

2017 ASCE SOUTHEAST STUDENT CONFERENCE

Geotechnical Lightweight Fill

Friday, March 17
Bldg. 36, EG, Rm.152
777 Glades Rd, Boca Raton, FL 33431

Overview and Objective

Lightweight geotechnical fill has been used in place of soil for building roadway embankments, retaining walls, and as backfill above buried pipelines as a more economically viable and lightweight material. Expanded polystyrene, also called geofoam, is typically used in these applications. Apart from many advantages, using geofoam has drawbacks including: adverse environmental impact, incompatibility with petroleum products, flammability, etc.

Research regarding recycled lightweight fill has been conducted to investigate the opportunity to replace geofoam with a more sustainable and economically viable material. Diverting potentially recyclable material from landfills and repurposing it for use in civil engineering applications offers many environmental benefits, as well as saving manufacturing and processing costs. For example, one project used PET bottles as subgrade for bike trails, but the proof of concept has not yet been expanded to roadway projects.

The objective of the Geotechnical Lightweight Fill Competition is to create a new sustainable lightweight fill and explore the mechanical properties, sustainability, and constructability of this new material as a lightweight geotechnical fill. The participants will create a new recycled lightweight fill material, characterize the material, and test the material strength through an unconfined compression test.

Eligibility

Each university may have one team with up to four students, one of whom may be a graduate student. Each team will have a captain who is responsible for submitting the lightweight fill cube and a paper copy of the technical report during registration. Each team may only submit one cube. All submitted cubes must meet all design specifications. Compliance evaluation will be conducted at least 24 hours before testing.

Submittals

Each university may have one team with up to four students, one of whom may be a graduate student. Each team will have a captain who is responsible for submitting the cube and a paper copy of the technical report during registration. Each team may only submit one cube. All technical reports must be submitted upon arrival to the conference at the time of registration. Reports must be bound or stapled and presented on 8.5" x 11" paper. Following items must be submitted:

- 1.0 ft x 1.0 ft x 1.0 ft cube lightweight fill cube
- Technical paper
- Material properties form
- Geotechnical Lightweight Fill Competition Scoring Summary Sheet

Electronic version of the Material Properties form due **March 3, 2017 at 11:59 p.m. EST** to **2017asce@fau.edu**, (Subject: Geotechnical Material Properties Form). Bring specimen and final technical paper to assigned testing time.

Construction Guidelines

Each team will construct one 1.0 ft x 1.0 ft x 1.0 ft cube from recycled material prior to the competition. Teams must use easily accessible recyclable material that can be held together with a binding agent. Each material used must be listed on the material breakdown form and justified as sustainable, recyclable, and constructible on the material properties form.

Specifications

The construction and testing requirements are summarized below.

- Cube must fit inside a 1.0 ft x 1.0 ft x 1.0 ft cube mold in all directions prior to competition.
- Cube must be made primarily of recycled material. (It is at the judges' discretion what constitutes a recycled material, majority rules)
- Weight may not exceed 12 pounds.
- Cube may not include any liquid.
- No fill material (bottles, etc.) may be more than 3 inches in any direction.
- Pressurized objects are not permitted.
- Teams must take their cube with them after it has been scored. Cubes may not be disposed of on campus or left in the testing lab after the conclusion of the competition.

Technical Paper

The technical paper shall be 750-1000 words in length and consist of:

1. Introduction
 - a. Name of University.
 - b. Names of team members.
 - c. Captain's name, email address, and cell phone number.
2. Material Documentation
 - a. Quantity and dimensions of all materials used in construction.
 - b. Information about binder used in construction.
3. Design Methodology and Construction
 - a. Explanation of all design assumptions used in the design.
 - b. Discussion of alternative designs considered.
 - c. Analysis procedures used to determine the member locations and sizes.
 - d. Discussion of the construction sequence.
 - e. Discussion of any problems encountered and overcome.

