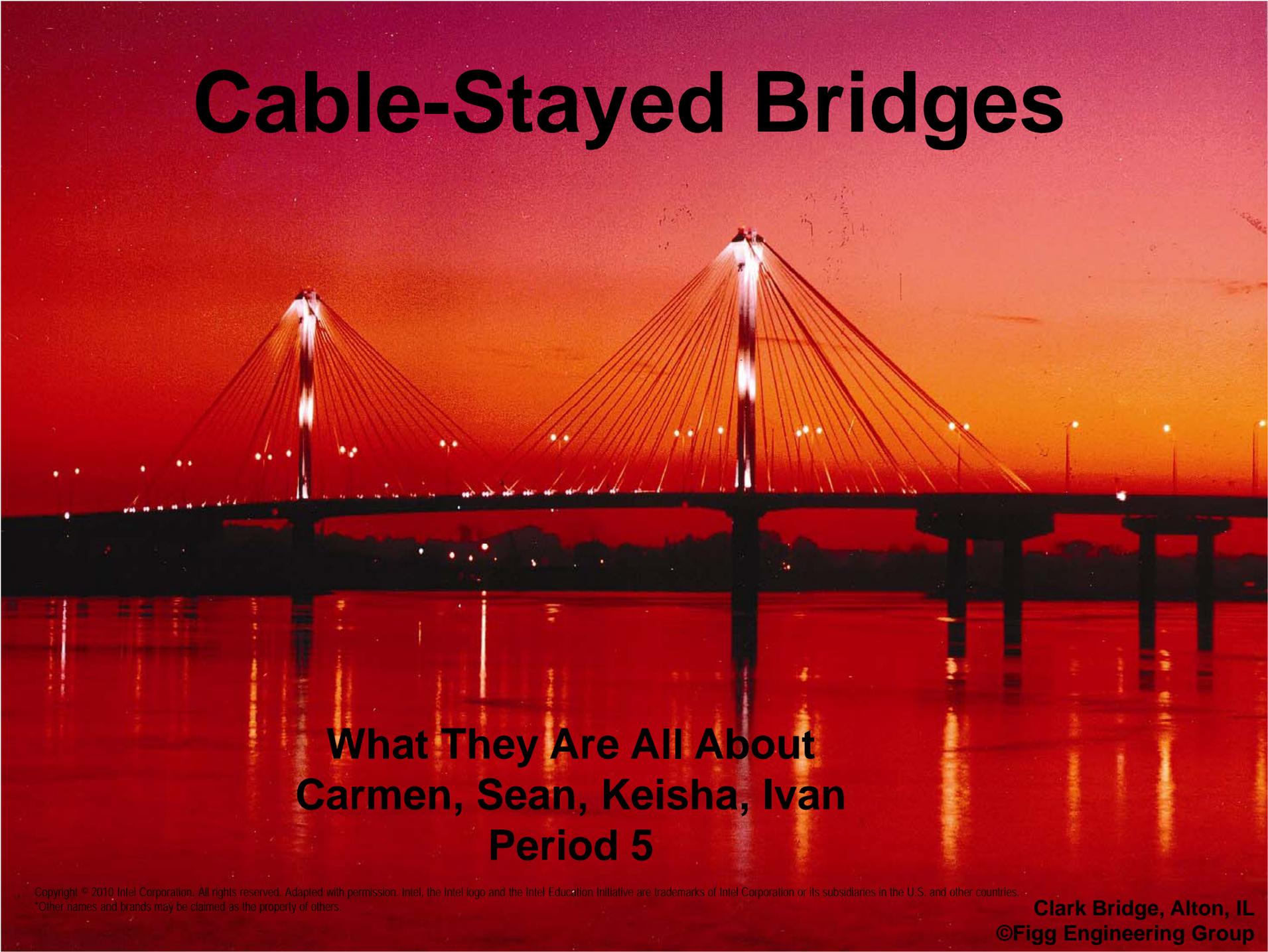


# Cable-Stayed Bridges



**What They Are All About  
Carmen, Sean, Keisha, Ivan  
Period 5**

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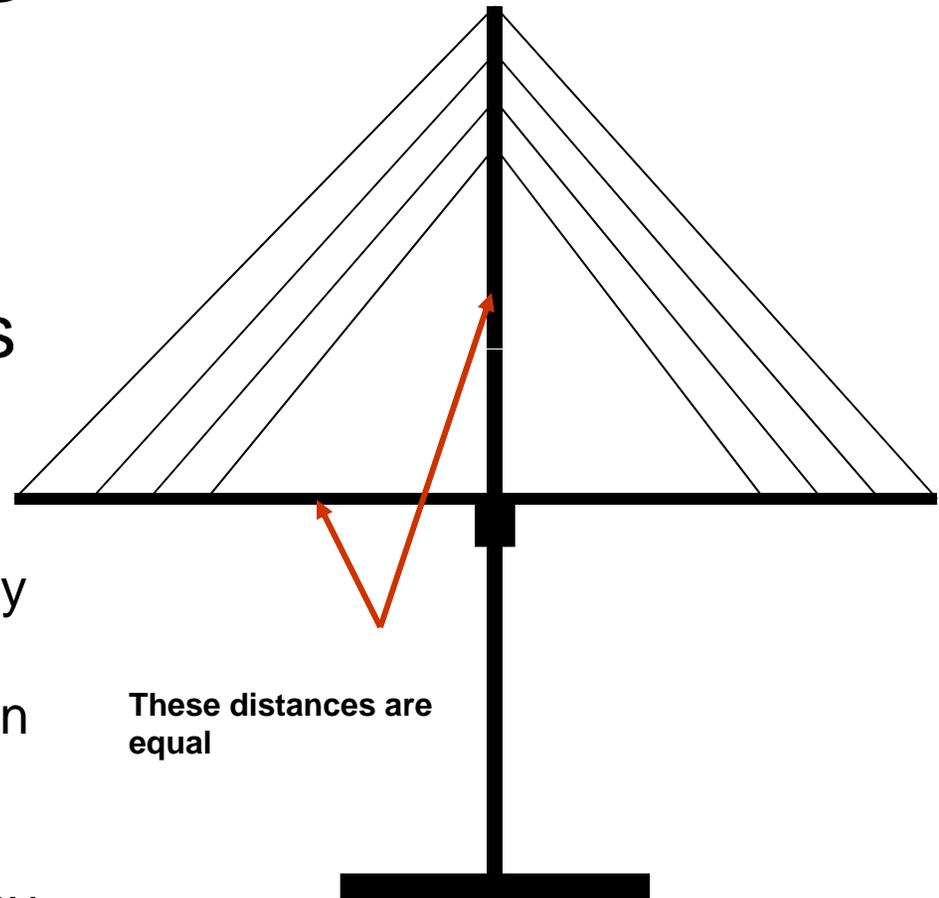
