



Load It Up

All Aboard: History, Culture, and Innovation on the Florida East Coast Railway

Grade Level:

6th Grade

Materials:

- Book:
Bridges! Amazing Structures to Design, Build and Test by Carol A. Johnson and Elizabeth J. Rieth
- Photo of:
Henry M. Flagler
- The Bridge Designs Introduced in the Book
- Map of:
The FEC Railway Showing the FEC Extension
- The FEC Extension to Key West
- Additional Supplies:
Straws
Paper Clips
Paper
Colored Pencils

Curriculum Connections:

Math, Reading, Science, Social Studies, Florida Education

Objectives:

Students will understand basic structural concepts related to bridge building by learning about the forces of tension and compression and how shapes aid in strengthening a structure.

Standards:

SS.6.G: Geography
SC.6.P: Physical Science
VA.68.C: Critical Thinking and Reflection
VA.68.H: Historical and Global Connections
VA.68.F: Innovation, Technology, and the Future

Corresponding Map Hot Spot:

Seven Mile Bridge, FL

Lesson Procedure

Introduction:

Bridges are essential components of our transportation system, especially in the Florida Keys.

Introduce the Overseas Railway by using the map and pictures of the railroad to have a discussion about the importance of bridge structures. Use the pictures of the failed bridges and the guiding questions below to introduce the topic of sound bridge structures.

Guiding Questions:

- What do you think happens to a structure if the forces acting upon it are too much for it to withstand?
- What are some examples of loads that bridges need to be able to hold?
 - Possible answers: people, cars, trucks, environmental strains such as wind, rain, ice, etc.
- What would happen to the normal course of your life if one day all the bridges suddenly collapsed?
- What kinds of problems would this cause?

Understanding Compression and Tension:

Compression and tension are forces that act upon bridge structures. Have students pair up.

Compression:

Have the student pairs stand face to face and press their palms together at about shoulder height. Then tell them to slowly lean into each other. Ask them to describe what they feel and what they think is causing it.

Tension:

While standing and facing each other, have student pairs grab hands and gently lean away from each other. Ask them to describe what they feel and what they think is causing it.

Strength in Shapes Activity:

Show the students the pictures of triangles and arches in bridges and discuss how these shapes provide strength to structures using this guiding question:

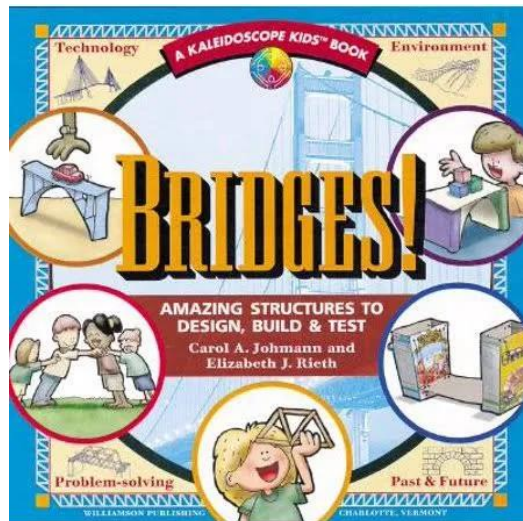
1. How do you think these shapes impact the designs that engineers choose for bridges?

Have students work in groups of two or three and give each group 7 straws and 14 paper clips. Tell them they will need to use these supplies to build a triangle and a square.

Once they have these shapes completed, ask them to predict which shape will be stronger, the triangle or the square. Now ask them to stand each shape up and press down on the top corner.

- What happens?
- How hard can you press down on each shape before it collapses?

Now show the students different types of bridges (arch, beam, truss, etc.) using the book, *Bridges! Amazing Structures to Design, Build and Test* by Carol A. Johnson and Elizabeth J. Rieth and sketch them out on chart paper. Pass out paper and colored pencils and ask them to sketch a bridge that would use shapes that withstand compression and tension forces.



Additional Resources:

[Overseas Railway Timeline](#)

This timeline on the Key West Art & Historical Society's website provides additional information about Henry M. Flagler's life, career, history and the development of the Florida East Coast Railway and extension to Key West, Florida.

[Online Collections Database](#)

With a collecting history that extends back to 1949, the Key West Art & Historical Society has unrivaled collections of contemporary and historic art and artifacts. Its collections, which number more than 35,000 works in all media, range from historical to present-day and span the entire Florida Keys.

