BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR

M.E. (CE) 2nd Semester Final Examination, 2013

Pavement Design - II

(CE-1022)

Time: 3 hours Full Marks: 70

Answer Question No.1 and any THREE from the rest

Assume data reasonably, if required.

1. Explain the following: [2X8]
   i. Design steps for the dowel bars of rigid pavement
   ii. Advantages and disadvantages of rigid pavement compared to flexible pavement

2. Design a undowelled concrete pavement for a two-lane two-way State Highway for the following load spectrum. The total two-way traffic is 3200 CVPd at the end of the construction period. The wheel load is 8 tones, grade of concrete is M-45 with flexural strength of 45 kg/cm^2 subjected to a temperature differential of 20 °C. Modulus of elasticity of concrete is $3x10^5$ kg/cm^2 and coefficient of thermal expansion of concrete is $10x10^{-6}$/°C. Design life is 20 years; annual traffic growth is 8.0 percent. Modulus of subgrade reaction is 9 kg/cm^3. Tyre pressure is 8 kg/cm^2, spacing of contraction joints is 5.0m and the width of slab is 3.5m. (use Appedix-1 if necessary)

Single Axle Loads		Tandem Axle Loads	
Axle load class, tonnes	Percentage of axle loads	Axle load class, tonnes	Percentage of axle loads
19-21	0.5	34-38	0.3
17-19	1.5	30-34	0.5
15-17	5.0	26-30	0.7
13-15	11.5	22-26	1.2
11-13	21.4	18-22	1.4
9-11	23.0	14-18	0.5
Less than 9	31.1	Less than 14	1.4
Total	94.0	Total	6.0

[18]

3. a) Derive the expression for determining the curling stresses in the finite slab

   b) Calculate the interior and edge stresses due to temperature in the concrete road slab with the following data:
   Lane width = 3.5 m
   Construction joint spacing = 4.5 m
   Thickness of slab= 20 cm
   Temperature differential= 18.5°C
   Coefficient of thermal expansion of concrete= $9x10^{-6}$ mm/mm/°C
   Modulus of elasticity of concrete= 27.6 GPa
   Modulus of subgrade reaction= 8 kg/cm^2

L/ℓ or B/ℓ	Value of 'C' (Bradbury Co-eff.)
3	0.175
4	0.440
5	0.720
6	0.920
7	1.030

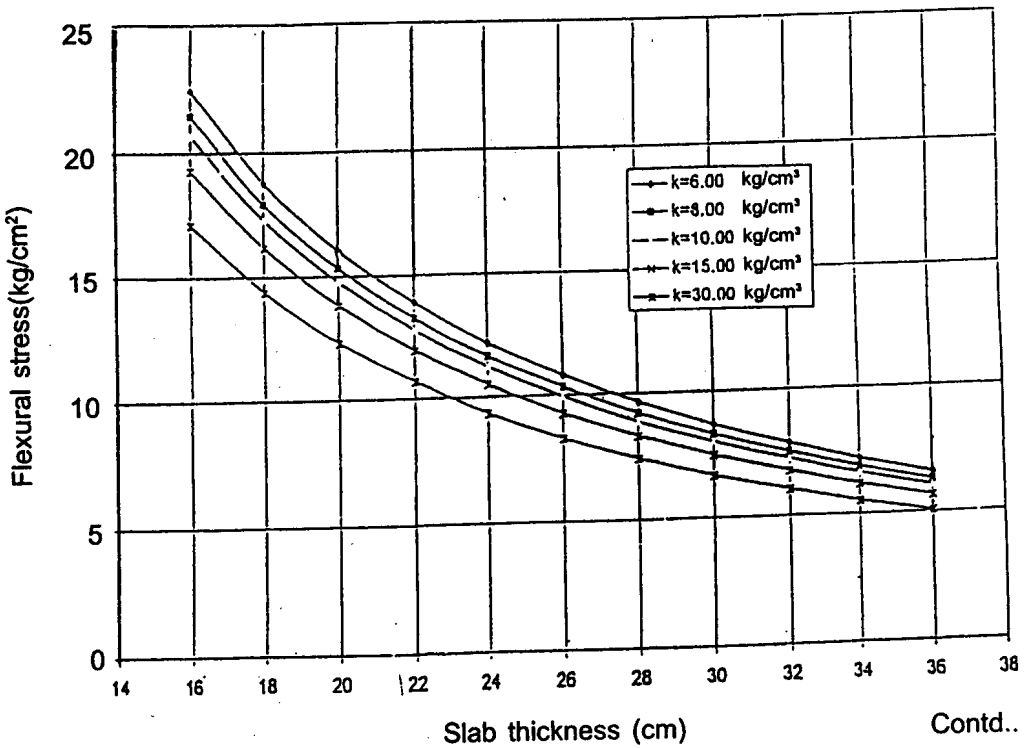
[8+10]

4. a) How the evaluation of existing PCC pavement is made for design a PCC overlay?
   b) Explain the design steps of the bonded PCC overlay as per PCA method.
   c) An existing concrete pavement is of a thickness 8.0 inch. after milling. The average splitting tensile strength and the standard deviation are 428 and 50 psi respectively are obtained by performing test on the cored samples. The regression constant is 1.48 and damage factor is 0.9. If the required thickness for a new full depth pavement is 11 inch. and the condition used to develop the design chart are all satisfied, determine the thickness of the bonded overlay required. [6+6+6]

5. a) Derive an expression for stress developed due to friction between subgrade and jointed plain cement concrete pavement.
   b) Design the Dowel Bars for the following parameters
      i. Design wheel load = 4100 kg
      ii. Design load transfer = 50%
      iii. Slab thickness = 35 cm
      iv. Joint width = 2.0 cm
      v. Modulus of dowel support = 42000 kg/cm^3
      vi. Modulus of elasticity of dowel bar = $2x10^6$ kg/cm^2
      vii. K – Value of sub base = 8 kg/cm^3
      viii. Grade of concrete = M 50 [6+12]

6. a) Explain with neat sketch the different types of joints of concrete slab for road pavement?
   b) Determine the diameter, spacing and length of the plain tie bar and required for a two lane concrete pavement of 35 cm thick and 8 m long with a longitudinal joint at the centre. The density of concrete is 2400 kg/cm^3. The allowable tensile stress and allowable bond stress in plain bar are 1250 kg/cm^2 and 17.5 kg/cm^2 respectively. [10+8]

Stresses in Rigid Pavement (Single Axle Load = 6 tons)



