LINE PLANT PRACTICE
OVERHEAD LINES

VISION: TO MAKE IRISET AN INSTITUTE OF INTERNATIONAL REPUTE, SETTING ITS OWN STANDARDS AND BENCHMARKS

MISSION: TO ENHANCE QUALITY AND INCREASE PRODUCTIVITY OF SIGNALLING & TELECOMMUNICATION PERSONNEL THROUGH TRAINING
# LINE PLANT PRACTICE

## OVERHEAD LINES

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CHAPTER 1

OVERHEAD TELECOM LINES

1.0. Introduction

On Indian Railways the Overhead telecom lines can be classified as
- Main line alignment
- Local line alignment

1.1. Main line alignment

Main lines, suitable for taking long distance communications circuits for control working, Administrative trunk circuits etc. which extends several hundreds of Kms. and Block circuits, LC gate lines on the same alignment.

Requirement of main lines over head plant

- To carry Railway control circuits i.e. section control, Dy. Control etc.
- To carry Administrative trunk (ADM) circuits
- To carry block circuit
- To carry Train wire circuits
- To carry any other circuits like LC gate telephones.

✦ **Control Circuits**: For efficient movement of trains and optimum use of line capacity ensuring the safety. A controller is connected to wayside stations for controlling the movement of trains.

✦ **Block Circuits**: For safety of train movement. Intercommunication between two adjacent stations is established for safe running of trains.

✦ **Magneto Telephone Circuits**: Point to point communication between cabins, station master and various points in yard.

✦ **Gate circuits**: Point to point connection between LC gates and cabins or station masters

✦ **Carrier Telephones Circuits**: For administrative trunk circuits for connecting headquarters to divisional offices and divisional offices to important points like Loco Shed, Workshop etc.
1.2. Local Line Systems

Local lines suitable for local telephone exchange circuits over short distance, eg. From cable termination point (DP) to subscriber's wall brackets.

1.3. Other types

♦ **Town Lines:** These lines are erected on tall and stout rail posts, so that town traffic are not interfered. Carry circuits to the main exchange.

♦ **Hill Lines:** Are erected taking advantage of the natural formation of the hill. Fanning the wires is done for achieving greater span length.

♦ **Temporary Lines:** Are erected in cases of urgency using saplings, bamboos or trees on temporary basis. Only GI wires are used. Telecommunication facilities are provided with semi permanent lines also. Greater wire spacing is provided by erecting two wires on the extremities of a cross arm.
Overhead Telecom Lines

Objective:

Fill up the blanks with suitable words:

1) Magneto circuits are used for __________ to __________ communication.

2) Block circuit is between two __________ _______ only.

3) Local lines suitable for over _______ distances only.

4) L.C. gate circuits are carried on _______ alignment.

5) Temporary lines are erected in cases of ____________.

6) The main line alignment carries __________ _________ _________ circuits.

Subjective:

1) What is the purpose of “Main Line Alignment”? Explain the different circuits coming under it?

2) What is the purpose of “Local Line Systems”? Explain about the other types of lines?
CHAPTER 2

POSTS

2.0. The main types of Posts:
♦ Released rail posts flat footed or bull headed
♦ Tubular posts of Telescopic construction

2.1. Availability of rails:
♦ BG Double headed or single headed
♦ MG Single headed

![Fig. 2.1 Rails Used As Telecom. Posts](image)

2.2. H posts, Tripod posts and Quadruped posts

Whenever the safe working moment of resistance is exceeded with a single post, two posts coupled together by means of cross arms, horizontal bracings and cross bracings can be erected. This type post is called as H post or coupled post. When the alignment is carried by H posts and is distributed in three directions or four directions they are respectively called tripod and quadruped posts.

2.3. Hamilton Standards

The posts for overhead alignments, most commonly used in the BSNL are tubular posts, known as Hamilton standards. The tubular posts consist of hollow tapered tubes of circular cross section made of galvanized mild steel sheets. Two or more such tubes are fitted together and mounted on a cast iron socket of the appropriate size. A circular disc shaped sole plate is screwed on to the tapered end of the socket at its bottom. At the top, the tubular post is fitted with a galvanized cast iron cap carrying a detachable lightening spike.
2.4. **Sockets**

Sockets form the base of tubular posts. They are made of cast iron and are tarred. Hence, they are corrosion resistant. The vent near the broader end hole provides an outlet for rain water that may collect inside the post.

2.5. **Sole Plates**

Sole plates are circular discs provided with a circular hole in the centre. Sole plates are made of cast iron and are tarred, corrosion resistant. Sole plate gives a greater bearing surface to the base of the post, viz., the socket, and hence, increases the stability of the post. It also prevents the post from sinking in swampy ground or in black cotton soil.

2.6. **Caps**

All posts are provided with a cap, fitted on the top-most component tube to prevent rainwater filling up the post. All caps are provided with a hole at the top, which is intended to take either an insulator stalk or a lightning spike. Caps are made of cast iron and are galvanized.

2.7. **Tubular Posts**

A tubular post is designated by the sizes of the component tubes, given from the top to the bottom, used for assembling that post. The advantages of tubular post over the other types of supports are its lightness combined with strength, ease of transportation and handling of the component parts, ease of fitting, erection and dismantling.

2.8. **Special Types Of Sockets**

**Swamp sockets:**

Used as the bottom component of tubular posts erected in water logged areas. These sockets will be longer than the normal sockets.
Bridge Sockets:

Used as a special type of cast iron socket for use with conventional steel sheet tubular posts, which are erected on the masonry piers of bridges.

Fig. 2.2 Swamp Sockets
**Objective:**

Fill up the blanks with suitable words:

1) Coupled post is used when ___________ is exceeded with a single post.
2) Tripod is to divert the control lines for ___________ directions.
3) Quadruped post is to divert the control lines for ___________ directions.
4) _____________ gives greater bearing surface to the base of the post.
5) Caps are used for ___________ posts.
6) Tubular post is the combination of _____________.

**Subjective:**

1) What is meant by “Post”? What are the main types of posts used for Telecom alignment?
2) Explain about the main parts of a “Hamilton tubular post”? Where it is mostly used?
3) Explain about the types of sockets used for posts?
4) Write short notes on any THREE of the following:
   a) Sockets
   b) Sole plates
   c) Caps
   d) Tubes
3.0. **Cross Arm**

Cross arms are 40mm X 32 mm MS channel conforming to IS 3954 and have horizontal slots on the web to allow 'U' bolts to fit them on the posts and vertical holes on flanges for insertion of stalks.

3.1. **Cross Arms for Local Lines**

These cross arms provide 200 mm horizontal separation between wires and 250 mm between pairs for single post. For local line system cross arms are available for taking 2 wires to 8 wires. Only 8 wire cross arms with 300mm spacing between wires and pairs should be used with coupled posts. Cross arms with single channel and double channel are available. Double channel types are used for Tripods and Quadrupeds.

3.2. **Cross Arms for Main Lines**

Cross arms 2 Way, 4 Way, 6 Way & 8 Way are available. The spacing between wires, pairs and cross arms is the same equivalent to 300 mm. These are used for VF circuits. As these brackets are not symmetrically fixed with respect to the post, it will be difficult to keep them perfectly horizontal by themselves. To overcome this difficulty, every post fitted with one or more offset telegraph brackets. Off set brackets is also provided with a strut and a tie where called for.
Channel Iron Brackets or Cross arms
& other Components

Fig. 3.1  Different Types Of Cross Arms
3.3. Saddles For Brackets

Saddles are moulded cast iron packing pieces suitably shaped for fitting between a bracket and a post to give a good bearing surface to the flat surface of the bracket on the cylindrical post. Saddles are invariably supplied in a tarred condition to prevent corrosion. The figure 3.2 gives details of saddle for channel Iron brackets for Tubular post. The rear side of this saddle has a circular shape to suit the cylindrical shape of the tubular or wooden post.

Fig. 3.2 Saddles

3.4. Distance Piece

The details of distance (spacing) piece for BGSH (Broad Gauge Single Headed) rail is shown in the Fig.3.3 For fitting a channel iron bracket on the web of a BGSH rail, a special cast iron spacing piece is used. This is placed on the head of the rail to bring it to the same level, as the foot of the rail, so that the bracket, when rested against the spacing piece and the foot of the rail, may be at right angles to the alignment. The spacing piece for MGSH (Metre Gauge Single Headed) rail is similar in construction to the spacing piece described above and is meant for use on MGSH Rails.
3.5. **U-Backs**

These are U-shaped clamping bolts, threaded at the open ends and provided with suitable nuts. They are used for fitting brackets and other attachments to posts or masts and are made of mild steel rods and galvanized. As the screw threads are not galvanized, the threaded portions are kept well oiled to prevent rusting. A typical U-Back for Tubular posts is shown in figure 3.4. These U-Backs are used for fitting various types of channel iron brackets and angle iron brackets to tubular or wooden posts. A saddle is used between the bracket and the post as a packing piece to get a good fit.
3.6. Ties And Struts For Brackets

On a line of posts having more than one bracket, it is generally desirable to ensure that:
- The brackets remain on the post in the same vertical plane
- The vertical separation is uniformly maintained throughout
- The brackets do not have a tendency to bend under load.

These requirements are met by the use of ties and struts on posts.

![Fig. 3.5. Ties](image)

3.6.1. Ties

Ties are galvanized mild steel strips with appropriate holes for linking the brackets together so as to impart rigidity to the bracket formation. Ties are made in various sizes, according to the required vertical separation and the number of brackets.

Normally when 8 wire brackets are used with single post, tie bars should be fitted to each post, both in the straight and at angles, because without the ties, the brackets are to get out of level. For four wire brackets, it is sufficient if ties are fitted at angles only, with special type brackets, however, ties must invariably be provided when more than two brackets are used.
3.6.2. Struts

Struts are mild steel supports fitted at an angle from the ends of a bracket formation to the post below to add to the rigidity of the construction. Struts are made in various sizes, according to the type of bracket they have to support. Their function is that of compression members. For fixing the struts to the posts and brackets, the pieces are flattened out and drilled at the two ends. A typical strut is shown in figure 3.6.

![Fig. 3.6 Struts](image)

3.6.3. Fitting Of Ties & Struts On Channel Iron Brackets

With rail posts, the struts should be attached using an appropriate U back and a slotted flat plate in place of the strut saddle. Figure 3.7 shows the method of fitting ties and struts to channel iron brackets.

![Fig. 3.7 Fitting Of Ties & Struts On Channel Iron Brackets](image)

3.7 Fittings Of Channel Iron Brackets

For fitting a channel Iron bracket on a BGDH rail, with web either in the alignment or across the alignment, no saddle is required.
Objective:

Fill up the blanks with suitable words:

1) ___________ is used for fitting the brackets and other attachments to posts on Telecommunication lines.

2) Saddles are used for fitting between ___________ a post.

3) The distant piece is placed on the __________ of the rail post to bring it to the same level.

4) Struts are fitted between ___________ and ___________.

5) Ties links the ___________ together.

Subjective:

1) What is U-Back? Where it is used? Explain about the different types of U-Backs with neat figures?

2) What is meant by Strut and Tie? Show how they are fixed on the post?

3) Write short notes on the following
   a) Saddle
   b) Ties and struts
   c) Distance piece

4) What is meant by “Cross arm”? Explain about the cross arms used for Maine line and Local lines? Draw the figure of 4-way cross arm?
4.0. Introduction

The type and size of wire is to be chosen depending upon the type of circuit, its length, resistance of the conductors and also the attenuation in case of voice frequency and carrier circuits. For train controlling signaling circuits like block circuits on physical wires the value of resistance is important. The attenuation of signals in the VF and Carrier circuits depends on the resistance, inductance, leakance and capacitance of the wires and is expressed in db. The limits of attenuation on overhead lines are given below for various circuits.

4.1. Max. permissible Limits Of Attenuation:

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<th>Description of Line</th>
<th>Loop Resistance</th>
<th>Attenuation</th>
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</thead>
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<td>Auto Exchange line</td>
<td>600</td>
<td>---</td>
</tr>
<tr>
<td>Junction Line</td>
<td>350</td>
<td>---</td>
</tr>
<tr>
<td>Trunk Units between two exchanges</td>
<td>---</td>
<td>12db</td>
</tr>
<tr>
<td>Control Line</td>
<td>---</td>
<td>20db</td>
</tr>
</tbody>
</table>

Table. 4.1 Max. permissible Limits Of Attenuation

Basing on these factors, the type and size of the line wire to be used is decided.

