CHALLENGES IN BUILIDING SPACE ELEVATOR

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ABSTRACT

The Space Elevator is the most promising Space Transportation system on the drawing boards today, combining scalability, low cost, qualify of ride, and safety to deliver truly commercial-grade space access-practically comparable to a train ride to space. A space elevator is a proposed structure designed to transport material from a celestial body's surface into space. [1]

All studies indicate that the idea, outrageous though it appears at first sight, is theoretically feasible and that its practical realization could follow from the mass-production of high-strength materials now known as laboratory curiosities

This paper is a semi-technical survey of the expanding literature of the subject. Also describe the current methods used for space elevator and merits and demerits of current method and give some proposed method's to overcome the limitation of recent method's to build a Space elevator.

As a result of which we save access to space-no explosive propellants or dangerous launch or re-entry.

K**eywords:- Space elevator, Nanotube, graphene, space debris, counterweight, space elevator impact.**

I.INTRODUCTION

What we want to talk about today is a space transportation system so offensive that many of you may consider it not even science-fiction, but pure fantasy. Perhaps it is; only the future will tell. Yet even if it is regarded as no more than a 'thought-experiment', it is one of the most fascinating and stimulating ideas in the history of astronautics [2].A space elevator is a proposed structure designed to transport material from a celestial body's surface into space. Many variants have been proposed, all of which involve traveling along a fixed structure instead of using rocket powered space launch. The concept most often refers to a structure that reaches from the surface of the Earth on or near the Equator to geostationary orbit (GSO) and a counter-mass beyond. The concept of a space elevator dates back to 1895 when Konstantin Tsiolkovsky [3] proposed a free-standing "Tsiolkovsky" tower reaching from the surface of Earth to geostationary orbit.

What's in a name?

Several problems in taxonomy: Space elevators have also sometimes been referred to as beanstalks, space bridges, space lifts, space ladders, skyhooks, orbital towers, or orbital elevators [2].

II.HISTORY

The key concept of the space elevator appeared in 1895 when Russian scientist Konstantin Tsiolkovsky was inspired by the Eiffel Tower in Paris to consider a tower that reached all the way into space, built from the ground up to an altitude of 35,790 kilometers above sea level (geostationary orbit) [4]. He noted that a "celestial castle" at the top of such a spindle-shaped cable would have the "castle" orbiting Earth in a geostationary orbit.
Tsiolkovsky's tower would be able to launch objects into orbit without a rocket. Since the elevator would attain orbital velocity as it rode up the cable, an object released at the tower's top would also have the orbital velocity necessary to remain in geostationary orbit. Unlike more recent concepts for space elevators, Tsiolkovsky's tower was a compression structure, rather than a tension structure.

In 1959 another Russian scientist, Yuri N. Artsutanov, suggested a more feasible proposal. Artsutanov suggested using a geostationary satellite as the base from which to deploy the structure downward. By using a counterweight, a cable would be lowered from geostationary orbit to the surface of Earth, while the counterweight was extended from the satellite away from Earth, keeping the center of gravity of the cable motionless relative to Earth. Artsutanov's idea was introduced to the Russian-speaking public in an interview published in the Sunday supplement of Komsomolskaya Pravda in 1960[5], but was not available in English until much later. He also proposed tapering the cable thickness so that the tension in the cable was constant—this gives a thin cable at ground level, thickening up towards GSO.

Both the tower and cable ideas were proposed in the quasi-humorous Ariadne column in New Scientist, 24 December 1964.

Making a cable over 35,000 kilometers long is a difficult task. In 1966, Isaacs, Vine, Bradner and Bachus, four American engineers, reinvented the concept, naming it a "Sky-Hook," and published their analysis in the journal Science [6]. They decided to determine what type of material would be required to build a space elevator, assuming it would be a straight cable with no variations in its cross section, and found that the strength required would be twice that of any existing material including graphite, quartz, and diamond.

In 1975 an American scientist, Jerome Pearson, reinvented the concept yet again, publishing his analysis in the journal Acta Astronautica. He designed [7] a tapered cross section that would be better suited to building the elevator.

