Technical specifications of cable work

1.1 SCOPE

This chapter covers the requirements for the selection, installation and jointing of power cables for low, medium and high voltage applications upto and including 33KV. For details not covered in these Specifications, IS:1255-1983 shall be referred to. All references to BIS-Specifications and codes are for codes with amendments issued upto date i.e. till the date of call of tender.

1.2 TYPES OF CABLES

1.2.1 The cables for applications for low and medium voltage (upto and including 1.1KV) supply shall be one of the following: -

(i) PVC insulated and PVC sheathed, conforming to IS:1554 (Part-1)- 1988
(ii) Cross linked polyethylene insulated, PVC sheathed (XLPE), conforming to IS: 7098 (Part-1)- 1988.

1.2.2 The cables for applications for high voltage (above 1.1KV but upto and including 11KV supply) supply shall be one of the following: -

(i) PVC insulated and PVC sheathed, conforming to IS:1554 (Part-2)- 1988.
(ii) Paper insulated, lead sheathed (PILCA) conforming to IS:692-1973
(iii) Cross linked polyethylene (XLPE) insulated, PVC sheathed conforming to IS:7098 (Part-2)- 1985.

1.2.3 The cables for applications above 11KV but upto and including 33KV supply shall be one of the following: -

(i) Paper insulated lead sheathed (PILCA) conforming to IS: 692-1973.
(ii) Cross linked, polyethylene insulated (XLPE) conforming to IS:7098 (Part-2)-1985.

1.2.4 The cables shall be with solid or stranded aluminium conductors, as specified. Copper conductors may be used, only in special applications, where use of aluminium conductors is not technically acceptable.

1.2.5 Where paper insulated cables are used in predominantly vertical situation, these shall be of non-draining type.

1.3 ARMOURING AND SERVING

1.3.1 All multicore cables liable for mechanical damage and all HV cabkes (irrespective of the situation of installation) shall be armoured. Where armouring is unavoidable in dingle core cables, either the armour should be made of nonmagnetic material, or it should be ensured that the armouring is not shorted at terminations, thus preventing the flow of circulating currents therein.

1.3.2 Short runs of cables laid in pipes, closed masonary trenches and similar protected or secured enclosures need not be armoured.

1.3.3 PVC and XLPE cables, when armoured, shall have galvanized steel wires (flat or round) for armouring.

1.3.4 Paper insulated cables shall have for armouring, a double layer of steel tape for normal applications. Steel wire armouring is preferred where the cables are liable to tensile stresses in applications such as vertical runs, suspended on brackets or laid in soil that is likely to subside.

1.3.5 Serving over armouring in paper insulated cables shall consist of a complete layer or layers of suitable compounded Hessian materials.

1.4 SELECTION OF CABLE SIZES

1.4.1 The cable sizes shall be selected by considering the voltage drop in the case of MV (distribution) cables and Current carrying capacity in the case of HV (feeder) cables. Due consideration should be given for the Prospective short circuit current and the period of its flow, especially in the case of HV cables.

1.4.2 While deciding upon the cable sizes, derating factors for the type of cable and depth of laying, grouping, ambient temperature, ground temperature, and soil resistivity shall be taken into account.

1.4.3 Guidance for the selection of cables shall be served from relevant Indian Standards such as IS:3961 (Part-1)-1967 for paper insulated lead sheathed cables, IS: 3961 (Part-2)-1967 for PVC insulated and PVC sheathed heavy duty cables, IS: 5819-1970 for recommended short circuit ratings of high voltage PVC cables, IS: 1255-1983 on code of practice for installation and maintenance of power cables upto and including 33KV rating etc.

1.5 STORAGE AND HANDLING

1.5.1 Storage

(i) The cable drums shall be stored on a well drained, hard surface, so that the drums do not sink in the ground causing rot and damage to the cable drums. Paved surface is preferred, particularly for long term storage.

(ii) The drums shall always be stored on their flanges, and not on their flat sides.

