University of California **Name:_____**
Department of Civil and Environmental Engineering
SEMM
Fall 2014

Preliminary Examination
Materials

Question 1: Concrete (50%)

a) High Strength Concrete (HSC) is often difficult to place due to its low workability. Give three examples how the workability of HSC can be enhanced.

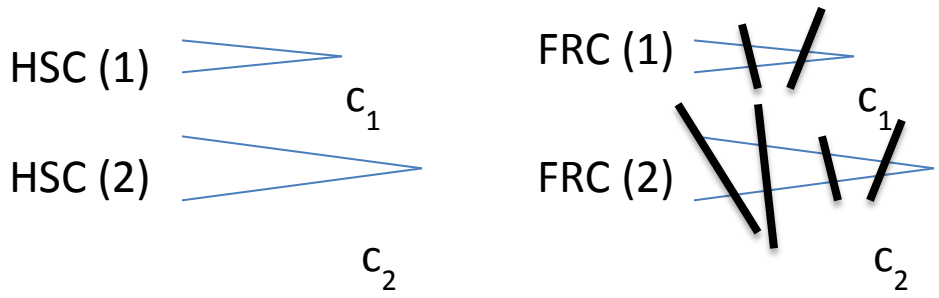
b) i) What w/c ratio is required for zero capillary porosity? Show your calculation. Assume the specific gravity of cement is 3.14.
ii) Do you expect 100% hydration if your w/c ratio is below that value?
iii) Assume your concrete with a lower w/c ratio than you calculated in i) exhibits shrinkage cracks and is exposed to rain water. Do you expect the cracked concrete to be weaker/stronger after exposure to rain water? Please explain.

c) Normal Strength Concrete (NSC) and HSC exhibit different stress strain curves in compression and tension when tested under strain control. What is responsible for the extended strain softening behavior in NSC compared to HSC?

d) Give at least two reasons why strain localization in HSC is delayed to higher stress levels.

f) If you want to increase the toughness of a fiber reinforced cement based composite what are the required toughening mechanisms?

g) HSC specimens (1) and (2) and FRC specimens (1) and (2) contain cracks of length c_1 and c_2 as shown below.



i) Which of the HSC specimens [HSC (1) or HSC (2)] will fail at a higher stress level? Which FRC specimens will fail at a higher stress level? Please explain your answers.

ii) Assume failure occurred in the HSC; do you expect the initial crack length (as shown in the schematic) and final crack length (i.e. at failure) to be of the same length? What about in the FRC specimen?

Question 2: Durability (25%)

Concrete structures may experience problems with durability:

a) Sulfate attack:
   i) What causes sulfate attack and how can it be prevented?
   ii) How can you identify that damage and cracking in a concrete structure is due to sulfate attack?
b) Alkali-Silica reaction:
   i) What causes alkali-silica reaction in concrete and how can it be prevented?
   ii) How can you identify that cracking was caused by alkali-silica reaction?
c) Corrosion:
   i) What causes steel reinforcing bars to corrode when embedded in concrete?
   ii) How could corrosion be prevented?

Question 3: Steel (25%)

a) i) Plastic deformation of steel occurs along certain planes within the crystal structure, called slip planes. Please show these slip planes in the i) fcc and ii) bcc crystal structure.
   ii) Why do materials with a bcc crystal structure in general have a higher yield strength compared to materials with a fcc crystal structure?
b) i) What are the typical microstructural features and mechanical properties of ordinary steel (A-36)?
   ii) How is the microstructure altered when the steel is quenched from the austenite regime?
   iii) Which of the mechanical properties change due to quenching? i) the E-modulus, ii) the yield strength, iii) the ductility? Please explain.
c) What are the most important parameters (list three) that reduce the fracture toughness of steel.

Name: _____

SPRING 2012

MATERIALS EXAM

Problem 1

I) The production of portland cement is responsible for 6% of the world's CO_2 generation. Describe the two sources for the production of CO_2 during the firing of the clinker in the kiln.

II) You are going to cast concrete in a site during a cold winter. The local market has the two cements available:
Cement A (%): C_3S= 50, C_2S= 35, C_3A= 5, C_4AF= 10
Cement B (%): C_3S = 65, C_2S= 15, C_3A= 10, C_4AF= 10
Which cement should you select?

III) What is the influence of the type and amount of aggregate on the modulus of elasticity of concrete?

Problem 2

I) You are in charge of the construction of a large massive dam:

a) describe four ways to reduce the temperature of fresh concrete. If you can pick only one of the four options, which one should you select?

b) describe three options to reduce the temperature rise

c) should you select an aggregate with low or high elastic modulus?

II) Describe a reason why a concrete mix can develop flash set.

III) High volume fly ash may not have high early strength. Describe how you could optimize a high volume fly ash concrete mix to obtain adequate early strength?

UNIVERSITY OF CALIFORNIA AT BERKELEY SEMM
SPRING SEMESTER, 2010

Name:_____

Materials Exam

Select 3 out of 4 questions

Question 1

I) Is it a good idea to use quartz sand instead of clays, as a raw material for portland cement?

II) What is the first hydration product to form in portland cement?

III) Draw the evolution of the amount of calcium hydroxide for a portland cement paste containing 50% fly ash.

IV) What concerns would you have if ASTM Type IV cement is used for a tall building?

Question 2

I) Draw the stress x volumetric strain for a simple compression test. Explain how you measure the volumetric strain.

II) Discuss the following statement: The splitting test is often used because it generates a state of uniform tension in the whole specimen

III) A design office discovered that somebody made a mistake in computing thee design stress in a column made of normal-strength concrete. After the new calculations were done, it was found out that the stresses are 90% of the compressive strength. Should you be concerned?

IV) Derive the elastic modulus for the series model

Question 3

I) After hydrating for four weeks, it is observed in a cement paste that the volume of unhydrated cement is three times the amount of hydrated products. Compute the degree of hydration of the paste.

II) Which of the following products can be classified as a pozzolan: portland cement, quartzitic sand, fly ash F, slag, silica fume. Explain.

III) Why is gypsum added to the cement clinker? When is it added?

Question 4

I) Describe how fracture mechanics can predict the influence of the size of a sample on the tensile strength of the material.

II) Describe in details how fibers can influence the toughness of a composite material.

III) How can you measure the pull-out strength of a fiber in a matrix.