

NEED SOME SUPPORT? — LEARNING FACILITATOR'S GUIDE

Introduction

This activity will highlight the STEM career of structural engineering. The activity includes a three-minute video which features a black female engineer discussing this branch of engineering. Encourage the participants to view the video.

Structural engineering is that part of civil engineering in which structural engineers are educated to create the 'bones and muscles' that create the form and shape of man-made structures (Wikipedia)

In the role of a structural engineer, participants will be designing and testing a model of a pier or pillar foundation that will elevate a building. Prior to that effort, they will try out two “shapes” to consider utilizing in their design.

Although several forces will act on their pier or pillar foundation, the main force, and the one discussed in the activity is compression.

The application of a compression force to an object causes it to become squashed or compacted. Some solid materials like stone and ceramics can withstand very large compressive forces with very little measurable deformation which make them a suitable building material for the construction of high walls and columns. (Ask.com) Participants in this activity will try to use the supplied materials to produce piers or pillars that will withstand the compression caused by the gravitational force (weight) of five (or more books).

Do not be surprised if the budding civil engineers succeed in designing a foundation that hold many more than five books!

Safety note

A minor safety concern is that the books stacked on the foundations will eventually fall. Participants should be warned to be careful that they do not fall in a way that could hurt someone.

Preparation

1. Materials:

- Masking tape – about 15 inches
- 3x5" index cards – four to experiment and ten for final design
- 8 ½" x 11" sheets of paper – one to draw prototype, one to tape foundation upon
- Books – at least five. Also, as noted above, participants may design very strong foundations that they may want to test with more books. Ideally, the books will be of a uniform size and shape: textbooks, encyclopedia volumes, etc.
- Scissors (although some will not use them)

2. Learners should not be permitted to use other materials. An important aspect of this activity is the limited materials, especially the length of tape.

3. Timing – If allocating 75 minutes for this activity, the approximate breakdown of the time should be:

20 minutes – introduction and experiments

45 minutes – design, build/construct and test

10 minutes – closing questions and follow-up

Note – this activity can be completed in as little as an hour or a longer time may be allotted if participants iterate upon their designs.

The Design Challenge Notes

1. The answers to Develop Knowledge about Foundations; Self Quiz

1. What is a foundation?

- The floor of a building that houses the executives
- The place that people park
- The lowest part of a building that you can see out of
- The lowest part of a building that supports weight

2. Which is NOT a purpose of a foundation?

- Keeping the structure dry
- Providing storage space
- Supporting the weight of the structure
- Keeping the structure standing upright

3. Which of the following forces do civil engineers need to think about when they design foundations?

- The force of the weight of the building on the foundation
- The force of the earth on the foundation
- The force of compression
- All of the above

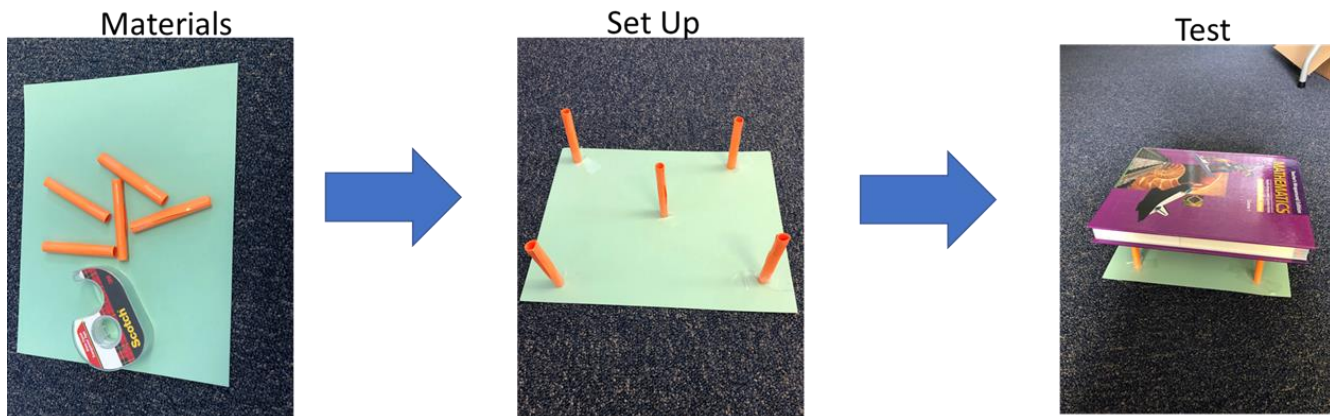
2. Steps Test Foundation Shape A and B

Answers may vary. Accept all responses.

Typically, for both the cylinder and triangle shapes, the first answer will be, "The card resisted until I pushed hard." For the second, answers will typically be, "The card bent in the middle." Some learners will find the cylinder will be better, others the triangle, and still others will find no difference. The crease added to the cylinder and triangle usually causes the structure to weaken. This should teach them to be careful when they roll and/or fold their materials when they build their foundation design.

3. As always, it is very important for participants to discuss, think, plan, and draw before they build. **DO NOT PROVIDE THE MATERIALS UNTIL THEY SHOW YOU THE SKETCH OF THEIR DESIGN!**

4. Once they are ready to start building the process will look like this:



4. The criteria that will be utilized to evaluate the designs: - Notice that for two of the criteria; the ratings are 1 to 4 and that there are “bonus points” for cost:

Foundation Rating	1	2	3	4
Strength	Able to support 0-1 books	Able to support 2-4 books	Able to support 5 or more books	Able to support 10 books
Stability	Crumbled/fell apart when weight applied	Able to bear weight of 5 books, but did worse over time; did not last 15 seconds	Able to bear weight of 5 books for 15 seconds	Able to bear weight of 10 books for 60 seconds
Height	0-2 inches	2-4 inches	5 inches or more	
Bonus--Cost	Uses all the materials provided	Uses half of the materials	Uses less than half of the materials	

Reflection

As with all the activities, the reflection part is crucial to the participant's experience. They will rate their design and contemplate how it could be improved.

Final notes:

If time allows or if additional sessions can be scheduled, three important aspects of engineering can be addressed:

1. Sharing of ideas and designs.
2. Engineering is iterative. It would be great if participants could go back and “try again:” modify their design, use new ideas – ultimately try to improve on their work.
3. What it's like to be a structural engineer.