(iii) Both ends of the cables especially of PILCA cables should be properly sealed to prevent ingress/ absorption of moisture by the insulation during storage.

(iv) Protection from rain and sun is preferable for long term storage for all types of cables. There should also ventilation between cable drums.

(v) During storage, periodical rolling of drums once in, say, 3 months through 90 degrees shall be done, in the case of paper insulated cables. Rolling shall be done in the direction of the arrow marked on the drum.

(vi) Damaged battens of drums etc. should be replaced as may be necessary.

1.5.2 Handling

(i) When the cable drums have to be moved over short distances, they should be rolled in the direction of the arrow marked on the drum.

(ii) For manual transportation over long distances, the drum should be mounted on cable drum wheels, strong enough to carry the weight of the drum and pulled by means of ropes. Alternatively, they may be mounted on a trailer or on a suitable mechanical transport.

(iii) For loading into and unloading from vehicles, a crane or a suitable lifting tackle should be used. Small sized cable drums can also be rolled down carefully on a suitable ramp or rails, for unloading, provided no damage is likely to be caused to the cable or to the drum.

1.6 INSTALLATION

1.6.1 General

(i) Cables with kinks, straightened kinks or any other apparent defects like defective armouring etc. shall not be installed.

(ii) Cables shall not be bent sharp to a small radius either while handing or in installation. The minimum safe bending radius for PVC/XLPE (MV) cables shall be 12 times the overall diameter of the cable. The minimum safe bending radius for PILCA/XLPE (HV) cables shall be as given in Table-II. At joints and terminations, the bending radius of individual cores of a multi core cable of any type shall not be less than 15 times its overall diameter.

(iii) The ends of lead sheathed cables shall be sealed with solder immediately after cutting the cables. In case of PVC cables, suitable sealing compound/tape shall be used for this purpose, if likely exposed to rain in transit storage. Suitable heat shrinkable caps may also be used for the purpose.

1.6.2 Route

Before the cable laying work is undertaken, the route of the cable shall be decided by the Engineer-in-Charge considering the following.

(i) While the shortest practicable route should be preferred, the cable route shall generally follow fixed developments such as roads, foot paths etc. with proper offsets so that future maintenance, identification etc. are rendered easy. Cross country run merely to shorten the route length shall not te adopted.

(ii) Cable route shall be planned away from drains and near the property, especially in the case of LV/MV cables, subject to any special local requirements that may have to be necessarily complied with.

(iii) As far as possible, the alignment of the cable route shall be decided after taking into consideration the present and likely future requirements of other services including cables enroute, possibility of widening of roads/lanes etc.

(iv) Corrosive soils, ground surrounding sewage effluent etc. shall be avoided for the routes.

(v) **Route of cables of different voltages.**

(a) Whenever cables are laid along well demarcated or established roads, the LV/MV cables shall be laid farther from the kerb line than HV cables.

(b) Cables of different voltages, and also power and control cables shall be kept in different trenches with adequate separation. Where available space is restricted such that this requirement cannot be met, LV/MV cables shall be laid above HV cables.

(c) Where cables cross one another, the cable of higher voltage shall be laid at a lower level than the cable of lower voltage.

1.6.3 Proximity to communication cables

Power and communication cables shall as far as possible cross each other at right angles. The horizontal and vertical clearances between them shall not be less than 60cm.

1.6.4 Railway crossing

Cables under railway tracks shall be laid in spun reinforced concrete, or cast iron or steel pipes at such depths as may be specified by the railway authorities, but not less than 1m, measured from the bottom of the sleepers to the top of the pipe. Inside railway station limits, pipes shall be laid upto the point of the railway station limits, pipes shall be laid upto a minimum distance of 3m from the center of the nearest track on either side.

1.6.5 Way Leave

Way leave for the cable route shall be obtained as necessary, from the appropriate authorities, such as, Municipal authorities, Department of telecommunication, Gas Works, Railways, Civil Aviation authorities, Owners of properties etc. In case of private property, Section 12/51 of the Indian Electricity Act shall be complied with.