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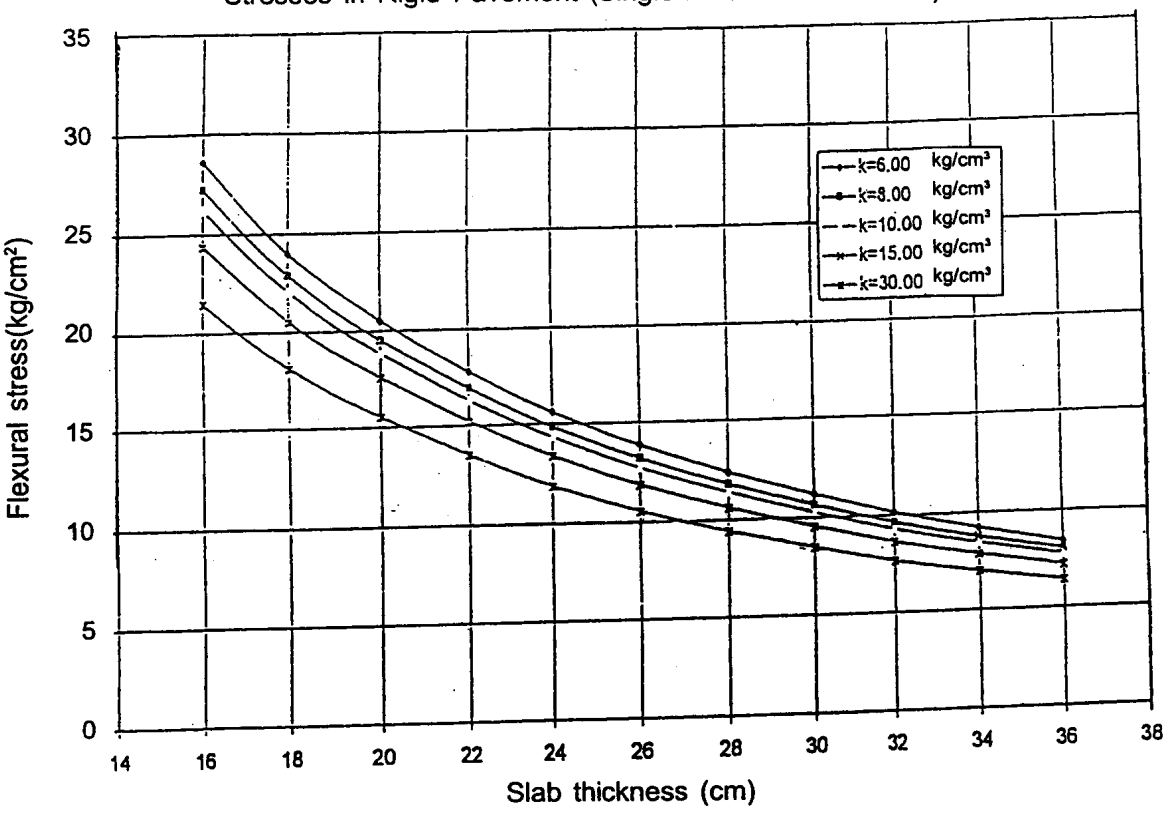
Appendix-1 (Contd.)

Stresses in Rigid Pavement (Single Axle Load = 8 tons)



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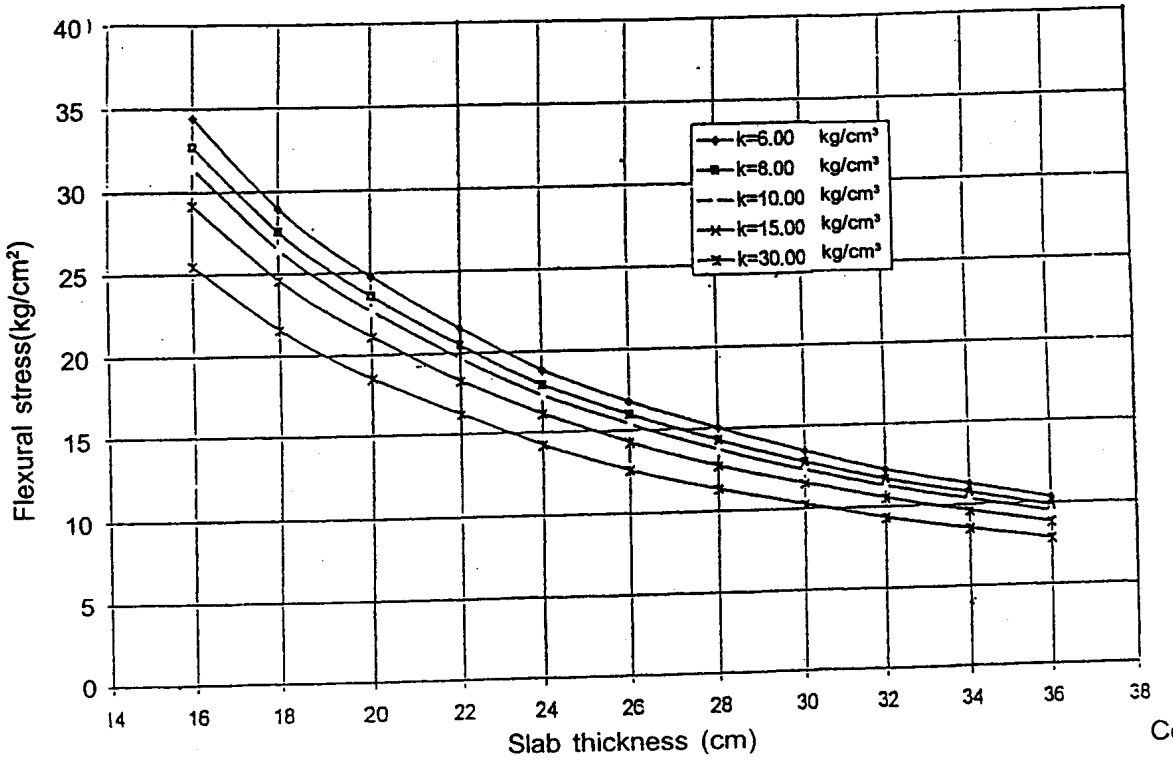
Appendix-1 (Contd.)

Stresses in Rigid Pavement (Single Axle Load = 10 tons)



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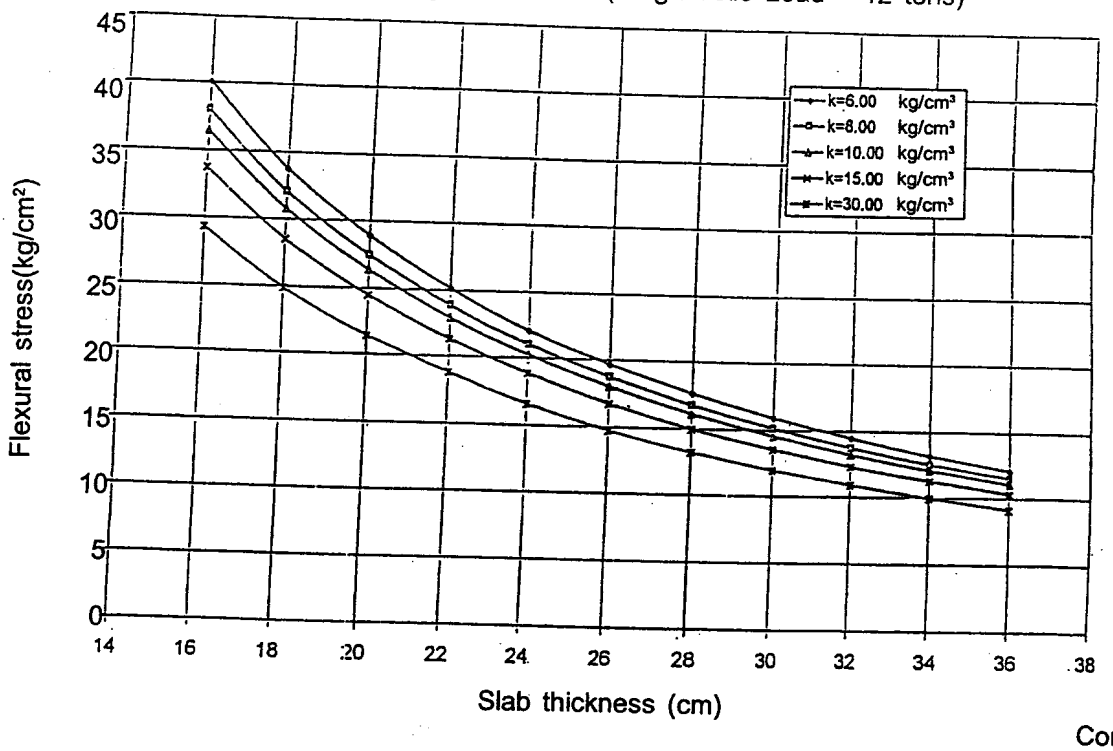
Stresses in Rigid Pavement (Single Axle Load = 12 tons)



