PROPERTIES OF CONCRETE
CIV_ENV 321
Winter 2023
1 Unit

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

Lecture Location: Tech L168

Prerequisites: CIV_ENV 216-0

Instructor: Dr. Matthew D'Ambrosia
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Assistant: tbd

Hours: By appointment

Textbook: Concrete, 2/E, Mindess, Young & Darwin (REQUIRED)

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 will require each student participate in experimental observation of cement and concrete material properties. Labs will require reporting of observations and discussion of the meaning of the results, as well as comparison with theory.

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	3-Jan	T	Introduction, Overview, Constituent Materials	M&Y 1-2, PCA 1-2	
2	4-Jan	W	Constituent Materials, Cement	M&Y 3-4, PCA 3-4	Hydration
3	6-Jan	F	Constituent Materials, Cement	M&Y 3-4, PCA 3-4	
4	9-Jan	M	Constituent Materials, Aggregates, Admixtures and Additives	M&Y 5-8, PCA 5-7	
5	11-Jan	W	Concrete Proportioning and Mixture Optimization	M&Y 9-12, PCA 9,12	Proportioning
6	13-Jan	F	Concrete Proportioning and Mixture Optimization	M&Y 9-12, PCA 9,12	
7	16-Jan	M	**NO CLASS – Martin Luther King Jr. Day**		
8	18-Jan	W	Mechanical Behavior I	M&Y 13-15, PCA 18	Maturity
9	20-Jan	F	**Lab 1:** Heat of Hydration		
10	23-Jan	M	Mechanical Behavior II	Handouts	
11	25-Jan	W	Durability Mechanisms Part I – Cracking, Freeze-thaw	M&Y Ch 18, PCA 14	Hiperpav
12	27-Jan	F	**Lab 2:** Flowability		
13	30-Jan	M	Durability Mechanisms Part I – Cracking, Freeze-thaw	M&Y Ch 18, PCA 14	
14	1-Feb	W	Durability Mechanisms Part II - Sulfate Attack, DEF	Handouts	
15	3-Feb	F	Durability Mechanisms Part II - Sulfate Attack, DEF		
16	6-Feb	M	**Midterm**		
17	8-Feb	W	Durability Mechanisms Part III - Corrosion and Service Life	Handouts	Service Life
18	10-Feb	F	**Lab 3:** Proportioning and Fabrication		
19	13-Feb	M	Durability Mechanisms Part IV - Corrosion and Service Life	Handouts	
20	15-Feb	W	Volume Change and Time Dependent Behavior	M&Y Ch 16-18, PCA Ch 13	Creep and Shrinkage
21	17-Feb	F	**Lab 4:** Mechanical Properties		
22	20-Feb	M	Mass Concrete Structures and Thermal Modeling of Concrete	PCA EB547	
23	22-Feb	W	Mass Concrete Structures and Thermal Modeling of Concrete	PCA EB547	Thermal Modeling
24	24-Feb	F	**Lab 5:** Volume changes		
25	27-Feb	M	Rheology, Flowability, and Self-Consolidating Concrete	Handouts	
26	1-Mar	W	Fiber Reinforced Concrete and Ultra High Performance Concrete	Handouts	
27	3-Mar	F	**Tour – Concrete Ready Mix Batch Plant**		
28	6-Mar	M	Forensic Investigation (Guest Lecture)	Handouts	
29	8-Mar	W	Non-Destructive Evaluation of Deteriorating Structures	M&Y Ch 19,22, PCA Ch 22	
30	10-Mar	F	Presentations **– Labs Reports due**		
31	17-Mar	F	**Exam day and Time: Friday, 03/17/2023: 12PM-2PM**		

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