Railway Accident Investigation

Basic information necessary for accident enquiries;

Why does a vehicle tend to derail?

Common possibilities of a derailment;

Travel marks created by the derailed wheels;

Major causes of accidents;

The preliminery work to be done for the enquiries;

Track and signalling gear parameters to be recorded at site;

Rolling stock parameters to be recorded on level uncanted track;

Types of derailments;

RAIL-WHEEL INTERACTION

a. Vehicle motion along the track;

b. Design of a 4-wheeled railway vehicles;

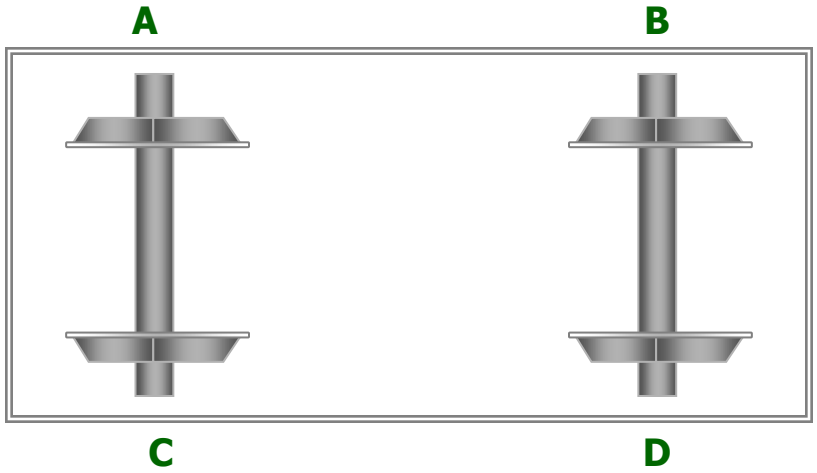
c. Design of bogie vehicles;

a. **Ability of the vehicle to follow the track geometry;**

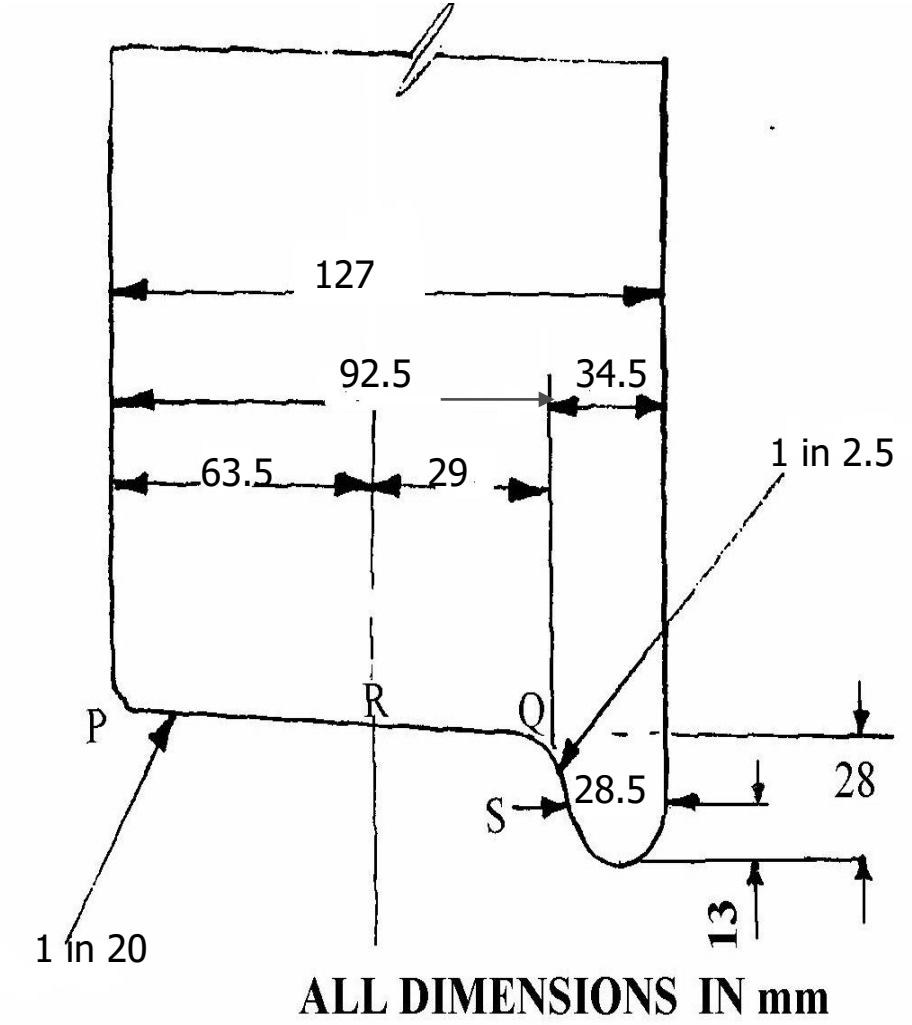
Let free cambers of spring A,B,C & D be FCa, FCb, FCc & FCd

Let tare cambers of spring A,B,C & D be TCa, TCb, TCc & TCd

Let Load cambers of spring A,B,C & D be LCa, LCb, LCc & LCd



CONICITY OF WHEEL TREAD



Dia at R……. D 'say'
Dia at P……. D – (65÷20)x 2
or D – 6.5
Dia at Q…… D + (31÷20)x 2
or D + 3.1
For a new wheel, thickness of flange at S = 28.5
Thickness of flange at Q…
28.5 +[(28-13) ÷2.5]
= 34.5

Tendency of the conical tread to rotate about the smaller diameter; (*Sinusoidal Motion)*

Effect of sinusoidal motion

Effect of curve on wheel flange

The effect of the positive angle of attack;

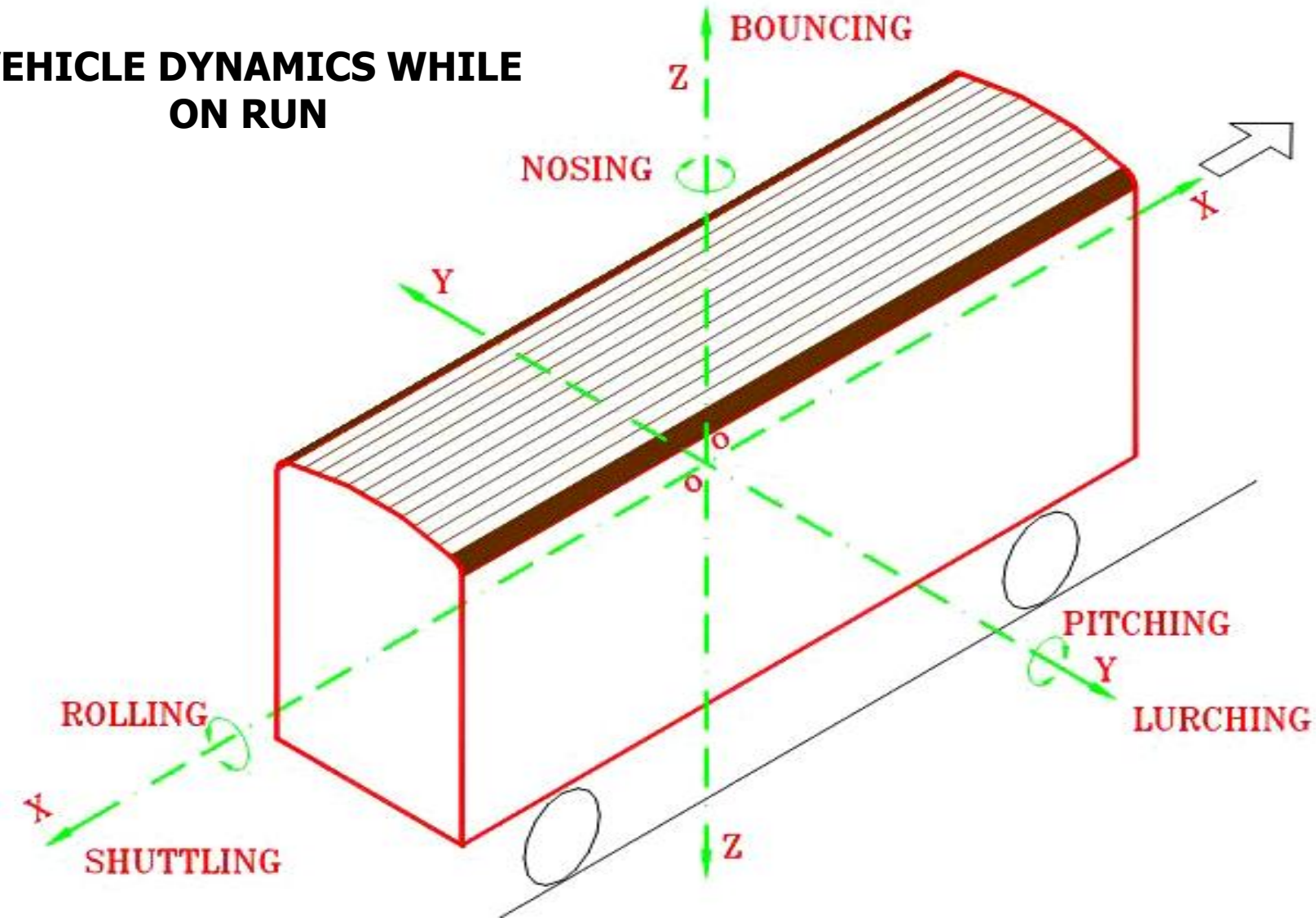
Effect of axle guard clearances;

Effect of under frame;

Effect of bogie frame;

Vehicle stiffness;

VEHICLE DYNAMICS WHILE ON RUN



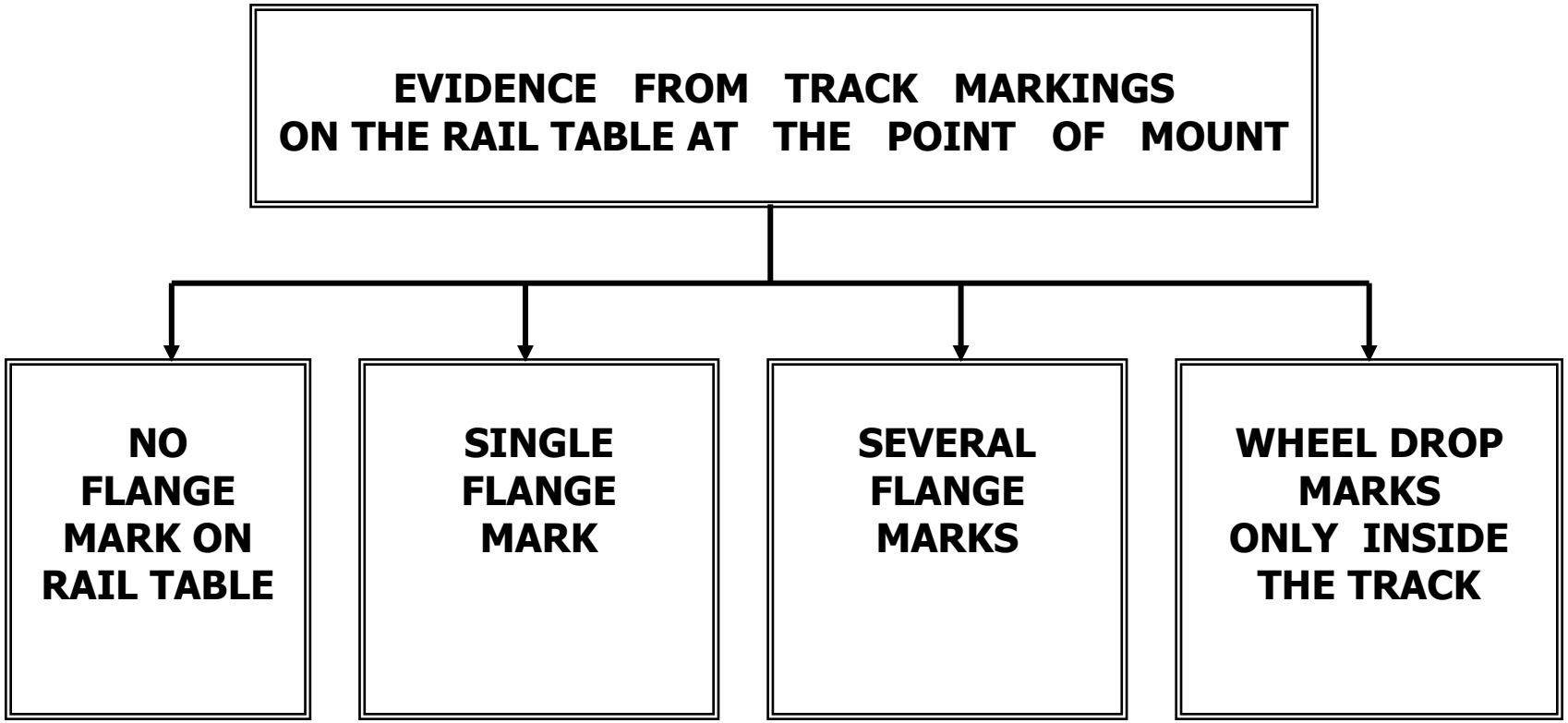
Vehicle oscillations:-

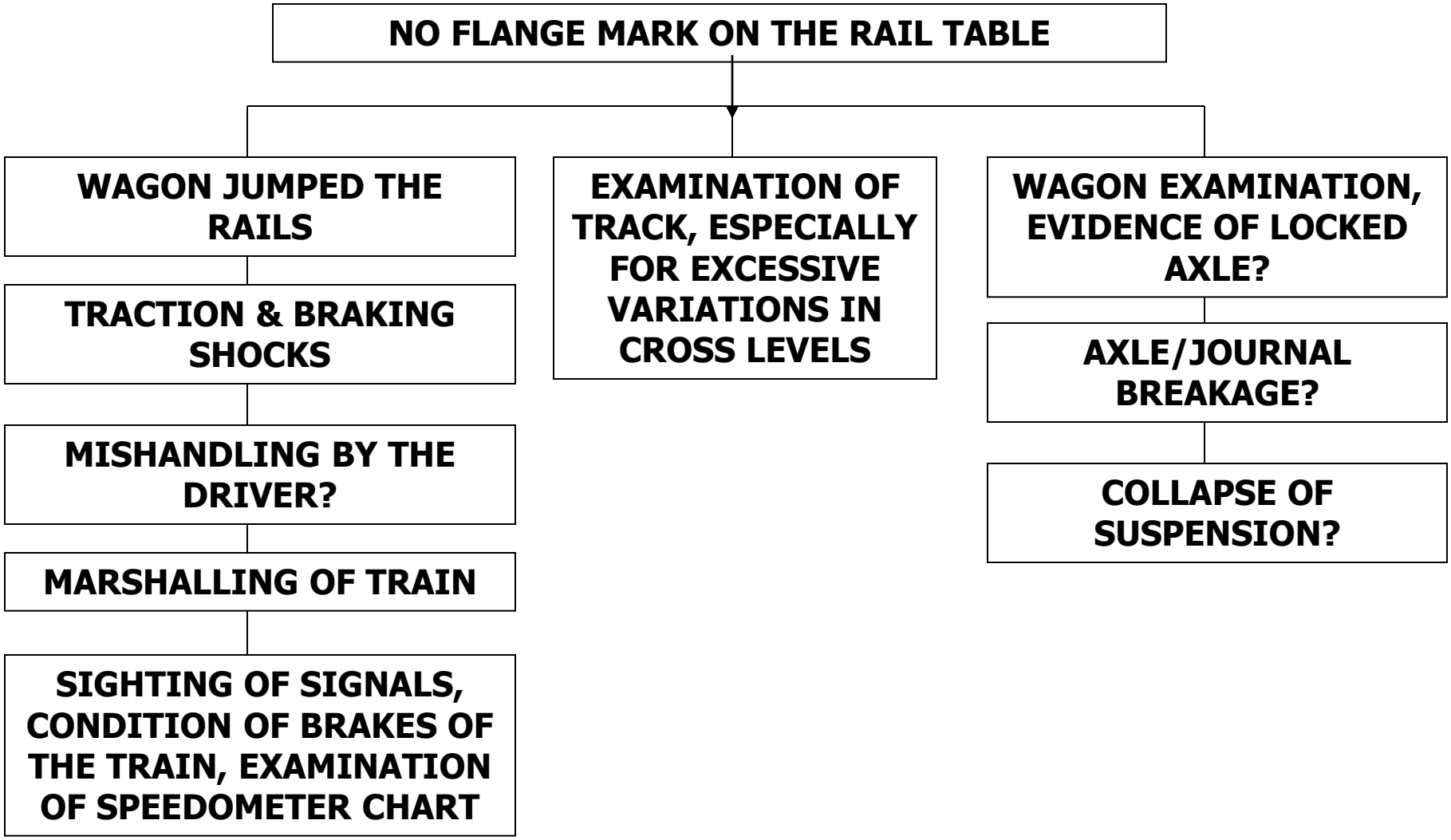
Along the longitudinal axis;

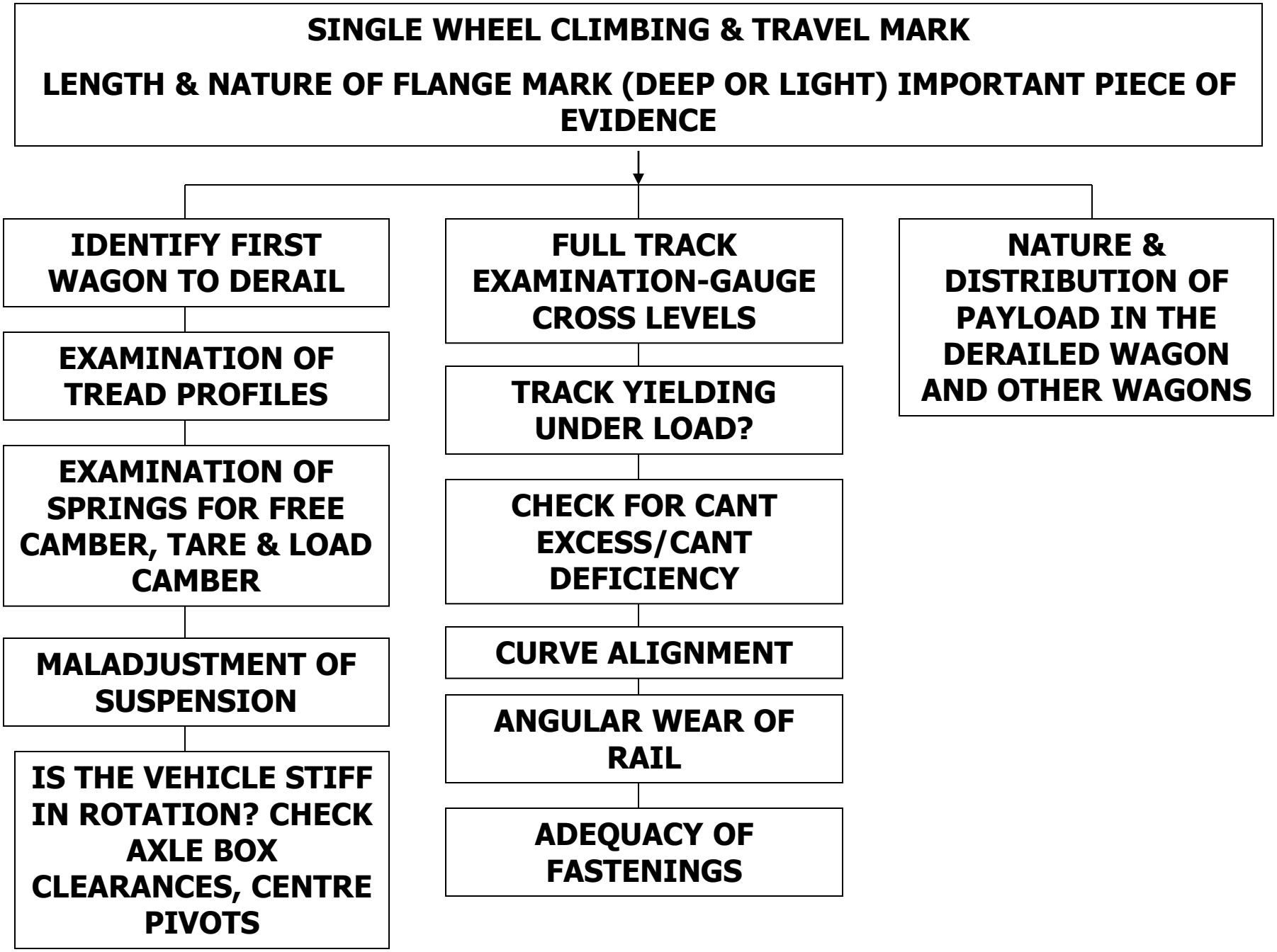
Along the vertical axis;

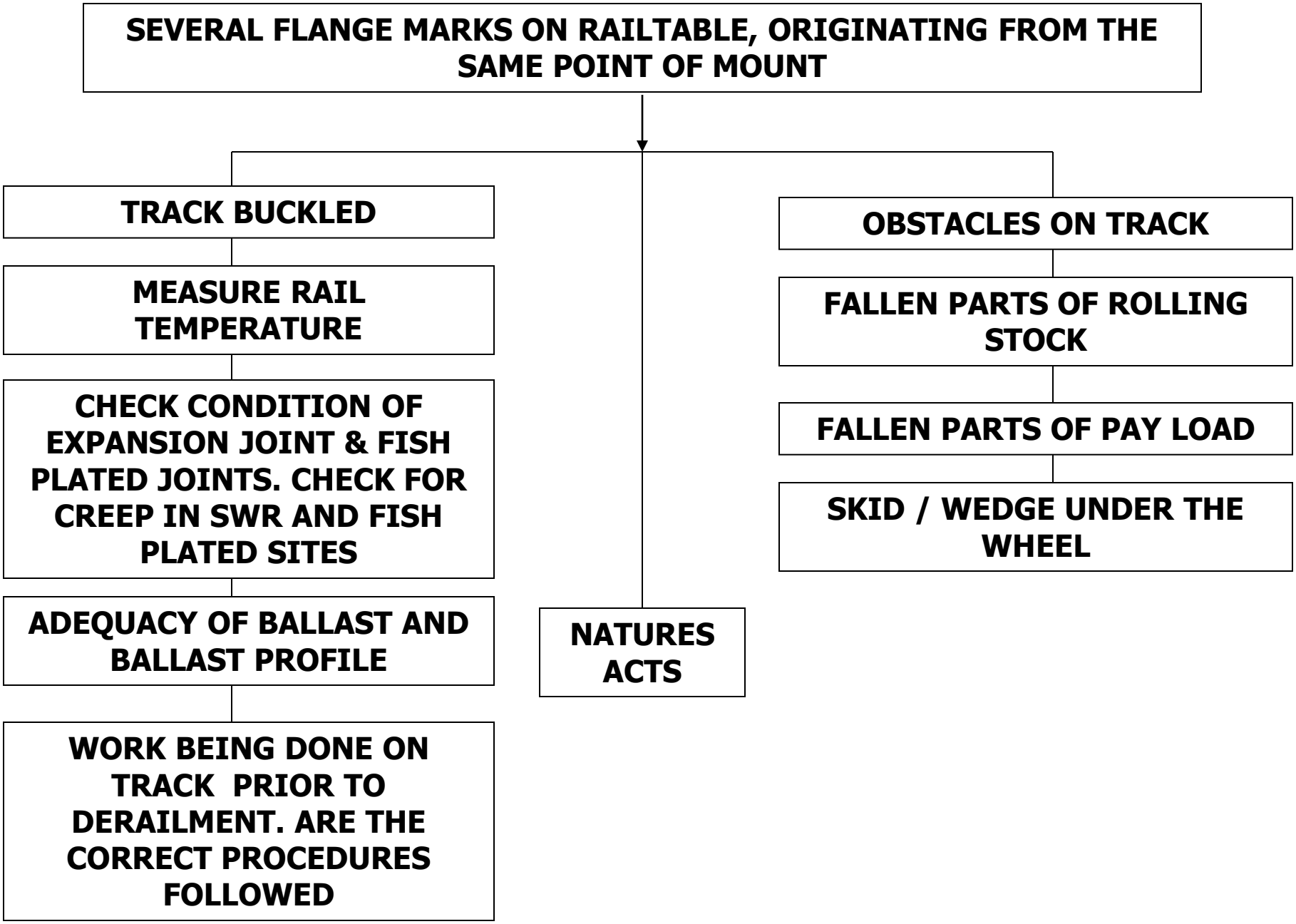
Along the lateral axis;

