Indian Institute of Engineering Science and Technology Shibpur

M.E. (CE) 2nd Semester Final Examination, 2014

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. Describe the followings: [2X8]
   i. Joints of rigid pavement
   ii. Design steps of longitudinal steel for CRCP

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 3500 CVPd at the end of the construction period. The axle load is 16 tones, grade of concrete is M-55 with flexural strength of 55 kg/cm^2 subjected to a temperature differential of 18 °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 7.5 percent. Soaked CBR of compacted subgrade is 7%. 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	3.5	34-38	0.6
17-19	6.5	30-34	0.8
15-17	6.0	26-30	0.7
13-15	11.0	22-26	1.5
11-13	18.4	18-22	1.9
9-11	17.0	14-18	0.7
Less than 9	29.6	Less than 14	1.8
Total	92.0	Total	8.0

Relationship between k-value and CBR value for homogeneous soil subgrade										
Soaked CBR (%)	2	3	4	5	7	10	15	20	50	100
k-value (MPa/m)	21	28	35	42	48	55	62	69	140	220

Chart for determination of Bradbury's Coefficient							
L/ℓ or B/ℓ	C	L/ℓ or B/ℓ	C	L/ℓ or B/ℓ	C	L/ℓ or B/ℓ	C
1	0.000	4	0.440	7	1.030	10	1.075
2	0.040	5	0.720	8	1.077	11	1.050
3	0.175	6	0.920	9	1.080	12	1.000

[18]

3. a) How the stresses and deflection in the infinite slab are determined by using the Westerguard's Equation?

   b) Determine the curling stresses at interior, longer and shorter edge of finite slab of 200 mm thick during the day under a temperature gradient of 0.07 °C /mm of slab. Assume the modulus of subgrade reaction is 13.55MN/m^3, co-efficient of thermal expansion of concrete is $9x10^{-6}$/°C, modulus of elasticity of concrete is 27.6 GPa and Poisson ratio of concrete is 0.15. [9+9]

P.T.O.

4. a) Discuss the factors governing the design consideration of jointed plain cement concrete pavement rigid pavements.
   b) Explain the limiting criterion for the design of longitudinal steel for CRCP.
   c) Discuss briefly different types of PCC overlays over PCC pavements. [10 + 4+ 4]

5. a) How the evaluation of existing PCC pavement is made for design a PCC overlay? Explain.
   b) Differentiate between the basic concept for design of bonded and unbonded overlay as per Asphalt Institute 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. [10+3+5]

6. a) What is meant by dowel bar? Why it is used in the rigid pavement? Explain.
   b) Design the Dowel Bars for the following parameters
      i. Design wheel load = 5100 kg
      ii. Design load transfer = 40%
      iii. Slab thickness = 30 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. Modulus of subgrade reaction = 8 kg/cm^3
      viii. Grade of concrete = M 50 [6+12]

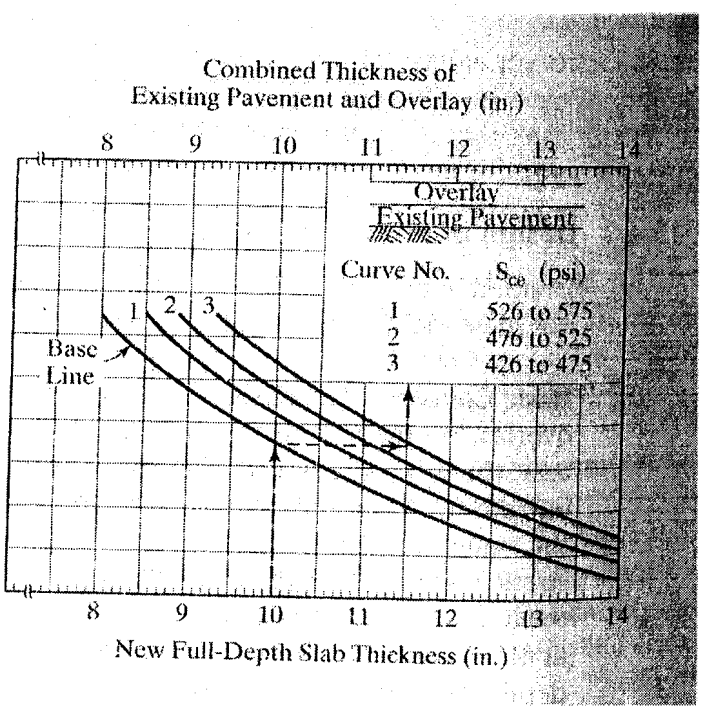
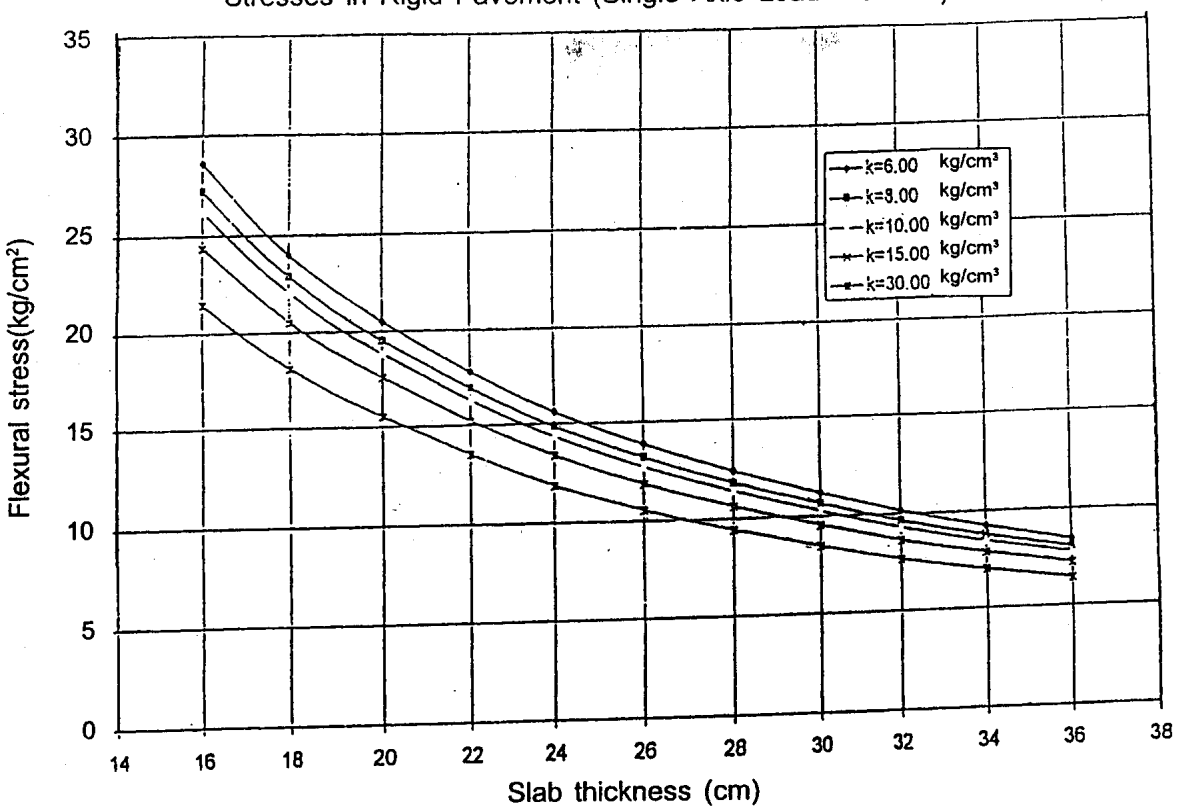


Fig. Design chart for bonded overlay

Appendix-1 (Contd.)

