भारत सरकार - GOVERNMENT OF INDIA
रेल मंत्रालय - MINISTRY OF RAILWAYS

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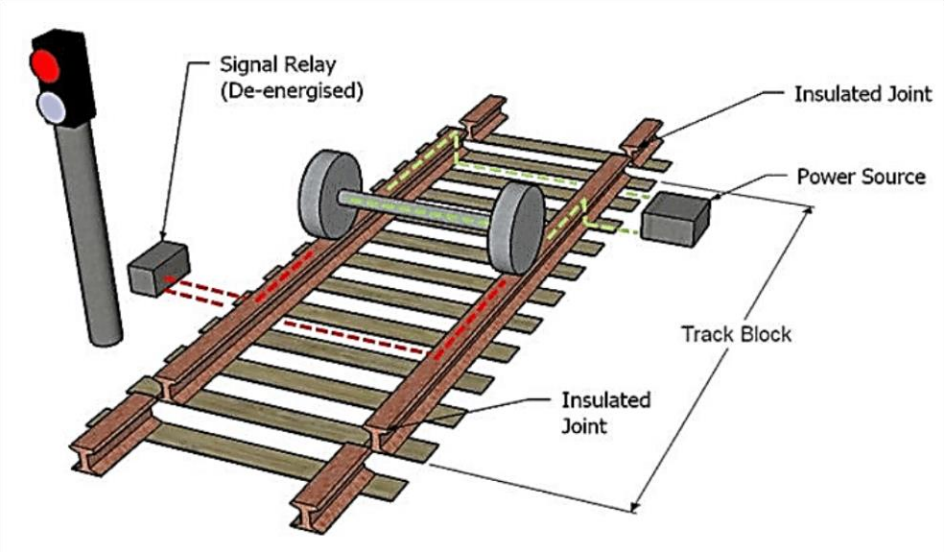
Basics

of

Track Circuit

for

P. Way Staff



CAMTECH/CP-02/2023-24

August-2023

End User: JE/SSE/P.way & Track Maintainer

Maharajpur, Gwalior (M.P.) – 474005

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FOREWORD

The track circuit is a vital signaling and safety mechanism that helps control train movements, track occupancy, and provides essential information to the railway infrastructure. It is an integral part of the signaling system, enabling precise monitoring and control of train movements, thereby enhancing the safety and efficiency of the railway network. By providing real-time information on track occupancy, these circuits enable safe and reliable train operations, minimizing the risk of collisions and ensuring the smooth flow of traffic across the network.

CAMTECH has prepared this Handbook to "Basics of Track circuits for P.way staff", so that P. Way Staff can take due care of it while maintaining the track.

I hope that the information given in this handbook will be quite helpful to the personnel associated with maintenance of track in Indian Railways and taking preventive measures to avoid safety hazards.

CAMTECH, Gwalior **JITENDRA SINGH**

Date: August 2023 **Principal Executive Director**

PREFACE

A Track circuit is an electrical device that is used to detect the presence of a train on a railway track. It works by passing an electric current through the rails of the track from power source (battery) at one end and relay at the other end of the track circuit. The track circuit is typically connected to a signaling system, which can then control signals, switches, and other railway equipment to ensure safe train operation. When a train enters into the track circuit, it gets short circuited through wheels & axles and it suitably indicates the occupation of track. Since a number of components of track circuit are on/near the railway track and some of these are maintained by Pway staff, it is of paramount importance that pway engineers/ staff must have a basic knowledge of track circuits.

In view of the above, CAMTECH has prepared Handbook on "Basics of Track circuits for P.way staff". Apart from general safety precautions, this handbook also covers Components of Track Circuit, Requirement, Applications and types of Track circuits etc.

It is expected that the document will be highly useful to Track maintenance staff and SSE/JE/P. Way of Indian Railways and it will result into better maintenance practices in Track circuited sections.

The document is not statutory & its contents are only for the purpose of knowledge dissemination. Most of the data & information in some form or the other are based on literature available and internet search. For more in-depth information/knowledge, the relevant detailed literature, IRPWM, IRSEM, GJM, IRICEN/RDSO literature, etc. as available on the subject may be referred to.

Since technological upgradation and learning is a continuous process, you may feel the need for some addition/modification in this handbook. If so, please give your comments on email address dircivilcamtech@gmail.com or write to us at Indian Railways Centre for Advanced Maintenance Technology, Maharajpur, Gwalior (M.P.) 474005.

CAMTECH/Gwalior **(Deepak Mehra)**

August, 2023 **Director/Civil**

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ISSUE OF CORRECTION SLIPS

The correction slips to be issued in future for this handbook will be numbered as follows:

CAMTECH/2023/C/PW-TC/1.0/CS # XX date_____

Where “XX” is the Serial number of the concerned correction slip (Starting from 01 onwards).

CORRECTION SLIPS ISSUED

S.No.	Date of Issue	Page No. and Item No. modified	Remarks

1.0 Introduction

Track circuit was first invented in the year 1872 in U.S.A. by William Robinson. Since this arrangement was very simple, nobody would have thought that the track circuit would make such an impact on signalling. Track circuit has become one of the most important safety devices in Railway signalling and has become an essential and integral part of modern signalling systems.

In Railways, Train operation is done with collective efforts of all technical departments viz. Engg./ P. Way, S&T ,Electrical, & Mechanical. Hence for proper coordination, staff of each department should also have a bare minimum Knowledge of other departments. This booklet is prepared to Provide basics knowledge of DC Track circuit (maintained by S&T Department) to P. Way staff so that they can maintained P. Way assets while keeping the Track circuit & other S&T assets protected.

2.0 What is Track Circuit

The presence of a vehicle in a particular section is checked by passing an electric current through the rail from one end. If the current reaches the other end, then the track is clear. If any vehicle remains in the section, the wheels and axles of the vehicle will short circuit the current and prevent it from reaching the other end. Since the current is passed through the rails and rails form an electrical circuit, this arrangement is called ***'Track Circuits'***.

A track circuit gives two indications on the Indication panel installed at Station Master's Room.

(a) Yellow/White/No light indication: When track circuit portion is clear i.e. when line is Unoccupied.

(b) Red indication: When track circuit portion is occupied by a vehicle or Track Circuit isin fail condition.

