

6014 (2)

N19-03800

TED (15) – 6014

Reg. No.

(REVISION – 2015)

Signature

DIPLOMA EXAMINATION IN ENGINEERING/TECHNOLOGY/
MANAGEMENT/COMMERCIAL PRACTICE — OCTOBER, 2019

TRANSPORTATION ENGINEERING

[Time : 3 hours

(Maximum marks : 100)

PART — A

(Maximum marks : 10)

Marks

I Answer *all* questions in one or two sentences. Each question carries 2 marks.

1. State the basic four E's in traffic management and their significances.
2. List any four NHs passing through Kerala.
3. List the four typical component layers of a flexible pavement.
4. Define plate laying in Railway Engineering.
5. What is scouring and scour depth ?

(5×2 = 10)

PART — B

(Maximum marks : 30)

II Answer any *five* of the following questions. Each question carries 6 marks.

1. Write about six major contributions of IRC in Indian Road Development.
2. Differentiate : (a) Spoil bank and borrow pit
(b) Super elevation and extra widening
(c) Cutback bitumen and bitumen emulsion
3. What is meant by gradient of a road ? Describe various types of gradients.
4. List out components of a railway track ? Explain the major functions of each component.
5. What are the objectives of signaling ? Describe Reception signals in Railway Engineering.
6. Draw a neat sketch of components of a bridge and mark salient parts. Briefly explain about abutment of a bridge.
7. Define the standard runway length required for an air craft. List any six major factors for selecting the site for an airport.

(5×6 = 30)

PART — C

(Maximum marks : 60)

(Answer *one* full question from each unit. Each full question carries 15 marks.)

UNIT — I

- III (a) What is meant by sight distance ? Briefly explain stopping sight distance and overtaking sight distance used for road design. 9
- (b) Explain how you estimate the traffic volume in a highway project. 6

OR

- IV (a) Explain briefly about various types of road structures - kerb, rotary and channelising islands. 9
- (b) Differentiate between at grade and grade separated intersections with one example. 6

UNIT — II

- V Explain the construction of Water Bound Macadam roads. 15

OR

- VI State the importance of drainage in roads. Explain different arrangements for surface and sub surface drainage. 15

UNIT — III

- VII (a) Briefly describe various types of station yards. 9
- (b) Explain coning of wheels and adzing of sleepers. Draw a neat sketch of coning of wheels. 6

OR

- VIII (a) Explain the plate laying operations by various methods. 9
- (b) Draw the sketch of arrangement of a points and crossings and explain its function. 6

UNIT — IV

- IX (a) What are docks ? Explain dry dock, floating dock and wet dock. 9
- (b) What are the necessity of tunnels and its uses ? 6

OR

- X (a) Explain breakwaters and its various types. 9
- (b) List any six methods of classification of bridge. 6

CODE:6014

COURSE: TRANSPORTATION ENGINEERING

VERSION:2015

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Sl No.	Module	Type of Questions							
		Part A		Part B		Part C		Total	
		No. of Question	Score	No. of Question	Score	No. of Question	Score	No. of Question	Score
1	I	2	4 ✓	1	6 ✓	2	30 ✓	5	40
2	II	1	2	2	12	2	30	5	44
3	III	1	2	2	12	2	30	5	44
4	IV	1	2	2	12	2	30	5	44

QUESTIONWISE ANALYSIS

COURSE: TRANSPORTATION ENGINEERING

VERSION:2015

Qn. No.	Specific Outcome (as per syllabus)	Module	Content Details	Score	Time in minutes
I.1	1.1.5	I	States the basic Es in transportation engineering and discuss its relevance.	2	5
I.2	1.1.3	I	IRC classifications of roads and the list the salient features of current road plan.	2	5
I.3	2.1.1	II	Explain the different layers of a road section and state the function of each layer.	2	5
I.4	3.1.5	III	Explain the track laying operations by various methods.	2	5
I.5	4.1.9	IV	Explain the different bridge parameters like economic span, afflux, linear water way, vertical clearance and scour depth.	2	5
II.1	1.1.3	I	Identify the role of IRC	6	10
II.2	2.1.10 2.1.4 2.1.5 2.1.11	II	Illustrate the procedure of earth work for formation. State super elevation. Explain the need of supper elevation & widening of road on curve. Explain the procedure for construction and maintenance of earthen road, WBM road and bituminous road.	6	10
II.3	2.1.3	II	Explain various slopes of the road such as camber, gradient & types.	6	10
II.4	3.1.2	III	Identify various components of a permanent way such as rails, fasteners & fixtures, sleepers, Ballast, formation and function of each component.	6	10
II.5	3.1.8	III	Explain the objectives & types of signaling system and the importance of interlocking.	6	10
II.6	4.1.5	IV	Explain various components of sub	6	10

