Lesson 8/9:
Data Analysis: Infiltration Rate and Composition of Concrete

1. **Background Narrative**

   One of the basic characteristics of pervious concrete is that it allows water to pass through it easily. The students have already made test cylinders of the three types of concrete by this point in the unit. There will be different recipes for the porous concrete, and these will be compared To show this property, there is an apparatus for testing concrete's ability to let water pass through it. The students will be able to record and compare the rate of the water flowing through the different recipes.

   The other cylinders will have been "tested" to determine the compressive strength of each. These results will be shared with the class. They will need to determine the best recipe to use for each of the types of concrete. These results will be one of the main sources of information for choosing the materials they will use as aggregates. The students will not be traveling to crush the cylinders, so video footage should be shown and results given.

   The students will use the information that they gather and that they have been given to create graphs for the different recipes. They will learn about the importance of presenting data in an organized and easy to understand format.

2. Performance Objectives

- Students will be able to analyze data using a spreadsheet program.
- Students will be able to identify effectively displayed data.
- Students will be able to calculate the infiltration rate given the elapsed time and volume.

3. Standards:

NYS Integrated: 1.2, 1.3, 1.5, 5.2, 7.1, 7.2
US Math: 4.1, 4.2, 5.2
US Technology: 1.3, 2.2

4. Resources

- Cylinder crushing video
- Cylinder crushing data
- Data table for collecting porosity data
- Porosity Activity materials
- Porosity Activity teacher notes
- 3 Porosity Testing Apparatuses (3 different recipes, 1 each)
- Water
- Stopwatch
- 3 buckets for water
- 9 concrete cylinders (3 of each porous concrete)

- Measuring cups

5. Vocabulary

Infiltration rate	**Apparatus**
Volume	

6. Instruction Plan

1. Introduction and recap: (10 minutes)

Take time to relate back to the previous lesson of forces and stresses. Review the concepts of compression and tension. Review force and stress and talk about how you have to test a material to see how it will react and how strong it is. It may take a little while to really go over the equations for force and stress. This is an important concept and should be understood before moving on. Do examples on the board, and remind them of the shoe discussion the day before.

Today we will be testing the pervious properties of the porous concrete test cylinders that you made before. We know that the concrete is designed to let water pass through it, but different recipes will let water through at different rates. We want our concrete to let water pass through it at a rapid speed.

2. Activity: (15 minutes)

Make sure that the activity is set up at the six stations. This should be done before the class actually starts so that no time is wasted. See the teacher's notes for setting up the demonstration for this lesson. Split the students into six groups and have them go to a table. The three groups that measure the infiltration rate first will go to the hands on activity second. Make sure to tell the students they should be recording the times and water volumes on their data sheet if they are operating the apparatuses. After the activity, go back into the classroom and average the results for the two trials. At the end, go over how to calculate the infiltration rate in volume/time. **Not sure what the units will be yet**

3. Activity: (10 minutes)

Now that we've tested our concrete, we have to create an organized and direct way of sharing this information with other people. When an engineer or a scientist, or any other professional runs experiments, they have to be able to present their results so that other people can see what they've done. Making the results clear and easy to read is important because you never know who will be trying to understand your results. Does anyone know of a way to make the results of our experiment easy to read and understand?

Pass out the information from the crushing of the concrete cylinders. Break the students into groups. Have the students use the computers to create graphical representations of the data.

There will be a few groups working on the data for each type of concrete. Have them all print out their graphs and bring them back into the classroom.

4. Recap and Closure: (3 minutes)

We've taken a closer look at our porous concrete and now we have some data about each type. You've made graphs of the data that we collected. Next time we will take a closer look at these graphs and also the data for crushing the other cylinders.

The lesson may be ended at this point if there are time constraints. Then begin the next class with a brief review .

5. Graphing Information: (10 minutes)

Last time, we did an experiment to test for the infiltration rate in the porous concrete. What did we do with the data that we got from the experiment? I have the graphs that you made and printed last class up here. I'm going to hold them up and have you tell me which ones are the best graphs. Have the students decide which graph is best, without knowing what "The Best" really means.

When you look at all of these graphs, you can see that there are a few different kinds. Which type of graph that you see up here is the easiest to get important information off of? Who can tell me what some of the important aspects of a good graph are? List these on the board. Make sure to prompt students with things if they don't have answers ready. Some important aspects are: Title, axis labels, units, legend (if necessary), not too crowded, easy to read.

