Lab 16: Compression Testing Cast Beams

Introduction

Plaster of Paris (hydrated calcium sulphate) is a brittle solid with fracture properties similar to cement, and can be used to model the load behavior of concrete beams. In this lab, cast beams are tested to destruction under compression. Quantities measured include Young's Modulus and the Compressive Strength for the material.

You will need Plaster of Paris, and utensils like cups and spoons to mix the plaster. The beams need to be made before lab to allow them to cure. Typical cure times are from several hours to several days.

Equipment

<table>
<thead>
<tr>
<th>Qty</th>
<th>Items</th>
<th>Part #</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Materials Testing Machine</td>
<td>ME-8236</td>
</tr>
<tr>
<td>1</td>
<td>Structures Beam Adapter</td>
<td>ME-8242</td>
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<tr>
<td>1</td>
<td>Structures Cast Beams Set</td>
<td>ME-6983</td>
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<tr>
<td>1</td>
<td>Calipers</td>
<td>SE-8710</td>
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</table>

Note: You will probably want to make a Compliance Calibration (using the Calibration Rod) before attaching the Beam Accessory! A max force of 3000 N is adequate for this experiment.

Written by Jon Hanks
Making Cast Beams

1. Snap the rebar into the mold (see Figure 2). Pour all of the beams from the same batch. Tap the sides to remove bubbles.

2. Make several beams so that you can see how much the beams vary in strength. You can also allow some of the beams to dry for a longer time, to observe the effect of curing time on strength.

3. Do not remove the beam from the mold until the plaster is dry. Allow a cure time of at least a few hours.

Setup

1. Measure the cross-sectional dimensions of the cast beam, and calculate the area. Edit the value for the area in line #2 of the calculator.

2. Confirm that the calculation for stress is correct. What are the units?

3. Measure the length of the cast portion of the beam, and edit the value for the length in line #4 of the calculator.

4. Confirm that the calculation for strain is correct. What are the units?

5. The ME-8242 Structures Beam Adapter consists of two major parts: The upper fixture with the longer thread sticks up through the cross-head and is held in place by the knurled cap nut. The lower fixture screws directly into the Load Cell as shown in Figure 1.

6. Install one of your cast beams and secure the covers on both fixtures using the cap screws.

7. When you are testing the beam, it is important that you use the plastic safety shields as shown in Figure 3. They attach with Velcro directly to the cross-head, and are easily installed and removed. Never touch the test sample when it is under load!

Beam Dimensions:

\[
L = 0.112 \text{ m} \\
A = 7.6 \text{ mm} \times 10.2 \text{ mm} = 7.75 \times 10^{-5} \text{ m}^2
\]
Taking Data

Note. Your data will look better if you use the normal procedure to "seat" the test sample. Remember that you should use the same method for testing your sample, as you used when performing a Compliance Calibration with the Calibration Rod.

1. Make sure the plastic Safety Shields are in place.

2. Click on Record. Turn the crank counter-clockwise, compressing the sample. Continue until the beam fails, then click on Stop.

3. Repeat the procedure for the other beams to be tested.

Note: A nice variation is to NOT test all your beams at the same time. Perform the testing over several hours, or even over several days, to observe the effect cure time has on the strength. Open the Data Summary (at left) to rename your runs, to keep track of the time.
Analysis

1. Use a linear Curve Fit to find the slope (Young's Modulus) for the beam material, and compare to values listed in reference data tables.

2. Measure the Compressive Strength (Max Stress) for the beam material, and compare to values listed in reference data tables.

3. If you measured more than one beam, discuss the variations you found.

4. For Further Study: Test beams from the same batch over a period of several days to see the effect of curing time. Also try making beams with a fairly dry mixture, and compare to beams made with a very wet mixture. Try testing one of your beams under tension!

Young's Modulus = E = 2 GPa  (5 day cure)

This value is probably too low. We are assuming a compression of only the plaster, but the plastic ends are giving some too. Typical values 2 to 5 GPa

Compressive Strength = 23 MPa  (5 day cure)
Typical values 20 to 30 MPa

Note the drastic decrease in these values for the 6 hr cure time.