unit 6

Construction Technologies

Chapters In This Unit:

18 The World of Construction
19 Building a House
20 Heavy Construction

Unit Thematic Project Preview

Planning a Green Shelter

As part of this unit, you will learn about construction systems for homes and commercial buildings. You will also find out how construction systems evolved from log homes to the skyscrapers of today.

As you read this unit, use this checklist to prepare for the project at the end of this unit:

PROJECT CHECKLIST

- ✓ Look at magazines and Web sites for examples of green buildings.
- ✓ Find out what features are important for green buildings.
- ✓ Check the Yellow Pages to find builders who specialize in green construction.

WebQuest Internet Project

Go to **glencoe.com** to this book's Online Learning Center (OLC) to find the WebQuest activity for Unit 6. Begin by reading the Task. This WebQuest activity will help you learn about bridge designs and how they work. You will also learn about the history of bridge building and some famous bridges.

Explore the Photo

Constructing Our World Buildings come in all shapes and sizes. From the smallest house to the most magnificent bridge and skyscraper, technology plays a part in design and planning for usefulness, beauty, and safety. *What materials do you think are used the most in construction?*

Good Shoot/SuperStock

chapter 18

The World of Construction

Sections

18.1 The Evolution of Construction
18.2 Design Requirements

What You'll Learn

- **Discuss** how construction systems evolved.
- **Name** some important structures.
- **Explain** the purpose of different construction materials.
- **Discuss** building codes and safety.

Explore the Photo

Super Tall The *Burj Al Arab* at Jumeirah Beach in Dubai, United Arab Emirates, is a unique sail-shaped building. It is one of the world's tallest hotels. *What is the disc-shaped "balcony" near the top floor?*

Launch the TECHNOLOGY LAB

Test the Strength of a Column

At the end of this chapter, you will be asked to test the strength of different column shapes, or designs. Get a head start by using this checklist to prepare for the Technology Lab.

PROJECT CHECKLIST

- ✓ Observe the columns that support roads, freeways, and bridges in your town. What materials are used to make the columns?
- ✓ Begin to collect some basic materials you will need, such as index cards, rubber bands, and plastic cups.
- ✓ Do Internet research to find and read articles about roads or bridges collapsing. What part of the structure collapsed at first?

ARCO/J Hildebrandt/age fotostock

section 18.1

The Evolution of Construction

Reading Guide

Before You Read **Predict** What kinds of construction have all civilizations needed?

Content Vocabulary

- stick construction
- skyscraper
- surfacing

Academic Vocabulary

- maintain
- require

Graphic Organizer

Draw the section diagram. Use it to organize and write down information as you read.

Types of Construction

1. Residential	2. Commercial	3. Civil
Apartments		
Houses		

Go to **glencoe.com** to this book's OLC for a downloadable graphic organizer and more.

TECHNOLOGY STANDARDS

STL 6 Role of Society

STL 7 Influence on History

STL 11 Design Process

STL 20 Construction Technologies

ACADEMIC STANDARDS

Social Studies

NCSS 2 Time, continuity, and change

Mathematics

NCTM Data Analysis and Probability Select and use appropriate statistical methods to analyze data.

STL *National Standards for Technological Literacy*

NCTM *National Council of Teachers of Mathematics*

NCTE *National Council of Teachers of English*

NSES *National Science Education Standards*

NCSS *National Council for the Social Studies*

Types of Construction

Besides homes and office buildings, what are some other structures?

When the weather is severe, you can stay safe and dry inside a well-built building. Perhaps you are inside a house or apartment building. You might be inside a school, store, restaurant, bus terminal, or hospital. The buildings we use every day for shelter were assembled by people who work in the construction industry.

Other important construction projects include building roads, bridges, and tunnels. Other large construction projects include dams, canals, and even space stations.

As You Read

Connect What materials would you use to build a house?

Construction systems have existed for as long as people have built structures. Technology enables construction. There are three basic types of construction: residential, commercial/industrial, and civil. (See **Figure 18.1**.)

1. **Residential construction** This type provides places where people live, including apartment buildings and single-family homes.
2. **Commercial/industrial construction** This type includes office structures, shopping malls, and factories, as well as churches and other houses of worship.
3. **Civil construction** This type creates large structures for public use. Hospitals and schools are examples, as are roads, bridges, tunnels, and dams. Most civil construction is paid for with tax money collected by the government.

Reading Check **Connect** What type of construction is used for your home?

EcoTech

Constructive Construction

A "sustainable design" considers the natural environment and ecosystem around a building to affect them as little as possible. It includes healthier and more efficient models of construction, renovation, operation, maintenance, and demolition.

