

Name of the Student: _____

CE 241 - EXAMINATION

Question 1 (24 points)

- I) Many factors affect the compressive strength of concrete. Briefly explain which one of the two options will result in higher strength at 28 days. (16 points)
- a) Moist curing temperature of 27 C vs 12 C
 - b) Using cylinders of size 150 by 300 mm vs 75 by 150 mm
 - c) Testing the specimens in saturated condition vs air-dry condition.
 - d) Using cement containing 65% C3S vs 40% C2S
- II) How many independent strain measurements do I need to make in order to determine the complete state of strain for a given point? (6 points)
- III) In class I showed cement pastes with $w/c=0.32$ have zero porosity assuming full hydration. For lower w/c , same cement grains will never have the chance to hydrate. Compute the maximum percentage of cement that will ever hydrate in a 0.2 w/c ratio cement paste. (12 points)

Question 2 (26 points)

- I) In class, we discussed the series and parallel model. Compute the elastic moduli of the composite assuming that we arrange a series model placed in series with a parallel model (see figure). The elastic modulus are known and for simplicity assume that the volume phases are equal (13 points)



- II) Why does ASTM recommend that the chord modulus should be used for concrete? (5 points)
- III) Describe the types of voids existing in a hydrated cement paste and explain their influence on the strength and creep of the cement paste. (8 points)

Question 3 (24 points)

I) Suppose that during a creep test (in compression), the concrete specimen is allowed to dry. Plot the time evolution of i) the elastic strain, ii) basic creep strain, iii) drying shrinkage strain, iv) total strain.

II) A concrete rod is fully restrained at the ends and exposed to low humidity. Plot the stresses caused by the shrinkage assuming that i) concrete is a linear elastic material and ii) concrete is a viscoelastic material

III) Suppose that during a relaxation test (in compression), the concrete specimen is allowed to dry. Plot the time evolution of i) the stresses caused by shrinkage alone, ii) the final stresses, including the viscoelastic stress relaxation.

Question 4 (26 points)

I) Plot a creep and relaxation curve for the following models: (14 points)

II) Considering the thermal stresses of concrete should you use: (a) sandstone aggregate or (b) quartzite aggregate. Please justify your answer (6 points)

II) Assume that a mass concrete structure should not have a temperature difference greater than 15 C. Given the following conditions,

Adiabatic temperature rise: 37 C

Ambient temperature: 18 C

Temperature losses: 12 C

determine the maximum temperature of fresh concrete to avoid cracking. (6 points)