

An aerial photograph of a large cable-stayed bridge spanning a wide river valley. The bridge features several tall, white, A-frame pylons and numerous stay cables. The surrounding landscape is lush and green, with a winding road visible in the distance. The title text is overlaid on the bridge's deck.

Understanding Bridge Stresses

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This is an oversimplification

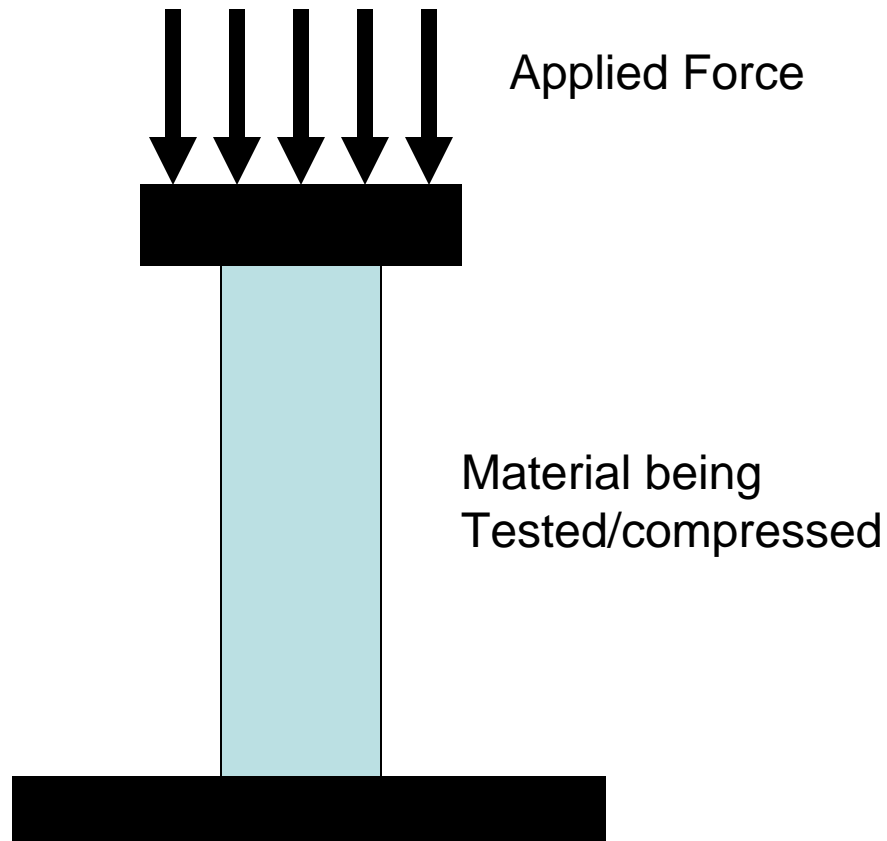
- This short presentation only touches on the forces at work and uses terms that are more *common* than *scientifically* accurate.
- More information can be found at www.wikipedia.org or www.HowStuffWorks.com