			structure and super structure of a bridge.		
II.7	4.1.15 4.1.16	IV	List the factors deciding selection of site for air port and run way alignment pattern. Define the standard runway length required for an air craft.	6	10
III a)	1.1.8	I	State the importance of various types of sight distance.	10	12
III b)	1.1.4	I	Identify the details to be investigated through engineering survey and traffic survey to prepare a detailed report of a road project.	5	5
IV a)	1.1.10	I	Explain different types of road structures, road markings and signals.	9	12
IV b)	1.1.9	I	Draw different arrangements of at-grade intersections and grade separated intersections.	6	5
V	2.1.11	II	Explain the procedure for construction and maintenance of earthen road, WBM road and bituminous road.	15	17
VI	2.1.7 2.1.8	II	State the importance of drainage in roads. Explain different arrangements for surface and sub surface drainage.	15	17
VII a)	3.1.7	III	Explain different types of station yards based on their function.	9	10
VII b)	3.1.3	III	Explain the need for coning of wheels and adzing of sleeper	6	7
VIII a)	3.1.5	III	Explain the track laying operations by various methods.	9	10
VIII b)	3.1.6	III	Draw the sketch of arrangement of a points and crossings and explain its function.	6	7
IX a)	4.1.18	IV	List the categories of dock and harbour based on their function.	9	10
IX b)	4.1.11	IV	State the need for a tunneling work.	6	7
X a)	4.1.19	IV	Draw the typical layout of a harbour, mark the components and explain the functions of each.	9	10

X b)	4.1.8	IV	List the factors governing the selection of location for a bridge and bridge alignment.	6	7
Total Time					231min

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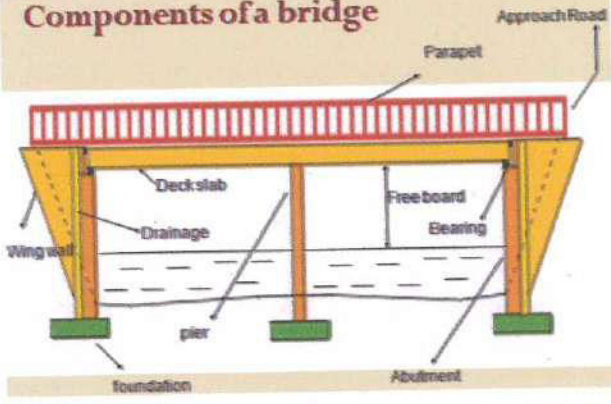
SCHEME OF VALUATION
(Scoring Indicators)

Revision: 2015		Course Code:6014		
Course Title: Transportation Engineering				
Qn. No.	Scoring indicator	Split up Score	Sub Total	Total
PART A				
I.1	4 Es Engineering, Enforcement, Education and Emergency – Listing and significance	0.5 marks each	2	10
I.2	NHs in Kerala Any four NH. (Marks may be given to new numbering system also.) National Highway 49 National Highway 87 Kollam Bypass. National Highway 66 National Highway 183 National Highway 183A National Highway 744 National Highway 766	0.5 marks each	2	
I.3	Subgrade, Sub base, Base and Surface or wearing course	0.5 x 4	2	
I.4	Plate laying definition – Preparation of formation, placing of sleepers and rails	2	2	
I.5	Explanation of scouring - Scouring is the vertical cutting of soil from the river bed by the action of water which will increase the depth of water. Scouring depth definition – Depth to which soil is eroded is called scour depth	1 1	2	

