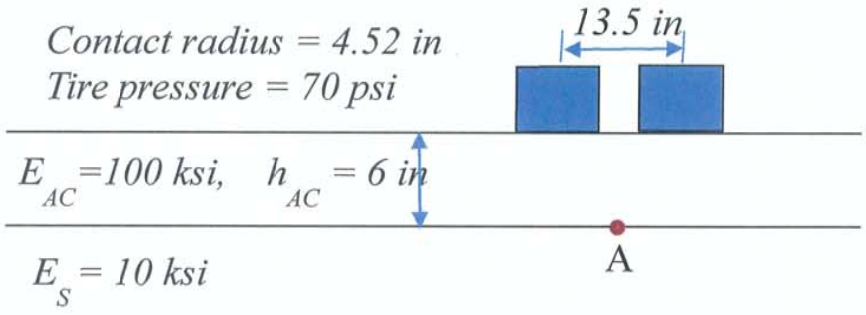
1. A set of dual tires with 4500 lb (20 kN) in total and a contact pressure of 70 psi (483 kPa). The center to center spacing of the dual is 13.5 in. (343 mm). Layer 1 has a thickness of 6 in. (152 mm) and an elastic modulus of 100,000 psi (690 MPa) and layer 2 has an elastic modulus of 10,000 psi (69 MPa). Determine the vertical deflection at point A, which is on the interface beneath the center of one loaded area. (20%)



2. A concrete slab, 10 in. thick, is supported by a subgrade with a modulus of subgrade reaction of 200 pci. A 10,000-lb wheel load with 80 psi contact pressure. Determine the maximum stress, maximum deflection in the concrete by Westergaard's equation. (20%)

3. Estimate the equivalent 18-kip single-axle load applications (ESAL) for a four-lane pavement (two lanes in each direction) of a rural interstate highway with a truck count of 1000 per day (including 2-axle, 4-tire panel, and pickup trucks), an annual growth rate of 5%, and a design life of 20 years. (20%)

4. Please describe the characteristics of the fatigue life of Portland cement concrete. (20%)

5. Please explain the differences of backcalculation algorithm between layered system and dense-liquid model. (20%)

1. Carefully derive the Hall-Petch relationship. Explain the assumptions that are used in the derivation of the relationship. Discuss the implications of the relationship for developing metallic alloys with simultaneously high strength and high ductility. (20%)

2. Discuss the deformation mechanisms of metal under creep, stress relaxation and sinusoidal loading in ambient and high temperature environment. (20%)

3. Discuss the effects of dislocation on the fatigue of metal. (20%)

4. Discuss the stress fields of the screw and edge dislocations. Use the stress fields to explain why the screw and edge dislocation are drawn toward the stress-free boundary of a metallic solid if the dislocations are very near the boundary. (20%)

5. Discuss the effects of driving frequency and applied temperature on the alpha and beta damping peaks in terms of loss tangent, as well as the corresponding underlying mechanisms that are associated with the damping peaks. (20%)

110 學年度第 1 學期博士學位候選人資格考試

高等瀝青材料學 (20% for each question)

1. Explain and commend the following paragraph.
   Empirical tests are used less frequently now because they are not able to predict performance for conditions that are different than those under which the tests were developed. These tests were never good at predicting performance and have become less reliable in prediction performance as axle loads and tire pressures have continued to increase.

2. Briefly describe the asphalt refining procedures.

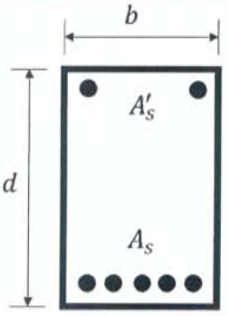
3. Briefly describe the major superpave asphalt binder testing equipment and purpose.

