

Lesson 2: Bridging the Gap, How do bridges stay up?

Lesson Snapshot

Overview, Grades 6-8

Big Idea: The forces act upon a structure. When designing, engineers must understand and predict the forces of compression and tension in order to keep a bridge standing.

Teacher's Note: Big ideas should be made explicit to students by writing them on the board and/or reading them aloud.

Purpose of Lesson: For student to develop an understanding for analysis and optimization.

Selected Learning Objectives: Students will learn to:

1. Describe the forces of static and kinetic loads that influence how a structure is designed and built.
2. Evaluate basic bridge designs and identify where the structure will in tension, compression and torsion.

Lesson Duration: Four to Six (50 min) Class Periods

Activity Highlights

Engagement: Students, working in pairs, will attempt to make the most cost effective bridge on West Point Bridge Designer.

Exploration: Students, in groups of three, will research, present, and replicate a historical Indiana bridge.

Explanation: The teacher will present an overview on forces that act upon bridges and identify specific engineering case studies that address these forces.

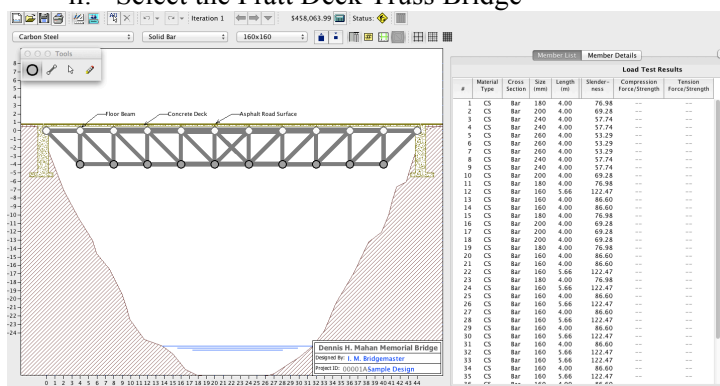
Extension: Students, working in pairs, will design bridge using balsa wood members. The students will evaluate where their bridge is under tension and compression.

Enrichment: Class will discuss the effects of natural disasters on bridges.

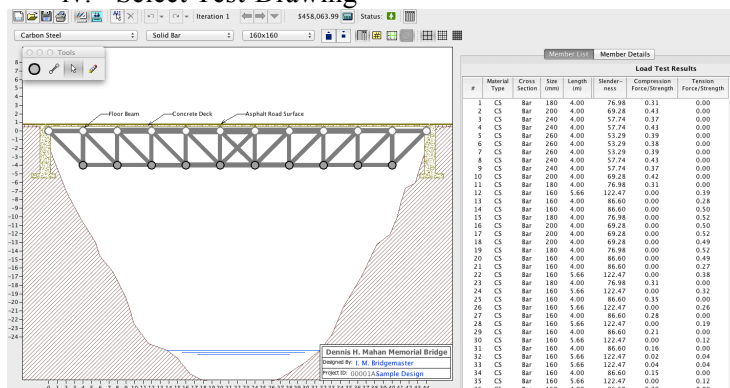
Lesson 2: 5-E Lesson Plan

Engagement

1. Teacher set up:
 - a. Computer Software: West Point Bridge Designer
 - i. <http://bridgecontest.usma.edu/>
 - b.
2. Students, working in pairs (2), will explore the West Point Bridge Designer Software.
 - a. Students will begin:
 - i. Load a sample bridge
 - ii. Select the Pratt Deck Truss Bridge



- iii. Select Test-Load Test
 1. View Animation
- iv. Select Test-Drawing



3. Students will discuss what they noticed during the animation.
 - a. What colors were present?
 - b. What do you think the colors mean?
 - c. Why did the bridge bend?
 - i. Do real bridges bend like the animation?
4. Students will report out about what they viewed in the animation.
5. Teacher will list what the student discussed on the board.

Exploration

1. Students, working in pairs, will view bridges of Indiana online at:
 - a. <http://earchives.lib.purdue.edu/cdm4/browse.php?CISOROOT=/inbridge>
2. Students will discover 10 unique bridges and record way they are unique from other bridges on the website. Student Resource 1, Lesson 2

3. Students will attempt to recreate 3 bridges they discovered on West Point Bridge Designer.
 - a. Each bridge must be unique.
 - b. Each bridge must be tested.
 - c. Record if the bridge was successful or failed.
4. Students will present on one original bridge and the West Point Bridge model to the class.
 - a. Presentation will include:
 - i. Which bridge the student selected
 - ii. Why the student selected that bridge
 1. Interesting
 2. Easy to replicate
 3. Familiarity with bridge design
 - iii. West Point Replication
 1. How the original bridge is similar and different from the WP model.
 2. Difficulties the student had while creating the bridge.

