UNIT-II - Railway construction and Maintenance.

Earthwork - Stabilization of track on poor soil - Tunneling methods, drainage and ventilation - Calculation of materials required for track laying construction and maintenance of tracks - Modern methods of construction & maintenance - Railway stations and yards and passenger amenities - Urban rail - Infrastructure for Metro, Mono and underground railways.

Earthwork and consolidation:-

(i) construction of formation
(ii) Height of embankment above highest water should be atleast 60cm.
(iii) Economical limit of moving the earth in long direction is decided by mass Haul curve.

cost depends on:-

(i) Type of soil used
(ii) Hauling distance
(iii) Lift required.

Purpose of consolidation is pack the track, so that larger quantities of stone ballast are not lost by sinking into loose earth formation.

After completion of embankment, small earthen walls are built of 15cm high and across the edges of formation at an interval of

Tunneling methods:-

Necessity of Tunnels:-

(i) Reduce the length of the railway line and also economical.

(ii) The use of tunnel under a river bed is often economical and convenient than providing a bridge over the river.

(iii) The costs of excavation for providing an open cut in a mountain are excessive and maintenance costs are also high. It is therefore, better to use a tunnel.

Size and Shape of Railway tunnels:-

The size of the railway tunnels depend upon whether it has to carry a single line (or) a double railway line

Polycentric (or) horse shoe type sections are commonly used for railway tunnels

It represents a compromise bwn polycentric and circular sections and has become extensively popular due to its simplicity in construction.

After fixing size, shape and ends of the tunnel, its centre line should be located exactly on ground to find the exact length of the tunnel.

The following operations are involved in the survey work for the

(i) Locating the centre line on the ground.
(ii) Transferring centre line to the inside of tunnels
(iii) Providing the required grade at the bottom of tunnel
(iv) Checking tunnel C/s details as per requirements.

Tunneling methods in rocks differ from that of soft ground tunnel construction in the following aspects:
(i) The operation of tunneling in rock is costly.
(ii) In rocks, for drilling and ~~drafting~~ blasting, it requires a power plant to operate machinery and excavating tools.
(iii) cutting operation in rocks is very expensive.
(iv) Rocks being self supporting, require less timbering for supporting.

Methods of tunnel construction in rocks:-
For tunnel driving in rocks, the following operations are involved.
(i) Setting up the section of tunnel and drilling.
(ii) Loading of holes and shooting of explosive.
(iii) ventilation and removing dust of explosion.
(iv) Loading and hauling of muck.
(v) Removal of ground water (if any)

sides and roofs if necessary.

(vii) Placing reinforcing steel if required.

(viii) Placing of concrete lining.

(i) Full Face method:-

The whole section of the tunnel is attacked at the same time. It is suitable for tunnels of same cross area say upto 8m diameter.

This method is frequently used for larger diameter tunnels also.

(ii) Heading and Bench method:-

(i) This method involves the driving of the top portion in advance of the bottom portion.

(ii) It is used when tunnel section is very large and quality of rock is not very satisfactory.

(iii) Drift method:-

Rock tunneling is sometimes carried out first in smaller section of the proposed tunnel and then widened. The method is called drift method

A drift may be classified as centre, bottom, side (or) top drift depending upon its relative position with reference to the main bore.

Drilling and Blasting of Rocks:-

Most commonly used drill in tunnelling is the drifter equipped with

that can be used are the following Types:-

(i) Percussion Drills.
(ii) Abrasion Drills.

Types of Explosives:-

A variety of explosives are available to meet particular requirement some common type of explosives are the following.

(i) Power Explosives
(ii) Disruptive Explosives.
(iii) Liquid Air.

Methods of tunnel construction in soft ground:-

It depends upon the following factors

(i) Size of tunnel
(ii) Type of ground
(iii) Available equipment, machinery and tools.
(iv) Method of excavations.

The tunneling in soft ground broadly involves the following operations-

(i) Mining (or) Excavation,
(ii) Timbering (or) Strutting the excavated section.
(iii) Mucking removal of excavated materials
(iv) Placing of lining.