Appendix A. Material Properties Form

Appendix B. Geotechnical Lightweight Fill Competition Scoring Summary Sheet

Note: Appendix forms do not count against the word count limit.

Material Properties Form

The material properties form should be completed prior to the competition and submitted as part of the technical paper, as Appendix A. Each material and binding agent used in constructing the cube should be listed in the Material column. For each material, calculate the percent of the total volume and the percent of the total weight that the material represents in the sample. Estimate the unit cost per cubic foot of lightweight fill and the sub-total for each material. A price for any donated or free materials should be included in the cost. Sum the sub-total values to calculate a total cost for the lightweight fill sample. Specify a grain size range in the space provided. Using the total cost of the lightweight fill sample, estimate the cost to construct a roadway embankment requiring 100,000 cubic yards of lightweight fill.

University Name	Geotechnical Lightweight Fill			
Material	Quantity	% Volume	% Weight	Cost
Binding Agents				
TOTAL		0%	0%	0
				Weight
				Total Cost:
				Cost Per Weight
				Cost to Construct a Roadway Embankment Cost per 100,000 cy
				Grain Size Range

Testing Procedure

Each team will bring its lightweight fill cube to the designated testing area at the competition. Before testing, each cube of lightweight fill will have to fit completely inside 12 inch x 12 inch x 12 inch cube mold in all orientations. Cubes that cannot fit through the mold will be disqualified. **Note: All team members must be wearing long pants and closed toed shoes to be admitted into the testing lab.**

- Total weight of the cube: Each team will record a weight for the lightweight fill cube on the material properties form. *Total weight may not exceed 12 pounds.*
- Unconfined compression test: The cubes will be subjected to an unconfined compression test to a maximum strain of 15%. The cubes will be compressed at a loading rate of 3% strain per minute.
- Calculate weight/load ratio: Based on the load and displacement values generated throughout the compression test, students will receive a stress vs. strain curve, a maximum unconfined compressive load value, and a Young's modulus value generated from the test. The peak stress value will be used to calculate the weight/load ratio. The maximum unconfined compressive strength, Young's modulus, and weight/load ratio will be recorded on the material properties form.
- Justification: Students will justify the sustainability and constructability of the lightweight cube by writing a justification statement on the material properties form. Teams should consider cost per cubic foot, second-use applications, regional availability, renewability, durability, and address any barriers that would prevent the widespread use of the material as a lightweight fill. The statement may be handwritten in the space provided on the material properties form or typed prior to the competition and brought to the testing location. The typed statement should be single-spaced, 12 point font, and a maximum of one (1) page long. Once each team submits its cube, they will not be able to make changes to it.

Judging

There will be a minimum of three (3) judges for the competition. It will be the judges' duty and responsibility to evaluate the teams fairly and consistently. The teams will be evaluated based on the criteria outlined in the Scoring section included below. The judges' ruling will be final for all competitors.

Scoring

Teams will be scored based on the unit weight, strength, constructability, and economy of their lightweight cube. Any type of recycled material can be used in the competition, but the team with the most creative material will be awarded a bonus of five (5) points. Please reference the Scoring Summary Sheet for a specific breakdown of points.

