Lesson 3 – Concrete Research

1. Background Narrative

Working in groups, students will research concrete topics on the internet, and then share the information they have gathered on their group's concrete topic with the entire class. By the end of the lesson students should have a solid grasp of the information covered in each concrete research topic. This will give students a basic understanding about some of the physical properties and how concrete is made and tested,

Note: If you need to make some groups larger than others, make groups 1 and 2 larger, there is more information in their topics.

This information sharing can be done quickly by having students just report their answers while other students fill in their worksheets. If an assessment is desired, groups could prepare overhead transparencies or PowerPoint slides of the answers to their sections and present to the class. If this is done, students should get a copy of the grading rubric that will be used so they know what is required.

2. Performance Objectives

- Students will be able to determine what information is relevant and necessary to understand in order to solve our problem.
- Students will be able to apply the new knowledge to the process and problem.

3. Standards:

- NYS Integrated 2.1, 2.2, 5.3, 5.5
- US Science: 2.3
- US Technology: 1.3, 3.2, 4.1, 5.4

4. Resources

- Key Concept Worksheet
- Student Research Worksheets, along with the answer key
- Computers and Internet access
- Blank overhead transparencies or PowerPoint access

5. Vocabulary:

hydration	**Compression strength**
curing	**Pounds Per Square Inch (PSI)**

Concrete – A heterogeneous mixture of cement, water, and aggregate.

Cement – The "glue" that holds the concrete together.

Fine Aggregate - Generally consist of natural sand or crushed stone with most particles ranging in size from 0.025 to 6.5 mm.

Course Aggregate - Any particles greater than 4.75 mm, but generally range between from 6.5 to 38 mm in diameter.

6. Instruction Plan

Introduction: (5 minutes)

Since maximizing discussion time is important for this lesson the introduction should be kept short. Simply recap what you told the students last lesson about what they are to do today. Explain that we will go through the work sheet in its entirety and the group that researched a given topic will be responsible for explaining the answers to those questions to the class (either just saying the answers or – preferably – standing in front and presenting the answers on an overhead), while the rest of the class writes down the answers on their own work sheet packets. Also explain that students will be given a grade based on student participation in class discussion, and correctness and completeness of group answers. (provide rubric if used) ***Remind students that they will be tested on this material at the end of the unit, so they need to record the answers!***

Computer time: (15-20 minutes)

Allow the students approximately 15 minutes on the computers to finish up any loose ends, and to give those students who could not obtain Internet access outside of the classroom a chance to participate. Students who finished the questions in their section are encouraged to "surf the web" to find information on other sites.

Discussion: (10 - 15 minutes)

Following this work period, instructors should facilitate discussion by reviewing the questions on the research worksheet and writing the correct answers on the blackboard or overhead. Having students write their answers on the overhead, or letting each group make a short presentation with their information takes longer, but is a good way to keep them engaged. Throughout discussion, keep students focused on relevant material. As each question is addressed, ask a different member of the designated group to provide an answer to assure all members have equally participated and are familiar with the content. If there are more students than questions in a group, ask for alternate responses and compromise on the answer.

Hand out key concept worksheet. If time permits go over the key concepts worksheet with the students and ask if there are any questions about it. Tell students to save these! Inform them that there will be a test at the end of this unit over this material!

Closure:

Review what the students learned through questioning. Focus on what they now know about the ingredients in concrete (cement, water, sand and gravel – cement and water critical for making "concrete," sand and gravel really just fillers to reduce the cost - cheaper than cement). They've used the web as an information resource . Was it effective? Was it efficient (quick)?
Tomorrow we will learn more about aggregates and how we can use waste materials as aggregates.

Concrete Research
Key Concepts

Name _____ Date _____

Clarkson Partnership

Key Concepts:

- The ratio of water to cement in most concrete mixtures is about **0.5:1** by weight. For example, if you used 2 pounds of cement in your concrete you would need to add 1 pound of water to your mixture.

- In most concrete mixtures sand is used as a fine aggregate and pea stone is used as a course aggregate.

- During the curing process concrete gains most of its strength. Concrete hardens due to hydration. Hydration only occurs if there is enough water to react with the cement. For this reason concrete needs to be kept wet during curing, by frequent watering and covering with wet cloth or plastic to hold in moisture.

- Concrete is usually tested after 7 or 28 days of curing. By the 28th day the concrete has gained most of its strength. Concrete's strength is most commonly tested by compression, and measured in PSI.

Concrete Vocabulary:

- **Concrete** – A heterogeneous mixture of cement, water, and aggregate.

