Deformation: Foam Compression

Subject Area(s): Physics, mathematics, measurement, and engineering

Associated Unit: None

Associated Lesson: None

Activity Title: Determining the compression of various foams

Header: Insert image 1 here, right justified to wrap

Image 1

ADA Description: Lego compressor design with motor

Caption: Compressor system

Image file name: foamcompression_image1.jpg

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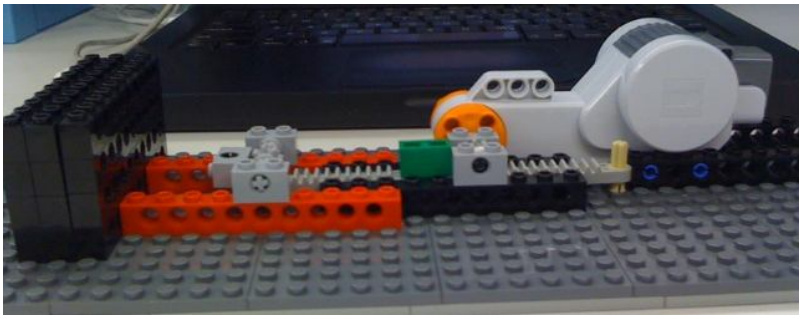

Level: 5 (4 and 6)

Activity Dependency: None

Time Required: 50 minutes

Group Size: Five

Expendable Cost per Group US $3.00

Insert Image 2 here, centered

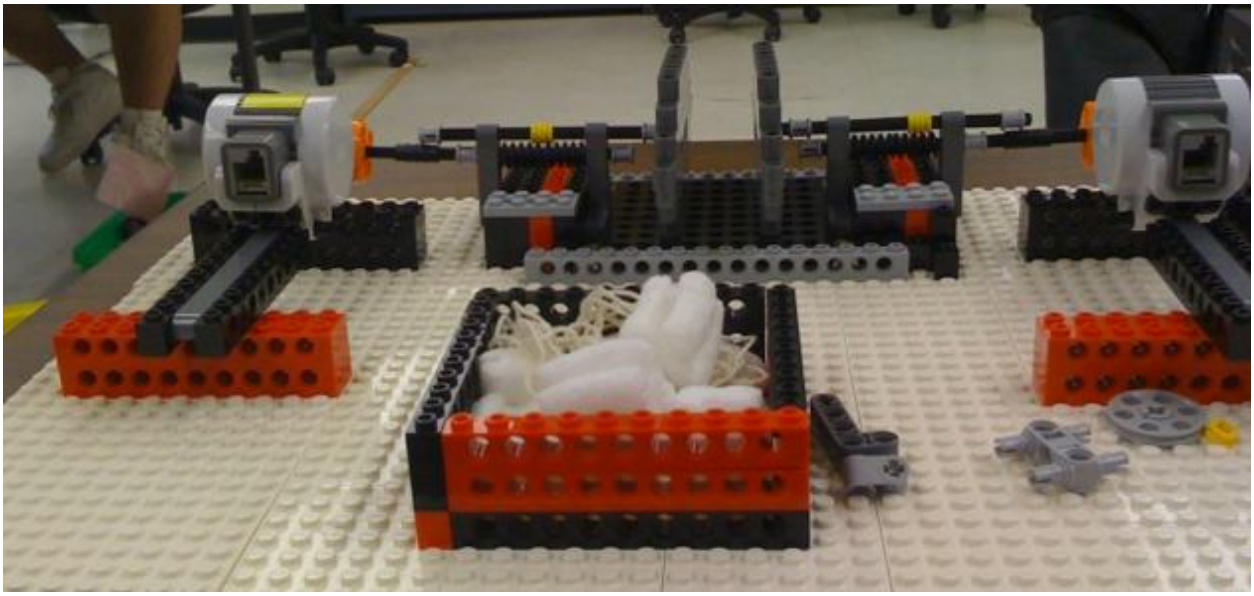

Image 2

ADA Description: One other type of robotic compressor

Caption: Robotic compressor

Image file name: Robotcompression_image2.jpg

Summary

Students will work as engineers and learn to conduct controlled experiments by changing one experimental variable at a time and study its effect on the outcome of the experiment. Specifically, they will conduct experiments to determine the amount of motor rotations it takes to compress a soft nanocomposite such as foam, marsh mellow and possibly dough. Students will measure the length and width of the object and also measure the change in length and width as a function of motor rotations to compress the object. Students will look at different objects and understand how they can compress a material.