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



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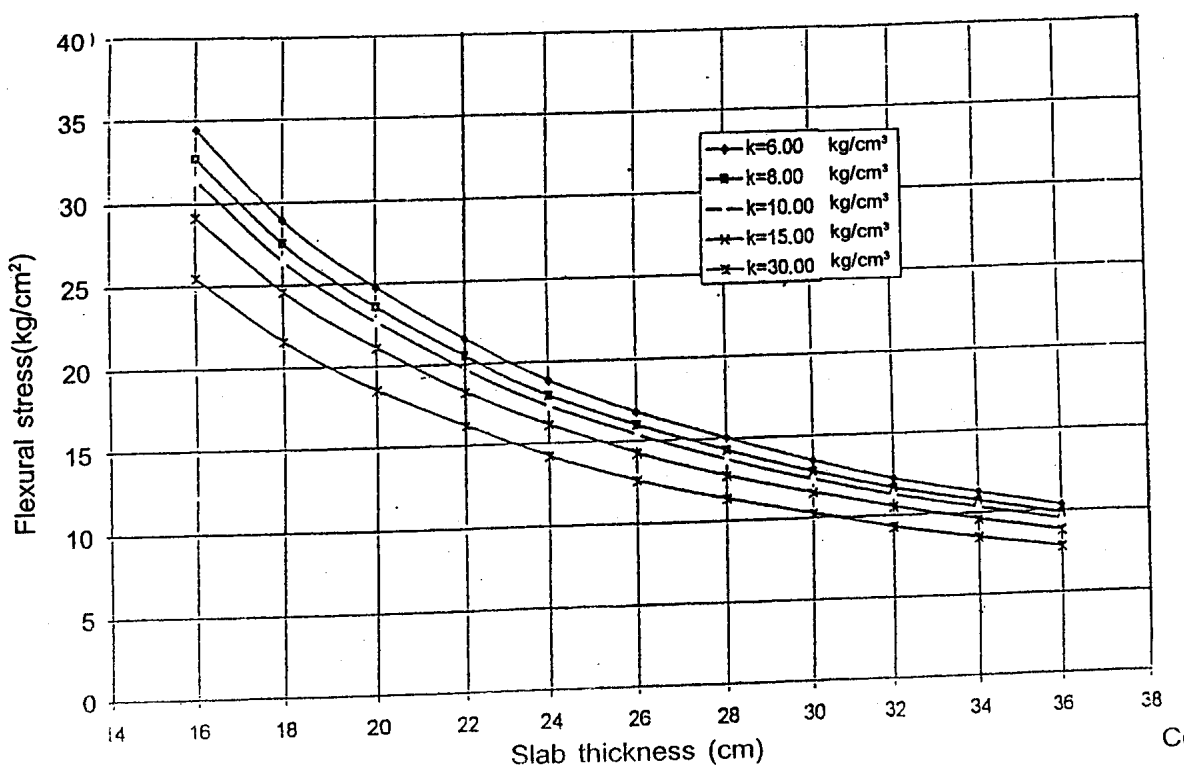
Appendix-1 (Contd.)

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



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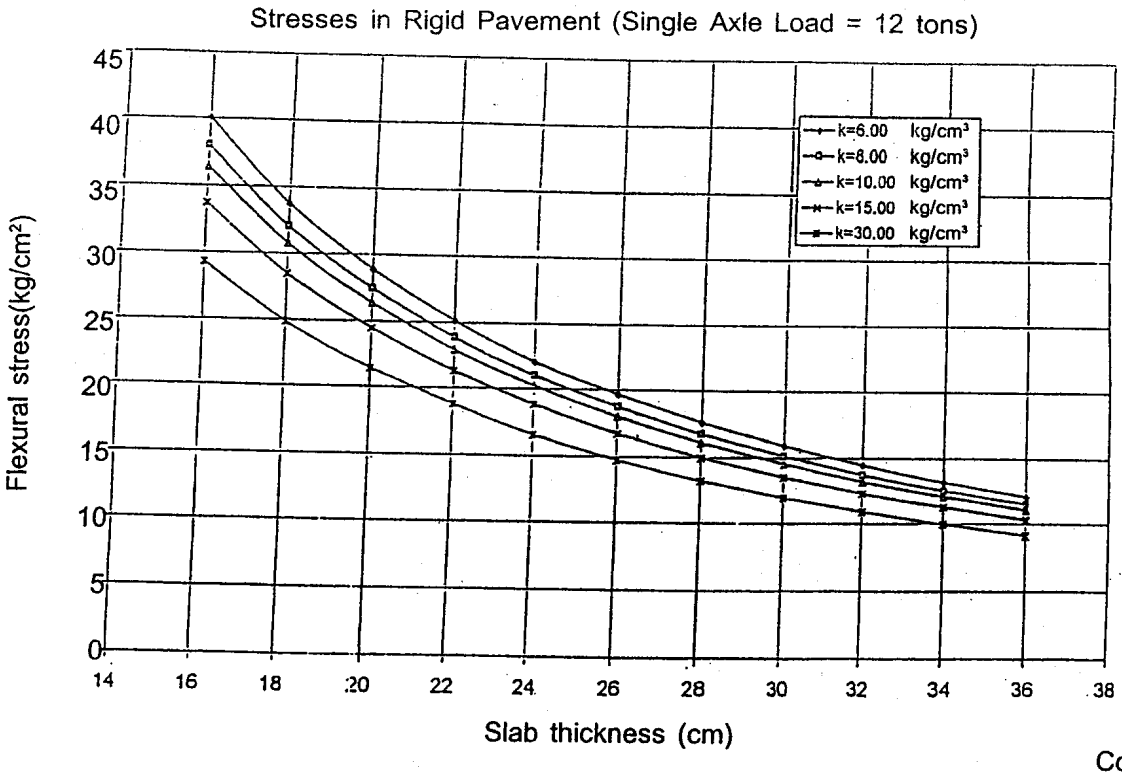
Stresses in Rigid Pavement (Single Axle Load = 12 tons)
Flexural stress(kg/cm²)
Slab thickness (cm)
k=6.00 kg/cm³
k=8.00 kg/cm³
k=10.00 kg/cm³
k=15.00 kg/cm³
k=30.00 kg/cm³
0
5
10
15
20
25
30
35
40
45
14
16
18
20
22
24
26
28
30
32
34
36
38