**Clark Bridge, Alton, IL  
©Figg Engineering Group**

# 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

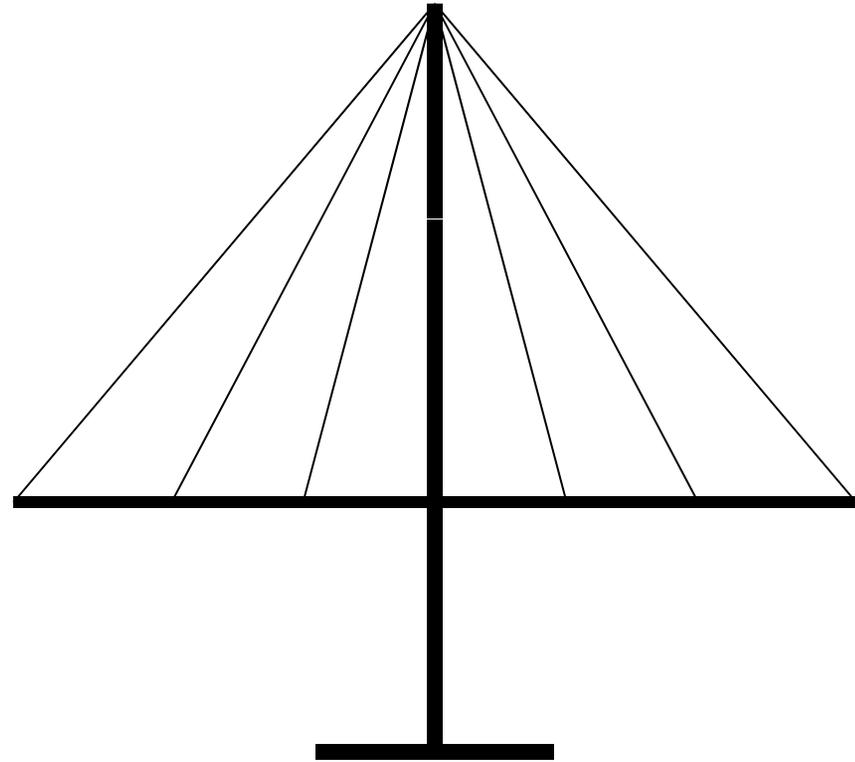
# Two Major Classes of Cable-Stayed Bridges

