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Review of Analemma Tower as Future of Buildings- The Road Ahead

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ABSTRACT:

Human and infrastructure tolls of natural disasters become ever more prevalent and it is the need of the hour to discuss the ways to make our buildings and other infrastructure more resilient to those forces. Several stakeholders in land use and development are looking at going beyond the minimum thresholds currently in use to further address disaster preparedness, safety, and climate mitigation in buildings. This paper reviews the possibility of Analemma Tower construction as an alternative solution and discusses the factors to be considered for structural design. Relationship between pressure and gravity was studied and presented in this article. Analysis on vibration is also contented. If the concept of Analemma Tower and such skyscraper infrastructure is constructed practically, it is possible to ensure the safety of the humankind from natural calamities..

Keywords:**Analemma Tower, asteroids, centripetal force, spring-dashpot system**

1. INTRODUCTION:

With the growing advancements, buildings have been grown up ever taller and lighter. It is believed that someday buildings will break free from earth's surface and keep the people safe from harmful floods, earthquakes, and tsunamis. Analemma upends the traditionalidea of an earth based foundation and provides a space based reinforced foundation from which the tower is suspended. By placing a huge asteroid into the orbit over the earth, a high strength cable can be lowered towards the surface of the earth from which a super tall tower (Analemma) can be suspended. The slope of the graph between buildings and time suggests the beginning of an exponential increase in height. It is inferred that humans are in the process of dislodging themselves from the planet's surface. Using mathematical calculations, the centripetal force acting on the earth can be found out. The effects on the tower due to different layers of atmosphere and the strength of cables could be reckoned.

2.CONSTRUCTION:

2.1.PRINCIPLE:

The Universal Orbital Support System is a concept for suspending an object from an external object orbiting in space. The orbital system is a coupled mass system wherein the upper supporting mass asteroid(A) is placed in an orbit around a given celestial body such that it can support a suspended mass. Building (B) at specific height above the surface of the celestial body but lowers than A. The relationship between A and B is such that if A moves higher

as B is lowered towards the surface, the distance is related as an inverse proportion of their masses.[5]

2.2.WORKING:

The tower will be suspended by a high strength cable from an asteroid and placed in eccentric geosynchronous orbit. The tower's position in the sky traces out a path of eight shaped figurefrom northern hemisphere to the southern hemisphere, where the top and bottom of the trace out experiences slowest speed of its travel.Ground trace annotated with 24 hours segments correspond to the tower position over a specific geographic feature.[6]

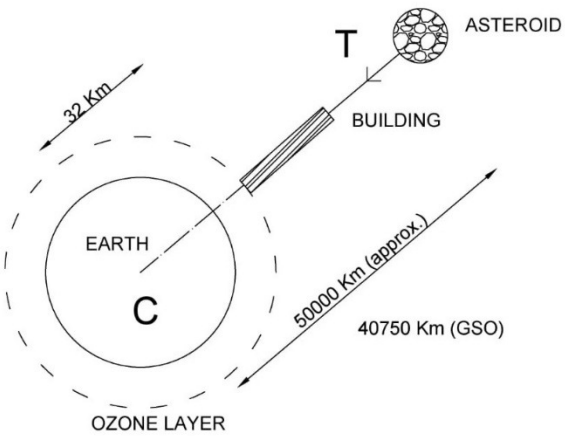

Fig.1.Plan of skyscraper

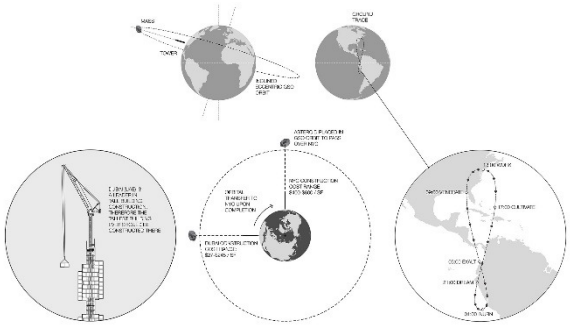

Fig.2.Trace out of eight shaped path[3]

2.3.PLANNING:

The bottom of the structure is seen as shopping and dining area. This firm talks about business being conducted above this zone in the lower and middle sections of the tower, with the residential quarters approximately two third of the way up. The plan has grand visions of tomorrow. Pressure and temperature changes according to the altitude of the tower.[11]

