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A SURVEY ON HYPERLOOP TRAIN OF FUTURE

Misba Inamdar[1], Rahul Panchal[2]

Student Scholar in Mechanical [1], Asst.Professor in Mechanical[2]

[1]Mechanical Engineering, AAEMF's COE & MS, Koregaon Bhima (INDIA)

[2]Mechanical Engineering, AAEMF's COE & MS, Koregoan Bhima (INDIA)

ABSTRACT

In today's date travelling is defined by rail, road, air and water. These are mostly available in world with very common sets of problem like safety, security of structure, environmental crisis, space, time for travelling, etc. And most important problems are that even best of these has high cost or slow speed or in sad cases both of them. Hyperloop is a concept that is believed to be originated from 20th century's sci-fi, which shifts paradigm of transport. Hyperloop is theoretically most safe, eco-friendly, relatively cheap, and the future face of transportation.

Keywords:Electromagnetism, Fluid Mechanics, Modern Technology, Safety, Transportation.

I.INTRODUCTION

Transportation is an industry in constant flux: forced to keep up with the ever-growing human population while providing faster and cheaper methods of travel. In 100 years, the industry has made colossal improvements, as seen by the replacement of horses with the large-scale implementation of mechanized cars, trains, planes, and boats [1]. Most impressive of all, flight, first achieved in 1903, has reshaped the human notion of travel [2]. In today's world, traveling at speeds of 560mph, the typical cruising speed for modern airliners, is excepted and for obvious reasons vastly preferred [3]. However, air travel is becoming increasing expensive and inconvenient. This is due in part to higher cost of fuel and increased security at airports, stemming from the inherent nature of airplanes not being restricted to a certain location like a train is to its tracks. For these reasons, a fifth method of transportation is needed to satisfy mankind's insatiable hunger for highspeed travel at a low cost. Hyperloop can be the technology to fill this void. Devised in 2013 by SpaceX CEO Elon Musk, Hyperloop is the idea of placing a passenger carrying pod in a near vacuum and shooting that pod around 760mph [4]. For reference, the speed of sound is about 767mph [4]. This technology is similar to how modern-day bullet trains work; however, it has the advantage of being incredible cheap, in theory, to build [4]. Currently, two companies are in a race to develop and capitalize on the possibility of this idea. Moreover, hyperloop excites me because of its ability to bring an alternative form of travel to the western coast of America, where airplanes and cars are dominant. Engineers are intrigued by the idea because it could prove to be pertinent in replacing the old transit infrastructure of America. Lastly, this technology could drastically reduce commute times while being cheap, safe, and convenient for many Americans. The underlying challenge is devising a way to make Hyperloop a reality.

II. LITERATURE REVIEW

2.1 Ahmed Hodaib, Samar F. Abdel Fattah (May 2016), discussed the **"Design of a hyperloop capsule with linear inductionpropulsion system"** which is used to accelerate and decelerate the capsule. They studied that like rotary synchronous motors; linear motors run on 3-phase power and can support very high speeds. However, there are end effects that reduce the motor's thrust force. Linear induction motors are thus less energy efficient than normal rotary motors for any required force output. They also discussed about the manufacturing of linear induction motor in this paper. [1]

2.2 Jeffrey C. Chin, Justin S. Gray, Scott M. Jones, Jeffrey J. Berton, they discussed about **the "Open-Source Conceptual Sizing Models for the Hyperloop Passenger Pod"** in this paper. They concluded that the refined analysis illuminates several interdisciplinary couplings that alter two major aspects of the initial concept. First, the pod travel speed and the tube cross sectional area are linked, forcing the tube size to be to be roughly twice the diameter of the original specification, in order for the pod to reach Mach 0.8. Second, the steady-state tube temperature is dominated by ambient thermal interactions unrelated to the heat generated by the pod compression system. [2]

2.3 Mark Sakowski (2016) Discussed "**The Current Maglev Technology Along with The Theoretical Evacuated Tube Technology"** and they concluded that the hyperloop is feasible and if properly designed, has the potential to be much more efficient in terms of energy usage of pods traversing down the tube. [3]