4.2. Bare Line Wires

Despite greater fault liability, bare overhead line wires are most commonly used, mainly for reasons of economy and superior transmission characteristics. The chief considerations for a line wire are adequate mechanical strength for working, freedom from corrosion and low resistance and self-inductance.
4.3. The various types of Line Wires used in Telecom are

♦ Galvanized Iron Wire
♦ Copper weld wire
♦ Aluminum conductor steel reinforced wire (ACSR)

4.3.1. Galvanized Iron Wires

They are manufactured from low carbon steel and protected by a coating of thin film of zinc. Due to their higher resistance, inductance and relatively shorter life, the use of iron wires is not generally favoured. They are, however, still used for local telephone lines and for short distance trunk lines. The higher gauges are normally used for long distance telephone lines.

The GI wires used by Indian Railway Telecommunications are

♦ 1.50mm gauge Binding Wire
♦ 1.80mm gauge Local Telephone Lines
♦ 2.12mm gauge Main Line Short Distance Magneto Lines
♦ 2.50mm gauge Gate Telephone Lines
♦ 3.55mm gauge Block, Train Wire,

4.3.2. Copper weld Wire

This type of wire combines the conductivity of copper with the tensile strength of steel. Solid copper conductors have better characteristics, but in the field of high frequency transmission (above 60 KHz, copper weld has a lower attenuation. In a solid copper wire, although the "skin effect" tends to force the higher frequency currents to the outer surface, there remains an out of phase component in the inner portion.

The copper weld wires used by Indian Railway Telecommunications are

♦ 3.25mm gauge Short distance train control & Admin. Trunks
♦ 4.81mm gauge Long distance train control & Admin. Trunks
4.3.3. Aluminium conductor steel reinforced (ACSR) wires

Due to the following advantages ACSR wires were preferred:

♦ Free availability in India
♦ Thefts comparatively less than copper since ACSR is cheaper
♦ No foreign exchange is involved
♦ ACSR wires are 20% lighter and 50% stronger than copper wires of equal size
♦ Because of lightness, the posts and supports used can be of less strength.
♦ Cost of transport is less.
♦ Minimum breaking load of 200 lbs / mile copper wire is 280 Kg while that of ACSR (6/1/1.5) is 425 kg. Hence longer spans can be used and the number of posts per Km could be less.
♦ Conductivity: The DC resistance of ACSR 6/1/1.5 is 2.7 ohms / Km and is almost the same as that of 200 lbs/mile copper wire.
♦ Working range of control circuits available with ACSR is considerably better than that with copper conductors.

4.3.4.1. Use Of ACSR In Indian Railway telecom. Circuits:

♦ ACSR 6 / 1/ 1.50 ............... Short distance section & deputy control circuits, admin. trunks.
♦ ACSR 6 / 1/ 1.96 ............... Long distance section & deputy control circuits, admin. trunks.
♦ ACSR 6 / 1/ 2.11 ............... Carrier circuits.

4.3.4.2 ACSR wire for use near seacoasts

For areas within 30 KM from the sea atmosphere is saline and severe electrolytic action may take place between iron core and aluminum wires causing corrosion of metals. Specially greased ACSR shall be used in such cases. Such greases are applied to ACSR wires around the steel core during manufacture. Before, installation in coastal area, it is important that the ACSR wires are checked for greasing.
4.4. Insulators For Bare Line Wires

The primary function of an insulator for a bare overhead telephone line is to support the wires while restricting the leakage current flowing from the line conductor to the stalk which supports the insulator on the bracket.

4.4.1 D S Large Insulator

The insulator D.S. (Double Shed) large is shown in Fig.4.1 (a). This is the standard insulator for all long lines. Such insulators can be used with all but 5 1/4" telephone stalks. The design incorporates a groove on the top for providing a support to the line wire before binding or when it is unbound for maintenance purposes.

![Fig.4.1(a) D S Large Insulator](image1)

![Fig.4.1(b) D S Small Insulator](image2)

4.4.2 D S Small Insulator

The insulator D.S. Small is shown in Fig.4.1 (b). This is the standard insulator for local telephone line. Such insulators are not intended for use on long lines or where the gauge of the conductor is higher than 3.55 mm dia. This insulator also has a groove on top for the purpose described above.
4.4.3 Pot Head Insulator

The Insulator Pot head large is shown in the Fig.4.2 (a). This is the standard insulator for terminating a bare overhead line wire at or near an office, station or premises with a view to extend it to the instrument by insulated wire. Such insulators are used for terminating all local telephone and trunk wires for leading into installations using insulated (V.I.R.) cables.

4.4.4 Shackle Insulator:

A typical shackle insulator is shown in the Fig.4.2 (b). This is the standard insulator for terminating steel span wires on mast terminals, when the length of the span is so great that proper termination at both ends of the span is necessary and the insulators described in the previous Para are not strong enough. These insulators are held with a pin inserted through the central hole.

4.5 Stalks:

Stalks are mild steel pins or spindles, threaded at one end to be inserted into the insulator thread and tapered at the other end to corresponding stalk holes of the different types of brackets, bracket attachments or other supports. Since the thread on the stalk is cut after galvanizing, the threaded portion is usually tarred to prevent rusting of the screw threads. Insulators are to be screwed fully on to the stalks.
4.5.1 **Stalks Transposition:**

Transportation stalks are of size 159 mm X 23.8mm (6 1/4" X 15/16"). These are used at transposition points and are fitted into transposition brackets.

![Fig. 4.3 Stalks Telephone](image)

4.5.2 **Stalks Swan Neck:**

Stalks Swan Neck Short are used for terminating wires on trees etc. Stalks Swan Neck Long are used for terminating wires on buildings.

4.6 **Bracket Attachment Terminal Double:**

Is used for terminating two line wires one on each side of a bracket. The maximum gauge of wire that can be terminated is 5.29 mm. When this is used on terminal brackets, a cast iron washer is also used. A rigid fitting is not possible without this washer.

4.7 **Jointing Of Line Wires:**

The essential requirements of a good joint are that the resistance of a short length containing a joint should not be higher than an equivalent length of the conductor without a joint and its mechanical strength shall not be appreciably less than the breaking load of the wire. It should be corrosion resistant. Further, the joint should not deteriorate more rapidly, both electrically and mechanically, than the line wire. Joints are potential sources of troubles such as high induction, resistance unbalance, noise etc., which are very difficult to trace. The number of joints should, therefore, be kept down to a minimum and great care is taken during the jointing operations, to ensure sound electrical contact and good mechanical strength. The jointing methods should be as simple as possible.
Jointing Of GI Wires:

Tools required:

- Eye bolt
- Britannia Joint vice
- Binding tool
- Soldering bolt T shaped large
- Soldering bolt copper large and medium.

Fig.4.4 Tools Used For GI Wire Jointing

(a) Twist Joint:
This joint is performed on wires up to gauge 1.8 mm. Both wires should be cleaned for about 30 cms (12 inches), straightened and made to overlap by about 40 cms (16 inches). At 20 cms (8 inches) from either end, they should be gripped firmly by Britannia Joint hand vice. One of the free ends of the two wires should then be taken into the eye bolt tool and twisted, four times around the adjacent line wire, with appropriate tension. The hand vice should be taken off and put back on the twisted portion. The other free end should now be twisted four times as before. There after the projecting ends should be cut off with a pair of pliers. The finished joint should be soldered.

Fig. 4.5 Twist Joint
(b) Britannia Joints:

The two wires are to be straightened by an eye bolt. Cleaned for about 30 cms. (12") and held together by a hand vice, known as B.J. vice, clear of that portion where the two wires are to be firmly tied together by means of a coiled piece of wire, known as B.J. Coil. The first 15cm (6 inches) of this BJ Coil should be left free and then the rest should be served tightly by a binding tool for the full length leaving three inches of overlapping line wires free on both sides. The free ends of the lines wire should be turned up 45° both sides and the main wires beyond the portion lapped should be served with three turns of B.J. Coil on both sides. The surplus portions of the B.J. coil should thereafter be trimmed and the projecting ends of the line wire on either side of the joint are broken off and flattened out somewhat with a hammer, care being taken not to damage the line wire itself in any way. The finished joint should then be soldered.

![Fig. 4.6 Britania Joint](image)

<table>
<thead>
<tr>
<th>Gauge of Line wire (in mm)</th>
<th>Gauge and length (in mm)</th>
<th>Length of joint (in cm)</th>
<th>No. of turns in a joint (in mm)</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.29</td>
<td>1.5</td>
<td>10</td>
<td>47</td>
<td>GI</td>
</tr>
<tr>
<td>4.5</td>
<td>1.2</td>
<td>8</td>
<td>44</td>
<td>“</td>
</tr>
<tr>
<td>3.55</td>
<td>1.2</td>
<td>7</td>
<td>34</td>
<td>“</td>
</tr>
</tbody>
</table>

Table 4.2 Different Types of Wire Used for Joints
c) Termination Joint:

Fig 4.7 Termination Joint

For terminating gauge 1.8 mm & 2.12 mm iron wires, the wires should be passed round the neck of the insulator and then brought back along itself and coiled four to six times round the line wire as shown in the figure. In case of iron wires of gauges 3.55 mm and more, the wire should be passed round the neck of the insulator and then brought back along its shelf, where it should be joined by a Britannia Joint using the appropriate size of Britannia Joints coil. The joints should also be soldered. Complete termination joint is shown in Fig. In both cases, at least 2 to 3 cm of the free end of the wire should be left projecting and the connecting wire soldered to this projecting end and not to the main wire. The twist of the Britannia Joint should always be placed well away from the insulator, so that, the loop, formed will permit the insulator to be slipped out when required without having to open out the termination joint.

d) Termination on BAT:

At all section terminals, where the lines are terminated on bracket attachments terminal double, a sufficient length of each end wire should be left spare and the two ends, jointed with a “nib joint” to form the jumper wire. A nib joint should always be made under the bracket as shown in Fig.4.8(a) except at “junction Transportation” where one line connecting should pass above the bracket and the other below it as shown in Fig.4.8(b) the jumper wire being clear of fixtures by about 10 cm. When the gauge of wire at the section terminal changes, the nib joint is not permitted. Only Britannia Joints should be made in such cases.
e) Binding:

For keeping down cross talk within limits in the range of frequencies up to 150 KHz, one of the requirements is to ensure that line wires maintain the uniformity of their horizontal separation throughout the route. On any post of a main trunk route, all the line wires should, therefore, be bound to the same side of the insulators. On straight sections of the alignment, the line wire should therefore, be bound away from the post on both sides. At transposition points also the line wires should be bound on the outside of the four cross arms. The line wire should normally be fixed to neck groove of the porcelain insulator as shown in the figure.

For this purpose, an iron binding wire of the appropriate size and a binding tool for iron wires (illustrated in Fig.4.9) should be used, without this binding tool it is not possible to secure the line wire effectively to the insulator. The binding operation is carried out as follows:

The person doing this work should place the line wire at the neck of the insulator on his own side. The binding wire should then be held on the opposite side of the insulator in such a manner that its length on the right side is about double that on the left. This shorter portion of the binding wire should be taken below the line wire, then diagonally across and over the line wire towards the right hand side of the insulator, where it should be lapped spirally round the line wire for one or two turns. The other portion of the binder should now be taken likewise to the left hand side of the insulator. Passed over the line wire, served tightly round the insulator neck, brought under the line wire at the right hand side, taken again across and over the line wire to the left hand side and finally lapped round the line wire as before. The ends of the binder should, there after be coiled tightly
round the line wire. To do this, one end of the binder should be inserted into the hole 'a' of the binding tool and then turned up at its back so as to tighten the wire.

Fig. 4.9 Types of Binding & Tools Used for Binding

By revolving the binding tool around the line wire as shown in Fig.4.9 it should be possible to put the binder firmly around the neck of the insulator and at the same time serve the coils on both sides fairly tightly. To ensure correct dip, the tension on both sides of the insulator should be the same. Tight binding is necessary to secure the line wire to the insulator. But the binder should not be applied so tightly as would cause the line wire to be bent.
4.8. **Soldering Of Wire Joints:**

For quick and uniformly good soldering, it is necessary that both the line wires and the B.J. coil in case of Britania joint are thoroughly cleaned. Oil, dirt, grease, etc., should be completely removed by wiping, in case the wires are new. In case of old and somewhat rusty wires, in service wires, they should be carefully cleaned with a file without damaging any galvanization on the surface of the wires. After cleaning and wiping, the wires should be rubbed with Voltoid (ammonium chloride) tablets or powder. For soldering, Solder sticks made of 50:50 lead and tin alloy are used as solder material and Voltoid as flux. As free hydrochloric acid is liberated from Voltoid, during the soldering operations, it is essential that the finished joint be treated with an alkaline solution like lime water (calcium chloride) to neutralize the acid, which would otherwise cause premature corrosion at the joint.