1.6.6 Methods of laying

The cables shall be laid direct in ground, pipe, closed or open ducts, cable trays or on surface of wall etc. The method(s) of laying required shall be specified in the tender schedule of work.

1.6.7 Laying direct in ground

1.6.7.1 General

This method shall be adopted where the cable route is through open ground, along roads/lanes, etc. and where no frequent excavations are likely to be encountered and where re-excavation is easily possible without affecting other services.

1.6.7.2 Trenching

(i) Width of trench

The width of the trench shall first be determined on the following basis (Refer figure 1)

(a) The minimum width of the trench for laying a single cable shall be 35cm

(b) Where more than one cable is to be laid in the same trench in horizontal formation, the width of the trench shall be increased such that the inter-axial spacing between the cables, except where otherwise specified, shall be at least 20cm.

© There shall be a clearance of at least 15cm between axis of the end cables and the sides of the trench.

(ii) Depth of trench

The depth of the trench shall be determined on the following basis (Refer figure 1): -

(a) Where the cables are laid in a single tier formation, the total depth of trench shall not be less than 75cm for cables upto 1.1KV and 1.2m for cables above 1.1KV.

(b) When more than one tier of cables is unavoidable and vertical formation of laying is adopted, the depth of the trench in (ii) a above shall be increased by 30cm for each additional tier to be formed.

© Where no sand cushioning and protective covering are provided for the cables as per 2.6.7.3(i)(b), 2.6.7.3(vii)(c) and 2.6.7.3(ix)(d) below, the depth of the trench as per (ii)(a) and (b) above shall be increased by 25cm.

(iii) Excavation of trenches

(a) The trenches shall be excavated in reasonably straight lines. Wherever there is a change in the direction, a suitable curvature shall be adopted complying with the requirements of clause 2.6.1(ii).

(b) Where gradients and changes in depth are unavoidable, these shall be gradual.

© The bottom of the trench shall be level and free from stones, brick bats etc.

(d) The excavation should be done by suitable means-manual or mechanical. The excavated soil shall be stacked firmly by the side of the trench such that it may not fall back into the trench.

(e) Adequate precautions should be taken not to damage any existing cable(s), pipes or any other such installations in the route during excavation. Wherever trickd, tiles or protective covers or bare cables are encountered, further excavation shall not be carried out without the approval of the Engineer-in-Charge.

(f) Existing property, if any, exposed during trenching shall be temporarily supported adequately as directed by the Engineer-in-Charge. The trenching in such cases shall be done in short lengths, necessary pipes laid for passing cables therein and the trench refilled in accordance with clause 2.6.7.4.

(g) It there is any danger of a trench collapsing or endangering adjacent structures, the sides may be left in place when back filling the trench.

(h)Excavation through lawns shall be done in consultation with the Department concerned.

1.6.7.3
Laying of cable in trench

(i) Sand cushioning

(a) The trench shall then be provided with a layer of clean, dry sand cushion of not less than 8cm in depth, before laying the cables therein.

(b) However, sand cushioning as per (a) above need not be provided for MV cables, where there is no possibility of any mechanical damage to the cables due to heavy or shock loading on the soil above. Such stretches shall be clearly specified in the tender documents.

© Sand cushioning as per (a) above shall however be invariably provided in the case of HV cables.

(ii) Testing before laying

All the time of issue of cables for laying, the cables shall be tested for continuity and insulation resistance (See also clause 2.8.1)

(iii) The cable drum shall be properly mounted on jacks, or on a cable wheel at a suitable location, making sure that the spindle, jack etc. are strong enough to carry the weight of the drum without failure, and that the spindle is horizontal in the bearings so as to prevent the drum creeping to one side while rotating.

