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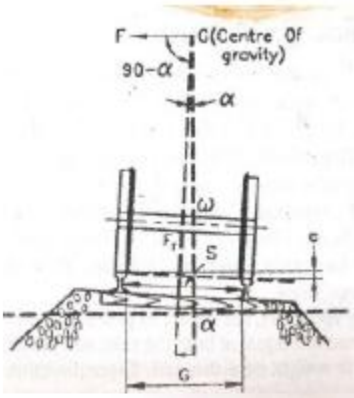
Sub:	Railways, Harbours, Tunnels and Airports.						
Date:	07.09.2018	Duration:	90 mins	Max Marks:	50	Sem:	V

1 **Derive an expression for super elevation (06)**



GEOMETRIC DESIGN OF THE TRACK 15.11

(*iii*) To provide an even and smooth running track to ensure comfortable ride to passengers and safe movement of goods.

Relationship of superelevation (e), with gauge (G), speed (V) and radius of the curve (R). Using the following notations and Fig. 15.3.

W = Weight of moving vehicle in kg.
v = Speed of vehicle in m/sec
V = Speed of vehicle in km. p.h.
R = Radius of curve in metres.
G = Gauge of track in metres.
g = Acceleration due to gravity in m/sec^2.
α = Angle of inclination.
S = Length of inclined surface in metres.

Centrifugal force is given by the following expression.

$$F = \frac{Wv^2}{gR} \quad ...(1)$$

Now resolving the forces along the inclined surface we get

$$F \cos\alpha = W \sin\alpha \quad ...(2)$$

where $F = \frac{Wv^2}{gR}$, $\cos\alpha = \frac{G}{S}$

and $\sin\alpha = \frac{e}{S}$

Therefore equation (2) becomes $\frac{Wv^2}{gR} \times \frac{G}{S} = W \times \frac{e}{S}$

Therefore, $e = \frac{v^2}{gR} \times G$ metres ...(3)

where, v is in m/sec.

$$= \frac{G(0.278V)^2}{9.81R} \text{ m. where, } V \text{ is in km. p.h.}$$

$$= \frac{GV^2}{127R} \text{ m.} \qquad ...(4)$$

$$= \frac{GV^2}{1.27R} \text{ cm.} \qquad ...(5)$$

where G is in metres.
V is in km. p.h.
R is in metres.

In India, G for B.G. = 1.676 m
M.G. = 1.0 m
and N.G. = 0.762 m.

So for B.G., $e = \frac{1.676\,V^2}{1.27\,R} = 1.315\frac{V^2}{R}$ cm (5a)

for M.G., $e = \frac{1.0\,V^2}{1.27\,R} = 0.80\frac{V^2}{R}$ cm ...(5b)

for N.G., $e = \frac{0.762 \times V^2}{1.27\,R} = 0.60\frac{V^2}{R}$ cm. ...(5c)

What is a junction station. Explain with diagrams(04)

(2) Junction Stations. A junction station is one where a branch line joins a main line and at such junctions special arrangements are made for the following :

(*i*) To facilitate the interchange of traffic between the main and the branch lines. This interchange of passengers takes place across the platform *MN* as shown

(*ii*) To enable the engine to be released at junctions for servicing. This function of releasing the engine or halting the train in the direction *CF* is performed by the loop line *BLC*

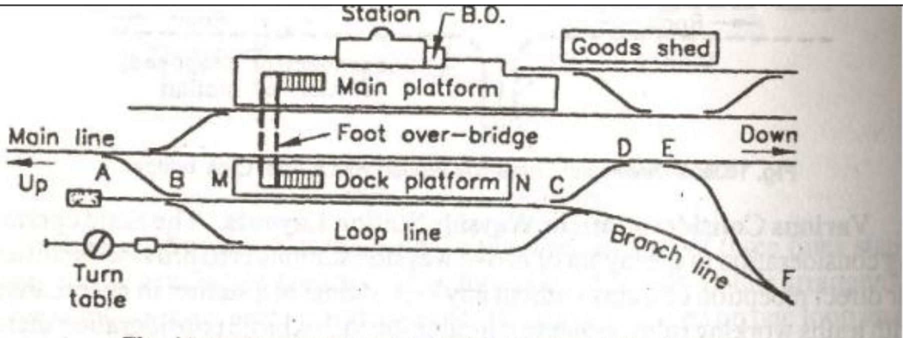


Fig. 18.10 Single Main Line and Single Branch Line Junction.

