CIVIL ENGINEERING 555: SUSTAINABLE CONSTRUCTION MATERIALS AND TECHNOLOGIES

Spring 2019

CLASS INFORMATION:

Class Time:	3:30-4:45 p.m., Mondays, CHM 195
Instructor:	Dr. Konstantin Sobolev
Office:	EMS W360
Office Telephone:	(414) 229-3198
Email:	sobolev@uwm.edu
Discussion Session:	10:30-11:55 a.m., Thursdays, PHY 232
Instructor:	Dr. Marina Kozhukhova
Office:	EMS W360
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Office Hours:	2:30 pm – 3:45 pm, Mondays, and by appointment
Instructor:	Clayton Cloutier
Office:	EMS W360
Email:	cloutie5@uwm.edu
Office Hours:	9:30-10:30 am, Thursdays

COURSE DESCRIPTION:

Sustainable Construction Materials and Technologies class introduces civil engineering students to the new and evolving world of sustainability considerations in construction. This class will focus on sustainable construction materials and methodologies related to commercial construction, including LEED/Green certifications. The construction industry is a major contributor to environmental degradation and sustainable building methods are being introduced to mitigate future damage. The course will encourage students to approach and evaluate engineering designs based on the four pillars of sustainable materials design: materials science, environmental, economic, and social. Students will become familiar with various methods for determining the sustainability of various building materials. Students will be encouraged to compare and contrast materials while maintaining awareness for potential drawbacks to any material selection.

TEXTBOOKS:

- Sustainable Buildings and Infrastructure by Annie R. Pearce, Young Han Ahn, and Hanmi Global. ISBN: 978-0-415-69092-8
- Binders for Durable and Sustainable Concrete by P.-C. Aitcin.

COURSE PREREQUISITES: Junior Standing

COURSE OBJECTIVES:

- Students will be familiarized with the concept of sustainability and its importance to the future of civil engineering;
- Students will gain an understanding of the risks associated with construction as it relates to sustainability;
- Students will learn various metrics for the evaluation of material sustainability;
- Students will be introduced to sustainable product certifications;
- Students will gain insight into processes for material fabrication and the resulting effects as it relates to sustainability;
- Students will be able to use methods for evaluating the sustainability of construction materials;
- Students will learn about new technological developments in sustainable building materials;
- Students will be encouraged to use natural processes as the baseline from which to measure sustainability metrics.

TOPICS COVERED:

- Application of materials science for sustainable design
- Composition-microstructure-property relations
- Sustainable structural steel and alloys
- Sustainable cements and by-product utilization
- Sustainable concrete
- Chemical admixtures
- Sustainable asphalt
- Sustainable masonry
- Sustainability for road base applications
- Nanotechnology and development of new construction materials

<u>Projects/Extended Problems</u>: Independent study projects (usually, the literature survey and laboratory experiment (competition on advanced construction material technology) projects are required.

<u>Written Communications</u>: For each literature study and laboratory test project, eight- to twelve-page reports are required.

<u>Oral Communication</u>: At the end of the semester, all students are required to present their literature study or lab project reports to the class. This oral presentation is evaluated and graded by the instructor(s) with the input from the students.

<u>Laboratory Exercises</u>: Minimum of two significant laboratory experiments are required to be conducted by graduate students to determine certain property of a test specimen prepared by the student. These laboratory experiments are demonstrated and taught to students for the correct methodology and practical skills.

Students Competition: At the end of the semester, students are encouraged to participate in Students

Competition based on the acquired theoretical and practical knowledge.

<u>Class/Laboratory Schedule</u>: Sixty class hours (each 75 minutes long) per semester are allocated to this class. About 80% of class hours are devoted to lectures by the instructor and/or invited lecturers from the industry; and the remaining 20% are devoted to laboratory/experimental sessions.

CONTRIBUTION OF COURSE TO MEETING THE PROFESSIONAL COMPONENT:

The microstructure - property relation is the key concept governing the properties and behavior of civil engineering materials, such as steel, concrete, composites. This course is organized to develop the student's abilities for designing the test specimens and determining from the laboratory experiment the most critical properties of construction materials and interpreting the test data. Students work about 5 weeks on their independent study projects and can learn about production and application construction materials (including local needs and local projects) through presentations made by the guest speakers.