(iv) The cable shall be pulled over on rollers in the trench steadily and uniformly without jerks and strain. The entire cable length shall as far as possible be laid off in one stretch. PVC/XLPE cables less than 120sq.mm. size may be removed by "Flaking" i.e. by making one long loop in the reverse direction.

Note: - For short runs and sizes upto 50sq.mm. of MV cables, any other suitable method of direct handing and laying can be adopted without strain or excess bending of the cables.

(v) After the cable has been so uncoiled, it shall be lifted slightly over the rollers beginning from one and by helpers standing about 10m apart and drawn straight. The cable shall then be lifted off the rollers and laid in a reasonably straight line.

(vi) **Testing before covering**

The cables shall be tested for continuity of cores and insulation resistance (Refer clause 2.8.1) and the cable length shall be measured, before closing the trench. The cable end shall be sealed /covered as per clause 2.6.1 (iii)

(vii) **Sand covering**

Cables laid in trenches in a single tier formation shall have a covering of dry sand of not less than 17cm above the base cushion of sand before the protective cover is laid.

In the case of vertical multi-tier formation, after the first cable has been laid, a sand cushion of 30cm shall be provided over the base cushion before the second tier is laid. If additional tiers are formed, each of the subsequent tiers also shall have a sand cushion of 30cm as stated above. Cables in the top most tiers shall have final sand covering not less than 17cm before the protective cover is laid.

Sand covering as per (a) and (b) above need not be provided for MV cables where a decision is taken by the Engineer-in-Charge as per sub clause (i)(b) above, but the inter tier spacing should be maintained as in (b) above with soft soil instead of sand between tiers and for covering.

Sand cushioning as per (a) and (b) above shall however be invariably provided in the case of HV cables.

(viii) **Extra loop cable**

(a) At the time of original installation, approximately 3m of surplus cable shall be left on each terminal end of the cable and on each side of the underground joints. The surplus cable shall be left in the form of a loop. Where there are long runs of cables such loose cable may be left at suitable intervals as specified by the Engineer-in-Charge.

(b) Where it may not be practically possible to provide separation between cables when forming loops of a number of cables as in the case of cables emanating from a substation, measurement shall be made only to the extent of actual volume of excavation, sand filling etc. and paid for accordingly.

(ix) **Mechanical protection over the covering**

(a) Mechanical protection to cables shall be laid over the covering in accordance with (b) and (c) below to provide warning to future excavators of the presence of the cable and also to protect the cable against accidental mechanical damage by pick-axe blows etc.

(b) Unless otherwise specified, the cables shall be protected by second class brick of nominal size 22cmX11.4cmX7 cm or locally available size, placed on top of the sand (or, soil as the case may be). The bricks shall be placed breadth-wise for the full length of the cable. Where more than one cable is to be laid in the same trench, this protective covering shall cover all the cables and project at least 5cm over the sides of the end cables.

© Where bricks are not easily available, or are comparatively costly, there is no objection to use locally available material such as tiles or slates or stone/cement concrete slabs. Where such an alternative is acceptable, the same shall be clearly specified in the tender specifications.

(d) Protective covering as per (b) and (c) above need not be provided only for MV cables, in exceptional cases where there is normally no possibility of subsequent excavation. Such cases shall be particularly specified in the Tender specifications.

(e) The protective covering as per (b) and (c) above shall, however invariably be provided in the case of HV cables.

1.6.7.4 Back filling

(i) The trenches shall be then back-filled with excavated earth, free from stones or other sharp ended debris and shall be rammed and watered, if necessary in successive layers not exceeding 30cm depth.

(ii) Unless otherwise specified, a crown of earth not less than 50mm and not exceeding 100mm in the center and tapering towards the sides of the trench shall be left

to allow for subsidence. The crown of the earth however, should not exceed 10 Cms so as not to be a hazard to vehicular traffic.

(iii) The temporary re-statements of roadways should be inspected at regular intervals, particularly during wet weather and settlements should be made good by further filling as may be required.