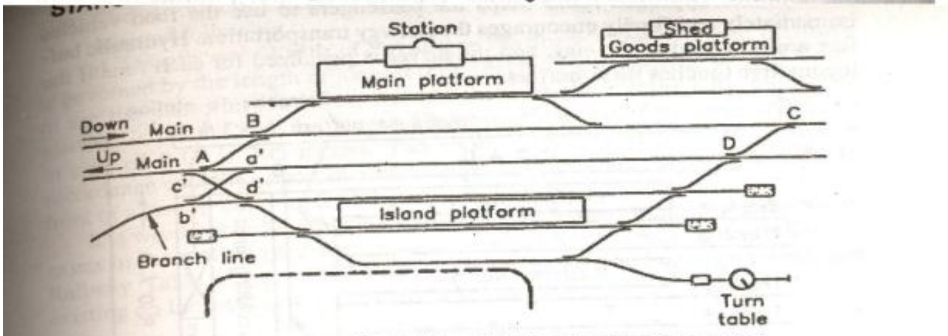


Fig. 18.11 Junction with a Double main line and a single branch line.

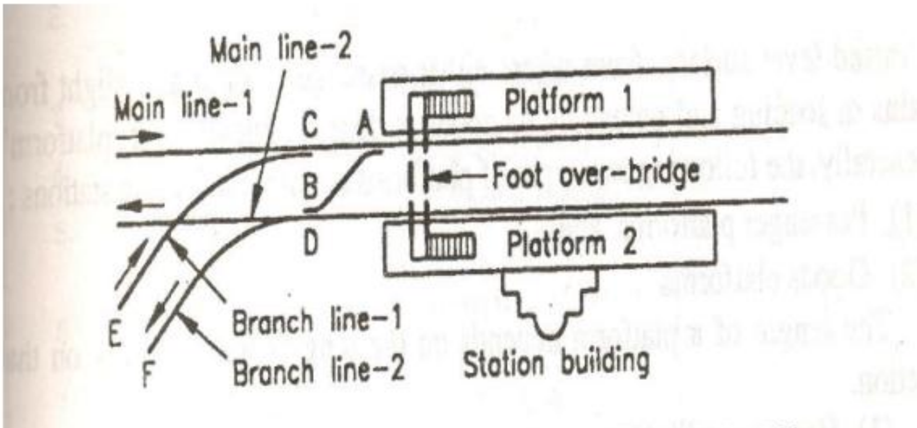
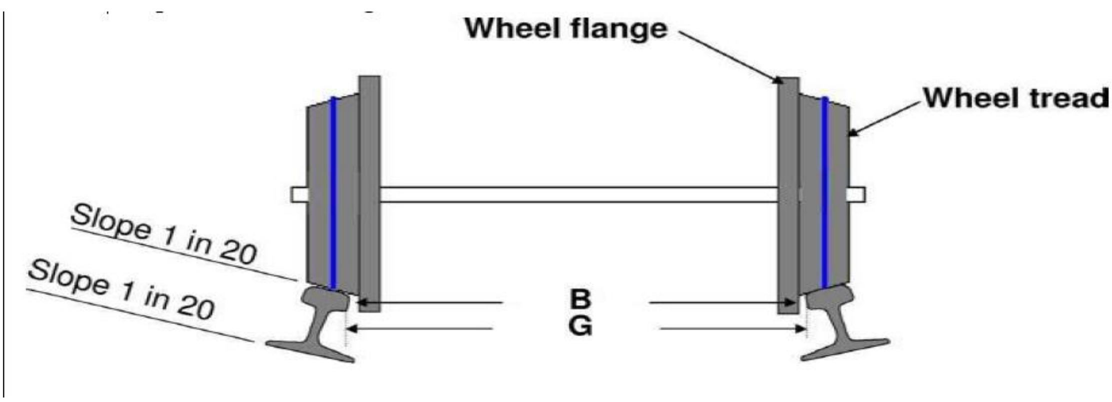


Fig. 18.12 Junction with Double Main Line And Double Branch Line.

2 (a) Explain Coning of Wheels (05)



Coning of wheels

1. The flanges of wheel is never made flat, but they are in the shape of cone with a slope of 1 in 20. (Sloping of the wheel from the vertical axis)
2. The coning of wheels is mainly done to maintain the vehicle in the central position with respect to the track.
3. It is done to maintain the vehicle in the central position with respect to the track.

Advantages of coning

a. Reduce the wear and tear of wheel flanges and rails.
b. To provide possibility of lateral movement of the axle with its wheels.
c. To prevent the slipping of wheels.