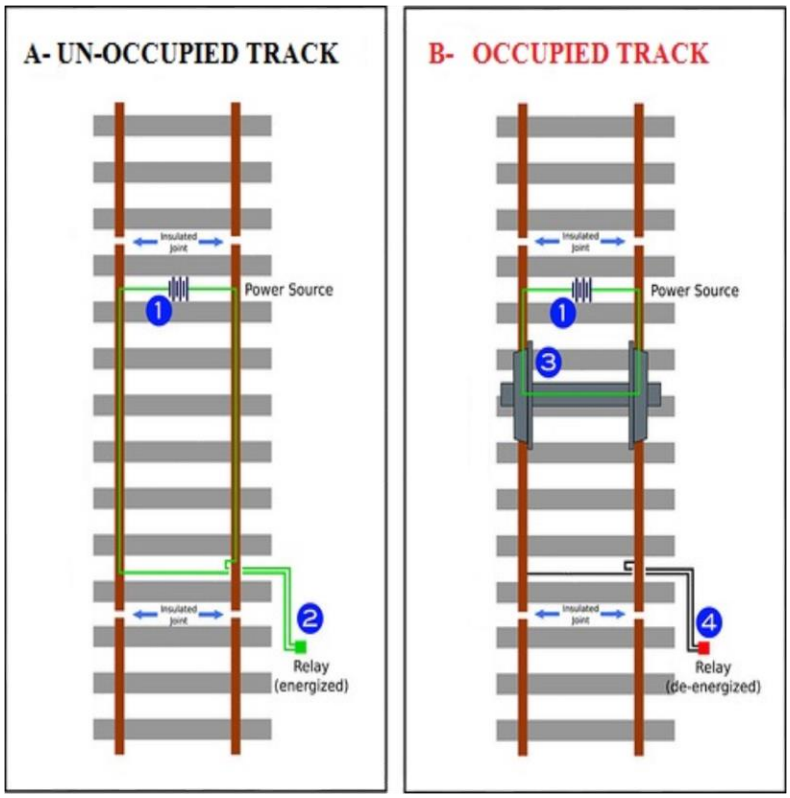


Fig-1: Track Circuit

Apart from Track Circuits (DC/AC/AFTC) Train detection can also be done by installing Axle Counters.

Minimum Length: The length of a track circuit shall not be less than the maximum wheel base of any vehicle. The Track circuits shall cover at least two rail lengths (26 meters). (*As per para 17.1.1 (c) of IRSEM-2021*)

Inspection: The regular inspection and testing of track circuit shall be done by Signal staff. Joint inspection of track circuit shall be done ***once in six months*** not below the rank of JE/SSE of signal and engineering department. (*As per para 17.3.9 of IRSEM-2021*)

3.0 Components of Track Circuits

The track circuit consists of the following components :-

3.1 Rails

The railway tracks themselves act as the conductors for the electrical current used in the track circuit. The rails form a continuous closed-loop electrical path throughout the track circuit.

3.2 Sleepers

The sleepers used in the track circuits should be of an insulating type viz. wooden or concrete sleepers. Cast iron or steel sleepers can not be used in track circuited section as they would directly short circuit the rails.

3.3 Insulated Rail Joints

To ensure that the flow of current is restricted to a particular section, insulated joints are provided at both ends of the section. Two types of these joints are presently in use:

i. Nylon Insulated Rail Joints (Block Joints)

In this type, insulation components are supplied by the S&T department, which have to be inserted in the rail joint when Track Circuit is being installed and also whenever they get crushed resulting in insulation failure. To prevent failures under normal conditions, Block Joint insulation is checked electrically by means of a multimeter by the S&T staff according to a time schedule.

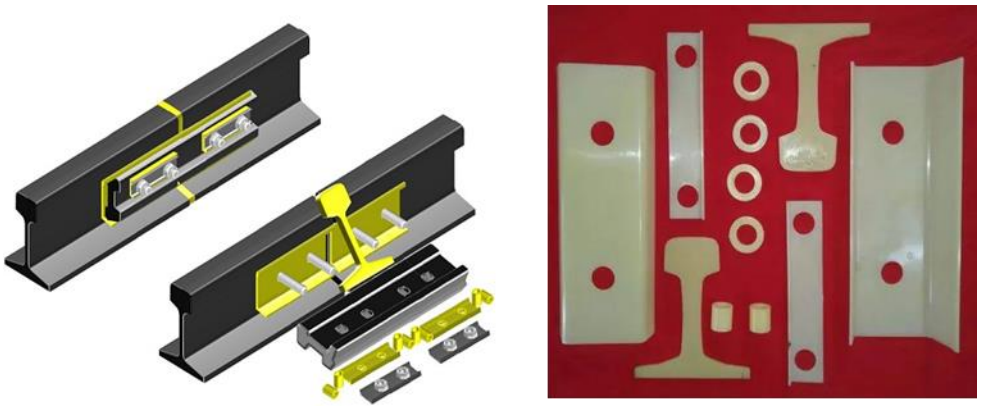


Fig-2: Nylon Insulated Rail Joint

The metallic components of the rail joints as supplied by the Civil Engineering Department for this purpose are not the usual ones. The fish plates are planed so as to accommodate insulation liners between the rails and themselves. The fish bolts have to be of 140 mm length instead of 115 mm. Also, four steel backing plates have to be provided for support over the nylon backing plates held by fish bolts.

ii. Glued Joints

These are having more mechanical strength to retain insulation and to withstand rail creep. The joints are fabricated in a workshop in 6.5 m Length and transported to the site for insertion in the track. Laying of these joints involves Civil Engg. Works viz. distressing of welded rails, welding of the joints into running track etc. The insulation is provided by special type of insulating side channels, bushes andend posts made of fiberglass cloth roving.

3.3.1 Glued joints are of two types

(a) G3L type consisting of 6 bolts are for use in LWR/CWR track.
(b) G3S type consisting of 4 boltsarefor use in fish plated track as well as in SWR track.



Fig-3: Insulated Glued Joint

3.4 Bond Wires

The fish plates do not provide reliable electrical connection and hence they are bridged by two mild steel wires to get good a electrical connection. These wires are called bond wires.



Fig-4: Bond wire

3.5 Battery

The current is passed by means of battery (4 V) at one end and current is regulated by a resistance.

3.6 Track Relays

The current at the other end is sensed by a device called Relay. This is an electromagnetic device, the relay remain energized when track is clear due to the current flowing through the relay. But when a vehicle occupies a track circuit, most of the current is diverted through the wheel and axle of the vehicle and very little current flows through the relay. Hence the relay will be de-energized. It is possible to control the signal as well as indicate the occupancy of a track through the relay contacts. A red indication is given when the track is clear. Since normally the track is clear, the relay remains in the energized position. The relay used in track circuits is of a special design compared to the conventional electrical relay. A conventional relay works with a current or no current. But a relay used in track circuit has to sense a drop in current. Since we can not positively say that the current through the relay will be reduced to zero value when a wheel and axle occupies a track circuit, when the current through the relay reduces to 32% of the normal current, the relay should get de-energized. Such relays are called relays with high percentage release.