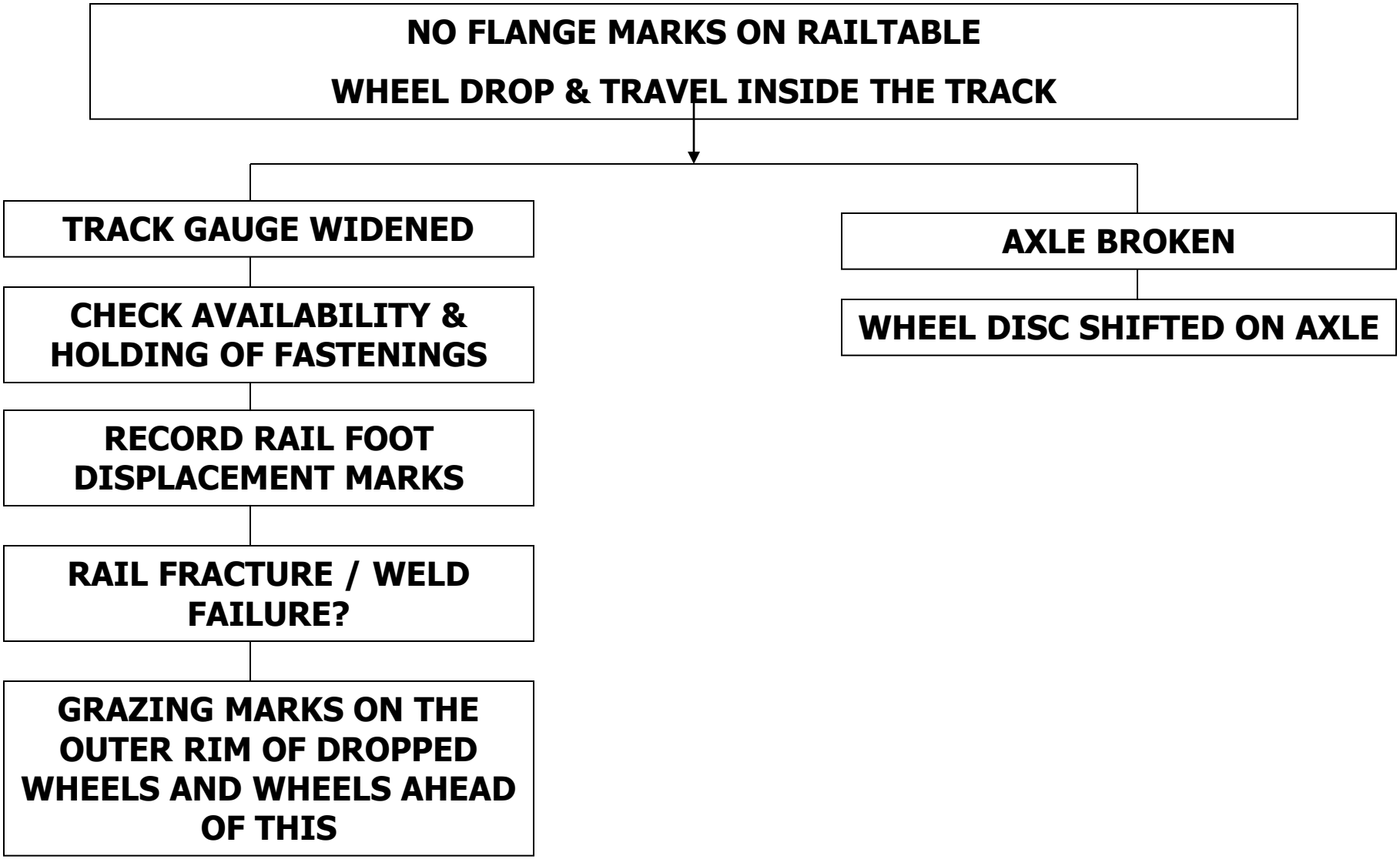
Creation of forces along the length of the train:


EVIDENCE FROM TRACK MARKINGS
ON THE RAIL TABLE AT THE POINT OF MOUNT
NO FLANGE MARK ON RAIL TABLE
SINGLE FLANGE MARK
SEVERAL FLANGE MARKS
WHEEL DROP MARKS ONLY INSIDE THE TRACK


NO FLANGE MARK ON THE RAIL TABLE
WAGON JUMPED THE RAILS
TRACTION & BRAKING SHOCKS
MISHANDLING BY THE DRIVER?
MARSHALLING OF TRAIN
SIGHTING OF SIGNALS, CONDITION OF BRAKES OF THE TRAIN, EXAMINATION OF SPEEDOMETER CHART
EXAMINATION OF TRACK, ESPECIALLY FOR EXCESSIVE VARIATIONS IN CROSS LEVELS
WAGON EXAMINATION, EVIDENCE OF LOCKED AXLE?
AXLE/JOURNAL BREAKAGE?
COLLAPSE OF SUSPENSION?

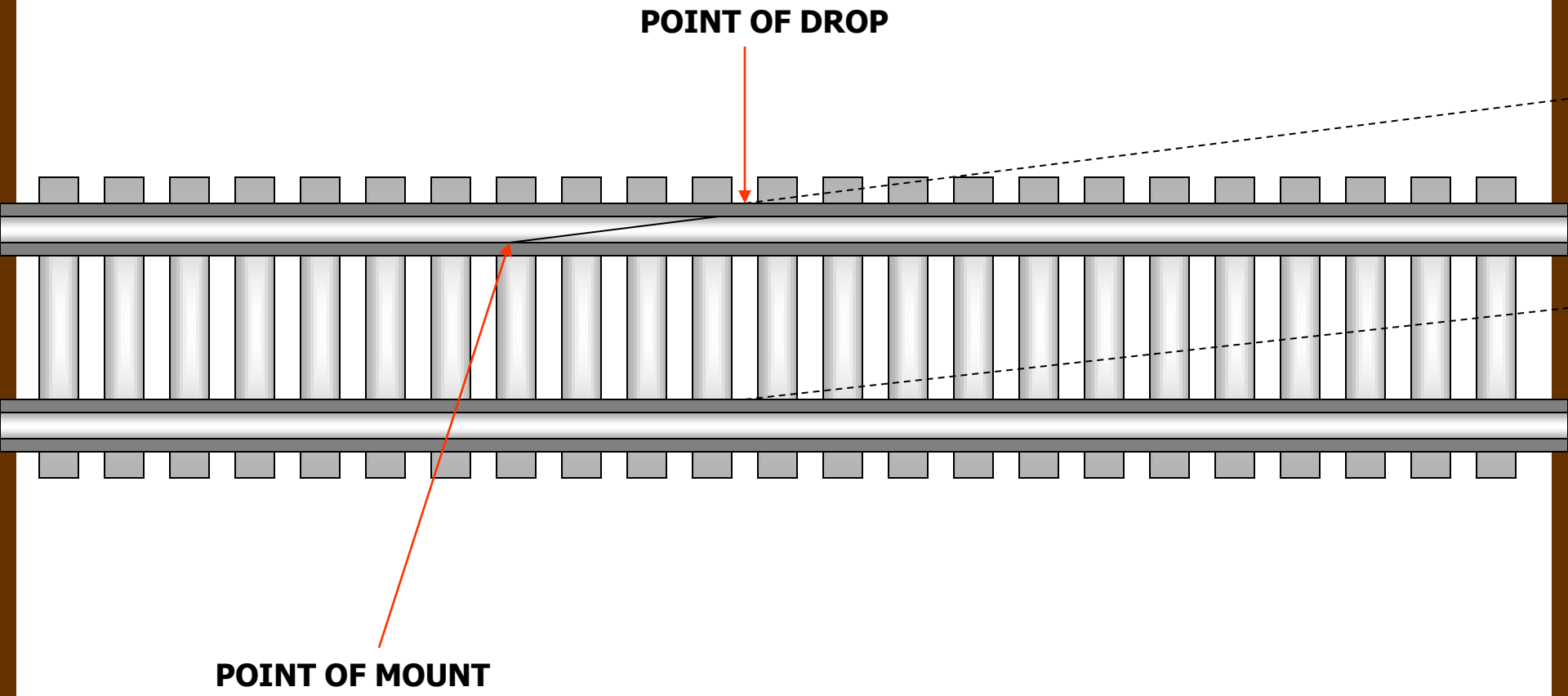

SINGLE WHEEL CLIMBING & TRAVEL MARK
LENGTH & NATURE OF FLANGE MARK (DEEP OR LIGHT) IMPORTANT PIECE OF EVIDENCE
IDENTIFY FIRST WAGON TO DERAIL
EXAMINATION OF TREAD PROFILES
EXAMINATION OF SPRINGS FOR FREE CAMBER, TARE & LOAD CAMBER
MALADJUSTMENT OF SUSPENSION
IS THE VEHICLE STIFF IN ROTATION? CHECK AXLE BOX CLEARANCES, CENTRE PIVOTS
FULL TRACK EXAMINATION-GAUGE CROSS LEVELS
TRACK YIELDING UNDER LOAD?
CHECK FOR CANT EXCESS/CANT DEFICIENCY
CURVE ALIGNMENT
ANGULAR WEAR OF RAIL
ADEQUACY OF FASTENINGS
NATURE & DISTRIBUTION OF PAYLOAD IN THE DERAILED WAGON AND OTHER WAGONS


SEVERAL FLANGE MARKS ON RAILTABLE, ORIGINATING FROM THE SAME POINT OF MOUNT
TRACK BUCKLED
MEASURE RAIL TEMPERATURE
CHECK CONDITION OF EXPANSION JOINT & FISH PLATED JOINTS. CHECK FOR CREEP IN SWR AND FISH PLATED SITES
ADEQUACY OF BALLAST AND BALLAST PROFILE
WORK BEING DONE ON TRACK PRIOR TO DERAILMENT. ARE THE CORRECT PROCEDURES FOLLOWED
NATURES ACTS
OBSTACLES ON TRACK
FALLEN PARTS OF ROLLING STOCK
FALLEN PARTS OF PAY LOAD
SKID / WEDGE UNDER THE WHEEL


NO FLANGE MARKS ON RAILTABLE
WHEEL DROP & TRAVEL INSIDE THE TRACK
TRACK GAUGE WIDENED
CHECK AVAILABILITY & HOLDING OF FASTENINGS
RECORD RAIL FOOT DISPLACEMENT MARKS
RAIL FRACTURE / WELD FAILURE?
GRAZING MARKS ON THE OUTER RIM OF DROPPED WHEELS AND WHEELS AHEAD OF THIS
AXLE BROKEN
WHEEL DISC SHIFTED ON AXLE

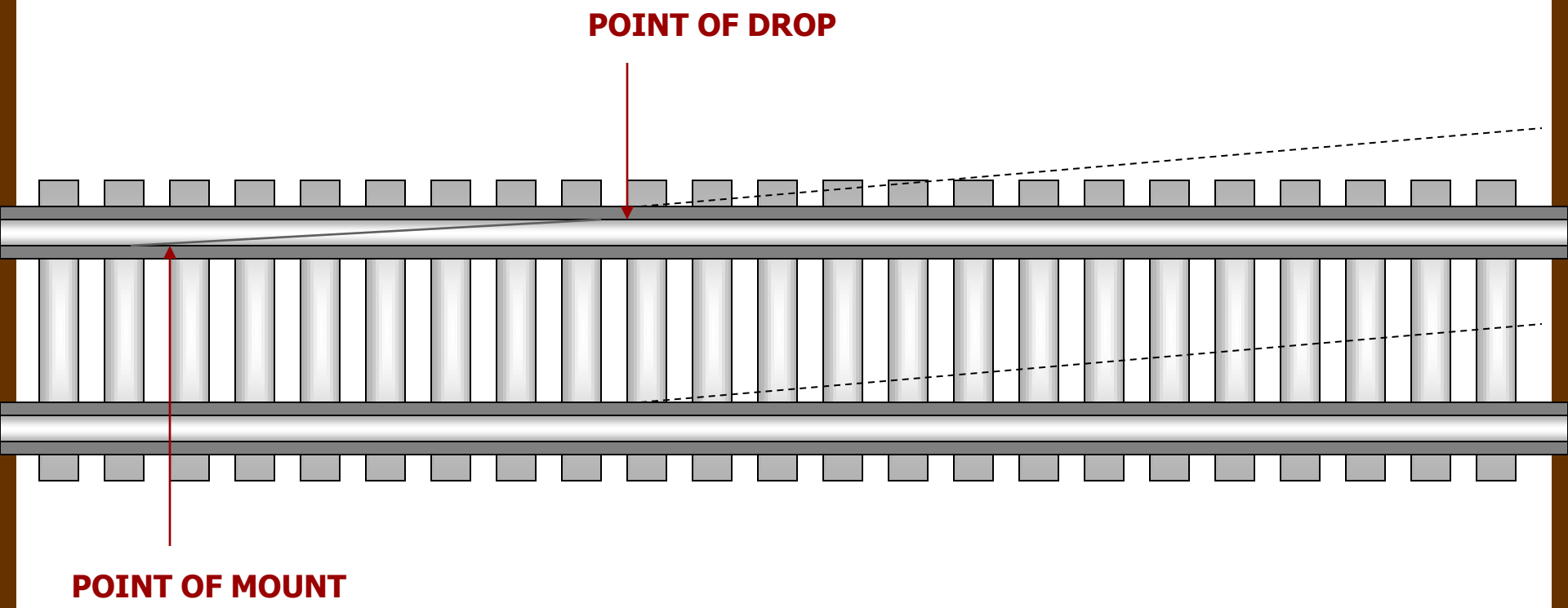
SUDDEN MOUNT AND DROP OF WHEEL

Short and sharp flange travel mark on rail table



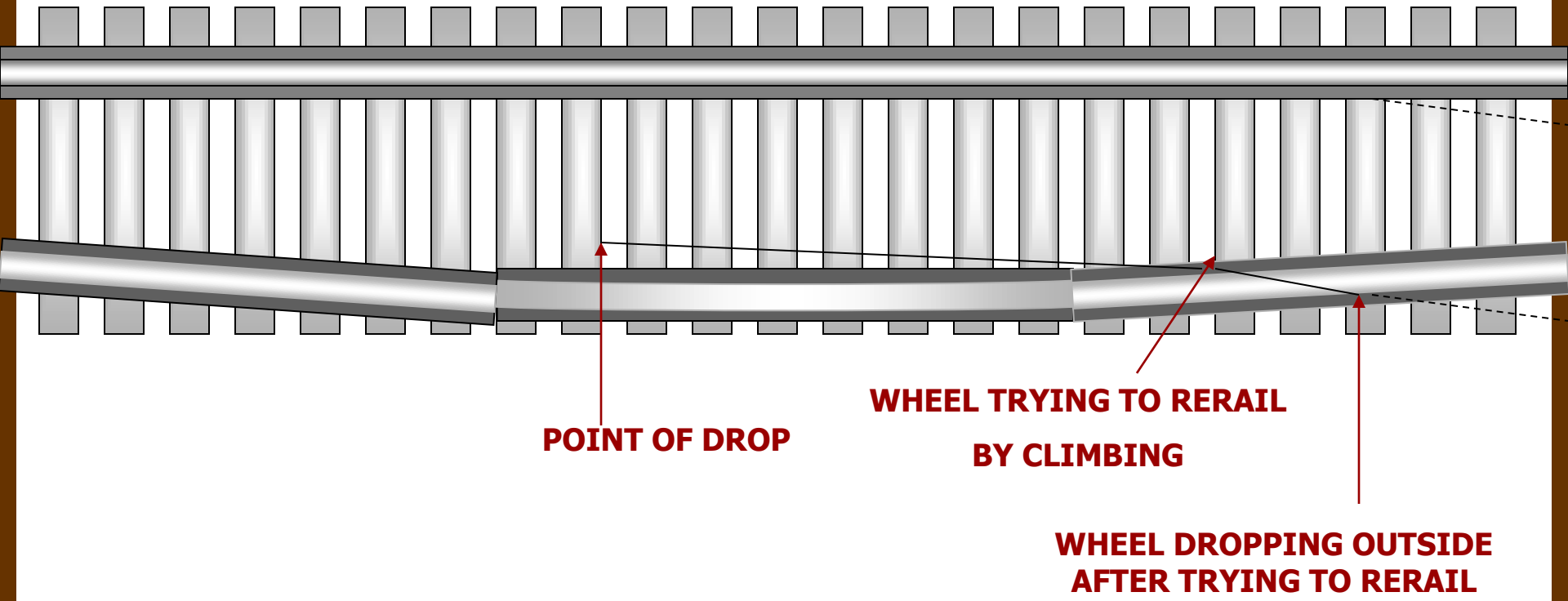
SLOW MOUNT, TRAVEL AND DROP OF WHEEL

Long , faint flange travel mark on rail table



DROP OF WHEEL INSIDE THE TRACK

Wheel travel mark inside the two rails, some times followed by another mount, short travel and drop

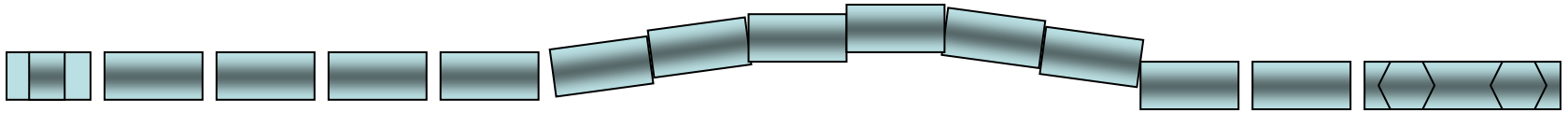


SITE INSPECTION AND OBSERVATIONS

Approaching site from rear :

Get down about 200 metres behind B.V.

Walk up to engine, observing all unusual features.



Approaching site from front :

Get down near the TE

Walk up to 200 meters beyond B.V , observing all unusual features.

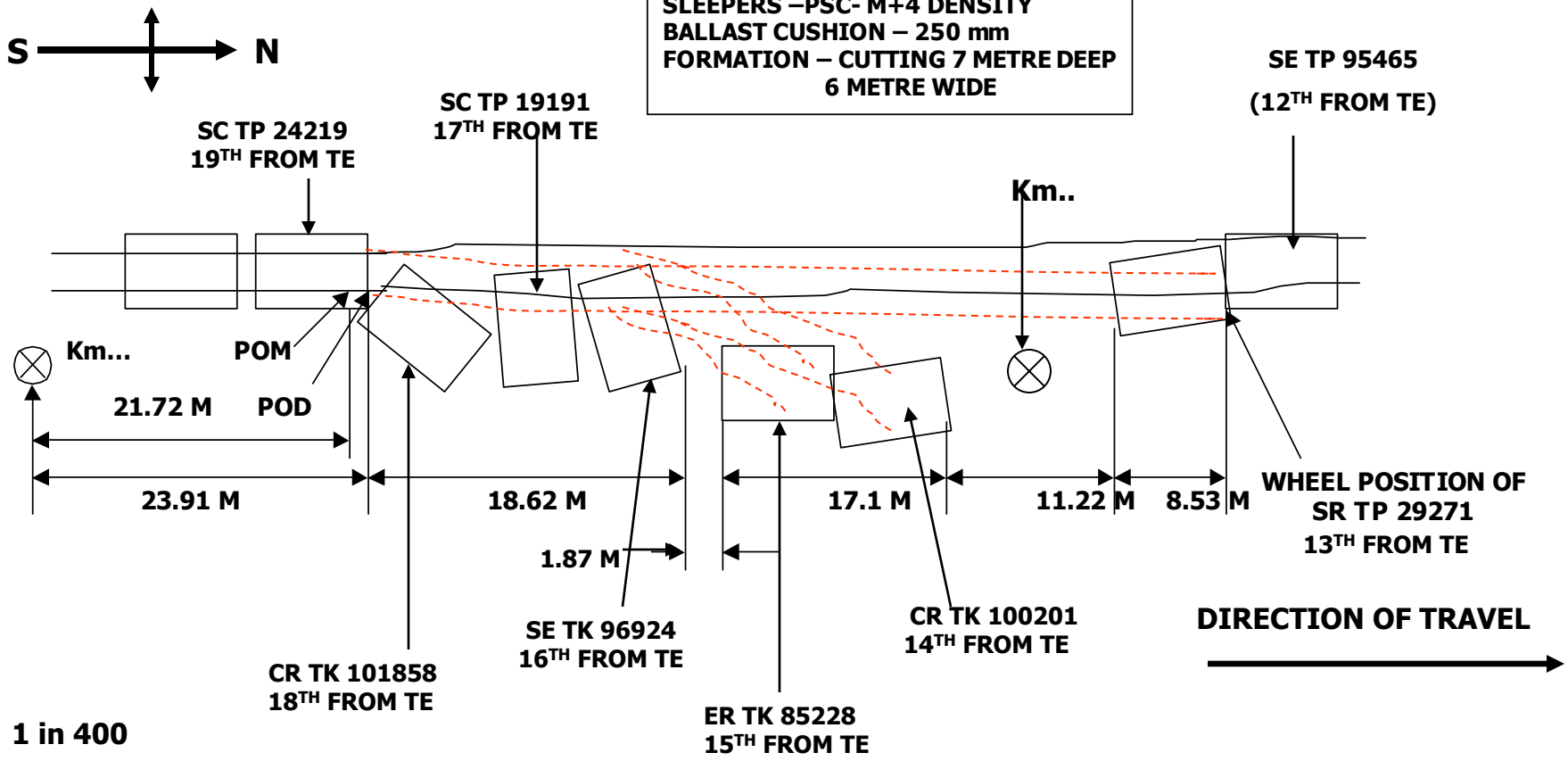
☺

ROUGH SKETCH INDICATING THE DISPOSITION OF WAGONS INVOLVED IN ACCIDENT BY TRAIN No. .....AT Km.... BETWEEN ..... ON .....

ALL DIMENSIONS ARE IN METRES

NOT TO SCALE

TRACK STRUCTURE
RAILS- 52 KG -LWR- LAID IN 2001
SLEEPERS –PSC- M+4 DENSITY
BALLAST CUSHION – 250 mm
FORMATION – CUTTING 7 METRE DEEP
6 METRE WIDE



1 in 400

L

1 in 150

L

TI

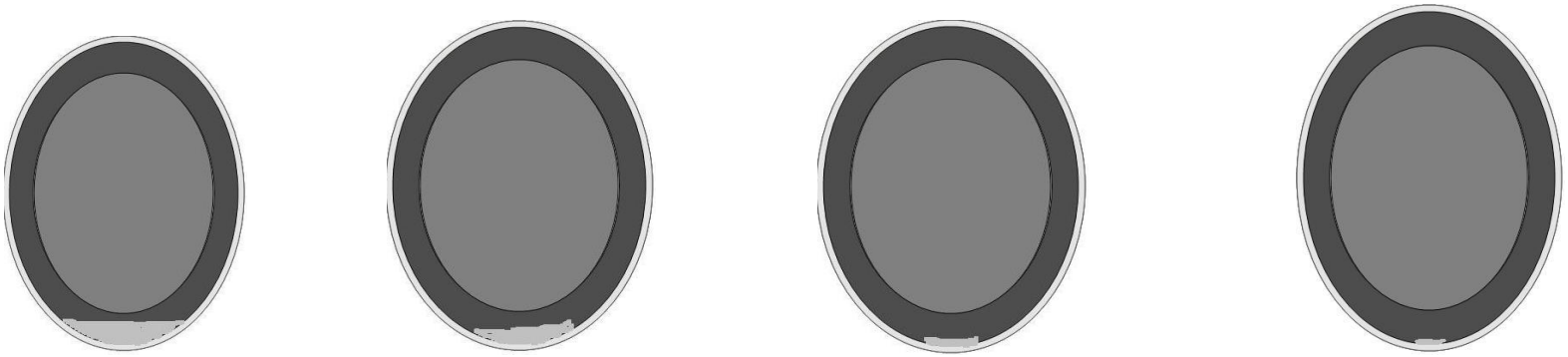
SSE/C&W

SSE/P.Way

TELL-TALE MARKS

1. Wheel travel marks on the table of the rail and on sleepers and ballast.

2. Grazing marks on the outer rim of the derailed wheel indicates that the wheel had derailed inside the track. These marks may be seen on the vehicles preceding the derailed vehicles also. This is because the gauge widens progressively before becoming wide enough to permit derailment.



3. Damage to the wheel flange.

4. Hit marks on the side panels.

5. Hit marks on the foot boards, axle boxes, trough floor, air pipes etc. on the derailed vehicle and vehicle preceding them.

6. Disturbance to ballast, dragging marks on the sleepers and ballast, presence of small metallic particles before the point of mount etc.

