Building the Tallest Tower

Difficulty	Easy
Time Required	Very Short (≤ 1 day)
Prerequisites	None
Material Availability	Readily available
Safety	No issues

Abstract

Skyscrapers are impressive structures. What does it take to design a building so tall? Engineers use strong materials and innovative design to push the limits of gravity. In this experiment you will use LEGO® components, rubber balls, and a 3-ring binder.

Objective

In this experiment you will make a shake-table to test if the height of a building will affect its stability.

Materials and Equipment

LEGO bricks

Flat LEGO plate, approximately 10 inches x 10 inches

Ruler, metric

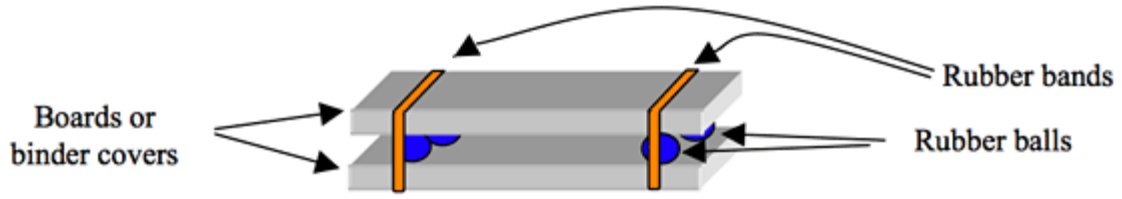
3ring binder

Scissors

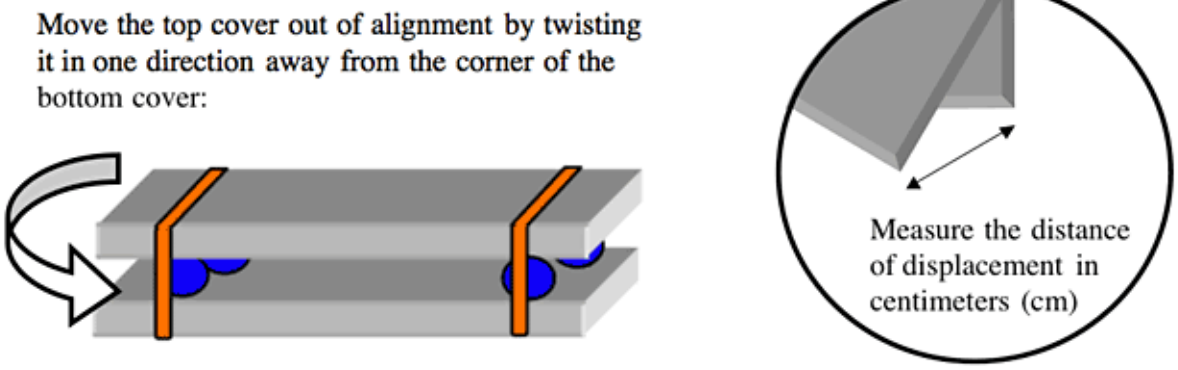
Small rubber balls of the same size, about 1 inch in diameter (4)

Large rubber bands (2)

Experimental Procedure 1. Cut the front and back covers off of a 3ring binder with scissors. 2. Place the two binder covers on top of one another. 3. "Rubber band" the two together by stretching a rubber band around each end, about 1 inch from the edge of the boards. 4. Insert the rubber balls between the boards at each corner, placing them about 5 cm in from the edges. 5. The shaketable should now be assembled as shown in this diagram:



6. Attach a large, flat LEGO mounting plate to the top of your shaketable by slipping it underneath the rubber bands. This will be where you mount your structures to the shaketable. 7. Build a series of LEGO towers of increasing height. You should use the same base pattern for each tower, so that the size of the tower's footprint does not change and only the height will be different. You can double check this after you are finished by measuring the length and width of the base of each tower, and they should be the same. 8. Measure the height of each tower in centimeters (cm) with the measuring stick. Write the height of each tower in a data table: Tower Height Table Displacement (cm) Did it Fall? (Y/N) 9. To test each tower, place it in the center of the top surface of the shaketable. Then you will pull the top layer of the shaketable out of alignment and then let it go to create a lateral shaking movement. 10. The distance that you pull the top layer away from the bottom layer is called the "Displacement" and you should write this in your data table. Use a ruler to measure how far you have pulled the top layer out of alignment before you let go. 11. Test each tower with increasing "Displacement" values until you find out when the tower will fall.



Compare your results. Did all of the towers fall at the same "Displacement" values or were there differences? Did tall towers have different values than short towers? Variations In this experiment you made the footprint of each tower the same, and only changed the height. Do you think that by changing the footprint you could make taller buildings more stable? Try making taller buildings with different sized bases to test this idea. Another factor is the ratio of the area of the base of the building to the height of the building. You can calculate the area of the base by multiplying the length times the width in centimeters. Then you can calculate the ratio by making a fraction of base: height. Build different towers with different ratios and test them on your shake table. Try building towers out of a different

material that allows you to test different structural designs. Good ideas are using straws, popsicle sticks, or toothpicks and marshmallows. Try comparing square designs to triangular or hexagonal designs. Try adding extra structural elements to your design. Can you design a more stable tower? How tall can you build it before it loses stability?