1 Chemical Degradation of Concrete

You may have seen concrete that is crumbling or has aggregates popping out of it. What causes concrete to degrade this way? In many cases, chemicals in the surrounding environment are the culprits. Can concrete be made so it is more resistant to chemicals? In this activity, you will observe the chemical degradation of concrete by acid. You will explore how the water-to-cement ratio of concrete affects its resistance to chemical degradation and learn the reasons why.

Think about these questions as you do the activity:

? How do chemicals get inside concrete?

? How can the porosity of concrete be measured?

? What is the relationship between the porosity of concrete, its hardening time, and its water-to-cement ratio?

? How does the water-to-cement ratio of concrete affect its resistance to chemical degradation?

? Why does the water-to-cement ratio have this effect?

Part A

Because concrete is porous, molecules and charged particles, called ions, can move through it. Thus, the porosity of concrete can be evaluated indirectly by measuring its electrical resistance—or its resistance to the movement of electric current. The less porous the concrete is, the greater is its electrical resistance.

In this part of the activity, the groups in your class will measure the electrical resistance of concrete samples that have different water-to-cement ratios. They will measure electrical resistance over a period of seven days to see if the porosity of the samples changes with time. Using class data, you will compare the porosity of the various concrete formulations and draw conclusions about any differences you observe.

Predictions

Look over the water-to-cement ratios of the concrete formulations listed in the chart on the next page. Which concrete formulation do you think will be the most porous? The least? To help you make your predictions, think back on what you learned about the density of concrete in Activity 3. Record your predictions and your basis for making them.

Make a data table with space to record:

- predictions about the porosity of the concrete formulations
- water-to-cement ratio of your formulation
- initial electrical resistance of each sample you made
- electrical resistance of each sample every hour during the first day

1 Extension Activity Planning Guide

Purpose
To observe how the water-to-cement ratio of concrete affects its resistance to chemical degradation and to explore the mechanism by which chemicals degrade concrete.

Suggested Groupings
Groups of three or four

To Save Time
Half of the groups in the class can do Part A, while the other half do Part B. Groups should share data.

Make the concrete samples yourself seven days before beginning Part B. Students can then treat the samples with acid.

You can use this activity after students have completed Activity 4; it will give them an opportunity to explore two other properties of concrete—porosity and resistance to chemical degradation.

Summary of the Activity

In Part A, students compare the porosity of various concrete formulations by measuring the formulations' electrical resistance. Using class data, they make conclusions about the effect of hardening time and the water-to-cement ratio on the porosity of concrete. In Part B, students explore the effect of the water-to-cement ratio on the chemical degradation of concrete by acid. They use data from Part A to explain their results and to describe the mechanism by which chemicals degrade concrete.

Estimated Time

Part A

- 40 minutes to make the samples and measure their initial electrical resistance
- 10 minutes every hour during the rest of the school day to measure the electrical resistance of the samples
- 10 minutes twice each day for 7 days to measure the electrical resistance of the samples
- 20 minutes to record and graph class data

Part B

- 20 minutes to make the samples
- 7 days for the samples to harden
- 10 minutes to measure the initial masses of the samples
- 10 minutes each day for 7 days to measure the masses of the acid-treated samples
- 20 minutes to record and graph class data