![Fig.4.10.(a)Soldering Bolt](image)

**Fig.4.10.(a)Soldering Bolt**

T-Shaped

![Fig.4.10.(b)Soldering Bolt](image)

**Fig.4.10.(b)Soldering Bolt**

Copper Large

Heavy soldering bolts of iron should be used for jointing the bare line wires. T shaped heavy iron soldering bolt and two sizes of copper soldering bolts are available. To ensure free flow of solder the soldering bolt should first be tinned as follows:

It should be heated, cleaned by rubbing with a piece of brick or stone, and treated with Voltoid tablet, which should be rubbed over the hot surface. The actual tinning should next be done, by rubbing a solder stick all over the surface. When the solder adheres, it presents a bright appearance. This condition should be maintained by periodical heating and wiping with a clean rag. As over heating the iron will burn off the tinning of the bolt and also reduce the tensile strength of the line wire near the joint, the bit should be just blue hot. This should enable soldering to be done by a single application of the iron. The joint smeared with Voltoid powder should be as level as possible and laid on the hot soldering iron (to which solder was applied) so that only the solder on its surface touches the binding wire. The solder will normally creep right over and into the joint, filling up all crevices. Finally fumes will come out of the heated joint. Then the soldering iron should be withdrawn immediately. The joint should be wiped to remove surplus solder and flux.
The joint should never be quenched with water or cooled by artificial means. This will make the wire brittle.

4.8.1. Precautions to be observed while making a joint:

- A joint, to be electrically sound, mechanically strong, and corrosion resistant should be made, keeping the following points prominently in view.
- The bond between the two conductors must have adequate mechanical strength. This can be ensured by serving the Britannia joint coil tightly by means of a binding tool, by twisting the line wires under proper tension by means of the eye bolt.
- At the joint the two conductors should have firm and unvarying electrical contact. This can be ensured by cleaning the two surfaces, which are to come into contact, and by soldering the joint with proper solder.
- Both binding and soldering should be done in such a manner that none of these operations impairs the tensile strength of the conductors at the joint. It is particularly important that during the soldering of the joint, the line wires should not get annealed at the joint and thus lose strength. The solder should enter all crevices of the joint so that it becomes one solid mass. The joint should be held by solder and not by the coil.
- The corrosion liability of the joint can be reduced to a great extent by ensuring that no corroding substance is left on the finished joint, which should be treated appropriately when necessary.

4.8.2. Jointing Of ACSR wires: (Special Instructions)

Jointing accessories are specially designed for aluminium wires so that electrical continuity is maintained with low contact resistance under all conditions. ACSR wires, when exposed to atmosphere, develop a thin film of highly resistive aluminium oxide. To prevent the formation of this layer, the surface of all ACSR wires should, therefore, be thoroughly cleaned with abrasive paper and then protected with loaded grease, before jointing.

4.8.2.1 ACSR wire Joints:

Tension Joints:
- Twist sleeve joint
- Compression sleeve joint - single sleeve
- Compression sleeve joint - double sleeve
- Termination joint
Non Tension Joints:
- P.G. Clamp Joint
- Repair sleeve joint
- Tap off connection
- Binding joint

a) Twist Sleeve Joint:

Materials tools required: Aluminium twist sleeve (Fig.4.11) of 12” length - two numbers, emery paper “0” grade (abrasive paper), wiping cloth, loaded grease, sleeve twisters two numbers, wire cutter.

Loaded Grease:

Contains grease with zinc, aluminium, copper, cadmium particles, and loaded with graphite. This is prepared under a special process. The graphite and metal particles help in improving the conductivity of the joint. Joints covered with loaded grease are protected from moisture and prevent formation of aluminium oxide film over the surface of the wires jointed.

![Fig. 4.11 Aluminium Twist Sleeve](image)

<table>
<thead>
<tr>
<th>ACSR Wire</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm</td>
<td>Mm</td>
<td>mm</td>
<td>mm</td>
<td>mm</td>
</tr>
<tr>
<td>6/1/1.50</td>
<td>12.00</td>
<td>6.35</td>
<td>2.25</td>
<td>1.5</td>
</tr>
<tr>
<td>6/1/1.96</td>
<td>14.50</td>
<td>7.50</td>
<td>2.75</td>
<td>1.5</td>
</tr>
<tr>
<td>6/1/2.11</td>
<td>16.35</td>
<td>8.45</td>
<td>3.00</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Table. 4.3 Sizes Of Twist Sleeve
Twist Sleeves: These are oval shaped, thin, walled, large enough to slide over the overlapped ends of ACSR conductors to be jointed.

Preparation Of ACSR Wire:

Both ACSR conductors and the accessories employed in jointing should be thoroughly cleaned before use. The 6 aluminium wires are fanned out. The steel and aluminium wires are gently cleaned by zero grade emery paper, to remove the impurities and oxide film from the surfaces of wires to be jointed, Wiped with wiping cloth. Loaded grease is applied over the surface of all the wires including the steel wire, wiped thoroughly again with wiping cloth. Loaded grease applied again liberally. The aluminium wires are reformed over the steel wire. The same process is repeated for the second wire to be jointed.

Precautions:

While fanning of aluminium wires,
- The wires should not be bent more than 40°, to avoid breaking of wires
- The original Helix should not be disturbed to facilitate proper reformation
- The impurities should be thoroughly removed by abrasing and wiping
- Zero grade emery paper is to be used to prevent loss of material
- Loaded grease should be liberally applied.

Preparation Of Sleeves: Both external and internal surfaces of the aluminium sleeves are also cleaned with a zero grade emery paper, wiped as described in case of wires. Loaded grease in sufficient quantity is applied.

Twist Sleeve Joint: The two ends of cleaned and greased ACSR are inserted into a pair of cleaned and grease filled aluminium sleeve. The wires should lie side by side on the flat side of the sleeve. The ends of wires should protrude 50 mm at both sides of sleeves with a gap of 5 mm in between the two sleeves. The ends are held in position with aluminium binding wire as shown in figure. One end of the sleeve is held in sleeve twister B in such a way that 6 mm of the sleeve remains out. The other end of the sleeve is similarly held in a sleeve twister A.
Sleeve Twister: Consists of two rods joined together by means of a screw. There is a slot in between to take the twisting sleeve as shown in the figure.

The sleeve twister A is held firmly on a suitable support. 6 half turns are given by turning sleeve twister B, with following precautions and sequences:

- Direction of the twist shall be opposite to the stranding lay.
- Twisting should be steady, slow, with uniform speed.
- Jerks are to be avoided.
- Twisting shall proceed in stages of half turns extending over 10 seconds.
- The next half twist should be at least after 5 seconds
- Precautions should be taken to avoid bending of the sleeve joint.
The second sleeve is also to be twisted similarly. The binding wires on the two conductors are to be removed and the fine ends are to be trimmed leaving 5 mm protruding out of the sleeves. The strands of the protruding portion are to be fanned out. Loaded grease applied on the ends and in between sleeves. Finished joint is as shown in figure

![Finished Joint](image)

**Fig. 4.14 Finished Joint**

**b) Compression Sleeve joints:**

**Compression Sleeve Joint Double Sleeve:**

Materials tools required: One aluminium compression outer sleeve, One inner steel sleeve, emery paper “0” grade (abrasive paper), wiping cloth, loaded grease, Hydraulic compression tool or hand compression tool, wire cutter. The aluminium strands are fanned out, all strands including sleeve strand are cleaned, wiped, applied with loaded grease as described in twist sleeve joint. The compression sleeve both aluminium and steel are also cleaned, wiped, applied with loaded grease as done for twist sleeve. The aluminium sleeve is slipped on one of the conductors. The steel strands of the wires to be jointed are inserted into the steel sleeve from opposite ends to meet approximately at the center. The steel sleeve is compressed with the compression tool. Now aluminium strands are to be reformed over the steel sleeve. But this creates a budging over the steel sleeve and prevents sliding of the aluminium sleeve over steel sleeve as shown in figure. To avoid this, the aluminium strands are cut on both side wires to the extent of the length covered by the steel sleeve before reforming over the steel sleeve and then reformed. The aluminium sleeve is slid over the steel sleeve and centered over the steel sleeve. Aluminium is thereafter compressed with a compression tool. While using compression tool, the compressions should be carried out at an interval of 3mm. To prevent opening out of the strands other than actually required, aluminium binding wires may be used to hold the strands in position at a suitable distance from the ends. ACSR in general and aluminium strands in particular need careful and gentle handling.
Compression Sleeve Joint Single Sleeve:

The two ACSR wires to be jointed and aluminium sleeve are cleaned, wiped, applied with loaded grease as described earlier. The only difference is, the strands are not fanned out. The cleaning, wiping etc are carried out only on the outer surface of wires. Cleaned and greased ends of ACSR wires are inserted into the thoroughly cleaned and greased aluminium compression sleeve from opposite ends of the sleeve. The ends will come to a stop at the middle of the sleeve. The sleeve is then subjected to a series of compressions with a compression tool. Compression starts from the center and proceeds towards the ends. The joints are finished as shown in the figure. The finished compression joint should be checked by gauge.
**Hand Compression Tool:**

This consists of two handles and a jaw with a steel head. At the end of the jaw is an opening for accommodating the die suitable for the respective sizes of wires. After inserting the sleeve joint inside the die, the compression tool is pressed by hand. The pressure on the compression sleeve is sufficient to produce the compression on the sleeve to tightly hold the wire under tension. With a series of compressions at a gap of 3 mm each the complete sleeve is compressed to complete the joint.

**The checks should be made once in every 20 joints:**

- If the gauge fits correctly over the hexagon compression the sleeve tool pressure is correct.
- If the gauge is loose, the tool pressure is high.
- If the gauge is tight or does not go over the compression, the pressure is low.
- The tool pressure can be corrected, by a screw, provided on the compression tool.

c) **Eye Loop On ACSR Wires (Termination Joint):**

Eye loop joints are done for termination. Eye loop should be prepared on ACSR wire as done in case of GI wires. The ACSR wire to be made as eye loop is wound by an aluminium armour tape to cover the length of loop.

![Fig. 4.17 Eye Loop On ACSR Wires (Termination Joint)](image)

The taped wire should be passed round the neck of the insulator and then brought back along it shelf, where it should be joined by a Britannia Joint using the appropriate size of Britannia Joint coil. The Britannia joint coil is of GI as aluminium binding wire breaks under tension when twisted for Britannia joint. The joints should also be soldered. Complete termination joint is shown in Fig.4.17. In both cases, at least 2 to 3 cm of the free end of the wire should be left projecting and the connecting wire soldered to this projecting end and not to the main wire. The binding should be without gaps keeping the
Line Wires

binding directions the same as that of the armour tape. The outer end of the GI binding wire is finally given three turns over the armour tape on the span wire. On account of using dissimilar metals i.e., iron over aluminium chances of corrosion exist. A coat of loaded grease of minimum thickness 3 mm should, therefore, be applied over the binding wire. Both ends of the joints should also be packed with grease.

(d) Pot Head Joint With ACSR:

The overhead bare wires of aluminium are jointed with insulated copper wires, which is a bimetallic joint and prone for faster corrosion. To protect the joint from corrosion, the pot on the head of the insulator is filled up with wax such that the joint does not come into contact with moisture or moistured air.

e) P.G. (Parallel Groove) Clamp Joint (Fig. 4.18):

P.G. Clamps:

![Fig. 4.18 PG Clamp Joint](image)

These clamps are used for jointing the two ends of ACSR wires. This is a non tension joint, as the wires to be jointed are terminated on the insulators and the extended ends of the terminated wires are only jointed through PG clamp.

The clamp consists of two aluminium alloy halves with grooves on both sides to take the conductors and have two galvanized steel bolts to tighten them together. Spring washers should be used with the bolts.
PG clamp joint provides convenience for isolation of faulty section in case failures, but by itself can become a source of failure if not maintained properly. The ACSR wires are cleaned on the outer surface with zero grade emery paper, wiped, applied with loaded grease as described earlier. Each half of the clamp contains two grooves. These clamp halves are thoroughly cleaned, wiped, and applied with loaded grease. The cleaned and greased ends of ACSR are placed in the two grooves of one clamp from the opposite sides.

The second half is placed on the first half upside down to cover the first half, in a way that the ACSR wire ends are positioned in the grooves of the second half also. The bolts and spring washer assembly is fitted and tightened to hold the wire ends. The excess grease is removed. The ends of the wire should protrude about 5 mm and the strands should be fanned out. The joint may be sealed with additional application of loaded grease. It should be ensured that no water can collect in the gaps and that the grease sealing is perfect.

f) Tap Off Connection (Fig. 4.19):

**Tap Off Connector:**

The tap-off connector is an aluminium casting with two holes. The bigger hole is meant for the ACSR wire and the smaller one is for the lead in wire. These wires are inserted within these holes and the tap off connector is compressed so that the connector and the two wires become common mass.

