Scoring Indicators

COURSE NAME : TRANSPORTATION ENGINEERING

COURSE CODE : 5013 **QID : 2109230006**

Q No	Scoring Indicators	Split score	Sub Total	Total score
	PART A			**9**
I. 1	Octagonal Shape		1	
I. 2	Highway alignment		1	
I. 3	Sight distance		1	
I. 4	White topping		1	
I. 5	1.676 m		1	
I. 6	1 in 20		1	
I. 7	Building used for servicing and repair of aircraft is called hanger		1	
I. 8	Masonry bridge RCC bridge Timber bridge Steel bridge Composite bridge Prestressed concrete bridge ***Write any TWO. Each carries 0.5 mark***		1	
I. 9	Runway		1	
	PART B			24
II.1	National Highway State Highway Major District Road	3	3	

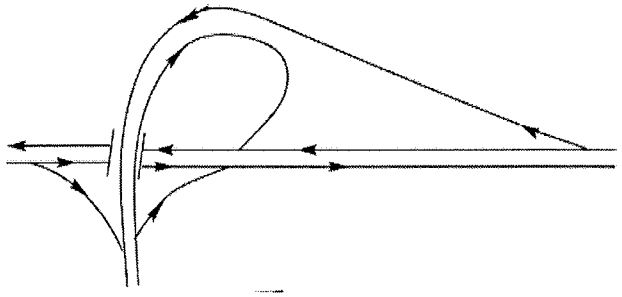
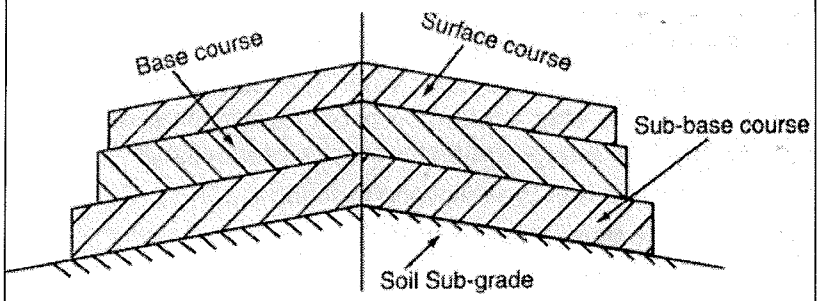
	Other District Road Village Road			
II. 2	1. Traffic volume is generally accepted as a true measure of the relative importance of roads and in deciding the priority for improvement and expansion. 2. Traffic volume study is used in planning, traffic operation and control of existing facilities and also for planning and designing of new facilities. 3. Traffic study is used in the analysis of traffic patterns and trends. 4. Classified volume study is useful in structural design of pavements, in geometric design and in computing roadway capacity. 5. Volume distribution study is used in planning one way streets and other regulatory measures. 6. Turning movement study is used in the design of intersections, in planning signal timings, channelization and other control devices. 7. Pedestrian traffic volume study is used for planning side-walks, cross walks, subways and pedestrian signals ***Write any three points. Each carry 1 mark***		3	
II. 3	**At Grade Intersection** • All intersections which meet at about the same level allowing traffic manoeuvres like merging, crossing, and weaving • Examples: Unchannelized, Channelized, Rotary intersections **Grade Separated Intersection** • Highest form of intersection treatment • Causes least delay and hazard to the crossing traffic • Grade separated by an over bridge or under pass	1 0.5 1	3	

