



MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)

(ISO/IEC -270001 – 2005 certified)

SUMMER -2017 EXAMINATION

Subject code: Highway Engg. (17602)

Page No:01/18

Important Instructions to examiners:

- 1) The answer should be examined by keywords and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language error such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and communication skill).
- 4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figure drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credits may be given step wise for numerical problems. In the some cases, the assumed constants values may vary and there may be some difference in the candidates answer and model answer.
- 6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidates understanding

Question and Model Answers	Marks
Q1(A) Attempt ANY Three :	12
(a) Classify road as per Nagpur plan.	
In Nagpur road plan, roads are classified into five categories as per IRC recommendations depending upon priority for development. 1. National Highway (NH) : The roads which runs through length and breadth of the country connecting state capitals, major ports, foreign highways and strategic places across country, which are called as National Highway. 2. State Highway (SH) : The roads which joins state capital to important cities within state, are known as State Highway. 3. Major District Road (MDR) : The roads which connects market centers and important places in within district, are considered as Major District Road. 4. Other District Road : The roads which joins Tahasil headquarters, block development headquarters, market centres other than MDR, are known as Other District Road. 5. Village Road : The roads which connects the group of villages to higher type of road, are called as Village Road.	4M

<p>(b) State the modes of transportation and explain any one</p>	
<p>Modes of Transportation System</p> <ol style="list-style-type: none"> 1. Roadway 2. Railway 3. Waterway 4. Airway <ul style="list-style-type: none"> • Roadways Road transportation is the most suitable type for short haul passenger and good transport. This is more so especially in the hilly terrain where other transport modes cannot reach. Road transportation provides better accessibility and door-to-door service. • Railway The best alternative for land transportation of bulk goods over long distance by vehicles is the railway. Traditionally, the railways have played a major role in economic development of a region. Railways run on specific tracks prepared for this purpose. Railways provide fairly comfortable and safe journey within the reach of the common man. • Airways The most sophisticated and has made the world a small place. In a matter of hours persons and things can be moved from one part of the globe to other. • Waterways Water transportation is probably the oldest mode of transportation. It is suitable for transportation of bulk cargo where time is not important factor. 	<p style="text-align: right;">2M (1/2 each)</p> <p style="text-align: right;">2 M any one</p>
<p>(c) State the objects of preliminary survey.</p>	
<p>The preliminary survey for any road construction project is done for following objectives</p> <ol style="list-style-type: none"> 1. To survey various alternative alignments proposed after the reconnaissance and to collect all the necessary physical information and details of topography, drainage and soil. 2. To estimate the quantity of earthwork materials and other construction aspects and to work out cost of alternate proposal. 3. To compare the different proposals in view of the requirement of good alignment.. 4. To finalize the best alignment from all consideration. 5 To know number of cross-drainage works and other obligatory points. 	<p style="text-align: right;">1 M each any four</p>

(d) State the four factors affecting road alignment.

- 1. Unavoidable obstructions:** The alignment is required to change in another direction due to avoidable obstructions.
- 2. Connectivity of obligatory points :**The selected alignment can be altered for better connectivity to existing roads, important places and high population zone
- 3. Railway or Bridge crossing:** The alignment is necessary to divert over railway or bridge crossing at right angle.
- 4. Nature of ground :**If ground is more steeper then alignment is required to change towards fairly leveled ground
- 5. Type of foundation soil:** If foundation soil available in the proposed alignment has less bearing capacity, then alignment is changed through hard sub grade soil.
- 6. Cost of land:** If cost of land in particular alignment more, it is necessary to pass it through less costlier land.
- 7. Excessive cutting of rock:** The alignment should be such that to avoid excessive cutting of hill rocks coming in alignment.
- 8. Locally available materials:** The alignment should be finalized to get continuous and maximum availability of materials required for road construction.

**1 M
each
any
four**

**(e) Define and states values of following term with IRS standard for
(i) Gradient (ii) Right of way**

Gradient:--

It is the rate of rise or fall of ground with respect to horizontal, is known as *Gradient* **OR** It is the longitudinal slope provided along the length of road, is known as *Gradient*

S. No.	Terrain	Ruling gradient	Limiting gradient	Exceptional gradient
1.	Plain or rolling	<u>3.3 per cent</u> (1 in 30)	5 per cent (1 in 20)	6.7 per cent (1 in 15)
2.	Mountainous terrain, and steep terrain having elevation more than 3,000 m above the mean sea level	5 per cent (1 in 20)	6 per cent (1 in 16.7)	7 per cent (1 in 14.3)
3.	Steep terrain upto 3,000 m height above mean sea level	6 per cent (1 in 16.7)	7 per cent (1 in 14.3)	8 per cent (1 in 12.5)

***4M**

Right of way – The area of land acquired for construction of development of road along its alignment, is known as Right of way or Permanent land width.

(metres)

S. No.	Road classification	Plain and rolling terrain				Mountainous and steep terrain	
		Open areas		Built-up areas		Open areas	Built-up areas
		Normal	Range	Normal	Range	Normal	Normal
1.	National and State Highways	45	30-60	30	30-60	24	20
2.	Major District Roads	25	25-30	20	15-25	18	15
3.	Other District Roads	15	15-25	15	15-20	15	12
4.	Village Roads	12	12-18	10	10-15	9	9

Note: Definition 1 M each, values of all the three gradients for any one terrain 1M, value of right of way for any one specifying area for any one type of road 1M.

Q1 (B) Attempt Any One of the following

06

(a) Define super elevation and state the method of designing super elevation.