(iv) After the subsidence has ceased, trenches cut through roadways or other paved areas shall be restored to the same density and materials as the surrounding area and –re-paved in accordance with the relevant building specifications to the satisfaction of the Engineer-in-Charge.

(v) Where road beams or lawns have been cut out of necessity, or kerb stones displaced, the same shall be repaired and made good, except for turfing /asphalting, to the satisfaction of the Engineer-in-Charge and all the surplus earth or rock shall be removed to places as specified.

1.6.7.5 Laying of single core cables

(i) Three single core cables forming one three phase circuit shall normally be laid in close trefoil formation and shall be bound together at intervals of approximately 1m.

(ii) The relative position of the three cables shall be changed at each joint at the time of original installation, complete transposition being effected in every three consecutive cable lengths.

1.6.7.6 Route markers

(i) Location

Route markers shall be provided along the runs of cables at locations approved by the Engineer-in-Charge and generally at intervals not exceeding 100m. Markers shall also be provided to identity change in the direction of the cable route and at locations of underground joints.

(ii) (a) **Plate type marker**

Route markers shall be made out of 100mm X 5mm GI/ aluminium plate welded / bolted on 35mm X 35mm X 6mm angle iron, 60cm long. Such plate markers shall be mounted parallel to and at about 0.5m away from the edge of the trench.

(b) CC marker

Alternatively, cement concrete 1:2:4 (1 cement:2 coarse sand: 4 graded stone aggregate of 20mm in size) as shown in figure 2 shall be laid flat and centered over the cable. The concrete markers, unless otherwise instructed by the Engineer-in-Charge, shall project over the surrounding surface so as to make the cable route easily identifiable.

(c) Inscription

The words 'CPWD-MV/HV CABLE' as the case may be, shall be inscribed on the marker.

1.6.8 Laying in pipes / closed ducts

1.6.8.1 In locations such as road crossing, entry in to buildings, paved areas etc. cables shall be laid in pipes or closed ducts. Metallic pipe shall be used as protection pipe for cables fixed on poles of overhead lines.

1.6.8.2

(i) Stone ware pipes, GI, CI or spun reinforced concrete pipes shall be used for cables in general; however only GI pipe shall be used as protection pipe on poles.

(ii) The size of the pipe shall not be less than 10cm in diameter for a single cable and not less than 15cm for more than one cable.

(iii) Where steel pipes are employed for protection of single core cable feeding AC load, the pipe should be large enough to contain both cables in the case of single phase system and all cables in the case of poly phase system.

(iv) Pipes for MV and HV cables shall be independent ones.

1.6.8.3

(i) In the case of new construction, pipes as required (including for anticipated future requirements) shall be laid alongwith the civil works and jointed according to the CPWD Building Specifications.

(ii) Pipes shall be continuous and clear of debris or concrete before cables are drawn. Sharp edges if any, at ends shall be smoothened to prevent damage to cable sheathing.

(iii) These pipes shall be laid directly in ground without any special bed except for SW pipe which shall be laid over 10cm thick cement concrete 1:5:10 (1 cemtnt:5coarse sand:10 graded stone aggregate of 40mm nominal size) bed. No sand cushioning or tiles need be used in such situations.

1.6.8.4 Road crossings

(i) The top surface of pipes shall be at a minimum depth of 1m from the pavement level when laid under roads, pavements etc.

(ii) The pipes shall be laid preferably askew to reduce the angle of bend as the cable enters and leaves the crossing. This is particularly important for HV cables.

(iii) When pipes are laid cutting an existing road, care shall be taken so that the soil filled up after laying the pipes is rammed well in layers with watering as required to ensure proper compaction. A crown of earth not exceeding 10cm should be left at the top.
(iv) The temporary re-instatements of roadways should be inspected at regular intervals, particularly after a rain, and any settlement should be made good by further filling as may be required.
(v) After the subsidence has ceases, the top of the filled up trenches in roadways or other paved areas shall be restored to the same density and material as the surrounding area in accordance with the relevant CPWD Building Specifications to the satisfaction of the Engineer-in-Charge.