	• Basically 2 types:- • *Grade separated intersections without interchange* • *Grade separated intersections with interchange*	0.5		
II. 4	Cross slope provided to raise middle of the road surface in the transverse direction to drain off rain water from road surface OBJECTIVES : ✓ Surface protection especially for gravel and bituminous roads ✓ Sub-grade protection by proper drainage ✓ Quick drying of pavement which in turn increases safety ✓ Too steep slope is undesirable for it will erode the surface	1 2	3	
II. 5	The outer edge of the pavement is raised with respect to the inner edge. This transverse inclination is termed as super elevation. Super elevation is expressed as the ratio of height of outer edge with respect to horizontal width. Significance of super elevation • It counteracts the effect of centrifugal force • It reduces the tendency of the vehicle to overturn or skid • If super elevation is provided, the pressure on inner wheels and outer wheels will be same.	2 1	3	
II. 6	A system of tracks laid usually on a level within defined limits, for receiving, storing, sorting making up new trains, dispatch of vehicles and for other purposes over which movements are not authorized by a time table. Types: 1. Passenger yard 2. Goods Yard 3. Marshalling yard 4. Locomotive yard	2 1	3	

II. 7	• The gauge should be uniform, correct and it should not get altered. • Both the rails should be at the same level on straight portion of the track. • Proper amount of *super elevation* should be provided to the outer rail above the inner rail on curved portion of the track. • The curves, provided in the track, should be properly designed (radii, super elevation) • An even and uniform gradient should be provided throughout the length of the track. • Track should be strong against lateral forces. • Track should be elastic to absorb shocks & vibrations • The *tractive resistance* of the track should be minimum. • Design should be such that the load of the train is uniformly distributed on both the rails so as to prevent unequal settlement of the track. • Drainage systems must be perfect • Alignment should be free from kinks or irregularities • Joints including points and crossings should be properly designed and maintained. • If there is trouble from creep, preventive measures should be done to prevent it. • Free from excessive rail joints and all joining should be properly designed and constructed. • All the components parts such as rails, sleepers, ballast, fixtures and fastenings, etc. should satisfy the design requirements & functions • It should be provided with safe and strong bridges coming in the alignment of the track.		3	

	• Repairs and renewals of any portion can be carried out without any difficulty • Track structure should be strong, low initial and maintenance cost ***List any 3 points. Each carry 1 mark***			
II. 8	• Tunnels are underground passages used for transportation. • Used for carrying freights and passengers, water, sewage, gas etc. • More economical than open cut beyond certain depth. (more than 18 m) • Avoid disturbing or interfering with surface life and traffic during construction. • Reduces length of railway line. • Cost of maintenance of tunnel is lesser as compared to a bridge. • Tunnels avoid dangerous open cut nearer to structure. • In busy and congested cities due to scarcity of land, tunnels are used for providing underground railway system provides rapid and unobstructed transportation. ***Write any three points. Each carry 1 mark***		3	
II.9	Docks are enclosed areas for berthing ships, to keep them afloat at a uniform level, to facilitate loading and unloading cargo. Types 1. Wet docks 2. Dry docks 3. Floating docks	2 1	3	
II.10	• Foundation • Abutment • Pier	3	3	

	• wing wall • deck slab • bridge bearing • girder beam • Approach road			
	PART C			42
III.	Traffic island is a defined area between traffic lanes for control of vehicle movements. <u>Classification of traffic islands</u> • Channelizing Islands: It is designed to control and direct traffic movement, usually turning. Channelizing islands may be installed in areas that otherwise would be broad expanses of pavement, to bring about an orderly flow of traffic. • Divisional Islands: It is designed to divide opposing or same direction traffic streams, usually through movements. Divisional islands are used to guide traffic around an obstruction within the roadway (such as a bridge pier), in advance of an intersection to separate opposing traffic and may be located to prevent overtaking and passing at hazardous points, such as sharp curves or narrow underpasses. • Refuge Islands: Pedestrian islands are provided to serve as safety zones for the aid and protection of persons on foot. Refuge islands are particularly useful at intersections in urban areas where • There is a considerable amount of pedestrian traffic • Where heavy volumes of vehicular traffic make it difficult and dangerous for pedestrians to cross	1	7	7