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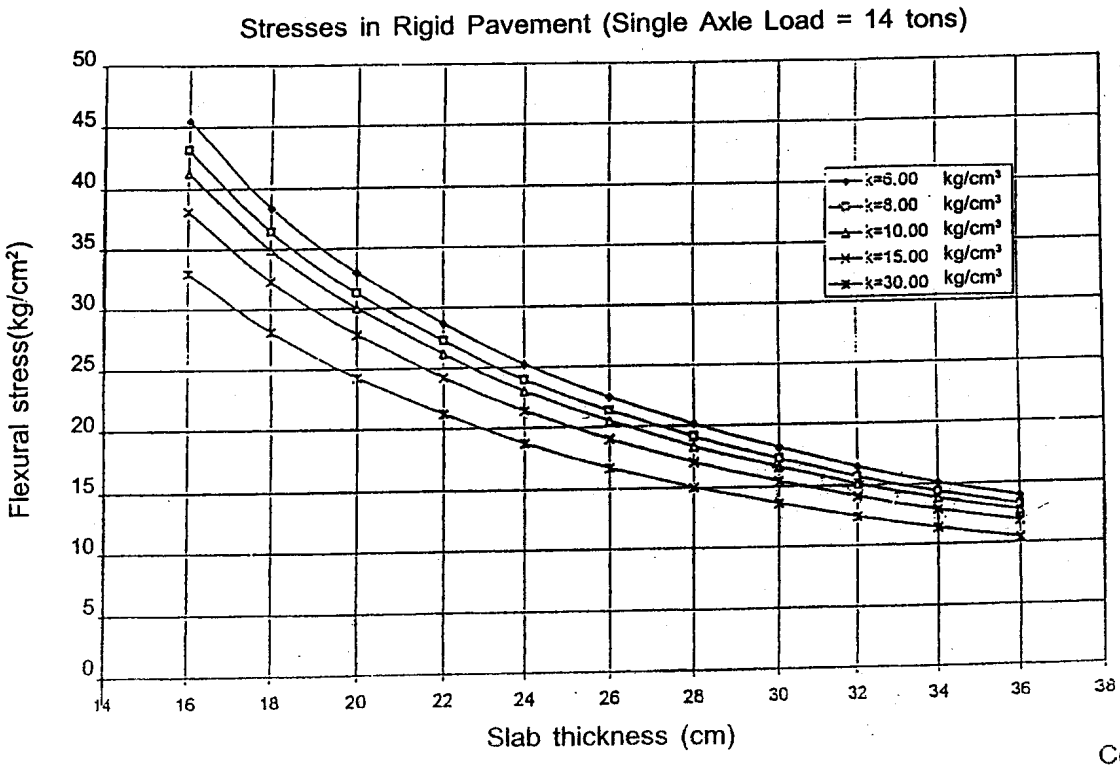
Stresses in Rigid Pavement (Single Axle Load = 14 tons)
Flexural stress(kg/cm²)
Slab thickness (cm)
k=6.00 kg/cm³
k=8.00 kg/cm³
k=10.00 kg/cm³
k=15.00 kg/cm³
k=30.00 kg/cm³
0
5
10
15
20
25
30
35
40
45
50
14
16
18
20
22
24
26
28
30
32
34
36
38

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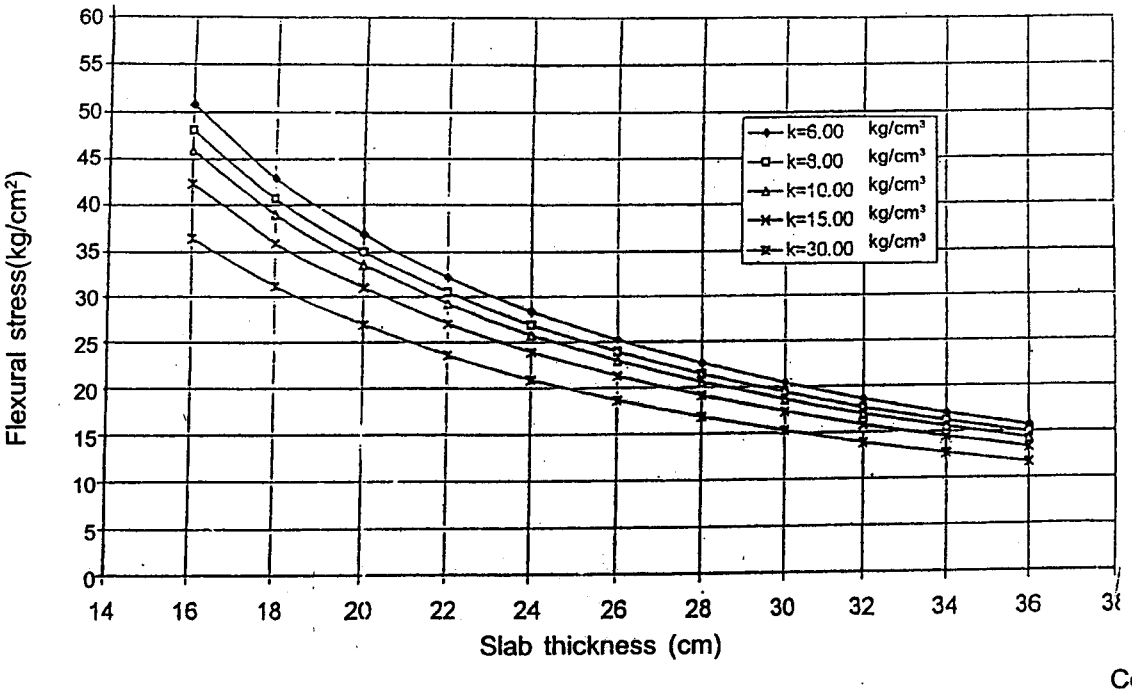
Stresses in Rigid Pavement (Single Axle Load = 16 tons)



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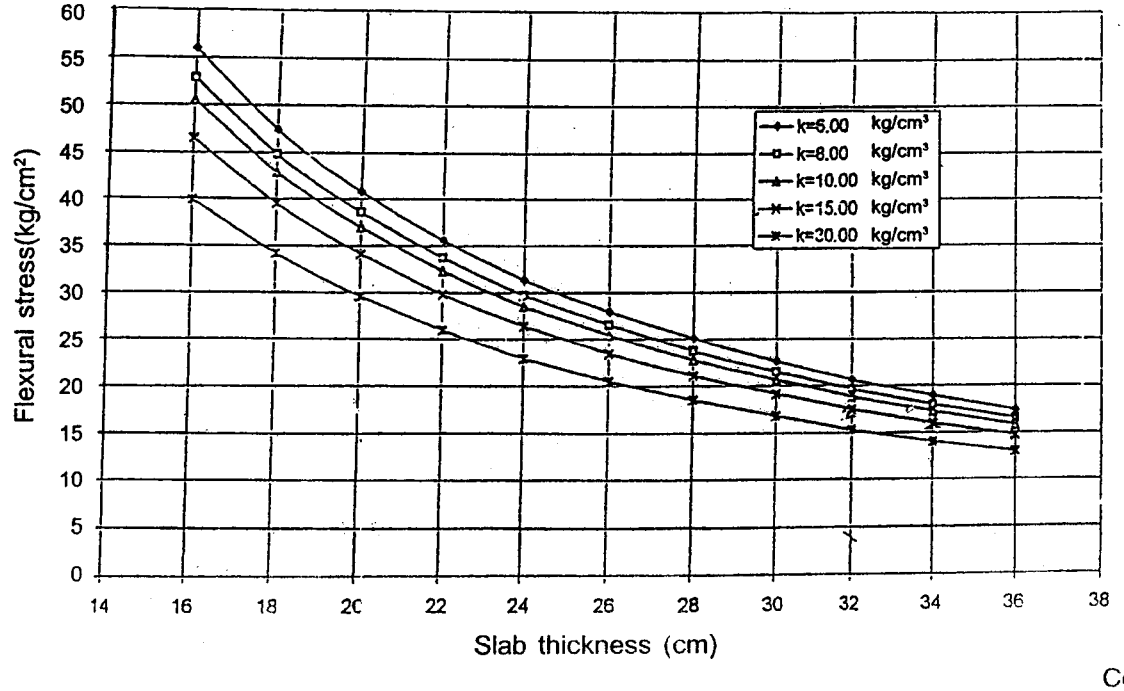
Stresses in Rigid Pavement (Single Axle Load = 18 tons)



