

INTRODUCTION

Cement is one ingredient in concrete. How the cement is made is important. The manufacturing process must be carefully controlled to produce a cement that has required chemical and physical characteristics. This process can be broken down into five basic stages.

FOCUS ASSIGNMENTS

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1. Take a virtual tour of a cement manufacturing operation. Visit <www.holnam.com>. Click on the “Plant Tour” link. You can also visit the Portland Cement Association at <www.portcement.org>. Click on “About Us,” then click on “Cement Industry.” You should find a virtual tour of a cement plant.
2. What do you find interesting about the manufacturing process?



UNIT OBJECTIVE

After completing this unit, you will show the following competencies by mastering the activities on the Assignment Sheet and by scoring at least 85% on the Written Test.

SPECIFIC OBJECTIVES

1. Distinguish between concrete and cement.
2. Describe the stages in making portland cement.
3. Identify key points in the history of cement.
4. Profile a structure built from concrete. (Assignment Sheet)





OBJECTIVE 1

Optional Activities/
Resources in Instructor's
Guide

Distinguish between concrete and cement.

WORDS YOU SHOULD KNOW	
aggregate	filler material in concrete that adds volume at low cost EXAMPLES: sand, gravel, crushed stone
kiln	oven, furnace, or heated enclosure used to process cement by burning, firing, or drying

The terms “cement” and “concrete” do not mean the same thing. *Cement* is a powder made from alumina, silica, lime, iron oxide, and magnesia burned in a kiln and finely pulverized. Cement is one ingredient in concrete.

Concrete is a building material. It is a mixture of air, water, cement, and aggregates in specific proportions.

OBJECTIVE 2

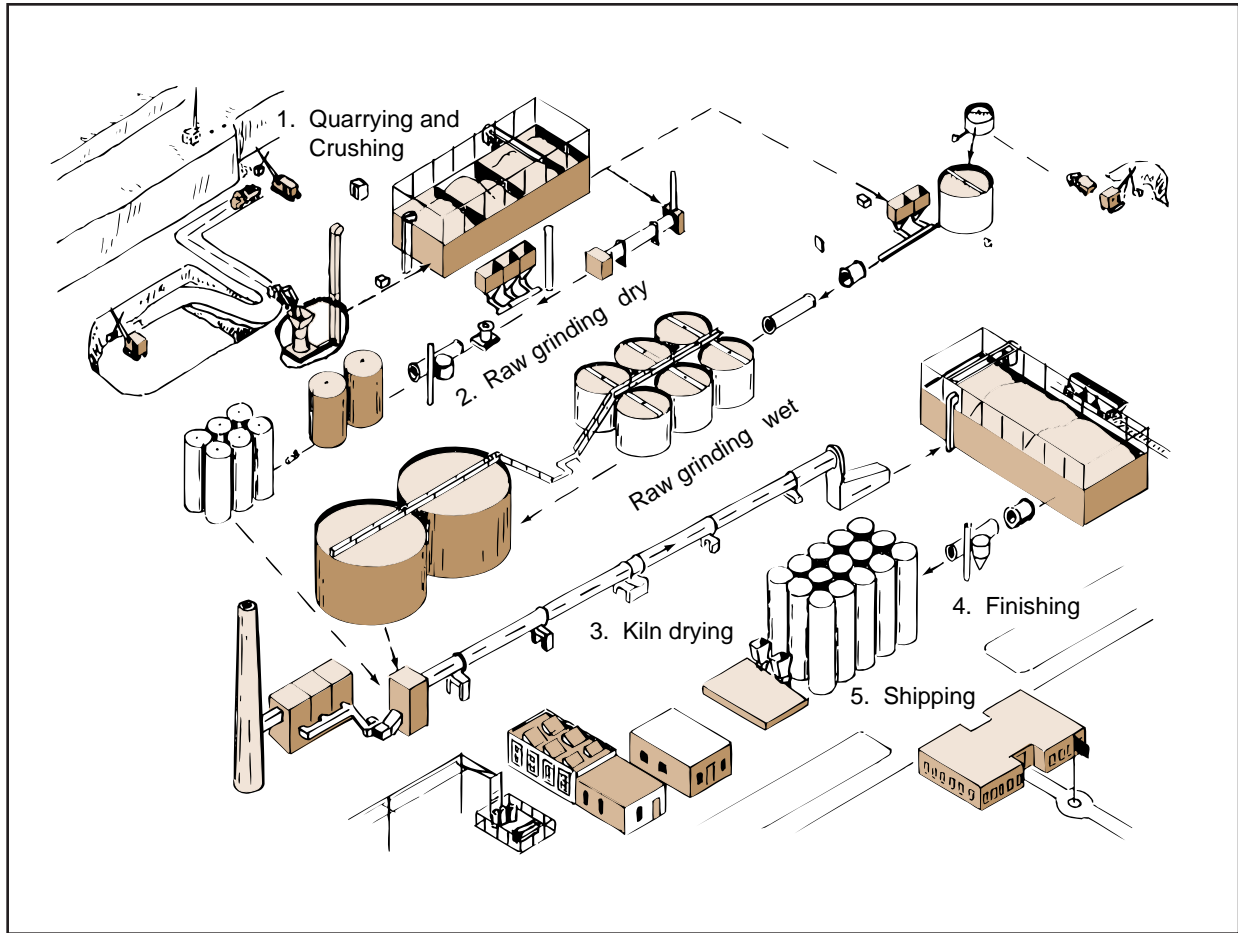
Optional Activities/
Resources in Instructor's
Guide

Describe the stages in making portland cement.

