SYLLABUS:

A.RAILWAY ENGINEERING

UNIT – I

Components of Railway Engineering:Permanent way components – Railway Track Gauge - Cross Section of Permanent Way - Functions of various Components like Rails, Sleepers and Ballast –Rail Fastenings –

Creep of Rails- Theories related to creep – Adzing of Sleepers- Sleeperdensity – Rail joints.

UNIT – II

Geometric Design of Railway Track:Alignment – Engineering Surveys - Gradients- Grade Compensation- Cant and Negative Super elevation- Cant Deficiency – Degree of Curve – safe speed on curves – Transition curve – Compound curves – Reverse curves – Extra clearance on curves – widening of gauge on curves – vertical curves – cheek rails on curves.

UNIT – III

Turnouts & Controllers:Track layouts – Switches – Design of Tongue Rails – Crossings – Turnouts – Layout of Turnout – Double Turnout – Diamond crossing – Scissors crossing. Signal Objectives – Classification – Fixed signals – Stop signals – Signalling systems – Mechanical signalling system – Electrical signalling system – System for Controlling Train Movement – Interlocking – Modern signaling Installations.

B.AIRPORT ENGINEERING

UNIT – IV

Airport Planning & Design:Airport Master plan – Airport site selection – Air craft characteristics – Zoning laws – Airport classification – Runway orientation – Wind rose diagram – Runway length – Taxiway design – Terminal area and Airport layout – Visual aids and Air traffic control.

UNIT – V

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Rehabilitation of Airfield pavements – Evaluation & Strengthening of Airfield pavements – Airport Drainage – Design of surface and subsurface drainage.

C.DOCKS & HARBOURS

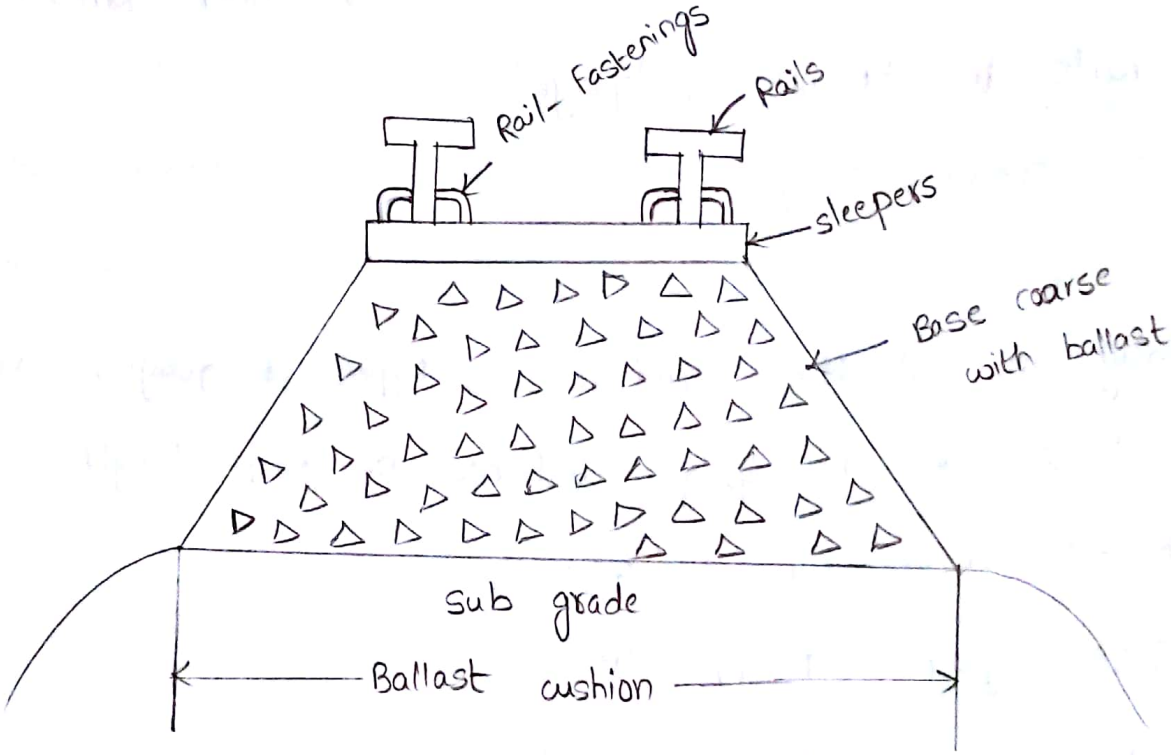
UNIT – VI

Planning, Layout, Construction & Maintenance Of Docks & Harbours:Classification of ports – Requirement of a good port – classification of Harbours – Docks - Dry & wet docks – Transition sheds and workhouses – Layouts; Quays – construction of Quay walls – Wharves – Jetties – Tides - Tidal data and Analysis – Break waters – Dredging – Maintenance of Ports and Harbours – Navigational aids

UNIT -I

COMPONENTS OF RAILWAY ENGINEERING

Components of Railway (or) permanent way section :



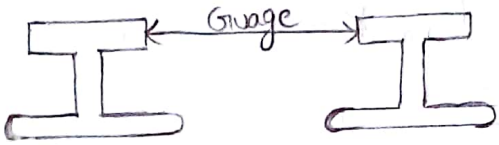
Site selection for permanent way :

* The alignment way is effected by components of the permanent way such as Rails, Rail fastenings, sleepers, ballast, and subgrade material.
* For aligning the permanent way we have to consider topographical features of the earth such as rivers, hills, valleys and climatic conditions
* The track alignment between the two stations which are needed should be minimum distance and safe stable and comfort and economical also.

* The track alignment well effected by population of the cities which are covered by the track alignment.

Types of guages :

The successive distance between two inner surface of the rails is known as 'guage'.



Normaly in all the countries 3 types of guages are used based on the guage distance or guage length.

1. Broad guage (B.G) (1.676 m)
2. Meter guage (M.G) (1m)
3. Narrow guage (N.G) (0.762m)

1. Broad guage :

* The guage having 1.676m between the two rails is known as Broad guage.
* Broad guages are used for high speed tracks, low gradient difference and suitable topographical conditions.
* Broad guages are also used for high traffic volumes in the track alignment in between the stations.

2. Meter guage :

* The rails having a length of 1m between the two rails is known as meter guage.

guages are used for average speedy Locomotives and medium traffic volume.

3. Narrow gauges :

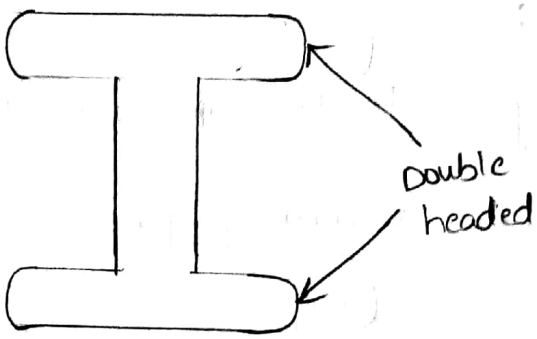
* The guage having a length of 0.762m between the two rails is known as narrow guage.
* Narrow guages are used in hilly regions where the steep gradient is present. Here the permissible speed and the average traffic volume is very less for the safe movement of Locomotives.

Rails :

* Rails are the steel girders laid on the permanent way just above the sleepers to transfer the both axial and transverse loads.
* Rails are mainly used for track alignment inbetween the stations.
* Rails must not be displaced or detached from the permanent way due to any reason. for maintaining uniform guage distance we have to use suitable rails which can be withstand aganist the thermal variations and loads coming from the locomotives.

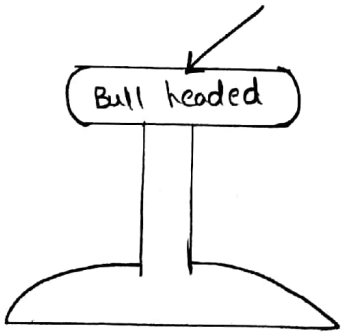
Types of Rails:

1. Double headed Rails:



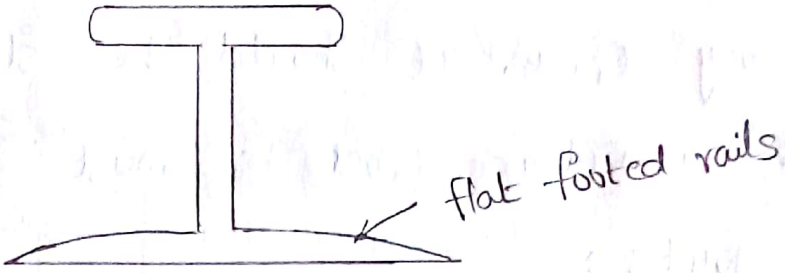
* In this type of rails the top and bottom portions of the flanges are equaly dimensioned.
* Doubly headed rails are used in the early stages of the railways.
* If the rails are weared then the rails should be riversed but due to high vibrations and axial loads the smooth movement of the locomotive is not possible.

2. Bull headed rails:



* In this the top portion of the rail is much thicker than the bottom portion.
* There are also mainly used in the Indian railways.
* Due to heavy head load it is much difficult to maintain the rails and rail joints.

1. Flat footed rails:



In this the foot of the rail much flatter than the bull headed rail. This flat footed rail is used for easy joining of sleeper and the rails

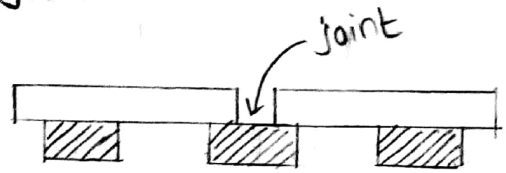
Requirements & functions of rails:

* For maintaining the proper guage distance we required rails
* For aligning the railway track rails are needed.
* Rails are used for distributing the heavy vibrations, axial, transverse load.
* Rails are also used for safe stable and comforted journey of both goods and passengers
* The rails must be well aganist the wearing and tearing actions. due to friction between the wheel and the rail.
* This must be aganist corrosion due to environmental actions (or) conditions.

Joints; Rail joints are required for aligning the rail way track. It should be strength, stable and smooth. Its maintance cost is must be economical.