7. Nature of rail fractures, weld failures and breakage of tongue rails, old or new.

8. On locally operated points, whether cotter is available and its condition

9. Condition of stretcher bars

RECORDING OF PARAMETERS

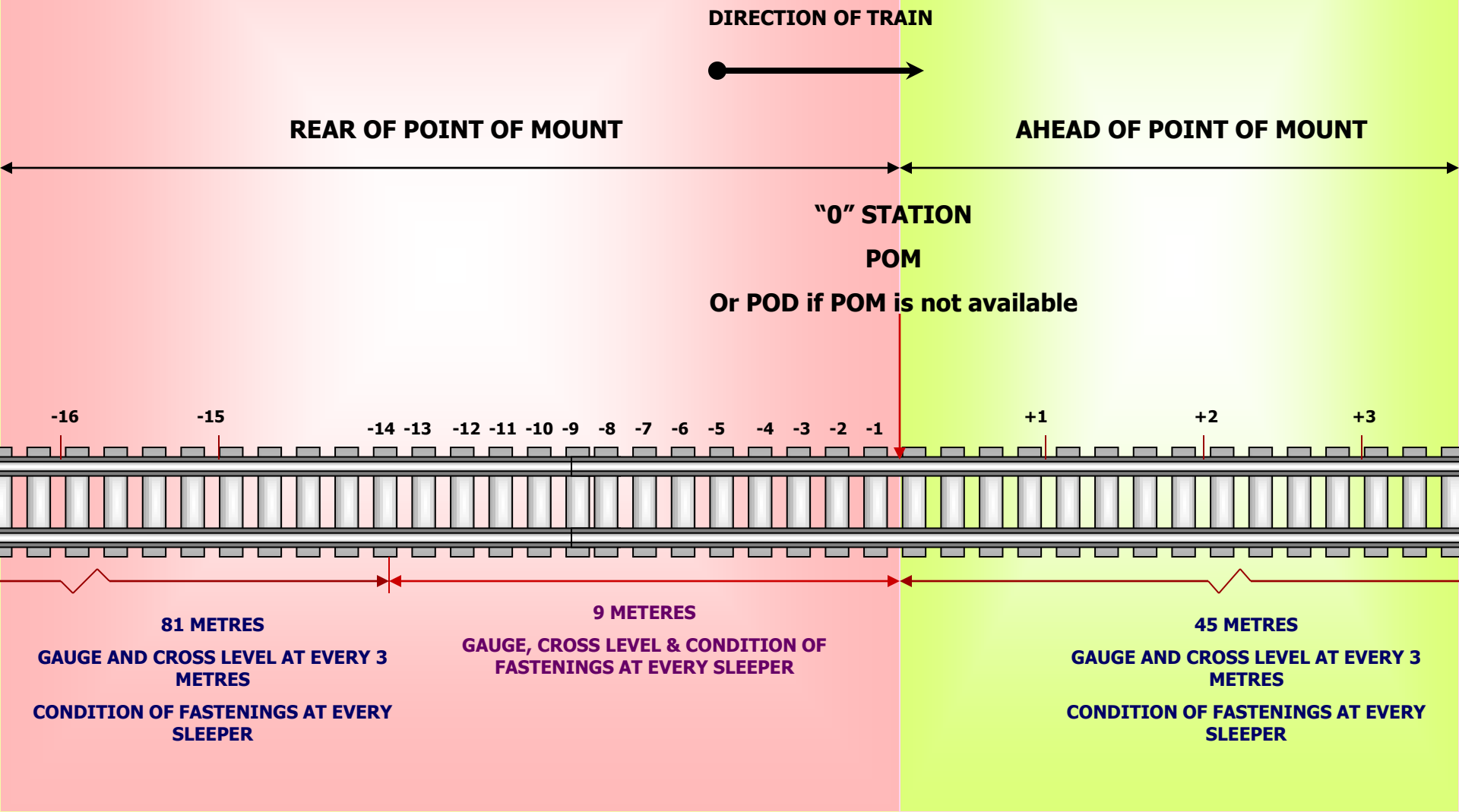
The parameters to be recorded for P.Way are given in P.Way manual in tabular form. The rolling stock details to be recorded in the format issued by Rly.Bd. These formats, along with information to be furnished to CRS in case of CRS enquiry, are given separately. These formats are given as MS Word documents in separate folder.

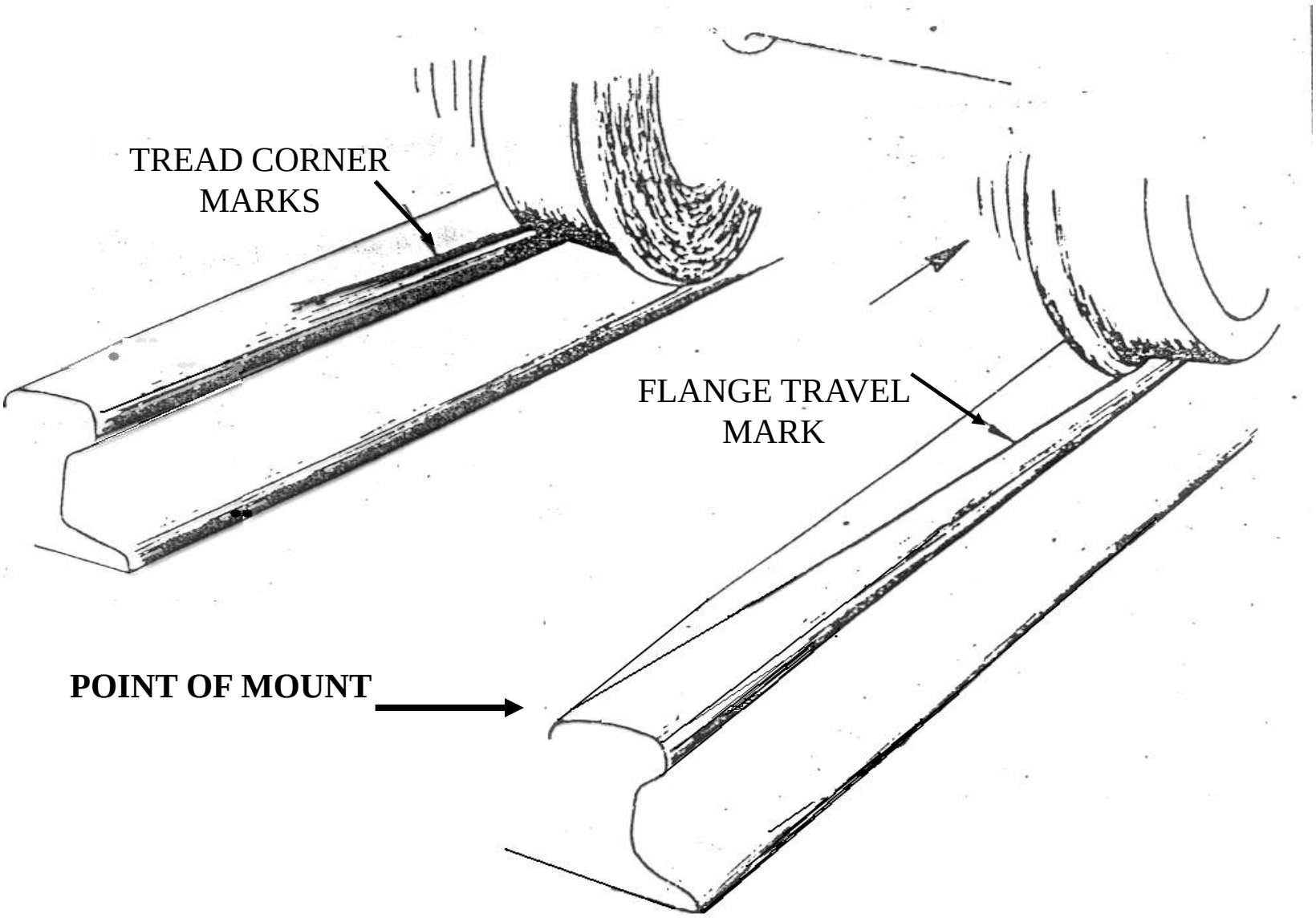
Certain information such as type of soil, amount of rainfall, weight classification of rails etc and type of axle (axle load), wheel base, carrying capacity etc are obtained from the marking on the rails, wagon body or basic record available with concerned maintenance depot.

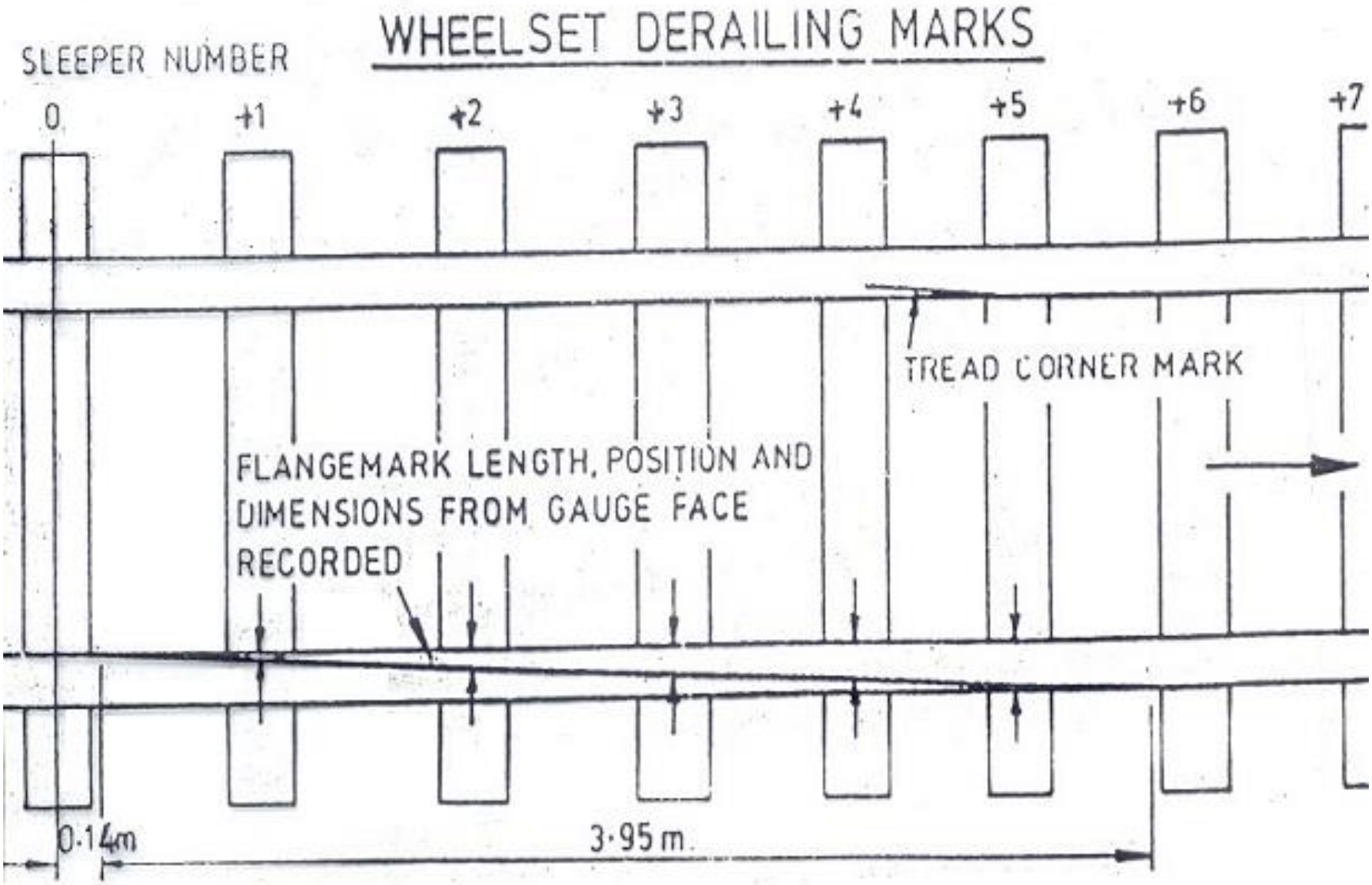
TRACK PARAMETERS TO BE RECORDED AT THE SITE

1. Reference point for starting the track measurements
2. Distance limits for taking the readings

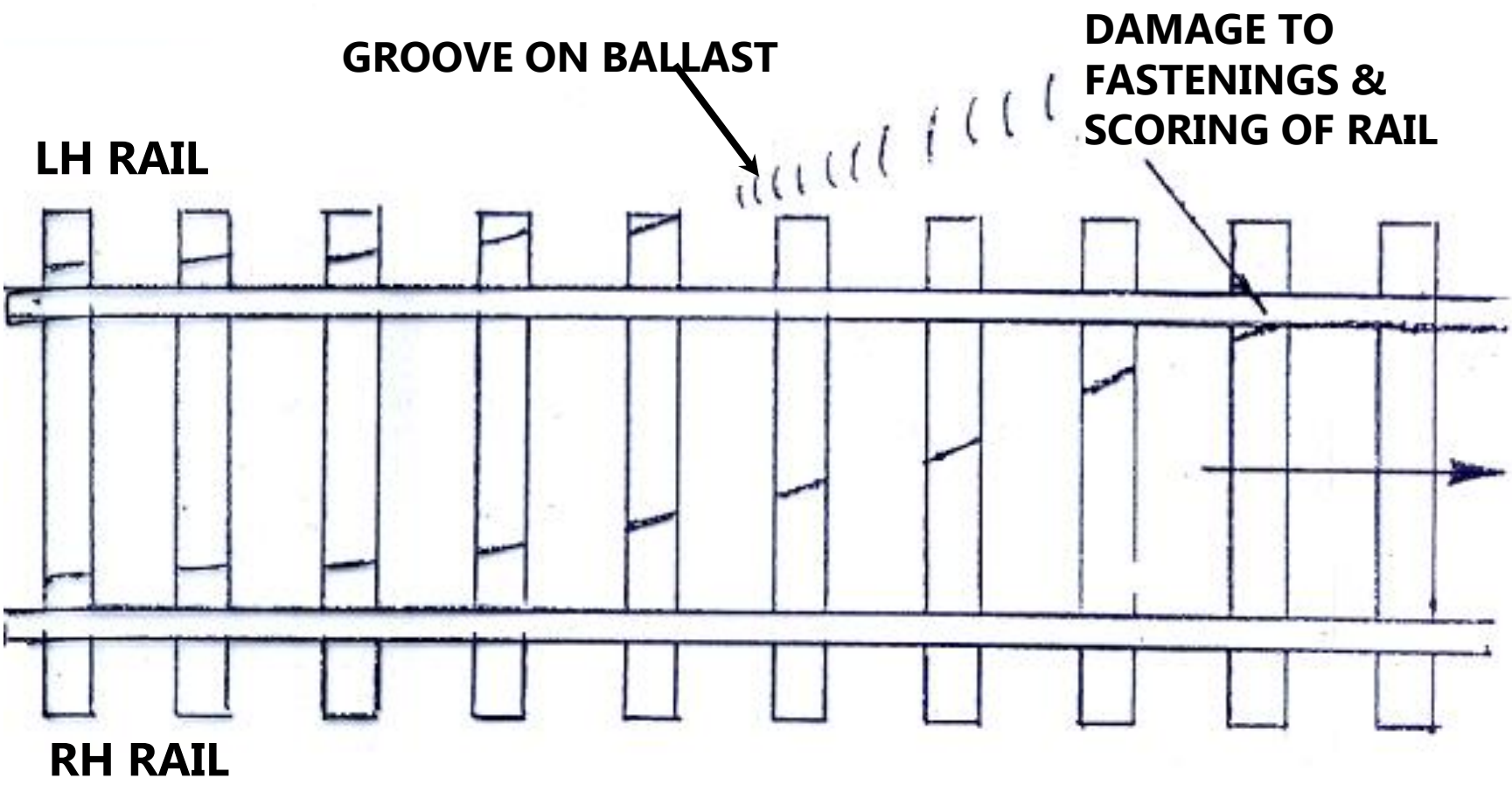
MARKING OF STATIONS FOR RECORDING TRACK PARAMETRES

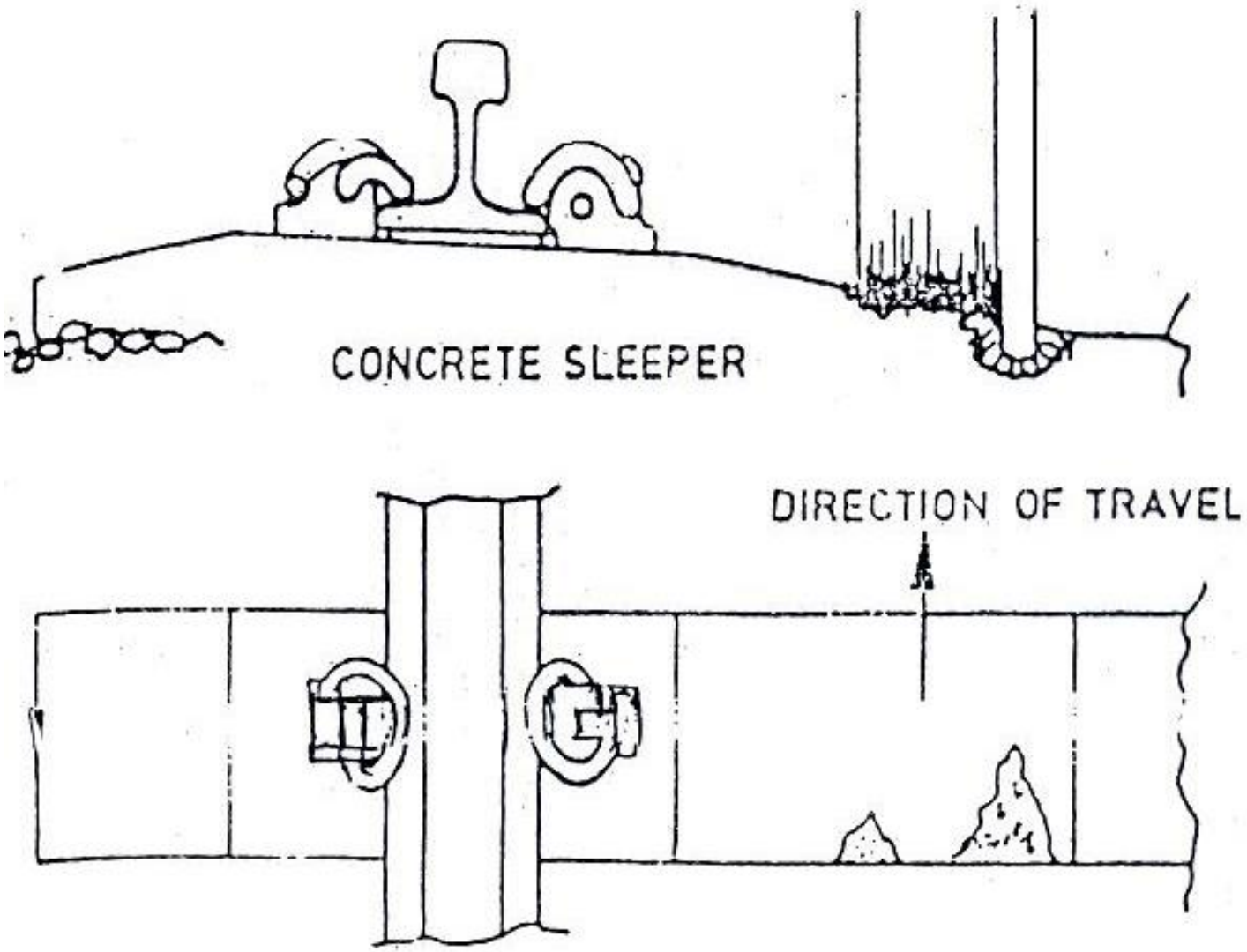



TREAD CORNER MARKS
FLANGE TRAVEL MARK
POINT OF MOUNT


WHEELSET DERAILING MARKS
SLEEPER NUMBER
0
+1
+2
+3
+4
+5
+6
+7
TREAD CORNER MARK
FLANGEMARK LENGTH, POSITION AND DIMENSIONS FROM GAUGE FACE RECORDED
0·14m
3·95 m.

WHEEL TRAVEL MARKS ON THE RAIL TABLE, SLEEPERS & BALLAST





FLANGE MARKS ON PSC SLEEPERS

The parameters to be submitted by the P.Way department, recorded jointly are as under:

Gauge, cross-level, condition of fastenings

Condition of ballast

Condition of rails

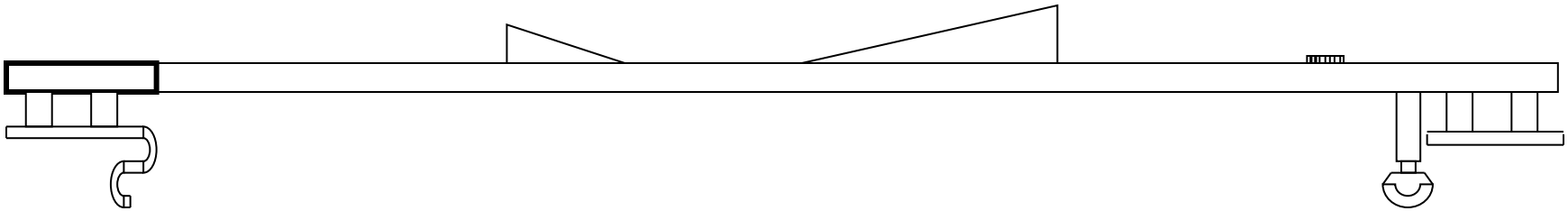
Evidence of creep & buckling;

Versines for curves , Points & crossings, turn-outs;

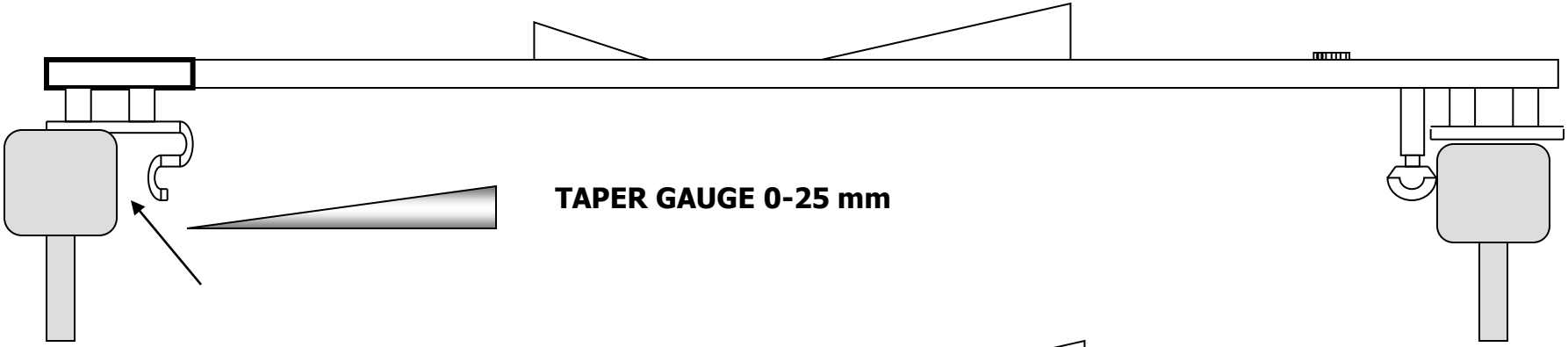
Additional measurements for Points & Crossing;

Longitudinal levels if derailment is within 90 metres of sag or if on a curve situated in a gradient.

