

ANNEXURE – 4

STANDARD TECHNICAL SPECIFICATIONS OF OPGW

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STANDARD TECHNICAL SPECIFICATIONS OPGW Cabling and Associated Hardware & Fittings

Optical Ground Wire is a dual functioning cable, which combines the functions of grounding and communications. The conductive part of the cable serves to bond adjacent towers to earth ground and shields the high-voltage conductors from lightning strikes. The optical fibers within the cable can be used for high-speed transmission of data, either for the electrical utility's own purposes of protection and control of the transmission line, for the utility's own voice and data communication, or may be leased or sold to third parties to serve as a high-speed fiber interconnection between cities.

1) The scope of OPGW requirement is described as follows:

The scope shall include planning, design, engineering, manufacturing, supply & testing of OPGW cable & associated items and documentation of

- a) 48F OPGW cable
- b) All associated hardware, fittings, and accessories (Tension assembly, Suspension assembly, Vibration dampers, reinforcing rods, Earthing clamps, Downlead clamps etc.) required for installation of OPGW cable.
- c) Joint box for above OPGW cable
- d) Fiber Optic approach cable including associated installation material.
- e) Fiber Optic Distribution Panels (FODP)

2) Optical Fiber Strain and Sag tension:

The OPGW cable the optical Fibers shall experience no strain under all loading conditions defined in IS 802. Zero Fiber strain condition shall apply even after a 25-year cable creep. For this specification, the following definitions shall apply:

- Maximum Working Tension (MWT) is defined as the maximum cable tension at which there is *no Fiber strain*.
- The no Fiber strain condition is defined as fiber strain of less than or equal to 0.05%, as determined by direct measurements through IEC/ ETSI (FOTP) specified optical reflectometry
- The Cable strain margin is defined as the maximum cable strain at which there is no fiber strain.
- The cable Maximum Allowable Tension (MAT) is defined as the maximum tension experienced by the Cable under the worst-case loading condition.
- The cable max strain is defined as the maximum strain experienced by the Cable under the worst-case loading condition.
- The cable Everyday Tension (EDT) is defined as the maximum cable tension on any span under normal conditions.
- The Ultimate Tensile Strength (UTS/ breaking strength) is defined as the

maximum tensile load applied and held constant for one minute at which the specimen shall not break.

While preparing the Sag-tension charts for the OPGW cable the following conditions shall be met:

- a) The Max Allowable Tension (MAT) / max strain shall be less than or equal to the MWT/ Strain margin of the cable.
- b) The sag shall not exceed the earth wire sag in all conditions.
- c) The Max Allowable Tension shall also be less than or equal to 0.45 times the UTS.
- d) The 25-year creep at 25% of UTS (creep test as per IEEE 1138) shall be such that the 25-year creep plus the cable strain at Max Allowable Tension (MAT) is less than or equal to the cable strain margin.
- e) The everyday tension (EDT) shall not exceed 20% of the UTS for the OPGW cable.

The Sag-tension chart of OPGW cable indicating the maximum tension, cable strain and sag shall be calculated and submitted under various conditions mentioned below:

- a. 53° C, no wind and no ice
- b. 32° C, no wind and no ice
- c. 0° C, no wind and no ice
- d. 32° C, full wind and no ice
- e. 32° C, 75% full wind and no ice
- f. 0° C, 2/3rd / 36% of full wind (IS 802:1977 / 1995)

The above cases shall be considered for the spans from 100 m to 600 m or higher span length in the range of 50 m spans. Max. Vertical sag, max. tension and max sag at 0° C & no wind shall be considered in line with the design parameter of transmission line. The full wind load shall be considered as the design wind load for all the specified transmission lines as per relevant IS 802 version and the sag-tension chart shall be submitted considering the transmission lines.

3) OPGW Properties:

Dual-Window Single mode (DWSM), G.652D optical fibers shall be provided in the fiber optic cables. DWSM optical fibers shall meet the requirements defined in Table 1.