(b) Draw the Cross section of a permanent way neatly and name its parts (05)

Track Cross-section

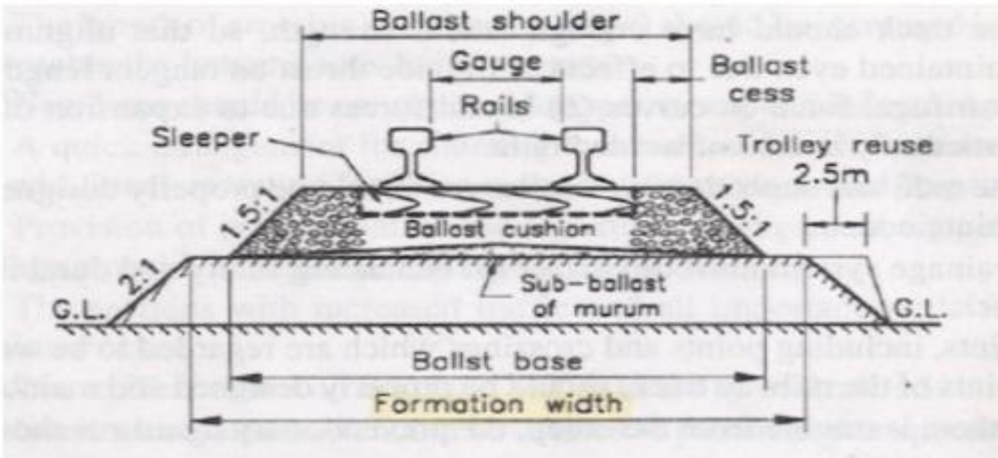


Fig. 3.1 Typical Cross-section of a Permanent Way on Embankment.

3 (a) Write the requirements of an ideal permanent way. (06)

REQUIREMENTS OF AN IDEAL PERMANENT WAY

The following are the principal requirements of an ideal permanent way or of a good railway track :-

1. The **gauge** of the permanent way should be **correct and uniform**.
2. The rail should be in proper level in straight portion. **Proper amount** of *super elevation* should be provided to the outer rail above the inner rail on curved portion of the track.
3. The permanent way should be sufficiently **strong against** lateral forces.
4. The **curves**, provided in the track, should be **properly designed**.

August 12, 2017 5

5. An **even and uniform gradient** should be provided **through out the length of the track**.

6. The ***tractive resistance*** of the track should be minimum.

7. The design of the permanent way should be such that the **load of the train** is **uniformly distributed on both** the rails so as **to prevent unequal settlement of the track**.

8. **All the components** parts such as rails, sleepers, ballast, fixtures and fastenings, etc. **should satisfy the design requirements**.

9. All the **points and crossings**, laid in the permanent way, should be **properly designed** and **carefully constructed**.

10. It should be provided with **proper drainage facilities** so as to drain off the rain water quickly away from the track.

11. It should be provided with **safe and strong bridges** coming in the alignment of the track.

12. It should be so constructed that **repairs and renewals** of any of its portion can be **carried out without any difficulty**.

(b) Explain any one theory of creep & Draw diagrams if applicable.(04)

Theories of creep

1. Wave action or wave theory:

Wave motion is set up by moving loads of wheels.
The vertical reverse curve ABC is formed in the rail ahead of wheels, resulting from the rail deflection under the load.

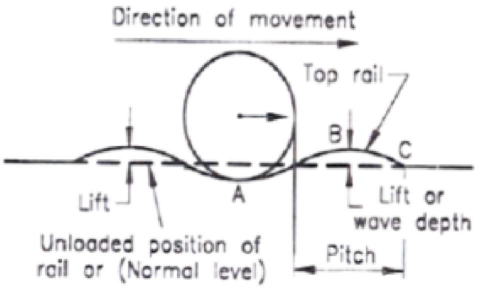


Fig. 8.2. Wave Theory of Creep (Formation of Wave)

