Paper ID: 22404
oral

12th IAA SYMPOSIUM ON VISIONS AND STRATEGIES FOR THE FUTURE (D4)
Global Strategy for Space Elevators (3)

Author: Mr. Stephen Cohen
Vanier College, Canada

Prof. Arun Misra
McGill University, Canada

STATIC DEFORMATION OF SPACE ELEVATOR TETHER DUE TO CLIMBER

Abstract

As higher strength to density ratio materials become available, the construction of a space elevator on Earth becomes more plausible. Though many fundamental aspects of the mechanical behaviour of a space elevator have been previously analyzed, several others have not been rigorously explored. This paper examines the deformation of the tether from its nominal state when it is loaded with a climber at any altitude.

The partial differential equation governing the static deformation of the elevator tether is derived in the paper, taking into account the presence of a climber. This equation is discretized using the assumed modes method. These discretized equations are solved numerically to determine the static deformation and the stress in the tether.

A spectrum of statically deformed tether profiles is presented. In general, when a climber is present below GEO, the extension (and stress) of the portion of tether below it is reduced and that above it is largely unaffected. When a climber is present above GEO, the extension (and stress) of the portion of tether below it is increased (that above it remains largely unaffected).

Corresponding stress and tension profiles are also computed and discussed. For both, there is a discontinuity at the location of the climber. These profiles provide insight into the limiting cases for the mass of a climber that will undergo transit.

Finally, the absolute displacement of the apex anchor (counterweight) is plotted against climber locations, and is found to be non-negligible. The largest decrease in apex anchor altitude occurs when the climber is situated in the bottom portion of the tether, whereas the largest increase in apex anchor altitude occurs when it is situated in the top portion.