1.6.8.5 Manholes shall be provided to facilitate feeding/drawing in of cables with sufficient working space for the purpose. They shall be covered by suitable manhole covers. Sizes and other details shall be indicated in the Schedule of work.

1.6.8.6 Cable entry into the building

Pipes for cable entries to the building shall slope downwards from the building. The pipes at the building end shall be suitably sealed to avoid entry of water, after the cables are laid.

1.6.8.7 Cable-grip / draw-wires, winches etc. may be employed for drawing cables through pipes / closed ducts.

1.6.8.8 Measurement for drawing/ laying cables in pipes/ closed duct shall be on the basis of the actual length of the pipe / duct for each run of the cable, irrespective of the length of cable drawn through.

1.6.9 Laying in open ducts

1.6.9.1 Open ducts with suitable removable covers (RCC slabs or chequered plates) are generally provided in sub-stations, switch rooms, plant rooms, workshops etc. for taking the cables. The cable ducts should be of suitable dimensions for the number of cables involved.

1.6.9.2
(i) Laying of cables with different voltage ratings in the same duct shall be avoided. Where it is inescapable to take HV & MV cables same trench, they shall be laid with a barrier between them or alternatively, one of the two (HV &MV) cables may be taken through pipe(s).
(ii) Splices or joints of any type shall not be permitted inside the ducts.

1.6.9.3
(i) The cables shall be laid directly in the duct such that unnecessary crossing of cables is avoided.

(ii) Where specified, cables may be fixed with clamps on the walls of the duct or taken in hooks/brackets/troughs in ducts.

1.6.9.4
Where specified, ducts may be filled with dry sand after the cables are laid and covered as above, or finished with cement plaster, specially in high voltage applications.

1.6.10
Laying on surface

1.6.10.1
This method may be adopted in places like switch rooms, workshops, tunnels, rising (distribution) mains in buildings etc. This may also be necessitated in the works of additions and/or alterations to the existing installation, where other methods of laying may not be feasible.

1.6.10.2
Cables may be laid in surface by any of the following methods as specified:

(a) Directly clamped by saddles or clamps,
(b) Supported on cradles,
(c) Laid on troughs/trays, duly clamped.

1.6.10.3
(i) The saddles and clamps used for fixing the cables on surface shall comply with the requirements given in Table-III.
(ii) Saddles shall be secured with screws to suitable approved plugs. Clamps shall be secured with nuts on to the bolts, grouted in the supporting structure in an approved manner.
(iii) In the case of single core cables, the clamps shall be of non-magnetic material. A suitable non-corrosive packing shall be used for clamping unarmoured cables to prevent damage to the cable sheath.
(iv) Cables shall be fixed neatly without undue sag or kinks.

1.6.10.4
The arrangement of laying the cables in cradles is permitted only in the case of cables of 1.1KV grade of size exceeding 120sq.mm. In such cases, the cables may be suspended on MS flat cradles of size 50mmX5mm which in turn shall be fixed on the wall by bolts grouted into the wall in an approved manner at a spacing of not less than 60cm.

1.6.10.5
All MS components used in fixing the cables shall be either galvanized or given a coat of red oxide primer and finished with 2 coats of approved paint.

1.6.11 Laying on cable tray

1.6.11.1

This method may be adopted in places like indoor substations, air-conditioning plant rooms, generator rooms etc. or where long horizontal runs of cables are required within the building and where it is not convenient to carry the cable in open ducts. This method is preferred where heavy sized cables or a number of cables are required to be laid. The cable trays may be either of perforated sheet type or of ladder type.