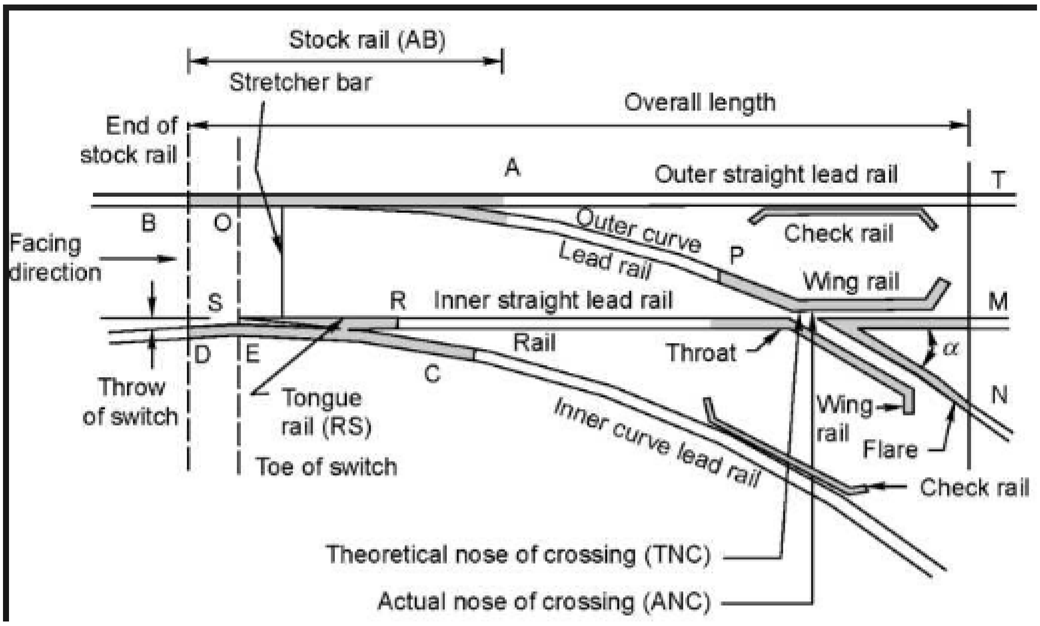
2. Drag (or) Dragging theory

- ✓ Backward thrust on driving wheels of locomotive of train push the rail off track backward.
- ✓ Mean while other wheel of locomotive and vehicles push the rail in the direction of travel.
- ✓ Since drag effect is more as explained in Wave Action Theory resultant creep of rails in forward direction.

3. Percussion Theory

This theory states that the creep is due to impact of wheels at the rail end ahead at joints. Hence as and when wheel leave the trailing rail and strike the facing rail end at each joint it pushes the rail in forward direction resulting in creep

4(a) Draw a right hand turnout and name its parts. Describe its working (03+03)



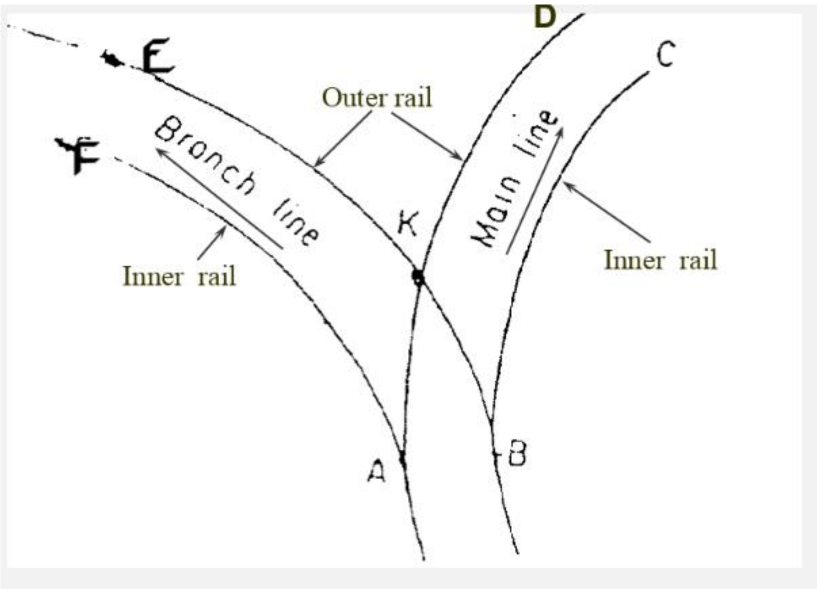
(b) What are the factors affecting the magnitude and direction of creep? (04)

Factors effecting the magnitude & direction of creep.

- Alignment of track: Creep is more on curves than on tangent tracks.
- Grade of track: More in case of steep curves, particularly while train moving downward with heavy loads.
- Type of rails: older rail have more tendency than new one.
- Direction of heaviest traffic: In heavier load moving direction occurs more creep.

