Bengal Engineering and Science University, Shibpur
M.E. (Civil) First Semester Examination, 2011
Pavement Design - I (CE-919)

Full Marks : 70 **Time : 3 hours**

Answer any *FIVE* Questions
The questions are of Equal Value

1. For a three-layer pavement structure, the following are the layer details:
   i) Asphalt concrete surface of thickness 150 mm and modulus of elasticity of 2.8×10^6 kPa
   ii) Granular base of thickness 600 mm and modulus of elasticity of 1.4×10^5 kPa
   iii) Subgrade of modulus of elasticity of 0.7×10^5 kPa.
   Assuming a Poisson's ratio of 0.5 for all the layers, calculate the following strains along the centre line of of a 283 kN wheel load with 1000 kPa tyre pressure. Clearly show the interpolations, if any.
   a) the vertical compressive strain at the top of the subgrade
   b) the horizontal tensile strain at the bottom of the asphalt concrete layer.
   c) Is there any other strain to be calculated as per IRC: 37-2001 stipulations? (2x6+2)
   [Note: Use of Peattie's chart and Jone's tables are allowed.]

2. (a) With the help of a neat sketch show the critical locations for checking of strains in flexible pavements as per IRC :37-2001.
   (b) Describe with sketches the phenomena of (i) fatigue failure and (ii) rutting failure in pavements.
   (c) State the fatigue criteria and rutting criteria stipulated in IRC: 37-2001.
   (d) What are the recommendations for obtaining the modulus of elasticity of subgrade, sub-base and base layers? (2x4+2x3)

3. (a) Illustrate with the help of a sketch the general concept of a multilayered elastic system, showing the stresses acting on a typical element. Clearly state the assumptions involved.
   (b) With the help of Burmister's two-layer theory show the variation of vertical stress with depth , and compare it with that from Boussinesq's one-layer theory.
   (c) Describe the steps in the design of base course thickness following Burmister method.
   (d) What additional information can be obtained from Huang's extension of Burmister's solution? (2x4+2x3)

4. From a designer's point of view, discuss in detail how you would approach to find optimum values of layer thicknesses and the values of modulus of elasticity of the layer materials representing the quality of the layer materials. (14)

5. a) How is effect of repetition of wheel load taken care in pavement design? (3)
   b) What is ESWL? Determine ESWL by Boyd and Foster's method for a flexible pavement of 600 mm thick for the following condition:
   i) single axle with dual tyres
   ii) tandem axle with dual tyres
   The rear axle of the truck is carrying 18 tonnes. The centre to centre distance between two tyres of the dual set is 300 mm. Tandem axels are 600 mm apart. The tyre pressure is assumed as 7.2 kg/cm^2 and the tyre contact surface is taken as circular. Clear distance between tyres is 100 mm in both the vehicles. Compare the ESAL of single axle over the tandem axle. (2+9)

6 a) A flexible pavement is to be designed for a highway having two lane single carriageways. The traffic survey, conducted 3 years before the completion of construction, recorded movement of commercial traffic of 265 CVPD. The VDF is calculated as 2.5. The subgrade CBR is found to be 3%. Design the flexible pavement as per IRC: 37-2001 using the table as given below. Assume traffic growth rate as 7.5 % per annum, and design life as 15 years. (10)

Cumulative Traffic (msa)	Total Pavement thickness (mm)	PAVEMENT COMPOSITION			
		Bituminous Surfacing (mm)		Granular base (mm)	Granular sub-base(mm)
		Wearing course	Binder course		
1	550	20PC		225	335
2	610	20PC	50 BM	225	335
3	645	20PC	60 BM	250	335
5	690	25 SDBC	60 DBM	250	335
10	760	40 BC	90 DBM	250	380
20	790	40 BC	120 DBM	250	380
30	810	40 BC	1400 DBM	250	380
50	830	40 BC	1600 DBM	250	380
100	860	50 BC	1800 DBM	250	380
150	890	50 BC	2100 DBM	250	380

b) Discuss briefly on advantages of mechanistic-empirical design method of flexible pavement. (4)