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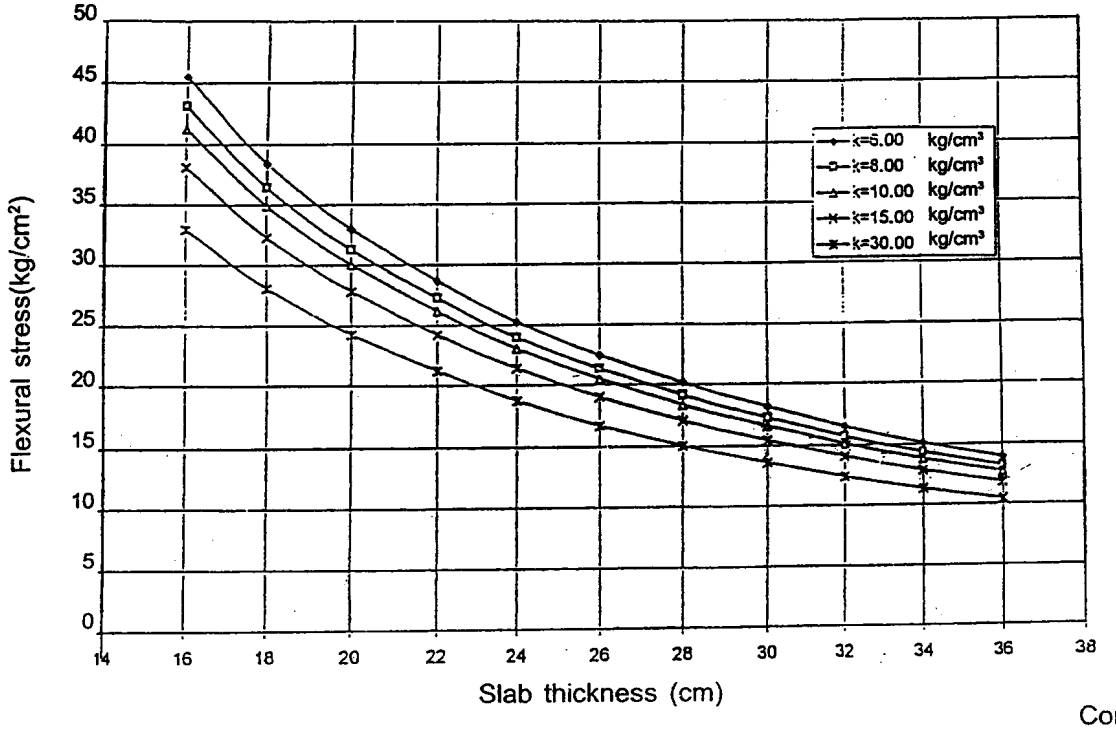
Stresses in Rigid Pavement (Single Axle Load = 14 tons)



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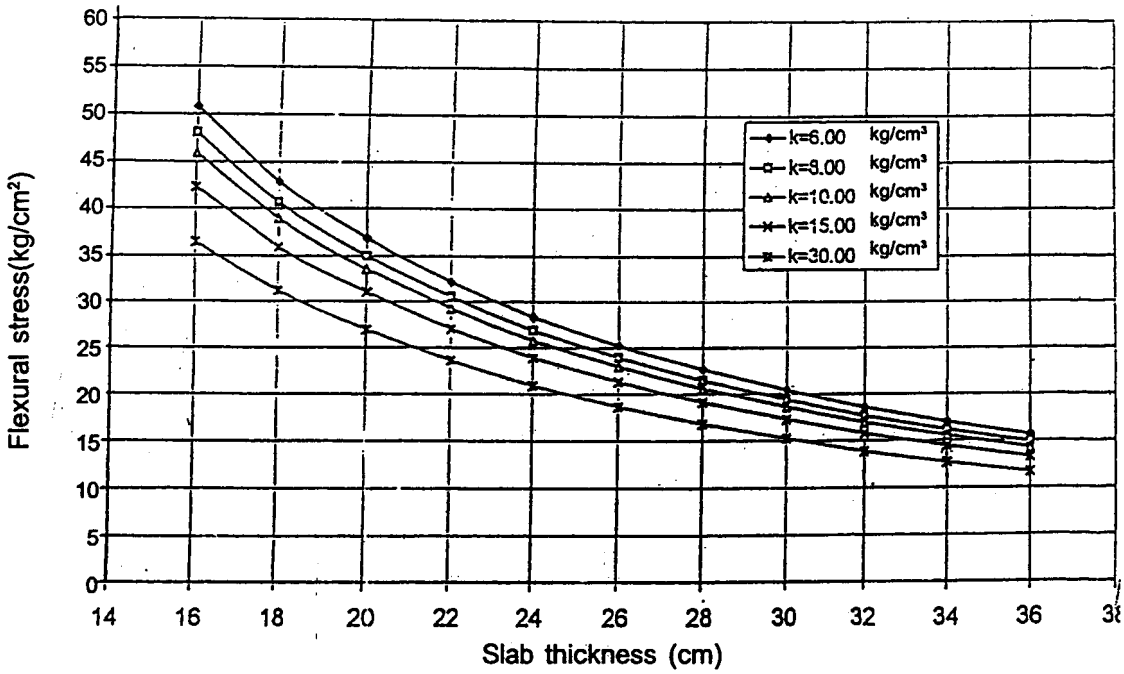
Appendix-1 (Contd.)

Stresses in Rigid Pavement (Single Axle Load = 16 tons)



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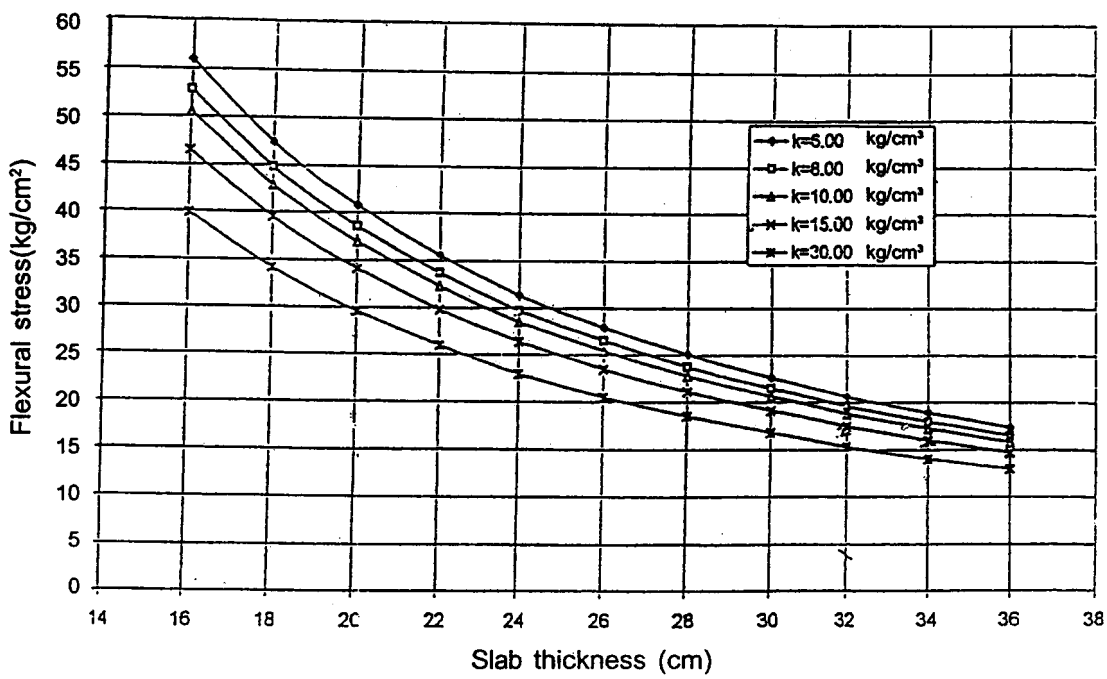
Appendix-1 (Contd.)

