PROBLEMS

2-1. A uniformly distributed load of intensity q is applied through a circular area of radius a on the surface of an incompressible ($\nu = 0.5$) homogeneous half-space with an elastic modulus E, as shown in Figure P2.1. In terms of q, a, and E, determine the vertical displacement, three principal stresses, and three principal strains at a point $2a$ below the surface under the edge ($r = a$) of the loaded area.

2-2. A 100-psi pressure is applied through a circular area 12 in. in diameter on a granular half-space, as shown in Figure P2.2. The half-space has a mass unit weight of 110 pcf, a coefficient of earth pressure at rest of 0.6, a Poisson ratio of 0.35, and an elastic modulus varying with the sum of normal stresses according to the equation shown in the figure. Assuming that the Boussinesq stress distribution is valid and that the stresses at a point 12 in. below the center of the loaded area are used to compute the elastic modulus, determine the maximum surface displacement.

2-3. A plate bearing test using a 12-in.-diameter rigid plate is made on a subgrade, as shown in Figure P2.3a. The total load required to cause a settlement of 0.2 in. is 10,600 lb. After placing 10 in. of gravel base course on the subgrade, a plate bearing test is made on the top of the base course, as shown in Figure P2.3b. The total load required to

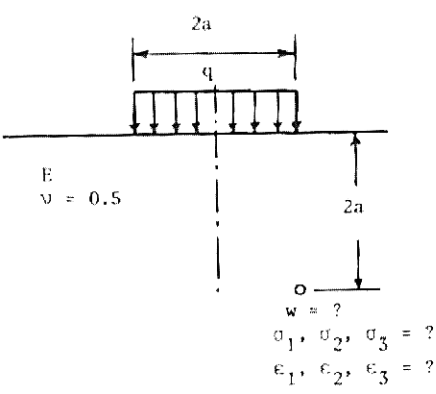

Figure P2.1

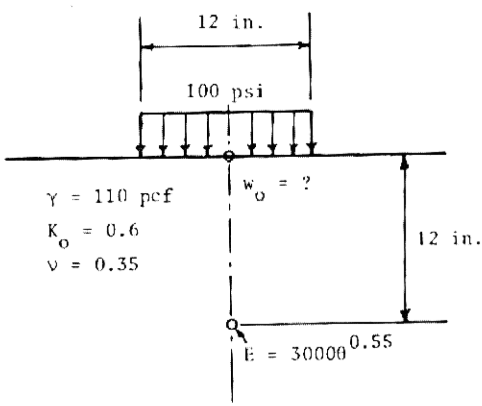

Figure P2.2

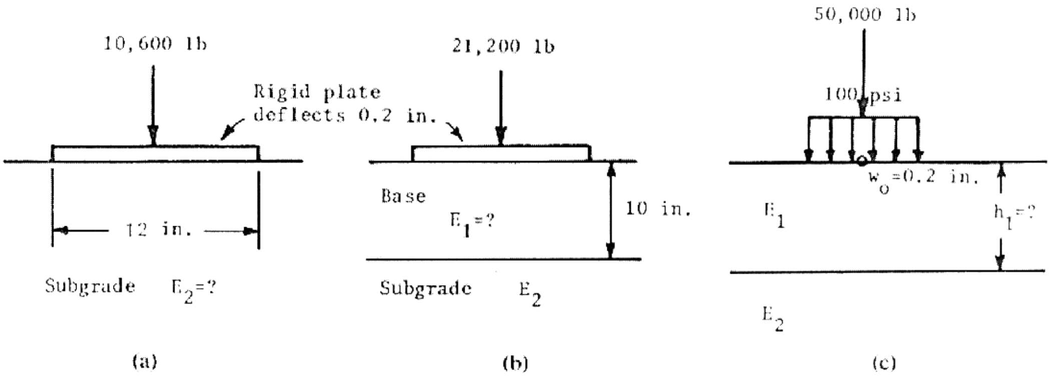

Figure P2.3

cause a settlement of 0.2 in. is 21,200 lb. Assuming a Poisson ratio of 0.5, determine the required thickness of base course to sustain a 50,000-lb tire with a contact pressure of 100 psi over a circular area, as shown in Figure P2.3*c*, and maintain a deflection of 0.2 in.

2-4. A 10,000-lb wheel load with a contact pressure of 80 psi is applied on an elastic two-layer system, as shown in Figure P2.4. Layer 1 has an elastic modulus of 200,000 psi and a thickness of 8 in. Layer 2 has an elastic modulus of 10,000 psi. Both layers are incompressible with a Poisson ratio of 0.5. Assuming that the loaded area is a single circle, determine the maximum surface deflection, interface deflection, and interface stress.

2-5. A full-depth asphalt pavement, consisting of an 8-in.-thick asphalt layer with an elastic modulus of 1,500,000 psi and a soil subgrade with an elastic modulus of 30,000 psi, is subjected to dual-tandem wheel loads, as shown in Figure P2.5. Each load weighs 50,000 lb with a tire pressure of 100 psi and center to center spacings of 28 in. between dual and 60 in. between tandem. Assuming a Poisson ratio of 0.5, determine the maximum tensile strain at the bottom of asphalt layer under the center of one wheel, and the vertical deflection on the surface of subgrade under the center of one wheel.

