

<b>FS – 14 / 15-16</b>
<b>Civil Engineering</b>
<b>Paper – II</b>

*Time : 3 hours*

*Full Marks : 200*

*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 **five** of the following questions :

- (a) (i) Write the classification and engineering requirements of Clay flooring tiles as per IS : 1478 and Clay roof tiles as per IS : 654. 5
- (ii) What are the factors considered for selecting the type and size of a Power Shovel ? 3

- (b) Calculate all floats of non-critical projects and critical path for the following activities duration (in days) with the various activities of a project : 8

Activity	Duration	Can start after
P	11	—
Q	8	P
R	13	—
S	6	—
T	12	P
U	8	Q, V
V	12	S
W	7	R

- (c) Determine the values of equilibrium cant, maximum permissible speed, length of the transition curve and off-sets for setting out the transition curve and salient elements of a combined curve consisting of a circular curve joined with a transition curve to its

either end of a BG line. The required curve design inputs are as follows :

Angle of deflection between two tangents of the proposed combined curve =  $68^{\circ}$

Speed considered for determining equilibrium cant = 80 km/h

Maximum sectional speed = 110 km/h

Radius of the horizontal curve = 650 m

Assume the maximum permissible cant and the cant deficiency values as per Indian Railway Board. 8

(d) (i) Explain the Bessel's method of resection of plane table surveying ? 5

(ii) Determine the probable error of the weighted mean of the following observations of the angle P with the corresponding weights : 3

$100^{\circ} 13' 24''$  Weightage = 2

$100^{\circ} 13' 27''$  Weightage = 3

$100^{\circ} 13' 22''$  Weightage = 2

- (e) Determine the months that are part of Seasonal Average Daily Traffic (SADT) and calculate the value of SADT from the following summary of traffic count : 8

Month	Number of days	MADT
January	31	201
February	28	209
March	31	345
April	30	983
May	31	1273
June	30	1979
July	31	1950
August	31	1483
September	30	1339
October	31	934
November	30	299
December	31	254

- (f) (i) Why lateral placement of wheel paths is considered for measuring roughness of pavements ? Describe



a few widely used guidelines on width of wheel path with a sketch. 3

- (ii) Write the basic working principles of Benkelman beam and falling weight deflectometer used for pavement evaluation. Write their advantages and limitations. 5

2. (a) (i) A supplier of prefabricated floor tiles produces each piece of tile for Rs. 750. The demand for tiles is 1000 units and it is estimated that a similar demand would prevail for another 3 years. Equipment to manufacture tiles is available for Rs. 22 lakh. The annual operating cost for producing 1000 pieces is estimated to cost Rs. 7 lakh for year 1, with 10% increase every year for 2 and 3. If the equipment has no salvage value at the end of 3 years,

should the supplier continue to outsource it or should he buy the equipment and start production by his own? Take the minimum attractive rate of return as 14%. 10

(ii) Explain the concept of Crash Cost and Time Cost Balancing and also state their relevance to building construction management and planning. 4

(b) (i) The elevations of two proposed triangulation stations A and B, 98 km apart, are 143 m and 431 m above mean sea level, respectively. The elevation of an intervening peak at C, 59 km from B, which is likely to obstruct the line of sight is 158 m. Ascertain, if A and B are inter-visible and if not find the height required for the scaffolding at B so that line of sight clears C by 2.9 m. 8

(ii) Derive an expression for correction for sag of a chain-line having multiple spans with standard notations. 5

(c) (i) Write the details of plate thickness requirement based on mounting type of Signs as recommended by IRC : 67 – 2012. 5

(ii) Design dowel bars for the following design inputs : Thickness of slab = 30 cm ; 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 day curing = 40 MPa ; elastic modulus of dowel bar =  $2.02 \times 10^5$  MPa and modulus of dowel bar support = 415200 MPa/m. Assume no load transfer on to the tied concrete shoulder (Note : Assume 30% of load transfer

at terminal stage in case of tied shoulder is considered (IRC : 58). 8

3. (a) (i) Explain the concepts of effective height and effective length of brick-masonry walls based on the condition of support. Also draw sketches for each case. 6

(ii) Explain the engineering measures can be taken for anti-termite treatment methods applicable to building construction during pre and post construction stages. 8

(b) (i) 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. Assume, any missing values as per the Indian Railway Board Standards. 5



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

Type of gauge : BG,  $G = 1676 \text{ mm}$

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

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

Divergence at heel =  $d_H = 136 \text{ mm}$

Straight length measured along main track, from theoretical nose of crossing to tangent point of lead curve =  $C = 864 \text{ mm}$