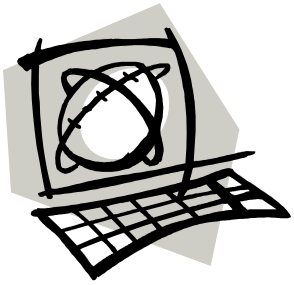
    1. **Cement** – The “glue” that holds the concrete together.
    2. **Fine Aggregate** - Generally consist of natural sand or crushed stone with most particles ranging in size from 0.025 to 6.5 mm.
    3. **Course Aggregate** - Any particles greater than 4.75 mm, but generally range between from 6.5 to 38 mm in diameter.
    4. **Water –** Reacts with the cement to start the hardening process of the mixture.

- **Hydration** – The hardening of concrete through a chemical reaction of cement with water.

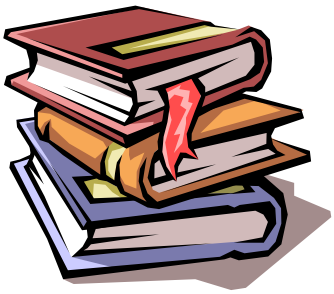
- **Curing** – The chemical process required for the hydration of cement. This process takes a period of time, which is referred to as “curing”.

- **Compressive strength** - Is tested by pouring cylinders of fresh concrete and measuring the force needed to break the concrete cylinders by applying compression at proscribed intervals as they harden.

- **Pounds Per Square Inch (PSI)** – The unit used to measure the compressive strength of concrete.



Concrete Web Research



Look through this website to help you answer the questions below:
{See the list of sites at the end of this document and give each group the relevant site.}
[We created a webpage that has all the web links to the concrete sites - to eliminate the need for students needing to type the url addresses – saves lots of time!]
If your group finishes your section try the extra credit or find the answers to some of the other questions. Also feel free to help other groups out that are having trouble finding answers to their questions.

Group 1. Cement and Concrete

What is the difference between concrete and cement?

What is the name of the chemical reaction that takes place in concrete?

What are the two ingredients that take part in this reaction?

There is more than one type of cement, list the name and type of the most common form used for general purposes.

Group 2. Concrete Mixture

What four ingredients do you mix together to make concrete?

Approximately what percentage of concrete's volume is made up of coarse aggregates, fine aggregates, and cement?

What is the best water-to-cement ratio to use to make strong concrete?

Explain the "Rule of 6's" for mixing concrete:

Group 3. Aggregates

What are the approximate sizes of coarse and fine aggregates (in mm)?

Give an example of each type of aggregate:

What happens to concrete if the aggregates are not clean?

What percentage of the concrete's volume is taken up by the aggregates?

Group 4: Curing

What is curing?

What temperature range is ideal for curing?

What chemical reaction happens during curing?

Will concrete cure underwater? Why or why not?

Group 5: Testing

What is 28-day strength?

How long does it take for concrete to reach its greatest strength?

What unit of measure is used to describe concrete's strength?

What would be a good strength for concrete?

What test do we usually perform to test concrete's strength?

<u>Extra Credit</u>

Search for "recycled waste materials in concrete." Can you name 2 waste materials that people have used to make concrete?

Describe 2 benefits of using waste materials instead of sand and gravel in concrete.

Concrete Web Research

List of Websites (2004):

http://www.cement.org/basics/
http://www.ecosmart.ca/facts/what.asp
http://www.wrmca.com/
http://dept.physics.upenn.edu/courses/gladney/mathphys/subsubsection1_1_3_1.html
http://va.essortment.com/mixingconcrete_rupc.htm
http://doityourself.com/concrete/cement_water_ratio.htm
http://www.clovisusd.k12.ca.us/rec/classofmatter.htm

For the instructor:

Note: before doing this activity, check the websites to see that they are still current!

Categories – Topics covered:

Cement- types (I-V), difference from concrete, reaction with water (hydration)
http://www.ecosmart.ca/facts/what.asp

Aggregate- Fine, course
http://www.cement.org/basics/concretebasics_aggregate.asp

Curing- how, length of time, temperature, under water?
http://www.cement.org/basics/concretebasics_curing.asp
http://www.cement.org/basics/concretebasics_faqs.asp

Mix – What recipe, Method of 6, 1:3:4, homogeneous mixture
http://va.essortment.com/mixingconcrete_rupc.htm
http://www.cement.org/basics/concretebasics_concretebasics.asp
http://www.cement.org/basics/
http://doityourself.com/concrete/cement_water_ratio.htm
http://dept.physics.upenn.edu/courses/gladney/mathphys/subsubsection1_1_3_1.html
http://www.clovisusd.k12.ca.us/rec/classofmatter.htm

Testing – Compression, Normal PSI strength
http://www.cement.org/basics/

Weathering- Hot & Cold, deicers, Air Entrained
http://www.wrmca.com/

Note: If you need to make some groups larger than others, make groups 1 and 2 larger, there is more information in their topics.

Concrete Web Research KEY

Group 1. Cement and Concrete

What is the difference between concrete and cement?
"*Cement* is the glue that holds *concrete* together." Although the terms cement and concrete often are used interchangeably, cement is actually an ingredient of concrete. Concrete is basically a mixture of aggregates and paste. The aggregates are sand and gravel or crushed stone; the paste is water and portland cement.