2.4 N. Kayela, (2014) investigated that "**The Hyperloop Is A Fifth Mode of Transportation Alongside Trains, Planes, Automobiles and Boats"**. He discussed about the railway track for the hyperloop, stations for the hyperloop. Also, discussed about the two version of capsule that is one is passenger only version and another is passenger plus vehicle version. [4]

2.5 Mohammed Imran (2016) He focused his **Study Element on The Hyperloop Technology (The Passenger Transport System)**. He discussed about the two version of hyperloop in that one is passenger only version and another is passenger plus vehicle version. Hyperloop System. [5]

3.BASIC PRINCIPLE OF HYPERLOOP

Hyperloop is based on a principle of magnetic levitation. The principle of magnetic levitation is that a vehicle can be suspended and propelled on a guidance track made with magnets. The vehicle on top of the track may be propelled with the help of a linear induction motor.

Hyperloop is a new technology, yet the idea behind it is perfectly feasible within our understanding of physics and implementation would not require any new technology [4]. In essence, creating a Hyperloop should only require paring together current technologies. The major theoretical hurdle for Hyperloop is something called the Kantrowitz limit [4]. This talks about speeds of projectiles as they move in a tube. A projectile in a tube has a minimum tube to projectile ratio in order to move at a high speed efficiently [4]. This is because as a projectile starts to move quickly in a tube it creates a large column of air in front of it [4]. If the tube diameter is too small,

the projectile will not only have to propel itself forward but also the entire column of air in front of it [4]. This occurs because the air cannot move around the projectile if the diameter is too small. Furthermore, this situation would require an infeasible amount of power for a very little speed benefit, or in other words a horrible transportation system [4]. The solution to this problem is to simply make a large tube, yet this too is inefficient for a largescale transportation system as material cost would be greatly increased [4]. Luckily in 2013, Elon Musk proposed a solution to both these problems. If an electric compressor fan is placed on the nose of the pod it could actively transfer high pressure air from the front of the pod to the back [4]. Moreover, this air could also be used to create a cushion for the train to glide on as it travels, known as an air bearing [4]. The benefit to air bearings are that Hyperloop would not lose any energy to fighting friction. The nemesis for anyone who wants to move an object quickly. The other components of Hyperloop are electromagnets to propel the train forward and a near vacuum inside its tube [4]. Electromagnets are current in use, known as maglev, in the fastest bullet trains in the world [9]. The difference would be that in Hyperloop the magnets are only used for propulsion [5]. This means that magnets will only be needed in the walls of the tube at the very start of track and about every 70 miles to keep the train at its top speed [4]. In total about 1% of the tube would need to be made up of magnets [4]. Another major feature of Hyperloop is the tube it travels in. While the outside is nothing special, the inside is a soft vacuum [4]. This is very important as it also reduces the amount of drag force in the tube [4]. Drag force is the other major force preventing objects from traveling at high speeds. The exact pressure in the tube will be around 100 pascals as compared to the pressure we live at of 101,325 pascals [4]. The reason the tube will not be a complete vacuum is due to cost and likelihood of leaks [4]. The figure 3.1 shows the basic principle of Hyperloop System.

