Pavement Design VTU Question Paper Set

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10CV833

Eighth Semester B.E. Degree Examination, Dec.2014/Jan.2015
Pavement Design

Time: 3 hrs. Max. Marks:100

Note: *1. Answer any FIVE full questions, selecting atleast TWO questions from each part.*
2. Plane graph sheet may be used.
3. INC charts are supplied.

PART – A

1 a. Explain the classification system of pavements based on their behavior. **(06 Marks)**

b. Bring out the differences between highway and airfield pavements. **(07 Marks)**

c. It is required to calculate the design repetitions for 20 years of period for various wheel loads equivalent to 22.68 kN using the following traffic survey data on a 4 laned road.

Wheel load kN	22.68	27.22	31.75	36.29	40.82	45.36
Traffic volume	50	45	32	30	15	10

(07 Marks)

2 a. List and explain the various factors to be considered in pavement design. **(08 Marks)**

b. Explain the various reasons for frost action in rigid pavements and how it is over come. **(06 Marks)**

c. Explain the procedure for calculating ESWL for dual wheel tandem axle wheel assembly. **(06 Marks)**

3 a. Plate bearing test was conducted on an 30cm ϕ steel plate and the following readings were observed. Find the corrected K value for standard plate of 75cm size: **(10 Marks)**

Mean settlement values, mm	0	0.26	0.51	0.75	1.01	1.26	1.54	1.74
Load values kg	0	465	910	1200	1350	1500	1600	1650

b. Design a flexible pavement by CBR method based on IRC: 37 – 2001 recommendations using the following data:

i) Pavement: 2 lane.
ii) Traffic volume 700 CV/day.
iii) Road construction period : 3 years.
iv) Rate of growth of traffic 8%.
v) Lane distribution factor 0.75.
vi) Design size 15 years.
vii) Vehicle damage factor 3.5.
viii) Subgrade CBR 6%. **(10 Marks)**

4 a. Explain the Mc Leod method of pavement design and indicate how it is different from triaxial method. **(10 Marks)**

b. For the following data, design an flexible pavement. Pressure sustained on 30cm ϕ plate on a soil subgrade at 0.5cm deflection was 1.25 kg/cm^2 and 4 kg/cm^2 over 15cm base course. Design the pavement section for 4100 kg wheel load with tyre pressure of 5kg/cm^2 for allowable deflection of 0.5cm using Burmister's approach. **(10 Marks)**

PART – B

5 a. Explain the following with reference to rigid pavement design:
   i) Radius of relative stiffness.
   ii) Equivalent radius of resisting section.
   iii) Critical loading positions.
   iv) Temperature stresses.
   v) Frictional stresses. **(10 Marks)**

   b. For a cement concrete pavement, find the magnitude of stresses at 3 regions for the following data and given charts:
   i) Wheel load – 5100kg
   ii) $E = 3 \times 10^5$ kg/cm^2
   iii) Pavement thickness, h = 18cm
   iv) Poisson's ratio for concrete 0.15
   v) Modulus of subgrade reaction K = 6 kg/cm^3
   vi) Radius of contact, a = 15cm. **(10 Marks)**

6 a. Explain with sketches the functions of various types of joints in C-C pavements. **(10 Marks)**

   b. Explain the functioning of dowel bars with neat sketches, the road transfer mechanism. **(10 Marks)**

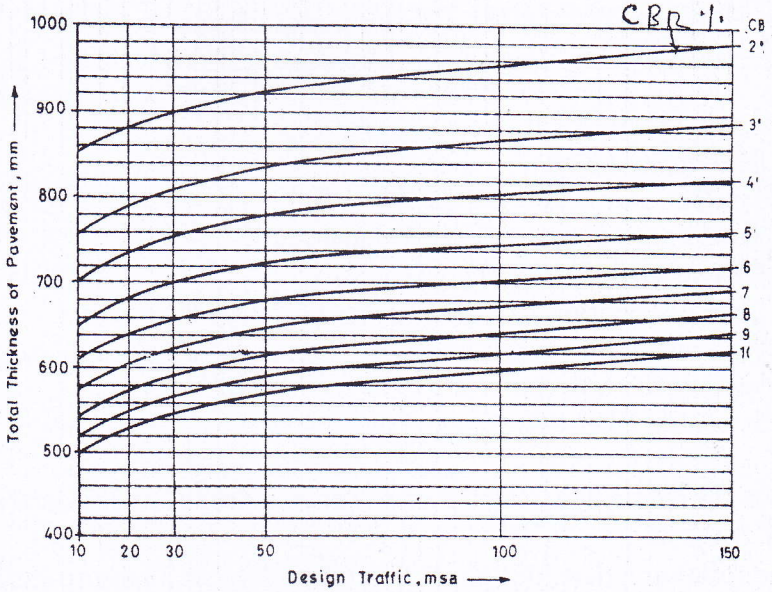
7 a. Explain the various recommendations for the design of dowel bars for all the 3 cases including minimum dowel length. **(10 Marks)**

