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Organized by

Department of Mechanical Engineering, Magna College of Engineering, Chennai-600055, India.

Design of Magnetic Levitation Train

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ABSTRACT : For decades, conventional trains, a major source of land transportation, have served people around the world. But the issue is that conventional trains create too much noise and pollution. Also the world is becoming a smaller place for business. As such, people travel longer distances, more often, and so there are longer travel times. This leads to too much fossil fuel consumption and that rate is increasing. That is why some people say, in the next 50 years, that the fossil fuel resource is going to run out. Faster fuel consumption also leads to increased pollution in the environment. So in short, we need travel times to be made shorter and we need a renewable energy source which is clean. But how do we get all this done in one shot? This is where the Magnetic Levitating train comes in.

KEY WORDS: Conventional, land transportation, faster fuel consumption, travel time made shorter.

I. INTRODUCTION

Imagine you are in a train and to your surprise; the train creates no noise, no pollution and has no wheels! As the train gets going, it goes faster and faster. You think you are going to crash. “But is the train going to really crash, or is it just “floating” and running along the track at high speeds on magnets?” Well, you’re right, that’s the concept behind the Magnetic Levitating train. Levitation means to rise or “float” in the air especially in seeming defiance of gravity. Using principles of magnetism to float in the air against gravity is called Magnetic Levitation.

The concept of magnetically levitated or maglev trains is of very much interesting. The conventional trains with wheels and guide rails turn to be uneconomical beyond 200 km/hr because at this high speed, air resistance and hence the drag force increases. Therefore, they are very much expensive and require intensive maintenance. Maglev trains avoid these disadvantages and prove highly beneficial.

It is based on the three principles viz. electro dynamic suspension, electromagnetic suspension and propulsion by LSM principle. Its various elements are carefully designed. The Maglev trains are proved very much useful by the environmental consideration. Because of its importance and benefits, it is important from the study point of view. Thus, thanks to scientists who have worked hard for its research and implementation? It is remarkably noted that progress has been achieved in the field of science and technology. Hence by absorbing those techniques, it is believed that the day of implementation of maglev trains all over the world will not be far away

2.1 Basic Principle Of Maglev Trains

The basic principles of Maglev trains are shown in Figure 1. Maglev trains have to perform the following functions to operate in high speeds

1. Levitation
2. Propulsion
3. Lateral Guidance

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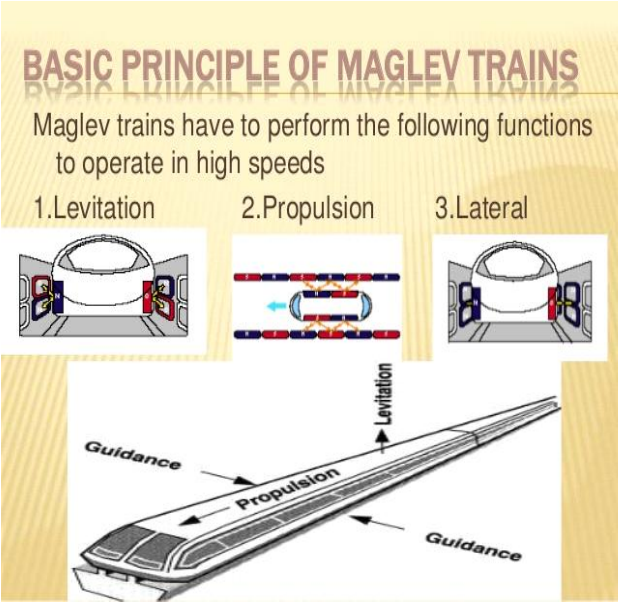

Figure 1 Basic Principle In Maglev Trains

IN EMS SYSTEM "LEVITATION BY ATTRACTION "may takes place. Attraction is caused by having the currents within each of the circuits traveling in the same direction. It is important to note that with attractive forces created between the train and the track.

2.2 Principle Of Propulsion In Ems System:

The Linear propulsion of the train is mainly based on two types of motors: Linear Induction Motor (LIM) Electric Motor (LEM) and, LATERAL GUIDENCE IN EMS The levitation magnets and rail are both SYSTEM: The mouths of UØU shaped(with rail being an inverted U). Face one another.

