Problem 1. (30%)
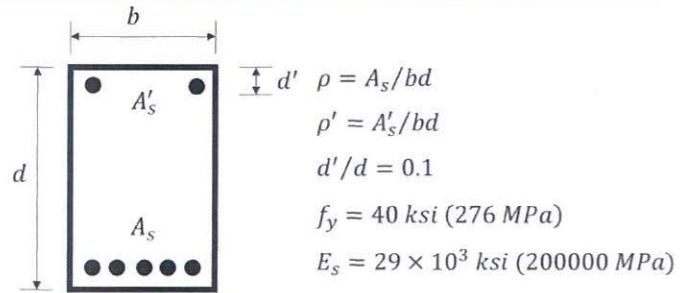
A cantilever beam has a design shown below. Beam length = 8000 mm, b=500 mm, d=900 mm, As = 5-D25, and As' = 2-D25. If the required μ_Δ=5, find the required μ_ϕ and design the appropriate f'c

d' $\rho = A_s/bd$

$\rho' = A'_s/bd$

$d'/d = 0.1$

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

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

Problem 2. (30%)

Design column AB in the nonsway frame shown in the figure. fy = 550MPa, concrete cylinder strength = 50MPa, and the service loads and moments listed below.
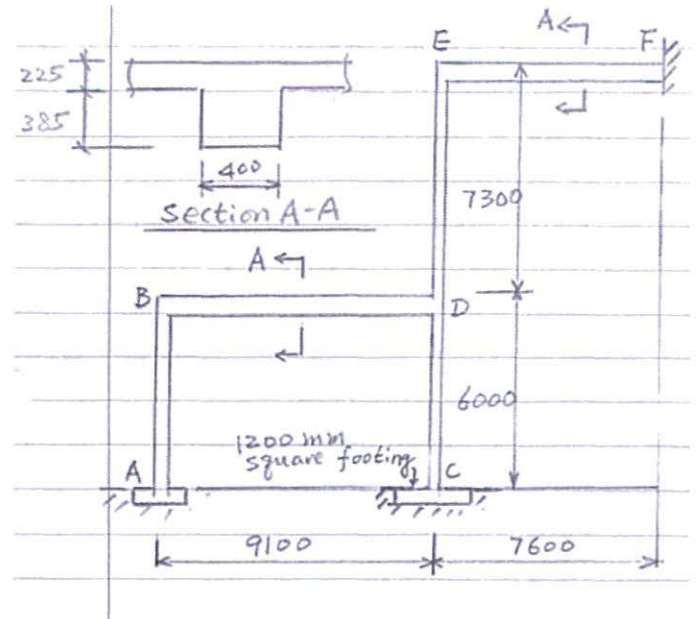
	Column AB
Service Load, P	$P_D = 300\ kN$
	$P_L = 90\ kN$
Service moments at tops of column	$M_D = -70\ kN - m$
	$M_L = -16\ kN - m$
Service moments at bottoms of column	$M_D = -26\ kN - m$
	$M_L = -10\ kN - m$

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 =350 kgf/cm^2, and the load demands summarized below.
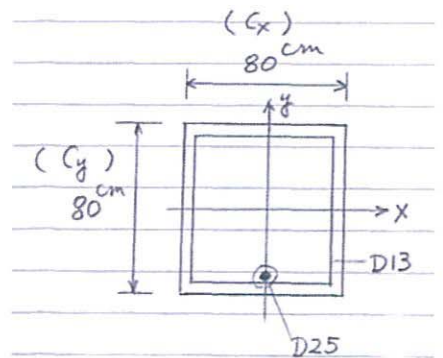
(a) For the design, please use the load contour method and (b) for the review, please use the reciprocal load method to check your design.

(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.

1. Use equations to describe the mechanism of temperature effects on pavement stresses in flexible pavement and rigid pavement, respectively. (20%)

2. According to EALF tables in the textbook "Pavement Analysis and Design", how would you evaluate the relationship between excess damages and wheel loads on asphalt pavement or rigid pavement ? (20%)

3. Please explain the difference between Elastic modulus and resilient modulus. (20%)

4. Which Westergaard's equations is relatively suitable for flexible pavement analysis? Why? (10%)

5. Why multi-layer elastic theory is not prevailing in design and alaysis of rigid pavement ? (10%)

6. Please add the legends of x-axis and y-axis for the figures below, and describe the meaning of figures and the legends. (10%)
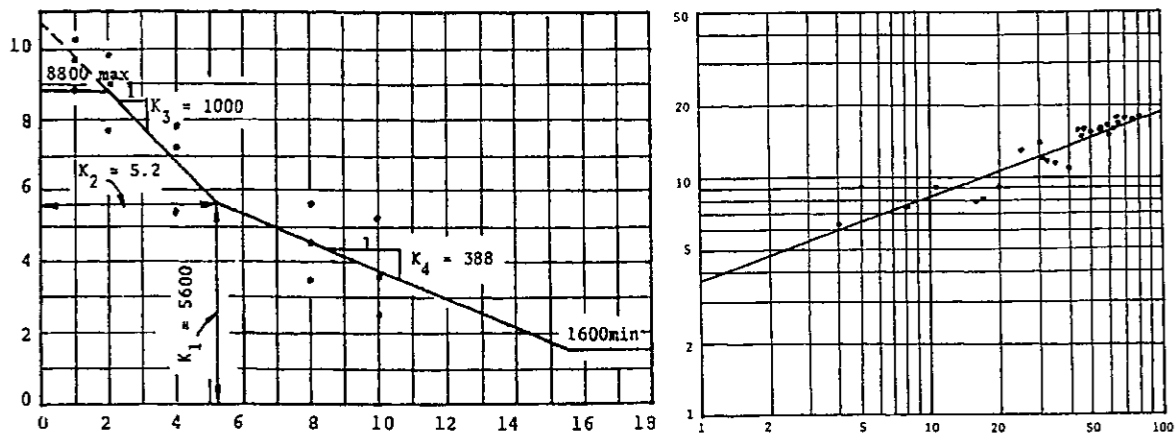
7. Please briefly introduce falling weight deflectometer and the application of the measured data. (10%)