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Hyperlop Transportation System

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ABSTRACT

As we know that there are four modes of transportation are, rail, road, water, and air. These modes of transport tend to be either relatively slow (e.g., road and water), expensive (e.g., air), or a combination of relatively slow and expensive (i.e., rail). Hyper loop is a new mode of transport that seeks to change this paradigm by being both fast and inexpensive for people and goods. 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. 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. The system consists of capsules that travel between Los Angeles, California and San Francisco, California. The total one-way trip time is 35 minutes from county line to county line. The capsules leave on average every 2 minutes from each terminal carrying 28 people each (as often as every 30 seconds during rush hour and less frequently at night). This gives a total of 7.4 million people per tube that can be transported each year on Hyperloop. The total cost of Hyperloop is under $6 billion USD for two one-way tubes and 40 capsules. Amortizing this capital cost over 20 years and adding daily operational costs gives a total of $20 USD plus operating costs per one-way ticket on the passenger Hyperloop.

Keywords-- Hyperloop, Eloun Musk, Compressor, Tubes

I. INTRODUCTION

The Hyperloopisa concept for high speed ground transportation, consisting of passenger pods travelling at sonic speeds in a partially evacuated tube. The concept was originally proposed in a whitepaper publishedbySpaceXin20131 as an alternative to the high-speed rails stem currently being developed between Los Angeles and San Francisco, which was deemed to expensive and low. The Hyperloop concept could fill a growing need for an alternative transportation mode for short-haul travel. For short routes, such as Los Angeles–San Francisco, or Boston–New York, the time spent travelling at the cruise speed is quite low compared to over all end-to-end travel time due to in escape able inefficiencies in air travel (runway taxiing, climb, descent, holding patterns, etc.).

The first ever concept of people transportation through a pod inside a closed tube was put forth by scientist G. Medhurst in a paper published in 1812 where concept was introduced to use power and velocity of air for travelling of passengers inside a tube. Similar concept redeveloped by young entrepreneurel on musk founder of tesla motors. the principle idea behind the Hyperloop was simple and is just to reduce the friction and air drag so as to get higher velocity, just like maglev trains. The Hyperloop system is a mean of a concord, air hockey table and rail gun.

II. WHAT IS HYPERLOOP?

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. 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.

III. WHY HYPERLOP?

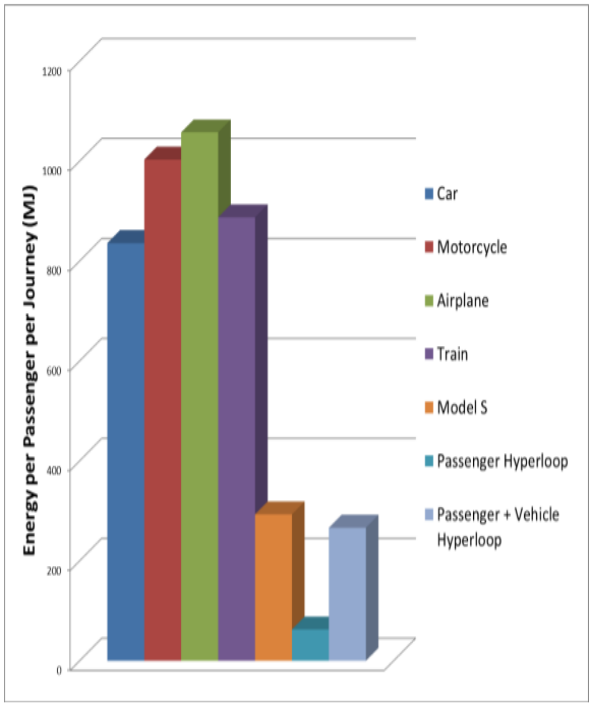

Fig 1. Energy cost per passenger for a journey between Los Angeles and San Francisco for various mode of transport

A new high speed mode of transport is desired between Los Angeles and San Francisco; however, the proposed California High Speed Rail does not reduce current trip times or reduce costs relative to existing modes of transport. This preliminary design study proposes a new mode of high speed transport that reduces both the travel time and travel cost between Los Angeles and San Francisco. Options are also included to increase the transportation system to other major population centers across California. It is also worth noting the energy cost of this system is less than any currently existing mode of transport (Figure 1). The only system that comes close to matching the low energy requirements of Hyperloop is the fully electric Tesla Model S.