RELATIONSHIP TO PROGRAM OUTCOMES:

v. Graduates will have an ability to function on multidisciplinary teams (ABET d); ix.

Graduates will have an ability to communicate effectively (ABET g);

x. Graduates will have the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context (ABET h); xi. Graduates will demonstrate a recognition of the need for, and an ability to engage in life-long learning (ABET i).

METHODS OF ASSESSMENT:

- ABET Rubrics
- Course Evaluations by Students
- Graded Projects
- Instructor and Peer Judgment
- Structural Division Jury Assessment

RESOURCES COMMONLY AVAILABLE:

- □ Instructor
- Laboratories: W180, W190, W360
- Departmental library on construction materials (books, journals, educational CDs)
 Data-show projector and/or Smart Board
 Software: MiniTab, Microsoft Office, etc.

DESIRABLE STUDENT COMPETENCIES:

- Ability to conduct laboratory tests and multi-step test data analysis and interpretation of results;
- Ability to conduct literature research and compile research information into a comprehensive report;
- Basic computer skills (MiniTab, Microsoft Office)

GRADING POLICY:

Course assignments and credit allocation are as follows (UG	i):		
Homeworks:	20%		
Discussion (class and D2L):	10%		
Three exams:	50%		
Presentation (literature):	20%		
Course assignments and credit allocation are as follows (G):			
Homeworks:	10%		
Three exams:	50%		
Term research project (lab experiment/case study):	30%		
Term paper:	5%		
Leading discussions:	5%		

Grade assignment:

A: 96.5-100%; A-: 93-96.5%; B+: 89.5-93%; B: 86-89.5%; B-: 82.5-86%; C+: 79-82.5%; C: 75.5-79%; C-: 72-75.5%; D+: 68.5-72%; D: 65-68.5%; D-: 61.5-65%; F: <61.5%

ASSIGNMENT POLICY:

Homework assignments are usually handed out on Mondays, and collected a week later (next Monday). Students who hand in homework two days later (the following Wednesdays) will be penalized by 50%. No assignment more than two days late is accepted. No make-up for quiz or presentation is allowed.

CREDITS AND WORKLOAD EXPECTATIONS:

Generally, when a one-credit course is taken, an average of three hours of learning effort per week (over a full semester) is necessary for an average student to achieve an average grade in the course. A student taking a three-credit course that meets for three hours a week should expect to spend an additional six hours a week on coursework outside the classroom.

POLICIES REGARDING SCHOLASTIC MISCONDUCT:

Academic dishonesty in any portion of the academic work for a course shall be grounds for awarding a grade of F or N for the entire course. Scholastic misconduct is broadly defined as "any act that violates the rights of another student in academic work or that involves misrepresentation of your own work." Scholastic dishonesty includes, (but is not necessarily limited to): cheating on assignments or examinations; plagiarizing (i.e., submitting the same project result or substantially similar result); depriving another student of necessary course materials; or interfering with another student's work.

STUDENTS WITH DISABILITIES:

It is the university policy to provide, on a flexible and individualized basis, reasonable accommodations to students who have disabilities that may affect their ability to participate in course activities or to meet course requirements. Students with disabilities are encouraged to contact me when possible to discuss their individual needs for accommodations.

UNIVERSITY POLICIES:

The detailed University Policies are here: <u>http://www4.uwm.edu/secu/news_events/upload/SyllabusLinks.pdf</u>

ADDITIONAL READING:

- The Science and Technology of Civil Engineering Materials by F. Young et al.
- Introduction to Materials Science for Engineering by J.F. Shackelford.
- The Science and Design of Engineering Materials by J.P. Schaffer, et al.
- Structure and Properties of Engineering Materials by Henkel and Pense.
- Advances in Cement Technology Chemistry, Manufacture and Testing by S. N. Ghosh.
- Special Inorganic Cements by I.Odler.
- Concrete: Structure, Properties, and Materials by P.K. Mehta and P.J.M. Monteiro.
- Properties of Concrete by A.M. Neville.
- Concrete Admixtures Handbook Properties, Science, and Technology by V. Ramachandran.