5(a)	Compare double headed rail, bull headed rail and flat footed rail.(06) The first rails used were double headed (DH) and made of an I or dumb-bell section (Fig. 1). The idea was that once the head wore out during service, the rail could be inverted and reused. Experience, however, showed that while in service the bottom table of the rail was dented to such an extent because of long and continuous contact with the chairs that it was not possible to reuse it. This led to the development of the bull headed (BH) rail, which had an almost similar shape but with more metal in the head to better withstand wear and tear (Fig. 2). This rail section had the major drawback that chairs were required for fixing it to the sleepers. A *flat-footed rail*, also called a *vignole rail* (Fig.3), with an inverted T-type cross section of inverted T- type was, therefore, developed, which could be fixed directly to the sleepers with the help of spikes. Another advantage of the flat-footed rail is that it is a more economical design, giving greater strength and lateral stability to the track as compared to a BH rail for a given cross-sectional area. The flatfooted (FF) rail has been standardized for adoption on Indian Railways.
(b)	**If the ruling gradient is 1 in 250 on a particular section of B.G & at the same time a curve of 4 degree is situated on this ruling gradient, what should be the allowable ruling gradient? (02+02)** **Solution:** **As per Indian railway recommendation, the grade compensation for of B.G track is 0.04% per degree of curve.** **Therefore, Grade compensation for 4 degree curve** **= 0.04 * 4 = 0.16%** **Ruling gradients is 1 in 250** **= 1/250 *100 = 0.4%** **Therefore, Required ruling gradient or Actual gradient** **= Ruling gradient – grade compensation** **= 0.4- 0.16** **= 0.24% or 1 in 417**

6	**What is meant by negative super elevation? Explain.(04)**



- Ref fig: AD which is the outer rail of the main line curve must be higher than inner rail BC or in other words, the point A should be higher than point B.
- For the branch line, however, BE should be higher than AF or the point B should be higher than point A.
- These two contradictory conditions cannot be meet at the same time within one layout . So, **outer rail BE on branch line is kept lower than the inner rail AF.** In such case branch line curve has a negative super elevation & therefore speeds on both tracks must be restricted, particularly on branch line.

(b)	**Calculate the materials required for laying one KM of a railway track. (06)**

(1) **Rails.** (*i*) Number of rails per km. = $\frac{1000}{\text{length of rail in 'm'}} \times 2$

For B.G., when rail length = 12.8 m.

$\therefore$ Number of rails per km. = $\frac{1000}{12.8} \times 2 = 156.2 = 157$ (say)

(*ii*) Weight of rails in tonnes per km

= Number of rails × length of rail in m × $\frac{\text{weight of rail in kg per m}}{1000}$

(say for laying 90 *R* type rail of B.G., wt. = 44.7 kg/m)

$\therefore$ Weight of rails per km = $\frac{157 \times 12.8 \times 44.7}{1000}$ = **90 metric tonnes**

(2) **Sleepers.** Number of sleepers per km = $\frac{1}{2}$ (No of rails per km) × $(M + x)$

where M = length of rail in m

x = Density factor.

Sleeper density = $(M + x)$

'x' density factor is any number which when added to a length of rail, will give sleeper density. In India $x = 4, 5, 6$ or 7 is used for main-tracks, depending upon design requirements of track.

For B.G., 12.8 m rail length, and $x = 4$,

Number of sleepers per km = $\frac{157}{2} \times (12.8 + 4) = 1319.$

(3) Fish-Plates. Number of fish-plates per km of track

= 2 × number of rails per km (i.e. 2 fish plates per joint)

when number of rails per km = 157 for B.G.

Number of fish-plates per km of track = 314.

(4) Fish Bolts. Number of fish bolts per km of track

= 4 × Number of rails per km (i.e. 4 fish bolts per joint)

when number of rails per km = 157 for **B.G.**

$= 4 \times 157 = 628$

(5) **Bearing Plates.** Number of plates per km of track depends upon design.

Number of Bearing plates per km of track is, either

$= 2 \times$ Number of sleepers per km of track $= 2 \times 1319$

$= 2638$ Nos.

or $= 4 \times$ Number of rails per km of track $= 4 \times 157 = 628$

Bearing plates:

- Mild steel, or cast iron plates used for fixing the rail with wooden sleepers.
- The rectangular plates made of either mild steel, cast iron, wrought iron, or malleable steel which are interposed between the foot of a flat footed rail and wooden sleeper to distribute the load on a larger area, are called bearing plates.

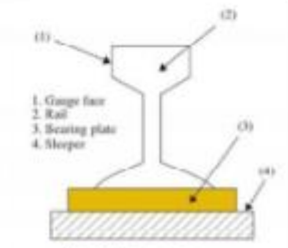


Fig. 5.21. Bearing plate.

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