(a) methods requiring use of timbers:-

(i) Forepoling method, (ii) Needle beam method.
(iii) Belgian method, (iv) Austrian method
(v) American method, (vi) English method
(vii) Army method (viii) German method.

(b) Other methods :-

(i) Linear plate method,
(ii) Shield method
(iii) Compressed air method.

Ventilation and Drainage for tunnels

The use of drilling machine, detonators, large explosive charges, loading machine, dust etc, require the provision of an efficient system for ventilation in view of the large no of men working at the tunnel face.

The most efficient ventilation system relies upon a combination of blower and exhaust fan.

Immediately after blasting, exhaust system is used for 15-30 mins. to dra smoke and dust.

Drainage :-

In tunnel driving, control of wate consists of the following two operatio

(i) Prevention of excess quantities of water, entering the tunnel.
(ii) Removal of water that enters the tunnel

The ground water can be removed by either.

(i) open ditch drainage system (or)
(ii) By pumping system

Piston type reciprocating (or) centrifugal

Railway Construction:-

First Stage - Earthwork → Formation and consolidation.

Second stage - plate laying → laying of a railway track.

Third stage - laying of ballast on track.

Second Stage (plate laying).

Operation of laying out the rails and sleepers over ready formation is known as plate laying.

The point where laying of track starts is known as base and point upon which the new track is carried out is known as rail-head.

Methods:-

(i) Tramline method (or) Side method.
(ii) Telescopic method.
(iii) American method.

Third Stage - laying of ballast:-

(i) Taken up after two (or) three monsoons.
(ii) Loaded in wagons and transport to site unload etc. no of heaps at suitable interval.
(iii) Packing of ballast.

Materials required per Km of Railway track:-

An Engineer-Incharge should work out the exact quantities of all the materials required for the proposed railway track.

The excess materials will lead to

may delay the work. The exact quantities of various materials are calculated as follows for one Km track.

(i) Rails:-

$$\text{No of rails per Km} = \frac{1000}{\text{length of rail in m}} \times 2$$

For B.G when rail length = 12.8m.

$$\therefore \text{No of rails per Km} = \frac{1000}{12.8} \times 2 = 156.2$$

$$= 157.$$

(ii) Weight of rails in tonnes per Km:-

$$= \text{No of rails} \times \text{length of rail in m} \times \frac{\text{wt of rail in kg/m}}{1000}$$

$$\therefore \text{Weight of rails per Km} = \frac{157 \times 12.8 \times 44}{1000}$$

$$= 90 \text{ metric tonnes.}$$

Sleepers:-

$$\text{No of sleepers per Km} = \frac{1}{2} \times \text{no of rails per Km} \times (M + a)$$

where,

M = Length of rail in 'm'

a = Density factor.

Sleeper density = (M + a).

a = Density factor, is any no. which when added to a length of rail, will give sleeper density.

In India a = 4, 5, 6 (or) 7.

For B.G 12.8m rail length and a = 4

$$\text{No of sleepers per Km} = \frac{157}{2} \times (12.8 + 4)$$

$$= 1219$$

Fish plates:-

No of fish plates per km of track
= 2 x No of rails per km.

when, no of rails per km = 157 for BG.

No of fish plates per km of track
= 314.

Fish bolts:-

No of fish bolts per km of track
= 4 x No of rails per km.

when no of rails per km = 157 for BG

= 4 x 157 = 628.

Bearing plates:-

No of plates per km of track depends upon design.

No of bearing plates per km of track is = 2 x No of sleepers per km of track.

= 2 x 1319 = 2638 Nos.

(or) = 4 x No of rails per km of track

= 4 x 157 = 628.

Dog Spikes:-

For use with timber sleepers.

No of Dog spikes per km of track
= 4 x No of sleepers per km of track

= 4 x 1319 = 5276.

Maintenance of track:-

Necessity:-

(i) Strength of track structure gets deteriorating.

(ii) other deteriorating effects like rain water, action of sun and wind.

of railway tracks gets

surface levels of rails.

Therefore it is essential to maint the track in good condition so that it may run over it safely.

