1.103 CIVIL ENGINEERING MATERIALS LABORATORY (1-2-3)

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LABORATORY ASSIGNMENT NUMBER 7

CONCRETE II: HARDENED PROPERTIES

Purpose: During this lab you will learn about:

(1) Measurement techniques for compression testing
(2) Measurement technique for indirect tension
(3) Mechanical properties of Concrete
(4) Effects of mix proportions on the strength and stiffness of Concrete

Reading:

Read this handout and know what will be done in the lab
Know what to expect for the strength and stiffness of Concrete
Review the following in Troxell et al. or similar text
Test 15 (pg. 454): Basic instruction on compression tests
Test 16 (pg. 456): Basic instruction on indirect tension tests
Read ASTM standards: D39 Concrete compression test

Organization:

- Meeting A 20 min. *group* overview, capping
- Meeting B 20 min *Subgroup* finish capping
- Meeting C 60 min. *Subgroup* testing specimens
- Meeting D 20 min *Individual* observation of specimens
- Data will be posted immediately after testing

Overview:

For this laboratory we will again use the compression test to investigate the mechanical properties of cured (hardened) concrete. This will be done with a different testing configuration than we used in the laboratory to measure the properties of wood. Concrete is a very non-uniform material due to the presence of the rather large aggregate particles and air voids. In an attempt to improve the data quality and increase the complexity of the laboratory test, we will use two extensometers placed on opposite sides of the specimen. This will allow you to compute the average on specimen strain. We will also increase the gage length of the extensometers to 2 inches in an attempt to reduce the effects of local non-uniformities.

For this laboratory assignment, we will use the compression test to investigate the effects of mix proportioning and water cement ratio of concrete specimens. We will test the five specimens that you made in laboratory number five. Compression test results on concrete and other stiff materials are sensitive to the surface contact between the specimen and the platens of the test machine. Irregular contact will cause high stress concentrations at the interface. The high stress leads to local yielding which will cause premature failure of the entire specimen. Proper surface contact is achieved by capping the specimens with a stiff material such as plaster of paris or other commercial capping produces.

We will start the capping process in Meeting A and then you must return to the laboratory on your own to finish capping the cylinders. It takes about 15 minutes to apply the caps and clean the equipment. The caps require about 30 minutes to set. **You must** have the cylinders capped before Meeting C.

Procedure:

Apparatus Preparation

1. Locate all the transducers and sketch the overall testing configuration for the compression test.
2. Record the calibration factors and data acquisition channel numbers.
3. Check the electronics including the input voltage, stability of the signals and direction of the displacement output signals.
4. Review the operation of the compression machine.

Specimen Preparation

1. Locate all the specimens to be tested in compression.
2. Measure the height and diameter of each specimen and record this on the data sheet. These specimens have already been capped. You should consider the cap as part of the specimen.
3. Measure and record the mass of each specimen.

Testing Specimens in Compression

1. Attach the two extensometers to the specimen.
2. Locate specimen cylinder in load frame.
3. Lower the cross head until the top cap just touches the specimen.
4. Set the cross head displacement transducer to measure the top cap movement.
5. Record the transducer zero readings (Lt_LVDT_0, Rt_LVDT_0 & LD_0).
6. Seat specimen with small load (less then 50 lbs) and check alignment.
7. Back off the seating load.
8. Put plastic shatter shield in place to contain any flying pieces.
9. Start computer with 1 second reading rate.
10. Load specimen at 8000 lb/min.
11. Stop test when specimen fails (load clearly decreased and deformation continues).

12. Describe and sketch failure geometry. Note any failure planes and angles. Look for shear versus tension failure, end cones, debonding of aggregate, etc.

Calculations:

For the Compression test:

Compute the vertical force, F_v, as:

$$F_v = (LD_t - LD_0) \times CF_{LD}$$

Compute the vertical stress, σ_v, as:

$$\sigma_v = F_v / A_i$$

where A_i is the initial area.

Compute the vertical deformation, Δ, for each extensometer transducer as:

$$\Delta\_Lt = (Lt\_Extr_t - Lt\_Extr_i) / Vin * CF_{Lt\text{-}Extr}$$

and

$$\Delta\_Rt = (Rt\_Extr_t - Rt\_Extr_i) / Vin * CF_{Rt\text{-}Extr}$$

where the subscript $_i$ indicates the start of specimen deformation. You must determine this value from the initial portion of the data set to eliminate the bedding and seating errors. In a perfect test this value would correspond to the zero reading.

