size cables may be allowed during approval of higher size cable.

iv) The manufacturer seeking Evaluation/Testing certificate for the **Lower Fibre Count** based upon the fact that he is having Evaluation/Testing certificate for higher fibre count cable shall be required to submit the following:

1) Application in prescribed forms as per the existing Evaluation/Testing certificate Procedures.

2) Compliance statement against each clause of the GR along with construction design details with dimensions.

3) The manufacture shall have manufacture at least 5 cable reels (of 2 km each approx.) of the particular fibre count of the cable for which application for the issue of Evaluation/Testing certificate is made. The manufacturer shall submit the sample of the cable at the time of seeking Evaluation/Testing certificate of **lower fibre count** of cable.

4) A separate application is required to be submitted for the issue of Evaluation/Testing certificate of each type of lower **fibre count** of cable.

5) The manufacture shall submit the actual test results (of the manufactured cable) against each clause of the GR (and as per the requirement of the latest test schedule applicable to the GR). Mere mentioning the word **"Complied"** may not be accepted.

6) The list of the **Raw Materials** used, the make and grade of the raw material and the certificate of source approval issued by CACT or any other recognized laboratory along with the details of the Raw Materials used in the manufacturing of the higher fibre count OF cable for which he is holding valid Evaluation/Testing certificate. Both the raw materials shall be compared and are required to be of same make and grade.

Additional required information from the manufacturer may be sought (regarding manufactured Optical Fibre Cable) and the manufactured cable may be inspected at the manufacturer's premises. After all the above requirements are met, the Evaluation/Testing certificate may be issued to the lower fibre count of the cable, in the respective group, based upon the test results and other details submitted by the manufacturer.

The tariff in each case is fixed as category – II. The first such case may be referred to HQ group for study and any change in the procedure required if any.

The following shall be mentioned in the Remarks column of the Evaluation/Testing certificate while it is issued for the lower fibre count of the cable:

"This certificate is issued on the basis of certificate No. _____ dated _____ for _____ fibre count cables".

The validity of the certificate for Lower Fibre Count Cables shall be restricted to the validity of Evaluation/Testing certificate of higher fibre count cables.

The above procedure shall be applicable only to the approval of ADSS Optical Fibre Cables against the GR No. TEC/GR/TX/OFC-22/02/MAR-17 and subsequent amendments, if any.

LIST OF ABBREVIATIONS

ADSS	-	All Dielectric Self Supporting
ASTM	-	American Society for Testing and Materials
ATPE	-	Anti Track Polyethylene
CACT	-	Component Approval Centre For Telecommunications
dB	-	Decible
EIA	-	Electronic Industries Association
ESCR	-	Environmental Stree Cracking Resistance
FOTP	-	Fibre Optic Test Procedure
FTIR	-	Fourier Transform Infrared Spectroscopy
Gpa	-	Gega Pascal
HDPE	-	High Density Polyethylene
IEC	-	International Electro -Technical Commission
IS	-	Indian Standard
ISO	-	International Standard Organisations
ITU-T	-	International Telecommunication Union – Transmission
KPSI	-	Kilogram Per Sq. Inch
MFD	-	Mode Field Diameter
MSDS	-	Materail Safety Data Sheet

Nm	-	Nanometer
Ps/nm	-	Pico second/Nano meter
Ps	-	Pico second
QA	-	Quality Assurance
UV	-	Ultra Violet
µm	-	Micrometer
°C	-	Degree Celsius

Annexure-A

WET CORE CABLE DESIGN (Without Ice Loading)

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:

S N	Parameter	Unit	12 Fiber OF Cable	24 Fiber OF Cable	48 Fiber OF Cable	96 Fibre OF Cable
1	FRP Rod EAA Coated	Mm	2.3+0.1/-0.0	2.3+0.1/-0.0	2.5+0.1/-0.0	3.0+0.1/-0.0
2	FRP up jacketing thickness	Mm	0	0	0	0.6
3	Tube ID (min)	Mm	1.4	1.4	1.7	1.7
4	Tube OD	Mm	2.2 ± 0.1	2.2 ± 0.1	2.4 ± 0.1	2.4 ± 0.1
5	No of fibre / tube	No	4	4	12	12
6	Color of fibre		BL, OR, GR, , NAT	BL, OR, GR, NAT	BL, OR, GR, BR, SL, WH, RD, BK, YL, VI, PK, NAT	BL, OR, GR, BR, SL, WH, RD, BK, YL, VI, PK, NAT
7	No of loose tubes	No	3	6	4	8
8	Color of loose tubes		BL, OR,GR	BL, OR, GR, BR, SL, WH	BL, OR, GR, BR	BL, OR, GR, BR,SL,WH,RD,BK
9	No of dummy cord	No	3	0	2	0
10	Tube stranding lay over length	Mm	90-110	90-110	90-110	100-120
11	Aramid Yarns-Min	Kg/ Km	10	10	10	13

12	Cable diameter	mm	14.0 ± 0.5	14.0 ± 0.5	14.5 ± 0.5	16.0 ± 0.5
13	Nominal cable weight	Kg/ Km	150-180	150-180	160-190	205-235
14	Cable to be designed to Fiber strain value of.	%	0.1	0.1	0.1	0.1
15	Excess fibre length	%	0.70	0.70	0.70	0.70
16	Cable to be tested at defined load for fiber strain value of	%	0.25	0.25	0.25	0.25

** In case of 96F use of FRP with 4.2mm± 0.1mm diameter can also be allowed in place of up coating option.

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

Annexure-B

WET CORE CABLE DESIGN (With Ice Loading)

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:

S N	Parameter	Unit	12 Fiber OF Cable	24 Fiber OF Cable	48 Fiber OF Cable	96 Fibre OF Cable
1	FRP Rod EAA Coated	mm	2.3+0.1/-0.0	2.3+0.1/-0.0	2.5+0.1/-0.0	3.0+0.1/-0.0
2	FRP up jacketing thickness	mm	0	0	0	0.6
3	Tube ID (min)	mm	1.4	1.4	1.7	1.7
4	Tube OD	mm	2.2 ± 0.1	2.2 ± 0.1	2.4 ± 0.1	2.4 ± 0.1
5	No of fibre / tube	No	4	4	12	12
6	Color of fibre		BL, OR, GR, NAT	BL, OR, GR, NAT	BL, OR, GR, BR, SL, WH, RD, BK, YL, VI, PK, NAT	BL, OR, GR, BR, SL, WH, RD, BK, YL, VI, PK, NAT
7	No of loose tubes	No	3	6	4	8
8	Color of loose tubes		BL, OR,SL	BL, OR, GR, BR, SL, WH	BL, OR, GR, BR	BL, OR, GR, BR,SL,WH,RD,BK
9	No of dummy cord	No	3	0	2	0
10	Tube stranding lay over length	mm	90-110	90-110	90-110	100-120
11	Aramid Yarns-Min	Kg/K	20	20	20	23

		m				
12	Cable diameter	mm	14.5 ± 0.5	14.5 ± 0.5	15.0 ± 0.5	16.5 ± 0.5
13	Nominal cable weight	Kg/Km	160-190	160-190	170-200	215-245
14	Cable to be designed to Fiber strain value of.	%	0.1	0.1	0.1	0.1
15	Excess fibre length	%	0.70	0.70	0.70	0.70
16	Cable to be tested at defined load for fiber strain value of	%	0.25	0.25	0.25	0.25

** In case of 96F use of FRP with 4.2mm± 0.1mm diameter can also be allowed in place of up coating option.

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

Annexure – C

SEMI DRY CORE CABLE DESIGN (Without Ice Loading)

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:

S N	Parameter	Unit	12 Fiber OF Cable	24 Fiber OF Cable	48 Fiber OF Cable	96 Fibre OF Cable
1	FRP Rod EAA Coated	mm	2.3+0.1/-0.0	2.3 +0.1/-0.0	2.5+0.1/-0.0	3.0+0.1/-0.0
2	FRP up jacketing thickness	mm	0	0	0	0.6
3	Tube ID (min)	mm	1.4	1.4	1.7	1.7
4	Tube OD	mm	2.2 ± 0.1	2.2 ± 0.1	2.4 ± 0.1	2.4 ± 0.1
5	No of fibre / tube	No	4	4	12	12
6	Color of fibre		BL, OR, GR, NAT	BL, OR, GR, NAT	BL, OR, GR, BR, SL, WH, RD, NAT	BL, OR, GR, BR, SL, WH, RD, BK, YL, VI, PK, NAT
7	No of loose tubes	No	3	6	4	8
8	Color of loose tubes		BL, OR, SL	BL, OR, GR, BR, SL, WH	BL, OR, GR, BR, SL, WH	BL, OR, GR, BR,SL,WH, RD,BK
9	No of dummy cord	No	3	0	2	0
10	Tube stranding lay over length	mm	90-110	90-110	90-110	100-120
11	Aramid Yarns-Min	Kg/K	10	10	10	13

		m				
12	Cable diameter	mm	14.0 ± 0.5	14.0 ± 0.5	14.5 ± 0.5	16.0 ± 0.5
13	Nominal cable weight	Kg/Km	140-170	140-170	150-180	190-225
14	Cable to be designed to Fiber strain value of.	%	0.1	0.1	0.1	0.1
15	Excess fibre length	%	0.70	0.70	0.70	0.70
16	Cable to be tested at defined load for fiber strain value of	%	0.25	0.25	0.25	0.25

** In case of 96F use of FRP with 4.2mm± 0.1mm diameter can also be allowed in place of up coating option.

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

Annexure – D

SEMI DRY CORE CABLE DESIGN (With Ice Loading)

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:

S N	Parameter	Unit	12 Fiber OF Cable	24 Fiber OF Cable	48 Fiber OF Cable	96 Fibre OF Cable
1	FRP Rod EAA Coated	mm	2.3+0.1/-0.0	2.3+0.1/-0.0	2.5+0.1/-0.0	3.0+0.1/-0.0
2	FRP up jacketing thickness	mm	0	0	0	0.6
3	Tube ID (min)	mm	1.4	1.4	1.7	1.7
4	Tube OD	mm	2.2 ± 0.1	2.2 ± 0.1	2.4 ± 0.1	2.4 ± 0.1
5	No of fibre / tube	No	4	4	12	12
6	Color of fibre		BL, OR, GR, NAT	BL, OR, GR, NAT	BL, OR, GR, BR, SL, WH, RD, BK, YL, VI, PK, NAT	BL, OR, GR, BR, SL, WH, RD, BK, YL, VI, PK, NAT
7	No of loose tubes	No	3	6	4	8
8	Color of loose tubes		BL, OR, SL	BL, OR, GR, BR, SL, WH	BL, OR, GR, BR	BL, OR, GR, BR,SL,WH,RD,BK
9	No of dummy cord	No	3	0	2	0
10	Tube stranding lay over length	mm	90-110	90-110	90-110	100-120

11	Aramid Yarns-Min	Kg/Km	20	20	20	23
12	Cable diameter	mm	14.5 ± 0.5	14.5 ± 0.5	15.0 ± 0.5	16.5 ± 0.5
13	Nominal cable weight	Kg/Km	160-180	160-180	160-190	210-235
14	Cable to be designed to Fiber strain value of.	%	0.1	0.1	0.1	0.1
15	Excess fibre length	%	0.70	0.70	0.70	0.70
16	Cable to be tested at defined load for fiber strain value of	%	0.25	0.25	0.25	0.25

** In case of 96F use of FRP with 4.2mm± 0.1mm diameter can also be allowed in place of up coating option.

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

Annexure –E

DRY DRY CORE CABLE DESIGN (Without Ice Loading)

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:

S N	Parameter	Unit	12 Fiber OF Cable	24 Fiber OF Cable	48 Fiber OF Cable	96 Fibre OF Cable
1	FRP Rod EAA Coated	mm	2.3+0.1/-0.0	2.3+0.1/-0.0	2.5+0.1/-0.0	3.0+0.1/-0.0
2	FRP up jacketing thickness	mm	0	0	0	0.6
3	Tube ID (min)	mm	1.4	1.4	1.7	1.7
4	Tube OD	mm	2.2 ± 0.1	2.3 ± 0.1	2.4 ± 0.1	2.4 ± 0.1
5	No of fibre / tube	No	4	4	12	12
6	Color of fibre		BL, OR, GR, NAT	BL, OR, GR, NAT	BL, OR, GR, BR, SL, WH, RD, , NAT	BL, OR, GR, BR, SL, WH, RD, BK, YL, VI, PK, NAT
7	No of loose tubes	No	3	6	4	8
8	Color of loose tubes		BL, OR, GR	BL, OR, GR, BR, SL, WH	BL, OR, GR, BR, SL, WH	BL, OR, GR, BR,SL,WH,RD,BK
9	No of dummy cord	No	3	0	2	0
10	Tube stranding lay over length	mm	90-110	90-110	90-110	100-120
11	Aramid Yarns-Min	Kg/Km	10	10	10	13

12	Cable diameter	mm	14.0 ± 0.5	14.0 ± 0.5	14.5 ± 0.5	16.0 ± 0.5
13	Nominal cable weight	Kg/Km	135-160	135-160	140-170	185-210
14	Cable to be designed to Fiber strain value of.	%	0.1	0.1	0.1	0.1
15	Excess fibre length	%	0.70	0.70	0.70	0.70
16	Cable to be tested at defined load for fiber strain value of	%	0.25	0.25	0.25	0.25

** In case of 96F use of FRP with 4.2mm± 0.1mm diameter can also be allowed in place of up coating option.

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

Annexure –F

DRY DRY CORE CABLE DESIGN (With Ice Loading)

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:

S N	Parameter	Unit	12 Fiber OF Cable	24 Fiber OF Cable	48 Fiber OF Cable	96 Fibre OF Cable
1	FRP Rod EAA Coated	mm	2.3+0.1/-0.0	2.3+0.1/-0.0	2.5+0.1/-0.0	3.0+0.1/-0.0
2	FRP up jacketing thickness	mm	0	0	0	0.6
3	Tube ID (min)	mm	1.4	1.4	1.7	1.7
4	Tube OD	mm	2.2 ± 0.1	2.2 ± 0.1	2.4 ± 0.1	2.4 ± 0.1
5	No of fibre / tube	No	6	4	12	12
6	Color of fibre		BL, OR, GR, BR, SL, NAT	BL, OR, GR, NAT	BL, OR, GR, BR, SL, WH, RD, NAT	BL, OR, GR, BR, SL, WH, RD, BK, YL, VI, PK, NAT
7	No of loose tubes	No	3	6	4	8
8	Color of loose tubes		BL, OR	BL, OR, GR, BR, SL, WH	BL, OR, GR, BR, SL, WH	BL, OR, GR, BR,SL,WH,RD,BK
9	No of dummy cord	No	3	0	2	0
10	Tube stranding lay over length	mm	90-110	90-110	90-110	100-120
11	Aramid Yarns-Min	Kg/Km	20	20	20	23

12	Cable diameter	mm	14.5 ± 0.5	14.5 ± 0.5	15.0 ± 0.5	16.5 ± 0.5
13	Nominal cable weight	Kg/Km	145-175	145-175	150-180	190-220
14	Cable to be designed to Fiber strain value of.	%	0.1	0.1	0.1	0.1
15	Excess fibre length	%	0.70	0.70	0.70	0.70
16	Cable to be tested at defined load for fiber strain value of	%	0.25	0.25	0.25	0.25

** In case of 96F use of FRP with 4.2mm± 0.1mm diameter can also be allowed in place of up coating option.

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