Fig-5: Track Relay

3.7 Signalling Equipments

The track relay signals are processed and interpreted by signaling equipment, which includes control panels, signal cabins, and electronic control systems. The signaling equipment manages the information received from multiple track circuits along the railway line and coordinates the safe movement of trains accordingly. It controls the signal aspects (red, yellow, green lights) displayed to train drivers and manages train speed restrictions to ensure safe train operations.

3.8 Train Wheel and Axles

While not a direct component of the track circuit itself, the metal wheels and axles of a train play a crucial role in its functioning. When a train enters a block covered by the track circuit, the metal wheels and axles provide an alternate path for the electrical current, causing a drop in current flow and triggering the track relay to indicate the presence of the train.

4.0 Requirement of Track Circuits

There are two very important requirements of track circuits - one concerning the **safety aspect** and the other concerning the **reliability**. The ideal condition of a wheel and axle occupying track circuit is causing a dead short circuit across the rails. Normally, the resistance offered by wheel and axle of a train is about 4 to 5 milli Ohms which is almost zero. However, it is very essential to provide some factor of safety. Hence our, track circuits are designed in such a way that even when wheel and axle offers a resistance of 0.5 Ohms, the relay would be able to sense it. This provides a factor of safety of (500/0.5 = 100). ***This resistance of 0.5 Ohms is called Train Shunt Resistance***.

Sometimes a track circuit will show as occupied though the track is clear. This is due to the continuous leakage of current through the ballast especially under wet and poor drainage conditions. This affects the ***reliability*** of a track circuit. It is stipulated in Signal Engineering Manual that the ***Ballast Resistance should not be less than 2 ohms/km in station section and 4 Ohms/km in block sections***.

5.0 Applications of Track Circuits

5.1 To Prove the Track Occupancy

The main application is to prove that a particular section is clear of vehicles. The track circuits in a station is normally done under three priorities.

First priority is for track circuits between fouling mark to fouling mark on the run through/main line.
Second priority is for track circuits between Home Signal to Fouling Mark and Fouling mark to Advanced Starter.
Third priority is for providing track circuits on loop lines.

5.2 Automatic Replacement of a signal

A small track circuit of 3 rails length (60 m) is provided ahead of Last Stop Signal (LSS) so that as soon as the train occupies this track circuits, the LSS signal is replaced to On. This small track circuit is called FVT (First Vehicle Track). This arrangement is required to ensure that only one train can enter the block section with the clearing of Last Stop Signal.

5.3 To indicate clearance of block overlap

A small track circuit of 3 rails length (60 m) is provided at the block overlap limit from First Stop Signal. When the train occupies and clears this track circuit, an indication is given in ASM's Office to inform the arrival of a train. The ASM/SM must ensure complete arrival of the train by checking the tail lamp/LV Board. This small track circuit is called Last Vehicle Track.

5.4 Route Holding

Wherever electrical operation of point is provided, track circuits are used to hold the route. The track circuits will be provided over the point portion. When the first point is occupied, it will not be possible to operate the point.

5.5 Fouling Protection

Track circuits are also provided over point portion with mechanically operated points and lock bar to ensure that the fouling mark is clear. This will help to prevent side collision of two trains, whenever there is an infringement of fouling mark.

5.6 Automatic Warning for LC Gate

Track circuits are also provided in rear of the level crossing gates at a distance of about 2 kms so that when the trains occupy the track circuits, the gate-men will get a warning to close and lock the gate before the train approaches the gate signal.

5.7 Approach Lighting of Signals

It is also possible to light the signals only when the train is approaching by having track circuits at a distance of 4 kms from the signal. The signals are lit up only if this track circuit is occupied by a train. This arrangement will help to reduce energy consumption.

5.8 Broken Rail Detection

Track circuits can help detect anomalies like broken rails or rail discontinuities. If there is a break in the rail or a poor electrical connection, it will affect the track circuit's ability to transmit a continuous electrical current, indicating a potential issue that needs attention.

6.0 Types of Track Circuits used in Indian Railways

(a) AC Track Circuits

Generally, AC Track Circuits are used in DC Traction Area (1500 V DC), but now DC Traction is withdrawn in Indian Railways working, Hence AC Track Circuit is obsolete.

(b) DC Track Circuits

A DC track circuit has mainly two ends i.e. feed end and relay end.
In DC Track Circuit, feed is connected at one end of the track with track feed charger and battery and the relay at the other end, which is normally kept energized. Track Relay drops when shunted by a Train or any other vehicle arrived on that portion of Track.

(c) Audio Frequency Track Circuits (AFTC)

Audio Frequency Track Circuit (AFTC) is a joint-less Track circuit, uses audio frequencies fed to track, to detect the presence or absence of a train.

6.1 Types of DC Track Circuits

i. Based on normal status of track relay

1. **Open Track Circuit:** The Open Track Circuit is a normally de-energised track circuit. The circuit gets completed when the track is occupied through the net resistance of the vehicle axles occupying the track circuit. This not used currently as any break in connection goes undetected which is unsafe.
2. **Closed Track Circuit:** Closed DC Track circuit is used on Indian railways which is normally in energized condition and de-energises when occupied by a vehicle or train.

ii. Based on use of one rail or both rail for passage of track circuit current

1. **Double rail track circuit used in Non- RE areas:** Double rail track circuit is to be provided on Non RE areas, as far as practicable. In double rail track circuit both the running rails are insulated from adjoining sections by insertion of block joints.
Simple Double Rail Track Circuits for Non-RE Area is shown in figure below:

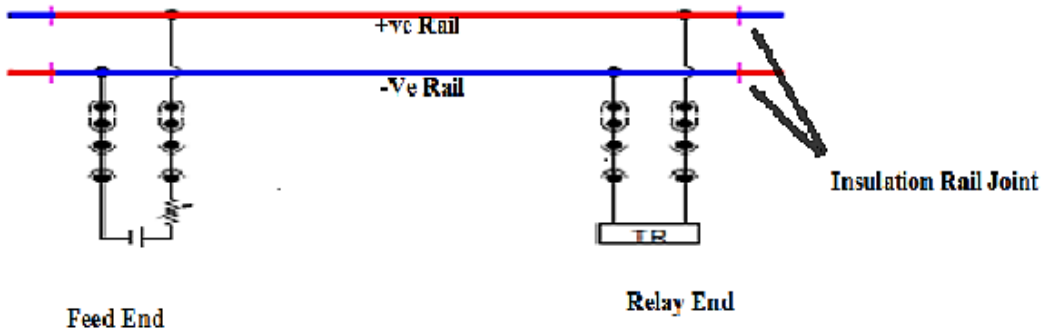


Fig-6: Double Rail Track Circuits for Non-RE Area

2. **Single Rail Track Circuits for RE Area:**

- In RE area (Electrified Section), single rail track circuit is used where one of the rails is reserved for the traction return current. This rail is referred to as the un-insulated rail.
- Any connection from the OHE mast or other structure shall be made only to the un-insulated rails.
- Similarly, connections for the return current at feeding points as well as from booster transformers and return conductors shall be made only to the uninsulated rail.