   b. A cement concrete pavement has a thickness of 20cm on a 2 lane road of 7.5m with a longitudinal joint along the centre. Design the dimensions and spacing of tie bars for the following data. Working stress in tension, S_s = 1400 kg/cm^2 density of concrete, W = 2500 kg/m^3, friction coefficient – 1.5. Allowable bond stress in concrete, S_b = 24.6 kg/cm^2. **(06 Marks)**

   c. Write a note on combination of stresses for pavement design during different seasons. **(04 Marks)**

8 a. Explain with a neat sketch, the mechanism of mud pumping in C.C. pavements constructed on clayey strata. Indicate the remedial measures. **(10 Marks)**

   b. List and explain the various factors to be considered in airfield pavement design. **(10 Marks)**

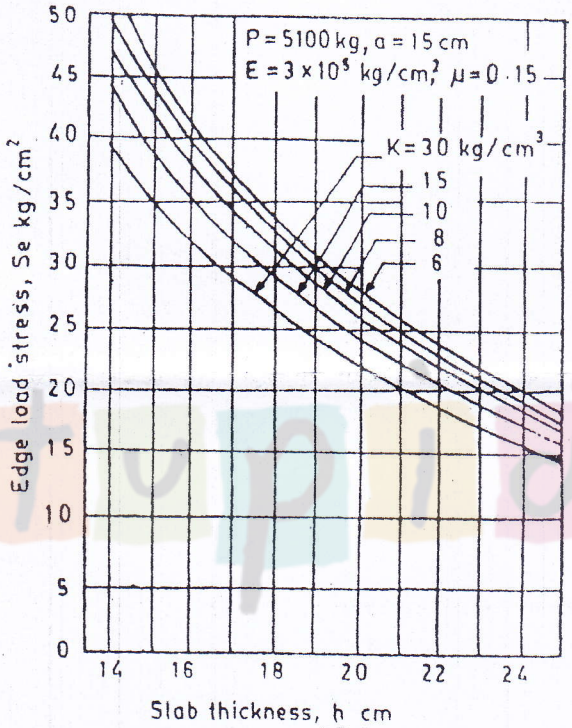


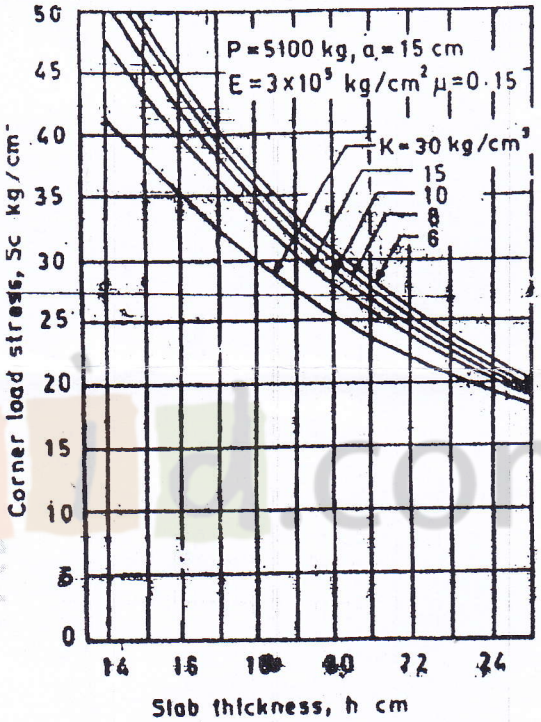
Pavement thickness design chart for traffic 10-150 msa.
(Source : IRC : 37-2001)

