CSM – 19 / 15
Civil Engineering
Paper – II

Time : 3 hours

Full Marks : 300

The figures in the right-hand margin indicate marks.

*Candidates should attempt Q. No. 1 from Section – A and Q. No. 5 from Section – B which are compulsory and **three** of the remaining questions, selecting at least **one** from each Section.*

Section – A

1. Answer any **three** of the following questions :

   (a) (i) Explain the details of pre-construction and post-construction treatment applied as anti-termite treatment to building. 10

   (ii) State the specifications with the suitable type of flooring of a food grain storage godown where trucks of 8 Ton capacity would come in and where the sub-soil water level is within 1.5 m of the existing ground level. 10

(b) Calculate the length of lead and radius of 1 in $8\frac{1}{2}$ Turnout with straight switch for the following given track conditions :

Type of gauge : BG, G = 1676 mm

Crossing angle = $\theta_c = 6.5^\circ$

Switch angle = $\theta_s = 1.5^\circ$

Divergence at heel = $d_H = 136$ mm

Straight length measured along mail track, from theoretical nose of crossing to tangent point of lead curve = C = 864 mm

Indian Railway Standards may be adopted for calculation of the turnout components. 20

(c) (i) A TRL 5th Wheel Bump Integrator was used to determine surface roughness of a State Highway in India, during December 2015. A sample of recorded readings from this survey is given as, number counts = 19 ; number of wheel revolutions = 136 ; duration = 30 seconds. Take each unit of the bump measures as 25.4 mm, number of wheel revolutions per/km as 1000 and the

wheel circumference as 2.18 m. Determine Unevenness Index value from the above readings of the Bump Integrator as measured at the standard spee of 32 km/hr ? 12

(ii) What does the cost-time slope represent ? Explain why this slope always has a negative value ? What does this line indicate ? 8

(d) Determine closing error, apply corrections and calculate independent coordinates by Bowditch's rule for the following field data which was obtained by compass traversing : 20

Line	Length (m)	Bearing
AB	89.31	$45^{\circ}\,10'$
BC	219.76	$72^{\circ}\,05'$
CD	151.18	$161^{\circ}\,52'$
DE	159.10	$228^{\circ}\,43'$
EA	232.26	$300^{\circ}\,42'$

2. (a) The following is the list of activities of a project with their start and finish nodes and durations. The project network proceeds from node 1 to node 10.

Work Activity	Start node	Finish node	Estimated time (days)
A	1	2	2
B	1	3	3
C	1	4	3
D	2	5	3
E	2	9	3
F	3	5	1
G	3	6	2
H	3	7	3
I	4	7	5
J	4	8	3
K	5	6	3
L	6	9	4
M	7	9	4
N	8	9	3
O	9	10	2

(i) Draw the Activity-on-Arc (AOA) project network

(ii) Calculate the earliest expected times and the latest allowable times for all the events

(iii) Determine the critical path(s) of the network 20

(b) Explain how the Bulldozer productivity is determined. State an example of calculation of drawbar horsepower of a Tractor. 10

(c) State the factors affecting production of an excavator as a function of the digging cycle. Explain how overall production of an excavator is accurately estimated based on the excavator cycle time and the average bucket payload. 10

(d) Determine depth (d) and spread of water (T_s) in a V-shaped traingular gutter channel, beside of carriageway. Take following values with reference to the notations given in Figure below :

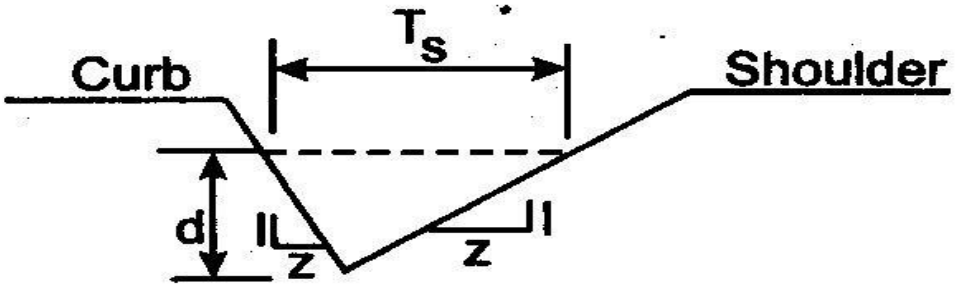


Figure. V-shaped Triangular Gutter Channel Section

Cross slopes, $S_c = 0.1667$

Longitudinal slope of the bed, $S_g = 0.01$

Manning's roughness factor, $n = 0.014$

Discharge in the Gutter = $0.03\ m^3/s$ 10

(e) A circular curve of 650 m is intended to be provided with a transition curve having limited length of 42 m. Calculate the maximum permissible speed and cant on a BG track. 10

