

CSM – 19/21
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 any **three** of
the remaining questions, selecting
at least **one** from each Section.*

SECTION – A

1. Answer any **three** questions of the following :
 - (a) Data for the material used in making a cement concrete mix are given below as :
 - (i) Water-cement ratio by mass = 0.45
 - (ii) Entrained air = 2%

S. No.	Material	Specific gravity	Bulk density (kg/m ³)	Proportion in mix by dry volume
1.	Cement	3.15	1450	1 part
2.	Fine aggregate	2.61	1660	1.359 part
3.	20 mm nominal size crushed coarse aggregate	2.70	1540	2.79 part

Determine the following for cement concrete :

- (i) Absolute volume of fully compacted fresh concrete (ignoring air content) produced by one bag of cement of 50 kg. 6
- (ii) Cement content per cubic meter of concrete (ignoring air content) produced by one bag of cement of 50 kg. 8
- (iii) Quantity of materials to make one cubic metre of concrete. 6

- (b) (i) Describe the terms : Grade of timber, location and factor of safety with reference to structural timber. 10
- (ii) What is the role of calcium sulphate in the hydration of cement ? Enlist different types of cement. Explain high alumina cement and water repellent cement. 10
- (c) The top of a stack was sighted from two stations A and B, which are 120 m apart and are in the same vertical plane with the top of the stack. The angle of elevation of the top of the stack observed from instrument station A is $35^{\circ}20'$ and that observed from instrument station B is $22^{\circ}28'$. The angle of elevation from B to a vane 1.85 m above the foot of the staff held at station A is $16^{\circ}15'$. The height of instrument at A and B were 1.856 m and 1.464 m respectively. The RL of

station B is 100.0 m. find out the RL of the top of the stack. 20

- (d) A truck with CG at $X = 1.4\text{m}$ and $Y = 1.7\text{ m}$ is travelling on curved road of radius 220 m and super elevation as 0.05. Determine the maximum safe speed to avoid both slipping and overturning, assuming that the coefficient of sliding friction of 0.15. Sketch, explain and derive the expression for the conditions when overturning is likely to happen. 20

2. (a) Describe a basic shovel by means of a simple diagram and name the main parts. Also indicate its suitability in field application. 15+5 = 20

- (b) What is a contract ? Enlist different contract documents and discuss them in general. 20

- (c) (i) With the help of data given below, draw the network diagram and find the project

completion time based on expected
time : 10

Preceding event node number	Succeeding event node number	Optimistic time in weeks	Most likely time in weeks	Pessimistic time in weeks
10	20	10	12	20
10	40	5	15	19
20	30	10	15	26
20	70	15	20	25
30	60	5	10	15
40	50	4	8	12
50	60	5	10	15
60	80	2	4	6
70	80	2	4	6

- (ii) If the project in (i) is to be completed within 40 weeks, draw a table showing the original early event time, late event time, original slack and revised early event time, revised late event time and revised slack time. Draw the revised network diagram. 10

3. (a) A driver travelling at the speed limit of 60 kmph was cited for crossing an intersection. He claimed that the duration of the amber display was improper and consequently a dilemma zone existed at the location, using the following data, determine whether the driver's claim was correct. 30

- (i) Amber duration = 4.5 sec
- (ii) Perception reaction time = 1.5 sec
- (iii) Comfortable deceleration = 3 m/sec^2
- (iv) Car length = 4.6 m
- (v) Intersection width = 15 m

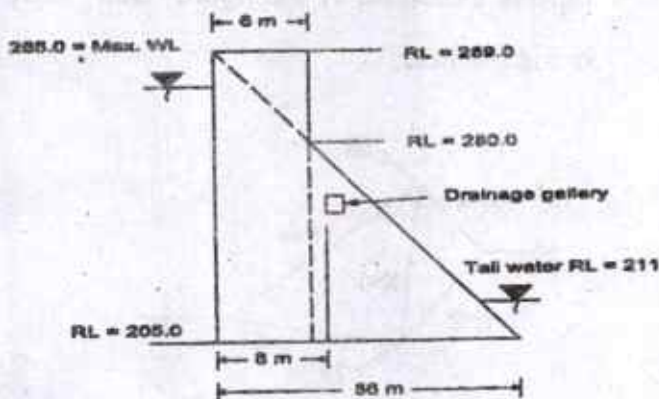
- (b) Write a detailed note on track ballast. Also, write the recommended ballast depth. With a neat, labelled sketch, write a note on points or turnouts. Write a detailed note on sleeper density for railways. 30

4. (a) The Figure below shows the section of a gravity dam (non-overflow portion) built of concrete. Calculate the maximum vertical stresses at the heel and toe of the dam,

assume weight of concrete 23.5 kN/m^3 .