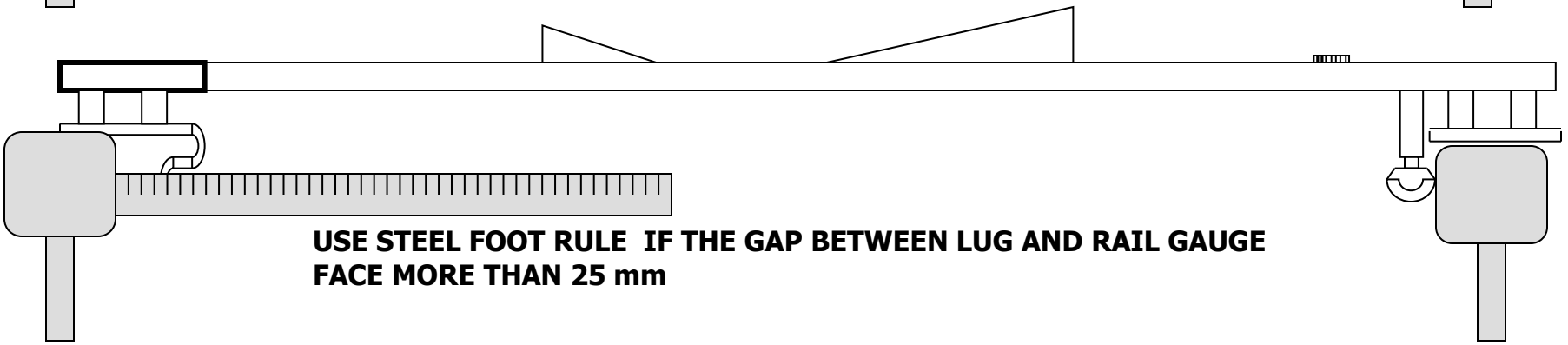
GAUGE



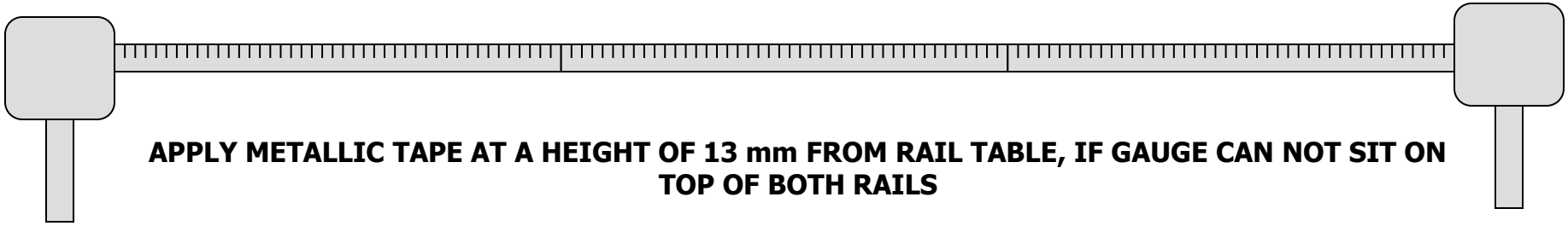
METHODS OF MEASURING SPREAD GAUGE



TAPER GAUGE 0-25 mm



USE STEEL FOOT RULE IF THE GAP BETWEEN LUG AND RAIL GAUGE FACE MORE THAN 25 mm



APPLY METALLIC TAPE AT A HEIGHT OF 13 mm FROM RAIL TABLE, IF GAUGE CAN NOT SIT ON TOP OF BOTH RAILS

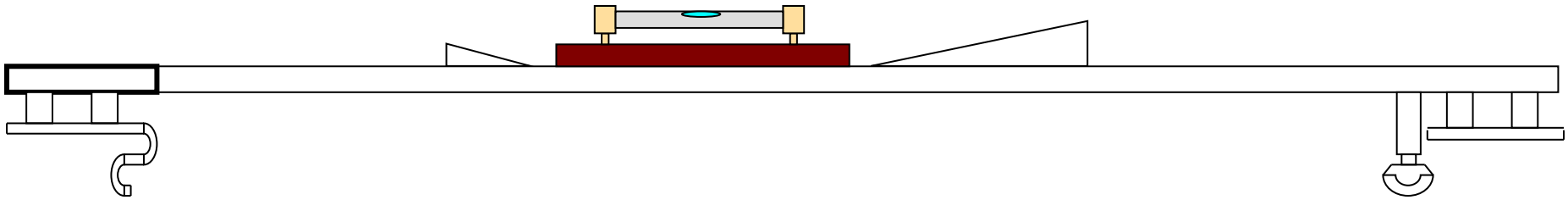
Measurements recorded at Km ------- & ------- between ------- & ------ on --------- in connection with the accident to train No------

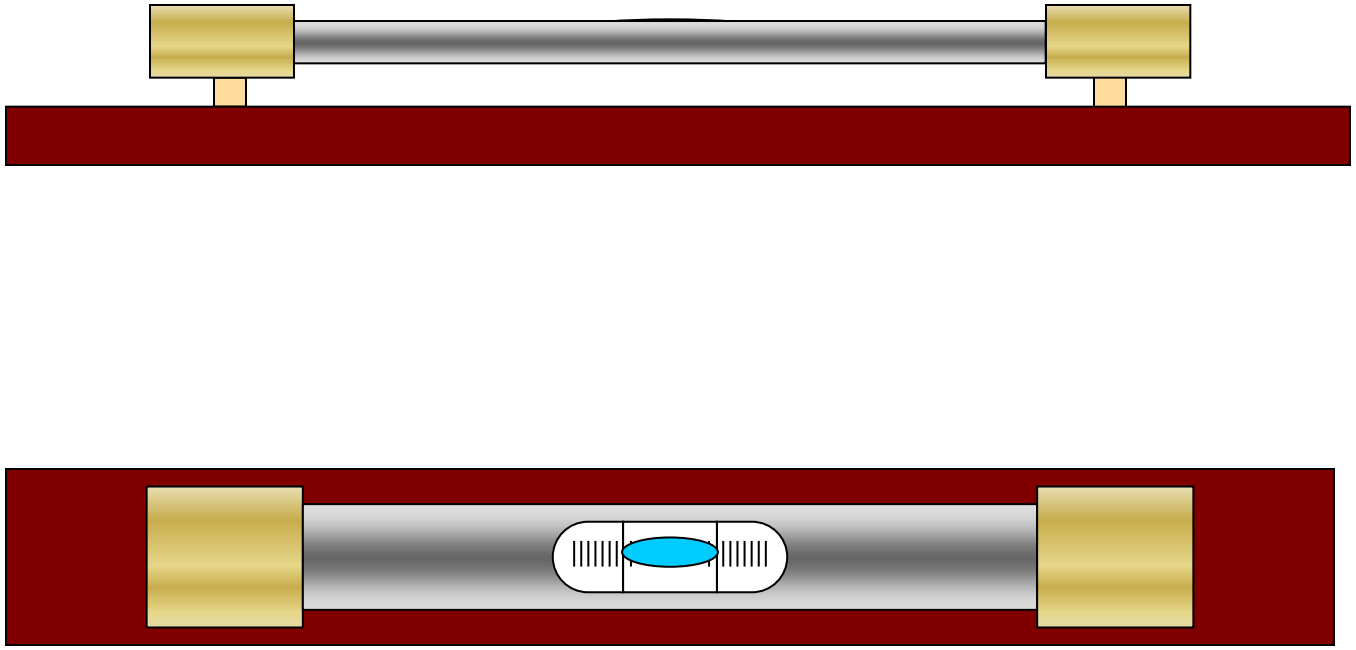
POM is on the – rail, at distance of --metres from OHE mast No.-- and same taken as "0" station

Stn. no	Sleeper No.	Sleeper Spacing In cm	Gauge in mm	Cross level In mm		Remarks			
						Left		Right	
			Free	Free	Under Load	Out side	In side	In side	Out side

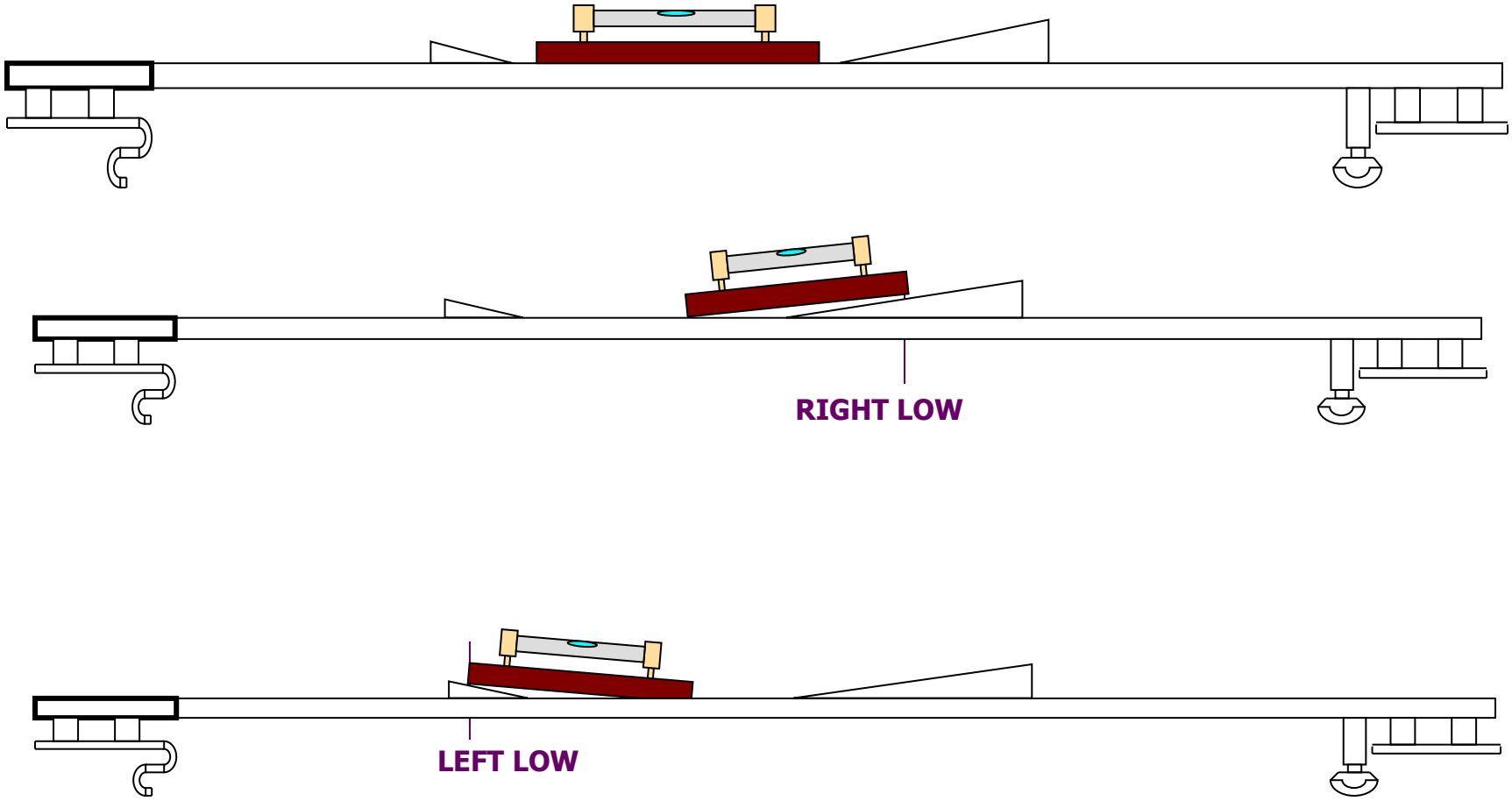
Stn. no	Sleeper No.	Sleeper Spacing In cm	Gauge in mm		Cross level In mm		Remarks			
							Left		Right	
			Free	Under Load	Free	Under Load	Out side	In side	In side	Out side
0	1	-	+ 5	+ 7	6 RL	9 RL				
- 1	2	68	+ 5	+ 8	4 RL	4 RL				
- 2	3	71	+ 4	+ 5	3 RL	C				
- 3	4	64	+ 4	+ 7	2 RL	1 LL				
- 4	5	69	+ 5	+ 5	C	4 LL				
- 5	6	68	+ 5	+ 7	3 LL	7 LL				
- 6	7	69	+ 3	+ 6	6 LL	9 LL				
- 7	8	70	+ 5	+ 5	7 LL	11 LL				
- 8	9	70	+ 3	+ 3	6 LL	7 LL				
- 9	10	70	+ 5	+ 7	6 LL	2 LL				
- 10	11	69	+ 5	+ 5	7 LL	7 LL				
- 11	12	68	+ 5	+ 9	5 LL	2 LL				
- 12	13	69	+ 5	+ 7	6 LL	6 LL				
- 13	14	70	+ 4	+ 4	6 LL	4 LL				

CROSS LEVELS





Cross level is measured at the same locations where gauge is measured. The spirit level is placed at the centre (level portion) of the instrument.



The cross level has to be taken under load also. Under-load reading should be taken with a loco or coach or loaded wagon.

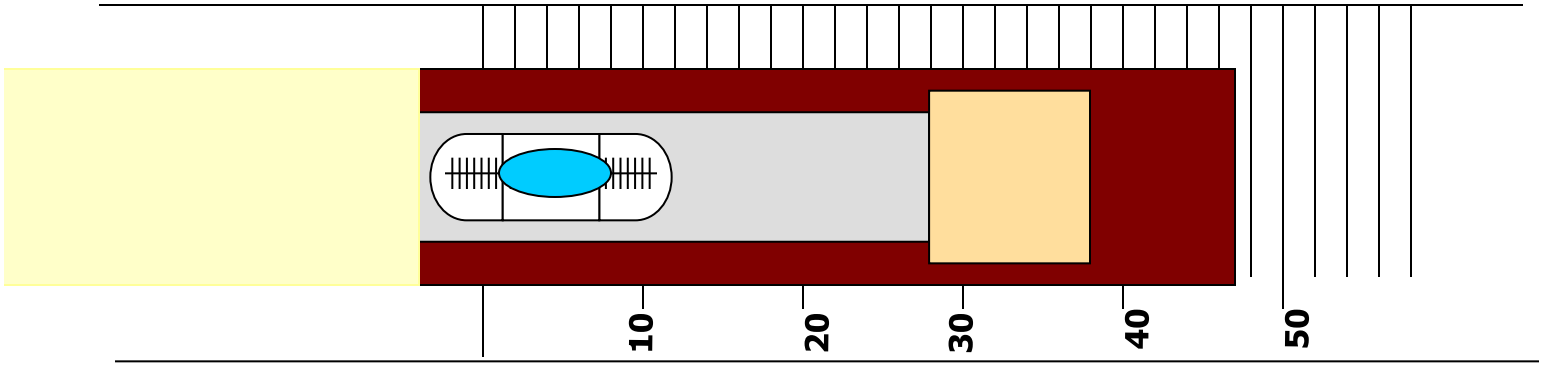
The difference in the readings taken in free (floating) condition and under load gives the extent to which the track is yielding under load.

For example, if the level in free condition is 5LL and under load 10 LL, it indicates that the LH rail is yielding under load due to improper packing / void under the sleeper.

If the level under free condition is 10 LL and under load 4 LL, it indicates that the packing under RH rail is insufficient.

PRECAUTIONS TO BE OBSERVED WHILE TAKING CROSS LEVELS

- ***The gauge for measuring cross level is graduated in 2 mm divisions. IRPWM stipulates that the cross levels should be measured to 2 mm accuracy. When the edge of the spirit level is in between two graduations, it can be interpreted to the lesser of the two graduations. However, should it be decided to interpret it to the higher of the two values, the same convention should be observed for the entire reading.***



In the diagram above, the edge of the spirit level is between 46 mm and 48 mm. Normally it is taken as 46. But if it is taken as 48 mm, the same convention should be followed throughout.

CALCULATING THE TWIST

The variation between cross level at the point of mount which is the location of leading wheel of the vehicle and the cross level at the rigid wheel base distance which is the location of the trailing wheel of the vehicle/bogie is calculated first.

If the cross levels at both the above locations are on the same rail, i-e, RL/RL or LL/LL, the difference between the two values is found by subtracting one value from the other.

If the cross levels at the leading wheel location and the trailing wheel location are on opposite rails, i-e, LL/RL, the difference between the two values is the sum total of the two values.

Example:

Cross level at POM ..... 5 LL
Cross level at rigid wheel base distance..... 11 LL
Cross level variation between the two wheels..... 6 mm

Let the wheel base of the vehicle be 2 metres;

Twist = 6÷ 2 = 3 mm per metre

Cross level at POM ..... 5 LL
Cross level at rigid wheel base distance..... 5 RL
Cross level variation between the two wheels..... 10 mm

Let the wheel base be 2 metres;
Twist = 10 ÷ 2 = 5 mm per metre

Calculating the twist for a 4-wheeler IRS wagon of wheel base 4.57 metres.

Stn. no	Sleeper No.	Sleeper Spacing In cm	Gauge in mm		Cross level In mm	
			Free	Under Load	Free	Under Load
0	1	-	+ 5	+ 7	6 RL	9 RL
- 1	2	68	+ 5	+ 8	4 RL	4 RL
- 2	3	71	+ 4	+ 5	3 RL	C
- 3	4	64	+ 4	+ 7	2 RL	1 LL
- 4	5	69	+ 5	+ 5	C	4 LL
- 5	6	68	+ 5	+ 7	3 LL	7 LL
- 6	7	69	+ 3	+ 6	6 LL	9 LL
- 7	8	70	+ 5	+ 5	7 LL	11 LL
- 8	9	70	+ 3	+ 3	6 LL	7 LL
- 9	10	70	+ 5	+ 7	6 LL	2 LL
- 10	11	69	+ 5	+ 5	7 LL	7 LL

Wheel base: 4.57 m

Cross level variation : 9+ 10

= 19 mm

The cross level at wheel base is between 9 LL and 11 LL at stations - 6 and –7. Hence the mean value of the two is taken.

In the tabulation shown on the previous page, the cross level at POM is 9 RL and at wheel base distance it is between 9 LL and 11 LL. The exact cross level can be taken as the mean value between the two or can be found out by graphical method. Hence this value is taken as 10 LL which is the mean value of 9 LL and 11 LL.

Cross level variation over wheel base of wagon …9 + 10 (Since cross levels are RL & LL)

=19 mm

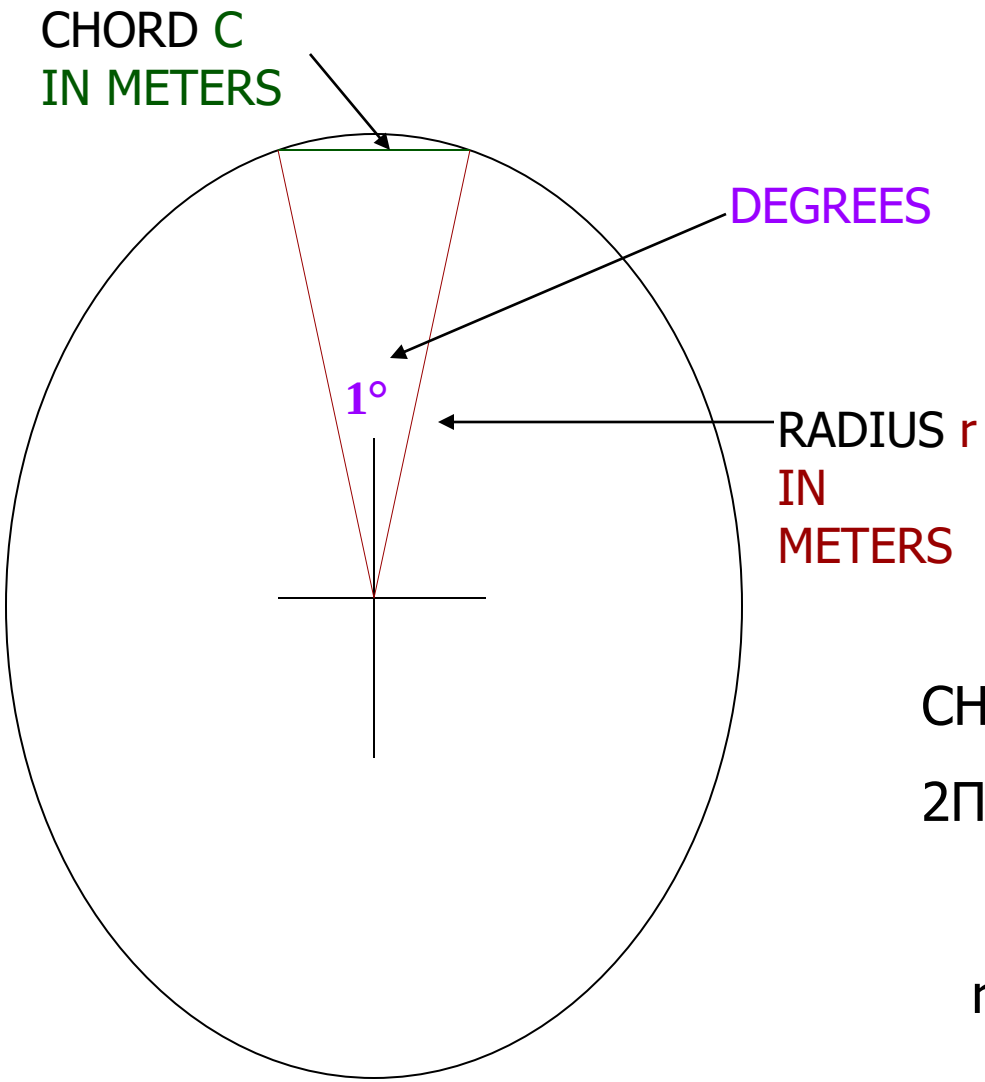
Wheel base……4.57 metres

Twist ……Cross level variation in mm /Wheel base in metres

= 19/4.57

= 4.16 mm per metre

CURVES



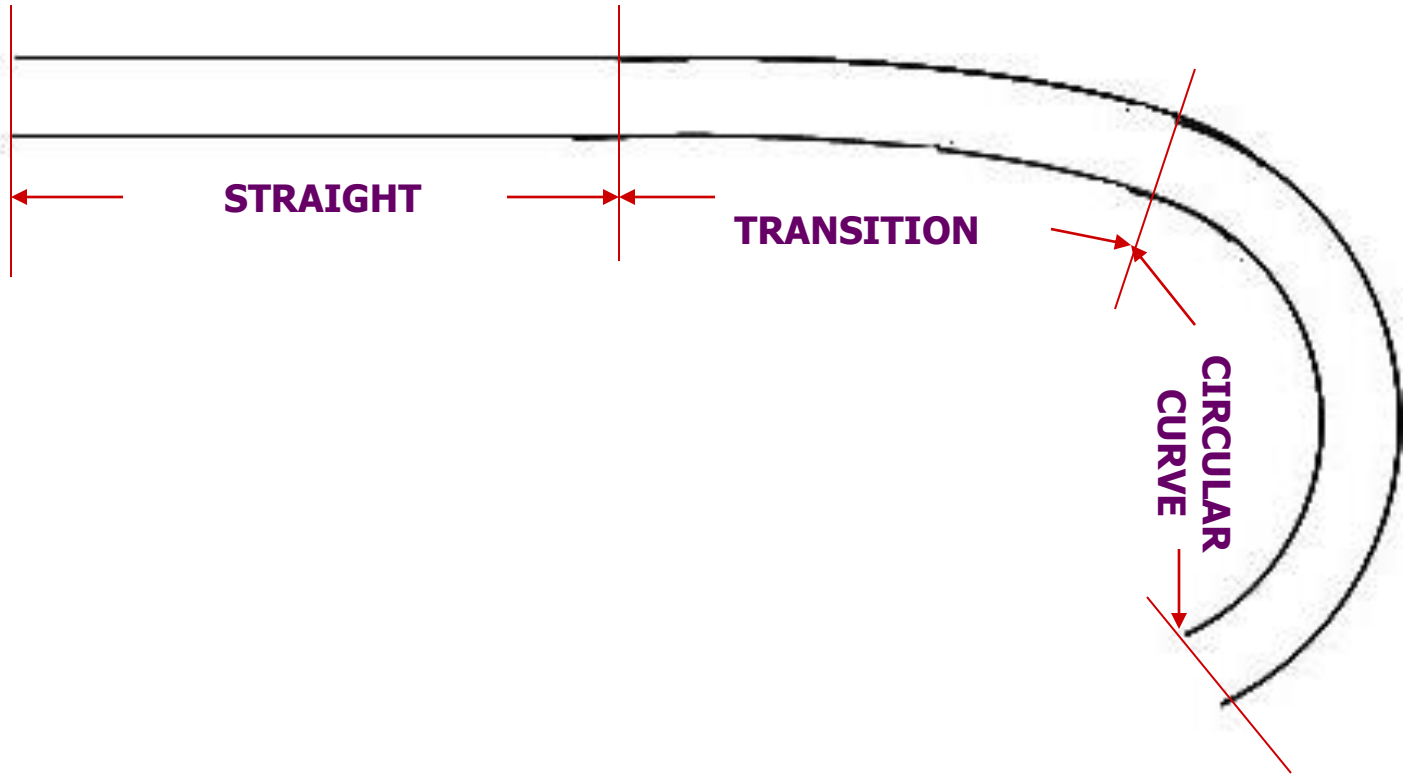
CHORD LENGTH = 30.5 mts

$2\Pi r = 360x\ C$

$= 360x\ 30.5$

$r = 360 \times 30.5 \div 2\Pi$

$= 1750$ MTS


STRAIGHT
TRANSITION
CIRCULAR CURVE

The super elevation to be provided is derived by the formula:

$$SE \text{ (in mm)} = GV^2/127\,R,$$

where G is the dynamic gauge in mm, i-e distance between the centres of the two rails (normally taken as 1750 mm);

V is the speed of the train in kmph;

R is the radius of curve in metres.

The super elevation obtained by the above formula is called equilibrium cant.

For example, the super elevation required for a train running at 100 kmph on 1° curve is 79 mm. But the actual super elevation provided is 43 mm. Thus, for this train, there is a cant deficiency of 36 mm. If a goods train has to run on the same track at 40 kmph, the super elevation required is 13 mm. For this train there is a cant excess of 30 mm.

The maximum cant provided over IR is 165 mm for tracks fit for more than 100 kmph and 140 mm for tracks fit for 100 kmph or less.

The rate at which the cant changes is called cant gradient. The maximum permissible cant gradient for BG is 1 in 360 or 2.8 mm per metre.

Since the cant gradient is a ratio, the variation in SE and the wheel base are both expressed in mm and converted into a ratio.

For example, if the variation in SE between POM and wheel base is 12 mm and the wheel base is 2 metres, the cant gradient is 12 in 2000 or 1 in 167

CALCULATING THE CANT GRADIENT

Stn. no	Sleeper No.	Sleeper Spacing In cm	Gauge in mm		Cross level In mm	
			Free	Under Load	Free	Under Load
0	1	-	+ 5	+ 7	45 SE	48 SE
- 1	2	68	+ 5	+ 8	46 SE	49 SE
- 2	3	71	+ 4	+ 5	44 SE	49 SE
- 3	4	64	+ 4	+ 7	40 SE	44 SE
- 4	5	69	+ 5	+ 5	40 SE	47 SE
- 5	6	68	+ 5	+ 7	38 SE	43 SE
- 6	7	69	+ 3	+ 6	36 SE	40 SE
- 7	8	70	+ 5	+ 5	35 SE	32 SE
- 8	9	70	+ 3	+ 3	39 SE	37 SE
- 9	10	70	+ 5	+ 7	39 SE	41 SE
- 10	11	69	+ 5	+ 5	40 SE	40 SE

Wheel base: 4.57 m

Cross level variation : 48 - 36

= 12 mm

The cross level at wheel base is between 48 SE and 32 SE at stations - 6 and –7. Hence the mean value of the two is taken.