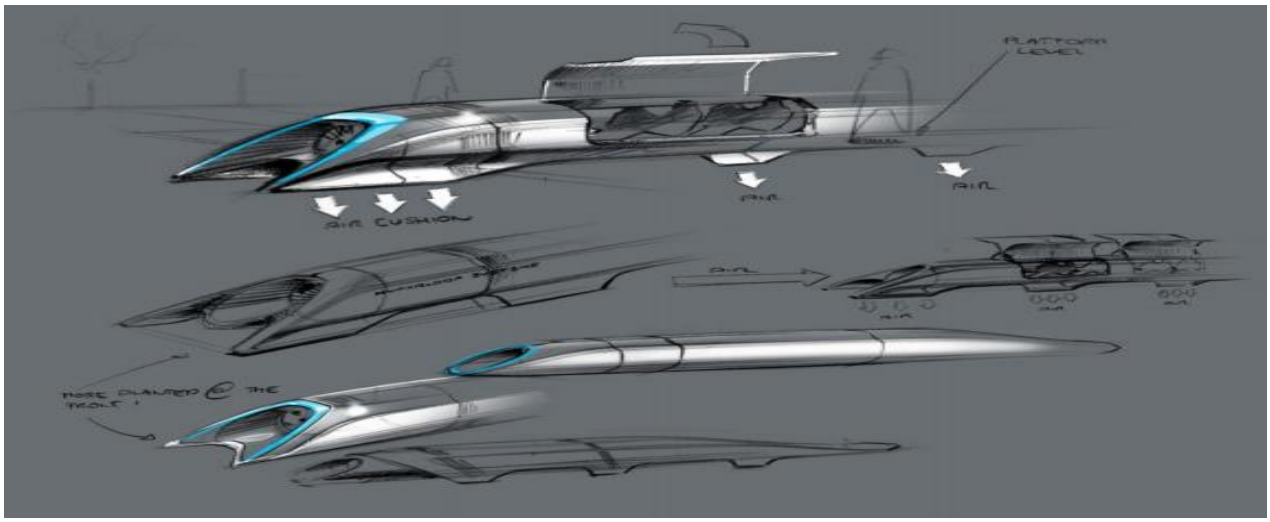

Fig.3.1 Hyperloop – the new mode of transportation.

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IV.CONSTRUCTION OF HYPERLOOP SYSTEM

4.1 TUBE

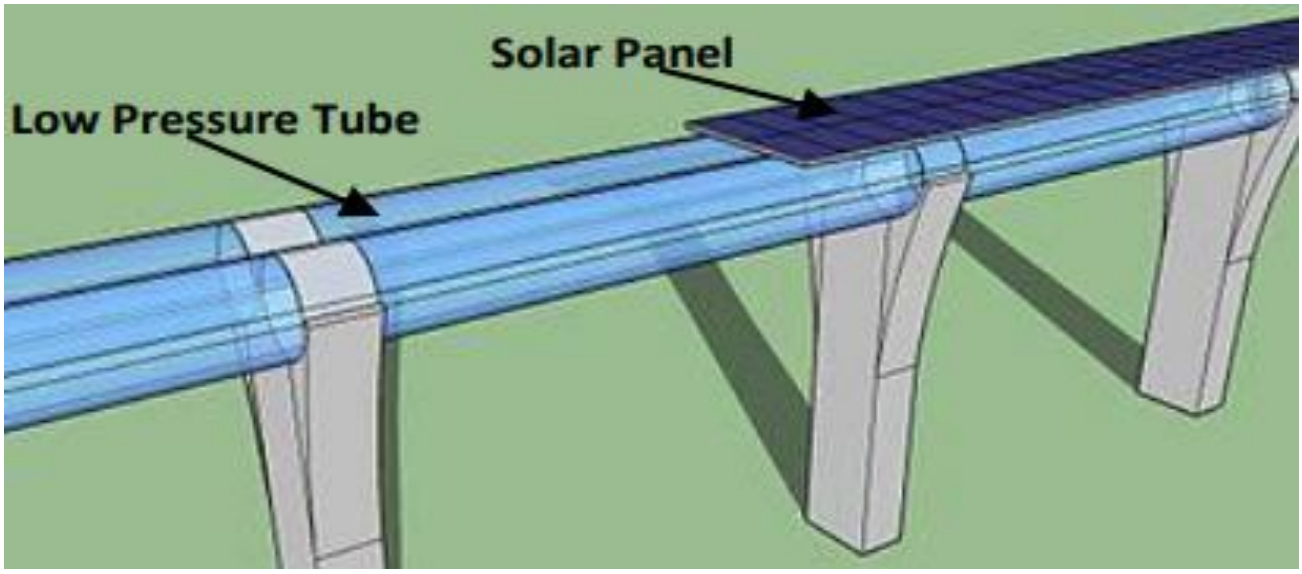

Fig.4.1.1construction of hyperloop tube.