Classification:-

(i) Daily maintenance

(ii) Periodic "

Daily maintenance:-

It is carried out by the year. The railway track is divided in suitable sections of 5 to 6 Km length. one gang allotted for each section.

Periodic maintenance:-

It is carried out after an interval of 2 (or) 3 years. It includes the maintena of

(i) Surface of rails:-

In this the top surface of two rai should be maintained properly on straight lengths. It involves the follo operations.

(i) Packing, (ii) Surfacing the track

(iii) Boding and dressing the track

(iv) Levelling of the track

(v) Lifting of the track

(vi) Surface defects and remedies.

(vii) Spot packing and track lifting.

(ii) Track Alignment:-

If the track goes out of alignment d to following causes,

(i) Increased hammering action of wheels.

(ii) Variation of centrifugal force by

temperature variations in hot weather. thermal stresses and heavy creep of rails.

The checking of perfectness of alignment is made either through eyes (or) by instruments such as theodolite and string line method.

(iii) Gauge :-

The variations in the gauge may occur due to the following case.

(i) Loosening of track fittings.
(ii) Widening of gauge
(iii) Keys are not tight
(iv) loose fittings lack of attention to packing.

It can be maintained by tightening of track fittings and proper maintenance of correct joints, creep, anchor etc.

(iv) Maintenance of Proper Drainage :-

It can be achieved by,

(i) clearing of ballast
(ii) clearing of weeds
(iii) clearing of cess
(iv) Provision of surface drainage and underground drainage.

(v) Maintenance of track components :-

Renewal of rails and sleepers.

It can be done by,

(i) Spot renewal, (ii) Through renewal.

(vi) Maintenance of Fittings :-

Graphiting of fish plates :

It is done for the following purposes.

(i) To protect the fish-plates against corrosion.

(iii) To increase the life of fish plates and bolts.

(vii) Maintenance of points and crossings:-

(i) Gauge should be perfect at all places

(ii) Creep should be prevented.

(iii) Periodic displacement of sleepers should be corrected.

(iv) Proper tightening of bolts should be done daily.

(v) Ballast should be repacked and screened periodically.

(vi) Fouling mark should be cleaned and painted.

(viii) Maintenance of Level crossings:-

(i) Rails and fittings should be tarred once a year.

(ii) Area of crossing should have wear bound macadam (or) bituminous pavement.

(ix) Maintenance of Tunnels:-

(i) Track materials should be examined for corrosion.

(ii) Ventilation should be clear of any obstruction.

(iii) Light arrangement in the tunnel should be checked.

(iv) Level and alignment and its approaches should be checked.

(v) Portals at the ends should be checked.

Modern methods of construction:-

India, max speed - 130 Km/ph.

For achieving speeds higher than 250kmph conventional track replaced by a new ballast less track consisting of concrete slabs fastened to rails with elastic fastening.

Modernization of existing track:-

Development of super high speeds:-

(i) Limitations of super high speeds.
(ii) Power requirement for different speeds.
(iii) Concepts for developing high speeds.

Limitations of super high speeds:-

(i) Wave formation
(ii) Adhesion between wheel and rails
It decrease with increase of speed of vehicle.
(iii) Vibrational limitations
(iv) Special problems on curved track

Power requirement for different speeds on straight track:

(i) Resistance to movement,

$$R = 2.8 + 3\left(\frac{V}{100}\right)^3 \text{ Kg/ tonne.}$$

(ii) Value of specific power,

$$P = 6V + 0.817\left(\frac{V}{10}\right)^3.$$

(iii) Resistance on gradient 'j' (per thousand)

$$R = 2.2 + 3\left(\frac{V}{100}\right)^3 + j$$

(iv) Specific power in watt (P)

$$= (6 + 2.78j + 278f)V + 0.817\left(\frac{V}{10}\right)^3.$$

Concepts for developing high speeds:-

(ii) Linear motor and Air cushion vehicle
(iii) Gas turbine and Air cushion (tracked air cushion vehicle).
(iv) Magnetic levitation vehicle (MAGLEV)

Modernization of track for high speed

Structural (or) strength requirements of track components:-

(i) Rails and Rail joints
(i) Section should be heavy.
(ii) Economical, strength, stiffness & durability
(iii) Weight 60kg/m and 52kg/m.