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

8

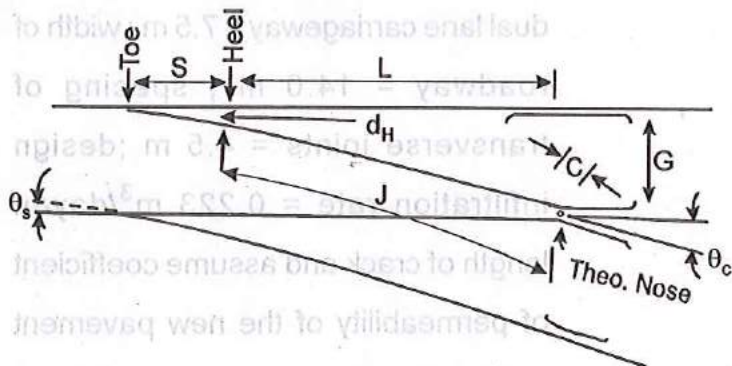


Figure 1; A Turnout with a Straight Switch

(c) (i) A horizontal curve of 270 m radius is to be designed for 65 kmph speed. The road is a two-lane road (7 m) and the super-elevation provided by rotating the pavement surface about its crown. The rate of introduction of super-elevation is 1 in 150. If the maximum wheel base length is 6 m, calculate the required minimum length of transition curve. 4

(ii) Determine infiltration rate into a new cement concrete pavement section as per the latest IRC : 37 code, for the given conditions : width of drainage layer under dual lane carriageway = 7.5 m ; width of roadway = 14.0 m ; spacing of transverse joints = 4.5 m ; design infiltration rate =  $0.223 \text{ m}^3/\text{day/m}$  length of crack and assume coefficient of permeability of the new pavement surface as zero. 4

- (iii) The following are the data collected for designing a 2-phase fixed type signal at an intersection having North-South and East-West approach roads. It is intended to straight ahead traffic is permitted to operate in these approach roads.

Parameter	Approach Road			
	North	South	East	West
Design hr. flow (PCU/hr)	845	750	850	490
Saturation flow (PCU/hr)	2500	2500	2100	2100

The time lost per cycle = 12.0 sec.

Determine the optimum cycle length as per Webster formula. Also calculate effective green time per phase North-South. 5

4. (a) (i) Explain the defects in Plastering and write remedial measures in minimizing the defects. 5
- (ii) Write the basic principles and standards of pumping rules of cement concrete mix. 4

(iii) Compare the Crawler-mounted versus Wheel-mounted Bulldozer with their advantages and limitations. 5

(b) (i) Draw a chart and determine 90 percentile and 80 percentile of the CBR values from the following measured CBR values of in-situ soil data obtained at an interval of 700 m along a proposed center line of sub-grade : 4

Location ID	CBR (%)
A	7.6
B	6.2
C	5.8
D	6.5
E	6.9
F	7.2
G	6.8
H	5.5
I	5.1
J	4.9
K	4.7



- (ii) State the failure criteria adopted for thickness design of flexible pavement as per IRC : 37, 2015. Draw sketches and explain the five typical pavement composition with reference to the considered failure criteria. 5

- (iii) Determine minimum required sight distance when a sag curve is passing under an overhead structure. The conditions given are : Take, design speed = 100 km/hr ; Angle of Deviation in decimal value =  $|G| = 0.05833$  ; Length of the curve = 148 m ; Vertical clearance at midway of the sag curve under overhead structure,  $c = 4.42$  m. Assume, standard conditions as per IRC standard. 4

- (c) (i) 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.

$Q_{1 \rightarrow 2}$	$Q_{1 \rightarrow 3}$	$Q_{1 \rightarrow 4}$	$Q_{1 \rightarrow 5}$
42	291	64	52
$Q_{2 \rightarrow 1}$	$Q_{2 \rightarrow 3}$	$Q_{2 \rightarrow 4}$	$Q_{2 \rightarrow 5}$
38	51	12	22
$Q_{3 \rightarrow 1}$	$Q_{3 \rightarrow 2}$	$Q_{3 \rightarrow 4}$	$Q_{3 \rightarrow 5}$
451	111	46	663
$Q_{4 \rightarrow 1}$	$Q_{4 \rightarrow 2}$	$Q_{4 \rightarrow 3}$	$Q_{4 \rightarrow 5}$
185	53	25	115
$Q_{5 \rightarrow 1}$	$Q_{5 \rightarrow 2}$	$Q_{5 \rightarrow 3}$	$Q_{5 \rightarrow 4}$
45	131	61	15

Calculate the weaving ratio between the legs 1 to 2, 2 to 3, 3 to 4, 4 to 5 and 5 to 1. Determine the value of weaving ratio that used to calculate the rotary capacity.

