BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
CE -G549 RURAL ROAD TECHNOLOGY
SEMESTER I, 2022-23
COMPREHENSIVE EXAMINATION (OPEN BOOK*)

Date : 20-12-2022 **Time : 180 minutes**
Max. Marks: 70

INSTRUCTIONS:

(i) Open Book – Prints of IRC:SP:62-2014 (Pg: 1 to 15) & IRC:SP:72 – 2015 (Pg:1-22, 33) are ONLY allowed .

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Q1. Consultancy agencies **X** and **Y** submitted their designs for a client that involves design of drainage system for site **S**. The site details are provided in Table 1.

The design provided by each company is as follows:

a) **X** suggested:
- Trapezoidal shaped road side drainage (Figure 1) lined with dense turfing.
- A sand blanket for capillary cut off.

b) **Y** suggested:
- Parabolic shaped road side drainage lined with rock (smooth & regular)
- Daylighted granular drainage layer meeting the side drain.

As a third-party consultant, provide a detailed response to the following queries put forward by the client.

(i) Benefits of each type of side drainage chosen by **X** and **Y**. ***2 Marks***

(ii) What is the cross section of the side drain and slope of the drain bed, designed by **X** such that it can accommodate the peak run – off and maximum permissible velocity to prevent erosion? Take free board of 0.15 m. ***10 Marks***

(iii) Is capillary cut - off suggested by **X** necessary for this project? If **yes**, justify your answer with neatly labelled cross section of capillary cut - off. If **no**, draw the cross section of the daylighted granular drainage layer meeting the side drain as per the suggestion by **Y.** ***8 Marks***

Table 1 : Site details

No.	Property	Remark / Value
1.	Site condition	Water logged area
2.	Rainfall intensity	28 mm / hr
3.	Area of water shed	0.25 km^2
4.	Surface	Steep rock with some vegetative cover

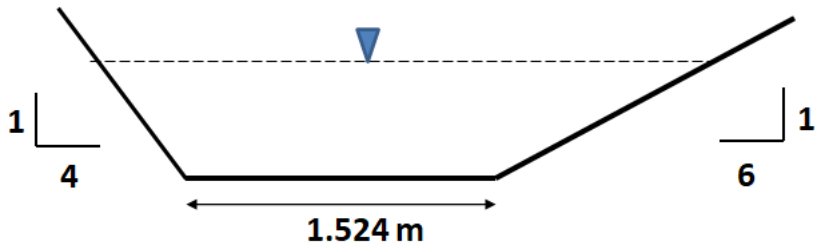


Figure 1

Q2. Design a rigid pavement of 5.5m carriageway using the following details. Draw the cross section of the designed pavement. ***20 Marks***

Duration of traffic survey : 3 days

- Total motorized vehicles : 1621
- Total non – motorized vehicles : 2825
- Total commercial vehicles: 354

Construction period : 18 months

Time delay between traffic survey and start of construction : 3 months

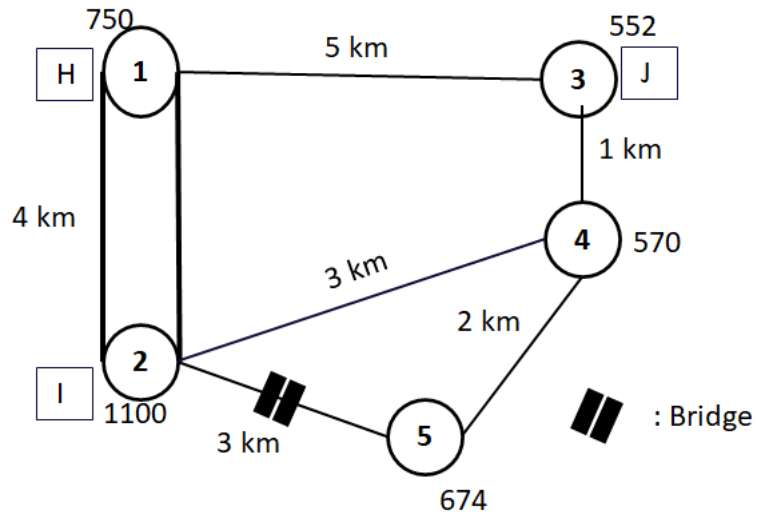
Temperature Zone : 3

Result of plate bearing test using 300 mm diameter plate : 70 MPa/m

Minimum grade of concrete is to be used. Consider trucks with dual wheel load for design and an economical design. Assume a trial thickness of 180 mm with 3.75 m joint spacing, traffic growth rate of 6%, and an acute scarcity of aggregates.

Q3. The subbase material for Site **S** is in need of mechanical stabilization. The subbase material mix after stabilization should result in maximum density with minimum voids. Under this scenario, calculate the percentage passing if the maximum size of aggregate is 26.5 mm and other sizes to be considered are 19 mm, 12.5mm, 9 mm, 6.36mm, 4.75 mm, 2.36mm, 300 micron and 75 micron. Detailed steps are required. ***5 Marks***

Q4. Find the optimum network for the area shown using FBRNP model, if JMAX=3 km, HMAX = 5 km, and IMAX = 10 km. ***15 Marks***



Q5. True / False. If False correct the statement technically. (NO PARTIAL MARKING). The statement must be corrected technically and not to be written as the opposite. ***(1 marks x 10)***

Eg: Statement :

(i) Circuity Index is the ratio of actual distance to air distance between village and market centre and a value less than 2 indicates that no link should be proposed between them.

(ii) Bituminous Macadam is recommended for flexible pavements with design traffic > 1 msa.

(iii) In FBRNP model, the cost of bridge is not taken into consideration while optimizing the network.