2.3 Pros and cons of EMS system

The system needs to(Electromagnetic -Low magnetic be monitored by suspension) fields inside and outside system to outside the vehicle maintain the distance between the Track -Commercially and the train available -Vibrations may -No secondary occur due to propulsion system instability and outside needed monitoring.

2.4 EDS (ELECTRO DYNAMIC Electrodynamics):

SUSPENSION uses Superconductors for levitation, propulsion and lateral guidance

2.4.1. Levitation principle in EDS system

IN EDS SYSTEM "LEVITATION BY REPULSION" may take place. The current in the top circuit travels in the opposite direction of the current in the bottom resulting in repulsion between the two.

2.4.2. Principle of propulsion in EDS system:

The propulsion coils located on the sidewalls on both sides of the guide way are energized by a three-phase alternating current from a substation, creating a shifting magnetic field on the guide way.

2.4.3 Principle of lateral guidence in EDS

When one side of the train nears the side of the guide way, the SYSTEM: super conducting magnet on the train

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induces a repulsive force from the levitation coils on the side closer to the train and an attractive force from the coils on the farther side. This keeps the train in the center.

2.4.4 Pros and cons of EDS:

Necessary use of highest speed magneting shielding (Electro dynamic (581 km/h) due to the strong suspension) magnetic fields. Heavy load the vehicle must be capacity wheeled to travel at low speed. The cryogenic system uses to cool the coils can be expensive.

PROS AND CONS OF EDS:

TECHNOLOGY	PROS	CONS
EDS (Electrodynamic suspension)	➢highest speed (581 km/h) ➢Heavy load capacity	➢Necessary use of magneting shielding due to the strong magnetic fields. ➢The vehicle must be wheeled to travel at low speed. ➢the cryogenic system uses to cool the coils can be expensive.

II. INDUCT TRACK

The Induct rack is a newer type of EDS that uses permanent room-temperature magnets.

There are two Induct rack designs:

- Induct rack I and
- Induct rack II

Induct rack I is designed for high speeds, while Induct rack II is suited for slow speeds. If the power fails, the train can slow down gradually and stop on its auxiliary wheels.

III. FIRST PATENT

High-speed transportation patents were granted to various inventors throughout the world. Early United States patents for a linear motor propelled train were awarded to the inventor, Alfred Zehden (German). The inventor was awarded U.S. Patent 782,312 (14 February 1905) and U.S. Patent RE12,700 (21 August 1907). In 1907, another early electromagnetic transportation system was developed by F. S. Smith. A series of German patents for magnetic levitation trains propelled by linear motors were awarded to Hermann Kemper between 1937 and 1941. An early modern type of maglev train was described in U.S. Patent 3,158,765, Magnetic system of transportation, by G. R. Polgreen (25 August 1959). The first use of "maglev" in a United States patent was in "Magnetic levitation guidance system" by Canadian Patents and Development Limited.

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IV. DEVELOPMENT

In the late 1940s, Professor Eric Laithwaite of Imperial College in London developed the first full-size working model of the linear induction motor. He became professor of heavy electrical engineering at Imperial College in 1964, where he continued his successful development of the linear motor. As the linear motor does not require physical contact between the vehicle and guide way, it became a common fixture on many advanced transportation systems being developed in the 1960s and 70s. Laithwaite himself joined development of one such project, the Tracked Hovercraft, although funding for this project was cancelled in 1973.[12]

The first commercial maglev people mover was simply called "MAGLEV" and officially opened in 1984 near Birmingham, England. It operated on an elevated 600-metre (2,000 ft) section of monorail track between Birmingham International Airport and Birmingham International railway station**,** running at speeds up to 42 km/h (26 mph); the system was eventually closed in 1995 due to reliability problems.

- Maglev (derived from magnetic levitation) is a method of propulsion that uses magnetic levitation to propel vehicles with magnets rather than with wheels, axles and bearings. With maglev, a vehicle is levitated a short distance away from a guide way using magnets to create both lift and thrust. High-speed maglev trains promise dramatic improvements for human travel if widespread adoption occurs.

