Florida Atlantic University
Department of Civil, Environmental and Geomatics Engineering
Engineering Scholars Program (ESP) 2017

CGN 1500: Innovative Materials for Infrastructure
3 credits

1. Course Description and Prerequisites

Description: Introduction to New-generation, Innovative and Advanced Materials for Civil Infrastructure Systems such as Bridges, Tall Structures, and Highway Pavements; Mix-Design and Mechanical Properties; Environmentally Sound Concepts; Solid Waste Recycling, Green Building, and Sustainable Development; Accelerated Testing and Long-Term Durability; Hands-on Laboratory Testing to determine Engineering Properties.

Prerequisites: Algebra 2 and Biology

2. Course Objectives (what we will do in this class)

A. Introduce emerging new materials for structures, bridges and highways
B. Introduce concepts of recycling, green building and sustainable development
C. Discuss the stress-strain-strength and durability properties of new materials
D. Provide hands-on laboratory testing experience for evaluating material properties
E. Teach how to use the material properties in simple design/construction modules
F. Discuss Infrastructure security and impact/blast resistant design

3. Course Outcomes (what we expect you to learn)

1. Learn about various high-performance new materials in Civil Engineering construction
2. Understand the concept of Green Building and Sustainable Development
3. Learn how to characterize engineering materials for design applications
4. Ability to perform laboratory tests to determine mechanical properties
5. Ability to apply theoretical concepts into practical engineering design.

4. Text Book (if required)

None

5. Resources (needed/ to be provided)

Lecture notes and handouts posted on Blackboard (blackboard.fau.edu)

Recommended Reference Materials

1. *Civil Engineering Materials*, Shan Somayaji, 2nd Ed., Prentice Hall, 2001
2. *Materials for Civil and Construction Engineers*, M. S. Mamlouk and J. P. Zaniewski, 2nd Edition, Prentice Hall, 2006
3. *Materials Science and Engineering, An Introduction*, W. D. Callister, Jr., 3rd Ed., John Wiley and Sons, 1994.
4. *Designing with Geosynthetics*, Robert M. Koerner, 5th Ed., Prentice Hall, 2005
5. *Fiber Reinforced Cement Composites*, P. N. Balaguru and S. P. Shah, McGraw Hill, 1992

6. Yrjanson, W. A. (1989). "Recycling of Portland Cement Concrete Pavements," *Synthesis of Highway Practice 154*, National Cooperative Highway Research Program, Transportation Research Board, Washington, D. C.

6. Grading Scheme

7 Laboratory projects and Reports:	**49%**
1 Quiz:	**10%**
1 Group Research Report/presentation:	**15%**
Final Exam:	**26%**

7. Course Schedule Details

Monday, June 12

Morning

MODULE 1: *Civil Engineering – Past, Present and Future*

Introduction and overview; What is Civil Engineering? American Society of Civil Engineers (ASCE); Code of ethics and professional conduct; Civil Engineering Infrastructure; Historical perspective; Current state of buildings, bridges and roadways; Need for Rehabilitation; Need for new high-performance materials.

Afternoon

Laboratory Project 1: ***Grain Size Analysis of Recycled Crushed Concrete***

Introduction to testing machines; laboratory safety; alternative materials, sensors, and composites; Sieve analysis of demolition aggregate; technical report writing.

Wednesday, June 14

Morning

MODULE 2: Civil Engineering Materials

Introduction to Civil Engineering Materials; What are some of the new-generation materials? Smart Materials and Sensors; Alternative and recycled materials in civil engineering construction; Need for Alternative, High-Performance Materials; Environmental issues; Solid waste management issues; Sustainable development; Long-term durability issues.

Afternoon

Laboratory Project 2: ***Concrete Mix Design using Recycled Aggregate (control specimen)***

Sample preparation, mix-design, and curing. **Lab 1 report due.**

Friday, June 16

Morning

MODULE 3: Mechanics of Engineering Materials

Concepts of stress, strain, strength and deformation; mechanics; mechanical testing; mechanical properties; failure analysis; ASTM standards; accelerated testing of long-term durability; theoretical formulations for predicting durability and performance; durability of recycled materials **QUIZ 1**

Afternoon

Laboratory Project 3: *Concrete Mix Design using Recycled Aggregate and Fly Ash or Rice Husk Ash as partial cement substitutes*

Concrete made from construction and demolition (C&D) aggregate and fly ash; Sample preparation, mix-design, and curing. **Lab 2 report due.**

Monday, June 19

Morning

MODULE 4: Science of Engineering Materials

Atomic arrangements and crystalline structure; lattice and unit cells; Miller Indices; defects and dislocations; Slip mechanisms and Schmid's Law

Afternoon

Laboratory Project 4: *Recycled Aggregate Concrete Reinforced with Post-Consumer HDPE Strips*

Concrete made from Concrete from C&D waste aggregate, fly ash and recycled plastic strips; sample preparation, mix-design and curing. Lab 3 report due

Wednesday, June 21

Morning

MODULE 5: New-Generation Concrete

High-performance concrete; fiber-reinforced concrete; alternative fibers; concept of strength and toughness; unconventional materials in concrete; Fiber-reinforced plastics (FRP) for strengthening / retrofitting; recycled aggregate concrete

Assignment of Technical Research Paper

Afternoon

Laboratory Project 5: Compressive Strength Testing of Control Recycled Aggregate Concrete

Test control specimens from lab 2 under compression/tension. Lab 4 report due.

Friday, June 23

Morning

MODULE 6: New-Generation Geo-Composites

Soils and geomaterials; shear strength and failure mechanisms; structural foundations; fiber-reinforced soil; recycled materials in geotechnical applications; geosynthetic reinforcement; bearing capacity of foundation soils

Afternoon

Laboratory Project 6: *Compressive Strength Testing of FA and RHA Recycled Aggregate Concrete*

Compressive strength testing of specimens from lab 3. Lab 5 report due. **QUIZ 2**

Monday, June 26

Morning

MODULE 7: Sustainable Development and Green Construction

Soil and base stabilization with unconventional and recycled materials; Recycled plastics for soil reinforcement; Recycled aggregate from Construction and Demolition (C&D) wastes; sustainable, energy-efficient building walls

Afternoon

Laboratory Project 7: *Strength Testing of Recycled Aggregate Concrete containing HDPE recycled plastic reinforcement.*

Compressive strength testing of specimens from lab 3; Lab 6 report due.

Wednesday, June 28

Morning

MODULE 8: Innovations in Solid Waste Management

Vertical enhancement of existing landfill capacities; Significance of Piggyback Landfills in solid waste management practices; compressibility and settlement; Innovative geosynthetic reinforcement for slope stability; Compacted Clay Liners (CCL) and Geosynthetic Clay Liners (GCL)

Afternoon

Laboratory Project 8: *Research Project Activities*

Friday, June 30

Morning

MODULE 9: Review, Discussions, Reflection / Meta-cognition; *Comprehensive Final Exam*

Afternoon

Presentation of Research Papers

8. Submission and Lab Usage Requirements

As described above

9. Instructor and Contact Information

Dr. Khaled Sobhan
Office: Bldg. 36 (EG), Room 221; Phone: 561-297-3473; Email: ksobhan@fau.edu

10. Class Dates, Time and Location

MWF: 9:30 AM – 4:30 PM; Location: Lecture GS 109; Laboratory: EG 262/152