

NOTES ON

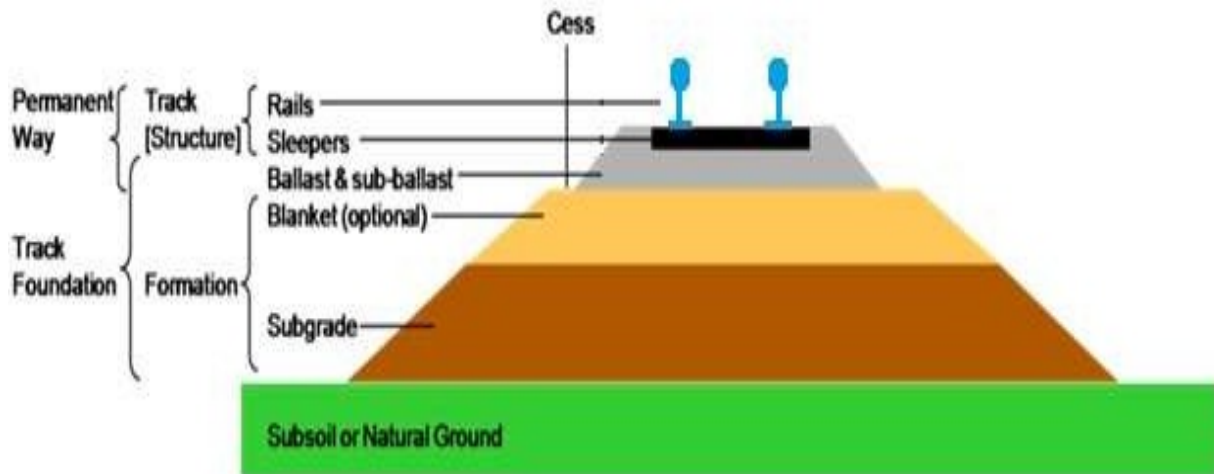
PERMANENT WAY



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COURSE MODULE Course No. CE 31: Refresher SSE/JE Duration:2Weeks Effective Days:12				
S. N.	CM No.	Subjects	Periods	Total Periods
1	31.5	P.Way, Establishment, Stores & Accounts		4
		Constituents of Railway Track, Points& Crossings, Curves, IRPWM Provisions on Regular Track Maintenance.	1	
		Provisions on Works incidental to Regular Track Maintenance, Maintenance of Track in Track Circuited Areas & Electrified Areas & Precautions during Machine working in Electrified Areas	1	
		Categorioes of Engineering Works, Engineering Fixed Signals/Indicators: Temporary and Permanent; Emergency Protection of track: Single Line & Double Line, Detonators & Flare Signals	1	
		HOER, Leave, Pass, D&AR & Conduct Rules. Stock heads of Accounts, Disposal of released and surplus materials, Indenting procedure, Issue note and Write-off statement. Stock verification and Inventory Control Technique.	1	
		Total	4	4

1. RAILWAY TRACK:

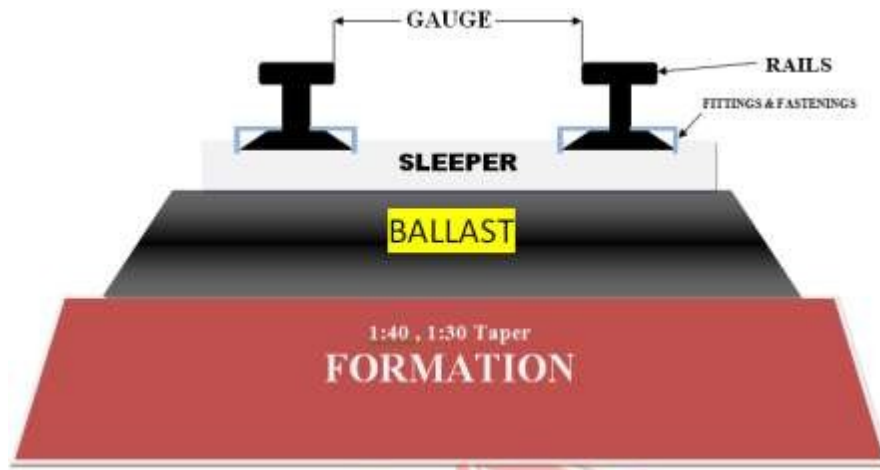


It is a rail road on which the train runs.

It is also called permanent way. It basically consists of two parallel rails having specified distance in between them and fastened to sleepers which are embedded in the layer of ballast, which is spread over formation.

Rail are joined to each other longitudinally by fish plates by end to end and fastened to sleeper by various fittings. Sleepers are placed at a specified distance and are held in position by embedding in the ballast.

Track Gauge:



The perpendicular distance between inner faces of rail is called gauge. It is measured 13mm below from rail top. The Indian Railways operate in three different gauges mainly Broad Gauge (1676mm), Meter Gauge (1000mm), and Narrow Gauge (762mm & 610mm) wide. The broad gauge accounts for nearly 94.6% followed by meter gauge 3.1% of the total route length. The gauge of track in India is measured as the minimum horizontal distance between the running or gauge faces of two rails 14mm below from top of rail. The standard gauge is 1435mm

DIFFERENT GAUGES ON INDIAN RAILWAY:

(i) B.G. (broad gauges)	:-	1676 mm
(ii) M.G.(Meter gauges)	:-	1000 mm
(iii) N.G. (Narrow gauges)	:-	762 mm
(iv) Special Narrow Gauge	:-	610 mm
(v) Standard Gauge	:-	1435 mm (Foreign Railways)

2. COMPONENTS OF TRACK:

Following are the main components of the track:-

- (1) Rails
- (2) Sleepers
- (3) Fitting & Fastenings
- (4) Ballast
- (5) Formation

3. REQUIREMENT OF GOOD TRACK:

A permanent way or track should give comfortable & safe ride at maximum permissible speed with minimum cost. For achieving the above objectives a good permanent way should have the following characteristics:-

- (i) The gauge should be correct and uniform.
- (ii) The rail should have uniform and perfect cross-level.
On curve outer rail should have proper super – elevation to take an account of the centrifugal force.
- (iii) The alignment should be straight and free of kinks. In case of curve proper transitioning should be provided between straight and curve to give smooth ride.
- (iv) The gradient should be uniform and as gentle as possible.
The change of gradient should be followed by proper vertical curve.
- (v) The track should be resilient and elastic in order to absorb shocks and vibrations of running trains.
- (vi) The track should have good drainage so that the stability of the track is not affected due to water logging.
- (vii) The track should have good lateral strength, so that it can maintain its stability due to variation of temperature and other factors.
- (viii) There should be provision for easy replacement and renewals of various track components.
- (ix) The laying & Maintenance cost of track should be low.
- (x) It should be antitheft type & shall be free from sabotage.

CLASSIFICATION OF ROUTES:

Broad Gauge Routes:

All the B.G. routes of Indian Railways have been classified based on speed criteria as given below:

(A) Group ‘A’ Lines:

These are meant for a sanctioned speed of >130 & up to 160 KMPH. In this category, the following lines fall:

1. New Delhi – Howrah – by Rajdhani Exp. Route.
2. New Delhi – Bombay – By Frontier Main or Rajdhani Route.
3. New Delhi – Chennai Central – By Grant Trunk Route.
4. Howrah – Mumbai VT - via Nagpur.

(B) Group ‘B’ Lines:

These are meant for a sanctioned speed >110 & up to 130 KMPH.

(C) Group ‘C’ Lines:

These include suburban section of Mumbai, Delhi, Chennai and Kolkata

(D) Group ‘D’ Lines:

These are meant for a sanctioned speed up to 110 KMPH

Classifications of M.G. Routes

Depending upon the importance of route, traffic carried and maximum permissible speed M.G. routes are classified in three categories as Q.R. and S. routes.

(1) ‘Q’ Routes:

These routes consist of routes where the max^m permissible speed will be more than 75 Kmph. And the traffic density will be more than 2.5 GMT. Max^m speed do not exceeds 100 Kpmh.. As Bangalore - Miraz route.

(2) ‘R’ Routes:

These routes will have a speed potential of 75 Kmph. and the traffic density will be more than 1.5 GMT. Routes have further been sub-divided into 3 categories depending upon the volume of traffic as follows:

- (a) R₁: Where the traffic density will be more than 5 GMT.
- (b) R₂: In between 2.5 GMT to 5 GMT
- (c) R₃: 1.5 GMT – 2.5 GMT

(3) ‘S’ Routes:

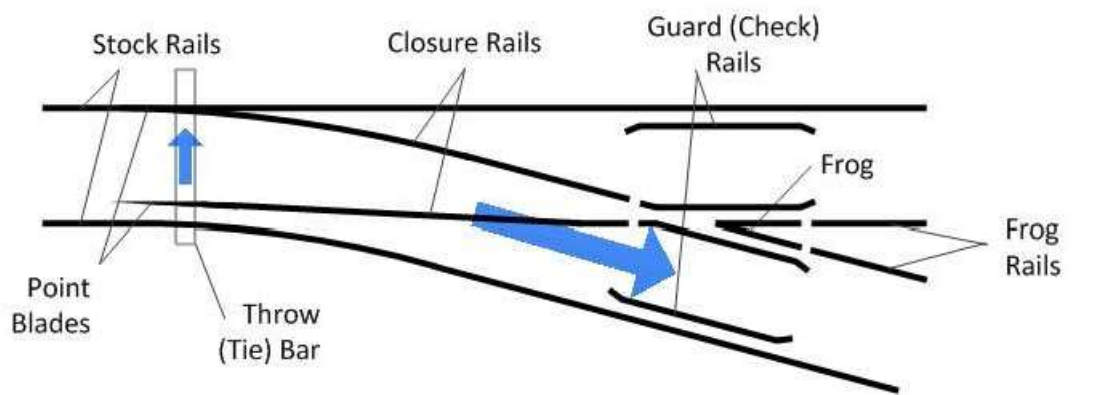
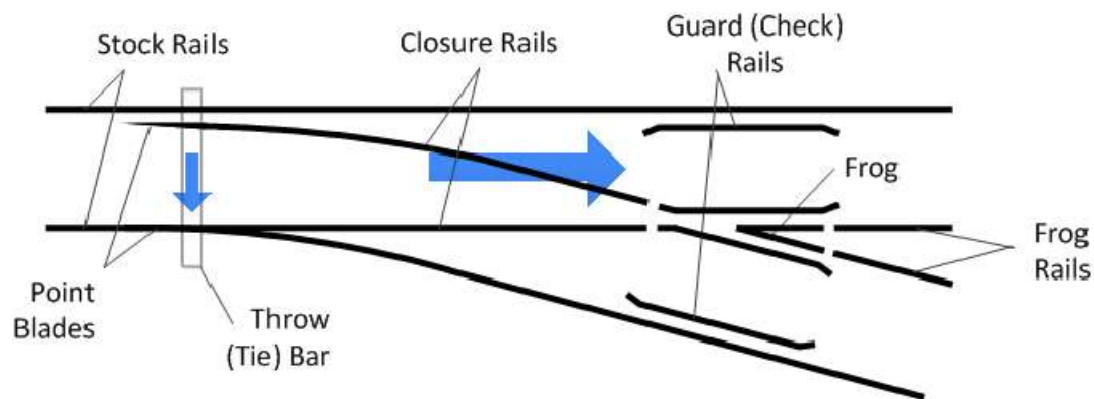
These routes will be the routes where speed potential will be less than 75 Kmph. and where the traffic density is less than 1.5 GMT. These will consists of other routes which are not covered in „Q“, „R₁“, „R₂“ and „R₃“ routes. S“ Routes have been further subdivided into 3 routes as S₁, S₂ and S₃ etc.

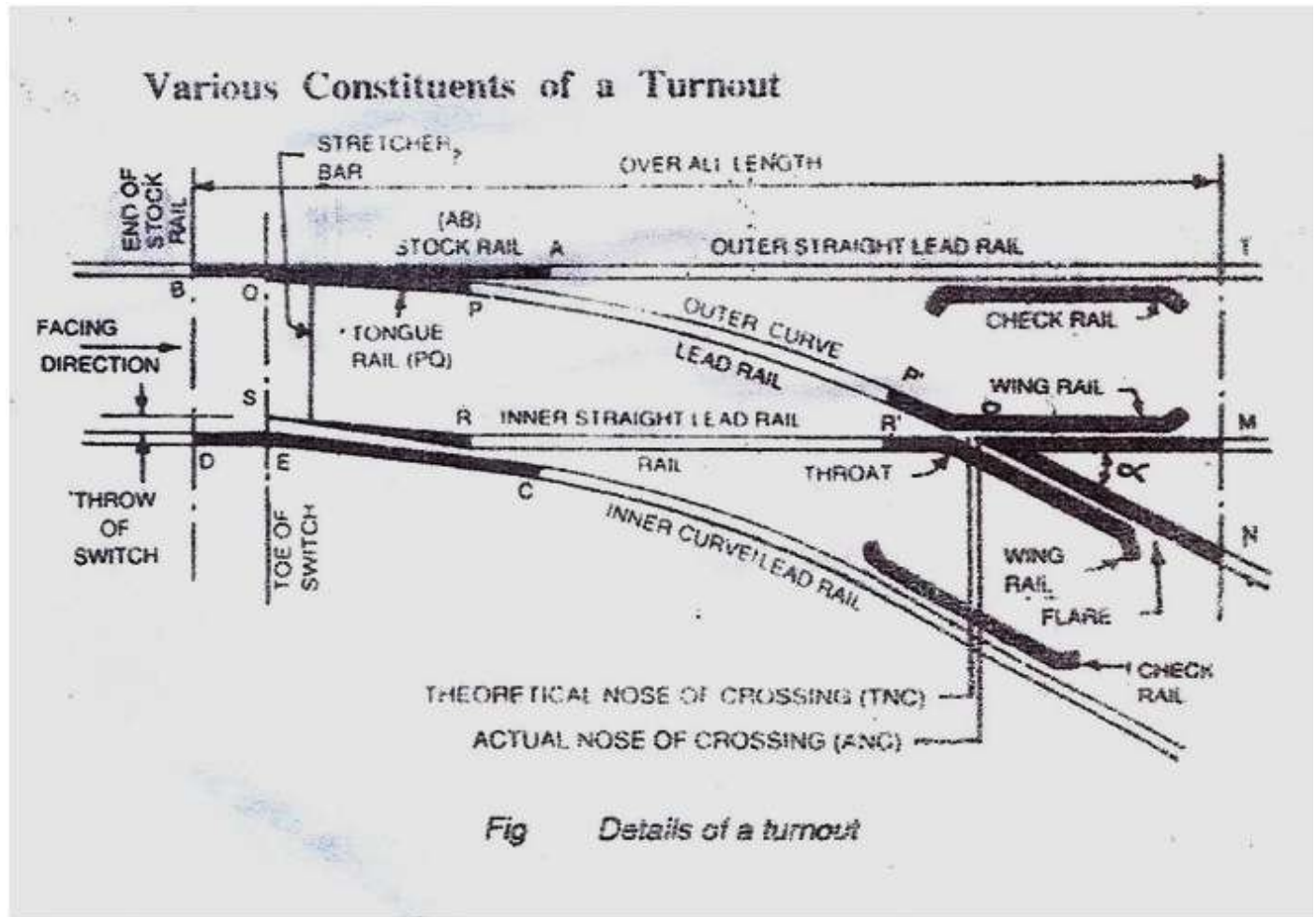
POINTS & CROSSING

Necessity of Point & Crossing

Point & Crossing i.e. turnout are necessary due to following reasons:

1. On single line track to give path to trains coming from both directions.
2. In double line, to give path to faster train against slow train coming from same direction
3. To connect the places which are not lying on main line
4. To place/direct the passenger train to platform line (or) goods train to yard line for stay





SOME IMPORTANT DEFINITIONS OF POINTS AND CORSSING:

Tongue Rail:

It is the tapered movable rail made of high carbon and manganese steel to withstand wear whose thicker end is connected with running rail/ lead rail. Some time it is also known as Switch Rail.

Stock Rail:

It is the running rail in which the tongue rail is housed.

Switch:

A pair of tongue e rail with necessary connections and fittings forms a switch.

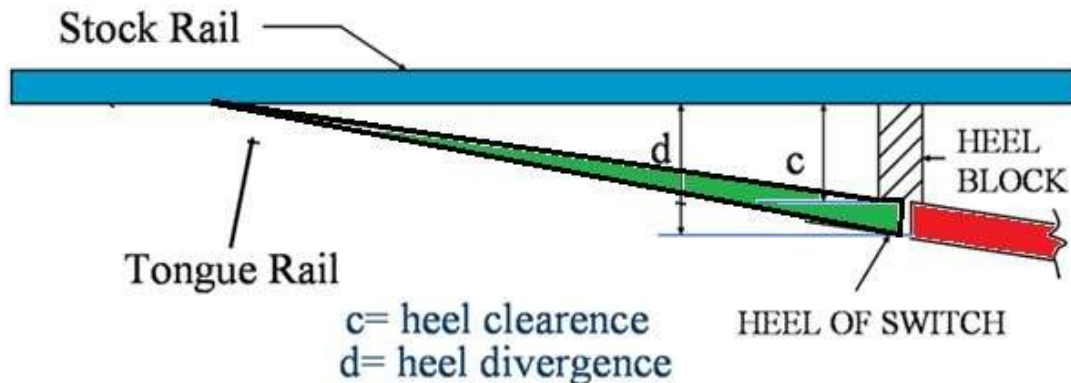
Point:

A pair of tongue rails and a pair of stock rails with necessary connections form a point.

Heel of Switch:

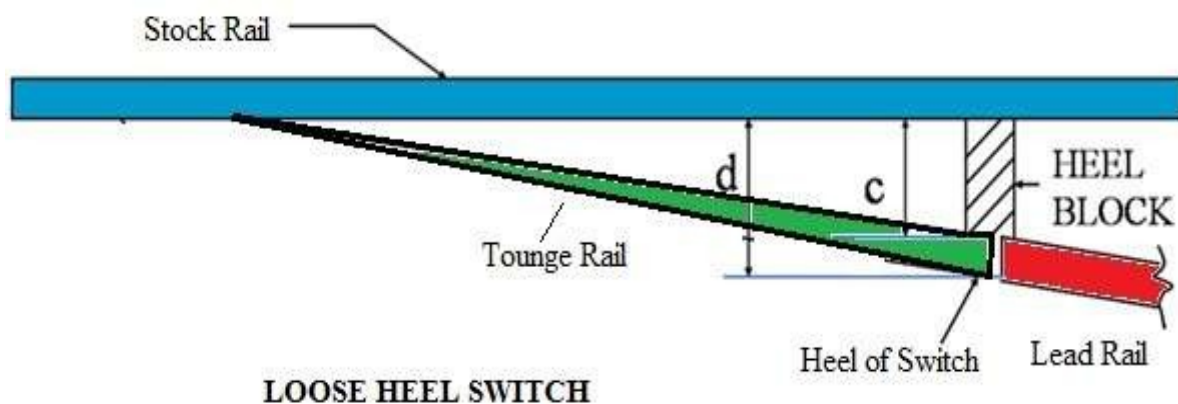
Heel of Switch is an imaginary point midway between the end of the lead rail and tongue rail in case of “loose heel switch.”

In case of fixed heel switches it is the point at the center of the heel block itself



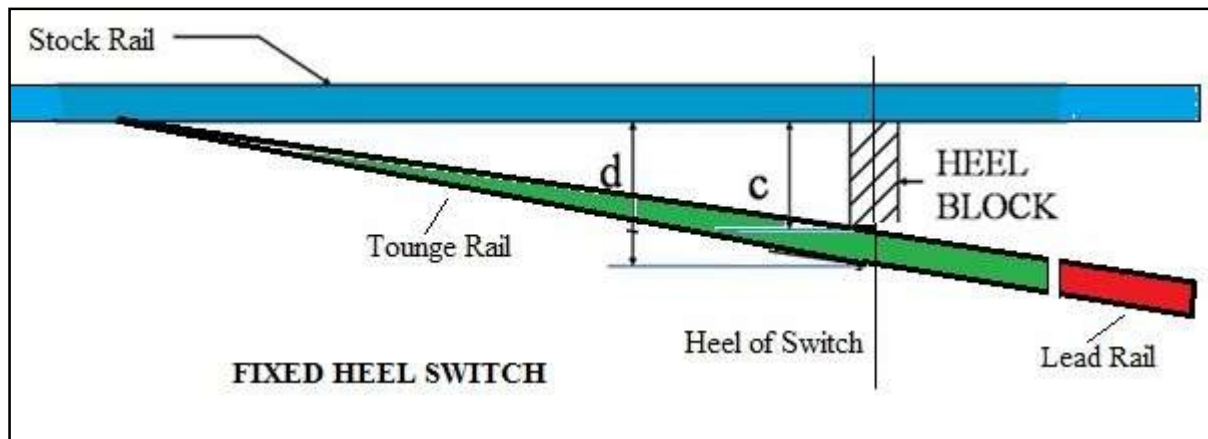
Loose Heel Type:

In this type, the switch rail or tongue rail finishes at the heel of the switch. In order to enable the free end of the tongue rail to be moved, two front bolts of the heel block are kept loose.



Fixed Heel Type:

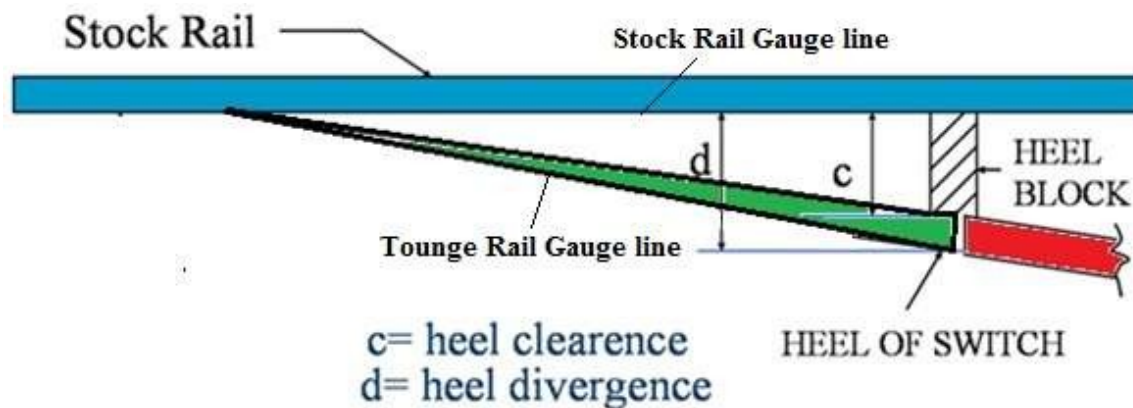
In this type of switch, tongue rail does not end at heel of the switch, but it extends further. The movement of the tongue rail is made on account of the flexibility of tongue rail by increasing its length.



Heel Divergence:

The minimum distance between gauge line of stock rail and gauge line of tongue rail at heel of switch is called Heel Divergence.

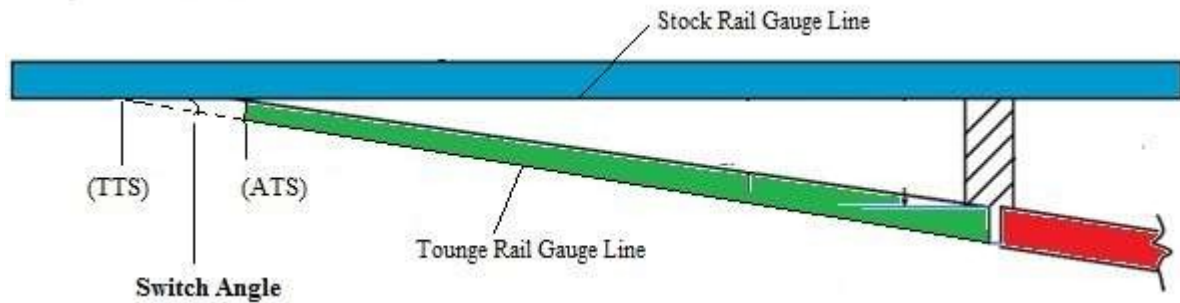
In other words it is the clearance between stock rail and running rail at HOS plus head width of tongue rail



Switch Angle:

It is the angle between the gauge lines of stock rail and tongue rail at theoretical toe of switch (TTS) in close position. This angle depends upon heel divergence and length of tongue.

In case of curved switches it is called as “Entry Angle”.

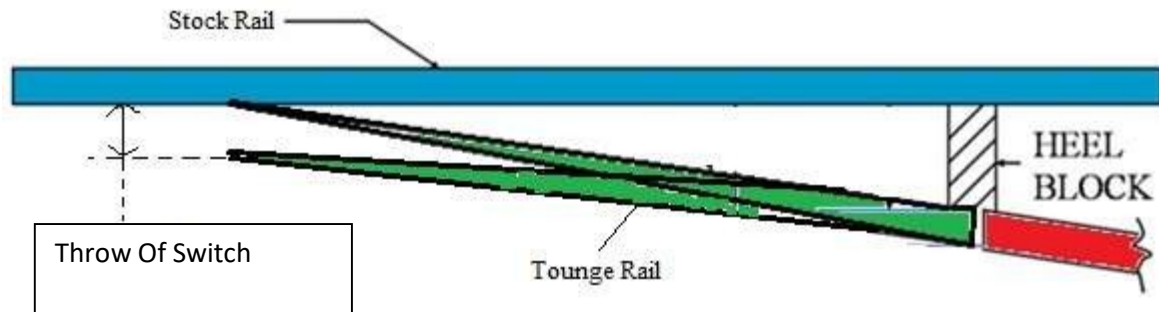


Note: In case of curved switches it is the angle between gauge lines of stock rail and tangent drawn at actual toe of gauge line of tongue rail. Hence it is called “Entry Angle”.

