UNIT IV - CONCRETE

Lesson 2: Factors Affecting the Quality of Fresh Concrete

Competency/Objective: Identify factors that affect the quality of fresh concrete.

Study Questions

1. What are the raw materials of concrete?
2. What are the different mixes of concrete and their uses?
3. What are the different concrete additives and their uses?
4. What is a slump test, and why is it important?

References

1. *Agricultural Structures (Student Reference).* University of Missouri-Columbia: Instructional Materials Laboratory, 1999, Unit IV.
2. Transparency Master
   a) TM 2.1: Slump Test
3. Activity Sheet
   a) AS 2.1: Mixing Concrete

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TEACHING PROCEDURES

B. ***Review***

The agricultural industry utilizes concrete as a construction material in many different applications. As discussed in Lesson 1, being able to work with concrete safely is important because it is so common. Lesson 2 will describe important factors that influence the quality of concrete. These factors include the raw materials used, the types of mixes, concrete additives, and the importance of slump tests in pouring quality concrete.

C. ***Motivation***

1. Show students examples of concrete construction around the agriculture facility. Ask them to determine if the final product is an example of quality concrete. If the example does not appear to be of good quality, ask the students why the concrete shows faults. Then ask the students if they think different types of concrete are used for different applications.

2. Ask if any of the students have ever poured concrete. For those answering yes, ask them to list the ingredients of the concrete and to explain how they were mixed. Then ask the students what the consistency and color of the concrete mixture resembled.

D. ***Assignment***

E. ***Supervised Study***

F. ***Discussion***

1. For the finished concrete to have the proper strength and finish, the correct ingredients must be mixed together. Ask students what materials are found in a concrete mix. List the ingredients on the board or a transparency. What does each ingredient add to the mixture?

What are the raw materials of concrete?

a) Aggregates (sand and gravel)
    1) Makes up 60 to 80 percent of the volume of the concrete mixture
    2) Classified into two main categories
        (a) Fine aggregates are those particles that are smaller than a quarter inch in size.

(1) Typically called sand
(2) Should be clean and relatively dry

(b) Coarse aggregates are particles larger than one quarter inch in size.
(1) Called gravel
(2) Should be clean and uniform in size

3) Functions of aggregates
(a) They provide a cheap filler material.
(b) They are stable materials that resist forces on the concrete.
(c) They help to maintain the volume of concrete while it sets and hardens.

4) Can use other compounds for specialty applications
(a) Vermiculite and pearlite are used in lightweight concrete that can be sawed.
(b) Clay, shale, and crushed brick act as insulation.
(c) Steel or iron shot may be used for high density concrete for radiation shielding, as in a nuclear reactor or in the walls surrounding an x-ray laboratory.

b) Water
1) Purposes
(a) Water allows the concrete to be molded or shaped.
(b) It aids in mixing.
(c) Water plays an important role in hydration, the chemical reaction between water and cement that bonds the mixture together.

2) Should be clean
(a) Water generally can be used if it is potable, or drinkable.
(b) It should have less than 2,000 ppm of total dissolved solids.

3) Abram's Law
(a) This rule describes the relationship between water and concrete.
(b) "For given materials and conditions of handling, the strength of concrete is determined primarily by the ratio of the weight of mixing water to the weight of cement as long as the mixture is plastic and workable."
(c) Less water is generally better in mixing concrete, as long as the mixture is workable.

c) Cement
1) With water, forms the glue that holds concrete together
2) Portland cement - most common cement used today; first patented in 1824 by Joseph Aspdin
3) Steps in manufacturing portland cement
(a) Limestone, the base material, is taken from a quarry and crushed into a fine powder.
(b) The powdered limestone is then mixed with clay or shale and ground again.
(c) This mixture is then sent to a kiln to dry; the dried product is clinker.

(d) Gypsum is then added, and the mixture is ground a final time to form portland cement.