Engineering Connection

Students will learn to design a setup for engineering experimentation. Specifically, they will design their own robot and write their own programs for the robot and determine the amount of rotations it takes to compress an object. Stress is simply the amount of force applied to an object over a given area. Strain is simply the amount an object stretches when a stress is applied. Moreover, by changing the design of the robot they will figure out what design features will help compress their object of interest.

Engineering Category

Relates physics to engineering

Keywords

Nanocomposite, Motor, Rotations, Compression, Stress and Strain

Educational Standards

- New York State Standards
  - New York science: 4.4, 4.5
  - New York math: 3.1, 3.2, 3.3, 3.5
  - New York Technology 5.1, 5.3, 5.4

Pre-Requisite Knowledge: Division, multiplication, and basic concept of function

Learning Objectives

After this activity, students will be able to:

- Design a Lego robot with a two motors to compress an object
- Program a robot with NXT MindStorms software
- Design a robot that compresses objects
- Open up MinStorms Data logging program with the rotation sensor and find out how many rotations it takes to compress the object
- Calculate the amount of stain on the object, using the formula below (L = Length)

$$\text{Strain} = (L_{\text{change}})/ L \qquad \text{(Eq. 1)}$$

Materials List

Each group needs:

- Lego NXT Kit
- Two NXT bricks
- Calculator
- Ruler

To share with the entire class:

- Computer with NXT MindStorms programming software
- Computer with NXT MindStorms Data logging Program

Introduction / Motivation

The term compression is often used to describe the deformation of a material. Here we will determine the amount of rotations it takes to compress an object. Here we will try to determine the amount of compression using a rotation sensor with the MindStorms Data logging Program. Then, we will adjust the robot till we get optimal compression for a given object. Students will determine the amount of strain on a given object by measuring the change in length of a material.

Students love watching objects be compressed. In this experiment, they will learn about all the math and science that goes into compression. They will make their own robotic creations and their own program that will cause the robot to compress an object. Students will also learn the importance of each variable in the outcome of the experiment. Thus, they will look at the important factors that will compress an object properly.

Vocabulary/Definitions

Word	Definition
Length	The measure of how long something is from one end to another
Compression	A system of forces that decrease the volume of an object
Force	The push or pull exerted on a given object
Deformation	
Stress	The amount of force exerted on a give area
Strain	The change in dimensions of a given object when influenced by an external force
Rotation Sensor	An NXT device that can measure rotation of an axel (16 positions per rotation)

Procedure

Before the Activity

1. Have the students design their own robot that will be used to compress an object.
2. Have the students program the robot and show that they can compress and object
3. Go over MindStorms Data logging program and show how the rotation sensor works in the program
4. Teach the students the vocabulary words in the vocabulary box provided above
5. Ask students how many rotations it will take to compress objects provide
6. Ask students to work with all materials provided
7. Divide students into groups and assign each group member a task.
8. Make sure each student has the handout for the activity.

With the Students

1. Show the students compression have them make observations about number of rotations.
2. Have the students design their compression robot along with their Mindstorms program.
3. Have the students work with the rotation sensor in MindStorms Data logging program.
4. Measure the amount of rotations for an object using the MindStorms Data logging and have them calculate strain using equation 1.
5. Once all data has been obtained for one object begin to look at other objects and calculate strain with equation 1.
6. Have the students discuss what they have learned from the experiment and have them fill out their conclusions in the lab report.

Attachments

Compression_Teach Engineering.doc
Compression_Teach Engineering handout.doc
Compression_robot_image1.jpg
Compression_robot_image2.jpg
Compression_robot_image3.jpg
Compression_robot_image4.jpg

Safety Issues

- Be careful not to touch gears when compressor is running MindStorms program are running

Troubleshooting Tips

Make sure that the number of rotations are accurately determined in the MindStorms Data logging program

Investigating Questions

Which was easy to compress? Why? How did the strain change with the different objects? What can be said about an object, which has more rotations and more strain?

Assessment

Pre-Activity Assessment

Guessing game: Ask them to predict which object requires the most rotations?

Activity Embedded Assessment

Design a robot: Tell the students to make a connection between object and number of rotations? How does the strain change with the objects?

Post-Activity Assessment

Tuning the equation: Challenge the students and ask them to relate the strain of an object to the stress on an object. See if they can make an equation that relates stress to strain

Activity Scaling
- For lower grades: None
- For upper grades: None

Additional Multimedia Support
None

References
Hewitt, Paul. Conceptual Physics. New Jersey: Prentice Hall, 2002.

Zitzewitz, Paul. Physics Principles and Problems. Ohio: McGraw-Hill, 2002.

Other

None

Redirect URL

http://gk12.poly.edu/amps/

Owners
Jennifer S. Haghpanah

Contributors
Jennifer S. Haghpanah

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