Appendix - E

Guidelines for Splicing of Fibre Optic Cable

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1. General

OPGW based Fibre Optic network being established by Power Utilities for catering data & voice communication requirements. OPGW is being supplied in number of drums for a link and required splicing for completing of a fibre optic link. Generally fusion method is being used for splicing of fibres in cable. For carrying out splicing work, experienced personnel is essential for handling splicing kit and necessary instruments such as OTDR etc.

a) Jointing of OPGW is usually carried out on the ground. For ease of jointing with accuracy, adequate space (with tent) to be ensured on the ground for jointer and equipment. This floor space should be protected against the heavy wind, strong sunshine, high temperature, rain and dusty atmosphere.

b) Attention must be paid so as not to damage OPGW including its optical components during handling, cutting, un-stranding of component wires and jointing.

c) Attenuation of optical fibers to be measured just before splicing and after splicing.

d) Typical organization chart for jointing work is given below:

A. Jointing In charge

-1 A.1 For Testing:

(i) Lineman – 1

(ii) Jointer & Tester – 1

(iii) Unskilled labor -1

A.2 For Jointing :

(i) Lineman- 1

(ii) Jointer & Tester – 1

(iii) Unskilled labor -1

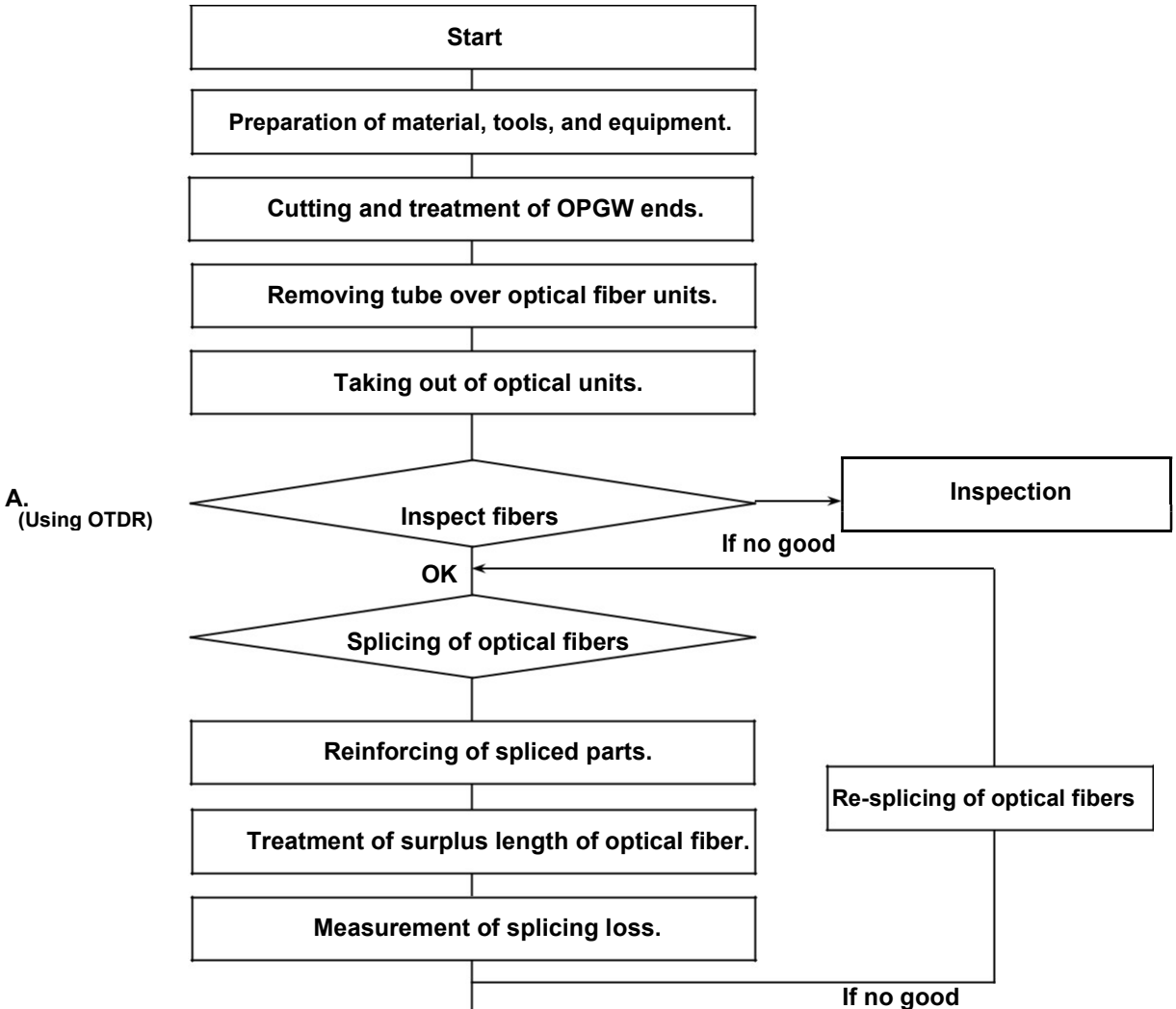
2. Jointing of optical fibre

Optical fibre are joined by using Fusion splicing. It is the process of fusing or welding two fibers together usually by an electric arc. Fusion splicing is the most widely used method of splicing as it provides for the lowest loss and least reflectance, as well as providing the strongest and most reliable joint between two fibers.



3. Flowchart of jointing procedure.

Process flow chart of OPGW jointing works is summarized briefly, as below:



Sealing and closing of the joint box

Installation of the joint box