The tube is made of steel. There are two tubes which are welded together side by side configuration to allow the capsules travel in both directions. The tube will be supported by pillars. There is a solar array are provided on a top of the tubes for the purpose of power to the system.The figure 4.1.1 shows the construction of hyperloop tube.

4.2 CAPSULE

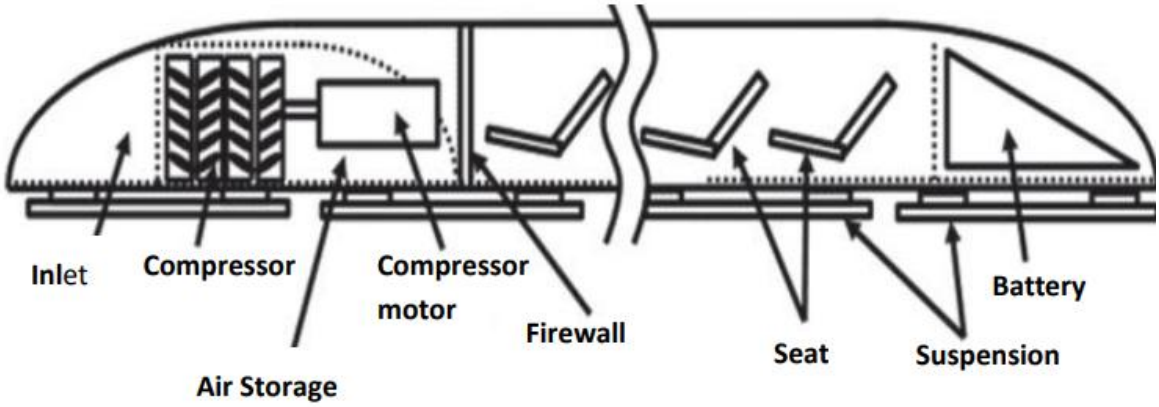

Fig.4.2.1 Arrangement in capsule.

The capsule can carry 28 passengers at a time and it send at a very high speed and it is levitated by a high-pressure air cushion. The design of capsule is start with the aerodynamic shape. There are two version of

capsule are being considered: a passenger only version and a passenger plus vehicle version. The figure 4.2.1 shows the Arrangement in Capsule

4.3 COMPRESSOR

Fig.4.3.1 Compressor

The compressor is fitted at the front side of the capsule. It supplies the air to the air bearings which supports the weight of the capsule. The compressor allows the capsule to traverse to the low-pressure tube without choking the air flow that travels between tube walls and capsule.The figure 4.3.1 shows the Compressor.