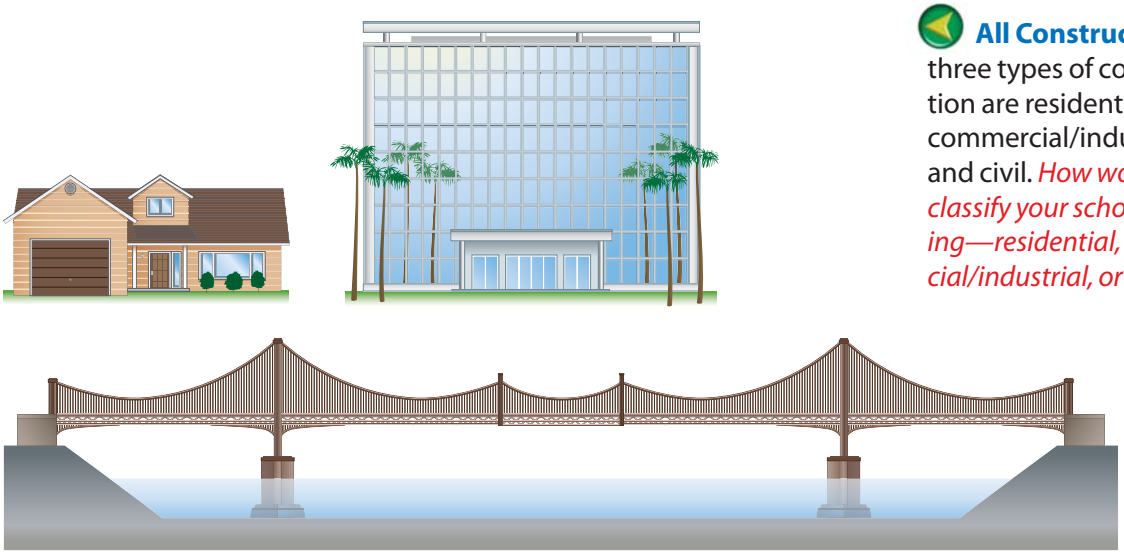
Try This Look at buildings in your neighborhood and identify examples of sustainable design.

Buildings

What kinds of shelters did early Americans construct?

During the American colonial period, many trees grew in the eastern United States. Log houses were popular because they could be quickly put together. Log houses, however, were wasteful because so much wood was used. Their construction also required a great deal of strength to position the heavy logs. A new type of house construction started to appear in the 1840s. Instead of using logs or large wooden beams, these new houses were made of lightweight pieces of wood. This method was called **stick construction**.

Figure 18.1 **Types of Construction**



All Construction The three types of construction are residential, commercial/industrial, and civil. *How would you classify your school building—residential, commercial/industrial, or civil?*

The First High-Rise The 1885 Home Insurance Building in Chicago was the world's first skyscraper. It utilized stick construction with steel instead of wood. *Why was Chicago the place where skyscrapers first appeared?*

Bettmann/Corbis, Jupiter Images RF

The frames went up quickly and provided both safe and strong dwellings. Almost all modern houses are still built this way. Even skyscrapers can be built with a type of stick construction that uses steel.

The first skyscraper was the 1885 Home Insurance Building in Chicago. At ten stories high, it was not as tall as some other buildings. However, it was the first to use a metal frame as a basic part of its design. The outside walls were connected to the metal frame. The walls did not support the building as in log houses.

One of the world's tallest skyscrapers is Taipei 101 in Taipei, Taiwan. It is 1,676 feet tall. Tall and strong modern skyscrapers are made with concrete and steel. One of the tallest buildings in the United States is the Sears Tower in Chicago, standing at 1,450 feet and 110 stories.

Reading Check **Recall** What is stick construction?

Roads

How were early roads constructed?

Most ancient roads were little more than dirt paths. The great road builders of the past were the Romans, who started to build improved roads about 300 B.C.E. They built 50,000 miles of roads, more than America's interstate highway system.

Types of Road Surfaces

Roads can more easily support heavy loads if the roads are covered with a strong and durable material. This covering process is known as **surfacing** a road.

Early Roads

The ancient Romans used flat stones for road surfaces; some early American roads were surfaced with logs or planks placed crosswise. Both types of roads were difficult to **maintain**. They were also so bumpy that people had to travel on them very slowly. The first section of the National Road in the eastern United States, which is now U.S. Highway 40, or Interstate 70, was made from logs!

McAdam Roads

Around 1800, George McAdam from Scotland developed a method for making a road surface smooth. He used tar, which comes from crude oil. The tar is heated and spread over a thick layer of crushed rocks on the ground. It is still a common way of surfacing roads, driveways, and parking lots. Americans call this surfacing material "asphalt" or "blacktop." The British call it "macadam," or they use the brand name "Tarmac."

