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A Literature Survey on Space Elevator

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Abstract: The goal is to create a feasible scenario using current or near future technology for the design, deployment and operation of a space elevator.To create a proposal for the first space elevator, computer simulations, engineering designs, literature studies and the use of existing programs are utilized.The findings of this project demonstrate a practical concept for the development of the first space elevator, using existing and near-term technologies.An efficient space elevator will require selectable gravity rates for larger and much longer term biological space studies.This system's high capacity and low operating costs would also allow for inexpensive life searches in our solar system and the first environmental engineering tests.The lack of atmosphere on the Moon, the thermal fatigue life of the lunar space elevator is smaller than that of the Earth-to-space and Mars-to space elevators.This contribution will help with the selection of appropriate materials for the space elevator system to build and install the space elevators with greater safety against thermal fatigue failures.

Keywords: Carbon Structures,CNT,Ribbon,Satellite,Space Elevator.

INTRODUCTION

The Space elevator first appeared in a Russian technical journal in 1960. The concept appeared several times in technical journals in the following years (Isaacs, 1966; Pearson, 1975; Clarke, 1979), and then appeared in science fiction (Clarke, 1978; Stanley Robinson, 1993). The simplest explanation of the concept of the space elevator is that it is a ribbon with one end attached to the surface of the Earth and the other ending in space beyond geosynchronous orbit (35,800 km altitude). Competitive gravitational forces at the lower end and centripetal outward acceleration at the farther end hold the cable under strain and stable over a single position on Earth[1]. This cable can be ascended to any Earth orbit by mechanical means, or used as a sling to deliver payloads to neighbouring planets. Advanced materials are needed for building a space elevator. One of the reasons for this is the elevator height that can be up to thousands of kilometres. CNT is one of the materials that can be used to build the space elevator, as its strength is 100 times greater than steel while its weight is lower than steel. Certain materials like boron / epoxy and graphite epoxy can also be used.Aluminium, gold, and platinum are the materials that can be used against space environment to coat the space elevator[2]. Pressurized Shell technology can be employed to improve the space elevator's compressive resistance. Technology of magnetic propulsion is recommended to achieve high-speed in space elevator. Due to the infrequent launches, high costs and pollution, access to space is difficult. Space elevator which is a long Earth-to-Space cable can be the key to solving these problems. In addition, space elevator will reduce the environmental concern and avoid the engine drop back to Earth caused by the launches.Space elevator is described as a cable that is attached to the planet at one end and the other end is floating in space at about 60,000 miles in length[3].The development of space elevators has many advantages such as reducing greenhouse gas, solving energy shortages, recycling high entropy,space access and toxic materials, safe and secure distribution, colonizing Moon,Mars, and asteroids, storing water in orbit for future manned missions, and creating space for production.

VIABLE SPACE ELEVATOR DESIGN

A grant from NASA Institute for Advanced Concepts, has defined a complete space elevator that can be built, deployed, and operated using current or near-term technology.Using four expendable launch vehicles and traditional satellite technology, the initial ribbon (8"long and on average micron thick) is deployed.The initial spacecraft deployment is launched to low Earth orbit and assembled afterwards.An electrical propulsion system elevates the spacecraft's orbit to above geosynchronous where the original ribbon is deployed back down to Earth[3].

Figure 1: Space Elevator

Using mechanical climbers, the initial ribbon with one end fixed to an anchor platform and the other 100,000 km up in space will be enlarged. Each climber will ascend the ribbon and add to it until it reaches a complete elevator.The final device will have a three-feet-wide ribbon and micron thick. To prevent storms, hurricanes, high winds and improve the ribbon dynamics, the anchor station will be an ocean-going platform situated in the eastern equatorial Pacific.A laser power beaming system consisting of a free-electron laser and a 13 m-diameter, segmented, focusing optic will provide power for the initial spacecraft and the mechanical climbers.To deal with the orbital object and debris problem, a debris tracking system will be used to enforce active avoidance.The ribbon, being the only basic component of the non-commercially available space elevator or in use elsewhere, is the major hurdle in the construction of the elevator[4].The material required to build the cable is a composite made from carbon nanotube. For carbon nanotube composites, the latest state of the art is the creation of fibres by mass carbon nanotube, with several per cent.Such fibres have shown the dispersion and interfacial adhesion needed near what is required for the elevator room.Additional efforts on the interfacial adhesion and in the composite carbon nanotubes fraction are needed before the elevator is completed.The space elevator would allow large fragile structures such as solar power satellites to be launched to provide clean renewable energy to the Earth, commercial manufacturing facilities, cheap stations for manned activities, and space exploration and development payloads[5].

CARBON STRUCTURES

Advanced carbon fibre-reinforced composite laminates have been widely used in satellite structures, where the advantages of these materials-their high specific stiffness, near-zero coefficients ofthermal expansion (CTE) and dimensional stability make them uniquely suitable for low-specific applications. Since the beginning of applications for composite structures, there has been a clear need to measure the environmental effects on the composite materials based on the laminate test data at the coupon stage[6].Atmospheric conditions which are most reflective of space and continue to degrade composite laminate properties include vacuum, thermal cycling atomic oxygen (AO) and micrometeoroid particulate matter.Development of an experimental database to capture the collective understanding of the composite laminate degradation processes in in-service environments is of considerable interest.To utilize these materials with confidence in critical load-bearing structures, it is necessary to be able to predict the long-term durability of composite laminates with engineering precision[7].