Stresses in Rigid Pavement (Single Axle Load = 18 tons)



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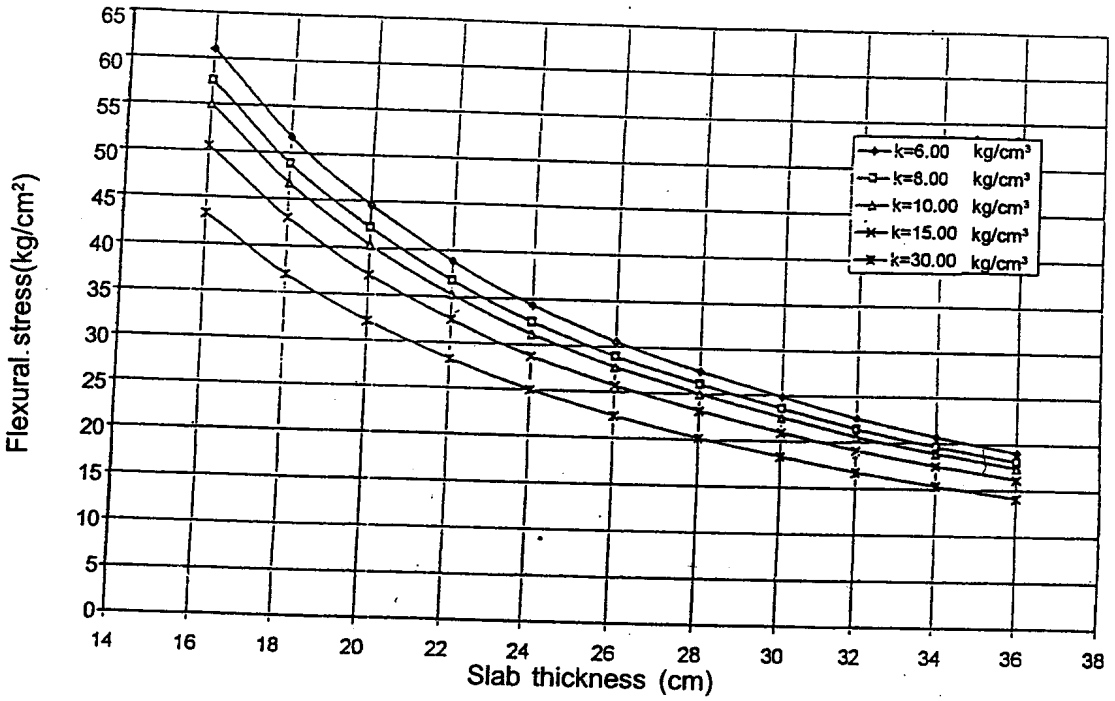
Appendix-1 (Contd.)

Stresses in Rigid Pavement (Single Axle Load = 20 tons)



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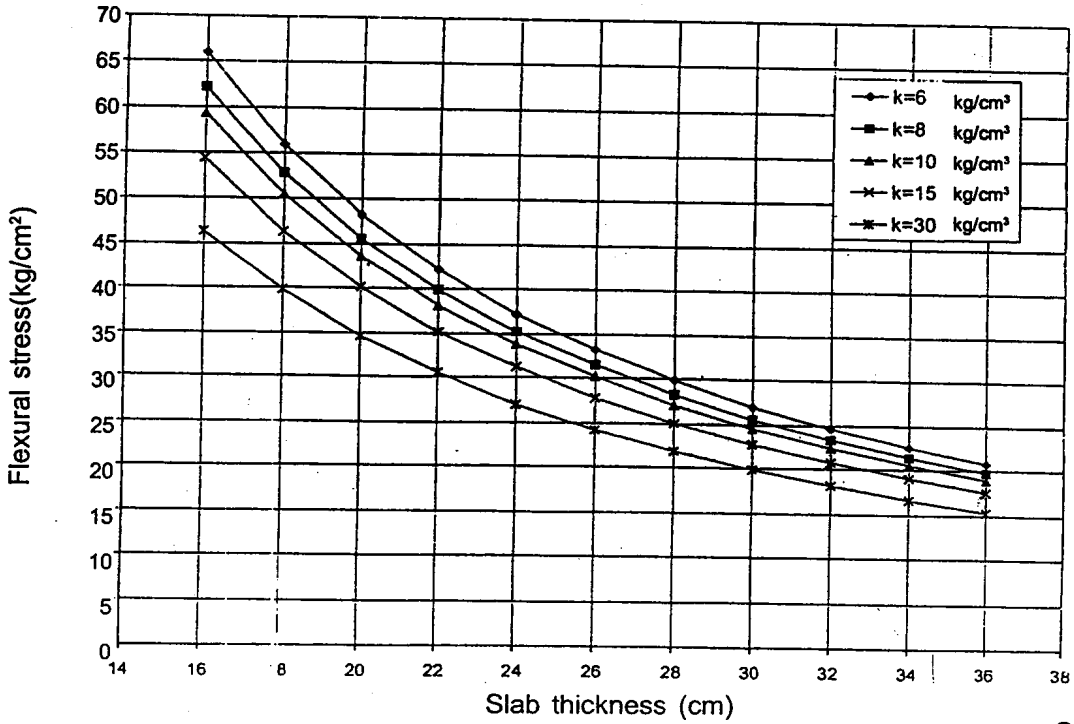
Appendix-1 (Contd.)

Stresses in Rigid Pavement (Single Axle Load = 22 tons)



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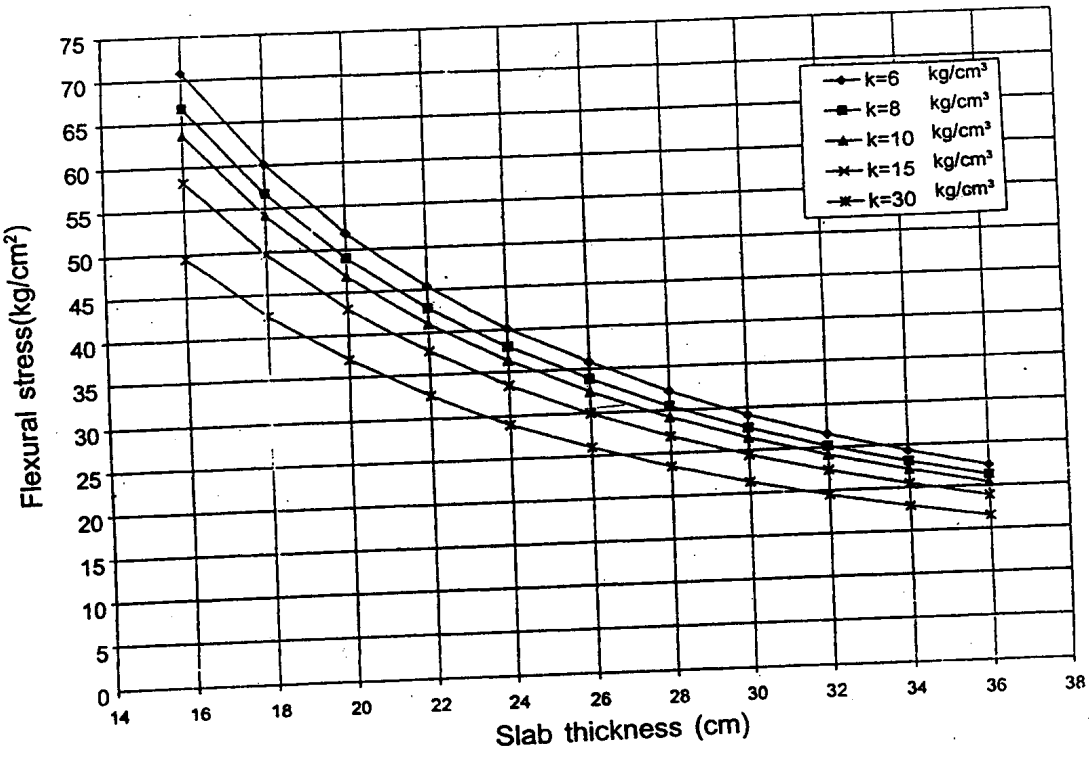
Stresses in Rigid Pavement (Single Axle Load = 24 tons)



