3rd National Conference on Green Technology and Science for Sustainable Development
© 2020 IJSRST | Volume 5 | Issue 6 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
International Journal of Scientific Research in Science and Technology

Space Elevator and Its Issues

Prof. P. D. Tupkari, Mohan B. Lonkar, Dipak D. Rathod
Department of Mechanical, Anuradha Engineering College, Chikhli, Buldana, Maharashtra, India

ABSTRACT

The Space Elevator is the most suspicious Space Vehicle transportation method on the articles and Sci-Fi today. Simple description of space elevator is a cable with one end attached to the Earth and the other end 47,000 km long in the space. low budget, all over cost, ride quality and various safety issue concern with the space elevator. In that structure designed to transport material form surface to geostationary earth orbit and deep space. All research shows that the idea about how to design and construct the space elevator in theoretically, its practical realization could follow from the mass production of high strength materials and components. This paper is focused to the major issue related to the space elevator concept tented to focus on either environmental or safety concerns. The environmental issues deal with the effects of the natural environment on Earth and in space would have on the space elevator system. Some of these concerns led to safety issues for public travelling on the space elevator as well as for others on earth and in space some serious failure. As a result of which we save the space elevator components with various environmental hazards and taking precaution of them.[4][1]
Keywords : Issues, Space elevator, Environment, Debris, Safety.

I. INTRODUCTION

Space elevators are going to be use a ribbon, it stretched out in geostationary earth orbit and far. The centripetal force counters the force of gravity, keeping the ribbon perfectly balancing position. But now scientist deal with the tensile strength of a cable. Imagine the gravitational forces and centripetal force trying to crush or break it. few years ago, there was no material enough strong to sustain those forces, but the technical development of carbon nano tubes will made the idea of space elevator possible. How should we make a space elevator? The most affordable idea is to move an asteroid into geostationary earth orbit, this is our counterbalance weight for countering centripetal force. A cable would then be manufactured on the space station of various country and fallen down toward the Earth. As the cable expand, the asteroid is revolve the Earth orbit , keep all component in balance. Ultimately, the ribbon arrived the Earth surface and is attached to a ground station with anchor. For the purpose of energy we use a renewable energy source it supposed to be solar powered machine and that are attached to the space elevator and climber, it fulfil the all energy requirement. The way to geostationary orbit and earth surface, travelling at a speed of 200 km/hour, it takes the climb the elevator almost 10 days to make that journey from the surface to an altitude of 36,500 kilometres and more. But the cost savings would be higher.

Unfortunately, the rocket cost about $20,000/kg to send a payload to geostationary earth orbit. A space elevator should deliver the same payload for $300/kg. Obviously there are curtain risks associated with a system like that. If the cable crake, some part of it would fall to Earth, and peoples travelling up in the elevator would be goes to burning radiation in the Earth's Van Allen belts. construct a space elevator from Earth is at the very limits of our technology and science. But there are places in the Solar System which might make much more useful places to make space elevators. The Moon and Mars, for example, has a fraction of the Earth's gravity, so the space elevator can operate there using available materials and current technology.[1]

II. HISTORY

The concept of the space elevator become visible in 1895 the Russian scientist Konstantin Tsiolkovsky is motivated with the Eiffel Tower. They consider a tower that reached way into space, built from the up to an altitude 35,800 km above surface level to geostationary earth orbit.

Tsiolkovsky tower should be able to launch objects into various earth orbit without using a shuttle and rocket. an object released at the tower's top would also have the orbit velocity necessary to remain in geostationary orbit. Unfortunatly more recent technical fantacy 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 centre 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, 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.