- Other rail carries positive polarity of DC track circuit. This positive polarity rail is insulated from either side.
  A schematic diagram of a 'DC Track Circuit' (Single Rail Track Circuits) is shown in Fig:

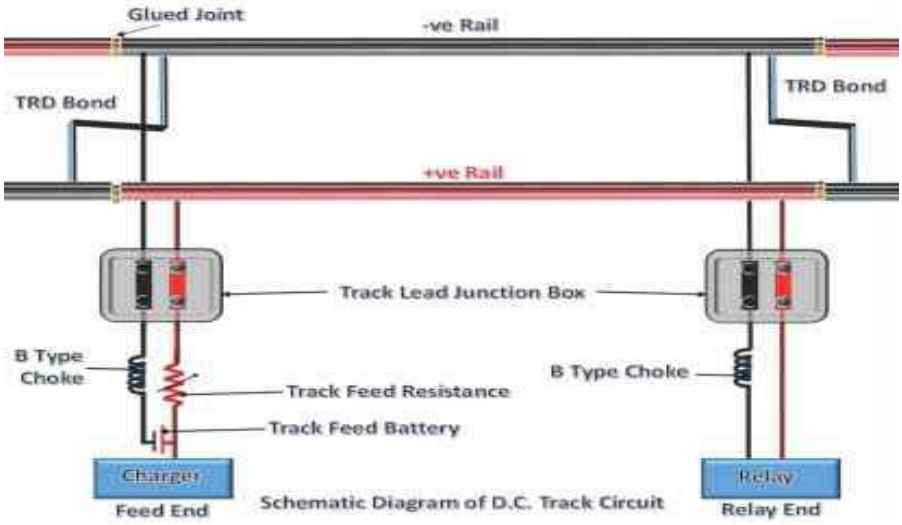


Fig-7: Single Rail Track Circuits for RE Area

6.2 Audio Frequency Track Circuit (AFTC)

Audio Frequency Track Circuit (AFTC) is a joint-less Track circuit, uses audio frequencies fed to track, to detect the presence or absence of a train.

Since, DC track circuit had certain disadvantages, So, Audio Frequency Track Circuits (AFTC) were developed to overcome the effect of AC induction in AC electrified tracks on conventional DC track circuits and also to avoid insulation block joints on tracks for bifurcation of track circuit sections.



Fig-8: Audio Frequency Track Circuit (AFTC)

6.2.1 Advantages of AFTC

- AFTC can be universally used in AC, DC and Non-RE sections.
- Electrical separation joints define AFTC geographical boundaries.
- No insulation joint is required except in point zone where adjacent AFTC is from different manufacturer or type of track circuit changes. Thus dependency on other departments is minimized.

- AFTC has built-in time delay for picking up its relay hence separate slow to pick up TPR (QSPA1 Relay) is not required.
- Not affected by harmonics generated by Thyristor controlled locomotives as it uses FSK/MSK principle for signal transmission.
- Both rails are available for traction return current.
- Suitable for longer length track circuits.
- Suitable for IB and Automatic Signalling section.
- Added safety with modulation (coding).
- Remote feeding up to 3 km possible.

6.2.2 Classification of AFTC

a) As per type of modulating signal

i. **Non-coded:** In this type of AFTC, the modulating signal is not coded.
ii. **Coded:** In this type of AFTC, the modulating signal is bit coded with digital message.

As bit coding of modulating signal enhances the safety, coded type track circuits are preferred over the non-coded type.

b) As per feeding arrangement

i. **Locally fed:** In this arrangement, Transmitter Tx, Receiver Rx, Power supplies to Tx and Receiver Rx and relay are kept in trackside location boxes. Track repeater relay is only kept at relay room.
ii. **Remote fed:** In this arrangement, Transmitter Tx, Receiver Rx, Power supplies to Transmitter Tx and Receiver Rx and relay, all equipments are kept centrally in AFTC room, while tuning units are kept in trackside location boxes.

7.0 Arrangement at Feed End Junction Box

At Feed end, incoming Track Circuit supply is fed by battery.

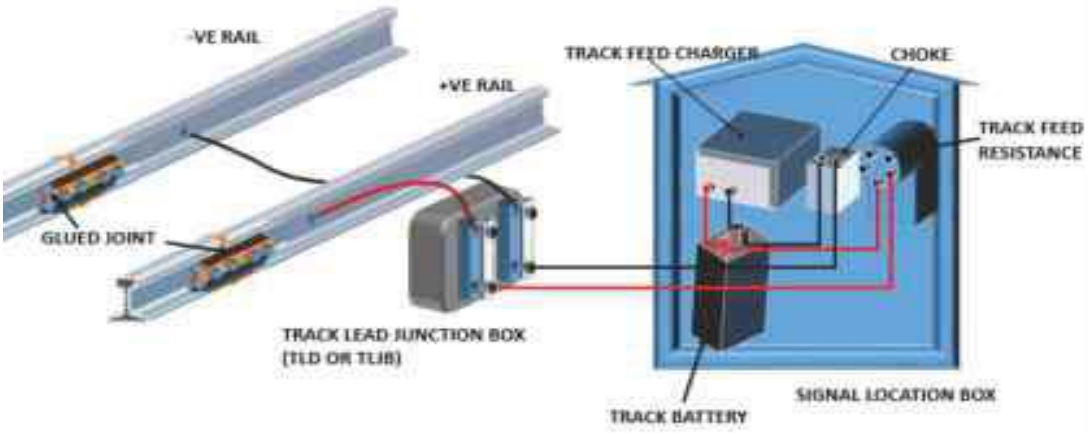


Fig-9: Arrangement at Feed End Junction Box

8.0 Arrangement at Relay End Junction Box

At Relay End, Track Circuit supply is received and Track Relay is kept energized.