(ii) Sleepers:-
(i) CST-9 and CST-13 are used for high speed track
(ii) Having high sleeper density.

(iii) Fastenings and Fittings:-
Use of elastening fastenings for greater stability and it have the following characteristics:
(i) Maintain correcte uniform gauge.
(ii) Held the rail in position
(iii) Enough resistance
(iv) Economical and require less maintenance

Types:-
(i) Pandrol clip
(ii) Pandrol clip with wooden sleepers / steel sleepers
(iii) Pandrol clip with C-Z sleepers, concrete sleepers.
(iv) Spring steel clip
(v) Sigma clip
(vi) ZRN -202 clip
(vii) Lock spike
(ix) Double shank elastic spike.

(iv) Ballast:
(i) Adequate in thickness
(ii) Proper gripping to sleepers.
(iii) Proper tamping and consolidation.
(iv) Enough resistance
(v) Min thickness 25cm and 27cm.
(vi) Shoulder width -35cm (straight)
50cm (curves)

(v) Formation:-
(i) Increase in depth of ballast
(ii) Increase density of sleepers.
(iii) Increase section of rail and no of sleepers.

(vi) Track Assembly:-
(i) Check the stability of materials design and fittings.
(ii) Proper joints and periodic checking.
LWR give more safety, efficiency and economy compared to conventional fish, jts. track.

(vii) Points and crossings:-
(i) Speeds limited on turn outs
(ii) Use manganese cast steel for crossings.
(iii) High cant defeciency rather than no S.E on turnouts.

(viii) Economic design of modern track:-
Balance in design of track, locomotive type, steam, Diesel (or) Electric goods.
(i) Rail Requirements → quality and stress sustainability
(ii) Wheel dia, and Axle loading.
(iii) Fastenings, weight of sleeper.

Modern methods of track maintenance

The following are the main modern methods of track maintenance

(i) Mechanized Maintenance (or) Mechanical tamping
(ii) Measured shovel Packing.
(iii) Directed Track Maintenance.

Methods of Mechanical Tamping :-

(i) Off track Tamping
(ii) On " "

Off track tamping :-

These are portable and can be taken off the track within a short period of time are used.

It requires no blocking of the traffic

Types :-

(i) Self contained (Percussion type, Vibratory type).
(ii) Off track tampers worked from a common power unit.

On track tamping :-

These are self propelled vehicles, used to tamp the sleepers automatically through various controls provided in the operators cabin.

Automatic aligning, lifting, cross and longitudinal levelling and packing are simultaneously possible.

Types :-

(i) Light on track tampers
(ii) Heavy " "

Measured Shovel Packing :-

In this method, unevenness and voids are accurately measured, the track is lifted by means of jacks and measured quantities of small broken stone chippings are placed under the sleeper, to bring the track to the predetermined level.

Directed Track Maintenance (D.T.M)

It is a method to maintain the track as directed by day to day requirements but not as prescribed routine.

It is also called as Track Maintenance System (or) TMS. It consists of 3 stages.

Railway Stations :-

Place where trains are halt

(i) For exchange of passengers
(ii) Exchange of goods.
(iii) control of train movements
(iv) enable the route
(v) For detaching engines.

Site selection :-

(i) Acquisition of land
(ii) Proximity to town (or) village.
(iii) Nature of land area.
(iv) Approach road to station site
(v) Station site alignment
(vi) site drainage
(vii) Station Amenities.
(viii) Type of station and yard.
(ix) Role of authorities.

Requirements :-

(i) Public requirements

(iii) Train requirements.
(iv) Requirements of locomotives.
(v) Requirements for development of railways.

Operational classification:-

(i) Block stations:

Place on railway line at which permission to approach and authority to proceed are granted.