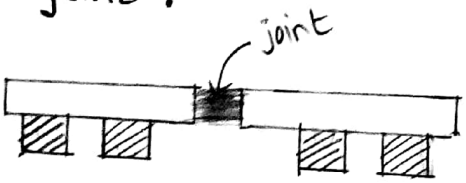
Types of joints :

1. Supported joint :



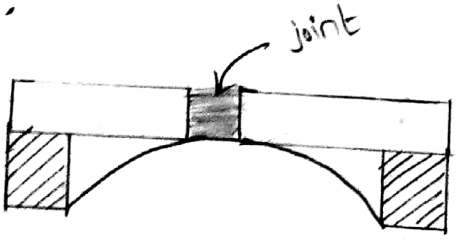
In this the rails are joined by using fillet material. that should be supported by sleeper.

2. Suspended joint :



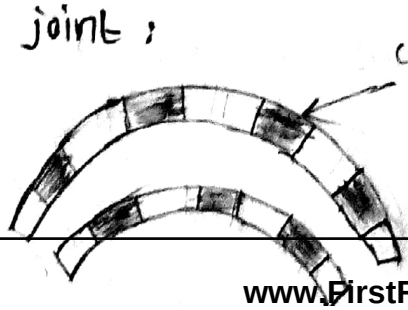
In this joint is filled with suspend material (melted)

3. Bridge joint :



In this the joint is supported by bridge which is made up of steel, concrete, wood which is connected to the sleeper.

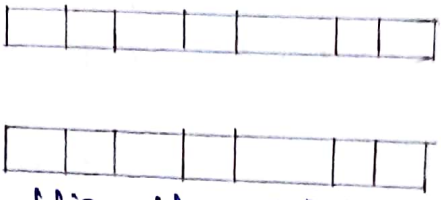
4. Conjugated joint :



In this the joints positions are changed on the inner curve and outer curve of the railway track.

These joints are placed on the curvature of the railway track.

5. Square joint :



In this the joints are inner rail and outer rails are paralled to the each other and they should be in square shape.

6. Expansion joints :

These joints are reacts with the thermal changes in the environment of the railway track such as expansions and contractions are takes place equally.

7. Welded joints :

These joints are placed between the rails by using welding operations.

Welding joints are the most prefarable joints in the railways

* The process of welding is easy.
* The dismanting and reusing of rails is easy.
* The maintaince cost is also less.
* The weight of the joint is also less.

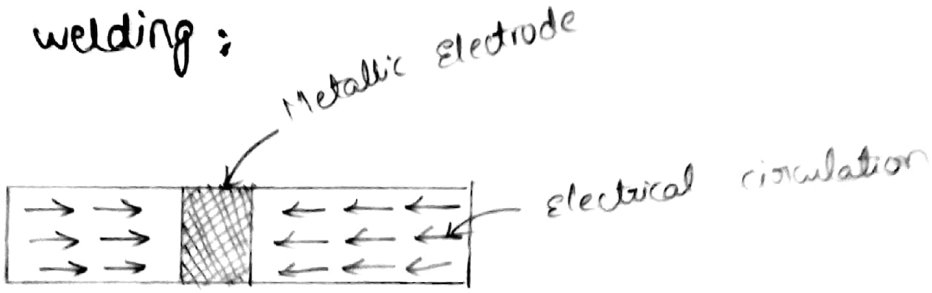
Connective joints:

In this the rails and the rail joints are connected by the fishplates. So these are called as connective joints.

Welded joints:

The welded joints are done by four welding operations

1. Electro - Arc welding:



In this method an metalic electrode is placed between the two rails then electrical supply is applied from the both ends of the rails upon the metallic electrode is melted

Then we have to applied 20 tonnes of load from both ends of the rails up to the joint is properly placed or closed.

2. Oxy Acetyl welding:

In this the metallic electrode is made up of oxygen and Acetyline materials.

When oxygen and Acetyline are connected

we have to supply the electrical current through them, then their will be a formation of heat.

This will be carried upto the oxy Acetyl is formed. Then the rails are forced to joined.

3. Thermal Welding :

In this the welding operations can be done by using heat or temparature.

The electrical supply is supplied from both ends of the rails upto the joints ends to the rails are melted then we have to applied 20 tonnes of load from both ends of the rails from proper joining the rails.

4. Chemical welding :

In this the joining material is a chemical

Creep of rails :

Creep is the change in position of rail in either longitudinal or lateral.

Effects of creep :

i) Detrailment of rails

ii) The rail joint should be failed due to creep.

iii) The guage distance should be varied due to creep.

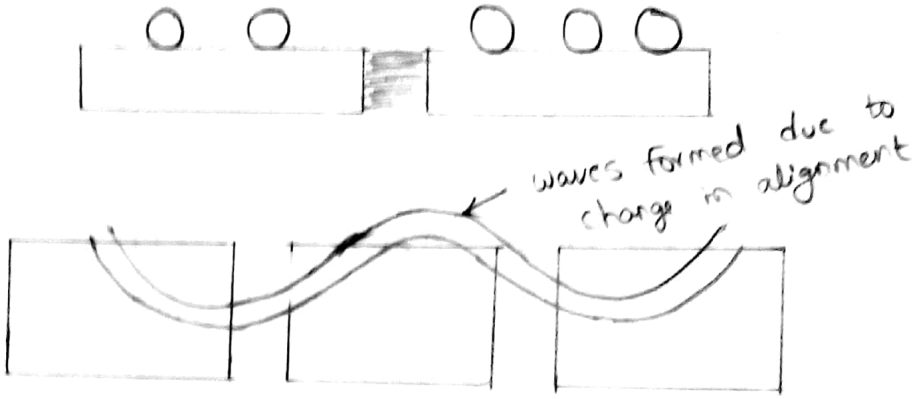
iv) The maintanance cost will be high.

Thus it is the possibilty of Accidents due to creep.

Study of creep:

The creep should be studied by various theories.

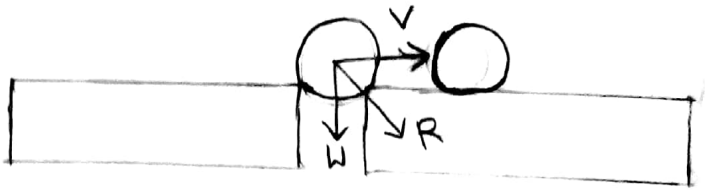
1. Wave action theory:



In this the creep is mainly due to the wave action at rail joints, bridges, level crossings intersections of joint junctions.

In this the creep occurs mainly in the direction of lateral direction.

2. percussion theory:



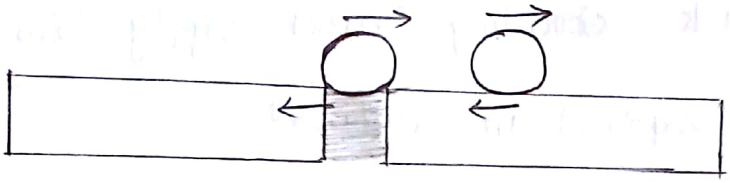
In this the creep mainly occurs due to self weight of the wheel (W)

The weight of the wheel always acts vertically downwards in rest position and inclined

the track when it is moving.

If the weight continously present at the junctions or joints there will be possibility of creep in lateral direction.

3. Dragging theory :-



Here the creep is mainly due to dragging of wheels on the rails aganist its movement.

In this the creep is mainly occurs in the longitudinal direction.

Creep measurement :

The creep in the rails measured by using

* It will be measured in mm or cm
* For measuring creep we have to mark one permanent chissel mark on both rails which are joined.
* The distance between two chissel marks is measured by the creep measurer.
* It is exceeds the limit we have to reposition the rails.

Sleepers : Sleepers is the member which is used for maintaining the guage distance by connecting

Functions of sleepers :

* For maintaining the guage distance sleepers are required.
* for distributing the load without any failure of track.
* for connecting the rails without any movement.
* four proper track circuiting (power supply blw two rails) sleepers (metallic sleepers) are required.
* For smooth movement of locomotive sleepers are required.
* The sleepers should be free from storage of rain water.
* sleepers should possess proper load for maintaining the ballast cushioning to transfer vibratory loads.

Requirements of sleepers :

* It should be having definite strength, durability for distributing the axial transverse load.
* The sleepers must be free from environment effects such as warpings, expansions and contractions and possibility of developing cracks due to hydration.
* The weight of the sleeper should be moderate because of transportation.
* Sleepers should be in simple sections for connecting the rails and rail fastenings.

sleepers also acts as insulators between the ballast and the rails.

Types of sleepers :

1. Wooden sleepers :

Advantage :

* These are available very frequently in the environment.
* The cost is less when compared to steel and concrete sleepers.
* These are easily handled below the rails.

2. Steel sleepers :

Types of steel sleepers :

i) cast iron sleepers :

cast iron sleepers are used in the railway frequently.

* These are having high tensile strength so there will be high resistant of transverse and longitudinal loads.

ii) C.S.T-9 (central standard trial -9) sleepers :

* These are having high tensile strength and flexural strength.
* These are well suitable for supporting the rails to remain their positions.
* These are corrosive resistance when compared to other metallic sleepers.

Advantages of metallic sleepers :

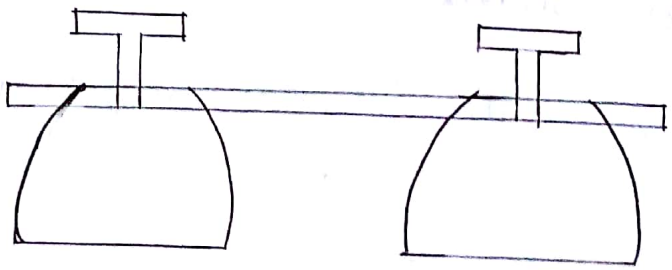
* These are stronger than wooden sleepers.
* these are having durability of 30 to 40 years due to flexibility nature these are well withstand of vibratory loads
* The connection should be easily laid between the rails and sleepers.

