

CHAPTER XIII

Optic Fibre Communication System

SECTION – I

PLANNING AND SYSTEM DESIGN

13.1.1. Optical Fibre communication system shall be provided for following types of communication needs: -

- (a) Control Communication with emergency communication
- (b) Administrative voice and data communication.
- (c) Both for control and long haul communication backbone for mobile train radio communication.

13.1.2. Guidelines for use of Optical Fibre System on various routes.

- (a) New Railway Projects – Gauge Conversion/New lines/Doubling/Railway Electrification.

On A, B, C, D & D Spl Routes, following Optical Fibre system configuration should be used.

- 24 Fibres Optical Fibre Cable (as per RDSO Specification IRS.TC.55/ or latest) with Six Quad cable (as per RDSO specification IRS.TC30/2005 or latest).

- Short Haul Communication will be on STM-1 System and Primary Digital Multiplexers (PDMUX). For back up a second pair of Fibre shall be used.

- b) On other routes, following Optical Fibre System configuration should be used:

Composite Cables (8/24 Fibre + 6 Quad) as per RDSO specification shall be used. Short Haul Communication will be on STM-1 System and Primary Digital Multiplexers (PDMUX). For back up a second pair of Fibre shall be used.

- c) Replacement of existing overhead/RE quad cable for control communication.

- (i) Existing RE Telecom Cable, whenever it is due for replacement on age cum condition basis, it should be replaced by Optical Fibre System. The system configuration for various routes shall be as indicated in Para 13.1.3 (a).
- (ii) Existing Overhead alignment on A, B, C & D-special should be replaced with Optical Fibre System. The system configuration for various routes shall be as indicated in 13.1.3(a).
- (iii) Existing overhead alignment on other routes should be considered for replacement with Optical Fibre system as per para 13.1.2 (b) above.

13.1.3. The objectives for the system design for the above types of communication are as under :-

- (a) Location of optic fibre stations and regenerators.
- (b) Optical loss budget of each block section. While calculating the Optical loss budget, following will be taken into consideration:
 - a. Equipment margin : 2 dB
 - b. Connector loss : 2 dB
 - c. Cable margin : 0.1 dB per Km.
 - d. System operational margin: 0.03 dB per Km.
 - e. Splice loss : 0.2 dB per Km.
- (c) Requirement of system capacity to meet present and future channel requirements.
- (d) Availability of the system.
- (e) Total expected jitter of the system.
- (f) Design of power supply system for each station.
- (g) Preparation of an estimate.

13.1.4. Capacity Of Fibre Optic System.

- a) For Control Communication application, SDH System having capacity of STM-1 shall be used. Generally, one E1 shall be used for various control applications.
- b) For Long Haul Communication, SDH System with capacity of STM-4 or above shall be used.

SECTION – II

LOCATION OF OPTIC FIBRE EQUIPMENT ROOMS

13.2.1. GENERAL :

- 13.2.1.1. The system design and the planning covered under section I lists out the requirements of optic fibre equipment locations along the route such as station, level crossing, etc.
- 13.2.1.2. For fixing the exact location of the optic fibre equipment room at such arrived locations, the following consideration need to be kept in view.

13.2.2. SURVEY OF EXISTING BUILDING :

- 13.2.2.1. In order to optimize the existing infrastructure facilities and to ensure cost effective project execution, it is necessary to scan the building at the station where optic fibre equipment room could be provided as per system design. For the purpose, the following order of preference should be followed :-
- (a) Housing of the optic fibre equipment in existing microwave repeater building.
 - (b) Housing of the optic fibre equipment in exchange building
 - (c) Housing of the optic fibre equipment in existing RE repeater station building (in case Optic fibre project being executed on account of replacement of main telecom cable).
- 13.2.2.2. However, the recourse to utilize any of the above mentioned alternative should be made subject to the following :-
- (a) Expenditure on addition/alternation necessary to make the room suitable for housing the optic fibre equipment shall be much less than cost of construction of new rooms at the appropriate site for Optic fibre equipment.
 - (b) The total area is sufficient to accommodate the layout as per Section-III.
 - (c) The location of building is close to the cable route to avoid extra cable length.
 - (d) Power supply is available and preferably standby power is also there.
 - (e) The site shall be higher than highest flood level of that place.
 - (f) It shall not involve many track crossings.

13.2.2.3. In case the existing building for wayside location is not available, a new optic fibre equipment building for wayside location shall be decided with the following considerations.

13.2.2.4. Site should be quite close to the station building:

- (a) Staff quarters and other residential building/restaurants, tea stalls should not be close by.
- (b) Site should be level.
- (c) Site in between track to be avoided.
- (d) Preferably the site should be on the same side of the track as the route of optic fibre cable.
- (e) There is road access to site.
- (f) Sufficient open space is available for –
 - Storage of the equipment
 - Construction of tower for train radio communication.
- (g) The copper cable required to join the drop insert location at the station is Minimum and its laying is easy.
- (h) for reasons of security of equipments, it should be as close to the ASM's Office.

13.2.3. FOR CONTROL ROOM LOCATION

13.2.3.1 All the above requirements are to be met except that of the location shall be a part of the control office complex.

SECTION – III

BUILDING LAYOUT

- 13.3.1 The wayside optic fibre room shall be as per drawing No.RDSO/TCDO/COP-1.
- 13.3.2 The building for the main control station shall be as per Drawing No.RDSO/TCDO/COP-2.
- 13.3.3 Following is to be ensured for the building:
 - 13.3.3.1 The front door shall be sturdy to prevent the intrusion by antisocial elements and sealing shall be such that it prevents ingress of dust also.
 - 13.3.3.2 Cable pit shall have depth of 1.25 m. Two RCC pipes of 100mm dia each will be provided separately for OFC and quad cable. The pipes shall be laid up to 2m length away from cable pit outside with suitable slope in such a way that smoother entry of cable inside the cable pit is obtained. One end of RCC pipe will open at the bottom of the cable pit in one of the side wall and other end will extend to 2m inside the trench with suitable slope. The cable trench will be made deeper at the entry. End of RCC pipes should be sealed with Plaster of Paris.
 - 13.3.3.3 Preferably the wiring for electrical fittings, plug points, etc. should be concealed type.
 - 13.3.3.4 To avoid frequent distempering, Oil distemper which may last for 10 to 12 years to be provided.
 - 13.3.3.5 Floor shall be provided with PVC tiles or any other suitable synthetic covering in the equipment room.
 - 13.3.3.6 In the battery room, the exhaust fan shall have a rain protection shed and hole covered with wire mesh to avoid entry of birds, insects, etc.
 - 13.3.3.7 Ventilation arrangements should be provided as shown in Drawing No.RDSO/TCDO/COP-1 & 2.
 - 13.3.3.8 Windows will be provided with suitable wire mesh and grill arrangement.
 - 13.3.3.9 Earth pit of 300 x 300 mm should be provided near the cable pit in control and repeater building.

SECTION IV

LAYOUT OF EQUIPMENT

13.4.1 The layout of equipments in the optic fibre equipment room at wayside stations and control office shall be as per Drawing Nos.RDSO/TCDO/COP-3 and RDSO/TCDO/COP-4 respectively.

13.4.2 The equipments shall be accommodated in standard size of the racks marketed by Indian manufacturers, maximum size if the racks shall be as under :-

Name of Rack	Size
	Width x Depth x Height
Slim Rack	120mm x 225mm x 2750mm
Euro 19" rack	600mm x 225mm x 2600mm

13.4.3 The wiring from battery to the location of equipment shall be inside PVC channels suitable size and suitably supported all along length.

SECTION V

PRELIMINARY SURVEY OF OPTIC FIBRE CABLE ROUTE

Preliminary survey shall be carried out for finalizing the drawing for the route of optical fibre cable as a part of project planning and execution.

Following main items of work shall constitute the survey.

- 13.5.1 Selecting the route in general.
- 13.5.2 Deciding the number of drop and insert locations.
- 13.5.3 Deciding the size and assessing the length of cable required.
- 13.5.4 Working out the requirement of circuits which are to be provided in the cable.
- 13.5.5 Working out the requirements of heavy tools and plants depending upon the nature of the territory, availability of roads along the tracks, etc.
- 13.5.6 Assessing the special problems of the section such as type of soil, long cuttings, new embankments, water logged areas, types of major bridges, major yards.
- 13.5.7 Collecting details of the existing telecommunication facilities and the additional requirements due to electrification and preparing tentative tapping diagrams.
- 13.5.8 Assessing the number of track crossings and other protective works required to be done.
- 13.5.9 Avoiding as far as possible laying of cable too close to a newly laid track.
- 13.5.10 Avoiding the toe of the embankment adjacent to the cultivated Fields.
- 13.5.11 Avoiding burrow pits and areas prone to water logging.
- 13.5.12 Avoiding soil made up of cinders, coal ashes, etc.
- 13.5.13 Avoiding heavily fertilized soils containing acids, electrolytes and decomposable organic materials promoting bacterial activity.

13.5.14 Avoiding proximity to chemical, paper and such other industries which discharge chemically active affluent.

13.5.15 Avoiding large rock cuttings, thick jungles, routes of existing cables and areas difficult to approach.

13.5.16 Deciding carefully the cable route approaches to cable huts to avoid built up areas including those areas where building, etc. are likely to come up in future.

13.5.17 Determining composition of the soil which may affect corrosion, etc. on the cable and special protection required for cable.

13.5.18 Working out the requirement of the various circuits to be provided in the cables along with the cable circuit chart and tapping diagrams.

13.5.19 Working out requirement of transport vehicles like jeeps, lorries, motor trolleys, etc. for the execution of the work.

13.5.20 Avoiding side of the alignment which is likely to be affected due to addition/alteration of earth work/supply structures (such as construction of double lane, shifting of alignment of the existing track etc.)

13.5.21 **Preparation of cable route plan and tapping diagrams.**

The cable route plan should indicate the route with respect to the main line, that is, whether the route along the DN main line or UP main line in case of double line sections and whether it is on both side or right side of the main line when facing a particular direction in case of single line section. A tentative tapping diagram should be prepared for the section indicating the tappings of various circuits.

13.5.22 **Selection of the Cable Route.**

Generally the terrain conditions on the two sides of the track vary to such an extent as the cable route on one side of the track has a distinct advantage over that on the other side. While operating on the principle, it should be borne in mind that frequent track crossings are not desirable.

In addition to the above, the following also need consideration :-

13.5.22.1 Avoiding underground structures, signalling cables, power cables, pipe lines, etc.

- 13.5.22.2 Avoiding the laying of cable on the side of the drains in built up areas which is generally difficult.
- 13.5.22.3 Selecting the cable route as far as possible on the opposite side where Railway signalling cables are already existing in station yards, etc.
- 13.5.22.4 Taking the cable route preferably through the bed of small culverts where water does not accumulate instead of taking it over the culverts.
- 13.5.22.5 Avoiding termites/rodents infected areas.
- 13.5.22.6 Preference at the side of main line away from coastal side.
- 13.5.22.7 Location of traction sub-stations, feeding posts and other OHE switching posts.

SECTION – VI

DETAILED SURVEY AND FINALISATION OF THE ROUTE PLAN OF OPTIC FIBRE CABLE

Detailed Cable Route Survey :

13.6.1 Purpose :

The purpose of the detailed survey is to undertake closer study of various existing telecommunication facilities to work out exact requirement of materials required for different items of work to finalize all the drawings and site plans required for the execution of work as also to examine the details collected during preliminary survey and to offer necessary changes/modifications, if any.

13.6.2 Main items of work :

The following are the main items of work which should constitute the detailed survey :

- i) Closely examining the proposed cable route and prepared cable route plans.
- ii) Siting of cable hut buildings and preparation of site plans.
- iii) Siting and preparation of site plans for buildings required for the execution of the work, as offices at different stations, store godowns, etc.
- iv) Siting of areas for loading/unloading of cable drums and siding facilities for the EMTs (Engineering Materials Trains) for the project.
- v) Estimating of requirement of special cable lengths for long girder bridges.
- vi) Preparation of the material schedule required for different protective works.
- vii) Arranging isolated telephone circuits to be provided in the cable.
- viii) Investigation on special problems, if any, of the section and finding out proposed solution thereof.

13.6.3 Procedure :

For the preparation of the main cable route plan, “5 km charts” should be prepared which covers a length of 3 Km of the route. The horizontal scale is 10cm = 1km.

Based on the OHE location survey plan, the locations of ASM's office, cabins, OHE switching posts, etc. should be marked on the charts. The name of the location should be put in the 'LOC' column and the chainage in the 'CH'

column. At every 10cm the km post number should be written and its exact equivalent chainage as per OHE survey plan entered in the 'CH' column. The equivalent chainage is required for working out the length of the cable required. The name of the station should be shown against the location of the Station Master's office.

Based on the OHE survey, the serial number and the length of culverts, bridges and level crossing shall be marked on the 'Track Line' of the cable route plan. The survey party should be supplied with prints of '5 km charts' with the above details entered for enabling them to mark the route, and other details after surveying.

The following are the guidelines for finalizing the route and preparation of the cable route plan :-

- i) Prepare the '5 km charts' as explained above and collect the latest copy of approved OHE survey plan to enter the relevant chainages and details in the '5 km charts'.
- ii) Actual measurement by 30m steel tape or chain along the route is necessary only in case of important locations to be termed as 'special terrains' for example, approach to long bridges, big yard, sharp diversions in the cable route from its parallel course along the main Railway tracks due to obstruction, cuttings, etc.
- iii) Inspect and decide the portions of route falling in category of 'special terrains' stated in para (ii) above, i.e. where actual longitudinal measurement is necessary.
- iv) The remaining portions of the route, i.e. other than the portion decided as 'special terrain' as per para (ii) above are to be termed as 'straight runs'. Actual chaining along the route is not necessary for such 'straight runs' and these can be marked on the '5 km charts' by taking chainages from the OHE plan.
- v) The cable route shall be started from control office. At that measurement along the route should be done by means of a 30m steel tape for a few drum lengths up to a convenient point along the main line where from the distances along the route may be reckoned from the OHE plan.
- vi) Actual measurements of the separation distance from the centre line of the reference track (a reference track shall always be the main line) is essential in case of 'special terrains' on 'straight runs' this measurement shall be made where necessary. In case of 'special terrains' the separation distance at some points on the route may also

have to be reckoned from some other permanent structures depending upon the site conditions.

- vii) The separation distance of the cable route from the nearest track on the 'straight runs' should be 10 metres. The deviation from this standard separation of 10 m should be kept to the minimum and as soon as an obstruction has been negotiated, the route shall again follow this standard separation distance.
- viii) As a rule, a minimum distance of 5.75m should be maintained between the OHE masts and the cable. In yards, etc. where observance of this rule may be difficult, a minimum distance of 3m shall be maintained. In exceptional cases where the cable trench depth is less than 0.5m near OHE masts, the above distance may be reduced to 1m.
- ix) The route shall be decided by walking along the track on long stretches of 'straight runs' a push trolley moving slowly may be used. The trolley shall be on the track closet to the proposed route.
- x) Actual measurement shall be made for the protective works required for the cable passing over the culverts under tracks, over long girder bridges, arch bridges, level crossings, rocky areas, under the bed of culverts and near OHE switching posts, etc.
- xi) The survey party shall visit each location such as cabins, SM's offices, loco sheds, pump houses, gate lodge, etc. and verify the details collected during the preliminary survey of all the existing telecommunication facilities to be provided due to RE such as tapplings on traction power control, traction loco control, remote control and emergency control circuits. For emergency control circuits in addition to the general tapplings to be provided at every 1 to 1.2 km. The details of tapplings specifically required by the Electrical Engineering Department for their switching posts such as sub-sectioning posts, sectioning posts, traction sub-stations and isolated locations, etc. shall be collected well in time. The exact location of the various tapplings on the emergency control shall then be worked out taking into consideration the tapplings to be essentially provided at specific locations for Electrical Engineering Department so as to ensure that the distance between the consecutive emergency socket posts does not exceed 1 to 1.2 km.

The position of each tapping shall thus be finalized and a final tapping diagram prepared.