Super elevation:-The inward inclination provided to the cross –section of the road on the horizontal curved portion is called Super-elevation.

Method of designing super elevation-

Super elevation is designed for 75% of design speed due to mixed traffic condition and limiting maximum super elevation to 1 in 15 or 6.7%.

Step-1 Super elevation for 75% of design speed is calculated by equation-

$$e = \frac{V^2}{225 \times R}$$

Step-2 If calculated value of 'e' is less than 1 in 15 or 6.7%, then the value so obtained is provided. If it exceeds 1 in 15, then limiting value of super elevation i.e. 1 in 15 is provided and further checking is done as below.

Step-3 For Maximum value of $e = 0.067$ (1 in 15), value of coefficient of friction is calculated by equation –

$$e + f = \frac{V^2}{127 \times R}$$

Step-4 If value of 'f' so calculated is less than prescribed limit of 0.15, the super elevation is safe for design speed, otherwise calculate limiting speed (V_r) by following formula-

$$0.217 = \frac{V_r^2}{127 \times R}$$

2M

4M

(1M for each step with correct sequence)

<p>(b) Calculate the minimum sight distance required to avoid a head on collision of two cars approaching from opposite direction, at 80 and 50 km/h. Assume a reaction time 2.5 sec , coeff. of friction of 0.7 and break efficiency of 50% in either case.</p>	
<p>Stopping distance for one of the cars.</p> <p>Stopping distance in meters $= vt + \frac{v^2}{2gf}$</p> <p style="text-align: center;">$V_1 = 80 \text{ kmph.}$</p> <p style="text-align: center;">$V_1 = \frac{80}{3.6} = 22.22 \text{ m/sec}$</p> <p style="text-align: center;">$V_2 = 60 \text{ kmph.}$</p> <p style="text-align: center;">$V_2 = \frac{50}{3.6} = 13.88 \text{ m/sec.}$</p> <p>As the brake efficiency 50%</p> <p>Coefficient of friction (f) = 0.5 x 0.7 = 0.35</p> <p>The stopping distance</p> <p>For the first car $SD_1 = 22.22 \times 2.5 + \frac{(22.22)^2}{2 \times 9.81 \times 0.35} = 127.44 \text{ m}$</p> <p>For the second car $SD_2 = 13.88 \times 2.5 + \frac{(13.18)^2}{2 \times 9.81 \times 0.35} = 62.75 \text{ m}$</p> <p>Sight distance to avoid head on Collision of two approaching cars $= SD_1 + SD_2$ $= 127.44 + 62.75 = 190.19 \text{ m}$</p>	<p style="text-align: right;">1M</p>
<p>Q2 Attempt Any Four :</p>	<p style="text-align: right;">16</p>
<p>a) State the objects of reconnaissance and location survey</p>	
<p>Object of Reconnaissance Survey-</p> <ol style="list-style-type: none"> 1) To collect the details of terrain soil conditions, geology of Area, nature of soil, drainage condition and nature of hill slopes. 2) To locate the obligatory points along the alternative routes. 3) To determine approximate estimate of the total cost of construction. 4) To determine two or three best possible routes. <p>Object of Location Survey:-</p> <ol style="list-style-type: none"> 1) To collect the data necessary for the acquisition of right of way. 2) To fix up the center line of the proposed road on the ground. 3) To determine the cost of the road project. 4) To collect data which is required for drafting of specifications, preparation of detailed drawing for working out items and quantities 	<p style="text-align: right;">2M (any two)</p> <p style="text-align: right;">2M (any two)</p>

b) Define cross drainage work. State necessity of cross drainage work.

Cross drainage work:

An efficient drainage system for disposing off the surface water collected in side drains or that of the natural streams across a road or railway track or across a hill road is called cross drainage.

Necessity of CD work:

1. Helps to maintain the continuity of a road or a railway track while going across the river, streams, nala, depressions and valleys.
2. Maintain the gradient in undulating area in case of railway.
3. Provides continuous access to the surrounding villages and towns even at the time of flood and heavy rain.
4. Maintains continuous communications.

2 M

1 M each (any two)

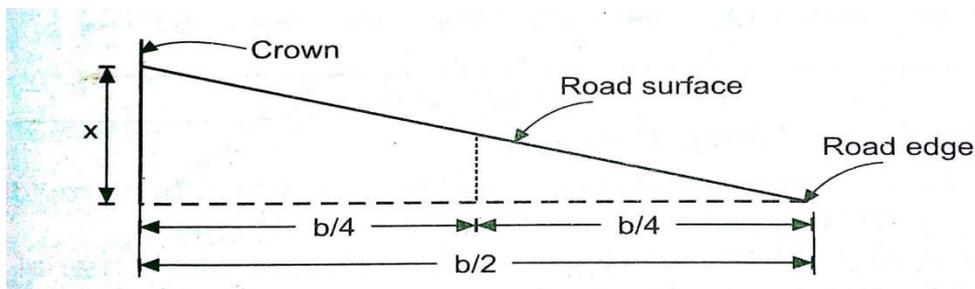
c) State types of camber and explain any one with a neat sketch.

Types of Camber:

The road cambers can have four shapes as mentioned below:

- a) Straight Camber
- b) Parabolic/Elliptical Camber
- c) Composite camber
- d) Barrel Camber

a) **Straight camber:** Joining the crown of the road to its edges by straight lines forms this camber. The straight camber can also be obtained by two straights of different slopes. This shape is easy to construct the straight camber.