3. (a) Determine thickness of drainage layer for the following conditions of pavement cross section (see Figure)

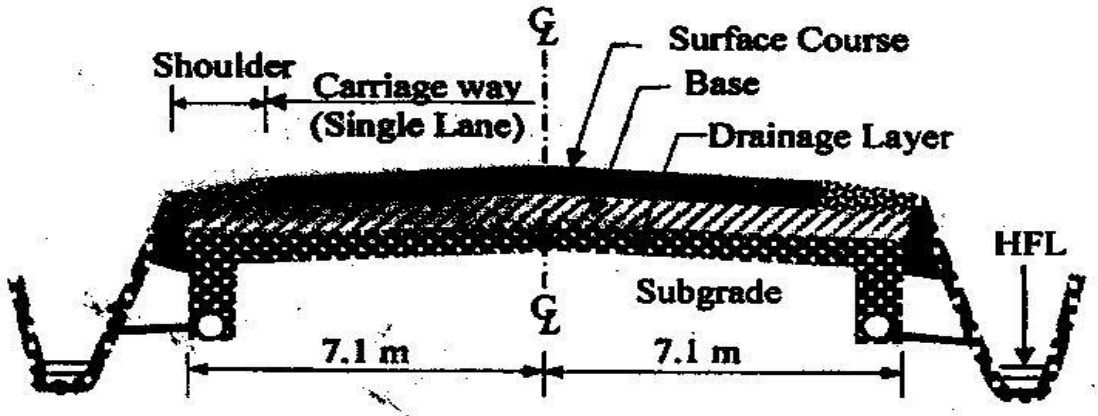


Figure Details of a Double-lane Pavement Cross Section.

Longitudinal grade = 3.5 %

Cross slope or Camber = 2.5%

Permeability of Drainage Layer per unit area = 300 m/day

At location of the pavement, the value of 25 year-1 hour maximum rainfall = 45 mm

Assume, net quantity of subsurface water to be drained as 20% of the rainfall water. Assume suitable values if any, as recommended by IRC code. 10

(b) The following input data is pertaining to a rigid pavement :

Design dowel bars for the given values as : Thickness of cement concrete pavement slab = 30 mm ; dual wheel load = 188 kN; efficiency of load transfer across the joint = 40% ; width of expansion joint = 20 mm; radius of relative stiffness = 0.994 m; characteristic compressive strength of cement concrete cube (150 mm) after a 28 days curing = 40 MPa; elastic modulus of dowel bar = 2.02×10^5 MPa and modulus of dowel bar support = 415200 MPa/m. Assume no load transfer on to the tied concrete shoulder (Assume any missing value as per the IRC : 58) 20

(c) A Rotary intersection has 5 legs which were designated as 1, 2, 3, 4 and 5. The Leg 1 is

in North-South direction and the remaining Legs are marked in clockwise direction. The traffic volumes observed during peak hour in the respective directions are given below in terms of PCU/hr.

$Q_{1\to2}$	$Q_{1\to3}$	$Q_{1\to4}$	$Q_{1\to5}$
40	299	65	55
$Q_{2\to1}$	$Q_{2\to3}$	$Q_{2\to4}$	$Q_{2\to5}$
37	52	11	29
$Q_{3\to1}$	$Q_{3\to2}$	$Q_{3\to4}$	$Q_{3\to5}$
450	112	49	666
$Q_{4\to2}$	$Q_{4\to2}$	$Q_{4\to3}$	$Q_{4\to5}$
181	50	21	116
$Q_{5\to1}$	$Q_{5\to2}$	$Q_{5\to3}$	$Q_{5\to4}$
44	133	60	19

Determine the value of weaving ratio that used to calculate the rotary capacity. 20

(d) As a routine maintenance work, a sum of Rs. 55,000,000 each year is to be spent on a series of row-building during the 5^{th} year 11^{th} year and 16^{th} year. Calculate the total

present worth of these expenditure, if the annual discount rate is 11% (compound). 10

4. (a) Determine minimum required sight distance when a sag curve is passing under an overhead structure. The conditions given are :

The curve is formed by a descending gradient of 1 in 30 meets with an ascending gradient of 1 in 50.