Having visual representations of the data is very important when reporting the results of an experiment. The graphs and pictures that you use make your results easier to understand for anyone who reads them. Someone may not know a lot about concrete, but they can tell from a good graph that when the average aggregate size is greater the infiltration rate will also be greater. Engineers and scientists use graphs in their reports all the time.

6. Crushing Concrete: (10 minutes)

So who can tell me what compressive strength is? (It's on your vocabulary sheets if you can't remember.) Right, compressive strength is a material's strength against a force that is trying to squish it. We know that concrete is strong in compression, but how strong is it? We tested the traditional and recycled aggregate concrete that you made last week to get the amount of force it took to make the cylinder fail. We have a video of the crushing to watch. Show the video of the cylinder crushing.

7. Activity: Graphing Compressive Strength: (15 minutes)

Now that we know the important aspects of an effective graph, we are going to graph the results of the compressive strength testing. The data that you will be getting is of the different concrete recipes and the force that it took to fail each one. Who can tell me how to figure out the compressive strength of the cylinders with the information that we have? That's right, the force measured divided by the area of the cylinders. The diameter of the cylinders is two inches. What does that make the area? (Take this chance to do this on the board if the kids don't know how to find the area of a circle. It should be review from the previous lesson: forces and stresses.)

Based on the characteristics of a good graph that we put on the board earlier, you are going to make the best graph you can for the different types of concrete. There are six types of concrete to graph the results for. You'll be in the same groups as you were for the last graphs. Each group will graph one of the recipes.

Group 1:
Group 2:
Group 3:
Group 4:
Group 5:
Group 6:

8. Recap and Closure: (5 minutes)

We've learned some important information about collecting and presenting data today. We will be using the graphs that you created today in our next lesson to determine the best recipe to solve the problem.

Teacher's Notes: Porous Concrete Infiltration Activity (Lesson 8/9)

Activity Materials List:

- 3 Porosity Testing Apparatuses (3 different recipes, 1 each)
- Water
- Stopwatch
- 3 buckets for water
- 9 concrete cylinders (3 of each porous concrete)
- Measuring cups

Set up of Activity:

There are 2 different setups in this lesson. The testing apparatuses are on separate tables. There are 3 other stations that have different porous concrete samples to be played with.

The apparatuses must be completely full of water. Ensure that the bottom valve is closed and fill it completely with water. Let some of the water flow through the apparatus to ensure that all the voids are filled. Make sure that the apparatus is full to one of the measured levels in the top cylinder. This must be done with each of the testing apparatuses each time they are used.

There are three other stations. These will have three porous concrete cylinders at each station, one of each recipe. There is also a bucket of water and measuring cups for the students to pour water through the cylinders and observe the differences.

Implementation of the Activity:

The students will be running the apparatuses themselves in groups. There will be six groups total, three on the apparatuses and three with the hands on activity. The groups will switch places, so that the three who were with the apparatuses are with the hands on activity, and vice versa. There will be two sets of data for each apparatus and these can be averaged in the classroom once all groups are finished.

To calculate the infiltration rate for the different recipes of porous concrete, the required information is the time and the volume that passes through the concrete in that time. It is important to note the starting and ending volumes in the top cylinder. This should be written down on the students' activity sheets for each test. It can be done multiple times for each recipe so that there is an average for each. The time for each run of the test will be measured by one of the students with a stopwatch. This should also be put on the board.

Make sure that students are recording this information on their data sheet. Go over what the units are for infiltration, volume/time. The units will be seconds for time, and _____ for volume.

Name: _____ Date: _____

Pervious Concrete Infiltration Rate

Directions: Record the data for the pervious concrete infiltration test in the table below.

Trial	Concrete Recipe	Start time	End time	Total Time	Start Volume	End Volume	Total Volume	*Infiltration Rate
1	1							
2	1							
1	2							

2	**2**							
1	**3**							
2	**3**							

***Infiltration Rate = (Total Volume)/(Total Time)**

Average Infiltration Rate:
Average the two values for the infiltration rate for each concrete recipe.

Recipe 1:_____

Recipe 2:_____

Recipe 3: _____