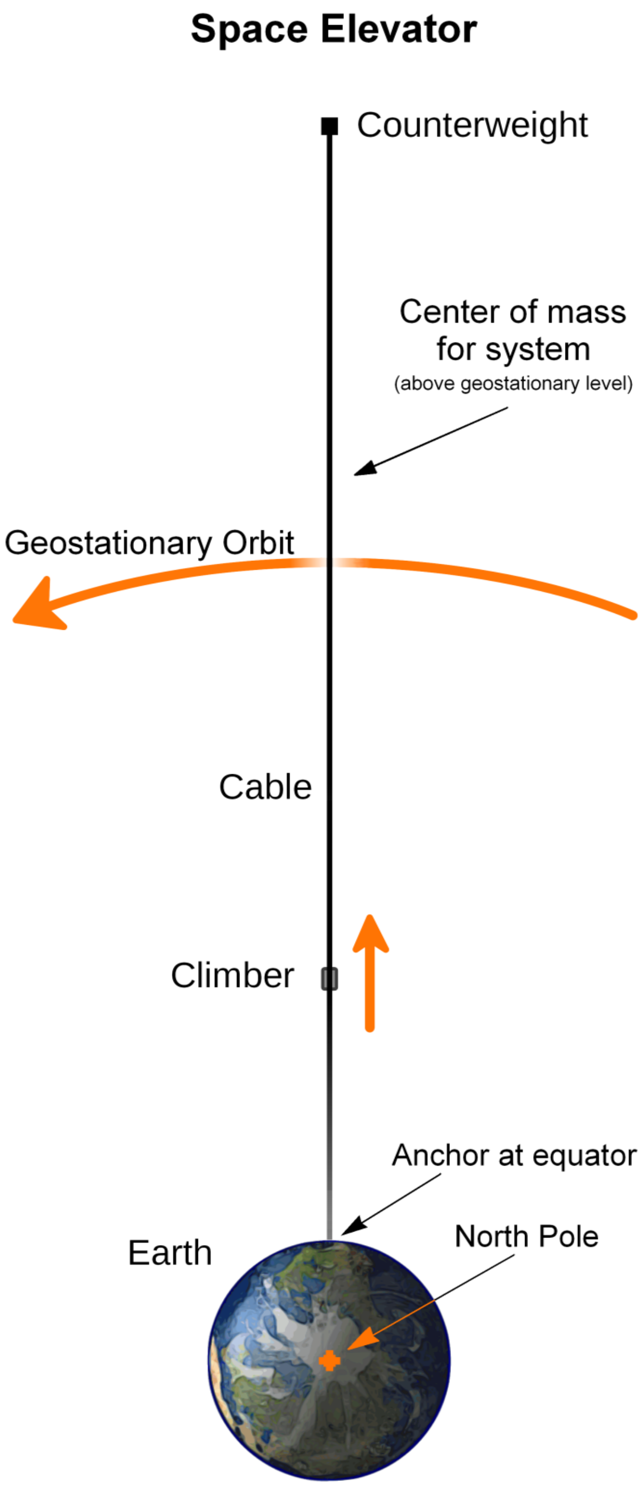

Figure: 1 Basic of Space Elevator Concept

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. [3]

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. 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 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. [2]

III. TECHNOLOGY FOR SPACE ELEVATOR

Recent 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.

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 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," [5]

A. Working of space elevator

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). [12]

B. Elevator tether or 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 centimetres 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. [11]

C. Climber

The robotic climber 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.

D. Anchor Place

The space elevator will originate from a surface platform in the equatorial Pacific or scientist choice place, which will anchor the ribbon to Earth.

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.

Figure 2. conceptual climber at roll on the ribbon.

F. Power Beam

The lifter will be powered by a free-electron laser system located on or near the anchor station. The laser will beam 2.4 megawatt 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)*

IV. SAFETY ISSUE

The design of the cable for the space elevator straddles a fine line between impossibility and too fragile to survive. On one hand the cable can be designed to be strong enough to survive any problem and have orders of magnitude more strength than theoretically required. The problem is that such a cable is so massive that there is no feasible way to deploy it in a reasonable time. On the other hand a cable can be designed skirting the theoretical lower limits in strength and come down before the first climber begins its ascent. The problem is to find any middle ground that is feasible. [6]

The single greatest safety concern identified centred on the hazards caused by potential collisions between the elevator structure and other objects in orbit. This included orbital debris, active spacecraft, and meteoroids. Orbital debris includes everything from paint chips to dead satellites, which are a threat to all active spacecraft today. Cleanup of orbital debris was identified as a high priority that needed to be done to protect all future spacecraft. Active spacecraft were also considered a threat to the space elevator but it was noted that future systems could include collision avoidance navigation systems. Meteoroids from space were perhaps the only natural debris hazard that will impact the maintainability of a space elevator structure. Impacts that could cause significant damage were found to be remote, but possible. [5]

1.Analysis of Space Debris

The U.S. Air Force tracks near by 8,700 objects 10 cm in diameter or larger that are orbiting the Earth. Of those objects, only 300 to 400 are operational spacecraft. The remaining debris is due to non functioning spacecraft, spacecraft breakups, one known collision, and a few unknown sources.

Small debris materials less than1 mm in diameter are numerous and can cause erosion of spacecraft surfaces. Space junk larger than 10 cm in diameter can be tracked by ground radar systems for collision avoidance purposes, and could eventually be captured and removed from Earth orbit. The real problem is with debris and incoming meteoroids in the 1 mm to 10 cm size. They are difficult to track with current technology and can cause significant damage to spacecraft systems.