PART B			
II.1	<p>Contributions of IRC containing the following (Any six points):</p> <ul style="list-style-type: none"> • Standard specifications • Professional guidance in road engineering • 20 year road development plan • Recommendations on materials, design and construction practice • Publish research journals • Highway Research Board • Motor vehicle act • Road classification 	6	6
II.2	<p>a) Difference between spoil bank and borrow pit</p> <p>Spoil bank is a pile of refuse material or waste earth material created by excavation of earth from a site or excess soil excavated from a site.</p> <p>Borrow pit is a pit resulted from excavation of material for use in embankment construction.</p> <p>b) superelevation and extra widening</p> <p>Superelevation is the raising of the outer edge of the pavement at curve compared to inner edge in order to counteract centrifugal force.</p> <p>Extra widening – width of pavement is widened especially for horizontal curves of smaller radii</p> <p>i) to account for mechanical off tracking of vehicles wheels and</p> <p>ii) to account for pshychological clearance between vehicles.</p> <p>c) Cutback bitumen and bitumen emulsion</p> <p>Cutback bitumen is the liquid bitumen by dissolving bitumen in a solvent like naptha, gasoline, kerosene or any petroleum</p>	2	6
		2	6
		2	6
		42	42

	<p>distillates. After laying the solvent will evaporate and bitumen will bind with aggregates.</p> <p>Bitumen emulsion – it is a mixture of water and bitumen. Bitumen is broken down to tiny droplets and is suspended in water.</p>			
II.3	<p>Gradient of a road is the rate of rise or fall along the length of the road with respect to the horizontal. It is represented as 1 in x or n%.</p> <p>Types of gradient:</p> <ol style="list-style-type: none"> 1. Ruling gradient – it is the maximum gradient within which designer designs the vertical profile of a road. 2. Limiting gradient – it is the gradient used at places where topography compels adopting steeper gradients due to enormous increase in construction cost with gentler slope. 3. Exceptional gradient – in extra ordinary situations, it may be unavoidable to provide still steeper gradients at least for shorter duration. But length of stretch should not exceed 100 m at a stretch. 4. Minimum gradient – minimum gradient is required to provide for drainage purpose. 	2		6
II.4	<p>Components of railway track – Listing the components - Rail, sleeper, ballast, fasteners and fixtures</p> <p>Rail – Act as steel girders that carry the axle load of train and transfer the load to sleepers.</p> <p>Sleeper – They are transverse members that support the rails in proper alignment and grade. They transfer load to ballast and subgrade.</p> <p>Ballast –It provides packing below and around the sleepers to transmit load from sleepers to the formation and to provide drainage as well as longitudinal and lateral stability of the track</p>	1		6

	Fasteners and fixtures – fasteners and fixtures are used to keep the rails in proper positions, tilt and gradient	1		
	Formation – it is the foundation of the railway track over which entire track is constructed. It provides the strength and stability to the track	1		
II.5	<p>Signaling is a Mechanism by which the station master conveys information to the Loco driver to Stop, Go with Caution or Proceed. The objectives are:</p> <ul style="list-style-type: none"> • To provide facilities for the efficient movement of trains • To ensure safety between two or more trains which cross or approach each others track • For maximum utility of the track • For safe and efficient shunting operations • To guide train movements during maintenance and the repair of the track • To guard trains at converging junctions and to provide directional indications at diverging junctions <p>Reception signal - Outer Signal, Home Signal, Routing Signal</p> <p>Outer signal - First stop signal while entering a station yard from a block. Train proceed to station only if it gets proceed signal from the outer.</p> <p>Home signal - Located at the door of the station. Bracketed arm indicates which track is to be used. Protect the sidings already occupied</p> <p>Routing Signal – Directs the train to proper siding</p>	3	6	
II.6	<p>Sketch of bridge components</p> <p>Marking of components</p>	2		
		2	6	