- Maglev trains move more smoothly and somewhat more quietly than wheeled mass transit systems. Their non-reliance on friction means that acceleration and deceleration can surpass that of wheeled transports, and they are unaffected by weather.

- Compared to conventional wheeled trains, differences in construction affect the economics of maglev trains. Maglev tracks have historically been found to be much more expensive to construct, but require less maintenance and have low ongoing costs.

Commercial maglev transport systems in operation, with two others under construction.[4] In April 2004, Shanghai began commercial operations of the high-speed Trans rapid system. In March 2005, Japan began operation of the relatively low-speed HSST "Limbo" line in time for the 2005 World Expo. In its first three months, the Limbo line carried over 10 million passengers. South Korea and the People's Republic of China are both building low-speed

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maglev lines of their own design, one in Beijing and the other at Seoul's Incheon Airport. Many maglev projects are controversial, and the technological potential, adoption prospects and economics of maglev systems have often been hotly debated.

5.1 History of maglev speed records:

- 1971 – West Germany – 164km/h (102mph)
- 1972 – Japan – ML100 – 60km/h (37mph) – (manned)
- 1971 – West Germany – Prinzipfahrzeug – 90km/h (56mph)
- 1974 – West Germany – EET-01 – 230km/h (140mph) (unmanned)
- 1975 – West Germany – Komet – 401km/h (249mph) (by steam rocket propulsion, unmanned)
- 1978 – Japan – HSST-02 – 110km/h (68mph) (manned)
- 1979-12-21 – Japan-ML-500R – 517km/h (321mph) (unmanned)
- 1987 – Japan – MLU001 – 401km/h (249mph) (manned)
- 1989 – West Germany – TR-07 – 436km/h (271mph) (manned)
- 1993 – Germany – TR-07 – 450km/h (280mph) (manned)
- 1999 – Japan – MLX01 – 548km/h (341mph) (unmanned)
- 1999 – Japan – MLX01 – 552km/h (343mph) (manned/five formation). Guinness authorization.
- 2003 – China – Transrapid SMT (built in Germany) – 501km/h (311mph) (manned/three formation)
- 2003 – Japan – MLX01 – 581km/h (361mph) (manned/three formation). Guinness authorization.

- **Simmons, Jack; Biddle, Gordon** (1997). **The Oxford Companion** to British Railway History: From 1603 to the 1990s. Oxford: Oxford University Press. p. 303. ISBN 0-19-211697-5. Electromagnetic suspension

V. ELECTROMAGNETIC SUSPENSION

In current electromagnetic suspension **(EMS)** systems, the train levitates above a steel rail while electromagnets, attached to the train, are oriented toward the rail from below. The system is typically arranged on a series of C-shaped arms, with the upper portion of the arm attached to the vehicle, and the lower inside edge containing the magnets. The rail is situated between the upper and lower edges.

Magnetic attraction varies inversely with the cube of distance, so minor changes in distance between the magnets and the rail produce greatly varying forces. These changes in force are dynamically unstable – if there is a slight divergence from the optimum position, the tendency will be to exacerbate this, and complex systems of feedback control are required to maintain a train at a constant distance from the track,(Approximately 15 millimeters (0.59 in)).

The major advantage to suspended maglev systems is that they work at all speeds, unlike electro dynamic systems which only work at a minimum speed of about 30 km/h (19 mph). This eliminates the need for a separate low-speed suspension system, and can simplify the track layout as a result. On the downside, the dynamic instability of the system puts high demands on tolerance control of the track, which can offset, or eliminate this advantage. Laithwaite, highly skeptical of the concept, was concerned that in order to make a track with the required tolerances, the gap between the magnets and rail would have to be increased to the point where the magnets would be unreasonably large.[28] In practice, this problem was addressed through increased performance of the feedback systems, which allow the system to run with close tolerances.

Other application

- **NASA** plans to use magnetic levitation for launching of space vehicles into low earth orbit.
- Boeing is pursuing research in Maglev to provide a Hypersonic Ground Test Facility for the Air Force.
- The mining industry will also benefit from Maglev.

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- There are probably many more undiscovered applications.

VI. CONCLUSION

Now that we know how the technology work, we believe that maglev system can be research further to be used in advanced application and maglev technologies are in demand due to it beings environmentally friendly

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