	• Rotary Islands: It is a type of at-grade intersection which permits the movement of traffic in one direction round a large central island. Crossing manoeuvre is converted to weaving by providing sufficient weaving length ***Explain any three types. Each carry 2 mark***			
IV	 • Trumpet interchanges have been used where one highway terminates at another highway. • Trumpets are suitable at the locations where the side road exists on only one side of the freeway, and traffic is relatively low.	5 1 1	7	7
V	 **Subgrade:** It is a layer of natural soil prepared to receive the layers of pavement materials placed over it. The loads on the pavement are ultimately received by the subgrade. **Sub-base course:** The sub-base course is the layer of material beneath the base course and the primary functions are to provide structural support, improve drainage, and reduce the intrusion of fines from the sub-grade in the pavement structure. **Base course:** The base course is the layer of material	3 1 1	7	7

	immediately beneath the surface of binder course and it provides additional load distribution and contributes to the sub-surface drainage It may be composed of crushed stone, crushed slag, and other untreated or stabilized materials. **Surface course:** Surface course is the layer directly in contact with traffic loads and generally contains superior quality materials. It provides characteristics such as friction, smoothness, drainage, etc. Also, it will prevent the entrance of excessive quantities of surface water into the underlying base, sub-base and sub-grade.	1 1		
VI	**1. Preparation of the existing base course layer** The base on which asphalt concrete or bituminous concrete is to be laid shall be prepared to the specified lines, grade and cross-sections. **2. Application of tack coat** It is desirable to lay bituminous concrete layer over a bituminous base or binder course. The quantity of application is 6 to 7.5 kg/10 m^2 for black top layer and 7.5 to 10kg/10 m^2 for non- bituminous base **3. Preparation and placing of premix** The premix is prepared in a hot mix plant of a required capacity with desired quality control. The bitumen may be heated up to 150-177°C and the aggregate temperature should not differ by over 14°C from binder temperature. The hot mixed material is collected from mixer by the transporters, carried to the location and is spread by a	1 1 2	7	7

	mechanical paver at a temperature of 121 to 163°C. The camber and the thickness of the layer are accurately verified. **4. Rolling** A mix after it is placed on the base course, is thoroughly compacted by rolling at a speed not more than 5km per hour. The wheels of the roller are kept damp with water. The number of passes required depends on the thickness of the layer. The final rolling or finishing is done by 8 to 12 tonne tandem roller. **5. Quality control of bituminous concrete construction** The routine checks are carried out at site to ensure the quality of the resulting pavement mixture and the pavement surface. **6. Finished surface** The bituminous concrete surface should be checked by a 3.0 m straight edge. The longitudinal and cross profile should not have undulation.	1 1 1		
VII	***Desirable properties*** • Strength • Hardness • Toughness • Durability • Shape of aggregates • Abrasion resistance ***Test on aggregates***	2	7	7

	1. Aggregate Crushing Value Test The Aggregate crushing value gives a relative measure of the resistance of an aggregate to crushing under a gradually applied compressive load. Aggregate Sample: The material for the test consists of aggregates sized 10.0 mm and 12.5 mm. The aggregates may be dried by heating at 100^0 to 110^0C for not more than 4 hours and cooled to room temperature before testing, if necessary. (i) Sieve the material through 12.5 mm and 10 mm IS sieves. (ii) Take about 3.25 kg of this material. (iii) Pour the aggregate to fill about just more than $1/3^{rd}$ depth of the measuring cylinder. (iv) Tamp the material by giving 25 gentle blows with the rounded end of tamping rod. (v) Add two more layers in similar manner, such that the cylinder is full. (vi) Remove the excess material with a straight edge. The quantity contained in the measuring cylinder is that amount of aggregates which will be used to prepare the test specimen. (vii) The tested sample thus taken is then weighed. The same weight of sample is taken in the repeat test. (viii) Transfer the whole of this weighed quantity to the test mould by filling it in 3 layers in the same manner as for cylindrical measure. The total depth of the sample is then about 10 cm and the surface a little below the top of the mould.	5 2		

(ix) Level off the surface and place the plunger over it so that it rests horizontally on the surface of the aggregates.

(x) Place this assembly on the pedestal of the compression testing machine.