	<p style="text-align: center;">Components of a bridge</p>  <p>Abutment – It is the end part (support) of the superstructure of a bridge. It transmits the load from the bridge to the foundation. It laterally supports the earth work of the embankment of the approaches. Usually made of masonry or concrete.</p>	2		
<p>II.7</p>	<p>Definition of standard runway length: It is the length of a runway under ideal conditions, like</p> <ul style="list-style-type: none"> • Altitude is at Mean Sea Level • Temperature is standard (15°) • No longitudinal gradient • No wind on the runway • Airport is loaded to full capacity • No wind en-route to destination • En-route temperature is standard 	3		
	<p>Listing of any six factors that control selection of airport site.</p> <ol style="list-style-type: none"> 1. Regional plan 2. Types of airport 3. Ground accessibility 4. Topography 5. Soil characteristics 6. Meteorological factors (wind, frost and fog, temperature) 7. Noise nuisance 	3	6	

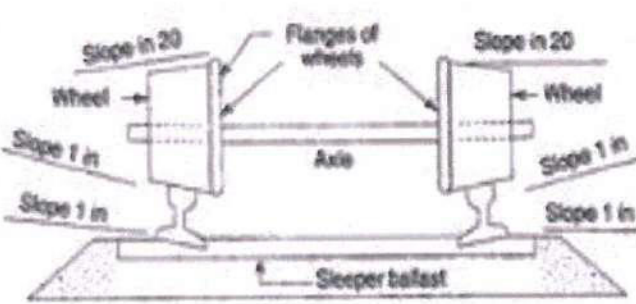
	<p>8. On-site and off-site infrastructures</p> <p>9. Shape and dimensions of site</p> <p>10. Future development</p> <p>11. Comprehensive evaluation</p>				
PART C					
III	<p>a) Definition of sight distance – it is the length of a road visible to a driver ahead of him. It is the most important element on a road from safety point of view.</p> <p>Stopping sight distance – it is the distance needed by a driver travelling at design speed to stop his vehicle before colliding with an obstruction ahead. IRC guideline – driver eye level at 1.2m and obstruction height 0.15m. It consists of two parts – reaction distance and braking distance.</p> $SSD = 0.28Vt + \frac{(0.28V)^2}{2g(n \pm \frac{s}{100})}$ <p>V – speed in km/h t – reaction time in sec. g – acceleration due to gravity m/sec² n – braking efficiency s - gradient</p> <p>Overtaking sight distance – It is the minimum distance that needs to be visible to a driver moving at design speed and intending to overtake a slow moving vehicle ahead, with safety against the traffic in the opposite direction. IRC guideline - overtaking and overtaken driver's eye levels at 1.2 m. various components of overtaking distance. It consists of three components – d1, d2 and d3.</p> <p>d1- distance between overtaking and overtaken vehicle at the start of overtaking process d2 – distance covered during actual overtaking process d3 – the clear distance required between overtaking vehicle</p>	2	3.5	15	120
		3.5			

	<p>and the vehicle coming in the opposite direction.</p> $OSD = d_1 + d_2 + d_3$ <p>b) Traffic volume study methods –</p> <p>Manual method – field team manually count the classified volume for each turning movement for each period of time. If continuous 24 hour data count is not possible, data may be collected on sample basis. Usually tally method of data counting is adopted.</p> <p>Mechanical counter methods – a mechanical counter automatically record total number of vehicles crossing a section of road in a desired period. Pneumatic hose placed across the road get actuated when vehicle moves over it. Lighter vehicles and pedestrians can not be counted by this method.</p>	<p>3</p> <p>3</p>		
<p>IV</p>	<p>a) Road structures</p> <p>1. Kerb – They are road structures provided to indicate the boundary between pavement and shoulder or island or footpath or parking space.</p> <p>Three types – Low or mountable type allows the traffic to enter the shoulder are in case of emergency. The height is 10 cm above the pavement edge with a slope to help vehicle climb.</p> <p>Semi-barrier type is provided on periphery of a road way where pedestrian traffic is high. Height is 15 cm. in case of acute emergency vehicle can climb it with some difficulty.</p> <p>Barrier type is provided in built up area adjacent to footpaths with considerable pedestrian traffic. Height is 20 cm above the pavement edge with steep batter.</p>	<p>3</p> <p>3</p>	<p>15</p>	