- 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



# 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.



# 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

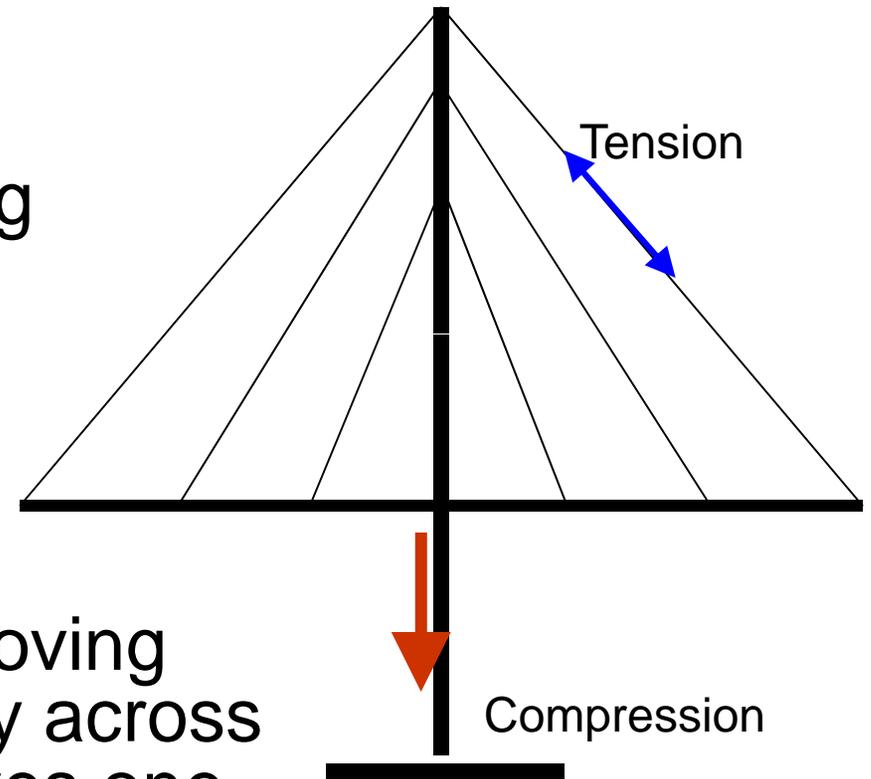
- The tower of the bridge forms the vertical side of the right triangle
  - The distance between the points of attachment of preceding cables on the tower should be equal
  - Likewise, the points of attachment of the cables on the beam of the span should be equidistant.
- You can calculate the length of the remaining cables after the first cable has been installed by applying the proportionality concept or the Pythagorean theorem

# 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

# Tension and Compression – Important!

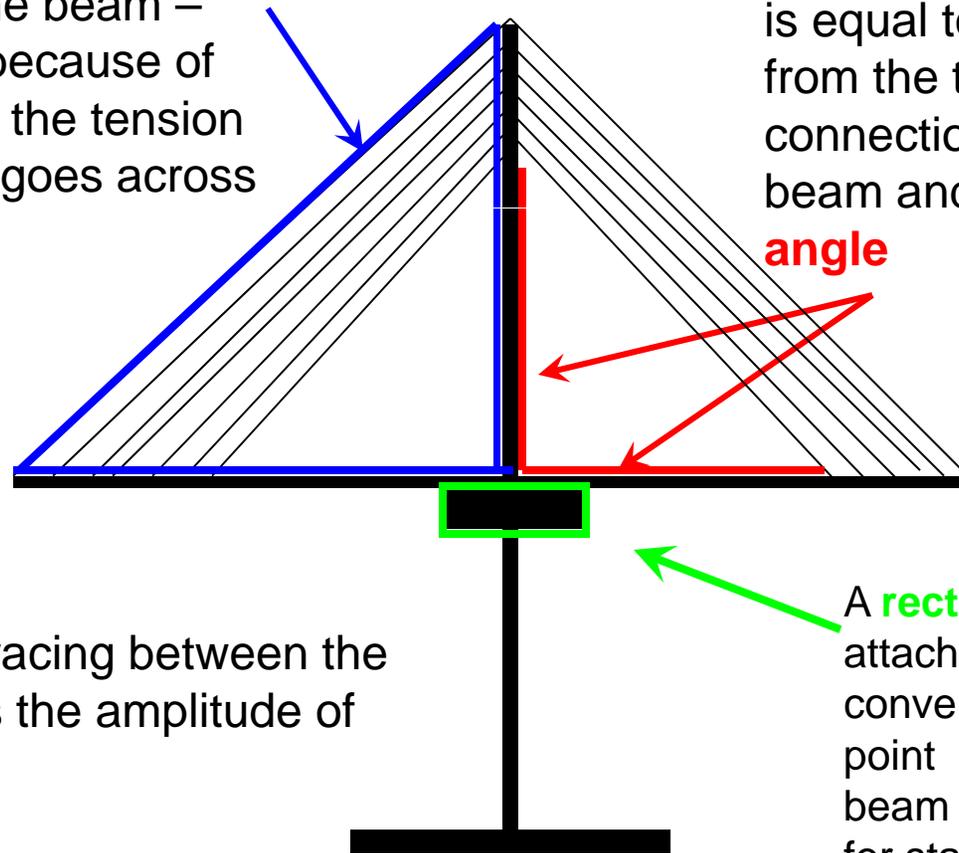
- The tower is responsible for absorbing and dealing with compression forces
- Tension occurs along the cable lines
- This works because a moving load is not applied evenly across the bridge, and as it moves one set or the other of the diagonals will find itself in tension