Disqualifications

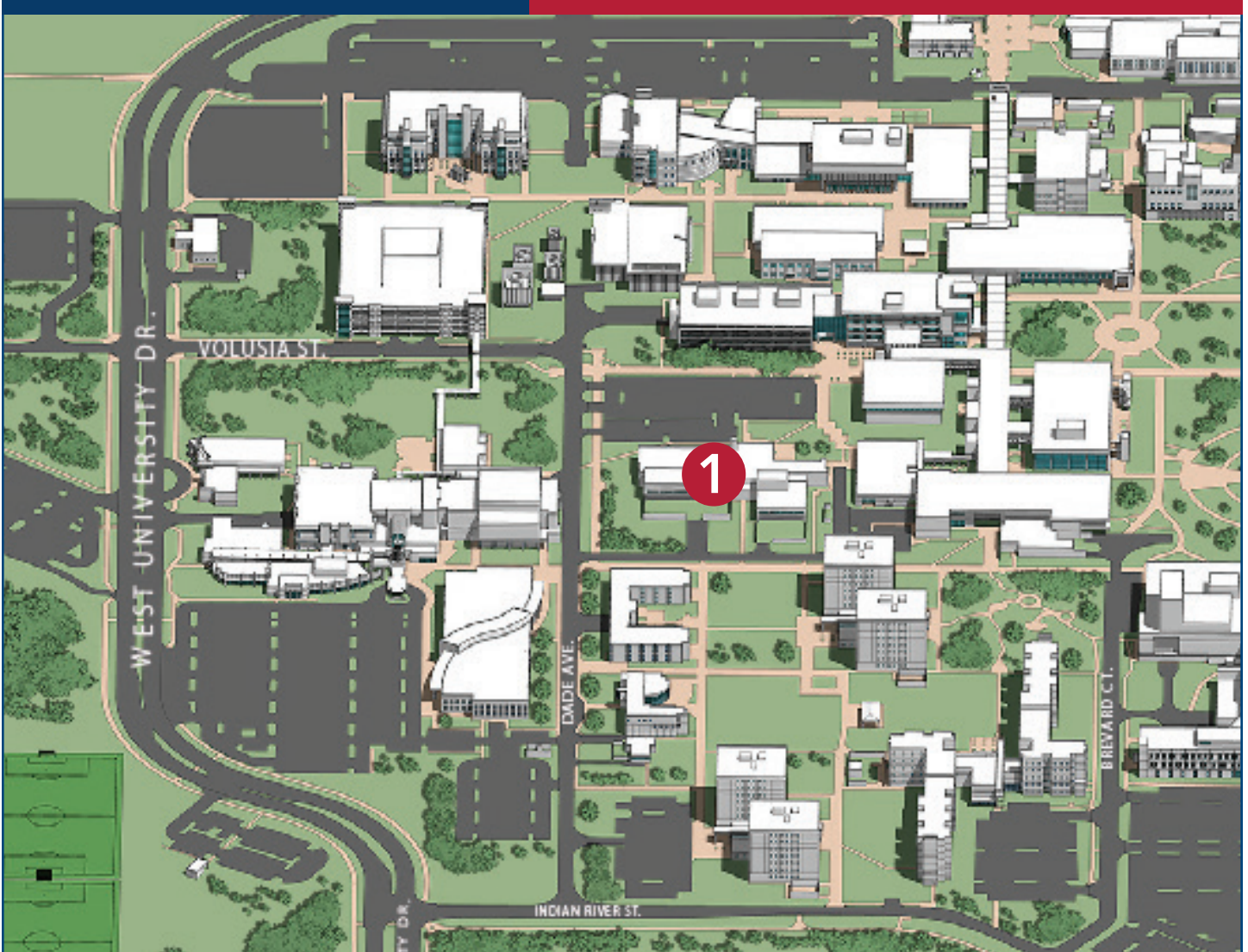
Any team that does not abide by the regulations presented above or performs unethically will be disqualified.

Location and Directions

Bldg. 36, EG, Rm.152
777 Glades Rd, Boca Raton, FL 33431

- From I-95
- Take Exit 45 east onto Glades Road
- In 1.8 miles left onto W. University Drive
- Right onto Indian River St.
- Left on Dade Ave.
- Pass main crosswalk
- Bldg. 36 on right

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Geotechnical Lightweight Fill Scoring Summary Sheet

University: _____

Cube Weight _____

Load Applied _____

Cube Load:Weight Ratio

Load: Weight Sub-Total Score (75 points maximum) _____

Technical Paper

1. Introduction (5 points maximum) _____

2. Material Documentation (5 points maximum) _____

3. Design Methodology and Construction (10 points maximum) _____

4. Figures (5 points maximum) _____

Technical Paper Subtotal Score (25 points maximum) _____

Overall Score _____