	<p>2. Rotary –</p> <ul style="list-style-type: none"> • <u>It is an enlarged road intersection where all converging vehicles are forced to move round a large central island in one direction</u> before they can weave out of traffic flow into their respective directions radiating from the central island. • The main objects of providing a rotary are to <u>eliminate the necessity of stopping</u> even for crossing streams of vehicles and to reduce the area of conflict. <p>3. Cannelising islands – Types and description</p> <ul style="list-style-type: none"> • Channelized islands use pavement markings or raised islands to designate the intended vehicle paths. • Vehicles can be confined to definite paths • Conflict area can be minimized at an intersection • Refuge islands can be provided for pedestrians • It provides space for installation of traffic signs and signals. <p>b) At grade intersection- roads meeting at the same level. Physical interaction between vehicles will be present. Any One example for at grade intersection with brief description. Unchannelised/ Police controlled, channelized, round about, rotary, signalized etc.</p> <p>Grade separated intersection – roads intersect at different levels. No physical interaction.</p> <p>Any One example for grade separated intersection with a brief description – Flyover, Subway, Clover leaf, Trumpet, etc.</p>	3	3	
V	<p>Construction of Water Bound Macadam road</p> <p>WBM is the base course of crushed or broken aggregates mechanically interlocked by rolling. Voids are filled by screening material along with water. It can be applied as based course, sub base or surface course.</p> <p>Preparation of subgrade – subgrade is prepared to the required</p>	2	15	

	<p>grade and camber. On existing pavement, depressions or pot holes are filled and undulations are removed. On existing bituminous road, 45 degree furrows are made to 5 cm depth and width.</p> <p>Provision of lateral confinement – lateral confinement is provided by constructing the shoulders to advance ahead of carriageway and by terminating the inner sides vertically.</p> <p>Spreading of course aggregates – coarse aggregates are spread uniformly to proper profile and even thickness. It is often checked by templates.</p> <p>Rolling – compaction is done by three wheeled roller of 6 to 10 tonnes capacity. Rolling is done from edge to the centerline by forward and backward rolling. There should be uniform overlap between each run.</p> <p>Application of screening – after rolling, dry screening is done to fill up the voids.</p> <p>Sprinkling and grouting – surface is then sprinkled with water, swept and rolled. Wet screenings are swept into the voids using hand brooms. Rolling is continued till coarse aggregates are well bonded.</p> <p>Application of binding material – binding material is then applied at uniform and slow rate at two or more successive thin layers. Water is sprinkled over the surface and wet slurry fills the voids. This is followed by rolling.</p> <p>Setting and drying – after final compaction, WBM course is allowed to set over night. On the next day, hungry spots are located and filled with screening or binding material. Traffic is not permitted till the WBM is completely dried.</p>	1		
		2		
		2		
		2		
		2		
		2		
		2		
VI	Importance of road drainage	5		
	Surface drainage methods	5	15	
	Subsurface drainage methods	5		

VII	<p>a) Station yards – Classification</p> <p>Four types – passenger bogie yard, goods yard, Marshalling yard, locomotive yard</p> <p>Station yards are the system of tracks laid on a level ground for receiving, storing making up new trains and dispatch of vehicles and for other purposes over which movements are not authorized by train timings</p> <p>Passenger Bogie Yard - Provide facilities for the safe movement of passengers and vehicles. Passenger platforms are regarded as Passenger Bogie Yard. Usually provided at terminal stations and junctions. Cleaning, washing and storing of bogies are done</p> <p>Goods Yard - Provide facilities for receiving, loading and unloading of goods, delivery of goods and movement of goods-vehicles. All stations except flag stations are provided with goods yard. Loading and unloading is done on goods platform and storing of goods in goods shed.</p> <p>Marshalling Yard - Loaded and empty trains are received from different tracks for booking in different directions. Wagons are separated, sorted and dispatched in the form of full trains for each track. Wagons are arranged in order so that required wagons can be conveniently detached at wayside stations.</p> <p>Locomotive Yard - Place where locomotives are housed. Fuelling, watering, repairing, oiling, cleaning etc. are provided. Installed at station junctions on the same side of marshalling yard. Number of tracks lead to engine shed, ash pit, repair pit, inspection pit, turn table etc.</p> <p>b) The Surface of wheels is made in cone shape at an inclination of 1 in 20, and the same slope is provided in the rails. Portion of the sleeper that receive the rail is also provided with an inclination of 1 in 20. It is known as adzing</p>	1						
		2						
		2			15			
		2						
		2						