**Tap Off Connections:**

The bare lead in wire from the pot head is inserted into the small hole of a thoroughly cleaned and greased tap off connector. The cleaned and greased span wire is then placed in the large hole of the tap-off connector. The tap off connector is positioned as close to the insulator as possible and is pressed with a compression tool. The tap off connector joint is shown in figure.

![Fig. 4.19 Tap Off Connector Joint](image)
g) Repair Sleeve Joint (Fig. 4.20):

A non tension joint as the joint is performed on a through wire but not used for jointing to end of wire. Repair Sleeves are for the reinforcement of ACSR wires, which have sustained a damage causing a few of the aluminium strands to be damaged or broken but not to the extent where the conductor has to be cut and spliced with a tension joint.

![Fig. 4.20 Repair Sleeve](image)

The sleeves are of swedge type and consist of two parts, 'body' and 'keeper' both made of aluminium. Swedge and the die made of steel are used for jointing such sleeves by compression. The thoroughly cleaned, greased repair sleeve is placed in position on thoroughly cleaned, greased damaged portion of the ACSR wire. Thereafter the repair sleeve is riveted or pressed in position with a suitable swedge and die set.

h) Binding:

The binding is done as explained in case of GI wire, but before binding the wire to the insulator, an aluminium armour tape is wound around the ACSR wire to the length to be covered under binding. Aluminium binding wire is used. The joint is as shown in Fig. 4.21 & 4.22.
Aluminium Binding Wires:

<table>
<thead>
<tr>
<th>Size of ACSR wire</th>
<th>Size of binding wire</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Length (mm)</td>
</tr>
<tr>
<td>6/1/1.50</td>
<td>1000</td>
</tr>
<tr>
<td>6/1/1.96</td>
<td>1050</td>
</tr>
<tr>
<td>6/1/2.11</td>
<td>1100</td>
</tr>
</tbody>
</table>

Table. 4.4 Sizes Of Binding Wires
Objective:

Fill up the blanks with suitable words:

1) dB loss of 6/1/1.5 mm ACSR line wire /Km is __________ dB.

2) Loop resistance of 6/1/1.5 mm ACSR line wire/Km is __________ Ω.

3) 3.55 mm Dia G.I wire is used for ____________ circuit.

4) Twist sleeve joint is done for _______________ wire.

5) Short swan neck stalks are used for terminating line wires on ____________.

6) BAT is used for terminating line wires at ________________.

7) Compression sleeve joint comes under _______________ joint.

8) Tap Off connector is used for jointing two _______________ wires.

Subjective:

1) What are the types of line wires used in Railway Telecommunications? Explain them briefly and mention their uses?

2) List out the advantages of ACSR wire?

3) Write short notes on the following?
   a) Twist joint
   b) Brittaniya joint
   c) Termination joint
   d) Tap-off connector
   e) Bind on ACSR wires
   f) P.G. Clamp
   g) Repair sleeve

4) List out the tension joints on ACSR wires? Write the procedure of making Twist sleeve joint?

5) What is the purpose of “Eye Loop” on ACSR wire? Explain the procedure of making it with figure?
5.0. Introduction:

Staying is generally the cheapest and simplest means of strengthening an existing single post. If a post is subjected to unbalanced forces (say wind, or Line wires) the post will bend down to one side. Stays are provided to counteract these unequal forces.. The different types of stays are shown in the figure and how and where they are provided is given below in table 5.1

5.1. Types of Stays:

<table>
<thead>
<tr>
<th>Type of stay</th>
<th>Why provided</th>
<th>How it is provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Angle stay</td>
<td>To prevent an angle pole from heeling or bending under tension of line wire</td>
<td>On the opposite side of the curvature bisecting the outer angle. The stay is provided if the angle of deviation is within 4(^0) to 28(^0)</td>
</tr>
<tr>
<td>2. Cross Stays</td>
<td>To counteract the wind pressure and when additional lines are run on the existing lines.</td>
<td>At right angle to the alignment on either side of the alignment. Every 5(^{th}) post in normal areas and every 2(^{nd}) post in coastal areas.</td>
</tr>
<tr>
<td>3. Longitudinal stays</td>
<td>To counteract sudden impact on the alignment such as boulder falling.</td>
<td>In the direction of alignment on either side of the post. Provided at every 10(^{th}) post.</td>
</tr>
<tr>
<td>4. Terminal stays</td>
<td>To counter the tension of line wires which tend to bend the post.</td>
<td>At terminal posts on the other side of the alignment.</td>
</tr>
<tr>
<td>5. Overhead stays</td>
<td>Where it is not possible to fit a ground stay on account of inadequate spread or obstruction due to a Road.</td>
<td>This is done with an auxiliary post and the auxiliary post is stayed to the ground</td>
</tr>
</tbody>
</table>

Table 5.1 Different Types Of Stays
When one stay is not sufficient to take the load two stays are fixed at different points on the pole to distribute the forces, they can be fixed on one stay rod of sufficient strength such as on a mast anchor or screw pile. Such an arrangement is known as V stay and used for heavy line terminals.

5.2. **Components of a stay:**

**Anchor:**

The common type of anchor in the use is called Mushroom anchor. It looks like a cast iron pan. It should withstand a load of at least 2250 Kg. without any sign of cracking. A protective coating of Tar is given.

**Stay Rod:**

Stay Rod is a straight MS Rod (13mm dia.) with an eye at one end and a hook at the other. Under working conditions it should be capable of taking a tensile load of 2250Kg. It is installed to a factor of safety of 2.5 (i.e. safe working load 900 kgs.).

![Fig. 5.1 Stay Rod](image)

c) **Straining Screw:**

Straining screw is intended for use for increasing and decreasing the stay wire tension. The two loops of stay wire are rigidly fixed to the bosses, which have screw threads to take the central rod that passes through them. The screw threads on the two sides of the central rod are left handed and right handed so that by turning the hexagonal nut provided at the middle of the central rod by a spanner, the two loops can be made to approach each other or vice versa. The straining screw is of mild steel and is galvanized to prevent rusting. It should be capable of taking a load of at least 1800 KG.

![Fig. 5.2 Straining Screw](image)
**Stay Wire:**

Stay wire should normally consist of seven strands of commercial quality iron wire (5 SWG). The grade and breaking load of various wires are shown:

<table>
<thead>
<tr>
<th>Grade</th>
<th>No. of strands</th>
<th>Diameter of Strands</th>
<th>Breaking load strands</th>
</tr>
</thead>
<tbody>
<tr>
<td>III</td>
<td>7</td>
<td>2.00</td>
<td>2750</td>
</tr>
<tr>
<td>III</td>
<td>7</td>
<td>2.50</td>
<td>4500</td>
</tr>
<tr>
<td>III</td>
<td>7</td>
<td>3.15</td>
<td>7000</td>
</tr>
</tbody>
</table>

**Table 5.2 Grade & Breaking Load Of Different stay Wires**

**Thimbles:**

![Thimbles Image](image_url)

*Fig. 5.3 Thimbles*

At heavy line terminals and masts it is necessary to protect the stay wire from chafing. Galvanization of eye loops of stay wire wears away due to stay wire movements and this causes rusting and consequently weakens the stay wire. Thimbles are provided to bear against the attachment and it will form the inner lining for the eye of the stay wire.

**Stay Shackles (Fig. 5.4):**

Stay Shackles are galvanized U-shaped mild steel links, having eyes at the open ends through which a galvanized MS Hex head bolt should pass. They are normally available in four sizes, viz., 12mm, 16mm, 19mm and 22mm, which represent the diameter of the mild steel rods from which they are made.

![Stay Shackles Image](image_url)

*Fig. 5.4 Stay Shackles*
Stays

Stay Attachment:

Stay attachment is a piece of galvanized mild steel angle of 50mmX50mm section one end of which is shaped in the form of a hook, the other end has an elliptic slot. The horizontal side has a clear hole for the insulator stalk to pass through. Wherever the spread of an angle stay is restricted, this attachment is fitted to the channel iron bracket of which it forms an extension piece. By its use, the possibility of a line wire coming into intermittent contact with the angle stay is eliminated.

5.3. Strutting And Trussing Of Posts:

5.3.1 Strutting:

In congested area, where posts have to be erected at severe angles and it may not be possible always to provide either the ordinary angle stay or stay to an auxiliary post due to obstructions. Similarly, fitting stays to a terminal post may not be possible at times. In such cases, strutting the post is the only way to strengthen it against the lateral loads.
Struts are members subject to compression and should be fitted in a manner opposite in sense to stay wires. Thus a strut should be provided on the inside of an angle post or on the line side of a terminal post. Although a strut should be fitted to the post at the center of the load, it may not be practicable and not desirable also to avoid alterations when extra wires are added. Hence, it should be fitted below the lowest bracket likely to come up. A typical arrangement is shown in Fig. 5.7

![Fig. 5.7 Tubular Post Strut for Post](image)

### 5.3.2 Trussing:

When the local conditions are such that neither a stay nor a strut can be fitted to angle post, the only way of strengthening that post is by means of a stay, which is fixed to a post spur and then anchored to the ground near the base of the post. This may be required only for overhead lines along congested roads having obstructions on both sides. The arrangement is known as trussing and should be resorted to only when all other methods of providing the additional strength and requisite stability to the post are inapplicable. By this method, the post is converted to a framed structure, which should more effectively resist the bending action resulting from the lateral force applied by the line wires to the post at an angle or terminal. The post spur should consist of an off set channel iron bracket fitted with an angle iron strut, as usual on one side. The stay wire should pass through the extreme stalk hole on the side of the stay and anchored to the ground close to the post.
5.4 The basic requirements of staying:

A single stay should be attached to that point on the pole at which the resultant force, due to the pull of the line wires acts. Attached at any other points, the stay would tend to bend the pole. The wider the spread of a stay, the greater is its stability. On the other hand, longer stays gives rise to difficulties of obstruction etc. The shorter the spread, the greater is the vertical loading on the pole and hence, the greater the buckling stress to which the pole is subjected. No stay need be fitted at an angle post, if the angle of deviation is $4^0$ or less, because the stress on insulators is so little that the stay is likely to work loss and foul with line wires. For carrier lines, however, a pair of cross stays should be fitted in such cases. On important routes, cross stays should be fitted at every fifth post, unless the loading demands cross staying every or every alternate post. A stay should be installed in such a manner that its tension would act directly against, and along the same line as that of the resultant pull of the line wires. Assembly and installation the components of a stay should be such that it would not result in any appreciable yielding of the stay as whole, while on load.
5.5 Preparations And Fitting Of Stays:

Proper attention should be paid to the marking and setting of stays in order to ensure the safety of a line. Terminal stays should be installed on the side of the post opposite to the line wires and must be directly in alignment with the route. Such alignment should be obtained by sighting between the terminal and the next pole in the alignment, allowance being made for the diameter of the pole.

5.6 Provision Of Stay At Angle Posts Or Terminal Posts:

At angles and terminals, the straining screws should be fitted at the top of the stay. This will avoid the possibility of the poles heeling over, due to the tampering by unauthorized persons. In case of frequent tampering by unauthorized persons, all straining screws may be fitted at the tops of stays. For a single post, the point of application of a stay should be somewhat higher or at the centre of the load on it, the latter should be the case for all terminal stays. As, however, cross and angle (at small angles) stays are liable to cause faults, staying of very small angles i.e. less than 4°, should not be allowed. The manner of attaching the terminal and angle stays to posts is detailed below.

5.6.1 Angle Stays:

Rail posts (without ties and struts)- The stay is to be attached below the lowest bracket likely to be fitted. A hole should be bored in the web and the end of the stay wire passed through it and finished off.

Single rail post with ties and struts - A stay shackle and a stay attachment should be used in the manner shown in Fig. 5.9. For a severe angle, a third stay should be fitted direct to the pole below the lowest bracket.

Coupled Post - Stay Shackle and stay attachment should be used for this purpose in the manner shown in Fig. 5.10
5.6.2 Cross Stays:

The Cross stays should be fitted by wire collars direct to the post, immediately below the lowest bracket as shown in Fig. 5.12 (a) & (b).

5.6.3 Terminal Stays:

The stay should be fixed direct to the post with wire collar, the gauge and number of turns being the same as those in stay wire itself. The wire collars should be fitted immediately above the bracket as shown in Fig. 5.11. For coupled post terminals, the number of stays should be divided equally between the two posts. At rail terminal posts, the stay should be fitted to holes drilled through the web.

