

Name of the Student: _____

CE 241 - EXAMINATION

Question 1 (28 points)

I) Compare the properties of C-S-H, ettringite and CH and their roles in determining the properties of hardened cement paste. (9 points)

II) A cement paste after 63% hydration had a porosity of 15%. Compute the original water-to-cement ratio. (12 points)

III) You employ the following conditions to simulate the hydration of C3S (specific density 3.2) using the hydra.2d program: number of C3S particles: 45, size of the particles: 13 pixels. The program indicates the initial phase fractions: porosity: 0.555 and C3S: 0.445. Compute the water-to-cement ratio of this simulation. (7 points)

Question 2 (28 points)

I) Which model predicts a higher elastic modulus: the parallel or series model? (7 points)

II) Draw the following diagrams for a concrete specimen loaded in uniaxial compression: a) stress versus volumetric strain, b) stress versus "Poisson's ratio"; (7 points)

III) Compare the compressive strength of a concrete tested in a 3x6" cylinder and 3x3x3 cube. (7 points)

IV) For a same concrete which test will give a higher tensile strength: a) pure tension, b) splitting tension, c) pure bending. Explain your answer. (7 points)

Question 3 (30 points)

I) A Burgers model consists of a Maxwell model (spring E_m and dashpot μ_m) in series with a Kelvin model (spring E_k and dashpot μ_k). During a creep test, the Burgers model will be subjected to a constant strain so until time t_1 . What will be the long-term (asymptotic) permanent strain? (14 points)

II) During a creep test (constant stress equal to 500 psi) a material has an initial strain of 10^{-4} and a strain of 2×10^{-4} after 30 days. The same material was also submitted to a relaxation test (constant strain equal to 1.5×10^{-4}). During the relaxation test, determine the stress after 30 days. Assume that the material follows the Maxwell model. (8 points)

III) Does it make sense to use many Maxwell units (springs and dashpots in series) in series? What about to use Kelvin units in parallel? (8 points)

Question 4 (24 points)

I) You are preparing a preliminary stresses analysis of a large concrete dam. The concrete technologist gives you the following information: (9 points)

maximum temperature difference: 16 C

tensile strain capacity of the concrete: 190×10^{-6}

coefficient of thermal expansion of the aggregate: $19 \times 10^{-6} / C$

coefficient of thermal expansion of the mortar: $6 \times 10^{-6} / C$

the aggregate occupies 70% by volume of concrete

Will the concrete crack due to thermal strains?

II) Draw the relationship between coefficient of permeability and porosity of the cement paste (6 points)

III) (a) How would cracks oriented as in (1), (2), (3) affect the measured compressive strength?

b) How would these cracks affect the tensile strength? (9 points)