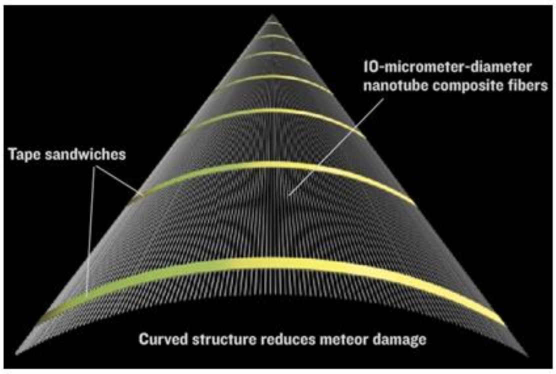

Figure 2: Elevator Ribbon would be made up of Strands of Carbon-Nanotube-Based Fibres

CHALLENGE

The biggest challenges to build an elevator find a cable material that is solid enough and then design and build the cable.The cable would be the heart of the elevator and historically the main obstacle to making the elevator into existence has been to find the right stuff for its manufacture.The idea resurfaced in the 1960s but there is no material solid enough for the cable to exist at the time[8].The cable must be made from something that is incredibly light and yet so solid that it makes steel look like soft-serve ice cream, to withstand its own weight as well as the weight of the climbers.The elevator cars would be operated by means of photovoltaic cells tuned to a ground-based laser wavelength, and would ascend the elevator cable by gripping it between treads.Every 20-ton climber will hold about 13tons of payload into space, which could either be basic cargo pallets or inflatable habitats designed to lift people in about eight days to geostationary orbit. There are two methods being examined,the first approach is to use long composite fibres that are about as strong as steel and have a 3 per cent carbon nanotubes composition, the rest being a typical plastic polymer.The carbon-nanotube wall's ability to bind to other molecules and increasing the nanotubes-to-plastic ratio in the fibre to 50%, it should be possible to produce fibres powerful enough for the space elevator cable.The second approach is to make the cable from carbon-nanotube fibres which are spun. Here long nanotubes, like traditional thread, would be twisted together.This approach has the potential to produce extremely strong material which can meet the space elevator requirements [9]. In the next few years both processes could be proven.These systems also included snagging asteroids at the end of the elevator to be used as the counterweight. It's enough to say that it's all well beyond our existing engineering capabilities — mechanical, electrical etc.

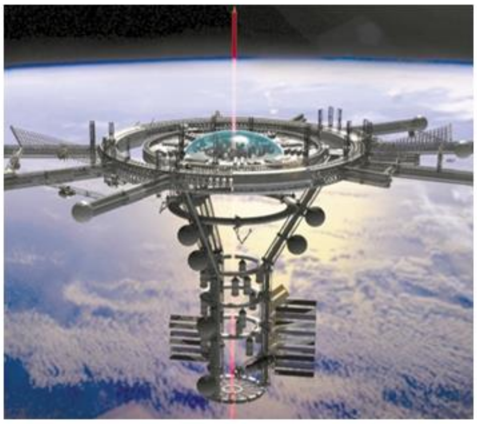

Figure 3: Substantial Transfer Station would be built at Geostationary Orbit

Science fiction scenarios have portrayed a space-elevator cable failure as a global disaster, but the reality would be nothing of the kind for design.The centre of gravity of the ribbon is in geostationary orbit, and the entire cable is under tension as the counterweight swings around Earth.If the ribbon is to be cut near the bottom, the entire cable above the cut would float up and begin floating. Calculations show that the ribbon and counterweight would most likely be flung into open space from Earth's orbit.If the initial estimates are verified and a space elevator is installed, the space will be available for applications that we can hardly imagine.With a space elevator providing cheap, fast, low-risk access to space, people's lives on Earth could be greatly improved as the solar system's wealth is brought to its doorstep.Humanity will finally be able to move on to space and onto the moon and Mars not as a horribly inefficient one-shot deal but as a continuing undertaking.Space travel will form a part of our everyday culture. The invention of stone tools has opened up vast new environments and ways of living for our distant ancestors[10].

CONCLUSION

The elevator room is under construction and could be operational within 15 years. This will allow low-cost transportation of Earth to space and will open up opportunities for gravitational and space biology.The larger masses and volumes, the more gentle transportation, delivery to neighbouring planetary bodies, and possible return to Earth of completed experiments allow many new investigations to be carried out.CNT is one of the materials that can be used to build the space elevator, as its strength is 100 times greater than steel while its weight is lower than steel.The development of space elevators has many advantages such as reducing greenhouse gas, solving energy shortages, recycling high entropy,space access and toxic materials, safe and secure distribution, colonizing Moon,Mars, and asteroids, storing water in orbit for future manned missions, and creating space for production.Advanced carbon fibre-reinforced composite laminates have been widely used in satellite structures, where the advantages of these materials-their high specific stiffness, near-zero coefficients of thermal expansion (CTE) and dimensional stability make them uniquely suitable for low-specific applications..The centre of gravity of the ribbon is in geostationary orbit, and the entire cable is under tension as the counterweight swings around Earth.If the ribbon is to be cut near the bottom, the entire cable above the cut would float up and begin floating.

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