General cleanup of space debris from Earth orbit was identified as a high priority for the space elevator and for current and future spacecraft. The infrastructure needed for space development in general, as identified in section 3.5, would create systems that could be used to track and collect orbital debris as part of an ongoing mission to keep the orbital environment safe for everyone. [7]

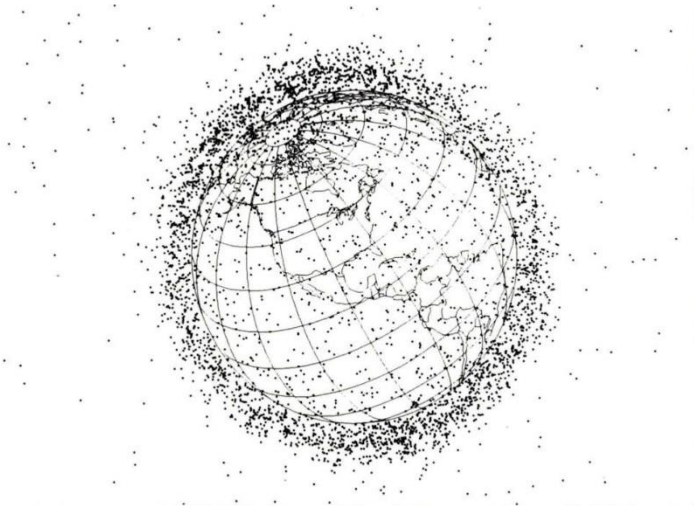

Figure:3 Estimated Space Debris

2. Space Elevator Collision & Precaution

The first space elevator will probably not be built until after the current generation of space assets have been used up. Next-generation space systems could be designed with the space elevator structure in mind and include automated collision avoidance systems for both satellites and the space elevator. This will be critical because all objects orbiting the Earth cross the equator twice per orbit and have the potential of colliding with a space elevator structure. Human-rated spacecraft like the Space Shuttle orbit the Earth at much lower altitudes with a 90-min period, crossing the equator once every 45 min. This equates to near equal to 32 equatorial crossings per day, or 11,680 crossings per year. The good news is that the orbital trajectories can be determined in advanced. Proper trajectory adjustments made at regular intervals or as part of the normal reboots of low earth orbit spacecraft could be made to avoid the space elevator structure.

Many new satellite constellations are under development for the mobile telephone industry. With the growth of communications, remote sensing, Global Positioning Systems (GPS's), and other Earth observation systems, it is apparent that the orbits from LEO to GEO will be populated by perhaps thousands of operational spacecraft by the time the technology is mature enough to build a space elevator. This congestion could improve the feasibility of space elevator structures by forcing, in advance, the cleanup of all orbits and the development of automated collision avoidance technology for all satellite systems.

3. Space Infrastructure

Another issue to consider is the effect a space elevator will have on other major space infrastructure developments like a space station, which are not so easily moved. the *ISS (*International Space Station*)* would make collision avoidance maneuvers at irregular intervals averaging maybe once per year to once per month, depending on the clearance range desired. It was determined that these collision avoidance could probably be done efficiently as part of the regular station reboots operations which normally occur several times per year. It appears important then that when collision avoidance systems are incorporated on both the space elevator and the spacecraft, such systems should be very accurate to permit low collision avoidance ranges. In other words, technology should be developed to allow clear or keep out ranges to be measured in meters, not kilometers, and automation will be needed to track and implement the thousands of commands per year.

Various options have been envisioned for doing collision avoidance on the elevator structure including swinging the entire structure and actively bending or vibrating the structure. [9]

V. ENVIRONMENTAL ISSUES

Major issues related to the space elevator concept tended to focus on either environmental or safety concerns. The environmental issues dealt primarily with the effects the natural environment on Earth and in space would have on the space elevator system. Some of these concerns led to safety issues for people travelling on the elevator as well as for others on Earth and in space in the event of a catastrophic failure. All title and author details must be in single-column format and must be centred.

A. Atmospheric Weather condition

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.

Ocean currents at the equator move from east to west except near the surface where there is an equatorial counter current that moves from west to east. Water temperatures from 24–28°C are typical with cold water up-wells along western coastlines near 20°C periodically. Precipitation is greater than evaporation at the equatorial region, making the ocean less salty at the equator than at higher and lower latitudes. Ocean depth along the equator varies to a maximum depth <8 km.

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. Rainfall can vary widely from 0.04 to 7.3 m per year, depending on the location along the equator. This has produced some of the most arid lands and tropical rain forests in the world in the equatorial regions.

B. Meteoroid

Meteoroids are a concern for space elevator systems as well as all other space systems. Whereas the space debris environment can be cleaned up over time, there is no control over incoming meteoroids from space. In general, the space environmental effect on materials is important to the design of the space elevator system. Past flight experiments provide a good database of space environmental effects on materials, and new materials being developed will always require testing to determine material survivability in the space environment.

