PROPERTIES OF CONCRETE
CIV_ENV 321
Winter 2025
1 Unit

Class Hours: MWF 4:00PM - 5:50PM

Lecture/Lab Location: Tech L168 (lecture), AG 53 (lab)

Prerequisites: None

Instructor: Dr. Matthew D'Ambrosia (he/him) matthew.dambrosia@northwestern.edu
Mobile: (630) 240-4118

Assistant: TBD

Hours: By appointment

Textbook: Concrete, 2/E, Mindess, Young & Darwin (electronic copy to be provided). Exams will be open notes, but no electronic files will be permitted so **students are strongly encouraged to obtain or print a paper copy**.

Other References: PCA EB001, Design and Control of Concrete Mixtures (to be provided)
Readings from scientific literature and engineering practice (to be provided)

Description: This course covers principles of concrete materials behavior, building on the principles of materials and mechanics from previous courses. Advanced topics will be discussed and computer modeling of behavior will be strongly emphasized. Topics will include manufacture of concrete constituents, concrete production, modeling materials durability and degradation, volume change and creep, forensic analysis and non-destructive testing. Other special topics may include mass concrete, fire behavior, and fiber reinforced concrete. The lab section will allow students to carry out experiments in cement and concrete materials behavior, reinforcing concepts learned in the lecture.

Course Objective: The objective of this course is to introduce students to theory and applications of concrete materials behavior, while examining real world cases and special topics. Computer modeling applications will be used throughout, with modules designed to give students an appreciation for tools available to practitioners, and how to apply them to project examples.

Course Outcomes: Upon successful completion of the course, students will have an advanced understanding of the behavior of concrete materials, including special areas of consideration. Upon completion, students will be able to:

1. Understand the materials behavior of concrete in various real-world structures
2. Describe the mechanical behavior of typical concrete used in reinforced concrete construction, as well as special types of concrete.
3. Understand the background research and reasons for some relevant code provisions
4. Understand advanced topics such as creep, degradation mechanisms such as alkali silica reactivity and freeze-thaw resistance.
5. Understand materials science and engineering-based computer models for concrete materials behavior

Grading Policy: Grades between 0 and 100 are assigned based upon the level of mastery of the subject by the student. Grades will not be curved.

Lab: Lab modules require student participation in experimental observation of cement and concrete material properties. Labs will require reporting of observations, discussion of results, and comparison with theory. Students will not be permitted to miss lab sessions. Students must read, understand, and follow the lab safety guide: https://www.mccormick.northwestern.edu/civil-environmental/research/lab-safety.html
We will be working with cement and concrete, so be aware that clothes will get dirty. Wear close-toed shoes, long pants, and remove all jewelry prior to lab sessions.

Final Grading: = 0.20 (Homework) + 0.20 (Midterm) + 0.30 (Labs) + 0.30 (Final Exam); A = 94-100; A- = 90-93; B+ = 88-90; B = 84-87; B- = 80-83; C+ = 78-80; C = 74-77; C- = 70-73.

Academic Integrity: Student-teacher relationships are built on trust. Acts that violate this trust undermine the educational process. The *Northwestern University Student Handbook* defines Academic Dishonesty and everyone should be familiar with the code of conduct. Assignments that are turned in must represent the student's own work. Submission of any assignment that is in violation of this policy will result in zero points granted for that specific assignment

Tentative Schedule:

	Date	Day	Topic	Reading	Assignment
1	6-Jan	M	Introduction, Overview, Constituent Materials	M&Y 1-2, PCA 1-2	
2	8-Jan	W	Constituent Materials, Cement	M&Y 3-4, PCA 3	Hydration
3	10-Jan	F	**Lab 1:** Heat of Hydration	M&Y 5-6, PCA 4	
4	13-Jan	M	Constituent Materials, Aggregates, Admixtures and Additives		
5	15-Jan	W	Constituent Materials, Aggregates, Admixtures and Additives	Handout	
6	17-Jan	F	**Lab 2:** Flowability		
7	20-Jan	M	**NO CLASS – Martin Luther King Jr. Day**		
8	22-Jan	W	Concrete Proportioning and Mixture Optimization	M&Y 7-8, PCA 5-7	Proportioning
9	24-Jan	F	Concrete Proportioning and Mixture Optimization	M&Y 9-12, PCA 9, 12	
10	27-Jan	M	Mechanical Behavior I	M&Y 13-15, PCA 18	Maturity
11	29-Jan	W	Mechanical Behavior I		
12	31-Jan	F	Mechanical Behavior II		
13	3-Feb	M	Durability Mechanisms Part I – Cracking, Freeze-thaw	M&Y 18, PCA 11, 13-14	Article
14	5-Feb	W	**Lab 3:** Proportioning and Fabrication		
15	7-Feb	F	Durability Mechanisms Part II - Sulfate Attack, DEF	Handout	
16	10-Feb	M	Durability Mechanisms Part II - Sulfate Attack, DEF		
17	12-Feb	W	Durability Mechanisms Part III - Corrosion and Service Life	Handout	
18	14-Feb	F	**Midterm (Up to but not including Corrosion & Service Life)**		
19	17-Feb	M	Durability Mechanisms Part IV - Corrosion and Service Life		Service Life
20	19-Feb	W	Mass Concrete Structures and Thermal Modeling of Concrete	PCA EB547	
21	21-Feb	F	Volume Change and Time Dependent Behavior	M&Y 16-17,PCA 10,15-17	
22	24-Feb	M	Rheology, Flowability, and Self-Consolidating Concrete	Handout	Thermal Modeling
23	26-Feb	W	**Lab 4:** Mechanical Properties		
24	28-Feb	F	Rheology, Flowability, and Self-Consolidating Concrete	Handout	
25	3-Mar	M	Fiber Reinforced Concrete and Ultra High-Performance Concrete	M&Y 19,22, PCA 19-20	Creep and Shrinkage
26	5-Mar	W	**Lab 5:** Volume changes		
27	7-Mar	F	Forensic Investigation or sustainability (Guest Lecture)	Handouts	
28	10-Mar	M	Non-Destructive Evaluation of Deteriorating Structures	Handouts	
29	12-Mar	W	**Tour (Ready mix plant or lab tour, TBD)**		
30	14-Mar	F	Non-Destructive Evaluation of Deteriorating Structures	Handouts	
31	21-Mar	F	**Final Exam, L168, 12PM-2PM**		

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