LABS 4/5, & 7: CONCRETE STRENGTH TESTS

1. Standards

- CSA A23.2-9C – Compressive Strength of Cylindrical Concrete Specimens
- ASTM C469 – Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression

2. Purpose

- To determine the compressive strength of concrete cylinders at 7/14 and 28 days.
- To investigate the effect of moist curing on concrete strength development

3. Material

- 9 concrete cylinders previously cast

4. Apparatus

- Forney compression test machine
- Compressometer of 200-mm gauge length, complete with dial gauges

5. Procedure

5.1. Compressive strength tests

1. A total of 9 cylinders have been cast. The schedule of testing of cylinders is in the following table:

Age (days)	Cylinder ultimate load test (CSA A23.2-9C)	Cylinder load-deformation test (ASTM C469)
7/14	2	1
28 not cured	2	1
28 cured	2	1

2. Conduct the compression test on the dry-cured as well as the moist-cured specimens. The moist cured specimens should be tested directly after removing them from the curing chamber, as test specimens must be moist when tested.
3. Measure the diameter of each cylinder with callipers to the nearest 0.25 mm by averaging two diameters measured at right angles to each other at the middle height of the specimen.

4. Do the ultimate load test first on one cylinder (CSA A23.2-9C). For the ultimate load test, the load is gradually applied until the cylinder is crushed. Write down the maximum load reached in each cylinder test.
5. For the load-deformation test (ASTM C469), the compressometer is used to measure the deformation for the applied load increments. Place the cylinder in the testing machine. See that the cylinder is properly centered, and that the compressometer frame is properly attached. Zero the dial gauges. Apply the load using load increments specified by the instructor, and record the dial gauge readings for these loads. Increase the load until the elastic limit is passed, as indicated by the increased increments of strain at this point. The maximum load for this test should not exceed about one-half the ultimate load value obtained from the two cylinders loaded to failure. After passing the elastic limit, take two or three more readings, if possible. Remove the compressometer and continue loading until the complete failure occurs.
6. Sketch the fracture for all the cylinders tested.

6. Results

6.1. Compressive strength tests

1. Calculate the compressive strength for each specimen. Note that the compressive strength f'_c is the maximum load divided by the original cross-section area measured. Results should be reported to the nearest 0.1 MPa.
1. Report the type of failure and the appearance of concrete (see Figure 1).
2. Plot the stress-strain curve from the load deformation test at each concrete age, and calculate the concrete compressive strength f'_c from this test. At the 28-day test, this should be done for the dry-cured as well as the wet-cured samples.
3. Determine the modulus of elasticity E_c from the load deformation test according to:

$$E_c = \frac{\sigma_2 - \sigma_1}{\varepsilon_2 - 0.00005} \tag{1}$$

   where σ_2 is the stress corresponding to 40% of the ultimate load, σ_1 is the stress corresponding to a longitudinal strain of 0.005%, and ε_2 is the longitudinal strain produced by stress σ_2.

4. Plot the modulus of elasticity E_c obtained versus concrete age in days.
5. Plot the average compressive strength f'_c for the 3 values of each of your test results at 7/14, and 28 days against age of concrete in days. Draw a mean curve through the points. Compare the compressive strength at different days.
6. Compare the average compressive strength f'_c that you obtained with the results reported in Table 1. Plot the average compressive strength f'c versus the w/c ratio for all the results (as illustrated in Figure 2.) Draw a mean curve through the points at 7, 14, and 28 days.
7. Compare the 28-day test for the dry-cured versus wet-cured samples.

7. Discussion

Compare your curves to those of published data. Do your results follow expected trends? The value and importance of the test results obtained and plotted should be discussed together with any comparisons and conclusions as to the validity of these results. Comment on the effect of moist curing the concrete on its strength.

Table 1: Results for the concrete compressive strength at different ages

Data set	w/c	f'_c (MPa)		
		7 days	14 days	28 days
1	0.49	35.3	37.6	40.8
2	0.49	38.3	39.1	41.9
3	0.54	34.2	36.4	39.15
4	0.50	39.0	41.0	46.0
5	0.97	10.81	12.98	14.95
6	0.63	25.45	25.67	28.89
7	0.54	31.39	33.46	38.6
8	0.53	31.3	34.0	37.4

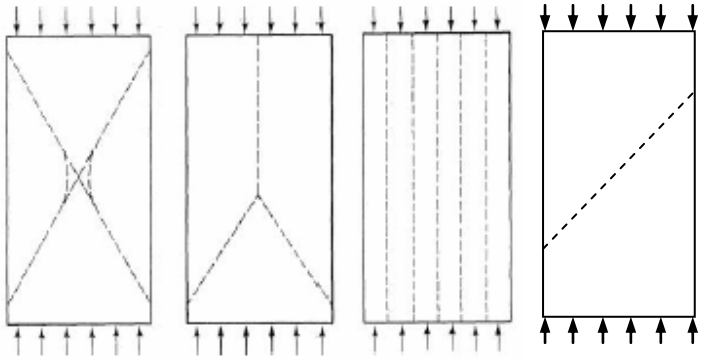

Figure 1: Types of fracture of concrete cylinders: (a) cone, (b) cone and split, (c) split, and (d) shear

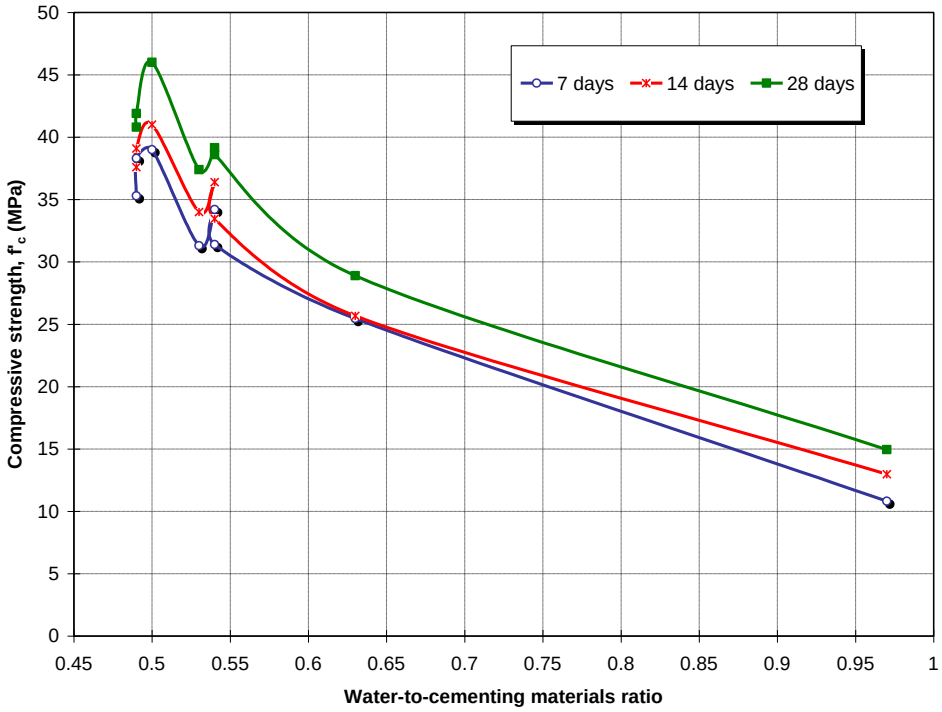

Figure 2: Relationship between concrete compressive strength and w/c for different ages