WORDS YOU SHOULD KNOW	
clinker	gray-black pellets of cement produced under high temperature in a kiln during the drying stage
slurry	a mixture, such as the ground raw materials in cement, with enough water to make the mixture fluid



FIGURE 1



- 1. Quarrying and crushing** — The raw materials for portland cement include combinations of limestone, shells or chalk, and shale, clay, sand, or iron ore. These materials are mined from a quarry near the plant (Figure 2) and are crushed to smaller sizes.



FIGURE 2



2. **Grinding and blending** — At the cement plant, the raw materials are proportioned to make a cement that has a certain chemical composition. Two different processes—a dry and a wet process—are used:

In the dry process, the dry raw materials are proportioned, ground to a powder, blended (mixed), and fed to the kiln.

In the wet process, the raw materials (already proportioned) are ground with water, blended, and fed to the kiln as slurry.

3. **Drying** — The mixture of raw materials passes through a rotating cylindrical kiln. High temperatures in the kiln cause chemical reactions to take place. These reactions produce clinker about the size of marbles. Red-hot clinker (Figure 3) leaves the kiln and is cooled to handling temperatures.



FIGURE 3



4. **Finishing** — Gypsum is added to the cooled clinker and ground into a fine, gray powder. Gypsum regulates the setting time of the concrete that will be produced with the cement.
5. **Shipping** — The cement is packaged and made ready for shipment.

OBJECTIVE 3

Optional Activities/
Resources in Instructor's
Guide

Identify key points in the history of cement.

WORDS YOU SHOULD KNOW

hydraulic cement cement that hardens under water

portland cement a type of cement (not a brand name) patented by Joseph Aspdin, a British stone mason, and named after a stone quarried on the Isle of Portland (off the coast of Britain)

Early History — The Egyptians used lime and gypsum mortar to make a binding agent. They used it to build the Pyramids. (Figure 4) The Romans used a cement mortar made with slaked lime and pozzolana (a volcanic ash from Mount Vesuvius). The result was hydraulic cement. The Coliseum (Figure 5), the Forum, and other structures used this cement mortar. After the fall of the Roman Empire, the art of making concrete was lost.



FIGURE 4



FIGURE 5



1756 — John Smeaton, a British engineer, rediscovered hydraulic cement and used it to build the Eddystone lighthouse. (Figure 6)

FIGURE 6



1824 — Joseph Aspdin, a British stone mason, patented portland cement.

1844 — Isaac C. Johnson, also from Britain, developed a composition for synthetic portland cement. His proportions are very similar to those used today.

1857 — The Allen House, one of the oldest concrete structures in America, was built in Honesdale, Pennsylvania. It used natural cement from America. Natural cement resulted from burning a mixture of lime and clay that occurred naturally. Since “nature” mixed these ingredients, the properties of the cement varied.

1868 — The first recorded shipment of portland cement arrives in America from Europe. European manufacturers of portland cement noticed the growing market for cement in America.

1871 — David O. Saylor mixed and produced his own patented portland cement in Coplay, Pennsylvania. His was the first portland cement plant in America. (Figure 7) The date of his patent is considered the beginning of the industry in America.



FIGURE 7



1889 — The first concrete-reinforced bridge is built. (Figure 8)

FIGURE 8



Early 1900s — The Portland Cement Association was founded (1916); the U.S. Bureau of Standards and the American Society for Testing and Materials established a standard formula for portland cement (1917); Mies van der Rohe proposed concrete high-rise construction (1919).

1936 — Hoover and Grand Coulee Dams (Figure 9)—the first major concrete dams—were built. Frank Lloyd Wright used the cantilever design to build Fallingwater.



FIGURE 9



1956 — The Guggenheim Museum (Figure 10) in New York City was built using reinforced concrete.

FIGURE 10



1970s — Fiber-reinforced concrete was introduced.

1980s and beyond — Newer and taller concrete structures are built.

OBJECTIVE 4

Complete the Assignment Sheet.



Name _____ Score _____

OBJECTIVE 4

Profile a structure built from concrete.

BASIC SKILLS



Reading



Writing



Critical Thinking



Social Studies

EQUIPMENT AND SUPPLIES

- Pen or pencil
- Reference resources (Internet access, encyclopedias, industry publications, architecture publications, etc.)

INSTRUCTIONS

- Identify a concrete structure that interests you. It can be a structure that was built anywhere in the world at any time.
- Use reference resources to find information about the structure you chose.
- Answer the following questions.

1. What structure did you choose? _____

2. When was it built? _____

3. Who built it? _____

4. How does it use concrete? (How much of the structure is concrete? Do any special principles apply?)



5. How is it a unique structure? (Can you identify any interesting facts about the structure? Did any special or challenging conditions apply to the structure?)

6. What is the purpose of the structure?