Sl NO	Description	Values*
1	Overall diameter	12 mm
2	UTS	92.90 KN
3	Coefficient of linear expansion	13.8×10^{-06}

4	Approximate mass	445kg/km
5	Cross sectional Area	73.48mm ²
* 6	Modulus of elasticity	140 KN/mm ²

Changes subject to approval from Indigrid.

TABLE-1

OPTICAL PARAMETERS			
Seq	Parameter:	Unit:	Particulars:
1.	Fibre manufacturer(s)/Type:		Sterlite Technologies Limited Fiber Type :DWSM G.652D
2.	Fibre production method:		Chemical Vapour Deposition (CVD)
3.	Attenuation Coefficient@ 1310 nm: @ 1550 nm:	dB/km dB/km	≤ 0.35 ≤ 0.21
4.	Attenuation Variation with Wavelength (±25 nm):	dB/km	≤ 0.05
5.	Attenuation at water peak @ 1383 nm	dB/km	≤ 0.35
6.	Point discontinuity @ 1310nm: @ 1550nm:	dB dB	≤ 0.05 ≤ 0.05
7.	Temperature dependence (induced attenuation):	dB	≤ 0.05 (-60°C to +85°C)
8.	Nominal Mode Field Diameter @ 1310 nm: @ 1550 nm:	μm	9.2 10.4
9.	Mode Field Diameter Deviation @ 1310 nm: @ 1550 nm:	μm	±0.4 ±0.8
10.	Mode field non-circularity:	%	≤ 6.0
11.	Chromatic Dispersion Coefficient @ 1310 (1288-1339) nm: @ 1310 (1271-1360) nm: @ 1550 nm:	Ps/nm.km	≤ 3.5 ≤ 5.3 ≤ 18
12.	Zero dispersion wavelength:	nm	1300 ~ 1324
13.	Zero dispersion Slope:	ps/nm ² .km	≤ 0.092
14.	Cutoff wavelength:	nm	≤ 1260
15.	Refractive Index :		1.4670 @1310 nm & 1.4675 @1550 nm

4) Applicable Codes:

The following standards and codes shall be generally applicable to the equipment and works supplied under this Contract:

American Society for Testing and Materials ASTM

ASTM-B415 Standard Specification for Hard-Drawn Aluminium-Clad Steel Wire

Bell Communication Research

GR-20 Generic requirements for optical Fiber and optical Fiber cable

ITU-T/CCITT Recommendations

G.650 Definitions and test methods for the relevant parameters of single-mode fibers.

G.652 Characteristics of a single-mode optical Fiber cable

IEEE

IEEE-1138, 2009 IEEE Standard for Testing and Performance for Optic Ground Wire (OPGW) for Use on Electric Utility power Lines

Telecommunication Industry Association EIA/TIA

EIA/TIA-455-3	Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components
EIA/TIA-455-16	Salt Spray (Corrosion) Test for Fiber Optic Components
EIA/TIA-455-20	Measurement of Change in Optical Transmittance
EIA/TIA-455-25	Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies
EIA/TIA-455-32	Fiber Optic Circuit Discontinuities
EIA/TIA-455-33	Fiber Optic Cable Tensile Loading and Bending Test
EIA/TIA-455-41	Compressive Loading Resistance of Fiber Optic Cables
EIA/TIA- 455-59	Measurement of Fiber Point Defects Using an OTDR
EIA/TIA-455-62	Measurement of Optical Fiber Macro Bend Attenuation
EIA/TIA-455-78	Spectral Attenuation Cutback Measurement for Single- Mode Optical Fibers
EIA/TIA-455-80	Measurement of Cut-Off Wavelength of Single-Mode Fiber by Transmitted Power
EIA/TIA-455-81	Compound Flow (Drip) Test for Filled Fiber Optic Cable
EIA/TIA-455-82	Fluid Penetration Test for Fluid-Blocked Fiber optic Cable
EIA/TIA-455-91	Fiber Optic Cable Twist-Bend Test
EIA/TIA-455-164	Single-Mode Fiber, Measurement of Mode Field Diameter by Far-Field Scanning
EIA/TIA-455-167	Mode Field Diameter Measurement, Variable Aperture Method in the Far-Field
EIA/TIA-455-168	Chromatic Dispersion Measurement of Multimode Graded Index