(xi) Apply the load at a uniform rate of 4 tonnes per minute until the total applied load is 40 tonnes, and then the load is released.

(xii) Take the aggregates out of the cylinder and sieve then through 2.36 mm IS sieve. Weigh this fraction passing through it to an accuracy of 0.1 g. This fraction is a measure of loss of material due to crushing.

(xiii) The above crushing test is repeated on second sample of the same weight in accordance with above test procedure.

(xiv) The mean of the two observations rounded to the first decimal place is reported as the 'Aggregate crushing value'

2. Aggregate Impact Value Test

The aggregate impact value is a measure of resistance to sudden impact or shock, which may differ from its resistance to gradually applied compressive load.

The test sample: It consists of aggregates sized 10 mm to 12.5 mm. The aggregates should be dried by heating at 100 to 110^0 C for a period of 4 hours and cooled.

i) Sieve the material through 12.5 mm and 10 mm IS sieves. The aggregates passing through 12.5 mm sieve and retained on 10 mm sieve comprises the test material.

	ii)	Pour the aggregates to fill about just 1/3rd depth of measuring cylinder.			
	iii)	Tamp the material by giving 25 gentle blows with the rounded end of the tamping rod.			
	iv)	Add two more layers in similar manner, so that the cylinder is full.			
	v)	Strike off the surplus aggregates.			
	vi)	Determine the net weight of the aggregates to the nearest gram (W1).			
	vii)	Bring the impact machine to rest without wedging or packing upon the level plate, block or floor, so that it is rigid and the hammer guide columns are vertical.			
	viii)	Fix the cup firmly in position on the base of machine and place whole of the test sample in it and tamp by giving 25 gentle strokes with tamping rod.			
	ix)	Raise the hammer until its lower face is 380 mm above the surface of the aggregate sample in the cup and allow it to fall freely on the aggregate sample. Give 15 such blows at an interval of not less than 1 sec between successive falls.			
	x)	Remove the crushed aggregates from the cup and sieve it through 2.36 mm IS sieve until no further significant amount passes in one minute. Weigh the fraction passing through the sieve to an accuracy of 0.1 g (W2). Also weigh the fraction retained in the sieve.			
	xi)	The fraction retained on sieve is also weighed and if the total weight of the fraction passing and retained on the sieve is added, it should not be			

less than the original weight of the specimen by more than 1 g.

xii) Note down the observations and compute the aggregate impact value. The mean of the two observations, rounded to the nearest whole number is reported as the Aggregate Impact Value.

3. Specific gravity and water absorption test

The specific gravity of an aggregate is considered to be a measure of strength or quality of the material.

i) About 2 kg of the aggregate sample is washed thoroughly to remove fines, drained and then placed in the wire basket and immersed in the distilled water at a temperature between 22^0C and 32 ^{0}C and a cover of at least 5 cm of water above the top of the basket.

ii) Immediately after immersion, the entrapped air is removed from the sample by lifting the basket containing the sample, 25 mm above the base of the tank and allowing it to drop 25 times at the rate of about one drop per second. The basket and the aggregate should remain completely immersed in water for a period of (24 ± 1/2) hour afterwards.

iii) The basket and the sample are then weighed while suspended in water at a temperature of 22^0C and 32 ^{0}C. The weight is noted while suspended in water = W_1 g.

iv) The basket and the aggregate are removed from water and allowed to drain for a few minutes, after which the aggregate are transferred to one

of the dry absorbent clothes. The empty basket is the returned to the tank of the water and, jolted 25 times and weighed in water = W_2 g.

v) The aggregate placed on absorbent clothes are surface dried till no further moisture could be removed by this cloth. Then the aggregate is transferred to the second dry cloth spread in single layer and allowed to dry for at least 10 minutes until the aggregate are completely surface dry. The surface dried aggregate is then weighed = W_3 g.

vi) The aggregate is placed in a shallow tray and kept in an oven maintained at a temperature of 110^0C for 24 hours. It is then removed from the oven, cooled in an air tight container and weighed = W_4 g

$$\text{Specific gravity} = \frac{\text{Dry weight of the aggregate}}{\text{Weight of equal volume of water}}$$

4. Shape test for aggregates

The particle shape of aggregate is determined by the percentages of flaky and elongated particles contained in it.