(i) A class station - (400m from home s
(ii) B class station → (530m " " "
(iii) C class station - block hut (where no passengers are booked)

(ii) Non block stations:

It is also called as D class (or) flag Stations situated bwn two consecutive block stations.

Special class stations:

Stations not covered under A, B, C and

Functional classification:-

(i) Non junction (or) way side stations -

Arrangement for crossing up and train for overtaking the slower moving trains.

Three ways:

(i) A way side station on single line
(ii) " " " on double line
(iii) " " " on triple line

(ii) Junction Stations:-

branch line joins a main line the following arrangements to be mad

(i) Interchange of traffic bwn main

(ii) Engine should be released for servicing.

(iii) Terminal stations / Junctions:-

Stations at which a railway line (or) branches terminate (or) continuity of a line stops is known as terminal station.

It provides facilities like servicing of engines and vehicles, reversing of engines are provided.

Platforms:-

Raised level surface, where passangers board, and loading and unloading of goods is done.

Types:-

(i) Passanger platform.

(ii) Goods platform

Length of platform depends on longest train running on that platform.

Station Yards:-

System of tracks laid on level within defined limits, for receiving, storing, sorting, making up new trains and despatch of new trains.

(i) Passanger bogie yards:-

Safe movement of passangers and vehicles.

(ii) Goods yards:

Receiving, loading, unloading, delivery of goods and movement of goods vehicles.

(iii) Marshalling yards:-

Machine to receive, break up, reform and despatch train onwards.

In otherwords where trains and other loads are received, sorted out and new

Types:-

(i) Flat yards, (ii) Gravitational yards
(iii) Hump yards.

Locomotive yards:-

Locomotive are housed and all the facilities for coaling, watering, repairing oiling, cleaning etc are provided for servicing and stability.

Passanger Amanities:-

As stations and their environment are the first point of contact bwn Railways and their customers; special importance is required to be given to the facilities provided to passangers in regard to their adequacy, quality and maintenance

While planning for provision / augmentation of stations, due consideration needs to be given to the importance of station from point of view of passanger traffic.

Facilities:-

(i) Booking offices.
(ii) Waiting Halls
(iii) Platforms
(iv) Shady trees on platforms.
(v) Lighting
(vi) Drinking water supply.
(vii) Latrines, Urinals and Dustbins.
(viii) Platform covers.
(ix) Foot over Bridges (or) Sub ways.
(x) Waiting Rooms.

(xii) Vending Trollies / Stalls.
(xiii) Retiring Rooms.
(xiv) Facilities for physically Handicapped.
(xv) Station Name boards.
(xvi) Platform sign Boards.
(xvii) Timetable Boards and Fare lists
(xviii) Pictogram.
(xix) Station Buildings
(xx) Approach Roads and circulating Area.

Urban rail:-

Urban rail transit is an all encompassing term for various types of local rail systems providing passanger service within and around urban (or) suburban areas. The set of urban rail systems can be roughly subdivided into the following categories.

(i) **Tram:-**

A tram, street car (or) trolley system is a rail based transit system that runs mainly (or) completely along streets with relatively low capacity and frequent stops.

(ii) **Light rail:-**

A light rail system is a rail based transit system that has higher capacity and speed than a tram. It operation is right of way seperated from automobile traffic.

(iii) **Rapid transit:-**

A rapid transit system is a railway [illegible] urban area, with high

and full grade separation from other traffic (including other rail traffic).

It is also called underground, subway tube, elevated, metro (or) mass Rapid Transit (MRT).

(iv) Monorail:-

A monorail is a railway in which the track consists of a single rail, as opposed to the ~~original~~ traditional tra with two parallel rails.

(v) Commuter rail:-

A commuter rail, regional rail, s urban rail (or) local rail system oper on mainline trackage which may be shared with intercity rail and freig trains.

(vi) Funicular:-

A funicular is a cable driven incl railway that uses the weight of desc cars to help pull the ascending cars slope.

(vii) Cable car:-

A cable car in the context of r transit is a system using rail cars are hauled by a continuously moving running at a constant speed.

Individual cars stop and start by releasing and gripping this cable as required.