	and Single-Mode Optical Fibers by Spectral Group Delay Measurement in the Time Domain
EIA/TIA-455-169	Chromatic Dispersion Measurement of Single-Mode Optical Fibers by the Phase-Shift Method
EIA/TIA-455-170	Cable Cut-off Wavelength of Single-Mode Fiber by Transmitted Power
EIA/TIA-455-174	Mode Field Diameter Measurement
EIA/TIA-455-175	Chromatic Dispersion Measurement of Single-Mode Optical Fibers by the Differential Phase-Shift Method
EIA/TIA-455-176	Method of Measuring Optical Fiber Cross-Sectional Geometry by Automated Grey-Scale Analysis
EIA/TIA-598	Optical Fiber Cable Colour Coding

International Electrotechnical Commission IEC standards

IEC-60793-1	Optical Fiber Cables – Generic specifications.
IEC-60794-2	Optical Fiber Cables – Generic specifications.
IEC-60794-1-2	Optical Fiber Cables – Basic optical cable test procedure.
IEC-60794-3	Optical Fiber Cables – Duct buried and aerial cable- sectional specifications.
IEC-60794-4	Optical Fiber cables – Overhead cables.
IEC-60794-4-10	Aerial optical cables along electrical power lines – Family specifications for OPGW
IEC-61089	Round wire concentric lay overhead electrical stranded conductor.
IEC-61232	Aluminum-clad steel wires for electrical purposes.
IEC-61284	Overhead Lines-Requirements and tests for fittings.
IEC-61395	Overhead electrical conductors – Creep test procedures for stranded conductors.
ITU-T G.652	Characteristics of a single -mode optical fiber cable.
ITU-T G.655	Characteristics of non – zero dispersion- shifted single -mode optical fiber cable.

Specifications and codes shall be the latest version, inclusive of revisions, which are in force at the date of the contract award. Where new specifications, codes, and revisions are issued during the period of the contract, the Contractor shall attempt to comply with such, provided that no additional expenses are charged to the Employer without Employer's written consent.

In the event the Contractor offers to supply material and/or equipment in compliance to any standard other than Standards listed herein, the Contractor shall include with their proposal, full salient characteristics of the new standard for comparison.

In case values indicated for certain parameters in the specifications are more stringent than those specified by the standards, the specification shall override the standards.

OPGW Hardware

1) Installation Hardware

Installation Hardware includes all required fittings and hardware such as Tension assembly, Suspension assembly, Vibration dampers, Reinforcing rods, Earthing clamps, Downlead clamps, splice enclosure etc.

The OPGW hardware fittings and accessories shall follow the general requirements regarding design, materials, dimensions & tolerances, protection against corrosion and markings as specified in clause 4.0 of EN 61284: 1997 (IEC 61284). The shear strength of all bolts shall be at least 1.5 times the maximum installation torque. The OPGW hardware & accessories drawing & Data Requirement Sheets (DRS) document shall consist of three parts: (1) A technical particulars sheet (2) An assembly drawing i.e. level 1 drawing and (3) Component level drawings i.e. level 2 & lower drawings. All component reference numbers, dimensions and tolerances, bolt tightening torques & shear strength and ratings such as UTS, slip strength etc. shall be marked on the drawings.