C. Gravity

The most stable gravitational location for the construction of a space elevator is in the Indian Ocean at 70° E., which is south of India near the Maldives Islands. Second to that is a site in the eastern Pacific at 104° W. near the Galapagos Islands. Any location along the equator could be feasible, although some advantage might be found for the first elevator construction at one of these sites

D. Space Environment

Space environmental effects on materials can be broken into distinct areas where different effects are more prominent: low earth orbit, where atomic oxygen , space debris, plasma, and ultraviolet (UV) and vacuum UV radiation effects are most prominent; and geostationary earth orbit , where particulate radiation, UV and vacuum UV radiation, and meteoroid effects are most prominent.

E. Atomic oxygen

Atomic oxygen in the 200- to 900-km altitude can have significant impact on spacecraft at orbital velocities. It will erode organic films and polymeric materials, oxidize metals, and can have a negative effect on the materials' thermal optical properties, conductivity, reflectivity, vacuum sealing capability, and strength. It is anticipated that the AO will erode the surface of exposed carbon materials like the future carbon nanotube structure proposed for the space elevator. On a more positive note, the natural erosion from AO can build up a protective oxide layer on some metals. So, creating a total system that includes a type of sacrificial or protective layer is conceivable. It is also noteworthy that the elevator structure is not traveling at orbital velocities since its rotation is fixed with the rotation of the Earth. This will decrease the AO effects on the space elevator structure

F. Ionospheric Plasma

Ionospheric plasma effects on materials include material erosion, changes in optical properties, arcing of thin coatings, and pitting of material leading to sputtering. Electron collection of highly positive surfaces can alter floating potential and increase parasitic current flow in the system. These energetic particles can cause damage in materials through a variety of mechanisms. For crystalline materials, elements of the crystal lattice can be displaced. This is a big problem in semiconductors and optical fibers. A charge can be deposited in a material and cause a chemical change.

G. Ultraviolet Radiation (UV)

Ultraviolet radiation will darken many materials causing changes to the optical properties of polymer materials and thermal control coatings, and pitting of anodized aluminum will occur over long-term exposure. In general, all metals require coatings with highly emissive material to prevent overheating, and the coefficient of thermal expansion of the various materials should be similar to eliminate stresses. [10]

H. Vibration

A final risk of structural failure comes from the possibility of vibrational harmonics within the cable. Like the shorter and more familiar 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 it 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.

VI. SUMMERY

The space elevator is under development and could be operational in 20 to 25 years before. This will allow low-cost Earth-to space transport and open up opportunities for gravitational and space hemisphere. The larger masses and volumes, transport, delivery to neighboring plane, and possible return of completed experiments to Earth allow for many new investigations to be conducted. Two such experiments were discussed: 1) the large, long-term biosphere for development and environmental studies in a constant low-gravity environment, and 2) planetary engineering studies as a adaptation of the Martian surface for human use.

VII. 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.

VIII. REFERENCES

[1]. D. V. Smitherman , " Space Elevators An Advanced Earth-Space Infrastructure For the New Millenium", August 2000, NASA/CP-2000-210429, Page No 23 to 25, Marsshall Space Flight Centre,Huntsville,Alabama.

[2]. Bradley C. Edwards, "The Space Elevator" , 2005, NIAC , Chapter 10- Challenges

[3]. Bradley C. Edwards, "A Hoist to the HEAVENS , August 2005, Future Tech Spacial - Space, IEEE Spractum.

[4]. Sourabh Kaushal, Nishant Arora, "Challenges In Space Elevator", Department of Electronics And Comunication, Institute of Science and Technology, kalwad, Hariyana.

[5]. Bradley C. Edwards, " The Space Elevator: A New Tool For Space Studies", Eureka Scientific , Seattle WA.

[6]. P.K. Aravind, "The Physics of The Space Elevator", Department of Physics, Worcester Polytechnic institute, Worcester, Masschusetts, DOI: 10.11190/1.2404957

[7]. NASA Science; share the science News letter, "Audacious & Outrageous: Space Elevators", https://science.nasa.gov/science-news/science-at-nasa/2000/ast07sep_1

[8]. http://www.isec.info

[9]. http//wiki.spaceelevator.com/@api/deki/files/6/=iac-04-iaa.3.8.2.01.edwards.pdf

[10]. https://www.universetoday.com/143256/the-spaceline-an-elevator-from-the-earth-to-the-moon/

[11]. https://www.wired.com/2003/02/to-the-moon-in-a-space-elevator/

[12]. https://science.howstuffworks.com/space-elevator.htm