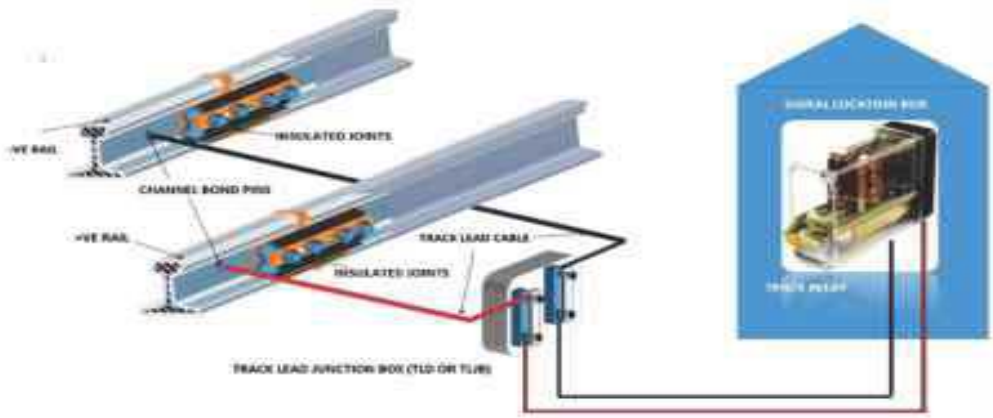


Fig-10: Arrangement at Relay End Junction Box

9.0 Track Lead Junction Boxes

These are the track cable termination boxes situated very near to the track. Track Circuit is provided with two track lead junction boxes, one at feed end insulation joint and another at relay end insulation joint. Jumpers are used for connecting track feed to rails from feed end junction box. Similarly, jumpers are used for connecting rails to relay end junction box. Cable from power source and feed end jumpers are terminated in feed end junction box. Similarly cable from track relay and relay end jumpers are terminated in relay end junction box.

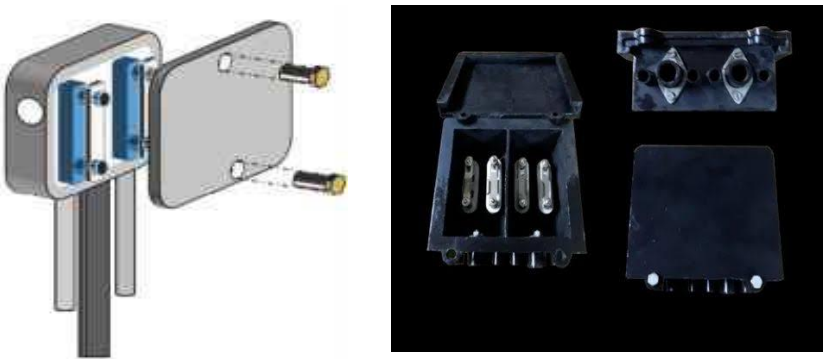


Fig-11: Track Lead Junction Boxes

10.0 Track Lead Cables

2 core, 2.5 Sq mm armored cables are used between Signal location box to Feed/Relay End track led junction boxes. This cable carries track supply.

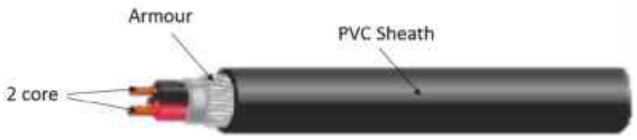


Fig-12: Track Lead Cables

11.0 GI Wires

The fish plates do not provide reliable electrical connection and hence they are bridged by two Galvanized Iron 8 SWG (Standard Wire Gauge) wires to get good electrical connection. These wires are called as bond wires used from track continuity bonding in Track Circuited area.

12.0 Factors Affecting DC Track Circuits

12.1 Ballast Resistance, R_B

- Ballast Resistance is the net resistance of various leakage paths across track circuit rails offered by ballast and sleepers.
- Ballast resistance is inversely proportional to length of Track circuit and it also varies with the condition (Dry/Wet) of the ballast and soil.
- Ballast resistance reduces with increase in the length of track circuit as there are more leakage paths in parallel.
- Clean ballast offers high resistance (low leakage). Water across the tracks causes leakage. So Ballast Resistance falls during rainy season.
- A good drainage is essential to avoid water logging and for maintaining ahigher ballast resistance.
- Periodical screening of the ballast is not only necessary to improve the strength oftrack bed but it also improves the track circuit ballast resistance.

12.1.1 Minimum permissible Ballast Resistance for Track Circuits

Minimum Ballast Resistance should not be less than (As per *IRPWM Para no.662 (2) (h)*)

Station Yard/Block Section	Minimum permissible Ballast Resistance per Kilometre Length
In Station Yard	2 Ohms
In Block section	4 Ohms

12.2 Rail resistance,R_R

- Rail resistance, **R_R** is the net resistance offered by the rails and continuity bonds at Rail. Rail resistance increases with increase in length of Track Circuit.

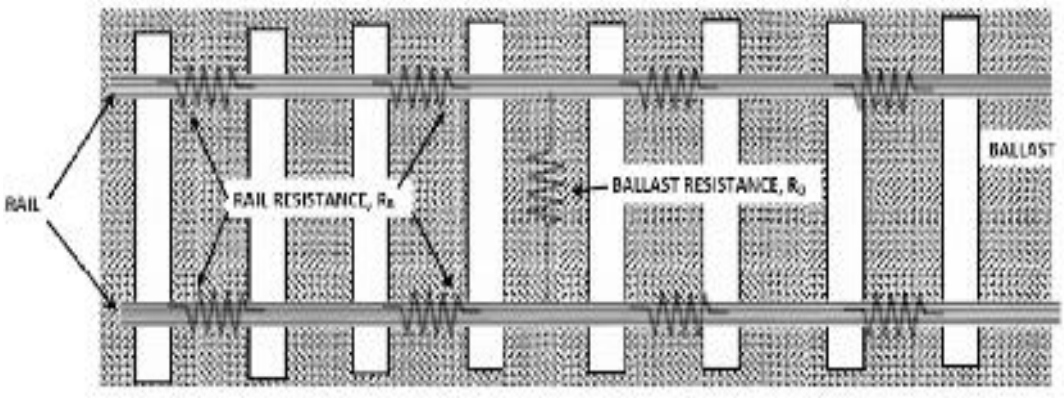


Fig-13: Rail Resistance

12.2.1 Maximum Permissible Rail Resistance Should not exceed

Track Circuit length	Maximum permissible rail resistance per Kilometre
Up to 700 m	1.5 Ohms
More than 700 m	0.5 Ohms

Note: *Generally, the Track Circuit length is limited to 700 m Clear Standing Room (C.S.R) length within station yards. Outside the station sections, Track Circuits may be longer.*

12.3 Resistance Offered by PSC Sleeper

- Measurement shall be made with a sensitive Multimeter of not less than 20 KW/Volt resistance of coil. **Megger should not be used.**
- After cleaning a spot on the surface of each insert, measurement shall be made between inserts A & B, A&C, A &D, B & C, B & D, and C&D. The lowest of these readings shall be considered the sleeper resistance.