(iv) For assessment of pavements for maintenance, a Mu – meter is used to detect voids in pavement layers.

(v) The joint filling sand and bedding sand should be of same gradation in ICBP.

(vi) In calculating AADT as per IRC:SP:72-2015, " n" signifies the number of harvesting seasons in a year.

(vii) Iron spikes in cell filled concrete pavement act similar to dowel bars.

(viii) The paver blocks must be laid from inner to outer edges.

(ix) A fin drain consists of partially perforated pipe which is laid horizontally with backfill material.

(x) Boggy action is caused due to provision of inadequate camber .

Table 2

No.	Description of surface	Coefficient of runoff
1.	Steep bare rock and watertight pavement surface (concrete or bitumen)	0.90
2.	Steep rock with some vegetative cover	0.80
3.	Plateau areas with light vegetative cover	0.70
4.	Bare stiff clayey soils (Impervious soils)	0.60
5.	Stiff clayey soils (impervious soils) with vegetative cover and uneven paved road surface	0.50
6.	Loam lightly cultivated or covered and macadam or gravel roads	0.40
7.	Loam largely cultivated or turfed	0.30
8.	Sandy soils, light growth, parks, gardens, lawns and meadows	0.20
9.	Sandy soil covered with heavy bush or wooded / forested areas	0.10

Table 3

S. No. (1)	Ditch Lining (2)	Manning's 'n' (3)	Allowable Velocity to Prevent Erosion m/sec. (4)
1	**Natural Earth**		
A.	**Without Vegetation**		
	i) Rock		
	Smooth & Uniform	0.035-0.040	6
	Jagged & irregular	0.04-0.045	4.5-5.5
	ii) Soils (Extended Casagrande Classification)		
	G.W.		
	G.P.	0.022-0.024	1.8-2-1
	G.C.	0.023-0.026	2.1-2.4
	G.F.	0.020-0.026	1.5-2.1
	S.W.	0.024-0.026	1.5-2.1
	S.P.	0.020-0.024	0.3-0.6
	S.C.	0.022-0.024	0.3-0.6
	S.F.	0.020-0.023	0.6-0.9
	CL and CT	0.023-0.025	0.9-1.2
	MI and ML	0.022-0.024	0.6-0.9
	OL and OI	0.023-0.024	0.9-1.2
	CH	0.022-0.024	0.6-0.9
	MH	0.022-0.023	0.6-0.9
	OH	0.023-0.024	0.9-1.5
	Pt	0.022-0.024	0.6-0.9
		0.022-0.025	0.6-0.9
B.	**With Vegetation**		
	Average turf		
	Erosion resistant soil	0.050-0.070	1.2-1.5
	Easily eroded soil		
	Dense turf	0.030-0.050	0.9-1.2
	Erosion resistant soil		
	Easily eroded soil	0.070-0.090	1.0-2.4
	Clean bottom with bushes on sides		
	Channel with tree stumps	0.040-0.50	1.5-1.8
	No sprouts	0.050-0.080	1.2-1.5

Table 4

L/*l* or W/*l*	1	2	3	4	5	6	7	8	9	10	11	≥12
C	0	0.04	0.175	0.44	0.72	0.92	1.03	1.077	1.08	1.075	1.05	1

REFERENCE FORMULA SHEET

SSD $= vt + \frac{v^2}{2g\left(f \pm \frac{n}{100}\right)}$	OSD = $v_b t + v_b T + 2s + v_c T$ $e + f = \frac{v^2}{gR}$		$W_e = \frac{nl^2}{2R} + \frac{\boldsymbol{V}}{9.5\sqrt{R}}$
$m = R\ - (R - d)cos\frac{\propto}{2} + \left(\frac{S-L_c}{2}\right)\sin(\frac{\propto}{2})$;			$L_s = \frac{Ne(W + W_e)}{2}$
$L_s = \frac{2.7V^2}{R}$; $L = 2\sqrt{\frac{Nv^3}{C}}$	$L_s = Ne(W + W_e)$ $S_g = vt = 0.278Vt$		$W = \frac{Q}{D}$
$m = R\ - Rcos(\frac{\propto}{2})$	$m = R\ - Rcos\frac{\propto}{2} + \left(\frac{S-L_c}{2}\right)\sin(\frac{\propto}{2})$		$m = R\ - (R\ - d\ )\ cos(\frac{\propto}{2})$
$L_s = \frac{v^3}{CR}$ $S = \frac{L_s^2}{24R}$	$L_s = \frac{V^2}{R}$; $L = 2S - \frac{2\left(\sqrt{h_1}+\sqrt{h_2}\right)^2}{N}$		$\frac{30 + R}{R}$; $\frac{75}{R}$
$L = \frac{NS^2}{2(h_1 + S\ tan\alpha)}$	$L = 2S - \frac{2(h_1 + S\ tan\alpha)}{N}$		$L = \frac{NS^2}{2\left(\sqrt{h_1} + \sqrt{h_2}\right)^2}$
$LPI = \frac{TN}{L} + 5B$	$VAI_{ij} = \frac{k \times P_i \times Q_j \times TPI(i)}{D_{ij}^n}$		$W_f = \frac{k}{N_f}$
$CS_i = (\sum_f n_f W_f)_i$	$F_{ij} = \frac{P_i P_j \lvert CS_i - CS_j \rvert}{D_{ij}^2}$	$LE_{ij}^1 = \frac{F_{ij}}{L_{ij}}$	$\sigma_{te} = \frac{E\alpha\Delta t}{4(1-\mu^2)}$
Q=0.028PAI_c	$V = \frac{1}{n}R^{2/3}S^{1/2}$	1 hectare = 0.01 km^2	