IV. ILLUSTRATION

The practically implemented prototype of Hyperloop comprises of the following fundamental parts

1. TUBE

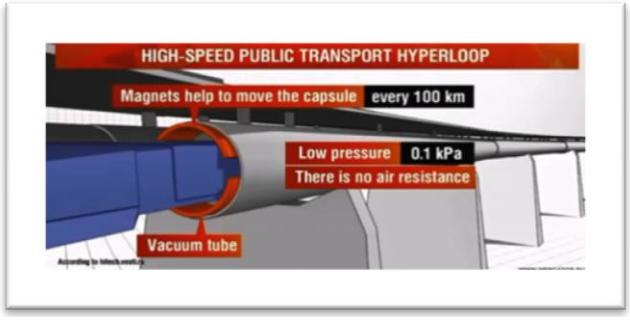

Fig2. Low pressure tubes

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 Tubes are made by the new material 'VIBRANIUM'.

2. CAPSULE

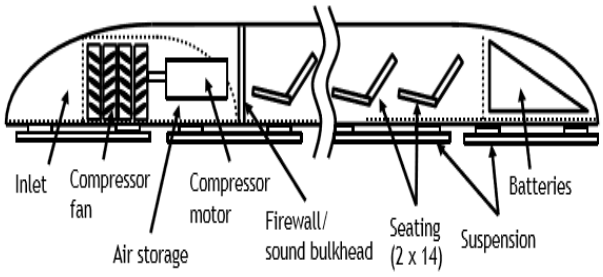

Fig3. Capsule

Sealed capsules carrying 28 passengers each that travel along the interior of the tube A larger system has also been sized that allows transport of 3 full size automobiles with passengers to travel in the capsule. The capsules are supported via air bearings that operate using a compressor air reservoir and aerodynamic lift .

3. PROPULSION

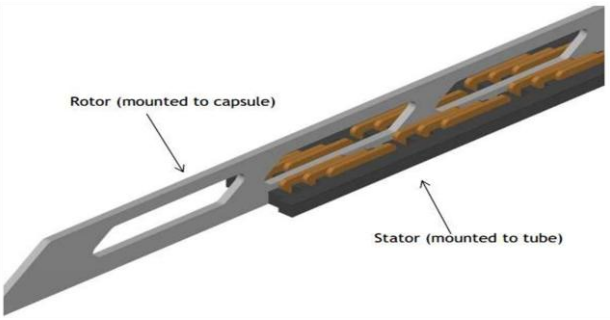

Fig4. Propulsion

Linear accelerations are constructed along the length of the tube at various locations to accelerate the capsule. Stators are located on the capsules via the linear acceleration. The propulsion system has these basic requirements:

1. Accelerate the capsule from 0 to 300 mph (480 kph) for relatively low speed travel in urban areas.
2. Maintain the capsule at 300 mph (480 kph) as necessary, including during ascents over the mountains surroundings.
3. To accelerate the capsule from 300 to 760 mph (480 to 1,220 kph) at 1g at the beginning of the long coasting section along the I-5 corridor.
4. To decelerate the capsule back to 300 mph (480 kph) at the end of the I5 corridor.

4. SUSPENSION

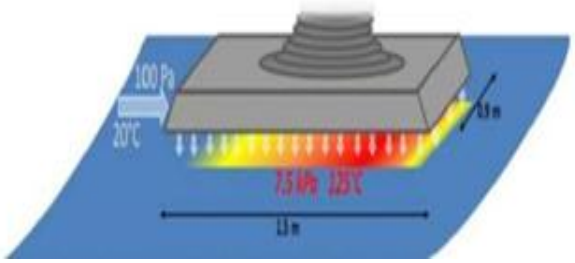

Fig5. Suspension

Suspending the capsule within the tube presents a substantial technical challenge due to transonic cruising velocities. Conventional wheel and axle systems become impractical at high speed due frictional losses and dynamic instability. A viable technical solution is magnetic levitation; however the cost associated with material and construction is prohibitive. An alternative to these conventional options is an air bearing suspension. Air bearings offer stability and extremely low drag at a feasible cost by exploiting the ambient atmosphere in the tube. Externally pressurized and aerodynamic air bearings are well suited for the Hyperloop due to exceptionally high stiffness, which is required to maintain stability at high speeds. When the gap height between a ski and the tube wall is reduced, the flow field in the gap exhibits a highly non-linear reaction resulting in large restoring pressures. The increased pressure pushes the ski away from the wall, allowing it to return to its nominal ride height. While a stiff air bearing suspension is superb for reliability and safety, it could create considerable discomfort for passengers onboard. To account for this, each ski is integrated into an independent mechanical suspension, ensuring a smooth ride for passengers. The capsule may also include traditional deployable wheels similar to aircraft landing gear for ease of movement at speeds under 100 mph (160 kph) and as a component of the overall safety system.

