109 學年度第 2 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 comment the following paragraph.
   The performance of a pavement is affected by the type, time of application, and quality of the maintenance it receives. Preventive timely maintenance slows the rate of pavement deterioration due to traffic and environmentally applied loads. Delays in maintenance and deferred maintenance increase the quantity of defects and their severity so that when corrected, the cost of repair is greater. Continued deferral of maintenance and rehabilitation actions shortens the time between overlays and reconstruction, and thus increases the life cycle costs of a pavement considerably.

2. Briefly describe the asphalt cement grading system.

3. Briefly describe the reasons to develop the superpave asphalt binder tests and specifications.

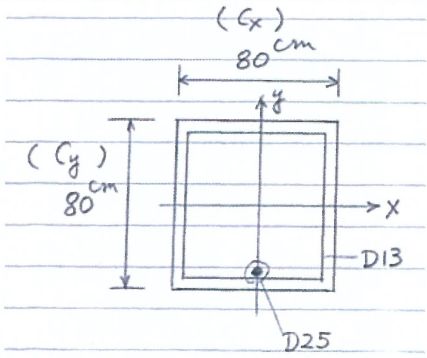
4. Briefly describe the procedures of the superpave mix design method.

5. Briefly describe the two principal types of HMA facilities (mixing plants).

Problem 1. (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 =400 kgf/cm^2, and the load demands summarized below.

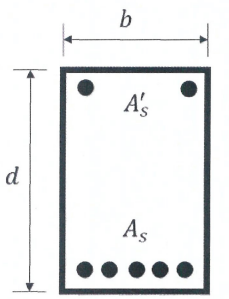
(a) For the design, please use the load contour method and (b) for the review, please use the reciprocal load method to check your design.



(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	-660.0	-12.0	15.0	120.0	-35.0	35.0

Problem 2. (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=4, find the required μ_ϕ and design the appropriate f'c



$\rho = A_s/bd$

$\rho' = A'_s/bd$

$d'/d = 0.1$

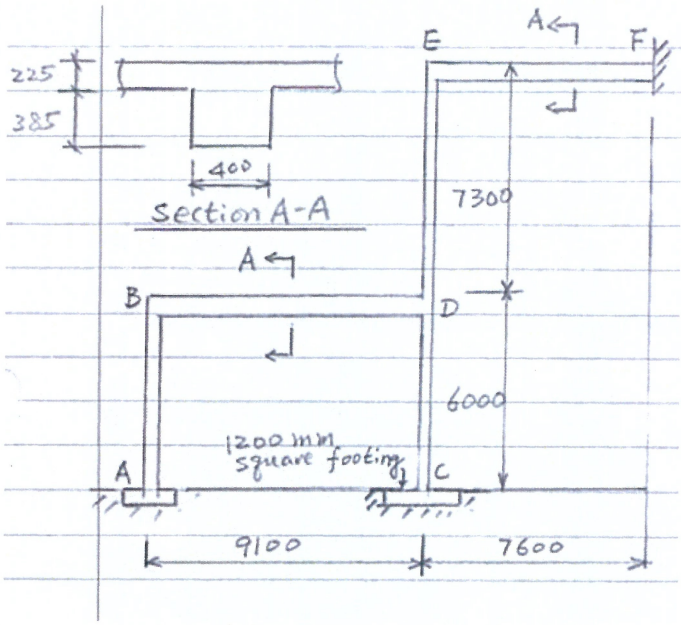
$f_y = 40\ ksi\ (276\ MPa)$

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

Problem 3. (30%)

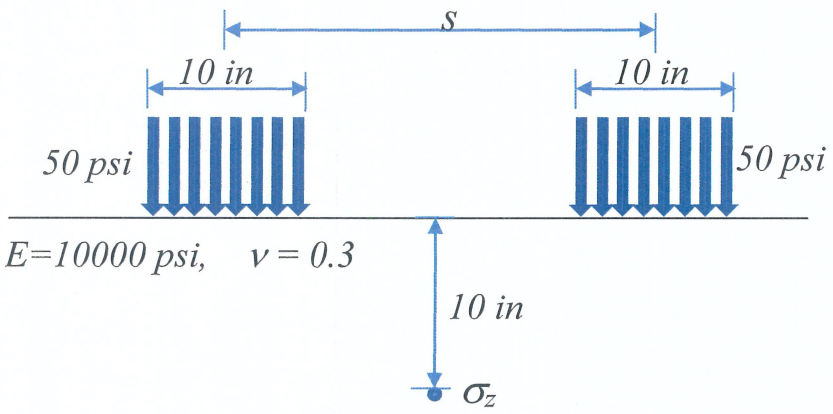
Design column AB in the nonsway frame shown in the figure. fy = 490 MPa, concrete cylinder strength = 28 MPa, and the service loads and moments listed below.

	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	$M_D = -26\ kN-m$
	$M_L = -10\ kN-m$



Note: You can make assumptions for the problems that you think are necessary.

1. Please plot the curve of wheel spacing (s) versus vertical stress (σ_z) for the pavement shown below **(20%)**



2. Use Westergaard's solutions to calculate the maximum stresses of a concrete slab (150in×210in×14in) resting on Winkler foundation (k=200 psi/in) and interiorly loaded with a single wheel, the results are different from the results of finite element analysis by 15%.
   (a) calculate the maximum tensile stress in the concrete slab. **(5%)**
   (b) calculate the maximum deflection in the concrete slab **(5%)**
   (c) calculate the maximum compressive stress in the subgrade. **(5%)**
   (d) please comment on the accuracy of the results between equations and finite element analysis on this case. (5%)

3. A flexible pavement with SN=4 is subjected to a tandem-axle load of 40 kip.
   (a) Based on a p_t=2.5, what is the tandem-axle load on a 9-in. rigid pavement that is equivalent to the EALF on the flexible pavement. (10%)
   (b) the tandem-axle load of 40 kip is more destructive to the flexible pavement of SN=4 or the 9-in. rigid pavement ? (10%)

4. (a) Explain the difference between Young's modulus and resilient modulus. (10%)
   (b) Plot the general relationship between deviator stress and resilient modulus of fine-grained soils and the expression of the model. (5%)
   (c) Plot the general relationship between 1st stress invariant and resilient modulus of granular materials and the expression of the model. (5%)

5. Please explain the theoretical and algorithm differences of backcalculation between flexible pavement and rigid pavement. (20%)