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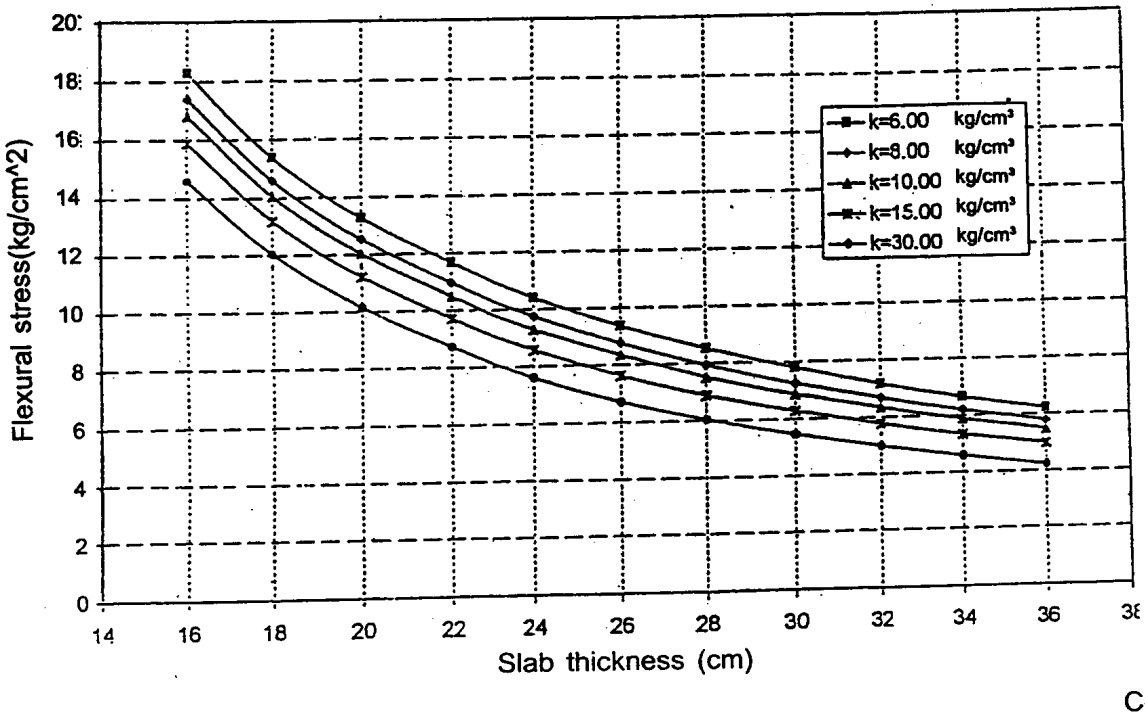
Stresses in Rigid Pavement (Tandem Axle Load 12 tons)



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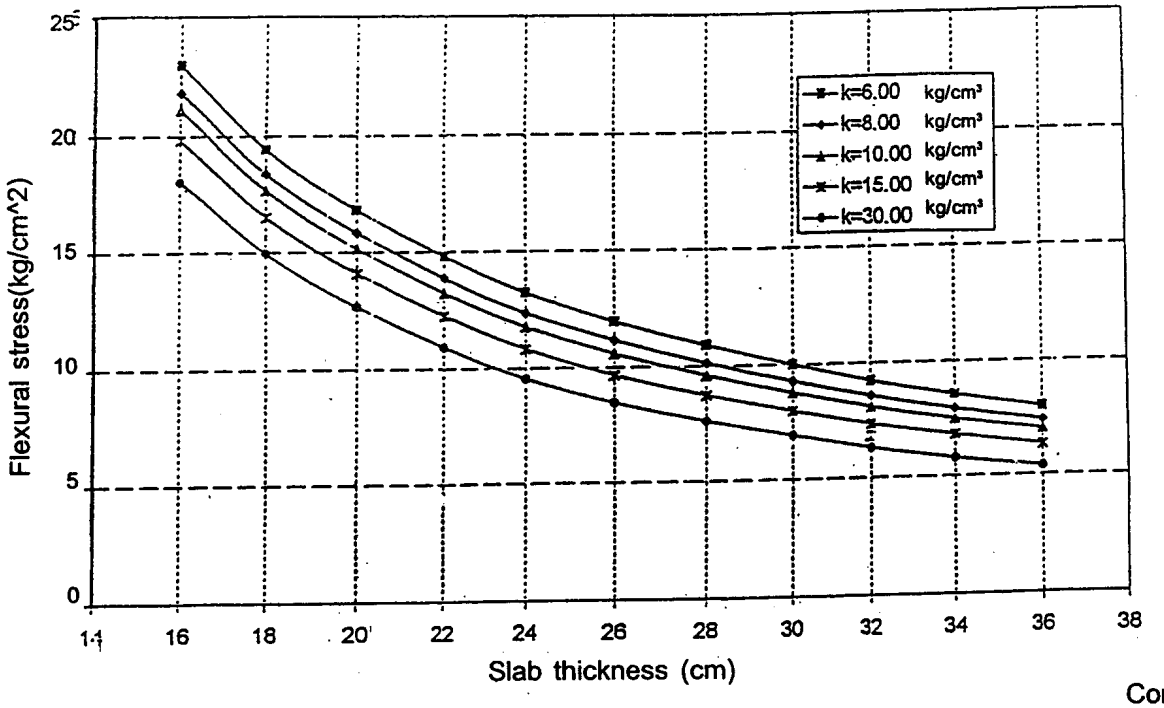
Appendix-1 (Contd.)

