KARNATAK LAW SOCIETY'S

GOGTE INSTITUTE OF TECHNOLOGY

UDYAMBAG, BELAGAVI-590008

(An Autonomous Institution under Visvesvaraya Technological University, Belagavi)

(APPROVED BY AICTE, NEW DELHI)

Department of Electronics and Communication

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Course Activity Report

"HYPERLOOP TECHNOLOGY"

Subject: Electronics and Communications

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Submitted in the partial fulfilment for the award of the degree of

Bachelor of Engineering

In

Electronics and Communication Engineering

Submitted by

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CERTIFICATE

Certified that the course activity entitled "Hyperloop Technology" done at is a bonafide work carried out by

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in partial fulfillment for the award of **Bachelor of Engineering** in Gogte Institute of Technology of the Visvesvaraya Technological University,Belagavi during the year 2020-2021. It is certified that all corrections/suggestions indicated have been incorporated in the report. The activity report has been approved as it satisfies the academic requirements in respect of course activity prescribed for the said Degree.

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Proposing a Fifth Mode of Transportation

“THE HYPERLOOP TECHNOLOGY”

Abstract:

This System works on the principle of Electromagnetic attraction of forces. This system uses both Electromagnets and Permanent magnets to levitate, propel and control the pod. This type of transportation system was proposed in the USA which is an ultrahigh speed transportation system in a vacuum medium with reduced air resistance and pressure. This ultra-low pressure inside the tube causes problems for the passengers so we are solving this problem with the help of different methods for the safety of passengers due to the leakage problem.

CONTENT:

Introduction:

This Transportation system was firstly proposed by Elon Musk, in this report he explained this project of ultra-high speed transportation system. This transportation system was planned for California (USA) to transport passengers between San Francisco and Los Angeles . This system uses a capsule which travels inside the tube at the speed of 1220 kph, which will cover the distance of 561km in approx. 30 minutes.[1]

This ultra-high speed transportation system called Hyper loop was so famous that many countries started construction for the use of this transportation system. The best part of the Hyperloop is independence from weather conditions and helps in ecological cleanliness due to using air, electricity generated by solar batteries. The system is safe from all the natural obstacles like floods, earthquakes, bad weather, against birds, animals and also different vehicles, pedestrians. As there is no physical interaction with cars and railways, pipelines, high voltage electric lines due to the tube, this makes it a safer and sounder travelling system.[1]

What is a hyperloop?

Existing conventional modes of transportation of people consist 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.
- It is the fifth mode of transport
- Hyperloop is a new mode of transport that seeks to change this paradigm by being both fast and inexpensive for people and goods.[1]

Major start-ups working on this vision include.

1. Hyperloop Transportation Technologies(HTT) and Hyperloop Technologies (HT) are working on Hyperloop tracks.[3]
2. Oerlikon Leybold Vacuum trying to master the vacuum for Hyperloop.[3]
3. Aecom taking on the technical side support[

Route:

Local topographical requirements, including the area of urban regions, mountain ranges, supplies, national parks, streets, railways, airplane terminals, and so forth. The course should regard standing structures. For streamlined effectiveness, the speed of a case in the Hyperloop is regularly:

- 300 mph (480 kph) where nearby topography requires a cylinder twist radii < 1.0 mile (1.6 km)
- 760 mph (1,220 kph) where neighbourhood geology allows a cylinder twist > 3.0 miles (4.8 km) or where nearby topography allows a straight cylinder.[3]

These twist radii have been considered with the goal that the traveller does not encounter inertial increasing speeds that surpass 0.5g. This is trusted the most extreme inertial increasing speed that can be easily supported by people for brief periods. To additionally diminish the inertial speeding up experienced by travellers, the case as well as cylinder will join a system that will permit a level of 'banking'.[3]

. **Fig no 1: Cities chosen to run hyperloop transportation in India**.

Figure no. 1 shows the different cities chosen to have Hyperloop technology in India in upcoming years.[1]

Components of Hyperloop:

1. Capsule
2. Tube
3. Propulsion

How does the system work??

Basic elements of transportation technology are:

• The capsule • The tube

1. Capsule:-

Capsule is the part which will travel inside the tube.

