

# Lesson 5 – Making Concrete & Safety Instructions

## 1. Background Narrative

Engineers often need to measure material properties to help evaluate different alternatives. We have defined some alternative waste materials that may be suitable as aggregates in concrete; we now need to choose which ones we will use. Experimental measurement of the strength of concrete samples, prepared with the different waste aggregates, will help us to decide which materials are best. When we perform experiments to provide quantitative data for engineering design, we don't have to form a hypothesis as in science experiments. Experimentation for engineering requires us to:

1. Determine what measurement we need to make and how we will make these measurements to provide the data we need for engineering decisions.
2. Define a matrix of experiments that includes all of the variables we want to test.
3. Perform the experiments to gather raw data.
4. Perform calculations and present data – often in a graphical fashion – to illustrate our findings.
5. Use the findings to help us make an engineering decision or design calculation.

In our case, we want to make measurements to determine the compressive strength of concrete made with various waste materials as aggregates. We must first make concrete samples with different aggregates so that we can test their strength when they have cured. We will need a matrix of aggregate mixtures so that we know we've tested all of the appropriate mixes.

Before the students make cylinders they should undergo a safety lesson and they should take the safety quiz. Safe work practices during experimentation protect yourself and others around you. By following the practices outlined in the handout, you make work more enjoyable and save yourself the aggravation of an injury and possible loss of work time. Employers look for workers who practice safe work habits.

### Major Concepts:

Basics of Concrete Mixing

Measuring of Ingredients

Waste Material Reuse

Tools

Safety

### Vocabulary Terms:

Cement  
Concrete  
Mortar  
Portland  
Caustic

## 2. Performance objectives

- Students will demonstrate safe work practices while working with cement.
- Students will be able to answer a safety exam to a 100% accuracy level before working with concrete.
- Students will continue to formulate ideas on how to incorporate waste in the making of a valuable construction product such as concrete.
- Students will be able to use a variety of hand tools and machines to mix and pour concrete into cylinder molds.

## 3. Standards (days 5, 8 and 9 combined):

- NYS Integrated: 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 4.5 5.2, 6.6, 7.1, 7.2
- US Math: 4.1, 4.2, 5.1, 5.2, 5.3
- US Technology: 2.2, 3.3
- US Science: 1.1, 1.2, 2.2

## 4. Resources

- Teacher resource: [“Teachers guide – concrete products”](#)
- Concrete Safety information sheet and quiz
- Concrete recipe worksheets
- Safety glasses, gloves
- 1 small cylinder mold per pair of students
- cooking oil – spray or bottled
- 1 Bucket per pair of Students
- 1 Spade per pair of Students
- 1 Measuring cup per pair of Students, or have several at each station
- 1 Rod per 2 pairs of Students
- Saran Wrap
- 2 Magic Markers
- 1 drop per pair of students of air entrainment solution
- Cement (5 cups per pair of students – amount depends on recipe)
- Water
- *Many different samples of waste materials in large quantities to test as aggregates! – need about 1 cup of each, encourage students to bring in from home*
- Coarse Aggregate, examples....
  - a. Shredded Rubber

- b. Shredded PVC – *note, this needs to be snipped into short (1-2 cm) pieces. This can be done ahead of time or have students do the day of mixing.*
  - c. Broken Glass
  - d. Gypsum
  - e. Glass marbles
  - f. Shredded plastic milk jugs
  - g. Shredded aluminum foil
  - h. Wood Chips
  - i. Paper
  - j. Pea Stone
- Fine Aggregates, examples...
    - k. Recycled Plastic
    - l. White Glass powder
    - m. Green beaded Glass
    - n. Wood stove ash
    - o. Saw dust
    - p. Waste Sand
    - q. Regular Sand

## 5. Vocabulary

<b>cement</b>	<b>mortar</b>
<b>concrete</b>	<b>caustic</b>
<b>Portland</b>	

## 6. Instructional Plan

### 1. Introduction – (5 minutes)

Briefly review the aggregates that we looked at yesterday. What step was that in the problem solving method? (Think of alternative solutions). What is the next step in the problem solving method? (Choose the best solution). But how do we make that choice? We need some more information first.

### 2. Concrete Types (10 minutes)

There are three types of concrete that we will be learning about that our concrete company produces. These are traditional concrete, porous concrete, and recycled aggregate concrete. Write all three types of concrete on the board, and put descriptions below them. Have the students write these in the worksheet provided. Make sure to mention they should take notes.