13.6.4 CABLE LENGTH :

13.6.4.1 Cable entry in cabin and other buildings shall be as per Drawing Number RDSO/TCDO/COP-18.

13.6.4.2 The cable length shall be worked out on the following basis :

- (a) Route length as per actual measurement plus contour allowance of 2.5%.
- (b) Extra length for track crossing including 2.5 meters loop on each side.
- (c) 10 meters extra length on approach/crossing of the bridges and culverts on each side as per measurement in the detailed survey.
- (d) 5 meters of cable to be kept on either side of major steel bridges and 2.5 meters of cable on short bridges.
- (e) At every joint a loop of 10 meters on either side shall be kept.
- (f) In cable huts a loop of 10 meters in the cable pit shall be kept.

13.6.4.3 Special lengths for long girder bridges.

For long girder bridges, special length of cable may be required. This is to avoid the location of a joint on such bridges, on slopes leading to bridge abutments and on top of deep cuttings, etc. These details regarding the approaches to the bridges shall be worked out.

13.6.5 Materials required for protective works.

13.6.5.1 For building masonry platform, at culverts, level crossings and road crossings etc. special protection for cable is required.

13.6.5.2 Actual measurement should be made for the length which special protection is necessary and requirement of materials for the protection should be worked out. The requirement of material based on the actual measurement should be shown in cable route plan at the appropriate place.

13.6.6 Isolated telephone circuits.

It is necessary that all telephone circuits such as isolated pump houses, quarry sites, gate lodges are taken note of and provision made for transfer of the overhead alignment into cables wherever considered necessary.

SECTION – VII

CABLE HANDLING TECHNIQUE FOR STOCKING & TRANSPORTATION OF OPTIC FIBRE CABLE

13.7.1 GENERAL :

The following practices are to be followed to prevent damages or deterioration of the cable during handling and storage.

13.7.2 The cable drums stored in open shall be kept on strong surface such as released sleepers to prevent sinking.

The drums shall not be stacked on its flat side and also suitable stoppers shall be placed properly for its stability.

13.7.3 The cable drums shall be stored in a manner allowing easy access for lifting and moving and the drums shall be stored away from other construction activities.

13.7.4 When rolling the cable drum either for unloading or transportation to cable laying site, the drum shall always be 'ROTATED IN THE DIRECTION OF AN ARROW WHICH IS MARKED ON THE SIDE BOARDS OF THE DRUMS' SOMETIMES 'ROLL THIS WAY' ARROW IS INDICATED ON THE DRUM FLANGE.

13.7.5 The drums shall not be rolled over objects that could cause damage to the protective battens or the cable.

13.7.6 After transit, the drums shall be inspected for damage such as broken battens and where possible, the outer layers of the cable should be inspected.

13.7.7 The cable drums shall always be kept upright with the cable ends securely tied to prevent unwrapping. All battens or coverings shall be left in a place until the cable is unrolled from the drums during installation.

13.7.8 UNLOADING OF CABLE DRUMS AT PLACE OF STORAGE OR AT CABLE LAYOUT LOCATION :

13.7.9 UNLOADING OF CABLE DRUMS

- (a) When unloading of a drum is carried out from a vehicle, the drums SHALL NOT BE DROPPED ON THE GROUND directly to avoid irreparable damages to the cable due to impact.

(b) Steps for unloading :

i) Unload the drums with fork lift truck with forks enough to take full width of the drum so that the weight is born by both the flanges.

OR

ii) The cable drum may be lifted by a suitable crane. For this purpose, a suitable size spindle shall be placed through a central hole and double ended shall be attached to the spindle. The spindle shall be equipped with a stopper of such a length that will not cause damage.

13.7.10 LOADING OF CABLE DRUMS

Same precautions as for unloading are to be followed.

13.7.11 SEALING OF CABLE END

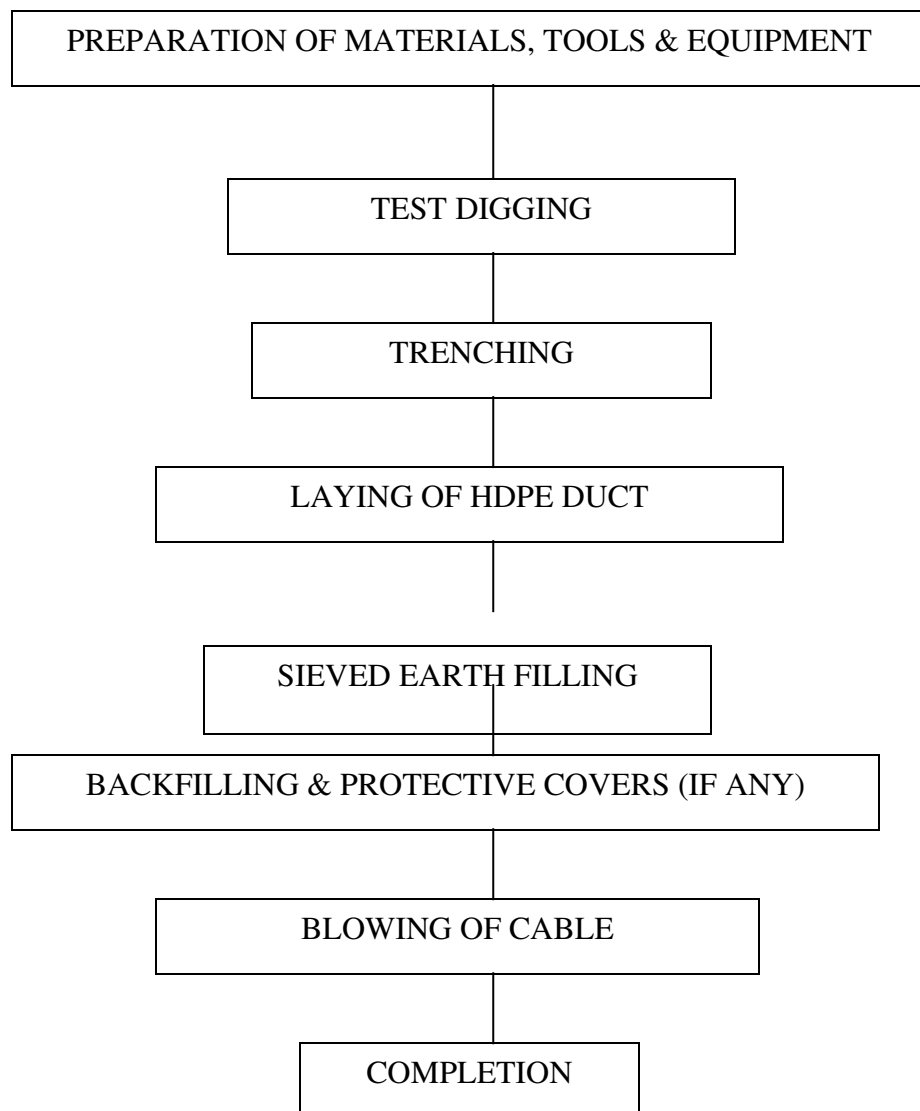
During all stages of storage/use, it is essential that the end of the cable are effectively sealed by heat shrink end cap. Failure to effectively seal may result in water entry in the cable and making it unfit for the use.

SECTION – VIII

LAYING OF DUCT IN TRENCHES AND CLOWING/PULLING OF CABLES IN DUCT

13.8.1 WORK FLOW DIAGRAM :

The major steps for cable laying in trenches are shown below. Before commencing each step, be sure to check how far the work of preceding step has been completed and how well the preparations for the work of subsequent step have been made.



13.8.2 CABLE INSTALLATION AND TRENCHES – GENERAL

14.8.2.1 Armored fibre optic cable shall be blown into duct laid and suitably aligned in the trench. The trenching and laying method is dependent on both ground configuration and nature of the soil at site. The duct shall conform to the latest Specification of TEC/RDSO.

14.8.2.2 From specifications and drawings, ascertain the route of the cable, requirement of the materials, labour and work period, etc.

13.8.3 PREPARATION OF MATERIALS , TOOLS AND EQUIPMENTS

- (a) Check that all tools and equipments for installation detailed in Section XI are ready at site.
- (b) Check that the required quantity and type of material for laying of cable in trenches are ready at site.
- (c) Take care to keep the tools metal fittings equipments in a warehouse to prevent being stolen lost.
- (d) In case, materials have to be kept on the road care must be taken to ensure that traffic is not hampered and no inconvenience is caused to the public.
- (e) Special attention must be paid to avoid keeping material on or around the fire plug or hydrants sewage duct. In case, it becomes unavoidable, use across such locations.

13.8.4 TEST DIGGING

14.8.4.1 Before cable installation, inspect the route with reference to the approved plans and the specification and ensure that there are no obstacles in the route.

14.8.4.2 Conduct test, digging to ascertain the existing facilities and record the position and depth of cable to be installed as well as any existing underground cable or water pipes etc.

13.8.5 INSPECTION

- (a) Check the cable installation position shown in the cable route plan vis-à-vis the actual condition site.
- (b) Determine the cable jointing points and curving points from the offset shown on the cable route plan and measure the distance between them and the surplus lengths.

13.8.6 TRENCHING

13.8.6.1 Traffic Safety :

At the site of cable installation, take the under mentioned measures for traffic safety:

- (a) Provide 'WORK IN PROGRESS" plate wherever necessary at both ends of the site and provide lighting devices.
- (b) Wherever necessary, provide suitable fences at the end and side of the trenches to keep vehicle and pedestrians away. At night, use warning lamps or equivalent at adequate distances.

13.8.6.2 Burying depth of duct

- (a) The depth of the duct shall be enough to prevent natural, artificial obstacles and damage. The standard depth must not be less than the specified.
- (b) In case, it is a rocky area, the depth may be reduced by using the concrete protection.

13.8.6.3 The standard trench :

- (a) The standard trenches are as follows for different conditions :
 - Trench for laying duct for optic fibre cable (typical RDSO/TCDO/COP-6).
 - Trench for laying duct for optic fibre cable with 4 quad cable and PIJF cable in the same trench (typical RDSO/TCDO/COP-7&8).
 - Trench on embankment for duct for optic fibre cable (RDSO/TCDO/COP-9).
 - The trenching in the rocky area for duct for optic fibre cable (typically RDSO/TCDO/COP-10).

13.8.6.4 Excavation :

The excavation for trenching may be made wither manually or by mechanical means.

(a) Manual excavation :

- The depth of the trench may be measured by a rule made of pipes as per RDSO/TCDO/COP-11
- When the surface of the ground where the trench is dug is slanting or uneven, the depth is measured with respect to lower edge.

(b) **Mechanical excavation :**

Excavation of trench can also be done mechanically by:-

- Loading backhoe (Escorts 710x or similar) equipped with excavating bucket of 0.8 meter, cleaning bucket, back filling blade and lifting tackle. This backhoe may be suitably used for lifting cable drum equipped suitably.
- Other mechanical excavation with mechanical fittings to trench and excavate.
- CATERPILLAR TRACTOR can be used for laying cable along cable route using adjustable ripper having typical preparation of 1.20 meter depth to install cable 1.2 meter depth.

13.8.6.5 After digging is done to specified depth, the bottom of trench should be levelled by removing the exposed stones or obstacles, etc.

13.8.6.6 A day's trenching is to be such a length that cable laying and back filling can be finished during the day. This however, would not apply to cases where operation does not hamper the traffic and where cable trenches are not exposed to likely interference/damages.

13.8.7 HANDLING AND LAYING OF DUCT :

13.8.7.1 The coil of duct shall be unloaded by the side of the Railway track from either a crane or by any other suitable means very carefully so as not to cause any damage to the duct. The coils at site shall be protected until they are laid. The duct shall be given the same care in handling as that given to the cable. The coils shall be kept as per the guidelines issued by the manufacturer. The coil shall not be set by jerks but shall be handled slowly and care. The walls of the ducts shall not be damaged while moving the coils, if required for unloading.

13.8.7.2 The coil shall normally be unrolled at the same place and the duct carried by workmen near the trench. The coils shall not be dragged in any case. But where the drums/coils of duct have to be moved should always be rolled in the direction of the arrow, otherwise the coils tend to unwind and the same may get battered. In case no such direction of arrow is given see the direction of winding of the coil and the coil should be rolled pointing in the opposite direction in which the upper end is coiled.

13.8.7.3 All care should be taken in handling the coils with a view to ensure safety of the coils but also of the working party handling them. The coil should not be broken by standing in front of the coil but only from side.

13.8.7.4 DUCT LAYING :

It is advisable to employ the same people at the same place or job while duct is being laid.

Before commencement of the laying, inspection of the trench and inspection of protection works should be carried out so as to ensure their conformity with the specification. The trench bottom should be clean, smooth and free of small stone. When the soil contains stone or pieces of rock and therefore cannot be raddled, sieved earth about 10 cm. thick should be used both for the bedding on which the duct is being laid.

The duct coil should be brought as close to the trench as possible. It should be lifted carefully with the aid of jacks

13.8.7.5 (i) It is customary for the mate to stand in a commanding position where he can view the entire road and shout evenly and call his men to pull. If there is proper synchronization between the mates call in the pulling by the men the duct will leave the coil without difficulty. It is important that the duct shall be pulled with steady and even pulls and there should not be unnecessary twists. Care should be taken to avoid twist as this is likely to damage the duct. When pulling around bends one or two men should be stationed to give the duct the correct bent when it passes.

(ii) While laying the duct employ adequate number of men so that the duct can be conveniently carried by them in both hands without stretched arms. The distance between any two persons carrying the duct shall be two to ten meters depending upon the weight such that the maximum sag of the duct between any two persons is not more than 0.5 meters.

(iii) While laying work is in progress one man has to continuously observe the duct along its line in order to determine indentations poles or other damaged parts are apparent. Such damaged parts have to be protected immediately.

(iv) The conditions of the duct shall be visually inspected throughout its line and in case damage or defect is noticed, the trench shall be filled up only after ensuring that the damage is not likely to affect the cable.

(v) The end of the duct should be sealed with flex to prevent entry of soil before filling back. Adjoining ducts shall be joined by couplers. Duct

integrity testing shall be carried out when laying is completed in a block section (8-10 kms). In case the continuity is not achieved the fault shall be localized and rectified by providing HDPE couplers/Compression couplers.

13.8.7.6 Tools necessary for laying Duct is detailed in Section XI to be checked as physically available before starting the Duct laying.

For efficient and safe Duct laying, communication may be provided between following points using portable VHF Walkie talkie sets :

- a. Duct Coil end
- b. Any intermediate manhole/diversion/track crossing through which the Duct will be pass.
- c. The Supervisor Incharge of the Duct laying.

During duct laying care must be taken not to twist duct in any direction. For this purpose, the survival (rotating hook) shall be attached between pulling line and pulling eye at the end of duct so as to avoid any possible twist during pulling and laying of the cable.

Whenever duct is to be laid in the duct (GI pipe or RCC pipe), suitable lubricant on duct may be used to reduce friction and consequently the tension on the cable.

During duct laying care must be taken not to twist duct in any direction. For this purpose, the survival (rotating hook) shall be attached between pulling line and pulling eye at the end of duct so as to avoid any possible twist during pulling and laying of the cable.

In case it is planned to lay the cable in duct by pulling the cable by using a winch; the duct should be provided with a nylon rope for pulling the cable.

13.8.8 PREPARATION FOR PAYING OUT CABLE

- (a) Check the drum number and length of the cable, etc.
- (b) Entrust cable drum to the contractor after testing the fibres with OTDR for attenuation and to ensure that no mechanical damage of the fibre exists while handing over the cable to the contractor.
- (c) Place the cable jack (to support cable drum) on a flat surface.
- (d) Put cable spindle through drum and adjust cable jacks so that the drum may be clear 3-5 cm from the ground and that the spindle may become horizontal. Remove carefully lags of drum with bar or other means by taking care that no damage to the cable takes place.
- (e) Pull out nails from lags or bend them so that operation can be done safely.

- (f) Normally both end of the cable is provided with cable grip and pulling eye. In case, it is not already provided, fit the cable grip/pulling eye to the survival and pull the wires by means of shackle.