5.6.4 Auxiliary Post:

The stay should be fastened to a stay shackle at the centre of the bracket formation and a straining screw fitted up as illustrated in Fig. 5.12(c). The auxiliary post itself should be erected with a slight lean against the pull of the horizontal stay and should be fitted with a lightening spike.
Fig. 5.10 Coupled Posts at Angles

Fig. 5.11 Stays at terminals with Wire Collar

Fig. 5.12 (a) Cross Stays Using Wire Collar & (b) Using Stay Clamp
Fig. 5.12 (c) Stays To Auxiliary Post
Stays

Objective:

Fill up the blanks with suitable words:

1) Stays are provided to counteract ______________ forces.
2) Auxiliary post is required for ______________ stay.
3) Straining screw is for adjusting the ____________ of stay.
4) Trussing is one type of ________.
5) The Overhead stay is fitted to ________________________.
6) The Cross stay is provided at ________________________.
7) Cross stays are provided on ______________ post.

Subjective:

1) What is the main purpose of ‘Stay’? What are the different types of stays provided on overhead alignment? Why and how they are provided?

2) List out the components of stay? Write their purpose?

3) Write short notes on the following?

   a) Strutting
   b) Trussing
   c) Stay rod
   d) Stay wire
CHAPTER 6

PERIODICAL MAINTENANCE AND INSPECTION OF LINES

6.1 Maintenance:

A high standard of efficiency in the telecommunication service demands amongst other things, that all minor defects and faults are detected and removed expeditiously. Even slight defects, which may appear to be negligible, if allowed to persist, may seriously affect working in the long run and it may become very difficult to trace and clear a large number of these minor defects at a later stage. Periodical maintenance is intended to prevent accumulating of these individually insignificant, but collectively significant defects over too long a period. The defects may have been left at the time of the original construction, or have arisen subsequently due to exposure to the elements, stress of weather etc. and may be attributable to either the supports or the line wires. The lines should, therefore, be inspected periodically and the requirements estimated well in advance of the actual time of the year, considered as suitable for maintenance work.

6.2 Periodical maintenance:

The following points should be taken into consideration:

- Ensuring adequate strength, stability and safety for the poles and fittings.
- Preventing deterioration of the line insulation.
- Maintaining the line resistance of each wire within limits.
- Reducing the possibility of line wire coming into contact with neighboring wire or fittings.
- Restricting corrosion in humid and coastal areas and replacing badly corroded wire or fittings.
6.3 **Defects to which particular attention should be paid:**

**A. Post:**

1. On dangerous ground
2. Inadequate headway at railway crossings
3. Terminating arrangements unsatisfactory
4. Posts corroded
5. Posts bent or heeling over.
6. Posts sinking
7. Bands of posts corroded
8. Sockets broken
9. Power line crossings not properly guarded.

**B. Brackets and Stay Material:**

1. Ties and struts missing.
2. Stays not tightened
3. Stays wrongly attached
4. Brackets crooked
5. No lightning spikes or caps.
6. Stays loose, broken or missing.
7. Ungalvanized fittings.
8. Stays require protection from cart tracks/roads.

**C. Insulators:**

1. Insulator dirty, broken or cracked
2. Ant's nests on insulators
3. Insulator off bracket
4. Pothead insulators not filled
5. Binders broken, rusty, or loose
6. Insulator not properly screwed down.
7. Crow nests
D. Wires:

1. Wires out of level
2. Wires sagging
3. Inadequate separation between wires.
4. Excessive length of spans
5. Wires broken.
6. Wires corroded
7. In correct transposition of wires.
8. Inadequate spacing between wires at transposition points.
10. Cloth, kites strings etc. on wires.
11. Wires tied down to insulators.

E. General:

1. Creeper on stay, post or wire.
2. Vegetation touching wires.
3. Vegetation growing under wires.
4. Trees dangerously near which require to be cut
5. Headway at road crossings inadequate
6. Branches or twigs on wires.

While removing these defects, the following standard methods should be strictly followed. The minor defects, if any, on original construction should also be rectified as far as possible in the course of the periodical maintenance.

1. The safety of a pole may be endangered with the passage of time, the soil may be eroded, the ground may sink or massive earth drift may take place. All posts which are not firmly embedded, perpendicular and in alignment should be dealt with in the manner detailed below. The soil all round the post should be loosened to the extent necessary and, if required, the post may be dug up completely, refilled and re-rammed. No attempt should be made either to straighten a post or to set it back into the alignment with out putting the line wires in the top grooves of the insulators as a temporary measure, otherwise the post may get bent.
2. Old posts should be examined carefully for loss of strength, blisters, and cracks do not always indicate that a post in service should be condemned as weak. Even posts having openings along the riveted seem 3 to 15 cm (1" - 6") long and 6mm wide, with relatively good portions in between need not necessarily be replaced immediately. If strengthening of such poles is considered necessary, cross stays should be fitted.

3. The bases of all posts should be cleared, the lower tube portion and the mounds are dressed with the object of preventing corrosion of the lower tube. The exposed portion of the socket and half of the lower band should be tarred for this purpose.

4. Even galvanized line materials corrode rapidly in the salt laden humid atmosphere of the seacoast. If, in addition, there is general abrasion due to sandstorms, the whole of the posts and fittings should be painted with coal tar. The tarring operations should be conducted in dry weather in the open. The mixture should be applied hot, preferably when the line is also fairly hot in the sun.

5. All stays should be tightened up, by screwing the straining screws unless they have reached the limit of their threads. In such cases, the stay wire should be shortened and the straining screw opened out to the maximum. At angle or terminal posts, before the straining screw is removed, a temporary rope stay should be used to take the load. The threaded portion of the straining screw should be oiled liberally and the soil around the stay rod dug for a few inches in order to check up that the rod has not lost its strength due to corrosion.

6. All brackets should be put at right angles to the alignment, properly spaced, and straightened wherever called for. If ties and struts are in use, any incorrect sizes should be replaced by the proper sizes, specially at angles and terminals. All bolts and nuts should be oiled and tightened.

7. A good insulator may cause low insulation when dirt accumulates on it. The line insulators should, therefore, be cleaned thoroughly at least once a year and, if necessary more frequently. After proper cleaning of insulators, the line insulation is restored to a higher figure. All cracked and broken insulators, should be replaced by new ones.
Periodical Maintenance & Inspection of Lines

8. All joints at terminals should be closely inspected and those which are corroded should be remade. Joints in spans do not normally require attention, but in case "high resistance" is reported by the testing officer, they should be checked by an Ohm-meter. At terminals, the jumper wires should be checked for being tight and continuous. All corroded binders should be removed and the insulators rebound after cleaning, this will prevent corrosion and consequent breakage of the line wires in the immediate neighborhood.

9. Old binders, Brittania Joint Coils, loops etc. are potential causes of line interruptions, they should therefore, be collected and buried. Wherever interruptions are caused by fencing wire, birds nest etc. special arrangements should be made for frequent clean-up of the affected areas, in addition to the routine patrol by the line staff.

10. Slack line wires being out of level, cause contact faults. They should be re-leveled, ensuring that, at the normal level, they have the proper tension. Wires get out of level mostly during interruption repairs due to change in their lengths.

11. Slack jumpers should be examined carefully for fault liability and trimmed and soldered wherever necessary.

12. A thorough clearance of the jungle and vegetation on both sides of the line is necessary, the extent of such clearance would, however, depend upon the importance of the alignment, how fast the jungle grows and how frequently it is necessary to undertake this job. Normally, it should be sufficient if every thing growing within 4 meters of each side is completely removed periodically.

13. The maintenance work done should preferably be recorded every month on a map of the section, which may be drawn on ordinary foolscap paper. Every year, a fresh map should be prepared. The charts should give a clear picture of the work done in each year, and it, therefore, can form the basis on which the maintenance programme for the ensuing year can be drawn up.

6.4. Special maintenance :

At the time of natural calamities like cyclones, breeches etc. there will be drastic destructions may take place for the overhead alignment. It requires complete construction practice as new alignment.
6.5 Digging Holes:

Digging of holes may be undertaken after the marking of the hole positions for posts and stays are completed. Where the soil is soft and is comparatively free from rocks and stones, earth augers may be used for digging holes for erection of posts not fitted with base plates. Where use of earth augers is not suitable, the hole should be dug by means of pickaxes, powrahs and crow bars.

**Soil:** In soft or loose soil special protection arrangements should be provided to retain the post in position. Posts shall be erected on raised concrete foundations if the area gets periodically inundated or remains water logged. In black cotton soil, the foundation should be taken down below till better soil is reached.

**Holes for posts:** The holes for the posts should be vertical. But for facility of erection, a slope may be made out on one side longitudinal to the alignment. Depth of hole may be from \( \frac{1}{6} \)th of the post height or 1.5 meters which ever is higher depending upon length of post and soil condition.

**Holes for Stays:** The holes for the stays should be big enough so as to allow anchor to be placed properly in position. Narrow groove shall be made for the stay rod. The stay rod when placed in position should be clear of all obstructions. In ordinary soils the depth of stay hole should be 1 meter but in black cotton and loose soils the depth should be increased.

6.6 Fittings:

The fitting party may fit cross arms, braces, etc., on the posts before their erection. Fitting may be made ahead and independent of digging. Stalks, insulators, stays, etc., are to be fitted after the erection of posts.

**Fitting up coupled posts:** Where coupled posts are to be erected, the posts should be coupled rigidly by fitting horizontal bracings first and later on cross bracings.

**Fitting Cross Arms:** The cross arms are fitted with 300 mm spacing between them generally for main line system, however, the spacing between the first and second cross arms is 600mm in case the alignment is to carry carrier circuits. The first cross arm is kept 50mm below the top of the post. Wherever a top insulator is proposed to be used, this distance should be increased to 100mm. After fitting the cross arms on the posts, they should be checked that they lie in the same plane.
Fitting Ties: Main line system should have ties whenever the alignment carries two or more cross arms. Local line system should have ties with 6 and 8 wire cross arms. Local line system with 4 wire cross arm does not need ties.

Fitting struts: Struts are to be provided only where the ties have been fitted. Struts may be provided at every third post for three cross arms, every alternate post for four cross arms and on each post for more than four cross arms. For single rail posts, the struts are supported on small angle irons fitted to the post by means of ‘U’ bolts for coupled posts, horizontal bracings are first fitted by means of 'U' bolts before the struts can be supported on them.

Post Top Fitting: In case of tubular posts the top of the posts must be fitted with caps for providing insulator stalks or lightning conductors. For rail posts, top insulator brackets or lightning conductors may be provided, as necessary. The top fitting shall be rigid in order to provide good electrical conductivity with the post.

Base plates: Base plate should be fitted at the bottom end of the post tightly, as they will be in accessible after they are buried.

Tarring: In highly corrosive areas a coat of tar may be applied to rail posts in such a way that when the post is buried, 300mm of the tarred portion remains above ground level as well as below ground level.

6.7 Tools for post erection:

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Powrah</td>
<td>1 No.</td>
</tr>
<tr>
<td>Crowbars</td>
<td>2 Nos.</td>
</tr>
<tr>
<td>Rope 300mm cir. 25 metres to 30 metres long</td>
<td>2 pieces.</td>
</tr>
<tr>
<td>Rope 60 mm cir. 4 metre long</td>
<td>1 piece</td>
</tr>
<tr>
<td>Tent mallet</td>
<td>1 No.</td>
</tr>
<tr>
<td>Tent pegs.</td>
<td>4 Nos.</td>
</tr>
<tr>
<td>Pair of bamboo scissors (For single post)</td>
<td>1 No.</td>
</tr>
</tbody>
</table>
6.8 Preparation for post erection:

Men should be distributed for different functions. Some men should keep the supporting ropes around tent pegs in tension. Some other men should lift the post slightly and position it with sole plate touching the crowbars.

![Fig. 6.1 Hole For The post And For The Stay](image)

A bamboo scissors may be placed in position to support the post. Post may be erected slowly, stage by stage the position of the scissors shall be moved and the scissors should continue to support the post. A bamboo scissors may be placed in position to support the post. Post may be erected slowly, stage by stage the position of the scissors shall be moved and the scissors should continue to support the post. The scissors support is not necessary once the post is lifted more than half and the post may be supported with the pulling rope. With the final pull, the base plate slides down the crowbars and the post takes the vertical position.

The post complete with base plate and top fittings is placed on the ground. Two tent pegs are driven in ground at right angle to the alignment at a distance of 5 to 6 metres. The centre of one 30mm rope is fastened to the post at the junction of cross arm and post, the ends of the rope are lopped around the tent pegs. Another 30mm rope is fastened at the junction of cross arm and post. The free ends are taken to the opposite side of the post. Crowbars are placed in the hole to aid sliding of the post.

