

53:086 Civil Engineering Materials
Review Materials for Final Examination
The University of Iowa
Spring 2005

During this course, we've covered some basic concepts in materials science, and general categories of construction materials systems: (1) metals such as steel and aluminum; (2) portland cement concrete; (3) bituminous materials; (4) fiber-reinforced plastic composites; and (5) masonry. For each of these topics, you should, at a minimum be familiar with the following:

1. Basic Materials Science

- Types of molecular bonding and some of the physical/mechanical characteristics associated with each.
- Basic concepts of Griffiths fracture model.
- The basic rules of mixtures for composites (Voigt-isostrain, Reuss-isostress, hybrid).

2. Structural metals (steel and aluminum)

- A sense of how the basic properties for these two materials compare. (mass density, stiffness, strength, ductility, toughness, susceptibility to corrosion)
- Microstructure of metals and its relation to mechanical properties (ie. grain size effects)
- Heat treatments and working-hardening, and their effects on strength and ductility
- Recognize those properties in metals are that are structure-dependent and those that are structure-independent.
- Fire resistance
- Zinc galvanization of structural steel
- The corrosion process

3. Portland cement concrete

- How portland cement is produced.
- Basic chemical constituents in portland cement and their effects (ie C_2S , C_3S , C_4AF , C_3A). Also the different types of portland cement.
- Cement replacement materials – what are they, and why might they be used?
- The hydration reaction
- Types of porosity in hcp and their effect on strength
- Essentials of portland cement concrete mix design
- Strength/stiffness characteristics of hcp and portland cement concrete
- Shrinkage behavior of concrete
- Durability characteristics of portland cement concrete
- Good curing practices
- Range of typical values for pcc's mass density, strength, and stiffness.

4. Bituminous materials

- Sources of asphalt and tar
- Aggregate requirements
- Fundamental ideas of HMA (hot-mix asphalt)
- Cutbacks and emulsions
- Oxidation of asphalt cement and its effect on mechanical properties
- Common lab tests used to characterize asphalt cements (binders)

5. Masonry

- Characteristics of clay units and concrete units
- Dimensional stability of clay and concrete units
- Efflorescence
- Absorption capacities of clay and concrete units

6. Structural Fiber Reinforced Plastic Composites

- Common plastics used as matrix
- Common fiber reinforcement materials
- Why are fibers made with such small diameters?
- Computing the directional stiffnesses/strengths of FRP composites using the rules of mixtures.
- Familiarity with the general strength, stiffness, and mass-density characteristics of FRP composites