End

4. Jointing works

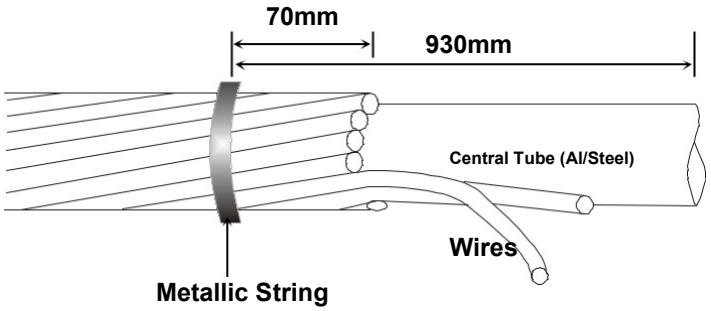
a) Preparation of materials, tools and equipment

It may be ensured that all the materials, tools and equipment listed in the Table-1 are available. The Table-1 shows tentative list of required tools & material.

b) Cutting and treatment of OPGW ends

Coiled OPGW to be brought down and cut-off unnecessary lengths of the OPGW with a cable cutter.

Put marks on OPGW at positions where OPGW is to be fixed to the glands of the joint box. Carryout mounting of OPGW at a position about 70mm below the cutting mark with a metallic string to prevent the stranded wires from becoming loose after cutting off the OPGW.



Notch the Strand wires of the OPGW with a hacksaw to the depth of 1/3 or 1/2 of the Strand wire diameter. In this case, take care not to damage the inside Central Tube (AL/Steel) of the OPGW. Loose the Strand wires from the OPGW ends one by one and snap them off at the notched position. Cut the Central Tube (AL/Steel).

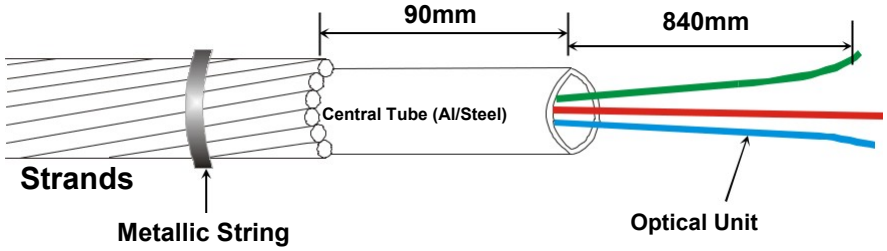


Table-1: Tools & Material

Description	Qt'y	Purpose
Stabilized light source	1	Measure loss
Optical power meter	1	Measure loss
Dummy fiber	1	Measure loss
Fusion splicer	1	Splicing fiber
Fiber cutter	2	Cutting fiber
Jacket stripper	2	Remove fiber jacket
Washing agent	2	Cleaning fiber
Ethyl alcohol	2	Cleaning fiber
Gauze	1 Set	Cleaning fiber
Dust remove	1	Cleaning splicer
Cable cutter	1	Cutting OPGW
Hacksaw	1	Cutting AW wire
Pipe cutter	1	Cutting al tube
Knife	1	
Screw driver set(+,-)	1	
Pliers	2	
Light stand	1	Lighting
Hexagon wrench	1	
Portable telephone set	2	
Engine generator(If need)	1	Power supply
OTDR	1	
Electric reel	1	
Optical telephone set	2	
Electric cord	1	

c) Fixing OPGW in the Passcable (see the Figure 4. for main assembling particulars)

Insert OPGW in the passcable until OPGW touch the internal clamping or until the Central Tube (AL/Steel) is outside from the passcable of about 90 mm.