**Alignment of Post:** The supervisor may make use of plumb to check if the post is vertical and should verify visually if the post is properly aligned with the marking pegs and other posts already erected.
**Ramming:** The post is to be secured in correct position, and the hole is to be filled with earth 300mm thick at a time along with gravel and ballast if available. The loose earth must be rammed properly with a rammer round the base till the entire hole is filled up.

**Mounding:** Except in railway colonies and station areas the base of a post should be mounted to a height of 200mm from the ground. The diameter of the mound should be about 1m and if practicable, stones, broken bricks and kunker should be added to the top layers of the earth for preventing logging of water around the base of the post.

### 6.9 Erection of post in hole bored with the auger:

When a post without a base plate is required to be erected in a hole bored with an earth auger, the post can be lifted up vertically and dropped into the hole. In erecting a heavier post a crowbar is to be put into the hole, the end of the post laid up against this and the post raised so that the end slides down the crowbar into position.

**Erection of Coupled posts:** While erecting the post care must be taken to erect both the legs simultaneously. Two bamboo scissors will be required for supporting both the legs and great care should be exercised so that the braces are not damaged. When coupled posts without braces and coupling are being erected a horizontal brace should be temporarily fitted near the bottom to keep the legs separated at correct spacing during erection.

**Erection of Stays:** The stray consists of a stay wire connected to a straining screw, a stay rod and an anchor. It is fixed at the post end through wire collars or suitable clamps immediately below the place where the lowest cross arm has been fitted or will be fitted considering future requirements.

**Point of Application:** On the post, the point of application of a single cross stay should be below the last cross arm. Where a second cross stay is required, the point of application should be below the last but one cross arm, and so on. Where cross arms are framed with ties and struts the stays may be taken off from the end of cross arms also. At terminals, the terminal stays should be applied immediately above the top cross arm. If more than one stay is required the subsequent stays may be at lower levels. Where a coupled post is used stays should be provided uniformly on both the legs.
Positioning of Straining Screw: The straining screw should be used along with shackles and should be positioned near the lowest cross arm.

Fitting the Straining Screw: Before connecting the straining screw in the stay arrangement, the screw should be opened fully so as to allow for maximum tightening after erection.

Fitting stay Rod with Anchor: The stay rod is provided with a hook at one end, which should be attached to the centre bar of the anchor. The eye at the other end should be joined to the wire of the stay.

Stay Protection: Stays planted near a road or path should be protected by slipping a 1.5m long iron galvanized tube over the stay wire, which will rest on the ground. The base of the stay should also be protected by a mound of earth or stones.

6.10 Erection Of Line Wires And Final Adjustments:

6.10.1 Erection Of Line Wires:

Precautions:
When wires are being erected at a crossing with power wires and fittings they should be considered as "live" and dangerous, whatever be the voltage. The usual precautions to avoid contact, either directly or indirectly should be taken.

Rope Loop Guides: ACSR wires are to be paid out through rope loop guides to prevent the wires scraping against the drum flange. A short rope with a loop made at one end may be tied to the four wire cross arm, driven in the ground, in front of each drum, for this purpose. The rope will guide the wire and prevent the wire scraping against the drum flange.

Rope Heading: While removing the wire heads from the drums, it may be ensured that there are no nails or projections inside the drum plates. Each wire may now be spliced into a 50mm circumference up to 2 meters long. Another 50mm rope 5 meters long may also be bound to both the ropes. The longer rope is used for pulling and ensuring that both the wires move together. If necessary, the long rope may be tied on a piece of thick wooden stick, which can be pulled conveniently.
6.10.2 Requirement Of Tensioning:

The erection of line wire includes the adjustment of the tension of line wire to a pre-determined value, which takes the relevant factors (like temperature, elasticity, etc.) into account. Lower tension causes contact faults and higher tension, undue strain. Variation of temperature leads to variation of tension. After erecting wires on the post, wires are to be tensioned in stages:

- Initial tension generally known as Killing tension.
- Final tension.

**Tensioning:** Pulley blocks or Winch type regulating equipment shall be used for tensioning. The tension may be applied manually or by suspending appropriate weights. Rope stop should be made of rope about 8 cm circumference and 1.5 meters long. A ring may be provided at one end for convenience of connecting pulley block or a dynamometer. The other end may be secured from opening out. The twists of the rope stop are undone gradually and then are re-twisted around the wire, so that the wire forms the core. The rope stop may be twisted on the wire for a length of about 50 cm. The grip is to be sufficient and the rope stop does not slip while tension is applied to the rope.

**Tensioning over Transposition Point:** While tensioning the wire, it is necessary to avoid straining the wire through the transposition. The wires may, therefore, be pulled up to the transposition point in the first instance and hold with rope stops at the transposition post until the correct tension is given on spans beyond the post and then finally bound at the transposition post.

**Tensioning Lengths:** The length of wire that can be pulled up in one stage may be as much as 500m if no transposition point is involved. When wires are transposed, tensioning is to be done between two consecutive transposition points.

6.10.3 Killing Tension:

When a new wire is tensioned just below its elastic limit, it does not regain fully its original length on removal of the tension, it becomes permanently elongated to a small extent. This wire generally behaves as an elastic material unless it is stressed still further, when more permanent set occurs. In fact, the amount of permanent set varies for different wires basing on the material. The line wires should, therefore, be made to behave as an elastic material within the range of maximum possible tension to which it is likely to be subjected under working conditions.
Before a wire is subjected to its proper (Final) tension, it is necessary to 'kill' it, otherwise its own weight will cause it to stretch very considerably. Killing is done by tensioning the conductor, at half of its breaking load for 20 minutes or 58% of breaking load for 6 minutes. The desired tension should be reached uniformly within a period of one minute. For this purpose while loading the regulating equipment with weights, the weight shall be allowed to fall gradually and slowly by resisting manually.

The killing tension for various types of wires is detailed below:

<table>
<thead>
<tr>
<th>Type and size.</th>
<th>Type and size.</th>
<th>Breaking load in Kg</th>
<th>Breaking load in Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACSR 6/1/1.50</td>
<td>43.00</td>
<td>407</td>
<td>203</td>
</tr>
<tr>
<td>ACSR 6/1/1.96</td>
<td>72.0</td>
<td>680</td>
<td>340</td>
</tr>
<tr>
<td>ACSR 6/1/2.11</td>
<td>85.0</td>
<td>768</td>
<td>385</td>
</tr>
</tbody>
</table>

Table 6.1 Killing Tensions for ACSR Wires

In order to adjust the tension of a wire within close limits, the wires are gripped by rope stops.

The tensioning is to be done in the following manner. The fixed end of the block and tackle should be tied to the base of the nearest pole by means of a piece of wire rope and the running end coupled to the tension dynamometer in a suitable manner. The other end of the dynamometer should be firmly attached to the loop of the rope stop, if necessary through an auxiliary link having a wider hook, which can be secured to the loop.

The rope stop should consist of a piece of sisal rope 76 mm (3 inches) in circumference and 1 1/2 meter (5 feet) in length. Opening out of its strands should be prevented by wrapping the ends with a few turns of soft thin wire like Britannia Joint Coil. One end of the rope stop should be untwisted by both hands, a little at a time, and lapped helically for some 450mm (18") over that portion of the line wire, which is intended to be gripped firmly for applying the tension required. The other end of the rope stop should be lapped in the same way in continuation of the first. The block and tackle should ordinarily consist of one single and one double block, about 55 metres (60 yard) of 36mm (1 1/2") circumference sisal rope. A piece of thin rope about 600 mm (2ft.) long, should be used to bind the ropes of the tackle by coiling it tightly around them all, after the tension has been applied. For wires heavier then 300 lbs / mile, the tensioning gear should consist of one double and one treble block 64 mm (2 1/2") size and sisal rope of the same kind 55 metres (60 yards) long.
6.10.4 Final Tension:

After the killing period, the weights should be reduced to arrive at the final tension. Where manual tensioning is employed, a rope stop should be used to hold the wire in that tension and rope fastened to the post tightly. The finally tension to which the wire shall be subjected to depends on the span and the temperature of the surrounding.

6.10.5 Sag:

If a wire of uniform weight is to be suspended in still air, from two fixed points, which are at the same level, it sags at the centre and assumes a shape known as catenary.

**Checking Of Sag:** The equality of sag from span to span is important. While tensioning the wire, sag may be checked. Sag may be adjusted visually. The conductor in the span may be set to vibration by striking it close to the insulator. The resulting wave will travel and will be reflected back from the next support. These reflections can be felt if the conductor is lightly touched.
6.10.6 Alignment with ACSR and G.I:

Recommended sizes of GI wires are mechanically weaker than recommended sizes of ACSR wires. GI of less than 3.55mm shall not be used on main lines. Sag of ACSR is to be so adjusted that at 30°C, the sag of ACSR is equal to sag of GI on the alignment.

6.11 Transposition:

If each telecom circuit is completely isolated from all other sources of electricity, no potentials other than those deliberately introduced for the purpose of telecom transmission, are present in any telecom circuit. In practice, however telecom circuits are rarely entirely isolated, as they are in close proximity to other telecom circuits and to other electrical circuits such as power lines. In addition they are exposed to interference from atmospheric disturbances and radio transmission also.

All electrical circuits set up electromagnetic fields, which cause interference in the form of cross talk and noise in neighbouring circuits.

Cross talk is the intelligible or unintelligible speech overheard on a telecom line as induced by an adjacent telecom line. The term noise is usually applied to all other forms of interference, which may arise from:

- An adjacent telecom line (eg. signalling pulses)
- External sources (eg: Power Lines, atmospheric disturbances, radio transmission and electric traction system.)

6.11.1 Electromagnetic Field:

When voltage and current exist on a telecom line, "Fields" or lines of force are set up about the wire of the line. There are two types of fields, one of which is associated with the voltage and the other with the current. The field associated with the voltage is called an electrostatic or electric field because it is caused by the voltage existing between -

- The two line wires
- The line wires and earth
- The line wires and nearly lines.
The field associated with the current is the magnetic field produced by the passage of current through the line wires. Both fields usually exist together and are spoken collectively as the electromagnetic field.

When these fields are "cut" by near by wires, EMFs are induced in the wires. The cutting of other wires by the fields is referred to as:

- Magnetic coupling (by magnetic field)
- Electrostatic coupling (by electric field)

**Magnetic Coupling:** In the figure, A & B represent the wires of a telecom circuit (the disturbing circuit). C & D are the wires of an adjacent telecom circuit (the disturbed circuit), which is running parallel to disturbing circuit. When an AC signal is being transmitted over A & B wires, the magnetic field set up around the wires induces an EMF into wires C & D. As strength of the field is greater at 'C' than at 'D' the EMF induced in 'C' will be greater than that induced in 'D' as shown by the dotted arrows. The resultant EMF between C and D causes current to flow in the disturbed circuit.

![Fig. 6.3 Magnetic Coupling](image)

**Electrostatic Coupling:** Wires which are insulated from each other and earth may be regarded as forming the plates of a capacitor, the air being the insulating medium. There are number of these capacitance couplings between telecom circuits and nearby power lines. The value of the capacitance will vary due to the different spacing between the wires. As the ratio of C1 to C3 is not the same as that of C2 to C4, an unbalance exists which results in a potential difference (induced emf) across C&D.
This potential difference causes current to flow and results in cross talk in the disturbed circuit C&D.

**Combined Effects Of Magnetic And Electrostatic Couplings:**

The figures show the induced currents in the disturbed circuit due to magnetic and electrostatic couplings respectively. The effect of these currents is to combine and produce.

- A high level of cross talk at one end of the disturbed circuit (Near End Cross Talk) because the currents at that end are in the same direction and are additive.

- A low level of cross talk at the other end of the disturbed circuit (Far End Cross Talk) because the currents are in opposition and only the difference between them produce cross talk.

**Circuit Balance:** Even both wires are equally spaced from a disturbing circuit, cross talk and noise will occur in the circuit if the pair is electrically unbalanced. One wire might have a greater resistance than the other perhaps due to a poorly made joint, or the use of a piece of wire of slightly different gauge to repair a fault. This unbalance often referred to as resistance unbalance. In case of overhead alignments the cross talk reduction depends upon three main factors namely

- Wire configuration on poles
- The distance between wires of a pair
- The distance between pairs
- The frequency of current in the disturbing circuit.
To reduce cross talk the paralleling wires are to be arranged in such a way that the effect of the field of one pair will be the same at both wires of other pair thus leaving no residual difference to cause currents in the second pair.