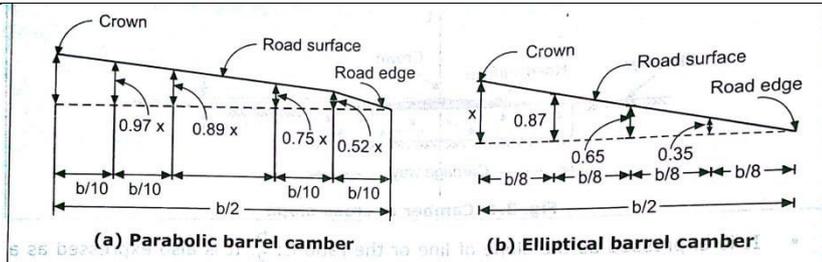


OR

b) **Parabolic or Elliptical camber:** The camber is given a continuous curve of parabolic or elliptical shape from the edge to crown.

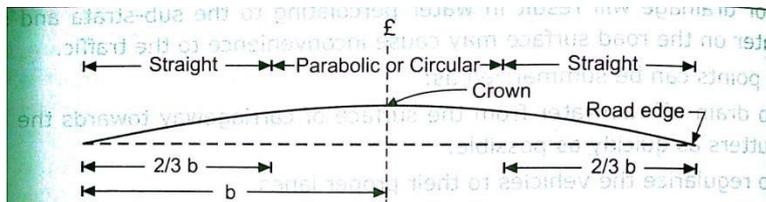
2 M

2M Any one type



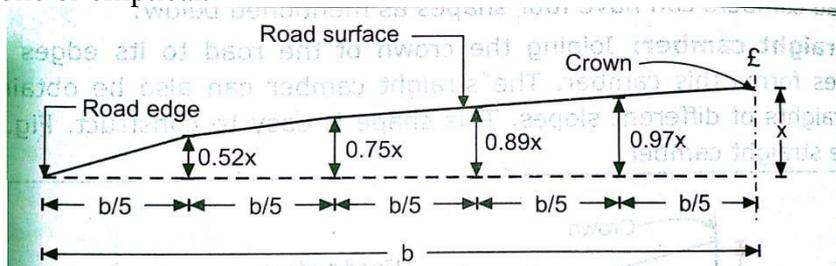
OR

- c) **Composite camber:** This camber is a combination of parabolic or elliptical and straight camber. Central portion of the road is formed by curve-parabolic or elliptical and edges are straight lines. Curved camber is difficult to construct for WBM road surface. Due to curved camber road cross-section is rather flat and vehicles find this cross-section more convenient.



OR

- d) **Barrel camber:** This camber consists of a continuous curve that may be either parabolic or elliptical.



d) Define Borrow pits, spoil bank, lead and lift.

Borrow pit: The trench excavated along the alignment of road for the use of excavated soil for road construction, is known as *Borrow pit*.

Spoil banks: The storage or stock of surplus soil excavated for further use is known as *Spoil banks*.

Lead: It is the horizontal distance up to which excavated material is transported for dumping, for which extra payment is not required to pay to the contractor, such min. Distance is known as *Lead*.

Lift: It is the vertical distance through which materials are raised after excavation, for which contractor need not to pay extra payment

1M each

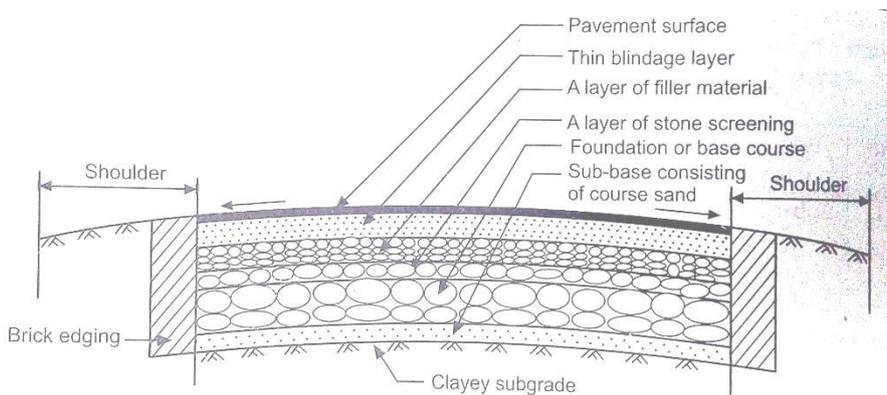
e) State eight difference between rigid pavement and flexible pavement.

Sr. No.	Flexible pavement	Rigid pavement
1	It undergoes the change its shape before is failure	It does not undergo such change, but fails due to rupture under load
2	Temperature variation does not produce stresses	Temperature variation exerts stresses
3	The load is transferred through layer by layer	The total load is taken by top most wearing surface.
4	Construction cost is less	Initial cost is more
5	Maintenance cost is high	Maintenance cost is low
6	It requires strong sub-grade	It may adjust comparatively weak sub-grade
7	Requires less time to construct, hence no delay in traffic	Requires more time for construction, hence delays traffic
8	More tractive resistance	Less tractive resistance
9	Poor visibility at night	Good visibility at night
10	Less durable	More durable