Flakiness index

The flakiness index of aggregate is the percentage by weight of particle whose least dimension (thickness) is less than three-fifths (0.6 times) of their least dimension. This test is not applicable to sizes smaller than 6.3 mm

Elongation index

The elongation index of aggregate is the percentage by weight of particle whose greatest dimension (length) is greater than four – fifths (1.8 times) their mean dimension. The elongation test is not applicable for sizes smaller than 6.3 mm.

(i) Sieve the sample through the IS sieves.

(ii) Take a minimum of 200 pieces of each fraction to be tested and weigh them.

(iii) In order to separate the flaky materials, gauge each fraction for thickness on a thickness gauge.

(iv) Weigh the flaky material passing the gauge to an accuracy of at least 0.1 percent of the test sample.

(v) Separate the non-flaky aggregates and find out the elongation index of these aggregates.

(vi) In order to separate the elongated material, gauge each fraction on the length gauge. Weigh the elongated material retained on the gauge to an accuracy of at least 0.1 percent of the test sample.

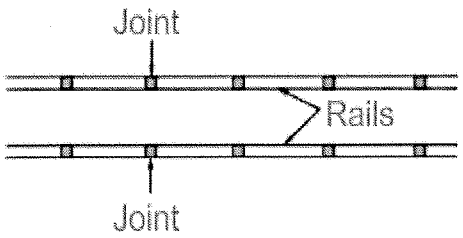
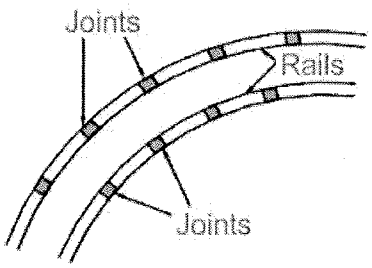
5. Determination of Los Angeles Abrasion Test

The principle of Los Angeles abrasion test is to produce the abrasive action by use of standard steel balls which when mixed with the aggregates and rotated in a drum for specific numbers of revolutions also cause impact on aggregates. The percentage wear of aggregates due to rubbing with steel balls is determined and is known as Los Angeles Abrasion value.

Test Sample: It consists of clean aggregates dried in the oven at $105^0C - 110^0C$ coarser than 1.70 mm sieve.

	i) Select the grading to be used in the test. It should be chosen such that it conforms to the grading to be used in construction, to the maximum extent possible. ii) Take 5 kg of sample for grading A, B, C or D and 10 kg for grading E, F and G. iii) Choose the abrasive charge. iv) Open the cover and feed the aggregates and steel balls in the cylinder. Replace the cover tightly. v) Rotate the machine at a uniform speed of 30-33 rev/min. vi) Allow the machine to run for 500 revolutions for grading A, B, C and D; 1000 revolutions for grading E, F and G. vii) Stop the machine after the required number of revolutions and remove the cover and take the material out. viii) Separate the steel balls and sieve the material on 1.7 mm IS sieve. ix) Weigh the material coarser than 1.7 mm size. x) Dry in the oven to a constant weight and weighed correct to an accuracy of 1 gm. xi) Calculate the percentage of fines from material. ***Write any one test in detail- 5 marks***			
VIII	**Merits** • Increased Strength Cement concrete roads have high flexural strength and exceptional load bearing capabilities. It is suitable for heavy traffic. • Low maintenance Cement concrete roads require minimal maintenance, which can lead to significant cost savings over the road's lifespan.	3.5	7	7