Today's Roads

Today high-speed highways are usually surfaced with concrete because concrete lasts longer than asphalt. Most of America's approximately 47,000 miles of interstate highways have concrete surfacing.

Reading Check **Compare** What materials were used to make the first roads and the most recent roads?

Academic Connections — Social Studies

Reach for the Sky
Many countries seem to compete to see who can construct the tallest skyscraper.

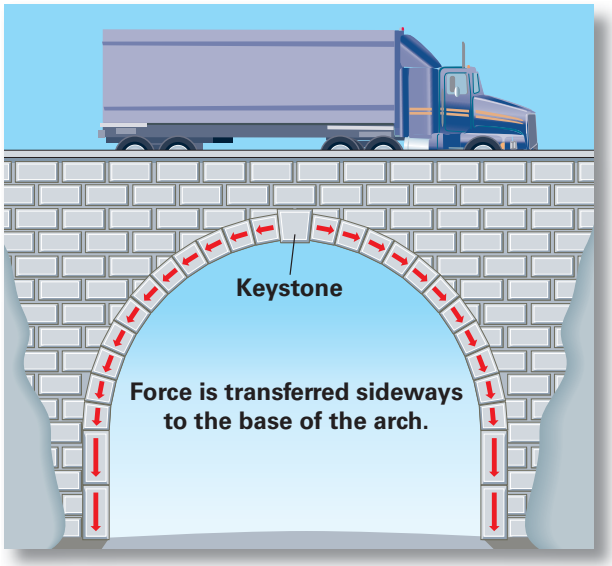
Apply Research the world's tallest buildings and make a list of the top five, arranged by height. Write down the year each one was completed. Copy a world map and label where each is located with its year.

Dennis MacDonald/age fotostock

McAdam's Method
Road workers lay down asphalt for a highway. *Why do you think asphalt is heated before it is used for road surfacing?*

Figure 18.2 **The Arch**

Simply Strong An arch transfers the truck's weight from the center to the two sides. *Could a bridge have two or more arches?*



Bridges

When were the first metal bridges made?

The Romans of 300 B.C. gave us long-lasting roads, but they also devised strong, well-designed bridges. They developed the arch—using wedge-shaped stones arranged and locked in a curve. The arch shape distributed weight sideways as well as downward. See **Figure 18.2**. Like their roads, some Roman bridges have lasted for many centuries.

During the late 1700s, improvements in metal manufacturing greatly reduced the price of iron. That was when people started to make bridges out of iron. One hundred years later, bridge builders began to use steel, which is a much stronger material. In 1874, the world's first major all-steel bridge, the Eads Bridge, was built across the Mississippi River at St. Louis, Missouri. It was named for its designer and chief engineer, James Buchanan Eads.

Modern bridges are still made of steel and supported by concrete. The modern bridge with the longest distance between supports is the *Akashi-Kaikyo* Bridge, which is near Kobe, Japan.

Reading Check **Identify** What material(s) is used to build the strongest bridges?

Tunnels

What is the purpose of a tunnel?

Bridges take people over obstacles, while tunnels take them through or under them. Tunnels are less noticeable than bridges and can be less inviting. They often make us think of mysterious caves.

Ethics in Action

Rebuilding New Orleans

In August 2005, Hurricane Katrina devastated the city of New Orleans. Eighty percent of the city was flooded. Now, the people of New Orleans are trying to rebuild their homes. They are getting help from governments, agencies, businesses, and individuals.

Planning to Preserve But it is not easy. Most people want to protect the city's landmarks. They also want to improve conditions for everyone. This requires good urban planning, which is the *design* of cities and communities.

English Language Arts/Writing

Maintaining Technology Why did the flood protection system in New Orleans fail? One reason is that the design was flawed. Another reason is that the system was not properly maintained.

1. Make a checklist of things you can do to properly maintain your bike, computer, or other device.
2. Write reminders in your calendar to do regular maintenance.

The first major tunnel in the United States was constructed through the Hoosac Mountains in western Massachusetts. The railway tunnel is almost five miles long, took over 20 years to complete, and opened in 1875. It is still used today.

The world's longest tunnel is the Seikan Railway Tunnel in Japan. It is more than 33 miles long, but more than 14 miles are under water.

Reading Check **Explain** What is the purpose of a tunnel?

Other Construction

What are some other large types of construction projects?

There are several other types of large construction that are not buildings or houses. These include canals, dams, and construction of structures used in space.

Canal Construction

Our ancestors used small canals to bring water to their crops. Canals are human-made waterways. Ships carrying passengers and products once had to travel a long, dangerous route around the southern tip of South America to get from the Atlantic Ocean to the Pacific Ocean. One of the largest waterways was opened in 1914, the Panama Canal in Central America. It was built by American engineers to connect the Atlantic and Pacific Oceans. Since then trade and travel has increased.