½M each point

F) Describe procedure of construction of water macadam road

Procedure of WBM road construction is –



2 M for sketch

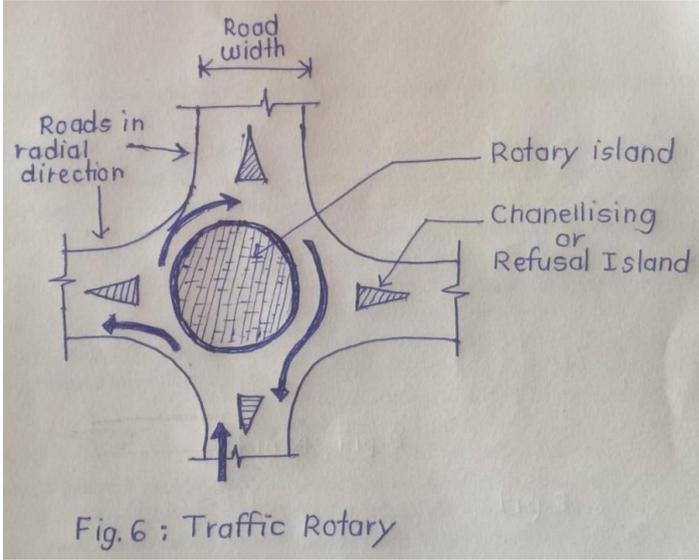
i. Preparation of Sub-grade- Sub-grade for WBM has to be Prepared carefully as any failure of the sub –grade affects the upper layers. The top of sub grade is finished to the required camber and grade. On clayey Sub-grade a layer of murum, gravel etc. is spread to a thickness of 10-15cm and is rolled properly.

2 M for procedure

<p>ii. Preparation of base Course- This is known as foundation course or soiling. It is formed by boulder, rubble or over burnt bricks. The thickness of the layer may range from 15 cm to 25cm.</p> <p>iii. Intermediate Layer- If the total thickness necessitates, an intermediate layer is provided between the wearing surface and rolling and soiling. This layer consists of oversize aggregate of the size 10 cm to 15 cm.</p> <p>iv. Wearing Surface- This layer lay in one or two layers. The thickness of loose material in each layer is restricted to 10 cm. Course aggregates are spread over specified length and between templates. Partial dry rolling is done. On the top of this a layer of bindage comprising of stone screenings of 12 mm size is spread. Screenings are dry rolled. Then wet rolling is done. After final compaction , the surface is allowed to dry for a day. A layer of 6 mm thickness consisting of sand or murum is spread , watered and lightly rolled. The surface is cured for 7 to 8 days</p> <p>v. Shoulders- while the surface is being cured shoulders are provided by filling the earth beyond the wearing surface to the desired cross slope.</p>	
<p>Q.3 Attempt Any four of the following</p>	<p>16</p>
<p>a) The speed overtaking and overtaken vehicle are 80 Kmph and 40 Kmph .resp. on two way traffic road . If the acceleration of overtaking vehicle is 0.99 m/sec²</p> <p>i) Calculate safe of overtaking sight distance.</p> <p>ii) Mention the minimum length of overtaking zone.</p>	
<p>Given :</p> <p>$V_1 = 80 \text{ kmph}, V_2 = 40 \text{ kmph}, a = 0.99 \text{ m/s}^2$</p> <p>Find OSD =?</p> <p>Solution:</p> <p>By formula of overtaking sight distance,</p> <p>OSD = D₁+ D₂+ D₃</p> <p>Here D₁=distance travelled during reaction time.</p> <p>D₁ = V_b.t</p> <p>Where V_b=design speed of overtaken vehicle B and t= perception time which is assumed as 2 sec</p> <p>$V_b = V_2 / 3.6$ $= 40 / 3.6$ $V_b = 11.1 \text{ m/s}$ $D_1 = 11.1 \times 2 = \underline{22.2 \text{ m}}$</p> <p>Now, D₂ =distance travelled during overtaking time</p> <p>D₂ = V_b.T + 2S</p> <p>$S = 0.7V_b + 6$ $= 0.7 \times 11.1 + 6 = 13.77 \text{ m}$ $T = \sqrt{4xS/a}$ $T = \sqrt{4x13.77 / 0.99}$ $T = 7.45$ $D_2 = V_b \times T + 2 \times S$ $D_2 = (11.1 \times 7.45) + (2 \times 13.8) = \underline{110.295 \text{ m}}$</p>	<p>1M</p> <p>1M</p>

<p>Now, $D_3 = \text{distance travelled by opposite vehicle}$ $D_3 = V \times T$ Where V = Design speed of overtaking vehicle A $V = V_1 / 3.6$ $= 80 / 3.6$ $= 22.22 \text{ m/s}$ $D_3 = 22.22 \times 7.45 = \underline{165.55 \text{ m}}$ $OSD = 22.22 + 110.235 + 165.55 = \underline{298.06 \text{ m}}$ Minimum length of Overtaking zone = $3 \times OSD = 3 \times 298.06 =$ $= \underline{894.18 \text{ m}}$</p>	<p>1M</p> <p>1M</p>
<p>b) The radius of horizontal circular curve is 100 m. The design speed is 50 kmph. And the design coefficient of lateral friction is 0.15. i) Calculate the super elevation required if full lateral friction is assumed to developed ii) Calculate the coeff. friction needed if no super elevation is provided</p>	
<p>Given Data, Radius (R) = 100m Super elevation (e) =? Coefficient of friction(f) = 0.15 Design speed(V) = 50 kmph i) Superelevation required if full lateral friction is assumed to developed $e + f = (V^2 / 127) R$ $e + 0.15 = (50^2 / 127) \times 100$ <u>e = 0.046 per meter of carriage way</u> ii) The coeff. of friction needed if no superelevation is provided $e + f = V^2 / 127R$ $e + f = (V^2 / 127) R$ $0 + f = (50^2 / 127) \times 100$ <u>f = 0.196</u></p>	<p>1M</p> <p>1M</p> <p>1M</p> <p>1M</p>
<p>c) Describe in brief causes of landslides.</p>	
<p>Causes of land slide – The causes of landslides are as follows. 1. Increase in water content of soil during rainy season. 2. Undermining caused by erosion or excavation. 3. Vibrations and shocks caused by blasting or earthquakes. 4. Hair cracking due to alternate swelling and shrinkage of the soil mass. 5. Formation of faults in bedding planes of the strata due to vibrations. 6. Due to seepage pressure of percolating ground water. 7. Due to failure of breast wall constructed for hill roads.</p>	<p>1M each any four</p>
<p>d) State objectives and functions of pavement.</p>	
<p>Objective & function of Pavement: 1) To carry superimposed moving or dynamic loads of vehicles. 2) To distribute the vehicular load in different sub layers without exceeding bearing capacity of subgrade soil. 3) To absorb the shocks and vibrations exerted by dynamic loads. 4) To dispose off rainwater away from road surface by avoiding entry of water in road substructure. 5) To avoid ground water table rise for keeping road in dry condition. 6) To provide the passage of actual movement of vehicle on it. 7) To provide a smooth surface. 8) To prevent ill effects of weathering agencies on subgrade soil</p>	<p>1M each any four</p>