Lock the moving clamping with torque force of 12 NM, like a Figure 5.

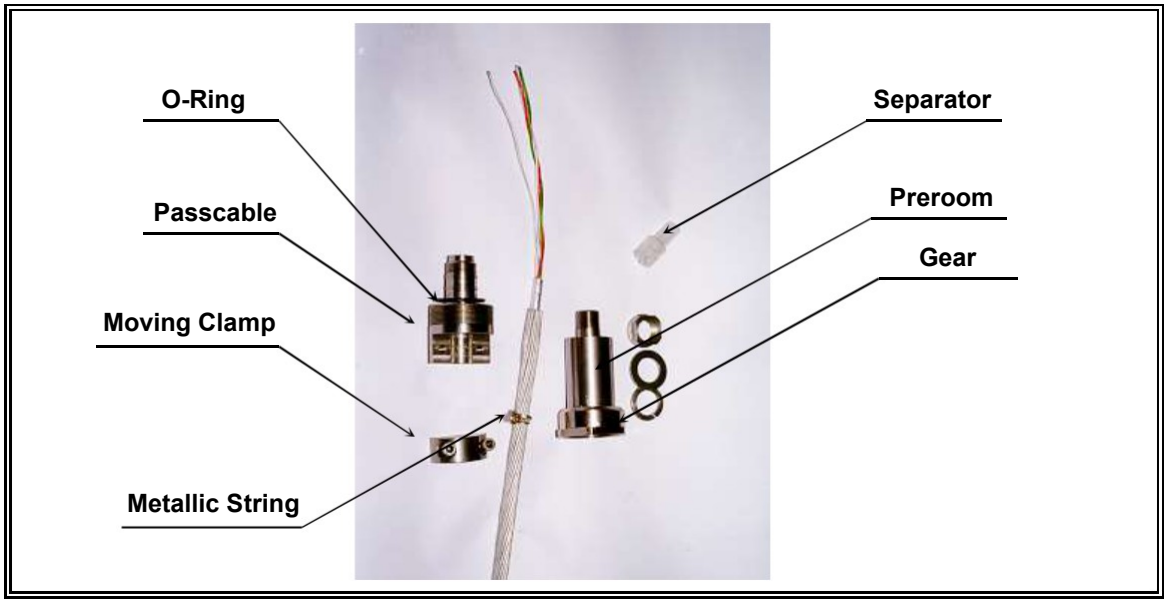


Fig. 4

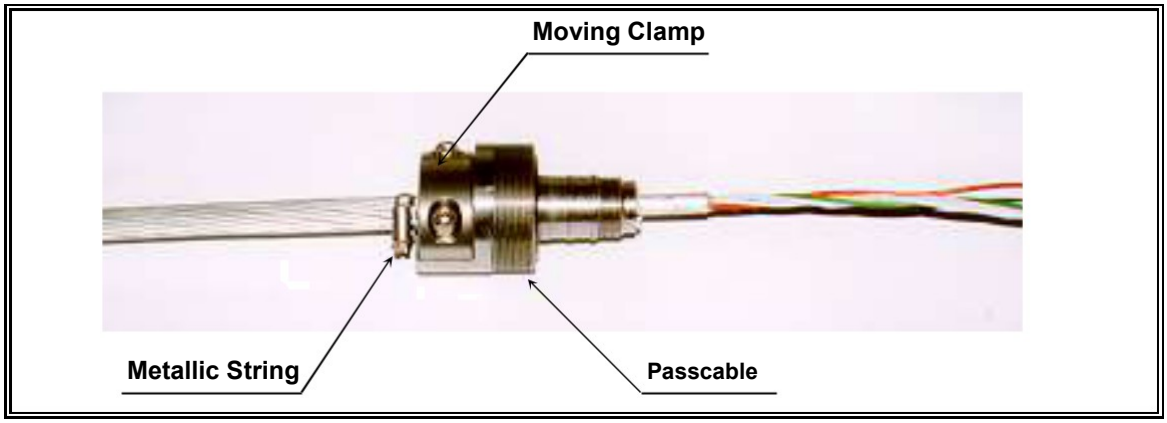


Fig. 5

d) Application of thermo-shrinkable tube

Cover the Central Tube (AL/Steel) with aluminium sheet and put the thermo-shrinkable tube with heating gun

or lamp, like a Figure 6.