The various switch angles in BG Track are as given below:

1 in 8 ½	Straight Switch	1°-34'-27"
1 in 12	Straight Switch	1°-8'-0"
1 in 8 ½	Curved Switch	0°-47'-27"
1 in 12	Curved Switch	0°-27'-35"

Throw of switch:



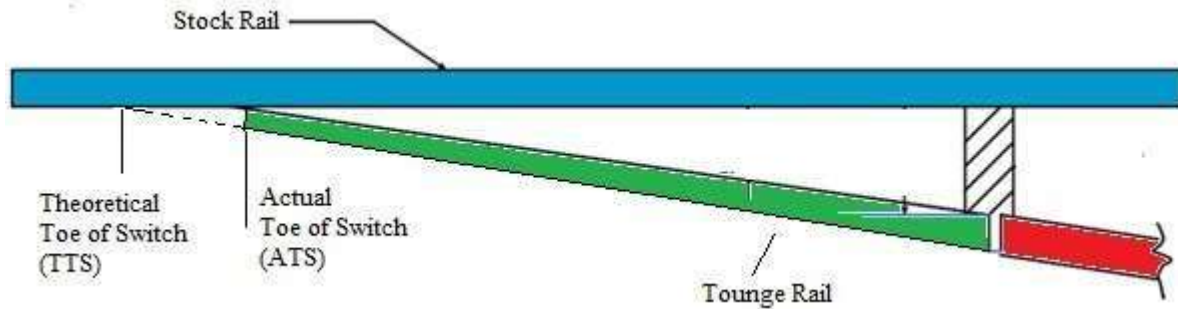
It is the distance moved by a tongue rail against stock rail at Actual Toe of Switch (ATS) at the time of making path to either side.

As per Schedule for Dimension (SOD) the maximum and minimum value of switch is as under following.

Track	Maximum Value in mm	Minimum value in mm
Broad Gauge	115	95
Meter Gauge	100	89

Toe of Switch or Actual Toe of Switch (ATS):

Thin tapered end of tongue rail is called Toe of Switch or Actual Toe of Switch (ATS).

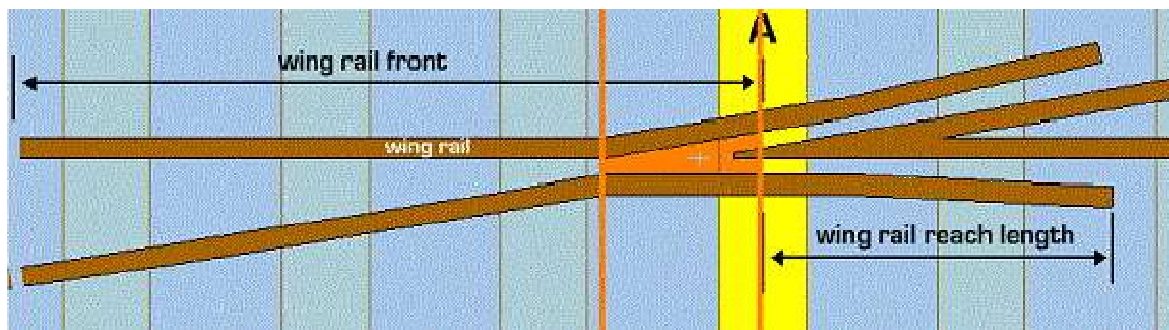


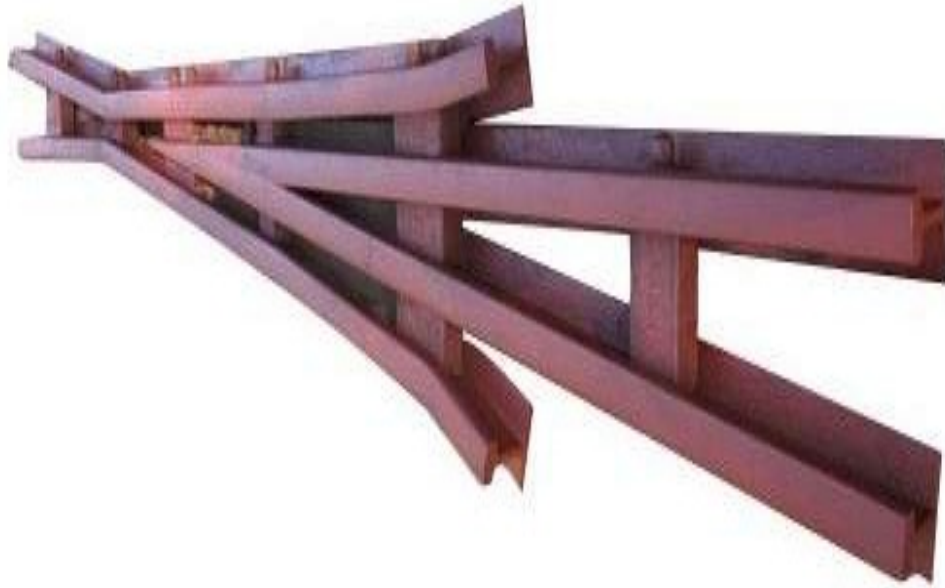
Theoretical Toe of Switch:

Theoretical toe of Switch is the point of intersection of gauge lines of tongue rail and stock rail in the closed position. It is imaginary point in field.

Crossing:

Crossing is a device introduced at the junction where two rails cross each other to permit the passing of the wheel flange of rolling stock, to pass from one track to another track. It is also known as “frog”.

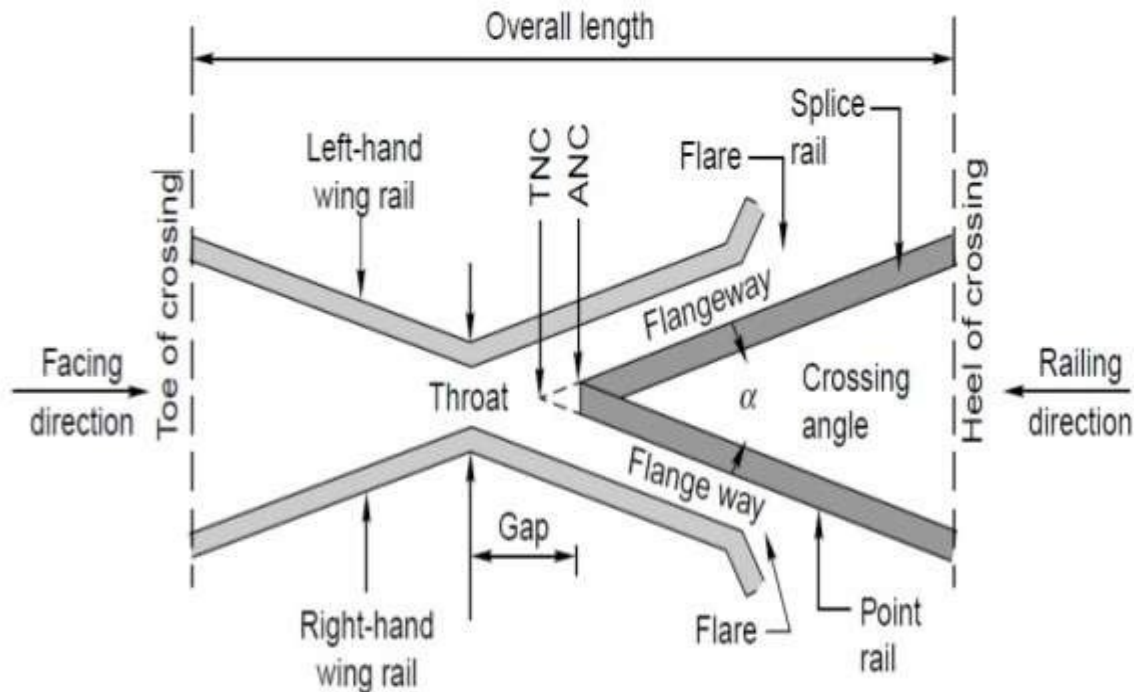




Theoretical Nose of Crossing: (TNC)

Theoretical nose of crossing is a theoretical point of intersection of two gauge lines of crossing.

TNC is used as a reference for all Calculations.



Actual Nose of Crossing: (ANC)

Theoretical Nose of Crossing is the point which is not practically possible to provide in track. Some thickness is provided (Equal to web thickness of rail section) at nose to give strength to the nose.

Hence actual nose of crossing is the point which spreads between the gauge lines of crossing at 'pointed end' which have sufficient thickness in view of giving strength and manufacturer consideration.

Throat of Crossing:

Throat of crossing is the portion at which the converging wing rail of crossing has minimum distance (closest position)

Note: Normally Throat clearance is kept 51mm.

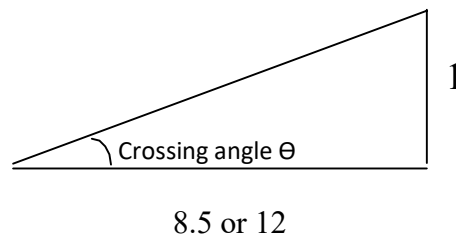
Number of Crossing OR Crossing Number:

Number of crossing is the co-tangent value of the crossing angle.

Normally it is denoted as 1 in N, where N is crossing number. For

Example: 1 in 8 ½, 1 in 12 etc

Both are standard crossing for IRS and are in use.



Crossing Angle:

Angle subtended between gauge lines of crossing nose piece is known as crossing Angle. It is measured at Theoretical Nose of crossing

The typical value of crossing angle is as below

$$1 \text{ in } 8 \frac{1}{2} = 6^\circ-42'-35''$$

$$1 \text{ in } 12 = 4^\circ-45'-49''$$

Numerical Problems (ANC to TNC Distances):

Question 1 . Calculate the distance from ANC to TNC for 1 in 12 Crossing of 60 kg rail

Answer; For 60 kg rail section, web thickness = 16.5 mm

$$\text{Now Cot } \Theta = \frac{12}{1}$$

The distance from ANC to TNC is = $16.5 \times 12 = 198\text{mm}$

Question 2 . Calculate the distance from ANC to TNC for 1 in 12 Crossing of 52 kg rail

Answer; For 60 kg rail section, web thickness = 15.5 mm

$$\text{Now Cot } \Theta = \frac{12}{1}$$

The distance from ANC to TNC is = $15.5 \times 12 = 186\text{mm} \approx 186 \text{ mm}$.

Check Rail:



At the throat of crossing wheel flange jumps from one rail to another to cross the rail in gap.(flange way gap). In order to ensure that this wheel negotiate the gap properly and does not strike the nose, the other wheel is guided with the help of a parallel fixed rail at specified distance. This rail is called check rail.

As per SOD Minimum = 44mm
Maximum = 48 mm

Turn Out:

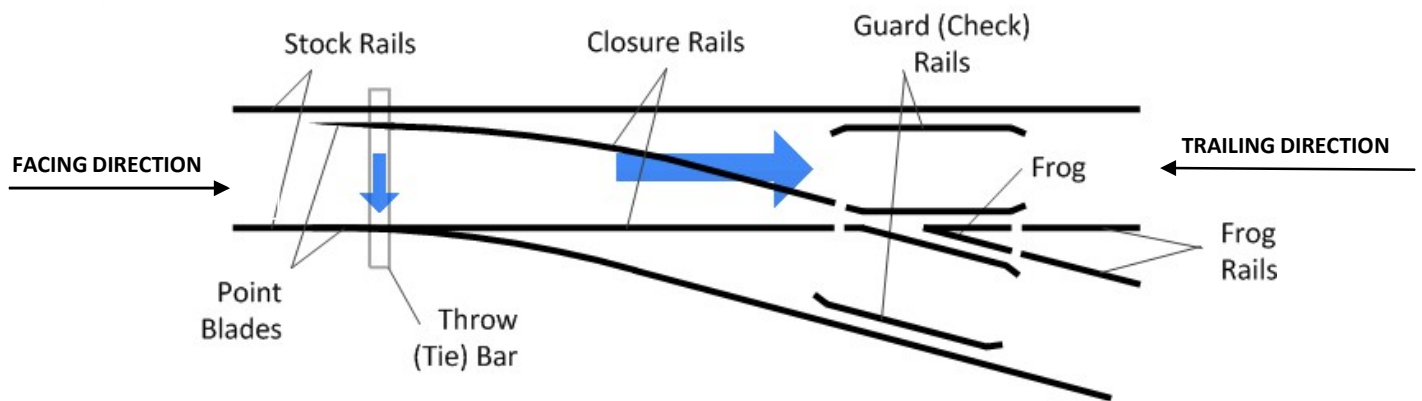


Turnout is a device which is used to direct the vehicle from one track to another.

OR

It is an arrangement of points and crossing with lead rails by means of which rollingstock (Vehicles) may be diverted from one track to another track.

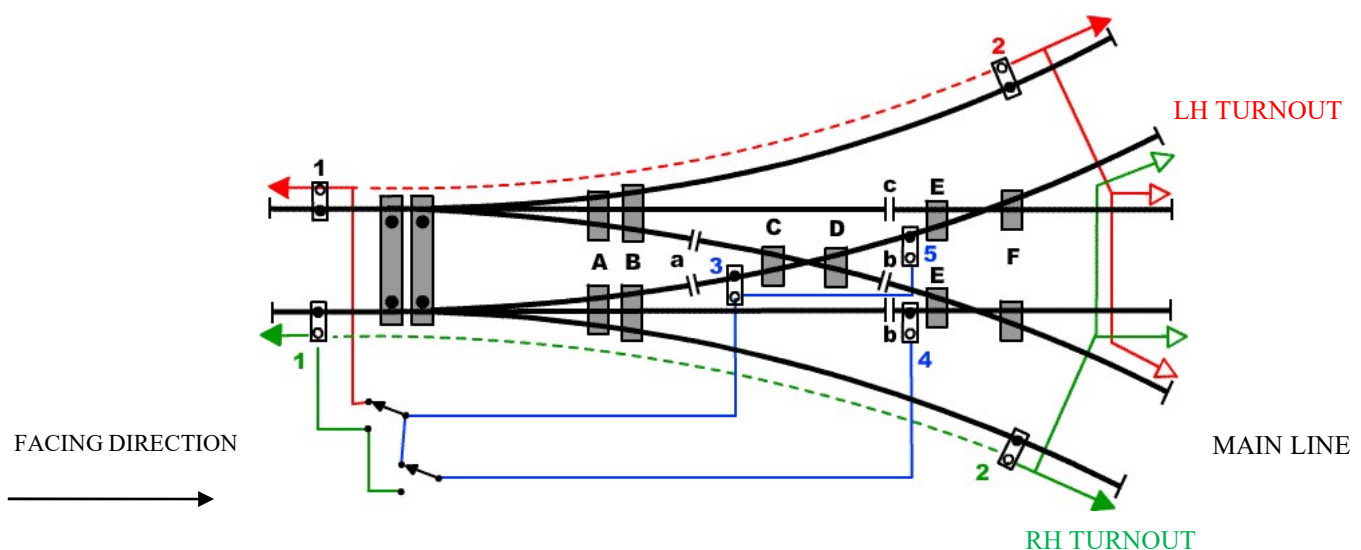
Facing Direction and Trailing Direction:



Train passing on turnout if first passes/crosses the point and then crossing. The direction of train / vehicle is to be known as **Facing Direction**.

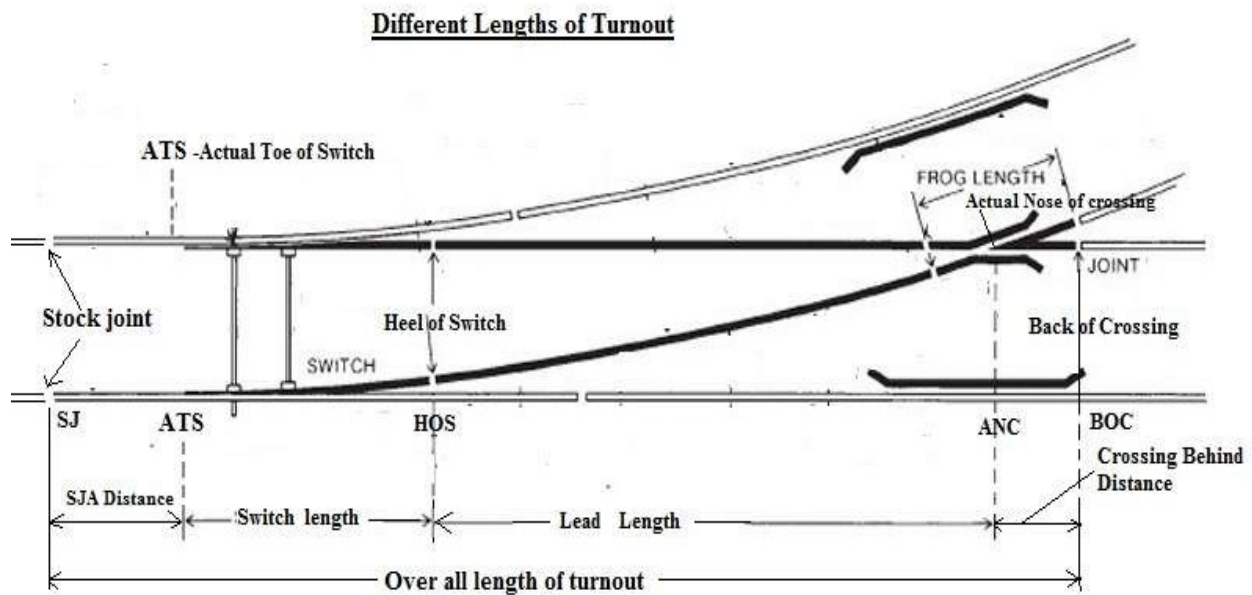
Train passing on turnout if first passes/crosses crossing portion and then switchportion. The direction of train will be identified as **Trailing Direction**.

Left-hand & Right Hand Turnout:



A turn out is designated as right hand or left hand depending upon whether the traffic is directed to right or to left respectively .

The vehicle approaching to turn out from facing direction if diverts right hand then it is denoted as Right Hand T/out if diverts left hand side – it will denoted as left hand turn out .



Different Lengths of Turn-Out

Stock Joints ahead Distance (SJA Distance)

It is the straight distance from stock joint to actual toe of switch is known as Stock Joint Ahead Distance.

Switch Length:

It is a straight distance from Actual Toe of switch (ATS) to Heel of Switch is known as switch length

Lead:

Straight distance from Heel of Switch to theoretical nose of Crossing is known as Lead.

Crossing Behind Distance:

It is the straight distance from TNC to Back of Crossing is known as Crossing behind Distance.

Overall Length of Turnout:

It is the straight distance from “stock joints” to “back of crossing” is known as overall length of turnout.

Overall length of turn out = SJA Distance + Switch Length + Lead Length + Crossing Behind Distance

Fouling Mark:



Fouling mark is a point between two adjacent tracks of turnout (behind crossing), where minimum distance as per SOD lies between two track centers so that vehicle on both track can safely pass.





Accessories of Point and Crossing:

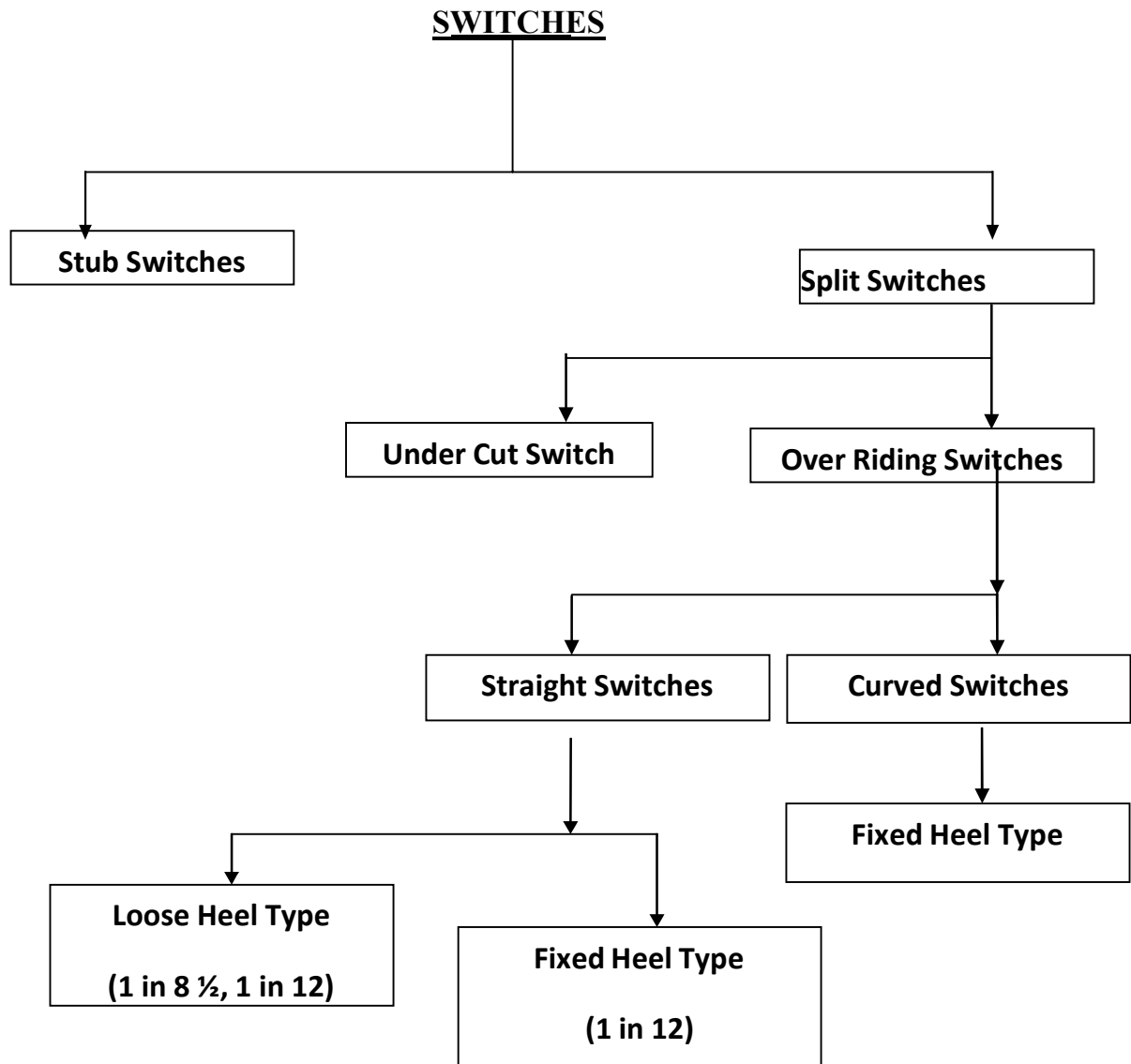
Stretcher Bars
Gauge Tie Plates
Switch Stops
Slide Chairs
Heel Block
Distance Blocks
Crossing Distance Block
Check Rail, etc

Important Notes:

- 1) Gauges are kept slack by 6mm at Actual Toe of Switch.
- 2) Exact gauges are maintained at nose of crossing to avoid hitting of the nose by moving flange.

SWITCHES

Types:-



STUB SWITCH:

In this type of switch, no separate tongue rail or stock rail is provided and some portion of the track is moved from one side to another side for giving path in either track. These switches are obsolete now.



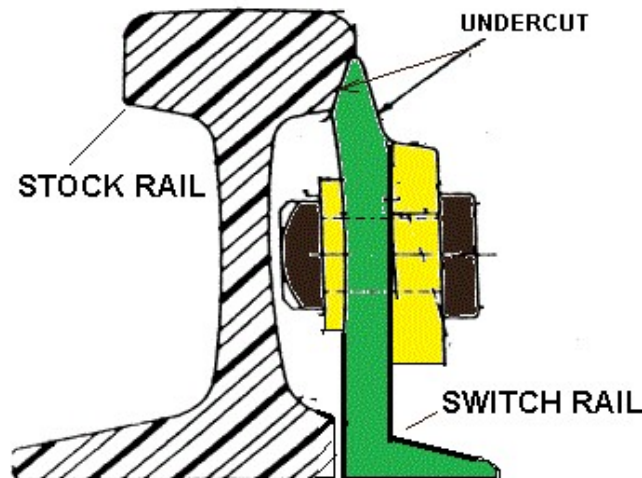
SPLIT SWITCHES:

This type of switches is in use in Indian Railways. It has a pair of stock rail and a pair of tongue rail. In split switches, only tongue rail is moved to give path to the train on either side.

