PROBLEMS

In these problems the following data are assumed: modulus of elasticity of concrete = 4×10^6 psi, Poisson ratio of concrete = 0.15, modulus of elasticity of steel = 29×10^6 psi, Poisson ratio of steel = 0.3, modulus of dowel support = 1.5×10^6 pci, coefficient of thermal expansion of concrete = 5×10^{-6} in./in./°F, and coefficient of friction between slab and subgrade = 1.5.

4-1. Determine the curling stresses in an 8-in. slab during the day under a temperature gradient of 3°F per inch of slab for the following two cases: (a) at an interior point and at an edge point of an infinite slab, and (b) at points *A*, *B*, and *C* in a finite slab, as shown in Figure P4.1. The modulus of subgrade reaction is assumed to be 50 pci.

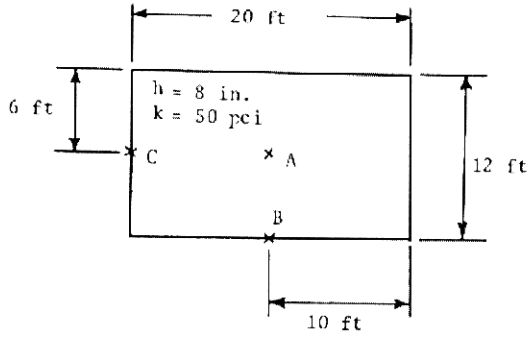

Figure P4.1

4-2. A concrete slab, 10 in. thick, is supported by a subgrade with a modulus of subgrade reaction of 200 pci. A 12,000-lb dual-wheel load (each wheel 6000 lb) spaced at 14 in. on centers is applied at the corner of the slab, as shown in Figure P4.2. The contact pressure is 80 psi. Determine the maximum stress in the concrete by Westergaard's equation with equivalent contact area.

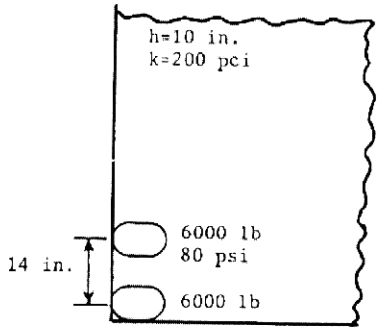

Figure P4.2

4-3. The pavement and loading are the same as in Problem 4-2 but the load is applied in the interior of an infinite slab, as shown in Figure P4.3. Determine the maximum stress in the concrete by (a) Westergaard's equation with equivalent contact area and (b) influence chart using dual tires.

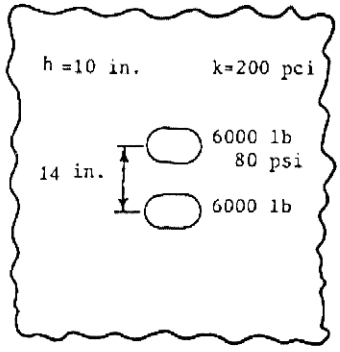

Figure P4.3

4-4. Same as Problem 4-3 except that the load is applied on the slab edge, as shown in Figure P4.4.

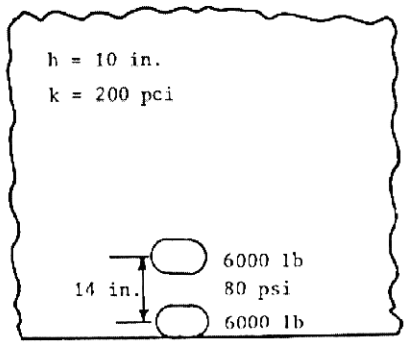

Figure P4.4

4-5. In Figure 4.12, what is the radius of relative stiffness of the pavement? If the thickness of slab is 11 in. and the contact pressure is 100 psi, determine the maximum stress due to the four tires under the center of one tire in the transverse, or n, direction. Estimate the maximum stress in the longitudinal direction under the center of one tire.

4-6. Figure P4.6 shows a set of dual tandem wheels with a total weight of 40,000 lb (10,000 lb per wheel), a tire pressure of 100 psi, a dual spacing of 20 in., and a tandem spacing of 40 in. The concrete slab is 8 in. thick and the modulus of subgrade reaction is 100 pci. Determine the interior stress in the y direction at point A under the center of the dual tandem wheels.

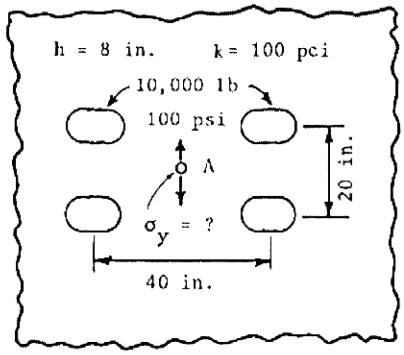

Figure P4.6

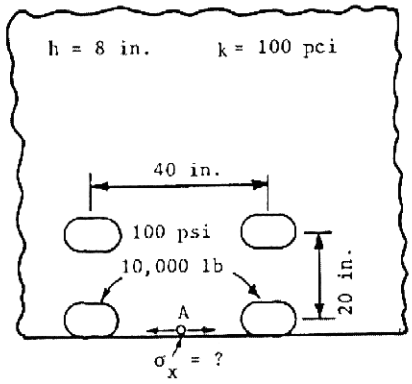

Figure P4.7

4-7. Same as Problem 4-6 except that the outside wheels are applied at the slab edge, as shown in Figure P4.7. Compute the edge stress at point *A* in an infinitely large slab by influence charts.