Explanation

1. The teacher will present on forces that affect bridge structure.
 - i. Teacher Resource 1, Lesson 2

Extension

1. Students, working in pairs, complete a physical bridge model.

Enrichment

1. Discuss:
 - a. How bridges are designed differently around the world.
 - b. Why some bridge materials are used instead of others.

Bridging the Gap

How do bridges stay up?



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Bridges don't always stay up

- Forces act on a bridge
- Engineers must *design* bridges that account for these forces.
- Forces can come from many sources.
- Can you think of any?
 - Cars
 - Bridge Materials
 - Wind? Earthquakes?



Tacoma Narrows Suspension Bridge
“Galloping Gertie”

<http://www.youtube.com/watch?v=j-zczJXSxnw>

Forces on a Bridge



- **Compression**

- Squeezing force on a material



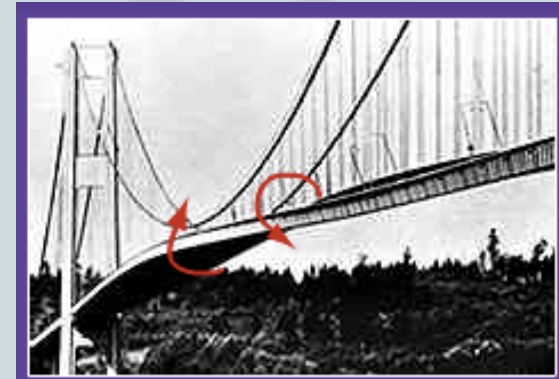
- **Tension**

- Pulling force on a material



- **Torsion**

- Twisting force on a material

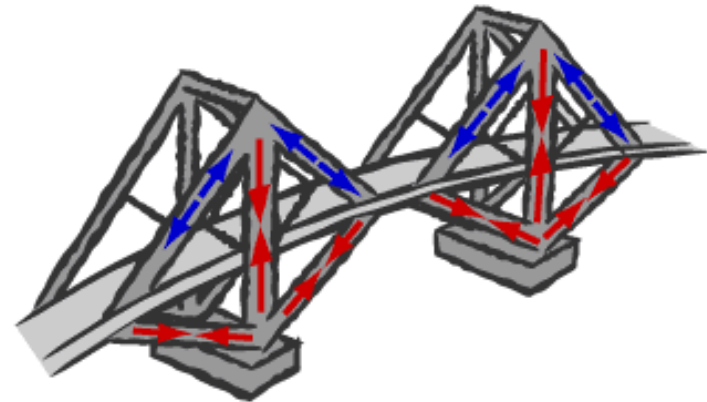


Dealing with Forces

Design

Bridge design allows for the dissipation or transfer of these forces.

- **Dissipation**
 - The spreading out of force over a large area to reduce specific impact.
- **Transfer**
 - The movement of forces to a specifically designed area to account for force extremes.



Revisit the Historical Bridges of Indiana



Extension Activity

- Revisit your West Point Bridge Designs
 - Select the most efficient design.
- Create a Physical Model
 - <http://earchives.lib.purdue.edu/cdm4/browse.php?CISOROOT=/inbridge>
 - Utilizing materials provided by the instruct, build a physical model of your bridge design.
 - Add a downward force on your physical model and color code where forces are acting compared to your West Point virtual model.
 - ✦ Blue – Tension
 - ✦ Red - Compression
 - Guess where your bridge will fail based on what you see in the bridge builder software.
 - Apply force until your bridge fails (breaks).
 - ✦ Was your guess correct?
 - ✦ How can you better predict where your bridge will break?

Enrichment



- Visit:
<http://www.eduweb.com/portfolio/bridgetoclassroom/engineeringfor.html>
- How might a natural disaster change you bridge design?
- Discuss:
 - How bridges are designed differently around the world.
 - Why some bridge materials are used instead of others.

Exploration: Bridges of Indiana

Instructions:

1. Visit the following website, Purdue University, e-Archives
 - a. <http://earchives.lib.purdue.edu/cdm4/browse.php?CISOROOT=/inbridge>
2. Search and list, by title, 10 bridges based on a bridge style and record what material the bridge was constructed with. See Example.

	<i>Bridge Title</i>	<i>Bridge Material</i>	<i>Bridge Style</i> “What does the bridge in the picture look like?”
Ex.	Clinton, Indiana, Road 63 [63-D-91A; Contr. 2276] Wabash River	Iron and steel	3 Arches
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			