5. ENERGY STORAGE COMPONENTS (BATTERIES)

Energy storage allows this linear accelerator to only draw its average power of 8,000 hp (6 MW) (rather than the peak power of 70,000 hp or 52 MW) from its solar array . Building the energy storage element out of the same lithium ion cells available in the Tesla Model S is economical. A battery array with enough power capability to provide the worst-case smoothing power has a lot of energy – launching 1 capsule only uses 0.5% of the total energy – so degradation due to cycling is not an issue.

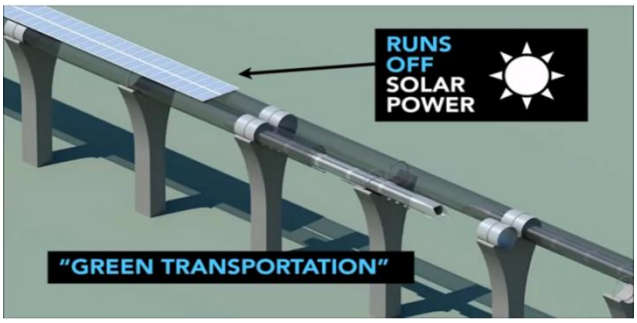

Fig6.utilization of solar power

6. COST

"Hyperloop Alpha" suggests fares of $20 for the San Francisco the Los Angeles route which would apparently be used to cover operating expenses. However, this research has not found any sources providing estimates of operating costs for the system. A presentation made by an HT executive cited $10 to $15 for a route linking Abu Dhabi to Dubai. However, that presentation seemed to indicate that that fare amount was a price point which the market could bear, rather than an estimate of the service's operating cost. In a pricing structure where fares are only used to cover operating costs, some entity would be required to fund the upfront capital construction and vehicle costs without repayment. An assumption of public funding can only be speculative, especially in the current constrained fiscal environment for government expenditures.

V. ADVANTAGES AND DISADVANTAGES OF HYPERLOOP TRANSPORTATION SYSTEM

5.1 Advantages

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.

5.2 Disadvantages

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.

VI. CONCLUSION

Hyperloop is the technology for the future. For the past decades, innovation in transport technology has been limited to improving or modifying traditional means. Thus growth in the transport technology has been stagnant. Hyperloop has the potential to break this slump and provide a very fast and cheap method of

transportation. Proposed Hyperloop between Mumbai and Pune could cut down the commuting time from 3-4 hours to a mere 30 minutes. Existing transportation technologies such as High speed rail (Bullet train) and Maglev are found to be wanting when it comes to expenses, effects on ecology and travel time. Solar arrays installed throughout the track, zero emission transport owing to no fuel requirement, no interference with communication lines, resistant to earthquakes, high speed of transportation coupled with low capital and maintenance cost give Hyperloop a leading edge. The intent of this document has been to bring light to the concept of the Hyperloop. The various fundamentals involved in making this technology successful have been briefly discussed in the paper. Hyperloop transportation has a very fast and ecological transportation of small needs, cargo and people. The ambitious project of absolutely new type of high-speed transport can connect some large cities of the world much more effectively, than the high-speed railroads. Hyperloop is considered an open source transportation concept. An additional passenger plus transport version of the Hyperloop has been created that is only 25% higher in cost than the passenger only version. This version would be capable of transport passengers, vehicles, freight, etc. The passenger plus vehicle version of the Hyperloop is less than 11% of the cost of the proposed passenger only high speed rail system between Los Angeles and San Francisco. Additional technological developments and further optimization could likely reduce this price.

1: Faster
2: Lower cost.
3: Pollution free
4: Immune to weather.
5: Safer
6: Sustainably self-powering

FUTURE WORK

The technology of Hyperloop is in its rudimentary stage. Even if the technology is successful, it can be worked upon for improvement in the future. The current capsule design allows only 28 passengers to commute at a time. Research can be focused on improving the design such that the numbers of passengers is more. Need to improve safety features.

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