What is the name of the chemical reaction that takes place in concrete?

Hydration is the chemical reaction that occurs in concrete.

What are the two ingredients that take part in this reaction?
Cement
Water

There is more than one type of cement, list the name and type of the most common form used for general purposes.

Type I is a general purpose portland cement suitable for most uses

Group 2. Concrete Mixture
What four ingredients do you mix together to make concrete?

Cement
Coarse aggregate
Fine aggregate
Water

Approximately what percentage of concrete's volume is made up of coarse aggregates, fine aggregates, and cement?
11% Cement
41% Coarse Aggregates
26% Fine Aggregates
What is the best water-to-cement ratio to use to make strong concrete?
About 0.5:1 by weight

Explain the "Rule of 6's" for mixing concrete:

A minimum cement content of 6 bags per cubic yard of concrete,

A maximum water content of 6 gallons per bag of cement,
A curing period (keeping concrete moist) a minimum of 6 days, and
An air content of 6 percent (if concrete will be subject to freezing and thawing).

3. Aggregates
What are the approximate sizes of coarse and fine aggregates (in mm)?

Coarse *(4.75 mm, but generally range between from 6.5 to 38 mm in diameter)*
Fine *(most particles ranging in size from 0.025 to 6.5 mm)*

Give an example of each type of aggregate:

Coarse: Pea Stone, crushed rock, gravel
Fine: Sand

What happens to concrete if the aggregates are not clean?

For a good concrete mix, aggregates need to be clean, hard, strong particles free of absorbed chemicals or coatings of clay and other fine materials that could cause the deterioration of concrete.

What percentage of the concrete's volume is taken up by the aggregates?
Aggregates account for 60 to 75 percent of the total volume of concrete.

4: Curing
What is curing?
Curing is the period of time that the concrete is left to harden.

What temperature range is ideal for curing?
After concrete is placed, a satisfactory moisture content and temperature (between 50°F and 75°F) must be maintained.

What chemical reaction happens during curing?

Hydration is the chemical reaction that occurs during curing.

Will concrete cure underwater? Why or why not?
Yes, concrete will cure underwater. Portland cement is a hydraulic cement which means that it sets and hardens due to a chemical reaction with water. Consequently, it will harden under water.

5: Testing
What is 28-day strength?

The time period of 28 days was selected by specification writing authorities as the age that all concrete should be tested. At this age, a substantial percentage of the hydration has taken place.

What unit of measure is used to describe concrete's strength?

Concrete's strength is measured in pounds per square inch (PSI).

How long does it take for concrete to reach its greatest strength?
Concrete will reach its ultimate strength after several years.

What would be a good strength for concrete?

3,000 – 4,000 PSI is a good strength for concrete.

What test do we usually perform to test concrete's strength?

Compressive tests are typically preformed to test concrete's strength.

Grading Rubric: Internet Research Activity and Presentation				
Outcome	**Distinguished**	**Proficient**	**Apprentice**	**Novice**
Category	**4 Points**	**3 Points**	**2 Points**	**1 Point**
Content	Thoroughly and clearly states the main points and precise details that are accurately focused on the internet research activity.	Adequately states the main points and details that are accurately focused on the internet research activity.	States most of the main points and details that focus on the internet research activity. May include some unnecessary information.	States few main points and details that focus on the internet research activity, or information does not relate to topic.
Organization	Clearly organized into a logical sequence. Excellent use of a flowchart. Excellent introduction and conclusion.	Adequate evidence of a logical sequence of information. Good use of a flowchart. Satisfactory introduction and conclusion.	Fair evidence of a logical sequence of information. Some use of a flowchart. Weak introduction and Conclusion.	Minimal or no logical flowchart usage. No logical organization; some digressions. Unclear, confusing, no introduction or conclusion.
Delivery	Effectively and creatively delivers the information while staying on topic and considering the audience. Uses voices and variations; interesting and vivid to hear.	Adequately delivers the information while staying on topic and considering the audience. Speaks clearly and confidently.	Delivers the information but does not stay on topic. Little consideration of the audience. Uses incomplete sentences.	Little or no attempt is made to stay on the topic. Does not consider audience. Difficult to understand.
Preparation	Presentation shows detailed preparation and practice in delivery.	Presentation shows satisfactory preparation as well as practice in delivery.	Presentation shows some preparation as well as some practice in delivery.	Presentation is lacking in preparation and in practice of the delivery.
Written Worksheet Questions	Answers the questions clearly and completely. Provides all key information.	Adequately answers the questions. Some information may be missing.	Answers the questions somewhat. Most information missing, and little or no use of vocabulary, or improper use.	Does not answer the questions correctly.
Neatness	Clear, creative, and concise.	Adequate.	Needs interpretation from student.	Not Legible.