What do you think traditional concrete is? This is the concrete that is used most often in construction. Concrete is a strong building material that has been used as far back as Egyptian

times and even before that. Traditional concrete is made from conventional aggregates like sand, gravel, and stone.

Can anyone tell me what pervious concrete is? Some other words meaning pervious are porous or permeable. Porous concrete is a type of concrete that is designed so that water can pass through it. There are pathways through the concrete that allow the water to travel to the ground below the concrete. Does anyone know why this may be a good thing? It makes less runoff during rainstorms. This means that the water that falls in one place doesn't just runoff and travel to another place. Water is better distributed, and there is less flooding in the area.

What else might pass through the concrete with the water? Pollutants, such as car products like oil, antifreeze, and gasoline. What do you think about this? Is this a good thing or a bad thing? It is actually good that these substances pass through the concrete. The material below the concrete filters the water and allows for the breakup of the substances before they are carried away into nearby waterways.

Does anyone know what recycled aggregate concrete is? We know that an aggregate is one of the ingredients of concrete. This means that some of the ingredients that go into the concrete are recycled solid waste. Some examples of solid wastes that can be used are shaved plastic, powdered glass, used sand, and other materials. Why might it be good to use solid waste in concrete? What could be some of the benefits of this? Using materials that don't have another use is cost effective. Also, using materials that don't have another use is good for the environment because these materials won't end up in a landfill.

### **3. Activity: (5-7 minutes)**

Now, take out the sheets from last time's activity. We're going to use what we've learned today to determine what type of concrete each of your cylinders was.

Break into the same groups that you were in last time. Take a couple of minutes with your group to look at the descriptions you gave for each cylinder and use the notes you took today to classify them as one of each type of concrete.

We need to gather more data. How can we gather more data about our aggregates? Today we will make some test samples to see how the aggregates work. Does anyone know why we might do this? Test if the mix holds together. But – what is an important property of concrete? Strength! So we will make small concrete test samples for testing the strength of the different mixes. “We have a lot to do today, so let's get right to work!”

#### **4. Safety Instruction**

Before we can work with concrete, we need to learn some safe practices. Display a list of safety practices to the class and go over the guidelines. Remove the safety guidelines and have a short discussion of the rules and their importance. Hand out a short quiz assessing the retention of the safety practices. Allow the students to complete the short exam. When all the students are done have the students correct the papers (go over as a group). Any students with an incorrect answer will have a short recap with the instructor and then be asked the question until they answer correct.

#### **5. Explain Making Concrete (10 minutes)**

Before beginning the activity, make sure you go over everything while the students are still in their seats. Have the recipes already written on the board, with numbers (students will write the recipe number on their cylinder, along with their names).

Tell the students they'll be working in pairs. Each pair will be assigned a recipe number (have students number off 1-2-1-2, then just assign recipes when ready). Tell the students that each pair will get a recipe worksheet and a cylinder - students should not leave the room until they have written down their recipe and number on their worksheet (along with their name and their partner's name), and have labeled their cylinder (use a sharpie) with the recipe number and their names or initials. Also, they should make sure that their cylinder has tape on the bottom over the hole, and is not cracked or broken.

Distribute dust masks, gloves and safety glasses to students. Have students write their names on their dust mask, tell them they have to save them to use again the next time we mix concrete. Tell the students – when they begin, students should bring their recipe and their cylinder to the work area. Each pair of students should go to the first station and get a bucket and a trowel. Also at this station they should spray the inside of their cylinder with cooking spray. Then they should get all of their dry ingredients, by rotating to the different stations – they will need cement, coarse aggregate, and fine aggregate, or if porous just coarse aggregate.

Students will all put cement and aggregates into the bucket and will mix it well before adding water. Students should get help adding water, to make sure they don't add too much at one time. Once the water is added the students should continue to mix until it is well mixed and ready to pour into the cylinders.

Once their concrete is completely mixed, they need to get an OK from the teacher, and then they can fill their cylinder mold. *[students may need a demonstration on the tamping part]* They will pour the concrete into the cylinders in two stages. This means that a student will fill his/her cylinder a half of the way and then will tamp the cement to uniformly mix it in the cylinder. NOTE: Students should not stir they should simple thrust up and down through the concrete mix.

Then the student should add more of the mix until it reaches to the top of the cylinder and should tamp it again. Then students should repeat for the remaining cylinder: topping it off, tamping it, then smoothing off the top, then sealing it with the top so it will cure properly.

When they are done, students should bring their cylinder molds to the designated area. The bucket and trowel need to be rinsed out in the water buckets provided, or if weather permits, outside at the hose (no concrete down the drains!) Students should write any notes about their concrete mix on the recipe worksheets, and then pass them in.