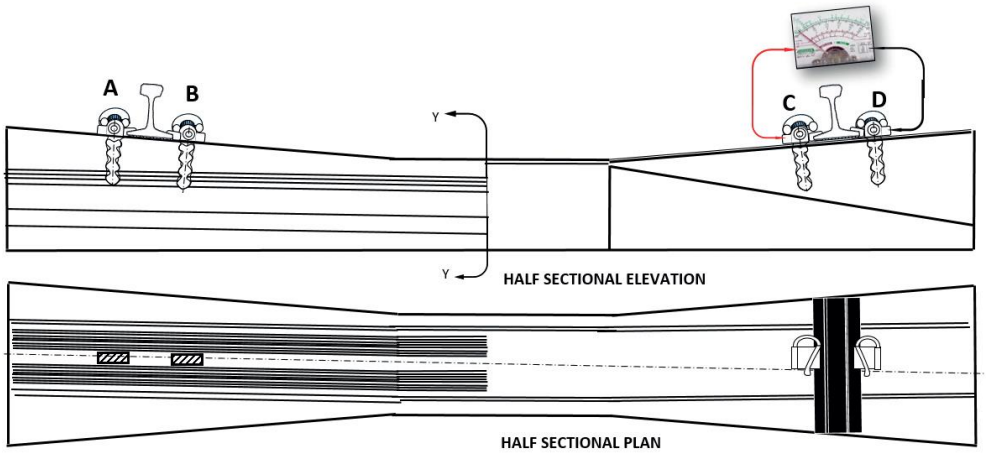


Fig-14: Measurement location at PSC Sleeper

12.3.1 Minimum Permissible Resistance of a Concrete Sleeper

Type of Area	Minimum Permissible Resistance of a Concrete Sleeper
In Non - RE and AC RE area	500 Ohms after six months from the date of manufacture.
In DC RE area.	800 Ohms for Single Rail Track Circuits of up to 200 m length and Double Rail Track circuits of up to 400 m length.
	1000 Ohms for Single Rail track circuits of more than 200 m length and Double Rail Track circuits of more than 400 m length.

Note:

- *Wherever PSC Sleepers are used, availability of insulated liners up to a minimum level of 97% shall be ensured. (As per IRPWM Para no.662 (2) (h)).*
- *GFN liners shall be provided in the track circuited area using concrete sleepers. (As per IRPWM Para 210 (5) (b))*
- *Rubber pads are also provided at both ends of PSC sleepers below rail.*



Fig-15: GFN Liner and Rubber Pad



Fig-16: Railway Track with GFN Liner and Rubber Pad

12.4 Track Lead Cables Resistance

Voltage drop in the Track Lead Cables shall be kept within limits so as to work sufficiently long Track Circuits with minimum power application.

Generally, feed equipment is kept in location boxes very close to the Track Circuits to get better track voltages with minimum applied source. But longer track lead cables at the Relay End cannot be avoided at way side stations because of the need to keep the Track Relays in the cabins and avoid thefts. Track Circuit may fail due to poor insulation resistance of track lead cable too. So these cable shall be tested by insulation tester (400 V). Insulation resistance of any kind of signalling cable shall be ***less than10 Mega Ohms***.

12.5 Train Shunt Resistance, TSR

This is the maximum value of resistance, which when applied across the track, drops the track relay. For DC track circuit, the minimum permissible value of TSR is ***0.5 Ohm.*** A higher value of TSR > 0.5 Ohm is always desirable to detect any vehicle such as Motor Trolley, Light engine, Full train provided the wheels and rails are not in rusty condition.

12.6 Continuity Rail Bonding

- The fish plates do not provide reliable electrical connection and hence they are bridged by two Galvanized Iron 8 SWG (Standard Wire Gauge) wires to get good electrical connection. These wires are called as bond wires used from track continuity bonding in Track Circuited area.
- To fix a pair of bonds at each rail joint, holes are drilled on the rails with a 7.2 mm drill bit. The bond wire ends are inserted in these holes and channel pins are driven to hold them tight. Two bonds are used together so as to get lesser bond resistance at the joints.This also ensures that one of these bonds at least is always secured.
- Two types of channel pins are in use. One has only one grove to hold bond wire. The other one has two groves so that two wires can be held by the same pin.
- Two bond holding clamps called ‘Bond Wire Protectors’ fixed on the fish bolts of joint as shown in fig. ensure that the bond wires do not loose-hang, swing under the train and get entangled with any hanging part of vehicle. The bond wire protector shall also ensure clearance of bond wires from the inserts to prevent track circuit failure during defective sleeper.

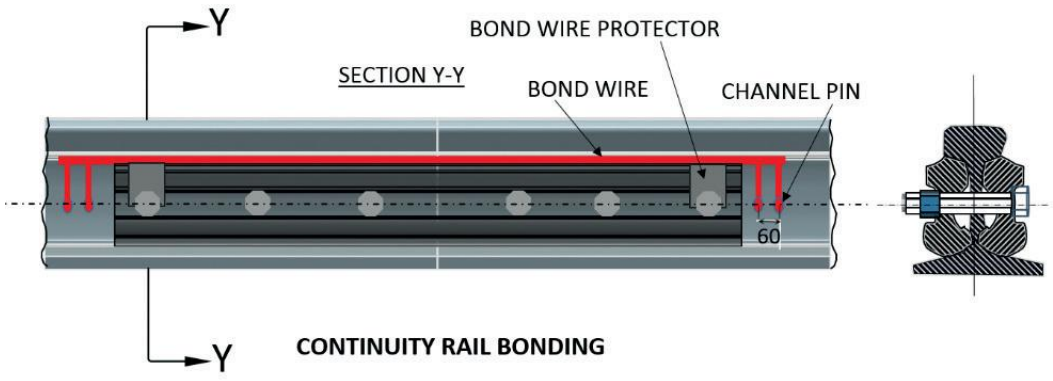


Fig-17: Continuity Rail Bonding

- In addition to these 'Continuity Rail Bonds', in RE areas, traction power department also provides high current capacity bonds at the rail joints for traction return current passage. bonds also can serve the purpose of Track Circuit continuity in negative rails. But their becoming loose or breaking at one or two places does not affect traction as much as it fails the Track Circuit. Hence, providing of rail bonds by the S&T department is considered essential at all places.