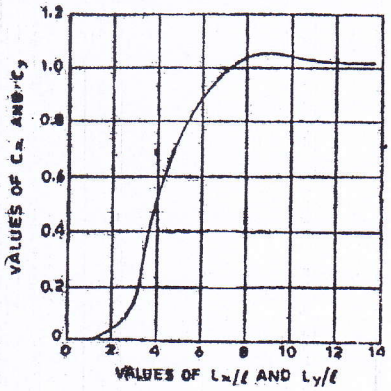
PAVEMENT DESIGN CATALOGUE I (Ref. 18)
RECOMMENDED DESIGNS FOR TRAFFIC RANGE 1-10 msa

CBR 6%

Cumulative Traffic (msa)	*Total Pavement Thickness (mm)*	*PAVEMENT COMPOSITION*		
		Bituminous Surfacing		*Granular Base and Sub-base (mm)*
		BC (mm)	*DBM (mm)*	
10	615	40	65	
20	640	40	90	
30	655	40	105	Base = 250
50	675	40	125	
100	700	50	140	Sub base = 260
150	720	50	160	







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8th Sem CV

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10CV833

Eighth Semester B.E. Degree Examination, June/July 2015
Pavement Design

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer FIVE full questions, selecting at least TWO questions from each part.***
2. ***Use of specified charts and tables is permitted.***

PART – A

1 a. With a neat sketch of pavement cross section (flexible type), explain the various components and briefly bringout their functions. **(10 Marks)**

b. Briefly explain the desirable characteristics of pavement. **(05 Marks)**

c. Bring out the differences between highway pavements and air field pavements. **(05 Marks)**

2 a. Explain briefly the factors affecting pavement design. **(08 Marks)**

b. A plate load test conducted with 0.3 m diameter plate on subgrade and on a pavement of thickness 0.4 m sustained pressure of 0.10 MN/m^2 and 0.40 MN/m^2 respectively at 5 mm deflection. Design the pavement section for 50 kN wheel load and contact pressure of 0.70 MN/m^2 for an allowable deflection of 8 mm using Burmisten's approach. If you want to maintain the deflection of 6.5 mm, what would be the required thickness? Use the chart in Fig. Q2 (b). **(12 Marks)**

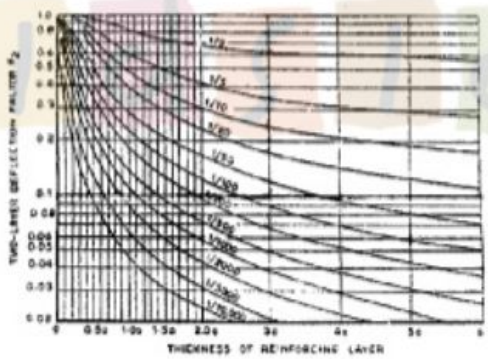

Fig. Q2 (b)

3 a. Calculate the ESWL of a dual wheel assembly carrying 2044 kg each for pavement thickness of 150 mm, 200 mm and 250 mm. Centre to centre tyre spacing is 270 mm and distance between the walls of the tyres is 110 mm. **(10 Marks)**

b. Calculate the design repetions for 20 years for various wheel loads equivalent to 2268 kg wheel load using the following traffic survey data on a four lane road. The average daily traffic in both the directions was 215. **(10 Marks)**

Wheel load (kg)	2268	2722	3175	3629	4082	4536
Percentage of total traffic volume (%)	13.17	15.30	11.76	14.11	6.21	5.84

4 a. Explain Mcleod's method of highway pavement design with the help of appropriate charts. **(08 Marks)**

b. Design the pavement section by triaxial test method using the following data:
Wheel load - 4100 kg ; Radius of contact area - 15 cm; Traffic coefficient, X - 1.5,
Rainfall coefficient, Y - 0.9, Design deflection, Δ - 0.25 cm;
E value of subgrade soil, $E_s = 100 kg/cm^2$
E value of base coarse material, $E_b = 400$ kg/cm^2
E value of 7.5 cm thick bituminous concrete surface course = 1000 kg/cm^2 **(12 Marks)**