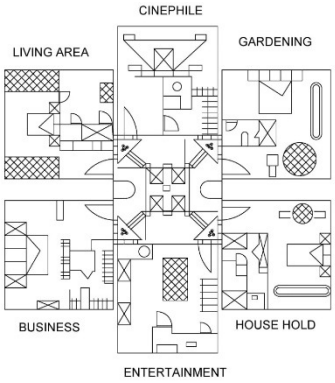

Fig.3.Plan of residence [11]

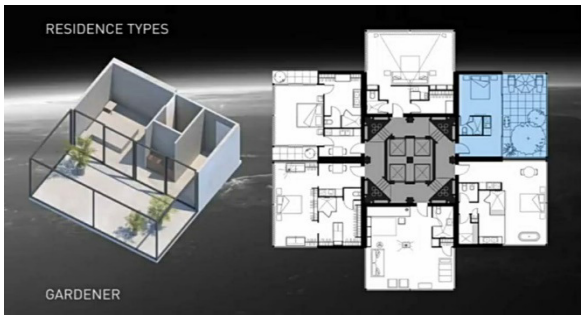

Fig.4.Planofresidenceinsidethetower- type A[11]

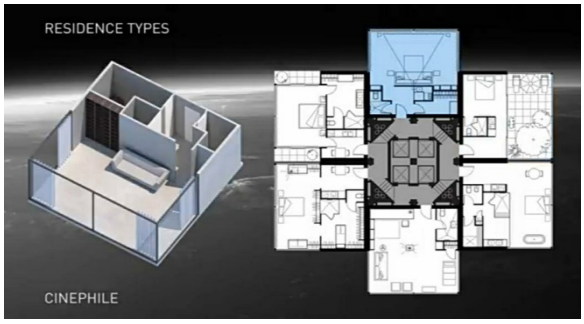

Fig.5.Plan of residence inside the tower- type B[11]

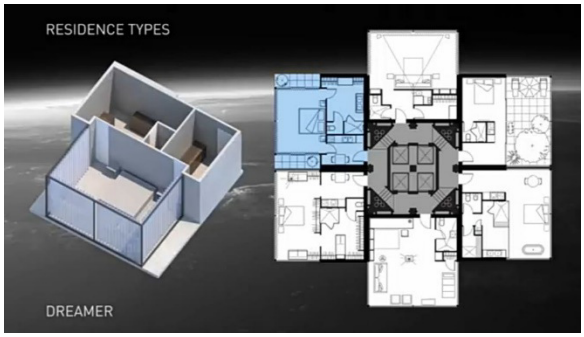

Fig.6.Plan of residence inside the tower- type C[11]

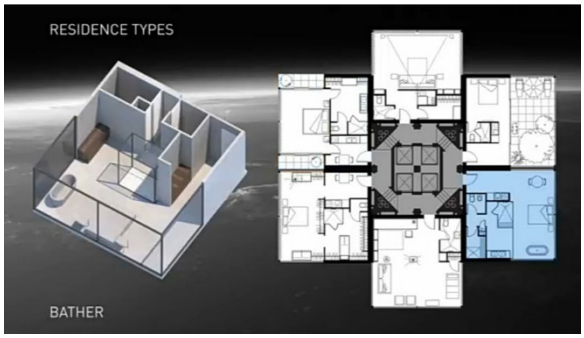

Fig.7.Plan of residence inside the tower- type D[11]

2.4.DESIGNING:

The design is proposed to be geosynchronous, but not geostationary. The Asteroid would be in an inclined orbit, so that the tower traces a pattern of Analemma with respect to the ground. North south motion will then be experiencedat the bottom end, and some amount of drag because of it. Gravity and centrifugal acceleration are balanced hence, the center of mass is at synchronous orbit.An inclined orbit can be followed without any difficulties. The lower parts of the Analemma are not in force balance. In order for the bottom to be accelerated north and south poles, the cable should be inclined. The distance to the ground changes, and a slender cable is subjectected to all kinds of dynamic vibrations in that case. The simplistic design also seems to ignore tidal effects of the Moon and Sun.**[11]**

Fig.8.Designed windows[11]

Fig.9.Windows[11]

Fig.10.Work space area[11]

Fig.11.Distinct view of windows architecture[11]

