Florida Atlantic University  
Department of Civil, Environmental and Geomatics Engineering 
Engineering Scholars Program (ESP) 2016

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

**Recommended Reference Materials**


6. Grading Scheme

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 Laboratory projects and Reports:</td>
<td>49%</td>
</tr>
<tr>
<td>1 Quiz:</td>
<td>10%</td>
</tr>
<tr>
<td>1 Group Research Report/presentation:</td>
<td>15%</td>
</tr>
<tr>
<td>Final Exam:</td>
<td>26%</td>
</tr>
</tbody>
</table>

7. Course Schedule Details

**Monday, June 13**

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 15**

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 17**

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 20

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

Wednesday, June 22

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 24

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 27

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 29

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, July 1

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: Room 221, BLDG. 36; Telephone: (561) 297-3473; Email: ksobhan@fau.edu

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