There are two types of split switches:

1. Under Cut Switch
2. Overriding Switch

UNDER CUT SWITCH:



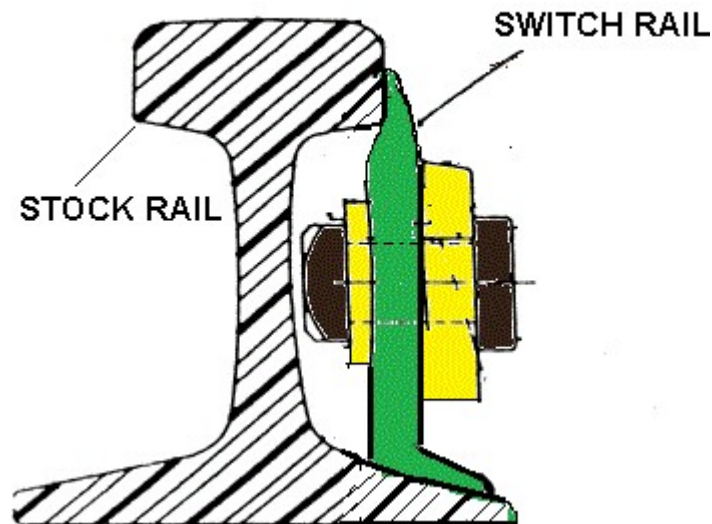
These are old and obsolete type switches for Indian Railway. Initially in this type of switches foot of stock rail is planned /cut to accommodate the tongue rail.

Under cut switches had following major two defects

1. First deficiency /defect was with tongue rail. It was planned in such a manner so that thickness of the toe was reduced to almost nil. Due to this, it worn out in very short period of service (Due to rubbing of wheel and load coming through wheel) and service life of tongue rail was very short.
2. Second deficiency was in stock rail itself. Due to planning, Cutting of the flange, it becomes weak and in under load it start to break

Due to above reasons these switches are now obsolete. To overcome above problems of undercut switches overriding type switches are designed. Which are the standard switches of the Indian Railway.

OVER RIDING SWITCH:



In this type of switch the stock rail has the full section and the tongue rail is planned to 6mm thick edge which over rides on the foot of the stock rail.

In this design the thickness of tongue rail at toe is 6mm, but top surface of the tongue rail is planned in such a way so that it never comes under load unless and until half of the head width not receive by moving wheel.

In this design, tongue rail looks weak but in fact it is very strong. After over riding on the stock rail foot, it becomes stronger. Also up keeping by 6mm at HOS to joint behind the wheel in case of fixed heel, reduces the chances of splitting of point.(In case of trailing direction moment and due to moment of false flange wheel.)

Advantages of Overriding Switches:

Overriding switches are more economical and superior design due to following reason

1. Since there are no cut in stock rail and have full rail section, it is much stronger.
2. Since manufacturing work is involved only in tongue rail, hence it is more economical and easy to manufacture.
3. Although the tongue rail has the thin edge of 6mm but it is supported by the stock rail for the entire weak portion of its length. This gives it more combined strength and chance of damage in tongue rail is eliminated.

Type of Overriding Switches

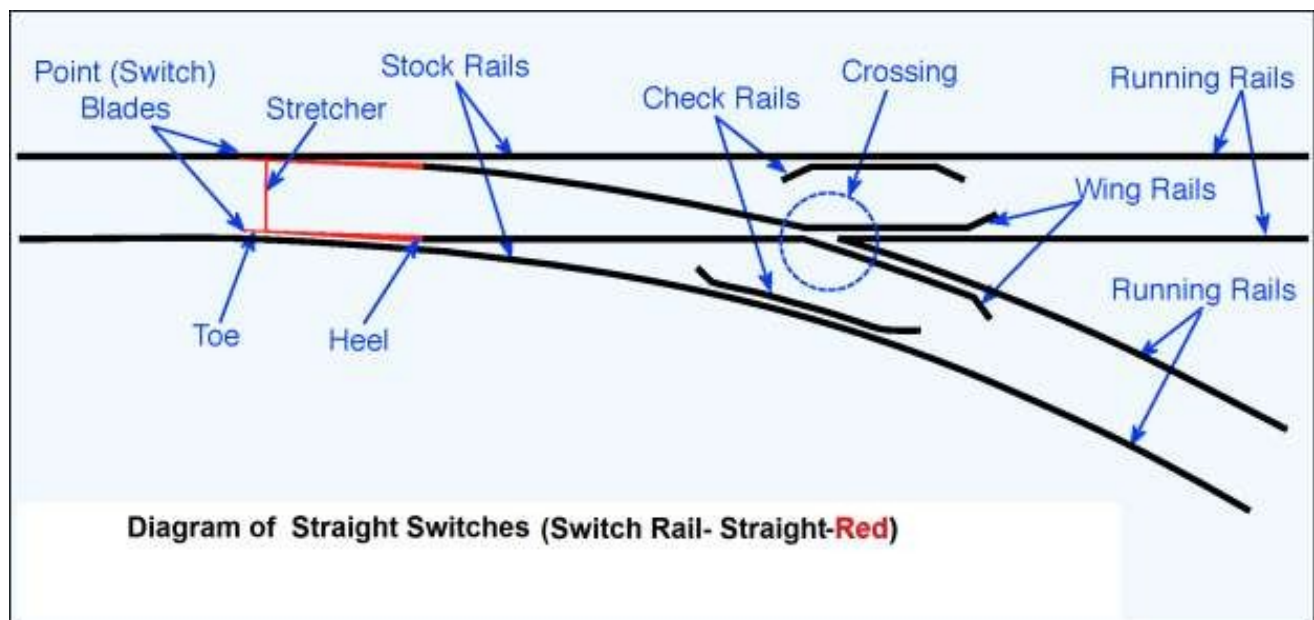
1. Straight Switches
 - a. Short with loose heel
 - b. Long with fixed heel
2. Curved Switch (Normally Longer Switches)

Straight Switches:

Switches having straight tongue rail is known as straight switches.

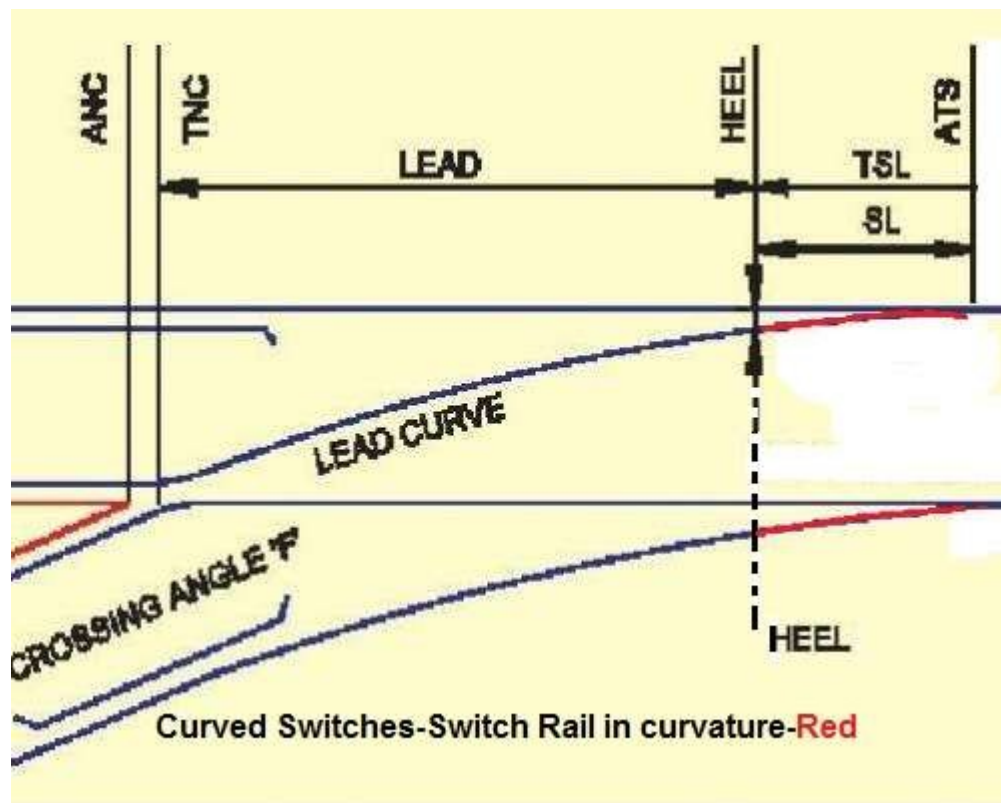
The straight tongue rail had advantage that these are simple in manufacturing and same tongue rail can be used for left hand Turn out and right hand Turnout.

But also has a disadvantage that there is an abrupt change observed in alignment at ATS resulting negotiating trains observe jerk while entry in turn out.





Curved Switches



In this case tongue rail is curved (manufactured) in a curvature of turnout from TOS to HOS resulting smoother entry of trains in turnout. But there is the disadvantage that these can be used only for a particular curvature of left or Right Turnout.



CROSSING

Classification of Crossing:

The Crossings are classified in following two aspects:

1. Based on Crossing Angle(Track Condition)
2. Based on methods of manufacturing

Based on Crossing Angle:

On basis of Crossing Angle the crossings are classified in three types

1. Acute Crossing / V- Crossing
2. Obtuse Crossing / Diamond Crossing
3. Square Crossing

Acute Angle Crossing:

An acute angle crossing or V-crossing is that in which the intersection of two gauges faces (gauge line of pieces) forms an acute angle. In Indian Railway, acute angle crossing is used for all turnouts and cross over.



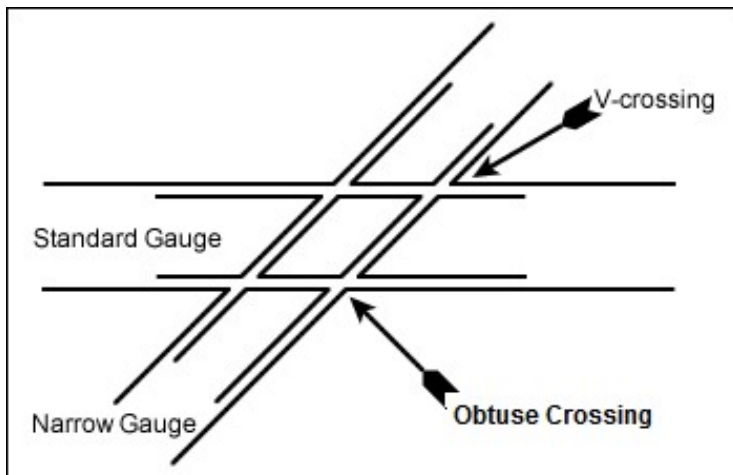
Obtuse Angle Crossing:

Obtuse crossing is that crossing in which the two gauge faces meet at an obtuse angle.

OR

When gauge faces or gauge line of a crossing intersect each other in such a way that angle between it forms an obtuse angle, the crossing is called obtuse angle crossing.

Since this type of crossing is only used in diamond layout hence it is also known as Diamond Crossing.



Square Crossing:

It is formed at the locations where two tracks cross each other at right angle. Because of unguided/Unchecked/ Unprotected flange moment at the nose (due to non-provision of checkrail), there are chances of derailment are more. Hence use of this type of crossing in Indian railway is not in practice.



Based on method of Manufacturing:

In this basis of methods of the crossing is classified into two

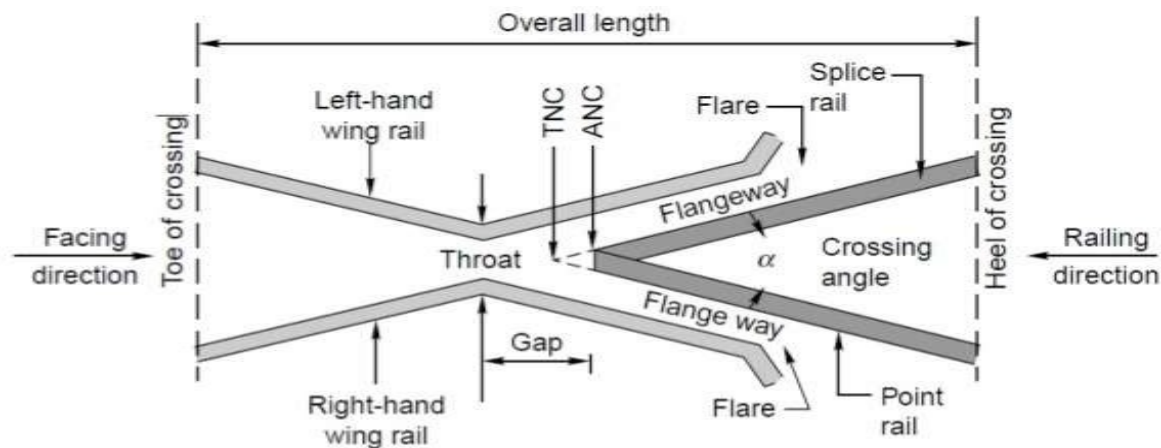
1. Built Up Crossing
2. Cast Steel Crossing

Built up Crossing:

In this type of crossing two flared wing rail and one nose or V-piece (combination of point & Splice rail) are connected by means of iron distance blocks, nut and bolts.

This type of crossing is broadly used on Indian Railways. The major advantage of this type of crossing is

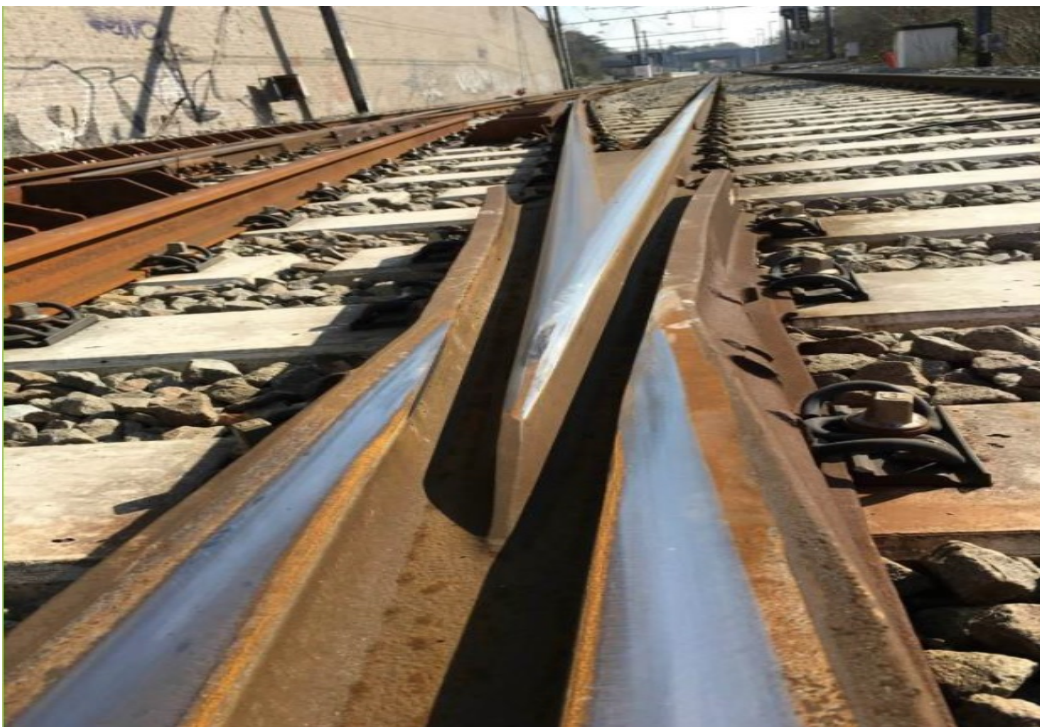
- I. Initial fabrication cost is low.
- II. Wear can be repaired at site without replacing the crossing.



Cast Steel Crossing (Cast Manganese Steel Crossing):

This type of crossing is manufactured by casting process in one piece

In this Series / Type of crossing, CMS (Cast Manganese Steel) crossing is adopted by Indian Railway and it is standard crossing for modern high speed track/Fan Shape turnout.



Advantages of CMS Crossing;

1. It is more rigid crossing in one mass and having no loose parts like bolts, nut etc:- resulting it needs very little maintenance as well as very low maintenance cost .
2. Although the initial manufacturing cost of crossing is high but due to its metallurgical composition (having high manganese percentage) and manufacturing process. It has very good anti-wear capacity even under heavier axle load.
3. Due to its chemical and physical properties it has very long life and about four times in comparison to ordinary built up crossing.
4. Very useful on heavy traffic density routes where traffic block margin is very less.

Check Rail Clearance

The equation for finding check rail clearance is as under:

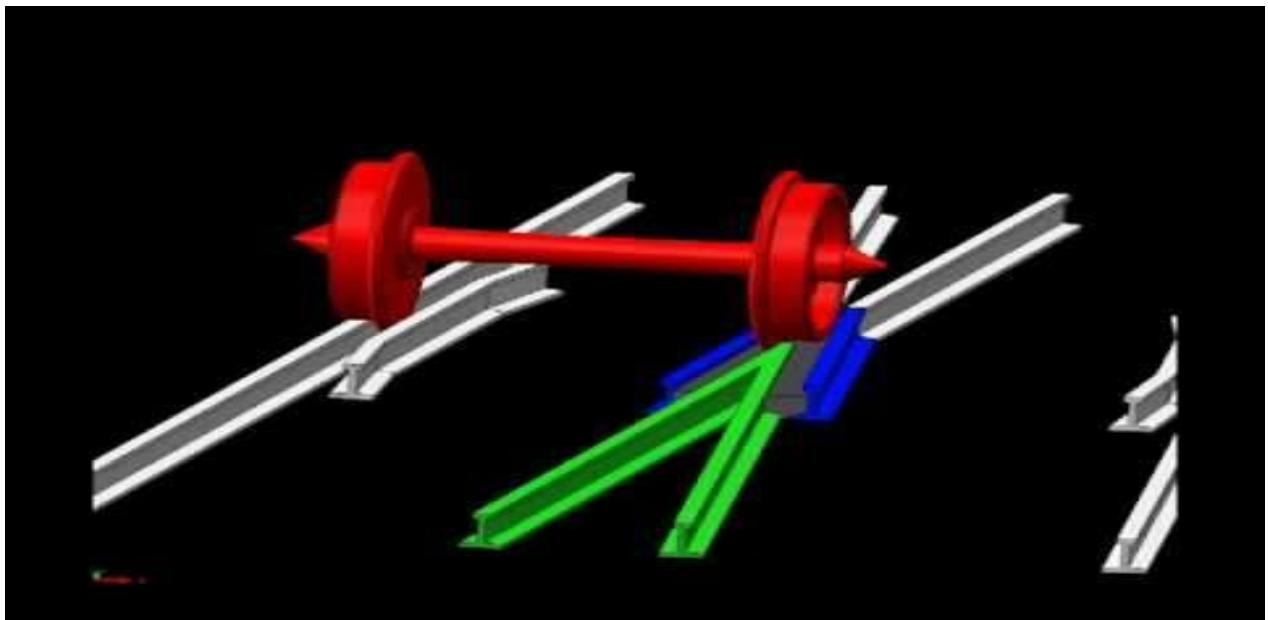
$$\text{Check Rail Clearance} = \text{Track Gauge} - (\text{Wheel Gauge} + \text{Wheel Flange Thickness})$$

For New wheel:

$$\text{Check Rail Clearance} = 1676 - (1600 + 28.5) = 47.5 \approx 48 \text{ mm}$$

For Old Wheel:

$$\text{Check Rail Clearance} = 1676 - (1600 + 16) = 60 \text{ mm}$$



It means the check rail clearance for new profiled wheel should be 48mm and maximum worn-out wheel it should be 60mm. if we will provide 46mm clearance, then old wheel worn out will hit check rail ends and if provide 60mm clearance, then new wheel will hit the nose of crossing.

Hence to overcome above problem 48mm clearance is provided in checkrail and to avoid hitting of check rails. Check rail and wing rail ends are given flared. So that entry of wheel in check rail will be smooth and easy without check rails end hitting.

To give wear out margin and to avoid frequent adjustment in CRC the check rail clearance in BG recommended as

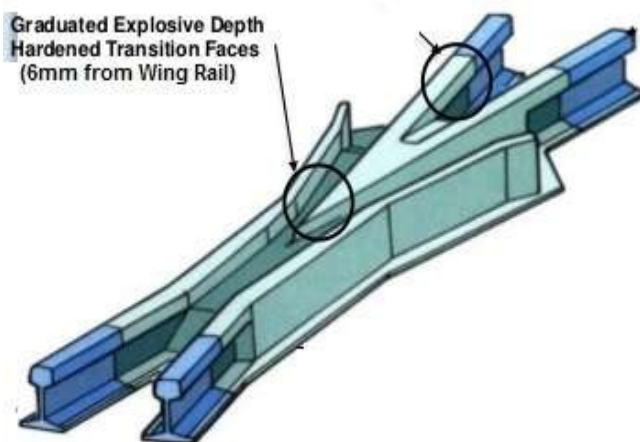
Minimum = 44 mm

Maximum= 48 mm

Note:

1. Instead of giving flare in Check rail / wing rail now-a-days the checkrail is planned in such a way so that the end clearance must be more than 60mm. this designed is specially given with CMS crossing.
2. As per equation of clearance, the track gauge is very important figure. Hence gauge in crossing portion must be very correct. Otherwise, slack or tight gauge will have adverse effect as explained above.

Ramping of Nose of Crossing:



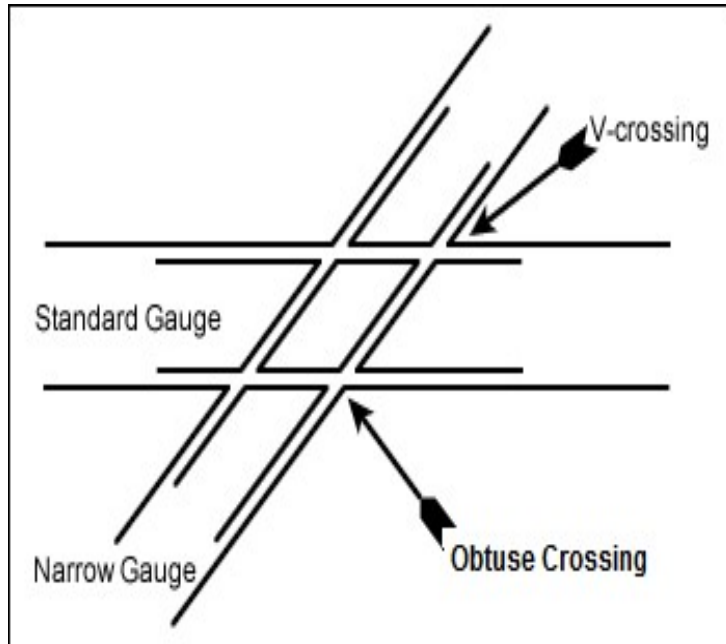
If we will trace the wheel path at crossing while moving on facing direction, we will see the contact area from wing rail is reducing and after a gap, contact area on nose is increasing suddenly. This results in heavy wear in crossing nose. Coning of 1 in 20 in wheel is also responsible for it (wear).

If nose piece will be in same level of wing rail, after arrival of wheel on nose piece from a gap and wing rails, sudden total load will impact on nose. Since thickness of nose is very less, the chances of cracking/breaking of nose is more.

To avoid this level of nose piece is kept 6mm down from wing rail level and leveled after the distance of 90mm. so that load will be impact on nose piece after achieving sufficient head thickness.

DIFFERENT LAYOUTS OF YARD

Diamond Crossing (Layout):



When two tracks cross each other at particular angle, the diamond is formed. These two tracks may be of same gauges or different gauges.

Note: The diamond consists of two acute crossing and two obtuse crossing

Limitation of intersecting angle of diamond crossing:

As per schedule of dimension (SOD) in IR, diamond crossing flatter than 1 in 8 ½ should not be laid. The reasons are following:

1. In diamond crossing, when wheel passes from point rail to elbow or vice-versa, it crosses an unprotected gap (of obtuse crossing). In 1 in 8 ½ diamond crossing the gap is less and as well as crossing will become flatter, this gap will increase. Hence to avoid longer unprotected gap, there is restriction to use diamond crossing flatter than 1 in 8 ½.
2. When intersecting angle will reduce the obtuse crossing of diamond will have tendency to come in front of each other in respect to wheel moment. This is dangerous condition and chances of derailment are more. So that there is a restriction in use of diamond crossing flatter, than 1 in 8 ½.