Reading Check **Recall** What is a canal and what is the purpose of a canal?

Hubertus Kanus/SuperStock

Super Canal The United States completed the Panama Canal, but ownership of it was later transferred to the country of Panama. *What was the purpose of the canal?*

Dam Construction

Dams divert the flow of water or cause it to form a pool. Sometimes this can prevent floods. Dams often improve water supplies and the economy of an area, but that can compete with other needs. Animal habitats can be changed or destroyed by human-made dams; people can be displaced from their homes; and areas downstream can become too dry. Preventing these problems **requires** a proper balance. The Chinese government is dealing with these problems as they build the Three Gorges Dam on the Yangtze River in China.

Construction for Space

However, the world's most unusual and advanced construction project is taking place above the earth—in space. This project is the International Space Station, being built by the United States and other nations. It circles, or orbits, around our planet every 90 minutes. Astronauts take turns living on the space station.

section 18.1 assessment

After You Read Self-Check

1. List the kinds of structures built by the Romans.
2. Identify the new type of house construction that began in the 1840s.
3. Name the type of construction that can make a bridge strong.

Think

4. You have been asked to build a dam. Name at least three problems you would have to overcome.

Practice Academic Skills

English Language Arts/Writing

5. Suppose you have been asked to build a tunnel. Write a paragraph describing three problems you must overcome.

STEM Mathematics

6. The five longest spans on suspension bridges include the *Akashi-Kaikyo* in Japan (6,529 feet), the *Great Belt Bridge* in Denmark (5,328 feet), the *Humber* in the United Kingdom (4,626 feet). Two bridges in China complete the list: the *Runyang Bridge* (4,888 feet) and the *Jiangyin Suspension Bridge* (4,543 feet). What are the mean and median of the spans of the bridges?

Math Concept Measure of Central Tendency Two ways to describe a collection of data are to compute the mean (average) of the elements and the median. The median is the middle number of the data listed from least to greatest.

1. Determine the mean. Add the numbers and then divide by the number of elements.
2. To determine the median, list the numbers in order from least to greatest.

For help, go to **glencoe.com** to this book's OLC and find the Math Handbook.

section 18.2

Design Requirements

Reading Guide

Before You Read **Predict** How are construction systems like other systems?

Content Vocabulary

- lumber
- curtain wall
- concrete
- building code
- conservative design

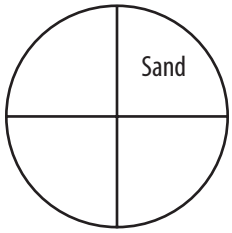
Academic Vocabulary

- objective
- route

Graphic Organizer

Draw the section diagram. Use it to organize and write down information as you read.

Ingredients of Concrete



Go to **glencoe.com** to this book's OLC for a downloadable graphic organizer and more.

TECHNOLOGY STANDARDS

STL 4 Cultural, Social, Economic & Political Effects

STL 7 Influence on History

STL 10 Troubleshooting & Problem Solving

STL 20 Construction Technologies

ACADEMIC STANDARDS

Science

NSES CONTENT STANDARD F Science and technology in society

Social Studies

NCSS 8 Science, technology, and society

STL *National Standards for Technological Literacy*

NCTM *National Council of Teachers of Mathematics*

NCTE *National Council of Teachers of English*

NSES *National Science Education Standards*

NCSS *National Council for the Social Studies*

Understanding Requirements

Why must construction projects meet certain requirements?

Like other technology systems, construction systems include inputs, processes, and outputs. *Inputs* include the seven resources—people, materials, tools and machines, information, energy, capital, and time. *Processes* include designing the structure and putting it together. *Outputs* include the structure itself. Malfunctions of any part of this construction system may affect the way the system works and the quality of the outputs. For example, if low-quality steel is used, the bridge may collapse.

As You Read

Identify What materials are used in construction?

Engineers and governments place many requirements on construction projects to ensure safety and long life. For example, the floor in your school classroom must be strong enough to support you and your classmates. In comparison, the floor in a single-family home must support a smaller load or weight. So, a building code may require your classroom floor to be made of concrete, but the floor in your house could be made of wood.

Although there are no perfect designs, engineers and designers can meet many requirements during the creative design process before building. Some requirements involve materials, building codes, and safety considerations.

Bernard Bisson/Sygma/Corbis

Reading Check **Identify** What are the elements in a construction system?

Materials

What are the best materials to use in construction?

Centuries ago, before people acquired scientific knowledge, they built their homes and other structures from whatever materials were available.