In 1977, Hans Moravec published an article called "A Non-Synchronous Orbital Skyhook", in which he proposed an alternative space elevator concept, using a rotating cable [8], in which the rotation speed exactly matches the orbital speed in such a way that the instantaneous velocity at the point where the cable was at the closest point to the Earth was zero. This concept is an early version of a space tether transportation system.

III.<u>CURRENT TECHNOLOGY</u>

Current technology is not capable of manufacturing practical engineering materials that are sufficiently strong and light to build an Earth-based space elevator. The primary issue is that the total mass of conventional materials needed to construct such a structure would be far too great to be economical. Recent conceptualizations for a space elevator are notable in their plans to use carbon Nanotube or boron nitride Nanotube based materials as the tensile element in the tether design, since the measured strength of microscopic carbon Nanotube appears great enough to make this theoretically possible [3].

And a space elevator - if it ever becomes reality - will be quite long. We need 144,000 miles of Nanotube to built one. In theory, a cable would extend 22,000 miles above the Earth to a station, which is the distance at which satellites remain in geostationary orbit. Due to the competing forces of the Earth's gravity and outward centrifugal pull, the elevator station would remain at that distance like a satellite. Then the cable would extend another 40,000 miles into space to a weighted structure for stability [9]. Space elevators could lift material at just one-fifth the cost of a rocket, since most of a rocket's energy is used simply to escape Earth's gravity. The biggest problem has always been finding a material that is strong enough and lightweight enough to stretch tens of thousands of miles into space," [9].

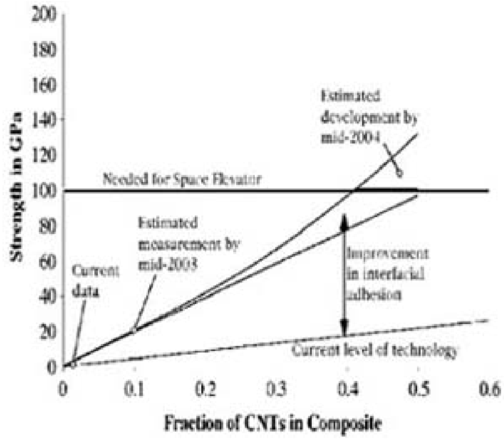

Figure 1 shows the CNT data

A. <u>How space elevator works</u>

A space elevator made of a carbon Nanotube composite ribbon anchored to an offshore sea platform would stretch to a small counterweight approximately 62,000 miles (100,000 km) into space. Mechanical lifters attached to the ribbon would then climb the ribbon, carrying cargo and humans into space, at a price of only about $100 to $400 per pound ($220 to $880 per kg) [10].

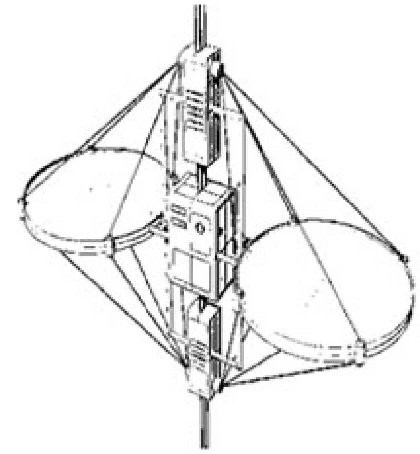

Figure 2 Lifter

Figure2 Shows The lifter in this picture carry at least 13 tones of cargo into space.

B. Space elevator ribbon

Carbon nanotubes have the potential to be 100 times stronger than steel and are as flexible as plastic. Once scientists are able to make fibers from carbon Nanotube, it will be possible to create threads that will form the ribbon for the space elevator. Previously available materials were either too weak or inflexible to form the ribbon and would have been easily broken.

"They have very high elastic modulus and their tensile strength is really high, and that all points to a material that, in theory, should make a space elevator relatively easy to build," said Tom Nugent, research director, Lift Port Group.