Disadvantage :

* Metalic sleepers are reacted by the thermal expansions and contractions.
* The compressive strength of the metalic sleepers is less when compared to concrete sleepers.
* The wearing action takes place due to friction between the wheels and rails
* Corrosion ation takes place.

Classification based on connection between the rails and sleepers :

i) pot type sleepers :



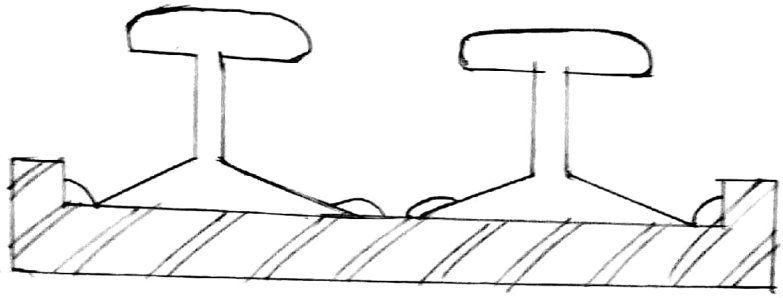
These sleepers are in the shape of pot.

on the inverted pot the base of the rail is connected by using chairs

pot sleepers are not provided on the curves

degree of super elevation is more than 4°.

Plate type of sleepers:



* Plate type of sleepers are commonly used in the railways.
* The top portion of the sleeper is in the shape of rectangle so these are having high supported area for rail foots.

iii) Concrete sleepers:

Concrete sleepers are mainly used in the railways.

Concrete sleepers are classified as

1) Reinforced concrete sleepers
2) Pre stressed concrete sleepers.

Advantages of Reinforced concrete sleepers:

* These are uneffected by the environment such as decaying and the insects will not effect the strength.
* Concrete sleepers are man made so the sufficient bearing area of rail should be provided.
* The track circulating and insulation is also be done

the concrete sleepers.

* Due to self weight the sleeper should not be pushed away due to loads coming from the rails.

Disadvantages:

* The weight of the concrete sleepers is more than 2 to 3 times the metalic sleeper so the handing operations require mechanical equipment.
* The concrete sleepers requires pads and plugs for connecting the spikes.
* The damage to the concrete sleeper is very high in the case of derailment.

Sleeper density:

Sleeper density is the number of sleepers required for a rail.

For example, in Indian railways the sleeper density will be taken as (M+4) and (M+7).

Here M = length of the each rail.

Problem:

When a broad guage of rail is used in the track the length of the rail is 12.8m. Calculate its sleeper density over a distance of 1.5km.

Sleeper density = M+4

= 12.8+4 = 16.8

1.5km = 1500m

$= 19.8$

for (M+4)

Sleeper density $= \frac{1500}{12.8} \times 16.8 = 1968.5 \simeq 1969$

for (M+7)

Sleeper density $= \frac{1500}{12.8} \times 19.8 = 2320$

for (M+4) sleeper density = 1969

for (M+7) sleeper density = 2320

Ballast : Ballast is the material which is layed just below the sleepers and surroundings of rails upto subgrade formations.

Types of Ballast :

Stone Ballast :

It is majorly used in the railways which is coming from the crushing of stones in a specific size.

Normally Ballast size depends on type of sleepers which varying from 3 to 5m.

Sand Ballast :

It is also used in the railways which is having frequent drainage system.

Sand ballast having high compressive strength so which is well sustainable for loads coming from top portions of the ballast. But due to fineness of

and the creeping actions of rails will takes place.

Murrom Ballast;

* Murrom Ballast is coming from the well settled and compacted soil or silt.
* This is also used as a ballast material where less traffic volume is presented.
* the crushing strength of ballast is low. so which is not suitable for high load tracks.

Thermal or cool ballast;

* The waste coming from the thermal power plants and in mining operations is also used as ballast.
* This type of ballast having low strength and less durable so this type of ballast is used for standing type of tracks.

Functions of Ballast:

* Ballast is used for retaining the rails and sleepers in their position.
* To transfer the loads coming from upper surface to the subgrade.
* for faster drainage system ballast is used due to the large number of voids are presented.
* For giving elasticity to the track ballast is suitable.

* The compressive and crushing strength should be high.
* Ballast will not be effected by the environmental conditions.
* It will not effect the rails and sleepers and chairs in the way of wearing.

Sub grade :

Sub grade is the base course of the permanent way which is supporting ballast, sleepers and rails.

The dynamic loads coming from the top layer which are distributed in to the inner layer of the earth (or) soil through subgrade.

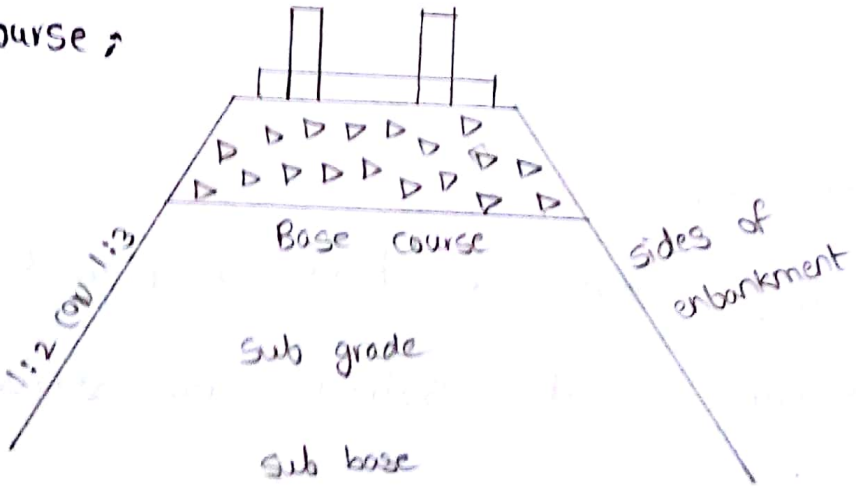
Functions of subgrade :

* For proper drainage system subgrade also prepared specially for removing of over headed water.
* For maintaining outer and inner rails at the same level.

The subgrade should be well compacted and stable.

Components of sub grade :

Base course :



* It is the top layer of the subgrade which is below the ballast cushion.

base course is prepared by aggregates, soil which laid by high rolling and compacting actions.

* The base course is used for supporting the top layers of the permanent way and distributing the dynamic loads coming from top to the base.
* Base course is prepared specialy for distributing to the soil and inner layers.

Sides of subgrade (or embankment):

* The sides are inverted to their natural for controlling the shear failure of the soil (or sliding action due to dynamic loads and water,
* Normaly the gradient provided for the sides is 1:2 to 1:3

Sub base:

* Sub base is provided below the base course for supporting the top portions of the permanent way.
* The sub base should have compressive strength for distributing the loads.
* It should be fast drained.
* for water logging cases we have to provide sand drains and geodrains in the sub base for removal of water.

Rail fastenings :

for fitting the rails and sleepers rail fastenings are required.

Types of Rail Fastenings

1. Fish plates
2. spikes
   i) Dog spikes
   ii) screw spikes
   iii) Round spikes
3. chairs
   i) Mild steel chairs
   ii) cast iron chairs
4. Blocks
   i) Heel blocks
   ii) cheek blocks
5. Bolts
   i) Fish bolts
   ii) Hook bolts
6. plates
   i) Bearing plates
   ii) Saddle plates

UNIT - II

GEOMETRIC DESIGN OF RAILWAY TRACK

Alignment :

* Alignment is the direction of the centerline of the railway track in which we are provided.
* Alignments are horizontal alignment (parallel, circular, perpendicular)
* In Railway track alignments perpendicular alignment is not possible.

Engineering survey's :

1. preliminary survey :

In this we have to investigate the site by visiting without any measurement.

2. Reconnaissance survey :

In this we have to study maps and past data.

3. Detailed survey
4. Topographical survey
5. Aerial survey

Factors affecting site selection of railway track :

* purpose of track
* connection between the two stations
* Hills, rivers and any large obstacles
* political need
* safety

pleasant surroundings.

Gradient : Gradient is the slope providing for the safe movement of locomotive on different ground levels.

* Normaly on equal terrains the slope provided is 1 in 150 to 1 in 200.

* On mountain or hilly regions 1 in 100 to 1 in 150

Types of Gradients :

1. Ruling Gradient : It is the maximum gradient which is provided on the railway track that should be negotiated by the capacity of locomotive.

* Hence on ruling gradient the locomotive should possess maximum capacity to rule this gradient.

* Ruling gradient depends on capacity of locomotive

2. Momentum Gradient :

It is the gradient attained in the railway track when the locomotive moves on steep slopes.

When the locomotive moves from higher level to lower level it acquires or it gains momentum which dominates the next gradient.

3. pusher gradient :

It is the gradient when single locomotive engine is not possible to carry the total load on the Gradient ; so we can use additional or extra engine to negotiate it. this gradient is known as pusher gradient

It is presented at hilly.

4. Gradient on Stations:

* There is no gradient in the stations because the standing operations should become difficult.

* for neglecting this we have to apply resisting force against the gradient which results economical loss & energy loss.

Gradient compensation:

The gradient is compensated in where the slope is maximum and steep for different type of guages the gradient is as follows.

For broad guage - 0.04% or $\frac{70}{R}$

For meter guage - 0.03% or $\frac{52.5}{R}$

For Narrow guage - 0.02% or $\frac{35}{R}$

Where

R = Radius of the curve

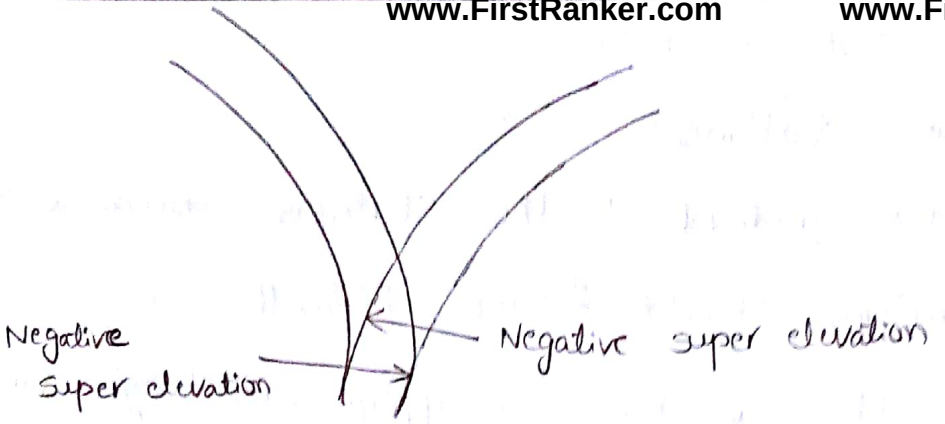
Super elevation:

The rise provided on the outer rail when compared to the inner rail on the curves to develop centrifugal force to against centrifugal force for the safe movement of locomotive.

$$\text{Super elevation } e = \frac{gv^2}{127R}$$

Negative super elevation:

It is defined as no super elevation provided for the outer rail in the case of rail crossings.