PART – B

5 a. Explain the following:
   i) Modulus of subgrade reaction.
   ii) Relative stiffness of slab to subgrade.
   iii) Equivalent radius of resisting section. **(10 Marks)**

   b. Determine the warping stresses at interior, edge and corner regions in a 25 cm thick concrete pavement with transverse joints at 11 m intervals and longitudinal joints at 3.6 m intervals. The modulus of subgrade reaction (K) is 0.069 N/mm^3. Assume temperature differential for day conditions to be 0.6°C per cm slab thickness. Assume radius of loaded area as 15 cm for computing warping stress at the corner. Take $e = 10 \times 10^{-6}$ per°C, $E = 0.3 \times 10^5$ N/mm^2 and $\mu = 0.15$. Use the chart in Fig. Q5 (b) **(10 Marks)**

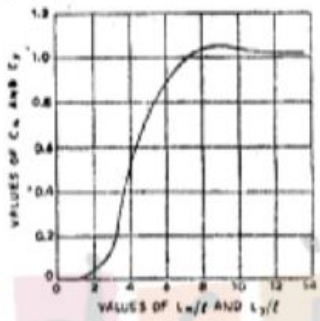

Fig. Q5 (b)

6 a. Write a brief note on spacing of expansion and contraction joints. **(06 Marks)**

   b. Design the size and spacing of dowel bars at the expansion joints of a cement concrete pavement of thickness 25 cm with radius of relative stiffness 80 cm, for a design wheel load of 5000 kg. Assume load capacity of the dowel system as 40% of the design wheel load. Joint width is 2 cm, permissible shear and flexural stresses in dowel bar are 1000 and 1400 kg/cm^2 respectively and permissible bearing stress in CC is 100 kg/cm^2. **(14 Marks)**

7 a. Explain any four typical flexible pavement failures. **(08 Marks)**

   b. Benkelman beam deflection studies were carried out on 15 selected points on a stretch of flexible pavement during summer season using a dual wheel load of 4085 kg, 5.6 kg/cm^2 pressure. The deflection values obtained in mm after making the necessary lag corrections are given below. If the present traffic consists of 750 commercial vehicles per day, determine the thickness of bituminous overlay required, if the pavement temperature during the test was 39°C and the correction factor for subsequent increase in subgrade moisture content is 1.3. Assume annual rate of growth of traffic as 7.5%. Adopt IRC guidelines 1.40, 1.32, 1.25, 1.35, 1.48, 1.60, 1.65, 1.55, 1.45, 1.40, 1.36, 1.46, 1.50, 1.52 and 1.45 mm. **(12 Marks)**

8 Write short notes on any four of the following:
   a. Rigid pavement failure.
   b. Maintenance measures in rigid pavements.
   c. Functional evaluation by visual inspection.
   d. Uneven measurements.
   e. Design factors for runway pavements.
   f. Design methods for airfield pavements. **(20 Marks)**

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10CV833

Eighth Semester B.E. Degree Examination, June/July 2016
Pavement Design

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. Describe the desirable properties of pavements. **(06 Marks)**

b. Explain the strategies adopted in pavement design. **(06 Marks)**

c. Bring out the characteristic differences between flexible and rigid pavements. **(08 Marks)**

2 a. Explain frost action. What are the remedial measures? **(06 Marks)**

b. List the assumptions and limitations of Boussinesquis Theory. **(06 Marks)**

c. A dual wheel load assembly with 70 kN load on each wheel and contact pressure of 0.7 N/mm^2 is applied on a homogeneous mass with modulus of elasticity 12 N/mm^2. If the centre to centre distance between the two wheels is 600 mm, determine the deflection value at a depth of 0.5 m at four points, at the centre of dual wheels, and at radial distances of 300, 600 and 900 mm from this centre along the line joining centers of the two wheel loads. Use deflection factor chart Fig. Q2(c). **(08 Marks)**