A ribbon could be built in two ways:

- Long carbon Nanotube several meters long or longer would be braided into a structure resembling a rope. As of 2005, the longest Nanotube are still only a few centimeters long.
- Shorter Nanotube could be placed in a polymer matrix. Current polymers do not bind well to carbon Nanotube, which results in the matrix being pulled away from the Nanotube when placed under tension.

.The ribbon would serve as the tracks of a sort of railroad into space. Mechanical lifters would then be used to climb the ribbon to space then be used to climb the ribbon to space [10].

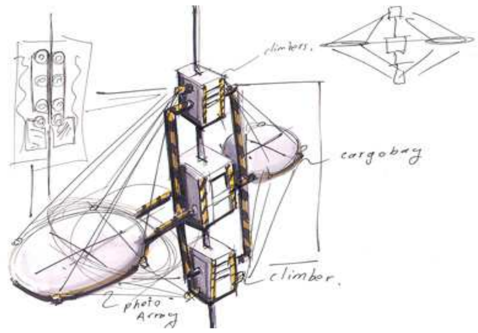

Figure 3 The climber
Figure show:The climbers at each end of the lifter will roll up the ribbon at a rate of about 200 mph.

C. Lifter

The robotic lifter will use the ribbon to guide its ascent into space. Traction-tread rollers on the lifter would clamp on to the ribbon and pull the ribbon through, enabling the lifter to climb up the elevator [10].

D. Anchor Station

The space elevator will originate from a mobile platform in the equatorial Pacific, which will anchor the ribbon to Earth [10].

E. Counterweight

At the top of the ribbon, there will be a heavy counterweight. Early plans for the space elevator involved capturing an asteroid and using it as a counterweight. However, more recent plans like those of Lift Port and the Institute for Scientific Research (ISR) include the use of a man-made counterweight. In fact, the counterweight might be assembled from equipment used to build the ribbon including the spacecraft that is used to launch it.

F.PowerBeam

The lifter will be powered by a free-electron laser system located on or near the anchor station. The laser will beam 2.4 megawatts of energy to photovoltaic cells, perhaps made of Gallium Arsenide (GaAs) attached to the lifter, which will then convert that energy to electricity to be used by conventional, niobium-magnet DC electric motors, according to the ISR.

Once operational, lifters could be climbing the space elevator nearly every day. The lifters will vary in size from five tons, at first, to 20 tons. The 20-ton lifter will be able to carry as much as 13 tons of payload and have 900 cubic meters of space. Lifters would carry cargo ranging from satellites to solar-powered panels and eventually humans up the ribbon at a speed of about 118 miles per hour (190 km/hour) [10].

IV. THE TRIBULATIONS WITH SPACE ELEVATOR

There are several issues with a space elevator that will need to be triumph over. For example, once you place some cargo on it, it has to move through the atmosphere and is subject to wind forces which will be a constant haul on the satellite hosting the ribbon. The ribbon itself will have little drag because of its thinness. The tension over such distances is also not properly understood while the cargo is in the atmosphere. So a higher altitude attachment point is preferred. However, you also want an equatorial location to minimize "vibrate" of the orbit. So you need to find the highest equatorial point Now perhaps the space elevator idea will be a lot easier to manage on the moon [11].

A. Problem of nanotube

We read that if those Carbon Nanotube lines destroy, the line itself would just burn up in the atmosphere, and the station will be in geosynchronous orbit, so it would stay exactly but I think if it so it may move back from there position in higher orbit or other orbit.

At geostationary orbit. Without the counterweight, the mass of the cable between Earth and GEO would pull the station into a lower orbit. Likewise, without the Earth on the lower end, the mass of the counterweight would pull the station into a higher orbit. Remember, the cable itself is not in orbit, except at GEO. With the system intact, the tension is high enough that any break will pull everything above the break into a higher orbit, leaving only the Earth end to impact [10].

- **Cost:** Nanotubes has high production cost as a result of which if we used the CNT the cost of our project i.e. space elevator could be increased.
- **Separation:**_Also there is a problem of separation i.e untangling nanotubes.
- **Length:**_There is a problem of length i.e. 63,000 mile is a lot of ribbon.