In the tabulation shown on the previous page, the cross level at POM is 48 SE and at wheel base distance it is between 40 SE and 32 SE. The exact cross level can be taken as the mean value between the two or can be found out by graphical method. Hence this value is taken as 36 SE which is the mean value of 40 SE and 32 SE.

Cross level variation
over wheel base of wagon …48 -36 (Since is SE is on same rail)

=12 mm

Wheel base……..4.57 metres

Twist ……Cross level variation in mm /Wheel base in metres

= 12/4.57

= 2.62 mm per metre

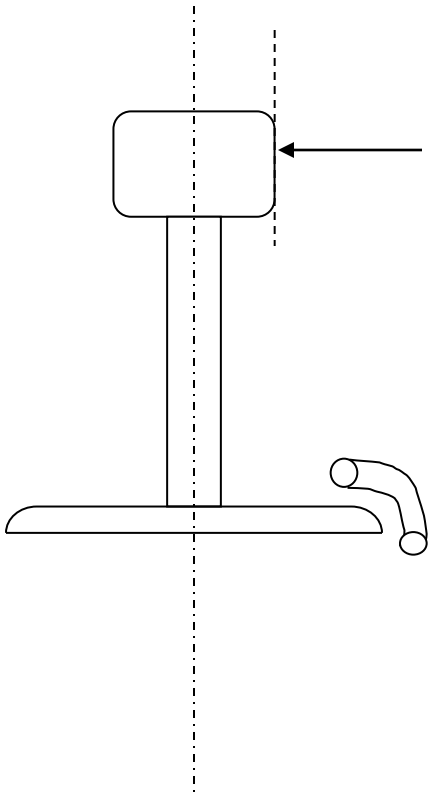
Cant gradient…… = 12:4570

= 1 : 380 or 1 in 380

FASTENINGS

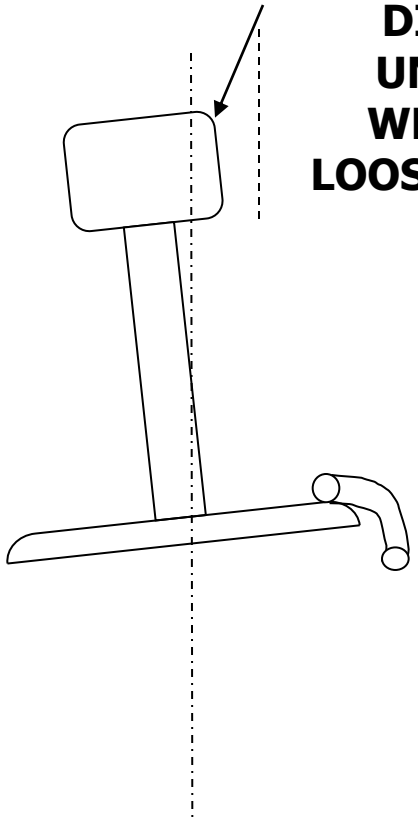
1. The various components which hold the rails firmly in the ballast are called fastenings. Thus, the sleepers, the fitting which hold the rails on the sleepers etc. can be classified as fastenings.
2. The stability of the track depends on the condition of fastenings. Deficient or improper fastening will lead to destabilization of track, ultimately causing buckling or gauge widening.
3. Condition of fastenings is recorded simultaneously with gauge and cross levels and filled in the remarks column. The remarks column can be divided into four sub-columns for convenience of entering the details of LH and RH rails, outside and inside.

WIDENING OF GAUGE UNDER DYNAMIC LOAD DUE TO POOR HOLDING OF FASTENINGS



GAUGE FACE

RAIL IN VERTICAL POSITION UNDER STATIC CONDITION



OUTWARD DISPLACEMENT UNDER MOVING WHEELS, DUE TO LOOSE PANDROL CLIP

RAIL TILTED UNDER DYNAMIC LOAD CAUSING INCREASE IN GAUGE

VARIOUS TYPES OF FASTENINGS USED ON P.WAY

PANDROL CLIP

TWO WAY KEY

SCREW SPIKE

ROUND SPIKE

DOG SPIKE

INSERT FOR
PANDROL CLIP

FISH PLATE

C. I. CHAIR

BEARING PLATE

WOODEN SLEEPER WITH SCREW SPIKES

S. T. SLEEPER WITH LOOSE JAWS & KEYS

S T SLEEPER WITH FIXED JAWS

S. T. SLEEPER WITH PANDROL CLIP

CST-9 SLEEPER

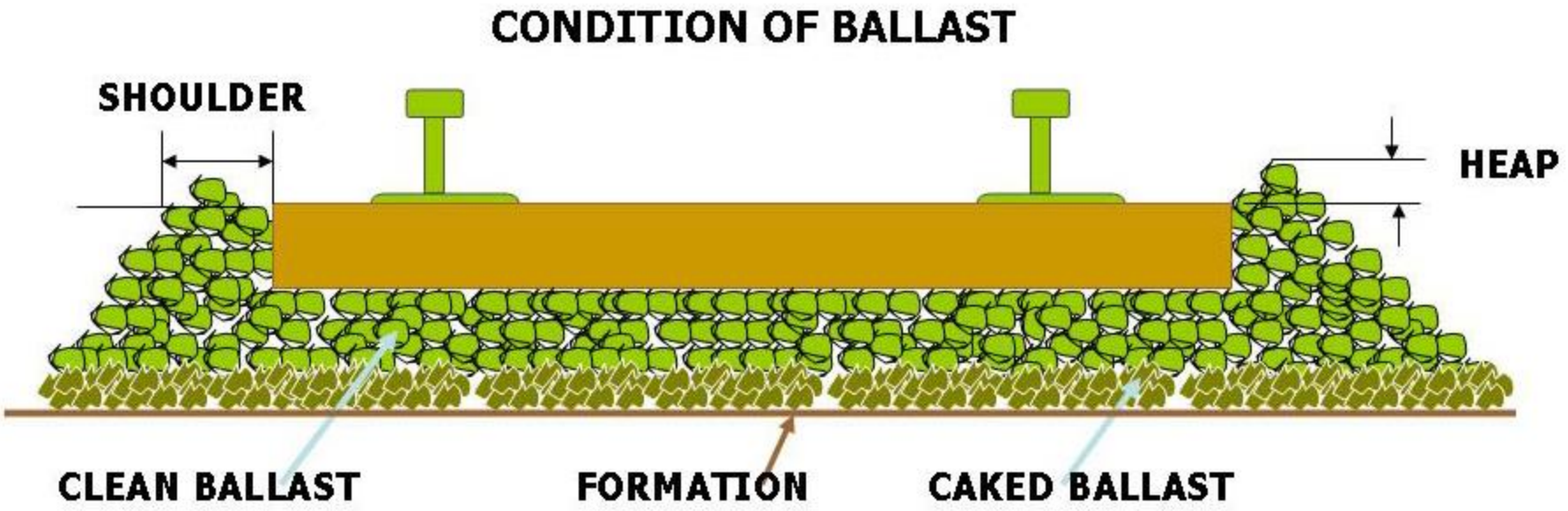
RCC SPLIT SLEEPER

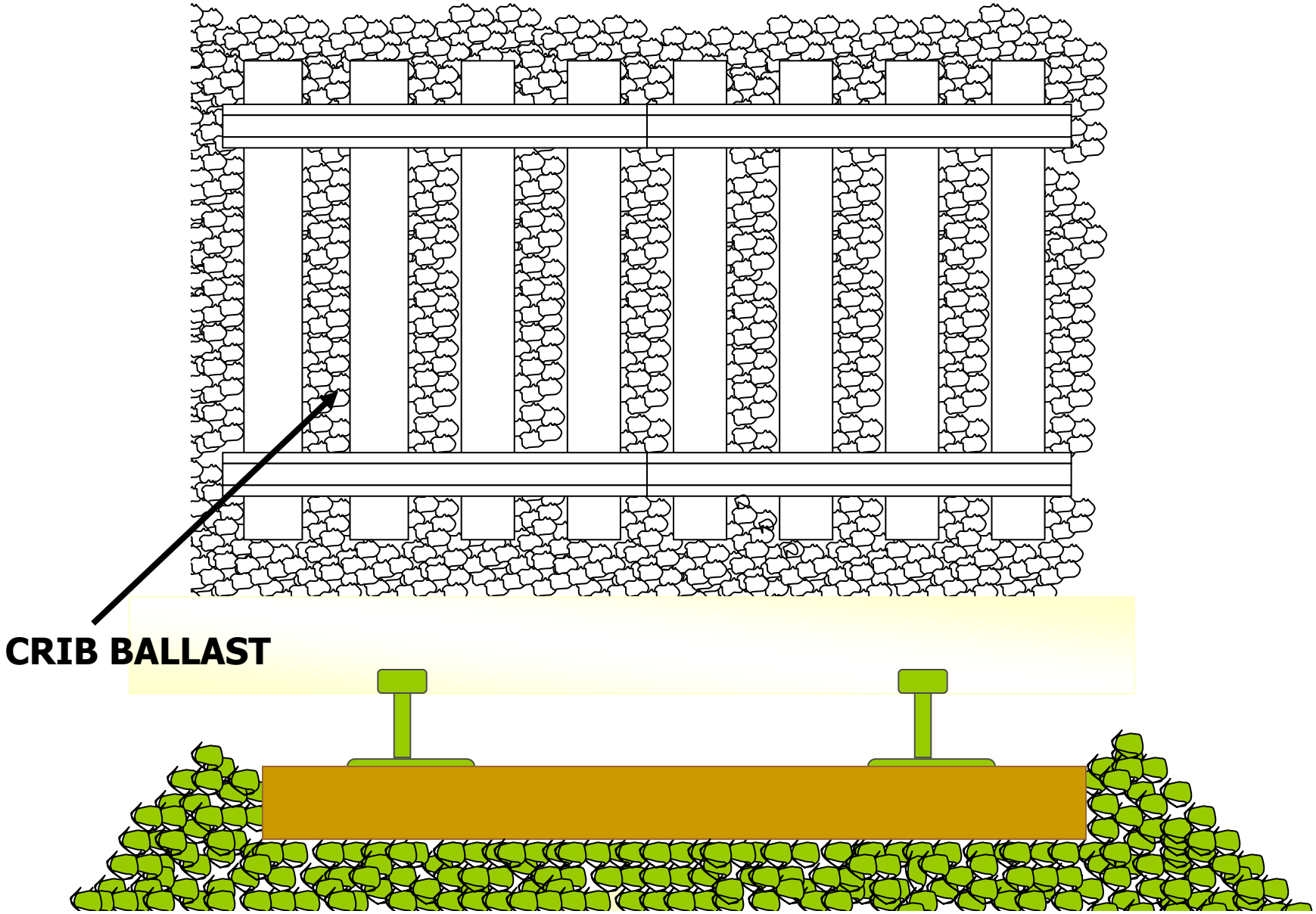
WITH TIE BAR

WOODEN SLEEPER

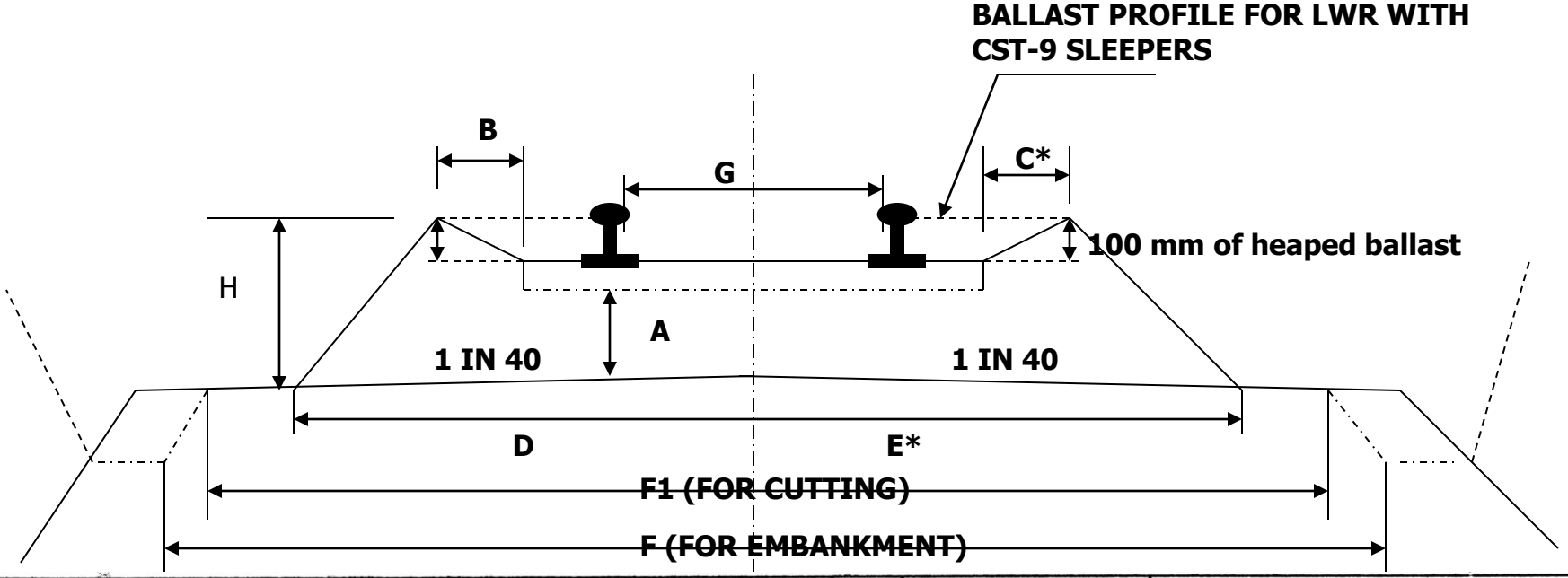
PSC SLEEPER WITH PANDROL CLIPS

CONDITION OF BALLAST

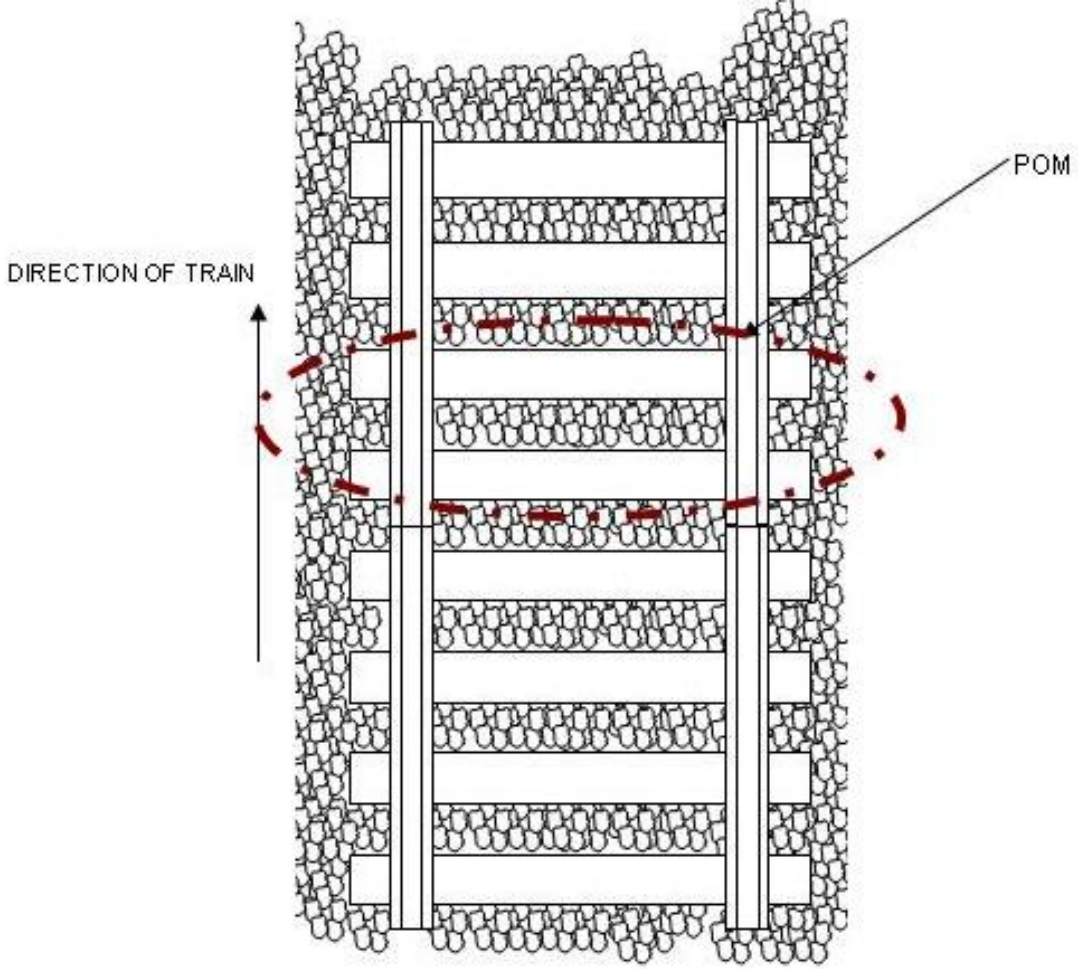


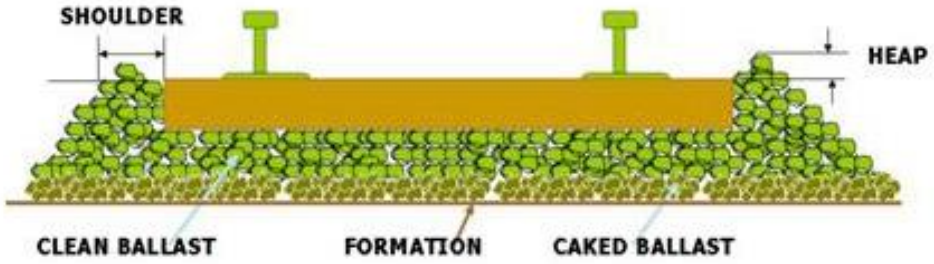

CRIB BALLAST

BALLAST PROFILE FOR LWR TRACK

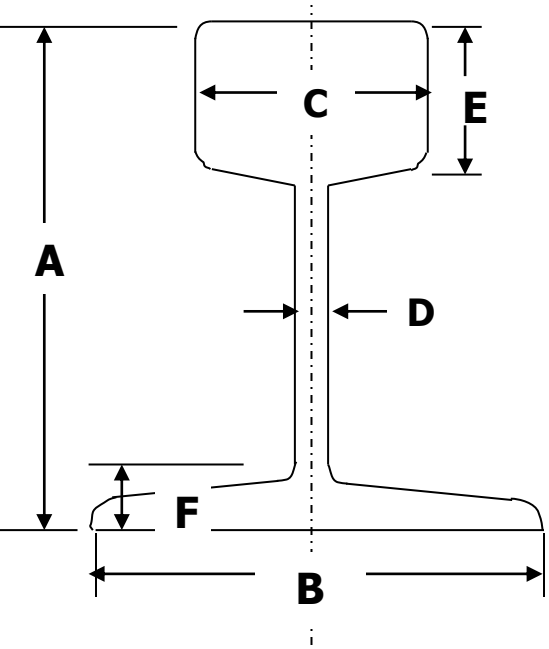


G Gauge	Type of Sleeper	A	B	C*	D	E*	F	F1	H	Quantity of Ballast per meter in		Remarks
										Straight Track	Curved Track	
1676 mm.	Wooden	250	350	500	2,270	2,420	6,100	5,490	540	1.682 M³	1.646 M³	1. The Minimuim Clean Stone Ballast cushion below the bottom of sleeper i. e., A–250 mm.
	"	300	"	"	"	"	"	"	590	1.782 "	1.853 "	2. For routes where increase in speeds are to be more than 130 Km.p.h. A–300 mm. or 200 mm. along with 150 mm. of sub-ballast.
	"	¶	"	"	"	"	"	"	640	1.982 "	2.060 "	3. Suitable dwarf walls shall be provided in case of cuttings, if necessary for retaining ballast.
	Steel Trough	250	350	500	2,280	2,430	6,100	5,490	550	1.762 M³	1.827 M³	4. *On outer side of curves only.
		300	"	"	"	"	"	"	600	1.962 "	2.035 "	5. Cess may be widened where required depending on local conditions and outside of curves.
		¶	"	"	"	"	"	"	650	2.162 "	2.242 "	6. All dimensions are in mm.
	PRC	250	350	500	2,360	2,510	6,100	5,490	630	1.954 M³	2.032 M³	7. ¶ 200 over 150 Sub-Ballast.
	"	300	"	"	"	"	"	"	680	2.158 "	2.243 "	
	"	¶	"	"	"	"	"	"	730	2.362 "	2.455 "	
	2 Block	250	350	500	2,360	2,510	6,100	5,490	630	2.110 M³	2.193 M³	
	"	300	"	"	"	"	"	"	680	2.314 "	2.405 "	
	"	¶	"	"	"	"	"	"	730	2.518 "	2.616 "	


