

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

**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; Infrastructure security and impact / blast resistant materials and design.

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](http://blackboard.fau.edu))

**Recommended Reference Materials**

- 1. *Civil Engineering Materials*, Shan Somayaji, 2<sup>nd</sup> Ed., Prentice Hall, 2001
- 2. *Materials for Civil and Construction Engineers*, M. S. Mamlouk and J. P. Zaniewski, 2<sup>nd</sup> Edition, Prentice Hall, 2006
- 3. *Materials Science and Engineering, An Introduction*, W. D. Callister, Jr., 3<sup>rd</sup> Ed., John Wiley and Sons, 1994.
- 4. *Designing with Geosynthetics*, Robert M. Koerner, 5<sup>th</sup> 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

The course grade is based on the following components:	
1 comprehensive Final Exam	15%
3 Quizzes	15%
1 group research paper / presentation	14%
7 laboratory design/construction modules and project reports	56%
Grading Scale: A: 90-100; B: 80-89; C: 70-79; D: 60-69; F: < 60	

## 7. Course Schedule Details

### Monday, June 10

#### 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; Infrastructure Security and need for impact/blast/fire resistant design

#### 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 12

#### 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 14

### 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 and evaluation 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 17**

### 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 19**

### 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 21**

### 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 24**

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 26**

Morning

**MODULE 8: Innovations in Solid Waste Management**

Vertical enhancement of existing landfill capacities; Significance of Piggyback Landfills in solid waste management practices; Design considerations such as 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 28**

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

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**10. Class Dates, Time and Location**

MWF: 9:30 AM – 4:30 PM; Location: Lecture (TBA); Laboratory: EG 262

**For further information:** [www.cege.fau.edu](http://www.cege.fau.edu)