Note: *Traction bands are provided only in negative rail in DC track circuit territory.*

- Following bonds must be checked on every visit for their good condition, intactness and rigid connection with rail to avoid the possibility of high resistance:

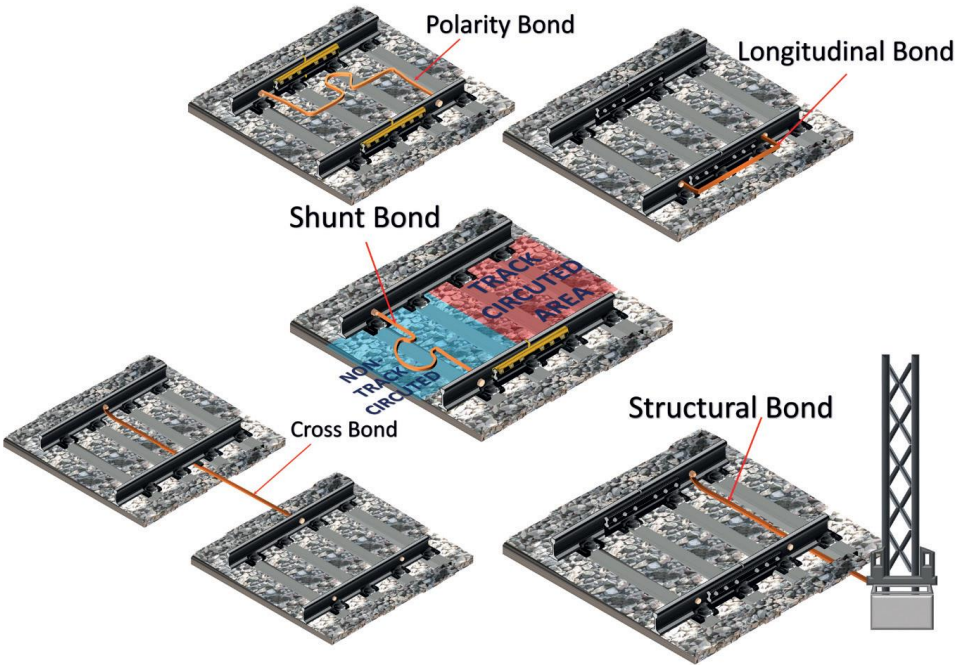


Fig-18: Different types of Traction Bonds

12.7 Insulated Rail Joints

12.7.1 Procedure for Joint inspection of Glued Joint in field

To prevent in service failure, the glued joint shall be inspected jointly by Engineering & Signal Departments at SSE/JE level at least ***Once in three months***.

i. For New Glued Joints:

- Some loss in insulation resistance is expected during loading, unloading, transportation and multiple handling at the site before installation. Before installation, the insulation resistance of a new glued insulated joint shall not be less than ***10 Mega ohms*** which is measured using an insulation tester of 100 V DC. Insulation should be tested across the end post as well as between fish bolts and the rails on either side of the rails. Good quality insulation tester duly calibrated by appropriate test house shall only be used for measurement of insulation resistance. Measurement of insulation of all glued joints shall be done jointly before installation.
- ERC-J Clip and end cut liners should be used at glued joints (as well as Nylon Insulated joints) to avoid contact of clip with the fish plates.

- Only ***FTC*** sleepers shall be used in track circuited areas. The sleeper spacing under glued joints shall be same as that of intermediate sleepers.
- At least ***10 sleepers*** on either side of the glued joints shall be properly packed to the correct level.
- Proper squaring of the glued joints shall be ensured. The glued joint shall be centrally located over adjoining sleepers as far as possible.

ii. Inspection of In-Service Glued Insulated Joints:

- Good quality insulation tester duly calibrated by appropriate test house shall only be used for in-service inspections.
- As glued insulated joints should behave as monolithic unit, there should not be any relative movement between rails and fish plates or separation of rail/fishplate surface and insulation. In case where glued insulated joints do not behave as monolithic unit and insulation resistance is not as para (III) below, the same should be replaced on priority.
- Insulation of glued joints shall be checked in dry condition at a frequency of at least ***Once in three months (Quarterly)***. Insulation condition of fish bolts with respect to rails shall be assessed by measuring insulation between fish plate/fish bolt and rail on either side of the joint. If the insulation is found to be less than ***1 Mega Ohms***, it shall be planned for replacement of glued joint within ***15 days***. However, if the insulation is found to be less than ***3 Kilo-Ohms***, it shall be replaced on priority within ***3 days***.
- A faulty glued joint may be checked by taking voltage readings across the track relay terminals. Any change in faulty reading when the adjacent track circuit feed is shunted or disconnected will indicate faulty insulation joints. Reasons for the same should be analysed and corrective action be taken in such case. Appropriate action shall be taken for replacement of glued joint as per the criteria given in para (III) above.
- The replacement of glued insulated joints, wherever required, will be done by Engineering department. The Signal staff as required for connection/reconnection and testing shall be provided at site.
- Metal overflows/burrs if any, on the rail table at the joints shall be removed skilfully by Engineering staff in presence of S&T staff for avoiding any damage to end post so that ends do not bridge with each other and cause a track circuit failure. It shall also be ensured that during removal of metal overflow/burrs, no dent/notch is formed in the rail.
- Any iron flakes or brake block dust accumulated at the glued joint or on adjacent rails shall be brushed off by the S&T staff so as to avoid possibility of electrical conductivity.
- The sleepers and fastenings at Glued insulated joints shall be ensured in proper and effective condition. Proper ERC should be used. Any missing/or incorrectly used ERC shall be replaced.
- The ballast in track in the vicinity of the glued joints shall be clean to ensure proper packing and efficient drainage. It shall be ensured that the ballast is clear off rails and rail fastenings. The clearance from the under side of rail to ballast shall normally not be less than 50 mm of the glued joint.
- It shall be ensured that spacing of sleepers under glued joints is same as that of intermediate sleepers. End post location shall be centrally placed between two sleepers as far as possible and in no case it should be on the sleeper.
- During inspection, glued joints should be closely observed for any loose/broken/missing bolts, fish plate cracks and rail end batter. Suitable corrective action should be taken in time.
- Proper records of all joint inspections of glued joints and actions taken there after shall be maintained in registers at station as per system prevailing on zonal railways.