3. OUTCOME OF THE SKYSCRAPER:

The present day construction in the Earth's surface has developed ever taller and lighter buildings. But this model of skyscraper releases us from all kinds of natural calamities experienced on the surface of theEarth. The skyscraper is situated above the ozone layer and experiences 45 minutes of extra day light factor compared to the construction on the Earth's surface. As the skyscraper in the stratosphere (above the ozone) experiences high thermal condition due to direct UV rays from the Sun, which generates enormous amount of energy using solar panels which is utilized by the skyscraper. From here the skyscraper has direct interaction between the clouds which can alter the rainfall pattern, nature of charges caused by the clouds and the source for water is from the clouds. Simultaneously recycling of water takes place. **[9,10]**

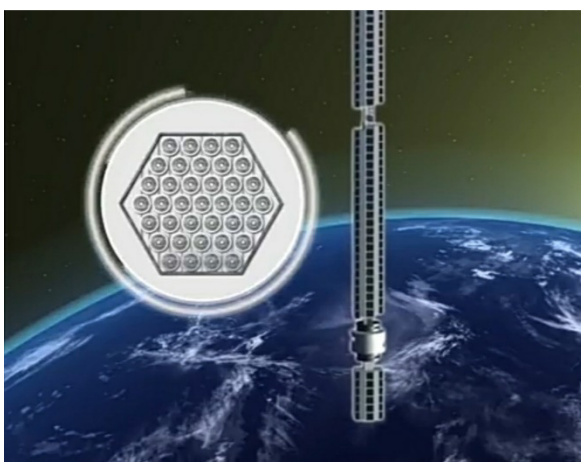

Fig.12.Solarcellsusedforgenerationofelectricity[1]

4. GEOMETRICAL PROJECTION DUE TO REVOLUTION OF ANALEMMA TOWER:

An object revolves in any orbit in space having its field in center and a least time of movement described are just then nascent. The versed sine of that are supposed to be drawn bisecting the chord and produced passing through the center of force. Thus the centripetal force results in the middle of the arc gives directly proportional to the versed sine and inversely proportional to the square of the time.

Centripetal force F_c= K (versed sine)

$=K/T^2$

Versed sine= 1-cosine

T: Time

COROLLARY 1: An object p revolving around a curve QPA about the center S, a tangent ZPR is drawn to the curve and touches p at any point. Drawing parallel line QR to the distance SP, where Q at any point of the tangent ZPR intersects and QTis drawn perpendicular to SP. The centripetal force is as reciprocal as solid,

$F_c= KQR/(SP^2XQT^2)$

If the solid is been taken, the magnitude is obtained when p and q coincide. For QR is equal to versed sine of double arc QP whose middle is P and double the triangle SQP or SP X QT proportional to time in which double arc is described and therefore used it for exponent of time.

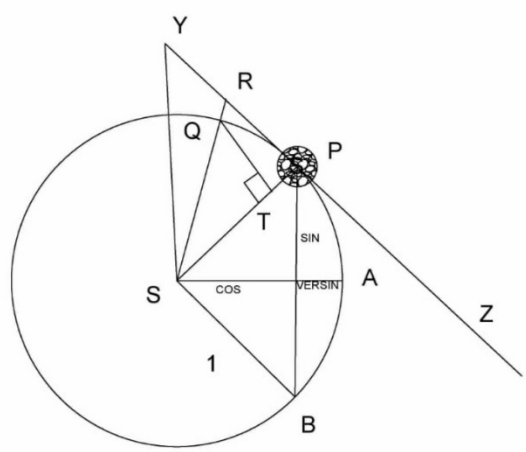

Fig.13.Pictorial representation[12]

COROLLARY 2: If SY is perpendicular from the center of the orbit, the rectangles SY X QP and SP X QT are equal.

SY X QP = SP X QT

COROLLARY 3: If any curvilinear figure APQ is given to which a centripetal force is perpetually directed that law of centripetal will be continuously drawn back to rectilinear course.

Therefore, $F_c=KQR/(SP^2XQT^2)$

Where, K is the proportionality constant

F_c is the centripetal force.**[12]**

5. STRENGTH OF THE CABLE:

Strength of the cable is determined by withstanding the ability of cable from geometrical projection due to revolution of Analemma tower tension (T) which is is given by

$T=KQR/(SP^2XQT^2)$----------1

The force acting on the cable is a center seeking force, that is, centripetal force is acting on the cable,

$F_{centripetal}=mv^2/r$---------- 2

Where, m =mass of the construction, v=Earth's rotational axis, r=length of the cable.