B. Problem of Gravity

Also, since the cable is not in orbit, anything dropped from it won't just float alongside. There will be effective gravity, either real or centrifugal, everywhere except at GEO. The main problem associated with the space elevator is the problem of gravity i.e. if elevator in the upward direction the gravity of earth attracts toward itself as a result the elevator will not properly work.

C. Long process, takes several years

My inquisitiveness put down in how many strands it would take. It will take 293 days to create one strand of nanotube 1 mile long .with a total of 62000 miles of nanotube required, it would take about 18,186,666 days to make it then if you multiply that by the number of strands necessary to support the space elevator. We think people think that is no long year or days to made a strand but we tell you this take 909,333,333,333 days. But from we figuring at the moment, at the current rate of production, it would take ~2,491,324,201 years to make the nanotube structure alone. Anyways, assuming our drunken math is around accurate there, then this is simply not realistic, as there is little to no possibility that manufacture of this nanotube will multiply by 2 billion fold to make around a 2112 yr project.

D. Problem of Attack

Also, we suspect that any terrorists would choose to attack the cable at a very high altitude, preferably above the atmosphere, May be they'd use one of those new spaceships we'll be building in our new orbital shipyard to smash into the cable or toss an asteroid at it. All of the cabling below the break would fall back to Earth with implausible momentum .The impact zone wraps several times around the planet and near the end of that string; the effect is like a continuous string of nuclear bombs.

Of course, space terrorists wouldn't necessarily need a space elevator to impose disaster on Earth. They could just hit a few hundred iron-based asteroids at us, and maybe we could deflect them all in time or maybe we couldn't. Or they could use a rail gun or a laser. The possibilities are boundless, and unfortunately our unpleasant technology seems to be outpacing the defensive. (We still have no technological defense against nuclear bomb) and this is the problem related to space elevator [9].

E. Problem of space Debris

One threat to a space elevator would be orbiting space debris such meteors or space junk. Space debris has become a growing concern in recent years, since collisions at orbital velocities can be highly damaging to functioning satellites and can also produce even more space debris in the process. Some spacecraft, like the International Space Station, are now armored to deal with this hazard but armor and mitigation measures can be prohibitively costly when trying to protect satellites or human spaceflight vehicles like the shuttle.

F. Economics

Most researchers think that the first space elevator could be built at a cost of ten to fifteen billion dollars. Initially, it would cost a hundred dollars a pound to send something into space on a space elevator, but sharply decreasing as capacity and volume are added.

The primary problem at this stage are not technical rather economic and political.

V. VERY EXPENSIVE SPACE ELEVATOR

The potential global impact of the space elevator is drawing comparisons to another great transportation achievement the U.S. transcontinental railroad. Completed in 1869 at Promontory, Utah, the transcontinental railroad linked the country's east and west coasts for the first time and sped the settlement of the American west. Cross-country travel was reduced from months to days. It also opened new markets and gave rise to whole new industries. By 1893, the United States had five transcontinental railroads [10].

As plans move forward on the design of the space elevator, the developers are considering the risks and ways to overcome them. In fact, to make sure there is always an operational space elevator, developers plan to build multiple space elevators. Each one will be cheaper than the previous one. The first space elevator will serve as a platform from which to build additional space elevators. In doing so, developers are ensuring that even if one space elevator encounters problems, the others can continue lifting payloads into space.

Current estimates put the cost of building a space elevator at $6 billion with legal and regulatory costs at $4 billion, according to Bradley Edwards, author of the "The Space Elevator, NIAC Phase II Final Report." (Edwards is also the Dr. Bradley Carl Edwards, President and Founder of Carbon Designs.) By comparison, the cost of the space shuttle program was predicted in 1971 to be $5.2 billion, but ended up costing $19.5 billion. Additionally, each space shuttle flight costs $500 million, which is more than 50 times more than original estimates [10].