9

- (ii) Draw a schematic diagram showing and labelled with No-Overtaking Stretch and Minimum Sight Distance on a Horizontal Curve by Road Markings as per IRC : 35. 4

### SECTION - B

5. Answer any **eight** questions from the following :

$$5 \times 8 = 40$$

- (a) Distinguish between theoretical and practical profile of a gravity dam.
- (b) List the circumstances under which ogee spillway is to be used.
- (c) Differentiate between single and multi purpose projects.
- (d) Define the term storage coefficient.
- (e) Explain briefly the different types of precipitations.
- (f) State the factors affecting evaporation.
- (g) State the functions of downstream drainage system.
- (h) Distinguish between zoned embankment and diaphragm type earth dams.

- (i) Briefly explain the foundation treatment to be carried out for gravity dams.
- (j) State the advantages of canal lining.
- (k) Write a note on contour canal alignment.
- (l) Explain the functions of a divide wall.
6. (a) Determine the capacity of the reservoir for the varying demand values given below : 14

Inflows (cumec)	Demands (cumec)
15	15
70	17
200	45
250	140
220	190
180	205
140	180
90	150
70	125
50	100
35	60
25	40
16	25
13	16



(b) Perform the hydraulic jump calculations for an under sluice portion based on the following data :

Full supply discharge intensity in the canal is 32.9 cumec/m, HFL on d/s is 261.70 m, Sill level of sluices is 257.00 m. 13

(c) Mention the causes of over-topping of earth dams. 3

(d) List the seepage control measures through embankments and foundations of earth dams. Further, explain any one of them under each category. 10

7. (a) With the help of the following data, estimate the population for the year 2010 and 2020 by arithmetic, geometric and incremental change methods : 10

Year	Population
1970	90,000
1980	1,35,000
1990	1,89,000
2000	2,57,000

- (b) A coagulation-sedimentation tank clarifies 10 Mld. The quantity of aluminum sulphate required is 72 ppm. If the raw water is having an alkalinity of 20 ppm of  $\text{CaCO}_3$ , determine the quantities of aluminum sulphate and quick lime (containing 85% of  $\text{CaO}$ ) required per year. 14
- (c) Design a settling tank for treating water for a population of 1,00,000 people, with an average daily consumption of 135 lpcd. Assume the detention time as 4 hr. 6
- (d) (i) State the causes of water leakage along water supply lines. 4
- (ii) Sketch the HGL for boosting the flow and the pressure. 6
8. (a) Design the underdrainage system for a trickling filter handling a maximum flow of 0.15 cumecs. 13
- (b) Determine the volume of the raw sludge, volume of the digested sludge and compute the volume of the digester for the given data:

Moisture content of influent sludge is 96%, initial volatile solids content in the sludge is 70%, volatile solids destroyed are 65%, digested sludge solid concentration is 8%, specific gravity of primary sludge is 1.03 and that of digested sludge is 1.04. 6

- (c) Determine the flow in the river required per 1000 population for disposing off sewage from a residential colony with the following data :

Average temp. of river water is  $25^{\circ}\text{C}$ , 5 day BOD of sewage at  $25^{\circ}\text{C}$  is 300 ppm, average sewage flow 150 lphd, values of deoxygenation and reoxygenation constants of the river at  $25^{\circ}\text{C}$  are 0.15/day and 0.27/day respectively, minimum DO concentration to be provided in river water is 4.0 ppm and saturation DO of river water at  $25^{\circ}\text{C}$  is 8.38 ppm. 14

- (d) Explain the systems of plumbing. 7



Moisture content of influent sludge is 98%,  
 initial volatile solids content in the sludge is  
 70%, volatile solids destroyed are 65%,  
 digested sludge solid concentration is 8%,  
 specific gravity of primary sludge is 1.03 and  
 that of digested sludge is 1.04.

(c) Determine the flow in the river required per  
 1000 population for disposing off sewage  
 from a residential colony with the following  
 data:

Average temp. of river water is  $25^{\circ}\text{C}$ , 5 day  
 BOD of sewage at  $25^{\circ}\text{C}$  is 300 ppm, average  
 sewage flow 150 lphd, values of  
 deoxygenation and reoxygenation constants  
 of the river at  $25^{\circ}\text{C}$  are 0.15/day and  
 0.27/day respectively, minimum DO  
 concentration to be provided in river water is  
 4.0 ppm and saturation DO of river water at  
 $25^{\circ}\text{C}$  is 8.38 ppm.

(d) Explain the systems of plumbing.