Provision of Strip on Check Rail of Obtuse Crossing

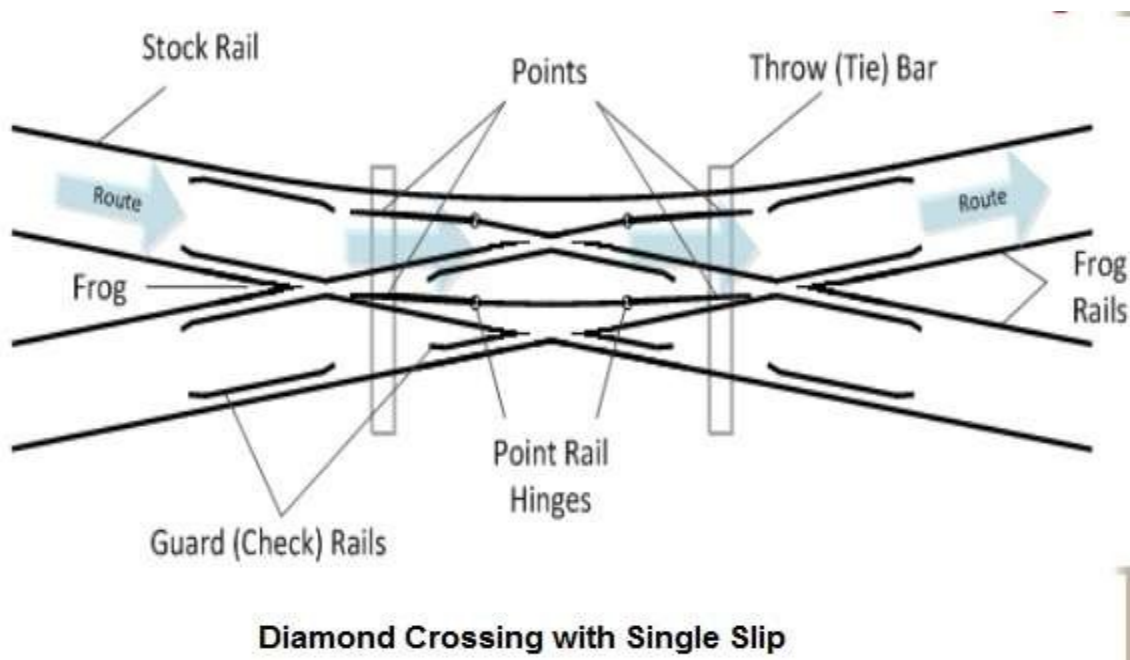
Unprotected gap of obtuse crossing in 1 in 8 ½ diamond is less and wheel passes on it with momentum in few seconds only.

But if the train/vehicle is stopped on it in such a way so that wheel is in the gap or near to gap and when train will start, the wheel will be subjected under jerk and due to this there are chances with wheel to take wrong path, resulting derailment on diamond crossing. There are so many derailments on diamond crossing like this specially with pony wheel of locomotive.

To overcome above problem, the check rail of obtuse crossing is welded with 25 mm thick steel strip for raising height. This welded strip reduces the unprotected gap as well as chances of derailment by protecting properly

Strip more than 25mm is not allowed because of there are chances of infringement of locomotive parts.

Diamond with Slip:-



Slip is an arrangement in diamond crossing through which train vehicle can be diverted from one track to another.

If we will use one pair (2 nos of switches) set of points then it will be called diamond with single slip and when we use 2 set pair (4 nos of switches) of point then it will be called diamond with double slip.

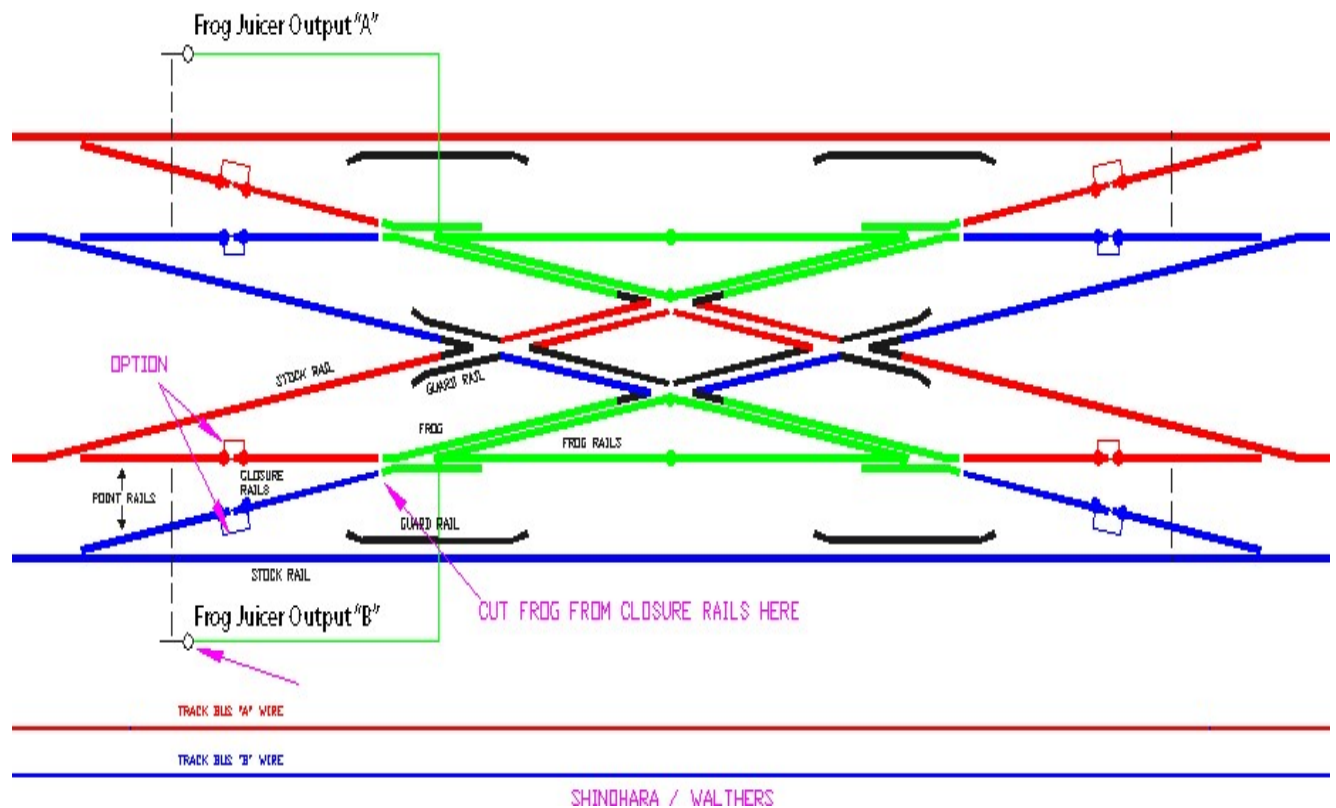


Cross Over:-

Cross over is a layout which is used to connect two through track. It has two turnouts which are connected with each other by intermediate portion.



Scissor cross over:



When two cross-over intersect each other then complete layout is known as scissor cross over.

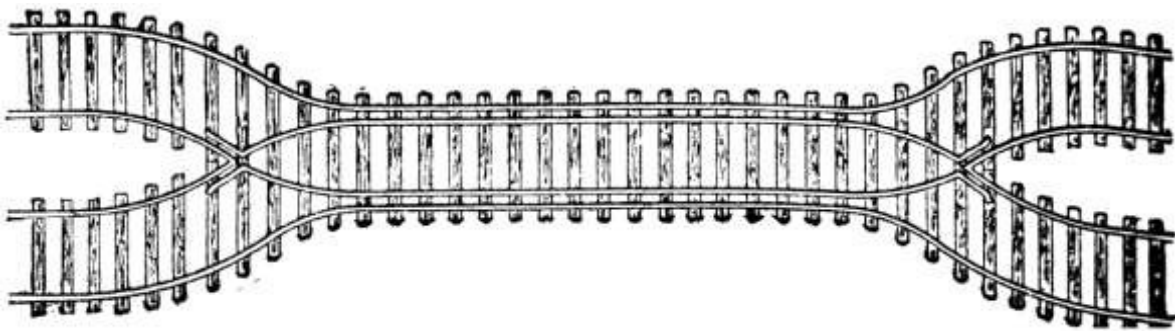
The scissor cross over is provided for a transfer the vehicle from one track to another and vice-versa. It is provided at the location where space does not permit for provision of two separate cross over especially in long platform lines.

Scissor cross over is consist of

1. Four set of turnout
2. One set of Diamond



Gauntleted track



(Line diagram)

When two tracks pass over on same formation and sleeper the layout is named as gauntleted track. This track may be same gauge or different gauge

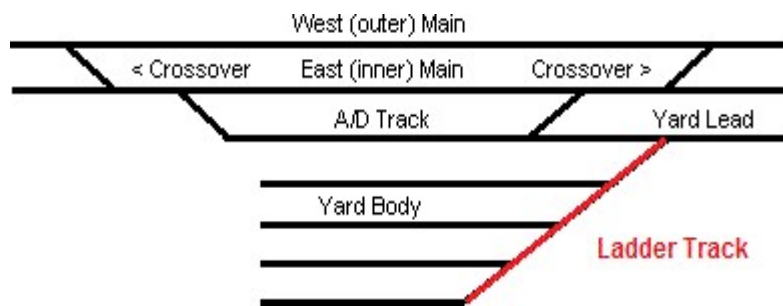
This is temporary diversion provided on double line track so that one of the track is shifted and passes through another on same sleepers.

It is useful connection where one side of the bridge or double line section is required to block for major repair or re-building.

Gauntleted track is also used where trains have to operate on mixed gauge say BG and MG.



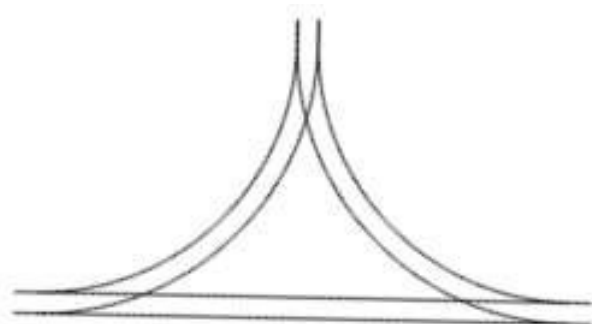
Gathering line/Ladder track



Gathering line is a slopping line in which number of parallel tracks gather or merge or branched off. This layout is very useful in yard section.



Triangle Layout



When three turnouts are laid on straight track or on curve track in such a way so that a triangle is formed in between, layout is called Triangle Layout. This is a substitute of turntable. But it has a disadvantage that it needs a longer space but maintenance of it is easy and cheaper.



RESTRICTION IN USE OF 1 IN 8 ½ TURN OUT IN PASSENGER RUNNING LINE

Restriction in use of 1 in 8 ½ turn out in passenger running line is restricted due to the following reasons:

Whenever a 1 in 8 ½ turnout is provided in passenger line, its turnout angle will be more and its “turn in curve” will be sharper. Due to engine flange force, turn in curve” will become more sharp. When a passenger train enters in a loop line by a speed more than the prescribed speed, chances of derailment on it will become more.

1. Keeping in view of this Railway Board issued a direction that in passenger running line, only 1 in 12 turn out will be used.
2. Until the removal of 1 in 8 ½ turnout from passenger running lines, there will be a speed restriction of 15 kmph on it. (Now a days it is 10Kmph)
3. Speed restriction on turnout will be as following

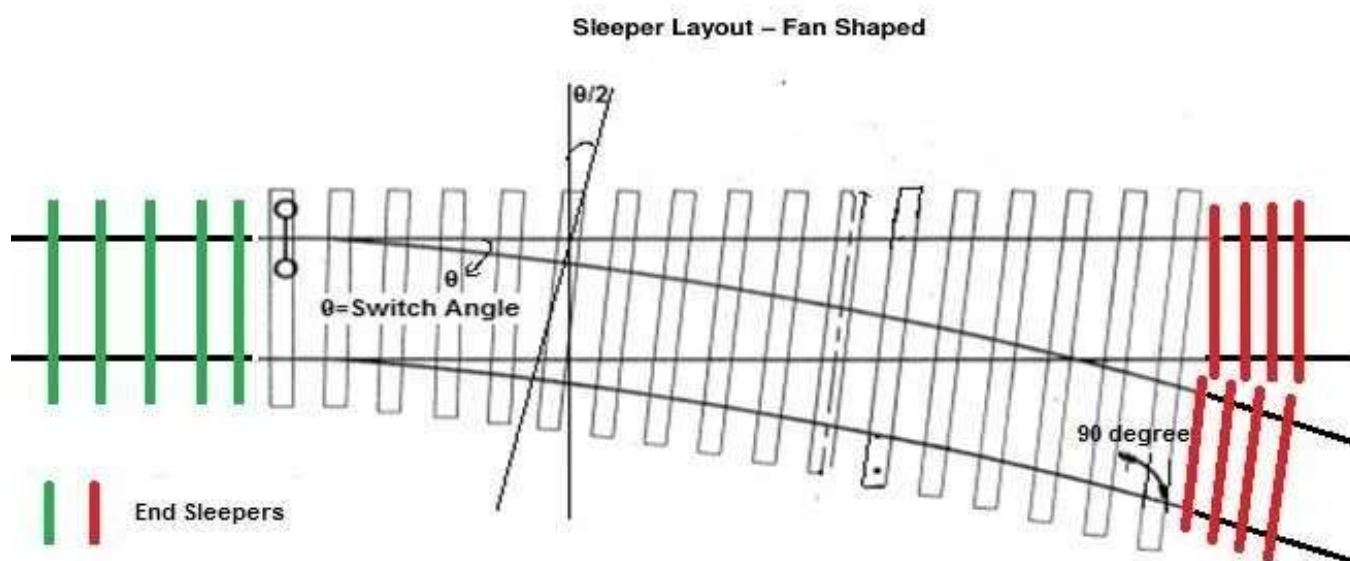
1	1 in 8 ½ Turn out	Curved/Straight Switch	15 Kmph
2	1 in 12 turnout	Curved/Straight Switch	30 Kmph
3	1 in 8 ½ turnout	Symmetrical split curved switch	30 kmph

Important Notes for Point and Crossings:

1. No gradient will be provided in approaches of turn out upto 30 metres.
2. If contrary split switch is provided in any turnout , then speed restriction will be 10 kmph.

FAN SHAPED TURNOUT

Special Features:



S.No.	Turnout	1 in 12	1 in 8 ½	Sleepers' Positions
1.	Sleeper no	1-20	1-13	switch sleeper-perpendicular to mainline track
2.	Sleeper no	21-65	14-41	Lead sleeper- at angle of $\theta/2$ from main line, where θ =Switch Angle.
3.	Sleeper no	66-83	42-54	Crossing sleeper- perpendicular to crossing turnout track.

1. The position of Switch sleeper will be perpendicular to mainline track
2. The position of sleepers on lead curve will be at angle $\Theta/2$ from perpendicular drawn on mainline from that point.

Where Θ is the angle between main lines and tangent drawn to lead curve through the point.

3. The position of crossing sleeper will be perpendicular to crossing turnout track.

Note :

Top view of this turn out looks like a fan (Hand fan), hence this turn out named as “FANSHAPED” Turn out .

Advantages of Fan Shaped Turn Out:

1. Complete one set of sleeper can be used for both types of turnout i.e. left & right, resulting to avoid unwanted inventory confusion.
2. It provides heavy, strong and robust type track structure due to PRC sleepers. Hence its lateral and longitudinal stability is very good.
3. Same set of sleepers can be used for 52kg and 60 kg rail section. Only with changing of the liner
4. CMS Crossing for different type of rail section (52kg and 60 kg) has identical footing.
5. Comparatively longer switch are used resulting in smooth entry of trains on turnout side.

Laying:-

1. Number of sleepers

Turn Out	Approaches End Sleeper	Turn Out Sleeper	Total Sleeper
1 in 8 ½	13(5+8=13)	54	67
1 in 12	13(5+8=13)	83	96

Note: S-Signal sleeper at motorized point for motor installation.

2. Precaution

MFG DATE	60 KG	RE
----------	-------	----

RE mark should always be kept in right side while laying whether it is right hand or left hand turnout.

3. Important Dimension of Fan shape Turn Out

DIMENSIONS	1 in 8 ½ in mm	1 in 12 in mm
Stock Joint Ahead Distance	1500	1144
Switch Length	6400	10125
Lead	18395	25831
Radius	232260	441360
Over All Length	28613	39975
Switch Angle	46°59''	0°20'0''
Length of Tongue Rail	7620	12356
Length of Stock Rail	12800	13000
Length of CMS crossing	3300	4350
Heel Divergence	182	175

Handling of Turnout Sleepers:

1. Switch and approach sleepers shall be loaded on BFR-perpendicular to track.
2. Lead and Crossing Sleepers-shall be loaded on BFR-along the track.
3. Wooden batterns shall be provided between two layers of sleepers-to avoid damage of sleepers.
4. Loading and unloading shall be done preferably by Crane.
5. Do not throw one sleeper on another.

PROTECTION

PATROLLING

The following are the types of patrolling in terms of track:

1. Keyman's daily patrol

In every morning every inch of track to a certain distance is watched by a keyman for any damaged (or) missing parts of the rail fastenings like pandrol clips, liners, fish plates etc.

2. Security Patrolling

- a. At the time of civil disturbances (Internal disturbances)
- b. External disturbance
- c. At the time of VIP movement

3. Weather patrolling:-

a. Monsoon Patrolling

This is done during Monsoon Season

i. Stationery Patrolling

This is done on standard points where the track invent/that may tend to wear very soon

ii. Mobile Patrolling

b. Hot weather patrolling

c. Cold weather patrolling

DAY: It is defined as the time between sun rise and sun set.

NIGHT: It is defined as the time between sunset and sun rise.

Engineering Work:-

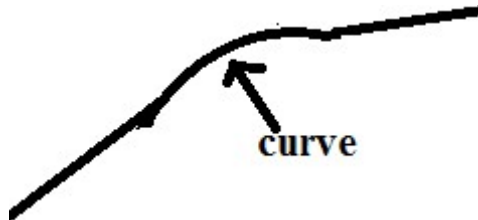
The work related with tracks like Maintenance, New laying etc. are known as Engineering Work. Normally engineering work should not be carried out in night.

1. **Short Duration Works:** The works which are carried out only in one day. E.g.- Rail Renewal, TTM working, Welding Etc. No night involves in it.
2. **Long Duration Work :** The works which are carried out in two days (or) more than two days including at least one Night or more. For example-Major bridge repair, deep screening etc.

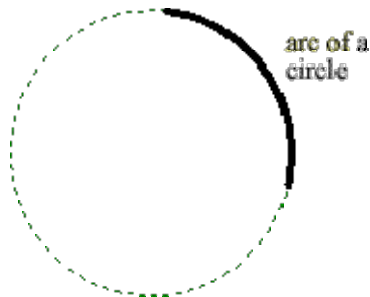
CURVE

Definitions: –

Curve: The geometrical “ARC” provided at the change of Alignment or Gradient is known as “Curve”



Arc: Any part of circumference of a circle is known as ARC.



Tangent: It is the straight line which touches the circumference of a circle only at one point. It is always at right angle to the radius at the point of contact. From any point outside the circle only two tangents can be drawn.

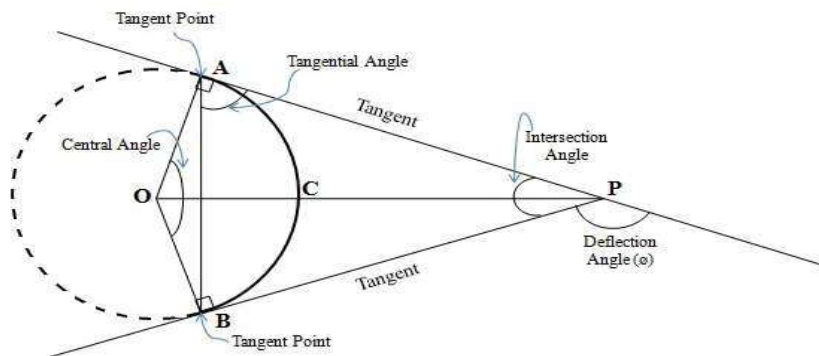


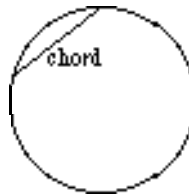
Figure 1.1

Tangent Point: It is the point of contact of Tangent and Circle (see Fig.1.1)

Tangent Length: It is the distance between the tangent point and the external point from where the two tangents are drawn. (AP & BP in Fig.1.1)

$$\text{Tangent Length (TL)} = R \cdot \left(\frac{\theta}{2}\right) \text{ Where } \theta = \text{Deflection angle}$$

Chord: It is a straight line joining two points of the curve



Short Chord: In Indian railways (Particularly on high speed), 20 mtrs length of short chord is considered as standard for track geometry measurement.

Long Chord: It is a straight line joining the two tangent points of a curve (AB in Fig.1.1.)

Longest Chord: The diameter of the circle is its longest chord.

Apex: It is the highest point on the curve which is also at middle of the ARC (Point „C“ in Fig.1.1.)

Apex Distance: It is the distance between intersection points of the tangents and middle of the Arc (CP in Fig.1.1.)

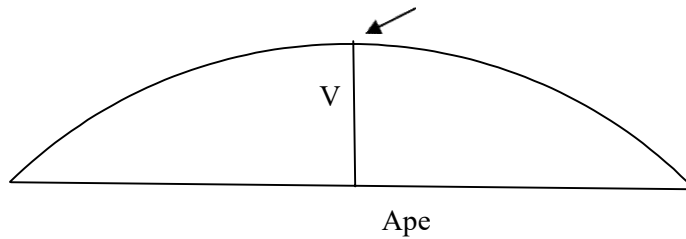
Deflection Angle: It is angle through which the curve turns. It is taken as an external angle between intersection points of two tangents (refer Fig.1.1.)

Intersection Angle: It is the internal angle of two intersecting tangents (refer Fig.1.1.)

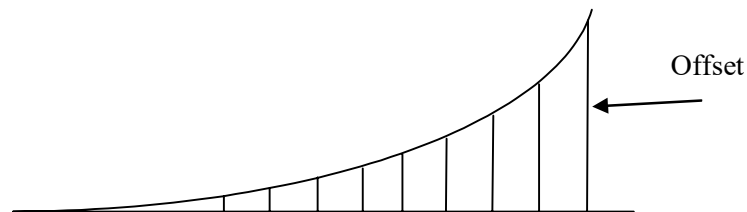
Tangential Angle: It is the angle which is formed by the long chord and tangent (refer Fig.1.1.)
It is equal to half of the deflection angle

$$\text{Tangential Angle} = \frac{1}{2} (\text{Deflection Angle})$$

Central Angle: The angle subtended at the centre of the circle by the curve selected is called Central angle. It is also equal to the deflection angle of that selected curve.



Versine : It is the perpendicular distance from the middle of the chord drawn to the curve.



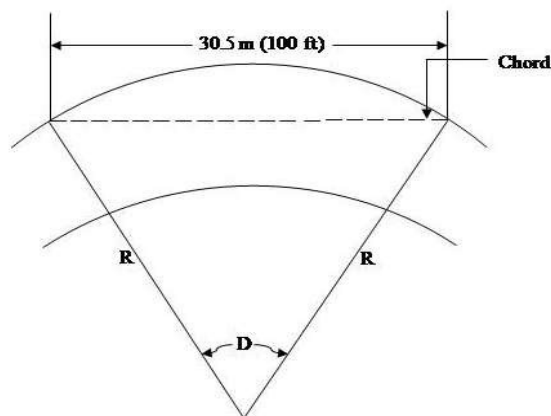
Offset: It is the perpendicular distance from the tangent to arc of circle.

Degree of Curve:

Definition:

A curve is defined either by its radius or by its Degree. **Degree of curve (D)** is the angle subtended at its centre by a chord of 30.5 meters/100 feet length.

Since railway curves are very flat (i.e., when Radius is very large, an arc of a circle is almost equal to the chord connecting the two ends of the arc) hence the degree of curve for all practical purposes is also defined as the angle subtended by a curve of 30.5metres/100 feet length at its centre.



Maximum Limit of Degree of Curve in Indian Railways

1. Broad Gauge (1676mm) :- 10^0
2. Meter Gauge (1000mm) :- 16^0
3. Narrow Gauge (762mm) :- 40^0

Relation between Degree & Radius of Curve:

Circumference of a circle = $2\pi R$

Angle subtended at the centre by a circle with this circumference = 360° Angle subtended at the centre by a 30.5-m chord, or degree of curve

$$= \frac{360^\circ}{2\pi R} \times 30.5 = \frac{1747.52}{R}$$
$$= \frac{1750}{R} \text{ approx., (where } R \text{ is in metres)}$$

The degree of the curve is thus given by the following formulae

$$D = \frac{1750}{R} \text{ (where } R \text{ is in metres)}$$

Hence radius of the curve in terms of degree of curve will be given by

$$R = \frac{1750}{D} \text{ (where } D \text{ is in degree)}$$

Value of versine in terms of chord:

Let “C” be the length of the chord AB and “V” be the Versine of the curve of radius „R”

From the property of curve we know that

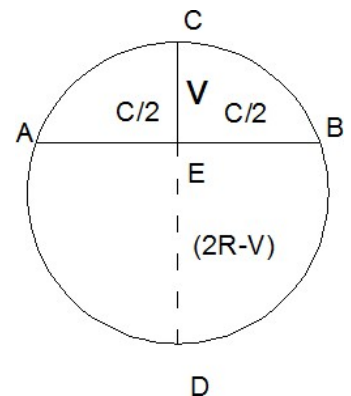
$$AE \times EB = CE \times DE$$

$$\frac{C}{2} \times \frac{C}{2} = V \times (2R - V)$$

$$\frac{C^2}{4} = 2RV - V^2$$

Since the value of V is very low, V^2 will be much lower and can be neglected

$$\frac{C^2}{4} = 2RV ; \quad V = \frac{C^2}{8R}$$



Question: Find out the length of the chord in meters for which Versine in cm is Equal to degree of the curve.

Given: Versine in cm = Degree of the curve

To Find: Length of chord “C” in meter.

