

Tennessee Technological University
Department of Civil and Environmental Engineering
CEE 4990/6900: Special Problems – Durability of Cementitious Materials
Elective
Spring Semester 2008

2007 Catalog Data: CEE 4990 (6900). Special Problems. Lecture 2. Lab 2. Credit 3. Prerequisites: CEE 3030 and approval of Department Chairperson.

Textbook: None; handouts and articles will be provided

References: S. Mindess, J.F. Young, D. Darwin, *Concrete*, Prentice-Hall, 2nd Edition, 2003.
P.K. Mehta, P. Monteiro, *Concrete: Microstructure, Properties and Materials*, McGraw-Hill, 3rd Edition, 2006.
A. Neville, *Properties of Concrete*, Longman, 4th Edition, 1996.
Design and Control of Concrete Mixtures, Portland Cement Association, 14th Edition, 2002.

Coordinator: Benjamin Mohr, Assistant Professor of Civil Engineering

Goals: To present students with a comprehensive overview of the durability of portland cement-based materials through multi-scale (nano-, micro-, and macro-scale) investigations, including economical considerations, mitigation strategies, and microstructural characterization and chemical analysis techniques.

Course learning objectives:

1. The mechanisms of concrete degradation due to alkali-silica reaction, external sulfate attack, delayed ettringite formation, shrinkage, freeze-thaw, and corrosion of reinforcing steel.
2. The use of mitigation strategies for durability problems.
3. The understanding of the economical considerations required for proper concrete design and repair/rehabilitation of distressed concrete.
4. The knowledge of microstructural characterization and chemical analysis techniques.

Course measurable outcomes:

Students will be expected to:

1. explain the mechanisms of concrete degradation;
2. understand proper concrete design to avoid durability problems;
3. apply strategies to mitigate ongoing concrete degradation;
4. understand the implications of inadequate concrete durability;
5. use microstructural characterization techniques to observe ongoing degradation; and
6. assess cement-based material durability performance through standard laboratory testing.

Topics covered: (1 class per week, 2 hours each; 1 lab per week, 2 hours each):

1. Introduction and review (1 classes)
2. Alkali-silica reaction (2 classes; 2 labs)
3. Sulfate attack and thaumasite formation (1 classes; 2 labs)
4. Delayed and secondary ettringite formation (1 classes; 2 labs)
5. Drying, plastic, and autogenous shrinkage (2 classes; 2 labs)
6. Shrinkage cracking mitigation strategies (1 classes; 2 labs)
7. Freeze-thaw durability (2 classes; 1 lab)
8. Concrete permeability (1 classes; 1 lab)
9. Corrosion of reinforcing steel in concrete (1 classes)
10. Tests (2 classes)

Contribution of the course to meeting professional component:

The ability to conduct laboratory experiments and to initially analyze and interpret data in more than one of the recognized major civil engineering areas

ABET category content as estimated by faculty member who prepared the course description:

Engineering science: 2.5 credits (83.33%)
Engineering design: 0.5 credits (16.67%)

Relation of course to program outcomes:

- Outcome 1: The graduates will have a broad understanding of the relevant principles of mathematics, science and engineering
Outcome 2: The graduates will have a general comprehension of four technical areas appropriate to civil engineering.
Outcome 4: The graduates will be capable of design activities and have the ability to identify, formulate, and solve civil engineering problems.
Outcome 8: The graduates will have the ability to use techniques, skills, and modern engineering tools needed for engineering practice.

Relation of course to ABET criteria:

<u>General Criteria</u>	Bloom's Level of Achievement
(3a) Knowledge of math, science, and engineering	3
(3b) Design, conduct experiments; analyze and interpret data	5
(3c) Design a system, component or process	3
(3e) Identify, formulate, and solve engineering problems	3
(3j) Knowledge of contemporary issues	2
(3k) Techniques, skills, modern tools for engineering practice	3

<u>Program Criteria</u>	Bloom's Level of Achievement
1. Apply knowledge of math and sciences	3
2. Apply knowledge of four technical areas appropriate to civil engineering	3
3. Conduct civil engineering experiments and analyze and interpret the resulting data	5
4. Design a system, component, or process in more than one civil engineering context	3

Computer usage:

1. Use image analysis software to qualify and quantify concrete degradation.
2. Use word-processing software to prepare laboratory reports.

Prepared by: B.J. Mohr

Date: September 2007