Stresses in Rigid Pavement (Tandem Axle Load 16 tons)



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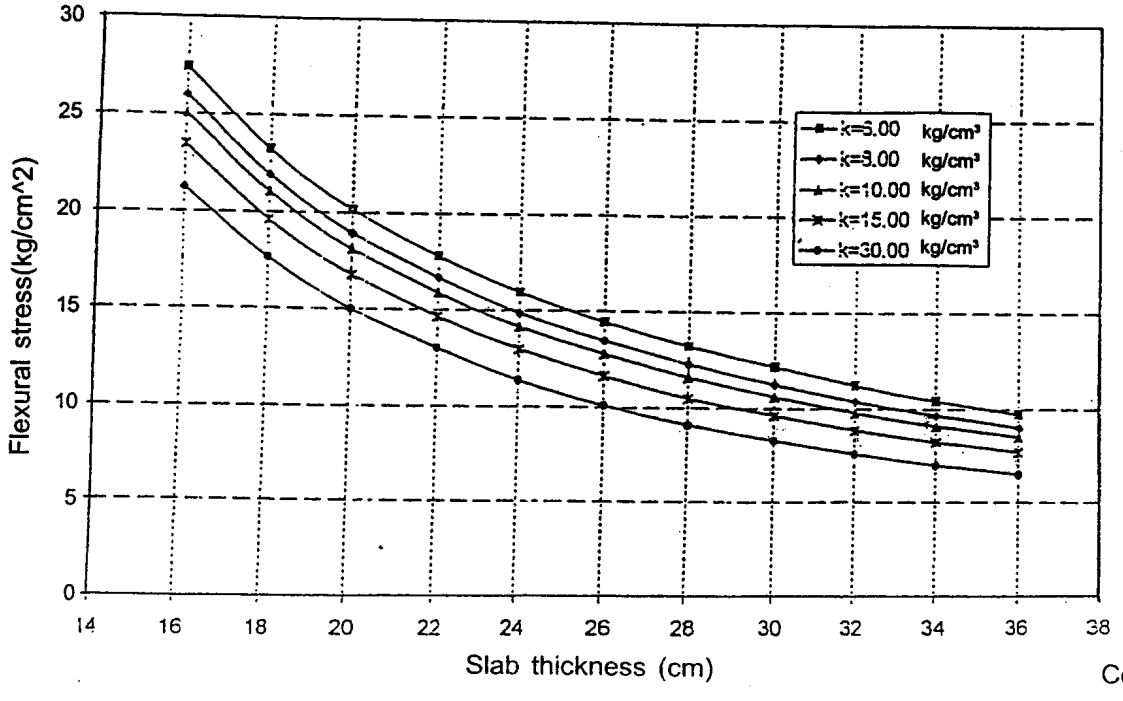
Appendix-1 (Contd.)

Stresses in Rigid Pavement (Tandem Axle Load 20 tons)



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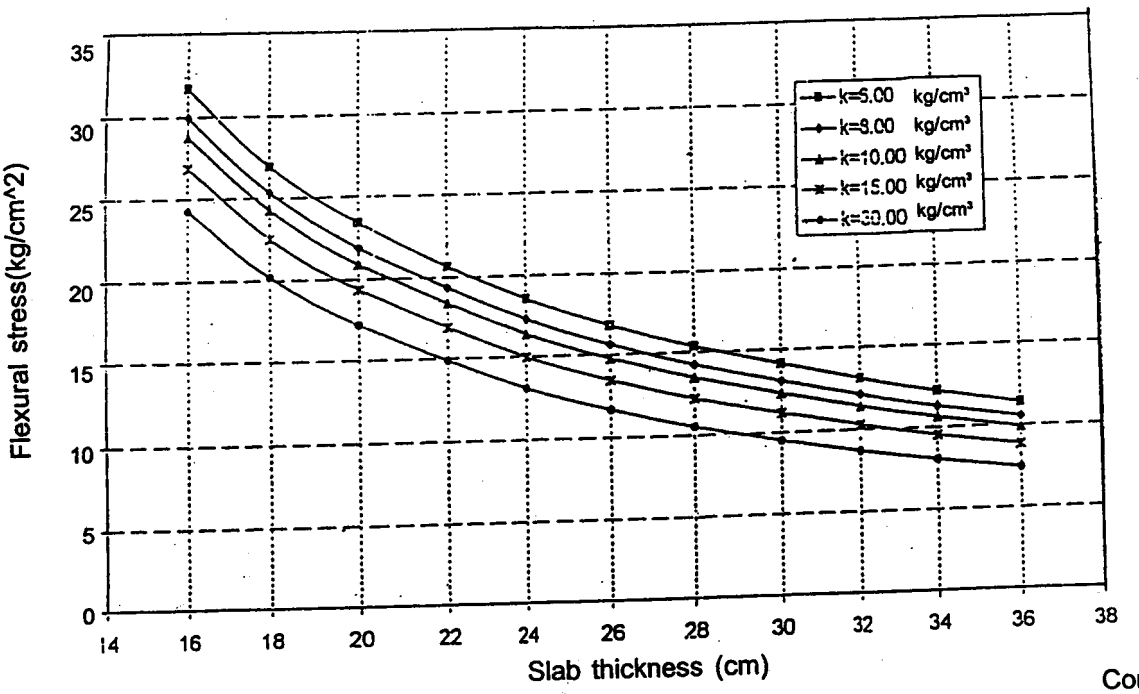
Appendix-1 (Contd.)

Stresses in Rigid Pavement (Tandem Axle Load 24 tons)



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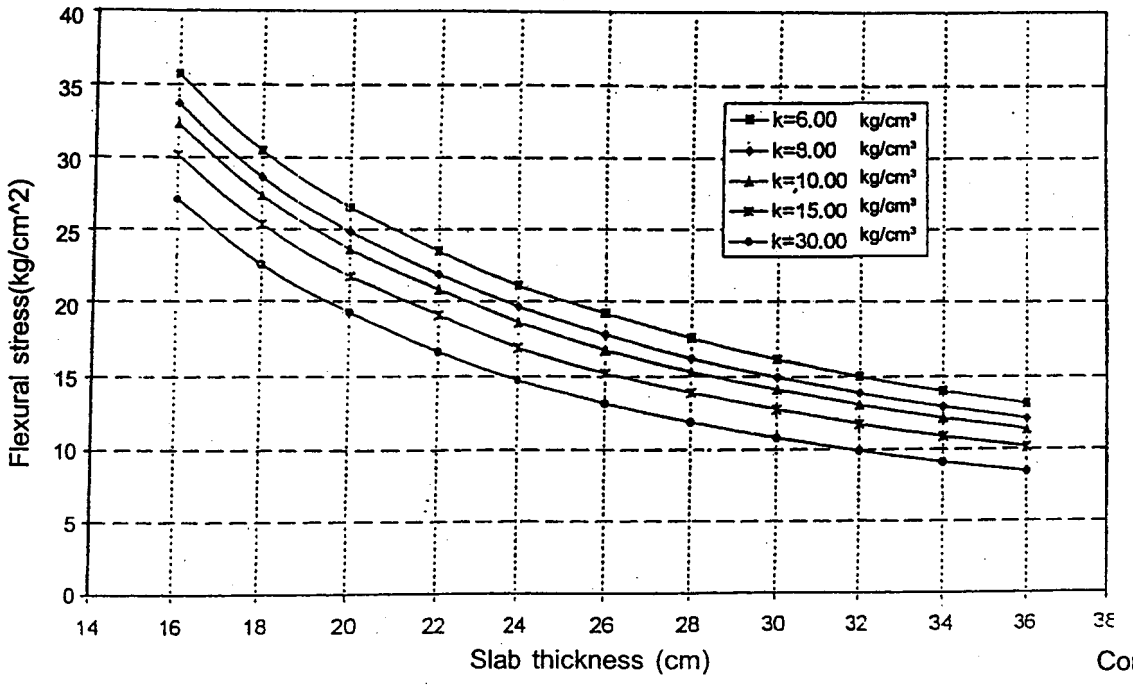
Appendix-1 (Contd.)