Formula to be used: $V = \frac{C^2}{8R}$

In the above versine formula, the chord length “C” and radius “R” are in meters. Let us convert their units in cms.

$$\text{Then } V = \frac{C^2}{8R}$$

$$V = \frac{C^2}{8R} \times 100\text{cm}$$

$$V = \frac{25C^2}{2R} \text{ cm} \dots\dots\dots (1)$$

$$\text{We know that } D = \frac{1750}{R} \dots\dots\dots (2)$$

Equating equations (1) and (2), i.e. $V = D$ (Since from the given condition)

$$\frac{25C^2}{2R} = \frac{1750}{R}$$

$$C^2 = \frac{1750 \times 2 \times R}{25 \times R} = 140$$

$$C = \sqrt{140}$$

$$C = 11.8 \text{ mtrs}$$

NOTE: It means Versine measured in cm on **11.8 mtrs** chord length is equal to the degree of the curve

[In FPS System: Degree of curve = Versine on 61.8 ft chord]

Numerical Problem:

1. Find out the value of degree of curve having following radius
a. 1750 mtrs b. 825 mtrs c. 1000 mtrs d. 3500 mtrs

Solution

Formula used: $D = \frac{1750}{R}$

a. $D = \frac{1750}{1750} = 1^\circ$

b. $D = \frac{1750}{825} = 2^\circ$

c. $D = \frac{1750}{1000} = 1.75^\circ$

d. $D = \frac{1750}{3500} = 0.5^\circ$

2. Find out the Radius of the curve having following Degree
a. 0.5° b. 1.5° c. 3° d. 2.9°

Solution

Formula used: $R = \frac{1750}{D}$

a. $R = \frac{1750}{0.5} = 3500 \text{ mtrs}$

b. $R = \frac{1750}{1.5} = 1166.66 \text{ mtrs}$

c. $R = \frac{1750}{3} = 583.33 \text{ mtrs}$

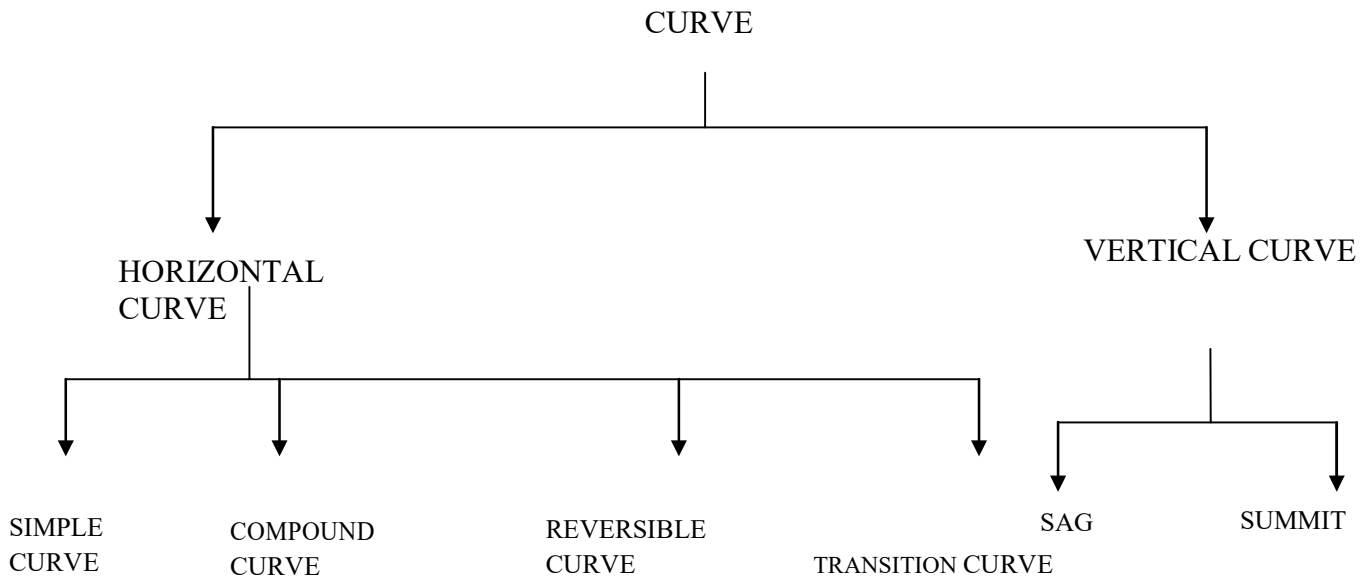
d. $R = \frac{1750}{2.9} = 603.448 \text{ mtrs}$

Necessity of curve:

Although laying and maintenance both are easy in straight line but due to the following reasons. It is essential to lay Curved Track.

1. To avoid Rivers, Mountains and other obstructions.
2. To avoid construction of major bridges, tunnels and deep cuttings
3. To connect the important cities with main line.

Classification of curve:

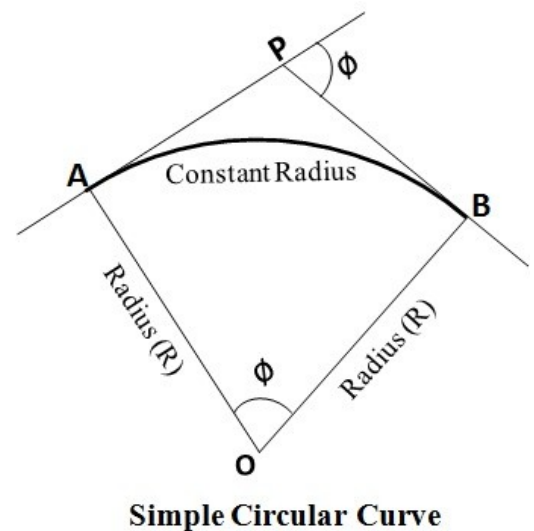


Horizontal Curve

The Curve laid on horizontal Plane is known as Horizontal Curve.

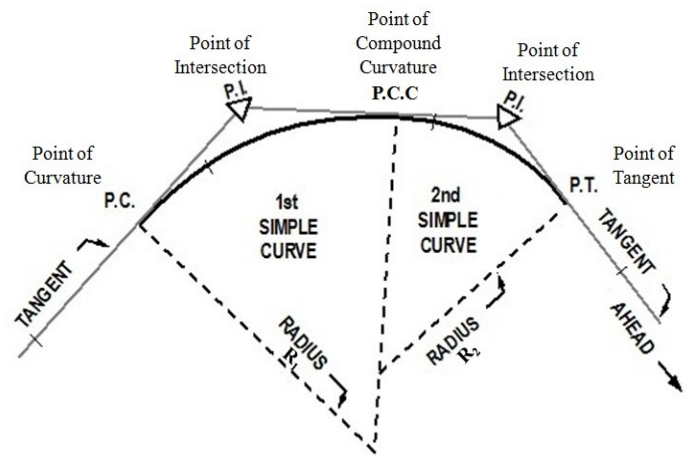
Simple Circular Curve:

Normally this curve is simple curve which connects two straight alignments (Line/Track). Since it has uniform radius and degree of curvature throughout its length, it is considered as standard and it is the most used type of curve used in Indian railways



Compound Curve:

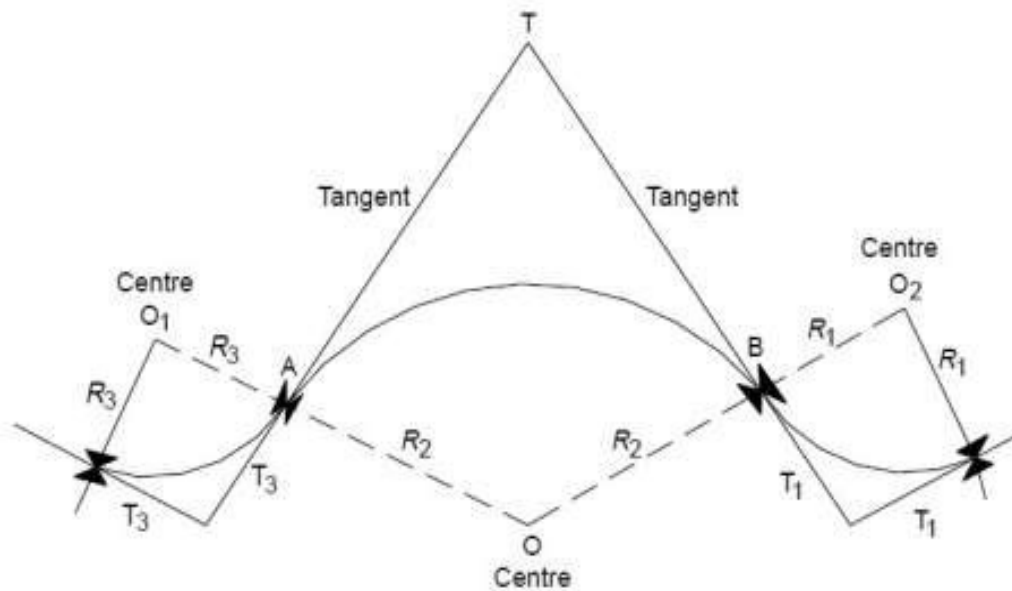
A compound curve is formed by the combination of two circular curves of different radii curving in the same direction. A common transition curve may or may not be provided between the two circular curves of a compound curve



Compound Curve

Reverse Curve:

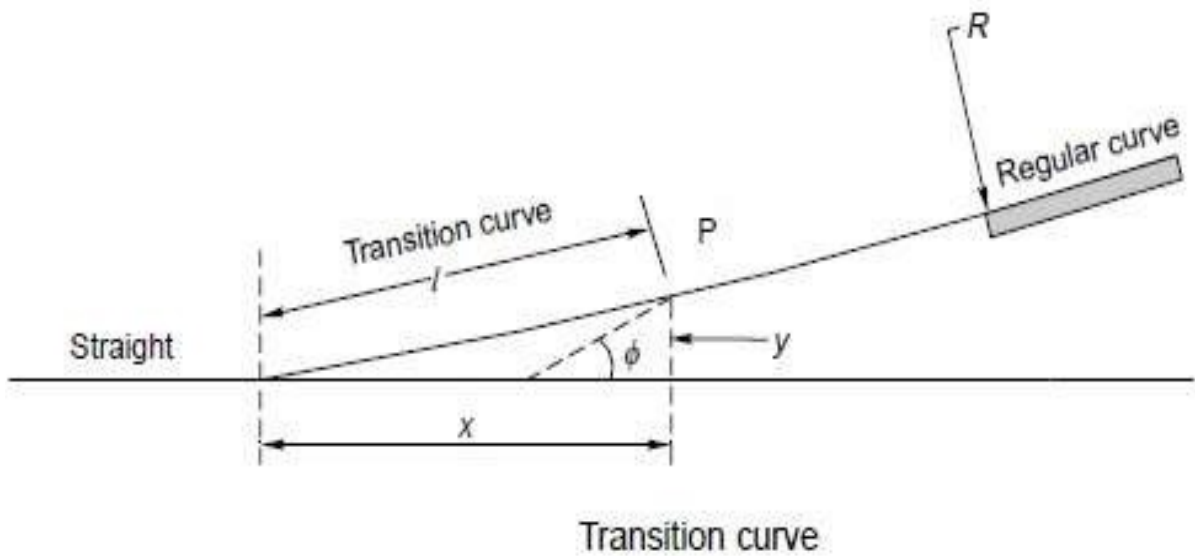
When two curves of same (or) different radius are laid next to each other in such a way that their flexures lay in opposite directions, then this is known as reverse curve. In this case the centre of the two curves will always lie in opposite direction. On account of the shape it is also known as „S“ curve. There may or may not be transition curve in between the two curves.



Reverse Curve

Transition Curve:

It is a curve having varying radius throughout its length. In Indian Railways this curve is laid at both ends of simple curve for gaining /losing the degree of curve from /to straight. Its shape is cubic parabola and it is also known as easement of curve.



❖ Vertical Curve

The curve which is provided in vertical plane and used to ease on the change of gradients is called a Vertical Curve.

Necessity:

When two gradients meet each other, an angle is formed at the junction forming the “Sag”(or) “Summit”. In case of Sags there is a danger for derailment due to motion of vehicles and in case of Summits, there is danger of train parting. Therefore to eliminate the sags and summits, vertical curves are provided.

Causes of Sag and Summit:

S. No	Sag	Summit
1		
2		
3		
4		
5		

Note:

1. Since vertical curves are very short, hence for all practical purpose it is treated as simple curve.
2. Vertical curve shall be provided only at the junction of two gradients either equal to or more than 4mm/m or 0.4%.

Minimum Radius of Vertical Curve:

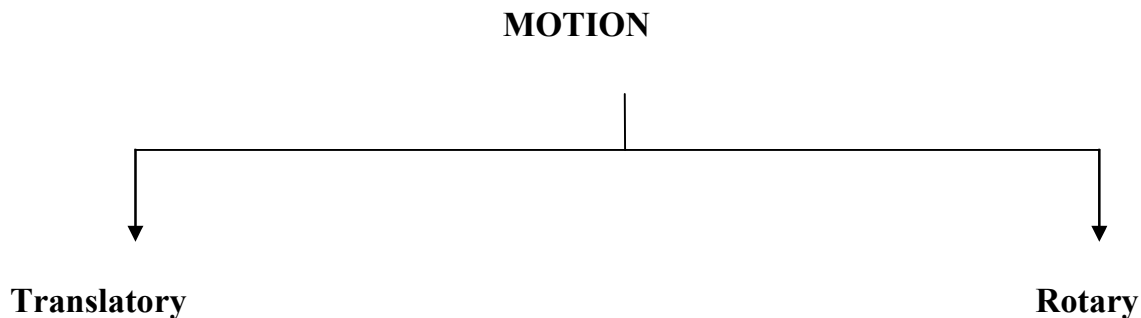
As per IRPWM and LWR manual the minimum value of radius of vertical curve is as below

BG: For A route, minimum R = 4000 mtrs

For B route, minimum R = 3000 mtrs

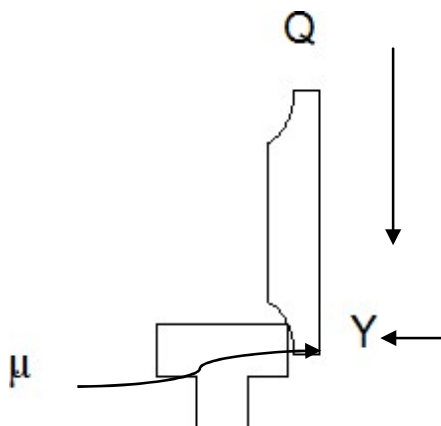
For C route, minimum R = 2500 mtrs

MG: For all routes, minimum R = 2500 mtrs

Motion of wheel on curve:**Factors Effecting μ (Frictional Force):**

The value of μ should be as less as possible. Increased Value of μ increases the tendency of derailment.

The value of μ is increased at



Q = Instantaneous load (or) stabilizing

Force Y = Flange Force (or) Derailment

Force

μ = Frictional Force

NADAL'S EQUATION:

$Q > Y + \mu$ (Safe Moment)

$Q < Y + \mu$ (Chances of Derailment)

- i. Rusted Rail

- ii. New Turned Rail
- iii. Sandy Particles on Rail

Super Elevation on Curves

Cant or Super-elevation:

It is the amount by which one rail is raised above the other rail. It is positive when the outer rail on a curved track is raised above inner rail and is negative when the inner rail on a curved track is raised above the outer rail.

Necessity for providing cant:

When a vehicle moves on a curved track, it is the tendency of the vehicle to take a straight path. While doing so the flange of leading outer wheel exerts pressure on outer rail. In reverse of it outer rails also exert pressure on wheel flange, which helps the wheel to move on curve path.

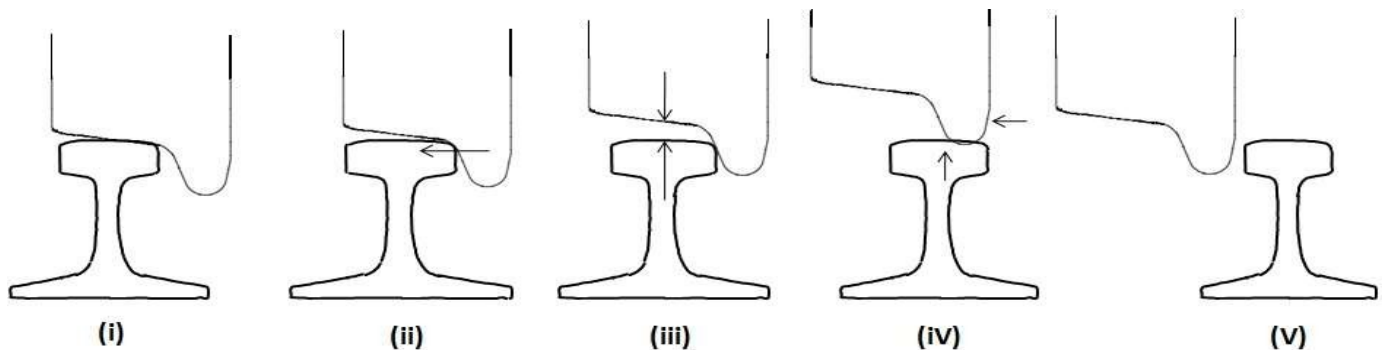
Hence the flange force is essential for motion of wheel on curve.

As soon as vehicle enters a curved path, it is also subjected to pseudo-force i.e., centrifugal force whose direction is always away from centre of the curve. Due to the centrifugal force, flange pressure increases on the outer rail.

Since the flange force is considered as a derailment force (by Nadal's equation) and due to this additional centrifugal force (mv^2/R), the amount of derailment force is increased enormously. Hence, it is essential to counter act (balance) this by another force.

In normal condition on straight track, the center of gravity of the vehicle passes through the centre of the track. It is considered as a balanced condition. Due to the additional flange force, the centre of the gravity of the vehicle gets misaligned towards the inner side of the curve and hence deviates from the center of the track. This causes the unbalanced condition which leads to derailment. Hence it is necessary to re-obtain the balanced condition i.e., the center of gravity of the vehicle should pass through centre of the track.

This force is generated by changing direction of self-weight (W) of the moving vehicle. For this outer rail is raised in comparison to inner rail, in such a manner, such that the resultant of the centrifugal force/flange force and weight of the vehicle (stabilization force) should pass through the centre of the track is at right angles to the plane of the top of rails.



Tendency of Derailment

Purpose of providing Super elevation:

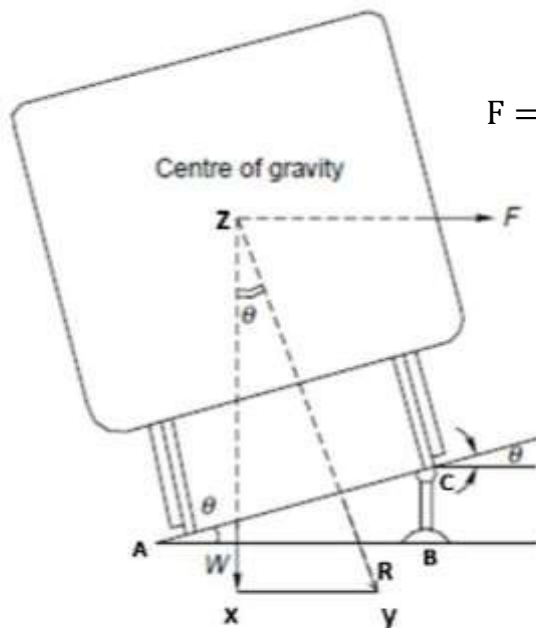
1. To counter balance the centrifugal force.
2. For proper distribution of load on both rails (Inner & Outer).
3. For better comfort of passengers.
4. To reduce the chances of wheel mounting.
5. To reduce wear and tear of the rail as well as the rolling stock.

Maximum Value of SE on BG Track

1. For Group 'A' & 'B' Routes : 185 mm
2. For Other Routes : 165 mm

Note: On all routes, maximum design cant to be limited to 140mm on track with turnouts.

Derivation of Formula for Super Elevation



$$F = \frac{mv^2}{R}$$

Given:

AB=AC= Track Gauge

BC = Super elevation

W = Weight of the Vehicle

R = Resultant of Weight „W“ and Centrifugal force „F“

$$\text{In } \Delta ABC \tan \theta = \frac{BC}{AB} \text{ --- (1)}$$

$$\text{In } \Delta XYZ \tan \theta = \frac{XY}{XZ} \text{ --- (2)}$$

Equating Eqⁿs 1 & 2

$$\frac{BC}{AB} = \frac{XY}{XZ}$$

$$BC = \frac{XY}{XZ} \cdot AB$$

$$BC = \frac{F}{W} \cdot AB$$

Where,

SE (Super elevation or Cant) is in mm

G (Gauge) is in mm

V (Velocity) is in Km/hr

$$SE = \frac{G \times mv^2}{mg \times R} = \frac{G v^2}{g R}$$

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R (Radius) is in meters

$$SE = \frac{G v^2}{g R}$$

For MKS System Putting Value

$$\text{Track gauge} = \frac{G}{1000} \text{ meter}$$

$$V (\text{Speed in Km/hr}) = \frac{1000}{60 \times 60} V \text{ m/sec} = \frac{5}{18} V \text{ m/sec}$$

Thus,

$$SE = \frac{G v^2}{g R} = \frac{G}{1000} \times \frac{5}{18} V \times \frac{5}{18} V \times \frac{1}{9.81} \times \frac{1}{R} \times 1000$$

$$SE = \frac{G \times 25 \times v^2}{18 \times 18 \times 9.81 \times R} = \frac{25G v^2}{3175 R} \text{ mm}$$

$$SE = \frac{G v^2}{127 R} \text{ mm}$$

Equilibrium Speed and Equilibrium Super Elevation

Equilibrium speed is the speed at which the centrifugal force developed during the movement of the vehicle on a curved track is exactly balanced by the cant provided.

For a particular curve on a particular speed super-elevation provided by Formula $\frac{GV^2}{127R}$ is known as Equilibrium Super Elevation and the particular speed is known as Equilibrium Speed. Provision of Equilibrium Super Elevation in track is not possible due to the following reasons

1. Provision and maintenance of much cant in track is not comfortable.
2. It's effect on slow moving track will be as below
 - a. Chances of derailment of inner wheel will increase.
 - b. Reaction on inner rail is increased.
 - c. In storm, chances of overturning of wagon will be increased.

Note: The equilibrium state means effect of centrifugal force (C.F) on curve is totally counter balanced and resultant of C.F and vehicle weight (W) passing perpendicularly to rail level plane in centre of track.

Cant Deficiency:

When a vehicle runs on a curved track at a speed more than the equilibrium speed, cant deficiency is observed.

The difference between the super elevation required for maximum permissible speed on the curve and the actual super elevation provided on the curve is known as cant deficiency.

$$\text{Cant Deficiency} = C_{\text{mps}} - C_{\text{Actual}}$$

Where, C_{mps} is the Cant on Maximum Permissible Speed C_{Actual} is the Actual Cant Provided.

Maximum Value of Cant Deficiency on BG Track:

For Nominated Rolling Stocks = **100 mm/150 mm**

Note 1: For Rolling stocks permitted with 150 mm cant deficiency, cant deficiency to be limited to 115 mm on track with turnout with crossing on outer rail and on track with expansion device.

Note 2: Nominated stock shall be permitted cant deficiency of 100 mm/115 mm/150 mm after found satisfactory during oscillation trial and specified as such in speed certificate

issued by RDSO.

For other Rolling Stocks not covered above = 75 mm

Adverse Effect of Cant Deficiency:

1. Wear and Tear of outer rail & outer wheel flange will be increased.
2. Lateral disturbance of track due to unbalanced centrifugal force
3. Discomfort to the passengers.
4. Chances of Derailment of vehicle/wagon will be increased

Cant Excess:

When a vehicle runs on a curve at a speed lower than the equilibrium speed, cant Excess is observed.

It is the difference between the actual cant and the theoretical cant required for such a lower speed.

$$\text{Cant Excess} = C_{\text{Actual}} - C_{\text{minimum Speed}}$$

Maximum value of Cant Excess = 75mm

Adverse effect of Cant Excess:

1. Wear and tear of inner rail and inner wheel flange is increased.
2. Chances of derailment of vehicle are increased due to „Off-loading“ of outer wheel.
3. Discomfort to passengers.
4. In heavy winds, Chances of overturning of vehicle is increased.
5. Chances of displacement of consignment in wagon

Maximum permissible speed (MPS) of the curve-

The highest speed which may be permitted on a curve is known as Maximum Permissible Speed of the curve.

The speed is permitted by taking into consideration of the following factors

- i. The radius of the curvature

- ii. Actual cant Provided
- iii. Cant deficiency/Cant excess
- iv. Transition Length of the Curve

When the maximum permissible speed (MPS) on a curve is less than the maximum sectional speed (MSS) of the section of a line, permanent speed restriction becomes necessary.

So a permanent speed restriction is imposed on that particular curve.

Maximum Sanctioned / permissible Speed of Section (MSS)

The highest speed permitted by Commissioner of Railway Safety (C.R.S) for a particular section is known as Maximum Sanctioned / permissible Speed of Section (MSS)

This depends upon the track structure and locomotives used for that section. Driver should never cross this speed in any case.