	• Better light reflecting property • Improved Road Safety Cement concrete roads are generally safer than other road solutions as increased strength helps to prevent cracking and potholes, which can be dangerous for drivers. • Long Durability. **Demerits** • Increased Construction Costs: Cement concrete roads can be expensive to build, as the cost of materials and labor for this type of road is usually higher than for other types of roads. • Long Construction Time: The construction of cement concrete roads can also take a long time, as the cement needs to fully cure and harden before it can be used for traffic. • Sensitivity to Extreme Temperatures: Cement concrete roads are sensitive to extreme temperatures and can be damaged by low or high temperatures. In colder climates, the cement can crack due to freezing temperatures. In hotter climates, the heat can cause the cement to expand, forming cracks.	3.5		

IX	A Joint between the two adjacent rails which also forms the weakest part of the railway track is called a Rail Joint. There are different types of rail joints depending on the position of the sleepers and the joints. • According to the Position of Joint • According to the Position of Sleepers	2	7	7
	According to the Position of Joint • **Square Joint:** the joints in the two different rails are exactly opposite to each other. It is the most commonly adopted joint on Indian Railways.	2		
	 **Square Joint**			
	• **Staggered Joint** In staggered joints, the joints in one rail are staggered and aren't exactly opposite to the joints in the other rail. These joints are generally used on curved tracks as they reduce the centrifugal force pushing the track in the outward direction.			
	 **Staggered Joint**	3		
	According to the Position of Sleepers • **Supported joint** – In this joint, the rail ends are directly supported			

on the sleeper.

- This joint is expected to reduce the wear and tear. However, the support still tends to raise the height of the ends of the rail. This makes the run on ear in rails by preventing a cantilever action. the supported joints hard.
- This joint also suffers from major wear and tear from the sleeper that supports the joint.
- The maintenance of the Supported joint is challenging

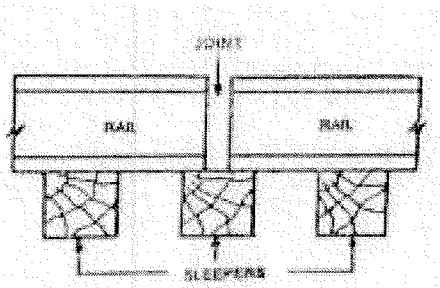
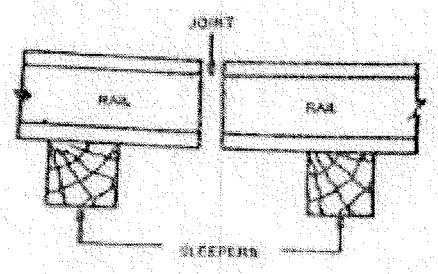
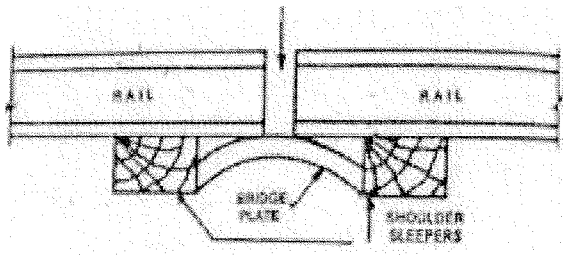
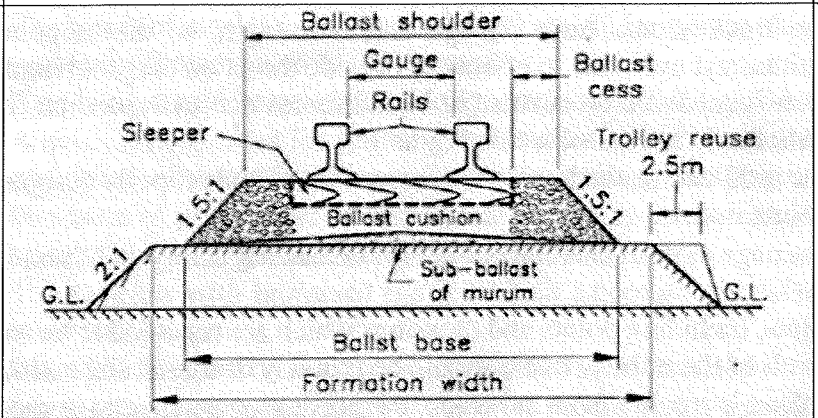