12.7.2 Maintenance of Nylon Insulated Joints

- Before opening an insulated rail joint, the components required for replacement, conforming to the rail section, shall be kept ready by the side of the track.
- For replacement of an end-post when there is no gap at the Insulated Rail Joint, loosen the rail fastening and pull back the rail and insert end-post between the rail ends.
- It is imperative that when an insulated rail joint is provided at least ***three sleepers*** on either side of the insulated rail joint shall be packed properly.
- Fish bolts shall be kept tight. Nuts shall be tightened several times during the first two weeks after installation/replacement, until all components of an insulated rail joint are firmly set.
- A metal flow is seen often at the rail-table at the joints. Such metal flow of metal forms a lip and creates sharp burrs at the rail ends. Projections formed at the rail ends shall be chiseled without damaging the end post so that these do not bridge the rail expansion gap and cause a short circuit.
- Brake block dust, which may accumulate on the head and sides of the end post and top surfaces of the fish-plates, shall be brushed off frequently so that the possibility of electrical conductivity being established between the rail ends is eliminated.
- Opening & fixing of fish plates of Nylon insulation joint for installation/replacement of joint shall be done by Engineering Department.
- Special type pandrol clips ('J' type) shall be provided at Nylon insulation joints/glued joint to avoid touching of pandrol clip with the fish plate.
- Periodic coating by insulating varnish/epoxy over the nylon-insulated joint/glued joint to avoid shorting due to brake dust shall be done.

13.0 Safety Precautions in Track Circuited Areas

13.1 General Maintenance of Signalling Fixtures in Track

- No signal fixtures/installation/ cables should be allowed to be fixed on or near track beween railway boundary without approved drawings.
- No signal fixtures/installation, which interfere with maintenance of track should be provided on track unless the approval for same is available from Track Directorate of RDSO or Railway Board.
- S&T Department shall provide adequate number of personnel for opening of signal rod, signal gears, other installations etc. to facilitate mechanized track maintenance.

13.2 Safety Precautions to be taken by P. Way Staff

- JE/SSE/P.Way should instruct the staff not to place across or touching two rails in the track, any tool or metal object which may cause short circuiting.
- All gauges, levels and trolleys used in the track-circuited length should be Insulated. Track circuited area shall be free of vegetation.
- Steel or C.I. pipes used for carrying water/gas under the track should be run sufficiently below the rails to prevent any short-circuiting.
- Use of steel tapes should be avoided in track-circuited section.
- Sleeper should be avoided below joint of insulation rail joint or glued joint.

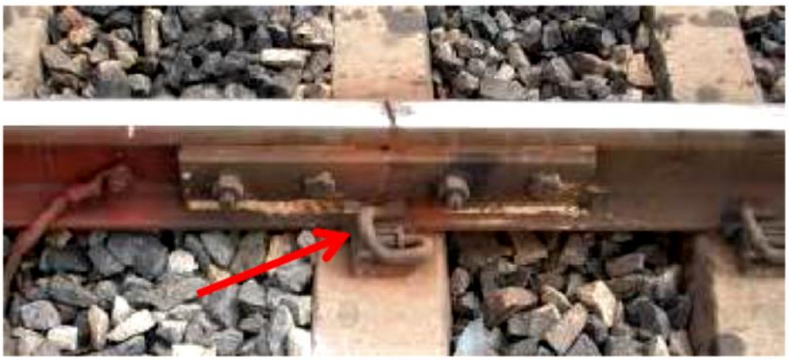


Fig-19: Sleeper below joint

- While carrying out the track maintenance, various S&T/Electrical installations should be got removed, wherever they interfere with the maintenance activities so as not to cause any damage of track circuit fittings like rail bonding wires, lead wires to rails, boot leg, jumper wires etc.
- Sleepers edge from insulation joint must be 4.5" so that dog spikes/pandrol clip may not short the insulation.



Fig-20: Sleeper below joint

- Where staggering cannot be avoided the distance between staggered joints shall not exceed the minimum wheel base of the vehicles.
- Rail ends of glued/insulated joints shall be square and true. All rough edges and burrs shall be removed from bolt holes. Battered ends shall be put right and the gap between the rails should be equal to the thickness ofthe end post.
- Fish bolts at the joints must be kept tight and the sleepers well packed inthe vicinity of the joints.
- To avoid crushing of end posts of insulated rail joints due to creep, at least one rail length on either side of insulated joint should be provided with anti creep devices.
- Pulling back of running rails in track should be done in track-circuited areas in the presence of S&T staff, where signalling connections are involved.
- Rail ends shall be kept free from brake-dust, dirt, sand, rust, other foreign materials etc. All rough edges and burrs at rail ends must be removed.



Fig-21: Cleaning of insulation joint with brush

- Proper drainage should be ensured so as to avoid flooding of track, during rains, particularly in yards, where watering of coaches is done. It would be desirable to provide washable concrete aprons on platform lines at originating stations in track-circuited areas.
- Ballast shall be kept clean throughout the track-circuited section and care should be taken to see that the ballast is kept clear off the rails and rail fastenings. The clearance from the foot of the rail should not be less than 50 mm. Well screened ballast right up to the formation level shall be provided. Any hole drilled in the rail for providing S&T fixtures should be at the neutral axis of the rail and chamfered.
- In track circuited sections and in yards where change in yard layout is contemplated notice should be given to the Signalling Department for getting assistance in executing joint works. Advance Notice as laid down by the respective railway should be given to the Operating Department of the actual commencement of work by the JE/SSE/P.Way, for sending advice to all concerned. The safety of traffic is of Paramount consideration.
- All the PSC sleepers are tested for electrical resistance at the time of manufacture, and sleepers are marked by paint with "**FTC**" to indicate **Fit for Track Circuiting** and "**NFTC**" to indicate **Not fit for Track Circuited** location. This shall be noted while using the sleepers at site.
- GFN liners shall be provided in the track circuited area using concrete sleepers.
- In case of turnouts and crossings, insulated stretchers, insulated gauge tie plates and insulated crossing plates shall be provided as per approved drawings. Care should be taken to see that the ballast is clear of rails and rail fastenings.



Fig-22: Insulation in point zone track circuit

- Where short welded rail panels are used, SWR shall not butt against insulated joint. Two rail lengths of 13 meters/12 meters shall be interposed to isolate short welded rail from insulated joint. This standard length of rails shall be anchored effectively to arrest movement in either direction.

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6. Booklet on Foundation Course (FC_Vol-II) by NAIR, Vadodara.
7. Technical Specification for Re-Furbishing of Existing Glued Insulated Rail Joints and in-situ Fabrication of Glued Insulated Rail Joints (Provisional) by RDSO – Jan-2020.
8. https://railsystem.net/track-circuit/

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12.	Rail Maintenance to Reduce Rail Deterioration
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9.	Handbook on Safety precautions at work-site adjacent to track
10.	Pamphlet on Destressing of LWR
11.	Pamphlet on Quality Assurance Planning for manufacturing of PSC Sleepers

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