



WEST BENGAL UNIVERSITY OF TECHNOLOGY

CE-601

HIGHWAY & TRANSPORTATION ENGINEERING

Time Allotted: 3 Hours

Full Marks: 70

The questions are of equal value.

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable. All symbols are of usual significance.

GROUP A

(Multiple Choice Type Questions)

1. Answer any *ten* questions. 10×1 = 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

- (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) If the CBR value obtained at 5 mm penetration is higher than that of 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
- (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) Bitumen of grade 80/100 means
- (A) its penetration value is 8 mm
(B) its penetration value is 10 mm
(C) its penetration value is 8 to 10 mm
(D) its penetration value is 8 to 10 cm.
- (vii) Abrasion test is carried out on aggregates to find
- (A) Hardness (B) Toughness
(C) Crushing strength (D) Shear strength

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- (viii) Service lane for a broken down vehicle operation is provided by
- (A) Carriage way (B) Shoulder
(C) Road margin (D) None of these
- (ix) The terrain may be classified as rolling terrain if the cross slope of land is
- (A) Up to 10% (B) Between 10 % and 20%
(C) Between 25% and 60% (D) More than 60%
- (x) An index map used highway project shows
- (A) The proposed and existing roads and important places to be connected
(B) Details of various alternate alignments
(C) The general topography of the area
(D) The general details of existing structures like building, wells etc
- (xi) Traffic volume is equal to
- (A) Traffic density \times Traffic speed
(B) Traffic density / Traffic speed
(C) Traffic speed / Traffic density
(D) None of the above
- (xii) Tie bars in Cement concrete pavements are at
- (A) Expansion joints (B) Contraction joints
(C) Warping joints (D) Longitudinal joint

GROUP B
(Short Answer Type Questions)

Answer any *three* questions.

3×5 = 15

2. State various recommendations made by Jayakar Committee.
What are the organizations formed based on above report? 3+2
3. Differentiate between (i) Tar and Bitumen, (ii) Skid and Slip. 2.5+2.5
4. How the combined effect to temperature stress and load stress considered in concrete pavement? 5
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. 5
Assume: $C = 10 \times 10^{-6}/^{\circ}\text{C}$, $W = 24 = 2400 \text{ kg/m}^3$, $f = 1.5$,
 $S_c = 0.8 \text{ kg/cm}^2$
6. Calculate the minimum sight distance required to avoid a head-on collision of two cars approaching from the opposite direction at speed 95 kmph and 75 kmph respectively. Assume a reaction time of 2.5 secs, coefficient of braking friction of 0.38 and a brake efficiency of 70%. In either case. 5

GROUP C
(Long Answer Type Questions)

Answer any *three* questions.

3×15 = 45

7. (a) Drive an expression for calculating the stopping sight distance. 3

- (b) Design the rate of super elevation for a horizontal highway curve of radius 600 m and speed 80 kmph. 5
- (c) The speed of overtaking and overtaken vehicle are 80 kmph and 60 kmph respectively. If the acceleration of the overtaking vehicle is 0.72 m/sec^2 , calculate the safe overtaking sight distance for one way and two way traffic. 7
8. (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 180m and 640m respectively. But due to site conditions the length of vertical curve has to be restricted to a maximum value of 500m if possible. 8
- Calculate the length of summit curve needed to fulfill the requirements of
- (i) Stopping sight distance, and
- (ii) Overtaking sight distance or at least intermediate sight distance and discuss the results.
- (b) The radius of a Horizontal curve is 400 m, the total pavement width at curve is 7.6 m and the super elevation is 0.07. Design the transition curve length for a speed of 100 kmph. Assume pavement to be rotate about the inner edge. 7
9. (a) What is semi rigid pavement? 2
- (b) What is warping stress for rigid pavement 3
- (c) Calculate the stresses at interior, edge and corner regions of cement concrete pavement using Westergaard's stress equations. Use the following data : 10
- Wheel load, $P = 5100 \text{ kg}$.
- Modulus of elasticity of cement concrete, $E = 3 \times 10^5 \text{ kg/cm}^2$
- Pavement thickness, $h = 20 \text{ cm}$.
- Poisson's ratio, $\mu = 0.15$
- Modulus of sub-grade reaction, $K = 8 \text{ kg/cm}^2$
- Radius of concrete area, $a = 15 \text{ cm}$.

10. (a) Define Crocodile crack, ruts and potholes in pavement. 3
- (b) What is the function of the weaving course of flexible pavement? 2
- (c) Draw a diagram of a rotary with labeled parts. 5
- (d) What is grade separated interchange? Explain what weaving angle and weaving length mean. For what type of intersection are these important and how? 5
11. Write short notes on any *three* of the following: 3×5
- (a) Extra widening of roads
 - (b) CBR test of California bearing ratio test
 - (c) PIEV theory
 - (d) Softening point test
 - (e) Vehicle operation cost
 - (f) Annual Cost Method