POM
DIRECTION OF TRAIN

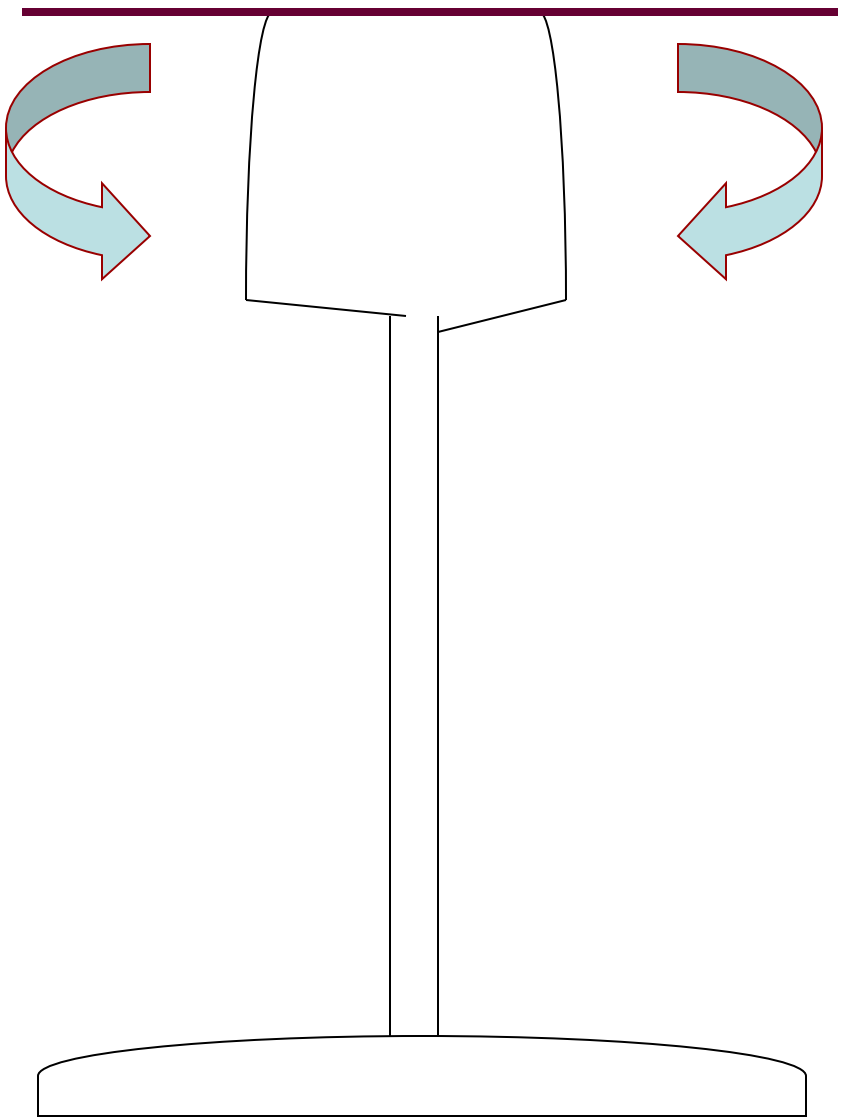

SHOULDER
HEAP
CLEAN BALLAST
FORMATION
CAKED BALLAST

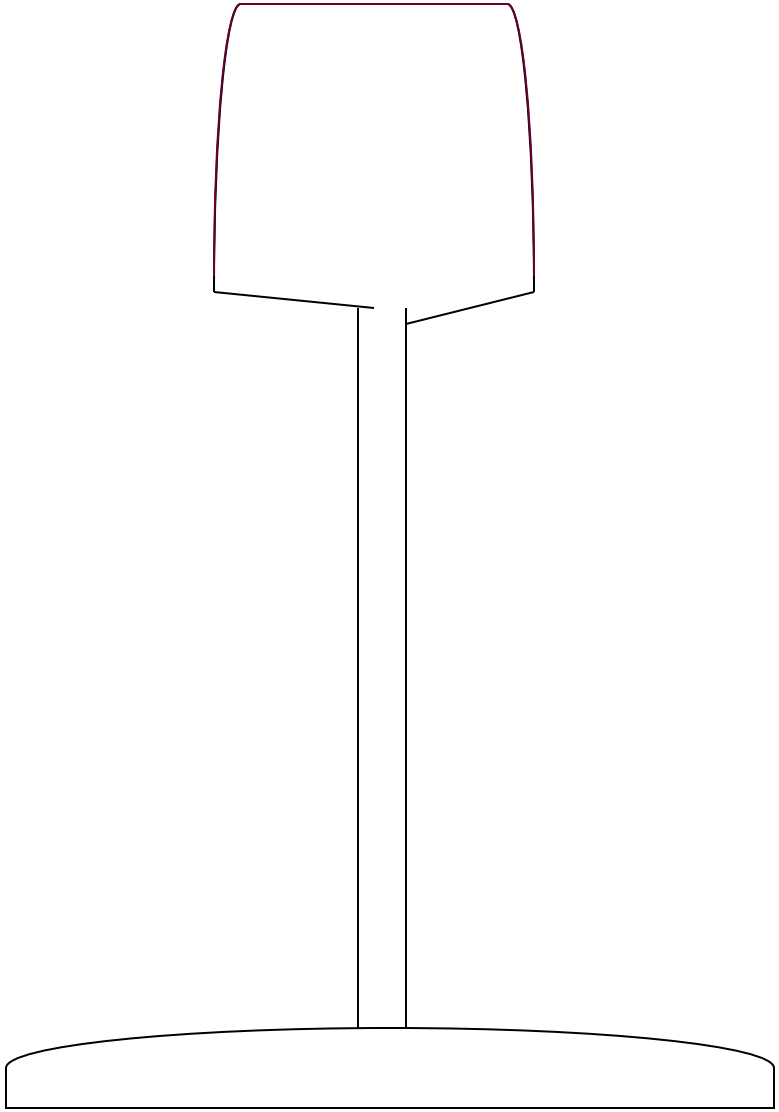
CONDITION OF RAILS

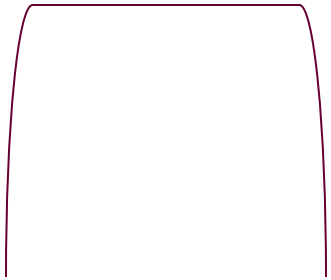


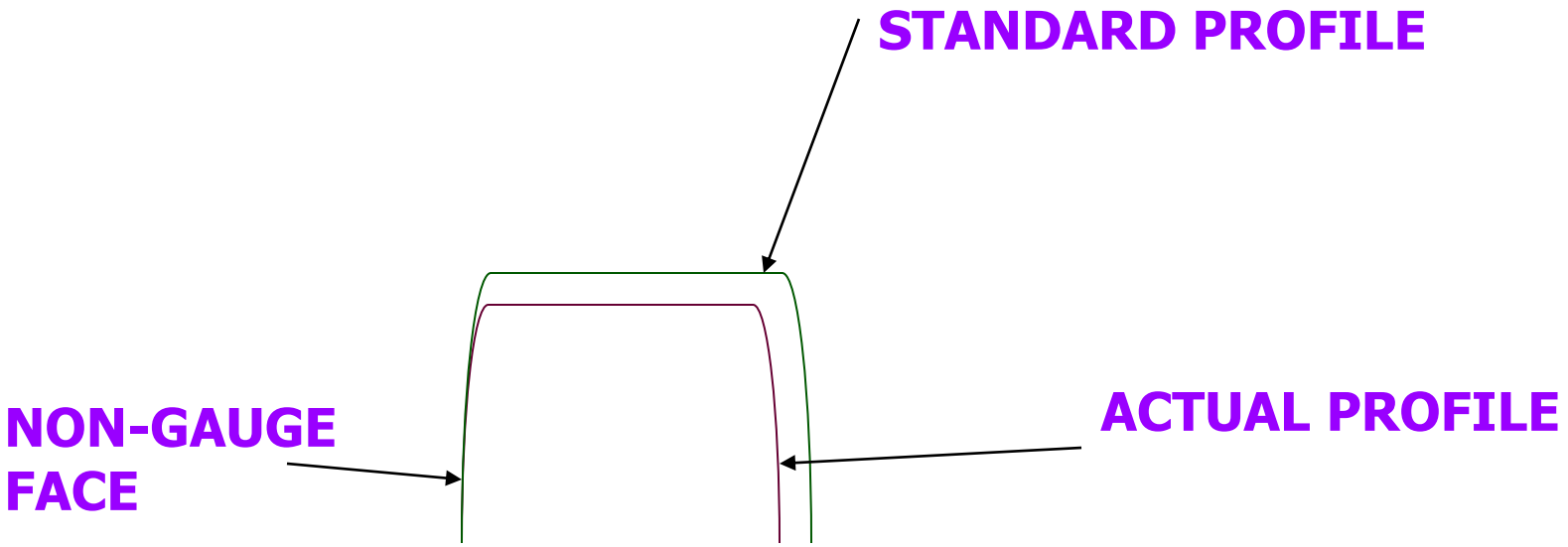
Rail Section	Wt/M (in kg)	Area Of section mm^2	DIMENSIONS IN mm.					
			A	B	C	D	E	F
60 kg UIC	60.34	7686	172	150	74.3	16.5	51	31.5
52 kg	51.89	6615	156	136	67	15.5	51	29
90 R	44.61	5895	142.9	136.5	66.7	13.9	43.7	20.6
75 R	37.13	4737	128.6	122.2	61.9	13.1	39.7	18.7
60 R	29.76	3800	114.3	109.5	57.2	11.1	35.7	16.7
50 R	24.80	3168	104.8	100	52.4	9.9	32.9	15.1

STANDARD RAILS

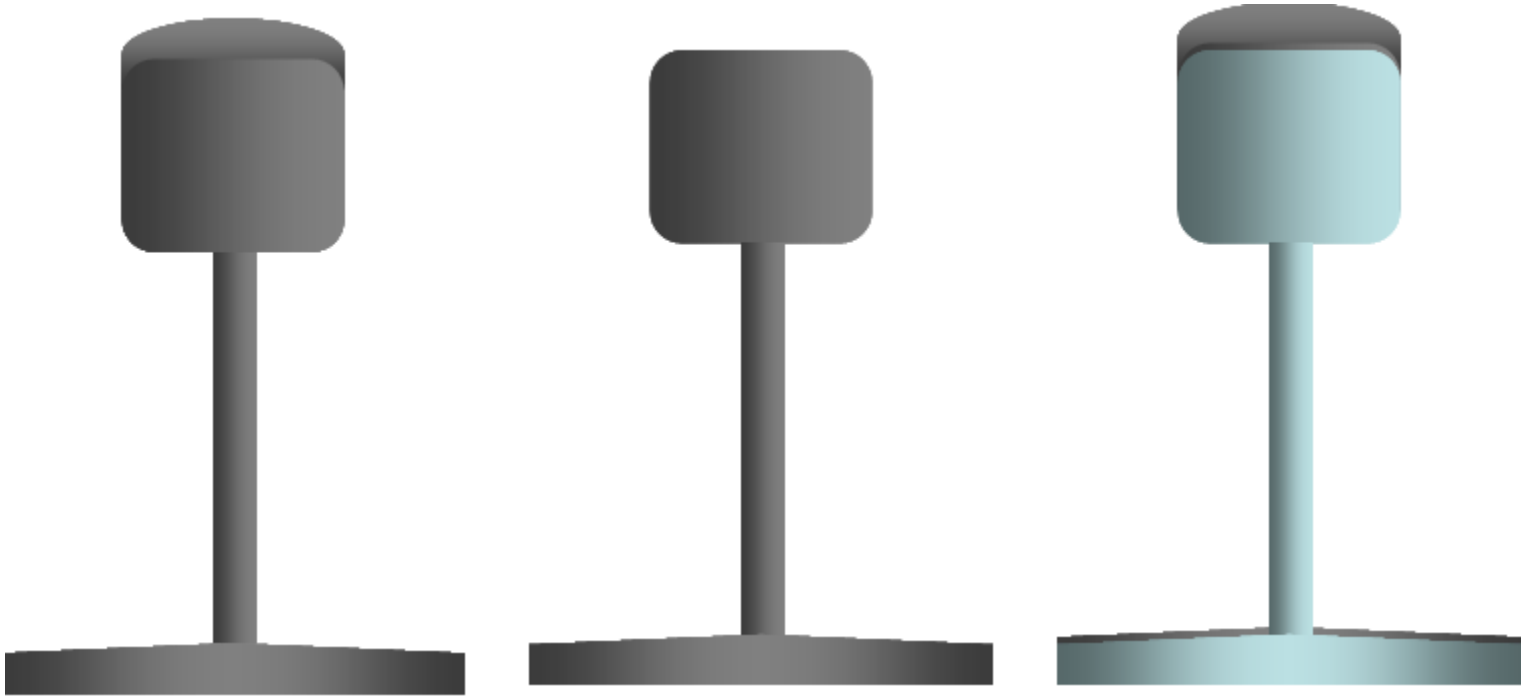


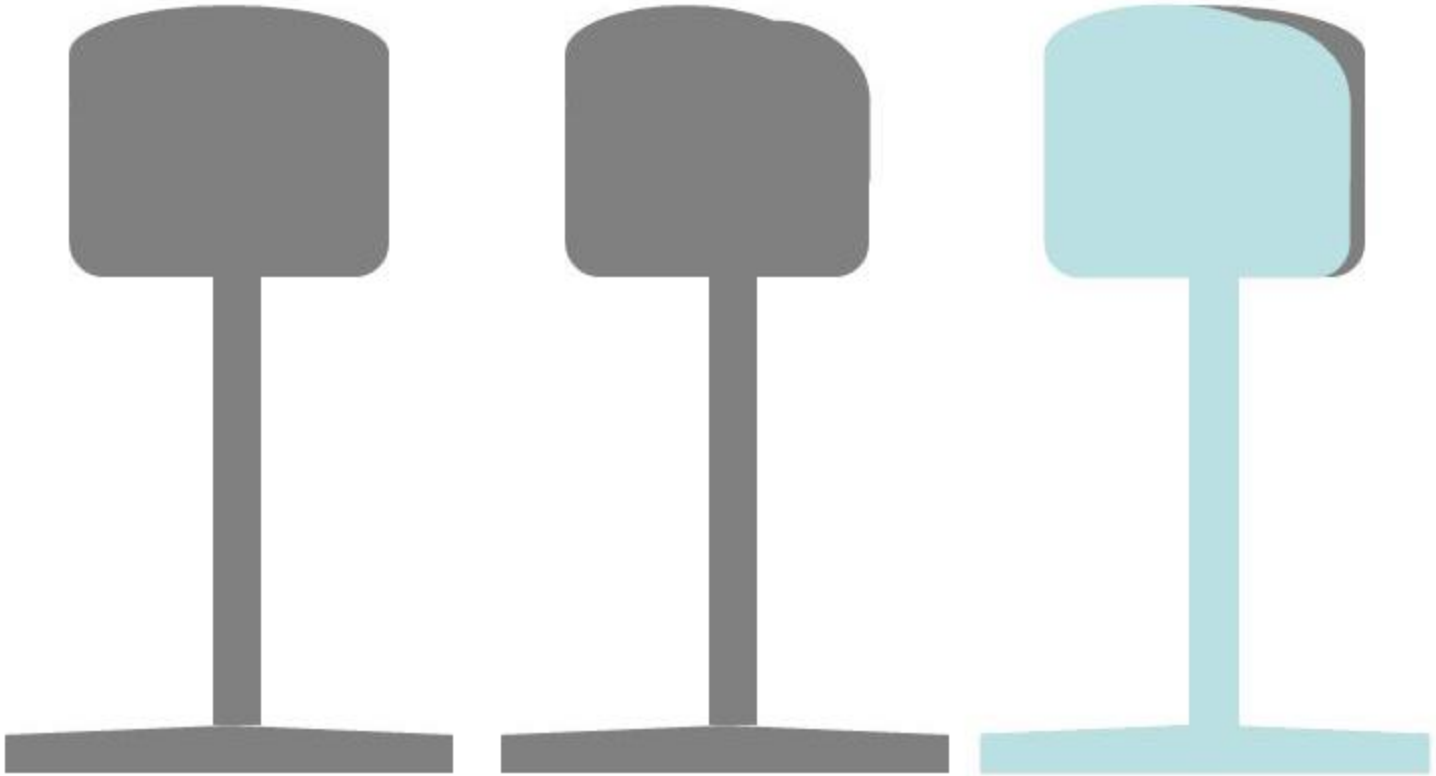


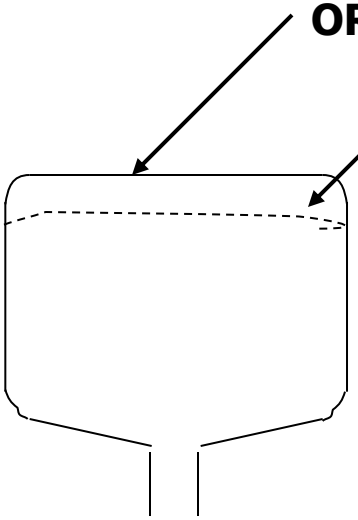



STANDARD PROFILE
NON-GAUGE FACE
ACTUAL PROFILE

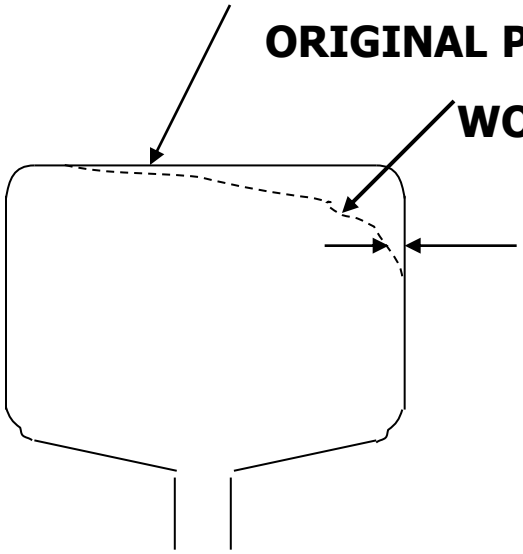
VERTICAL WEAR

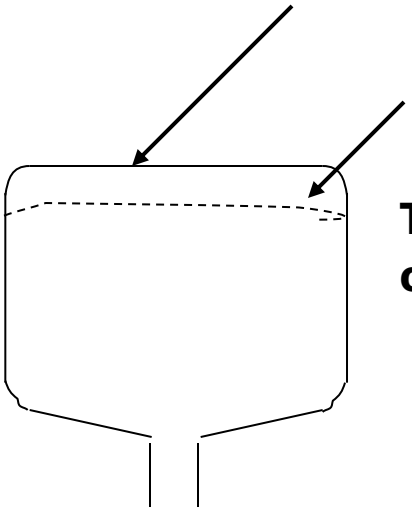






VERTICAL WEAR

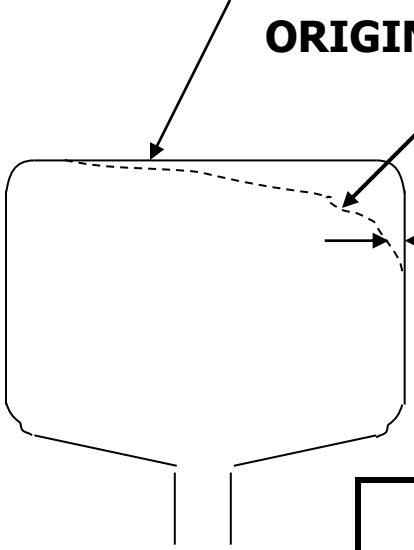




VERTICAL WEAR

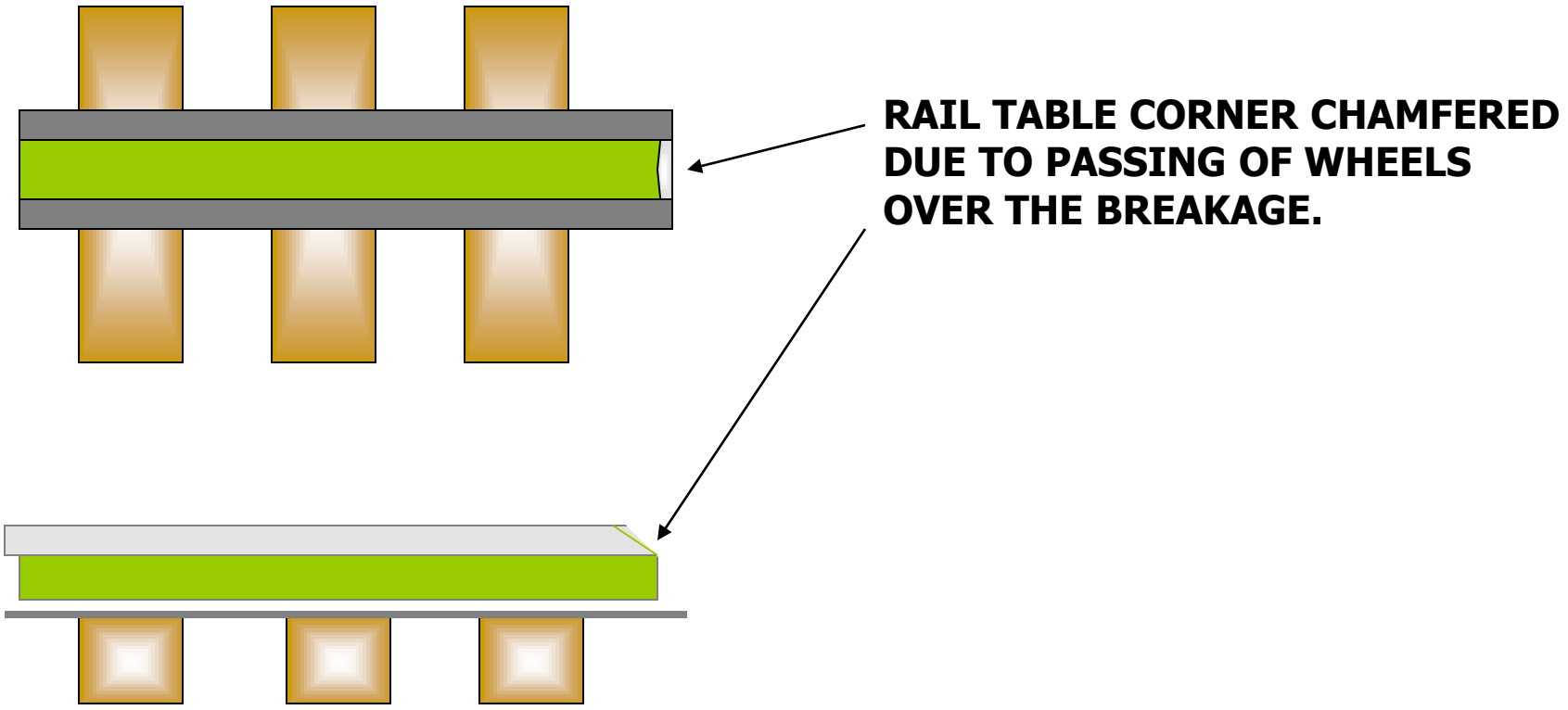
The extent of vertical wear as laid down in para 302 (c) (iii) of IRPWM, is as follows: -

GAUGE	RAIL SECTION	VERTICAL WEAR
BROAD GAUGE	60 KG / METRE	13.00 MM
	52 KG / METRE	8.00 MM
	90 R	5.00 MM
METRE GAUGE	75 R	4.50 MM
	60 R	3.00 MM

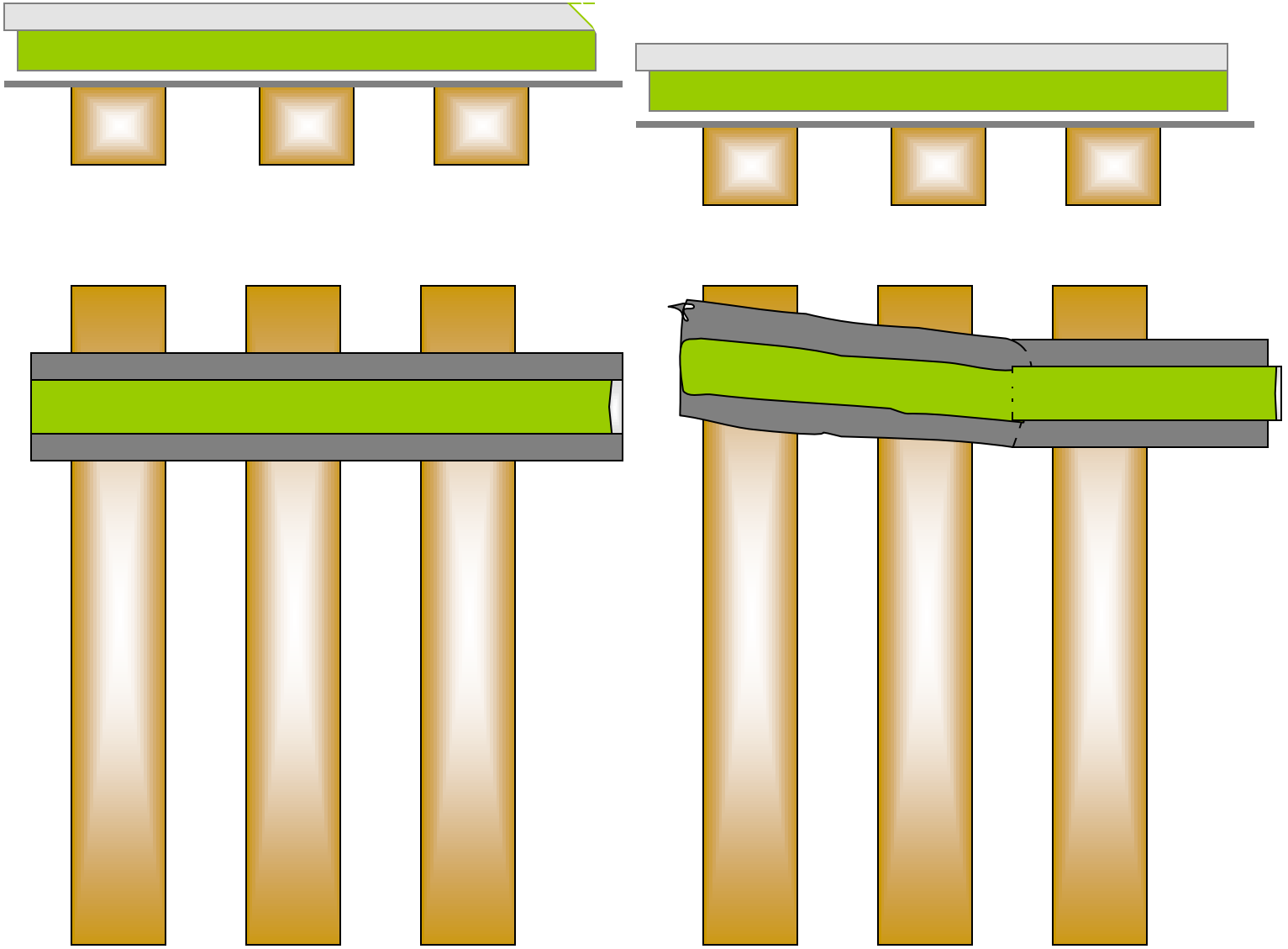


Para 302 (b) (iv) of IRPWM is as follows:-

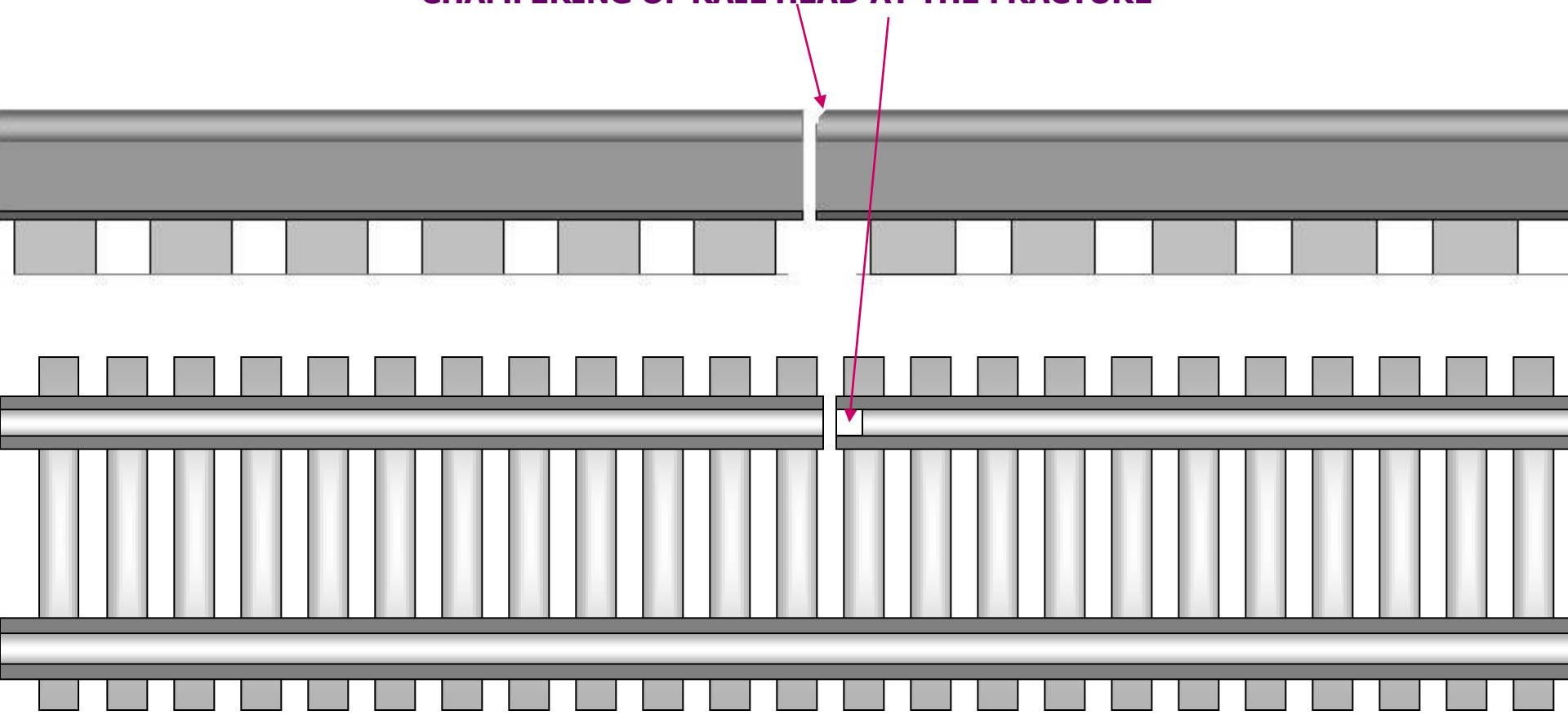
SECTION	GAUGE	CATEGORY	PERMISSIBLE LATERAL WEAR
CURVE	BG	GROUP A & B	8 mm
		GROUP C & D	10 mm
	MG	GROUP Q & R	9 mm
STRAIGHT	BG	GROUP A & B	6 mm
		GROUP C & D	8 mm
	MG	GROUP Q	6 mm
		GROUP Q	8 mm


RAIL TABLE CORNER CHAMFERED
DUE TO PASSING OF WHEELS
OVER THE BREAKAGE.