NASA funded Dr. Edwards' research for three years. In 2005, however, it only awarded $28 million dollars to companies researching the space elevator. Although it's still very interested in the project, for now it would prefer to sit back and wait for more concrete developments [10].

VI. REMEDIES FOR TRIBULATIONS

There are many safety issues associated with the construction and operation of a space elevator. A space elevator would present a significant navigational hazard. As compare to other means like spacecraft, rockets, planes deal with by mean of air-traffic control constraint but bang by space objects (in particular, by space debris, meteoroids and micrometeorites) pose a more difficult problem that could be a show-stopped for construction of a space elevator.

We have proposed some techniques to overcome the problems related to current technology as we have discussed above in section IV of this paper.

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A. Use of graphene

Graphene is the material to make space elevator. Graphene is a one-atom-thick planar sheet of sp^2-bonded carbon atoms that are densely packed in a honeycomb crystal lattice. It can be visualized as an atomic-scale chicken wire made of carbon atoms and their bonds. The name comes from graphite-ene; graphite itself consists of many graphene sheets stacked together.

The carbon-carbon bond length in graphene is about 0.142 nm. Graphene is the basic structural element of some carbon allotropes including graphite, carbon nanotubes and fullerenes. It can also be considered as an infinitely large aromatic molecule, the limiting case of the family of flat polycyclic aromatic hydrocarbons called graphene.

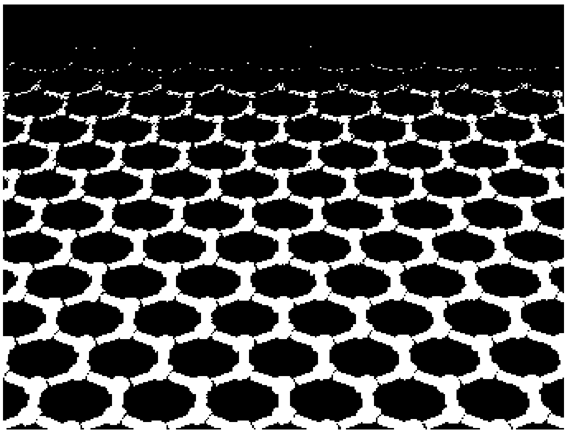

Figure 4 structure of graphene

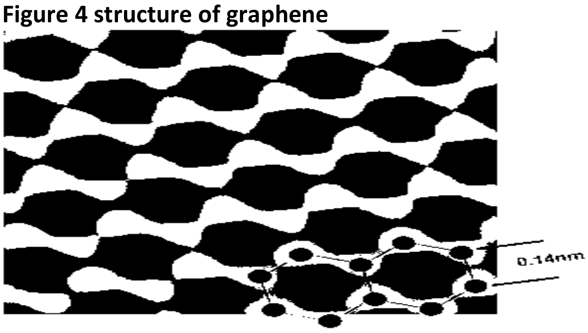

Figure5 image of graphene

Graphene sheets in solid form (density > 1 g/cm^3) usually show evidence in diffraction for graphite's 0.34 nm (002) layering. Transmission electron microscope studies show faceting at defects in flat graphene sheets, and suggest a possible role in this unlayered-graphene for two-dimensional dendritic crystallization from a melt.

Using an atomic force microscope (AFM), the spring constant of suspended graphene sheets has been measured. Graphene sheets, held together by van der Waals forces, were suspended over silicon dioxide cavities where an AFM tip was probed to test its mechanical properties. Its spring constant was in the range 1-5 N/m and the Young's modulus was 0.5 TPa, which differs from that of the bulk graphite. These high values make graphene very strong and rigid. These intrinsic properties could lead to using graphene for NEMS applications such as pressure sensors and resonators.

Graphene nanoribbons (GNRs) are essentially single layers of graphene that are cut in a particular pattern to give it certain electrical properties. Depending on how the un-bonded edges are configured, they can either be in a zigzag or armchair configuration. Calculations based on tight binding predict that zigzag GNRs are always metallic while armchairs can be either metallic or semi conducting, depending on their width. Graphene have a measured tensile modulus of 32 GPa . They even can significantly change the pathway of polymerization and similar chemical processes. The problem associate with this graphene is that its edges are configured but several techniques should come to overcome this limitation and graphene can be used to make space elevator [12].

