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Hyperloop Transportation System

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***Abstract*: This paper is all about the research on the 5th mode of transportation called Hyperloop (HL). In this, all the concepts of Hyperloop are mentioned. It is an advance technology which definitely in the field of transportation. History of Hyperloop are also there in this paper. It provides the best performance to High Speed Rails. The fare of this High Speed Rail is also acceptable. It runs in the close pods which has very low air pressure. Magnetic force is present due to which the train levitates. Four competition discussed in this paper and in all the competitions having high speed or prime speed is the main criteria for winning the competition. Hyperloop bring a Global Revolution in the field of transportation. In India Hyperloop runs in the panel from Mumbai to Pune.**

***Keywords*: HYPERLOOP (HL), Technical University of Munich, Massachusetts Institute of Technology (MIT), Kantrowitz limit, WARR Hyperloop, Space X.**

1. Introduction

Hyperloop (HL) is the latest technology that will come into existence after some years. A pod may travel substantially free of air resistance as it has low air pressure packed tube. The travel times after decreases as compare to other trains and airlines over distances of near about 1500 km.

Fig 1. Introduction of Hyperloop

Currently this is the best way of fasting the transportation. It is the type of fast train which runs between the particular distance (just say from A to C) without stoppage in middle (say B) having speed of more than 1000 km/hr. It also reduces the time of transportation. The global airlines demand of using airlines is increased by 4.1 percent which generates 872 billion dollars (U.S) revenue. In 2019, approximate estimate is near about 838 billion U.S dollars. Mode of other transportations like bus is declining and some private modes like car, bikes is stable. The HL (Hyperloop) system provides best performance to High Speed Rails for which the cost of fare is acceptable. Travel time decreases, transport costs decreases, better energy consumption and also provides safety. It consisting of passenger pods in a tube which have low Air Pressure and runs in the speed of near about 1000 km/hr.

2. History and Background

A. History

The concept of Hyperloop first publicly mentioned in 2012 by Elon Musk. From late 2012, the joint team of Tesla and SpaceX was working together and in August 2013 it was first published [1]. The concept was originally proposed in a white paper published by SpaceX. Musk first mentioned that about the fifth mode of transportation calling it Hyperloop. This high-speed mode of transportation would have the major advantages like immunity to weather, twice the speed of a plane, collision free, energy storage capacity of hours and low power consumption. It will run into a loop that's why name as Hyperloop.

On January 2017, first Hyperloop pod competition was held. The second Hyperloop pod competition took place in August 2017 and third Hyperloop pod competition took place in July 2018.

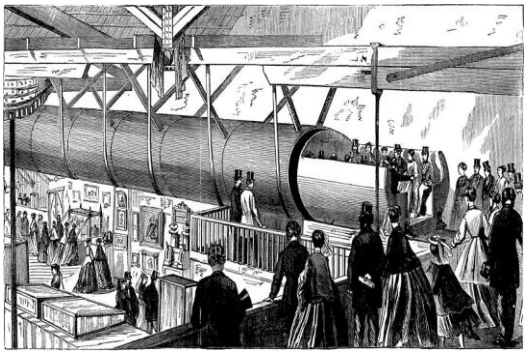

Fig. 2. Background

B. Background

The ideas for high-speed trains in vacuum or exhausted tubes comes back in early 1909's, once Robert H. Goddard physicist human planned high-speed passenger-carrying pods traveling through exhausted tubes. Bachelet introduced the core plan behind magnetically levitating trains as early as 1910. Over the years, these ideas area unit further refined, as an example by the Rand Corporation in 1972 with their "Very High Speed Transport System".

