Tensegrity – Kurilpa Bridge

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(Fig 1.1 Kurilpa Bridge in Australia)

Background:

The Kurilpa Bridge is a pedestrian and bicycle bridge over the Brisbane River in Brisbane, Queensland, Australia. The whole project costs (AUD)$ (Australia dollar)63 million. The bridge connects Kurilpa Point in South Brisbane to Tank Street in the Brisbane CBD. Baulderstone Queensland Pty Ltd constructed the bridge and the company's design team included Cox Rayner Architects and Arup Engineers. Kurilpa Bridge is currently the world's largest tensegrity bridge.

The Kurilpa Bridge is a multiple-mast, cable-stay structure based on principles of tensegrity producing a balanced tension and compression forces to create a light structure that is incredibly strong. The bridge is 470m long with a main span of 120m. and features two large viewing and relaxation platforms, two rest areas, and a continuous all-weather canopy for the entire length of the bridge

Theory of Tensegrity:

Tensegrity (or called tensional integrity) is a complete new structural concept which never covered during the lectures. Students learnt tension and compression forces from Year 1 Structural and Stress Analysis, but they've not been told what happen of a structure which has two different components provide two different types of forces? If the tensile and compression force can balance each other, the structure will be stable. Otherwise, it may cause structural problems.

Tensegrity is defined as integrity based on a balance between tension and compression forces.

This is the definition of tensegrity structures from Wikipedia:

Tensegrity structures are structures based on the combination of a few patterns:

1. loading members only in pure compression or pure tension, meaning the structure will only fail if the cables yield or the rods buckle
2. preload, which allows cables to be rigid in tension
3. mechanical stability, which allows the members to remain in tension/compression as stress on the structure increases

Because of these patterns, no structural member experiences a bending moment. This produces exceptionally rigid structures for their mass and for the cross section of the components.

I also attach a video link below to show how simple it is to build a tensegrity structure.
http://video.google.com/videoplay?docid=3055471462547676374#

Tensegrity applied in Kurilpa Bridge:

Fig 1.2 Part of Kurilpa Bridge

The cables act as tension forces and tubes act as compression forces in Kurilpa Bridge. Fig 1.2 is a part of the structure of Kurilpa Bridge. The cables are trying to pull out the tubes (tension) to cause the structure collapse but the tubes (consider as rigid body) have compression itself to prevent this happens.

We defined this kind of system as Tensegrity Prism. Tensegrity Prism is a system composed any stable three-dimensional unit using *n* bars (or tubes). There are 12 bars in Fig 1.2 left side photo. Therefore, n=12. (the minimum number of bars needed to build a tensegrity Prism system is 3) There is a simple rule applied to find the number of strings required to make sure the structure is stable:, **the min no. of strings = 3 x the number of bars (*n*)**, in this case, the number of strings are definitely more than 36.

In the future, there will be a dramatic increase in tensegrity concepts in engineering. Tensegrity structures can be designed to efficiently take tension, compression, or bending. As material costs increase, it is reasonable that methods that make more efficient use of material will become more acceptable.

Further Reading:

A booked named "*Tensegrity Systems*" written by Robert E Skelton and Mauricio C. de Oliveira has more detail calculations based on tensegrity systems, and more models to help students to understand the concept of tensegrity. You can download the free e-book on http://www.springerlink.com/content/vrk180/ as a University of Manchester student.

Reference:

E-book:

Tensegrity Systems, written by Robert E Skelton and Mauricio C. de Oliveria, 2009, publisher is Springer Science+Business Media

Websites:

http://en.wikipedia.org/wiki/Tensegrity

http://en.wikipedia.org/wiki/Kurilpa_Bridge