VERTICAL AND LONGITUDINAL ALIGNMENT OF RAILS DISTURBED



CHAMFERING OF RAIL HEAD AT THE FRACTURE



The three categories of defects shall be marked in the field, on the rails, as follows:

S.No.	Classification	Painting on both faces of web
1.	I.M.R	Red - 3 stars
2.	R.E.M.	Red - 2 stars
3.	O.B.S.	Red - 1 star
4.	OBS (B)	Red - 1 star
5.	Other OBS	Red - 1 star

S. No.	Classification of defects	Action required to be taken	Speed restriction etc. to be imposed if action under column (3) is delayed.
1.	IMR	Immediate replacement (not later than 3 days)	Impose 30 km/h and depute a watchman till defective part replaced.
2.	REM	Replace within 15 days	Impose 30 km/h if not replaced within 15 days.

3.	**OBS (E)**	**Replace or end crop within 15 days**	**Impose 30 km/h if not replaced within 15 days.**
4.	**OBS (B)**	**Replace within 15 days**	**Impose 30 km/h if not replaced within 15 days.**

MARKING OF RAIL CRACK WITH RED STARS AFTER CONDUCTING USFD

CREEP & BUCKLING

Creep is the longitudinal movement of track, caused by various factors. The creep is caused by the ironing out of yielding track, by the moving load and its impact on the ends of the rails, especially at times when they are in the process of expansion or contraction due to temperature variations. Some causes of creep are given below:-

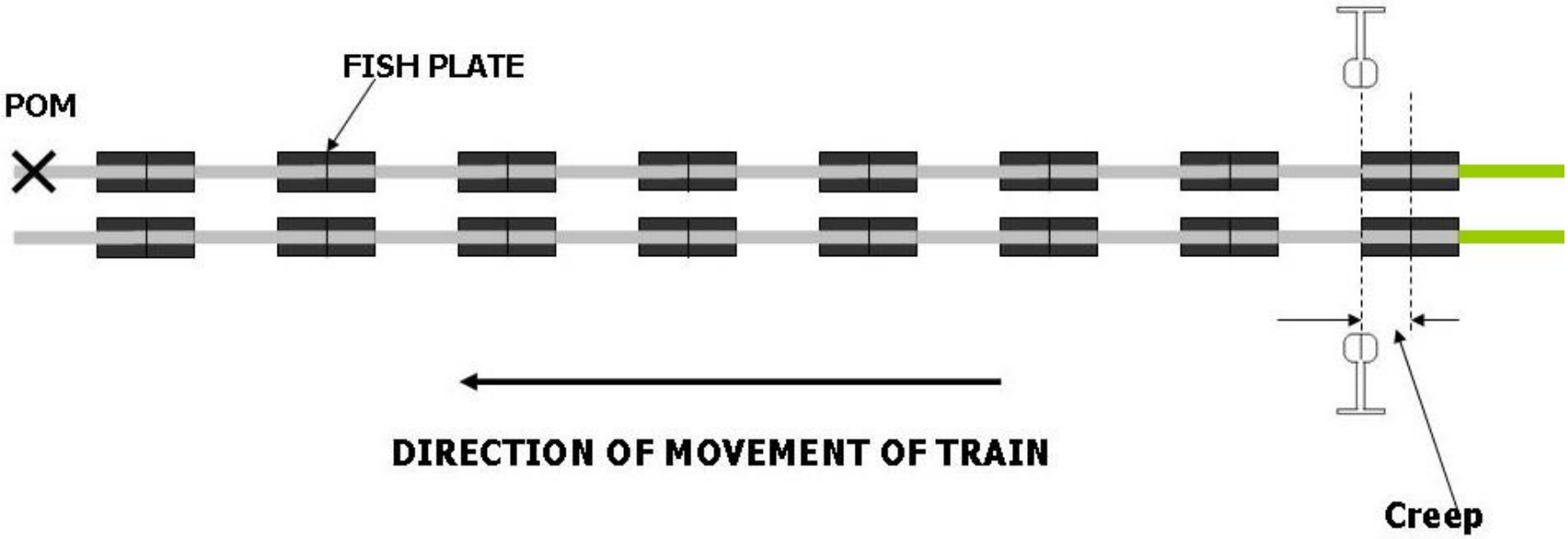
a) Rails not secured properly to the sleeper.
b) Insufficient ballast which yields to the movement of sleeper during wheel movement.
c) Badly maintained rail joints.
d) Rails lighter than the prescribed type for the particular section of track.
e) Improper expansion gap.

f) Decay of sleepers.
g) Uneven spacing of sleepers.
h) Improper drainage.
i) Loose and uneven packing.
j) Rail seat worn out in the metal sleepers.

Creep in the track causes the sleepers to go out of square, distorts the gauge, causes shearing and breaking of spikes, bolts and fishplates and in some extreme cases buckling of the track.

At accident site, the creep has to be measured at the nearest kilometre. For this purpose creep posts are erected at approximately one km intervals, opposite to the fish plate joints. The creep posts are discarded rails fixed vertically on either side of the ballast cushions. The centre line is marked with chisel on the top of the rail in line with the rail joint.

These posts are so erected that they are slightly above the rail level. A nylon cord is held over the two posts on the centre line marked in the post.



The displacement of the rail joints with reference to this cord is then recorded separately for the left rail and right rail. If the joint had moved forward with reference to the direction in which the measurement is being taken the creep is indicated as positive. If the creep is opposite to the direction of the measurement it is indicated as negative.

Buckling

Buckling of track occurs when high compressive forces are created in the rails associated with inadequacy of lateral resistance in the track at the place.

HOW TO IDENTIFY BUCKLING:

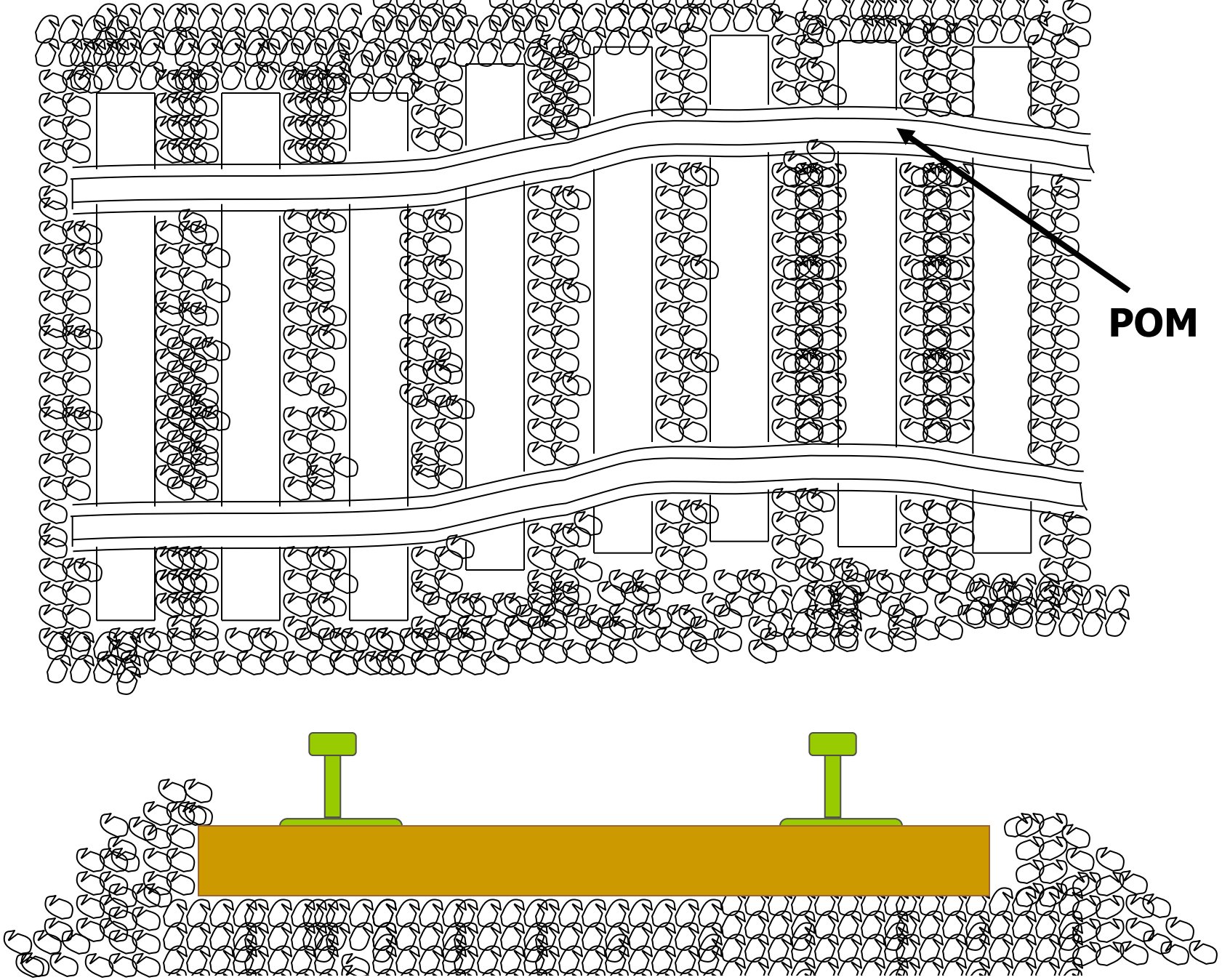
Point of mount will be found at the distorted location or slightly ahead of the distorted location;

More than one travel mark can be noticed from the POM.

Gap can be noticed between the edges of the sleepers and the ballast on one side and heaping of ballast on the other side;

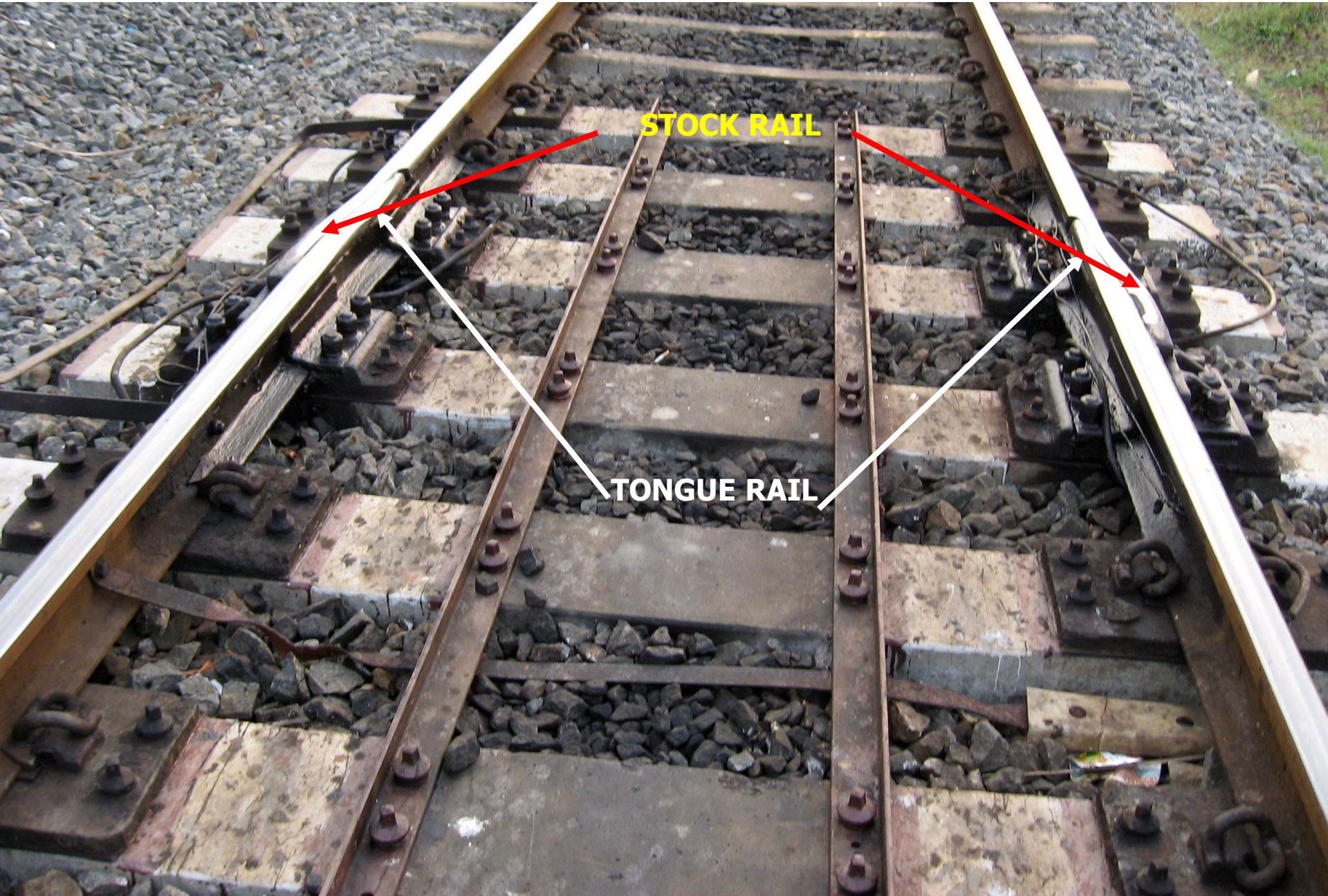
Record the extent of displacement of the track with reference to ballast and the original alignment immediately before the conditions are disturbed;

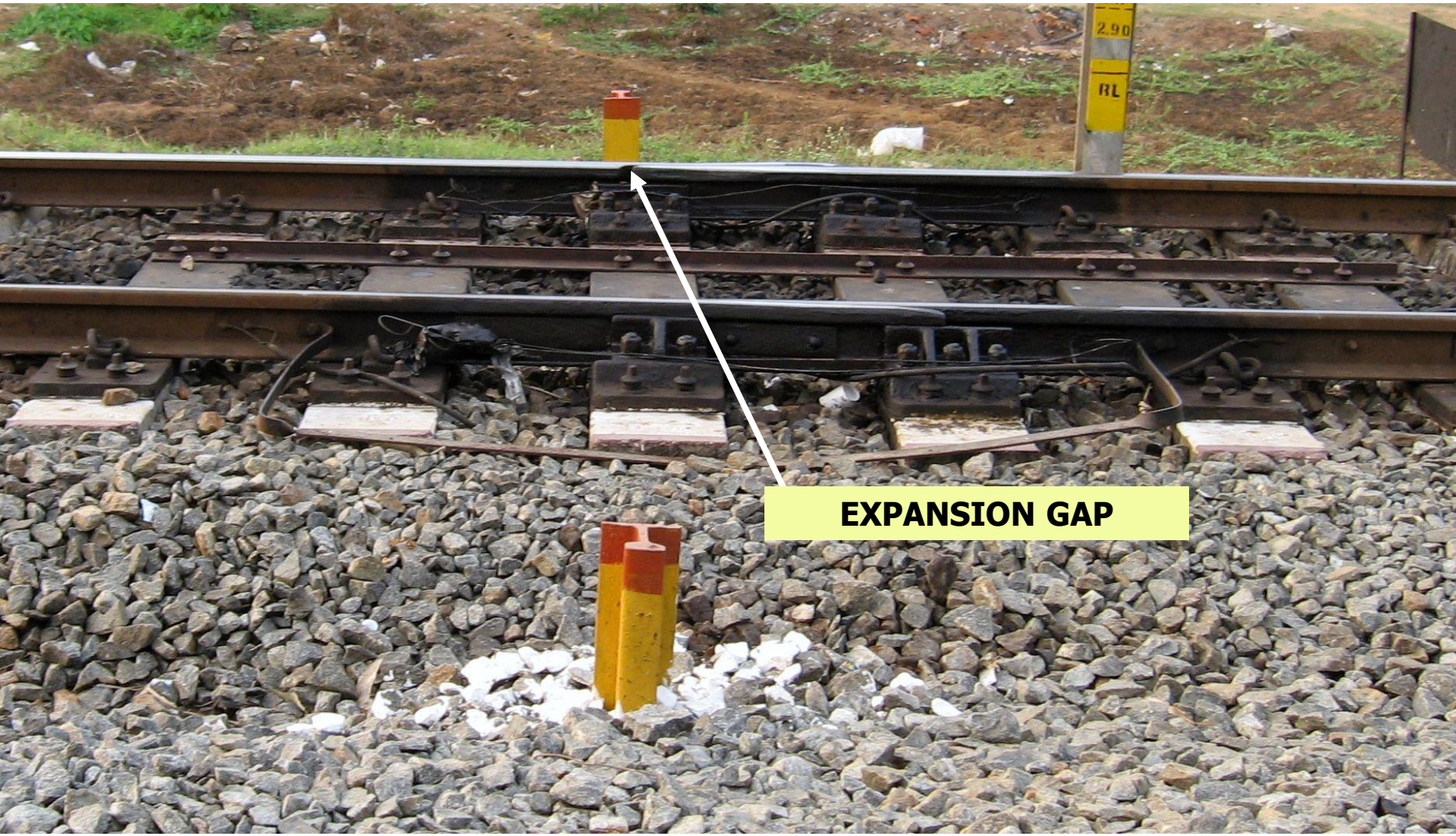
In case of LWR/ CWR, measure the gap at the nearest expansion joint;