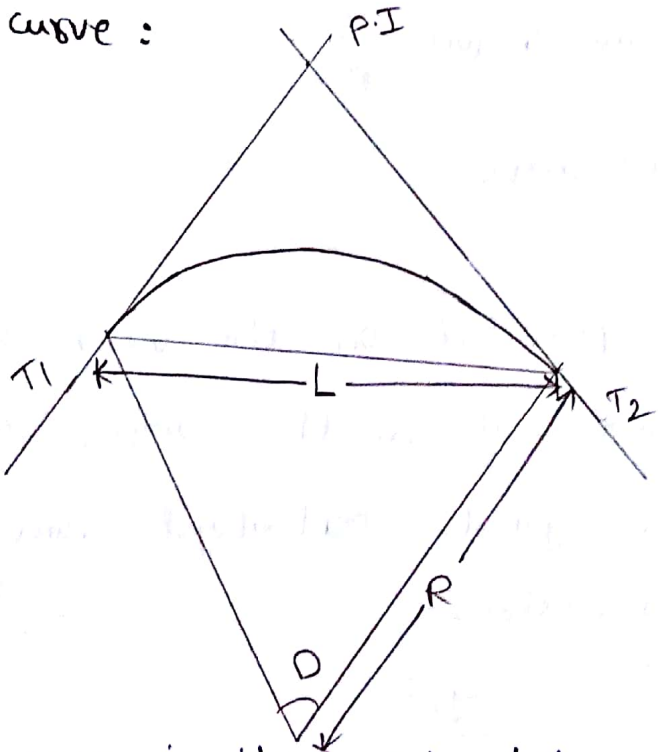
Here we have to give instructions to the locopylate regarding the safe speed on main line (or) branch line.

The safe speed depends on radius of the curve and degree of the curve.

Safe speed on curves:

The permissible speed on a curve depends on the radius of the curve and type of the curve.

Degree of curve:



Degree of curve is the angle between the two tangents and the ending of the T_1, and T_2 which are the starting and the ending of the curve.

degree of curve is derived from the

$$\frac{D}{30} = \frac{360}{2\pi R}$$

D = Degree of the curve

30 = Length of chord (L)

R = Radius of the curve

$$D = \frac{360^{\circ} \times 30}{2\pi R}$$

$$D = \frac{1718}{R} \simeq \frac{1720}{R}$$

Curves : Curves are mainly used in the alignment of railway track both horizontally and vertically.

Classification of Curves :

1. Horizontal curves
2. Vertical curves

1. Horizontal curves :

Types of horizontal curves :

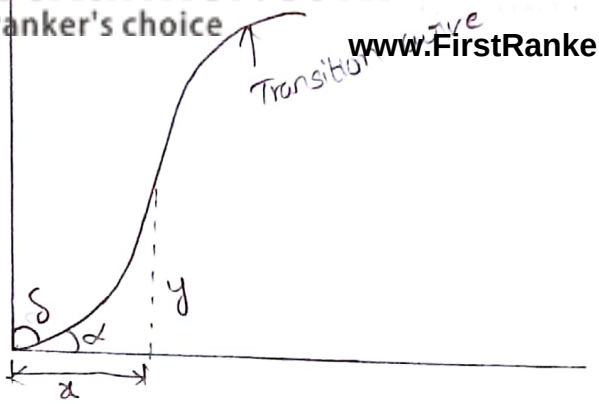
1. Simple curve : Simple curve is curve which symmetrical at both ends.

* Simple curves are used frequently in Indian railways which are provided by required superelevation.

2. Transition curve :

These curves are mainly used to align the straight path to the curvature of the railway track.

Transition curves are placed inbetween the two simple curves to attain circular movement.



For frauds curve adjustment the equation for transition curve (cubic parabola) $y = \frac{x^3}{GRL}$

Here, y = perpendicular offset of transition curve at a distance x from the commencement of the curve

x = Distance of y-from the starting point of the curve

R = Radius of the curve

L = Length of the transition curve

for deriving length of the curve, we have to replace $\frac{1}{GRL}$ with 'c'.

Where C is the constant.

$$y = cx^3$$

derivating on both sides with respect to x

$$\frac{dy}{dx} = c\frac{d}{dx}(x^3)$$

$$\frac{dy}{dx} = c(3x^2)$$

again derivating on both sides with respect to x

$$\frac{d^2y}{dx^2} = c(3 \times 2x)$$

Where $\frac{d^2y}{dx^2} = \frac{1}{R}$

$$\therefore \frac{1}{R} = 6cx$$

length of the curve $L = 7.20e$

Which is also depends on safe speed on curve that

$$L = \frac{3.28V^2}{R}$$

Here V = maximum speed on curve

The total length of the curve required to give locomative from circular motion to linear motion and as well as linear motion to circular motion. which depends on maximun speed and super elevation.

Compound curves :

A curve which is formed by combination of two (or) more simple curves or combination of simple curve and transition curve.

Vertical curves :

for giving smooth and safe movement of journey to the locomotive on the gradients.

For joining or connecting different gradients by using curves is possible.

Safe speed on curves :

1. Where transition curves are present

* for Broad guage and meter guage

Safe speed $(V) = 4.44\sqrt{R-70}$

* For narrow guage $V = 3.65\sqrt{R-6}$

2. Where transition curves are absent

* for broad guage & meterguage $V = \frac{4}{5} \times 4.4\sqrt{R-70}$

For narrow gauge $V = \frac{4}{5} \times 3.65 \sqrt{R-6}$

3. In Indian railways the safe speed is calculated as follows.

* for broad gauge,

$$\text{Safe speed } (V) = \frac{(C_a + C_d) R}{13.76}$$

Here V = safe speed

C_a = cant efficiency

C_d = cant defficiency

R = Radius of the curve

* for meter gauge, $V = 0.347 (C_a + C_d) R$

* for narrow gauge, $V = 3.65 \sqrt{R-6}$

Widening of guages on curves:

It is defined as the distance between the outer rail and the inner rail when the locomative wheel striking the outer rail there will be possibility of widening of guage.

Widening of guage can be calculated by

$$d = \frac{13 (B+L)^2}{R}$$

Where B = Rigid wheel base in (m)

for broad guage $B = 6m$

for meter guage $B = 4.88m$

R = Radius of the curve

L = Lap of flange

h = depth of flange below the top rail (cm)

D = Diameter of the wheel in cm.

Problem ;

If the wheel base of a vehicle moving on a broad guage track is 6m. The diameter of the wheel is 1.5m and the depth of the flange below the rail is 3.75cm. Determine the extra width provided on guage if the radius of the curvature is 160m.

Given data ;

diameter of the wheel = 1.5m

depth of the flange below the rail $h = 3.17cm = 0.0317\,m$

for broad guage $B = 6m$

Radius of curvature $R = 160m$

$$L = 0.02\sqrt{h^2 + Dh}$$

$$= 0.02\sqrt{0.0317^2 + (1.5 \times 0.0317)}$$

$$= 0.0044m$$

$$\therefore L = 0.440cm$$

$$d = \frac{13(B-L)^2}{R}$$

$$= \frac{13(6+0.0044)^2}{160}$$

$$= 2.92m$$

Extra clearance on curves:

* The minimum visible distance required on the straight path or linear path will not be sufficient on the curves so which requires more visibility for the locopilot to run the train safely.

* The surrounding parts of railway track will not have any type of obstacles upto a certain distance from the railway track.

Cant defficiency:

It is the ratio between cant required on the rail and cant provided on the rail

$$\text{cant deficiency} = \frac{\text{Cant required on the rail}}{\text{Cant provided on the rail}}$$

Which must be less than safe cant.

UNIT - III

TURNOUTS & CONTROLLERS

Points and crossings :

points and crossings are the different items which are used to control the locomotive by controlling and aligning the railway track.

The points and crossings are placed in the diverging and converging of railway track.

points and crossings are also used for turnouts of the locomotive.

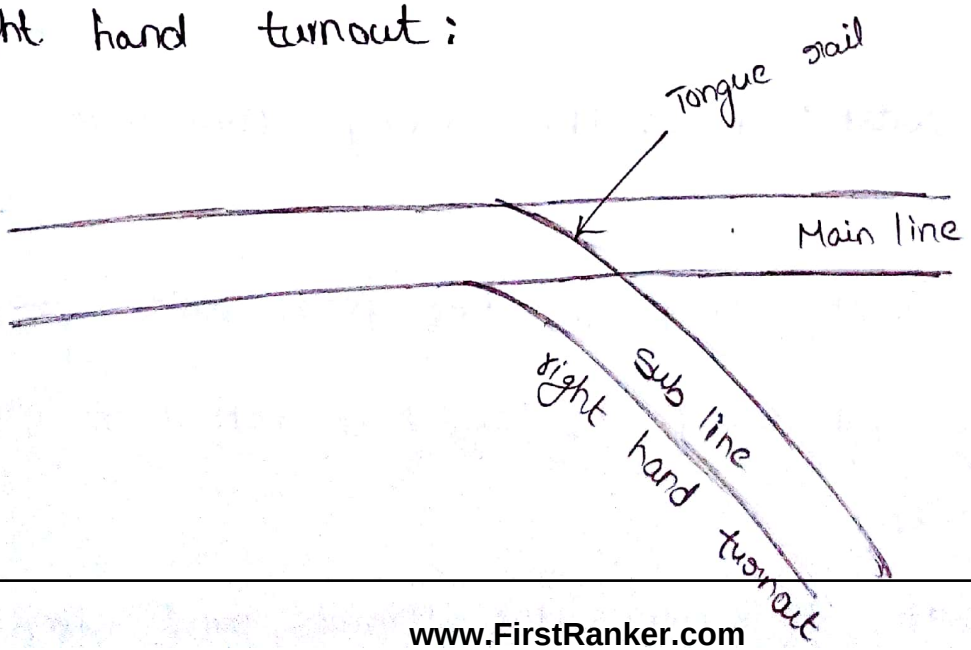
points and crossings are operated by either manual, mechanical or electrical.