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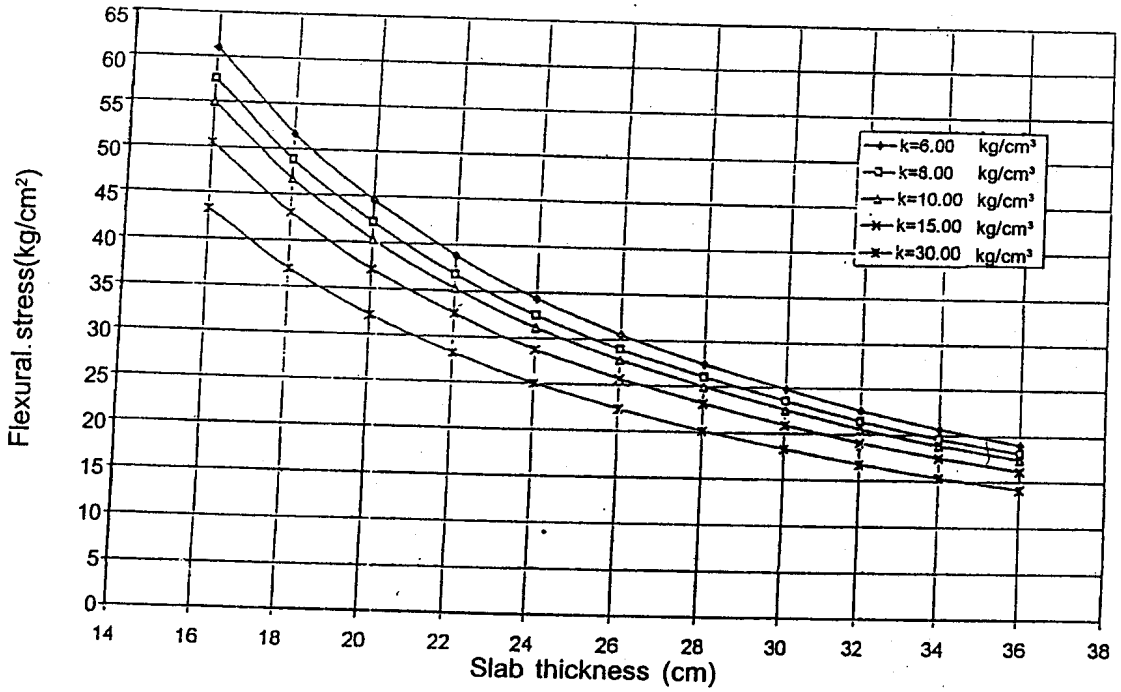
***Appendix-1** (Contd.)*

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



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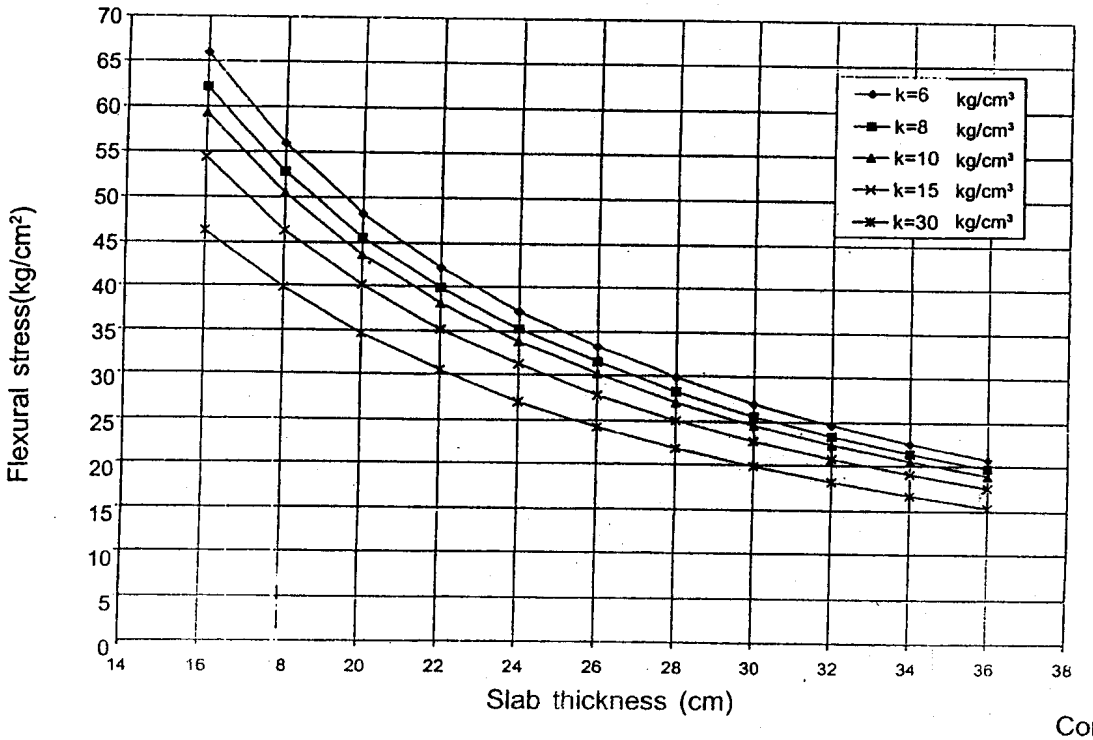
***Appendix-1** (Contd.)*

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



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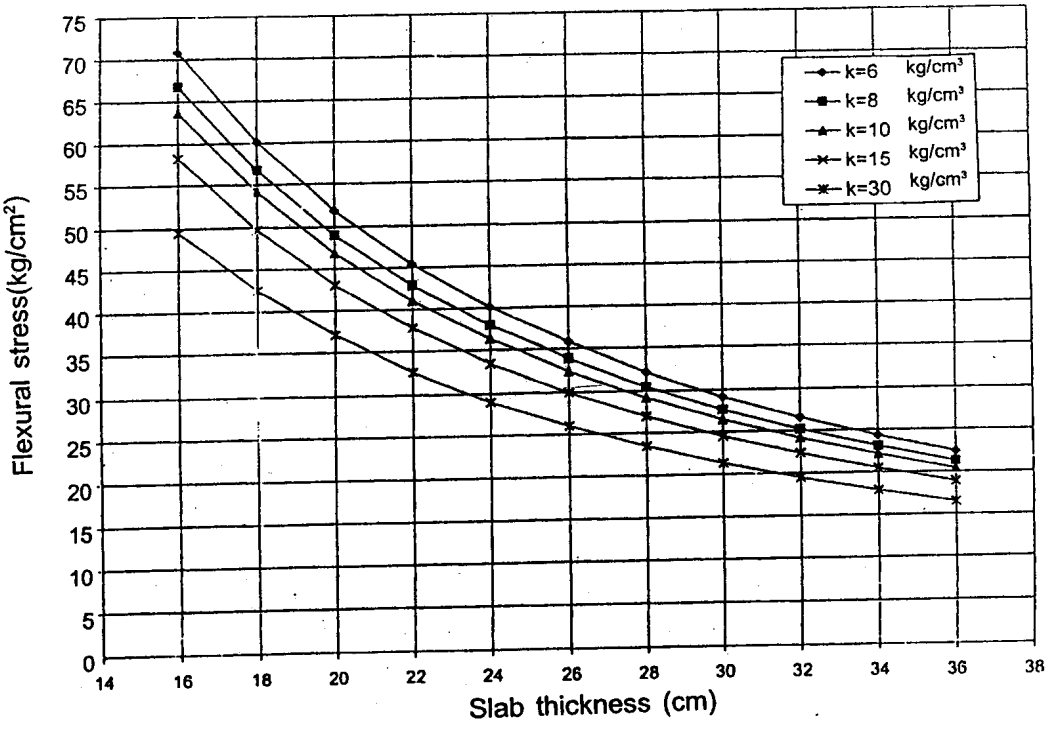
Appendix-1 (Contd.)

