

Hyperloop, Train of Future

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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 is 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— Transportation, Effectiveness, Development, Modern Tech, Hyperloop Train, Fluid Mechanics, Thermodynamic, Electromagnetism, Safety, Quality, Inexpensive, Compressor fans, Air bearings, Suspensions

I. INTRODUCTION

Wheel being the most important initial invention of human signifies the elevation of standard of human being since ancient times, as we have progressed in science and technology and entered the era of microprocessor we gained transportation means like car, trucks, airplanes, ships, etc. We have brought such a huge change in these means by upgrading them time to time but since time is moving ahead we must race with it by bringing up more advance means of transportation which can be face of future.

Today's transportation majorly includes-

- i. Roadways (cheap, time consuming, not so eco-friendly)
- ii. Airways (not cheap, time saving, not eco-friendly)

- iii. Railways (not cheap, time consuming, relatively much more eco-friendly than others).

Present condition demands for alternate travelling means which could nullify negative aspects of above system with following requirements-

- i. Which is comfortable with passenger schedule.
- ii. Cheap as Road ways
- iii. Time saving as air ways
- iv. Eco-friendly
- v. More secure

II. LITERATURE SURVEY

Earlier, in all types of transportation mode, we have encountered many accidents, cost issues, comfort issues, affordability, conservation issues and environmental issues. Hyperloop confront all the above point issues to provide better way to future

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with help of modern science and engineering solutions.

III. HYPERLOOP TRANSPORTATION SYSTEM

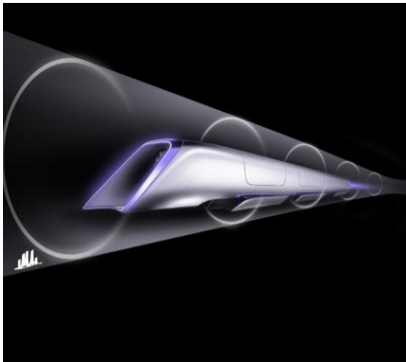


Fig 1: Hyperloop

Hyperloop is basically a train inside tube with low pressure. (figure 1)

Hyperloop is answer to the modern human transportation needs BUT this unique answer gives rise to many questions which basically asks one question, how can this dream come true, some initial problems where Kantrowitz limit [2], friction and power source which were answered very smartly by components and mechanism of hyperloop.

Some of major components and characteristics which answers the questions are chalked out below.

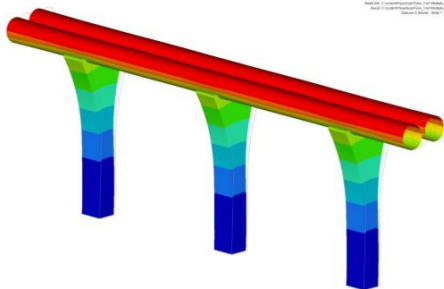


Fig 2: Hyperloop Tube

i. Tube

There are two tubes welded side by side, both unidirectional and opposite to each other, acting just like highway. These tubes were theoretically meant to have vacuum inside them which should remove any resistance offered by air in direction where train is travelling, but still practically vacuum cannot be achieved for such a long track. Thus, capsule consist of very low pressure air which offers very negligible resistance. (figure 2)

But low pressure air doesn't solve the problem wholly. While capsule is travelling the air ahead of it get compressed and increase pressure offering resistance to capsule giving rise to Kantrowitz limit [2], which can eventually stop the train but this problem was solved by adding compressor fan on bow(front) of train.

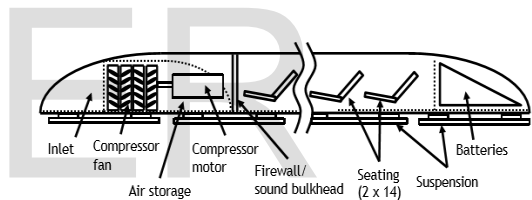


Fig 3: Hyperloop capsule

ii. Capsule

Just like train have bogeys and engine hyperloop have capsules, there are two type of capsules

1. Hyperloop passenger capsule
2. hyperloop passenger with capsule

For increasing speed and efficiency of capsules certain geometrical changes are brought in capsule design by minimizing frontal surface area which makes it more comfortable for passengers. (figure 3)

The vehicle is streamlined to reduce drag. Interior design was highly concentrated for comfort of passengers. The seats are design as to nullify high speed acceleration

discomfort produced during the travel. Entertainment of passengers are kept in mind and modern accessories are equipped to suffice also passengers will be provided with access to landscape scenery. [4]

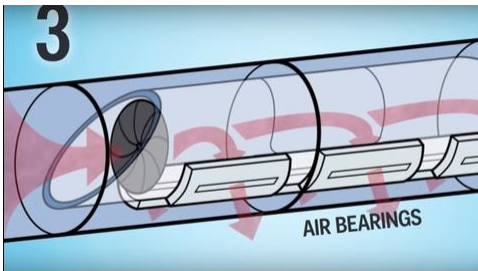


Fig 4: Compressor Fan and Air bearing

iii. Compressor Fans

Since need of vacuum was not sufficed in tube, capsule travelling in low pressure tube accumulates air on its front side, which is further compressed by motion of capsule, this compressed air will resist motion of capsule decreasing its velocity, forming a choke inside the tube and eventually stopping it.