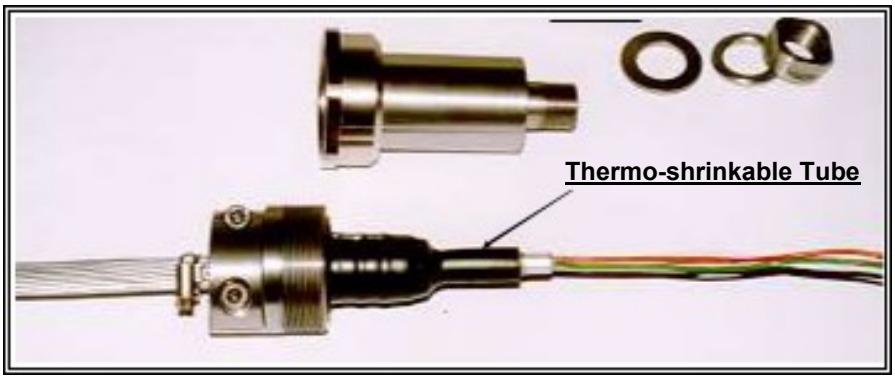


Fig. 6

e) Application of the preroom

Lock the passcable to the preroom.

Screw down the preroom to the passcable.

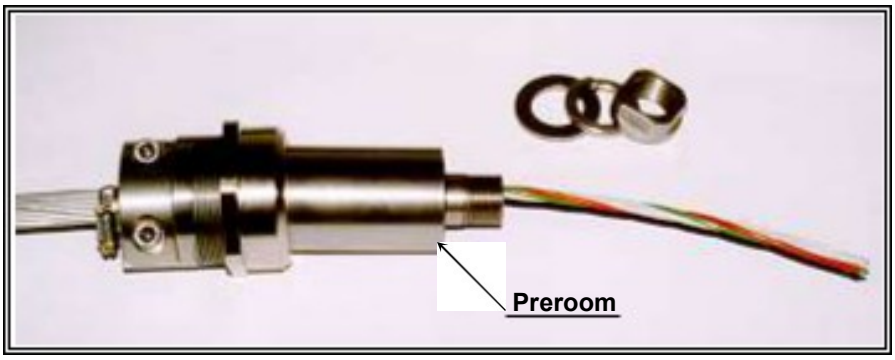


Fig. 7

f) Fixing of the preroom

Put the preroom in the hole of the splice enclosure base.

Give attention that the O-ring is in the right position and fix with the torque force of 50 NM

g) Taking out of optical units

Remove the PBT tube of optical units leaving a suitable distance (around 1m) from the edge of the AL tube.

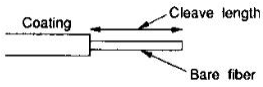
Make each optical unit into loops of about 5 to 10 cm diameter, and stick these optical unit loops at a suitable

position on the joint box with plastic adhesive tape in order to ensure that the optical unit is not damaged during splicing work.

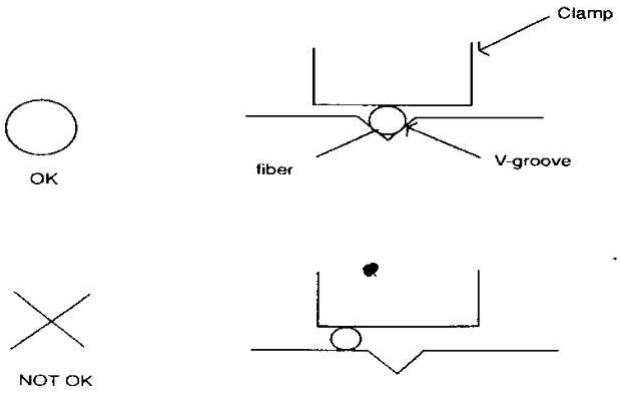
h) Splicing of optical fibers.