Stresses*

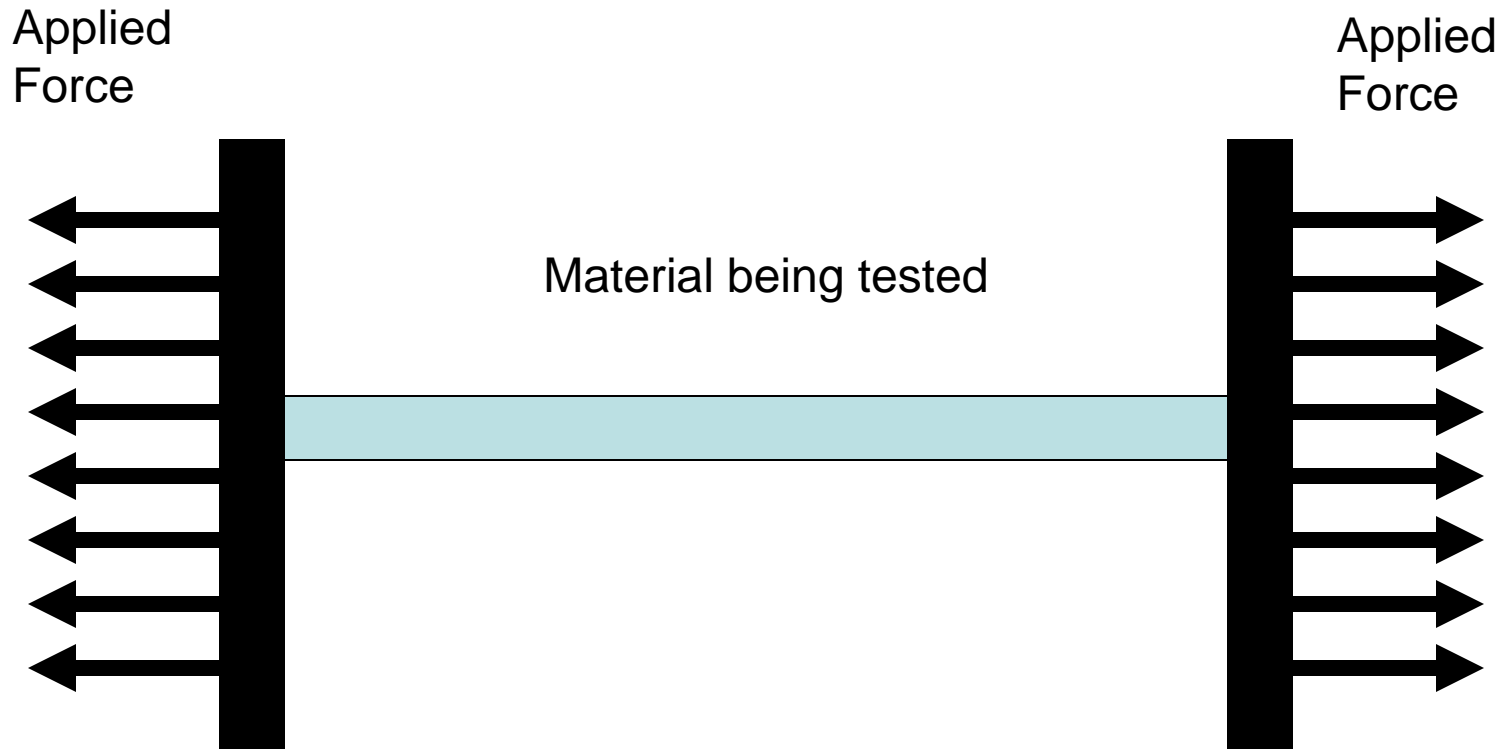
- Compression
 - This is the stress that an object is subjected to that wants to shorten or compress the material.
 - Concrete (and LEGO bricks) have excellent compressional strength.
 - Wire and string have none.
- Tensile (tension)
 - This is the stress that an object is subjected to that wants to lengthen or stretch the material.
 - Steel varies from about 250 to 2500 MegaPascals of force required to deform the material (Mpa=1,000,000 pascals=1,000,000 Newtons/meter²)
 - Plastics are more on the order of 20-50 MPa, but there are extreme exceptions as well.
 - Concrete has a very low tensile strength compared with its compressional strength.

•Note, these explanations are not complete, but serve to increase one's understanding of the principles.