Tech Stars

I.M. Pei

Master Architect

Award-winning architect I.M. Pei was born in China in 1917. He was educated in Hong Kong and Shanghai before moving to the United States at age 18. He studied architecture at the University of Pennsylvania, MIT, and later Harvard University. Pei was from a prominent family whose residence was surrounded by many rock sculptures, carved naturally by water. This led to a keen interest in how nature combined with buildings and how light and shadow mixed.

Career Building Pei is a master of high-modernist architecture. He works in abstract forms, using concrete, glass, stone, and steel. His many designs include the Mile High Center in Denver, the Four Seasons Hotel in New York City, the Pyramids of the Louvre in Paris, the Rock and Roll Hall of Fame in Ohio, the John F. Kennedy Library in Boston, and the Chinese Embassy in Washington, D.C. Pei is one of the most successful architects of his time. Yet despite his many awards, immense wealth, and high acclaim, he remains a humble man.

English Language Arts/Writing Describe in a short essay what types of architecture you find interesting.

Go to **glencoe.com** to this book's OLC to learn about young innovators in technology.

Today scientists and engineers work to develop new and better materials, such as:

- Wood
- Steel
- Concrete
- Other materials

Ken Davies/Masterfile

Strong as Steel Steel reinforcing bars make concrete much stronger. *Why?*

Wood

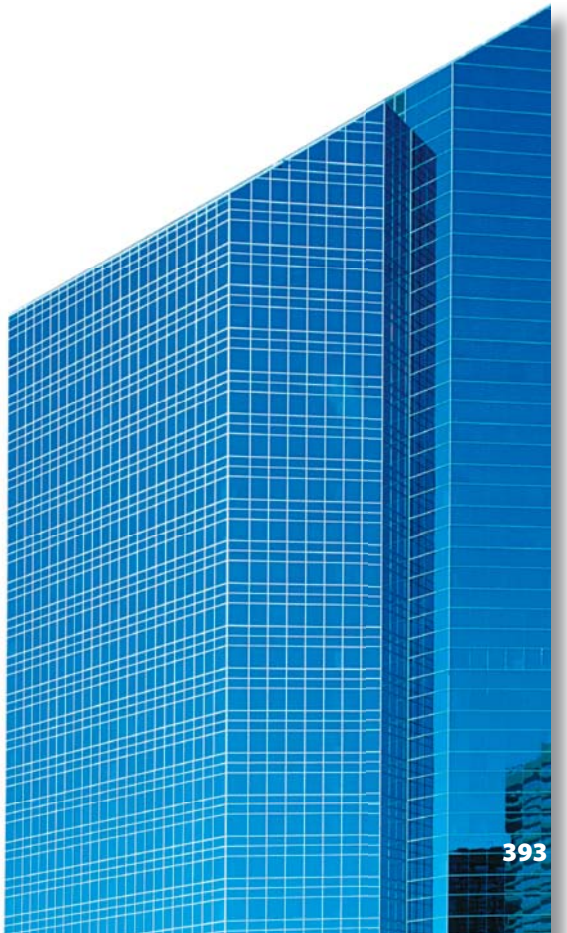
Trees growing on commercial tree farms produce wood in its natural state. People cut this wood to make **lumber**. Most single-family homes are made from lumber because it is readily available, easy to work with, and economical.

Wood is also a renewable resource. After trees are cut down, new ones can be planted in their place. However, trees take many years to grow, so it is important to "stretch" our current supply of wood. To do this, crooked trees, sawdust, and other wood wastes are used to create engineered wood materials, such as beams, plywood, and hardboard. Some engineered wood beams are even stronger than beams made from natural wood.

Steel

Steel is a mixture of iron and small amounts of carbon. It is used primarily to support large structures. Skyscrapers, for example, are built with a steel framework. Then floors and interior walls are added. The outside walls are hung on the metal frame. The walls do not help support the building. These exterior walls are called **curtain walls**. They can be made of many different materials, including glass.

Commercial buildings are sometimes made with steel supports and painted steel walls. These buildings might be airport terminals, grocery stores, and factories. Many suspension bridges are made of steel.



A Glass Tower? This triangular office building has glass curtain walls. *With all that glass, what holds up the building?*

David R. Frazier/PhotoEdit

Paving the Way These workers are screeding the concrete for a driveway. *What do you think* screeding *means?*

Concrete

Made of a mixture of dry cement, sand, stones, and water, **concrete** is the most adaptable construction material. Builders use it for large buildings, highways, dams, bridges, and foundations of houses. Nearly every structure contains some concrete. Some people call concrete "cement," but cement is just one ingredient in a concrete mixture. It is the binder that holds everything together.

Concrete begins as a mixture that looks like ordinary mud. It is poured into forms or molds that hold it in place while it hardens. These forms give the concrete its final shape. Depending on the shape, it can be used for many purposes. Steel reinforcing rods or other steel shapes can be placed in the wet concrete to help strengthen it.