<p>e) Describe in brief joints in rigid pavement.</p>	
<p>Following are the joints in Rigid Pavements</p> <p>a) Longitudinal joints b) Transverse Joints</p> <p>Longitudinal joints: The joints provided in the longitudinal direction between two strips of the road slab, when the pavement width exceeds 4.5 m are known as longitudinal joints.</p> <p>Types of Longitudinal joints are</p> <p>a) Plain Butt joint. b) Butt joint with tie bar. c) Tongue and groove warping joint.</p> <p>Transverse joints: The joints provided in the Transverse direction between two strips of the road slab, maximum at 5 m intervals are known as transverse joints.</p> <p>Types of Transverse joints are</p> <p>a) Expansion joint. b) Contractions joints. c) Warping joints. d) Construction joints.</p> <p>Note: If students have written objects of joints and sketches are drawn marks may be given.</p>	<p>1M 1M 1M 1M</p>
<p>Q.4 (A) Attempt Any three of the following</p>	<p>12</p>
<p>(a) Define:- asphalt, emulsion, cutback, tar</p>	
<p>Asphalt: - It is defined as a material or mechanical mixture in which bitumen is associated with inert mineral matter.</p> <p>Emulsion: - It is defined as a liquid product obtained by vigorously stirring up a mixture of two unmixable liquids.</p> <p>Cut back: - The solution of bituminous materials in a volatile solvent is known as cut back.</p> <p>Tar:- The residual product obtained by destructive distillation of organic matter such as coal, oil , wood , etc. is known as tar.</p>	<p>1M each</p>
<p>b) Define:- PCU , Traffic control device</p>	
<p>PCU: - Practically, the passenger car is considered as standard vehicle to convert the other vehicle classes is known as "Passenger Car Unit.</p> <p style="text-align: center;">OR</p> <p>In order to convert different vehicle class to one class such as passenger car conversion factor known as PCU</p> <p>Traffic control device:- The arrangements or provisions made to the road users so as to avoid accidents on the road and for the free and effective traffic flow are known as traffic control device.</p>	<p>2M 2M</p>

<p>c) define:- Traffic island and draw a sketch of circular rotary island</p>	
<p>Traffic island: - These are the raised areas constructed within the roadways to establish physical channels through which vehicular traffic may be guided</p>  <p style="text-align: right;">2M</p> <p style="text-align: right;">2M</p>	
<p>(d) define:- road drainage and state its purpose</p>	
<p>Road drainage: A system by which efficient collection, removal and disposal of surface and sub- surface water can be properly done is called as road drainage.</p> <p>The purpose of providing road drainage:</p> <ol style="list-style-type: none"> 1) Road drainage is necessary to collect surface water in side drains and to keep road surface in dry condition. 2) It is also required to carry sub surface water away from sub layers in heavy rainfall regions. 3) It helps to reduce occurrence of road defects due to rainwater and rise of groundwater. 4) It is beneficial to minimize landslides and related undesirable effects. 5) It increases load carrying capacity due to dry condition and maintained density of sub layers. 6) It also results a good durable road with lesser maintenance as well. 	<p style="text-align: right;">2M</p> <p style="text-align: right;">1M any two</p>
<p>Q 4 B) Attempt Anyone of the following</p>	<p style="text-align: right;">06</p>
<p>a) Describe with neat sketch of CBR test on soil as subgrade material.</p>	
<p>CBR test</p> <ol style="list-style-type: none"> 1) This method combines a load penetration test performed in the laboratory or in-situ with the empirical design charts to determine the thickness of pavements and of its constituents layers 2) This is the most widely used method for the design of flexible pavements. 3) Observation are taken between the Penetration resistance i.e. test load Vs penetration of plunger. 4) Penetration resistance of the plunger into a std. sample of crushed stone for the corresponding penetration is called standard load. 5) C.B.R. is defined as the ratio of test load to the standard load expressed as percentage for given penetration of plunger 6) C.B.R.= (test load / Standard load)*100 	<p style="text-align: right;">3M*</p>