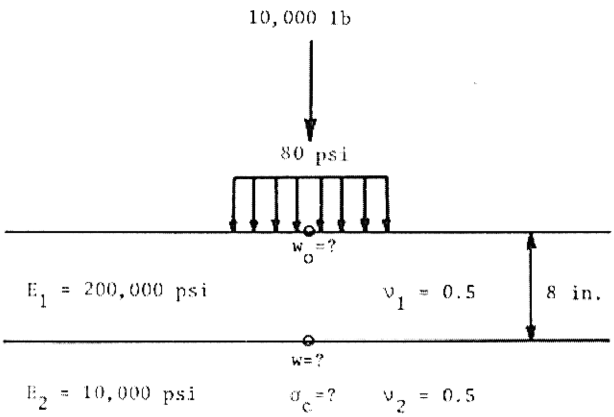

Figure P2.4

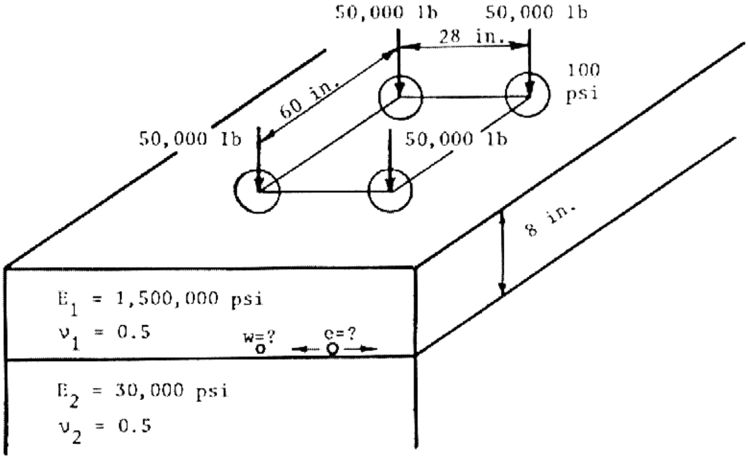

Figure P2.5

2-6. Figure P2.6 shows a pavement structure composed of the following three layers: 5.75 in. HMA with an elastic modulus of 400,000 psi, 23 in. granular base with an elastic modulus of 20,000 psi, and a subgrade with an elastic modulus of 10,000 psi. All layers are assumed to have a Poisson ratio of 0.5. Calculate the maximum horizontal tensile strain at the bottom of HMA and the maximum vertical compressive strain on the top of subgrade under a 40,000-lb wheel load and 150-psi contact pressure, assuming that the contact area is a circle.

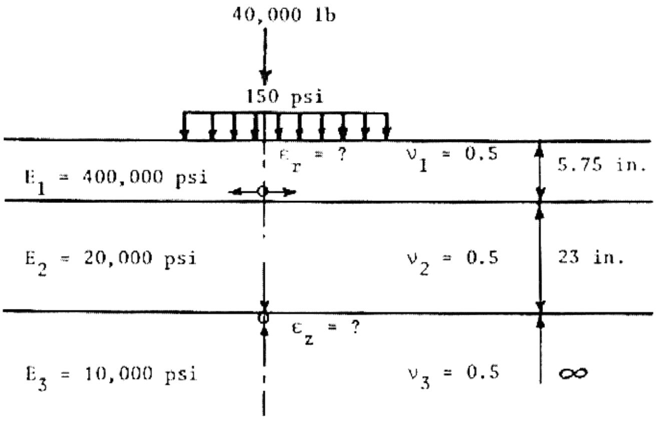

Figure P2.6

2-7. In Problem 2-6 if the base and subgrade are combined as one layer, as shown in Figure P2.7*a*, what should be the equivalent elastic modulus of this combined layer so that the same tensile strain at the bottom of HMA can be obtained? If the HMA and base are combined as one layer with the same total thickness of 28.75 in., as shown in Figure 2.7*b*, what should be the equivalent elastic modulus of this combined layer so that the same compressive strain on the top of subgrade can be obtained?

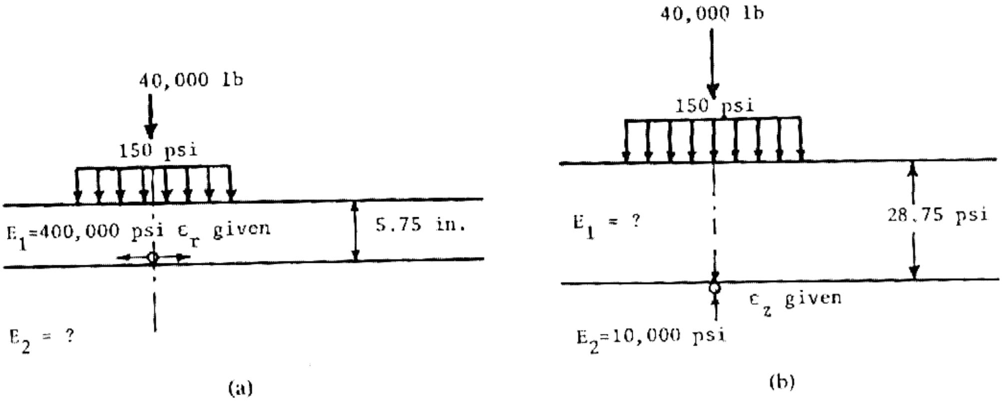

Figure P2.7