4.4 SUSPENSION

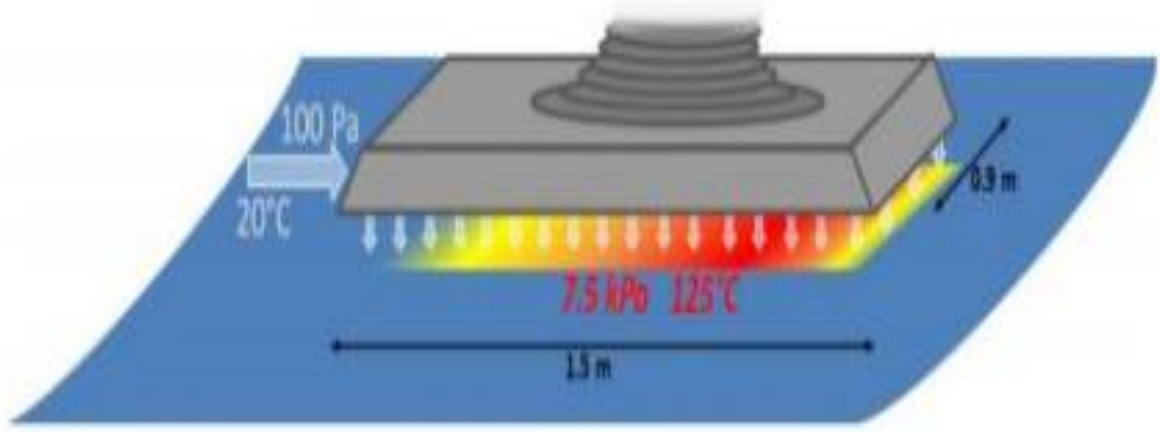

Fig.4.4.1Schematic of air bearing skis that support the capsule.

Air bearing suspension offers stability and extremely low drag at a feasible cost. A stiff air bearing suspension is superb for reliability and safety. When there is a gap between ski and tube walls is high then it shows the nonlinear reaction and which results in large restoring pressure. The figure 4.4.1 shows theSchematic of air bearing skis that support the capsule.

4.5 PROPULSIONS

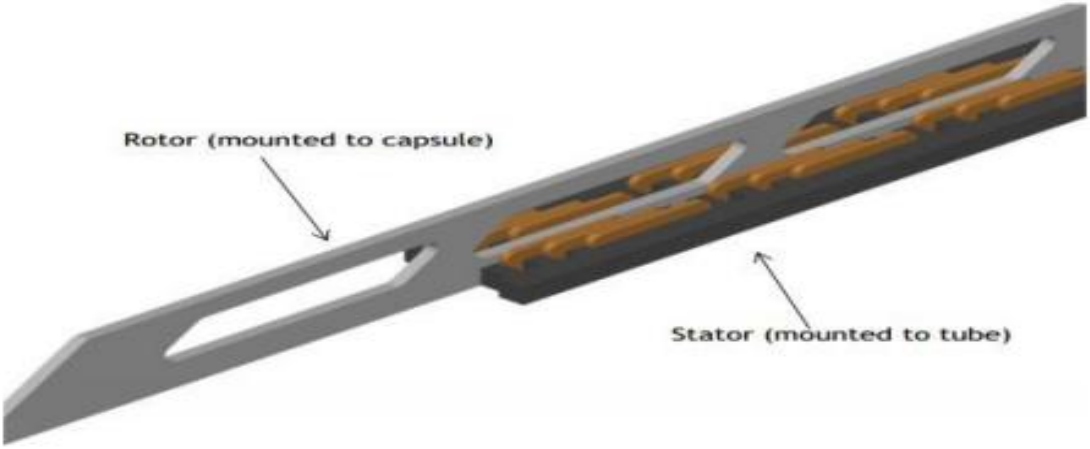

Fig.4.5.1 Propulsion.

To accelerate and decelerate the capsule the linear induction motor is used in hyperloop system. It provides some advantages over a permanent magnet motor. To accelerate the capsules there is linear accelerators are constructed on a length of the tube. Stators are placed on the capsules to transfer momentum to the capsules via the linear accelerators.. The figure 4.5.1 shows the Propulsion.

V. WORKING OF HYPERLOOP SYSTEM

Working of hyperloop system is based on magnetic levitation principle. As we know that the passenger pad travel through low pressure tube which is pylon-supported tube. In hyperloop system an air compressor fan is fitted on front side of pod which sucks the air. It transfer high pressure air front side to the rear side of capsule (pod) and it propel the pod. It creates the air cushion around the pod, so that the pod is suspended in air within the tube. On the basis of magnetic levitation principle, the pod will be propelled by the linear induction motor. By the linear induction motor the capsule send from one place to another place to a subsonic velocity that is slower than the speed of sound. The pod will be self-powered. There is solar panel fitted on top of the tube. By this solar panel there is enough energy is stored in battery packs to operate at night and in cloudy weather for some periods. The energy is also is stored in the form of compressed air. The air between the capsule acts as a cushion to prevent two capsules from colliding within the tube. The figure 5.1 shows the working of Hyperloop system.

