DYNAMIC SKYSCRAPERS

AT A GLANCE

Students design, build, and test model skyscrapers as they learn about forces that affect real skyscrapers.

OBJECTIVES

Students will:

- Learn that engineers must consider dynamic loads which include wind, earthquakes, and other forces when designing skyscrapers.
- Learn how different design elements play into the structural integrity of a building.
- Use critical thinking skills to evaluate structural design.

KEY VOCABULARY

Skyscraper, engineer, dynamic loads, force, structural design, blueprint.

SUGGESTED GRADE LEVELS: 4—8

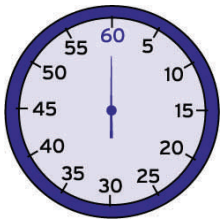
ILLINOIS STATE LEARNING GOALS

7: A, B, C; 9: A, B; 11:A, B; 13:A, B

PACE YOURSELF

60 MINUTES

Depending on the level of your students and the materials you choose to use



ADVANCE PREPARATION

1. Designate a table in front of the class where students can test their building's ability to withstand strong wind. Place two hair dryers or fans on the table.
2. Designate a second table in front of the class where each group can test their building's ability to withstand an earthquake.
3. Construct a skyscraper that is 61 cm tall or tape two or more paper clips together to use in the demonstration.

MATERIALS

Per Class:

Pictures of skyscrapers
Four or more meter sticks
Two tables
Two hair dryers or fans
Building supplies such as:

balsa wood	wood glue	straws
popsicle sticks	newspaper	tape
Q-Tips	rubber cement	paper clips
toothpicks	card stock	pipe cleaners
paper or plastic cups		playing cards

WHAT YOU NEED TO KNOW

When designing buildings, engineers must consider dynamic loads which are loads that can change quickly over time. Wind and earthquakes are two examples of dynamic loads.

As wind hits the side of a building, it puts pressure on the front of the building and creates suction at the rear of the building. Therefore, if a building and its windows are not designed correctly, a strong gust of wind could push the building's windows in on the windward side and blow them out on the opposite side. Buildings must be flexible enough to absorb this force, but if a building is too flexible, people on the top floors may get sick from feeling the building sway back and forth.

The effect of an earthquake on a building is similar to the effect of strong wind. However, wind usually blows in smooth gusts but earth quakes act in a quick jerk, making them more dangerous. This is because a sudden applied force is greater than a force applied

slowly. With an earth quake, a sudden change in force can cause structures to collapse, so buildings in earthquake areas must be constructed stronger to avoid collapsing.

WARM UP

The term “skyscraper” was first used in the 1880s after the first tall buildings were constructed in the U.S.

1. Show students pictures of skyscrapers or tall buildings like the Willis (Sears) Tower or John Hancock Center. Ask students, “What do engineers need to think about when designing and constructing tall buildings? What challenges will their skyscrapers have to withstand?” (Answers will vary but should include forces such as wind, earthquakes, rain, snow; loads such as people, furniture.)
2. Discuss dynamic loads with students (refer to the What You Need to Know section).

ACTIVITY

1. Tell students they will be working in engineering teams to design and construct a 61 cm tall skyscraper that must be able to withstand two different dynamic loads: strong winds and earthquakes.
2. Demonstrate what students will do with their model skyscrapers at the two testing stations. At the “wind” table, place your skyscraper in the center of the table, point one hair dryer or fan at it and turn it on. If your skyscraper is strong enough to withstand the wind from one hair dryer, try two hair dryers. At the “earthquake” table, place your skyscraper in the center of the table. Students will stand around the table and gently shake the table to simulate an earthquake.

Decide what building materials will work best for you and your students. Newspaper and tape make quick and easy building materials, but if you have more time and money, try more complex materials like balsa wood and wood glue.

3. Divide students into groups of two to four.
4. Give students five minutes to brainstorm what their building will look like and to draw a blueprint.
5. Pass out building supplies.
6. Give students 30 minutes to build their 61 cm tall skyscraper.
7. After 30 minutes, allow groups to test their buildings one at a time in front of the whole class.

WHAT’S HAPPENING?

In the real world, wind speeds increase with height so wind blows faster at the top of a skyscraper than at the bottom. A heavier base will make for a sturdier, more balanced building. Buildings that have more weight at the bottom of the structure than the top will withstand both the wind and the earthquake tests better.

CHECK IN

Have students answer the following questions in their teams or as a whole group.

1. In your own words, how would you describe a dynamic load? What are two examples of dynamic loads?

2. Did your skyscraper pass or fail the wind and earthquake tests? If it failed, what would you do differently? If it was successful, why?
3. Would you want to become an engineer? Why or why not?

EXTENSIONS

Have students draw a picture of their skyscraper and write an advertisement persuading people to live or work in their building.

- How much would rent be?
- What amenities would their skyscraper have?
- Where would it be located?
- What would they name it?

When they are finished, have each group present their advertisement.