GX508

OLLSCOIL na hÉIREANN, GAILLIMH

NATIONAL UNIVERSITY OF IRELAND, GALWAY

SECOND SEMESTER EXAMINATIONS, 1999

B.E. DEGREE

HIGHWAY AND TRAFFIC ENGINEERING
B.E. Degree: Paper 2

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Time allowed: two hours.
Answer all questions.

1. (30%)

(a) Lay out a flow diagram showing the principal stages of a sequential transportation-planning model.

(b) A base year origin-destination (O-D) matrix for a road network is tabulated below together with the target numbers of trips originating and terminating in each zone for the design year. Using a doubly constrained growth factor distribution model, compute the design year O-D matrix after three iterations.

	1	*2*	*3*	$\sum j$	*Target Oi*
1	0	50	100	150	**150**
2	50	0	100	150	**200**
3	100	200	0	300	**400**
$\sum i$	150	250	200	600	
Target Dj	**250**	**300**	**200**		**750**

2. (40%)

Analytical pavement design equations based on Odemark's equivalent layer theory are provided below. Determine the number of repetitions, N_s and N_f, of a standard 80 kN axle load that will cause failure in a flexible pavement comprising 50 mm of dense bitumen macadam, 450 mm of wet-mix macadam and 300 mm of crushed rock on a weak subgrade foundation. The average temperature is 16°C.The properties of the pavement materials that are necessary to solve the problem are provided below:

dense bitumen macadam: initial penetration of the bitumen =100 dmm; R & B softening point = 44°C; bitumen content = 4.5%; voids content = 8%; $\nu_1 = 0.4$.
granular materials: combined thickness = 750 mm with $\nu_2 = 0.4$.
subgrade: CBR = 3 %; $\nu_3 = 0.4$
standard axle load: tyre pressure = 0.6 MN/m^2; wheel load = 40 kN; speed of travel = 50 km/hr.

ANALYTICAL PAVEMENT DESIGN (calibrated to LR 1132, TRL)

$$P_r = 0.65\,P_i \qquad SP_r = 1.1\,SP_i \qquad A = \frac{\log(800/P_r)}{SP_r - 25} \qquad PI_r = \frac{20(1-25A)}{1+50A}$$

$$t(s) = \frac{1}{V_d(km/h)} \qquad S_b = 1.157\times10^{-7}\times t^{-0.368}e^{-PI_r}(SP_r - T)^5$$

$$C_w = 1 - B_w \qquad C_v = \frac{C_w}{2.7 - 1.7C_w} \qquad C_v^1 = \frac{C_v}{0.97 + V_a}$$

$$E_3 = 10\times CBR \qquad E_2 = 0.206\,h_2^{0.45}\,E_3 \qquad n = 0.83\log\left\langle\frac{4\times10^4}{S_b}\right\rangle$$

$$S_m = S_b\left\langle 1 + \frac{2.5C_v^1}{n\left(1-C_v^1\right)}\right\rangle^n \qquad H_{ij} = h_i\left\langle\frac{E_i\left(1-\nu_j{}^2\right)}{E_j\left(1-\nu_i{}^2\right)}\right\rangle^{1/3} \qquad z_s = 0.8\left(H_{13}+H_{23}\right)$$

$$\varepsilon_z = \frac{p}{E_3}\left\langle 1 - \left\{1+\left(a/z_s\right)^2\right\}^{-3/2}\right\rangle \qquad k = 1.167\,h_1^{0.415}\,E_3^{0.179}$$

$$\varepsilon_r = \frac{kp(1+\nu_2)}{2E_2}\left\langle(1-2\nu_2) + \frac{1}{\left\{1+\left(a/H_{12}\right)^2\right\}^{3/2}} - \frac{2(1-\nu_2)}{\left\{1+\left(a/H_{12}\right)^2\right\}^{1/2}}\right\rangle$$

$$V_b = 100\left(1-V_a\right)\frac{2.7B_w}{1+1.7B_w}$$

$$A = 14.39\log V_b + 24.2\log SP_i - 40.341 \qquad B = 5.13\log V_b + 8.63\log SP_i - 15.8$$

$$\log N_f = A - B\log\left(\varepsilon_r\times10^6\right) \qquad \log N_s = -6.49 - 3.78\log\varepsilon_z$$

3. (15%) Where I is the intensity and I_o is the reference intensity of a sound wave, the sound level in decibels dB is given by

$$10\log_{10}\frac{I}{I_o}$$

Compute the energy mean noise level from a highway given that the traffic noise is equally distributed between 20 and 40 dB(A); 40 and 60 dB(A); 60 and 80 dB(A); and 80 and 100 dB(A); using a 20 dB(A) class interval.

4. (15%)

(a) Explain the principle of the moisture condition value (MCV) test for assessing the condition of a subgrade soil during earthworks.

(b) The following MCV results were obtained for a heavy clay subgrade. Establish whether or not the material is suitable for use in shaping the formation level? Semi-logarithmic graph paper is provided below to obtain the solution.

No. of blows	1	2	3	4	6	8	12	16	24	32	48
Penetration (mm)	35	56	69	78	88	96	100	101	101	101	101