The fittings and accessories described herein are indicative of installation hardware typically used for OPGW installations and shall not necessarily be limited to the following:

1.1 Suspension Assemblies:

Preformed armour grip suspension clamps and aluminium alloy armour rods/ reinforcing rods shall be used. The suspension clamps shall be designed to carry a vertical load of not less than 25 kN. The suspension clamps slippage shall occur between 12kN and 17 kN as measured. For river crossing and special transmission lines (where heavier earthwire used e.g. 7/4.5) OPGW installation hardware design slippage shall occur between 9% and 14% of UTS of OPGW.

The Contractor shall supply all the components of the suspension assembly including shackles, bolts, nuts, washers, split pins, etc. The total drop of the suspension assembly shall not exceed 150 mm (measured from the centre point of attachment to the centre point of the OPGW). The design of the assembly shall be such that the direction of run of the OPGW shall be the same as that of the conductor.

1.2 Dead End Clamp Assemblies:

All dead-end clamp assemblies shall preferably be of performed armoured grip type and shall include all necessary hardware for attaching the assembly to the tower strain plates. Dead end clamps shall allow the OPGW to pass through continuously without cable cutting. The slip strength shall be rated not less than 95% of the Ultimate tensile strength of the OPGW.

1.3 Clamp Assembly Earthing Wire:

Earthing wire consisting of a 1500 mm length of aluminium or aluminium alloy conductor equivalent in size to the OPGW shall be used to earth suspension and dead-end clamp assemblies to the tower structure. The earthing wire shall be permanently fitted with lugs at each end. The lugs shall be attached to the clamp assembly at one end and the tower structure at the other.

1.4 Structure Attachment Clamp Assemblies:

Clamp assemblies used to attach the OPGW to the structures, shall have two parallel grooves for the OPGW, one on either side of the connecting bolt. The clamps shall be such that clamping characteristics do not alter adversely when only one OPGW is installed. The tower attachment plates shall locate the OPGW on the inside of the tower and shall be attached directly to the tower legs/cross-members without drilling or any other structural modifications.

1.5 Tension Fitting for Suspension Tower:

The OPGW cable sections shall also be terminated & spliced on suspension towers as per requirement. For this, a special fitting, namely Yoke plate along with tension fittings shall be provided for termination/jointing of OPGW on Suspension tower.

1.6 Vibration Dampers:

Vibration dampers type 4R Stockbridge or equivalent, having four (4) different frequencies spread within the Aeolian frequency bandwidth corresponding to wind speed of 1m/s to 7 m/s, shall be used for suspension and tension points in each span. The Contractor shall determine the exact numbers and placement(s) of vibration dampers through a detailed vibration analysis.

One damper minimum on each side per OPGW cable for suspension points

and two dampers minimum on each side per OPGW cable for tension points shall be used for nominal design span of 400 meters. For all other ruling spans, the number of vibration dampers shall be as per manufacturer recommendation and damper placement chart.

The clamp of the vibration damper shall be made of high strength aluminum alloy of type LM-6. It shall be capable of supporting the damper and prevent damage or chaffing of the conductor during erection or continued operation. The clamp shall have smooth and permanent grip to keep the damper in position on the OPGW cable without damaging the strands or causing premature fatigue failure of the OPGW cable under the clamp. The clamp groove shall be in uniform contact with the OPGW cable over the entire clamping surface except for the rounded edges. The groove of the clamp body and clamp cap shall be smooth, free from projections, grit or other materials which could cause damage to the OPGW cable when the clamp is installed. Clamping bolts shall be provided with self-locking nuts and designed to prevent corrosion of threads or loosening in service.

The messenger cable shall be made of high strength galvanized steel/stainless steel. It shall be of preformed and post formed quality to prevent subsequent drop of weight and to maintain consistent flexural stiffness of the cable in service. The messenger cable other than stainless steel shall be hot dip galvanized in accordance with the recommendations of IS: 4826 for heavily coated wires.