Length of the curve = 148 m

Vertical clearance at midway of the sag curve under on overhead structure = 4.42 m. Assume, safe stopping sight distance is less than the length of the curve. Use IRC recommended standards. 15

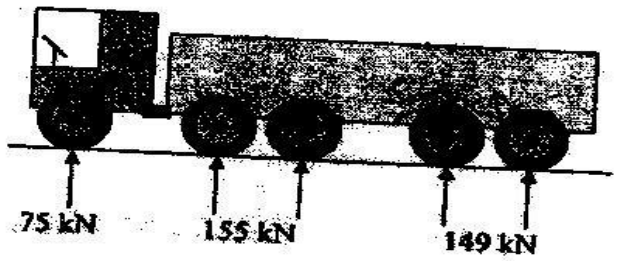
(b) Draw a schematic diagram demarcated and labelled with No-Overtaking Stretch and Minimum Sight Distance on a Horizontal Curve by Road Markings. Also state the thickness of these lines. 10

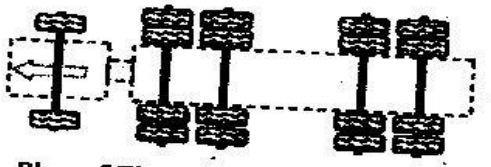
(c) Determine the months that are part of Seasonal Average Daily Traffic (SADT) and claculate the value of SADT from the following summary of traffic count : 20

Month	Number of Days	Monthly Average Daily Traffic
January	31	211
February	28	207
March	31	346
April	30	980
May	31	1263
June	30	1978
July	31	1951
August	31	1473
September	30	1329
October	31	931
Novembr	30	298
December	31	254

(d) State the significance of curved tongue rails and what designated standards of crossing angles are selected for this purpose. 5

(e) Calculate ESALs of a vehicle with the following axle and wheel configuration for design of a (i) flexible pavement and (ii) rigid pavement. 10





Plan of Five-axle tractor semi-trailer

SECTION – B

5. Answer any **three** of the following questions :

(a) The ordinates of 4 hr unit hydrograph are given below :

Time (hr)	Ordinates of UH (cumec)
0	0
4	54.0
8	68.6
12	43.2
16	22.0
20	10.7
22	0

If the effective rainfall is having storms of 1.5 cm, 5.0 cm, and 2.0 cm at equal time periods of 4 hr each, compute the flood hydrograph assuming a base flow of 15 cumec. 20

(b) (i) Distinguish between single and multipurpose projects. 10

(ii) List the methods of control the silt entry into a canal. 10

(c) (i) State the consequences of earth quake failure in earthen dams. 10

(ii) Explain the steps involved in the fixation of spillway crest level. 10

(d) Explain the nitrogen cycle with help of a diagram. 20

6. Answer the following sub-questions :

(a) A gravity well has a diameter of 60 cm. The depth of water in the well is 40 cm before pumping is started. When pumping is being done at the rate of 2000 lpm, the drawdown in a well 10 m away is 4 m and in another well 20 m away is 2 m. Determine the radius of zero drawdown, coefficient of permeability, drawdown in the well, specific capacity of well, and maximum rate at which water can be pumped from the well. 20

(b) Design the crest, and cistern of an un-flumed non-metered straight glacis canal fall with the following data :

Full supply discharge is 30 cumec, u/s FSL

is 204.30 m, d/s FSL is 202.50 m, u/s CBL is 203.00 m, d/s CBL is 201.20 m, bed width is 28.0 m, canal fall is 1.80 m, side slopes of the channel are 1 : 1, and safe exit gradient is 1/5. 20

(c) Design an irrigation channel by Kennedy's theory for the following data :

Full supply discharge is 6 cumec, bed slope is 1 in 5000, critical velocity ratio (m) is 1.0 and rugosity coefficient (n) is 0.0225. 20

7. (a) Design a set of rapid sand filters for treating water required for a population of 50,000. 20

(b) A 600 mm diameter sewer is required to flow at half depth on a grade ensuring a degree of self cleansing equivalent to that obtained at full depth at a velocity of 0.9 m/s. Find the required grade, associated velocities and discharge at full depth and half depth. Adopt a constant n of 0.015. 20

(c) The 5 day BOD at 20°C is equal to 250 mg/l for three different samples but at 20°C, the K values are 0.12/d, 0.16/d, and 0.2/d. Determine the ultimate BOD of each sample. 20

8. (a) Determine the capacity of an equalization tank for the given flow variation. 20

Time(hr)	Cumulative flow (m^3)
0	0
2	25
4	50
6	75
8	100
10	120
12	130
14	140
16	150
18	160
20	170
22	198
24	225

(b) Discuss the various types of solid wastes. Give the average composition of solid waste of an Indian City. 20

(c) Explain the effects of air pollution. 20