Project Cornerstone, Inc.
3511 Camino Del Rio South, Suite 403
San Diego, CA 92108
www.Project-Cornerstone.org

GRADATION /SIEVE ANALYSIS: Activity

STANDARDS COVERED		
NGSS MATTER & ITS INTERACTIONS	**NGSS ENGINEERING DESIGN**	**MATH**
2-PS1-1 **2-PS1-2** **5-PS1-3**	**K-2-ETS1-3** **3-5 – ETS1-1**	**MP.1** **6.RP.A.1, 6.RP.A.3C, 6.RP.A.3C, 6.RP.A.3D, 6.NS.B.3, 6.NS.B.3** **7.RP.A.1, 7.RP.A.2A, 7.RP.A.2D, 7.G.B.6, 8.NS.A.1, 8.EE.B.5, 8.G.C.9**

INTRODUCTION: Concrete is made by mixing construction aggregate (i.e., sand and gravel), cement and water. However, not all sand and gravel is suited for making concrete. In this activity, students will utilize a gradation or sieve analysis to determine which aggregate mixture is best suited for making concrete.

A sieve analysis is a test method that evaluates the different grain sizes of aggregate. The sieve is a tool used to separate smaller particles from larger ones using a series of screens. The aggregate is placed into the top of the sieve and shaken. The shaking forces the aggregate to be distributed into different grain sizes. The different sizes can be measured to determine which sample is best suited for making concrete. Then, the sample can be graphed by the particle size distribution.

Concrete cures (or hardens) as a result of a chemical reaction known as hydration. Hydration occurs when the major compounds in cement form a chemical bond with water molecules. The cement must have adequate water for the chemical reaction to occur. Thus, the size of the sand used in the concrete mix will affect the hydration process. If the sand is too fine, it will soak up the water preventing the cement to react with the water. Therefore, coarse or larger sized grain of sand must be used to allow the cement to react with the water.

Students will test two aggregate samples (one with river sand and another with beach sand).

Note: River sand is used for making concrete because it has a larger grain than beach sand, and will not absorb water like beach sand does. This is a good opportunity to discuss how sand is made through the Earth's natural cycles.

DURATION: 40 minutes

PURPOSE: To introduce students to the scientific method by developing a hypothesis and testing the hypothesis with a lab experiment, then analyzing the results.

MATERIALS:

- Sieve
- Scale
- Bowl or tray
- Calculator
- Pencil for each student
- Sample 1 (aggregate with river sand)
- Sample 2 (aggregate with beach sand)
- Worksheet for each student

ACTIVITY:

1) Divide the class into groups of 4-6 students. The group members should sit together.

2) After discussing aggregates and the chemical process of hydration, encourage the students to open both samples (aggregates with river sand and aggregate with beach sand), and compare the two types of materials. Then, have each group to decide which sample they think is best for making concrete. Each student will form a hypothesis for which sample they think is best suited for making concrete and why. They should write their hypothesis in a complete sentence or two on the worksheet.

3) Explain the following steps to the class and have them complete the steps within their groups, or walk the class through step by step.

   Make sure the sieve screens are in the proper order: #5, #10, #60, #230, and bottom pan.

4) Open the lid to the sieve and pour one of the samples into the top. Replace the lid. <u>Make sure one hand is on the top of the</u>

Hypothesis: Which sample do you think is best suited for making concrete and why?
I think river sand is best for making concrete because it is larger than the beach sand and will not soak up too much water.

sieve and one hand is on the bottom. Shake the sieve horizontally from right to left or forward and backward. The sieve must remain upright.

After a few minutes of students taking turns shaking the sieve, remove the lid. Place the empty bowl or tray on top of the scale and turn it on. The scale should be in grams and read zero (0). This indicates the scale will account for the weight of the bowl or tray.

5) Pour the contents of screen #5 into the bowl on the scale and record the weight in grams on the #5 row in the corresponding table on the worksheet (either for river sand or beach sand). Once weighed, pour the contents back into the original sample's container.

6) Repeat Step 5 for screens #10, #60, #230 and the bottom pad.

7) Add all the weights for Sample 1 and write the total at the bottom of the column. Make the math portion grade appropriate.

8) Put the sieve screens in order and repeat the process for the second sample.

NOTE: If you are short on time, ask the students to only test the sample they think is best for making concrete.

9) For students in 6th grade or higher or if they are ready: Calculate the percentage of the material from each screen. If you are limited on time, have the students calculate the percentage for the #230 screen

Material Specification

Screens	Weight Range	% Range	Pass
#5	165 - 210g	65% - 75%	Pass
#10	12 - 25 g	3% - 9%	Pass
#60	15 - 65 g	18% - 22%	Pass
#230	3 - 10 g	0% - 4%	Pass
Bottom Pan	0 - 2g	0% - 2%	Pass

In order to pass, the weight and % must be within specified ranges.

Beach Sand

Screens	Weight	%	Pass/Fail
#5	171 g	60.42	Fail
#10	20 g	7.06	Pass
#60	12 g	4.24	Fail
#230	80 g	28.26	Fail
Bottom Pan	0 g	0	Pass
Total	283 g		

(Weight ÷ Total Weight) x 100 = Percentage

for both samples only. If the students are not comfortable with percentages, they may look at the weights from the #230 screen to determine which sample has the least amount of very fine sand.

River Sand

Screens	Weight	%	Pass/Fail
#5	209 g	73.07	Pass
#10	18 g	6.29	Pass
#60	55 g	19.23	Pass
#230	4 g	1.39	Pass
Bottom Pan	0 g	0	Pass
Total	286 g		

(Weight ÷ Total Weight) x 100 = Percentage

10) Using the Material Specification table on the worksheet, the students will determine if the materials from each screen have passed or failed the specification requirements.

Explain that the very fine sand will soak up water when making concrete, thus preventing the cement and water from mixing in order to cause the hydration process to begin.

River sand, with the least amount of very fine sand, is the one best suited for making concrete.

11) Ask students to circle the sample best suited for making concrete. Students may also be asked to write out an explanation as to why river sand is the better type of sand.

1. Based on the data collected, which aggregate sample is best suited for concrete?
   a. Sample 1 (river sand)
   b. Sample 2 (beach sand)

12) Next, using the data the students collected from the sieve analysis, they will graph the percentages of the material from the Sample 1 onto a pie chart.