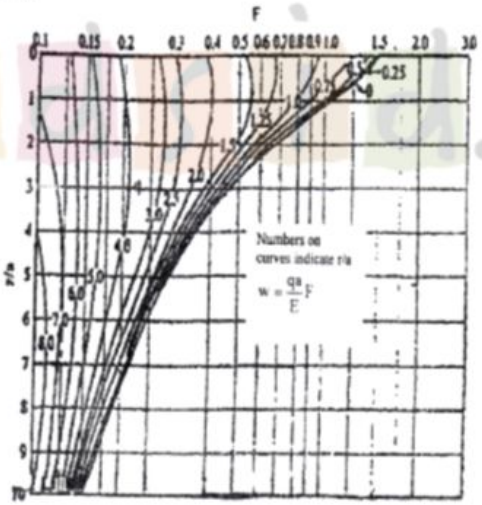

Fig. Q2(c)

3 a. With a sketch, describe the significance of design wheel load and contact pressure in design of pavement. **(06 Marks)**

b. Describe the procedure of calculating ESWC by equal deflection criteria. **(06 Marks)**

c. Calculate design repetitions for 20 years period for various wheel loads equivalent to 22.68 kN wheel load, using the following traffic survey data on a four lane road. **(08 Marks)**

Wheel load, kN	Average daily traffic (both) directions	% of total traffic volume
22.68	Total volume considering traffic growth = 215	13.17
27.22		15.30
31.75		11.36
36.29		14.11
40.82		6.21
45.36		5.84

4 a. Explain with examples, how are the flexible pavement design methods classified. **(06 Marks)**

b. Design a highway pavement using Mcleod's method for a wheel load of 57 kN (5100 kg) and tyre pressure 0.63 N/mm^2 (6.3 kg/cm^2). The subgrade support from repeated plate load test using 300 mm (30 cm) diameter plate was 14.30 kN (1430 kg) at 5 mm (0.5cm) deflection. Assume base course constant as 90. **(06 Marks)**

c. Design the pavement by triaxial method using the following data :

Wheel load	= 51 kN
Radius of contact area	= 150 mm
Traffic coefficient	= 1.5
Rainfall coefficient	= 0.9
Design deflection	= 2.5 mm
E – value of subgrade soil	= 10 N/mm^2
E – value of base course material	= 40 N/mm^2
E – value of 75 mm thick bituminous concrete surface	= 100 N/mm^2.

(08 Marks)

PART – B

5 a. What is warping stress? With a sketch explain how warping stresses are developed in CC pavements. **(06 Marks)**

b. Write a note on :

i) Critical load positions

ii) Critical combination of stresses. **(06 Marks)**

c. A CC pavement, 200 mm thick, has longitudinal joints at 3.5 m and transverse joints at 4.5 m spacing. The modulus of subgrade reaction is 0.1 N/mm^3 and modulus of elasticity of CC is 3×10^4 N/mm^2. Find the wheel load stresses at edge and corner regions of the slab due to wheel load of 51 kN with radius of contact area 150 mm. **(08 Marks)**

6 a. The maximum increase in temperature is expected to be 26°C after the constructions of a CC pavement. If the expansion joint gap is 22 mm, design the spacing between expansion and plain contraction joints. Assume all other data suitable. **(06 Marks)**

b. A CC pavement 200 mm thick and 7.5 m wide has a longitudinal joint along the centre line. Design the diameter length and spacing of tie bars if permissible stream in steal is 140 N/mm^2 and coefficient of friction is 1.2. Assume unit weight of concrete as 24000 N/m^3. **(06 Marks)**

c. Describe the step by step procedure in design of dowel bars. Indicate the equation used. **(08 Marks)**

7 a. Explain the typical flexible pavement failures with respect to their causes. **(10 Marks)**

b. Explain the step by step procedure of conducting Benkelman beam deflection studies in the field on a stretch of flexible pavement for providing flexible overlay. What are the necessary corrections to be applied? **(10 Marks)**

8 a. Explain the following with respect to rigid pavement :

i) Scaling of cement concrete

ii) Spalling of joints

iii) Mud pumping. **(10 Marks)**

b. Explain the following in rigid pavements :

i) Treatment of cracks

ii) Maintenance of joints. **(10 Marks)**

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10CV833

Eighth Semester B.E. Degree Examination, June/July 2014
Pavement Design

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting atleast TWO questions from each part.***