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



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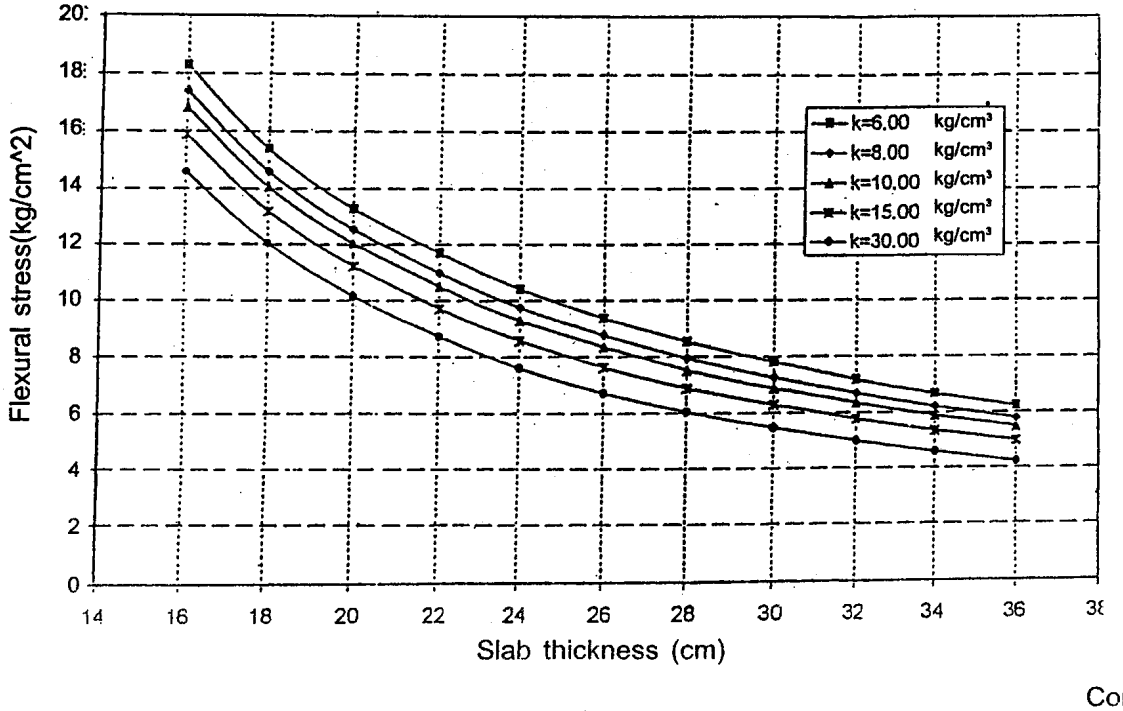
Appendix-1 (Contd.)

Stresses in Rigid Pavement (Tandem Axle Load 12 tons)



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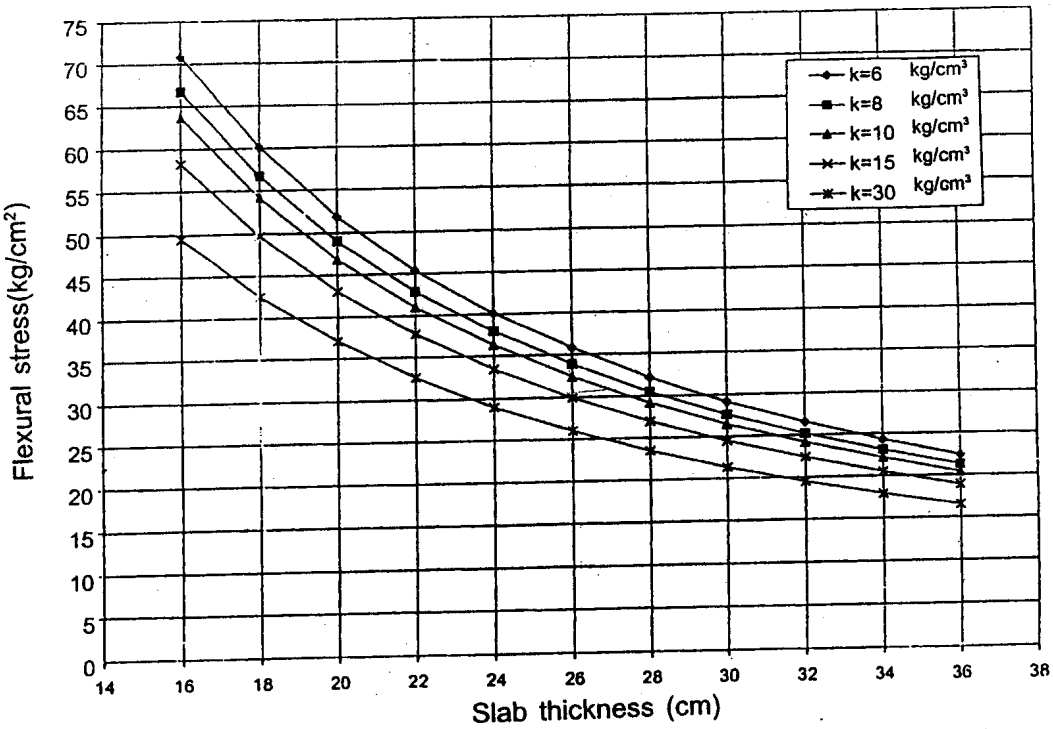
Stresses in Rigid Pavement (Single Axle Load = 24 tons)



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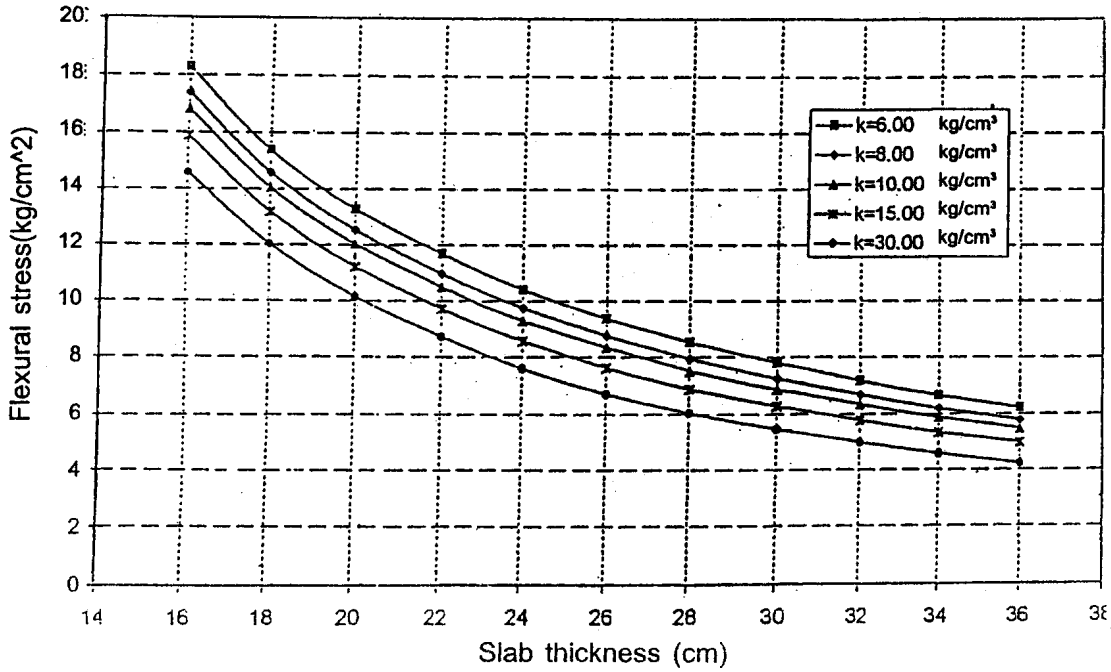
Stresses in Rigid Pavement (Tandem Axle Load 12 tons)