Other Materials

Many construction methods use materials besides wood, steel, or concrete for specific applications. For example, asphalt is an important surfacing material, made of crude oil and other substances, used for road construction and repair, driveways, and walkways.

Composite Materials

Composite materials are used for some bridges. A composite is a combination of two or more materials, such as fiberglass and carbon. Composite materials are much lighter than concrete and are weather-resistant, unlike steel. Composites are used for products such as bathtubs and roofing materials.

Bridge Materials This bridge is made of composite materials that were created in a factory and shipped to the site to be used. *Is it better to build a concrete bridge onsite or to have it shipped from the factory?*

Materials for Subsystems

Builders also use other materials in construction, such as masonry (bricks and stone), window glass, vinyl exterior wall coverings, fiberglass insulation, copper wire, and plastic water pipes. These materials are usually part of a structure's subsystems.

Reading Check **List** What are the materials used in construction?

Regional Requirements

Are all buildings built the same way?

Many regions in the United States have different types of terrain and weather. Structures designed for one region might not be suitable for another region. For example, flatter roofs commonly appear on houses in the south, where there is little snow. However, people in the north must be concerned about the weight of snow on their roofs in the winter. If flat roofs were used, the snow would not slide off easily, and the roofs might collapse. The people in California and some other states must build structures to withstand earthquakes. People in some central states experience tornadoes. Other regions must be ready for floods and rising water, and/or landslides.

Building Codes

Local governments establish rules regulating the types of structures that can be constructed in their areas. Rules are part of the information inputs used by construction systems. They are called **building codes**.

Construction specialists agree that there must be certain standards for each structure. Commercial buildings must have enough exits in case of an emergency. Houses must have safe water supplies. Bridges and tunnels must support heavy loads. These are just a few of the many objectives of building codes.

Building codes can vary by state, county, or city. They are modified as new materials and methods of construction are developed. Before construction begins, builders contact a local inspection office at city hall or the county courthouse to apply for a permit. The builders must follow the regulations in the building code books.

Imagine This...

House Roofs of Metal

Many residential houses have roofs made of asphalt shingles. But metal roofs are increasing in popularity. They keep houses cooler in the summer because they reflect more of the sun's energy. They are also safer because they do not burn. Some aluminum roofs are made from recycled beverage cans and resemble cedar shingles. The more popular metals include painted aluminum, steel, and copper. *Do you think a metal roof is a good choice for the house in which you live?*

Go to **glencoe.com** to this book's OLC for answers and to learn more about new roofing materials for homes.

Tim Street-Porter/Beateworks/Corbis

Rooftop Construction Tile roofs with little slope are common in the southern states. *Why are steeper roofs common in the northern states?*

For example, a builder might not be allowed to construct a tall building in a town's historic district because people want to preserve the historic appearance of the area. In another case, the building codes might permit building a house near a lake, river, or seashore if the house is on strong poles to keep it above water.

Building codes are designed to protect people's safety and the environment. They cover electricity, plumbing, energy use, and most other aspects of construction. That is why there is a lot of paperwork associated with building a new structure.

Safety

Buildings, bridges, and other structures are designed to support much more weight than would be placed on them. Engineers call this **conservative design**. Any major structural failure usually appears on the national news because it is a rare event. The failure of an interstate highway bridge in Minneapolis, Minnesota, in 2007, caused loss of life and disrupted traffic, but it was unusual. Nature can produce disastrous volcanic eruptions, tornadoes, tsunamis, and hurricanes, such as Hurricane Katrina in 2005, that result in severe damage.

Things happen that nobody can predict. So, engineers design escape **routes** and safety devices. All tall buildings have elevators, but they also have stairways in case electricity is cut off. Sprinklers put out small fires and keep them from spreading. Entrance doors and emergency exits in public buildings open outward so people can leave quickly. When accidents or other problems occur, engineers troubleshoot to prevent problems from happening again. New innovative technologies have sometimes resulted.

section 18.2 assessment

After You Read — Self-Check

1. Name the four ingredients of concrete.
2. Define composite material. Give an example.
3. Identify the standards for building.

Think

4. You have been asked to design a house built on the side of a hill and a house built in an area that has tornadoes. Explain the differences in your designs.

Practice Academic Skills

English Language Arts/Writing

5. Make a composite material by gluing a small section of window screening between two index cards. Write a paragraph evaluating the product for strength.

STEM — Science

6. Using products that do not harm the environment or waste natural resources is known as "going green." Construction companies have been using materials that are friendly to the environment. Research some materials that construction companies use when they build a structure that is friendly to the environment. Write a few paragraphs about these materials and the pros and cons of using them.