Cleave length

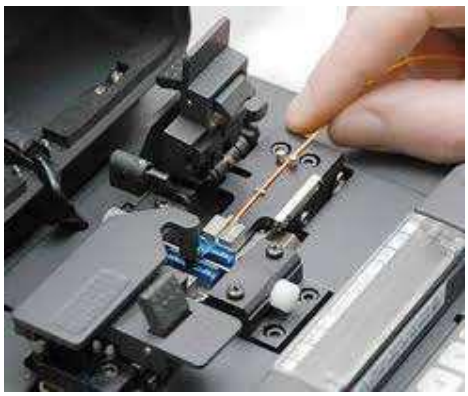
Bare fiber length should be 16mm ±5 after cleaving.



Remove the fiber coating. Clean the fiber and then cleave the bare fiber to the predetermined length. Slip a protection sleeve over one of the two fibers for reinforcement after splicing. Set the prepared fiber in the v grooves as shown in the figure below.



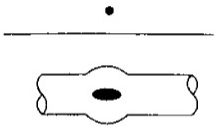
Clamp the prepared fiber exactly by pushing the clamp lever. After clamping the right and left fibers, close the hood. Make sure that the prepared fiber is not trapped by the hood, and not caught by any other part of the machine.



Evaluate the splice.

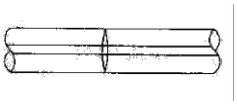
The evaluation of the splicing should be done by the splicing loss and the external appearance at the splice point.

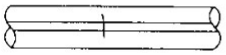
(1) Splicing having the following appearance shall be rejected.

Bubble 	**Be sure to remove this type of splice, because the splice loss can be extremely high.** **Caused by** **1. Dust on fiber end** **2. Condensing** **3. Bad cleaving** **4. Pre-fusion time is too short.** **5. Arc power is too strong.**
Thick black line 	**In this case, make re-fusion by ARC Switch, and check it again.(*)**
Black shadow 	

(*) **In the case where fluorine doped fiber is splicer, a black line will always appear at the splicing point, but does not cause any damage to the characteristics of the optical transmission.**

(2) The following splices are acceptable, even if the external appearance at the splice point does not look good.

White line 	**It is all right if the estimated splice loss is within the specified value.** **This is due to optical causes upon observation, and there is no effect on the splice characteristics.**

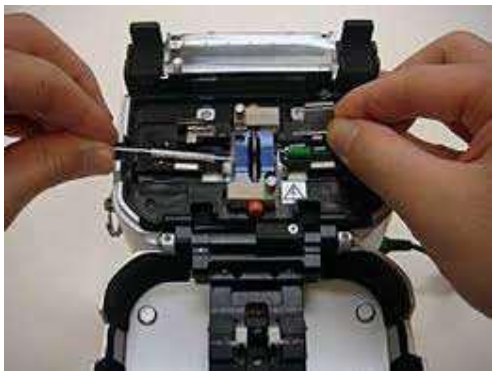
Blurred thin line 	**Same as above**
	**Because of core alignment, this is possible for fiber with large core eccentricity.**
	**This appearance is due to differences in fiber diameter.**

When the spliced portion is required to be observed in detail, "FIELD CHANGE" and "FOCUS UP" and "FOCUS DOWN" SW on top mounted console panel are useful.

i) Reinforcing of spliced parts.

(I) Open the heater cover, the left fiber clamp and right fiber clamp

(II) Open the hood, take out the spliced portion, close the hood, and press the "RESET" SW.



(III) Slide fiber protection sleeve over the spliced portion.

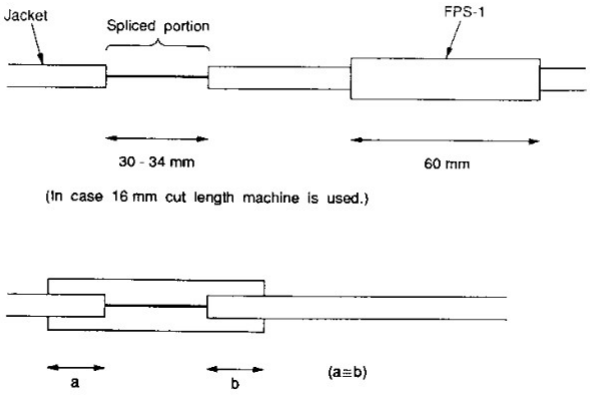


Fig. 5

Note

Make sure fiber coating is clean.

Put the sleeve over the splice as shown in Fig. 5. Don't twist the fiber.