7. a) What is meant by overlay? (2)

b) The following are the BBD, field moisture content and temperature readings at equidistant points obtained along a stretch of a major road. If the pavement is to sustain further 15 msa of traffic repetitions, design an overlay thickness for the stretch. The average annual rainfall of the area is found to be 1400 mm and the soil is of clayey nature, with average plasticity index 14. (12)

Sl.No.	Pavement temp.(°C)	Moisture content (%)	Dial gauge reading (mm)		
			Initial	Intermediate	Final
1	35	10	0.00	0.54	0.56
2	35	11	0.00	0.54	0.57
3	38	10	0.00	0.51	0.54
4	37	10.5	0.00	0.50	0.51
5	36.5	10.5	0.00	0.48	0.49
6	37	11.5	0.00	0.46	0.49
7	36	10	0.00	0.48	0.51
8	35	11	0.00	0.57	0.57
9	34	10	0.00	0.53	0.56
10	35	10	0.00	0.53	0.54

8. a) How to control the subsurface drainage? Explain with neat sketch.

b) Why the drainage system is complicated in the urban area compare to that of rural area?

c) Discuss the principal parameters to be considered in the design of flexible pavements.

(6+3+5)

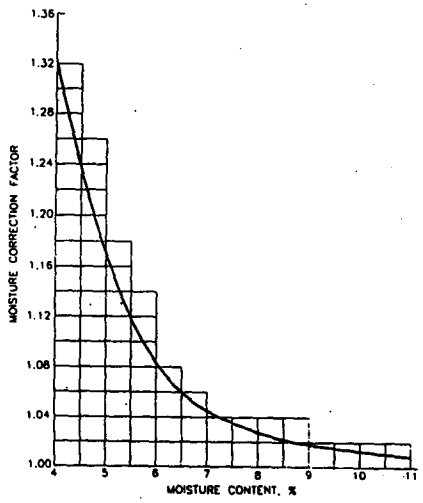

Fig. 2. Moisture correction factor for Sandy/Gravelly soil subgrade for low rainfall areas (Annual rainfall ≤ 1300 mm)

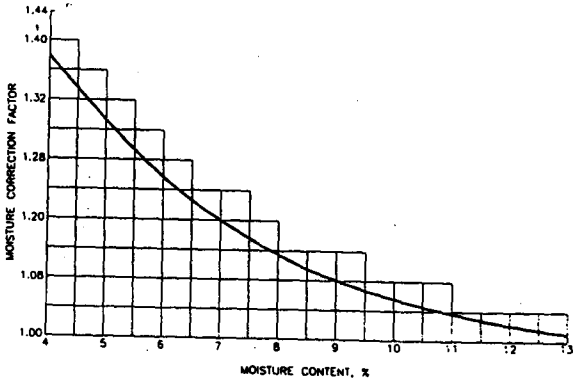

Fig. 3. Moisture correction factor for Sandy/Gravelly subgrade for high rainfall areas (Annual rainfall > 1300 mm)

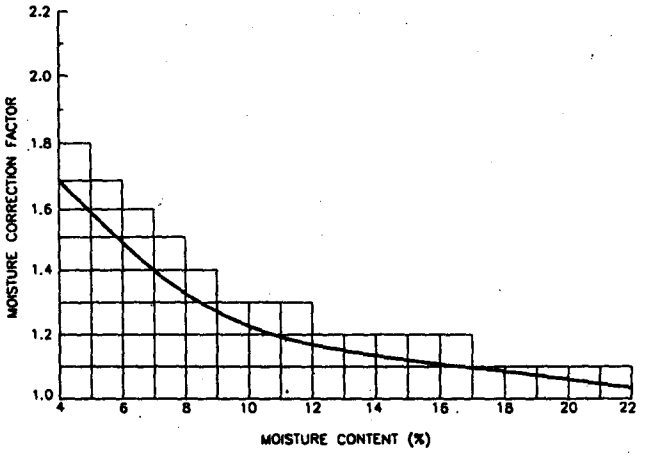

Fig. 4. Moisture correction factor for clayey subgrade with low plasticity (PI < 15) for low rainfall areas (Annual rainfall ≤ 1300 mm)