From equation 1 and 2 we see that the tension developed in the cable is equal to the centripetal force acting on the cable.

$T=KQR/(SP^2XQT^2)=mv^2/r$

Where, K is the proportionality constant.

By using this result the strength of the cable and various other factors are analyzed.

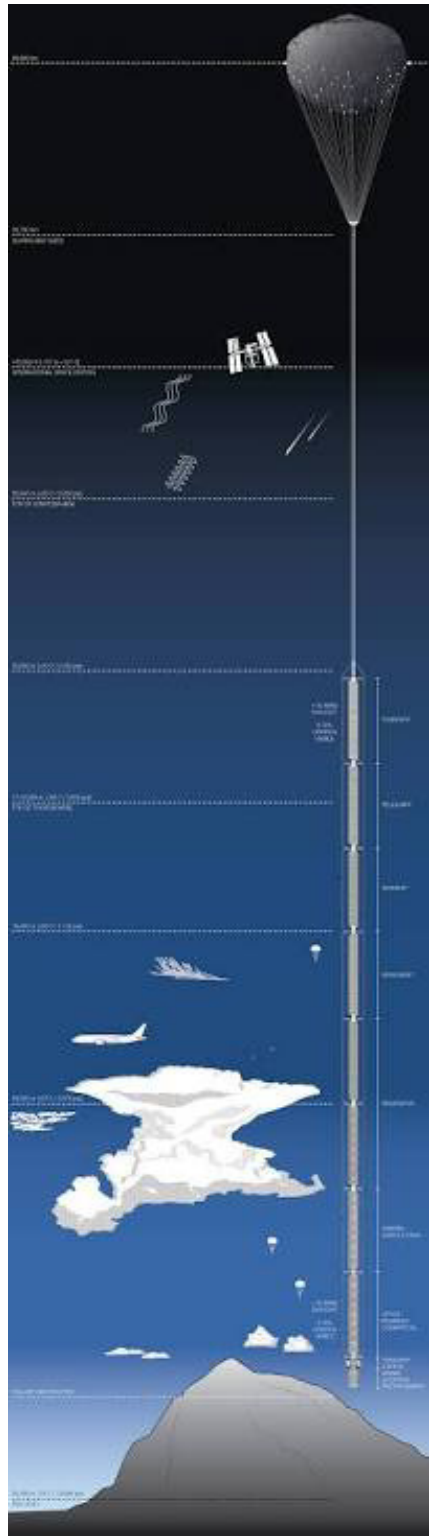

Fig.14.Cables holding the asteroid and the tower [2]

Fig.15.Cables that could hang from an orbiting asteroid[4]

Fig.16.Cables holding the megastructure[1]

6.FACTORS WITH RESPECT TO DIFFERENT LAYERS OF ATMOSPHERE:

Earth's unique atmosphere has four different layers. Here the main construction part of the tower lies in the stratosphere at the height of 32km above the sea level and it is just above the ozone layer.**[3]**

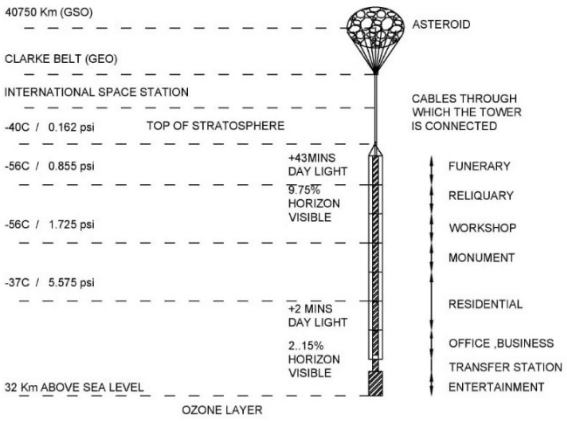

Fig.17.Elevation of Analemma tower [4]

The various factors which reflects on distinct layers of atmosphere:

6.1.TEMPERATURE:

In troposphere, the temperature decreases with respect to the height. This temperature decrease is known as environmental lapse rate and averages 65 degree Celsius per km. This extends from surface up to an average altitude of 11km (Arehins: 10). This altitude can range as high as 16 km in tropics and less than 9 km over the poles. (Lutgens: 19)

In stratosphere, a large concentration of ozone (O_3) is found. The greatest is experienced at 25 km. This ozone layer absorbs UV rays emitted by the sun which heats the atmosphere.