# 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

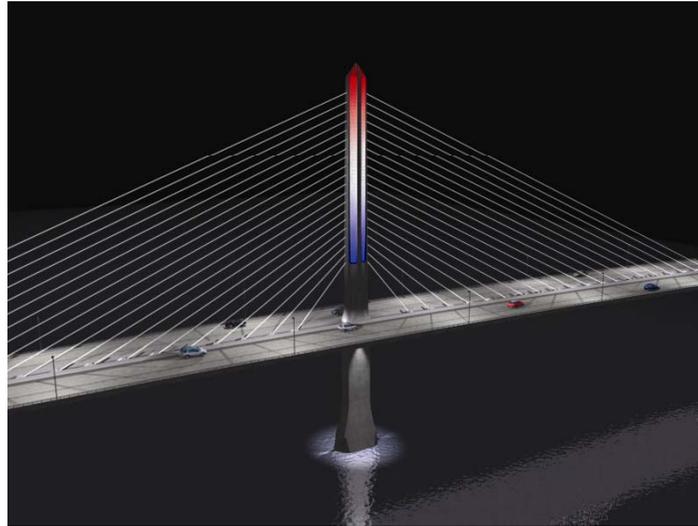
In this bridge, the distance of the cable up the tower is equal to the distance from the tower to connection point on the beam and is a **90 degree angle**



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

# Visions of Cable-Stayed Bridges

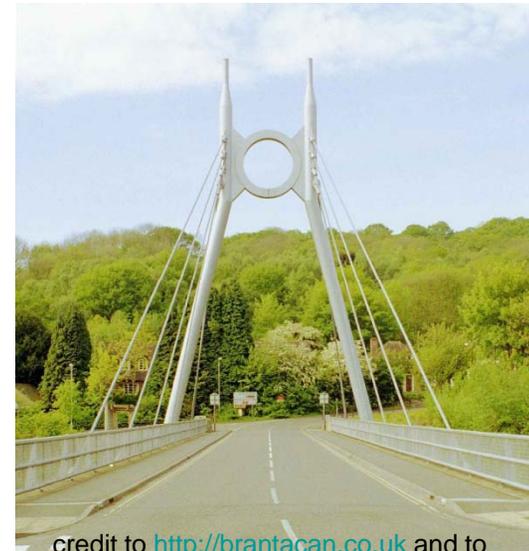


Maumee River Bridge,  
Toledo, OH

© Figg Engineering Group



Cable  
Stayed  
Bridge,  
Kiev,  
Ukraine



credit to <http://brantacan.co.uk> and to  
Derek Locke.