Turnouts :

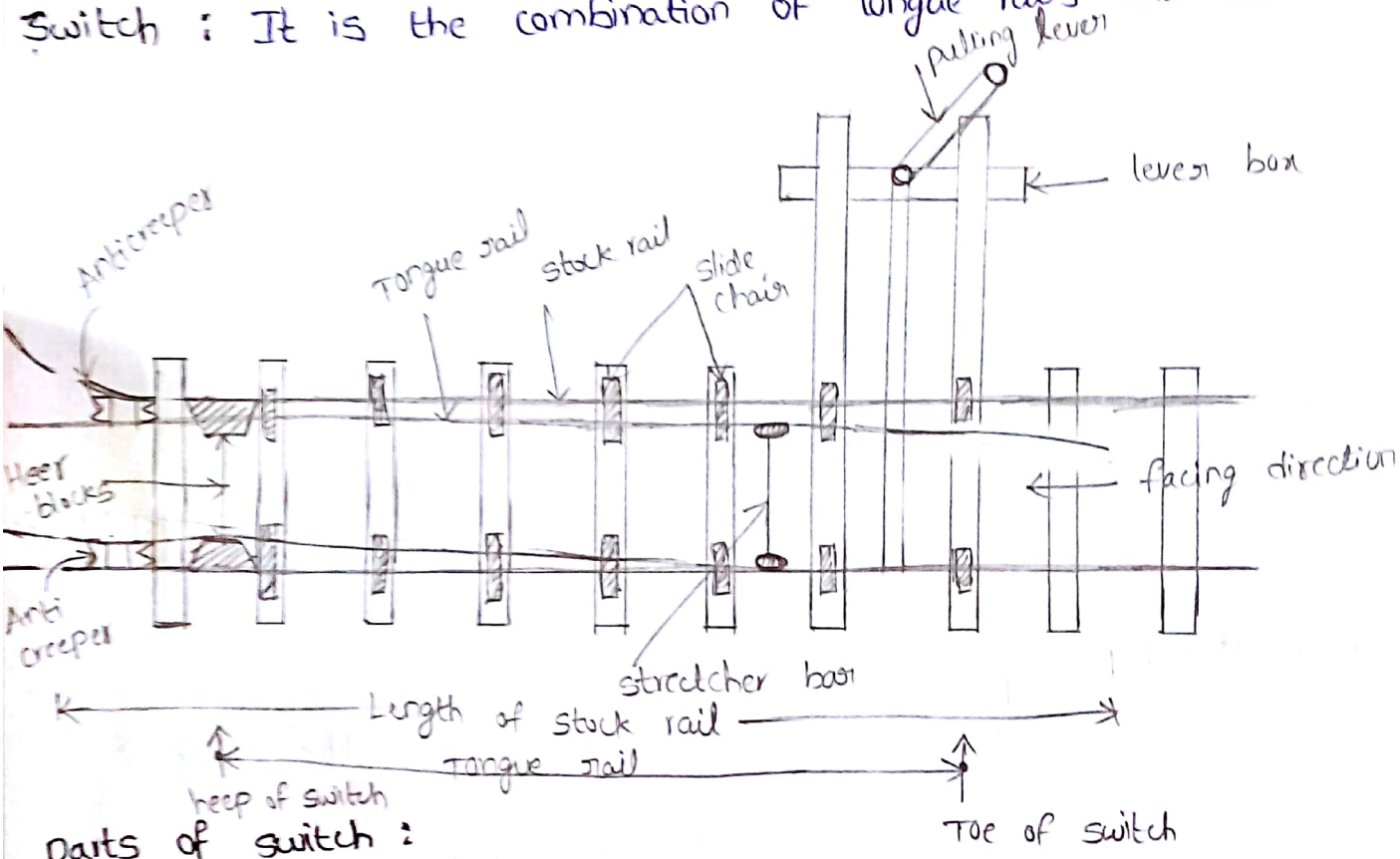
Turnout are the places in which the diversion of railway track from main line to sublines.

Types of Turnouts :

1. Right hand turnout :



Switch : It is the combination of tongue rails and stock rails.



parts of switch :

Heel of the switch : It is the starting portion of the switch operation.

Toe of the switch : It is the ending portion of the switch.

Stock rails : Stock rails are the main rails where the wheel is moving and which is beyond or behind or beside the tongue rails.

Stock rails are not moved and which are displaced by the wheel.

Rails: These are the main rails in the switch operation along the stock rails.

Tongue rails are used to change the wheel movement from main path to sub path and vice versa.

Tongue rails are operated by lever operations which are manual or mechanical or electrical.

Heel block:

It is the starting point of switch where the tongue rails are moved by the lever operations.

Stretcher bar:

Stretcher bar is the mechanically operated jack which is connected to the lever box and moved from main branch to sub branch of tongue rails.

Check rails: These are the rails which are giving path to the flange of the wheel along tongue rails.

Slide chair:

for switching operations the front portion of the tongue rail is connected to the fish plate of the chairs when the switch is operating the sliding action of tongue rails takes place due to sliding of chairs.

Anti creeper:

In the place of points and crossings the axial loads are heavy then there will be possibility of creep of rails.

for resisting creep we have to provide

epers against the creep direction by placing point chisels and heavy hangers.

Pulling lever:

It is a mechanically operated equipment to move the tongue rails.

The lever key operation can be connected the pulling lever

Types of switches:

1. Stud switch:

In this type of switch, no tongue rails are used. The main track is moved from main path to sub path and vice versa.

2. Split switch:

These consist of a pair of stock rails and a pair of tongue rails.

There are 2 types.

1. Loose heel type
2. Fixed heel type

1) Loose heel type:

* In this the switch of the tongue rails is free for the free movement.
* For this the fish plate bolts are loosened and other two are fixed.

2) Fixed heel type:

In this the tongue rail is extended over the switch and which is connected rigidly

ed on the type of switches :

i) under cut switch :

In this the bottom portion of the tongue rail is cutted for free movement of train.

ii) Straight cut switch :

In this the tongue rail is cutted along the length to give more thickness at the top of the switch.

Due to this the flange portion is well directed into the sub path.

iii) Over riding switch :

For neglecting the splitting nature of tongue rail and the stock rail due to flange movement. we have to place tongue rail over the stock rail. This is known as over riding switch.

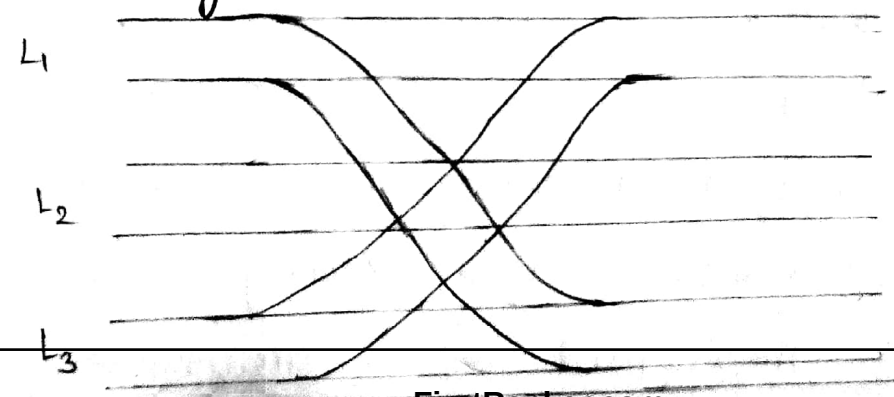
Crossing :

Crossing is a junction where the two rail way tracks crossing each other.

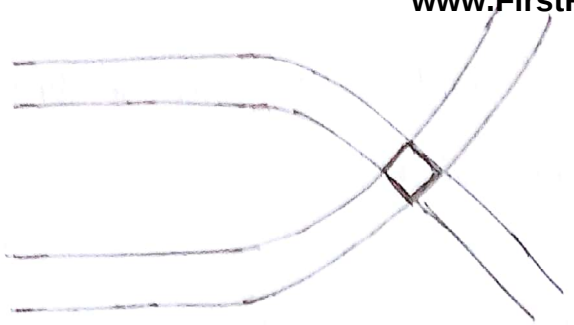
Crossings are mainly required in the case of 2 or more different alignments in different directions.

Types of crossings :

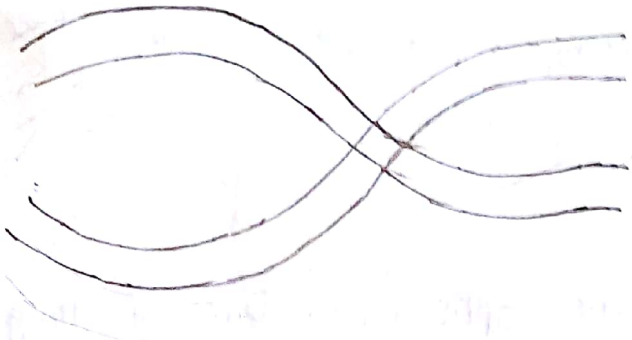
1. Double Crossing



Diamond crossing :



3. Scissor crossing :



Signalling :

Objectives of signalling :

* To give instructions to the locopilate about the proceding or stopping of locomotive across the blocks, station yards, railway crossings and points.
* For controlling the traffic over a lane signallings are required.
* To avoid accidents signals are required.
* For giving direction signals are required.

