Paper ID: 71307
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20th IAA SYMPOSIUM ON VISIONS AND STRATEGIES FOR THE FUTURE (D4)
Modern Day Space Elevators Entering Development (3)

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SPACE ELEVATOR TETHER ATMOSPHERIC WIND LOADING AND A CABLE LIFT CONCEPT

Abstract

The present concept for an Earth Space Elevator system includes a ribbon tether of the order of 1 metre wide. This width is considered adequate for debris impact survival and to enable ascent by a wheeled climber, but there are potential issues in the atmosphere.

This paper considers potential wind loading levels and resultant tether stresses, concluding that Earth Port retention forces are likely to exceed the strength limits of current-concept early operational tethers under foreseeable weather conditions. One calculation estimates wind loading on a 1m tether could reach 438 tonne-f, requiring an order-of-magnitude increase in tether strength and mass to maintain tether integrity.

Methods to address weather-related operational issues are discussed, including the use of the Earth Port winches to raise the climber using the tether stored strain potential energy. Other options are discussed before describing one concept in more detail.

The **Cable Lift** concept involves a pulley suspended on the lower end of the ribbon tether at some point in the lower mesosphere (45-85km altitude) creating a 'Pulley Node'. A cable is wrapped over the pulley and connected to winch systems on the Earth's surface : climber systems and payloads are then attached to the cable and raised separately to the pulley, then transferred to the tether above the pulley before final robotic assembly. The cable would be constructed using a new material with adequate specific strength, either similar to the main tether (perhaps single crystal graphene) or an alternative more suited to atmospheric conditions (perhaps hexagonal boron nitride). The cable would be of circular cross-section with a diameter of the order of 2 mm, thus able to withstand wind loading without requiring excessive retention forces.

Under calm weather conditions it would be possible to lower the Pulley Node to the surface for maintenance or upgrade : it may then be possible for climbers to ascend from the surface using either onboard motors or the stored-energy method.

The Cable Lift concept should be able to operate in most weather conditions, enabling the Space Elevator to approach the target 'all weather capability'. Operations may need to be paused under extreme storm conditions, but methods are discussed that would maintain system integrity.