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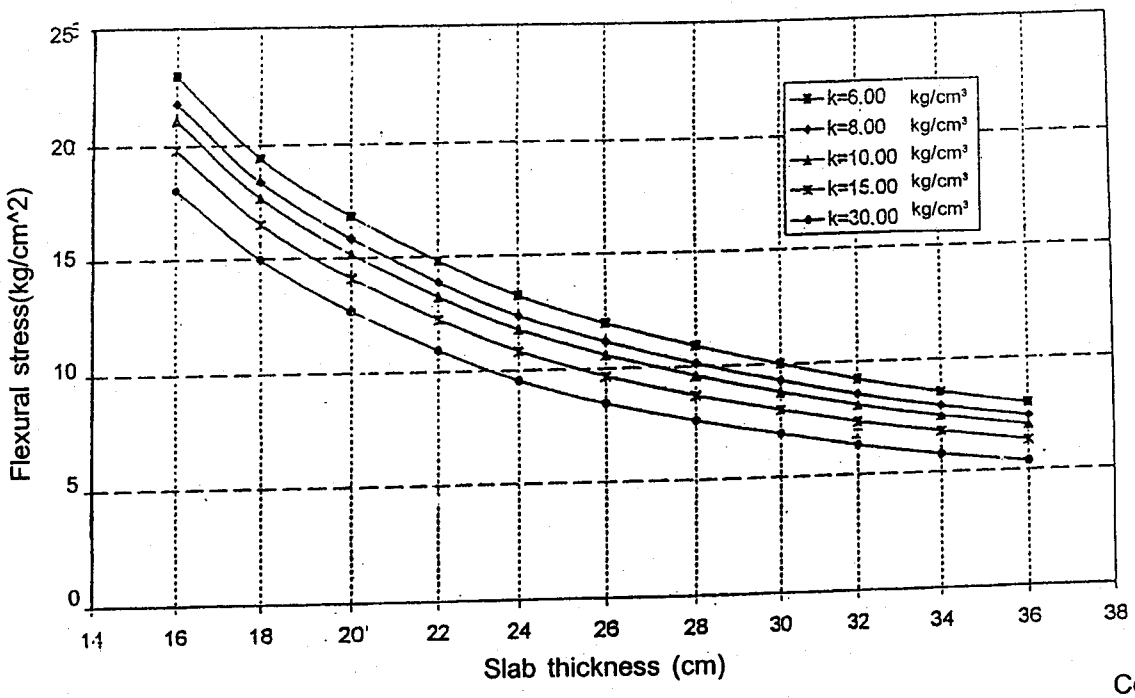
Stresses in Rigid Pavement (Tandem Axle Load 16 tons)



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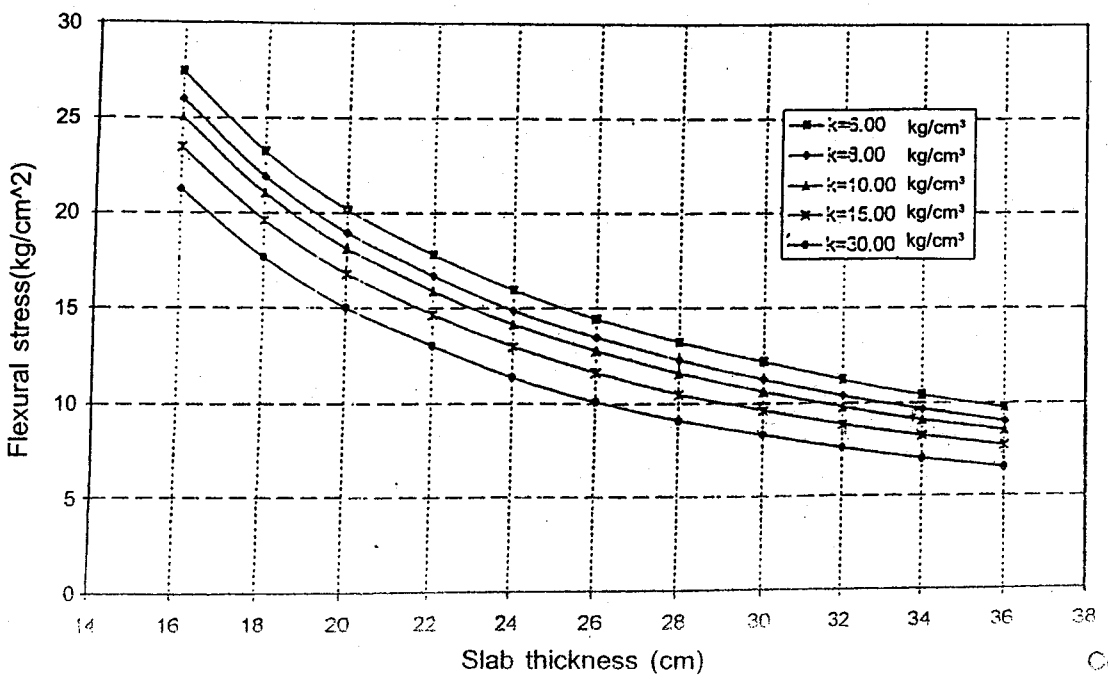
Stresses in Rigid Pavement (Tandem Axle Load 20 tons)



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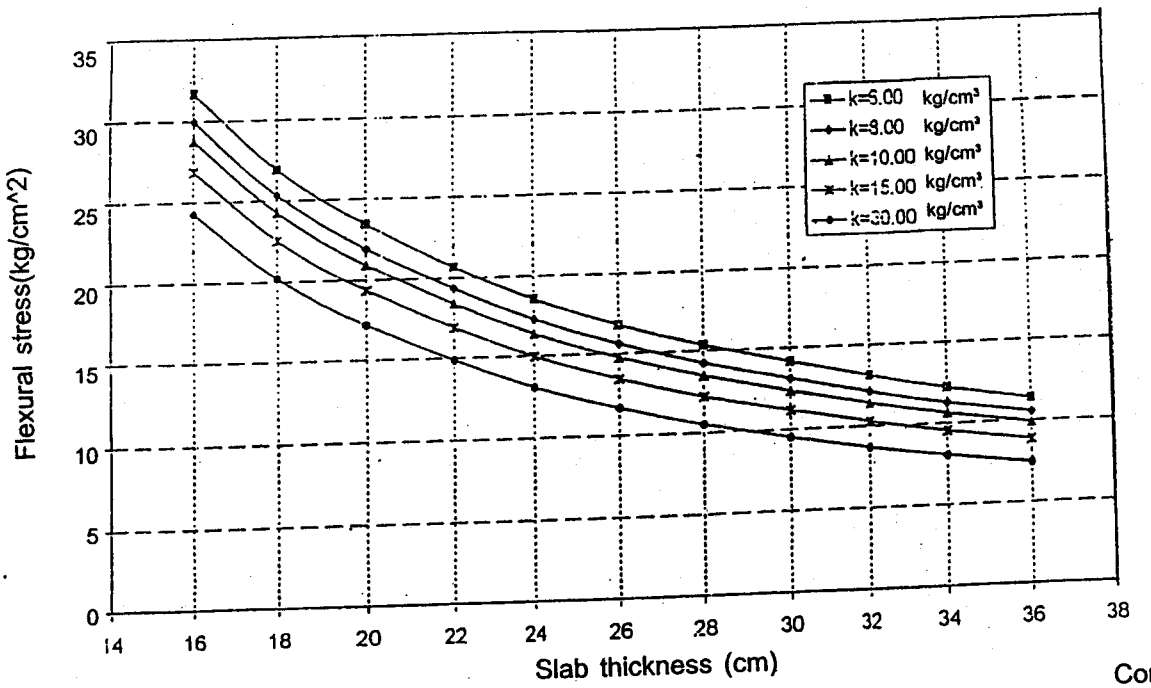
Stresses in Rigid Pavement (Tandem Axle Load 24 tons)