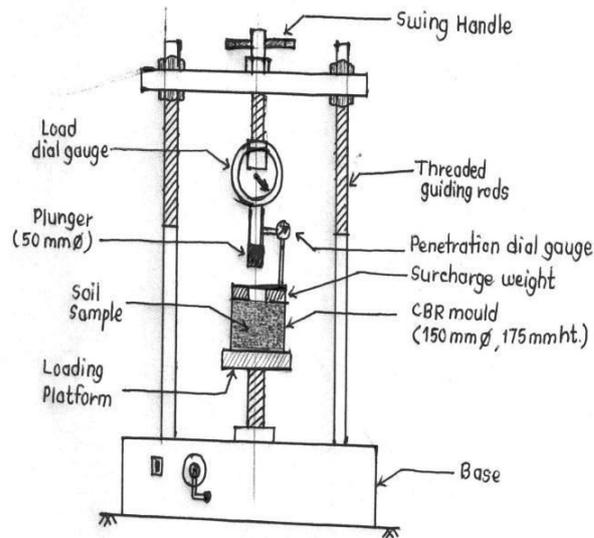


Fig.3. Experimental set up for CBR Test on Subgrade soil

3M

(Note- * If the students write the procedure of CBR test full 3M may be given)

b) Define Soil Stabilized road. Explain one method of soil stabilization.

Soil Stabilized road : The Engineering properties of poor soils can be improved by the use physical, chemical or physiochemical method is known as soil stabilization and the road constructed in this way is called soil stabilized road.

2M

Methods of soil stabilization are :

- i. Mechanical soil stabilization
- ii. Soil-lime stabilization
- iii. Soil-cement stabilization
- iv. Soil-bitumen stabilization
- v. Stabilization by heating
- vi. Stabilization by grouting
- vii. Stabilization by freezing
- viii. Stabilization by chemicals.

Mechanical soil stabilization:

- i. Excavation of subgrade soil should be done by JCB.
- ii. Pulverization should be done to form fine particles.
- iii. A specific size of aggregate as per IRC are added in soil to improve soil particles.
- iv. Then suitable compaction should be done using heavy compaction roller followed by curing.
- v. After alternate curing and compaction for minimum 7 days, the road is said to be stabilized.

4M
for
expl.

(Note- If the students explain any other method then marks may be given accordingly)

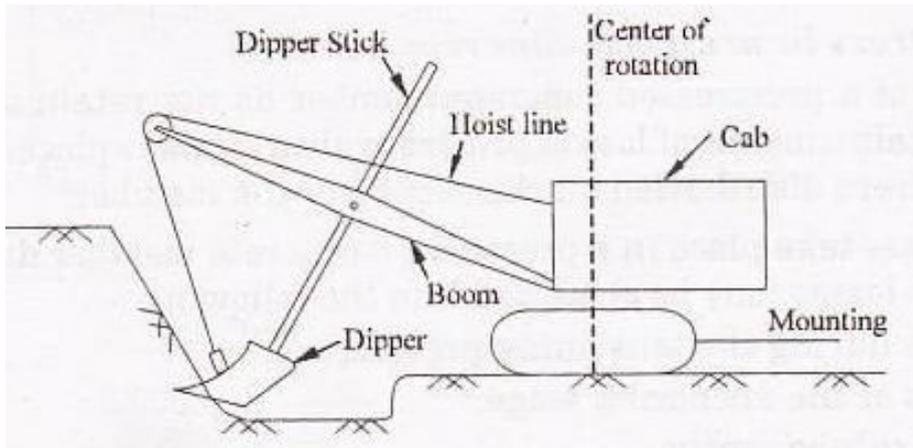
<p>Q 5 Attempt ANY four of the following</p>	<p>16</p>
<p>a) Draw a cross section of Highway embankment and label its complement</p>	
<p style="text-align: center;">Fig.1. Cross-section of State Highway in Embankment</p>	
<p>(Note - 2 marks for sketch and 2 marks for labeling)</p>	
<p>b) Draw sign for the following :</p>	
<p>i) One way ii) No parking iii) Narrow bridge iv) Speed Limit</p> <div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <p>One way</p> </div> <div style="text-align: center;"> <p>No parking</p> </div> <div style="text-align: center;"> <p>Narrow bridge</p> </div> <div style="text-align: center;"> <p>Speed limit</p> </div> </div>	<p>1M each</p>
<p>c) State and explain classification of maintenance of road.</p>	
<p>Following are the classification of maintenance of road.</p> <ol style="list-style-type: none"> 1. Routine repair: - These are the regular repair carried out to keep road surface intact for e.g. pot hole repairs, manual reshaping of earthwork, vegetation trimming, repainting of kerb and traffic signs and kilometer stone etc. 2. Periodic repair: - Due to the moving traffic and adverse climatic conditions, highways are subjected to wear. Therefore road required periodic maintenance such as resurfacing of wearing course, maintenance of cross drainage works etc. 3. Special Repairs: - These repairs are carried put for special type of failure of pavement. It mainly includes improvement of geometrics of highway such as improvement to curves, improvement to visibility, significant repairs to culverts & bridges etc., new safety measures and amenity provisions and repairs/ rehabilitation of major distressed sections. 4. Flood Damages and Emergency Repairs: -It includes repairs or restoration which arises from heavy rains, flooding, snowfall, cyclones, landslides, etc. High priority shall be assigned to traffic safety and restoration of traffic. 	<p>1M each</p>

d) Explain working of power shovel with suitable line sketch.