Florida East Coast Railway Showing the Key West Extension

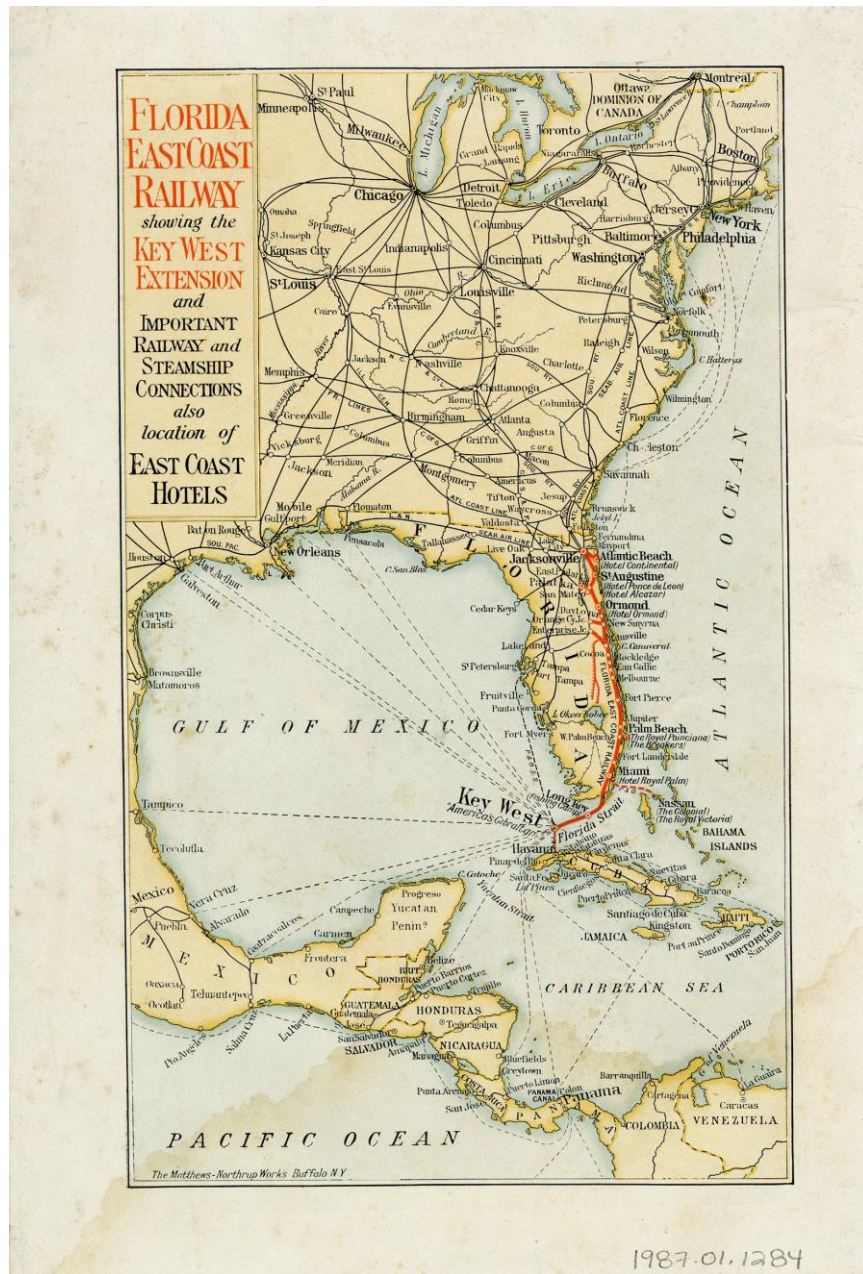


Photo: Key West Art & Historical Society

Florida East Coast Railway Key West Extension



Photo: Florida East Coast Railway

Henry M. Flagler



Photo: Key West Art & Historical Society

Types of Bridges

Beam Bridge:

Beam bridges are the simplest structural forms for bridge spans. The weight of the load is passed along the beam, and down through the bridge supports to the ground.

