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Review of Hyperloop : The Fifth Mode of Transport

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***Abstract*—Existing conventional modes of transportation of people consists of four unique types: rail, road, water, and air. These modes of transport tend to be either relatively slow (i.e., road and water), expensive (i.e., air), or a combination of relatively slow and expensive (i.e., rail).**

Hyperloop is a new mode of transport that seeks to change this paradigm by being both fast and inexpensive for people and goods. Hyperloop consists of a low pressure tube with capsules that are transported at both low and high speeds throughout the length of the tube. The capsules are supported on a cushion of air, featuring pressurized air and aerodynamic lift. The capsules are accelerated via a magnetic linear accelerator affixed at various stations on the low pressure tube with rotors contained in each capsule. Passengers may enter and exit Hyperloop at stations located either at the ends of the tube, or branches along the tube length.

In this study, the initial route, preliminary design, and logistics of the Hyperloop transportation system have been derived.

***Index Terms*—Features, Working and Construction.**

I. INTRODUCTION

Hyperloop is a tradename and a registered trademark of the Space Exploration Technologies Corporation (SpaceX) for the high speed transportation of passengers and goods in tubes[4].In these tubes, capsules are propelled by linear induction motors and air propellers. Recently there has been a resurgence in interest in pneumatic tube transport systems since being reintroduced by Elon Musk. It incorporates reduced-pressure tubes in which pressurized capsules ride on an air cushion driven.Hyperloop technology has been explicitly open-sourced by Musk and SpaceX[1]. To that end, several companies have been formed, and dozens of interdisciplinary student-led teams are working to advance the technology.

A. Features of the Hyperloop

Hyperloop is also unique in that it is an open design concept, similar to Linux. Feedback is desired from the community that can help advance the Hyperloop design and bring it from concept to reality[3].

The system consists of capsules that travel between Los Angeles, California and San Francisco, California. Thetotal trip time is approximately half an hour, with capsules departing as often as every 30 seconds from each terminal and carrying 28 people each. This gives a total of 7.4 million people each way that can be transported each year on Hyperloop. The total cost of Hyperloop in this analysis is under $6 billion USD. Amortizing this capital cost over 20 years and adding daily operational costs gives a total of about $20 USD (in current year dollars) plus operating costs per one-way ticket on the passenger Hyperloop.

B. Working and Construction

Building a safe, scalable and feasible pod for the Hyperloop system is extremely important.

Cars would basically be propelled in the tube. A huge sort of pneumatic tube is proposed, where high-speed fans would compress and push the air. It would work if the friction implications are considered[1].

Another option is having vacuum in the tube and using electromagnetic suspension instead. But, it is hard to maintain a vacuum as one small leak in hundreds of miles of tubing, and the system shut down, nevertheless, there are pumping solutions to overcome this.

C. Components of HyperloopTransportation System

1. Capsule
2. Tube
3. Propulsion
4. Route

CAPSULE

Sealed capsules carrying 28 passengers each that travel along the interior of the tube depart on average every 2 minutes from Los Angeles or San Francisco (up to every 30 seconds during peak usage hours).

The maximum width is 4.43 ft (1.35 m) and maximum height is 6.11 ft (1.10 m). With rounded corners, this is equivalent to a 15 ft2 (1.4 m2) frontal area, not including any propulsion or suspension components.

The capsules are accelerated via a magnetic linear accelerator affixed at various stations on the low pressure tube with rotors contained in each capsule[3].

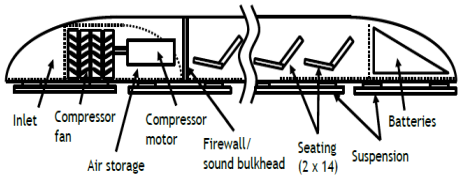

Fig:1

Aerodynamic drag increases with the square of speed, and thus the power requirement increases with the cube of speed.

For example, to travel twice as fast a vehicle must

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overcome four times the aerodynamic resistance, and input eight times the power[2].

capsules are separated within the tube by approximately 23 miles (37 km) on average during operation.

The capsules are supported via air bearings that operate using a compressed air reservoir and aerodynamic lift.