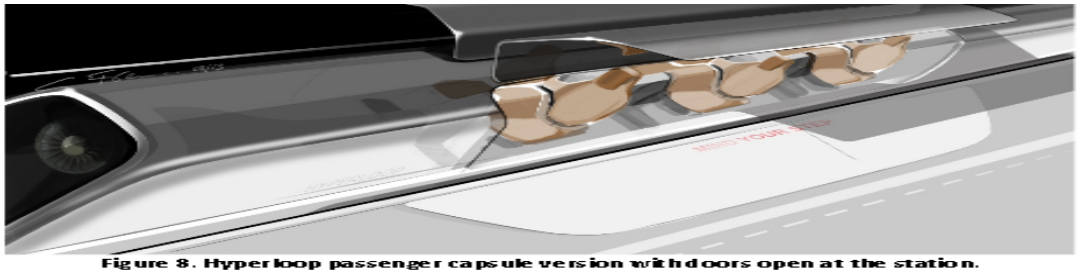

Figure 8. Hyperloop passenger capsule version with doors open at the station.

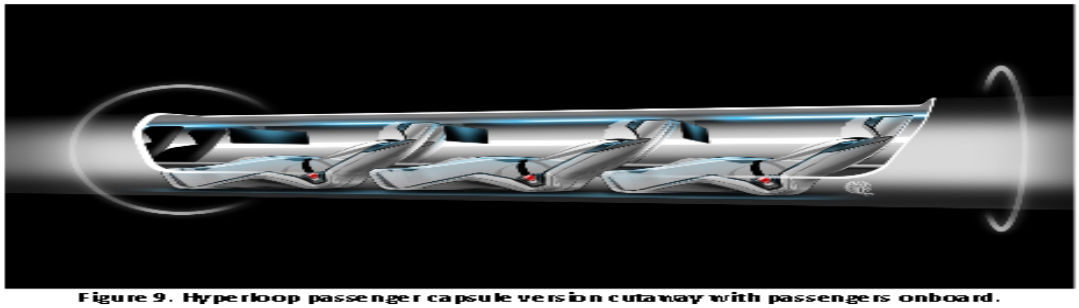

Figure 9. Hyperloop passenger capsule version cutaway with passengers onboard.

Fig No. 2: Capsule in hyperloop

Figure 2 shows the model construction of capsule inside a tube of hyperloop train.[1]

So two types of Hyperloop capsules are:

1.1 Hyper loop passenger capsule

Supposing an avg. departure time of two minutes between capsules, a minimum number of 28 Passengers per capsule are required to meet 840 passengers per hour. By decreasing the time between the departures we can increase the Hyperloop capacity. During rush hours 40 capsules are required during movement at current model in which six are used for the loading and unloading purpose.[2]

1.1.1 Hyper loop passenger plus vehicle capsule

This type of capsule will work as a passenger one but the only difference is it uses 3 more capsules for travelling. To overcome air resistance high power is required to travel at high speed. Aerodynamics drag increases as the square of the speed and hence power increases as a cube of speed. This is an effective pressure of 100 Pascal, which diminishes the drag force of the air by 1000 times comparative to sea level conditions and would be equivalent to flying above 150000 feet height. Vacuums are costly and difficult to maintain compared with low pressure solutions so the vacuum is avoided. In spite of the low pressure, aerodynamic challenges must still be considered. As the speed of the capsule reaches the speed of the sound then the formation of shockwaves takes place and the air resistance increases instantly and hence the acceleration felt by the passengers decreases and the power required by the capsule also decreases.[2]

2. Tube:-

The capsule used for travelling moves inside the tube and low air pressure inside the tube is maintained which increases the speed of transportation. 100 Pascal pressure is maintained inside the tube which is 1/1000 times pressure on earth. The drag forces on the capsule get reduced because of the low air pressure inside the tube. The

tubes are constructed on the pillars which will ease the transportation system as it will not affect the traffic on the roads and will increase the area Inside the tube with the help of air bearings and suspension. To control the speed and by accelerating and decelerating motors are used which

of construction. This tube also helps in the smooth journey to the passengers as it is

will also guide the capsule in a respective direction.[3]

Fig no 3: Structure of a tube

The above, figure no.3 gives a gist of the structure and shape of the hyperloop tube.[1]

3. Propulsion:-

The need of the propulsion system are as follows- :-

1. In urban areas the speed should be low so it is maintained between 0 to 480 kmph.
2. For mountain or hilly areas the speed is maintained near 480 kmph.
3. For the long coasting area the speed is accelerated from 480 to 1220 kmph.

