LABORATORY #8
QUESTIONS

1. Calculate and report the total mass of batched ingredients (M), total absolute volume of batched ingredients (V), air-free theoretical unit weight (T), unit weight (D), yield (Y), cement content (C) and gravimetric air content (A) of your concrete per ASTM C-138.

   Remember to use the actual "water used", not the estimated "water needed" in your mass and volume calculations. You should always use a specific gravity of 3.15 for cement and 1.00 for water. For the aggregate, use the specific gravities from the lab notes. Which specific gravities? See the notes on the next page.

2. Using the required cylinder strength (f'_{cr}) from the lab notes, calculate how much force (P) will be needed to fail a 4"x8" cylinder in unconfined compression. Express your answer to 2 significant digits.

3. If we assume the tensile strength of the concrete can be estimated from the unconfined compressive strength as

   $$f_t = 6.7\sqrt{f'_{cr}}$$

   approximately how much force (P) will be needed to fail a 4"x8" concrete cylinder in a splitting tension test? Express your answer to 2 significant digits.

4. Next week, to determine the elastic modulus of this concrete, we'll slowly load a 6"x12" cylinder to a stress level of approximately 0.6 f'_{cr} while one person reads the dial gage on the compressometer and another person reads the digital readout on the concrete testing machine. At what force level should we stop the test? What will be the stress in the concrete at that point? Express your answers to 2 significant digits.

5. If we assume the elastic modulus of the concrete is given by the empirical equation

   $$E = 57{,}000\sqrt{f'_{cr}}$$

   what will be the approximate vertical <u>strain</u> in the concrete at the end of the test? What will be the vertical deformation of the cylinder (in inches) at that point? Express your answer to 2 significant digits.

6. If we want approximately 20 data points on the load-deflection curve and the dial gage on the compressometer reads deflection in increments of 0.0001 inches, how many increments should there be between data points? Express your answer as an integer (whole) number.

Calculating the Absolute Volume of Aggregate Particles

Note 2 in ASTM C-138 says that the "absolute volume of each ingredient in cubic feet is equal to … the mass of that ingredient divided by the product of its specific gravity times 62.4 … For the aggregate components, the bulk specific gravity and mass should be based on the saturated, surface-dry condition." This needs a bit of explanation.

The absolute volume of the cement is easy because we generally assume that the specific gravity is 3.15 and the cement is always batched dry. The absolute volume of the aggregate and water is a bit more difficult because it depends on whether you count the water needed to bring the aggregate to an SSD condition as part of the aggregate volume or part of the water volume.

One approach (the one in Note 2) is to divide the *SSD* mass of each aggregate by its bulk specific gravity (*SSD*) and the density of water to get its *gross* volume. Since the *gross* volume includes the volume of the water in the aggregate pores, you don't want to double count that water when you calculate the absolute volume of the water. To use this approach then, you must first calculate the mass of water absorbed by each aggregate (it's just the dry mass of the aggregate multiplied by the absorption capacity of the aggregate). Next, *add* that amount to the mass of each aggregate to get its *SSD* mass, and *subtract* that same amount from the total mass of water added to the mix to get the mass of water *outside of* the aggregate pores.

A second approach is to divide the *OD* mass of each aggregate by its bulk specific gravity (*OD*) and the density of water to get its *gross* volume (the same gross volume as above). Next, calculate the mass of water absorbed by each aggregate and subtract those masses from the mass of water added to the mix to get the mass of water *outside of* the aggregate pores.

A third approach is to divide the *OD* mass of each aggregate and by its *apparent* specific gravity and the density of water to get its *net* volume. Since this net volume does *not* include the volume of water in the aggregate pores, you do *not* need to subtract the mass of the absorbed water from the mass of water added to the mix. In effect, you are counting the pore water as part of the water volume, not part of the aggregate volume.

All three approaches will yield different water and aggregate volumes, but the sum of the water and aggregate volumes will be the same. You just want to be careful not to mix and match because you will end up either double counting the pore water or not counting it at all. That can lead to strange results, like getting a negative gravimetric air content!