**6. Closure:**

Explain that the cylinders will cure, and then the different mixtures will be tested for compressive strength. Ask the students how they think we can test these cylinders for compressive strength, and ask them what strengths they think we will get.

**7. Clean Up : NO CONCRETE DOWN THE DRAINS!!**

**NOTE: Allow ample amount of time for curing, at least 5 days!**

Table 1: Recipes for concrete – enough for 1 cylinder, 2” diameter x 4” high

**(see teacher notes for additional recipes)**

Cylinder #	Coarse aggregate		Fine Aggregate		Cement
	Type	amount (8 oz. cups)	Type	amount (8 oz. cups)	amount (8 oz. cups)
1	Woodchips	1	Sand	0.75	0.75
2	Paper	1	Sand	0.75	0.75
3	PVC	1	Sand	0.75	0.75
4	Rubber	0.75	Sand	0.75	0.75
5	Stone	0.75	Recycled Plastic	0.75	0.75
6	Stone	0.75	Waste Sand	0.75	0.75
7	Stone	0.75	Green Glass	0.75	0.75
8	Stone	0.75	White Glass	0.75	0.75
9	Stone	0.75	Sand	0.75	0.75

## Making Concrete Test Cylinders

Names: \_\_\_\_\_

Cylinder #: \_\_\_\_\_

<b>Ingredient</b>	<b>Amount added*</b>	<b>Type</b>
Coarse aggregate		
Fine Aggregate		
Cement	$\frac{3}{4}$ cup	
Water		

\* as measured with an 8 oz. cup

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Water		

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## Concrete Safety

Name : \_\_\_\_\_

Date: \_\_\_\_\_

Teacher: \_\_\_\_\_

Period: \_\_\_\_\_

Directions: Circle the letter in front of the best possible answer.

1. Wet concrete is:
  - a. Caustic
  - b. Mild
  - c. Hot
  - d. Smooth
  
2. Prolonged contact with wet concrete can cause:
  - a. Skin irritation
  - b. Eye injury
  - c. Severe chemical burns
  - d. All of the above
  
3. When working with concrete you should wear:
  - a. Safety glasses
  - b. Long sleeves
  - c. Water proof gloves
  - d. Long trousers
  - e. All of the above

True/false: Read each of the statements below and write a T in the space provided if the statement is true, and a F in the space provided if the statement is false.

4. \_\_\_ You should wear waterproof boots if standing on wet concrete.
5. \_\_\_ It is not harmful to breath in concrete dust.
6. \_\_\_ It is alright to leave wet concrete on clothing.
7. \_\_\_ Tight fitting glasses should be worn at all times during concrete work.
8. \_\_\_ Slight discomfort or skin irritation is not a reason to wash you hands.
9. \_\_\_ Caustic means that a chemical will burn the skin and eyes.
10. \_\_\_ A respirator filters air entering your lungs.

## **Working Safely With Concrete/Mortars**

Special precautions are necessary when working with concrete, mortars or cement. Prolonged contact between fresh, wet cement-based products can cause skin irritation and burns. These products are highly caustic and may result in skin injury if used improperly.

*Please be aware of the following information from the U.S. Consumer Products Safety Commission and take the recommended safety precautions and suggestions.*

***WARNING: INJURIOUS TO EYES  
CAUSES SKIN IRRITATION  
READ THIS WARNING BEFORE USING***

***Contains Portland Cement***

- Contact with wet (unhardened) concrete, mortar, cement or cement mixtures can cause skin irritation, severe chemical burns, or serious eye injury.
- Avoid contact with eyes and skin.
- Wear waterproof gloves, a fully buttoned long-sleeved shirt, full-length trousers, and tight-fitting eye protection when working with these materials.
- If you have to stand in wet concrete, use waterproof boots that are tight at tops and high enough to keep concrete from flowing into them. If you are finishing concrete, wear knee pads to protect knees.
- Wash wet concrete, mortar, cement, or cement mixtures from your skin with fresh, clean water immediately after contact. Indirect contact through clothing can be as serious as direct contact, so promptly rinse out wet concrete, mortar, cement or cement mixtures from clothing.
  - Seek immediate medical attention if you have persistent or severe discomfort. In case of eye contact, flush with plenty of water for at least 15 minutes. Consult a physician immediately.
  - Wear a well made respirator while handling dry cement dust. Do not breath in air-born cement dust or other fine particles.

***KEEP OUT OF REACH OF CHILDREN***