Ref. No.: Ex/CE/T/321/2017

B. CIVIL ENGINEERING 3RD YEAR 2ND SEMESTER EXAMINATION 2017
TRANSPORTATION ENGINEERING – II

Time: 3 Hours **Full Marks: 100**

Answer Two Questions each from Group A & Group B

GROUP – A

1. a) Discuss briefly about different uses of bitumen in road construction. 9
   b) Discuss about Sub-Surface Drainage and Filter Material. 8
   c) The following test results are obtained for a CBR test on a sub-grade soil sample. Considering standard test procedure determine the CBR value of subgrade soil 8

Penetration (mm)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5
Load (kg)	0	5	17	29	42	50	58	70	78	92	102	108

2. a) Where, How and Why Dowel Bars are provided in a rigid pavement? 6
   b) Determine the thickness of a suitable flexible pavement section for a 6-lane dual carriageway 2-way street AB following the IS method on subgrade with CBR value of 4.2%; annual growth rate of 7.5% and design life of 15 years from present day and Lane Distribution Factor as 60%. Using the following standard design tables (as provided) and considering a three layer system of Sub-base, Base and Surfacing draw neatly the cross section so designed for the following traffic – 9

Single Axle Load	8.0t	6.0t	5.0t	3.0t
Traffic Volume in veh/day (A to B)	1000	9250	9400	1850
Traffic Volume in veh/day (B to A)	1250	9150	10600	1800

   c) Plate bearing tests were conducted wth a 75cm dia plate on soil subgrade and a granular base layer. The stress noted, when the deflection was 0.25cm on the subgrade soil, was 0.07MN/m^2. On the base course a deflection of 0.25cm was noted under a stress of 0.14MN/m^2. Design the pavement for an allowable deflection of 0.5cm under a wheel load of 40kN and tyre pressure of 0.5MN/m^2. 10

3. Following the IRC recommended method, design a suitable rigid pavement and all its components for a design traffic volume of 5000veh/day. Consider the following data – Design Wheel Load= 8.1t, Width of Expansion Joint Gap – 25mm, Maximum variation in temperature between summer and winter – 35°c, Modulus of Sub-grade reaction= 8kg/cm^3, Width of Slab= 3.5m, Coefficient of Surface Friction= 1.5, Diameter of Dowel= 20mm, Diameter of Tie Bar= 10mm, Radius of Equivalent Contact Area – 15cm, Modulus of Elasticity of Concrete= 3×10^5kg/cm^2, Thermal Coefficient of Concrete= 1×10^{-5}/°c, Unit Weight of Concrete= 2400kg/cm^3, Poisson Ratio of Concrete= 0.15, Flexural Strength of Concrete= 40kg/cm^2, Tensile Strength of Concrete= 0.8kg/cm^2, Bearing Strength of Concrete= 100kg/cm^2, Load Transfer through Dowel= 40%, Flexural Strength of Dowel Bar Steel – 1400 kg/cm^2, Shear Strength of Dowel Bar Steel – 1000 kg/cm^2, Bond Strength of Deformed Bar= 24.6 kg/cm^2. The other relevant values may be taken from the tables and charts as given 25

Table 1: Temperature Differential (°C) for Concrete slabs

Slab Thickness (cm)	15	20	25	30
Temperature Differential (°C)	15.6	16.4	16.6	16.8

Table 2: Warping Stress Coefficient (C)

l/l'	1	2	3	4	5	6	7	8	9	10
C	0	0.04	0.175	0.44	0.72	0.92	1.03	1.077	1.08	1.075

Table 3: Adjustment due to Traffic Volume

Design Traffic Volume (veh/day)	0 to 45	45 to 450	450 to 4500	More than 4500
Adjustment of thickness (cm)	-5	-2	0	+2

Standard Expressions

1. **Radius of Relative Stiffness** $l = \left[\frac{E.t^3}{12k(1-\nu^2)}\right]^{\frac{1}{4}}$

2. **Temperature Stresses**

   Edge = $\frac{C.E.T_c.T_l}{2}$; **Corner** = $\frac{E.T_c.T_l}{3.(1-\nu)}\sqrt{\frac{a}{l}}$; **Inside** = $\frac{E.T_c.T_l}{2}\left[\frac{C_x+\nu C_y}{1-\nu^2}\right]$

3. **Load Stresses**

   Edge = $0.529\frac{P}{t^2}(1+0.54\nu)\left(4\log_{10}\frac{l}{b}+\log_{10}b-0.4048\right)$;

   Corner = $\frac{3P}{t^2}\left[1-\left(\frac{a\sqrt{2}}{l}\right)^{1.2}\right]$; **Inside** = $0.316\frac{P}{t^2}\left(4\log_{10}\frac{l}{b}+1.069\right)$

4. **Length of Dowel Bar** $= 5d\left[\frac{f_{st}}{f_{bc}}\times\frac{L_d+1.5\delta}{L_d+8.8\delta}\right]^{1/2}$

5. **Load Transfer Capacity of a Dowel**

   Shear = $0.785.d^2.f_{ss}$; **Bending** = $\frac{2.d^3.f_{st}}{L_d+8.8\delta}$; **Bearing** = $\frac{d.L_d^2.f_{bc}}{12.5(L_d+1.5\delta)}$

GROUP – B

4. a) Write Short Notes on the following
   i) Representation of Accident Data
   ii) Off Street Parking System
   iii) Directional Design Traffic Volumes for Optimum Signal Cycle Design

   b) The observations of a moving car study over a length of AD are as follows. Determine the total volume of traffic, journey speed and running speed over the section AD.