Stresses in Rigid Pavement (Tandem Axle Load 28 tons)



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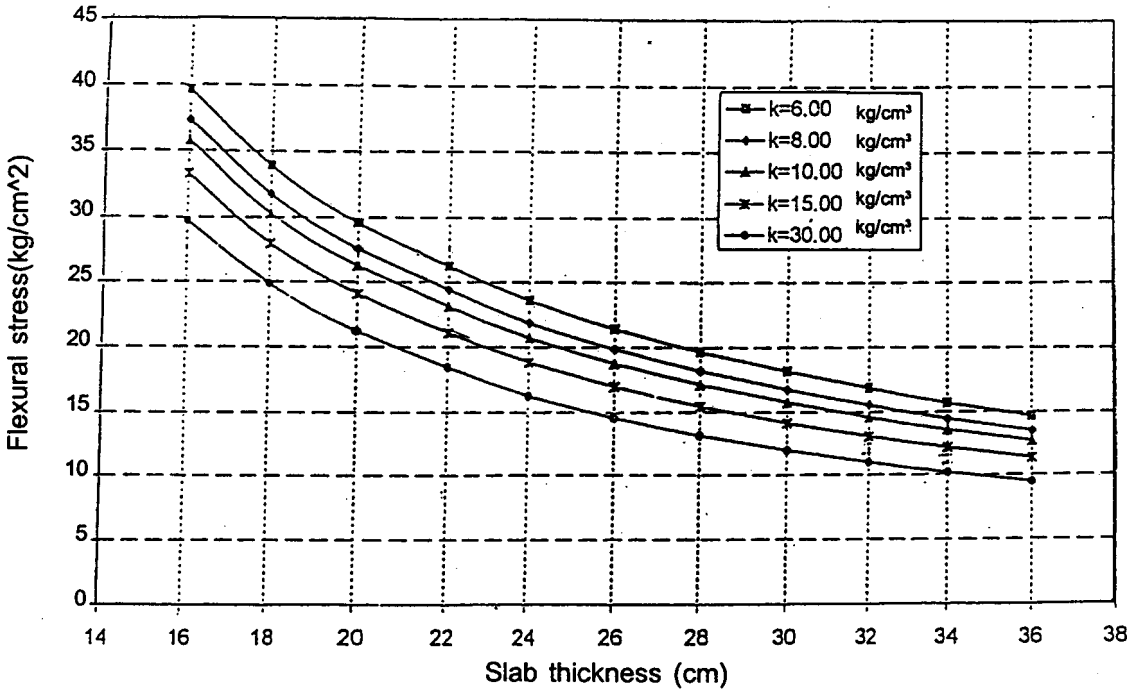
Stresses in Rigid Pavement (Tandem Axle Load 32 tons)



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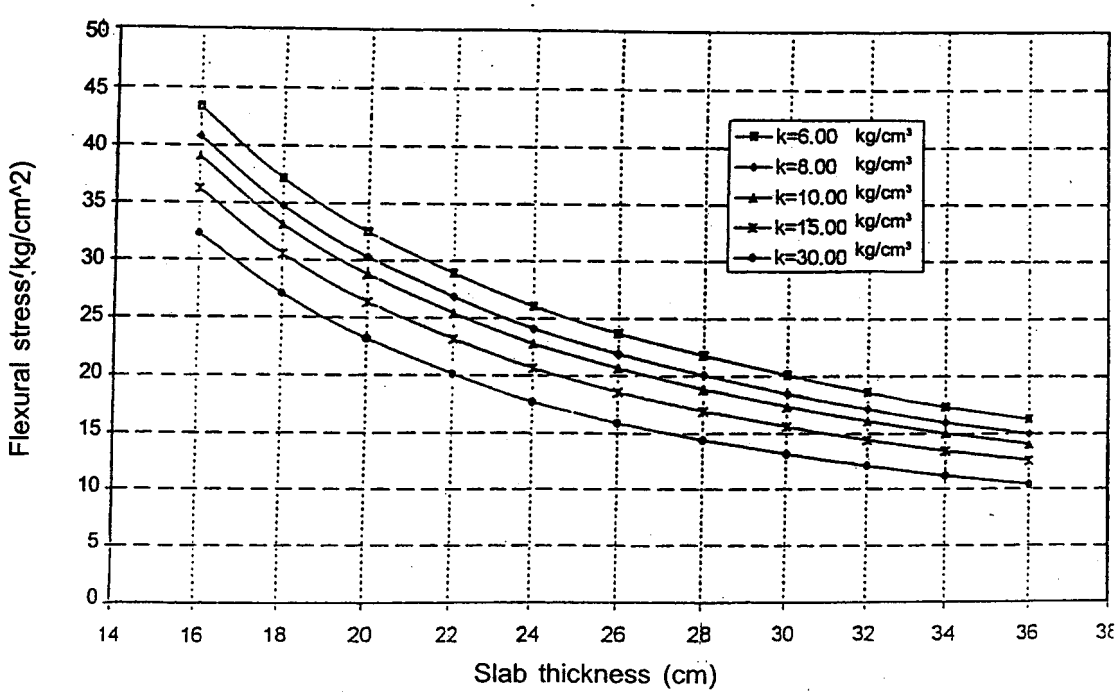
Stresses in Rigid Pavement (Tandem Axle Load 36 tons)



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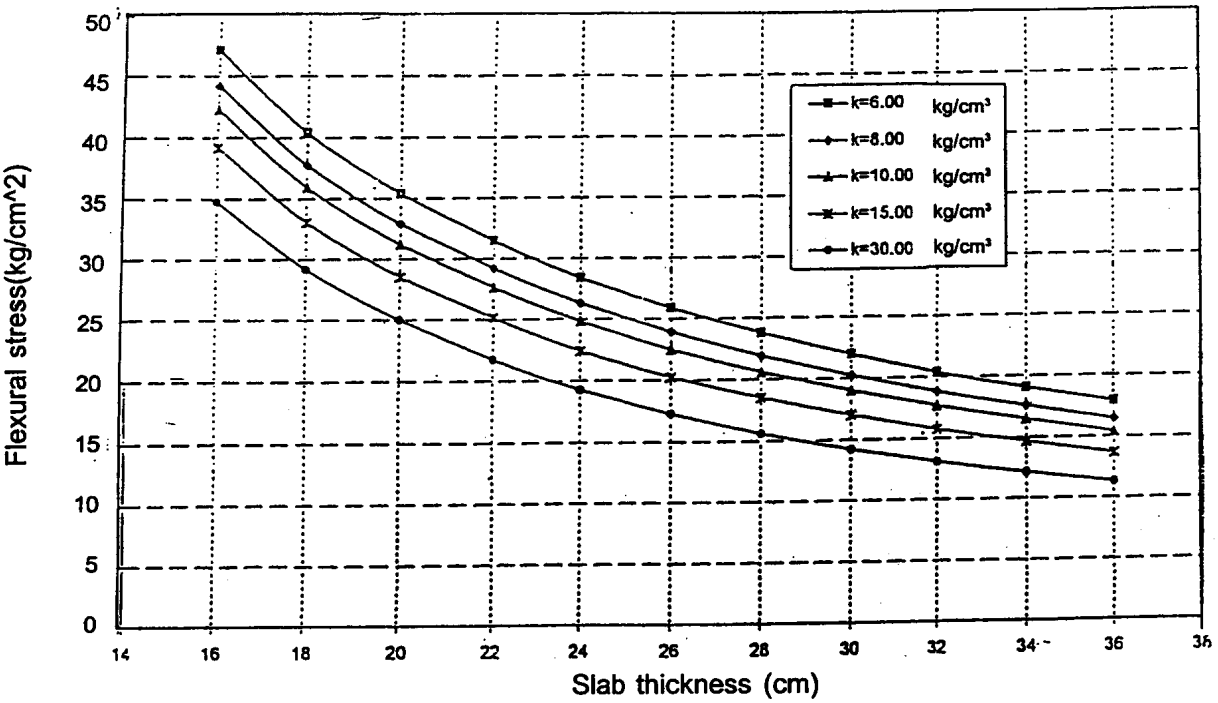
Appendix-1 (Contd.)