1.6.11.2 Perforated type cable tray

(i) The cable tray shall be fabricated out of slotted/perforated MS sheets as channel sections, single or double bended. The channel sections shall be supplied in convenient lengths and assembled at site to the desired lengths. These may be galvanished or painted as specified. Alternatively, where specified, the cable tray may be fabricated by two angle irons of 50mmX50mmX6mm as two longitudinal members, with cross bracings between them by 50mmX5mm flats welded/bolted to the angles at 1 m spacing. 2mm thick MS perforated sheet shall be suitably welded/bolted to the base as well as on the two sides.

(ii) Typically, the dimensions, fabrication details etc. are shown in figure 3A,B and C.

(iii) The jointing between the sections shall be made with coupler plates of the same material and thickness as the channel section. Two coupler plates, each of minimum 200mm length, shall be bolted on each of the two sides of the channel section with 8mm dia round headed bolts, nuts and washers. In order to maintain proper earth continuity bond, the paint on the contact surfaces between the coupler plates and cable tray shall be scraped and removed before the installation.

(iv) The maximum permissible uniformly distributed load for various sizes of cables trays and for different supported span are given in Table IV. The sizes shall be specified considering the same.

(v) The width of the cable tray shall be chosen so as to accommodate all the cables in one tier, plus 30 to 50% additional width for future expansion. This additional width shall be minimum 100mm. The overall width of one cable tray shall be limited to 800mm.

(vi) Factory fabricated bends, reducers, tee/cross junctions, etc. shall be provided as per good engineering practice. (Details are typically shown in figure 3). The radius of bends, junctions etc. shall not be less than the minimum permissible radius of bending of the largest size of cable to be carried by the cable tray.

(vii) The cable tray shall be suspended from the ceiling slab with the help of 10mm dia MS rounds or 25mmX5mm flats at specified spacing (based on Table III). Flat type suspenders may be used for channels upto 450mm width bolted to cable trays. Round suspenders shall be threaded and bolted to the cable trays or to independent support angles 50mmX50mmX5mm at the bottom end as specified. These shall be grouted to the ceiling slab at the other end through an effective means, as approved by the Engineer-in-Charge, to take the weight of the cable tray with the cables.

(viii) The entire tray (except in the case of galvanized type) and the suspenders shall be painted with two coats of red oxide primer paint after removing the dirt and rust, and finished with two coats of spray paint of approved make synthetic enamel paint.

(ix) The cable tray shall be bonded to the earth Terminal of the switch bonds at both ends.

(x) The cable trays shall be measured on unit length basis, along the center line of the cable tray, including bends, reducers, tees, cross joints, etc. and paid for accordingly.

1.6.11.3 Ladder type cable tray

(i) The ladder type of cable tray shall be fabricated of double bended channel section longitudinal members with single bended channel section rungs of cross members welded to the base of the longitudinal members at a center to center spacing of 250cm.

(ii) Alternatively, where specified, ladder type cable trays may be fabricated out of 50mmX50mmX6mm (minimum) angle iron for longitudinal members, and 30mmX6mm flat for rungs.

(iii) Typical details of fabrication and dimensions of both the types of trays are shown in figure 4A,B,C and D.

(iv) The maximum permissible loading, jointing of channel sections, width of the cable tray, provision of elbows, bends, reducers, horizontal tee/ cross junctions etc. suspension of cable tray from the ceiling slab; painting and measurement of the cable tray shall be as per sub-clauses (ii) to (x) below clause 2.6.11.2, except that the overall width of one cable tray may be limited to 800mm.

1.6.11.4 Cables laid on cable trays shall be clamped on to the tray at suitable intervals as per Table-III.

1.6.12 Cable identification tags

Whenever more than one cable is laid / run side by side, marker tags as approved, inscribed with cable identification details shall be permanently attached to al the cables in the manholes / pull pits / joint pits / entry points in buildings / open ducts etc. These shall also be attached to cables laid direct in ground at specified intervals, before the trenches are backfilled.