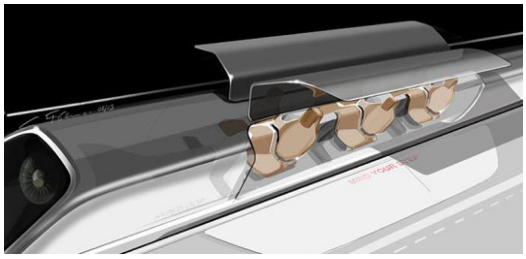

Fig:2

TUBE

The tube is made of steel. Two tubes will be welded together in a side by side configuration to allow the capsules to travel both directions.

Pylons are placed every 100 ft (30 m) to support the tube.

Solar arrays will cover the top of the tubes in order to provide power to the system.

The inner diameter of the tube is optimized to be 7 ft 4 in. (2.23 m) which is small enough to keep material cost low while large enough to provide some alleviation of choked air flow around the capsule.The tube cross-sectional area is 42.2 ft2 (3.91 m2) giving a capsule/tube area ratio of 36% or a diameter ratio of 60%[2].

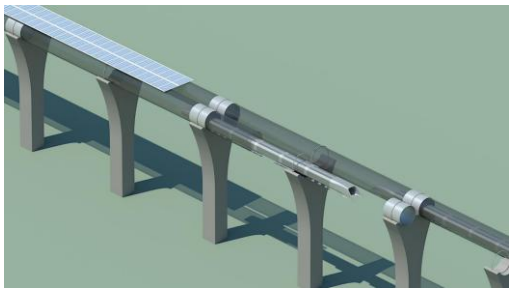

Fig:3

The expected pressure inside the tube will be maintained around 100pa (less pressure).This low pressure minimizes the drag force on the capsule while maintaining the relative ease of pumping out the air from the tube.

II. PROPULSION

Linear accelerators are constructed along the length of the tube at various locations to accelerate the capsules. Stators are located on the capsules to transfer momentum to the capsules via the linear accelerators.

III. ROUTE

There will be a station at Los Angeles and San Francisco. Several stations along the way will be possible with splits in the tube.The majority of the route will follow highway and the tube will be constructed in the median.

Fig: 4

IV. ADVANTAGES

The fast speed of the Hyperloop enables the passenger to travel as soon as he enters the pod. Also, it is inexpensive, as the outer surface of the tubes would be lined with Solar panels for safe, efficient and economical way of generation of electricity. This generated electricity will help in driving the Hyperloop and will also be able to power near-by industries.

If a major power failure occurs, there is a battery backup system in the pods.

V. DISADVANTAGES

A. Drawbacks of design:

The main issue with the Hyperloop low pressure vacuum tubes is that a tiny leakage in any tube would cause the entire system to crash. Also, the pod would be extremely small in size, restricting[3] the movement of passengers during the journey. Hence, it might become difficult for a claustrophobic person to travel in the closed system.

Lastly, the breaking system of the pods have not been tested well enough, to guarantee a safe journey.

B. Safety concerns

The maximum force that the human body can take is measured in terms of ‘g-force’, where ‘g’ is the gravitational constant of earth. MATLAB[3], in collaboration with Simulink has found out that the maximum force experienced by a person using Hyperloop is 0.5g, which might make some passengers feel uneasy.The g-force would drastically increase when the pod would take turns of smaller radii.

Also, in case of an emergency health condition, the pod cannot be stopped abruptly, in the middle of the tube.

When a natural disaster like earthquake occurs, there is a major threat to the lives of the people inside the pod.

VI. RESULTS AND CONCLUSIONS

Hyperloop is a new way to move people or things anywhere in the world quickly, safely, efficiently on demand with minimal impact on the environment. Travelling in a vacuum tube as fast as the speed of sound, will take on an entirely new meaning. It eliminates direct emissions, noise delay, weather concerns and pilot error.

Our cities are polluted, our roads are crowded, and travel experiences are now defined by chaos and calamity[4]. Hyperloop is not just about record-breaking speed, it is about improving the entire transportation infrastructure. It is time to use resources smartly, travel green, and the cost of mass

transit for everyone. It is indeed the next mode of transportation.

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