	<p>of sleeper.</p> <ul style="list-style-type: none"> • When the train running on the straight track tries to move in any direction, the diameter of the wheel increases over one rail and the wheel assembly is automatically forced to move back in its original central position • This keeps the train in its central position of the rails, and does not allow any sidewise movement on a straight track • It prevents wheels from slipping 	<p>3</p>		
<p>VIII</p>	<p>a) Plate laying operation- Laying out of rails and sleepers over the ready formation is known as plate laying</p> <p>Base – point from where laying of track starts</p> <p>Rail head – point upon which the new track is carried out</p> <p>Methods of Plate Laying: Tram line method</p> <p>Temporary tram line or track is laid by the side of proposed track for carrying materials. Suitable at locations where scheme for doubling a track is proposed. If scheme for doubling the track is not there, then a road is constructed side by side to carry the materials. Progress of work is slow = 1.6 km/day</p> <p>Methods of Plate Laying: Telescopic method</p> <p>Most widely used method in India. Materials stored at the farthest end of the new track and transported to the rail head where work is progressing.</p> <p>Telescopic method – Operations</p> <ol style="list-style-type: none"> 1. Collection and preparation of materials at Depot 	<p>2</p> <p>5</p>	<p>15</p>	

<p>2. Depot usually provided at the junction of existing and new railway lines. Preparation of materials like adzing and boring of wooden sleepers etc. is done at depot. Prepared materials are transferred to the rail head.</p> <p>If lead does not exceed 1.6 km – trollies If lead exceeds 1.6 km – material train</p> <p>3. Unloading of the material is by labour force – <i>material gang</i>. They carry the material to rail head and supply to <i>linking gang</i>. To carry rails minimum 16 labourers are required. Material gang supply material from depot to rail head regularly and quickly. About 37.5% of total labour force should be employed as material gang</p> <p>4. Linking gang fixes rails to the sleepers and joining rails.</p> <ul style="list-style-type: none">• First centre line of track is marked with pegs. A string is stretched from peg to peg along the centre line. Sleepers are placed below the string with an appropriate spacing. Each rail is marked with a chalk to indicate the exact spacing of sleepers. Sleepers are then provided with suitable chairs or bearing plates to attain specified cant. When one rail is fixed to sleeper, opposite rail is also fixed to the same sleeper to attain proper gauge. Fixing of rail to sleepers is continuously done. At the rail joints, liners are placed to provide expansion joint. Fish plates are then put in position and four bolts are loosely fixed. Once all the sleepers are fixed to rails, fish bolts are tightened. Nearly 37.5% of labour force is employed as linking gang. <p>5. <i>Packing gang</i> packs the ballast to attain correct level and alignment as required. They straighten the newly laid track. Required grade is attained by packing or removing earth or ballast under the sleepers. If consolidation is not over for the track, level of the track is kept higher by a few millimeters</p>			
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than the actual.

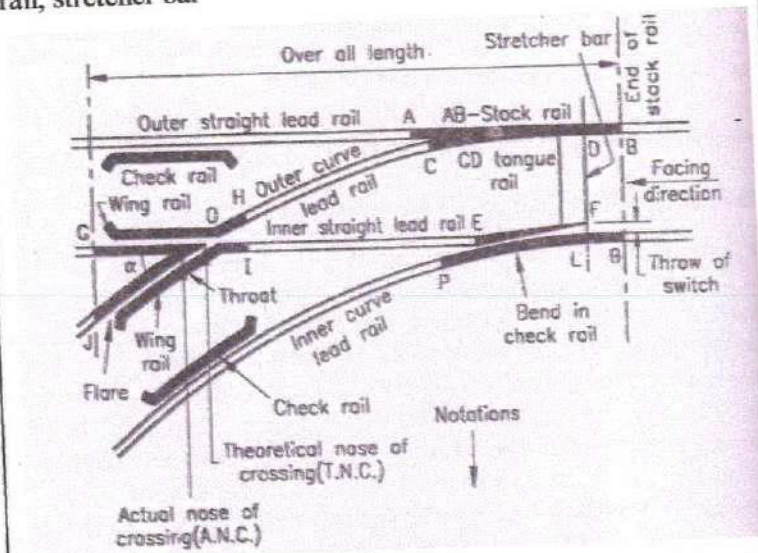
Methods of Plate Laying: **American method**