Protection sleeve should be straight.

(IV) Apply a slight tension and place the splice in the heater, close the right hand heater clamp by pressing down with the right hand fiber.

(V) Next, close the left hand heater clamp while pulling the fiber slightly, and close the heater cover.

Note

Fiber should be straight.

Make sure that there is no dust, or jelly in the protection sleeve.

(VI) Press the "HEATER SET" SW, and the "working" indicator will light up.



Fig. 5

(VII) After the tensile proof test (a few seconds), it will take a few minutes until the fiber protection sleeve is shrunk. A buzzer will indicate the finishing of shrinking the sleeve. If the fiber breaks, or the fiber is loosely clamped or slips during the tensile proof test, the buzzer will beep intermittently. Correct the condition before proceeding.

Note 1

Both the splicer and heater can be operated simultaneously.

Note 2

The tensile proof strength can be set from 50 to 500 grams. This value is set to 200 grams normally.

(VIII) Open the heater cover and clamps.

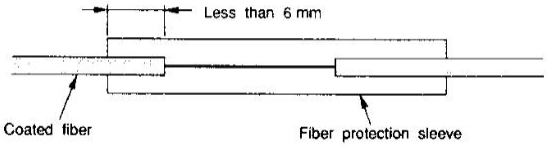
Take out the protected splice carefully while pulling the fiber slightly.

Cool the protection sleeve for a few minutes, as it is very hot just after reinforcement.

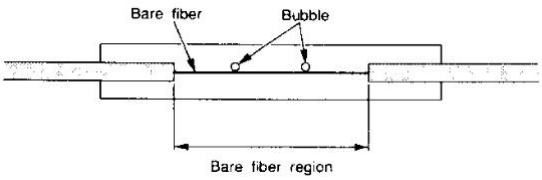
(IX) Check the appearance of the reinforced portion.

Bad protection examples

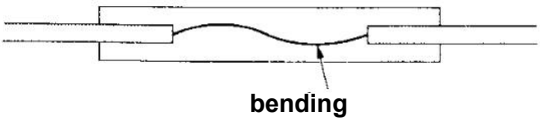
Short coverage of coated fiber.



Bubble on bare fiber.

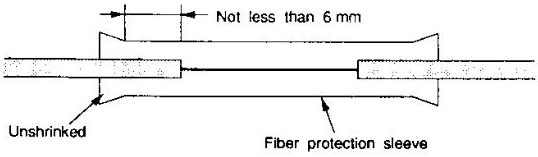


Bending bare fiber

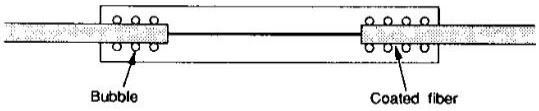


Good protection examples

Unshrink sleeve end



Bubble on coated fiber



5. Treatment of surplus length optical fibers.

Arrangement of loose tube

The loose tube should be dressed up while closing joint box so that it is protected against impact, corrosion and bend. The loop diameter of loose tube is more than 50mm.

Arrangement of optical fiber

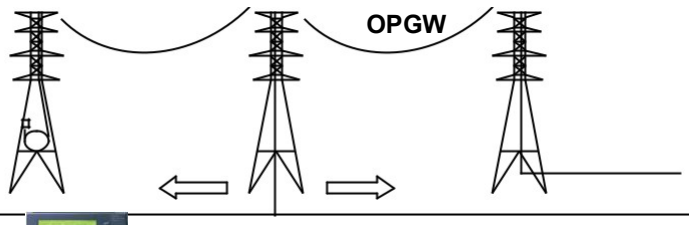
The spliced portion of optical fiber should be put in regular order in the fusion splice protector, and the extra length of optical fiber should be put on the splice tray.

The loop diameter of optical fiber is more than 50mm.