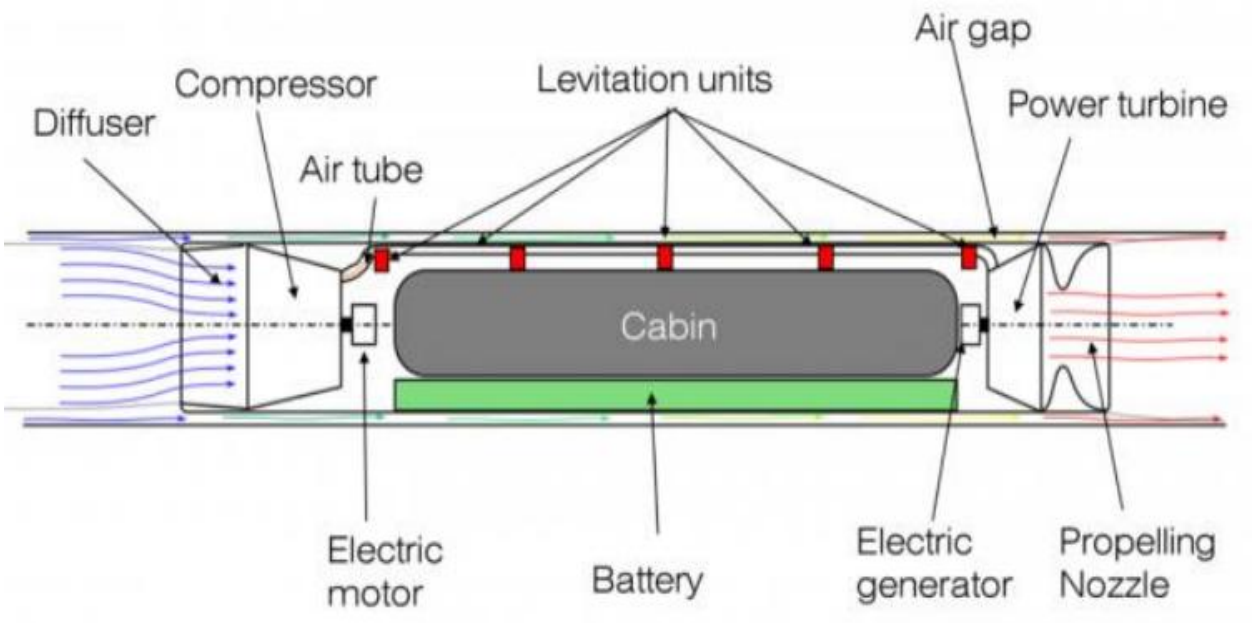

Fig.5.1 Working of hyperloop system

VI. WHY HYPERLOOP

The corridor between San Francisco, California and Los Angeles, California is one of the most often traveled corridors in the American West. The current practical modes of transport for passengers between these two major population centers include: 1. Road (inexpensive, slow, usually not environmentally sound) 2. Air (expensive, fast, not environmentally sound) 3. Rail (expensive, slow, often environmentally sound) A new mode of transport is needed that has benefits of the current modes without the negative aspects of each. This new high-speed transportation system has the following requirements: 1. Ready when the passenger is ready to travel (road) 2. Inexpensive (road) 3. Fast (air) 4. Environmentally friendly (rail/road via electric cars) The current contender for a new transportation system between southern and northern California is the "California High Speed Rail." The parameters outlining this system include:

6.1Currently $68.4 billion USD proposed cost

6.2 Average speed of 164 mph (264 kph) between San Francisco and Los Angeles

6.3 Travel time of 2 hours and 38 minutes between San Francisco and Los Angeles

6.3.1 Compare with 1 hour and 15 minutes by air

6.3.2 Compare with 5 hours and 30 minutes by car

6.4 Average one-way ticket price of $105 one-way

6.4.1Compare with $158 round trip by air for September 2013

6.4.2 Compare with $115 round trip by road ($4/gallon with 30 mpg vehicle)

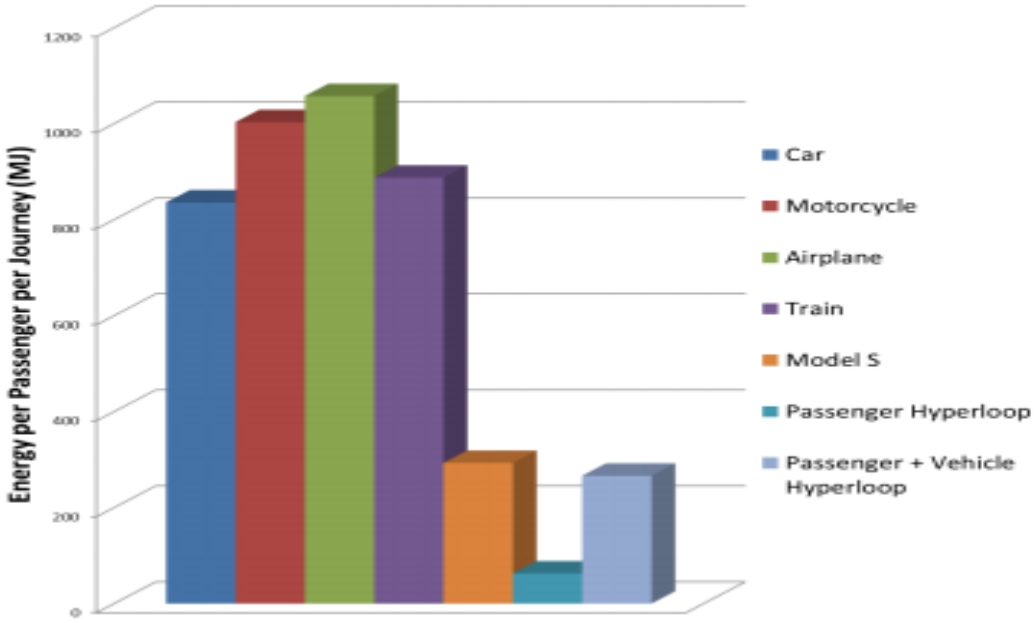

Fig.6.1Energy cost per passenger for a journey between Los Angeles and San Francisco for various modes of transport.

VII. POWER SOURCE

Hyperloop uses modern technology to solve problems but this tech requires abundant power. The Tube's roof is covered with solar panel throughout the track which produces more energy than needed by whole hyperloop setup without consuming a drop of petrol, diesel or kerosene. It is self-sufficient environment friendly technology.

VIII. SAFETY & RELIABILITY

Since levitation of air bearing produces excellent suspension, earthquakes cannot produce any damage to capsules. The supporting structures of tubes have foot print of size of telephone pole so they can sway in worst case and again without any possible damage to capsule. Besides, statistically, it is known that most of accident are caused by human factor but there is no human factor in hyperloop since everything is managed by computer system so accidents are next to impossible.

IX. MERITS

1. It saves the travelling time.
2. There is no problem of traffic.
3. It is powered by the solar panel.
4. It can travel in any kind of weather.
5. Cost of hyperloop is low.

6. Not disruptive to those along the route.
7. More convenient.
8. Resistance to earthquake.

X. DEMERITS

1. Turning will be critical.
2. Less movable space for passenger.
3. High speed might cause dizziness in some passenger.
4. Punctured tunnel could cause shockwaves.

XI. FUTURE SCOPE

1. Improve the passenger capacity.
2. Detailed station designs with loading and unloading of passenger.
3. Safety features improvement.

XII. CONCLUSION

1.A high speed transportation system known as Hyperloop has been developed in this report.

2.Hyperloop transportation system can be used over the conventional modes of transportation that are rail, road, water and air.

3.At very high speed it provides better comfort and cost is also low.

4.By reducing the pressure of the air in the tube which reduces simple air drag and enables the capsule to move faster than through a tube at atmospheric pressure.

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