Power shovel is also called as dipper shovel ,it represents shovel family of rope operated excavators. It is used for digging above machine level. The working of power shovel is explained below

- i) First step is release the hoist to bring bucket down and stick in vertical position so as to bucket teeth rest on ground
- ii) Now the bucket is moved forward and downward by lifting hoist
- iii) Next step is to fill the bucket with material by giving power
- iv) Next step is to swing the stick and dump the excavated material at suitable position

The above cycle is repeated again and again



Line sketch of Power Shovel

(Bucket and dipper are the extensions provided to the shovel)

e) State the component parts of hill road with their function

Following are the component parts of hill road :

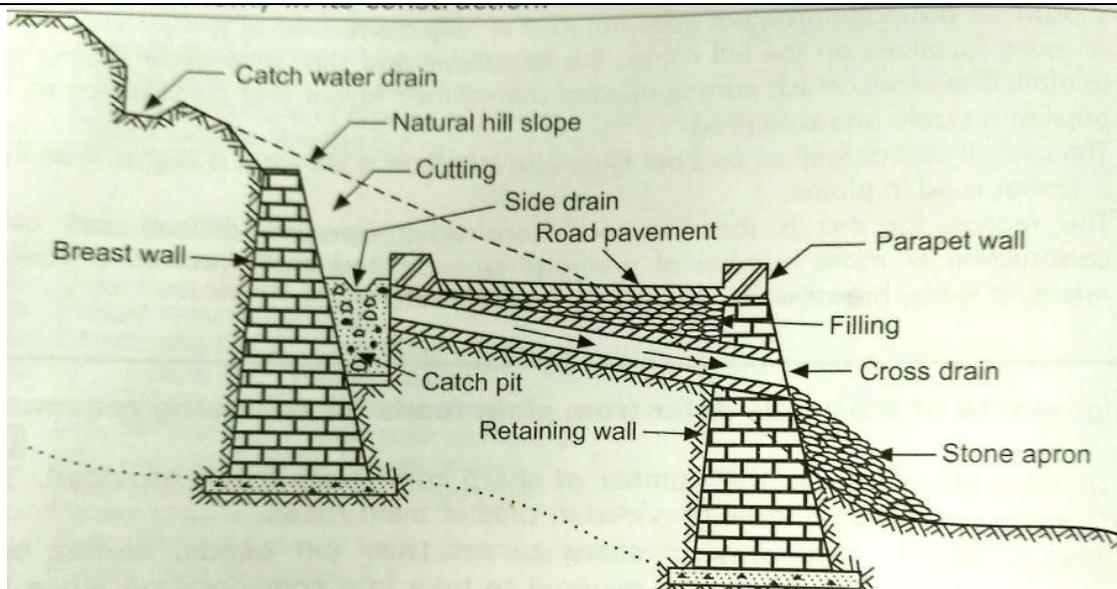
- 1. Road Pavement: - The main function of pavement is to carry vehicular load and distribute it evenly.
- 2. Parapet wall :- Parapet wall is to provide to provide protection to the traffic against falling down in valley
- 3. Breast wall :- Breast wall is provided at the upslope side of the road to prevent Lateral pressure of earth.
- 4. Retaining wall: - This wall is constructed at the downslope side to resist pressure from earth filling of pavement due to traffic load and other load.
- 5. Catch water drain :- These drains are provide on hill slope to collect or intercept the rainwater and divert them to nearby cross drainage work
- 6. Side Drainage :- These drains are provided at the foot of hill slope to collect rainwater from carriageway and from hill slope and divert it to the nearby cross drainage work
- 7. Cross drainage works: - Cross drainage works are provided at regular intervals in hill road to drain off rain water across the road.

**1M
each
any
four**

f) Describe in brief component parts of a Hot mixed bitumen plant.												
<p>A typical modern hot mix bitumen plant consist following parts:</p> <ol style="list-style-type: none"> 1. Cold feed bins :- These bins are provided to store cold aggregates in different sizes. Each bins has different size material. 2. Vibrating screen :- Theses screen separates the oversize material. 3. Weighing conveyer :- These conveyors transfer the aggregates from cold bin to drying drum 4. Drying and mixing drum: - In first half of drum aggregate is heated at required temperature and in second half bitumen is mixed with aggregate. 5. Bitumen storage tanks :- These tanks are used to store and heat the bitumen and supply it to mixing drum. 6. Filler silo :- Filler silo store and supply the additional binder material if required. 7. Dust collector :- This unit collects the dust from drier which is formed by heating of aggregate . 8. Control panel :- This unit controls the all operations of hot mix bitumen plant. 			1M each any four									
Q 6 Attempt any four of the following			16									
a) Enlist eight types of equipment's used for excavation in construction of road.												
<p>Following are the equipment's used for excavation in road construction</p> <ol style="list-style-type: none"> 1. Bulldozer 2. Scrapper 3. Grader 4. Power shovel 5. Back hoe 6. Dragline 7. Clamshell 8. Loaders 9. Excavators 10. Ripper 			½M each any eight									
b) State four compacting equipment and its suitability.												
<p>Types and suitability of different types of compactors are tabulated below.</p> <table border="1"> <thead> <tr> <th>Sr No</th> <th>Type of Compactors</th> <th>Suitability</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Static three wheeled self-propelled compactors</td> <td> <ol style="list-style-type: none"> 1. For compacting of thick layer of earth,Gravel and stone/aggregates 2. For compacting layer of bitumen (These are used on soils which does not require great pressure for compaction. These rollers are generally used for finishing the upper surface of the soil) </td> </tr> <tr> <td>2</td> <td>Pneumatic Tyred roller</td> <td> <ol style="list-style-type: none"> 1. For compacting cold laid bituminous pavements(used specially for final pass of compaction of bituminous road) 2. For compacting soft base course materials or layers of loose soil. </td> </tr> </tbody> </table>			Sr No	Type of Compactors	Suitability	1	Static three wheeled self-propelled compactors	<ol style="list-style-type: none"> 1. For compacting of thick layer of earth,Gravel and stone/aggregates 2. For compacting layer of bitumen (These are used on soils which does not require great pressure for compaction. These rollers are generally used for finishing the upper surface of the soil) 	2	Pneumatic Tyred roller	<ol style="list-style-type: none"> 1. For compacting cold laid bituminous pavements(used specially for final pass of compaction of bituminous road) 2. For compacting soft base course materials or layers of loose soil. 	1M each
Sr No	Type of Compactors	Suitability										
1	Static three wheeled self-propelled compactors	<ol style="list-style-type: none"> 1. For compacting of thick layer of earth,Gravel and stone/aggregates 2. For compacting layer of bitumen (These are used on soils which does not require great pressure for compaction. These rollers are generally used for finishing the upper surface of the soil) 										
2	Pneumatic Tyred roller	<ol style="list-style-type: none"> 1. For compacting cold laid bituminous pavements(used specially for final pass of compaction of bituminous road) 2. For compacting soft base course materials or layers of loose soil. 										