13.8.9 LAYING OF CABLE BY WINCH

- (a) Stretch pulling rope on rollers and fix its end on winch.
 (b) Use 2-3 tonnes winch and put it near the dug trench. The winch shall be fastened at the back wire to a pile driven into the ground to prevent from moving out of place due to pulling tension may arise during operation.
 (c) After all is ready, post workman at winch, cable and using communication, pull slowly into the duct by means of winch.
 (d) Cable shall be laid under a specified pulling tension bending radius and pulling speed as shown below :
 (e)

DURING INSTALLATION	ITEM	VALUE
	PULLING TENSION	1.1* w Kg.
	BENDING RADIUS	30* D
	PULLING SPEED	Max.15 m/min

D – Cable outer dia

W – Weight of Cable per Km. in Kg

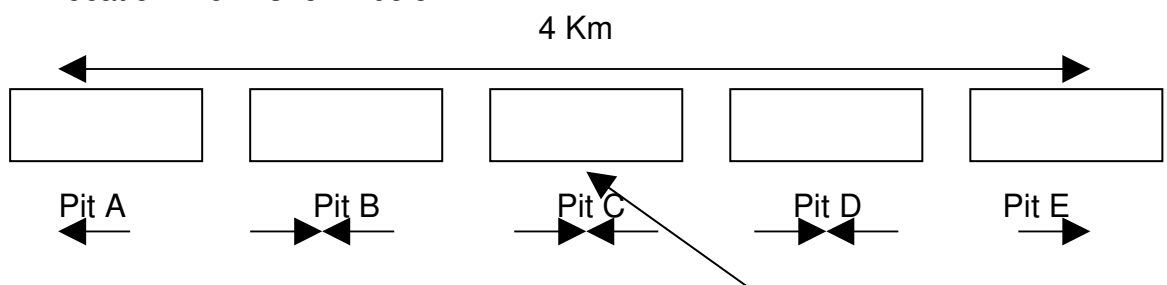
13.8.10 BLOWING OF OFC CABLE

Optical fibre cable will be blown into pre-lubricated HDPE duct laid with the help of a compressor and blowing equipment. (With minimum pressure of 8 bar and maximum pressure of 12 bar with flow rate of minimum 10m³/minute).

The blowing method involves feeding of optical fibre cable into the duct with the help of consistent high pressure airflow, equally distributed along the entire cable throughout the duct.

The following steps may be adopted for safe blowing of OFC :

- i) Position the compressor and blowing machine at blowing pit C for location A & E shown below.



(Location of Compressor and blowing M/C)

- ii) Put the cable drum on cable wheel and blow the OFC towards pit A. A pusher equipment may be placed at B if required.
- iii) When the cable reaches pit A and coil of 10 – 15m of OFC should be kept in pit A. Then seal the duct end at A with the sealing plug.
- iv) Uncoil the cable on the drum in a figure of eight configuration and blow towards blowing pit E and coil of 10 – 15m of OFC should be kept in pit E.
- v) Since the cable will be available in length of 3 km and above, so the contractor has to plan the location of blowing pits before laying of HDPE duct. The contractor has to ensure that excess OFC is not coiled in the blowing pit and also optical fibre cable does not fall short of the location of blowing pit. The contractor has to match the cable drum length with the location of blowing pits, to ensure minimum cut length and wastage of OFC. To achieve the blowing of above shown strength, blowing can be carried out downhill, wherever possible.
- vi) HDPE ducts will be sealed with the help of cable sealing plugs after blowing of OFC into the duct at jointing pit locations.

13.8.11 TREATMENT OF CABLE AFTER IT IS LAID

- a. After completion of cable laying check the following items :
 - Confirm extra jointing length as required at end.
 - In case cable is damaged, take necessary prevention and remedial steps for removal of defects.
 - If there is any snaking or rise in cable put right.
 - Examine interior of the trench and remove any pebbles, etc.
 - Take protective step for such objects projecting the trench such as sewer pipe etc.
- b. While laying one piece of cable, when part of the work is to be put off till the following day, keep the remaining portion of cable wound on the drum, reduce as much as possible the distance of the drum from already laid cable considering cable bending radius and general traffic safety and also ensure that drum is prevented from tumbling down or rolling away. Already laid cable shall be fully covered to avoid outside interface.

SECTION – IX

PROTECTION OF OPTIC FIBRE CABLE ROUTE AND BACK FILLING OF TRENCHES

13.9.1 GENERAL :

13.9.2 This chapter covers the various protection arrangements, which are required to be provided along the cable route for the purpose of preventing damage to the cable and protection to staff.

13.9.3 The chapter also covers the arrangement for back filling of cable trenches to provide protection to the cable.

13.9.4 PROTECTION OF CABLE ROUTE :

13.9.5 PROTECTION OF CABLE CROSSING BRIDGES/CULVERTS. (The typical arrangements for protection for the following types of bridges/culverts are as under.)

- i) Arrangement of cable troughs and channel for girder bridges and major culverts (Typical Drawing RDSO/TCDO/COP-12) and RDSO/TCDO/COP-13). Separate troughs should be provided for laying 6 quad cable & OFC.
- ii) Drawing of crossing major culverts (high flood level and normally blocked by water) and major bridges by steel troughs at rail level (Typical drawing RDSO/TCDO/COP-14).
- iii) Drawing of crossing of Railway bridges by perforated GI pipe (Typical drawing RDSO/TCDO/COP-17).
- iv) Drawing for crossing culverts pipe/box with high flood level (Typical Drawing RDSO/TCDO/COP-16).

13.9.6 MEASURE AGAINST THEFT OF STEEL TROUGHS :

- (a) In the drawing for major culverts and bridges steel troughs are to be provided on the channels as indicated in the drawing RDSO/TCDO/COP-12 and RDSO/TCDO/COP-13.
- (b) In order to prevent theft of optic fibre cable steel troughs with optic fibre cable should be filled up by bitumen compound conforming to IS specification. The cover of the trough to be effectively secured as per the drawing.
- (c) Bitumen filling job should be supervised at responsible level not below the rank of Sr. Supervisor.
- (d) In order that the temperature of the cable does not increase beyond 55°C, bitumen compound should be poured in the early hours/late hours of day when ambient temperature is around 18°C or less.

- (e) While pouring the heated bitumen compound, steel trough covers should be removed all through the bridges in order to permit fast cooling.
- (f) Before pouring bitumen compound, its temperature should be accurately measured to ensure that the pouring temperature is not more than 140°C.
- (g) The bitumen compound should be filled upto a height of approximate 60mm.

13.9.7 ARRANGEMENT ACROSS CULVERTS :

- (a) Most of the culverts are generally dry and as such the arrangement as indicated in RDSO/TCDO/COP-17 can be adopted.
- (b) For culverts which are normally filled with water or which are having high flood level, the protection arrangement can be done as per the arrangement shown in drawing RDSO/PCDO/COP-16.

13.9.8 ARRANGEMENT FOR LAYING OF FIBRE OPTIC CABLE ACROSS GIRDER BRIDGES :

- (a) Girder bridges up to span length of 12 meter :
 - i) Girder bridges of up to 6 meter span can be crossed with perforated GI pipe as per the arrangement shown in drawing No.RDSO/TCDO/COP-17.
 - ii) The same arrangement can be followed for girder bridges of span length between 6 and 12 meter where an intermediate support to GI pipe can be provided.
- (b) Girder bridges of span length more than 12 meters.
 - i) The crossing of girder bridges of more than 12 length can be done as per the drawing No.RDSO/TCDO/COP-14. The arrangement for fixing of steel trough indicated in drawing RDSO/TCDO/COP-12 and RDSO/TCDO/COP-13.
 - ii) The procedure for filling bitumen compound is indicated in Clause 13.9.6 above.
 - iii) Separate trough for laying 6 quad cable should be used.

13.9.9 PROTECTION ARRANGEMENT ON THE CABLE ROUTE :

The typical drawings of cable trenches under various situations are given in Section-VIII. These drawings include the protection arrangement of brick

provided along the cable route. These protection arrangements are summarized below:

- (a) The cable laid in the station yard (Home Signal to Home signal) and on the embankment, after covering the duct with riddled earth, B-class brick to be placed transversely through out to over the cable laid in station yard/embankment.
- (b) The cable marker shall normally be provided at distance of every 50 meters on the cable route and at places wherever the route changes. A joint indicator shall be provided at all types joints. The cable marker and joint marker provision shall be as per Drawing No.RDSO/TCDO/COP-18 for normal and rocky area.
- (c) The cable marker and joint markers provided shall be of standard stone RCC type.

13.9.10 CABLE CROSSING TRACKS AND LEVEL CROSSING GATE :

- (a) In such cases, the cable shall be laid in RCC pipes keeping the depth same as in normal routes.
- (b) In case of cable crossing the LC gates, HDPE pipe to be laid on the road and for a distance of at least two meters from either side of the road.
- (c) Minimum depth at any track crossing shall not be less than 1.2 meters with RCC/GI pipe. In case cable crossing the track, it may be ensured that it should not be bent less than 600mm radius. Suitable fixture with HDPE pipe should be provided to ensure proper bending radius to be used at each end.
- (d) The drawing for track crossing, road crossing platform shall be as per Drawing No.RDSO/TCDO/COP-19.
- (e) Arrangement of RCC pipe under metalled road shall be as per RDSO/TCDO/COP-20.
- (f) In case of difficult terrain along road/platforms/Railway track, etc. where trenching is difficult, trench less horizontal directional drilling may be adopted. A minimum depth of 1.2 meters to be ensured.
- (g) Cable should not be buried directly, it should be laid in permanently lubricated HDPE/DWC pipes (conforming to latest RDSO/TEC specification with latest amendments) at one meter depth from surface in plains.

Cable should be taken in GI pipe in rocky areas, culverts, girder bridges and PSC girder bridges (without duct). At the end of these structures where the pipe enters the trench the pipe should extend right into the trench and then should be protected with a concrete/brick masonry work, 5 meter cable should be kept at the ends.

- (h) Wherever new PSC girders are being constructed, provision of ducts should be catered, OFC cable shall be taken through class B GI pipes of 80 mm diameter.
- (i) In tunnel area the cable should be laid by excavating a suitable depth in the drainage area levelling the bottom surface in B class GI pipe of 80 mm diameter, the entire length of GI pipe will be concreted and substantially protected.
- (j) Wherever ballast less track is constructed as in the case of long tunnels provision for HDPE pipe should be catered, which can be embedded in the concrete base. In such cases, tapping holes may be made at every 200 meters so that emergency control circuits can be tapped at convenient locations.

13.9.11 BACK FILLING OF TRENCHES :

13.9.12 For back filling of cable trenches following precautions shall be taken :

- (a) At least 120mm from the surface of the last cable, cable should be covered with riddles earth. This portion of the earth is not loose. This will also prevent entry of rodents and other insects.
- (b) At 500mm depth a PVC warning tape shall be provided continuously running in the trench.
- (c) For the remaining portion of the trench, the released earth may be used. However, after filling up the trench, the earth shall be consolidated by ramming.
- (d) Re-filling of trench and ramming shall be supervised by a responsible Supervisor and also at officer's level for the specified percentage of the section.
- (e) It shall be ensured that before the start of monsoon session, all open trenches are properly back filled to avoid water logging of the trench.

13.9.13 In case of any unforeseen situation/controversy final decision will be taken by the Engineer at site.

SECTION – X

JOINTING AND TERMINATION OF OPTIC FIBRE CABLE

13.10.1 Techniques for jointing of optic fibre cable.

13.10.2 Following types of techniques shall be used for splicing of fibres :-

- (a) Mechanical Splice
This align the axis of the two fibres to be joined and physically hold them together.
- (b) Fusion Splicing
This is done by applying localized heating (i.e. by electric arc or flame) at the interface between the butted, pre-aligned fibre end, causing them to soften and fuse together.

13.10.3 Mechanical splicing shall be used for temporary splicing of fibres or where fusion splicing is impractical or undesirable.

13.10.4 At all other location and during initial installation of optic fibre cable, fusion splicing shall be adopted.

13.10.5 STRAIGHT JOINT FOR OPTIC FIBRE CABLE

13.10.6 There are various types of joint enclosures available in the market. The procedure for assembly of joint closure is described in the installation manual supplied with straight joint closure. This includes the following :

- (a) Material inside joint closure kit.
- (b) Installation tools required.
- (c) Detailed procedure for cable jointing
- (d) Procedure for reopening the closure.

13.10.7 Generally, the following steps are involved for jointing of the cable :

- Preparation of cable for jointing
- Stripping/cutting the cable
- Preparation of cable and joint closure for splicing
- Stripping and cleaving of fibres
- Organising fibres and finishing joints
- Sealing of joint closure and
- Placing joint in pit

13.10.8 PREPARATION OF CABLE FOR JOINTING

- (a) During the installation, a minimum of 10 meter of cable at each end is coiled in the jointing pit to provide for jointing to be carried out at convenient location as well as spare length to be available for future use in case of failures.
- (b) The pit size shall be so as to ensure the length of the wall on which joint is mounted is greater than closure length plus twice the minimum bending radius of the cable. A pit length of 1 meter is sufficient for most of the cable and joint closures. Bracket to support the cable coil are also fixed on the wall of the pit. Details of cable pit are given in Drawing No.RDSO/TCDO/COP-21.
- (c) The cable is then coiled on to the pit wall in the same position as required after the joint is complete. The marking is done on all the loops so that it will be easier to install it later.
- (d) The distance from the last centre to the end of the cable must be at least 1.8 meters. This is the minimum length to be stripped for preparation of joint.
- (e) Sufficient cable length at both ends up to the jointing vehicle/enclosure is then uncoiled from the pit for jointing.

13.10.9 STRIPPING/CUTTING OF THE CABLE

- (a) The cable is stripped of outer and inner sheath with each sheath staggered approximately 10mm from the one above it.
- (b) Proper care must be taken when removing the inner sheath to ensure that the fibres are not scratched or cut with the stripping knife or tool. To prevent this, it is better to score the inner sheath twice on opposite sides of the cable, rather than cutting completely through it. The two scores marking on either side of the cable can be easily stripped of the inner sheath by hand.
- (c) The fibres shall be then removed from cable one by one and each fibre is cleaned individually using kerosene to remove the jelly.
- (d) Armouring shall remain outside the gland and will not be connected through.

13.10.10 PREPARATION OF CABLE JOINT CLOSURE FOR SPLICING

The type of preparation work performed on the cable prior to splicing differs on the type of joint closure and fibre organizer used. However, the following steps shall be usually common for different types of joint closure.

- (a) The strength member of each cable shall be joined to each other and/or the central frame of the joint closure.
- (b) The joint closure shall be assembled around the cable.
- (c) The sealing compound or heat shrink sleeve shall be applied to the cables and closure, or prepared for application after splicing is complete.
- (d) Tags which identify the fibres number shall be attached at suitable location on the fibres.
- (e) Splice protectors shall be slipped over each fibre in readiness for placing over the bare fibre after splicing.

13.10.11 STRIPPING AND CLEAVING OF FIBRE

- (a) Prior to splicing, primary protective coating of each fibre shall be stripped off up to length of 50 mm. by using fibre stripper. Fibre strippers shall be manufactured to fine tolerances and only score the coating without contacting the glass fibre.
- (b) The bare fibre shall be then wiped with a lint tissue paper rinsed with ethyl alcohol.
- (c) Cleaving of the fibre shall then be performed to obtain as close as possible to a perfect 90 degree face on the fibre.

13.10.12 SPLICING OF THE FIBRE

As discussed above there are two types of methods which shall be used for fibre splicing.

13.10.12.1 FUSION SPLICING OF FIBRE

Some of the general steps with full automatic micro processor control splicing machines shall be as under:

- (a) Hands shall be thoroughly washed prior to commencing this procedure.
- (b) The clean bare fibre shall be dipped in the beaker of ethyl alcohol of the ultrasonic cleaver and ultrasonic cleaver switched on for 5-10 seconds.
- (c) The bare fibre shall then be placed inside 'V' groove of the splicing machine by opening clamp handle, in such a way so that 1 mm gap is available between the electrodes and the end of fibre being spliced and heat shrink protector inserted.
- (d) The same procedure shall be repeated for other fibre.
- (e) The start button on the splice controller shall be pressed.
- (f) The machine shall pre-fuse set align both in 'X' and 'Y' direction and then finally fuse the fibre.
- (g) The splice shall be inspected on monitor provide on the fusion splicing machine, there shall be no nicking, bulging and cores are adequately

aligned. The above procedure shall be repeated if the splice is not visually good looking.

- (h) The heat shrink protector shall be slid over the splice and tube shall be placed in tube heater. Heating shall be considered complete when soft inner layer is seen to be 'oozing' out of the outer layer of the protector.
- (i) The steps 9a) to (h) above shall be repeated for other fibres.