4) Five types of portland cement
   (a) Type I is for normal applications.
   (b) Type II is used where heat buildup is a concern.
   (c) Type III, or high early strength cement, is used where the concrete needs strength in the first two to three days after pouring.
   (d) Type IV, or low heat cement, reduces the heat generated by hydration.
   (e) Type V, sulfate resistant cement, is poured over alkaline soils.

5) Regulated by two agencies that determine the requirements for the different categories of portland cement and work to maintain concrete quality
   (a) American Society for Testing and Materials (ASTM)
   (b) Canadian Standards Association (CSA)

d) Air
   1) Air entraining - trapping small pockets of air in the concrete
   2) Benefits of air entraining
      (a) Air-entraining improves concrete's workability.
      (b) It improves watertightness.
      (c) It improves finish qualities.
      (d) It increases the concrete's resistance to freezing and thawing.
      (e) It increases concrete's resistance to salt and sulfates.

2. Just as concrete has many applications, it may consist of many different mixes. What is being built affects the mixture of ingredients in the concrete. Discuss the different mixes. Have students complete AS 2.1.

NOTE: Several weights are important when calculating a concrete mixture. A review of common weight conversions may be helpful to fully understand the calculations needed for the mixture.

What are the different mixes of concrete and their uses?

a) The first method of describing concrete mixes refers to the number of bags of cement in each yard of concrete, which is equal to 27 cubic feet of volume.
   1) Ready-mix concrete ordered through a supplier is usually ordered using this method.
   2) Three common ready mixes are used.
      (a) Five bags of cement/yard; used for foundation walls and footings
      (b) Six bags of cement/yard; used for house floors, dairy floors, driveways, and septic tanks
      (c) Seven bags of cement/yard; used for concrete under severe conditions and concrete exposed to acids or severe weather

b) A second method of referring to concrete mixes uses a ratio that shows the relative amounts of the different components of the concrete.

1) A common mixture is 1:2:3:6, which is one part cement, two parts sand, three parts gravel, and six parts water.
2) Each part consists of a particular volume, such as one cubic foot.

c) The third method used to describe concrete mixes indicates the gallons of water mixed with each sack of cement.
   1) Common mixes described in this manner are 5.0, 6.0, and 7.0, which correspond in their uses to the various ready-mixes already discussed.
      (a) Five gallons of water/sack of cement; used for concrete under severe conditions and concrete exposed to acids or severe weather
      (b) Six gallons of water/sack of cement; used for house floors, dairy floors, driveways, and septic tanks
      (c) Seven gallons of water/sack of cement; used for foundation walls and footings
   2) To learn the amounts of other components needed to make the cement, specific charts must be consulted to find the volume of each ingredient in a cubic yard.

3. For many applications and instances, changing the concrete that is poured or being able to pour concrete in less than ideal circumstances is desirable. Various additives can be used to change the properties of the concrete. List the different additives.

What are the different concrete additives and their uses?

a) Also called admixtures
b) Seven main categories
   1) Air entraining
      (a) Force small air pockets in the concrete
      (b) Air entraining - process of trapping air in the concrete
      (c) Improves workability, watertightness, and finish
      (d) Increases resistance to freezing and thawing
      (e) Increases resistance to salt and sulfates
   2) Superplasticizers - increase the strength of the concrete by altering it to need less water to be workable
   3) Retarding
      (a) Slow down the setting process
      (b) Result in greater long-term strength
   4) Accelerating
      (a) Speed up setting
      (b) Result in more early strength
      (c) Makes the concrete less vulnerable to temperature changes during setting
      (d) Frequently used in cold weather to force the concrete to set more quickly
      (e) Common additive - calcium chloride
   5) Mineral - increase strength
   6) Fibers

(a) Reduce the tendency of the concrete to break along seams or at the edges
(b) Helps to bind the concrete together.

7) Pigment
(a) Change the color of the concrete
(b) May be added to the whole batch of concrete or only to the final layer

4. Mixing concrete does not involve following a cookbook recipe, since some of the materials may already contain a certain moisture content, especially the sand. Ask students how they would determine whether the concrete has the proper consistency. Describe how to perform a slump test. Show the students TM 2.1.