Special track laying machines are used for plate laying

- A truck mounted projecting arm or jib – to lay materials from material train. A wagon mounted cantilevered arm or jib – used to lay assembled panels of rail and sleepers on the ballast bed. The assembled panels of two rails and number of sleepers required are first prepared in the workshop. Assembled panels and special material handling cranes are delivered at rail head by material trains. One set of two rails and sleepers is unloaded by a special machine and is linked with the rail head. Material train moves ahead of rail head by one rail length. The whole procedure is repeated till the entire track is laid.

b) Sketch of points and crossings

labeling of point region, crossing, wing rail, tongue rail, check rail, stretcher bar



Function of point and crossing- Transfer trains from one track to the other

Point (Switch)- the device that is used to divert the wheels

2

3

3

	<p>from one track to the other</p> <p>Crossing – gaps in the rail that enables the actual diversion</p> <p>Turnout – Complete set of points and crossings including the main or lead rail. Combination of lead rails with curved rails and fastenings help in diverting the train from one track to the other.</p>			
IX	<p>a) Definition of docks - Enclosed area usually controlled by gates. It is for execution of repairs, cleaning, painting of ship bottom or for berthing vessels for loading and unloading of cargo or passengers.</p> <p>Types of docks – dry/ graving dock, floating dry dock, wet dock with brief description</p> <p>Dry/ graving dock:</p> <p>Long excavated chamber with side walls, a semi circular end wall and a floor. Open end is provided with a gate. Side walls made up of series of steps (<i>alter courses</i>) to receive ends of shores that keep vessels in a vertical position. Dock floor – concrete. Alter courses – granite. Dock floors are provided with keel and blocks on which a ship is brought to rest on emptying the dock. Provided with big capacity pumps, lifting and hoisting machines and repair equipments. Ship enters the dock on adjusting the water level inside the dock to that outside. Entrance to the dock is then closed. Powerful pumps remove water and ship is lowered on to keel.</p> <p>Floating Dry Dock:</p> <p>It is a floating vessel. A hollow structure of steel or concrete consisting of two side walls and a floor. Ends are open.</p> <p>Method of working:</p> <ul style="list-style-type: none"> • To receive a ship, structure is sunk to required depth by filling its interior chambers with water • Ship is then floated into position and berthed 	<p>1.5</p> <p>2.5</p> <p>2.5</p>	<p>15</p>	

	<p>• Dock is then raised with the ship by pumping out water from chambers</p> <p>Wet Dock:- Provided to ensure sufficient water depth for the vessels. Equipped with entrance lock and massive gates operated by machinery. Needed when the tidal level varies considerably (tidal range around 15 m). Water is impounded by means of locks to maintain water depth.</p> <p>Advantages:</p> <ol style="list-style-type: none"> 1. Maintain uniform water level 2. Avoid rubbing of ships against quay wall 3. Prevent disturbances of sea from affecting the working of dock system <p>b) Necessity of tunnels: To meet the requirements of rapid transportation in big cities - To connect two terminals separated by a mountain by the shortest route - To reduce very steep grades - To avoid the excessive cost of maintenance of an open cut subjected to land slides or snow drifts - To avoid the expensive acquisition of valuable built up land, tearing up pavements and holding up traffic for long periods in large cities - When the depth of ordinary cutting exceeds 20m and the ground rises rapidly for a considerable distance after wards</p> <p>Application of tunnels: Underground engineering structure or artificial gallery used for transporting – Traffic, Sewage, water, Oils and Minerals etc.</p>	<p>2.5</p> <p>3</p> <p>3</p>		
<p>X</p>	<p>a) Description of breakwaters :</p> <p>Most prominent feature of an artificial harbor. Break up and disperse heavy sea. Prevent the waves from exerting their destructive influence within enclosed area of harbour.</p> <p>Two methods for reducing wave action:</p> <ol style="list-style-type: none"> 1. Wall of sufficient height and strength takes up the 	<p>1.5</p>	<p>15</p>	