Types of signals :

Operational signals :

1. Hand signals : Hand signals are used by the station masters, guard mans, track maintaining operators and etc. These hand signals are signelled by the

[illegible] and green in the day time.

In night time lamps of different colour plates are used and also torch lights of high intensities are used.

2. Audible signals :

In the case of low visibility conditions due to fog and heavy rains we have to use audiable signals by means of detonators.

These detonators are placed on the rails when the wheel of locomotive runs over it blasts and an intimating sound will passed to the locopilate.

By hearing this the locopilate should understand he has to stop the locomotive in the next signals.

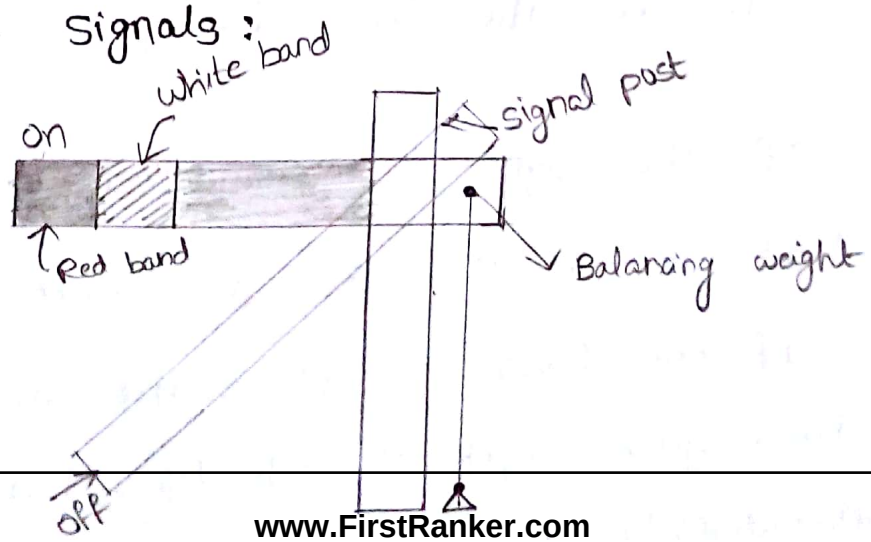
These detonators are placed 400 to 600m dong the rails for no disturbance in the railway track.

3. Fixed signals :

These signals are fixed at a position.

Classification of fixed signals :

i) semaphore signals :



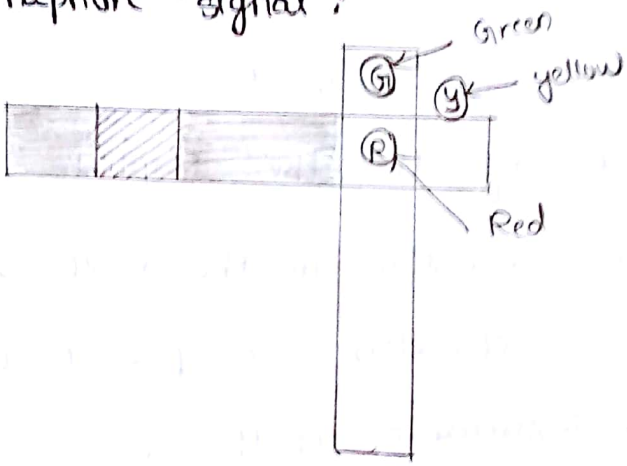
Semaphore signals are the mechanically operated signals in this a signal post which is attached by the horizontal lever.

This lever can be operated by an wire which is connected to the pulling rod.

If the lever is in "on operation" it indicates that we have to stop the locomative on the next signals.

If the lever is in "off position" it indicates that we have to do that the next signal is proceed.

ii) Warner semaphore signal :



Warner semaphore signals are the advanced to the semaphore signals which include lever with the high intensified lights. These are red, yellow, Green.

In this the lever having a circular open disk.

If the signal is in on position the open disk shows red light it indicates that the next signal is stop

If the lever is 45° to the on position the open disk shows yellow light it indicates that the next signal is precautionally move.

when the lever is in off position the open disk shows green light. It indicates that the next signal is Proceed with your maximum permissible speed at that position.

Interlocking system:

It is defined as the connections between the tracks and signals and points are interconnected. because there should be no conflictions between the track signals and the point.

Example: When the signal is in off position then there should be no fluctuations in the signal aganist the movemen

Need of Interlocking:

* To give proper directions to the locopilot.
* To avoid errors such as signal operations, points operations and speed control.
* To reduce energy loss, time loss and economical losses.

Types of interlocking system:

1. Mechanical interlocking system:

In this system we have to use mechanical equipments such as Levers, stretcher bars and Tappered bars with are connected interlockingly

These mechanical operations are included in the railway track by means of rails, signal posts and points.

2. Electrical Systems :

Electrical systems are connected to the mechanical system.

Electrical system requires

* Less manpower
* Time and energy

But the constructional cost and maintaince is high.

UNIT - IV

AIRPORT ENGINEERING

Recommandations by ICAO (International civil aviation organization):

This gives recommondations for the airport terminal point and runway characteristics depends on the aircraft characteristics.

Air crafts having different characteristics depends on the utilization such as civil purposes, goods purpose, Army purposes.

FAA (Federal Ariation Authority):

This gives recommandations for the air craft characteristics such as length, size, wheel load, wings length and width, weight of the aeroplain, engine capacity.

It also gives recommandations for aircraft airport requirements such as runways, taxiways, aprons, gradients and drainage system.

Factors affecting site selection of airport:

1. Topographical conditions:

The airport should be far away distance from the hills, valleys and uneven topographical conditions.

2. Accessibility:

The airport should be easily accessible from the all of its surroundings.

3. ~~The airport should be~~ placed at outcuts of the city

because it creating lot of noise pollution.

4. The airport surroundings should be free from tallest buildings and trees.

5. The airport should be high wind.

6. The wind fluctuations should be equal.

7. The climatic changes will be minimum.

8) Future developments :

Whenever we are going to select an site for airport we have to access the future development of airport aspectives such as runways, taxiways, terminal buildings, hangers and other airport things.

9) The airport should be far away ~~for~~ distance from the residential zones, public zones.

10) The airport site pooling should be easy and economical.

Airport master plan :

The plan consisting of all the airport configurations such as runways, taxiways, aprons, terminal buildings, hangers, parking provisions for air crafts, Drainage systems, signaling blocks, light house.

It should consists of runway length, width, gradient, Taxiway and their lengths from the terminal point. the width which depends on type of Taxi.

Orientation of runway :

It is defined as in which direction we

Direction of runway (NE, NW, SW, SE, NS, SN, EW, & WE).

The runway orientation depends on wind direction, site area and neutral gradient obstacles & surrounding around the airport.

Classification of airports:

The airports are classified based on the different aspects. they are as follows.

i) Wheel load

2) Engine capacity

3) Total weight of the aeroplane when it is taking of.

1) Based on wheel load (kg/m^2 or kg/cm^2)

from class A to class B.

Air craft characteristics:

1. propulsion: propulsion is the combination of length of the aircraft, width of the air craft, wheel load, height of the air craft.

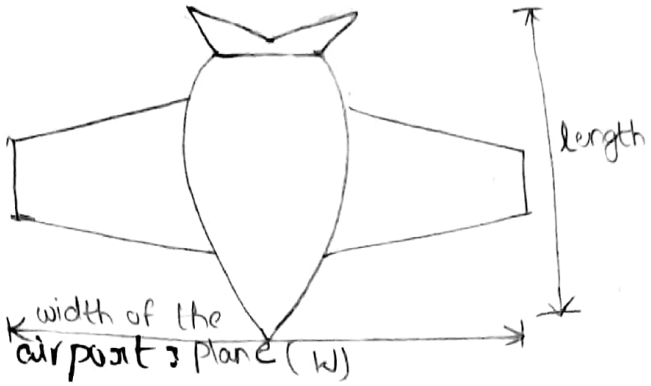
2. Engine capacity: The capacity to withstand and overcome the gradient of runway and to attain its maximum speed.

3 Wing base: The distance between the two outer curvature of the wings with a certain thickness is known as wing base.

4. Radius of the air craft:

The surrounding curvature of the air craft beyond its length, width.

5. Length of the aircraft :



Zones of airport :

for safe movement of air craft we have to consider different aspectives of aircraft.

Based on the different aspectives airport zones are classified as follows.

1. Imaginary surfaces :

i) Take off surface :

It is the distance travelled by the aircraft upto which it take off's from the run way.

Here no air craft or taxi ways or other obstacles in the zone of take off zone are not permissible.

ii) Conical surface :

The internal surface which is around the runway which is suitable for both landing and take off activities.

Conical surface also used for proper drainage system.

iii) Internal horizontal surface :

It is the internal surface which is around the runway which does not have any obstacles regarding airport operations such as landing, take off, exporting

and importing of goods and cargos and other high rised buildings.

iv) outer horizontal surface:

It is the outer surface of the runway which does not have any obstacles such as landing, take off, exporting, importing of goods and other high rised buildings.

v) visible surfaces above the ground level:

1) approach zone:

It is the zone or portion of the runway which having taking and building operations

Approach zone is major important thing in the taking and landing operations it should not have any type of obstacles infront or behind or besides of the runway.

2) clear zone: It is the starting portion of the approach zone which does not any type of obstacles.

3) Turning zone:

Whenever aircraft having take off or landing operations problems because of engine failure, clearance, visible conditions etc...

for overcoming this type of obstacles we have to provide turning zones.

(iv) Runway orientation:

Runway orientation mainly depends on wind characteristics such as duration, direction, intensity.