4. After the completion of the coastal area the speed is decelerated again to 480 kmph.
5. The average power consumption is 28000hp or 21MW which involves the power desired by the propulsion motor including changes, air resistance interruptions, the train compressor (charging batteries) and to keep the vacuum in the tube throughout. So to fulfil the needs of the power in the Hyperloop system we will cover it with a solar plant as this system is very large. We will connect batteries at the times of peak demand or peak power as the average power is 1/3 times the peak power demand so batteries will fulfil the power demand but when the power demand is very high and the solar plant cannot withstand it only then the power from the grids will be given. Large accelerators are used to increase the speed from 480 to 1220 kmph at 1G in long coastal areas, small accelerators are used in urban areas and this system can also be used in mountain areas. Induction motors are used to increase or decrease the speed of the capsule. We use induction motor rather than permanent magnet motor because of the following benefits:
6. The material cost is low as we are using aluminium in the rotor.
7. The weight of the capsule is less.
8. The dimensions of the capsule are reduced.
9. In this we don't need to align the rotor to the air gap because of the lateral forces exerted by the stator on the rotor.[3]

Working principle and feature of this new technology:

1. Simply, it has the same working principle of Air Hockey.

2. The pods would accelerate to cruising speed gradually using a linear electric motor and glide above their track using passive magnetic levitation or air bearings.

2.1. It is levitated and propelled forward using powerful electromagnets. This itself

considerably reduces losses due to friction, as the train is literally gliding over the track and is not in contact with the track. Hence there are no frictional losses allowing the train to move at high velocities.

3. The absence of air in the hyperloop will further increase the efficiency by nearly eliminating losses due to air drag and make it much faster.

4. The capsules are supported on a cushion of air, featuring pressurized air and aerodynamic lift.

5. Residual air in the tube is captured, compressed, and forced through holes in skis attached to the bottom of the capsule.

5.1 The gap between the skis and the tube during operation is between 0.5mm and 1.3mm.

5.2 The air pressure in the tube is very low, a capsule travelling at 700mph will cause significant air pressure at the nose of the vehicle ,which must be considered in the design. Since the tube has a larger cross-section than the capsule, some air flows around the vehicle.[2]

How electronics plays a vital role in success of hyperloop technology

A hyperloop pod travels at top speeds along a track with variable air pressure and arrives at the destination safely. In support of this development, the Hyperloop Electronics Core (HEC) provides on-board electronics systems for a hyperloop pod, allowing for successful command and control of the pod leading to a safe and fast run.[6]

The HEC includes subsystems in the pod including power conversion and the central control board that allows for a reusable control scheme for future iterations of the pod to build upon. One of the major components of the HEC is the central control board, which includes the main microprocessor (MCU), external storage, on-board IMU, and connections to all external electronics in the pod. The external storage is used for pod data logging to store run data for separate analysis outside of test runs, while the on-board IMU is used for local checking of the pod's movements and for consensus checks

with the external sensors. Another major component of the HEC is the power conversion system. The HEC provides power to the components of the pod via the batteries safely through two stages of power conversion.[6]

The first stage is a power distribution board includes a switch mode boost converter that would bring the line voltage to a high level suitable for travelling the power harnessing to the endpoint conversion boards throughout the pod. These endpoint conversion boards facilitate the second stage of power conversion via a buck converter to convert the harness voltage to appropriate periphery voltage levels. The batteries and related Battery Management System (BMS) will feed power and battery status information to a secondary MCU located on the power distribution board centered around power monitoring and failsafe pod shutdown. This MCU will communicate critical information from the BMS and individual conversion boards to the main MCU.[6]

HEC will also process all incoming commands and packetizes telemetry to send out via an Ethernet connection to from the main MCU to an external radio. HEC can be manually controlled for braking from a remote ground station or autonomously sends signals to actuate brakes based on telemetry data and empirical data for the brakes, allowing for a safe and controlled journey.[6]

All components of the HEC are designed to work in a low-pressure environment where passive air cooling is at a minimum. This will drive the design of the power conversion and handling, the active data processing of the control board, and the long-range capabilities of the wireless communications system to be efficient and unique. Future iterations of the design will benefit by having the completed system to build upon. Additionally, the product can be incorporated in other low-pressure transportation vehicles.[6]

