

The University of Iowa
Department of Civil & Environmental Engineering
CONSTRUCTION MATERIALS 53:130
Spring Semester 1999 Examination II
Prof. C.C. Swan

300 Possible Points.

Due: Wednesday, May 12, 10am.

Asphalt Questions (Answer any five). 100 Points.

Question A-1: (20 points)

- a. Today, where does asphalt come from and what is the essence of its production?
- b. What is the difference between asphalt and tar?

Question A-2: (20 points)

- a. What are the implications of oxidation of asphalt cement on HMA pavements?
- b. Which asphalt cement grading system attempts to take account of oxidation, and briefly how is it done?

Question A-3: (20 points)

- a. In selecting aggregates for HMA pavements, what factors are most important?
- b. With respect to ideal gradation of the aggregates, what is Fuller's curve, and how is it used?

Question A-4: (20 points)

- a. Briefly, please list all of the major steps involved in SuperPave Mix Design of an HMA pavement.
- b. How might a pavement designed (with SuperPave system) for interstate highway in a comparatively hot desert state like Arizona differ from an interstate highway pavement designed for a state like North Dakota with moderate summers and very cold winters.

Question A-5: (20 points)

- a. Briefly, describe the process of pothole formation underneath asphalt cement concrete pavements.
- b. In designing roadways, what are a few of the most important measures that can be taken to avoid potholing?

Question A-6: (20 points)

- a. What are the differences between HMA, cutbacks, and emulsions?
- b. What are the major advantages and disadvantages of each.

Masonry Questions. 100 Points.

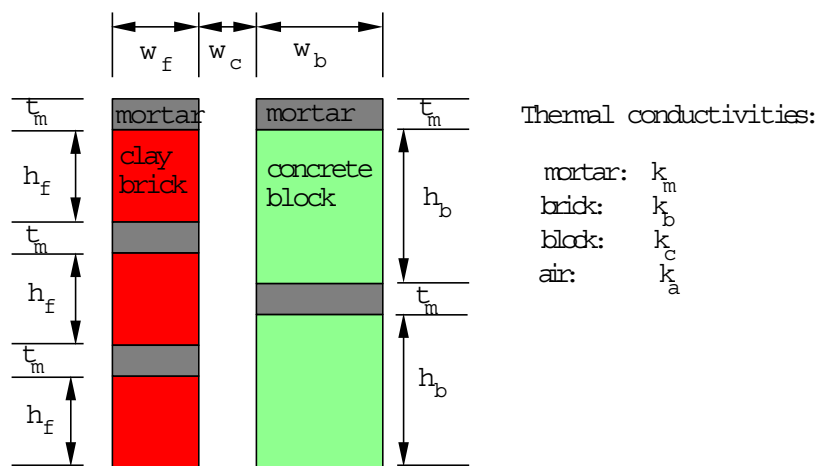
Question M-1: (30 points)

There is a fundamental difference between the way that fired clay units interact with water and the way that cast concrete units interact with water.

- What is it?
- How does it affect the long term deformation characteristics of each?
- In building a brick and block wall masonry cavity wall, how might the differences between the concrete block and the clay brick lead to potential problems?

Question M-2: (30 points)

- For the cavity masonry wall shown below, please derive an expression for the thermal resistivity of the wall in terms of the thermal conductivities of the clay brick, the concrete block, the mortar, and air, and the dimensions shown.
- Would you expect the cavity to improve the thermal resistivity of the wall? Please explain why or why not.



Brick and block cavity wall.

Question M-3: (20 points)

- What is efflorescence of masonry and why does it occur?
- What can be done to prevent its occurrence?

Question M-4: (20 points)

Please examine the ten figures on the following page and identify the types of unit arrangement patterns, and the basic wall construction types shown.

FRP Questions. 100 Points.

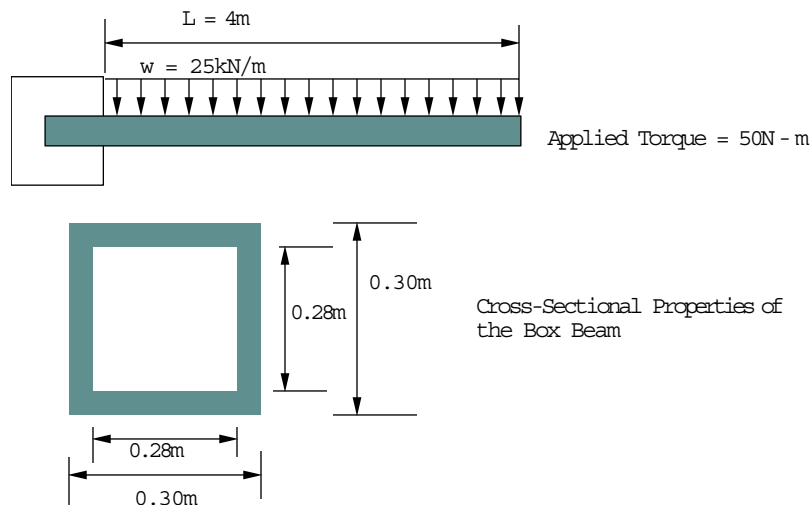
Question F-1: (20 points)

- What are some of the perceived advantages of FRP composites as a structural materials system over those of steel and concrete?
- What are some of the major dis-advantages of FRP composites in relation to steel?

Question F-2: (50 points)

As a structural engineer, you've been asked to compare the elastic deflection and twisting performance of box cantilever beams made respectively of steel, glass-epoxy (65% E-glass, 35% epoxy) and graphite-epoxy (65% Type-II PAN fibers, 35% epoxy).

- For all of the basic materials (glass, graphite, epoxy, and steel, use reasonable material property estimates) and then calculate the mass density, the axial Young's modulus, and the transverse shear modulus values for the composite materials. To calculate the axial Young's modulus of the composite materials, use the Voigt mixing rule. To calculate the transverse shear modulus of the composite materials, use the Reuss mixing rule.
- Assume that all beams have identical lengths and cross-sections as shown below, and that the only differences between the three beams is their different material stiffness and mass density properties. In calculating the deflections, consider both the weights of the beams and the applied loads.
- Summarize your findings on the relative stiffness characteristics of the materials and the impact on the structural deflection/twist performances of the beams.



Cantilever beam problem.

Question F-3: (30 points)

Please compute and compare the strength characteristics (axial and transverse) of the following materials:

- a. 70% S-glass, 30% polyester, aligned fiber arrangement;
- b. 70% Type-I PAN graphite, 30% polyester, aligned fiber arrangement;
- c. A-36 steel;
- d. A-242 steel;