13.10.12.2 MECHANICAL SPLICING OF THE FIBRE

There are two types of mechanical splicing system. In case, one with precision alignment of fibre in 'V' groove and fibre ends are sealed with some index matching fluid and adhesive. The other system uses ultrasonic light source for curing optical adhesive in addition to alignment etc.

The general steps involved above are as under:

- (a) Stripping and cleaving of fibres shall be done as per Clause 13.10.11.
- (b) Protective end cap shall be removed from mechanical splice and vent tube pulled up.
- (c) Adhesive shall be injected into splice as specified by supplier into splice.
- (d) Fibre shall be inserted till it butts against fibre end already bonded in place.
- (e) Adhesive shall be cured with UV light following exposure times as specified by supplier.
- (f) The steps (a) to (e) above shall be repeated for all fibres.

13.10.13 ORGANISING FIBRE AND FINISHING JOINTS

- (a) After each fibre has been spliced, the heat shrink protection sleeve shall be slipped over the bare fibre before any handling of fibre takes place as uncoated fibres are very brittle and cannot withstand small radius bends without breaking.
- (b) The fibre shall then be organized into its tray by coiling the fibres on east side of the protection sleeve using the full tray side to ensure the maximum radius possible for fibre coils.
- (c) The tray then shall be placed in the position.
- (d) OTDR reading shall be taken for all splices in this organized state and recorded on the test sheet to confirm that of all fibres attenuation is within specified limits. The OTDR test confirms that fibres were not subjected to excessive stress during the organizing process. Care should be taken that the fibres are not interchanged while jointing.
- (e) The joint shall then be closed with necessary sealing etc. and considered ready for placement in the pit.

13.10.14 PLACING OF COMPLETED JOINT IN PIT

- (a) Joint shall be taken out from the vehicle and placed on the tarpaulin provided near the pit.
- (b) The cable is laid on the ground and looped according to the marking done in the beginning. These loops shall then be tied together with the tape.
- (c) The joint shall be permanently closed and sealed by heating heat shrinkable sleeve, etc.
- (d) The joint closure shall be fixed to the bracket on the pit wall and pit closed.

13.10.15 REOPENING OF THE JOINT

For attending faults, etc. special kits shall be used for opening of the joint and the instructions shall be followed. The general steps are as under :-

- (a) Suitable knife shall be used to cut heat shrink sleeve longitudinally along its entire length.
- (b) It shall be ensured that there is no damage the smaller heat shrink sleeve on the ends of the joint.
- (c) Heat shall then be applied to the cut sleeve until it begins to separate.
- (d) The cut sleeve shall be removed gently from the joint so that joint can be opened.
- (e) Protective sleeve/cover shall be removed for attending to faults, etc.

13.10.16 TERMINATION JOINT FOR OPTIC FIBRE CABLE

13.1.0.16.1 This joint is provided in the cable hut for terminating the outdoor optic fibre cable of both the sides, splicing through fibres, connecting fibres to pigtails for connection to optical line terminal equipment, etc.

13.1.0.16.2 The procedure for installation of termination joint box shall depend on the type of joint enclosure. The installation manual shall contain the step by step procedure for installation. The general steps shall be as under :-

- Marking the cable
- Stripping/cutting the cable
- Gripping cable in sheath/clamp
- Treatment of tension member
- Fibre splicing
- Enclosing fibre
- Fixing strength member
- Closing the cover
- Fixing termination box
- Fixing the cable

13.10.17 MARKING THE CABLE

- (a) The cable length shall be determined up to the proposed location of termination box. It shall also be ensured that at least 10 meters of cable is coiled in the cable pit.
- (b) The cutting point shall be determined and the cable marked.
- (c) The length sheath peeling point shall be determined and cable marked.

13.10.18 CUTTING/STRIPPING THE CABLE

- (a) The cable shall be cut as per the marking.
- (b) The sheath shall be removed from cable end. During sheath stripping care shall be taken that the fibres are not damaged.
- (c) The length and the steps for various sheath cutting shall be as per the instructions given in the manual.

13.10.19 GRIPPING THE CABLE

- (a) PVC tape shall be wound around the cable core just beside edge of the sheath.
- (b) The bushing inside sheath shall be inserted by cutting the cable sheath for about 25mm.
- (c) The sheath grip (lower half and upper half) shall be placed and tightened it with the help of torque wrench.

13.10.20 FIXING OF TENSION MEMBER

- (a) The tension member shall be marked for the specified length and cut.
- (b) The tension member shall be thoroughly cleaned by alcohol and cotton cloth.
- (c) Tension member holder shall be fixed at the end of tension member with the help of instant adhesive.

13.10.21 FIBRE SPLICING

The procedure for fibre splicing shall be same as described for straight joint closure in Clause 13.10.12.

13.10.22 ENCLOSING FIBRES

- (a) The fibre cassette shall be set on the base of the joint closure.
- (b) Excess length of fibre shall be arranged to make double figure of eight.
- (c) The spliced fibre and its excess length shall be enclosed carefully.
- (d) The steps (a) to (c) above shall be repeated for other fibres.

13.10.23 MOUNTING OF TERMINATION BOX

Termination box shall be fixed either on wall or on equipment rack.

- (a) The fixing holes shall be marked on the walls/bracket/frame.
- (b) The termination box shall be placed and the nuts inside the base box shall be tightened.
- (c) Sufficient silica gel in bags shall be kept inside and the covers shall then be put on termination box and closed.
- (d) Fibre Distribution Management System (FDMS).
At major termination stations OFC cable should be installed in suitable Fibre Distribution and Management System (FDMS). The system could be compatible with 19" rack. The FDMS shall conform to TEC specification for generic requirement No.GR/FDM/0101 with latest amendments and RDSO specification.
- (e) Patch Cords/Pigtails.
Patch cords and pigtails shall be procured as per RDSO/TEC's latest specification.
- (f) Jointing/Splicing: The optic fibre placed in the joint should be safely protected in a brick masonry chamber or concrete chamber of approximate dimension 1 meter x 1 meter (50 cm depth). The chamber should be filled with fine sieved sand. The upper surface of the chamber should be kept 50 cm below the surface; a suitable joint marker should be placed on all joint locations. 10 meters of extra cable should be coiled in the pit for future use. Armoring must not be put through. The armoring should be earthed.

13.10.24 FIXING THE CABLE

The cable on wall/frame shall be secured at two places within one meter from termination box keeping in view straight entry of cable into termination box.

13.10.24.1 After the cable is laid and splicing has been completed, measurements in the enclosed proforma has to be prepared.

Section		Distance	Cable length	Fibre No	Loss in dB		Remarks
Fro m	To				1310nm	1550nm	

The end to end loss should not exceed 0.25db/Km at 1550 nm and 0.40 db/Km at 1310 nm.

SECTION – XI

TOOLS AND EQUIPMENTS FOR INSTALLATION AND TESTING OF OPTIC FIBRE CABLE

GROUP – I TOOLS REQUIRED FOR TRENCHING, CABLE LAYING AND BACK FILLING.

SNo.	Tool's Name
1.	Cable Jack
2.	Cable Grip
3.	Reopening device
4.	Free Hood Hook
5.	Shackle free head hook
6.	Growling hook
7.	Pulling bolt
8.	Tension meter
9.	Pulley
10.	Anti twist device (swivel)
11.	Roller
12.	Flexible cable
13.	Pulling rope
14.	Brush
15.	Mandrel
16.	Chain
17.	Measuring cord for strain gauge
18.	Slip winch
19.	Wire rope
20.	Portable VHF set
21.	Measuring tape
22.	Phawarah
23.	Iron Plate
24.	Loader Backhoe for drilling
25.	Warning Tape
26.	Caterpillar tractor
27.	Fork lifter
28.	Vehicle Van type
29.	Tachometer
30.	Portable K oil Generator
31.	Umbrella
32.	Blank dark coloured cloth for splicing machine

**GROUP – II TOOLS AND EQUIPMENTS REQUIRED FOR JOINTING AND
TERMINATION OF OPTIC FIBRE CABLE.**

SNo.	Tool's Name
1.	Branch Joint Closure
2.	Termination Box
3.	Rubber and Block
4.	Sheath Clamp
5.	Bushing
6.	Strength Member holder
7.	Heat Shrinkage tube
8.	Arc fusion splicer machine
9.	Power cord AC/DC
10.	Walkie-Talkie 12V DC source
11.	Tube heater
12.	Precision cleaver
13.	Cable sheath stripper
14.	Fibre stripper
15.	Knife for HDPE cutting
16.	Hacksaw for strength membrane
17.	Isopropyl alcohol or methanol of high specific gravity
18.	Johnson Buds
19.	Tweezers
20.	Gun heater blower type
21.	Sleeve for splice protection
22.	OTDR
23.	Stabilized optical power source and power meter
24.	Optical Talk set
25.	Stickers for numbering of splicers

SECTION – XII

13.12.1 List of items to be handed over to Maintenance Organization before handing over the section for maintenance.

The following items should be handed over to the maintenance in charge before handing over the section for maintenance.

1. The Cable Route Plan in electronic form (CD) preferably using AUTOCAD. Distances from fixed reference structures like centre of track, OHE mast, bridges, culverts, etc. should be indicated in the route plan for easy reference in future.
2. The Fibre Distribution Plan
3. Measurements of Optical Parameters which includes sectional losses, splice wise losses, records of dispersion measurements (in case of long haul systems) for set of measuring equipments and tools as per the yardstick should be handed over to the maintenance organization.

13.12.2 Staff Requirement.

There should be a full-fledged cable gang for a section length of about 300 Kms. The staff strength should be as per yardstick laid down in Board's Letter No.2000/Tele/MW/7/RCIL/A/Pt. dated 6/9/2004.

Without AMC total No.of staff = 26

SNo	Gang Description	Category of staff	Number per Gang	Number of Gangs	Total
1	General Supervision	SSE TA/Clerical Artisan Group 'D'	1 1 1 4	1	7
2	Cable Gang	JE-I/II TCM-III/WTM-III Cable Jointer Group 'D'	1 1 1 2	2 (one gang for every 150 Kms)	10
3	Equipment Gang	SE/JE-I TCM-I/II/WTM-I/II Group 'D'	1 4 2	1	7
4	EMC Patrol Gang	TCM-III/WTM-III	2	1	2
Grand Total					26

With AMC total No.of Staff (for cable maintenance) = 20

SNo	Gang Description	Category of staff	Number per Gang	Number of Gangs	Total
1	General Supervision	SSE TA/Clerical Artisan Group 'D'	1 1 1 4	1	7
2	Cable Gang	JE-I/II TCM-III/WTM-III Cable Jointer Group 'D'	1 1 1 1	1	4
3	Equipment Gang	SE/JE-I TCM-I/II/WTM-I/II Group 'D'	1 4 2	1	7
4	EMC Patrol Gang	TCM-III/WTM-III	2	1	2
Grand Total					20

The maintenance gang should have provision for a vehicle where the men and material (as enlisted) in Annexure II can be loaded and comfortably reach the site.

APPENDIX I

MAINTENANCE SCHEDULE FOR FIBRE OPTIC SYSTEM

EQUIPMENT	ITEM	MAINTAINER	SECTIONAL SUPERVISOR	SUPERVISOR INCHARGE
POWER SUPPLY EQUIPMENT	Maintenance of Batteries	weekly	monthly	Quarterly
	Meas. of Battery voltages	weekly	monthly	Quarterly
	Main. of Charger and In/Out voltages and currents	weekly	monthly	Quarterly
	Checking of fuses and terminations	weekly	monthly	Quarterly
	Check of Earthing	weekly	monthly	Quarterly
GENERAL	Cleaning of the flooring	weekly		
	Removal of dust from the equipment and cards	weekly		
	Measurement of room temperature	weekly		
	Earthing of the racks, power equipment etc.	weekly	monthly	Quarterly
	Measurement of earth resistance		Quarterly	Quarterly
	Check of electrical devices.	weekly	monthly	Quarterly
	Maintenance of pigtails, fibre distribution frame etc.	weekly	monthly	Quarterly
OPTICAL FIBRE CABLE	OTDR Measurement of spare fibres		Quarterly	
CABLE ROUTE	Integrity of cable route	Fortnightly	Quarterly	Yearly
	Protective works on bridges & culverts	Fortnightly	Quarterly	Yearly
	Cable route markers	Fortnightly	Quarterly	Yearly
	Earthing of sheath of cable	Fortnightly	Quarterly	Yearly
Periodical line up	OTDR meas. on all Fibres			Yearly
	Tx/Rx optical power			Yearly
	Pulse mask for all digital interfaces		Quarterly	Yearly
	Channel meas. as per CCITT		Quarterly	Yearly

	<ul style="list-style-type: none"> • G821/G823 tests on 64KBPS/2MBPS for 10 days 		Quarterly	Yearly
	<ul style="list-style-type: none"> • Loss measurement with optical source & power meter. 		Quarterly	Yearly
	<ul style="list-style-type: none"> • Measurement of orderwire performance circuits. 		Quarterly	Yearly

Note :

1. Items related to cable gang shall be done by cable maintenance Gang.
2. Items related to equipment shall be done by equipment maintenance gang.

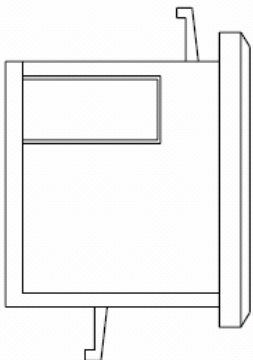
APPENDIX II

T&P ITEMS AND MEASURING EQUIPMENTS FOR MAINTENANCE STAFF

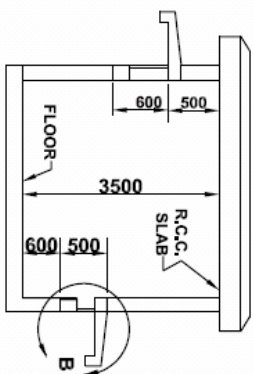
S.No.	GANG	RECOMMENDED T&P ITEMS & EQUIPMENTS
1.	Equipment Maintenance	<ul style="list-style-type: none"> • Soldering Iron • Vacuum Cleaner • Standard Tool Kit containing Screw Drivers, etc. • Digital Multi-meter • Optical Fibre connector Cleaning kit
2.	Sectional Supervisor Equipment	<ul style="list-style-type: none"> • All equipments as prescribed for equipment maintenance gang. • Portable BER & PCM Test Set • Meager • Optical Attenuation Measurement set consisting of optical power meter, optical source and optical attenuator
3.	Supervisory Incharge	<ul style="list-style-type: none"> • Test and Repair Van

	for equipments	<ul style="list-style-type: none"> • PCM Transmission Analyzer • PCM Channel Analyzer along • Digital Storage Oscilloscope • Frequency Counter • Fibre Optic tool kit • Mini portable Generator • SDH analyzer
4.	Sectional Engineer Cable Maintenance	<ul style="list-style-type: none"> • Digital Multi-meter\ • Mini ODTR • Mechanical splicing kit • Ruggedised Optical Fibre cable 200 Mts • Splicing machine with battery • Fibre Optic Tool Kit • All types of Adopters & Connectors • Fibre Optic Talk set • Insulation Tester • TMS kit
5.	HQ gang for cable	<ul style="list-style-type: none"> • 200 Mtr of OFC cable • Test & Repair van • Portable generator • Automatic Fusion Splicing machine • OTDR • Fibre Optic Tool Kit • Mechanical Splicing kit • Optical Talk set • All types of Adopters & Connectors. • Lighting arrangements and emergency lamps (2 Nos) • Emergency phones (4 Nos) • Walkie-Talkie sets (4 Nos) • Torches with batteries (6 sets) • Spare batteries for splicing machines (1 No) • Puncha (to remove ballast) (2 Nos) • Pickaxe (4 Nos) • Motar pan & showel (4 Nos) • Spade (4 Nos) • Portable tent (1 No) • Crow bar (2 Nos) • OFC spare cables (cables of adequate length) • HDPE pipe pieces (10 Nos) • Drinking water can (20 litres) (1 No)

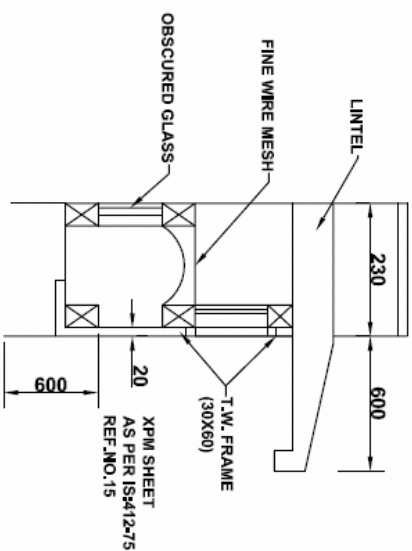
		<ul style="list-style-type: none">• Glasses (2 Nos)• Folding table and chair (1 each)• Stool light weight (2 Nos)• First aid box (1 No)
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FRONT ELEVATION



SECTION AT 'AA'



DETAIL AT 'B'

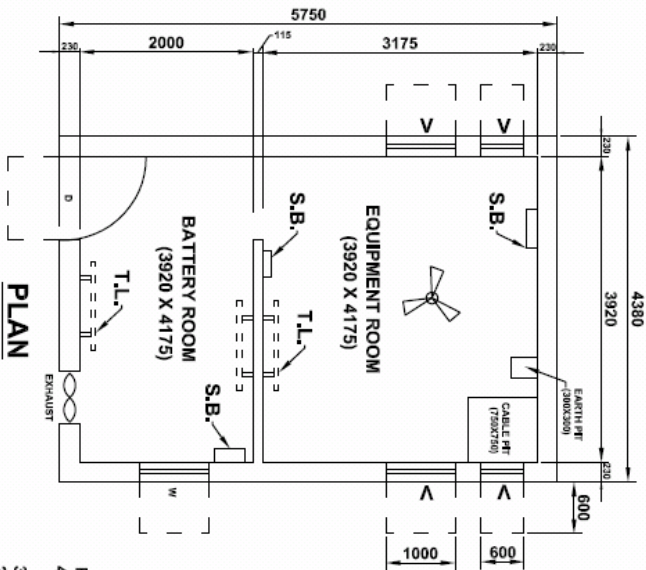
- EQUIPMENT ROOM**
1. EQUIPMENT ROOM SHOULD HAVE DOOR CLOSURE.
 2. 2 NOS. OF THIN DECORATIVE TUBE LIGHTS.
 3. 2 NOS. OF 5 AMP SOCKETS WITH PLANO TYPE SWITCH ON SWITCH BOARD (SB).
 4. 1 No. OF CEILING FAN.
 5. MARBLE TILE FLOORING.