4-8. A concrete slab, 40 ft long, 11 ft wide, and 9 in. thick, is placed on a subgrade having a modulus of subgrade reaction of 200 pci. A 9000-lb single-wheel load is applied on the edge of the slab over a circular area with a contact pressure of 100 psi, as shown in Figure P4.8. Compute (a) the curling stress at the edge during the night when the temperature differential is 1.5°F per inch of slab, (b) the loading stress due to the 9000-lb wheel load, and (c) the combined stress at the edge beneath the load due to (a) and (b).

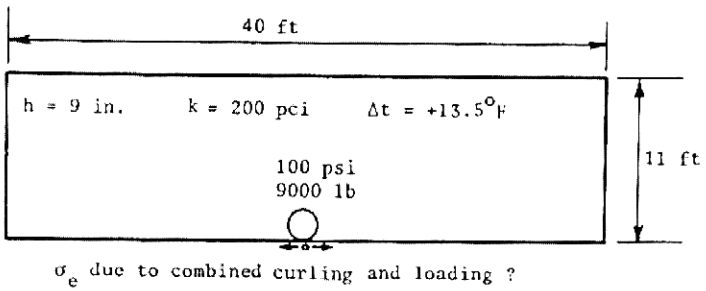

Figure P4.8

4-9. If the pavement in Problem 4-8 is one lane of a two-lane highway, as shown in Figure P4.9, design the welded wire fabric and tie bars.

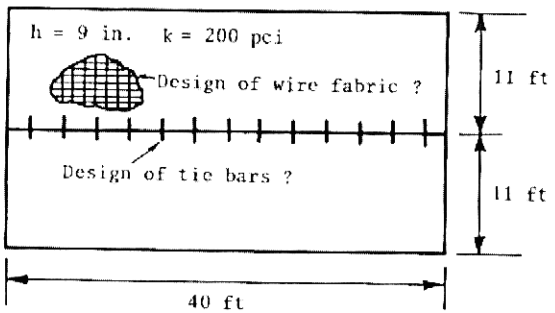

Figure P4.9

4-10. Develop a design chart for required area of temperature steel in terms of the thickness and length of slab, assuming an allowable tensile stress of 40,000 psi.

4-11. A concrete slab has a width of 12 ft, a thickness of 10 in., and a modulus of subgrade reaction of 300 pci. A 24,000-lb axle load with a wheel spacing of 6 ft is applied at the joint with one wheel 6 in. from the edge, as shown in Figure P4.11. Determine the maximum bearing stress between concrete and dowel, assuming 100% load transfer, 0.25-in. joint opening, and 1-in. dowel bars at 12 in. on centers. The maximum

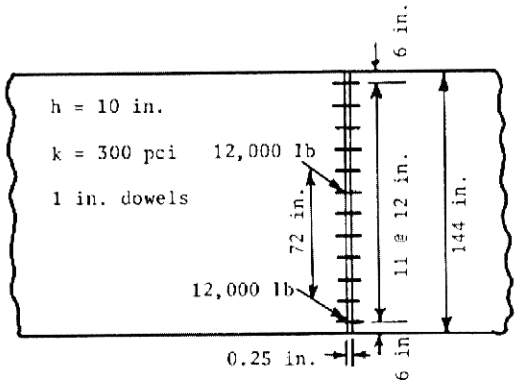

Figure P4.11

negative moment is assumed to occur at a distance of 1.8ℓ from the load, where ℓ is the radius of relative stiffness.

4-12. Repeat Problem 4-11 by assuming that the maximum negative moment occurs at a distance of 1.0ℓ from the load.

4-13. Same as Problem 4-11 except that each of the 12,000-lb wheels is placed at a distance of 2.5 ft from the edge, as shown in Figure P4.13.

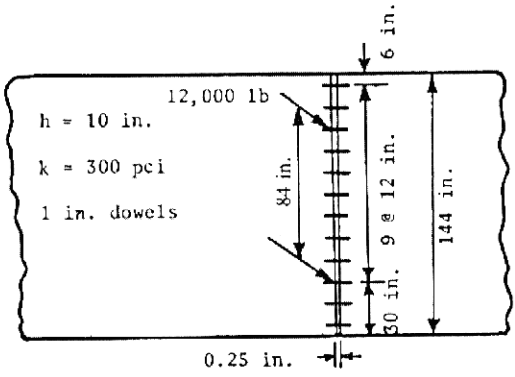

Figure P4.13

4-14. Repeat Problem 4-13 by assuming that the maximum negative moment occurs at a distance of 1.0ℓ from the load.