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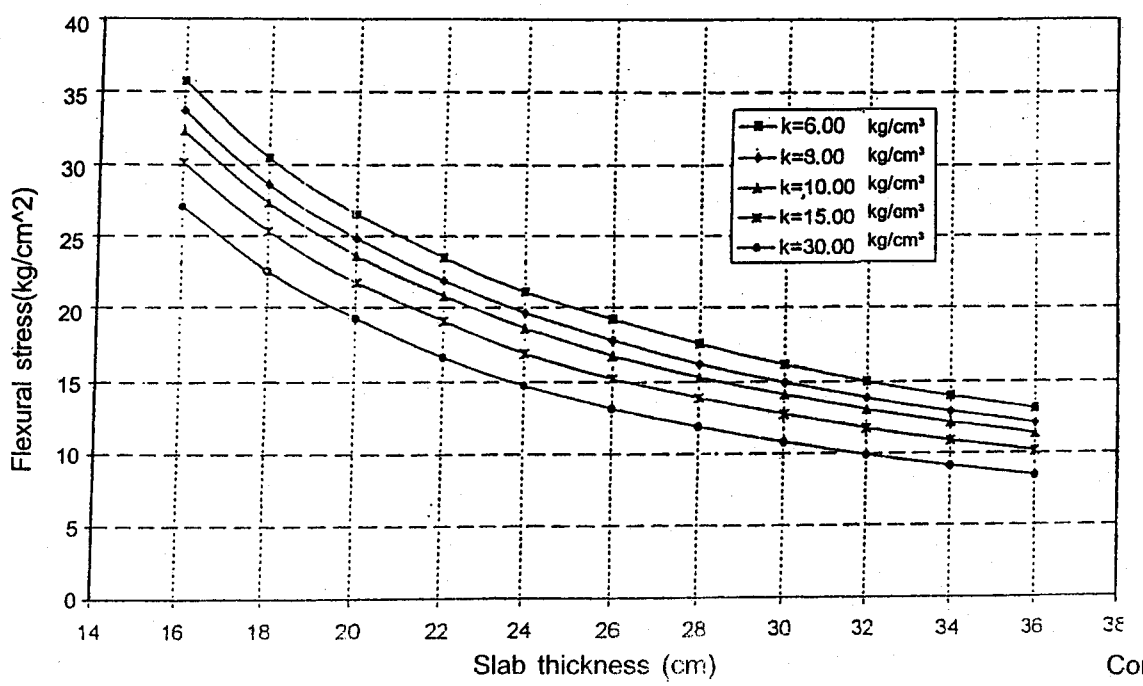
Stresses in Rigid Pavement (Tandem Axle Load 28 tons)



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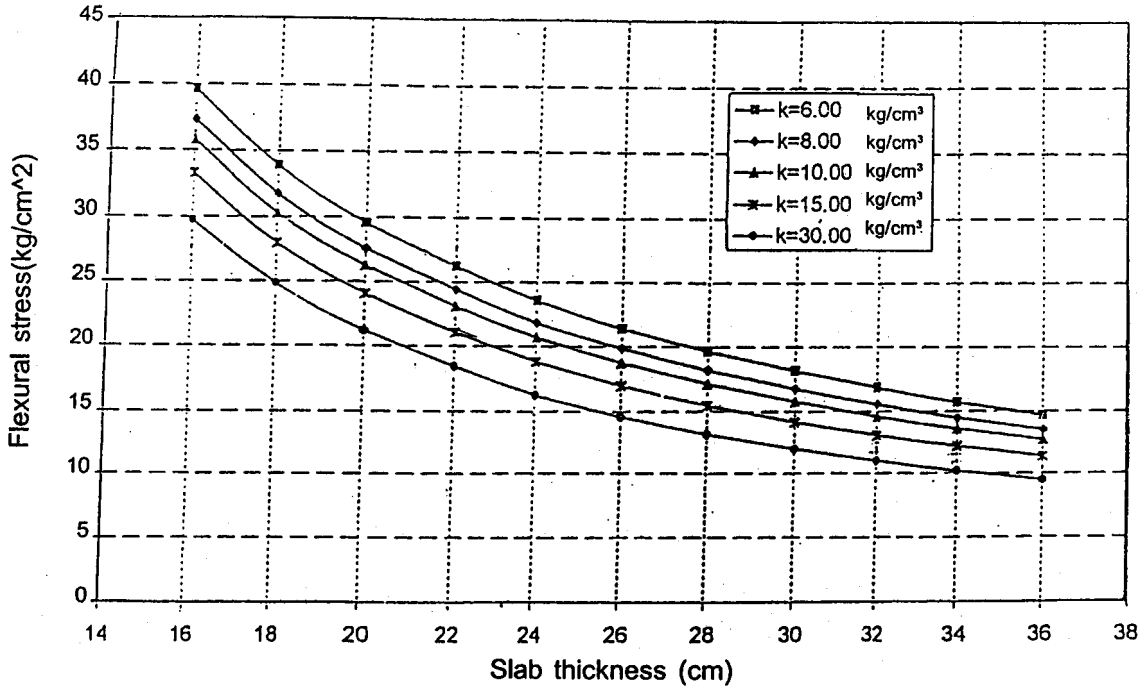
Stresses in Rigid Pavement (Tandem Axle Load 32 tons)



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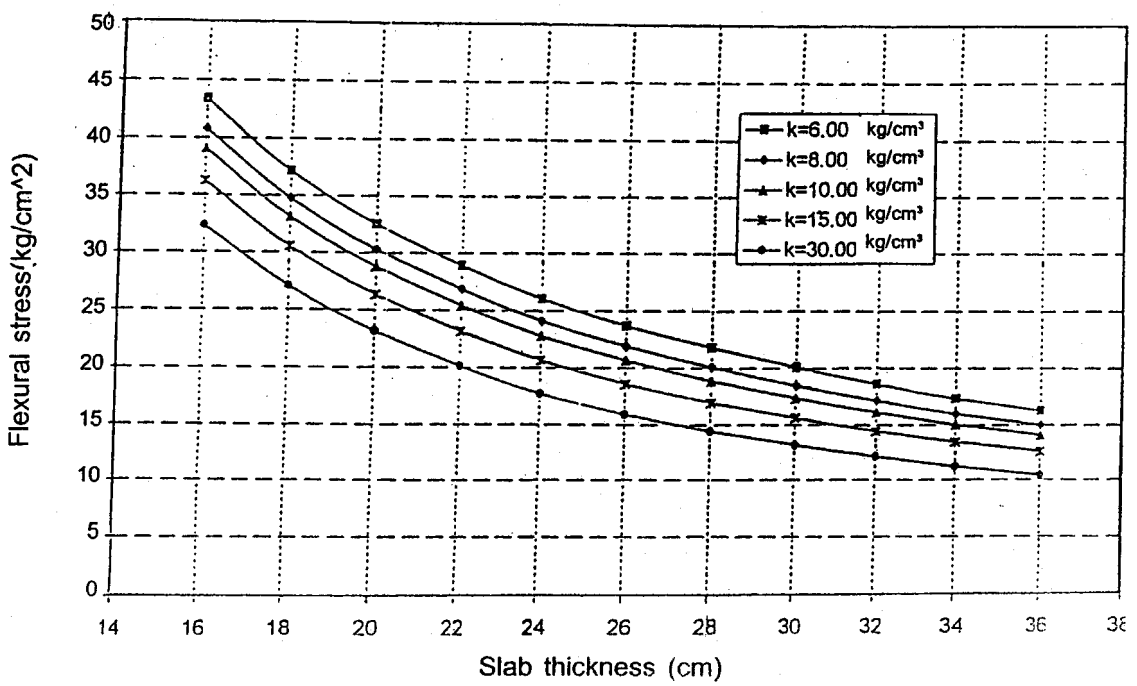
Stresses in Rigid Pavement (Tandem Axle Load 36 tons)