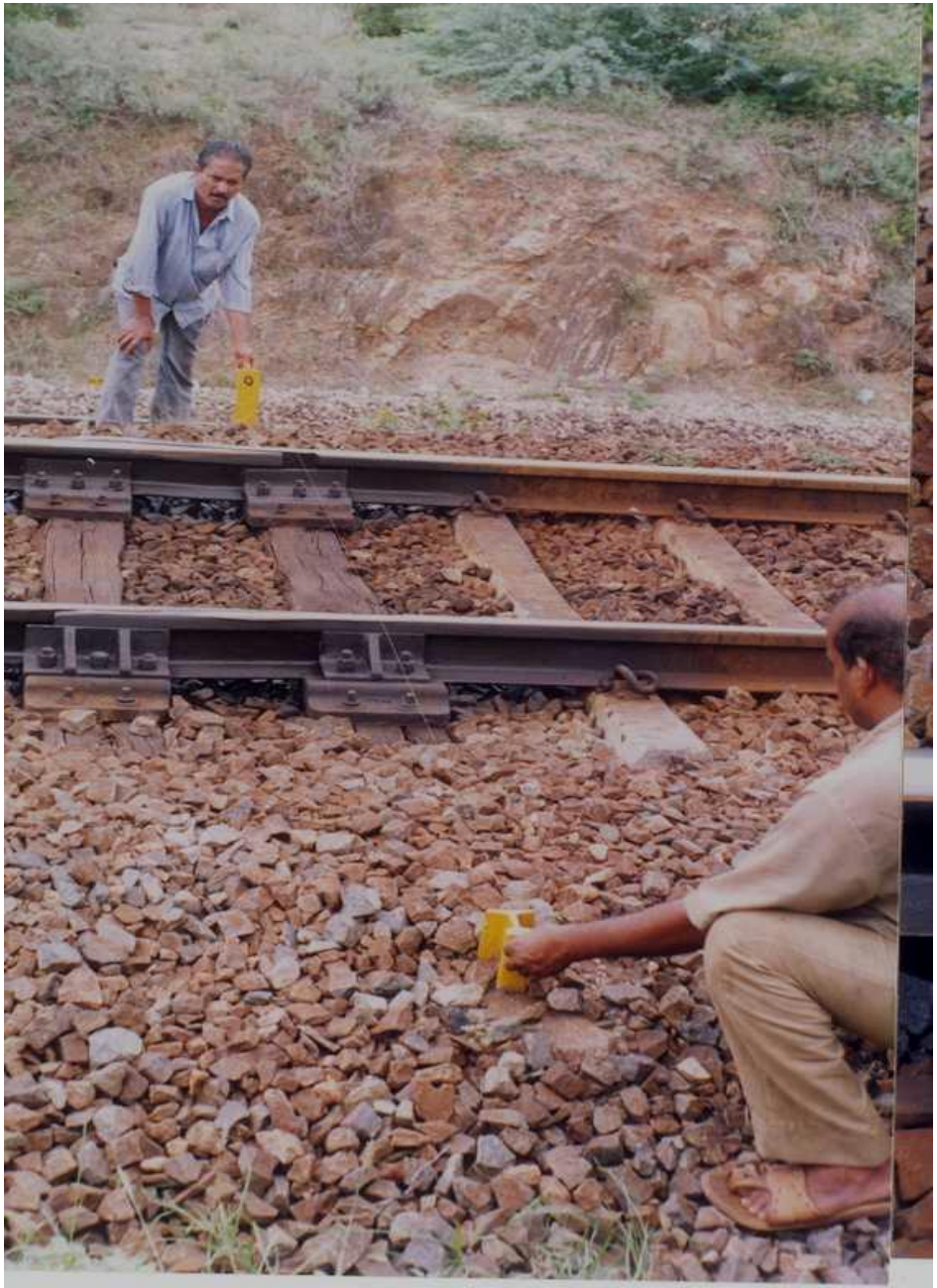
BALLAST AFTER DISPLACEMENT OF TRACK

EXPANSION JOINT

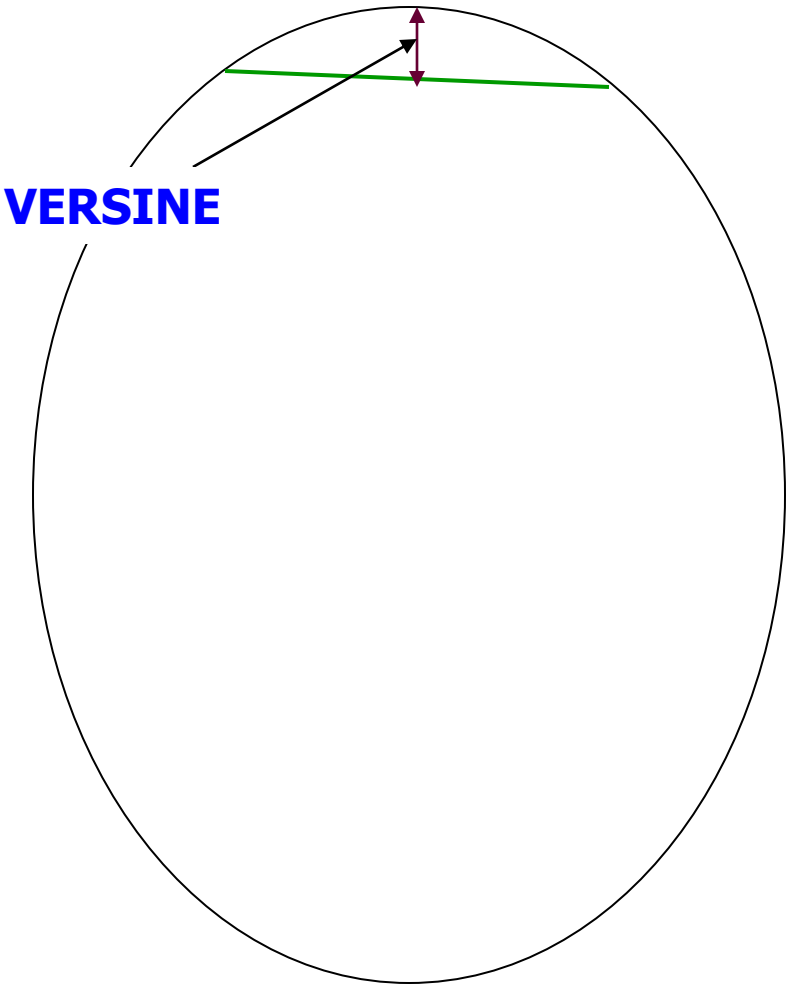



2.90
RL
EXPANSION GAP

CHECKING EXPANSION JOINT



MEASURING THE VERSINE



VERSINE IS OBTAINED BY USING THE FORMULA

V (Versine in mm) = $125C^2/R$

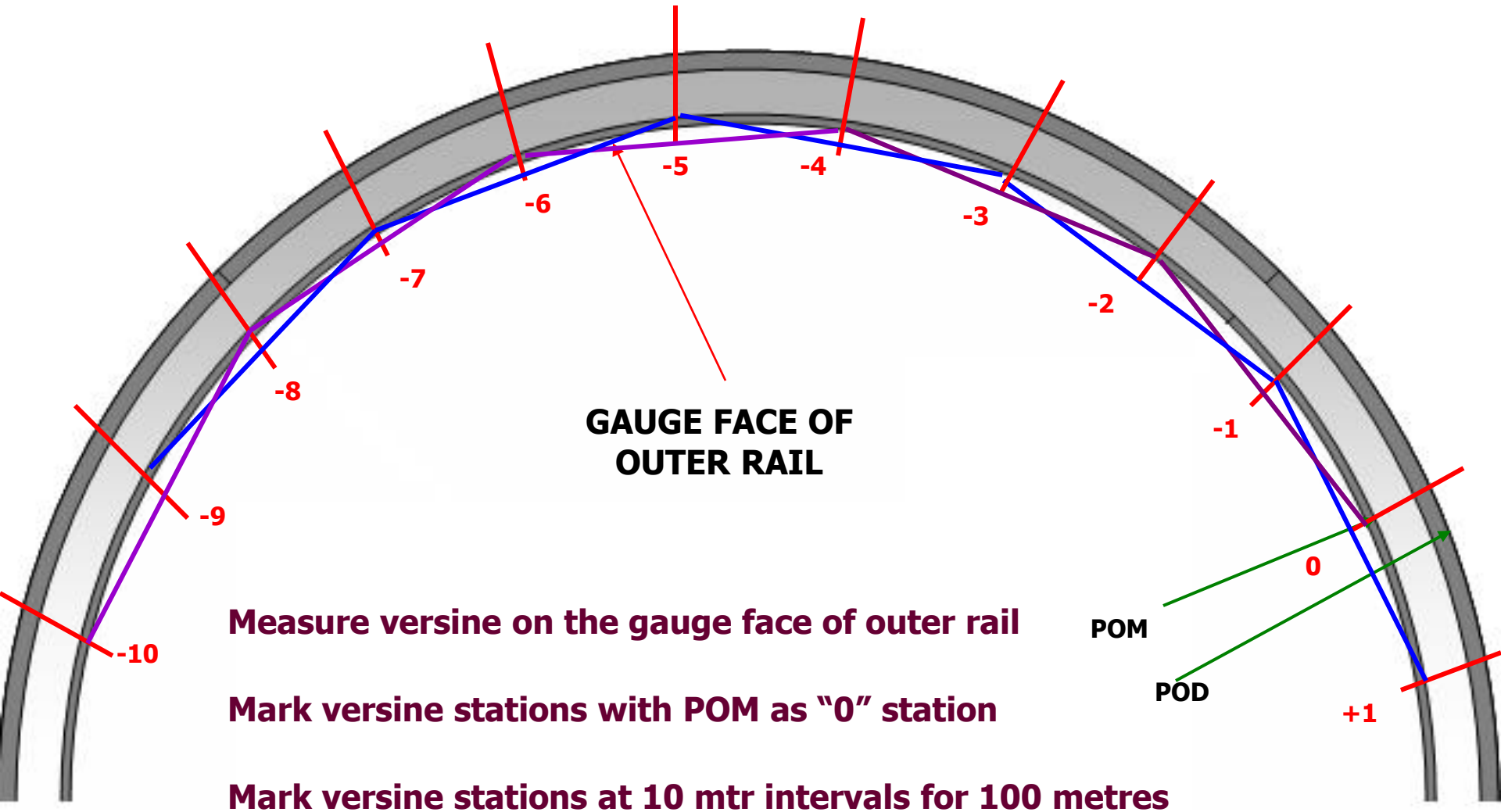
where C is the length of chord used in metres and R is the radius of curvature in metres;

Thus for a 1° curve, the versine measured on a 20 metre chord :-

125 x20 x 20/1750 = 28. 6 or 29 mm

The equipment for measuring versine consist of two specially designed forks, a specially calibrated scale and a spool with nylon cord of about 30 metre length.

On curves other than points and crossings , turn-outs and turn-ins, the versine is measured with a 20 metre nylon chord at 10 metre intervals. For this, the locations are marked with POM as '0' station and other stations at every 10 metres for 90 metres in rear of of point of mount and 50 metres ahead. However, if the portion ahead is badly disturbed, only one station can be marked ahead of POM.



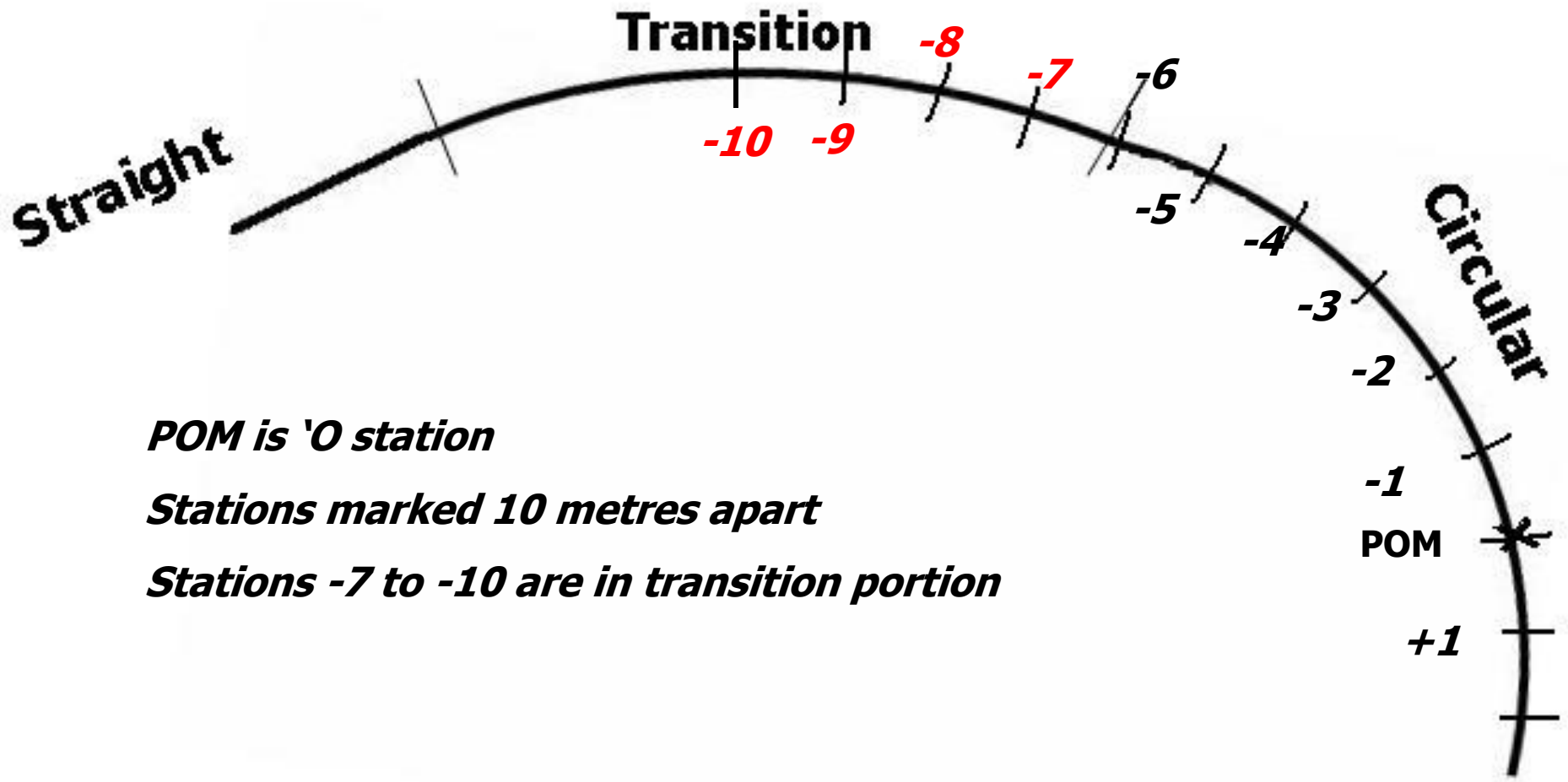
Measure versine on the gauge face of outer rail

Mark versine stations with POM as "0" station

Mark versine stations at 10 mtr intervals for 100 metres in rear and 50 metres ahead of "0" station.


LAKSHMI-MEERUT

Station No.	Versine
+4	79
+3	88
+2	71
+1	92
0	99
-1	80
-2	88
-3	78
-4	94
-5	101
-6	79
-7	81
-8	82
-9	90



POM is 'O station

Stations marked 10 metres apart

Stations -7 to -10 are in transition portion

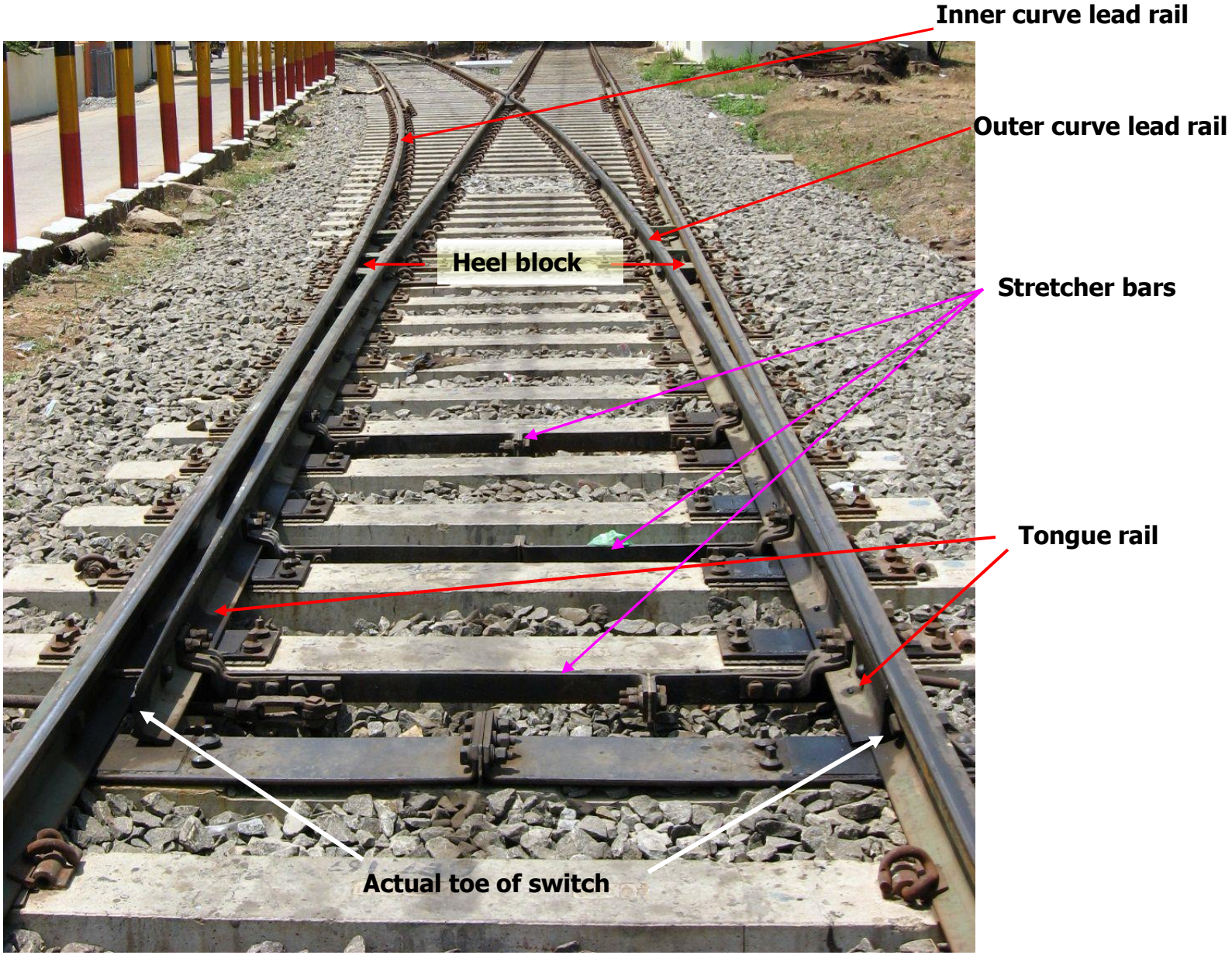
Tabulating the versine

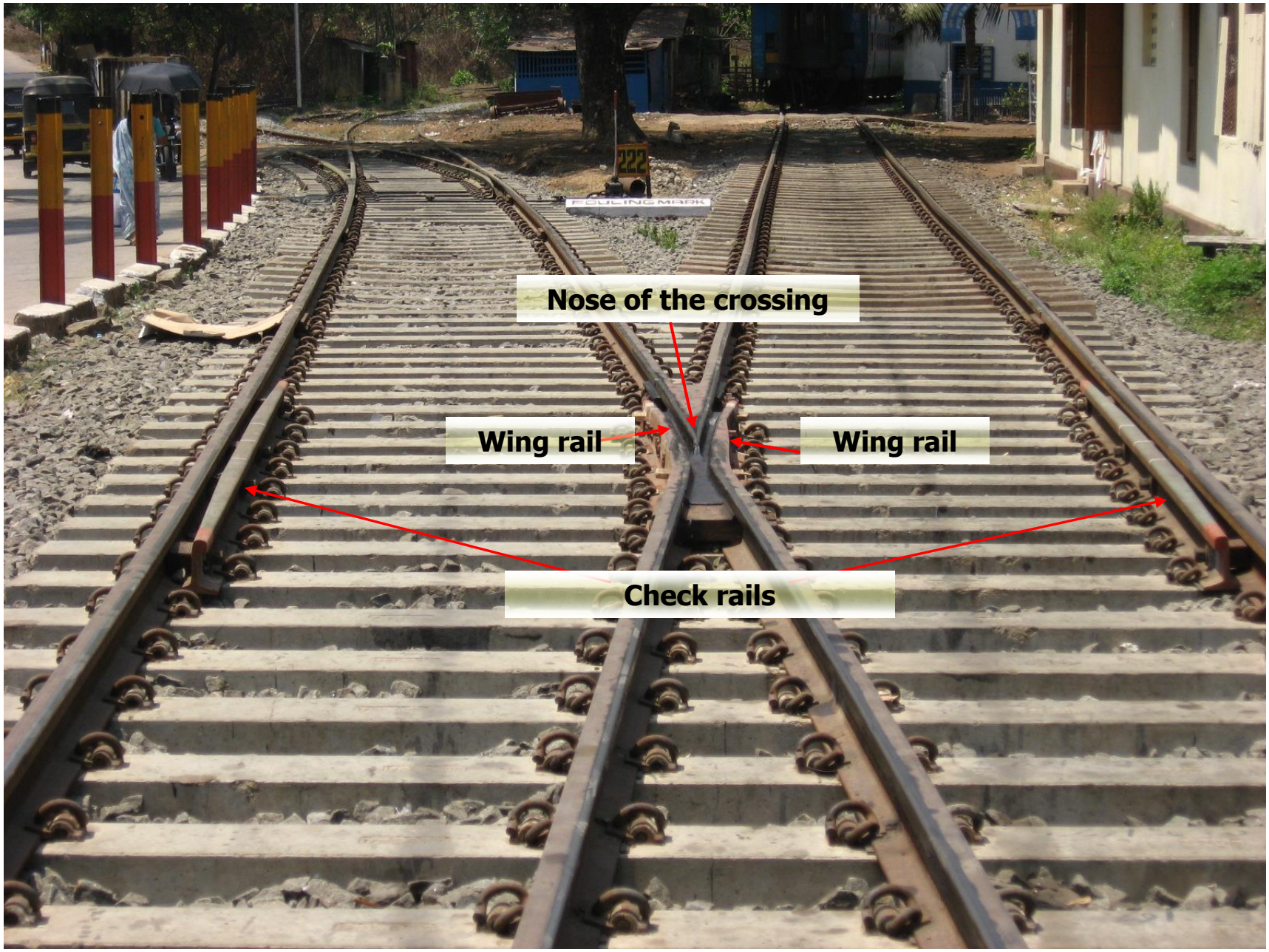
Station	Versine in mm	Variation Stn to Stn	REMARKS
0	89		+1 STN IN DISTURBED PORTION
-1	76	13	
-2	94	18	
-3	80	14	
-4	76	4	
-5	97	21	
-6	70	27	One end of chord in transition portion
-7	62	8	Transition
-8	52	10	Transition
-9	44	8	Transition

AVERAGE VERSINE OF CIRCULAR PORTION = (89+76+94+80+76+97)÷6=85.33 MM

25% OF AVERAGE VERSINE OF CIRCULAR PORTION = 21.33 MM

POINTS & CROSSINGS


Inner curve lead rail
Outer curve lead rail
Heel block
Stretcher bars
Tongue rail
Actual toe of switch


Nose of the crossing
Wing rail
Wing rail
Check rails

Derailments over points & crossings:

Vehicles taking two roads at the entry to the points;

Vehicles taking two roads at the nose of the crossing;

Mounting over the tongue rail and taking two roads;

Side collision due to rolling back of loose shunted vehicle in marshalling yards.

Vehicle taking two roads may happen due to:

Wheel defect;

Defect in the points and crossing components;

Defect in the points & crossing mechanism;

Opening of points due to trailing through and backing of a vehicle;

Derailments can occur due to skids kept under a vehicle not being removed and getting dragged to the points & crossings where it will get stuck up and cause derailment.

Derailments can also occur due to vehicle parts or consignments falling on the track and getting caught in the points & crossings.

Measurements to be taken:

As usual, readings are taken in the same manner described for other locations. However, gauge and cross level over points and crossings are taken only at specified locations.

Versines are taken in lead rail portion and the turn out, on a 6 metre chord at three metre intervals.

Points to remember:

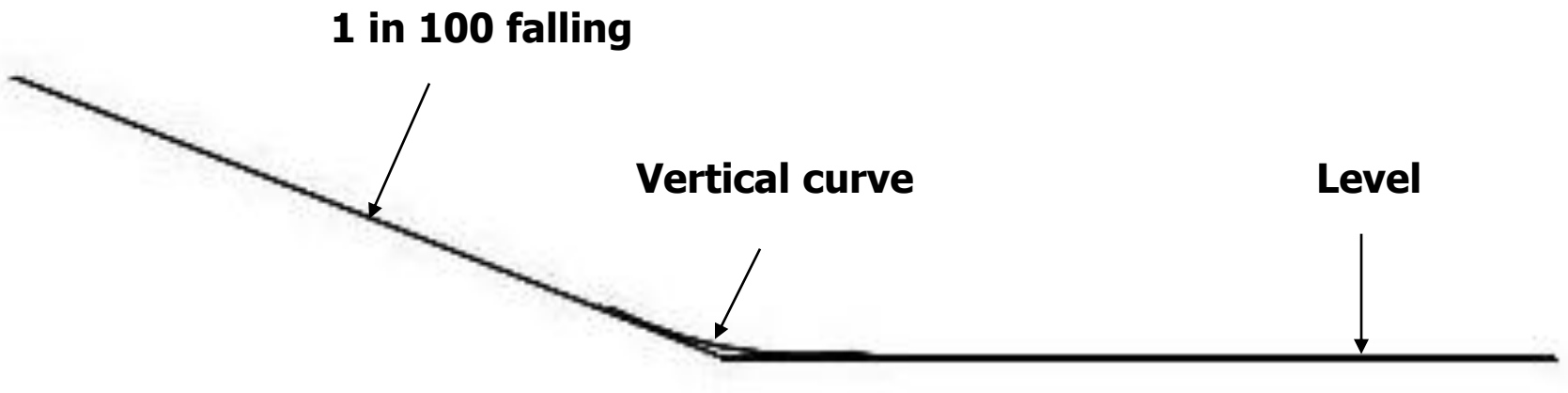
1. **Gauge;**
2. **Alignment;**
3. **Versine variations;**
4. **Super elevation of turn outs;**

Longitudinal level

Longitudinal levels are checked to verify the gradient in the location of accident;

Longitudinal levels are to be measured when:

1. **The POM is located within 90 meters of the sag portion, and the algebraic difference between the grades is equal to or more than 4 mm per metre or 0.4 percent. ;**



2. When the point of mount on a curve situated on a gradient;

On the basis of the ruling gradient of the section where the derailment occurred, a compensation of 0.04 percentage of the degree of curvature to the percentage equivalent of the ruling gradient has to be provided to ease the gradient at the location.

Longitudinal level has to be measured to a distance of 300 metres in rear of the point mount and 100 metres ahead. The level should be taken at the centre of the track at 10 meter intervals.

PARAMETERS OF SIGNALLING EQUIPMENT

all interlocking schemes usually enforce several or all of the following rules:

No signal can be pulled off unless corresponding points are set correctly.

Facing points are locked to the corresponding route when a signal is pulled off.

Signals for conflicting movements cannot be pulled off simultaneously.

Points for conflicting routes cannot be set simultaneously.

Trailing points are locked to the rear when a signal is pulled off.

Distants, warners, repeaters, etc. cannot be pulled off unless the corresponding stop signals are pulled off.

Gate stop signals cannot be pulled off unless level-crossing gates are blocked to road traffic.

Electrically operated interlocking

More advanced electrical or electronic interlocking system;

The points and signals are worked from one integrated mechanism in a signal cabin;

Displays the entire track layout with indications of sections that are occupied, free, set for reception or dispatch, etc.

The interlocking is accomplished not by mechanical devices but by electrical circuitry -- relays and switches in older electrical or electropneumatic systems, and computerized circuits in the newer electronic systems.

Panel Interlocking (PI) is the system used in most medium-sized stations on IR. In this, the points and signals are worked by individual switches that control them.

Route Relay Interlocking (RRI) is the system used in large and busy stations that have to handle high volumes of train movements. In this, an entire route through the station can be selected and all the associated points and signals along the route can be set at once by a switch for receiving, holding, blocking, or dispatching trains.

PARAMETERS OF SIGNALLING EQUIPMENT

1. Accidents involving signalling equipment:

a. Passing signals at "on";

b. Signals flying back in the face of approaching train;

c. Train entering a line not nominated for it;

i. Averted collision

ii. *Head-on* or *end on* collision

iii. Running through unoccupied road and derailing at dead-end

Train passing signal at "ON"

Block instrument fails in TGT position;

Check the position of indicators and knob/lever position of signals in routing diagram available on the panel.

Check the cancellation counter and corresponding entry in the register;

Check the cancellation counter and corresponding entry in the register;

Check the data logger and confirm the nature of operations of points and signals, just before the accident;

Check the signal failure register and ascertain whether any failures have been reported recently, the nature of failure and its relevance in the present case.

Study the information collected from event recorder in case the same is fitted in the locomotive.

Check the brake power of the train by recharging air pressure if necessary.

Remove the speedometer chart with the help of shed staff and analyse the same.

ENQUIRIES

- Need for enquiry
- Ordering enquiry & making arrangements
- Scale of enquiry
- Components of enquiry
- Discussion of evidence

- **Reasons for findings**
- **Explaining the derailment mechanism**
- **Joint findings**
- **Dissenting note, if any**
- **Reply to dissenting note**

- **Staff responsible**
  - **Primary**
  - **Secondary**
- **Rules violated**
- **Matters brought to light**
- **Suggestions, if any**
- **Accepting authority**
- **Imposition of penalty**