B. <u>Space debris</u>

Any debris that is a centimeter size or smaller will hit and damage the ribbon. Objects larger than a centimeter will be tracked continuously monitored. The elevator, which will be located in the ocean, will need to be moved approximately once every 14 hours in order to avoid hitting larger debris. So these issues are by no means difficult.

Solution of Space Debris: The use of very large ferromagnetic rare-earth magnets to attract the small metallic debris, even though it can't remove the non-metallic debris but this method can be very successful in removing large amount of metallic debris.

We also propose that satellites and other man-made space machines should be made with decayable material i.e. the space machine or satellite should decay themselves after they become defunct.

Further we propose a separate orbit for the disposal of man-made waste.

C. <u>Radiation</u>

The space elevator would employ both active and passive radiation protect.

Solution of radiations: A large toroid and that would eliminate most of the charged particles. A small amount of additional shield would absorb the remaining radiation. The weight penalty issues would be rather modest - only a few tons. Four tons of extra heaviness on a twenty ton satellite is not prohibitive.

Elevator is also protected from radiations by providing the protective shield which is resist-radiation. .

D. Cable strength

A newly discovered type of carbon nanotube called the colossal carbon tube may be strong and light enough to support a space elevator. Its tensile strength is only 6.9 GPa, but its density is only .116 g/cm^3, making its specific strength sufficient for a space elevator. Its breaking length is 6066 km [13].

In the latest method of CNTs, the purity 99.8% and the density 0.037 g/cm^3 is produced in 2004. The breaking length of this material expected to reach tens of thousands of km.It is thought that the breaking length becomes 35,813 km, and meets the requirement of the cable enough when assuming 13GPa equal with strength of general CNT. We can make the cable which has high strength and doesn't break.

E. Satellite

Most active satellites are capable of some degree of orbital maneuvering and could avoid these predictable collisions, but inactive satellites and other orbiting debris would need to be either pre-emotively removed from orbit by "garbage collectors" or would need to be closely watched and nudged whenever their orbit approaches the elevator. Some solar sail satellites are used to re-orbit the defunct material into the lower earth orbit.

Solution: We use the solar sail satellite which is helpful in de-orbit the defunct human activities in space or satellites into L.E.O

F. Meteoroid and Micrometeorites

Far worse than meteoroids are micrometeorites; tiny high-speed particles found in high concentrations at certain altitudes. Avoiding micrometeorites is essentially impossible, and they will ensure that strands of the elevator are continuously being cut. Most methods designed to deal with this involve a design similar to a hoytether or to a network of strands in a cylindrical or planar arrangement with two or more helical strands [3].

Solution: A satellite called "MEDUSSA", which stands for Meteoroid and Energetic Detection for Understanding Space Situational Awareness. The MEDUSSA satellite will be able to study exactly what takes place when the micrometeoroids and energetic particles slam into it [15].

G. Corrosion

Corrosion is a major risk to any thinly built tether. In the upper atmosphere, atomic oxygen steadily eats away at most materials [14].

Solution: A tether will consequently need to either be made from a corrosion-resistant material or have a corrosion-resistant coating, adding to weight. Gold and platinum have been shown to be practically immune to atomic oxygen; several far more common materials such as aluminum are damaged very slowly and could be repaired as needed. If we have use the gold and platinum, the main problem of using gold and platinum is there cost. If we use these materials the cost of space elevator is goes on increasing.

Another potential solution to the corrosion problem is a continuous renewal of the tether surface. This process would depend on the tether symphony and it could be done on the nanoscale or in fragment.

H. Weather

In the atmosphere, the risk factors of wind and lightning come into play. The basic mitigation is location. As long as the tether's anchor remains within two degrees of the equator, it will remain in the quiet zone between the Earth's Hadley cells, where there is relatively little violent weather. Remaining storms could be avoided by moving a floating anchor platform.