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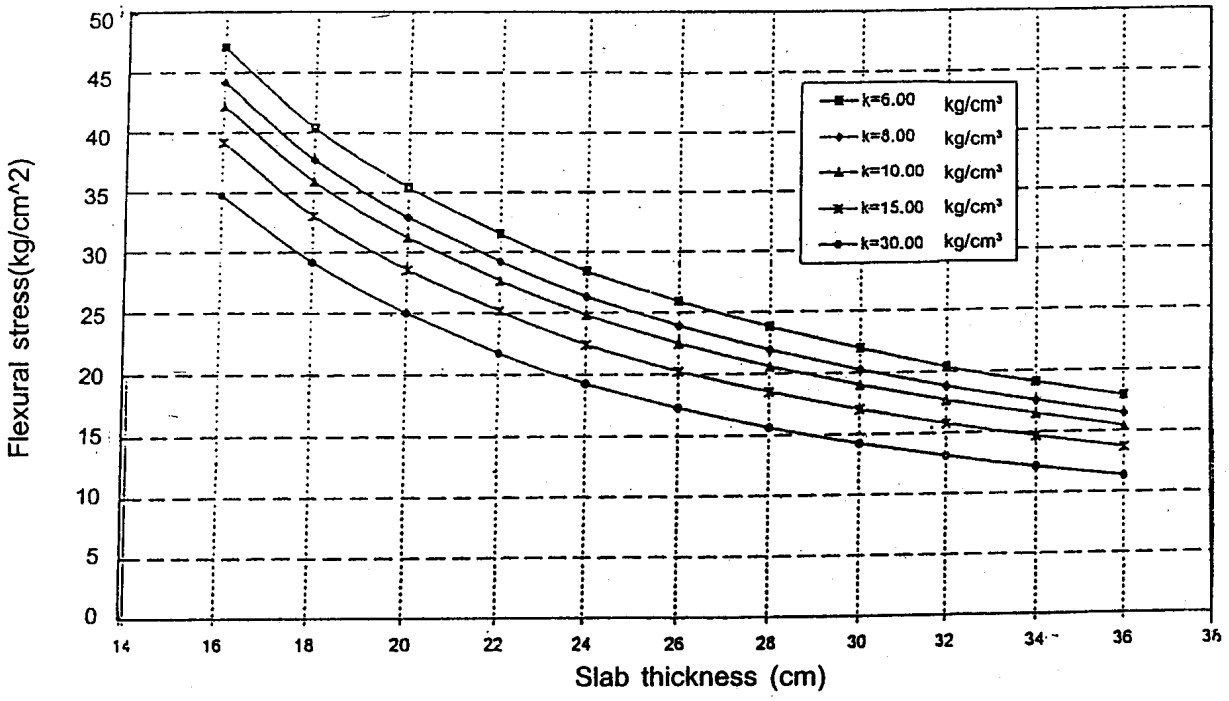
Stresses in Rigid Pavement (Tandem Axle Load 40 tons)



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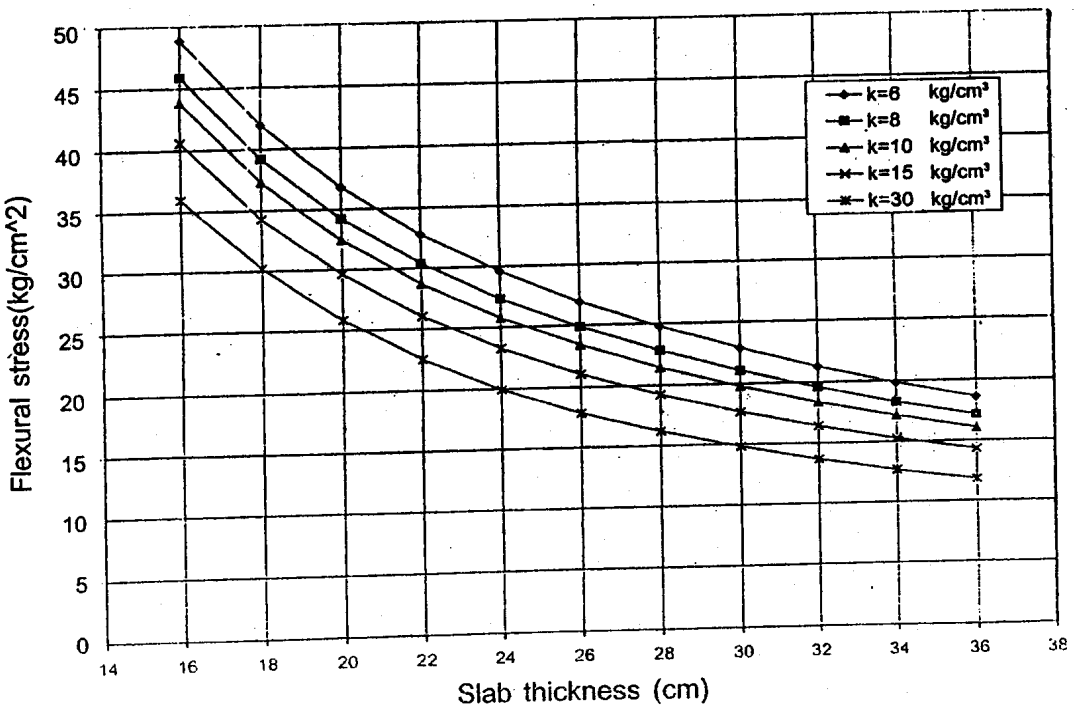
Stresses in Rigid Pavement (Tandem Axle Load 42 tons)



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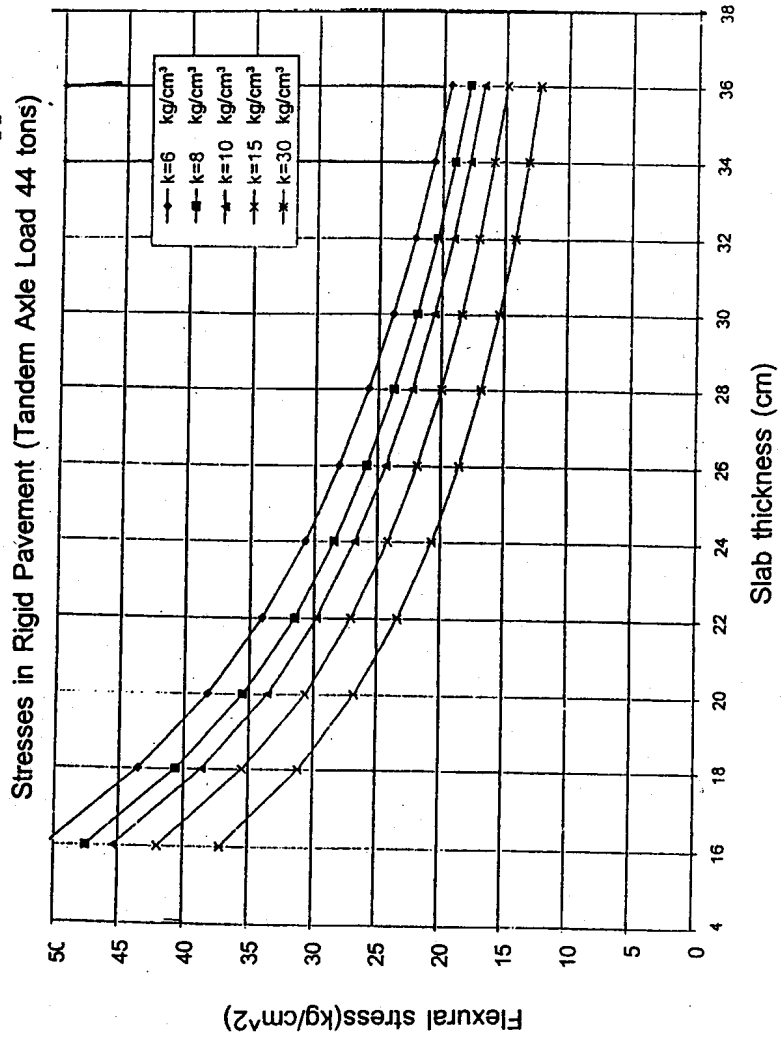

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