Booked Speed:

It is the Speed on which a particular train is allowed or booked to run in a particular section. Normally this speed is lesser by 10-12% from the MSS.

Cant gradient and Cant deficiency gradient

This indicates amount by which cant or deficiency of cant is increased or decreased in a given length of transition.

Ex.: 1 in 1000 means that cant or deficiency of cant of 1 mm is gained or lost in every 1000 mm/1m of transition length.

Rate of change of cant or rate of change of cant deficiency

This is the rate at which cant or cant deficiency is increased or decreased per second at the maximum permissible speed of the vehicle passing over the transition curve.

Ex.: 35 mm. per second means that a vehicle when travelling at a maximum speed permitted will experience a change in cant or deficiency of cant of 35mm. in each second of travel over the transition Curve.

Preferably it should be **35 mm/sec** in BG Track. In the worst case it should not be more than **55 mm/sec** in BG Track.

Speed on Curve for 'D' and 'E' Route (M.S.S=100 kmph)

1. Assumption of Equilibrium Speed

Equilibrium Speed = $\frac{3}{4}$ of the M.S.S. of section

2. Assumption of Safe Speed

For all practical purposes safe speed means a speed which protects a carriage from the danger of overturning and derailment and provides a certain margin of safety.

a) Transitioned Curves

The maximum permissible speed for transitioned curves should be determined (based on the assumption that the centre-to-centre distance between railheads is 1750 mm) using the following formulae:

$$\text{Safe Speed, } V = 0.27 \sqrt{R (Ca + Cd)} \text{ Kmph}$$

Where,

V = Speed in Kmph.

R = Radius in metres.

Ca = Actual cant in mm.

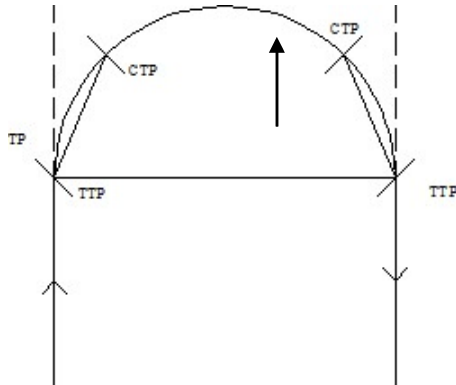
Cd = Permissible cant deficiency in mm.

b) Non-transitioned Curves

$$\text{Safe Speed} = \frac{4}{5} \text{ Kmph}$$

Where, V is the speed in km/h and R is the radius in meters.

TRANSITION CURVE



TTP – Tangential Tangent Point

CTP – Curve Tangent Point

$$C.F. = \frac{mv^2}{R}$$

$$\frac{mv^2}{R} = \text{Radial acceleration}$$

Necessity of Transition Curve:

When a vehicle passes with a uniform speed on a curve, it is subjected with radial acceleration resulting $\frac{v^2}{R}$ where v = uniform speed, R = Radius of curve

When a radial acceleration acts uniformly or rate of change of radial acceleration is less than $(0.305 \text{ meter/sec}^2)/\text{sec}$, there is no discomfort to the passengers.

When a vehicle runs on a straight track, there is no radial acceleration/centrifugal force reacts on it. As soon as the vehicle enters in a curved track from straight track it is subjected to sudden radial acceleration, which not only causes discomfort to the passengers but also infringes the safety. At slow speeds, this jerk will be less and at high speeds this jerk will be more. Hence on high speed routes transition curve is essentially provided not only for comfort but also to ensure safe running of vehicle. In order to provide smooth entry and exit of train in the curve, the transition curve is provided on both ends of the circular curve.

The radial acceleration is „build up“ (or) „ease out“ gradually in the transition length. Hence the transition curve is also known as an easement curve in which degree of curve is gained (or) lost gradually while entering from straight line (or) vice versa.

The centrifugal force generated due to the above radial acceleration is counter balanced by providing super elevation (raising outer rail of curve) on curve, at tangent point of curve. Since sudden raising of rail is not possible, hence gradual gain of super elevation and cant deficiency is carried out in transition length of curve from Tangent Point.

Objectives of introducing a Transition curve:

1. To decrease the radius of the curvature gradually in a planned way from infinity at the straight line to the specified value of the radius of a circular curve in order to help the vehicle negotiate the curve smoothly.
2. To provide a gradual increase of the super elevation starting from zero at the straight track to the desired super elevation at the circular track.
3. Easy and smooth entry and exit of the vehicle from straight to curve and vice-versa.
4. To reduce/ avoid the chances of derailment.

Requirement of an ideal transition curve

1. It should be tangential to the straight line of the track i.e., it should start from the straight part of the track with a zero curvature, at TTP.
2. It should join the circular curve tangentially, i.e., it should finally have the same curvature as that of the circular curve, at CTP.
3. Its curvature should increase at the same rate as the super elevation.
4. The length of the transition curve should be adequate to attain the final super elevation, which increases gradually at a specified rate.

Shape of transition curve:

The shape of the transition curve in Indian Railway is normally “Cubic Parabola”. The equation is

$$y = \frac{x^3}{6RL}$$

Where,

R= Radius of Curve, Y = offset,

x= Distance from TTP,

L= Length of Transition Curve

In this curve, both the curvature and cant increase at the linear rate

Length of Transition Curve for speed up to 100 Kmph

a. $\frac{C_A \times V_m}{178}$

a. $\frac{C_D \times V_m}{178}$

c. $0.72 C_A$

Where,

C_A = Actual Cant

C_D = Actual Cant Deficiency

V_m = Average Speed

Curve on High Speed Route (On BG Curve)

S.No.	Parameters	For Routes other than A & B	For A & B Routes
1	Maximum Cant	165 mm	185 mm
2	Equilibrium Speed	$\frac{3}{4}$ of M.S.S	To be decided by Chief Engineer for each Section
		Safe Speed whichever is less	Maximum of 100 Kmph upto 2° curve
3	Cant Deficiency	a. 100 mm for nominated rolling stocks b. 75 mm for stocks other than covered above	
4	Maximum Cant Excess	75 mm	75 mm
5	Safe Speed For Transition Curve	1. $V = 0.27\sqrt{R(C_A + C_D)}$	
	For non-Transition Curve	2. $\frac{4}{5}$ of M.S.S	
6	Rate of change of Cant Deficiency	35 mm/sec	1. Preferable for it should be 35 mm/sec 2. In any case it should not exceed 55 mm/sec
7	Cant Gradient	1. 1 in 720 desirable 2. 1 in 360 Maximum (Not more sharper in any case)	Cant gradient so chosen that the rate of change of cant & cant deficiency at maximum permitted speed does not exceed 55mm/sec under any circumstances.

8	Track Gauge	1676 mm	Dynamic gauge of 1750 mm will be considered for speed calculation
9	Maximum speed for which 6 & 7	Upto 100 Kmph	Upto 160 Kmph

Length of Transition Curve on high speed route (minimum Length)

1. Minimum Length of Transition

$$a) \frac{C_A \times V_m}{268}$$

Where,

C_a = Actual Cant

$$b) \frac{C_D \times V_m}{268}$$

C_d = Actual Cant Deficiency

V_m = Average Speed

The larger value among the two relations, in the next multiple of 10

2. Desirable Transition Length

$$a) \frac{C_A \times V_m}{137}$$

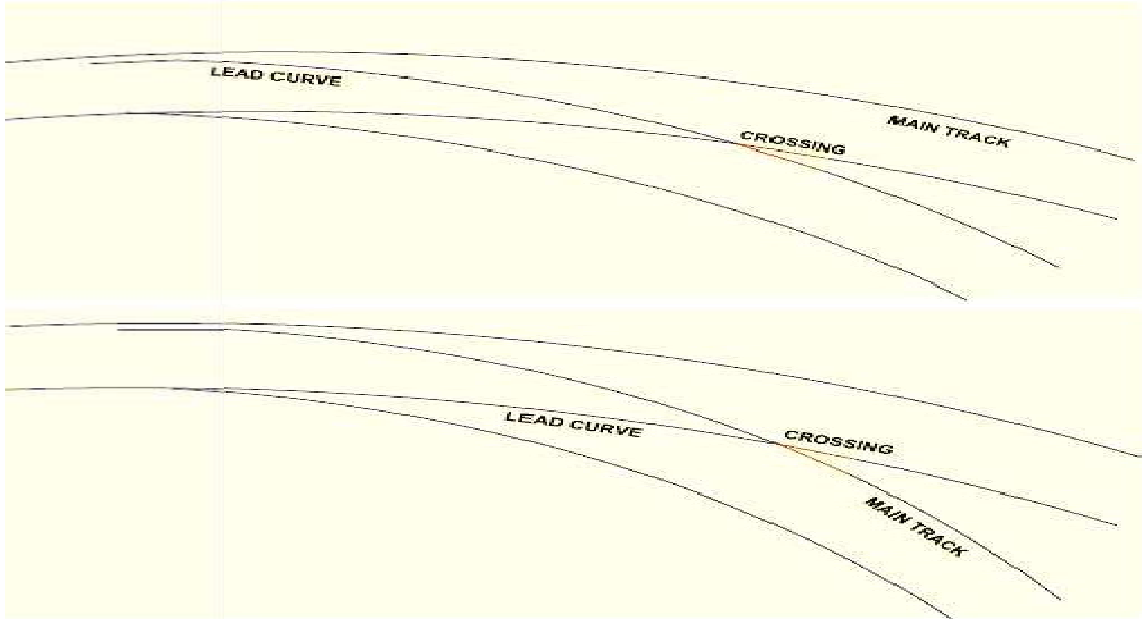
$$b) \frac{C_D \times V_m}{137}$$

$$c) 1.2 \times C_A$$

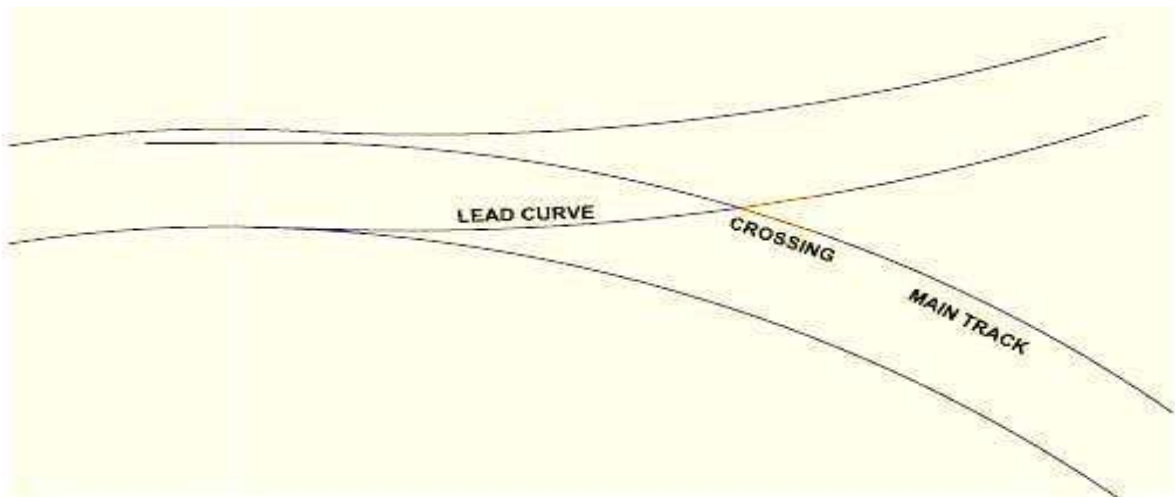
The larger value among the three relations, in the next multiple of 10

Types of Turnouts in Curve

Similar Flexure:

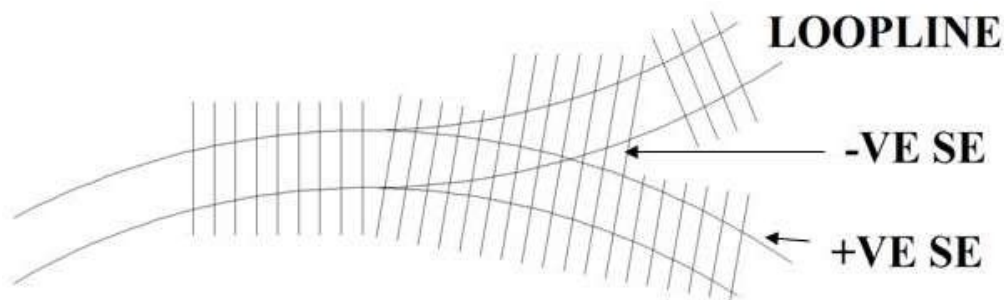


Contrary Flexure:



Negative Super elevation:

When the main line lies on a curve and has a turnout of contrary flexure leading to a branch line, the super elevation necessary for the average speed of trains running over the main line curve cannot be provided. In such cases, the branch line curve has a negative super elevation and, therefore, speeds on both tracks must be restricted, particularly on the branch line.



On the curve, the amount by which the inner rail is raised in comparison to outer rail is known as negative super elevation.

Note:

1. In case of negative super elevation, speed restriction must be provided on loop line as well as on main line as per situation.
Turnout side – Minimum Speed restriction = 30 kmph
2. Max value of negative super elevation is 50 mm.
3. For BG, Maximum superelevation on turnout = $\frac{11860}{R_t}$ mm (loop line)

Where, R_t = Radius of turnout

4. Hence, negative superelevation for turnout = Cant deficiency – Turnout Cant ($= \frac{11860}{R_t}$)
5. The negative superelevation should be rounded upto lower multiple of 5.

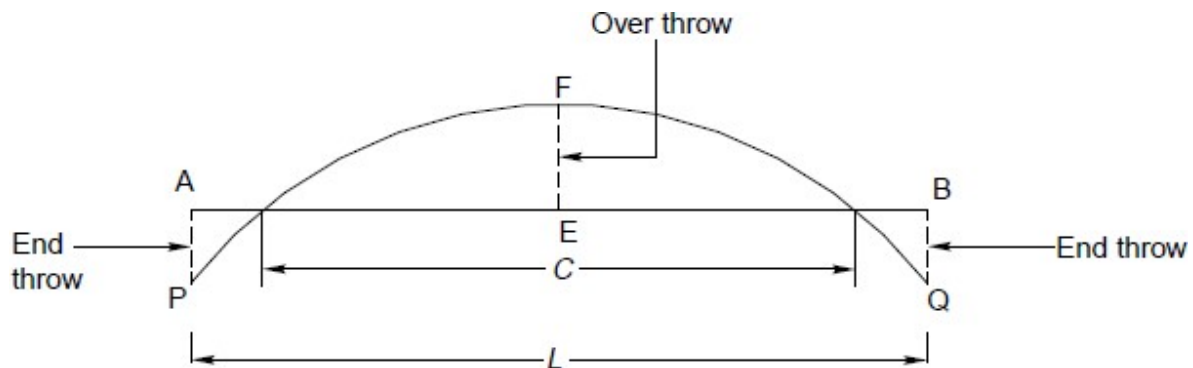
EXTRA CLEARANCE ON THE CURVE:

In schedule of dimensions (SOD), distances of various structures are given from the centre of straight track. But when a vehicle moves on curved track, these considered dimensions are not sufficient in selection with maximum moving dimensions of vehicle due to lean, learch sway, over throw, End throw, etc., resulting infringement. This occurs with open doors of vehicle. To avoid these infringements, extra clearance is provided on curved track.

Reasons for providing extra clearance on curve:

1. Effects of Curvature (over throw & End Throw)

When a vehicle negotiates a horizontal curve, its frame does not follow the path of the curve, since, being a rigid structure, it is unable to bend. The vehicle, therefore, projects towards the inside of the curve at its central point and toward the outside of the curve near its ends. The distance by which the longitudinal axis of the body of vehicle moves out from the central line of



the track is the extra clearance required.

- (i) The extra clearance required at the centre of the vehicle, which projects towards the inside of the curve, is called **overthrow** and is given by the equation

$$EF = \frac{c^2}{8R}$$

- (ii) The extra clearance required at the ends of the vehicle, which project towards the outside of the curve, is called **end-throw** and is given by the equation

$$AP \text{ or } BQ = \frac{L^2 - C^2}{8R}$$

Where, „L“ is the length of the vehicle

„C“ is the centre-to-centre distance between the bogies

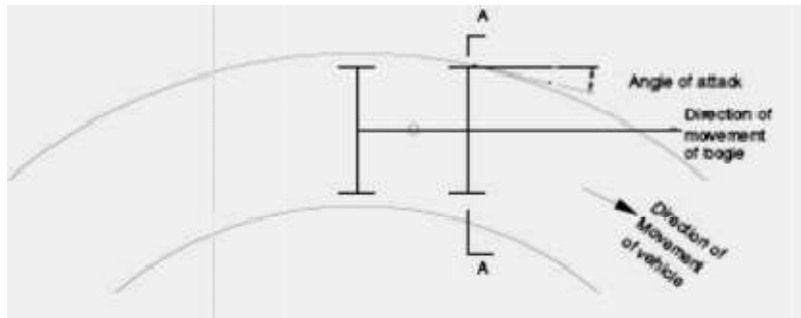
„R“ is the radius of the curve

Empirical Formula of throw for BG:

$$\text{Over Throw} = \frac{27330}{R} \text{ mm}$$

$$\text{End Throw} = \frac{29600}{R} \text{ mm}$$

These empirical formulae are based on standard BG bogie lengths and the value of R is in metres. C = 14.785 m , L = 21.34 m



2. Effect of leaning due to super elevation

On account of the super elevation provided on a curve, the vehicle leans towards the inside of the curve, thereby requiring extra clearance as shown in Figure. The extra clearance required for leaning is as follows

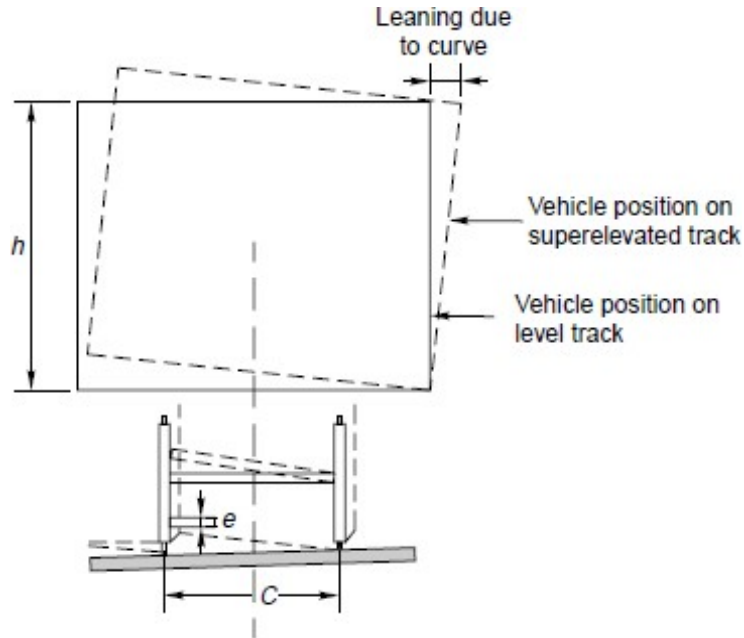
Where,

$$\text{Lean} = \frac{h \times e}{G}$$

h- height of the vehicle (=4.025 m for IR)

e- Super elevation

G – Track Gauge



3. Effect of Unbalanced centrifugal force (sway)

On account of unbalanced centrifugal forces caused due to cant deficiency or cant excess, the vehicles tend to experience an additional sway. The extra clearance required on the inside of the curve due to the sway is taken as one-fourth of the clearance necessary due to leaning.

Mathematically,

$$\text{Sway} = \frac{1}{4} (\text{Lean})$$

Total extra clearance

On summarizing, the total extra clearance (in mm) required on curves is as follows:

- **With Structure**

- Extra clearance inside the curve = overthrow + lean + sway

$$Ec_1 = \frac{C^2}{8R} + \frac{h \cdot e}{G} + \frac{1}{4} \frac{h \cdot e}{G}$$

- Extra clearance outside the curve = end-throw

$$Ec_2 = \frac{L^2 - C^2}{8R}$$

- **For platform and other Structures (To avoid gap)**

- Inside = Over throw + $\frac{5}{4}$ (*Lean*) – 51 (mm)
- Outside = End throw – 25 (mm)

- **Between two adjacent Tracks**

- Extra Clearance = Over throw + End throw + 2(Sway)

Check Rail on Curve:

Check rails are provided parallel to the inner rail on sharp curves due to the following reasons.

1. Due to uneven loading of vehicle, due to worn out wheels, due to long wheel base and due to insufficient S.E (Cant deficiency), there are always chances of mounting of outer wheel on outer rail resulting in derailment. Check rails prevent the wheel mounting on outer rail as well as decreases the chances of derailment.
2. Due to the flange force and un-counteracted centrifugal forces, outer rail gets wear out rapidly on sharp curve. Check rail prevents the wear of outer rail, but it wears rapidly itself which is cost wise not valuable because it is used with release rail.
3. It increases the lateral stability of track on sharp curve.

Disadvantages of check rail

1. Additional track Maintenance cost
2. Additional resistance provided to moving wheels resulting increase of haulage cost
3. Additional wear in inner rail.

Degree of limitations

BG → 8° and above check rail must be provided.

Check rail clearance

1. Minimum rail clearance = 44 mm
2. Maximum rail clearance = 48 mm

Note: If gauge slackness is provided on curve, check rail clearance (CRC) will also increase by $\frac{1}{2}$ of its amount.

Necessity of gauge slack on curve:

On sharp curve, gauge is kept slack for free movement of the rigid bogie wheel base to reduce the excessive wheel flange force on the outer rail. On B.G track, the gauges are kept slack as under:

1. Up to 4° Curve = Exact gauge is maintained
2. More than 4° Curve = + 6mm slack in gauge is maintained

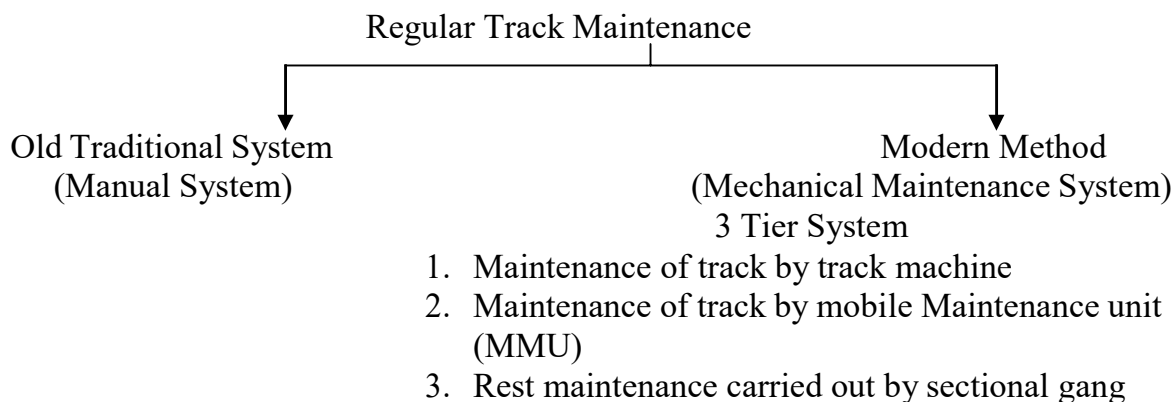
Lubrication on Gauge faces of outer rail of curve:

On curved track, to reduce the outer rail wear it is the best method to lubricate the gauge face / inner face of outer rail.

The outer rail gauge face is lubricated to obtain the following advantages:

- 50% wear and tear of the outer rail and outer wheel are reduced
- Fuel economy increases
- Condition and parameters of the curve are maintained
- By reducing the frictional losses we can increase the speed on sharp curve
- Chances of derailment is reduced
- Haulage cost is reduced

REGULAR TRACK MAINTENANCE



Note: MMU is a combination of road cum rail vehicle

Manual Maintenance (Traditional method)

S.No	Process	Duration	Properties Maintained	IF m/C used Which M/C
1	Through Packing	Once in a year	Track health and track parameters	TTM(Tie Tamping Machines)
2	Overhauling	Once in 4/3 Years	Shoulder , Crib ballast Screening	FRM, SBCM
3	Deep Screening	Once in 10 to 12 years	Entire Ballast Section is screened with 1": Squares mesh	BCM
4	Pick up The Slacks	As per Need	Un wanted material are removed from track	
5	Special Work	As per Need	Renewal of track, Rails, Fasteners, ballast regulation, Lubrication of fittings and fastenings etc	BRM,T-28,PQRS, SQRS ,ATRT,RTRT etc

PROPOSED SCHEDULES FOR DEEP SCREENING (MANUAL PACKING)

Day	Sequence of events	Speed in Kmph
1st	Deep Screening and initial packing	20
2nd	1 st through packing	20
3rd	2nd through packing	20
4 th to 9 th	Picking up of slacks as required	45
10th	3rd through packing	45
11 th to 19 th	Picking up of slacks as required	75
Speed raised to normal sectional speed, only after one round of tamping by machine in design mode and stabilisation in controlled settlement mode		

PROPOSED SCHEDULE FOR DEEP SCREENING (MACHINE PACKING /B.G.)