- BATTERY ROOM**
1. 2 NOS. OF FLUORESCENT TUBE LIGHTS.
 2. ONE EXHAUST FAN.
 3. ONE 5 AMP SOCKETS WITH PLANO TYPE SWITCH ON SWITCH BOARD (SB).
 4. ACID PROOF TILES FLOORING IN BATTERY ROOM.

SCHEDULE OF DOOR, WINDOW & VENT			
DOOR 'D'	WIDTH	HEIGHT	BILL
WINDOW 'W'	1000	2135	600
VENTILATOR 'V'	1000	1535	IN NOTE
	600	500	

**BUILDING LAYOUT FOR
FIBRE OPTIC HUT
FOR REPEATER.**

DRG.NO.RDSO/TCDO/COP-1



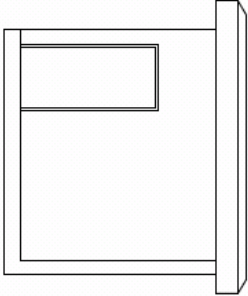
PLAN

DETAIL OF VENTILATOR 'V'

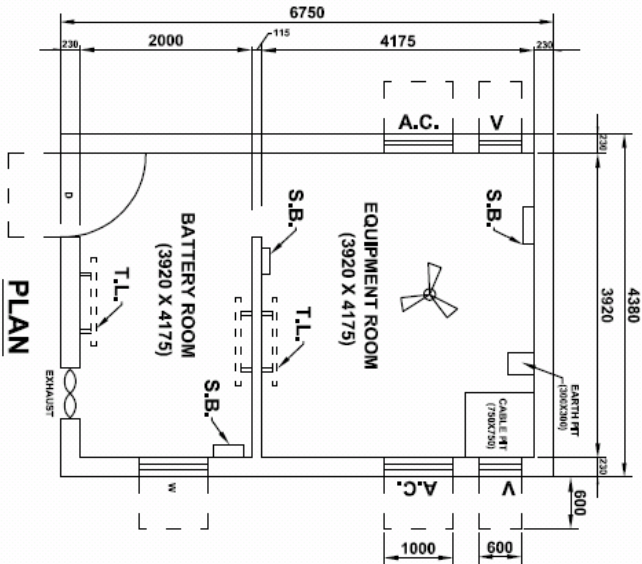
INSIDE VIEW

OBSCURED GLASS
T.W. FRAME (50X30)

- REF. NO. IS : & SUITABLE GRID INSIDE
4. PROPER SLOPE TO BE PROVIDED ON THE ROOF FOR THE RAIN WATER DRAINAGE.
 3. ALL DIMENSIONS ARE IN mm.
 2. XPM SHEET AS PER IS: 412-75, SHOULD BE PROVIDED IN OUT SIDE OF THE WINDOW GRILL.
 1. TWO VENTILATORS SHALL BE PROVIDED IN OPPOSITE WALLS . ONE AT 600mm ABOVE GROUND LEVEL & OTHER AT 600 mm BELOW ROOF SLAB.



FRONT ELEVATION



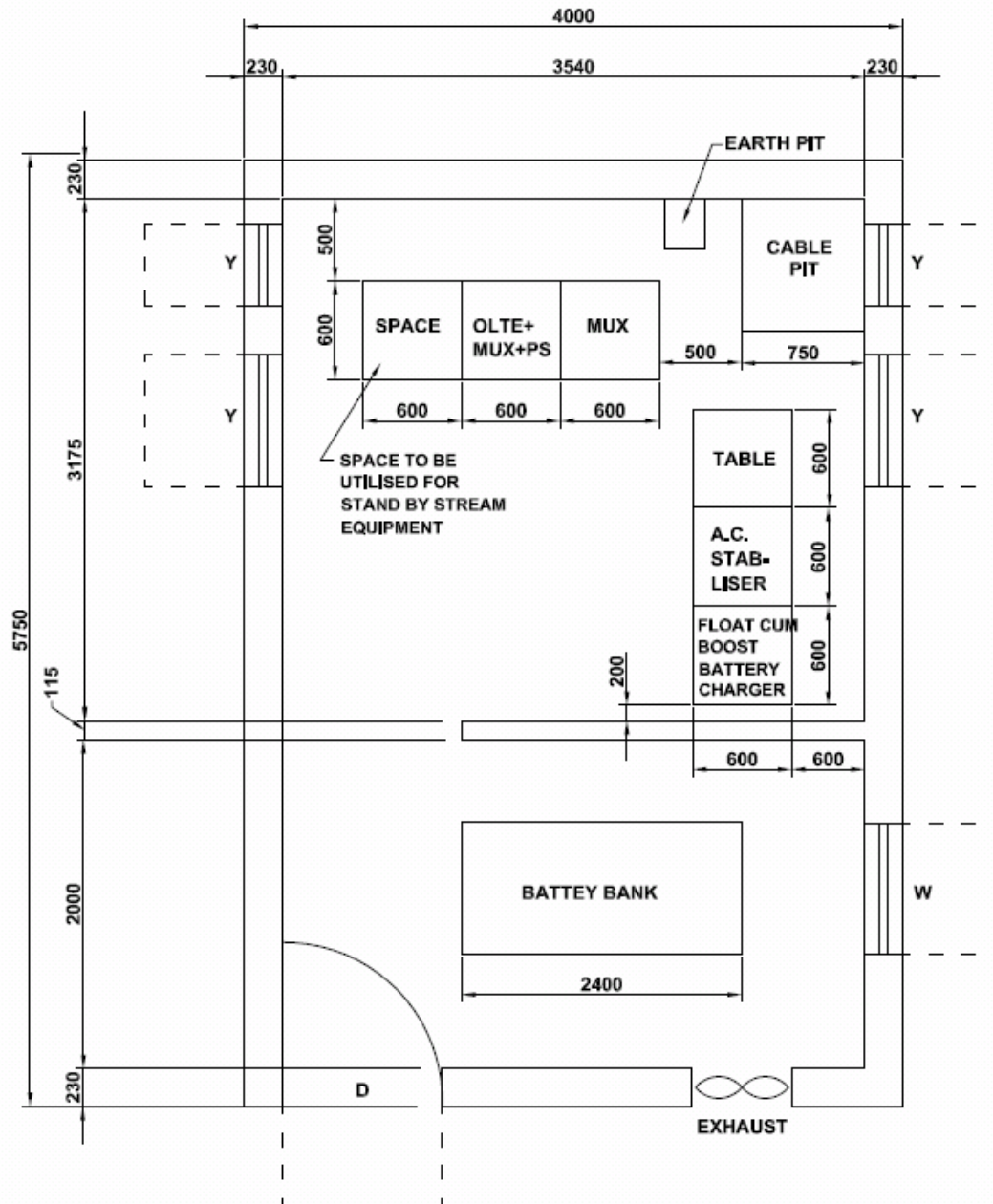
- EQUIPMENT ROOM**
- 1. EQUIPMENT ROOM SHOULD HAVE DOOR CLOSURE.
 - 2. 2 NOS. OF THIN DECORATIVE TUBE LIGHTS.
 - 3. 2 NOS. OF 5 AMP SOCKETS WITH PLANO TYPE SWITCH ON SWITCH BOARD (SB).
 - 4. 1 No. OF CEILING FAN.
 - 5. MARBLE TILE FLOORING.

- BATTERY ROOM**
- 1. 2 Nos. OF FLUORESCENT TUBE LIGHTS.
 - 2. ONE EXHAUST FAN.
 - 3. ONE 5 AMP SOCKETS WITH PLANO TYPE SWITCH ON SWITCH BOARD (SB).
 - 4.ACID PROOF TILES FLOORING IN BATTERY ROOM.

SCHEDULE OF DOOR, WINDOW & VENT			
DOOR 'D'	WIDTH	HEIGHT	BILL
WINDOW 'W'	1000	2135	600
VENTILATOR 'V'	1000	1535	IN NOTE
	600	500	

BUILDING LAYOUT FOR
FIBRE OPTIC HUT
FOR MAJOR STATIONS .

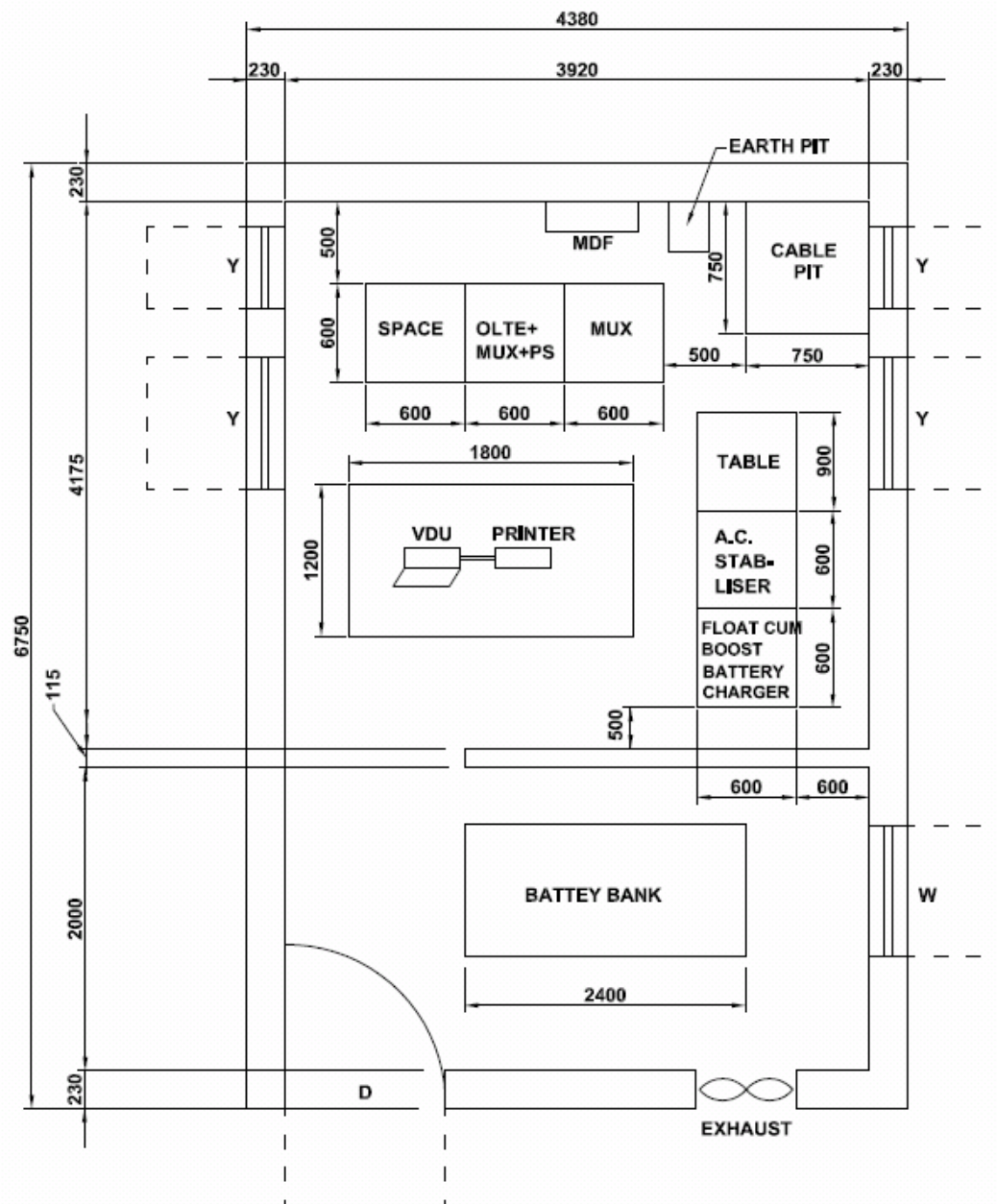
DRG.NO.RDSO/TCDO/COP-2



ARRANGEMENT OF EQUIPMENTS IN OPTIC FIBRE HUT FOR REPEATER.

DRG.NO.RDSO/TCDO/COP-03

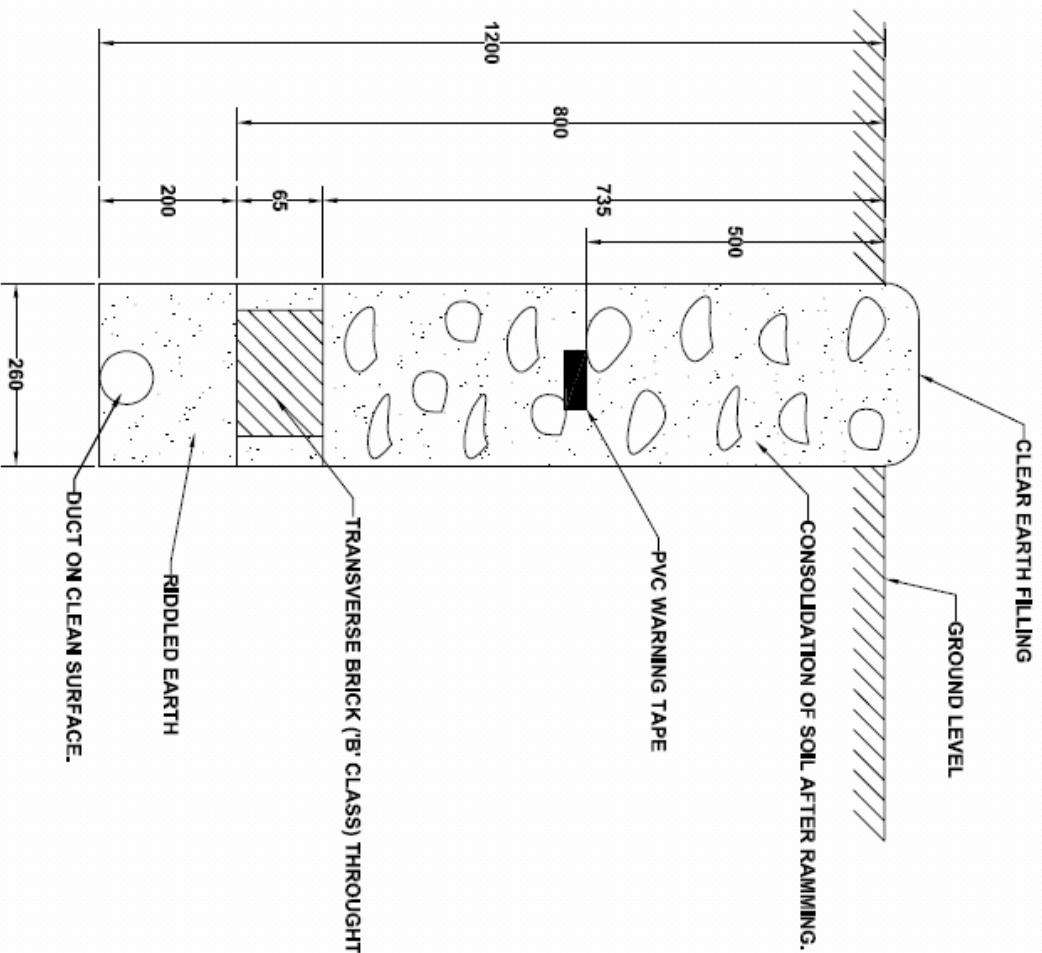
1. ALL DIMENSIONS ARE IN mm.