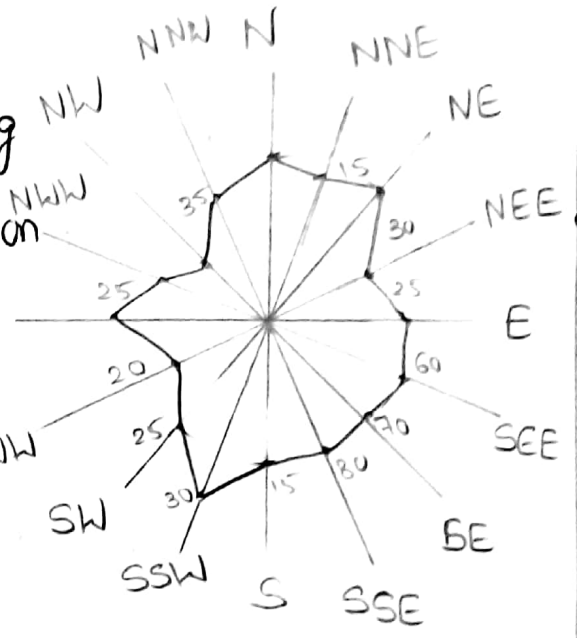
Wind rose diagram:

Type – 1

Type – 2

Type-1 wind rose diagram:

In this we are to studying and representing wind direction, duration in an year.



In this we have to give different directions of wind for the study purpose.

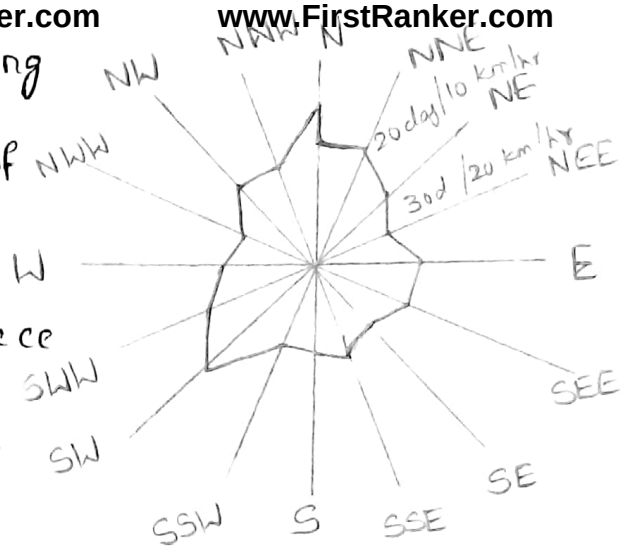
In this diagram we have to place different directions (N, NNE, NE, NEE, E, SEE, SE, SSE, S, SWW, W, NWW, NW, NNE with different durations in an year.

then we have to place an transparent white sheet which is moved in the directions of same duration and join these points.

By this we have full awareness on the direction and direction of the wind.

2. Wind rose diagram :

In this we are studying direction, duration and intensity of wind in an year.



In this we have to place transparent white strip along the center of the wind rose diagram.

Then we have to move this strip along same intensity of the wind.

Then join these points.

The runway orientation should not be placed along high intensities, high duration.

Runway length :

The runway length mainly depends on following 3 factors.

1. Normal takeoff case
2. Normal landing case
3. Engine failure case

1. Normal takeoff distance :

It is the minimum distance required to attain its maximum speed (or velocity to overcome the aircraft load.

So we have to provide such distance for takeoff case.

ICAO (International Civil Aviation organization) recommends the minimum runway length of total runway length.

2. Normal landing case:

It is the distance between the aircraft wheel touches firstly on the runway to the aircraft rest position.

for landing operations ICAO recommends 70 to 80% of total runway length.

3. Engine failure case:

In this case the aircraft should not come into rest position when the failure occurs in the engine.. So it requires some distance on the runway for turning operations and landing also.

ICAO recommends some specific values for runway lengths depends on aircraft characteristics.

Characteristics of runway:

Runway length

Runway width: It depends on the air craft characteristics It is mainly used for free movement of aircraft without any collisions.

Runway sides (width of safety area)

Runway sides of the supportive shoulders for the runway against its failure due to heavy

 loads of the aeroplanes, movementary loads of the aeroplane.

Transverse gradient:

It is provided on the runway for fast drainage of rain water.

Longitudinal gradient:

It is provided for proper take off and landing operations because normally aircrafts are in horizontal position to the Runway. so it requires some gradient along its length for take off and landing.

Sight distance:

It is the minimum distance requires for the pilot to contrd the aircraft in both the take off and landing operations.

Taxi ways:

Taxi ways are the exist ways of aircraft from runway.

Characteristics of Taxiways:

1. Length of the taxi way:

The taxiway length should not have any restrictions. because it depends on aircraft characteristics It should be provided as per requirement of aircraft.

Terminal area mainly consists of a building, parking for cars and outer vehicles.

Requirements of terminal building :

The terminal building should have following objectives.

1. Verification of passport, visa and boarding passes.
2. Checking operations with respect to security smuggling of illegal items.
3. Utilities, toilets, rest rooms.
4. Controlling of aircrafts by using various signaling operations.

Airport layout :

Airport layout is a representation of airport objectives such as runways, taxiways, terminal buildings, roads, parking, hangers etc.

It mainly shows characteristics of runway, type of runway.

Normally runways are

1. Intersection runways
2. parallel runways
3. off set railways

Visual Aids : These are the representation of different items of airport such as runways, runway shoulders, runway length, runway width, taxiway, aprons and terminal building and etc...

UNIT-V

RUNWAY DESIGN

Factors affecting designing of pavement :

1. Design of wheel load :

for designing of pavement the wheel load of the aircraft considered.

It should be varied for different type of of aircrafts.

Normaly aircrafts having 3 wheels upto a maximum of 4.

2. Strength of materials used for pavement :

The strength of pavement depends on material used for pavement construction and their properties (strength, elastcity, rigidity, size, thickness, specific gravity, Density)

3. Subgrade formation for suitably of pavement :

The pavement design will also depends on subgrade characteristics of the soil with respect to type of soil, availability of bed rock exploration of ground water etc..

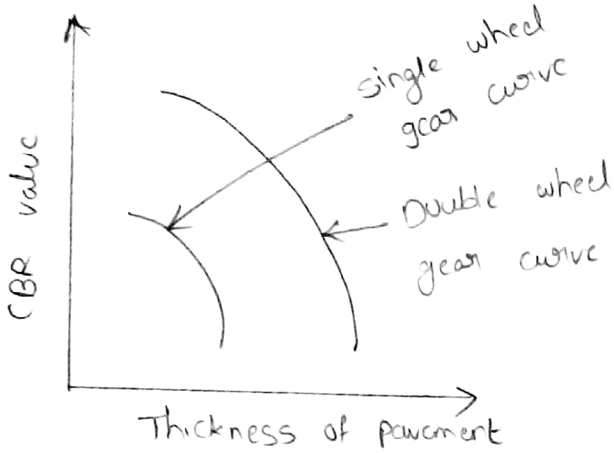
so for attaining required strength of subgrade we have to adopt some reinforcements groutings, stabilizations with different materials.

Design methods of flexible pavements :

1. CBR method :

In california bearing into ratio we have to conduct load test on different type of pavement materials with different thickness

 for obtaining thickness of the pavement we have to draw a graph between California Bearing ratio, thickness of the pavement.




single wheel gear system


Double wheel gear system

This graph representing 2 curves

1) Curve - a
2) Curve - b

Curve - a drawn with wheel load (single wheel gear system)
curve - b drawn with wheel load (double wheel gear system)

2. Mac Leod method :

In this method we have to conduct several plate load tests on different pavements with different thickness.

By this method we get maximum loads of the different materials at which they are failing.

By observing this values we have to adopt different thickness of the pavements for which they are suitable.

Burmister method :

In this method the burmister conducted so many plate load tests on a particular area.

Here the area means the contacted area of the wheel.

different materials there should be different wheel carrying capacity of a particular area of contact.

Burmister given so many load capacities for different wheel loads and for different area of contacts.

4. Analytical method :

from different type of methods we are getting different formulaes attaining the load capacities, wheel loads and area of contacts. so for easy adoption of formulae we have to produce one single method of determining load capacities.

By this method the pavement design proredure is simple.

5. LCN method :

LCN - Load classification number

In this method several load tests on different thicknesses are contained for both rigid and flexible pavements.

from this load members we can get wheel loads, area of contacts.

By this we can get a formula

$$\frac{W_1}{W_2} = \left(\frac{A_1}{A_2}\right)^{0.094}$$

Here W_1, W_2 are failure wheel loads (maximum wheel loads)

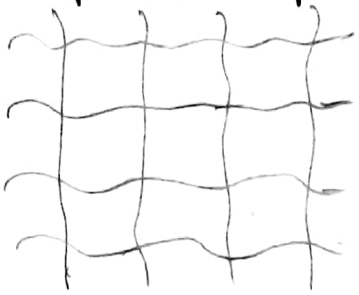
A_1, A_2 are area of contacts.

Field Pavement failures :

1. Failures in flexible pavements :

i) Alligator cracks :

These cracks are mainly due to failure in the pavement materials and heavy wheel loads. These are in the shape of maps.



ii) Cracks due to consolidation :

In this the failure of pavement is mainly due to consolidation of pavement by absorbing moisture content or water.

The bottom layers of the pavement is continously settled due to consolidation.

iii) Pavement failed due to shear :

The sliding action of pavement materials due to heavy wheel loads from top of the pavement.

By this, their should be possibility of unevenness on the pavement.

iv) Failure due to frost heaving :

In this the failed pavement should have possibility of failure of top layer of the pavement due to frost heaving action.

Longitudinal cracking:

These cracks are appeared in the direction of length due to take off and landing operations.

Airport drainage system;

There are 2 methods.

1) Surface drainage system:

i) It should be done by installing proper pipe line system beneath the pavement, pavement shoulders (width of safety area).

ii) The airport surface should have fast runoff and percolation.

iii) It should not have catchment area characteristics.

iv) The rain water should be drained by using electrical motors in case of excessive storage.

2) Sub surface drainage system:

It involves 4 steps for maintaining the proper drainage below the ground level.

i) Lowering the ground water table by using sumps, well points and deepwell points.

ii) Base course preparation:

The base course should be prepared with coarse aggregate for filtering the water from top layer to bottom, by layer rapidly.

The base course must not allow the ground water to above layers.

iii) Should have adequate strength for maintaing and carrying the pavement and its loads.

Subgrade characteristics for fast draining:

a) It should have permeability nature.

b) The subgrade should be in unsaturated condition.

c) The subgrade should be hard and durable.

d) It should be aganist the water logging case.

iv) Intercepting the under ground drainage system:

The connection of sub surface drainage System to the main drain of the airport surrounding areas.