If the two wires of a pair are spaced very close to each other and separated by large distance from the wires of the other pair, cross talk would reduce to a minimum. For example if the spacing between A&B is small and they are spaced at large distance from C&D the effects of the fields produce by A&B will be practically the same on C&D and little cross talk will result.

Correct spacing of line wires only reduces cross talk and noise but does not eliminate it, because both wires of one circuit are at different distances from the conductors of the other circuit, therefore resultant voltages are still induced in the disturbed circuit by electrostatic and electromagnetic couplings. Transpositions are a method of further reducing cross talk and noise, by interchanging the position of the two wires of a pair at specific intervals along a route. As a pair of aerial wires are referred to as a "Physical line" the transpositions in the line are called "Physical transposition".

6.11.2 Effect Of Transposing The Wires:

The figure shows an example of a telecom circuit, which has induced 4 volts in one wire and 1 volt on the other wire due to coupling. This would cause cross talk due to the difference in voltage and the resulting current flow in the circuit.

![Fig. 6.5 EMF Induced in Telecom. Line](image)

If we insert a transposition as in figure, we are exposing each half of the circuit to the disturbing circuit at an equal distance. The effect is that we have 4 volts in half of one
wire and 4 volts in half of the second wire. Similarly 1 volt is induced in other half of each wire making the total induced voltage $4 + 1 = 1 + 4$ in each wire equal. The voltages cancel out, there is no current flow hence no cross talk or noise in the circuit.

![Fig. 6.6. Effect Of Transposition In Disturbed Line](image)

A single transposition as shown is not satisfactory on an aerial alignment as the condition vary throughout the length of the line. For this and other reasons, a number of transpositions are made in all the lines on a trunk route and some times on long subscribers line. The number and spacing of these transpositions vary according to the type and location of the circuit.

It does not matter, electrically, whether the wires cross left over right or right over left, but to standardize the construction, all wires in physical transpositions cross left over right.

### 6.11.3 Transposition Schemes Adopted In Railways:

In Railways the length of the Block Section will be taken as transposition section. Depending upon the actual length, it will be made in to a full section, or a full plus half section i.e., the length of the Block section will be converted to number of transposition section plus half sections or quarter sections etc.

For the "Transposition interval", only the span length will be calculated, depending upon the terrain, no of wires etc. The transposition interval will be divided into number of spans. If a Transposition interval is divided into 6 equal lengths of spans, then the circuit on the top most bracket jungle side will have a T.P. at every sixth post and the circuit which is placed jungle side on Second Bracket will have a T.P. at every 24th post.
Transposition arrangement for 15 pole per km. alignment.

- Administrative Trunk Every 4th pole
- Section Control Every 7th pole
- Deputy Control Every 13th pole
- Carrier Circuits Alternative Poles

6.11.4 Definition:

- Zero Post: The beginning of the alignment is known as zero post.
- Span: The distance between two consecutive posts.
- Transposition Interval: Length of line between two consecutive transposition points.

6.12. L-14 Diagrams:

L-14 diagrams give the line details of the particular circuits on over head line alignment showing the positions of the individual circuits in the form of drawing (charts). The diagrams are also shows the KM No. and alignment direction with respect to the track i.e. left or right side of the track while facing Up/Dn direction as the case may be.

The construction department prepares the diagrams after completion of construction of the alignment, and supplied to the maintenance organization in sufficient copies.

These diagrams are provided to Guards of all trains to locate the control circuits for connecting the PCP in the mid section during emergency for control communication with the section controller.

The line alignment will have the following plans according the priority of the circuit.

1. On the top most bracket of the alignment, ADM circuits and Block circuits will run along the track.
2. Middle brackets carry other lines like LC Gate etc.
3. Bottom most brackets carries section control circuits and Dy.control circuits.
6.13 Inspection:

The inspections may be of two types -

- Preventive Patrols
- Periodical inspections.

The first type is meant for eliminating those sources of fault over which there is normally no control and which cannot be foreseen. Such patrols should be carried out regularly by the members of the line staff and occasionally by the supervisory staff as a measure of check on the work of the former. The second type is restricted to the controlling and supervisory officials and is intended to bring out the defects, which are preventable, with full details, so as to take suitable steps to eliminate them at the earliest.
Every lineman, who has a definite section of line allotted, should regularly patrol the same, according to the orders of the concerned officer. In course of routine patrols, the following items of work should be carried out –

- Replacement of broken insulators and removal of cobwebs, kite strings etc.
- Removal of creepers from posts, stays etc.
- Isolated clearing and chopping of tree branches.
- Tightening or repairing of stays.
- Straightening brackets.
- Tightening guard wires.
- Examining and re-soldering suspected joints at line and office terminals.
- Other minor items of work, which may prevent a fault from developing either intermittently or permanently.

Where the faulty condition cannot be repaired on the spot, the matter should be reported with full details to the sectional supervisor, who will arrange to get the work done as soon as possible.

A suitable programme should be drawn up to ensure that linemen patrol their sections as frequently as required under the conditions prevailing locally, no two adjacent lineman, should, however be out on patrol on the same way. While deciding the frequency of these inspections, the officer should be guided mainly by the importance of the routes depending upon the traffic carried and also by the climatic and physical features of the country. The carrier routes should be patrolled by linemen once a week. Maintainer, if any, should accompany the linemen, so that they may inspect the whole of their section once a month.

6.14 Primary object of all inspections:

To eliminate to the utmost all interruptions, which can be classified as "preventable". Hence, there should be effective and close control on line maintenance. All items of such work concerning maintenance of line, for a particular period should be determined only after careful inspection of the sections concerned and not left to the discretion of the maintenance party, on the basis of general instructions. For this purpose, a correct estimate of the actual amount of jungle cutting, post and wire maintenance should be prepared only after the routes have been personally inspected by a responsible officer about one month before the maintenance season.
It is the duty of the supervisory, executive and administrative officers to take active interest in the condition of lines within their jurisdictions. The officers should decide the mode of carrying out inspections by officials directly under them. However, while traveling in connection with other duties, all officers up to the rank of supervisors should note defects on pole routes requiring attention. It should be appreciated by all concerned that the value of such reports is largely lost, if they are filed without proper action being taken to remove the faults quickly. Accordingly, the higher officers should make it a point to verify, by reference to recent reports, that all specific faults, pointed out there in have actually been eliminated. Thereafter they should take steps to have all defects (still continuing) promptly removed and take suitable notice of anything that points to neglect on the part of the staff. The supervising officers should also inspect any line on which the duration or number of interruptions is on the increase or there are reasons to believe that the line is faulty in any other way.

The officers should inspect their lines by day train, in case of railway alignments and submit their reports promptly, paying particular attention to the common cause of faults. One copy of the report should be forwarded to the next higher officer for scrutiny and record. The action taken on each defect should be noted and the reports kept pending until all defects have been removed. The higher officer after perusal of the Inspection Report should satisfy himself, if necessary, by personal inspection, that extensive renewals or replacements wherever reported as urgent or essential, are actually necessary.

In order to trace difficult types of frequent faults, officer may have to inspect a line on foot. In such cases, he should preferably, be accompanied by the sectional lineman, who should repair any defect that requires immediate attention.

Officers and Supervisors should inspect the main lines as frequently as circumstances may render necessary. The higher officers should inspect such routes at least once a year. Because of their importance, carrier routes require special attention. The Junior Officers should inspect such routes at least once in six months and, if possible, more frequently by the supervisors, the frequency of these inspections should be at least once per month. The official in direct charge of line should usually inspect all lines along railway track by train once a month, and on foot once in every three months, in case of side lines along road, the inspection on foot should be once every three months.
6.15 **Common Defects:**

All inspecting officers should inspect the lines carefully for the following common defects and make a detailed report.

**A - Posts:**

1. On dangerous ground,
2. Inadequate headway,
3. Unsatisfactory terminal,
4. Corrosion,
5. Bending or healing,
6. Sinking,
7. Corroded bands,
8. Broken sockets,
9. Electric power line crossings - guarding arrangements,
10. Missing of lightning spike or cap.

**B - Brackets And Stay Materials:**

(i) Ties and struts are not properly fitted or missing
(ii) Stays broken, loose or not properly fitted
(iii) Brackets - bent or crooked
(iv) Corroded Fittings
(v) Stay - protection required.

**C - Insulators:**

(i) Broken, cracked or abode of ants, insects etc.
(ii) Out off the bracket or not properly screwed down
(iii) Pot head not filled or cap broken/missing.

**D - Wire:**

(i) Out of level
(ii) Sagging or too tight
(iii) Excessive span length
(iv) Corroded wire
(v) Transpositions not proper
(vi) Corroded joints
(vii) Foreign matter on wires.
E – Jungle:

(i) Creepers on stay, post or wire
(ii) Vegetation touching wires
(iii) Vegetation under wires
(iv) Trees dangerously near the line.

F - Miscellaneous:

(i) Houses, hay stacks etc. being built too close to the line
(ii) Infringement of standard dimensions laid down for lines along railway
(iii) Lines crossed by electric wire without guarding
(iv) H.T. power wires running close to departmental lines.
Objective:

Fill up the blanks with suitable words:

1) Killing tension of ACSR 6/1/1.5 is __________ Kg.

2) Transposition arrangement for section control is at every _______ pole.

3) Transposition arrangement for Deputy control is at every _______ pole.

4) The post at the beginning of the alignment is known as _______ post.

5) By transposition _____________ can be kept minimum.

Subjective:

1) What are the points to be considered during periodical maintenance of overhead lines?

2) What is the periodical maintenance to be carried out for the following?
   a) Bracket and stay material
   b) Line wires
   c) Insulators

3) Explain the following terms briefly
   a) Killing tension
   b) Final tension
   c) Sag

4) What information is given by L-14 diagram? Explain with atypical L-14 diagram?

5) What inspection is to be carried out on overhead alignment? What is the work to be done in course of routine patrols?
CHAPTER 7

PROTECTION FROM POWER LINES
AND INDUCTIVE CO-ORDINATION

7.1 Power Line Interference:

The telecommunication circuits are likely to be interfered from power lines due to:

- Direct contact between the power line and the telecom line
- Induction from power line due to parallelism.

7.1.1 Contact from Power Lines:

The chances of contact from power lines must be eliminated. As such contacts are likely to be dangerous to the lives of telecommunication operators and maintenance staff.

Guarding wires may be provided on -

i) Power circuits and ii) Telecommunication circuits.

The guards should be of substantial construction and must be efficiently maintained. The guard has to withstand conditions, which may be sufficient to break line conductors and in addition it has to bear the weight of the conductors, which falls on it.

7.1.2 Guard wires on Power Circuits:

Usually power circuits are above the telecommunication circuits. The guard wire is provided on power circuits in such a way, that in case a wire in the power alignment snaps, the wire will be earthed immediately by falling on the guard wire. Guarding arrangements may be divided into two main clauses:

- Guards for High tension power crossings
- Guards for Low tension Power crossings.

High tension power line may be considered as one on which the voltage between any two conductors insulated from earth or between any conductor and earth is 650V or above: low tension line is below that figure.
7.1.3 Power lines to Cross over Telecommunication Lines:

The main principle to be observed during erection of power/telecommunication lines, is that, in the case of high tension crossings, always, and in the case of low tension crossings, in every instance possible, the power lines should cross over the telecommunication lines. The advantages of this arrangement are that power wires being of heavier gauge, not so liable for breakage and chances of power lines breaking and falling on the telecommunication lines are very rare. The telecommunication wires also require more attention during maintenance operations than power wires, hence lower height is advantageous.

7.1.4 High Tension Power Crossings:

High tension power lines crossing over telecommunication lines should always, if possible, be avoided. The placing of power line terminal post beyond a telecommunication route and high tension underground cable crossing, are means whereby open wire crossings may be avoided.

If the telecommunication alignment is a main line and particularly if it is carrying carrier circuits, introduction of a length of cable on this line, as a means of avoiding an overhead crossing, should not be adopted. The change of gauge caused by the cable in such circumstances, leads to reflection troubles and difficulties in repeater working. If the alignment carries only telegraph and local telephone circuits, a cable may be used. In some circumstances diversion of an existing route to avoid the effects of crossing the high tension power lines may be the most satisfactory method.