Solution: The lightning risk can be minimized by using a nonconductive fiber with a water-resistant coating to help prevent a conductive buildup from forming. The wind risk can be minimized by use of a fiber with a small cross-sectional area that can rotate with the wind to reduce resistance. Ice forming on the cable also presents a potential problem. It could add significantly to the cable's weight and affect the passage of elevator cars. Also, ice falling from the cable could damage elevator cars or the cable itself. To get rid of ice, special elevator cars could scrape the ice off.

I. Vibrational Harmonics

A final risk of structural failure comes from the possibility of vibrational harmonics within the cable. Like the shorter and more familiar strings of stringed musical instruments, the cable of a space elevator has a natural resonant frequency. If the cable is excited at this frequency, for example by the travel of elevators up and down it, the vibrational energy could build up to dangerous levels and exceed the cable's tensile strength [14].

Solution: This can be avoided by the use of suitable clammy systems within the cable, and by scheduling travel up and down the cable keeping its resonant frequency in mind. It may be possible to dampen the resonant frequency against the Earth's magnetosphere.

J. Counterweight

Solutions have been proposed to act as a counterweight:

- A heavy, captured asteroid
- A space dock, space station or spaceport positioned past geostationary orbit; or
- An extension of the cable itself far beyond geostationary orbit.

VII. ALTERNATIVE CONCEPTS

A. Many different types of structures for accessing space have been suggested. As of 2004, concepts using geostationary tethers seem to be the only space elevator concept that is the subject of active research. Other alternatives to a space elevator include an orbital ring, a pneumatic space tower, a space fountain, a launch loop, a Skyhook, a space tether, and a space hoist.

B. Launching into deep space

The velocities that might be attained at the end of Pearson's 144,000 km (90,000 mi) cable can be determined. The tangential velocity is 10.93 kilometers per second (6.79 mi/s), which is more than enough to escape Earth's gravitational field and send probes at least as far out as Jupiter. Once at Jupiter a gravitational assist maneuver permits solar escape velocity to be reached [14].

C. Extraterrestrial elevators

A space elevator could also be constructed on other planets, asteroids and moons.

A Martian tether could be much shorter than one on Earth. Mars' surface gravity is 38% of Earth's, while it rotates around its axis in about the same time as Earth Because of this, Martian areostationary orbit is much closer to the surface, and hence the elevator would be much shorter. Current materials are already sufficiently strong to construct such an elevator. However, building a Martian elevator would be a unique challenge because the Martian moon Phobos is in a low orbit, and intersects the Equator regularly (twice every orbital period of 11 h 6 min). A lunar space elevator can possibly be built with currently available technology about 50,000 kilometers (31,000 miles) long extending though the Earth-Moon L1 point from an anchor point near the center of the visible part of Earth's moon [14].

VIII. CONCLUSION

The construction of the Space Elevator will be considered to mark the true beginning of the Space Age. The idea of space elevator is brilliant. Having the potential to place massive payload into LEO and beyond at a fraction of today’s cost, on paper, the space elevator seemingly may have what it make to open up the inner solar system for business. A space elevator would create a permanent Earth-to-space connection that would never close. While it wouldn't make the trip to space faster, it would make trips to space more frequent and would open up space to a new era of development.

The space elevator could substitute the space shuttle as the main space vehicle, and be used for satellite deployment, defense, tourism and further exploration. To the latter point, a spacecraft would climb the ribbon of the elevator and then would launch toward its main target once in space. This type of launch would require less fuel than would normally be needed to break out of Earth's atmosphere. At a length of 62,000 miles (100,000 km), the space elevator will be vulnerable to many dangers, including weather, space debris and terrorists. In this paper we have concerned on the problems related to space elevator and overcome these problems. As a result of which we save access to space-no explosive propellants or dangerous launch or re-entry.

So at last we conclude the paper by saying that **“SPACE ELEVATOR IS THE PATH TO HEAVEN.”**

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