Thus, hyperloop demands new innovation to solve this problem known as Kantrowitz limit [2].

Compressor fans were introduced to nullify effect of Kantrowitz limit. (figure 4)

Compressor fans are installed on front of capsules. These fans suck the accumulated compressed air from front of train and exhale it to air bearings. Thus, resistance is removed and no further choking because of Kantrowitz limit is caused.

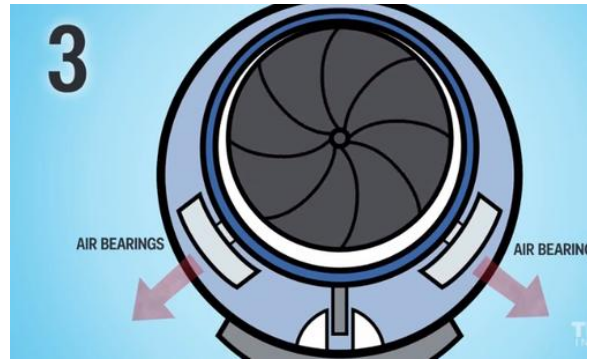


Fig 5: Air bearings

iv. Air Bearings

Friction was another major hurdle of hyperloop, which had only one solution to remove any surface contact between capsule and tube i.e. capsule should be levitating i.e. it should float in air.

Air bearings are installed on surface of capsules, the air inhaled by front of capsule's compressor fan is exhaled by air bearing providing it hovering and levitation. (figure 5)

Air bearing also provide suspension to capsules so traveling is more smooth in hyperloop.

v. Propulsion

Finally, hyperloop requires a propelling machine. And thus, linear induction motor is used in hyperloop, the same motor used in tesla cars which in hyperloop can produce velocity of 20000 meter per second. The moving motor element (rotor) will be located on the vehicle for weight savings and power requirements while the tube will incorporate the stationary motor element (stator) which powers the vehicle. [1]

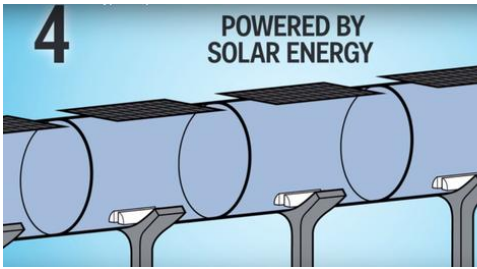


Fig 6: Hyperloop Solar Panel

vi. 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. (figure 6)

vii. Safety and 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.

viii. Cost

The total cost of hyperloop passenger only version is as follows (figure 7)-

Component	Cost (million USD)
Capsule	54 (40 capsules)
Capsule Structure & Doors	9.8
Interior & Seats	10.2
Compressor & Plumbing	11
Batteries & Electronics	6
Propulsion	5
Suspension & Air Bearings	8
Components Assembly	4
Tube	5,410
Tube Construction	650
Pylon Construction	2,550
Tunnel Construction	600
Propulsion	140
Solar Panels & Batteries	210
Station & Vacuum Pumps	260
Permits & Land	1,000
Cost Margin	536
Total	6,000

Fig 7: Hyperloop Cost

And another version i.e. passenger plus vehicle version is estimated to be \$7.5 billion USD.

IV. PRESENT WORK

Presently the idea of hyperloop was proposed for route between San Francisco, California and Los Angeles in 35 minutes.

V. FUTURE WORK

Hyperloop is a newborn technology since it is nothing like anything the design for everything inside it is like invented for even a smaller entity. Thus, Technology welcomes further development for inventors. Hyperloop also conducted a worldwide competition for building it which would award by building hyperloop in winning nation.

VI. RESULT AND CONCLUSION

The Train of future is reviewed in this paper. Hyperloop has two versions namely passenger only and passenger plus vehicle hyperloop. This technology can reduce travel time between Los Angeles and San Francisco up till 35 minutes. The price of

one way trip would be as less as \$20. Hyperloop is much cheaper compared to railway between Los Angeles and San Francisco.

On other hand passenger plus vehicle version would just cost more 25%. This version would be capable of transporting passengers, vehicles, freight, etc. this version is 11% more cheaper than proposed by rail system between Los Angeles and San Francisco. Furthermore the hyperloop is at development stage in future the price will be much lower than present price.

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