The damper mass shall be made of hot dip galvanized mild steel/cast iron or a permanent mould cast zinc alloy. All castings shall be free from defects such as cracks, shrinkage, inclusions and blow holes etc. The surface of the damper masses shall be smooth.

The damper clamp shall be casted over the messenger cable and offer sufficient and permanent grip on it. The messenger cable shall not slip out of the grip at a load less than the mass pull-off value of the damper. The damper masses made of material other than zinc alloy shall be fixed to the messenger cable in a suitable manner in order to avoid excessive stress concentration on the messenger cables which shall cause premature fatigue failure of the same. The messenger cable ends shall be suitably and effectively sealed to prevent corrosion. The damper mass made of zinc alloy shall be casted over the messenger cable and have sufficient and permanent grip on the messenger cable under all service conditions.

The contractor must indicate the clamp bolt tightening torque to ensure that the slip strength of the clamp is maintained between 2.5 kN and 5 kN. The clamp when installed on the OPGW cable shall not cause excessive stress concentration on the OPGW cable leading to permanent deformation of the OPGW strands and premature fatigue failure in operation.

The vibration analysis of the system, with and without damper and dynamic characteristics of the damper as detailed in Technical Specification, shall have to be submitted. The technical particulars for vibration analysis and damping design of the system are as follows:

Sl. No.	Description	Technical Particulars
1	Span Length in meters	400 meters
	Ruling design span:	1100 meters
	Maximum span:	
	Minimum Span:	100 meters
2	Configuration:	Vertical
3	Tensile load in each:	As per sag tension calculations
4	Armour rods used:	Standard preformed armour rods/AGS
5	Maximum permissible dynamic strain:	+/- 150 micro strains

The damper placement chart for spans ranging from 100m to 1100m shall be submitted by the Contractor. Placement charts should be duly supported with sample calculations and manufacturer recommendations.

The damper placement charts shall include the following
Location of the dampers for various combinations of spans and line tensions clearly indicating the number of dampers to be installed per OPGW cable per span.

Placement distances clearly identifying the extremities between which the distances are to be measured.

Placement recommendation depending upon type of suspension clamps (viz Free center type/Armour grip type etc.)

1.7 Joint BOX:

All splices shall be encased in Fiber Optic Splice Enclosures. Suitable splice enclosures shall be provided to encase the optical cable splices in protective, moisture and dust free environment. Splice enclosures shall comply with ingress protection class IP 66 or better. The splice enclosures shall be designed for the storage and protection of the required number of optical Fiber splices and

equipped with sufficient number of splice trays for splicing all Fibers in the cable. No more than 12 Fibers shall be terminated in a single splice tray. They shall be filled with suitable encapsulate that is easily removable should re-entry be required into the enclosures.

Splice enclosures shall be suitable for outdoor use with each of the cable types provided under this contract. Splice enclosures shall be appropriate for mounting on transmission line towers above anti-climb guard levels at about 10 metres from top of the tower and shall accommodate pass-through splicing. The actual mounting height and location shall be finalized after Survey

1.8 Optical Fiber Splices

Splicing of the optical Fiber cabling shall be minimized through careful Contractor planning. There shall be no mid-span splices allowed. All required splices shall be planned to occur on tower structures. All optical Fiber splicing shall comply with the following:

- a) All Fiber splices shall be accomplished through fusion splicing.
- b) Each Fiber splice shall be fitted with a splice protection sheath fitted over the final splice.
- c) All splices and bare Fiber shall be neatly installed in covered splice trays.
- d) For each link, bi-directional attenuation of single mode fusion splices, shall not average more than 0.05 dB and no single splice loss shall exceed 0.1 dB when measured at 1550 nm.
- e) For splicing, Fiber optic cable service loops of adequate length shall be provided so that all splices occurring at tower structures can be performed at ground level.