6. Measurement of splice loss: Splice loss shall be measured by

using OTDR. A. Test (Before splicing)

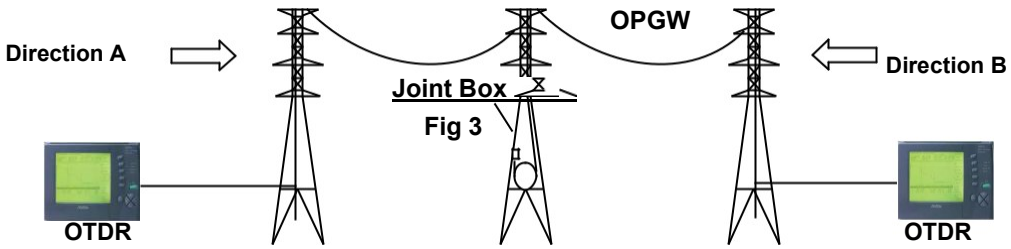
- **After successfully completion of the installation, check for optical attenuation and discontinuity at every splicing points (Joint Box Locations).**



- The attenuation of the fibres shall be distributed uniformly throughout its length such that there are no point discontinuities in excess of 0.1dB. The overall optical fibres attenuation should be less than 0.21dB/km at 1550nm and 0.35dB/km at 1310nm.

B. Splicing Test (After splicing)

- Before closing the splice enclosure, splice loss shall be measured for checking the splicing condition.



- Before closing the in-line splice enclosure, the splice test shall be executed at both sides (direction A & direction B) of jointing point.

- The average of bi-directional attenuation of fusion splices shall not be more than 0.05 dB and no single splice loss shall exceed 0.1 dB at 1550 nm.

- Appearance of splice enclosure shall have no defect,

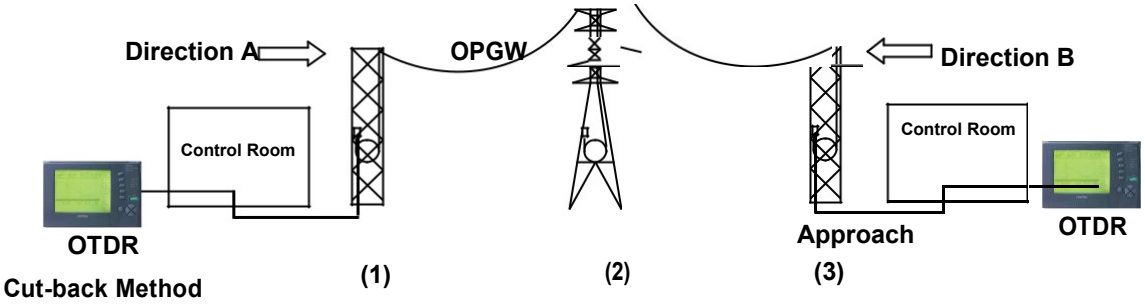
- Splice enclosure shall have good sealing condition to prevent moisture and dust free environment, and render it waterproof.

*No point discontinuities in excess of 0.1dB

Every effort shall be taken to minimize the splice loss during splicing so that every splice loss in the link shall lies within o.o5 dB. Maximum splice loss at any splice joint may be permitted up to 0.1 dB. However, such events shall be avoided to minimize the splice loss and total loss in the link.

C. Measurement of splicing loss.

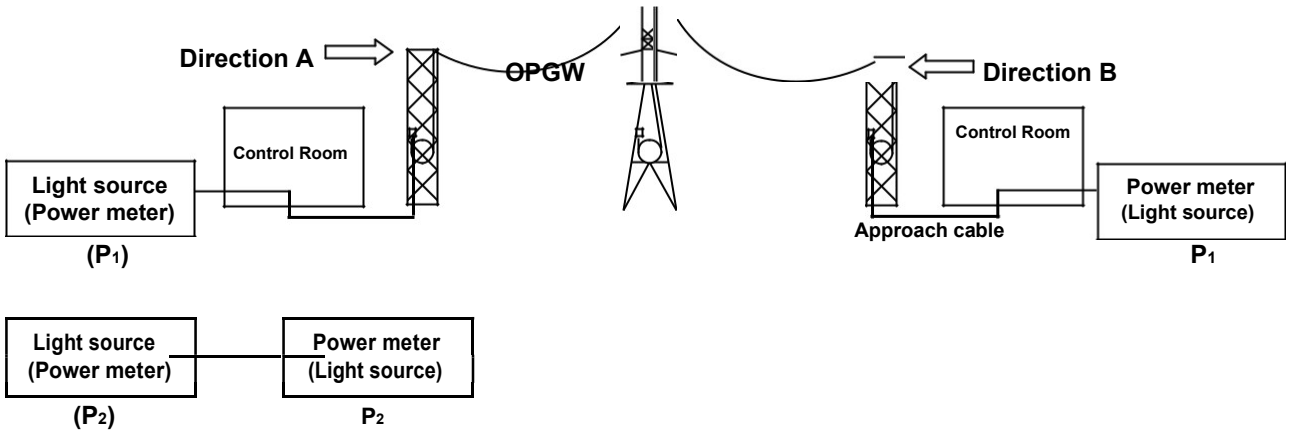
Measure the of splice loss by OTDR



Transmission Loss (dB) = $P_2 - P_1$

P_1 : Power measured when light source is connected to power meter with the OPGW fibre in between.