PART – A

1 a. What are the different layers of flexible pavements? Explain the functions of each. **(10 Marks)**

b. Explain briefly the basic design differences between an airport and a highway pavement. **(10 Marks)**

2 a. Explain the factors, that effect design and performance of highway pavements. **(10 Marks)**

b. Plate bearing tests were conducted with a75cm diameter plate on soil subgrade and a granular base. The stress noticed when the deflection was 0.25cm on the subgrade soil, was 0.07 MN/m^2. On the base course, the same plate yielded 0.25cm deflection under a stress of 0.14 MN/m^2. Design the pavement for an allowable deflection of 0.5cm. Under a wheel load of 40kN and a tyre pressure of 0.5 MN/m^2 assume thickness of base course is 15cm. **(10 Marks)**

3 a. Calculate design repetitions for 20 years period for various wheel loads equivalent to 2268 kg wheel load using the following traffic survey data on a four lane road: **(10 Marks)**

Wheel load, kg	2268	2722	3175	3629	4082	4536
ADT in both direction, CVPD	←		215		→	
% of total traffic volume	13.17	15.30	11.76	14.11	6.21	5.84

b. Explain briefly on important of gross wheel load and contact pressure in stress distribution pattern and in pavement design. **(10 Marks)**

4 a. Explain the California resistance value method of flexible pavement design. **(10 Marks)**

b. It is proposed to widen an existing 4 lane NH section to 3 lane dual carriage way road. Design the pavement for new carriageway with the following data:
Initial traffic in both directions: 4932 CVPD
Construction period: 20 months
Design life: 15 years
Design CBR of soil (identified murram borrow pot soil): 7%
Traffic growth rate: 8%
VDF: 4.5

Pavement Design Catalogue
Plate 2- Recommended Designs for Traffic Range 10-150 msa

CBR 7%				
Cumulative traffic (msa)	Total pavement thickness (mm)	Pavement Composition		
		Bituminous Surfacing		Granular base and sub-base (mm)
		BC (mm)	DBM (mm)	
10	580	40	60	
20	610	40	90	
30	630	40	110	Base = 250
50	650	40	130	
100	575	50	145	Sub-base = 230
150	695	50	165	

Catalogue Q.4(b) **(10 Marks)**

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

PART – B

5 a. What are the advantages of Bradbury's stress coefficients and other load stress characters in the design of rigid pavements? **(10 Marks)**

b. Calculate the stresses at interior, edge and corner regions of a C.C. pavement using Wester Gaard's stress equation use the following data:
Wheel load = 5100kg, $E = 3 \times 10^5$ kg/cm^2, $\mu = 0.15$, pavement thickness = 18cm, modulus of subgrade reaction = 6 kg/cm^3, radius of contact area = 15cm. **(10 Marks)**

6 a. A C.C. pavement has a thickness of 18cm and has two lanes of 7.2m with a longitudinal joint along the centre. Design the dimensions and spacing of the tie bar. The other data are
Allowable working stress in tension – 1400 kg/m^2
Unit weight of concrete = 2400 kg/m^3
Coefficient of friction = 1.5
Allowable bond stress in deformed bars in concrete = 24.6 kg/m^2. **(10 Marks)**

b. Explain briefly the IRC recommendations for determining the thickness of C.C. pavement. **(10 Marks)**

7 a. Benbelman beam test was carried out on a stretch of flexible pavement of a NH with 2 lane single carriageway as per IRC-81-1997. The mean value of deflections and standard deviation computed are 1.57mm and 0.12mm respectively. The other data are
i) Temperature during test = 25°C
ii) Correction factor for subgrade moisture content = 1.2
iii) Initial commercial traffic in the year of completion of construction of overlay = 1200 CVPD
iv) Annual growth rate of commercial vehicle = 7.5%
v) Vehicle damage factor = 3.5
vi) Design life = 10 years
Take 1cm of B.M. equal to 0.7cm of DBM/BC/SDBC. Determine the thickness of granular layer and bituminous layer using IRC equation and also determine thickness of bituminous macadam overlay using the overlay thickness design curves. **(14 Marks)**

b. What are the various causes of formation of waves and corrugations in flexible pavements? Suggest remedial measures. **(06 Marks)**