Jackfield Bridge in  
Coalbrookdale

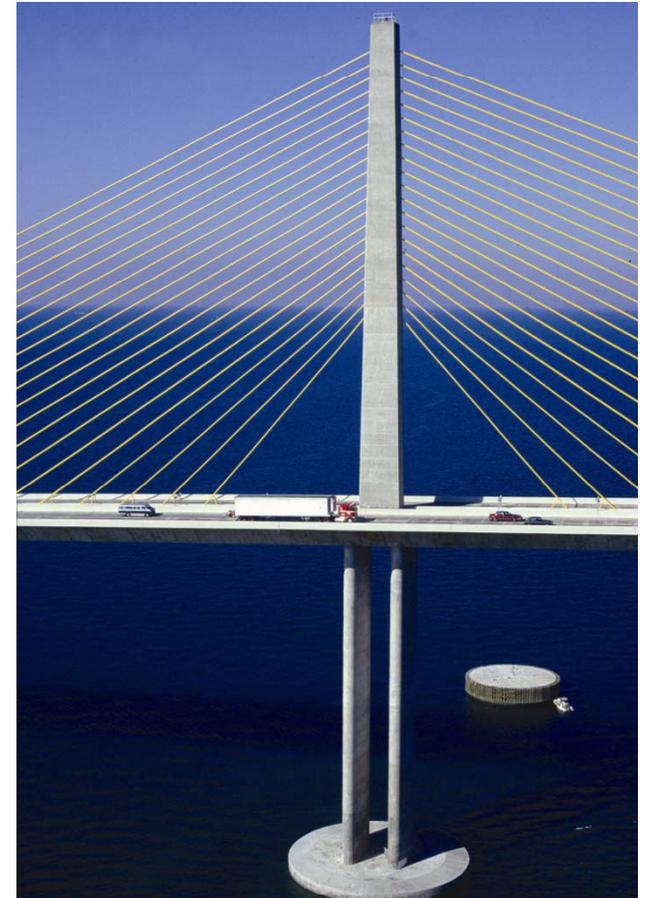
# Visions of Cable-Stayed Bridges



The Sunshine Skyway Bridge over Tampa, FL

Winner of 17 design awards

© Figg Engineering Group



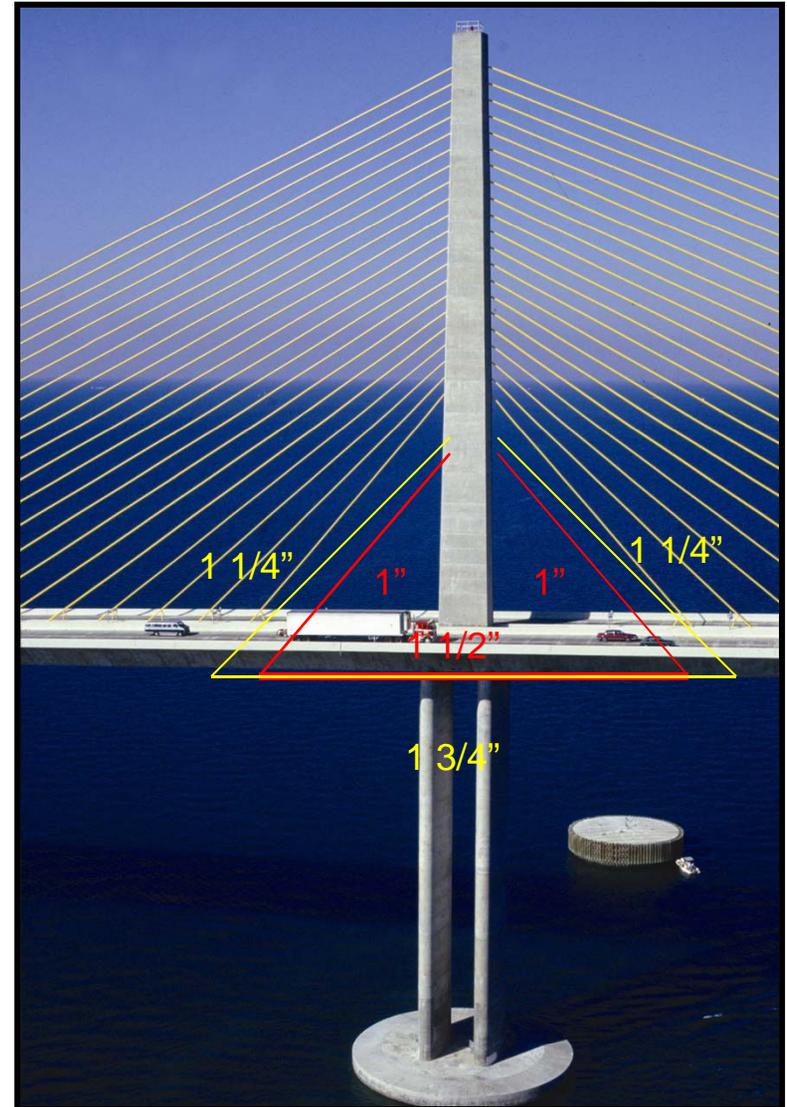
# Let's Look at Combinations of Side Lengths

- 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.





# 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

# 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