Neglect earthquake effects.

30



(b) Briefly specify the following three methods used in the estimation of evaporation : 30

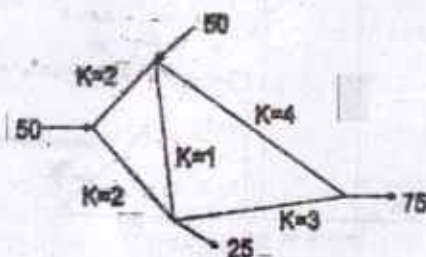
- (i) Evaporation-pan method
- (ii) Empirical method
- (iii) Analytical method

SECTION – B

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

- (a) Determine the distribution of flow in the pipe network shown below. The head loss H_L may

be assumed as kQ^n . The flow is turbulent, and pipes are rough. The value of 'k' for each pipe is indicated in the figure. Use hardy-cross method : 20



- (b) An environmental survey for a town with population of 40000 revealed the following : Domestic sewage produced at the rate of 260 litres per capita per day. The per capita BOD of the domestic sewage being 72 g/day. Industrial wastes produced were estimated as 5 million litres per day with BOD of 1500 mg/L. Sewage effluents can be discharged into a river with a minimum dry weather flow of 4500 litres/sec and a saturation dissolved oxygen content of 7 mg/L. It is necessary to

maintain dissolved oxygen content of 4 mg/L in the stream. For designing a sewage treatment plant, determine the degree of treatment requirement to be given to the sewage. Assume the followings : 20

k_D = deoxygenation coefficient = 0.1

k_R = reoxygenation coefficient = 0.3

an overall expansion factor of 10% to be provided.

- (c) A two-lane national highway passing through rolling terrain has horizontal curve of 500 m radius. Assuming design speed of 85 kmph, pavement width of 7m, with a wheelbase of 6.1 m, and determine the extra width of the pavement required for this curve. Assume other parameters as per relevant IRC recommendations.

Also, write why are origin and destination studies are conducted for a road ? Describe briefly suitable methods for conducting these studies. 20

- (d) (i) What are the factors affecting evaporation from water surfaces ?
(ii) Briefly describe any three methods of estimating the evaporation from weather data. 20

6. (a) Defining coagulation, explain the different mechanisms of coagulation and its usefulness in removal of particles. A flocculation chamber of 40 m long, 14 m wide and 4.6 deep is to treat 75 MLD of water. It is equipped with 12 m long, 0.3 m wide paddles supported parallel to and moved by four horizontal shafts which rotate at a speed of 2.5 rpm. The centre line of paddles is 1.8 m from the shaft which is at mid depth of tank. Two paddles are mounted on each shaft, one opposite to another. If the mean velocity of water is $\frac{1}{4}$ th velocity of paddles, find :

$$10+10+10 = 30$$

- (i) Power consumption
(ii) Time of flocculation
(iii) Value of G

$$\text{Kinematic viscosity of water} = 1.31 \times 10^{-6} \text{ m}^2/\text{s}.$$

- (b) Water emerges from a spillway with a velocity of 22m/s and a depth 0.5 m at the toe. Estimate the distance of the hydraulic jump from the spillway toe if no specific measures are taken for the formation of jumps at the toe. For the downstream channel take, Manning's $n = 0.020$ and $S_0 = 0.001$. Calculations may be performed by direct step method, taking only one step. Assume channel to be wide and rectangular. 30
7. (a) Design a sewer to serve a population of 42000 ; the daily per capita water supplied being 135 litres of which 75% finds its way into the sewer after use. The slope available for the sewer to be laid is 1 in 625 and the sewer should be designed to carry three times dry weather flow when running full. What would be the velocity of flow in the sewer when running full ? Assume $n = 0.012$ in Manning's formula. 30
- (b) What are the various advantages and disadvantages of septic tanks ? And how to Imhoff tanks differ from septic tanks in principle of operation ? Mention the

advantages and disadvantages of Imhoff tanks. 30

8. (a) Briefly explain the various sources of errors in Global Positioning System (GPS), and explain the following terms in brief : 20

- (i) Ecliptic
- (ii) Sensible horizon
- (iii) Equation of time
- (iv) Local mean time

(b) Write short notes on the following : 20

- (i) Leakage in water distribution system
- (ii) Break point chlorination
- (iii) Water softening
- (iv) Water borne diseases

(c) What is the importance of track drainage ? State the measures to be adopted with suitable illustrations. And also write what special measures and precautions are required in geometric features of a modern railway track ? 20