UNIT V

DOCKS HARBOURS & PORTS

Harbour :

Harbour is a place which is used for parking of ships, in and discharge of passengers, exporting and importing the cargoes.

Harbour should not have an effect of tidal waves.

Habours are classified as follows.

1. Natural harbours :

These harbours are formed by the pheromean of natural tidal actions and topographical features.

2. Semi natural harbours :

These are formed by natural actions and artificial actions (man made)

3. Artificial harbours :

These are purely manmade.

4. Fishing harbours
5. Marine harbous
6. Military harbous
7. River harbous
8. Lake harbous

Requirements of a good harbour :

1. Harbour should not have high effect of tidal waves
2. The depth of the seashore should be high because

vessel (ship) should require more depth for free

movement.

3. The dredging operations should be easy.

4. The width at the starting of harbour should be narrow and it will be wider after.

Port : Port is the a place which is used for parking of ships, in and discharge of passengers, exporting and importing of cargoes and storing of goods in transition sheds, ware houses and combination of Docks.

Classification of ports :

1. Military port
2. Lake port
3. Sea port
4. River port
5. Marine port

Requirements of good port :

1. The port should be located very nearer to the center land of the country.
2. It is easily connected to the road and rail transports.
3. The depth of the sea at the port is high.
4. The tidal effect should be minimum.
5. The spare parts of the ship should be easily available.
6. The maintanance of the port should be minimum or Economical.

 the port area should be free from cyclones and tsunamies.

Docks :

Docks are the places where ship maintanance operations are happening and here no tidal waves are allowed for easy shiping operations.

These are classified into 2 types.

1. Wet Docks
2. Dry Docks

Wet Docks ;

In this the docks are constructed considerable distance from the sea with basin and provided with strong gates at the entrance of the docks.

Due to this gates the tidal energy is not allowed into the docks.

Here the sea water be stable.

Dry Docks :

Here the dry docks are operated by using crane operations, fast pumping out of stored water, then the vessel should be lowered slowly. This is known as dry docks.

Quays :

Quays are the concrete structures layed in the ports or harbours agonist the sea waves.

These are horizontal platforms constructed along a parallel to the basin of the port.

Quay walls:

The supporting walls of quays are known as quay walls.

These are helpful in the protection of beds of ports.

This will be also useful aganist the scouring action due to tidal waves.

Transtion sheds:

These are the sheds constructed for giving transportation facilities of the goods with are imported or exported into the ships.

Transition sheds are mainly used for protection of goods or cargoes for a small peroiod of time.

These are provided with gate operations with rapid opening and closing facilities.

These should have large floor space for Stoaing and free moving of goods.

For large volumes mechanically operated cranes also srequired for moving of goods. So, it requires minimum height based on applications and free space.

Ware houses:

These are as like as transition sheds but the difference is here we can store goods (or) cargoes over a large peroiod of time.

These are constructed either by wood (or) RCC in multiple storey's.

Layout of port or harbour:

Layout is the representation of all the items which are required in the port/harbour.

Which consists of transition sheds ware houses, docks, basins, quays, jetties.

Jetties:

Jetties are the structures which are constructed below the sea water act the entrance of the basin and total length of the port.

Jetties are used for minimizing the sea waves and tidal energy.

This also prevents the scouring action due to sea waves.

Break water:

The water which is applied aganist the sea water is known as break water.

Break waters are the concrete (or) masonry structures which are constructed for resisting the sea waves.

1. Floating type break waters:

These are the floating type of waters which are placed at the surface of the sea from bottom of these the basin water, sea water merged without any separation.

Tides are the waves formed in the sea due to natural attraction between the moon and the earth, sun and the earth.

The waves are formed due to passing of sun/moon over the meridian of the earth.

Types of tides:

1. Lunar tides (due to moon):

These are the tides formed when the moon crosses the meridian at a single place with in 24 hours of time. These are known as lunar tides.

2. Double lunar tides:

When two tides are formed because of the moon crosses the meridian mixed with in 24 hours of time.

3. Mixed tides:

When a tide is formed with high energy and the second one is low energy is known as mixed tides.

4. Solar tides:

i) Single bi solar tide:

These are the tides when the sun crosses the meridian at a single place within 24 hours.

Double Solar tides:

When two tides are formed because of sun crosses the meridian with in 24 hours.

iii) Mixed solar tides

5) Spring tides:

The tides rise and fall more than the new and full moon times are known as spring tides.

6) Neap tides:

When the rise and the fall of the tides are less than new moon, full moon days. These are known as neap tides.

Problems:

1) Calculate the maximum permeability speed on a curve of high speed of BG track having the particulars.

Degree of a curve = 1°

Amount of super elevation e = 8 cm

Maximum speed of the section litely to be sanctioned 153 kmph

Length of the transition curve = 130 m

Sol: Given data;

Degree of curve D = 1°

Super elevation e = 8cm

Maximum permissible speed on section = 153 kmph

Length of transition curve = 130m

Calculation of radius of curve

$$D = \frac{1720}{R}$$

$$R = \frac{1720}{D} = \frac{1720}{1} = 1720m$$

$\therefore R = 1720m$

Calculation of Safe speed on curves for Broad guage

$$V = 4.44\sqrt{R-70}$$

$$V = 4.44\sqrt{1720-70}$$

$$V = 180.35 \text{ km/h}$$

Safe speed on the section with super elevation of 8 cm.

$$C = \frac{GV^2}{127R}$$

Assume for high speed tracks the cant defficiency is 10cm.

$\therefore$ Theoritical super elevation provide $= 8+10$

$= 18cm$

$= 0.18m$

G = Guage distance

for Broad guage, $G = 1.676$

$\frac{18}{100} = \frac{0.76\ V^2}{127 \times 1720}$

$V = 153.16$ kmph

Length of the transition curve

$$l = \frac{e \times V_{max}}{198}$$

$$130 = \frac{0.18 \times V_{max}}{198}$$

$V_{max} = 143000$ mph

$V_{max} = 143$ kmph

The permissible speed should be 143 kmph.

2) Determine the length of the transition curve and draw the offsets at every 15m. Given the design speed of the train on a curve is 90 kmph on a broad guage.

Sol: calculation of radius of curve

$V = 4.44\sqrt{R-70}$

$25 = 4.44\sqrt{R-70}$

$R = 480$ m

$V = 90$ kmph

$= \frac{90 \times 1000}{60 \times 60}$ m/sec

$= 25$ m/sec

Super elevation $e = \frac{GV^2}{127R}$

$$e = \frac{1.676 \times 25^2}{127 \times 480}$$

$e = 0.22$ m

$e = 22$ cm

Length of transition curve $l = \frac{3.28 V^2}{R}$

$= \frac{3.28 \times 25^2}{480}$

$= 55.35\ m$

Calculation of offsets

offset at 55m

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

$y = \frac{55^3}{6 \times 480 \times 55}$

$y = 1.05\ m$

offset at 40m

$y = \frac{40^3}{6 \times 480 \times 55}$

$y = 0.40\ m$

offset at 25m

$y = \frac{25^3}{6 \times 480 \times 55}$

$y = 0.098\ m$

offset at 10m

$y = \frac{10^3}{6 \times 480 \times 55}$

$y = 0.0063\ m$

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The runway length required for landing at sea level in standard atmospheric condition is 3000m. Similarly length required for takeoff at sea level in standard atmospheric condition is 2500m. Aerodrome reference temparature is 25° and that of the standard atmosphere at aerodrome elevation is of 150m is 14.025°C. If the efficietive runway gradient is 0.5%. Determine the runway length to be provided.

Sol: Corrections to runway takeoff length

1) correction for elevation :

$$\text{Correction for elevation} = \frac{7}{10} \times \text{take of length required} \times \frac{\text{elevation}}{300}$$

$$= \frac{7}{10} \times 2500 \times \frac{150}{300}$$

$$= 87.5\,m$$

$$\text{Corrected take of length} = 2500 + 87.5$$

$$= 2587.5\,m$$

Corrections for temparature:

$$\text{Rise of temparature} = 25^\circ - 14.025^\circ$$

$$= 10.975^\circ C$$

$$\text{correction for temparature} = \frac{\text{corrected take of length}}{100} \times \text{Rise of temparatu}$$

$$= \frac{2587.5}{100} \times 10.975$$

$$= 283.97m$$

correction for take of length required based on temparature correctio

$$= 2587.5 + 283.97 = 2871.47m$$

correction for gradient

correction for gradient $= \frac{20}{100} \times$ total corrected length $\times$ % of gradient

$= \frac{20}{100} \times 2871.47 \times 0.5$

$= 287.14$ m

The runway length provided is $= 2871.47 + 287.14$

$= 3158.617$ m

4) The length of a runway under standard conditions is 2100 m. The airport is to be provided at a elevation of 410m above the mean sea level. The airport reference temparature is 32°C. If the runway is to be constructed with an efficient gradient of 0.2%. Determine the corrected runway length.

Sol:

Correction for elevation $= \frac{7}{100} \times$ runway length required $\times \frac{\text{elevation}}{300}$

$= \frac{7}{100} \times 2100 \times \frac{410}{300}$

$= 200.9$ m

Corrected length $= 2100 + 200.9$

$= 2300.9 \simeq 2301$ m

Determination of standard atmospheric temparature of given elevation $= 15° - (0.0065 \times \text{elevation})$

$= 15° - (0.0065 \times 410)$

$= 12.335°C$

Correction for temparature $= 32° - 12.335°C$

$= 19.665°C$

Correction for temparature = $\frac{\text{corrected length}}{100} \times$ Rise of temparature

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$= \frac{2301}{100} \times 19.665$

$= 452.49$

Correction for length based on temparature correction

$= 2301 + 452.49$

$= 2753.49\ m$

Correction for gradient $= \frac{20}{100} \times$ Total corrected length $\times$ % of gradient

$= \frac{20}{100} \times 2753.49 \times 0.2$

$= 110.14\ m$

∴ The total runway length required

$= 2753.49 + 110.14$

$= 2863.63\ m$