Stresses in Rigid Pavement (Tandem Axle Load 40 tons)



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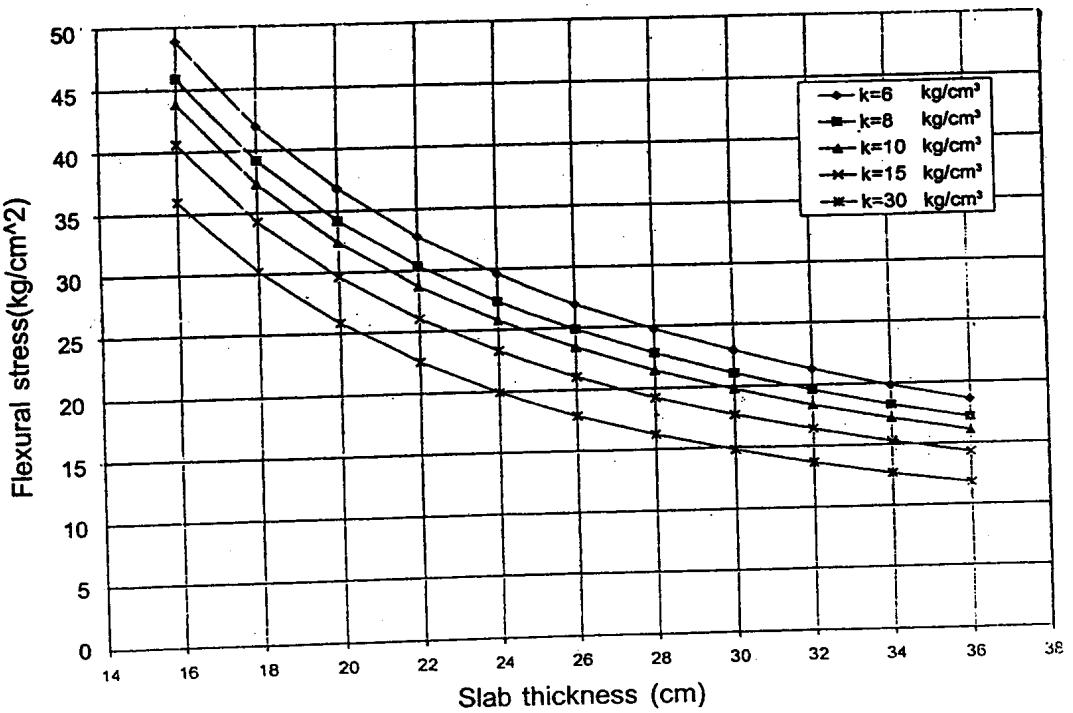
Appendix-1 (Contd.)

Stresses in Rigid Pavement (Tandem Axle Load 42 tons)



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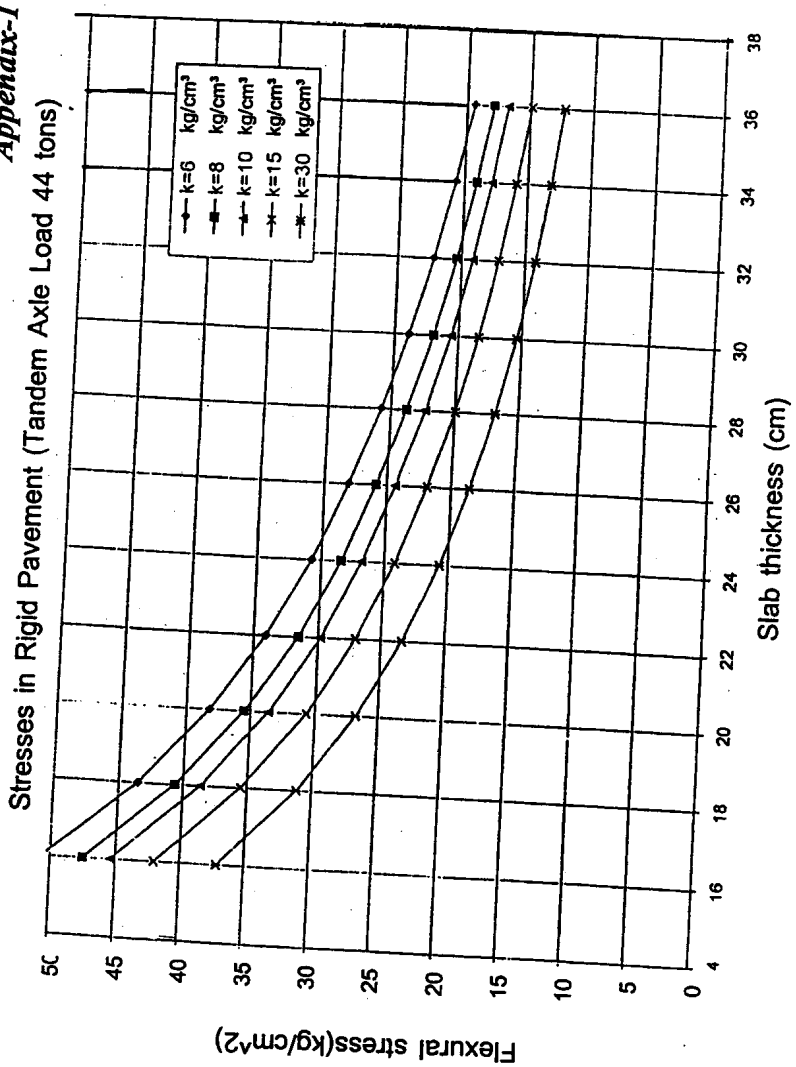
Appendix-1 (Contd.)



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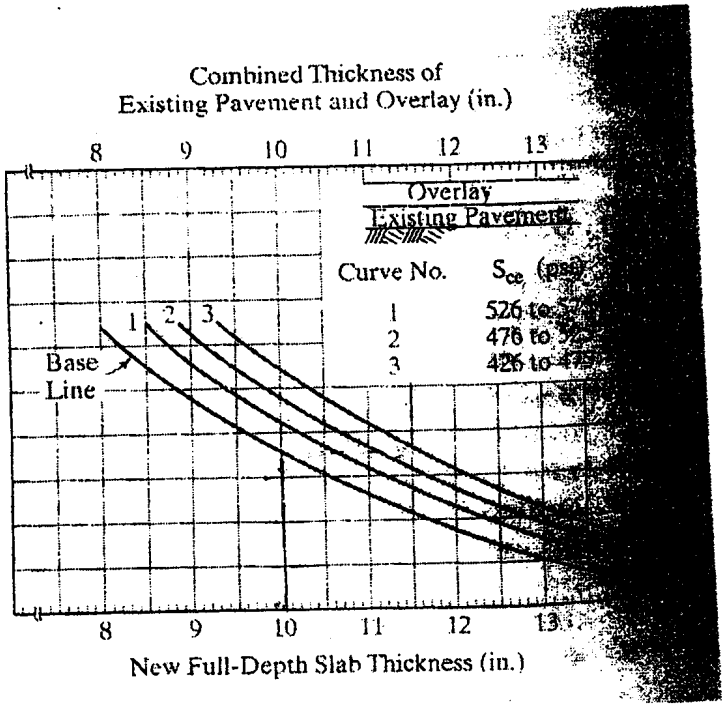

Fig. Design chart for bonded overlay (After Tayabji and Okamoto, 1985)