Day	Sequence of Events	Speed in Kmph
1st	Deep Screening with Initial Packing	20
2nd	First Machine Packing	20
3rd to 5th	Picking up of slacks as required	45
6th	Second Machine packing	45
7th& 8th	Picking up of slacks as required	75
9th	Third Machine packing	75
10th	Normal Sectional speed	

Note :

Normally all the process are not complete without through packing. In case of Deep Screening 7 Rounds of through Packing +21 days of speed restriction is provided on the track in case of Manual maintenance. In case of Machine Maintenance it is 10 days.

Through Packing:

Through packing consists of the following operations in sequence. The length of track opened out on any one day shall not be more than that can be efficiently tackled before the end of the day:

1. Opening of track.
2. Examination of rails, sleepers and fastenings
3. Squaring and spacing of sleepers.
4. Slewing of track to correct alignment.
5. Gauging.
6. Packing of sleepers.

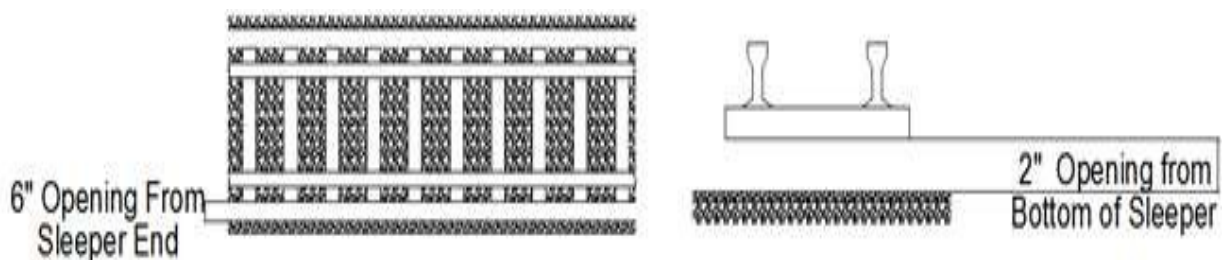
7. Repacking of joint sleepers.

8. Boxing and tying.

The sectional gang start in working season the work of through packing from one end of gang beat and goes to another end till completion of the work in that section.

Opening of Track :

Opening of ballast is carried out in both ends of sleeper up to 6" away and crib ballast under the rail seat up to minimum depth of 2" from the bottom of the sleeper by the claw.

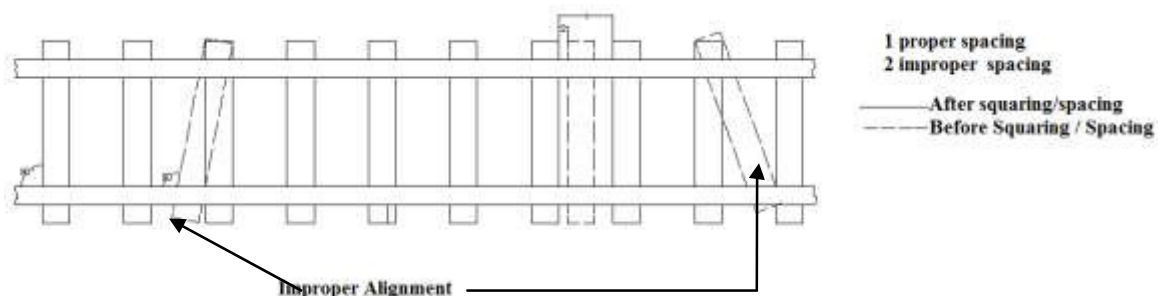


Examination of Rails, Sleepers and Fastenings –

Operation of this sequence track health is made strong. Worn-out/ Unserviceable sleepers are replaced by serviceable sleepers, missing fitting and fasteners/unserviceable fitting and fastenings are replaced by new one

Spacing and Squaring of sleepers: -

In this sequence after the replacement of Worn-out/ Unserviceable components of track, the sleepers are spaced and squared as per requirement. This is necessary for smooth /Good/Efficient running of the train.



Slewing of track to correct alignment:

In this sequence of operation the gang mate collects workmen at one place and select one rail as reference rail. This reference rail is aligned manually with crow bar and in the eye view standing 3 rail behind from the aligned position.

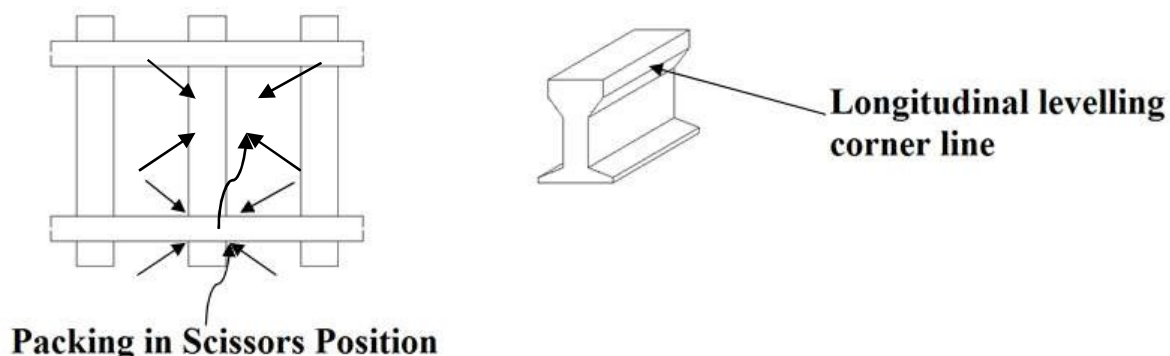
Gauging:-

After the alignment gauging to the track is corrected in second rail (other than reference rail) normally this gauging is also carried out in eye view to avoid kinks etc. No sudden change in the gauge is allowed even tolerance is permitted. After the correction the gauge correctness is checked by the gang mate with the help of track gauge measuring instrument.

Packing of sleepers

In this sequence longitudinal and cross level of the track is corrected by lifting of the track and packing of the sleepers. The work of longitudinal leveling is supervised by the gang mate in eye view from one rail behind and looking reference rail cutter face bottom corners.

After the leveling of the reference rail, second rail is also lifted and packed in zero cross level in same fashion as reference rail is packed. After the leveling each pair of gang men return in the sleeper bit and well packed in scissor's position.



Repacking of joint sleepers:

After coming back from the lunch gang mate examines the deficiency of the track generated by moving train during the period of the lunch. Such locations are identified by the mate and repacked /realigned as per need to correct alignment and leveling of track . After this each pair again packed each sleepers as a final packing and joint sleepers are specially repacked

Boxing and Tyding: –

After final packing of the track the opened ballast repositioned in the track with the help of claw and sleepers are fully boxed as per standard ballast profile of the track. Ballast deficiency is re-equipped and excess ballast are removed and collected to the cess. All the green dries are removed from the track , drains are repaired, cleared and trolleyrefuges are required..

Over Hauling of Track:-

Overhauling of the track is done for the following purpose

1. To improve the drainage
2. To make availability of the clean ballast for packing

In this process shoulder ballast and crib ballast up to 4” from the bottom of sleepers screened by 25mm manually. Since no cushion ballast is disturbed hence no caution is required for carrying out the process. After the screening all eight operations of the through packing is essential to carry out in the track then only overhauling operation willbe treated complete

Normally one fourth section of the gang bit is overhauled every year but the location around the sub-urban areas and other track circulated zone. Where chance of dirty ballast is more overhauling can be carried out in every three years.

Deep Screening

In this operation entire ballast section is cleaned by 25mm mesh manually. Since in thisoperation cushion ballast bed is disturbed. Hence the operation is carried out by supporting track on wooden block under the 15 kmph(20 kmph caution). This caution isrest after six round of through packing and intermediate stabilization period gradually from (20-30-50-70) to normal about 21 days are involved in this operation.

Various restrictions applied immediately after the work

After Manual Packing

- | | | |
|-----------------------------------|---|---------|
| 1. Pre-Stressed concrete sleepers | – | 20 kmph |
| 2. Other stressed | - | 10 kmph |

After BCM working (only on PRC)

- | | | |
|----------------|---|---------|
| 1. BCM | - | 20 kmph |
| 2. BCM+TTM | – | 30 kmph |
| 3. BCM+TTM+DGS | – | 40 kmph |

Note:

Normally 15kmph should be implemented on the track after immediate end of the Packing / Screening. Since nowadays the implementation of speed is not in multiples of 5 for slower speed so it is implemented in the multiples of 10.

Picking up of Slacks

Basically it is the need based maintenance. Which is carried out in the track in non-working seasons (in monsoons etc) when through packing and other maintenance work could not be carried out . in this operation only the affected portion of the track(settles track) is attended to maintain the certain maintenance standard of the track. So that safe running of the train can be assured.

The location of defect is identified by the track recording car (TRC) restart trolley in section, foot plot inspection and foot inspection only.

Normally in this operation following locations are attended regularly.

- i) SEJ, Glued Joints and fish plated joint.
- ii) Approaches of the girder bridges, Level crossings and points & Crossing
- iii) Weak formation
- iv) Pedestal and cattle crossing
- v) Breathing length of LWR
- vi) Location where ballast is dirty etc.

Precautions to be taken while Working in Track circuited Areas-

1. The Permanent way inspector 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.
2. All gauges, levels, trolleys and lorries used on the track circuited length should be insulated.
3. 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.
4. While carrying out track maintenance, care should be taken to see that no damage of track circuit fittings like rail bonding wires, lead wires to rails, boot leg, jumper wires etc., takes place.

5. Use of steel tapes should be avoided in track circuited section.
6. Pulling back of rails should be done in track circuited areas in the presence of S&T staff, where signaling connections are involved.
7. Proper drainage should be ensured so as to avoid flooding of track, during rains, particularly in yards, where watering of coaches is done and in water columns and ash pits. It would be desirable to provide washable concrete aprons on platform lines at originating stations, in track circuited areas.
8. Ballast must be kept clean throughout the track circuited section and care should be taken to see that the ballast is kept clear of the rails and rail fastenings. The clearance from the foot of the rail should not be less than 50mm. During every packing this point should be taken note of.

Other Precautions to be taken while Working in Track circuited Areas are as follows

1. In charge Sectional P. Way Engineer shall instruct the staff not to place across or touching two rails in the track, any tool or metal object which may cause short circuiting.
2. All gauges, levels, trolleys and Lorries used on the track circuited length shall be insulated.
3. Steel or C. 1 pipes used for carrying water gas under the track shall be placed sufficiently below the rails to prevent any short circuiting.
4. While carrying out track maintenance, care shall be taken to ensure that no damage of track circuit fittings like bond wires bootlegs, jumped wires etc. takes place.
5. Use of steel tape should be avoided.
6. Pulling back of rails in track circuited areas shall be done in the presence of S&T staff.
7. Proper drainage shall be ensured in yard to avoid flooding of track during rains. where watering of coaches is done. It would be desirable to provide washable concrete aprons on platform lines.
8. Ballast shall be kept clean throughout the track circuited length and care shall be taken to ensure that ballast is kept clear of rails i.e. 50mm from under side the foot of rail.
9. Min. ballast resistance per Km. of track < 20 ohms in the station yards and < 4 ohms in block sections.

Maintenance in Electrified Areas

General Instructions to staff –

(1) General Knowledge of Engineering Staff-

- a) Every engineering official working in electrical traction area shall be in possession of a copy of rules framed for the purpose of the operation of the Traction Power Distribution system pertaining to Engineering Department and ensure that staff working under him is also acquainted with the rules. He will ensure that rules pertaining to carrying out engineering works are strictly observed.
- b) All electrical equipment, every power line or cable shall be regarded as being 'live' at all times. No work shall be commenced adjacent to any electrical equipment except on authority issued in writing by a competent official of the Electrical Department to the effect that the equipment has been made dead and earthed.

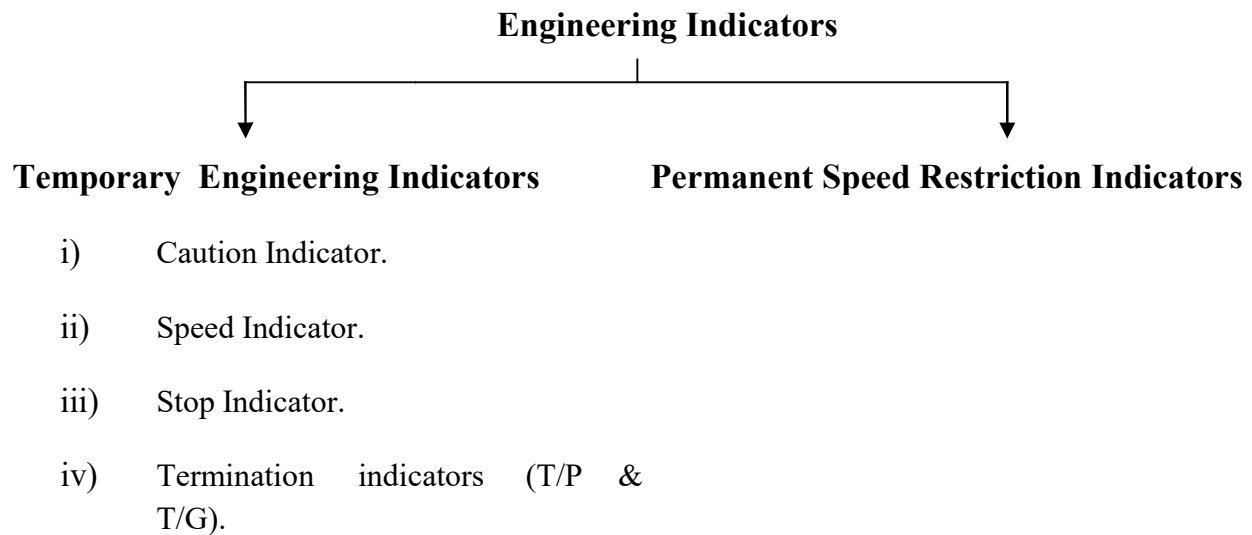
(2) Defects in an Overhead Equipment:-Defects or break-downs in the overhead equipment including track and structure bonds noticed by the Engineering staff shall be reported immediately to the Traction Power Controller. When defects in the overhead equipment that are likely to cause damage to pantographs or trains, are noticed and it is not possible to convey information to Station Masters or signalmen to enable them to issue caution orders, the line shall be protected by the staff noticing such defects according to General Rule 3.62.

(3) Traction Bonds - In electrified areas the return current fully or partially flows through the rail. To ensure a reliable electrical circuit continuity and also to ensure proper earthing in case of leakage of current, various types of traction bonds as described below are provided at suitable places and maintained by the Electrical Traction Department.

- (a) **Longitudinal Rail Bonds** - In the case of D.C. traction system, practically the whole return current flows through the rail. Therefore, two flexible copper bonds offering minimum resistance to the flow of current are provided at each rail joint under the fish-plates. Two solid lugs at the two ends of the copper bonds are inserted in holes drilled at the two rail ends between the fish bolt holes and are pressed by using a bend press to rivet them firmly to the rail. On points and crossings and at junction fish-plates where continuity bonds of the above type cannot be provided due to space constraint, continuity of return current path is achieved by using mild steel straps or G.I. wire ropes. Absence of such bonds may cause unsafe working condition and in extreme cases may damage the rail ends.

- (b) **Cross Bonds (D.C.)** :- Cross bonds are provided between adjacent tracks at regular intervals to reduce resistance of the current to the minimum. Such cross bonds are also known as transverse bonds.
- (c) **Structure Bonds** .-All structures supporting overhead equipment either in A.C or D.C. track circuited areas are connected to the running rails for ensuring good earthing. Failure of insulator or leakage of current switches off the supply from the sub-station so that men coming in contact with supporting structure etc. do not get electric shock. Removal or tampering of such bonds can, therefore, result in unsafe conditions. Since the structures are grouted in concrete, they are likely to become charged in case such bonds are kept disconnected. Similarly other steel structures such as foot-over bridges, sheds, etc., in the vicinity of O.H.E. lines are also connected to rails through similar structure bonds.

ENGINEERING INDICATORS

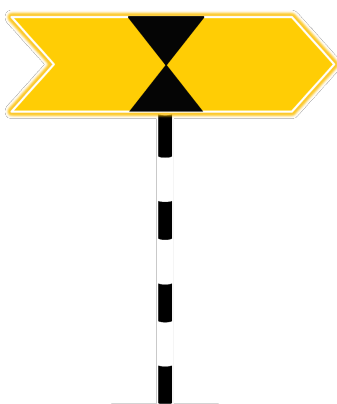
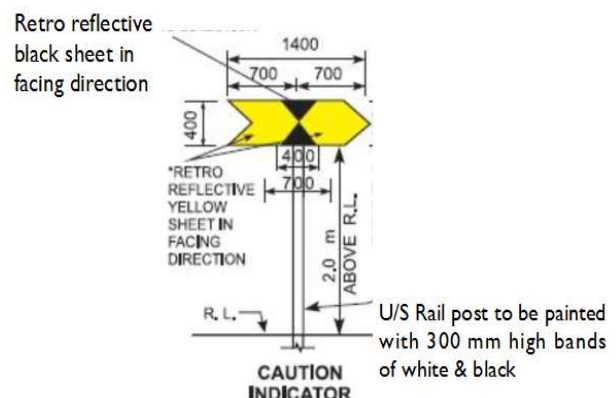


(i) Caution Indicator :-

This cautions the driver to get ready to reduce the speed. Caution indicator shall be provided at 800m in rear of the speed indicator and at 1200m where the trains are required to stop dead as in this case more braking distance is required by driver.

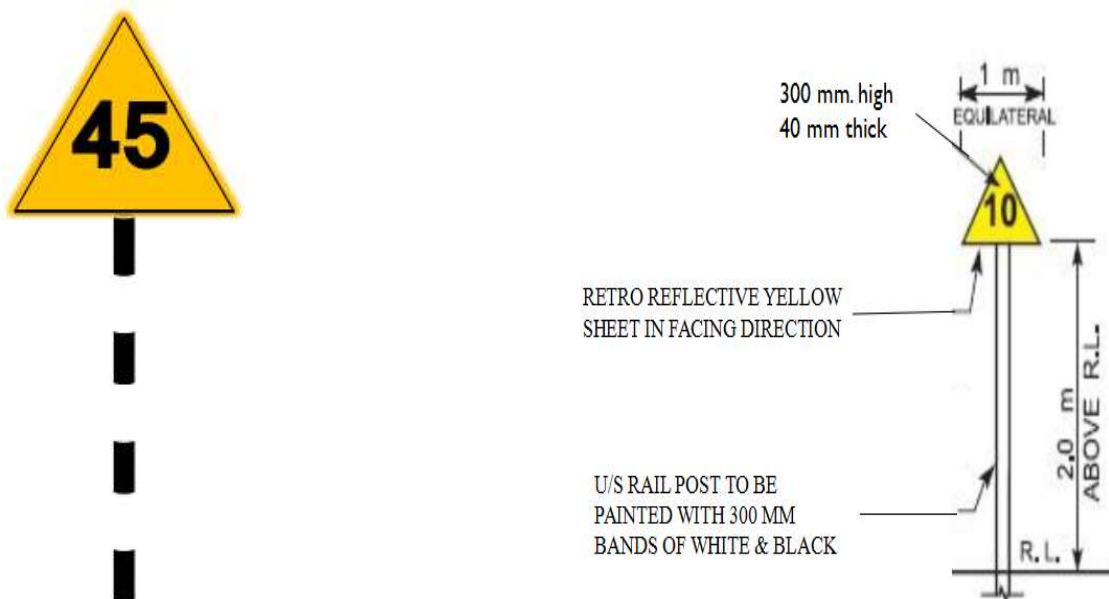
This shall consist of 1400mm long, 400mm wide. Fish tailed at one end and pointed at the other having 130mm dia. holes 2 nos. for showing yellow lights at night. The board shall be painted yellow & black.

Height of the board (bottom of the board) shall be 2.0m from rail level post will have 300mm high bend of white and black. Indicator shall be used in case of permanent as well as temporary restrictions. Temp. Engg. Indicator shall display at night 2 yellow lights to approaching trains or provided with fluorescent tape luminous paint or retro- reflective indicators (need not to lit at night).



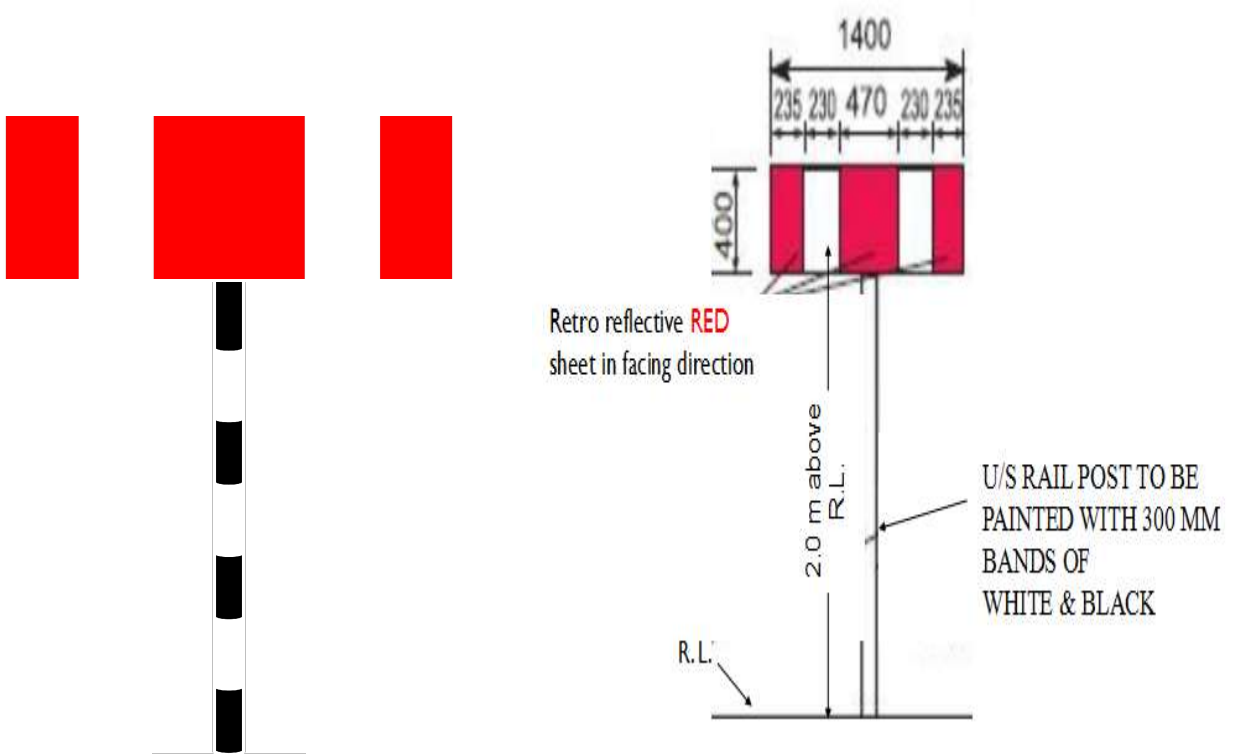
ii) **Speed Indicator :-**

It indicates to the driver to reduce the speed as indicated. This shall be provided 30m in rear from the point of commencement of speed restriction. Indicator shall consist of an equilateral triangular board with 1 meter sides having yellow base, 300mm high and 40 mm thick figures in black indicating the speed at which the train may proceed. The board shall be provided on a 2.0m high post (from the rail level to bottom of the board) painted with 300mm high white and black bands. Indicator shall be illuminated at night by fixing a hand signal lamp in front of it or provided with luminators.



(iii) **Stop Indicator :-**

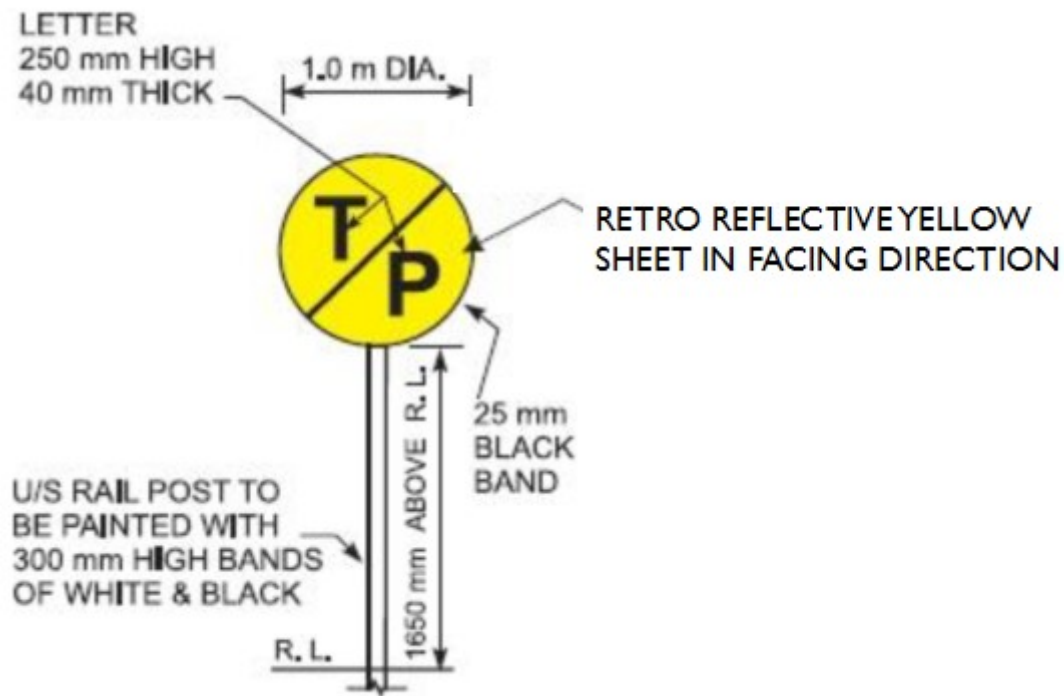
It indicates to the driver to stop the train short of indicator. Indicator shall be provided 30m m in rear of the commencement of stop dead restriction. This shall consist of a rectangular board 1400mm x 400 mm in size having 130mm dia. holes 2 Nos. for showing red lights at night painted with red and white vertical strips or provided with fluorescent tape luminous paint or retro reflective indicator. The board shall be fixed 2.0 meter high from rail level to the bottom of the board) painted with 300 mm high bands of white & black.