4. Briefly describe the procedures of the Marshall mix design and superpave mix design method.

5. Briefly describe the properties of an ideal pavement binder.

Problem 1. (30%)

A cantilever beam has a design shown below. Beam length = 6000 mm, b=500 mm, d=900 mm, As = 5-D25, and As' = 2-D25. If the required μ_Δ=6, find the required μ_ϕ and design the appropriate f'c



$\rho = A_s/bd$

$\rho' = A'_s/bd$

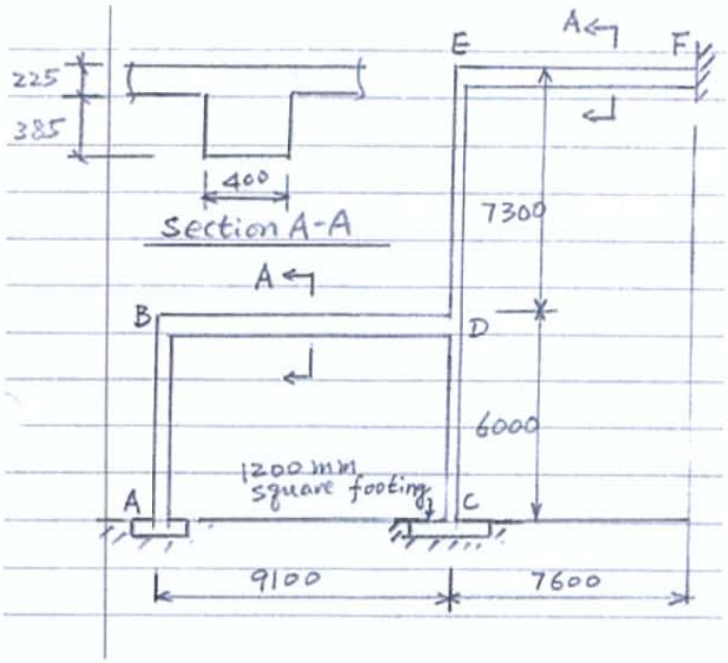
$d'/d = 0.1$

$f_y = 40\ ksi\ (276\ MPa)$

$E_s = 29 \times 10^3\ ksi\ (200000\ MPa)$

Problem 2. (30%)

Design column AB in the nonsway frame shown in the figure. fy = 550MPa, concrete cylinder strength = 30MPa, and the service loads and moments listed below.

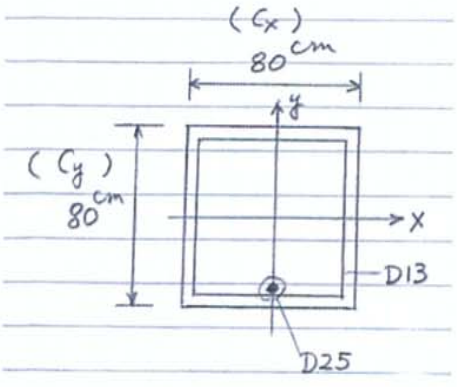


	Column AB
Service Load, P	$P_D = 300\ kN$
	$P_L = 90\ kN$
Service moments at tops of column	$M_D = -70\ kN - m$
	$M_L = -16\ kN - m$
Service moments at bottoms of column	$M_D = -26\ kN - m$
	$M_L = -10\ kN - m$

Problem 3. (40%)

Design the longitudinal reinforcement for a reinforced concrete column subjected to axial compression and biaxial bending. fy = 5500 kgf/cm^2, concrete cylinder strength =280 kgf/cm^2, and the load demands summarized below.

(a) For the design, please use the load contour method and (b) for the review, please use the reciprocal load method to check your design.



(unit: tf and m)	Axial load (tf)	Top of column M_{ux}(tf-m)	Top of column M_{uy}(tf-m)	Bottom of column M_{ux}(tf-m)	Bottom of column M_{uy}(tf-m)	V_u (tf)
Minimum axial load combination	-600.0	-10.0	12.0	108.0	-30.0	30.0

Note: You can make assumptions for each problem that you think are necessary.