**ARRANGEMENT OF EQUIPMENTS
IN OPTIC FIBRE HUT FOR
MAJOR STATION.**

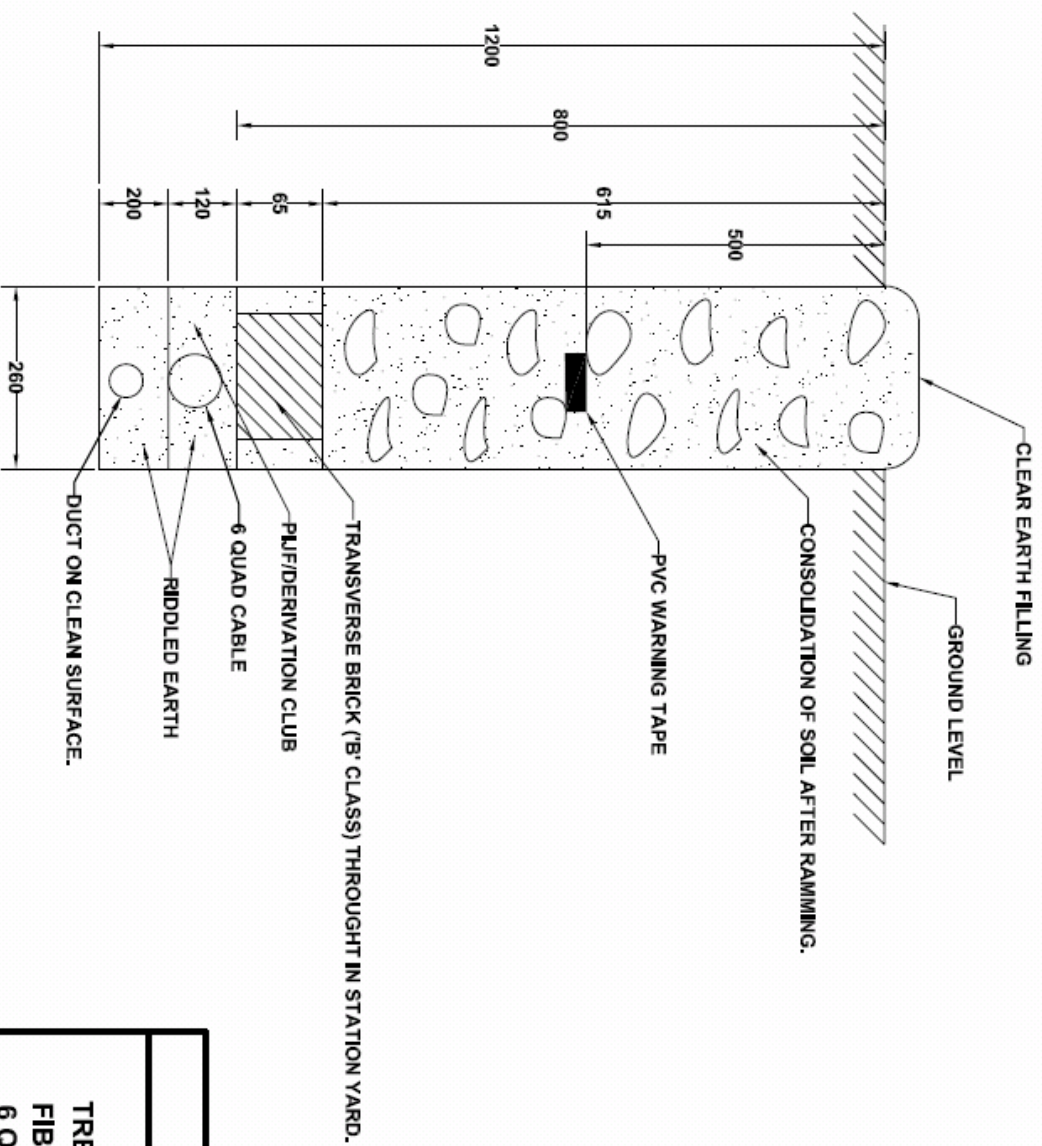
DRG.NO.RDSO\TCDO\COP-04

1. ALL DIMENSIONS ARE IN mm.



DRG.NO.RDSO/TCDO/COP-6

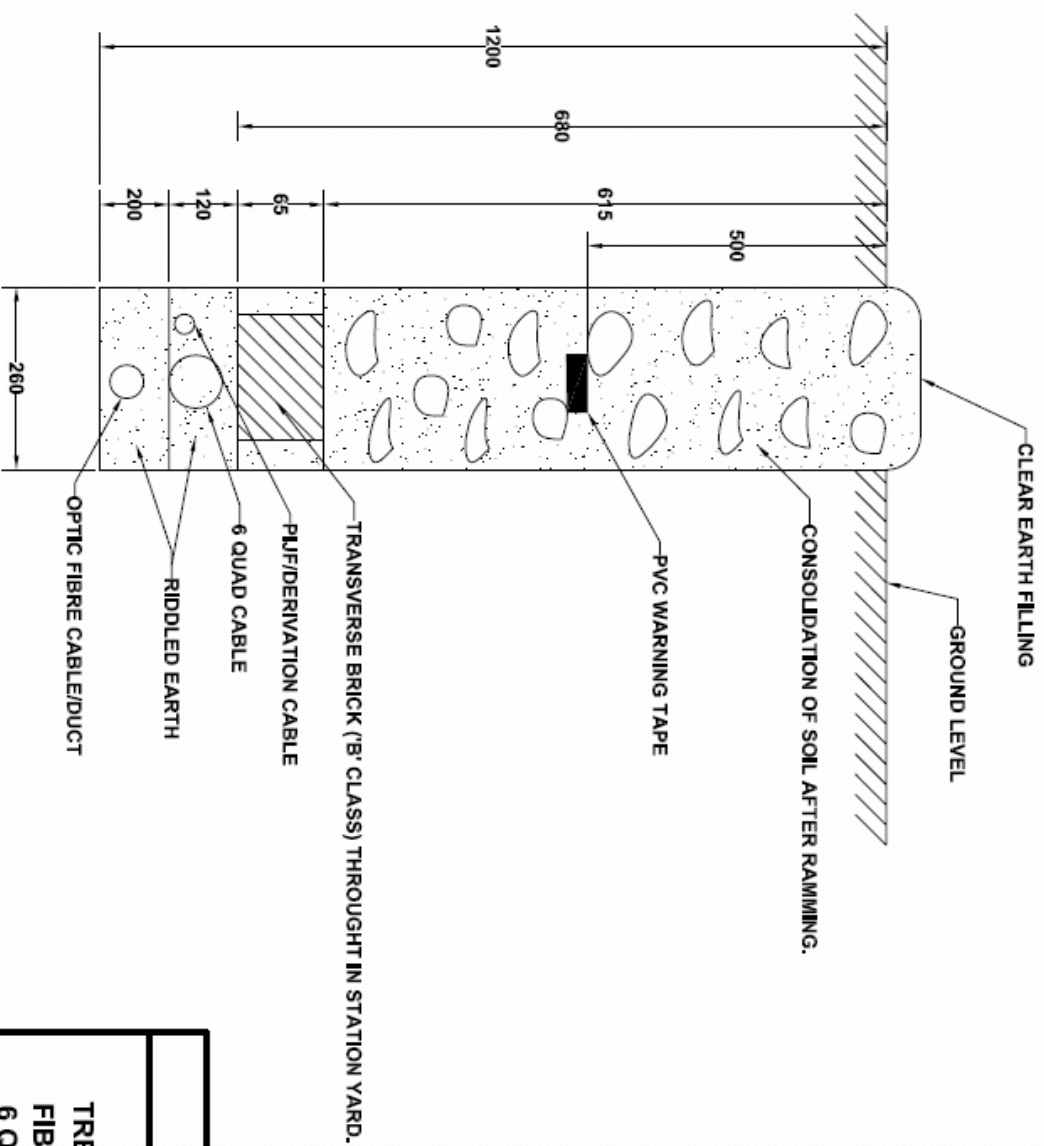
DRG.NO.RDSO/TCDO/COP-6



NOTE : 1. ALL DIMENSIONS ARE IN mm.

**TRENCH FOR LAYING ARMoured
FIBRE OPTIC CABLE WITH
6 QUAF CABLE AND PU/F
CABLE AT 1000 mm.**

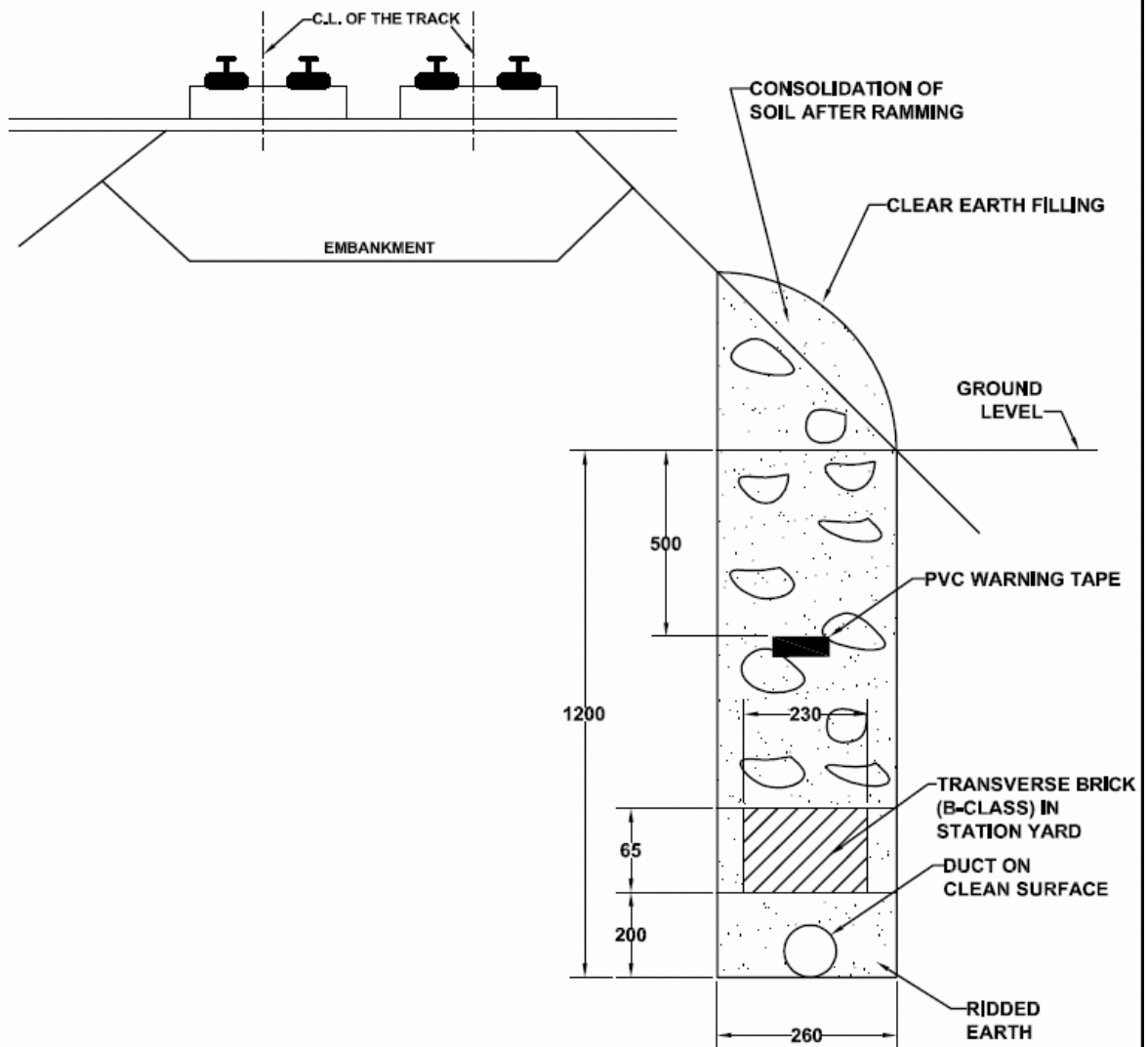
DRG.NO.RDSO/TCDO/COP-7



NOTE : 1. ALL DIMENSIONS ARE IN mm.

**TRENCH FOR LAYING ARMoured
Fibre Optic Cable With
6 Quaf Cable And PUJ
Cable At 1200 mm.**

DRG.NO.RDSO/TCDO/COP-8

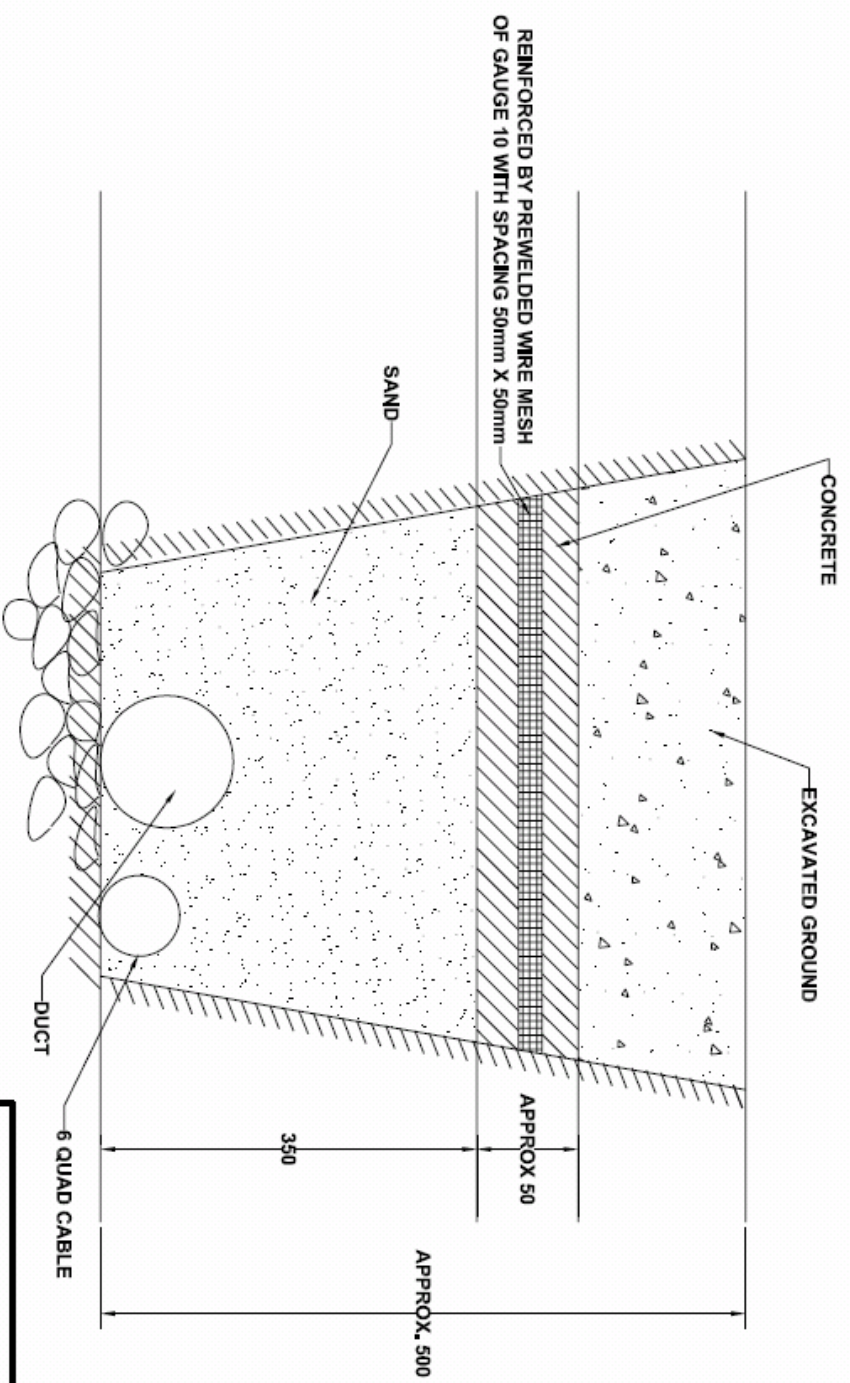


EXCAVATION OF EARTH AND REFILLING

3. APPROVAL OF P-WAY ENGINEERS TO BE OBTAINED AS PER SITE CONDITION.
 2. THIS ARRANGEMENT TO BE FOLLOWED IN RARE CASES WHEN CABLE TRENCHING AT END BEYOND TOE OF EMBANKMENT NOT POSSIBLE.
 1. ALL DIMENSIONS ARE IN mm.
- NOTES :

TRENCH ON ENBANKMENT FOR ARMoured OPTIC FIBRE CABLE .