Compression Strength

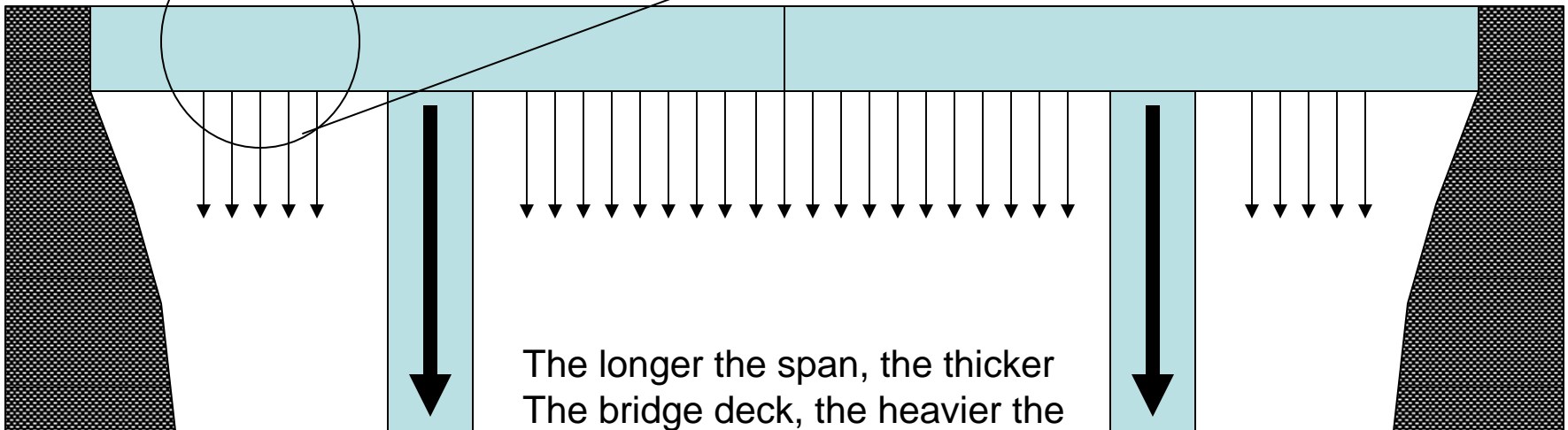
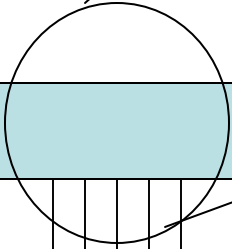
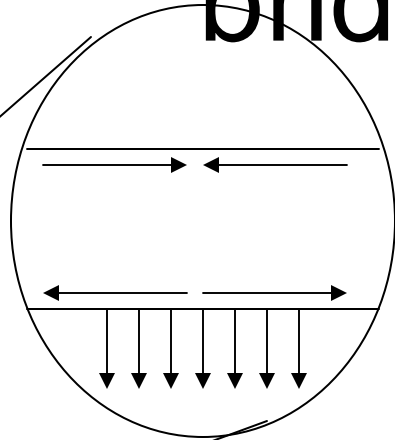


Tensile Strength



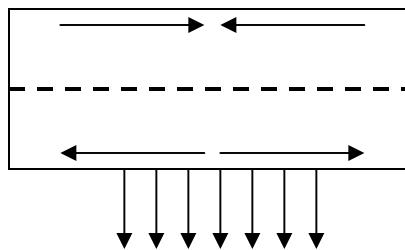
How does this work for a bridge?

As a piece of steel (or steel reinforced Concrete) is stressed by gravity to bend Down, the cross section of the material Must do several things. The bottom Must stretch and the top must compress (in general). So builders must match These strengths and stresses.

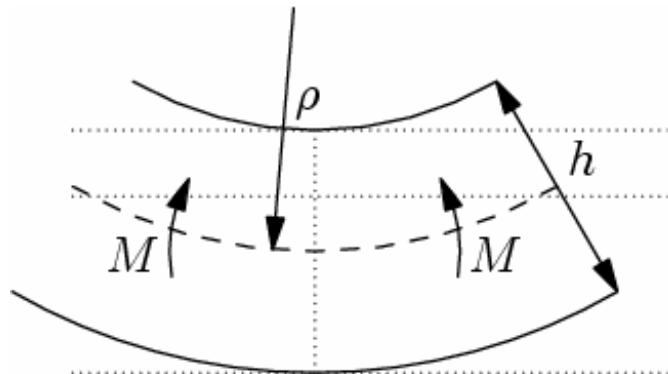


The longer the span, the thicker
The bridge deck, the heavier the
Bridge, the thicker the deck.....