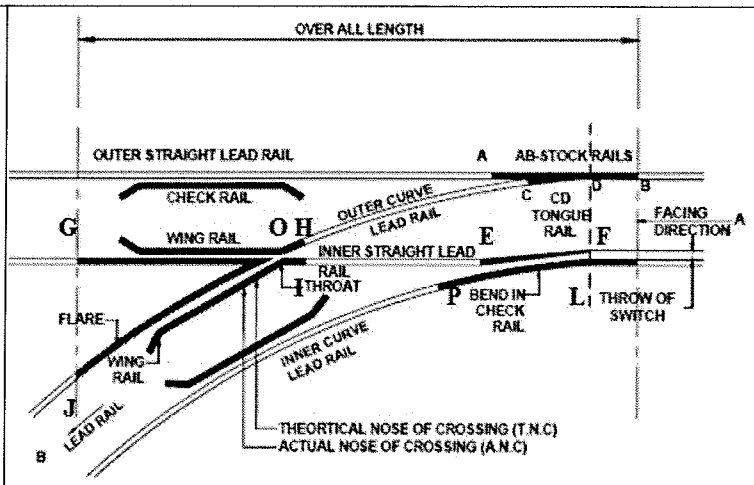
Fig. 7.5 SUPPORTED JOINT

- **Suspended Joints**
  - In a suspended joint, the rail ends are suspended between the sleepers, with some rail portion being cantilevered.
  - Due to the cantilever action, the sleeper packing becomes loose due to a hammering action by the loads from the moving trains.
  - These are the most commonly used joints on railway systems in the world.

	 Fig. 7.4 SUSPENDED JOINT • **Bridge Joint** – This joint is almost similar to the suspended joint. The only difference is that the two sleepers on both sides of the bridge joint are joined by a flat metal or corrugated plate. This plate is also called a bridge plate. – Bridge joint is not used on Indian Railways.  Fig. 7.5 BRIDGE JOINT			
X	Sleeper ***Requirements*** • The sleepers to be used should be economical. Initial cost and maintenance cost should be minimum • Weight of the sleeper should be moderate for easy handling • The design of sleeper and fastenings should be such that it is possible to fix and remove the rails easily • The sleeper should have sufficient bearing area to resist crushing due to rail seat and crushing of ballast underneath the sleeper.	2 5	7	7

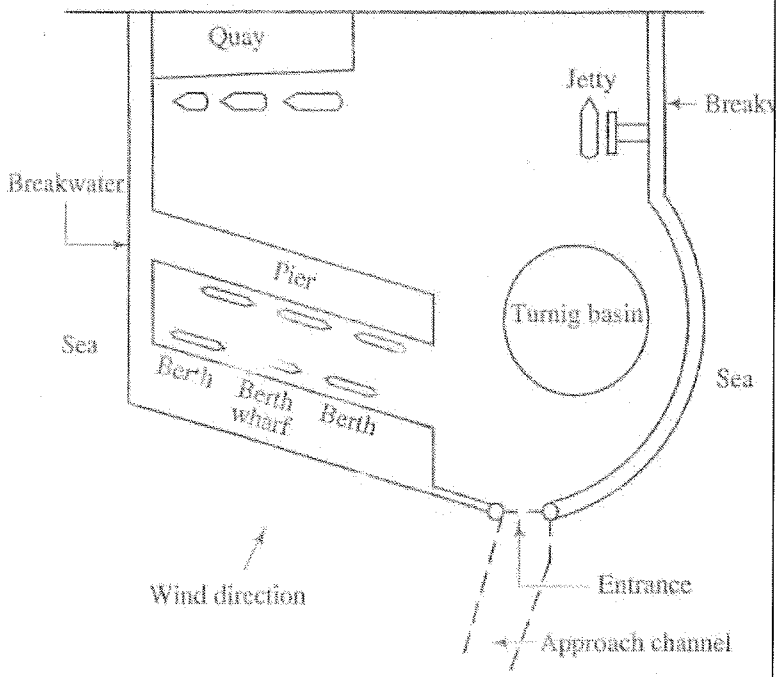
	• The sleeper should be such that it is possible to maintain and adjust gauge properly • The sleeper design and spacing should be such as to facilitate easy removal and replacement of ballast. • The sleeper should be capable of resisting shock and vibrations • Ideal sleeper should have antisabotage or antitheft property. • The design of sleeper should be such that they are not damaged during packing process ***Write any 5 points. Each carry 1 mark***			
XI	 **Fig. 3.1** Typical Cross-section of a Permanent Way on Embankment **Rails:** • Rails provide hard, smooth and unchanging surface for passage of heavy moving loads with minimum friction between steel rail and steel wheel • Rails bear the stresses developed due to heavy vertical loads, lateral and braking forces and thermal stresses • The rail material used is such that it gives minimum wear to avoid replacement charges and failure due to wear • Rails transmit the loads to sleepers and consequently reduce pressure on ballast and formation below	4 1	7	7