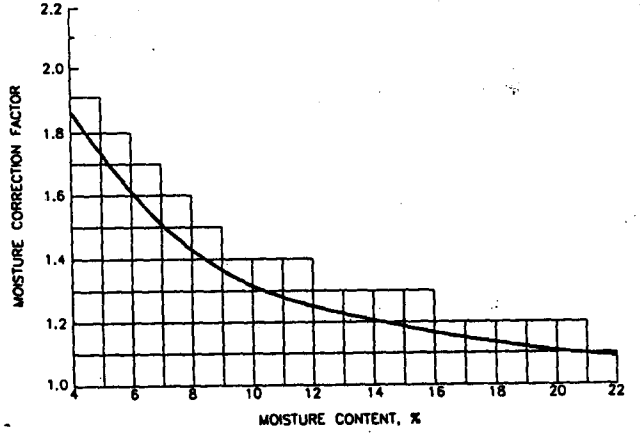

Fig. 5. Moisture correction factor for clayey subgrade with low plasticity (PI < 15) for high rainfall areas (Annual rainfall > 1300 mm)

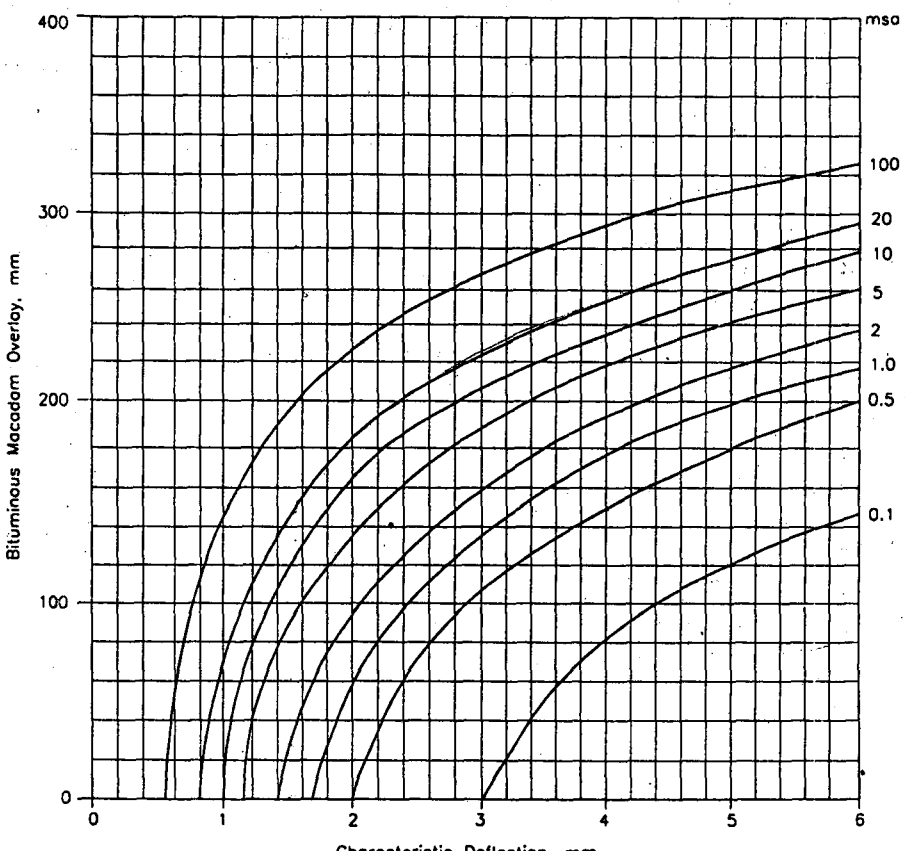

Fig. 9. Overlay Thickness Design Curves