P_2 : Power measured when light source and power meter are connected to one another with reference fibre in between.



7. Fixing the joint box lid

Fix the cover to the joint box after having confirmed that nothing is left in the joint box such as tools and dusts. Lock the lid with the torque force of 10 NM.

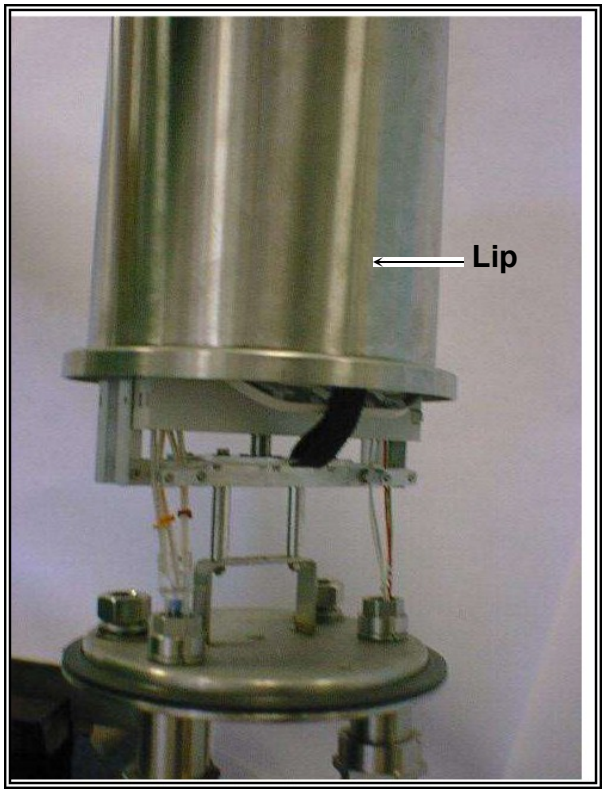
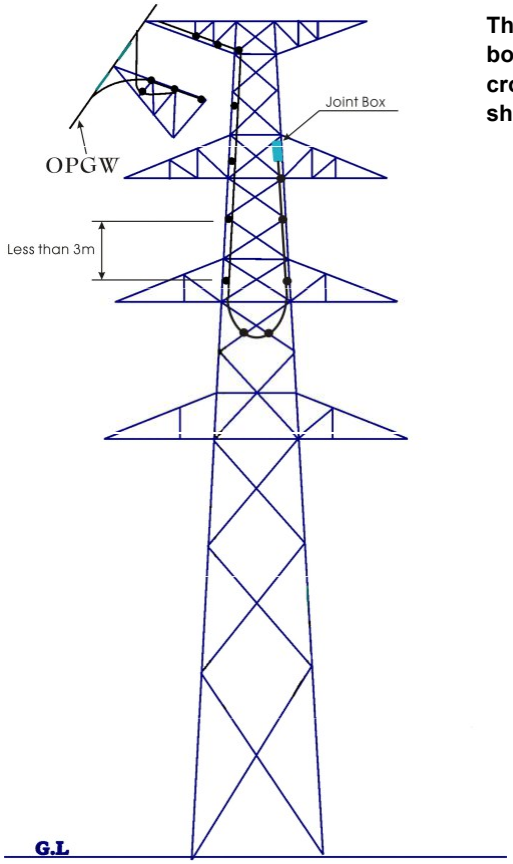


Fig. 6

8. Installation of a joint box.

SPLICING TOWER

The balanced length of OPGW should be coiled around a circle having a diameter of more than 1.5 meters after completion of jointing and firmly fixed to the tower as shown in figure.



The position of the joint box should be near the top cross-arm of the tower as shown in the figure.

Check Point

Check the status of water proof.

Fusion splice working is protection it against dirt, grit and moisture. Lift the joint box using the eye bolt of lid.

Fixing condition of joint box on the tower.

Coiling condition of sur-plus(balanced) length of OPGW