3	Sheep footed roller	<ol style="list-style-type: none"> 1. This type of roller mostly used for compaction of cohesive soils such as heavy clays and silty clays 2. Sheep foot rollers are used for subgrade layers in pavements 	
4	Vibratory Roller	<ol style="list-style-type: none"> 1. This types of roller is use when higher level of compaction is required at greater depth.(Specially used for sandy soil) 2. A vibratory roller is used for compacting granular base courses. It is sometimes used for asphaltic concrete work also. 	

c) Draw neat sketch of side drain and catch water drain.



***4M**

(Note :- 3 marks for figure and 1 marks for labeling)

d) Explain maintenace of water bound macadam road.

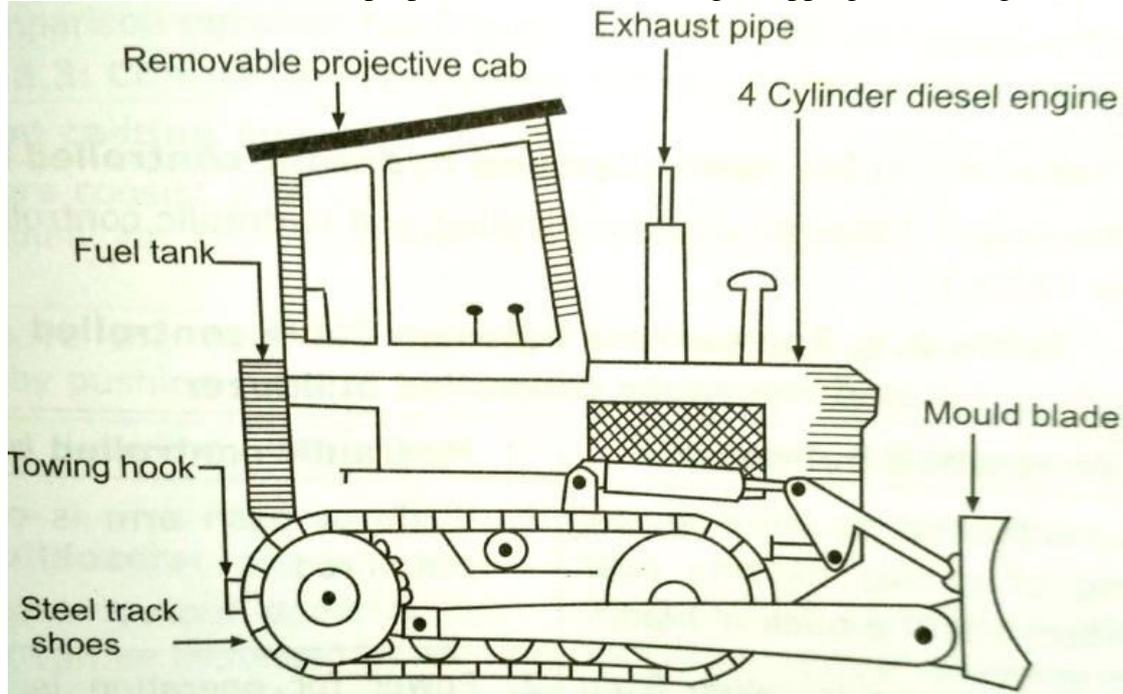
W.B.M road faces dust formation in dry weather and mud formation in rainy season. Pot holes and ruts is formed in WBM road due to combined effect of traffic and rain water. By spreading thin layer of moist soil binder periodically, prevention loosening of aggregate soil is possible. Dust formation can be prevented by providing thin bituminous layer over WBM pavement. Patch repair work is carried out to treat ruts and pot holes. In this cutting of effected portion of road is carried out and then coarse aggregate and binder is placed and get well compacted. If the road extensively fails or after the useful period of WBM road ,resurfacing is carried out

4M

e) Explain Working of bulldozer with suitable line sketch.

Ans:- Bulldozers are designed primarily for cutting and pushing of the material over relatively short distance. Bulldozers are mounted with blade perpendicular to the direction of travel, controlled by hydraulic cylinder to vary the depth of cut. Rear mounted rippers can be fitted to loosen the hard material before dozing. Bulldozer is basically pushing unit but can be used for other purposes like land clearing, stripping backfilling, ditching etc.

2M



2M