	Sleepers: • Holding rails to correct gauge and alignment • Giving a firm and even support to rails • Transferring the load evenly from the rails to wider area of ballast • Acting as an elastic medium between the rails and the ballast to absorb the blows and vibrations of moving load • Providing longitudinal and lateral stability to permanent way • Providing means to rectify track geometry during service life **Ballast:** • To provide a level and hard bed for the sleepers to rest • To hold the sleepers in position during the passage of trains • To transfer and distribute the load from sleepers to a large area of formation • To provide elasticity and resilience to track for getting proper riding comfort • To provide necessary resistance to track for longitudinal and lateral stability ***Write any one function of each component***	1 1		
XII	Turnout	2	7	7

	 ***Sketch- 3, Marking of components -2***	5		

XIII	• Regional Plan: Regional plan should fit well into the regional plan
	• Airport Use: Selection of site depends upon the use of an airport such as Civilian or military operations, during emergency, civilian airports are taken over by the defense, should be such that it provides natural protection to the area from air raids, especially for the ones located in combat zones
	• Proximity to other airport : Proximity to other airport should be at a considerable distance from existing airports Landing in one airport does not interfere with movement of aircraft at other airport. It requires separation between airports mainly depends upon
	  • Volume of air traffic
	  • Type of aircrafts
	  • Circling radius of largest aircrafts vAir traffic control
	• Ground accessibility: Fast and efficient access
			7	7

	facilities for passengers and freight, sites offering convenient road network is better than those with inefficient and inadequate transport system, best when adjacent to main highway, quick access • Topography: This includes natural features like ground contours trees streams etc. A raised ground a hill top is usually considered to be an ideal site for an airport. • Obstructions: When aircraft is landing or taking off it loses or gains altitude very slowly as compared to the forward speed. For this reason long clearance areas are provided on either side of runway known as approach areas over which the aircraft can safely gain or loose altitude. • Visibility - The site selected should therefore be free from visibility reducing conditions such as fog smoke and haze. • Wind- Runway is so oriented that landing and take off is done by heading into the wind should be collected over a minimum period of about five years • Noise nuisance – Site should be so selected that the landing and take off paths of the aircrafts pass over the land which is free from residential or industrial developments. • Grading, Drainage and Soil Characteristics: Grading and drainage play an important role in the construction and maintenance of airport which in turn influences the site selection. The original ground profile of a site together with any grading operations determines the shape of an airport area			

	and the general pattern of the drainage system • Future Development: Considering that the air traffic volume will continue to increase in future more member of runways may have to be provided for an increased traffic. • Availability of utilities from town – water supply, sewer etc. • Economic Consideration ***Explain any 7 points***			
XIV	 Typical layout of an artificial harbour ***Layout – 5 marks*** ***Marking of components – 2 marks***	5 2	7	7