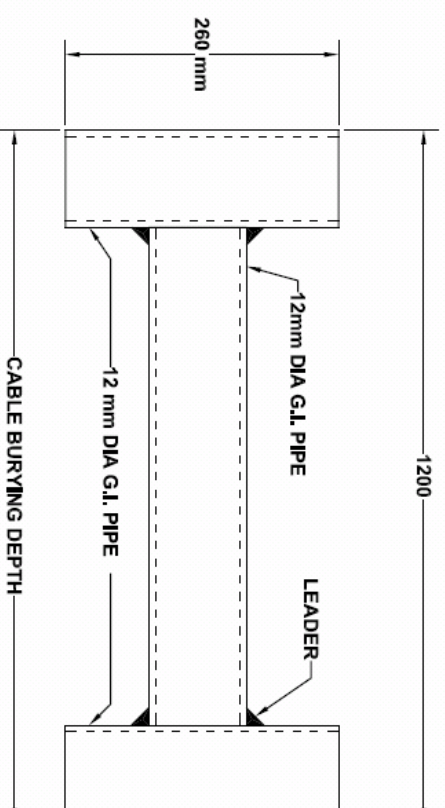
DRG.NO.RDSO/TCDO/COP-9



2. NOT TO SCALE.
NOTE : 1. ALL DIMENSIONS ARE IN mm.

LAYING OF OPTIC FIBRE
CABLE IN ROCKY AREA

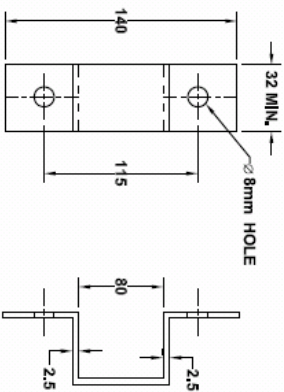
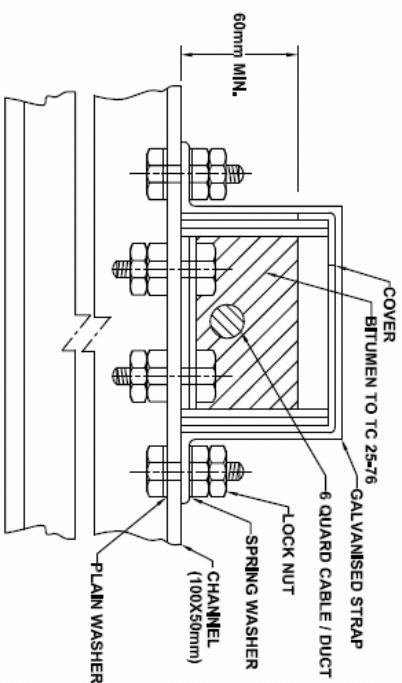
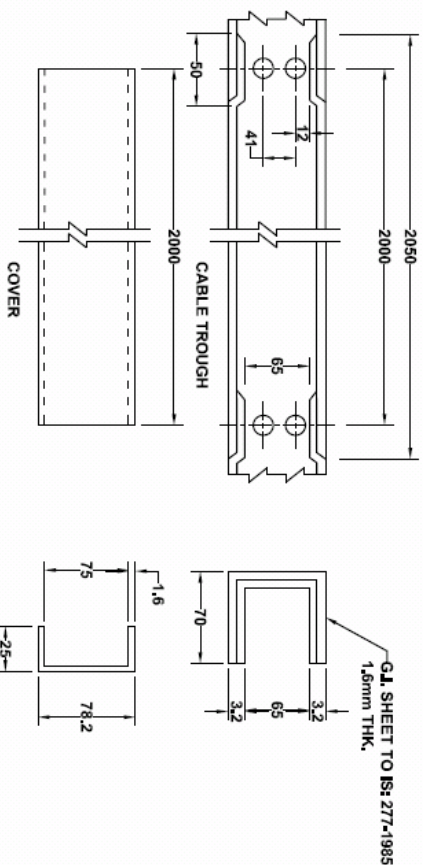
DRG.NO.RDSO\TCDO\COPI-10



NOTE : 1. ALL DIMENSIONS ARE IN mm.

**RULE MADE OF PIPE FOR
MEASURING TRENCH DEPTH**

DRG.NO.RDSO\TCDO\ COP-11



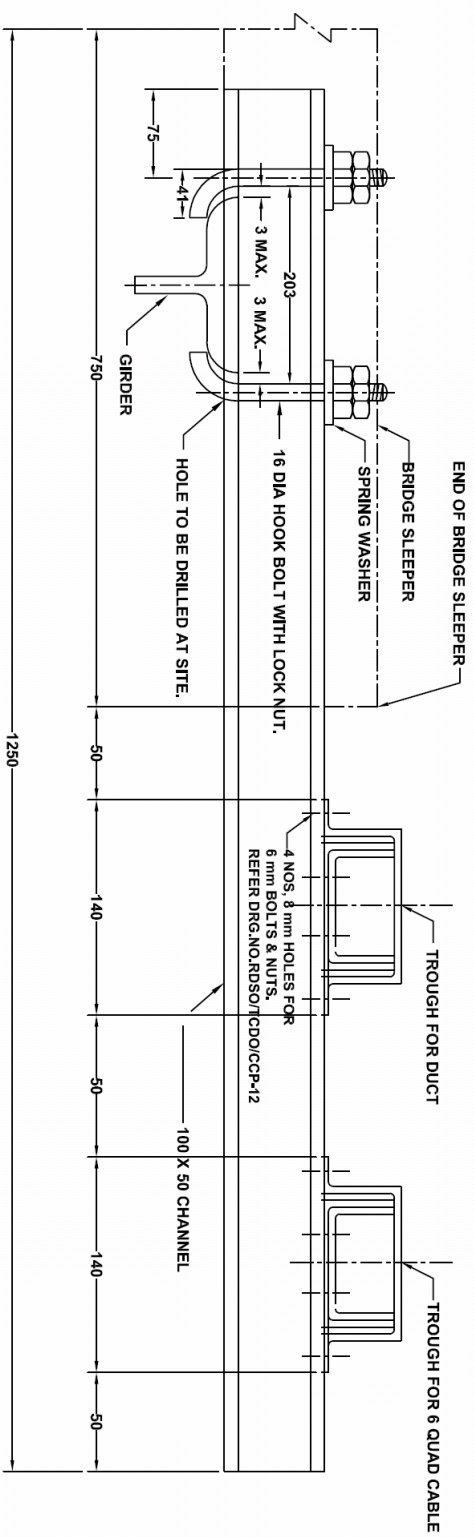
5. AFTER TIGHTENING NUTS FOR FIXING STRAP, THE THREAD OF THE BOLT MAY BE BURIED TO PREVENT THEFT.
4. CABLE TROUGH TO BE FITTED TELESCOPICALLY.
3. NO WELDING SHALL BE DONE ON ANY COMPONENT FOR FABRICATION.
2. TROUGH TO BE FABRICATED OUT OF GALVANISED STEEL SHEET TO IS-277-1983 WITH FOLLOWING STIPULATIONS.
- THICKNESS : MINIMUM 1.6 mm.
- GRADE OF ZINC COATING : 200.
1. ALL DIMENSIONS ARE IN mm.

SCHEDULE OF MATERIALS

S.NO.	DESCRIPTION	NO.REQD.
1.	TROUGH 2.05 M LONG	1
2.	COVER 2.0 M LONG	1
3.	STRAP	2
4.	BOLT HEX. HEAD 6 mm Ø X 32 mm	4
5.	NUT FOR ABOVE	4
6.	LOCK NUT FOR SL-4	4
7.	DISH WASHER FOR SL-5	4
8.	PLAIN WASHER FOR SL-5	4

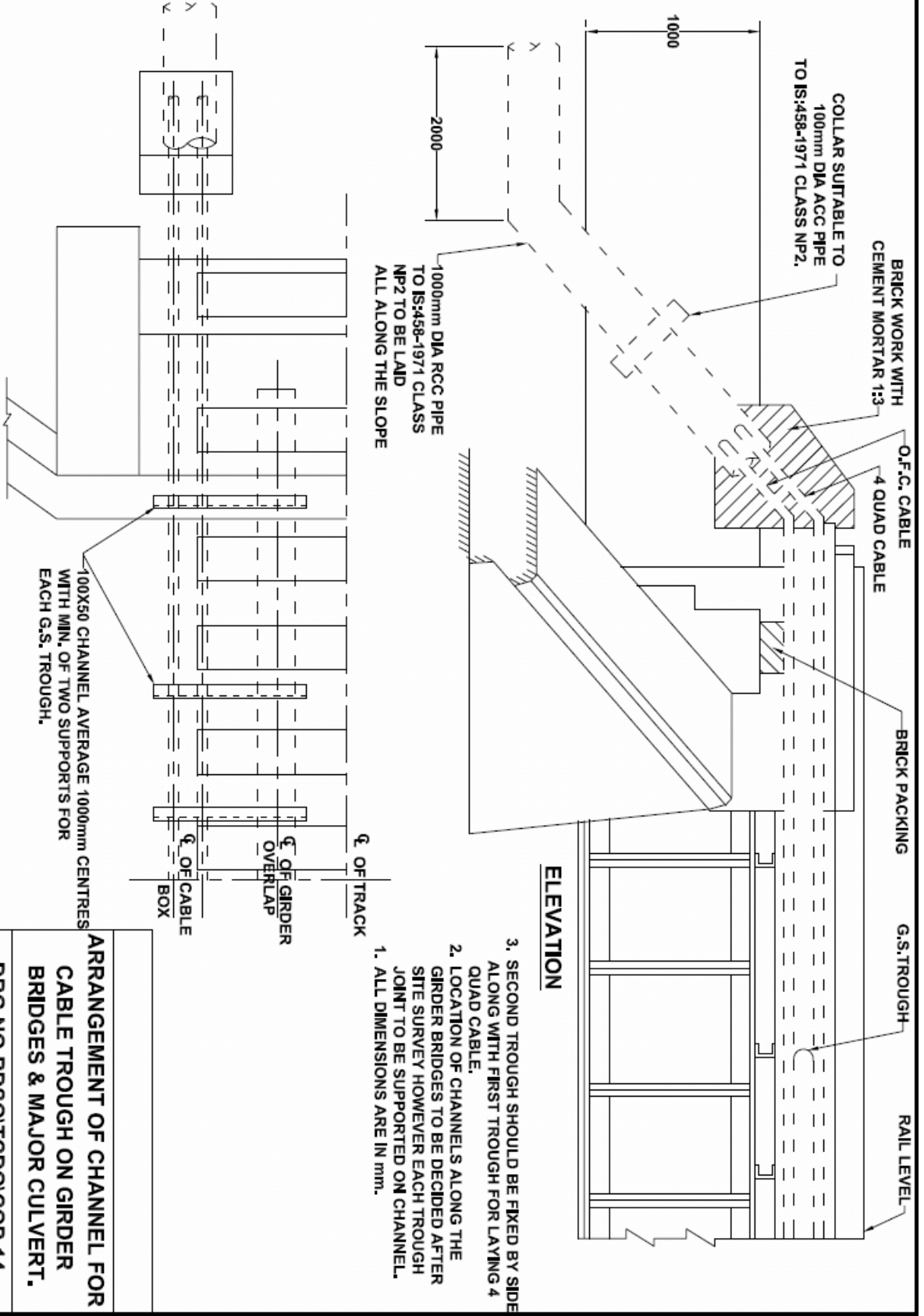
ARRANGEMENT OF CABLE TROUGH (G.S.) FOR GIRDER BRIDGE.

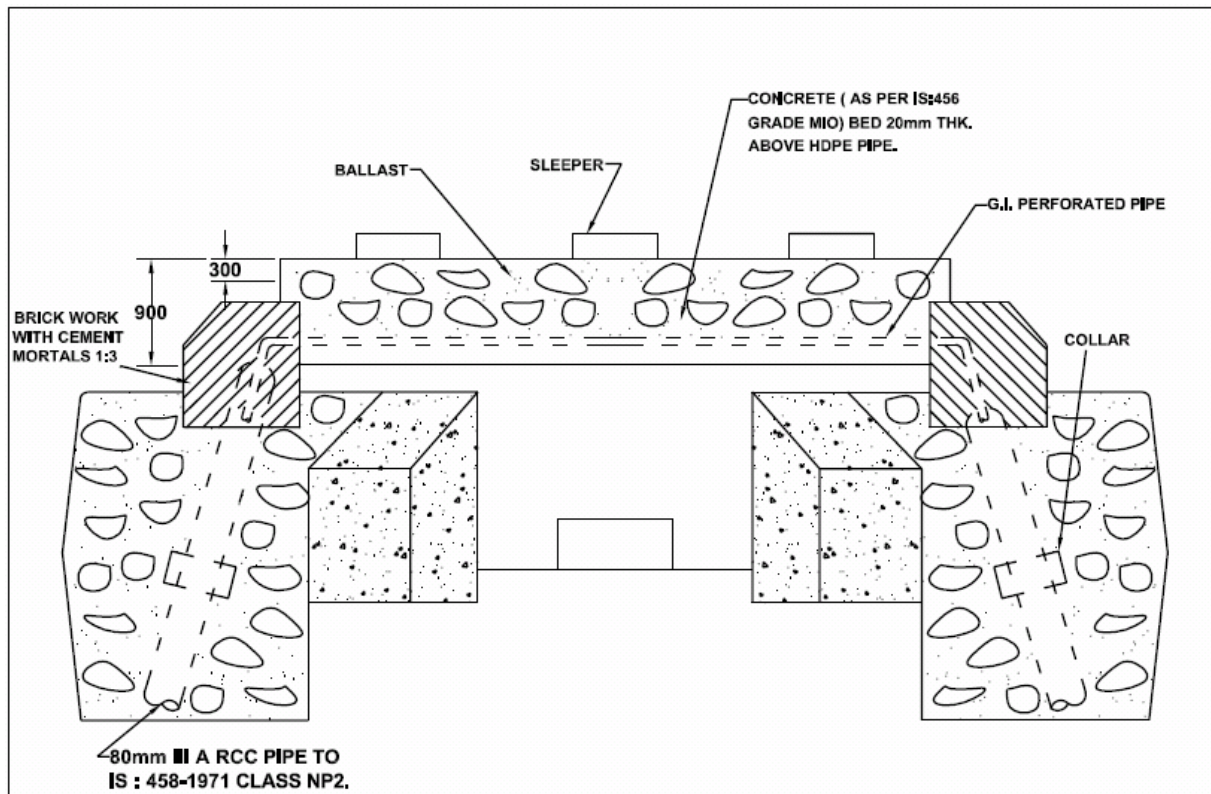
DRG.NO.RDSO\TCDO\COP-12



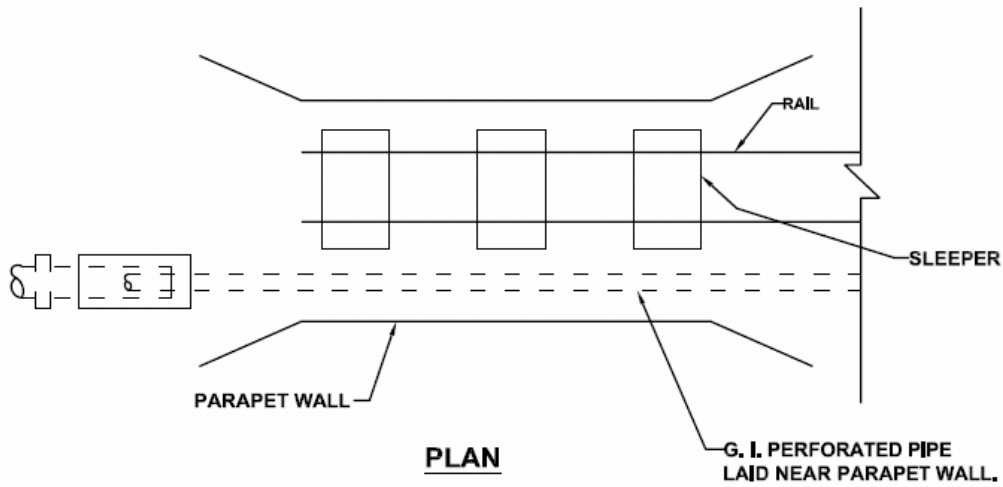
ARRANGEMENT OF CHANNEL FOR
CABLE TROUGH ON GIRDER
BRIDGES & MAJOR CULVERT.