Source: *Bridges! Amazing Structures to Design, Build and Test*

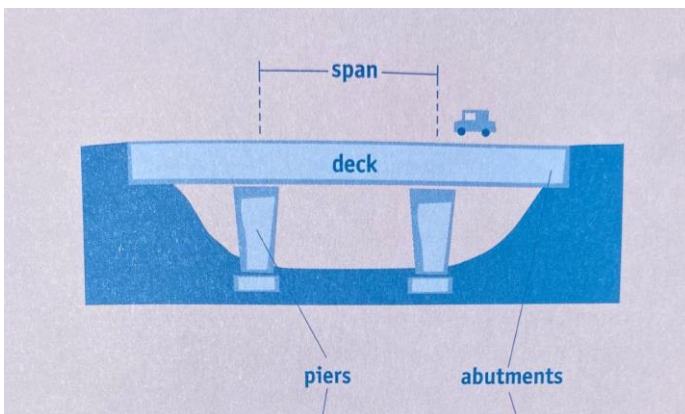
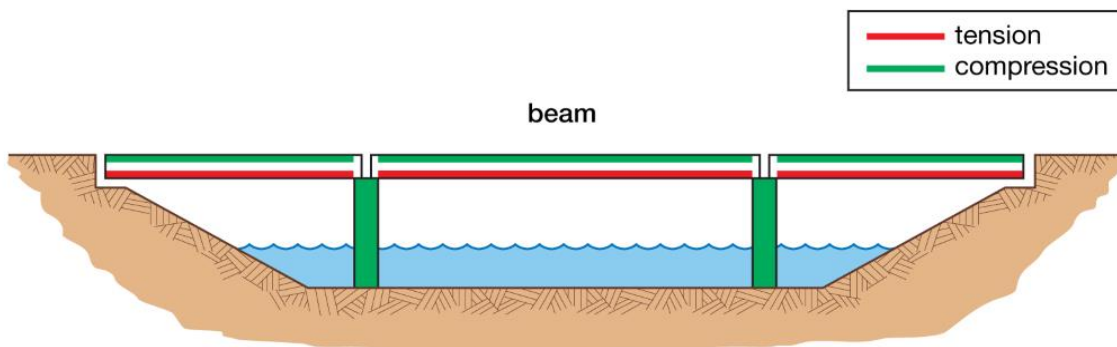


Photo: (left) *Bridges! Amazing Structures to Design, Build and Test*
(right) Broward County Library Digital Archives

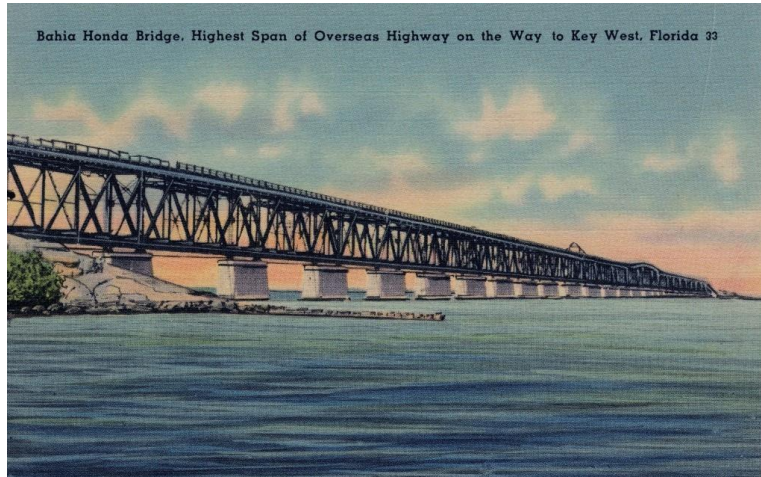


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Types of Bridges

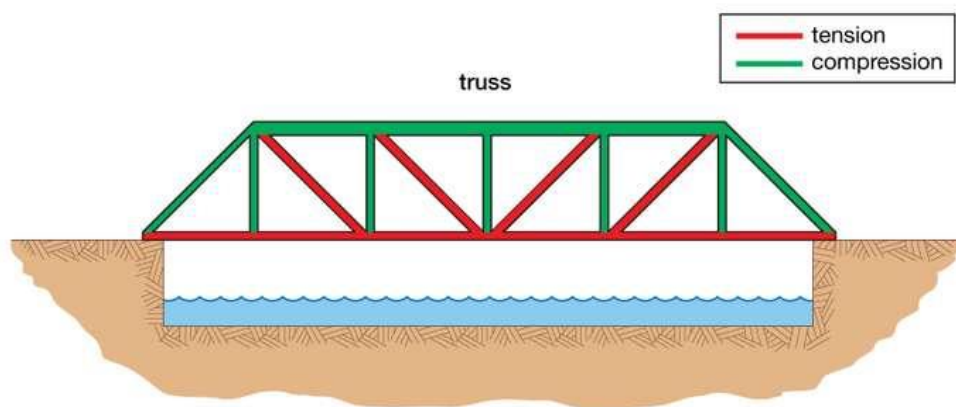
Truss Bridge:

A truss bridge is similar to a beam bridge. The truss is a lightweight option added to the top or bottom of the structure to provide additional support.