The Hyperloop Alpha report combined many of those

historic concepts and spurred a decent deal of public interest in Hyperloop (HL), one issue in the earlier ideas were lacking. This report discusses an Hyperloop pod that travels at 1220 km/h throughout a partially exhausted tube (1/1000th of region pressure) levitating with the help of air bearings. The utilization of wheels at these high speeds would be quite problematic due to large centripetal forces on them. Air bearings area unit planned as an additional efficient mechanism, where the pod floats on a skinny film of compressed air. The onboard compressor provides this compressed air and linear induction motor supplies propulsion. The main advantage of this is that, the intense parts are built track-side and so the pod entirely should carry a rotor that makes the propulsion quite efficient. In order to recover the substantial amount of energy, the same linear induction motor is used for the braking on the other end.

The onboard compressor also helps to improve the efficiency of the pod at higher speeds. Once the pod reaches transonic speeds (through the speed of sound), the flow around the pod will begin to choke, i.e. the flow around the pod will become transonic. The mass flow around the pod is maximum at this sonic condition (Kantrowitz limit). On the increasing the furthermore speed, all flow cannot travel around the pod and so collected in head of pod. The result is a column of air being pushed by the pod throughout its run and that pressure build-up results in significant another drag. The Hyperloop Alpha plan so introduces the on-board compressor to compress the additional flow and suck it through the pod, whereas at identical time supplying compressed air to the air bearings.

3. Space X Hyperloop Competition

On Jan 29, 2017, nearly one year after Hyperloop pod competition, the Massachusetts Institute of Technology Hyperloop pod exhibit the primary ever not high pressure Hyperloop run within the world. At intervals this initial competition the Delft University team from Netherlands winning the best competition score and price for “best overall design”. The award for the "fastest pod" was won by the team WARR Hyperloop from the Technical University of Munich (TUM) from Germany. The SpaceX engineers judges the third overall score in the competition for the team from the Massachusetts Institute of Technology (MIT) [2].

From 25-27 August 2017, second Hyperloop pod competition took place. To win the competition Speed is the main criteria and was followed by booming deceleration. WARR Hyperloop team from the Technical University of Munich had a great day and won the competition (as shown in Fig 3) by reaching a prime speed of 324 km/h which is 201 mph and so breaking the previous record of 310 km/h for Hyperloop prototypes set by Hyperloop One on their own trial track.

On July 2018, third Hyperloop pod competition was organized. The previous champions, the WARR Hyperloop team from the Technical University of Munich, break their own record with a prime speed of 457 km/h (284 mph) throughout their run.

In August 2019, fourth competition took place and again the WARR Hyperloop team from the Technical University of Munich, currently called TUM Hyperloop (by NEXT Prototypes), once more winning the competition and beak their own record with a prime speed of 463 km/h (288 mph).

Fig. 3. TUM wins Hyperloop Competition

4. Design and Construction

A. *Overview*

The overall goal of the MIT Hyperloop Team at intervals this competition was to style and build a pod that scores well in each aspects of the competition that is speed and scalability of systems used. The speed goal favors a light-weight style, whereas the scalability goal comes back in each facet of the pod. There are many approaches that might be taken to style for scalability, as an example to style a full Hyperloop pod with an oversized traveler compartment and scale it down for the competition. The MIT Hyperloop team took the approach of specializing in the foremost vital technologies for the Hyperloop construct, and developing climbable technologies for those [3]. The pod so doesn't have an infatuated controlled traveler compartment, as this technology is already out there from body style in craft, and so not distinctive to a Hyperloop. Instead, a serious focus throughout the (style, the planning, the look} and build method was the scalable of the levitation design, the braking style, and therefore the aeromechanics.

Other major driving needs for the look were obligatory by the team itself. Firstly, the pod had to be in-built four months (February 2016 begin of producing – might 2016 totally assembled), that meant that simpler/easier-to-manufacture styles were typically favored. Secondly, the pod required to accelerate at 2.4 t^t – the utmost projected acceleration offered by the SpaceX pusher. Finally, the pod had to be sturdy to changes in performance specifications and track tolerances.

