

Cable-Stayed Bridges Presentation Outline

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Period 5

Reviewed by John on 9/10

Comment [j1]: The only thing that I see missing is a slide that wraps up "convincing evidence for your choice of design." You don't actually show them your specific cable-stayed bridge design and why it's best for the location. You also don't note any charts or graphs in this outline. Will there be any included?

What is a Cable-Stayed Bridge?

- A cable-stayed bridge, one of the most modern bridges, consists of a continuous strong beam (girder) with one or more pillars or towers in the middle
- Cables stretch diagonally between these pillars or towers and the beam
 - These cables support the beam
- The cables are anchored in the tower rather than at the end

Comment [j2]: It would be helpful to have a picture with labels that point out each of these items.

Comment [j3]: I'm not sure what this means.

Two Major Classes of Cable-Stayed Bridges

- Different based on how the cables are attached to the pillars
 - **parallel attachment design**
 - cables are made nearly parallel by having the height of attachment on the pillar be similar to the distance from the pillar along the roadway

[picture of parallel attachment design](#)

Two Major Classes of Cable-Stayed Bridges

- Different based on how the cables are attached to the pillars
 - **Radial attachment design:**
 - the cables all connect to or pass over the top of the pillar.

[picture of radial attachment design](#)

Comment [j4]: So which one did you choose for your design? What are the benefits of one over the other?

Building A Cable-Stayed Bridge

- Many things to think about mathematically:
 - Horizontal distance from tower to point of attachment
 - Height of point of attachment above bridge level
 - Stretched length of cable
 - Angle between cable and tower
- Experiments to consider:
 - Cable needs to be tested to see how its stretch varies with the angle to the vertical
 - an experiment to determine how much a length of cable stretches when it supports a mass

Building A Cable-Stayed Bridge

- The tower of the bridge forms the vertical side of the right triangle
 - The distance between the points of attachment of preceding cables on the tower should be equal
 - Likewise, the points of attachment of the cables on the beam of the span should be equidistant.

Comment [j5]: Picture maybe?

- You can calculate the length of the remaining cables after the first cable has been installed by applying the proportionality concept or the Pythagorean theorem

Comment [j6]: Can you show this somehow?

Building A Cable-Stayed Bridge

- When building a cable-stayed bridge, to figure out how long the cables need to be, engineers either use scale drawings or Pythagoras and trigonometry to find the required length of cable for each section and the angle between the cable and the vertical

Comment [j7]: Some examples would be nice

Tension and Compression – Important!

- The tower is responsible for absorbing and dealing with compression forces
- Tension occurs along the cable lines
- This works because a moving load is not applied evenly across the bridge, and as it moves one set or the other of the diagonals will find itself in tension

[Picture showing tension and compression](#)

Let's Look at Shapes

- Triangles** are one of the shapes used by the attachment of the cables and the beam – this shape is used because of its ability to transfer the tension as the moving load goes across the bridge
- In this bridge, the distance of the cable up the tower is equal to the distance from the tower to connection point on the beam and is a **90 degree angle**
- Triangulated bracing between the cables reduces the amplitude of oscillations
- A **rectangle** is attached at the convergence point of the beam and tower for stability

Comment [j8]: Could you explain what this means?

[Image of shapes](#)

Visions of Cable-Stayed Bridges

[Pictures of Cable-Stayed Bridges](#)

Comment [j9]: Which design did you choose to support?

Let's Look at Combinations of Side Lengths

- The red triangle has two sides of 1" and one side of 1 1/2". If you use what we learned about triangles,
- $a + b > c$; $1 + 1 > 1 \frac{1}{2}$.
- The yellow triangle has two sides of 1 1/4" and one side of 1 3/4". So, $1 \frac{1}{4} + 1 \frac{1}{4} > 1 \frac{3}{4}$
- Both triangles are very close to an equilateral triangle with all sides being equal. This is the strongest triangle.

[Picture of bridge with measurements](#)

Strengths of Cable-Stayed Bridges

- Uses a single support only
- Well-balanced
- Cables can be fabricated separately
- Horizontal loads are contained within the structure
 - Ideal for use when the river banks are fragile

- For example if the banks are **alluvial mud**
- The cables disperse a load across more area easily
 - Cables from nodes on tower to road is variant of a triangle
- **Greater inherent rigidity** of the triangulated cable-stayed bridges

Comment [j10]: What's alluvial mud?

Comment [j11]: What do you mean by this?

Math - Helping Me Understand My World

- Civil engineers need to use a combination of geometric shapes to build the strongest structures
- Extremely important for engineers to carry out the technical calculations necessary to plan a bridge project
 - If the specifications are not correct, the bridge could collapse
- For **medium length spans** between 500 and 2,800 feet, cable-stayed is fast becoming the bridge of choice
 - Modern looking – geometric shapes (eye pleasing as well as necessary for strength)
 - Cost effective

Comment [j12]: You give a lot of good examples of how geometry is important

Comment [j13]: Does this really fit on this slide? Maybe it should go on the one before?

References

Basic Information

- **Bridge from Fact Monster**
www.factmonster.com/ce6/sci/A0808901.html
We got basic information about bridges.
- **Basic Bridge Types from Matsuo Bridge**
www.matsuo-bridge.co.jp/english/bridges/index.shtm
We found information about different bridge types
- **Super Bridge from PBS NOVA Online**
www.pbs.org/wgbh/nova/bridge
We learned about the four major types of bridges..

Comment [j14]: This looks like a great list of resources. I like how you arranged them in categories.

Bridge Design

- **Bridge Basics: A Spotter's Guide to Bridge Design**
<http://pghbridges.com/basics.htm>
We researched diagrams and descriptions of a wide variety of kinds of bridges.
- **Knowhere: Bridges**
<http://www.polymorf.net/engineer23.htm>
We learned about the stability and structure of different bridges.
- **Building Big: All About Bridges**
www.pbs.org/wgbh/buildingbig/bridge/index.html
We explored forces, loads, materials, and shapes of bridges.
- **PBS "Build a Bridge" Game**
<http://www.pbs.org/wgbh/nova/bridge/build.html>
We used the simulation to practice building a bridge.
- **Understanding: Cable Stay Bridge Design**
<http://videos.howstuffworks.com/tlc/28818-understanding-cable-stay-bridge-design-video.htm>
This video was helpful to understand cable stay bridge design.

Photos, Graphs, and Charts

- **Brantacan: Cable-Stayed Bridges**
http://www.brantacan.co.uk/cable_stayed.htm
- **Figg Engineering Group**
<http://www.figgbridge.com>