Bahia Honda Bridge, Highest Span of Overseas Highway on the Way to Key West, Florida.

Photo: Key West Art & Historical Society



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Types of Bridges

Suspension Bridge:

The load pulls down on hangers, which pull on cables. The cables pull on the towers and anchors, and the anchors pull back, or resist the pull on them, because they are heavy and buried in the ground. All of these parts are in tension. The towers are also compressed and as the cables push down on them and their foundations.

Source: *Bridges! Amazing Structures to Design, Build and Test*

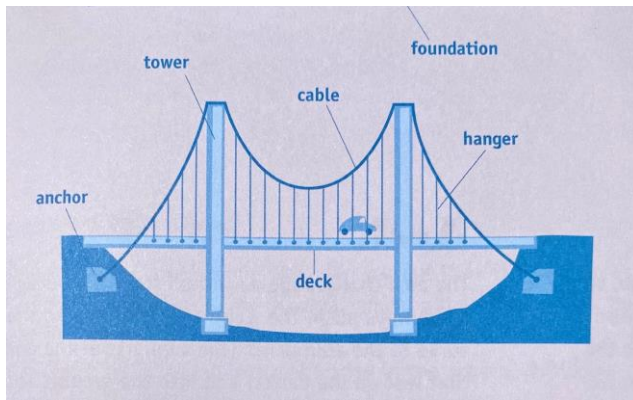


Photo: (left) *Bridges! Amazing Structures to Design, Build and Test* (right) The Golden Gate Bridge, Golden Gate Bridge Highway & Transportation District



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Types of bridges

Arch:

The arch changes the downward force of gravity into a sideways push. The weight is carried along the curve to the abutments and into the ground. This creates lots of compression, but little tension.

Source: *Bridges! Amazing Structures to Design, Build and Test*

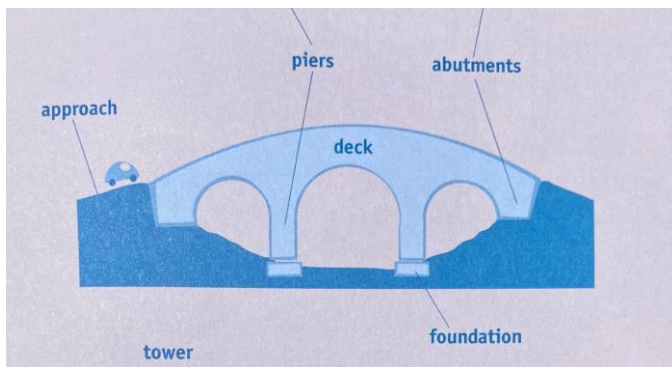
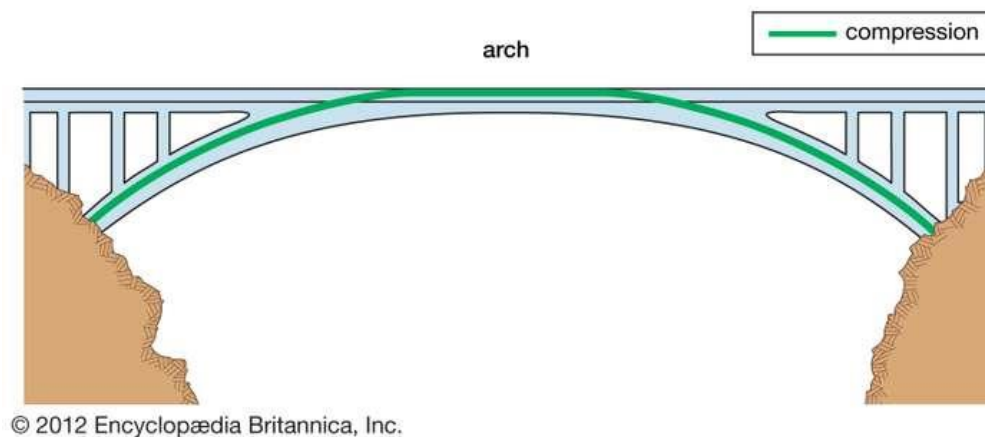


Photo Source: (left) *Bridges! Amazing Structures to Design, Build and Test*
(right) Key West Art & Historical Society



Failed Bridges

The Tacoma Narrows Bridge



The Tacoma Narrows Bridge is located in Tacoma, Washington and originally opened on July 1, 1940. Four months later, excessive wind, around 40 mph, made the bridge flex back and forth which eventually caused the bridge to break apart. A new bridge opened on October 14, 1950, in the same design. On July 16, 2007, another suspension bridge was built next to the existing bridge. The photo on the right is how it appears today.