The cables used for hanging this tower is located in thermosphere and exosphere where it experiences extreme heat.**[15]**

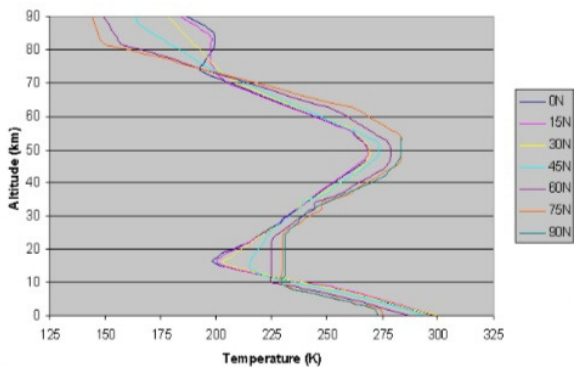

Fig.18.Graph depicts temperature vs altitude[15]

6.2.PRESSURE:

The average sea level pressure is 1013.25mb or 14.7lb ln^{-2}. This means that 14.7 pounds of pressure acts on every square inch of our body. Construction of the tower is placed in two different regions where one half of it lies in 5.6km and 90% of mass lies within 100km of earth's surface(weight). Due to the lack of air molecules, the cables experiences very little pressure. (Lutgens:18).**[14, 17]**

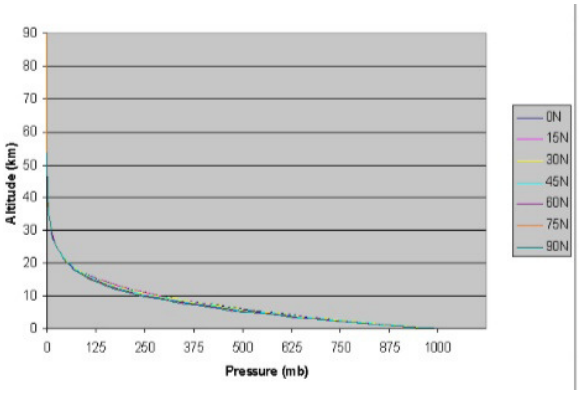

Fig.19.Graph depicts pressure vs altitude[14]

6.3.DENSITY:

The atmospheric density decreases with respect to the height in all seasons and latitudes. Maximum density is experienced at the bottom of the construction. The density gradually decreases as the height increases.**[16]**

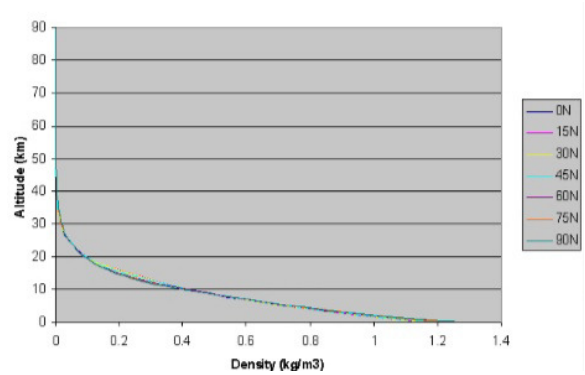

Fig.20.Graph depicts density vs altitude[16]

7.PRESSURE, GRAVITY RELATION:

Pressure is given with the relation, p=mgh where, h denotes depth and mg denotes weight. On differentiating p with respect to r we get, dp/dr=g/rho

All these quantities depend on radius r, density rho. The local acceleration due to gravity is given by, $g(r) = GM/r^2$

Where dp / dr is the derivative or tangent of the curve p(r). On integrating we get, p(r)=integral of g/rh_0 dr where r varies from 0 to infinity.

Assuming that the pressure at infinity is zero, when g(r) is close to the constant, p=mg/ rho, is obtained.

mgh is the potential energy of mass m, at height h, in gravitational field of acceleration g.

