

Name :

Roll No. :

Invigilator's Signature :

CS/B.Tech/CE (NEW)/SEM-6/CE-601/2013

2013

HIGHWAY & TRANSPORTATION ENGINEERING

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

- i) Camber in the road is provided for
 - a) effective drainage
 - b) counteracting the centrifugal force
 - c) having proper sight distance
 - d) none of these.
- ii) On a single lane road with two-way traffic the minimum stopping sight distance is equal to
 - a) stopping distance
 - b) two times the stopping distance
 - c) half the stopping distance
 - d) three times the stopping distance.

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- iii) Capital recovery factor for annual cost of pavement having a life of 10 years at 8% compound interest is
- a) 0.08174 b) 0.1490
c) 0.080036 d) 0.1030.
- iv) For the water-bound macadam road, in localities of heavy rainfall, the recommended camber is
- a) 1 in 40 b) 1 in 33
c) 1 in 25 d) 1 in 50.
- v) The maximum spacing of contraction joints in rigid pavement is
- a) 2.5 m b) 3.5 m
c) 4.5 m d) 5.5 m.
- vi) Abrasion test is carried out on aggregates to find
- a) hardness b) toughness
c) crushing strength d) shear strength.
- vii) Which of the following tests is done to determine consistency of Bitumen ?
- a) Viscosity tests b) Ductility tests
c) Penetration tests d) Softening point tests.
- viii) If the CBR value obtained at 5 mm penetration is higher than that at 2.5 mm, then the test is repeated for checking; and if the check test reveals a similar trend, then the CBR value is to be reported as the
- a) mean of the values for 5 mm & 2.5 mm penetration
b) higher value minus the lower value
c) lower value corresponding to 2.5 mm penetration
d) higher value obtained at 5 mm penetration.

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- ix) The method of design of flexible pavement as recommended by IRC is
- a) Group index method
 - b) CBR method
 - c) Water guard method
 - d) Benkelman beam method.
- x) Warping joint is a
- a) traverse joint
 - b) construction joint
 - c) longitudinal joint
 - d) none of these.
- xi) Dead slow is
- a) regulatory sign
 - b) warning sign
 - c) informatory sign
 - d) none of these.
- xii) When path travelled along the road surface is more than circumferential movement of the wheels due to rotation, then it results in
- a) slipping
 - b) skidding
 - c) turning
 - d) revolving.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. State various recommendations made by Jayakar Committee.

What are the organizations formed based on above report ?

4 + 1

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3. Discuss briefly the various engineering surveys carried out before finalizing a new highway project.
4. The radius of a horizontal circular curve is 100 m. The design speed is 50 kmph and the design coefficient of lateral friction is 0.15.
 - a) Calculate the superelevation required if full lateral friction is assumed to develop.
 - b) Calculate the coefficient of friction needed if no superelevation is provided.
 - c) Calculate the equilibrium superelevation if the pressure on inner and outer wheels should be equal. $1\frac{1}{2} + 1\frac{1}{2} + 2$
5. The maximum increase in temperature is 25°C after the construction of a cement concrete pavement. If the expansion joint gap is 2.2 cm, design the expansion and contraction joints.

Assume : $C = 10 \times 10^{-6} / ^\circ\text{C}$, $W = 2400 \text{ kg/m}^3$, $f = 1.5$,
 $S_c = 0.8 \text{ kg/cm}^2$. 3 + 2
6. Calculate the minimum sight distance required to avoid a head-on collision of two cars approaching from the opposite direction at 95 kmph and 75 kmph. Assume a reaction time of 2.5 secs, coefficient of braking friction of 0.38 and a brake efficiency of 70%, in either case.

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7. There are four alternative plan proposals P , Q , R & S with different road length. Work out the utility per unit length for each of the system and indicate which of the plans yield the maximum utility based on saturation system.

| Proposal | Total road length km | Number of towns and villages served with population range | | | | Total agricultural and industrial products thousand tonnes. |
|----------|----------------------|---|-----------|------------|---------|---|
| | | 1001-2000 | 2001-5000 | 5001-10000 | > 10000 | |
| P | 300 | 160 | 80 | 30 | 6 | 200 |
| Q | 400 | 200 | 90 | 60 | 8 | 270 |
| R | 500 | 240 | 110 | 70 | 10 | 315 |
| S | 550 | 248 | 112 | 73 | 12 | 335 |

GROUP – C**(Long Answer Type Questions)**

Answer any *three* of the following. $3 \times 15 = 45$

8. a) Derive an expression for calculating the overtaking sight distance on a highway. Explain all the variables you used in this expression with their proper units. 7
- b) The speed of overtaking and overtaken vehicles are 80 kmph and 60 kmph respectively on a two-way traffic road. If the acceleration of overtaking vehicle is 0.99 m/s^2 , then calculate safe overtaking sight distance and minimum length of overtaking zone. Take other data values as per IRC. 4
- c) Explain the PIEV theory. 4

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9. a) A vertical summit curve is to be designed when two grades, $+1/50$ and $-1/80$ meet on a highway. The stopping sight distance and overtaking sight distance required are 180 m and 640 m respectively. But due to sight consideration the length of vertical curve has to be restricted to a maximum value of 500 m, if possible.

Calculate the length of the summit curve needed to fulfil the requirements of

- i) stopping sight distance
- ii) overtaking sight distance or at least intermediate sight distance and discuss the results. 8

- b) A national highway which passes through a rolling terrain in heavy rainfall area has a horizontal curve of radius 500 m. Design the length of transition curve assuming suitable data. 7

10. a) Design the flexible pavement section by triaxial test method using the following data :

Wheel load = 4100 kg

Radius of contact area = 15 cm

Traffic coefficient (X) = 1.5

Rainfall coefficient (Y) = 0.9

Design deflection = 0.25 cm

E -value of sub-grade soil $E_s = 100 \text{ kg/cm}^2$

E -value of base course material $E_b = 400 \text{ kg/cm}^2$

E -value of 7.5 cm thick bituminous concrete surface course = 1000 kg/cm^2 . 7

- b) Write down the construction steps for water-bound macadam road. 8

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11. a) Name the four major strength related tests of road aggregates. What is the basic difference among them context to the type of load ? 2 + 2
- b) For a soil sample with 60% finer than 75 m, $L1 = 46\%$ and $PI = 15$, find the group index. 3
- c) Compare the annual costs of two types of pavement structures.
- i) WBM with thin bituminous surface at total cost of Rs. 2.2 lakhs per km. life of 5 yrs., interest at 10%, salvage value of Rs. 0.9 lakh after 5 yrs., annual average maintenance cost of Rs. 0.35 lakh per km.
- ii) Bituminous macadam base and bituminous concrete surface total cost of Rs. 4.2 lakhs per km life of 15 yrs. interest at 8%, salvage value of Rs. 2 lakhs at the end of 15 yrs. annual average maintenance cost Rs. 0.25 lakh per km. 8
12. Write short notes on the following : 5 × 3
- i) Traffic separator
- ii) Construction of gravel road
- iii) Equivalent single wheel road
- iv) Softening point test
- v) Extra widening of roads.
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