CE 530: Properties of Concrete and Advanced Cement-Based Composites

Instructor:
Mohammad Pour-Ghaz
Office: MN 431C, Tel: 919-515-2235, Email: mpourghaz@ncsu.edu
Office hours: Tuesday and Thursday 10:00 am – 11:00 am
EOL students can contact during the same hours.
If these time slots do not work, I can be available for additional office hours by appointment.
Please email me to make appointments.
Web address: http://courses.ncsu.edu/ce530/

Class Session:
Spring Semester, 3 Credit hours
Tuesday and Thursday, 8:30 AM - 9:45 AM
406 Mann Hall

Pre- and Co-requisites:
CE 313: Mechanics of Solids
CE 332: Materials of Construction

Student Learning Outcome:
By the end of the course, the students will be able to:

- Design concrete materials for different exposures according to ACI 318 and Portland Cement Association (PCA) guidelines
- Design concrete materials for specific applications that are not covered by codes
- Design internally cured concrete for structural and pavement applications
- Explain the microstructure development in portland cement systems
- Explain the deterioration mechanisms and factor affecting durability of concrete
- Explain the fundamental difference between portland cement and non-portland cement binders
- Use service life prediction models for concrete structures as design tools while understanding their limitation

References:
Textbook(s) – optional:
- Concrete, 2nd Edition, Mindess, Young, and Darwin, Prentice-Hall © 2003
- Design and Control of Concrete Mixtures, 15th Edition, PCA © 2011

Other references:
- Properties of Concrete, Neville, 4th Edition © 1999
- Concrete Science – Treatise on Current Research, Ramachandran, Feldman, and Beaudoin, Heyden and Son Inc © 1981
CE 530: Properties of Concrete and Advanced Cement-Based Composites

Description:
This course consists of three parts. In the first part, basic properties of hydraulic cements, aggregates, mixture proportioning, mineral and chemical admixtures, and placement and curing are discussed. The second part of this course deals with mechanical properties of concrete and covers subjects such as compressive and tensile strength, multi-axial loading, composite models, fracture mechanics of concrete materials, and shrinkage cracking. In the second part of the course, porosity and micro-structural models are also discussed. The third part of this course deals with durability and deterioration mechanisms of concrete materials. This part of the course cover subjects such as corrosion of steel in concrete, mass transport in cementitious materials, service life prediction, and non-destructive testing. Advanced laboratory techniques such as calorimetric, electrical measurements, and acoustic emission are discussed. This course also covers emerging topics in concrete materials such as internal curing, self-consolidating concrete, fiber reinforced concrete materials, and low carbon footprint materials.

Course Structure:
This course is delivered as lectures. Lecture notes will be posted on the course website one week ahead of time. Students are required to print the lecture notes and bring them to class or alternatively students may use their tablet or laptop in class to follow the notes or take notes.

Course Schedule:
The course schedule is subjected to change with appropriate notification to students

Projected schedule of readings, assignments, quizzes, and tests:
- Reading materials will be assigned each lecture, mainly consisting of the lecture notes.
- Homework assignments will be assigned approximately every two to three lectures. Depending on the level of difficulty, the homework will be due 7 to 14 days after the assignment date.
- Test 1 will be cover the materials up to the end of Porosity and Powers Model.
- Final Test will be comprehensive covering all the materials in the course.
- Several research articles will be assigned as reading assignments. Questions from the research articles will be asked in tests and the final exam.
Topics Covered:
Topics and the order in which the topics will be covered may vary slightly. Number of lectures might slightly change depending the holidays.

<table>
<thead>
<tr>
<th>Lecture Title</th>
<th>No. of Lectures</th>
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<tbody>
<tr>
<td>Introduction to Concrete and Cement Production</td>
<td>1</td>
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<tr>
<td>Cement Hydration</td>
<td>1</td>
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<tr>
<td>Water/Aggregates/Admixtures</td>
<td>1</td>
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<tr>
<td>Mixture Proportioning, Batching, Mixing, Transport, Placement, and finishing</td>
<td>1</td>
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<tr>
<td>Fresh Properties, Curing Concrete, Maturity, and Quality Control</td>
<td>1</td>
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<tr>
<td>Water/Aggregates/Admixtures, Supplementary Cementitious Materials</td>
<td>1</td>
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<tr>
<td>Porosity and Powers Model</td>
<td>3</td>
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<tr>
<td>Mechanical Properties and Loading</td>
<td>2</td>
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<tr>
<td>Fracture Mechanics of Concrete</td>
<td>3</td>
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<tr>
<td>Volume Stability: Shrinkage and Creep, measurement</td>
<td>2</td>
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<tr>
<td>Mid-term Exam</td>
<td>1</td>
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<tr>
<td>Transport Phenomena: Saturated flow, unsaturated flow, and diffusion</td>
<td>2</td>
</tr>
<tr>
<td>Durability I: Corrosion, ASR, Freeze-thaw</td>
<td>3</td>
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<tr>
<td>Durability IV: Other Degradations</td>
<td>1</td>
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<tr>
<td>Internal Curing</td>
<td>1</td>
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<tr>
<td>Geopolymers and Inorganic Binders</td>
<td>2</td>
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<tr>
<td>Low clinker binders and limestone replacement</td>
<td>2</td>
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<tr>
<td>Aluminate cements</td>
<td>2</td>
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<tr>
<td>Total</td>
<td>30</td>
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Grading:

- 97-100  A+
- 93-96.9  A
- 90-92.9  A-
- 87-89.9  B+
- 83-86.9  B
- 80-82.9  B-
- 77-79.9  C+
- 73-76.9  C
- 70-72.9  C-
- 67-69.9  D+
- 63.66.9  D
- 60-62.9  D-
- <60     F

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<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Homework</td>
<td>20%</td>
</tr>
<tr>
<td>Test 1</td>
<td>30%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>45%</td>
</tr>
<tr>
<td>Article Presentations</td>
<td>5%</td>
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</tbody>
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Policy on late assignments:
Late assignments will only be accepted under special circumstances such as medical emergency. Completion of the missed homework assignments are required.
Attendance:
Full participation in classes and examinations is expected of all students. Excused absences will be accepted however students are required to complete the missed work.
The University attendance regulation (NCSU REG 02.20.3) can be found at: http://policies.ncsu.edu/regulation/reg-02-20-03

Academic Integrity:
Students are required to comply with the university policy on academic integrity found in the Code of Student Conduct found at http://policies.ncsu.edu/policy/pol-11-35-01.

Accommodations for Disabilities:
Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, student must register with the Disability Services Office (http://www.ncsu.edu/dso), 919-515-7653. For more information on NC State's policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation at http://policies.ncsu.edu/regulation/reg-02-20-01.

NC State University Policies, Regulations, and Rules (PRRs):
Students are responsible for reviewing the PRRs which pertain to their course rights and responsibilities. These include: http://policies.ncsu.edu/policy/pol-04-25-05 (Equal Opportunity and Non-Discrimination Policy Statement), http://oied.ncsu.edu/oied/policies.php (Office for Institutional Equity and Diversity), http://policies.ncsu.edu/policy/pol-11-35-01 (Code of Student Conduct), and http://policies.ncsu.edu/regulation/reg-02-50-03 (Grades and Grade Point Average).

Course Evaluation:
Class evaluations will be available for students to complete during the last two weeks of classes. All evaluations are confidential and instructors will never know how any one student responded to any question. Also, students will never know the ratings for any particular instructors.

Evaluation website: https://classeval.ncsu.edu
Student help desk: classeval@ncsu.edu
More information: http://www.acs.ncsu.edu/UPA/classeval/

For further information please contact:
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