Re: Telescope mirrors under tension.

Source: http://sci.tech−archive.net/Archive/sci.optics/2005−03/0393.html

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From: Robert Clark (*rgregoryclark_at_yahoo.com*)
Date: 03/18/05

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Date: 18 Mar 2005 10:12:03 −0800
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redbelly wrote:
> *Robert Clark wrote:*
> > *In this article Geoffrey Landis proposes builing a space tower*
using
> > *pressurized structures:*
> >
> > *THE TSIOLKOVSKI TOWER RE−EXAMINED*
> > *Journal of The British Interplanetary Society, Vol 52, pp.*
175−180,
> > *1999.*
> >
>
http://www.aeiveos.com/~bradbury/Authors/Engineering/Landis−GA/TTTR.html
> >
> > *He notes that typically materials have higher failure or ultimate*
> > *strength in tension than in compression ...*
>
> *Funny, I could have sworn it was the other way around.*
>
> *Fused silica glass is about 20x stronger in compression than in*
tension
> *(1100 MPa vs. 50 MPa). See*
>
> *http://www.sciner.com/Opticsland/FS.htm*
>
> *and look at "compressive" and "tensile" strength on that page.*
>
> *Mark*

Yes, for brittle materials such as concrete or glass the compressive strength is usually greater than the tensile strength. This is the reason why steel is used to reinforce concrete, to give it greater tensile strength. Perhaps Landis is considering the materials that might be used for a space cable such as steel or carbon fibers for instance, where the tensile strength is larger, since he makes a comparison to the lengths that could be achieved with current materials for a space cable.

BTW, I received an answer to my question of why Landis did not have to consider the compressive strength of the sides of the pressurized structure. The situation is analogous to for example a beachball. It can support significant compression due to the tensile strength of the material, but the material itself has little compressive strength.

Here's another interesting question to ponder. The formula for deflection of a mirror due to its self−weight is:

Deflection ~ Density *(1−Poisson's ratio^2)/Young's Modulus

Usually for constructing large mirrors it has only been the Young's modulus and density that has been considered since the Poisson is usually about 1/3 for most materials.

But I thought what if you could find a material with a Poisson of 1? Then the deflection would be 0.

Honeycombed structures in 2−dimensions can have Poisson equal to +1:

Properties of a chiral honeycomb with a Poisson's ratio −1.
D. Prall and Roderic Lakes (University of Wisconsin), Int. J. of Mechanical Sciences, 39, 305−314, (1996).
"Two dimensional honeycombs with regular hexagonal cells (Fig. 1a) exhibit a Poisson's ratio of +1 in the honeycomb plane; the out−of−plane properties differ due to anisotropy. The cell walls have 120 deg. angles between walls and all walls must be of equal thickness and composition. In contrast honeycombs with inverted cells (Fig. 1b) give rise to negative Poisson's ratios in the honeycomb plane [2−5]."
http://silver.neep.wisc.edu/~lakes/PoissonChiral.html

Is it believed the Poisson ratio can not be +1 in 3−dimensions or is this still an open question? Note that this Poisson ratio might not have to be isotropic. It might be sufficient for example if when the applied stress is in one direction say the vertical the expansion in the horizontal direction is 1.

Bob Clark