7.1.5 Guards for High Tension Power Crossings:

Wherever it is not possible to avoid an overhead high tension power line crossing, the guarding arrangements should be made as follows:

- The power line should cross over the telecommunication line at right angles to the telecommunication alignment.
- They should continue at right angles for a distance of not less than 2 m, on each side of the crossing.
• In difficult cases a deviation of 30° from the right angle may be allowed for a straight through crossing.
• The power line span should be enclosed in a substantial cradle guard of the formation shown in figure 7.1
• The minimum vertical distance allowed between the telecommunication guard wires and the lowest power line guard wires is 1 metre.
• At the crossing span the power line must be provided with stranded conductor with duplicate insulators, bridle and an earthing device.
• The top or outside wires on the sides of the cradle guard shall be so arranged that lines drawn upwards from them towards the centre at angle of 45° will totally enclose the power wires.
• The poles or structures supporting the power wires at the crossing span must be sufficiently strong to serve as terminals, should the wires in the adjacent spans break.
• The minimum size allowed for the main supporting wires of the cradle guard is 7/2 mm galvanized steel.

7.1.6 Independently supported Cradle Guards:

Where the span length of the power lines is considerable, it may be uneconomical to provide guarding arrangements throughout the span. Alternatively the posts may not be strong enough to support the guard wires. In such cases independently supported cradle guard may be erected to provide the protection to the telecommunication line underneath. The guarding arrangement in such cases will be as shown in Fig.7.2. The independent posts supporting the cradle guards should be of iron, steel or reinforced concrete.
The clearance between the guard and the power conductors must be sufficient to prevent contact under the worst possible conditions other than by breakage of conductors.

Fig. 7.1 Cradle Guard for Power Lines

Fig 7.2 Guards Independently Supported
7.1.7 Approval of Electrical Inspector:

Since the Electrical Inspectors of the Govt., are the statutory authorities for determining whether a guarding arrangement is satisfactory, the method of guarding the high tension crossing may be modified with the approval of the Electrical Inspector to the Govt., if local circumstances are such that the modification of the standard arrangement is necessary. The Electrical Inspector's approval in writing should be obtained and recorded in all such cases where modifications in the guarding arrangements for high tension power crossings are introduced.

7.1.8 Guards for Low Tension Power Crossings:

Where power lines have already been erected and it subsequently becomes necessary to put up railway telecommunication lines in close proximity to, or across, an unguarded portion of the same, one month's notice in writing of the proposed erection should be given to the power undertaking, so that they can arrange for the necessary guards within a reasonable time. The Electrical Inspector to the Government should also be informed.

The best way of guarding low tension power wires, where, they cross telecommunication wires, is to enclose the former in a cradle composed of guard wires as shown in fig. 7.3 angle iron brackets are fixed on the posts on each side of any span which crosses a telecommunication wire. Guard wires are run from four end points A, B, C and D of the angle iron fixture to the corresponding points of a similar fixture on the next post. At intervals of 1 metre along the span of guard wires other cross guards are fastened commencing at one of the top wire running round the bottom wires and finally ending up to the other top wire, thus forming a cage round the low tension wire. With such a guard on a low tension power line, there is no need for any other guards on the telecommunication alignment. In cases where a cage cannot be fixed, a net guard as shown in figure 7.4 should be fixed on the power posts underneath the low tension wires.

![Fig. 7.3 Cage Guards on LT power Lines](image)
7.1.9 Guards on Telecommunication Alignment:

Usually telecommunication alignment will pass under the low tension power wires and if proper guard wires as mentioned in the above are provided, it is not usually necessary to provide guard wires at the top of telecommunication posts. Where a net guard only is provided on the power line posts, guard wires should be provided on the telecommunication also. In spite of providing guard wires by the Electrical Department, it will, however, be safe always to provide guard wires on top of telecommunication posts. Such double guarding is considered as an added safe guard to prevent interruption of the important circuits and protection to operating and maintenance staff, should a power wire and a guard wire simultaneously break. The minimum separating distance between the overhead telecommunication wires and low tension power wires at a crossing should be 1.3 metres or more. Guards on telecommunication posts should be arranged well clear of the telecommunication wires and the tension on the guard wires should be sufficient as not to allow them to come in contact with the telecommunication wires. Cross Guard Wires should be provided at distances of 50 cm and a net guard should be provided below the power lines. On account of the extra tension due to the guard wires, the posts are likely to be pulled out of the perpendicular and, therefore, longitudinal stays in the alignment should be provided to the posts supporting the guard wires against the pull of the guard wires.

Fig.7.4 Net guard For LT Power Crossing Over Telecommunication Wires.
7.1.10 *With these arrangements the principal points to be remembered:*

i) A sufficient number of guard wires should be erected to ensure that the space between them does not exceed 800 mm.

ii) The outside guard wires should be 200 mm beyond the outside telecommunication wires.

iii) The guard wires should preferably be at a height of not less than 600 mm above the telecommunication wires.

7.1.11 *Earthing Guards:*

It is extremely important that wherever guard wires are erected, they shall be properly earthed. For this purpose the frame on which the guard wires are supported and the guard wires themselves should be provided with efficient earth connections at several points, as an unearthed guard wire may lead to dangerous conditions.

7.1.12 *Guard over Electric Traction Wires:*

Where telecommunication lines have crossed over direct current electric traction wires, guard wires shall be provided to prevent the telecommunication wires from falling on the traction wire in case of break faults. The minimum clearance between the guard wire and the electric traction wire should be 600 mm. The arrangement of guard wires in this case will be the same as described except that the guard wires should be erected below the telecommunication wires preferably at a distance of 300 mm below the lowest telecommunication wires.

7.1.13 *Insulated Line Wires:*

The use of insulated line wires at power crossings increases the measure of protection from contacts with power lines. But even then the usual guarding arrangements should be provided, as if the telecommunication wires were bare.

7.1.14 *Stays:*

The Stays should not be run over or under low tension power conductors, when there is any reasonable alternative. Where such crossings are unavoidable, guarding is necessary. Where there is danger of stay making simultaneous contact with telegraph and low power tension conductors, a shackle insulator should be fitted in the stay wire to isolate the portion likely to make contact with the telecommunication wires from the portion which may make contact with the power wires. Stays should never be erected over or near high tension wires.
7.2 **Induction from power lines due to Parallelism:**

Power lines running at close distances parallel to the telecommunication lines produce noise and disturbance in the telecommunication circuits during normal working conditions and the induced voltage rises dangerously in faulty conditions of the power lines. To eliminate these effects a considerable separation between the power lines and the telecommunication lines has to be ensured in addition to reduction of the length of parallelism, as far as practicable.

7.2.1 **Separation to avoid inductive interference:**

The most effective remedy for securing freedom from inductive interference is avoidance of close proximity between power lines and communication circuits. The minimum separation between the circuits consistent with the requirements of construction and maintenance for both sides of lines avoiding the effects of inductive interference in normal conditions is given by the expression –

\[
S = 4.4 \times E \times L
\]

Where

- \( S \) = separating distance in metres.
- \( E \) = voltage between the phases of the power lines.
- \( L \) = length of parallelism in Km.

7.2.2 **Effects of Fault Current:**

The voltage limits adopted in this country are the same as recommended by ITU Viz., 60V for high security lines and 430V for non-high security lines. All power lines of voltage class 33 KV and below, fall under the category of non-high security lines and hence the prescribed limit for induced voltage is 430V. The separation between the power and telecommunication lines should, therefore, be such that the induced voltage does not exceed the limit prescribed. The minimum safe separation required between the power and telecommunication lines is determined by the product of the fault current and the length of parallelism.
7.2.3 Fault Current:

The fault current \( I \) is dependent on -

- Voltage class of the power line (33, 22 or 11 KV).
- Size of conductor used for the power line.
- The total capacity of the substation transformer in Mega volt amp. = \( K \).
- The distance of the point of fault on the power line from the substation in Km = \( L \)

Assuming that a single line to ground fault occurs, the formula for calculation of the earth current based on the principle of symmetrical components using 8% reactance for the step down transformer, is as follows:

\[
I = \frac{A}{(B.L + 24 / K)} - \frac{C.L}{K}
\]

Where

\[
A = 5250 \text{ for } 33 \text{ KV } 7875 \text{ for } 22 \text{ KV } 15750 \text{ for } 11 \text{ KV}
\]

Values of \( B \) and \( C \) may be obtained from the table 7.1 value of fault current \( I \) is calculated.

<table>
<thead>
<tr>
<th>Conductor Size</th>
<th>B (33 KV)</th>
<th>B (22 KV)</th>
<th>B (11 KV)</th>
<th>C (33 KV)</th>
<th>C (22 KV)</th>
<th>C (11 KV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.16 cm²</td>
<td>-</td>
<td>-</td>
<td>3.5</td>
<td>-</td>
<td>-</td>
<td>72.0</td>
</tr>
<tr>
<td>0.19 cm²</td>
<td>0.348</td>
<td>0.784</td>
<td>3.14</td>
<td>6.06</td>
<td>13.5</td>
<td>54.5</td>
</tr>
<tr>
<td>0.26 cm²</td>
<td>0.300</td>
<td>0.676</td>
<td>2.72</td>
<td>3.81</td>
<td>8.54</td>
<td>34.4</td>
</tr>
<tr>
<td>0.39 cm²</td>
<td>0.260</td>
<td>0.586</td>
<td>2.34</td>
<td>1.96</td>
<td>4.5</td>
<td>18.0</td>
</tr>
<tr>
<td>0.48 cm²</td>
<td>0.246</td>
<td>-</td>
<td>-</td>
<td>1.40</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>0.65 cm²</td>
<td>0.229</td>
<td>-</td>
<td>-</td>
<td>0.87</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Table 7.1 Calculation Of Fault Current – Values Of B & C**

7.2.4 Minimum Permissible Separation:

The minimum permissible separation in meters can be read off directly from the graph given at figure 7.4, against the product of fault current and length of parallelism in Amp./Km. Separate curves have been given for soil resistivities of 5000, 10000, 20000 and 50000 Ohm / Cm².
7.2.5 Transposition of Power Wires:

If in actual installation it is not possible to maintain the minimum permissible separation, transposition of the power lines need be considered by the Elecl. Dept.

![Fig. 7.5 Minimum Permissible Separation](image)

7.2.6 Extract of Telecom. Manual - Article 528:

Annexure - Para 528 (a) of Telecom. Manual.

- The minimum clearance between low and high tension power wires and telecommunication wires shall be as given in Annexure Para (528).

- The minimum separation between the power line and the parallel telecomm line shall be such that in the event of either of the lines falling down, the wires of the two lines will not come in contact.

- In localities where heavy storms are prevalent, poles (over 15 M in height and important terminal pole) which are not shielded from closely adjacent trees or buildings shall be equipped with lightning rods.
Para 77:
1. Clearances between LT Power and Communication Lines:

<table>
<thead>
<tr>
<th>Minimum Vertical Clearance</th>
<th>I</th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum vertical clearance between the bottom-most power cross-arm and fittings and the topmost communication cross-arm and fittings.</td>
<td>1220</td>
<td>1380</td>
<td>1980</td>
</tr>
<tr>
<td>Minimum vertical clearance between power &amp; communication wires at the pole.</td>
<td>1380</td>
<td>1525</td>
<td>2130</td>
</tr>
<tr>
<td>Minimum vertical clearance between communication wires and ground wire on the power line</td>
<td>1070</td>
<td>1070</td>
<td>1070</td>
</tr>
</tbody>
</table>

Table 7.2 Telecommunication & Power Line On Common Pole

I – Low & Medium Voltage Lines – Clearance in mm
II – High Voltage Lines upto including 7.2 KV – Clearance in mm
III – High Voltage Lines above 7.2 KV and upto and including 12 KV – Clearance in mm

7.2.7 Low And Medium Voltage Power Line:

1. Minimum clearance between insulated power line and telecom wires : 915mm
2. Minimum clearance between guard wire on power line support and telecom wires: 915mm
3. Minimum clearance between guard wire on telecommunication line supports and power line: 1220mm

7.2.8 The minimum Clearance Between High Tension Up to 132 KV Power Wires And Communication Wires:

- For voltages above 36 KV upto and including 72.5 KV: 2440 mm
- For line of voltages above 72.5 KV - upto & including 145 KV: 2740 mm
- For lines of voltages above 145 KV - upto and including 245 KV: 3050 mm.
- For lines of voltages above 245 KV: 3050 mm + 305 mm for every addl. 33 KV or part thereof.
Objective:

Fill up the blanks with suitable words:

1) The telecommunication line shall cross ___________ the power lines.
2) The power lines should cross telecommunication lines at _________angle.
3) The guard wires are shall be properly ___________.
4) During normal functioning of power line, or electric traction system, the longitudinally induced voltage in telecom circuits should not exceed ________V.

Subjective:

1) What is the effect of power lines on Telecommunication lines? How the Telecom lines are guarded from them?
2) What precautions to be taken while providing guarding for high tension power lines?
3) Explain how low telecommunication lines are guarded from low tension power lines?
4) Explain how guards are provided oh Telecommunication lines?