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Conceptualizing Space Elevators and Tethered Satellites (3)

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ORBITAL MOTION OF VERY LONG SYSTEMS

Abstract

The purpose of the paper is to examine the dynamics of a very long space object and to have an understanding of how a space elevator can be built. When a geostationary object extends its length in radial direction, the object gradually starts to drift eastward until it is no longer stationary. This is due to the nonlinearity of gravity force which increases in inverse to the square of radius. The center of gravity of the object no longer coincides with its center of mass, and the gravity force itself increases with the increase of the length. The orbit makes a spiral motion down to lower orbit. Assuming a uniform distribution of mass along the length, at the time the low end of the object touches the earth surface, the object circles the earth four times in a day, and the mass center comes down to the radius of 23000km. Then if the object starts to decrease its length, the orbit raises until it reaches back to the geostationary orbit. We are interested in a very long system with its lower end touching the earth, and revolving once in a day. It is feasible when the length is 143,890km. It can be synchronized with the earth motion while its lower end touches the earth. However, when the object length is retracted, the object takes an orbit that escapes the earth. As long as we stick to an object of uniformly distributed mass, we cannot build such an object. A tapered object can be different. The gravity non-linearity is less effective when the lower portion has less massive segments. Simulation of these objects describes the boundary where the space elevator can be established.