Bending Stress



As a piece of steel (or steel reinforced Concrete) is stressed by gravity to bend Down, the cross section of the material Must do several things. The bottom Must stretch and the top must compress (in general). So builders must match These strengths and stresses.



A sagging closet pole, or a foot bridge with people Standing on it would both be experiencing bending.

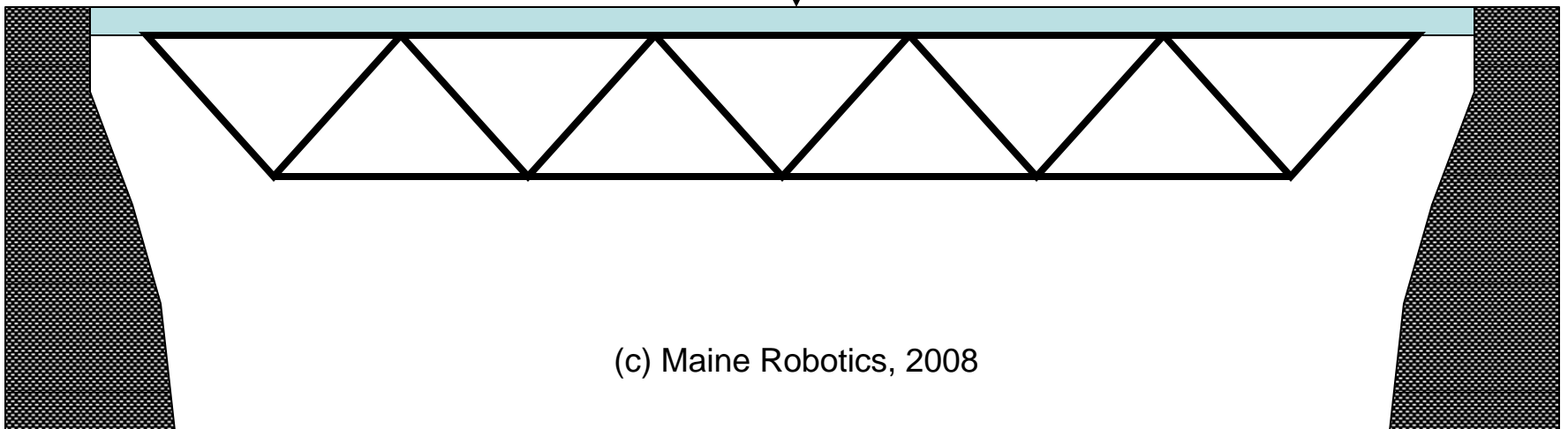
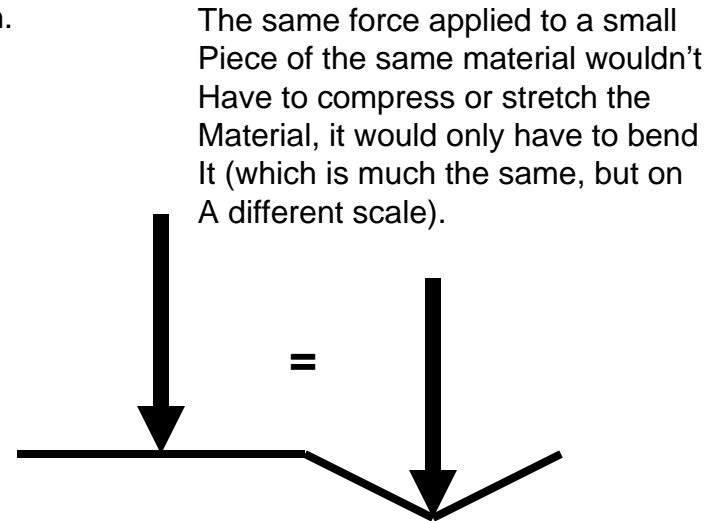
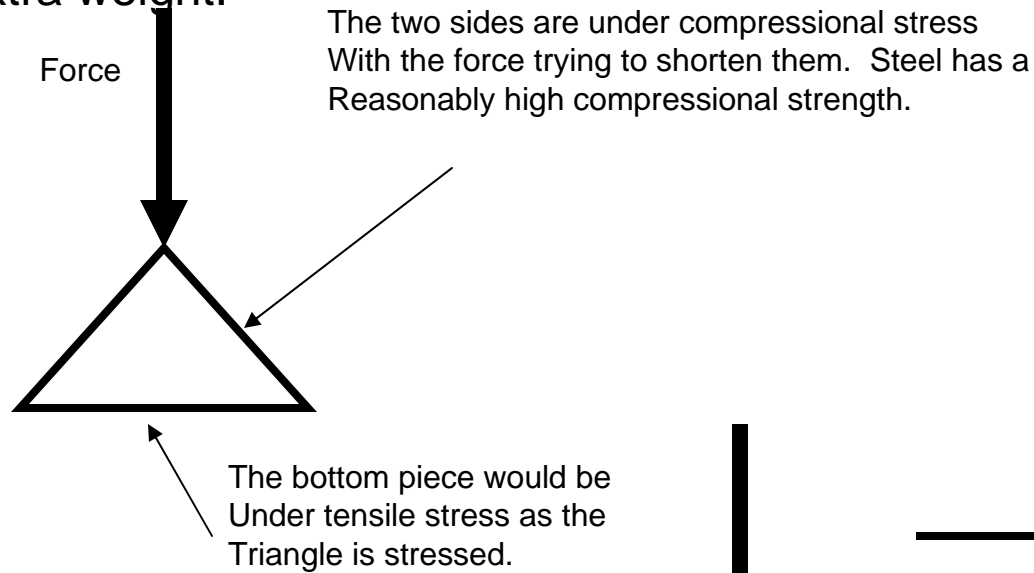
Bridges experience the same stress, but engineers Must build to accommodate these factors.