1.9 Fiber Optic Approach Cables

For purposes of this specification, a Fiber optic approach cable is defined as the Armoured underground Fiber optic cable required to connect Overhead Fiber Optic Cable (OPGW) between the final in line splice enclosure on the gantry / tower forming the termination of the Fiber cable on the power line and the Fiber Optic Distribution Panel (FODP) installed within the building. The estimated Fiber optic approach cabling length requirements are indicated in the BoQ. Actual supply to be done as per directives of Project Manager.

2) Basic Construction

The cable shall be suitable for direct burial, laying in trenches & PVC/Hume ducts, laying under false flooring and on indoor or outdoor cable raceways.

2.1 Jacket Construction & Material

The Approach Cable shall be a UV resistant, rodent proof, armoured cable with metallic type of armouring. The outer cable jacket for approach cable shall consist of carbon black polyethylene resin to prevent damage from exposure to ultra-violet light, weathering and high levels of pollution. The jacket shall conform to ASTM D1248 for density.

2.2 Optical, Electrical and Mechanical Requirements

Approach cable shall contain Fibers with identical optical/physical characteristics as those in the OPGW cables. The cable core shall comprise of tensile strength member(s), Fiber support/bedding structure, core wrap/bedding, and an overall impervious jacket.

2.3 Fiber Optic Approach Cable Installation hardware

At all locations, approach cable shall be laid within PLB HDPE duct along with necessary accessories such as pushfit coupler, end cap, cable bends etc.

2.4 Optic Distribution Panel

At each location requiring the termination of at least one Fiber within a cable, all Fibers within that cable shall be connectorized and terminated in Fiber Optic Distribution Panels in a manner consistent with the following:

- a) All Fiber optic terminations shall be housed using FODPs provisioned with splice organizers and splice trays. All Fibers within a cable shall be fusion spliced to preconnectorized pigtails and fitted to the "Back-side" of the provided Fiber optic couplings.
- b) FODPs shall be suitable for use with each of the cable types provided as part of this contract. FODPs shall accommodate pass-through splicing and Fiber terminations. No more than 12 Fibers shall be terminated in a single splice tray.
- c) FODPs shall be supplied in suitable cabinets/racks with locking arrangements. The dimension of FODP cabinet shall be minimum 2200mm x 600mm x 600mm (HxWxD) and shall meet or exceed ingress protection class IP55 specifications.
- d) All FODPs shall be of corrosion resistant, robust construction and shall allow both top or bottom entry for access to the splice trays. Ground lugs shall be provided on all FODPs and the Contractor shall ensure that all FODPs are properly grounded.

- e) Flexible protection shall be provided to the patch cord bunches going out from FODP to other equipment.

2.5 Optical Fiber Connectors

Optical Fibers shall be connectorized with FC-PC type connectors preferably. Alternatively, a connector with matching patch cord shall also be acceptable. Fiber optic couplings supplied with FODPs shall be appropriate for the Fiber connectors to be supported. There shall be no adapters.

3) Testing and Inspection

All materials furnished and all work performed under this Contract shall be inspected and tested. Deliverables shall not be shipped until all required inspections and tests have been completed, and all deficiencies have been corrected to comply with this Specification and approved for shipment by the Employer.

The entire cost of testing for factory & site acceptance, routine tests, production tests and other test during manufacture & site activities specified herein shall be treated as included in the quoted unit price of materials, except for the expenses of Inspector/Employer's representative.

Acceptance or waiver of tests shall not relieve the Contractor from the responsibility to furnish material in accordance with the specifications.

All tests shall be witnessed by the Employer and/or its authorized representative (hereinafter referred to as the Employer) unless the Employer authorizes testing to proceed without witness. The Employer representative shall sign the test form indicating approval of successful tests.

Should any inspections or tests indicate that specific item does not meet Specification requirements, the appropriate items shall be replaced, upgraded, or added by the Contractor as necessary to correct the noted deficiencies at no cost to the Employer. After correction of a deficiency, all necessary retests shall be performed to verify the effectiveness of the corrective action.