Section	Length (m)	Time Taken (sec)	Vehicles met with		
			Opposite Direction	Overtaking	Overtaken
AB	500	152	25	8	6
B	---	15	08	--	--
BC	600	172	31	5	2
C	---	10	03	--	--
CD	400	138	28	3	6
D	---	20	12	--	--
DC	400	132	50	12	11
C	---	12	04	--	--
CB	600	160	55	6	7
B	---	18	06	--	--
BA	500	145	45	7	2

5. a) Comment on Automatic Methods of Speed Study
   b) Write briefly on Delay and its Types

Signature of the Moderator

c) The parking survey data collected from a 10-bay parking lot by license plate method is as shown below. Determine Overall Parking Load, Average Parking Index, Parking Volume, Average Turnover, and Average Duration of the parking lot. 5×2=10

Time	Bays									
	1	2	3	4	5	6	7	8	9	10
0-10	9881	7223	2269	9730	6656	4394	2987	3295	5617	6432
10-20	9881	7223	2269	9730	6656	4394	2987	4702	5617	6432
20-30	3462	7223	2269	9730	6656	4394	2987	4702	5617	6432
30-40	9919	7223	2269	9730	5692	4394	2987	3080	5617	8255
40-50	--	3803	--	9730	5692	6353	2987	3080	5617	8255
50-60	--	3803	5372	--	5692	6353	2987	9893	1564	8255

6. A 5-phase (including 1 vehicular phase) traffic signal is to be designed for perpendicular intersection of two 6-lane dual carriageway roads AB and CD both having 2m wide refuge islands on them. Assume pedestrian green time of 8secs, starting delay of 3 secs, and Amber period of 4secs applicable in vehicular phases only. Draw the possible phase diagrams and Determine which among them is optimum. Consider the movement from A to C as left turn, intersection characteristics as good and pedestrian speed as 1.5 m/s. Use the following traffic data expressed in pcu/hr. 25

From		A			B			C			D	
To	C	B	D	D	A	C	B	D	A	A	C	B
flow	38	785	169	91	611	162	37	630	159	57	832	153

total

PAVEMENT DESIGN CATALOGUE

PLATE 1 – RECOMMENDED DESIGNS FOR TRAFFIC RANGE 1-10 msa

CBR 3%					
Cumulative Traffic (msa)	Total Pavement Thickness (mm)	PAVEMENT COMPOSITION			
		Bituminous Surfacing		Granular Base (mm)	Gran. Sub-Base (mm)
		Wearing Course (mm)	Binder Course (mm)		
1	550	20 PC		225	435
2	610	20 PC	50 BM	225	335
3	645	20 PC	60 BM	250	335
5	690	25 SDBC	60 DBM	250	335
10	760	40 BC	90 DBM	250	380

IRC:37-2001

PAVEMENT DESIGN CATALOGUE

PLATE 1 – RECOMMENDED DESIGNS FOR TRAFFIC RANGE 1-10 msa

CBR 4%					
Cumulative Traffic (msa)	Total Pavement Thickness (mm)	PAVEMENT COMPOSITION			
		Bituminous Surfacing		Granular Base (mm)	Granular Sub-Base (mm)
		Wearing Course (mm)	Binder Course (mm)		
1	480	20 PC		225	255
2	540	20 PC	50 BM	225	265
3	580	20 PC	50 BM	250	280
5	620	25 SDBC	60 DBM	250	290
10	700	40 BC	80 DBM	250	330

IRC:37-2001

PAVEMENT DESIGN CATALOGUE

PLATE 1 – RECOMMENDED DESIGNS FOR TRAFFIC RANGE 1-10 msa

CBR 5%					
Cumulative Traffic (msa)	Total Pavement Thickness (mm)	PAVEMENT COMPOSITION			
		Bituminous Surfacing		Granular Base (mm)	Granular Sub-Base (mm)
		Wearing Course (mm)	Binder Course (mm)		
1	480	20 PC		225	205
2	540	20 PC	50 BM	225	215
3	580	20 PC	50 BM	250	230
5	620	25 SDBC	55 DBM	250	250
10	660	40 BC	70 DBM	250	300

IRC:37-2001

PAVEMENT DESIGN CATALOGUE

PLATE 2 – RECOMMENDED DESIGNS FOR TRAFFIC RANGE 10-150 msa

CBR 4%				
Cumulative Traffic (msa)	Total Pavement Thickness (mm)	PAVEMENT COMPOSITION		
		Bituminous Surfacing		Granular Base & Sub-base (mm)
		BC (mm)	DBM (mm)	
10	660	40	90	
20	690	40	110	
30	730	40	130	Base 250
50	770	40	160	
100	820	50	170	Sub-base 250
150	890	50	190	

IRC:37-2001

PAVEMENT DESIGN CATALOGUE

PLATE 2 – RECOMMENDED DESIGNS FOR TRAFFIC RANGE 10-150 msa

CBR 5%				
Cumulative Traffic (msa)	Total Pavement Thickness (mm)	PAVEMENT COMPOSITION		
		Bituminous Surfacing		Granular Base & Sub-base (mm)
		BC (mm)	DBM (mm)	
10	660	40	90	
20	690	40	110	
30	730	40	130	Base 250
50	770	40	150	
100	820	50	170	Sub-base 250
150	890	50	190	