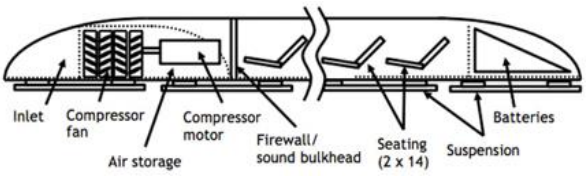

Fig. 4. Hyperloop Design

B. Levitation

A number of potential choices for a levitation system were investigated in an iterative method because the rules of the competition were slowly developed. This can be not essentially an optimized methodology for levitation, however fits inside the context of the competition (prototype version), the tight timeline and therefore the simplicity of applying this technology.

Air bearings, whereas investigated timely within the method, were determined to be impractical because of the massive gap heights (1 mm) between plates of the track. Wheels were found to not be scalable and a range was created within the team to within the non-wheeled vehicle category for a lot of connection to an actual Hyperloop System. A Magnetism Suspension (EMS) magnetic levitation system wasn't attainable while not the mandatory infrastructure inside the tube whereas the mandatory system is sophisticated, the system has several positives that create it a heavy possibility within the event of future tube changes. Ultimately, an Electrodynamics Suspension (EDS) magnetic levitation system was choose because of it being passive, ascendible with increasing L/D with speed, massive gap heights, compatible with the track and comparatively easy to implement.

The overwhelming majority of the planning effort was spent in characterizing the physics behind EDS magnetic levitation, determining the relevant magnetic array parameters and their effects, and simulating numerous array geometrics in an effort to optimize L/D whereas minimizing mass, cost, and maintaining acceptable gap height. The most parameter touching L/D make up my mind to be array wavelength that drove the bulk of style selections.

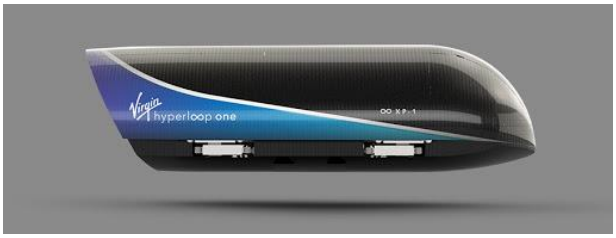

Fig. 5. Levitation in Hyperloop

C. Aerodynamics and Structures

One of the earliest selections created for the Aero Structures scheme was to separate the functions of the structural frame and also the mechanics shell into 2 separate elements. This allowed United States of America to cut back the look and producing risk well.

The structural frame consists of aluminum ladder frame, this is often associate applicable structural concept thought as a result of all the major loads are in one direction – the pusher loads and also the braking loads. Furthermore, the aluminum ladder frame permits for a good deal of flexibility within the style likewise as throughout the producing and testing part, if elements got to modification. The mechanics shell on the opposite hand is created from carbon fiber and covers all elements of the pod to cut back the mechanics drag the maximum amount as potential.

5. Hyperloop: A Global Revolution in Transportation

Hyperloop Transport systems have the potential to guide in era of low cost, and convenient long-distance travel across the planet, further as supply a low-carbon emission different to flying.

Domestic travel might even be remodeled. If quick and low cost Hyperloop systems do become a reality then remote regions might suddenly become viable places for commuters to measure, reducing demand for housing in already overcrowded cities and rising job opportunities in rural areas.

Hyperloop routes area unit being thought of across the planet. Virgin Hyperloop One has signed Associate in Nursing agreement with the Indian government that might see a route engineered that may permit passengers, and presumably load, to travel between the Indian cities of Pune and urban center in twenty-five minutes. Under the agreement the route would be engineered among seven years.

And whereas the first Hyperloop conception showed a route from Greater Los Angeles to the San Francisco, one among the foremost careful route proposals so far has been Hyperloop One's define of a 500km link between the Swedish capital national capital Stockholm and also the Helsinki capital of Finnish.

Hyperloop One has printed 9 potential European routes, connecting seventy-five million folks in forty-four cities and spanning 5000 km [4]. Worldwide, Hyperloop One incorporates a rank of ten potential routes, and has already entered into a public-private partnership with the Colorado Department of Transportation to conduct a practicability study into building a 360-mile route linking Cheyenne with state capital and Pueblo.

