Paper ID: 95709
student

23rd IAA SYMPOSIUM ON VISIONS AND STRATEGIES FOR THE FUTURE (D4)
The Modern Day Space Elevator as a Permanent Transportation Infrastructure (3)

Author: Ms. Ritwika Maiti
India

THE SPACE ELEVATOR: UNLOCKING A NEW ERA OF SPACE ACCESS

Abstract

Abstract

Imagine a world where accessing space is as simple as pressing an elevator button. The space elevator, once a science fiction dream, is now a tangible solution to the limitations of rocket-based transportation. This permanent infrastructure offers a cost-effective, eco-friendly, and scalable alternative, capable of transporting 30,000 tonnes of cargo annually, surpassing all payloads launched from 1957 to 2022. It will revolutionize satellite deployment, off-world manufacturing, and lunar/Martian colonization.

Unlike rockets, which convert only 2% of their pad mass into geostationary orbit (GEO), the space elevator achieves an unmatched 70% efficiency, reducing costs and emissions. Zero-emission climbers provide sustainable, continuous transportation, unlocking advancements in space-based solar power, asteroid mining, and deep-space exploration.

Despite its promise, key barriers remain. The lack of ultra-strong tether materials is a primary challenge—while carbon nanotubes and graphene show promise, they are not yet scalable. Orbital debris collisions at LEO and MEO present risks, and efficiently powering climbers over 36,000 km is another hurdle. A hybrid power model combining solar energy and laser beaming offers a viable solution. Solar farms at GEO can harvest energy, while laser/microwave beaming from Earth ensures uninterrupted power, reducing environmental impact and increasing efficiency.

Breakthroughs in nanomaterial synthesis (e.g., diamond nanothreads, boron nitride nanotubes) are moving us closer to a feasible tether. AI-driven collision avoidance systems and debris removal strategies enhance safety. Floating ocean-based anchor stations mitigate atmospheric and weather-related challenges, ensuring long-term stability. Beyond engineering, legal frameworks surrounding ownership, jurisdiction, and international regulations remain uncertain. Compliance with the Outer Space Treaty and a unified Space Elevator Consortium will be crucial for ensuring security, equitable access, and global collaboration. The space elevator is no longer a distant dream but an engineering challenge on the brink of realization. With continued advancements in materials, AI safety, hybrid power, and policy frameworks, humanity stands at the threshold of a seismic shift in space access. The next great leap won't be on a rocket—it will be on an elevator to the stars.