What is a slump test, and why is it important?

a) Determines if the concrete is of the proper consistency
b) Indicates if more or less moisture is needed
c) Makes it possible to prepare a concrete mixture with the optimal combination of strength and workability
d) Procedure
1) The slump test involves the use of a metal cone that is 12 inches tall, with a diameter of 4 inches at the top and 8 inches at the bottom, and open at both ends.
2) The cone is placed on a flat surface with the wide end down.
3) Prior to being filled with concrete, the cone may be moistened with oil to make cleanup easier.
4) The cone is filled one-third full with concrete.
5) The concrete is tamped down with a 12-inch metal rod 25 times to make it settle and remove any air pockets.
6) Concrete is added until the cone is two-thirds full, and the concrete is tamped again.
7) The cone is filled, and the concrete is tamped for the third time.
8) The cone is carefully removed, and the concrete "slumps," or drops in height due to gravity.
9) A straight edge is placed across the top of the cone, and a measurement is taken from the straight edge down to the average level of the top of the concrete.
10) In most instances, the slump should be between 1 and 3 inches.
11) Too much slump indicates too much water, while not enough slump indicates a lack of water.
12) If too much water is present, adding aggregates or cement will thicken the mixture.
(a) Adding ingredients should be the last resort in mixing concrete because it will result in weaker concrete.
(b) Most state or federal construction contracts prohibit adding ingredients after the initial mix.

G. ***Other Activities***

1. Using concrete mixing charts, prepare several trial mixtures and perform slump tests.

2. Visit the local ready-mix concrete plant to observe the mixing of different types of concrete.

H. ***Conclusion***

Concrete has many applications. How concrete is mixed depends upon the final use of the concrete. Good concrete does not result from a random mixing of ingredients. It involves using the right raw materials in the proper proportions and any necessary additives to get the desired quality of concrete.

I. ***Answers to Activity Sheet***

AS 2.1

1. 545 lbs./yd. × 11.74 yds. = 6,398 pounds
2. 1,140 lbs./yd. × 11.74 yds. = 13,384 pounds
3. 1,800 lbs./yd. × 11.74 yds. = 21,132 pounds
4. 300 lbs./yd. × 11.74 yds. = 3,522 pounds
5. 3,522 lbs. ÷ 8.3 lbs./gal. = 424 gallons

J. ***Answers to Evaluation***

1. a
2. d
3. a
4. c
5. b

6. 1 part cement, 2 parts sand, 3 parts gravel, 6 parts water

7. Aggregates, cement, water

8. To determine if the concrete is of the proper consistency and indicate if more or less moisture is needed

9. Calcium chloride

10. Answers may include any four of the following: air entraining additives, superplasticizers, retarding additives, accelerating additives, mineral additives, fibers, and pigments.

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EVALUATION

Circle the letter that corresponds to the best answer.

1. The type of portland cement that should be used for normal applications is:

   a. Type I.
   b. Type II.
   c. Type III.
   d. Type IV.

2. Aggregates compose _____ percent of the total volume of concrete.

   a. 10 to 30
   b. 20 to 40
   c. 40 to 60
   d. 60 to 80

3. In making portland cement, what is the name of the mixture before the gypsum is added?

   a. Clinker
   b. Paste
   c. Concrete
   d. Masonry

4. Air entraining improves concrete's:

   a. Color.
   b. Texture.
   c. Workability.
   d. Flexibility.

5. An acceptable slump on general use concrete would be _____ inches.

   a. 0
   b. 1-3
   c. 3-5
   d. 5-7

Complete the following short answer questions.

6. What do the numbers mean in a 1:2:3-6 concrete mixture?

7. What are the three main ingredients used in concrete?

   a.

   b.

   c.