TENTATIVE SCHEDULE

Week	Topics	HW
1	Introduction	1
2	Drivers of sustainability in the built environment	2
3	Sustainability policies and programs	3
4	Design of materials based on sustainability principles	4
5	Utilization of byproducts	5
6	Mid-term exam	
7	Invited lecture	
8	Spring Recess	
9	Factors of improved performance and increased service life	6
10	Green rating systems	7
11	Sustainable construction opportunities and best practices	8
12	Mid-term exam	
13	The business case for sustainability	9
14	Trends for the future of sustainable design and construction	10
15	Student lab/case study competition	
16	Project presentation	
17	Final exam	

REQUIRED AND RECOMMENDED READINGS

Title	Year
Review of the assessment of thermal mass in whole building performance simulation tools	2015
E Mantesi, MJ Cook, J Glass, CJ Hopfe	2015
Assessment of ICF energy saving potential in whole building performance simulation tools	2015
E Mantesi, MJ Hopfe, J Glass, MJ Cook	2015
Comparison of generic and product-specific Life Cycle Assessment databases: application to construction	
materials used in building LCA studies	2045
S Lasvaux, G Habert, B Peuportier, J Chevaller	2015
The International Journal of Life Cycle Assessment 20 (11), 1473-1490	
Influence of simplification of life cycle inventories on the accuracy of impact assessment: application to construction products	
S Lasvaux, N Schiopu, G Habert, J Chevalier, B Peuportier	2014
Journal of Cleaner Production 79, 142-151	
Environmental impacts of bamboo-based construction materials representing global production diversity	
EZ Escamilla, G Habert	2014
Journal of Cleaner Production 69, 117-127	
Adaptation of environmental data to national and sectorial context: application for reinforcing steel sold on	
the French market	
F Gomes, R Brière, A Feraille, G Habert, S Lasvaux, C Tessier	2013
The International Journal of Life Cycle Assessment 18 (5), 926-938	
Future use of life-cycle assessment in civil engineering	
J Glass, T Dyer, C Georgopoulos, C Goodier, K Paine, T Parry,	2013
Proceedings of the ICE-Construction Materials 166 (4), 204-212	
Lowering the global warming impact of bridge rehabilitations by using Ultra High Performance Fibre	
Reinforced Concretes	2012
G Habert, E Denarie, A Sajila, P Rossi	2013
Cement and Concrete Composites 38, 1-11 Reducing environmental impact by increasing the strength of concrete, quantification of the improvement to	
concrete bridges	
G Habert, D Arribe, T Dehove, L Espinasse, R Le Roy	2012
Journal of Cleaner Production 35, 250-262	
An environmental evaluation of geopolymer based concrete production: reviewing current research trends	
G Habert, JBDE De Lacaillerie, N Roussel	2011
Journal of Cleaner Production 19 (11), 1229-1238	
Cement production technology improvement compared to factor 4 objectives	
G Habert, C Billard, P Rossi, C Chen, N Roussel	2010
Cement and Concrete Research 40 (5), 820-826	
Environmental impact of cement production: detail of the different processes and cement plant variability	
evaluation	
C Chen, G Habert, Y Bouzidi, A Jullien	2010
Journal of Cleaner Production 18 (5), 478-485	

Managing for sustainability: findings from four company case studies in the UK precast concrete industry	
I Holton, J Glass, ADF Price	2010
Journal of Cleaner Production 18 (2), 152-160	
LCA allocation procedure used as an incitative method for waste recycling: An application to mineral additions	
	2010 <u>in</u>
<u>concrete</u>	
C Chen, G Habert, Y Bouzidi, A Jullien, A Ventura	
Resources, Conservation and Recycling 54 (12), 1231-1240	
Architects' perspectives on construction waste reduction by design	
M Osmani, J Glass, ADF Price	2008
Waste Management 28 (7), 1147-1158	