Compute the average axial strain in percent, ε_a, as:

$$\varepsilon_a = (\Delta\_Lt + \Delta\_Rt) / 2 / Ht_i \times 100$$

Compute the secant modulus, E_s, as:

$$E_s = (\sigma_v - \sigma_{vi}) / \varepsilon_a * 100$$

where the subscript $_i$ indicates the starting stress on the specimen. It is essential that the first significant data point correspond to a strain value of zero but the stress may have a non zero value.

Report:

Your report should include all the hand recorded data sheets, one page printout of computer data file and results for one specimen, a complete set of example calculations for one specimen which are referenced to the computer printout.

Your report should also include the following:

- Plot stress-strain curve for each specimen using the strain computed from the average of the two Extensometer measurements (You only need to do this for the specimens your group tested).
- Draw a line through the initial portion of the stress strain curve that corresponds to the slope of the initial modulus (again only for your specimens). Pay particular attention to the starting point of the curve and don't include any seating deformations in the modulus calculation.
- Plot the failure stress versus the water cement ratio for all tests and mark the specimens with superplastizer, and mortar.
- Plot the initial modulus vs. the strength for all the specimens.
- Provide a summary table that includes the specimen information, initial modulus, failure stress, failure strain, failure secant modulus, and description of failure geometry.
- One page of computer print out with data and results
- One set of example calculations

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DATA SHEET (1 of 2)

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All dimensions in __________ Group No. ____________ Date ________

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Measurement Device	Vertical Force	Act. Disp.	Lft Disp. Extr	Rgt Disp. Extr
Calibration. Factor	____________	____________	____________	____________
DAQ Channel	____________	____________	____________	____________
Input Voltage	____________	____________	____________	____________
		Gage Length	____________	____________

==

Test Description _____________ File Name ___________ Front Side

Specimen Height __________ , __________ , __________

Specimen Dia. ________, _______ , ________ , ________

Specimen Mass ___________(gm) Vin ___________

Zero Lt-LVDT _________ Zero Rt-LVDT ___________

Zero Load ________

==

Test Description _____________ File Name ___________ Front Side

Specimen Height __________ , __________ , __________

Specimen Dia. ________, _______ , ________ , ________

Specimen Mass ___________(gm) Vin ___________

Zero Lt-LVDT _________ Zero Rt-LVDT ___________

Zero Load ________

==

Test Description _____________ File Name ___________ Front Side

Specimen Height __________ , __________ , __________

Specimen Dia. ________, _______ , ________ , ________

Specimen Mass ___________(gm) Vin ___________

Zero Lt-LVDT _________ Zero Rt-LVDT ___________

Zero Load ________

==

Test Description _____________ File Name ___________ Front Side

Specimen Height __________ , __________ , __________

Specimen Dia. ________, _______ , ________ , ________

Specimen Mass ___________(gm) Vin ___________

Zero Lt-LVDT _________ Zero Rt-LVDT ___________

Zero Load ________

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CONCRETE II: HARDENED PROPERTIES

DATA SHEET (2 of **2)**

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Test Description ____________ File Name __________ Front Side
Specimen Height _________ , _________ , _________
Specimen Dia. _______, ______ , _______ , _______
Specimen Mass __________(gm) Vin __________
Zero Lt-LVDT ________ Zero Rt-LVDT __________
Zero Load _______

==

Test Description ____________ File Name __________ Front Side
Specimen Height _________ , _________ , _________
Specimen Dia. _______, ______ , _______ , _______
Specimen Mass __________(gm) Vin __________
Zero Lt-LVDT ________ Zero Rt-LVDT __________
Zero Load _______

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Test Description ____________ File Name __________ Front Side
Specimen Height _________ , _________ , _________
Specimen Dia. _______, ______ , _______ , _______
Specimen Mass __________(gm) Vin __________
Zero Lt-LVDT ________ Zero Rt-LVDT __________
Zero Load _______

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Test Description ____________ File Name __________ Front Side
Specimen Height _________ , _________ , _________
Specimen Dia. _______, ______ , _______ , _______
Specimen Mass __________(gm) Vin __________
Zero Lt-LVDT ________ Zero Rt-LVDT __________
Zero Load _______

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Test Description ____________ File Name __________ Front Side
Specimen Height _________ , _________ , _________
Specimen Dia. _______, ______ , _______ , _______
Specimen Mass __________(gm) Vin __________
Zero Lt-LVDT ________ Zero Rt-LVDT __________
Zero Load _______

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