8. Why is it necessary to perform a slump test?

9. What additive is commonly used to allow concrete to be poured in cold weather?

10. What are four of the common types of concrete additives, or admixtures?

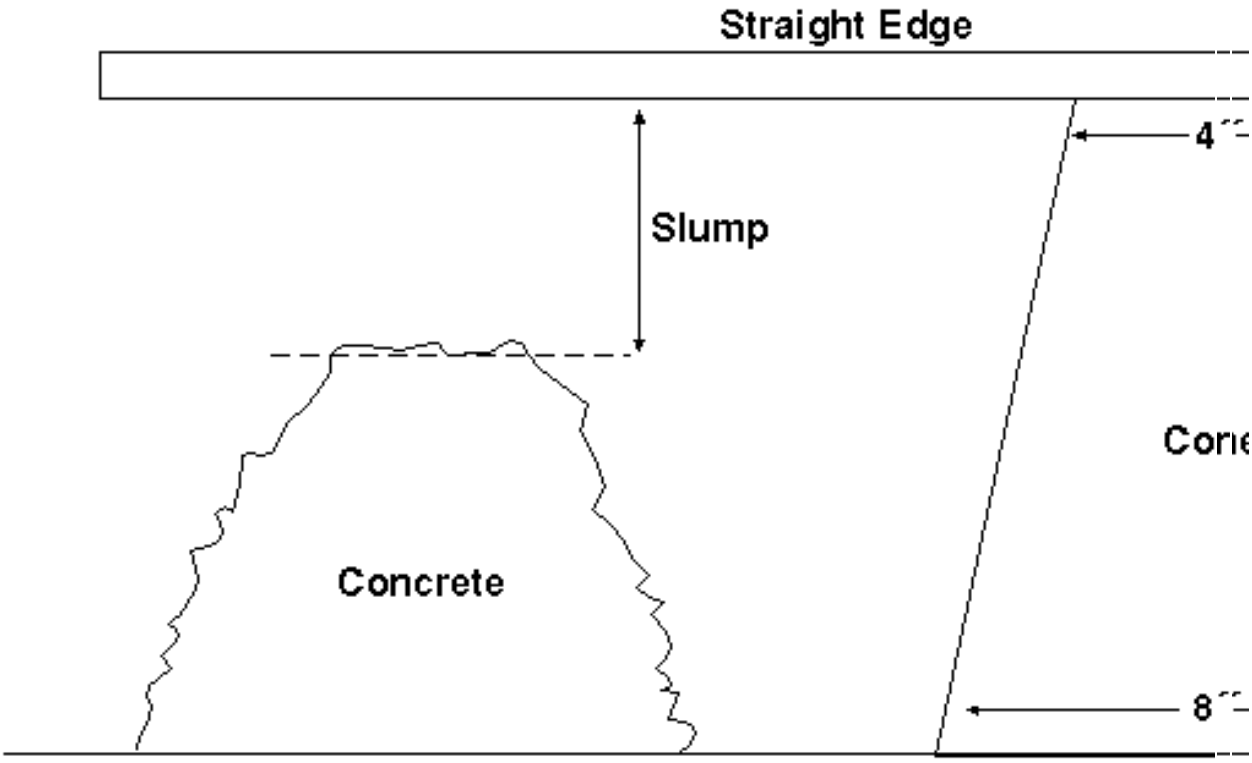
    a.

    b.

    c.

    d.

TM 2.1


Straight Edge
Slump
Concrete

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Mixing Concrete

Objective: Calculate the volume of ingredients required for a specific concrete job.

Perform the necessary calculations to figure out the volume of the raw materials needed for the concrete slab described in the problem.

Assume you are going to pour a slab that will require 11.74 cubic yards of concrete. The concrete will include ¾" aggregate, fine dry sand, and air-entrained cement. You will use a mixture of .55 gallons of water per pound. Looking at a chart, you discover that you need:

Pounds of cement per cubic yard	545
Pounds of sand per cubic yard	1,140
Pounds of gravel per cubic yard	1,800
Pounds of water per cubic yard	300

Figure the total amount of materials needed for the concrete slab. (Round to the nearest pound or gallon.)

1. Total pounds of cement _____

2. Total pounds of sand _____

3. Total pounds of gravel _____

4. Total pounds of water _____

5. Gallons of water (8.3 lbs./gal.) _____