8 a. What are the various design factors to be considered in airport pavements? Discuss the significance of each. **(10 Marks)**

b. Explain briefly the pavement evaluation. **(10 Marks)**

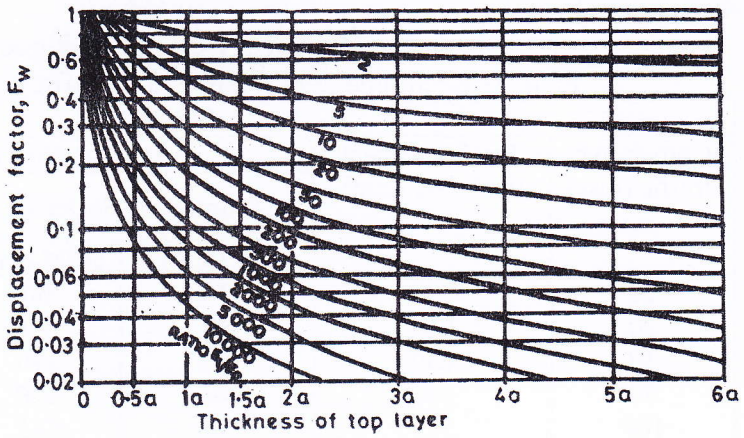

Fig.Q.2(b)

Overlay Thickness Design Curves

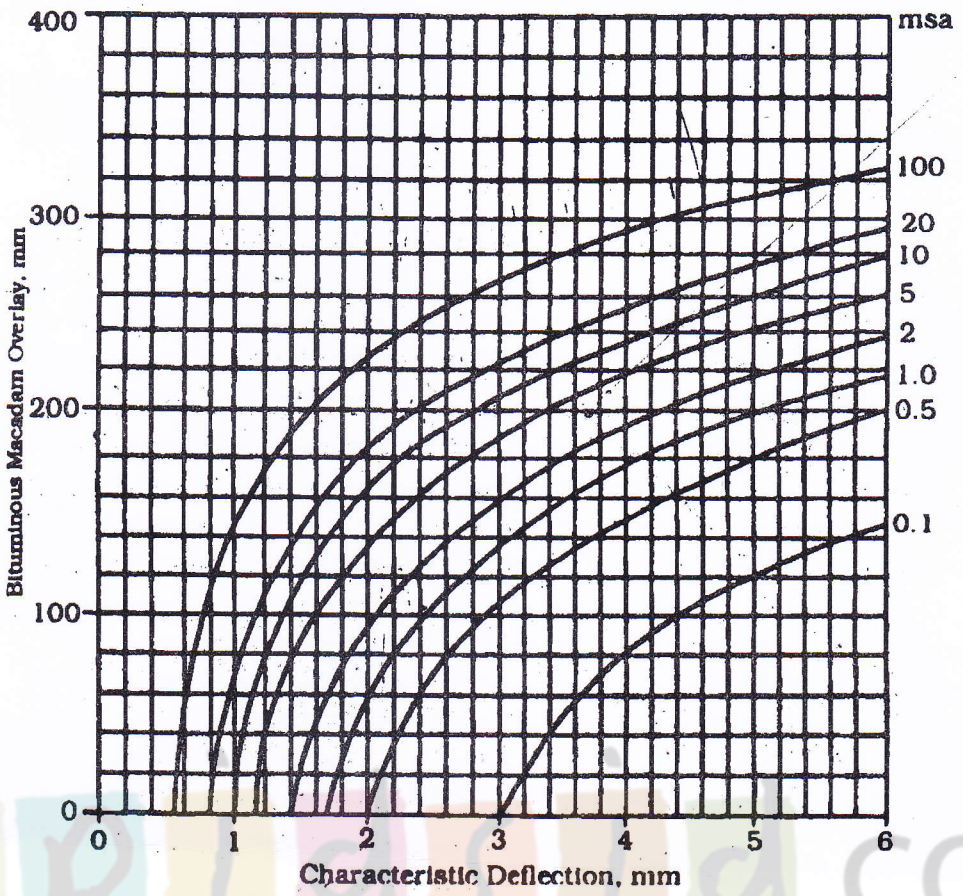

Fig.Q.7(a)

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