Exploring Careers in Technology

Sue Tsoi

LAND SURVEYOR

Q: *What is a typical day like in your job?*
A: Each day varies, but it mostly involves talking with clients, researching and analyzing data, generating maps, writing legal descriptions, working on boundary resolution, and managing projects.

Q: *How did you get interested in your job?*
A: In my junior year, our high school offered its first environmental science class, and that got me hooked on science. I started going to nature camps and decided to major in forestry. In college, I was required to take some land-surveying classes and decided to major in the field.

Q: *What kind of training and education did you need to get this job?*
A: I took many science classes in college, such as botany, geology, and soil science, and received a degree in land surveying. After college, I worked for different surveying firms and earned my Land Surveying intern certificate and my Professional Land Surveyor license.

Q: *What do you like most about your job?*
A: I enjoy working in a profession that is considered behind the scenes. Most land surveyors are the first and last people who work on a construction project.

English Language Arts/Writing

Connect Construction Write a one-page report on how land surveyors are integral to the field of construction, and include the following information:

1. Do research online and at the library to find out what is required to receive a Land Surveying Intern certificate.
2. Write a step-by-step plan for a high school student who wants to become a land surveyor.
3. Go to a job-search Web site to find jobs advertised by construction companies seeking land surveyors.

Go to **glencoe.com** to this book's OLC to learn more about this career.

Real-World Skills

Communication, problem solving, adaptability

Academics and Education

Biology, geology, statistics, mathematics, English language arts

Career Outlook

Growth faster than average for the next ten years

Source: *Occupational Outlook Handbook*

Construction Photography/Corbis

chapter 18 Review and Assessment

Chapter Summary

Section 18.1 Construction occurs at a building site. The first skyscraper was the Home Insurance Building in Chicago. It had a metal frame design. Roads are construction projects. The Romans were the first great road builders. The British developed a material called "macadam" for surfacing roads. The material is called "asphalt" in the United States. The first major all-steel bridge was built across the Mississippi River in St. Louis, Missouri. The first major American tunnel was the Hoosac Tunnel in Massachusetts.

Section 18.2 Many structures are built of lumber, which is wood cut into useful shapes. Tall buildings are built with a steel framework. The outside walls, or curtain walls, are hung on the framework. Concrete is a construction material made of cement, sand, stones, and water. Because it can take on any shape, concrete is the most adaptable material used in construction. Structures built in different regions have different requirements. Building codes protect the environment and people's safety. They vary by region and are regulated by local governments.

Review Content Vocabulary and Academic Vocabulary

1. On a sheet of paper, use each of these terms and words in a written sentence.

Content Vocabulary

- stick construction
- skyscraper
- surfacing
- lumber
- curtain wall
- concrete
- building code
- conservative design

Academic Vocabulary

- maintain
- require
- objective
- route

Review Key Concepts

2. **List** some important structures.
3. **Discuss** the purpose of a tunnel.
4. **Describe** the first types of shelter.
5. **Explain** how early roads were once constructed.
6. **Tell** when and why metal bridges were first used.
7. **Describe** how wood is often used in building.
8. **Discuss** why steel is popular.
9. **Explain** how concrete is made.
10. **Explain** the purpose of having building codes.

Real-World Skills

11. **Building Materials** Research the types of materials that are used for homes and businesses. Look at your own house and school and notice the types of materials used. Write a few paragraphs summarizing your findings.

STEM **Technology Skill**

12. **Construction Safety** The construction industry is a dangerous field, despite numerous types of safety equipment to protect construction workers.
    a. Research the hazards at a construction site, and technologies for improving safety.
    b. Write a paper outlining some of the hazards and the safety equipment. Discuss gaps in safety equipment and how to solve the problem.

Academic Skills

Social Studies

13. Research construction practices of different countries. Choose a country from each of the continents. Write a few paragraphs explaining the construction practices, for both residential and commercial buildings, in each country.

STEM **Mathematics**

14. Telephone poles are placed every 40 yards on a country road. How many poles would there be on a 2-mile stretch of this road?

Math Concept **Measurement** When solving word problems involving measurements it is necessary to convert the measurements to like units.

TSA WINNING EVENTS

TECHNOLOGY STUDENT ASSOCIATION

Urban Planner

Situation Your city council has proposed a four-lane highway through your neighborhood to reduce traffic congestion. Your team must identify the location and positive and negative impacts on your neighborhood.

Activity Work with your team and use a map of your neighborhood to determine where the highway should be located. Identify its impacts upon the environment, your neighbors, and the area's economy.

Evaluation Your assessment will be evaluated by these criteria:

- Report—well researched
- Impacts clearly identified for:
  - Neighborhood environment
  - Neighborhood citizens
  - Neighborhood economy

Go to **glencoe.com** to this book's OLC for information about TSA events.