forces from waves

2. Waves are made to run along the sloping beach, their energy is absorbed gravitationally

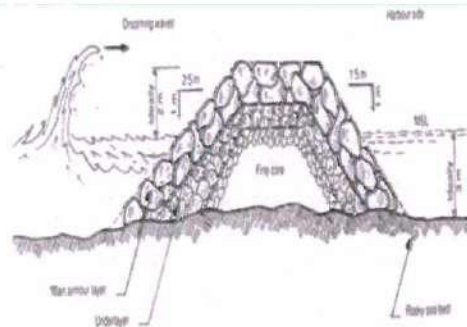
Types of breakwaters:

- a) Upright Wall Breakwater
- b) Mound with superstructure
- c) Heap or mound breakwater

Mole: a breakwater constructed in such a way that it can be used as a platform for loading and unloading of cargo in calm waters (as a substitute for quay)

a) Heap or mound breakwater

- A breakwater constructed by a heterogeneous assemblage of natural rubble or undressed stone.
- When water depths are large it may be uneconomical in view of huge volume of rocks required.
- Built upto water depth of 50 m.
- Not suitable when space is a problem. If the harbor side may have to be used for berthing of ships, the RBW with its sloping faces is not suitable for berthing.
- These type of breakwaters dissipate the incident wave energy by forcing them to break on a slope and thus do not produce appreciable reflection.



b) Mound with superstructure:

2.5

2.5

Large artificial blocks of concrete, as heavy as possible (50 T – 100 T) are used. Their size is limited only by the capacity of the handling equipment. Maximum height is governed by the height of wave, that does not exceed 15 m.

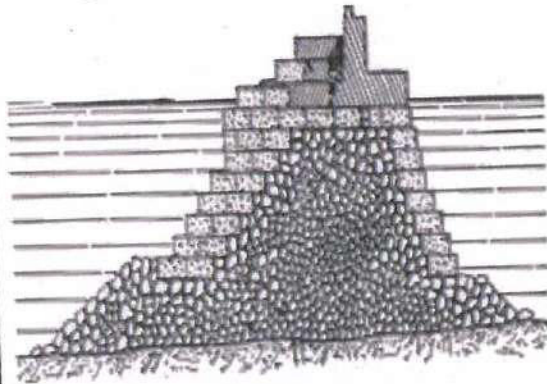
- Mound with super structure founded at low water level.

A solid super structure consisting of a quay protected by a parapet on the sea face is constructed on the top of rubble mound.

- Mounds with super structure below low water level.

The superstructure can be founded well below the level of disturbance.

Waves practically have no disturbing effect.



c) Upright Wall Breakwater

Reflect the incident waves without dissipating much wave energy. Normally it is constructed in locations where the depth of the sea is greater than twice the design wave height.

Two types of construction

- Constructed with heavy rectangular concrete blocks weighing from 25 to 50 tonnes.
- Wall is constructed over concrete bags weighing upto 100 t
They are deposited across the full width upto low

<p>water level</p> <p>The vertical wall breakwater may be constructed with</p> <ul style="list-style-type: none"> - Concrete blocks - Rock filled steel sheet pile cells - Concrete or steel caisson - Rock filled timber crib <p>Concrete caisson based breakwater reduces under water construction difficulties. The bulk of the work is done in the shore itself and is later floated to actual installation location</p> <p>b) Factors controlling selection of site for a bridge (Any six factors)</p> <ol style="list-style-type: none"> 1. Based on function of purpose 2. Based on materials used for construction 3. Based on alignment 4. Based on position of high flood level 5. Based on position of deck slab 6. Based on loading 7. Based on type of superstructure 8. Based on movement of deck slab 9. Based on life 	6		
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