UNIVERSITY OF CALIFORNIA AT BERKELEY
SPRING SEMESTER 2021

Department of Civil and Environmental Engineering
Structural Engineering, Mechanics and Materials

Name:_____

MS Comprehensive Examination
Materials

Question 1: (50%)

Let's compare Normal Strength Concrete (NSC) with High Strength Concrete (HSC)

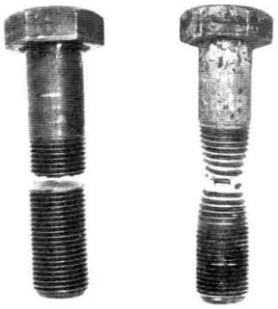
a) The capillary porosity is considerably reduced in HSC compared to NSC. Why does capillary porosity dictate the strength of the hydrated cement paste even though the capillary voids are far smaller compared to entrapped air voids?
b) Why does Normal Strength Concrete exhibit a rising R-curve whereas High Strength Concrete exhibits a Flat R-curve behavior?
c) What causes the formation of a porous region (i.e. the interfacial transition zone) between the coarse aggregates and the cement paste in NSC?
d) This interfacial transition zone is either absent or considerably reduced in HSC; please explain why.
e) The stress strain curves of HSC and NSC tested in tension differ in their ascending and descending portions. Show schematically and explain what is responsible for that difference.

Question 2: (25%)

This question deals with steel

a) A steel bar is being stressed in tension and undergoes necking at the ultimate strength. Explain why necking is delayed up to high strain levels in TRIP steel.

b) Let's look at fracture and fracture surface characteristics:



Which of the two bolts failed in a brittle manner? Please explain briefly.

If you would analyze their fracture surfaces at high magnifications would these fracture surfaces look the same? Please explain briefly.

A fracture surface of a steel piece is shown on the left at high magnification. What type of failure is responsible for such features on a fracture surface?

Question 3: (25%)

Short question on Polymers

a) What are the main differences between a thermoplastic and a thermoset polymer?

b) Would you expect a ductile or brittle behavior below the glass transition temperature for thermoplastic polymers? Please explain briefly.

Name: _____

University of California, Berkeley
Civil and Environmental Engineering

Structural Engineering, Mechanics & Materials
Spring Semester, 2020

Comprehensive Examination - Materials

Problem 1

I) Plot the heat evolution vs. time for regular concrete and for concrete containing large amount of fly ash substitution

II) Describe the hydration reaction of the dicalcium silicate.

III) Would the use of biofuels eliminate the generation of CO_2 during the production of portland cement?

IV) Discuss the following statement: "If we use Type V cement for a concrete structure, we don't have to worry about sulfate attack".

V) Why and when is gypsum added to portland cement during production?

Problem 2

I) For a 9500-psi concrete, a contractor has an option of using the aggregate from **source A** with elastic modulus of 50 GPa or from **source B** with elastic modulus of 30 GPa.

a) Which concrete will have a higher compressive strength?

b) Which concrete will have higher creep?

c) Which concrete will have higher shrinkage?

d) Would the answers be different if instead of 9500 psi concrete, the job requires a 4000 psi concrete?

II) Describe the advantage and disadvantage of using $CaCl_2$ in concrete.

Name: _____

University of California, Berkeley
Civil and Environmental Engineering

Structural Engineering, Mechanics & Materials
Spring Semester, 2019

MATERIALS EXAM
Please justify your answers

Problem 1

I) List four major consequences if an engineer is foolish enough to build a concrete column without aggregate.

II) Consider the following mix proportions:

Mix A (lb/yd3)
Cement: 450
Gravel: 1200
Water: 230

Mix B (lb/yd3)
Cement: 360
Fly-Ash: 90
Gravel: 1200
Water: 230

Mix C (lb/yd3)
Cement: 450
Fly-Ash: 90
Gravel: 1200
Water: 230

a) which mix will generate the highest amount of heat?
b) which mix will be the cheapest?
c) comparing the mixes A and B: which one will have higher early-age compressive strength?
d) comparing the mixes A and B: which one will have higher late-age compressive strength?
e) comparing the mixes A and B: which one will generate higher amount of heat?

Problem 2

I) Describe the corrosion mechanism in reinforced concrete and three methods to avoid this reaction.

II) How does presence of free water in a sample affect a) the strength of concrete and b) the elastic modulus of concrete

III) How does the relative humidity affect the corrosion of reinforced concrete?