SYMPOSIUM ON VISIONS AND STRATEGIES FOR THE FAR FUTURE (D4)
Space Elevator Design and Impact (3)

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THE SPACE ELEVATOR CONSTRUCTION CONCEPT

Abstract

In this paper we describe a newly designed whole space elevator system including construction process, and then examine its feasibility. The space elevator is planned to be built by the year 2050 with a capacity to carry 100-ton climbers.

It is composed of 96,000-km carbon nanotube cable, 400-m-diameter floating Earth Port, 12,500-ton Counter Weight, and several other facilities, which include Martian/Lunar Gravity Centers, LEO (Low Earth Orbit) Gate, GEO (Geostationary Earth Orbit) Station, Mars Gate, and Solar System Resource Mining Gate.

The construction process consists of deployment of cable and construction of facilities. It is necessary to analyze cable dynamics for estimating the characteristics of cable, counter weight, facilities, and climbers, and also for determining the construction procedures. The cable dynamics include tension, displacement, and elongation of the cable due to ascending climbers, masses of counter weight and cable, wind, as well as fixed loads of facilities. With a help of a computer simulation of the equations of motion, we designed the system and determined the construction process. Based on the results, we conclude the following: the construction will be technically feasible with the assumed cable tensile strength of 150 GPa; it take roughly 20 years to construct the cable; the impacts of wind or Coriolis force on cable displacement are small; and it is essential to fix one end of the cable to the earth surface and always impose pre-tension at the ground end. According to the plan, an initially deployed 20-ton cable is reinforced 510 times by successively ascending climbers over roughly 18 years up to 7,000 tons. Then the facilities are transported and constructed within one year.

For our model, we estimate that the construction cost is approximately10 trillion yen (100 billion

USD), and the transportation operation cost approximately 5,000 to 10,000 yen/kg (50 to 100 USD/kg). The large initial construction cost, according to our estimate, will be paid off just by constructing and operating a single space solar power system of conventional type, 5-GW power output and 50,000-ton mass, by using the space elevator. This means all the other space transportations will benefit from significantly lower transportation operation cost of the space elevator which is roughly one-hundredth of that of conventional launches.

The current technology levels are far from ready yet to realize the concept, however, the relatively realistic plan we developed shall be one stepping stone towards the construction of the space elevator.