The Employer reserves the right to require the Contractor to perform, at the Employer's expense, any other reasonable test(s) at the Contractor's premises, on site, or elsewhere in addition to the specified Type, Acceptance, Routine, or Manufacturing tests to assure the Employer of specification compliance.

All security related features shall be demonstrated during FAT/SAT as required by the Employer.

4) Type test

"Type Tests" shall be defined as those tests which are to be carried out to prove the design, process of manufacture and general conformity of the materials to this Specification. Type Testing shall comply with the following:

- a) All cable & equipment being supplied shall conform to type tests as per technical specification.
- b) Validity period of type tests conducted on the equipment i.e. the period for which Type Test Reports shall remain valid and acceptable to employer provided no major change has been introduced in the basic design/technology/material/mechanical construction/functionalities of the equipment/ performance characteristic/manufacturing process of the equipment, is as mentioned below:

S.No	Name of Equipment	Periodicity (in years)
1	OPGW and its Hardware fittings & accessories / Fiber Optic Cable (Approach cable)	5
2	Telecom Equipment and all other items.	5
3	DCPS / Battery & Battery Chargers	7

4.1 Type Test Samples

The Contractor shall supply equipment/material for sample selection only after the Quality Assurance Plan has been approved by the Employer. The sample material shall be manufactured strictly in accordance with the approved Quality Assurance Plan. The Contractor shall submit for Employer approval, the type test sample selection procedure. The selection process for conducting the type tests shall ensure that samples are selected at random. At least three samples of each of the proposed equipment/item/cable drum except FO cable installation hardware & fittings shall be offered for selection. For FO cable installation hardware & fittings at least ten (10) samples shall be offered for selection.

4.2 List of Type Test

The type testing shall be conducted on the following equipment/items

- (a) Optical Fibers
- (b) OPGW Cable

- (c) OPGW Cable fittings
- (d) Vibration Damper
- (e) Splice Enclosure (Joint Box)
- (j) Approach Cable

4.3 Optical Fiber Type Test

The type tests listed below in table shall be conducted on DWSM Fibers to be supplied as part of overhead cables. The tests specific to the cable type are listed in subsequent sections.

S. No.	Test Name	Test procedure
1	Attenuation	IEC 60793-1-40 Or EIA/TIA 455-78A
2	Attenuation Variation with Wavelength	IEC 60793-1-40 Or EIA/TIA 455-78A
3	Attenuation at Water Peak	IEC 60793-1-40 Or EIA/TIA 455-78A
4	Temp. Cycling (Temp dependence of Attenuation)	IEC 60793-1-52 Or EIA/TIA 455-3A, 2 cycles
5	Attenuation With Bending (Bend Performance)	IEC 60793-1-47 Or EIA/TIA 455-62A
6	Mode Field dia.	IEC 60793-1-45 Or EIA/TIA 455-164A/167A/174
7	Chromatic Dispersion	IEC 60793-1-42 Or EIA/TIA 455-168A/169A/175A
8	Cladding Diameter	IEC 60793-1-20 Or EIA/TIA 455-176
9	Point Discontinuities of attenuation	IEC 60793-1-40 Or EIA/TIA 455-59
10	Core -Clad concentricity error	IEC 60793-1-20 Or EIA/TIA 455-176
11	Fiber Tensile Proof Testing	IEC 60793-1-30 Or EIA/TIA 455-31B

4.4 Type Tests for OPGW Cables

The type tests to be conducted on the OPGW cable are listed in Table 3-4 Type Tests for OPGW Cables. Unless specified otherwise in the technical specifications or the referenced standards, the optical attenuation of the specimen measured during or after the test as applicable, shall not increase by more than 0.05 dB/Km.