Table comparing different modes of transportation:

Mode of transport (MoD)	1st MoD (Vehicles)	2nd MoD (Trains)	1rd MoD (Ships)	1rth MoD (Plans)	5st MoD (Hyperloop)
Energy Consumption	Very Low	High	Very High	Very High	Low
Top Speed	120 kph	500 kph	44 kph	924 kph	1000 kph
Weather Resistance	Moderate	High	Moderate	Low	Very High
Risk of Accidents	High	Moderate	Low	High	Low
Loading Passengers	Fast	Fast	Moderate	Slow	Fast
Comfort Level	Good	Excellent	Excellent	Fair	Good
Traveling Costs	Low	Moderate	High	High	Very High
Carriage Capacity	Low	Very High	Very High	Moderate	Low

The above comparison table depicts the different aspects like energy consumption, travelling costs, speed, risk of accidents etc. of different modes of transportation and hyperloop technology. From this table we can predict that hyperloop technology gives much better results than the other modes of transportation including air travel.[4]

Is Hyperloop a difficult-to-implement technology?

1. The concept of Hyperloop is not very difficult in terms of physical manifestation, but as to cost-efficiency and practicality, the technology faces a lot of challenges.
2. Building the infrastructure (loop) is going to be very expensive.
3. Because the loop has to be built in a straight line, this fifth transport mode is only suitable for transcontinental travels. Interstate traveling would mean the network of pipelines would pass through private properties, which not all

the individuals might find welcoming.

4. The fact is that the possible depressurization of the passenger capsule at the chosen pressure value in the tube leads to the instant death of passengers. To solve this problem each passenger should be dressed up with a special suit like spacesuits.
5. The establishment requires cutting of substantial← number of trees. This prompts condition misfortune

Once completed, Hyperloop could meet the fate of Concorde because though the service was fast, the tickets were ridiculously pricey.[2][3][4]

One of the latest research

On July 29, 2017, Hyperloop One completed phase 2, after its pod travelled nearly the full distance of the 500-metre DevLoop track in the Nevada desert and achieved record test speeds in a tube depressurized down to the equivalent of air at 200,000 feet above sea level. The Hyperloop One XP-1, the company's first-generation pod, accelerated for 300 meters and glided above the track using magnetic levitation before braking and coming to a gradual stop. All components of the system were successfully tested, including the highly efficient electric motor, advanced controls and power electronics, custom magnetic levitation and guidance, pod suspension and vacuum system.[4]

The below table are the Test results of phase 1 VS phase 2 of Hyperloop One:

	Phase 2	vs.	Phase 1
Top Speed:	192 mph		69 mph
Total distance:	1,433 feet		315 feet
Propulsion segment:	300m		30m
Pod power:	3,151hp		891hp

Future Scope:

1. Hyperloop is viewed as an open source transportation idea. The creators energize all individuals from the network to add to the Hyperloop configuration process. Emphasis of the plan by different people and gatherings can help convey Hyperloop from a plan to a reality.
2. The creators perceive the requirement for extra work, including however not restricted to:
   2.1 The whole top of the tube's outer side will have solar panels to produce power from sunlight
   2.2 More development on the control component for← Hyperloop containers, including frame of mind thruster or control minute gyros.
   2.3 Detailed station structures with stacking and emptying← of both traveller and traveller in addition to vehicle renditions of the Hyperloop cases.
   2.4 Trades contrasting the expenses and advantages of← Hyperloop with increasingly customary attractive levitation frameworks.[3]

Conclusion:

Being a transportation system fast is not enough; it should be durable, sustainable and safer than others. It was outlined with safety in mind by Elon Musk, known as Hyperloop. Hyperloop could transport individuals, vehicles, and cargo between Los Angeles and San Francisco in 35 minutes. Transporting 7.4 million individuals every way consistently and amortizing the expense of $6 billion more than 20 years gives a ticket cost of $20 for a single direction trip for the traveller variant of Hyperloop. The traveller just form of the Hyperloop is under 9% of the expense of the proposed traveller just fast rail framework between Los Angeles and San Francisco. Except the US many come forward to develop this new technology like Dubai, China, And India, etc. Extra innovative improvements and further advancement could almost certainly diminish this cost. It is a great privilege to the traveler which can save time and money at the same time.

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