1.7 JOINTING

1.7.1 Location

(i) Before laying a cable, proper locations for the proposed cable joints, if any, shall be decided, so that when the cable is actually laid, the joints are made in the most suitable places. As far as possible, water logged locations, carriage ways, pavements, proximity to telephone cables, gas or water mains, inaccessible places, ducts, pipes, racks etc. shall be avoided for locating the cable joints.

(ii) Joints shall be staggered by 2m to 3m when joints are to be done for two or more cables laid together in the same trench.

1.7.2 Joints pits

(i) Joint pits shall be of sufficient dimensions as to allow easy and comfortable working. The sides of the pit shall be well protected from loose earth falling into it. It shall also be covered by a tarpaulin to prevent dust and other foreign matter being blown on the exposed joints and jointing materials.

(ii) Sufficient ventilation shall be provided during jointing operation in order to disperse fumes given out by fluxing.

1.7.3 Safety precaution

(i) A caution board indicating "CAUTION – CABLE JOINTING WORK IN PROGRESS" shall be displayed to warn the public and traffic where necessary.

(ii) Before jointing is commenced, all safety precautions like isolation, discharging, earthing, display of caution board on the controlling switchgear etc. shall be taken to ensure that the cable would not be inadvertently charged from live supply. Metallic armour and external metallic bonding shall be connected to earth. Where "Permit to work" system is in vogue, safety procedures prescribed shall be complied with.

1.7.4 Jointing materials

(i) Jointing materials and accessories like conductor ferrules, solder, flux, insulating and protective tapes, filling compound, jointing boxes, heat shrinking joint kit etc. of right quality and correct sizes, conforming to relevant Indian Standards, wherever they exist, shall be used.

(ii) The design of the joint box and the composition of the filing compound shall be such as to provide an effective sealing against entry of moisture in addition to affording proper electrical characteristic to joints.

(iii) Where special type of splicing connector kits or epoxy resin spliced joints or heat shrinkable jointing kits are specified, materials approved for such application shall be used. Storing as well as jointing instructions of the manufacturer of such materials shall be strictly followed.

1.7.5 Jointer

Jointing work shall be carried out by a licensed/ experienced (where there is no licensing system for jointers) cable jointer.

1.7.6 Cable work with joints

(i) About 3m long surplus cable shall be left on each side of joints as laid down in clause 1.6.7.3 (viii).

(ii) Insulation resistance of cables to be jointed shall be tested as per clause 1.8.1. Unless the insulation resistance values are satisfactory, jointing shall not be done.

(iii) Cores of the cables must be properly identified before jointing.

(iv) Where cable is to be jointed with the existing cable, the sequence should be so arranged as to avoid crossing of cores wile jointing.

(v) Whenever the aluminium conductor is exposed to outside atmosphere, a highly tenacious oxide film is formed which makes the soldering of aluminium conductor difficult. This oxide film should be removed by using appropriate type of flux.

(vi) The clamps for the armour shall be clean and tight.

1.7.7 Jointing procedure

While it would be necessary to follow strictly the instructions for jointing furnished by the manufacturers of cables and joint kits, a brief on the jointing procedures is given for general guidance in Appendix F.

1.8 TESTING

1.8.1 Testing before laying

All cables, before laying, shall be tested with a 500V megger for cables of 1.1KV grade, or with a 2500/5000V megger for cables of higher voltage. The cable cores shall be tested for continuity, absence of cross phasing, insulation resistance from conductors to earth / armour and between conductors.

1.8.2 Testing before backfilling

All cables shall be subjected to the above mentioned tests, before covering the cables by protective covers and back filling and also before taking up any jointing operation.

1.8.3 Testing after laying

(i) After laying and jointing, the cable shall be subjected to a 15 minutes pressure test. The test pressure shall be as given in Table VI. DC pressure testing may normally be preferred to AC pressure testing.

(ii) In the absence of facilities for pressure testing as above, it is sufficient to test for one minute with 1000V megger for cables of 1.1KV grade and with 2500/5000V megger for cables of higher voltages.