S. No.	Test Name	Test Description	Test Procedure
1	Water Ingress Test	IEEE 1138-2009	IEEE 1138-2009 Method 6.4.3.5
2	Seepage of filling compound	IEEE 1138-2009	IEEE 1138-2009 Method 6.4.3.6
3	Short Circuit Test	IEEE 1138-2009	IEEE 1138-2009 Method 6.4.3.3
4	Aeolian Vibration Test	IEEE 1138-2009	IEEE 1138-2009 Method 6.4.3.1
5	Galloping test	IEEE 1138-2009	IEEE 1138-2009 Method 6.4.3.2
6	Cable Bend Test	IEEE 1138-2009	IEEE 1138-2009 Method 6.4.2.3
7	Sheave Test	IEEE 1138-2009	IEEE 1138-2009 Method 6.4.2.1
8	Crush Test	IEEE 1138-2009	IEEE 1138-2009 Method 6.4.2.2
9	Twist Test	IEEE 1138-2009	IEEE 1138-2009 Method 6.4.2.4
10	Creep Test	IEEE 1138-2009	IEEE 1138-2009 Method 6.4.1.1
11	Strain Margin Test	IEEE 1138-2009	IEEE 1138-2009 Method 6.4.1.3
12	Stress Strain Test	IEEE 1138-2009	IEEE 1138-2009 Method 6.4.1.2
13	Temperature Cycling Test	IEEE 1138-2009	IEEE 1138-2009 Method 6.4.3.7
14	Corrosion (Salt Spray) Test	IEEE 1138-2009	IEEE 1138-2009 Method 6.4.3.8
15	Ultimate Tensile Strength Test	IEEE 1138-2009	IEEE 1138-2009 Method 6.4.1.4
16	Lightning Arc Test	IEEE 1138-2009	IEEE 1138-2009 Method 6.4.3.4
17	DC Resistance Test	IEEE 1138-2009	IEEE 1138-2009 Method 6.4.1.5

4.5 Type Test on OPGW Cable Fittings

- a) The type tests to be conducted on the OPGW Cable fittings and accessories are listed below:
- b) Mechanical Strength Test for Suspension/Tension Assembly- Applicable Standards: IEC 61284, 1997.
- c) Clamp Slip Strength Test for Suspension Assembly
- d) Grounding Clamp and Structure Mounting Clamp Fit Test
- e) Structure Mounting Clamp Strength Test

4.6 Type Test on Vibration Damper

S. No.	Test Name	Test Procedure
1	Vibration Analysis	
2	Fatigue Test	
3	Visual examination & Dimensional and material verification	IEC 61897 Clause 7.1 & 7.2
4	Clamp Slip test	IEC 61897 Clause 7.5
5	Clamp bolt tightening test	IEC 61897 Clause 7.7
6	Attachments of weights to messenger cable	IEC 61897 Clause 7.8
7	Attachment of clamps to messenger cable	IEC 61897 Clause 7.8
8	Damper effectiveness evaluation	IEC 61897 Clause 7.11.3.2

4.7 Type Tests for Splice Enclosures (Joint Box)

- a) Temperature Cycling Test
- b) Humid Heat test
- c) Water Immersion test
- d) Vibration Test
- e) Bending and Torsion test
- f) Tensile test
- g) Drop Test

4.8 Type Tests for Fiber Optic Approach Cable:

S. No.	Test Name	Test Procedure
1	Water Ingress Test	(IEC 60794-1-F5 / EIA 455-82B) Test duration: 24 hours
2	Seepage of filling compound	(EIA 455-81A) Preconditioning: 72 hours, Test duration: 24 hours.
3	Crush Test	(IEC 60794-1-E3/ EIA 455-41)
4	Impact Test	(IEC-60794-1-E4/ EIA 455-25A)
5	Stress strain Test	(EIA 455-33A)
6	Cable Cut-off wavelength Test	(EIA 455-170)
7	Temperature Cycling Test	(IEC60794-1-F1/EIA-455-3A) – 2 cycles