(iv) Termination Indicator :-

This indicates that the driver to resume normal; speed and last vehicle has cleared the restricted zone. This indicator shall be fixed at a distance equal to the longest length of passenger/goods train running in the section beyond the restricted zone.

The indicator shall be in accordance with the diagram & shall consist of one meter diameter disc painted yellow bearing 250mm high and 40mm thick letter T P and T.G. in black. The board shall be painted with 25mm thick black band at the circumference. It shall be fixed on a post 1650mm high (from rail level to the bottom of the disc) and shall be painted with 300mm high bands of black & white. The indicator shall be lighted at night by a fixed hand signal lamp or provided with fluorescent tape luminous paint or retro reflective indicator.



Temporary Engineering Indicators:

These indicators are used in connection with execution of some engineering work and removed as soon as the work is over. These indicators are flood lit at night. Retro-reflective indicators need not to lit at night. Significance of each indicator is given as below:

PERMANENT SPEED RESTRICTION INDICATORS:

(i) These indicators are same as mentioned above but used at the locations requiring permanent speed restriction (less than maximum sanctioned speed) such as weak bridge, sharp curve, weak formation turn out etc. As these restrictions last beyond the currency of the working time table hence mention of such restrictions are made in the working time table. Indicators provided are not lit at night.

(ii) Siding Boards – Siding boards indicating speed restriction are provided at facing of an outlying siding letter „S“ is painted in 300 mm height with black paint on 1 metre dia circular board having yellow base. These boards are provided in addition to caution & speed indicator where maximum sanctioned speed of the section doesnot exceed 59 kmph.

Indicators (General):

These indicators are provided either to give audible warning by the driver to ensure safety or shunting operation.

<p>Whistle Indicator (W):</p> <p>Whistle Indicators shall be provided at 600 m in rear of the places where the view of driver is obstructed by cutting or tunnel or curves and where it is necessary to give audible warning at the approach of a train to those working on the track.</p>	
<p>Whistle Indicators for Level Crossing (W/L):</p> <p>These indicators shall be provided at the approaches of all unmanned „C“ class level crossing or manned level crossing where the view is not clear on either side for a distance of 600 metres and those which have normal position open to road traffic. Bilingual whistle boards shall be provided at 600 m distance along the track from the level crossing to give audible warning by the drivers of approaching trains to the road users.</p>	
<p>Shunting Limit Boards:</p> <p>A rectangular yellow board (600 x 1000 mm) with a black cross at the top and the words 'Shunting Limit' (or 'S/L') indicates the end of a shunting section. This sign normally also has black and white bands on it, and white lamps attached on both sides (although the words are only on the side towards the station). This is usually provided at class 'B' stations on single-line sections (sometimes double-line) where shunting is permitted on the block section and advanced starters are not provided.</p> <p>The sign is placed 400m to the rear of the first stop signal of the station in lower-quadrant signaling (180m in modified lower-quadrant, upper-quadrant, and MACL systems). A single white lamp may appear through a hole in the sign above the centre.</p>	

Works at Times of Poor Visibility:-

No work which may cause obstruction to the passage of train shall be undertaken during foggy or tempestuous weather impairing visibility except in case of emergency. When such works are undertaken 2 detonators, 10 m apart shall be fixed 270 m in rear of caution indicator and caution hand signal exhibited to approaching trains.

Speed Restriction:-

In case where the trains are required to pass with restricted speed from site of work, the following temporary Engineering Indicators shall be exhibited.

(i) **Caution Indicator** – At 800m in rear of the obstruction.

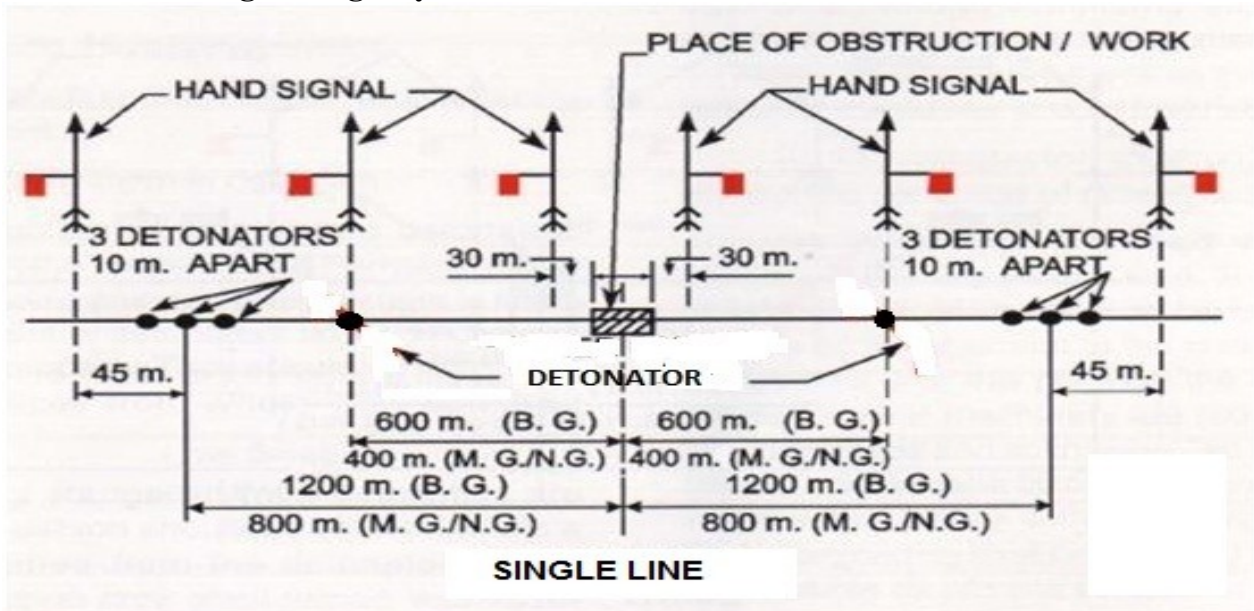
(ii) **Speed Indicator** – At 30m in rear of the obstruction.

(iii) **Termination Indicators for passenger & goods train** – At a place from where the driver may resume normal speed, which is the length of longest passenger/goods train running in the section.

PROTECTION:-

1. Protection During Emergency
2. Protection During Short Duration Work
3. Protection During Long Duration Work
 - i. When stop dead & 10 KMPH is required
 - ii. When only speed restriction is required

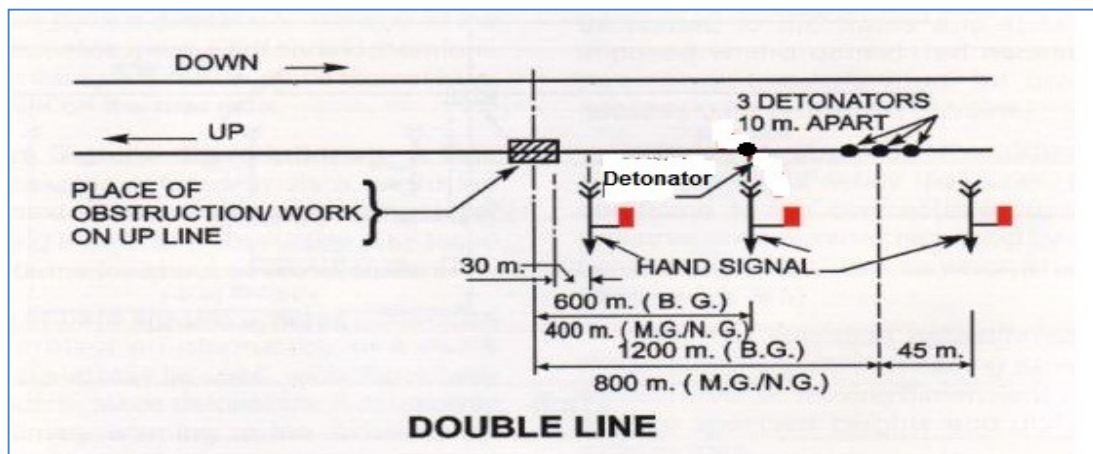
Protection During Emergency:



Key Man Having (1). 6 Nos of detonators (2) 2 Red flag & 1 Green Flag

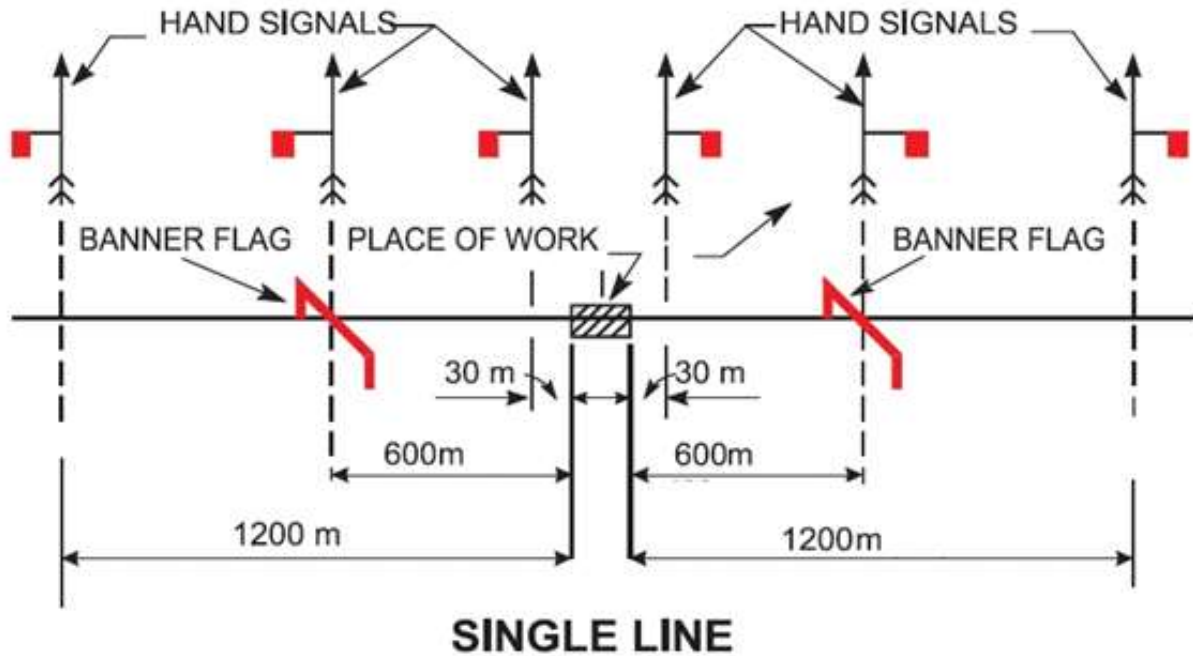
Note:

1. Red hand signal Flag (HS Red Flag) for day and Hand signal red lamp is considered as a danger signal.
2. All distances should be measured from the danger zone
3. Single line protection will be made in both direction and in double line protection will be made in direction from which the train as to come.
4. In case of emergency concerned railway person will take his own decision to stop the train in any how before reaching the danger zone.



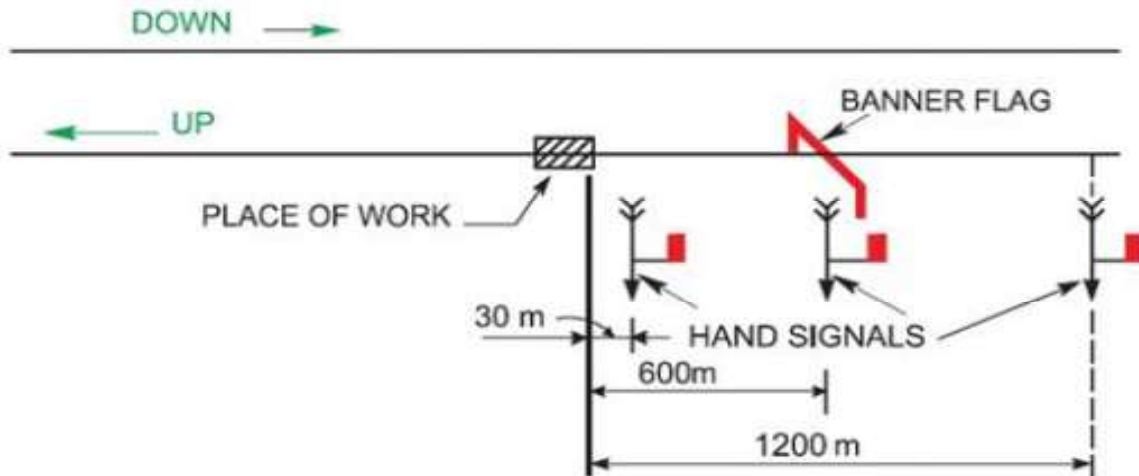
Protection during short duration work (In single Line BG Track)(6 Flag men used)

WORKS OF SHORT DURATION - PROTECTION OF LINE IN CASE OF REDUCED SPEED



Note:

1. In this protection red banner flag is considered as a stop signal
2. In this protection 3 flagmen required in one side(single line- 6flagmen , Doubleline 3 Flagmen)
3. In single line protection will be made in both direction and in double line protection will be made in 1 direction
4. In case of TTM working these flag man will also be mobiled keeping the standard distance as maintained

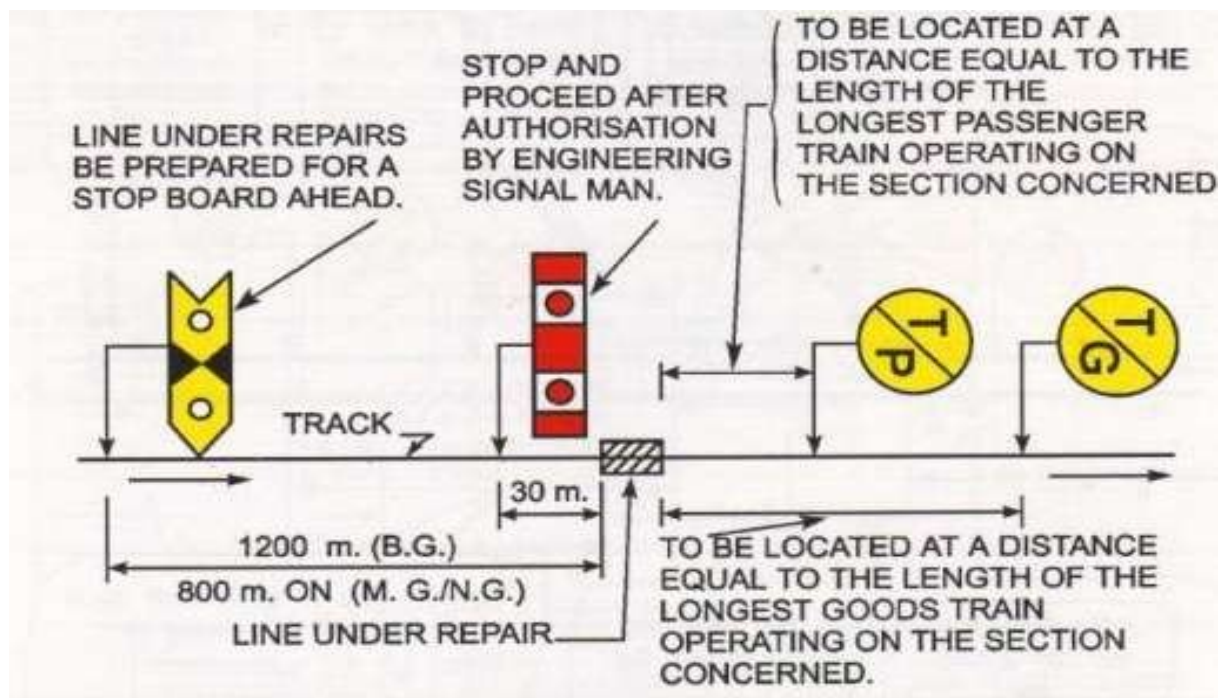


DOUBLE LINE

Note-

INTERMEDIATE FLAGMAN WILL KEEP BANNER FLAG UNTIL THE SPEED OF THE TRAIN HAS BEEN REDUCED, AFTER WHICH THE BANNER FLAG WILL BE REMOVED AND TRAIN HAND - SIGNALLED FORWARD.

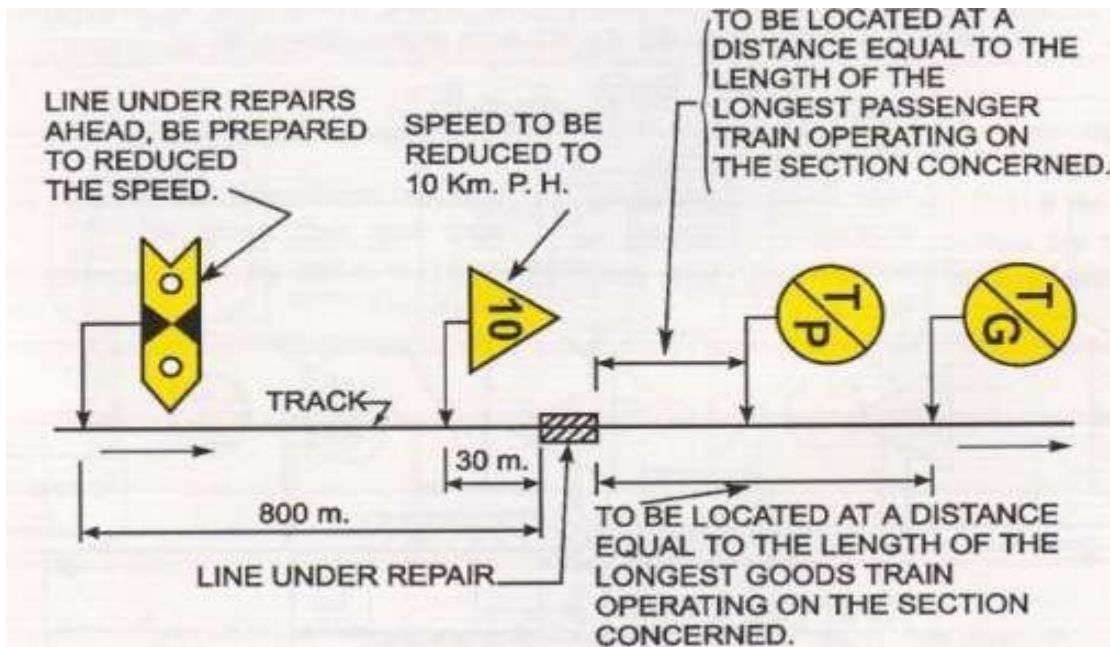
Protection During Long Duration Work (Single Line BG)



Note:

1. For long duration work protection of track is carried out with the help of caution board etc
2. During night each board will be manned and lighted only stop dead board will be equipped with a stationery patrolman (round the clock) with patrol book.
3. After passing out the train the entire danger area will be inspected by stationery patrolman and If found satisfactory then only next train will be permitted to pass out on danger one with the speed of 10 KMPH
4. All the distances shall be measured from danger zone.
5. During day H.S. Red flag & during night H.S Red Lamp is considered as dangersignal.

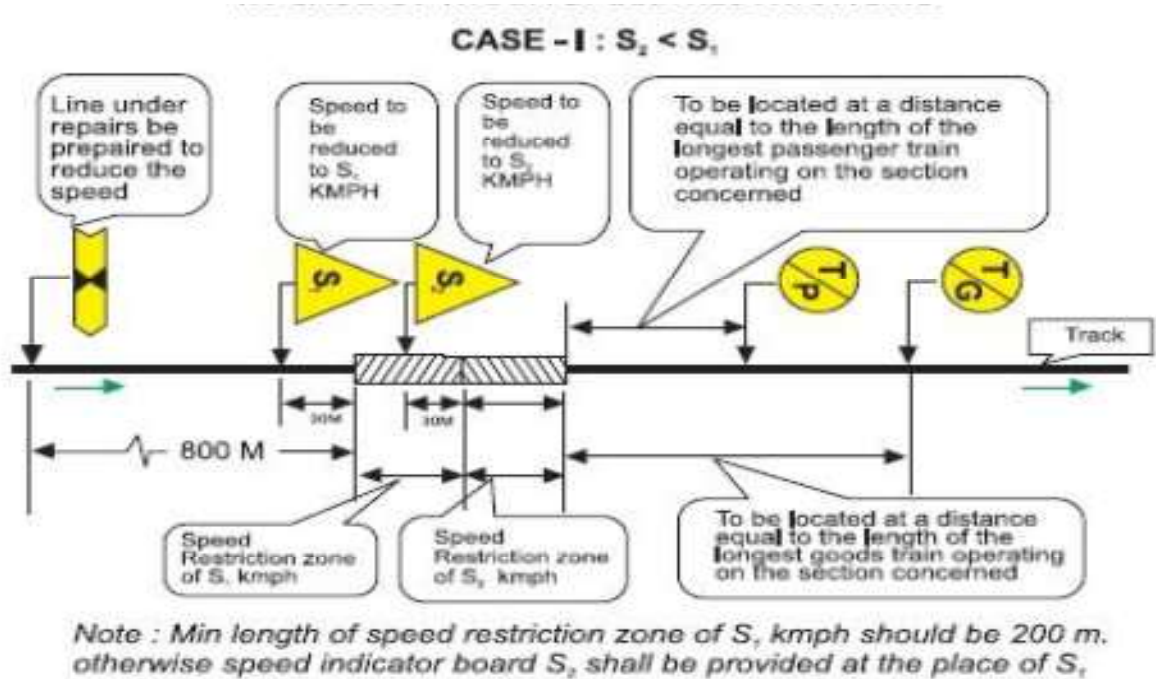
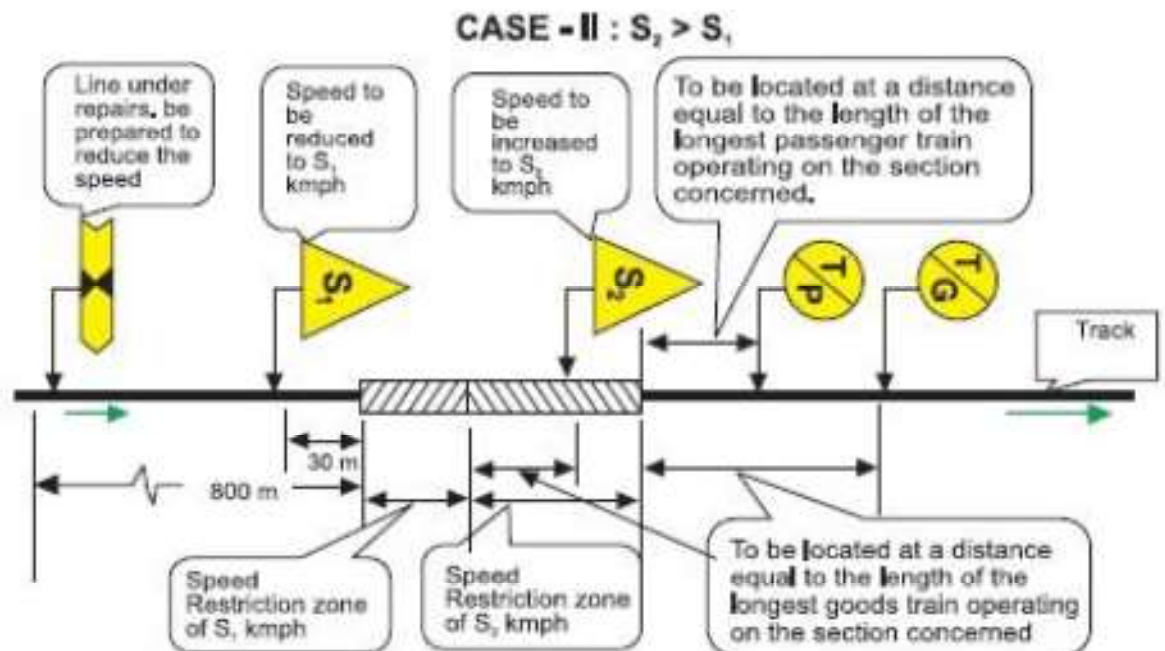
Projection during Long Duration (When Speed restriction only required)



Note:

1. During day no patrol man is required.
2. In night all board will be ignited
3. During night patrolman is required
4. All dimensions should be measured from danger zone
5. Speed restriction depending upon track condition.

POSITION OF ENGINEERING INDICATORS IN CASE OF MULTI SPEED RESTRICTIONS



By:-IRTMTC/ALD