The Impact of Materials on Society
Module 7 - Concrete Research Experiment – In-Class Activity

Pre-Class Assignments: Optional reading for those interested in following an anthropological perspective on materials this week: The Materials of Life (PDF), from Tim Ingold (2013) *In the Making: Anthropology, Archaeology, Art and Architecture.* Chapter 2: The Materials of Life. London: Routledge
Activity Objective: How does Concrete composition affect its tensile strength?

Question:
What is the optimum ratio of cement to sand to gravel to make the strongest concrete in tension (unreinforced)?

Background:
The optimum ratio according to the experts is 1 part cement to 2 parts sand to 3 parts gravel if the concrete is used in compression. Our goal is to try to determine if the ratio is the same when the concrete is used in tension.

Approach:
As a class we will make bars of concrete with different compositions. We will then break these bars using an impact testing approach and measure the energy absorbed by each bar during fracture. Each group will submit their findings and then as a class we will take the results of all the groups and plot a 3-D graph of how composition affects the tensile strength.

Day 1 class - Making concrete bars

In-Class Assignment: Day 1–Concrete Research Experiment (Word)
Over the next three days, the class will conduct an experiment to determine the toughness of your concrete blocks.

Preparations before class: Build simple molds for making concrete bars.

1. Cut a piece of 1/2" plywood into 12 x 12" squares
2. Cut 2 pieces of 1" x 2" into 3" lengths and another 2 pieces into 8" lengths.
3. Nail together into a rectangle to create a box that is 8" long by 4 1/2" wide and 1 3/4" deep.
4. Attach 2 of these boxes to each piece of plywood with screws from underneath.

Provide the students with sand, cement, and gravel and a small bucket, gloves and a paint stirring stick. Each group of 4-5 students will make 2 bars.

1. The first bar uses just these three ingredients and you can provide each group with a different ratio of the ingredients if you want to conduct an experiment to determine what ratio is the strongest or allow them to decide the ratio.

2. For the second bar, allow them to reinforce the bar with whatever they want to bring to class (pencils, paper, fabric, wood, whatever)

Make the bars on a Monday and allow them to cure until Friday.

Possible variations of concrete for each group to make.

Group #	Cement	Sand	Gravel
1	1	2	3
2	1	0	5
3	1	0.5	4.5
4	1	1	4
5	1	1.5	3.5
6	1	2	3
7	1	2.5	2.5
8	1	3	2
9	1	3.5	1.5
10	1	4	1
11	1	4.5	0.5
12	1	5	0
13	1.5	0.5	4
14	1.5	1	3.5
15	1.5	1.5	3
16	1.5	2	2.5
17	1.5	2.5	2
18	1.5	3	1.5
19	1.5	3.5	1
20	1.5	4	0.5
21	2	1	3
22	2	1.5	2.5
23	2.5	1	2.5
24	2.5	1.5	2
25	3	1	2
26	3	1.5	1.5
27	3.5	1	1.5
28	3.5	1.5	1
29	4	1	1
30	4.5	0.5	1
31	4.5	1	0.5
32	5	0.5	0.5
33	5.5	0	0.5
34	5.5	0.5	0
35	6	0	0

Day 2 Class – Review for Mid-term Exam

Once the class has processed all the content, taken the quizzes, and completed the assignments from Modules 1-6, they are ready to review and take Exam 1.

Use the list of key terms (Word) to guide the review of any notes and course materials in preparation for your exam.

Mid-Course Exam 1
Exam 1 questions and answer key are available upon request. Contact Kevin Jones, University of Florida, at kjones@eng.ufl.edu.

Day 3 Class – Breaking Concrete

In-Class Assignment: Day 3–Concrete Breaking Experiment (Word)

Testing the bars

Bring the bars to class. Set up a big tarp to protect the floor and provide safety glasses for the students.

Preparations before class: Building the Impact Testing Machine

Materials:

1. 10 Kg sledgehammer
2. two sawhorses
3. metal rod (1/2" diam. ~3 feet long)
4. two flat concrete blocks typically 15" x 15" x 3"
5. two 36" clamps
6. two meter sticks.

Drill a hole in the end of the sledge hammer so as to allow the metal rod to be inserted and support the metal rod on the sawhorses. This allows the sledge hammer to swing 4-5" off the ground.

Classroom Activity: Impact Testing

The concept is to create a simple impact testing machine by allowing them to pull the sledge hammer up to a height determined by a meter stick and then release the hammer, have it break the bar that is clamped between the 2 concrete blocks using the 36" clamps.

Each group breaks both bars and then the next group goes. Have the students calculate the toughness of each bar and turn in a short report on their observations.

Breaking Concrete

We will set up to break all the bars in class using an izod impact test. To do this we need to be extremely efficient. Each group will have people who load the bars, hold the measuring stick, drop the hammer, and film the process using their phone and record the data.

Using a cell phone camera, video measure how high the hammer swings after passing through the bar. The difference in height between the run without a bar and the one with the bar can easily be converted into the energy absorbed (mgh) upon breaking the bar and thus the toughness of the bar.

You will be required to by the end of Day 3 to turn in a short report (1 page) which discusses what you used to make each bar, your observations from the breaking process, the height of the sledge hammer before and after it strikes the bar and the calculated energy absorbed.

(energy absorbed = change in mass time gravity constant times height) (mgh).

Use the mass of the sledge hammer in kilograms, g=9.81m/s2 and the height difference in meters to get the energy absorbed in joules. Include your conclusions on the reinforced sample as well.