Introduction
This manual outlines the steps necessary to design, prepare and evaluate a Portland cement concrete mix.

Safety Considerations
This lab involves working with Portland cement, sand, aggregates and some admixtures. Some lifting and shoveling is required. Portland cement in both dry and wet form can be an irritant and so breathing the dust should be avoided by working in a well-ventilated area and staying out of the path of the airborne dust. It can also dry the skin so avoid touching it. The concrete mixer is powered by an electric motor, so your hands and feet must be dry if you are operating the switch. Also, be sure everyone is clear of the equipment before applying electric power.

In addition to the standard lab safety requirements, you are required to bring and wear the following safety items:
- safety glasses
- long pants
- shoes that completely cover your feet

In addition to the items above, you will be provided with a lab coat as needed for certain operations in the lab.

Two days before the lab
Collect enough coarse and fine aggregate for producing 1.2 ft³ of concrete for each lab group. Avoid collecting from segregated parts of the stockpile. Mix the stockpile as needed.

Place the aggregate (coarse in one pile, fine in another) on a plastic tarp in the concrete lab. Spread the piles so that they are less than 4 inches deep to allow air drying.

One day before the lab
Test aggregate moisture content. Collect two representative samples of the coarse aggregate (500 g each) and two representative samples of the fine aggregate (300 g each). Weigh the wet samples, then place in oven at 230°F (110°C) for 24 hours.

Concrete Mix Lab Procedure
Each lab group should follow steps below.

Verify the following equipment and materials are present:
- 3 cu ft mixer
- Press-ur-meter Air Content Tester
- Slump cone set (base, rod, cone)
- Portland cement
- Coarse aggregate, air-dried
- Fine aggregate, air-dried
- Five 5-gallon buckets
Air entrainment admixture
4000 ml graduated cylinder
50-100 ml graduated cylinder
Scoops (2)
Cylinder molds, 4 in x 8 in (9)
Shovel

Combining and Mixing

1. Remove aggregate samples from the oven. Weigh oven dried aggregate in bowl, weigh empty bowl, compute moisture content of the aggregate. Discard oven-dried aggregate in outside stockpiles.

2. Weigh out and keep separate proportions of coarse aggregate, fine aggregate, Portland cement and water as determined in the mix design phase.

3. Of the water measured, place 500 ml of it in the large graduated cylinder. This water will be held in reserve pending the results of the slump test.

4. If air entrainment is required measure the air entrainment admixture using the graduated cylinder. Mix the admixture into the pre-measured water. Use the following proportioning relation as a guide:

   \[
   \text{Add 12 cc of admixture to 1.2 ft}^3 \text{ concrete } \Rightarrow 6 \% \text{ entrained air}
   \]

5. Spray inside of the mixer with light coating of water. Dump out excess water.

6. Put all the coarse aggregate and \( \frac{1}{2} \) of the fine aggregate into the mixer, Turn the mixer ON for about 15 seconds.

7. Put about \( \frac{1}{2} \) the water into the mixer. Turn the mixer ON for about 30 seconds. Turn the mixer OFF.

8. Put about \( \frac{1}{2} \) of the Portland cement in the mixer. Cover the mixer opening with a board to keep dust from escaping. Turn the mixer ON for about 30 seconds. Turn the mixer OFF.

9. Put about \( \frac{1}{2} \) of the Portland cement in the mixer. Cover the mixer opening with a board to keep dust from escaping. Turn the mixer ON for about 30 seconds. Turn the mixer OFF.

10. Dump in the remaining sand and Portland cement. Turn the mixer ON for about 30 seconds. Turn the mixer OFF.

11. Dump in the remaining water (do NOT use the reserve water yet). Turn the mixer ON for about 3 minutes. Turn the mixer OFF.

   \text{CAUTION: Be sure the person controlling the mixer and the person working the shovel in the mixer communicate so the mixer is not started while the work is in progress.}

   Stop the mixer and use the small shovel to break up deposits of unmixed material stuck against the bottom or vanes in the mixer. Turn the mixer ON for about 1 minute to finish thoroughly mixing the concrete. Turn the mixer OFF.

Slump Test
The freshly mixed concrete will be checked for slump. Follow ASTM C-143. If the slump is more than 2 inches less than designed then put the concrete back in the mixer, add some of the reserve water, and mix for about one minute before repeating the test. If the slump is more than 2 inches greater than the design slump ask your instructor for guidance.

Air Entrainment and Unit Weight tests

Once the slump test results are acceptable, test the air content of the concrete. Follow ASTM C-231. Do NOT discard the concrete at the completion of the test yet.

After completing the air content test, remove the lid/pressure gauge assembly. Dry the exterior of the bucket of concrete and weight it. Record the weight of the bucket and concrete. Empty the bucket, dry it and weigh it. Measure the bucket volume. Compute the density of the concrete that was in the bucket.

Now discard the concrete in the outdoor scrap bin. Do NOT put the concrete back into the mixer.
Cast Test Cylinders

Using the fresh concrete, cast nine 4 in x 8 in cylinders. Follow ASTM C-31. Cover the top of the cylinders with plastic wrap and seal with masking tape. Mark each cylinder with Group number and date. Set on level surface out of traffic areas.

Clean all equipment thoroughly before the concrete sets. Dry all equipment before returning it to storage.

One Day After Mixing

Remove the concrete cylinders from their plastic molds. Be careful to avoid dropping or nicking the concrete. Using a waterproof marker, mark the top of each concrete cylinder with the group number and date the cylinder was cast. Place the concrete cylinders in the curing bath, marking side up.