

CIVE 2700: Civil Engineering Materials
Fall 2019 Lab:
Concrete Lab

This lab is divided into three sections (A, B, and C). Part A covers the mix design of concrete, Part B covers the casting of concrete and Part C covers the testing of concrete in compression and tension. Even though there are three sections, only one individual report will be submitted. The lab will be due December the 5th.

A) Background:

Concrete is a composite building material, which is used extensively in all types of construction practices. Although it has low tensile strength, its high compressive strength and relatively low cost make it the most widely used construction material in the world.

Basic constituents of concrete:

1. Portland Cement:

Portland cement is a mixture of lime (CaO), silica (SiO₂), alumina (Al₂O₃), iron oxide (Fe₂O₃), usually some magnesia (MgO), and a small percentage of sulfur trioxide (SO₃), which is added to retard the set of the finished product. Proper combination of these oxides gives us different types of Portland cement, which is used to produce different types of concrete. Cement reacts with water in a hardening reaction called “hydration”, which is temperature and moisture dependent. During the initial hardening process the temperature and the moisture around the concrete must be controlled (curing). Otherwise, the hydration reaction may stop under severe conditions such as very cold weather or low humidity.

2. Aggregates:

They can be subdivided into two main groups: Coarse aggregates (gravel, etc.), fine aggregates (sand, etc.). The benefit of using aggregates in concrete is two-fold: First, they increase the strength; second, they reduce the cost of the concrete. Fine and coarse aggregates must be proportioned (gradation of the aggregates) very well so that the amount of void space (air) in the concrete can be minimized. This is achieved by using sieve analysis tests and gradation curves. A good gradation also provides interlocking of the aggregates providing high shear resistance. Aggregates must be clean (dust and salt free). If not, they have to be washed before mixing.

3. Water:

Water to be used in the concrete must be clean and salt free. It has two functions in concrete: First it is used in the hydration reaction, which eventually gives hardness and strength to concrete. Second, it increases the workability of the cement paste. (The higher the water content, the higher the workability of the cement paste.)

4. Admixtures (superplasticizers, air entraining agents, etc.):

These are the chemicals used to improve certain properties of the concrete. For example, in order to increase the workability of the cement paste without adding water, super plasticizers can be used.

5. *Air:*

Strength of Concrete: Concrete gains almost 80% of its ultimate strength 28 days after the mixing. The strength of the concrete depends on several factors such as water cement ratio (w/c), amount of air in concrete, type of cement used, type of aggregates used, the gradation of the aggregates. The strength of the concrete is inversely proportional to the water cement ratio (The lower w/c, the higher strength). High levels of air in concrete reduce the strength of concrete. A good gradation of aggregates contributes the strength significantly. Developing cement technology allows us to produce cements, which are used to produce concretes with strengths above 100 MPa.

A. Mix design Procedure

Follow the concrete mix design procedures that covered in the class and design a concrete mix similar to the mix that provided to you by your TA.

B. Concrete casting

Concrete will be cast based on the lab schedule. Nine cylinders will be casted according to standard procedures.

A) Equipment:

1. concrete molds,
2. tamping rod,
3. pan,
4. mallet,
5. trowel and
6. hand scoop.

B) Procedure:

1. Cast concrete and perform slump test
2. Cast concrete cylinders (9)
3. Moist-cure the specimens in the curing room.
4. Remove the specimens from the molds between 20 and 48 hrs after casting.
5. Waiting for 7, 14 and 28 days for cylinder tests (Part C).

B.1 Mixing of Concrete

B.2 Slump test

B.3 Casting of concrete cylinders

C. Concrete testing

A) Concrete will be tested in compression on 7, 14 and 28 days, deformation will be recorded on the 28 days for modulus of elasticity calculation, split test (concrete tension test) will be performed on 28 days only (Following ASTM C39.).

B) Equipment:

1. universal loading machine
2. compressometer

TO SUBMIT

Students (individually) are required to submit a lab report on the due date posted on CU Learn. This lab is scored out of 25 and is worth 5% of your final grade.

Lab reports should contain the following sections. Total marks are also distributed as follows:

1. Title page (*Include title, course information and lab date*) 1/1
2. Abstract (*Summarize the lab in one paragraph*) 1/1
3. Table of contents (*List contents figures and tables*) 1/1
4. Objectives (*Describe the objectives*) 1/1
5. Theoretical background (*Describe the theory, equations used, define key parameters*) 1/1
6. Materials and equipment (*Describe the specimen and equipment*) 1/1
7. Experimental procedure (*Describe the experimental procedure, note any changes to lab handout*) 1/1
8. Analysis of data (*see below*) 4/4
9. Discussion of results (*see below*) 6/6
10. Conclusions (*should resemble key points in abstract*) 1/1
11. References (*should be noted throughout and summarized at the end of the report*) 1/1
12. Raw data and sample calculations (*include mix design in appendix*) 6/6

Full marks will be awarded for accuracy, presentation, formatting, and language. Including images from cameras and phones is highly encouraged.

A completed lab report should respond to the following questions in the analysis of data:

1. Tabulate your mix design and refer to appendix with actual values.
2. Tabulate your compressive strength test results.
3. Draw compressive strength vs age (7, 14 and 28 days)
4. Plot the strain vs stress for the 28 days samples in compression.
5. calculate the modulus of elasticity and compare it with the theoretical one.
6. Sketch failure planes for all your tests.
7. compare the experimental tensile strength with the theoretical value.

A completed lab report should respond to the following questions in the discussion of results:

1. Comment on the observed values (slump and strengths) with respect to the design values.
2. Comment on the difference between tensile strength and compressive strength of concrete.
3. Calculate the average and standard deviation of compressive strength from all groups in your lab session and comment.
4. Compare the concrete's failure to the steel failure observed in Lab 1.
5. Explain the failure patterns observed and what they mean.
6. Explain any sources of error.