Heavy duty commercial trailers

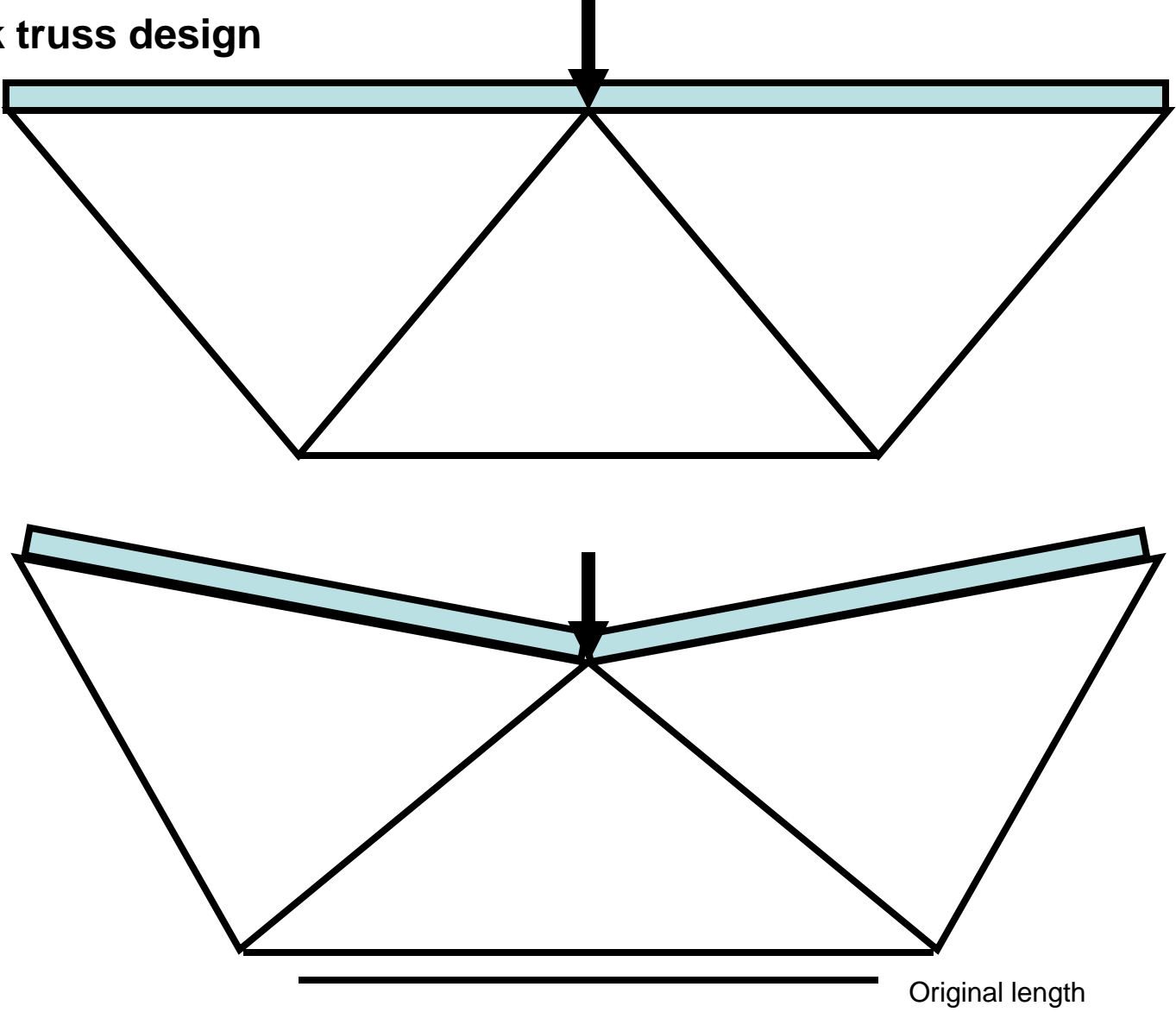


- Notice that this trailer has been constructed so the main deck is pre-bent. When this trailer is fully loaded (this one is rated for 110,000 pounds) it will flatten out. This is more desirable than to start flat and then end up with a downward bow (would scrape the ground)
- These are used for large pieces of machinery and for very heavy loads like steel girders. Not every trailer is like this, but you should be able to see some around Maine.

Triangles were used a lot in construction before composite materials (like steel Reinforced concrete) became easy to use. With a Triangle, you can force stresses To be spread out over a larger area. And make a frame act like a solid, without The extra weight.