HTT is additionally creating inroads in its bid to develop an operating Hyperloop system, and recently signed a deal to launch a practicability study into projected routes between Cleveland and Chicago within the U.S. The agreement with the North Ohio area wide coordinative Agency and also the Illinois' Department of Transportation can see the HTT and also the public bodies examine numerous choices to attach the cities employing a Hyperloop system.

The agreement is one among many HTT has with alternative public organizations worldwide, as well as bodies in Europe and Asian nation. As a part of those arrangements, HTT is functioning with authorities within the European country and Slovak Republic to explore whether or not a track may be engineered between the 2 national capitals. Additionally, HTT disclosed it'll build a 10 km check track in China, within the province of Guizhou.

However, these routes can solely be completed if industrial Hyperloop systems sway be viable. To date, no organization has made an operating Hyperloop system, and there are earlier

failing makes an attempt to form a sealed tube train system. In 1864, the Crystal Palace part railway, stop working once solely some months of operation. However, technology has advanced up to now on the far side these crude nineteenth century efforts that fashionable systems measure incomparable.

Fig. 6. Map showing Hyperloop Route of Germany

6. Hyperloop in India (Pune – Mumbai Hyperloop Project)

The Maharashtra Government has proposed to set a high speed next generation transportation technique known as Pune-Mumbai Hyperloop. It connects the two cities.

In India, Hyperloop routed will be between PUNE-MAHARASTRA [5]. The total estimate cost of this project is INR 70,000 crores. The project is name as Pune-Mumbai Hyperloop Project

Some key points of Pune-Mumbai Hyperloop are as follows:

- Name of the Project: Pune-Mumbai Hyperloop
- Estimated Cost: INR 70,000 crore
- Land Provider: Maharashtra Government
- Train Speed: Nearly 510 km/h
- Distance Covered: 118 km
- Operator: DP world
- Investor and Executer: Virgin Hyperloop One
- Deadline of the Project: 2026
- Journey Time: 35 minutes
- Connectivity: Central Pune, Navi Mumbai International Airport and Mumbai

Fig. 7. Hyperloop Route in India

A. Key Points

- In February 2018, PMRDA and Virgin Hyperloop One sign the framework agreement.
- In June 2018, Maharashtra CM Devendra Fadnavis visits test site.
- In August 2018, Virgin Hyperloop submits feasibility report to PMRDA.
- In November 2018, Maharashtra Government declared it as public transportation project.
- In June 2019, Maharashtra Government forms a committee.
- In July 2019, the final approval was given by the Maharashtra Government.

7. Conclusion

The proposed design would achieve cost reduction. Speed is also one of the most important advantages of the system. It surely is fast, safe and cheap way of transportation. With this we can surely say that we are one step closer to the future we all desired.

This HL attain price reduction and the speed is additional one in every of the foremost vital blessings of the system. It surely is fast, safe and low-cost means of transportation.

Hyperloop (HL) may be a new mode of transport that claims to be a competitive and property different to the long-distance rail transport HSR (High Speed Rail) and also the medium-distance APT (Air traveler Transport) system (less than or adequate 1500 km). Taking under consideration that the performance of the HL system will be thought of in numerous ways that and from the views of various stakeholders (i.e., passengers, transport operators, government authorities, and society) the operational, financial, social/environmental performances of the HL system are investigated and evaluated.

Finally, from social/environmental perspective, any analysis is needed in exploring the whole life-cycle energy consumption and GHGs emissions of the system together with infrastructure development (lines and stations/ terminals), wheeled vehicle (capsules), and operation of subsystems like the vacuum pumps. Moreover, estimation of social performance of the system would be improved by any analysis on potential implications of HL for welfare like accessibility to life-enhancing opportunities and creation of jobs.

With this we ensures that we are one step nearer to the longer term we tend to all desired.

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