Photo: (left) Encyclopædia Britannica
(right) Encyclopædia Britannica

The I-35W Mississippi River Bridge



The I-35W Mississippi River bridge was located over the Mississippi River in Minneapolis, Minnesota and opened in 1967. The bridge collapsed on August 1, 2007, due to a design issue and added weight from being repaved multiple times. On September 18, 2008, the I-35W Saint Anthony Falls Bridge opened, replacing the previous bridge. The photo on the right is the new bridge that was built in its place.

Photo: (left) Wikipedia
(right) Wikipedia

Bibliography:

*Information is in the order that it appears in the document

The Matthews-Northrup Works Buffalo, N.Y. *Map of Florida East Coast Railway*. Circa 1917. Key West Art & Historical Society, Florida. kwahs.pastperfectonline.com/webobject/255FD84A-8976-4EE3-97CE-354071993920.

Florida East Coast Railway. *Key West extension, Florida East Coast Railway, opened January 22, 1912*. Matthews Northrop Works, 1912. doi: www.doi.org/10.5479/sil.56485.39088001792985.

S.n. *Studio Portrait of Henry M. Flagler*. 1904. Key West Art & Historical Society, Florida. kwahs.pastperfectonline.com/photo/3A0FC45E-3C0C-4A56-82B7-243218404905.

S.n. *Photographs - - 1912 - 1935 - - Key West by rail. 1912-1935*. Broward County Library Digital Archives, Florida. <https://digitalarchives.broward.org/digital/collection/greatdays/id/305/rec/6>.

Encyclopædia Britannica, Inc. *A beam bridge, with forces of tension represented by red lines and forces of compression by green lines*. 2012. Encyclopædia Britannica. www.britannica.com/technology/bridge-engineering.

Tichnor Quality Views. *Bahia Honda Bridge, Highest Span of Overseas Highway on the Way to Key West, Florida*. Circa 1940s. Key West Art & Historical Society, Florida. <https://kwahs.pastperfectonline.com/webobject/59E43A34-71A6-485E-8CA3-534408430138>.

Encyclopædia Britannica, Inc. *A single-span truss bridge, with forces of tension represented by red lines and forces of compression by green lines*. 2012. Encyclopædia Britannica. www.britannica.com/technology/bridge-engineering.

Golden Gate Bridge Highway & Transportation District. *Golden Gate Bridge*. N.d. Golden Gate Bridge Highway & Transportation District, California. <https://www.goldengate.org/contemporary-photos/>.

Encyclopædia Britannica, Inc. *A suspension bridge, with forces of tension represented by red lines and forces of compression by green lines*. 2012. Encyclopædia Britannica. www.britannica.com/technology/bridge-engineering.

S.n. *Overseas Railway Train on Long Key Viaduct*. Circa 1920s. Key West Art & Historical Society, Florida. <https://kwahs.pastperfectonline.com/photo/A6BB0F78-C722-4A4F-92C1-579277521046>.

Encyclopædia Britannica, Inc. *An arch bridge, with forces of compression represented by the green line*. 2012. Encyclopædia Britannica. www.britannica.com/technology/bridge-engineering.

Encyclopædia Britannica, Inc. *Collapse of the Tacoma Narrows Bridge, Washington state, 1940*. 1940. Encyclopædia Britannica. <https://www.britannica.com/topic/Tacoma-Narrows-Bridge>.

Encyclopædia Britannica, Inc. *The Tacoma Narrows Bridge, Washington state*. N.d. before 2016. <https://www.britannica.com/topic/Tacoma-Narrows-Bridge>.

Wills, Mike. *The scene at the I-35W Mississippi River Bridge, the first morning after its collapse*. Morning of August 2, 2007. Flickr. www.commons.wikimedia.org/w/index.php?curid=2509174.

Baseball Bugs. *I-35W new bridge*. September 20, 2008. Wikipedia. commons.wikimedia.org/w/index.php?curid=6018900.