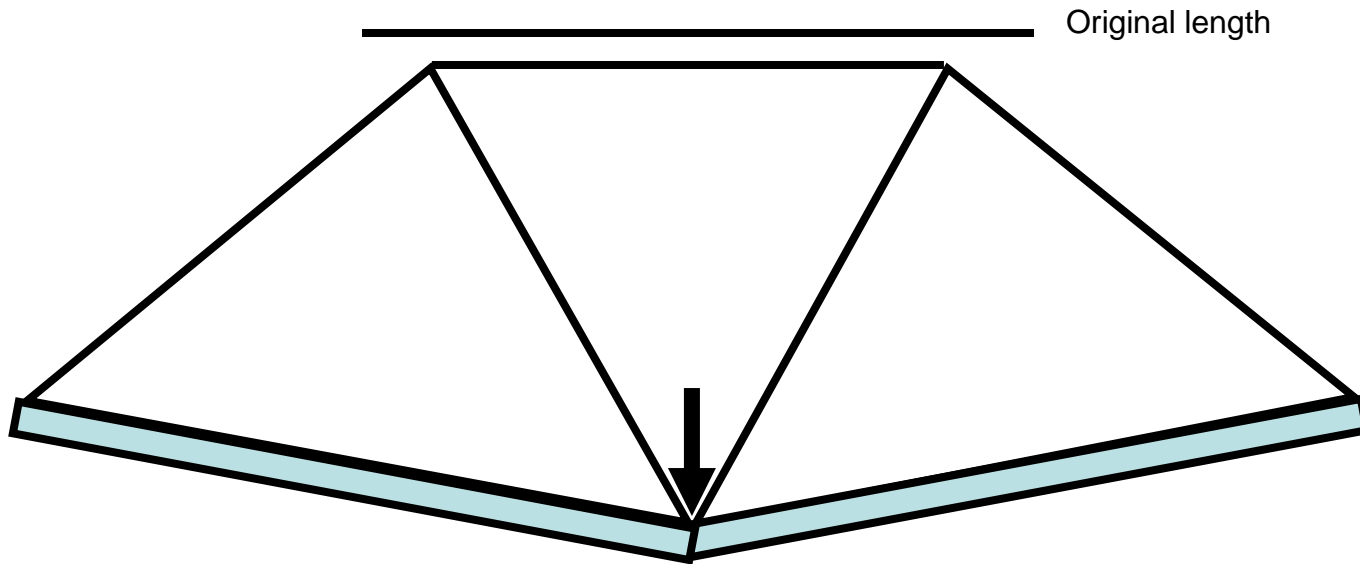
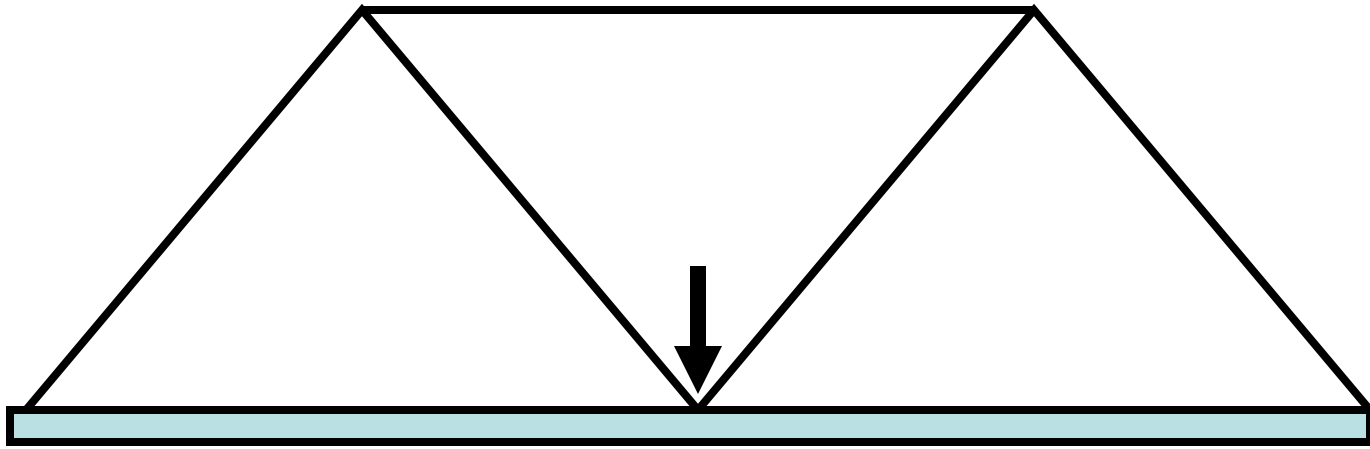


Below deck truss design



Notice how, with the downward flexion of the bridge triangles, the bottom connector would have to be significantly stretched. This is where this form of bridge gets the strength. Steel has a very high tensile strength and resists this form of deformation.

Overhead truss design



Notice how, with the downward flexion of the bridge triangles, the top connector would have to be significantly compressed. This is where this form of bridge gets the strength. Steel has a reasonably high compression strength and resists This form of deformation.

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