Proportioning Concrete

Concrete mix designs are often given by a ratio:

- Coarse Aggregate – crushed rock
- Fine Aggregate – sand
- Cement

Usually the ratio is in terms of weight of the components.

In this case, the ratio implies 1 part (by weight) of cement to 2 parts coarse aggregate to 2 parts fine aggregate.

Part of your design for this project is to develop mix ratios that lead to high compression stresses at failure.

The two criteria for a successful mix ratio are:

1. High compressive stress
2. Adequate workability

Once a mix ratio is selected, you need to compute the amounts of cement, water, and aggregates required.

To start, we need to estimate the volume of concrete required for the job.

In your work, we used cylinder molds to form our concrete specimens.

The volume of a cylindrical mold is:

\[ V_{\text{cylinder}} = \frac{\pi h D^2}{4} \]

where \( D \) is the diameter of the cylinder and \( h \) is the height.

The cylinders for Project 2 are always 6 inches in height and 3 inches in diameter.

How much concrete do we need to make 5 cylinders?

\[ V_{\text{cylinder}} = 5 \left( \frac{\pi (6 \text{ in.}) (3 \text{ in.})^2}{4} \right) = 212 \text{ in.}^3 \]

We need 5 cylinders.

\[ V_{\text{total}} = 212 \text{ in.}^3 \]
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Next, we need to convert this volume to cubic feet and account for any errors.

\[ \text{Volume}_{\text{Total}} = 212 \text{ in.}^3 \left( \frac{1 \text{ ft.}^3}{(12 \text{ in.})^3} \right) = 212 \text{ in.}^3 \cdot \frac{1}{1,728 \text{ in.}^3} \]

\[ \text{Volume}_{\text{Total}} = 0.123 \text{ ft.}^3 \times MSYHEF \]

\[ \text{Volume}_{\text{Total}} = 0.123 \text{ ft.}^3 \times 2 = 0.25 \text{ ft.}^3 \]

Make sure you have enough factor

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Next, we need to convert this volume to an equivalent weight of concrete.

\[ \text{Weight}_{\text{concrete}} = 0.25 \text{ ft.}^3 \left( \frac{150 \text{ lb.}}{\text{ft.}^3} \right) = 37.5 \text{ lb.} \]

To compute the amount of each component required for this mix, use the ratio of each component to the sum of all components.

For a 1:2:2 mix, the weight of cement required is 1/5 of the total weight.

\[ \text{Weight}_{\text{cement}} = \left( \frac{1}{5} \right) \times 37.5 \text{ lb.} = 7.5 \text{ lb.} \]

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To compute the amount of each component required for this mix, use the ratio of each component to the sum of all components.

For a 1:2:2 mix, the weight of fine aggregate required is 2/5 of the total weight.

\[ \text{Weight}_{\text{fine aggregate}} = \left( \frac{2}{5} \right) \times 37.5 \text{ lb.} = 15 \text{ lb.} \]

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Next, we need to determine the amount of water required.

The weight of water is specified by the w/c ratio.

In this example, the w/c = 0.45.

For this mix, the weight of cement is 7.5 lb. Therefore, the weight of water required is:

\[ \text{Weight}_{\text{water}} = 7.5 \text{ lb.} (0.45) = 3.38 \text{ lb.} \]
Typical mixing procedure:
1. Clean mixer
2. Add aggregates and mix for 2 minutes
3. Add cement and mix for 2 minutes
4. Add ½ of the mixing water and mix for 2 minutes
5. Add remaining mixing water and mix for 5 minutes
(pay close attention to the concrete in the back of the mixer and make sure that all the materials are well mixed and as homogeneous as possible)

Group Problem – 1:2:2 mix with w/c = 0.4 for 5 cylinders
1. What volume of concrete do you need if your MSYHEF = 1.5
2. What is the weight of concrete for your mix?
3. What is the weight of cement?
4. What is the weight of fine aggregate?
5. What is the weight of coarse aggregate?
6. For your mix in lab, what is the weight of water?

V = 0.184 ft³
W = 27.61 lb.
WC = 5.50 lb.
WFA = 11.05 lb.
WCA = 11.05 lb.
Wwater = 2.2 lb.

The End