For constant density we get,

$p_2 - p_1 = p_i rho^2 (r_2^4 - r_1^4)/3$

Where, p_2-p_1 and r_2^4-r_1^4 are change in pressure and radius respectively.**[18]**

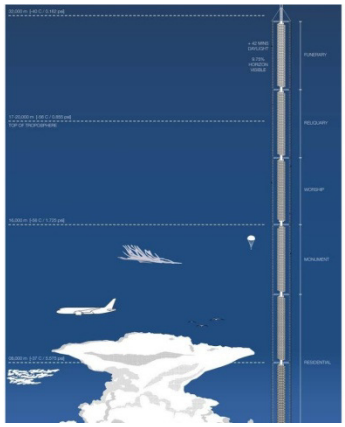

Fig.21.Analemma tower in distinct layers of atmosphere [3]

8. VIBRATIONAL ANALYSIS:

From the dynamics of structure, the building is a hanging system supported in an asteroid. Thus it's in a forced spring-dashpot system. The spring and dashpot are connected parallel and represent the cables which we used to hang, where the spring constant, density of liquid and area are high in that system so that it remains in static condition.

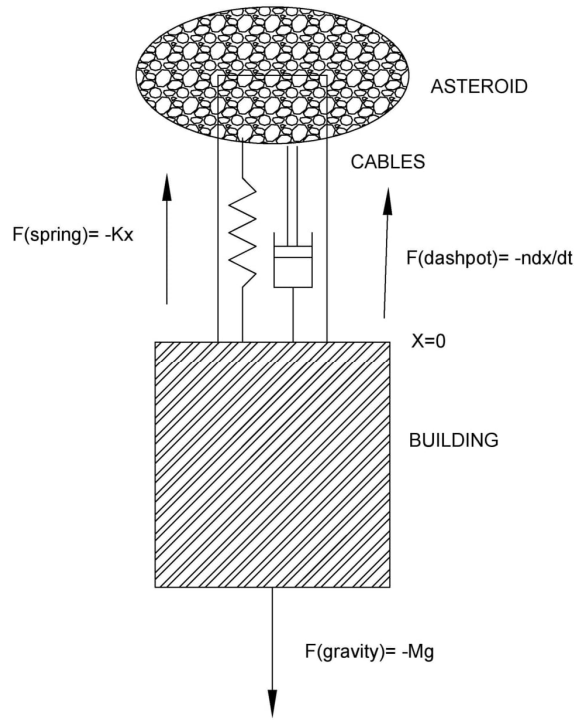

Fig.22.Spring damper system of cables

$F_{total}=ma=F_{gravitational}+F_{spring}+F_{support}$

$m\, d^2x/dt^2= -mg-kx-n\, dx/dt$

$m\, d^2x/dt^2 +n\, dx/dt+ kx= -mg$

It has single degree of freedom and is a second order differential equation and non-homogenous ordinary differential equation.

A natural frequency of vibration determined by the physical parameter of the vibrating object is said to be resonant frequency. Where it should be minimum to get the less vibration, better the structure will exist.

$w= (((2km-n) \pm((n-2km)^2+4m^2(f_0^2/w-k^2))^{1/2})/m^2)^{1/2}$

Thus the minimum value of vibration can withstand the structure safely at the atmosphere. Thus the vibrational analysis is done for this dynamic structure.

9.CHALLENGES DURING EXECUTION:

The Skyscraper experiences the following practical difficulties during the construction.

1. Establishment of the space based foundation is quite difficult to analyze. Other asteroids in space mayaffect the main construction.
2. The high strength cables are used to hang the building have a certain life period of excellence. Fixing cables to the selected asteroid mayact differently in space.
3. Balancing the weight and movement of the building when it travels a path of eight shaped projection. The instant emergency measures are quite difficult to make it happen at that movement.
4. Shifting people to the building and various other components of construction to shift up forces a major difficulty for the construction.[7]

10.CONCLUSION:

The skyscraper keeps the people safe from natural calamities. It experiences 45 minutes of extra day light factor. The tension developed in the cable and its withstanding ability of the cable determines the strength of the cable. Therefore, tension is $(mv^2)/r$. So, the centripetal force equals to tension developed in it. The velocity of the movement of the tower is slowest at the top and the bottom end of the 8 shape, so it is not uniform. Hence it moves under the law of rectilinear motion.The minimum resonant frequency is acquired by the vibrational analysis for this dynamic structure under the law of mass spring damper system.

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