Standardized Test Practice

Directions Choose the letter of the best answer. Write the letter on a separate piece of paper.

1. What is the area of a triangle with a base of 18 and a height of 12?
   A 108 **C** 54
   B 216 **D** 30
2. A curtain wall is an exterior wall that does not help support the building.
   T
   F

Test-Taking Tip Answer all questions on a multiple-choice test in order. Identify doubtful answers by marking them in the margin. Recheck these if you have time after you have answered all questions.

chapter 18

TECHNOLOGY LAB

Test the Strength of a Column

Look at the concrete columns supporting highway bridges and overpasses, particularly on an interstate highway. Some columns are cylinders, and others have square corners like boxes. They might be wide or they might be narrow. Their shape depends upon the load that the bridge or overpass has to carry. The shape of the column affects its strength.

Tools and Materials

- ✓ 3 × 5-inch index cards, four per experiment group
- ✓ Thin rubber bands
- ✓ Lightweight plastic cups
- ✓ Small weights, such as metal washers or bolts
- ✓ Scales for weighing the cup and the weights
- ✓ Plastic tubs
- ✓ Calculators

Set Your Goal

For this activity, you will fold index cards into different shapes to discover how much of a load each one can carry before it collapses.

Know the Criteria and Constraints

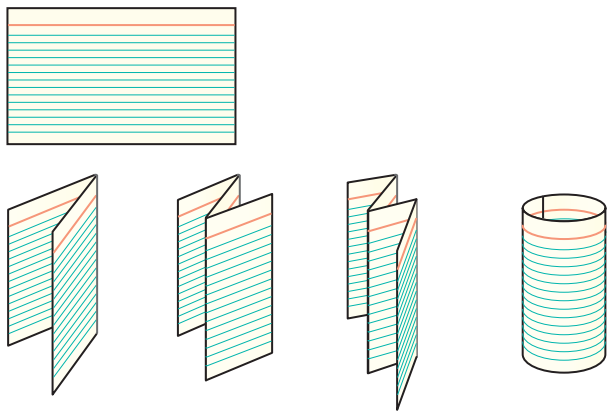
In this lab, you will:

1. Make paper folds that are sharp and uniform.
2. Keep a record of the maximum loads carried by each of the columns.
3. Observe the influence that each shape has on the column's load-carrying ability.

Design Your Project

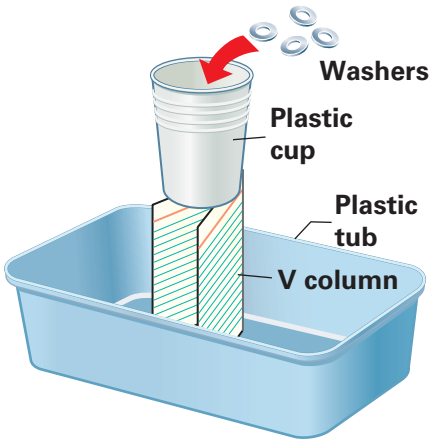
Follow these steps to design your project and complete this lab.

1. Look at the drawing of column shapes. Call them V (one fold), N (two folds), M (three folds), and O (tube). Your folded cards will look like the letters when viewed from the top.



V Column N Column M Column O Column

2. Weigh the plastic cup on the scale. Then weigh ten washers or bolts. After you know what ten of them weigh, you will be able to calculate how much 20, 35, or any other number will weigh. Do not mix types of weights. Use only washers or only bolts.
3. Now you are ready to start the experiment.
   - Fold one card into a V and place it in the plastic tub.
   - Carefully set the plastic cup on top of the folded card. If necessary, use a rubber band to help your V column keep its shape.
   - Slowly and carefully, add weights to the cup as shown in the illustration.
   - Eventually, the column will collapse and scatter the washers or bolts in the tub.
   - Collect and count them, and then calculate the maximum load supported by the V column. It will be a small amount, but add in the weight of the plastic cup.
4. Repeat the experiment for the N column and the M column.
5. Make the O column using a rubber band to hold its shape. Repeat the experiment.



Evaluate Your Results

After you complete the lab, answer these questions on a separate piece of paper.

1. Of the V, N, and M columns, which one carried the largest load? Why?
2. Did the O column carry a smaller or larger load than the folded columns carried?
3. What conclusions can you draw about column design from this lab experiment?

Academic Skills Required to Complete Lab

Tasks	English Language Arts	Math	Science	Social Studies
Weigh washers, bolts, and cup.		✓		
Do experiment, counting the number of weights each column could hold.		✓	✓	
Calculate the actual weight each paper column could hold before breaking.		✓		
Consider the relationship between column shape and strength.	✓		✓	