DRG.NO.RDSO/TCDO/CP-13





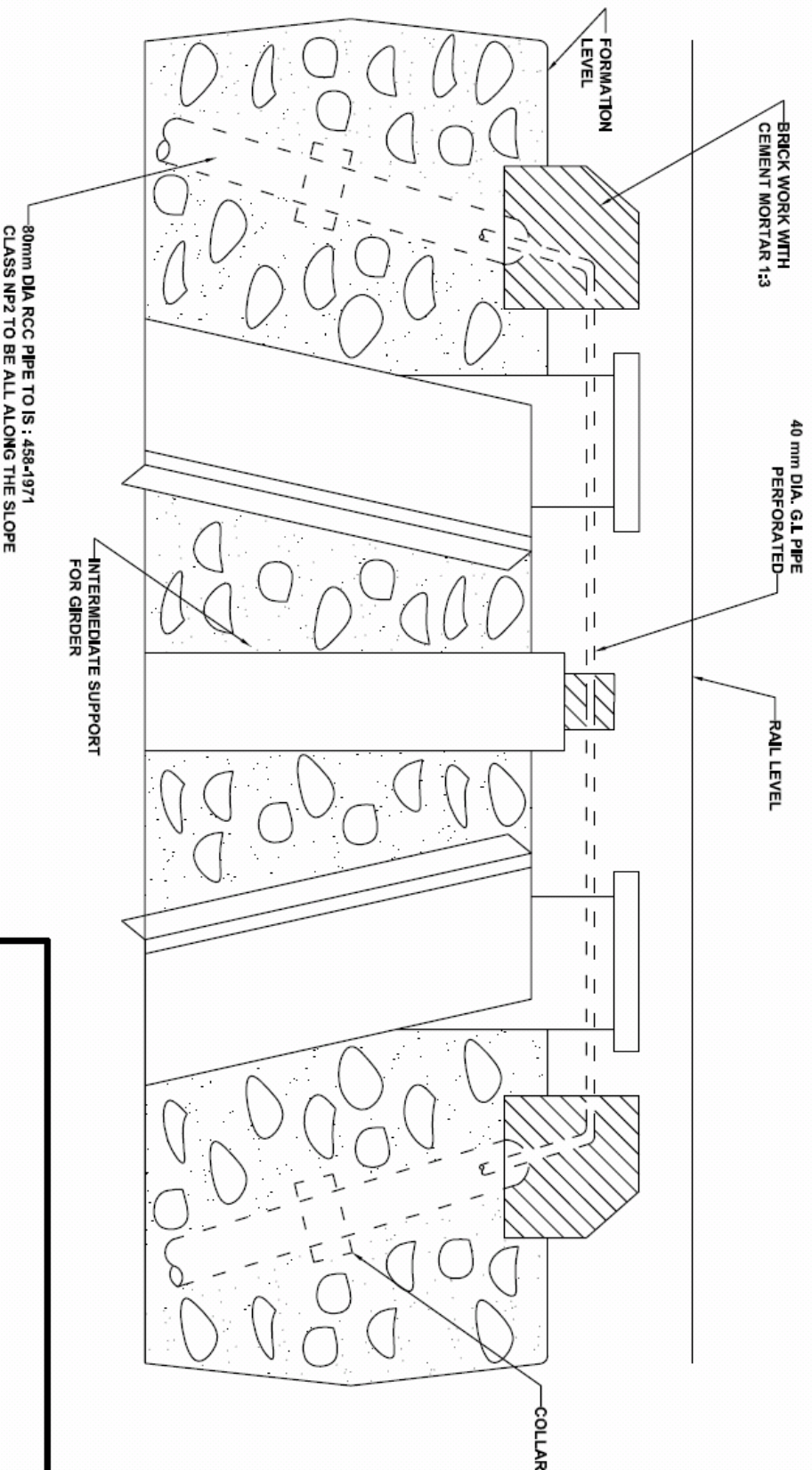
ELEVATION



PLAN

**FIBRE OPTIC CABLE CROSSING
CULVERT (PIPE/BOX)
WITH HIGH FLOOD LEVEL.**

DRG.NO.RDSO/TCDO/COP-16



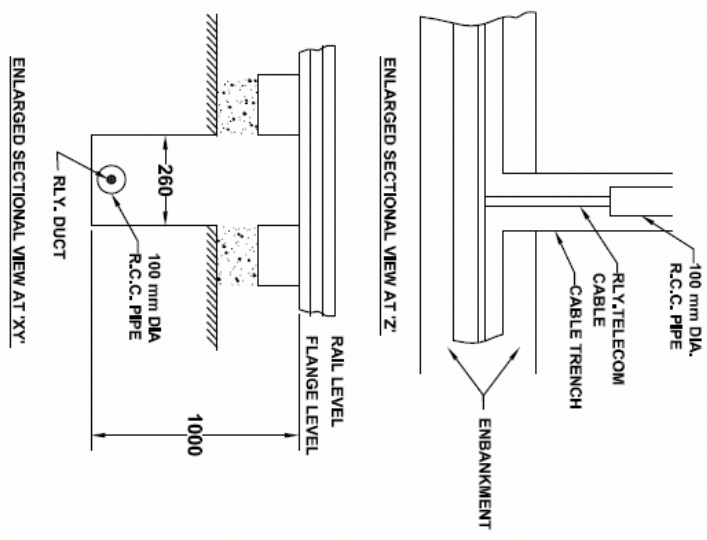
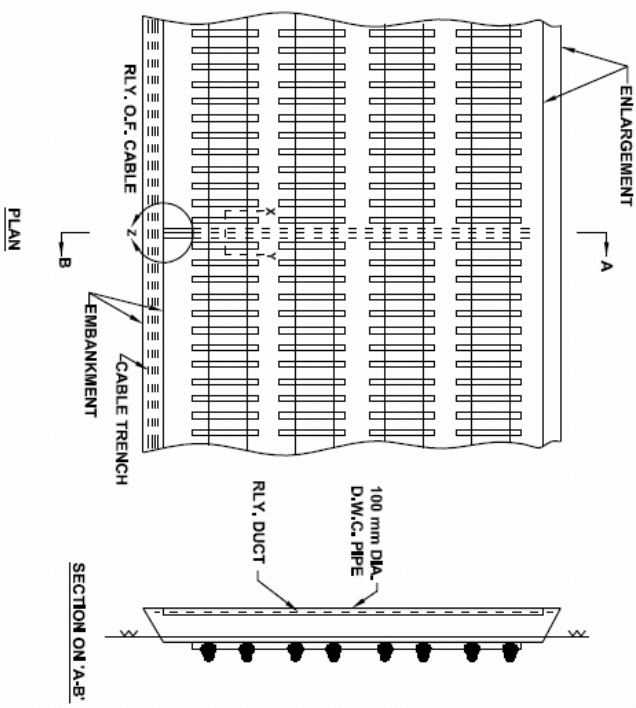
ELEVATION

2. THIS ARRANGEMENT IS APPLICABLE FOR GIRDER BRIDGE HAVING SPAN UPTO 6 MTRS WITHOUT ANY INTERMEDIATE SUPPORT AND UPTO 12 METERS WITH AN INTERMEDIATE SUPPORT.
1. THE HEIGHT AT WHICH G.I. PIPE IS TO BE LAID SHALL DEPEND ON SITE CONDITION.

NOTES:

ARRANGEMENT OF FIBRE
OPTIC CABLE LAYING IN
G.I. PIPE ON GIRDER BRIDGE.

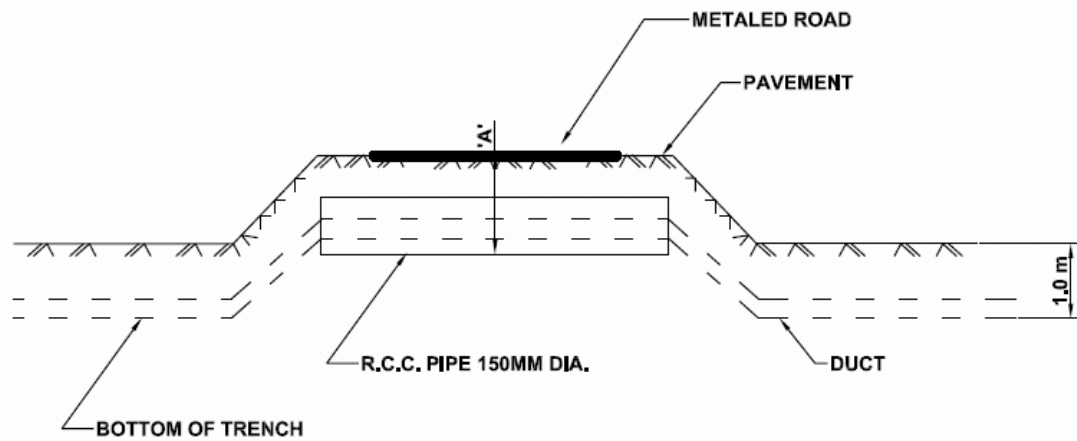
DRG.NO.RDSO/TCDO/COP-17



ARRANGEMENT OF O.F. CABLE
R.C.C. / D.W.C. PIPE UNDER
TRACK CROSSING.

ALL DIMENSIONS ARE IN mm.

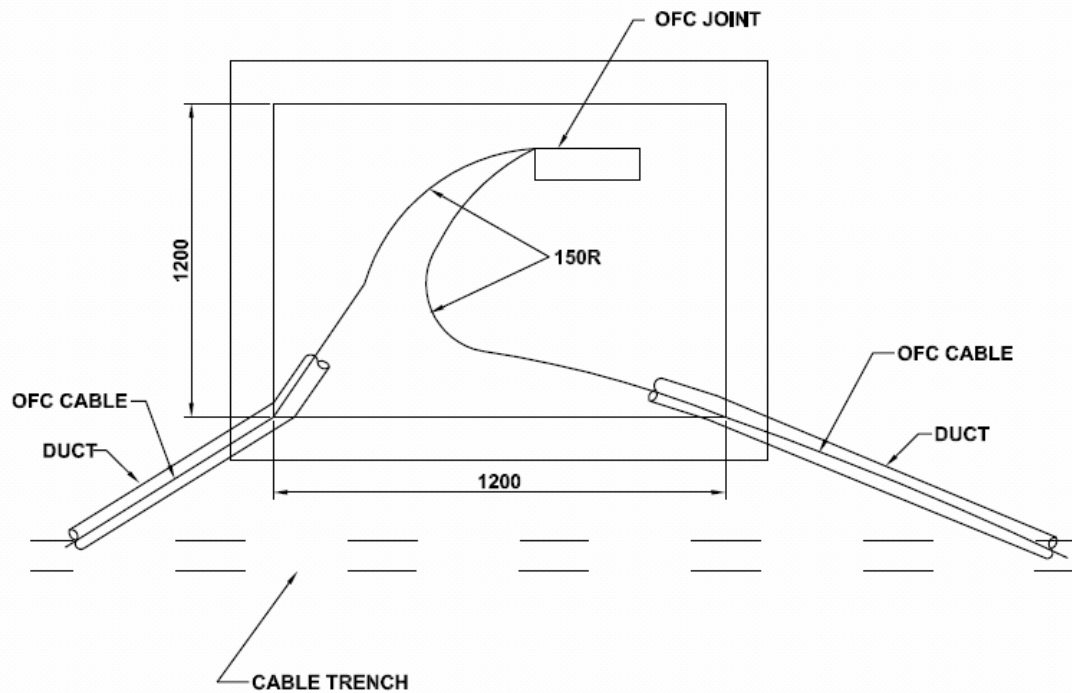
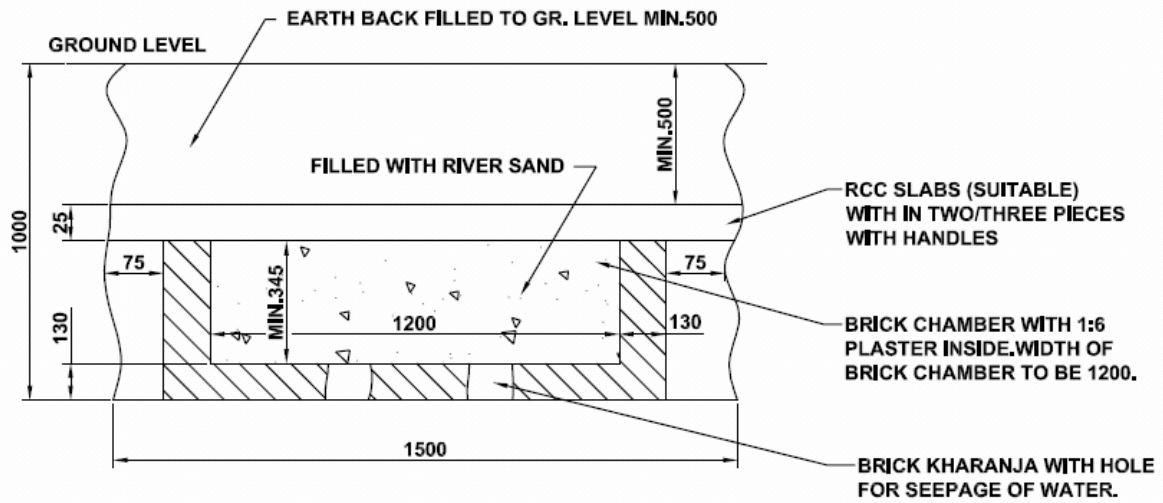
DRG.NO.RDSO/TCDO/COP/19



NOTE:
 'A' DEPTH WILL BE 1.0 m,
 OR OTHERWISE WILL BE
 DECIDED BY THE ENGINEERS
 AT SITE.

**ARRANGEMENT OF R.C.C. PIPE
 UNDER METALED ROAD**

DRG.NO.RDSO/TCDO/COP-20



5. ALL DIMENSIONS ARE IN MM.
4. EXTRA COIL TO BE LEFT IN THE PIT DULY CLAMPED ON THE WALL.
3. PIT ABOVE RCC SLABS TO BE FILLED BACK WITH EARTH / SOIL MIN.500.
2. RCC SLAB OF MIN.25 THK TO BE PROVIDED AS COVER WITH PROVISION OF 2 NOS. HANDLE/SLOT FOR LIFTING.
1. ALL THE FOUR WALLS & BOTTOM OF PIT TO BE BRICK WALLED & PLASTERED.
- NOTES:

CABLE PIT FOR OFC JOINT

DRG.NO.RDSO/TCDO/COP-21

