# INTRODUCTION TO MAGLEV TRAIN A REVIEW

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**Abstract—Maglev has became the fastest high speed train in the world. This technology is a dominating one in the terms of technical infrastructure of the existing railways. The main aim of this system is to give a best solution for the old transportation problem that remains in the world. Maglev trains which are based on the principle of maglev is always been compared with high speed transportations .High-speed maglev trains provides dramatic improvements for human travel over the years. Maglev trains move more smoothly and somewhat vibration free than other means of transportation. This paper briefly examines some commercial applications of rare earth magnets and magnetic levitation and gives a brief summary.**

**Keywords—Maglev; Technology; high speed.**

## I. INTRODUCTION

Maglev word which is derived from magnetic levitation is a Type of train transportation that uses two sets of magnets, one set to repel away and other push the train up off the track as in levitation hence it is called as Maglev or Magnetic-levitation then another set to move the 'train' ahead at great speed taking advantage of zero friction. Maglev can compete with high speed rail and airplanes. In Maglev technology there is no moving parts. The train travels along a guideway of magnets which control the train's stability and speed. Maglev trains are therefore quieter and smoother than earlier trains, and have the potential for much higher speeds. Maglev vehicles hold the speed record for trains and Maglev trains can accelerate and decelerate quickly than earlier trains; the only practical limitation is the safety and comfort of the passengers.[1] Maglev systems have been much more expensive to construct than earlier train systems, although the simpler construction of maglev vehicles makes them cheaper to manufacture and maintain. Despite over a period of research and development, maglev transport systems are in operation in just three countries (Japan, South Korea and China) Magnetic levitation provides fast, cost-efficient and environmentally friendly transportation and it can be very efficient and affordable. Under this paper is about analyzing magnetic levitation and also to look in to its feasibility with respect to India also. It has been reported that India is considering maglev technology during his Japan visit and interaction here with Chinese; Prime Minister Narendra Modi will be exploring complete financing option at close to zero interest rate [2]

## II. TECHNOLOGY OF MAGLEV TRAIN

### A. History

High-speed transportation patents were granted to various inventors all over the world. The first use of "maglev" in a United States patent was in "Magnetic levitation guidance system"by Canadian Patents and Development Limited.

In 1968, while delayed in traffic on the Throgs Neck Bridge, James Powell, a researcher at Brookhaven National Laboratory (BNL), thought of using magnetically levitated transportation.

Transrapid 05 was the first maglev train with longstator propulsion licensed for passenger transportation. In 1979, a 908 m (2,979 ft) track was opened in Hamburg for the first International Transportation Exhibition (IVA 79). Interest was sufficient that operations were extended three months after the exhibition finished, having carried more than 50,000 passengers.

The world's first commercial maglev system was a low-speed maglev shuttle that ran between the airport terminal of Birmingham International Airport and the nearby Birmingham International railway station between 1984 and 1995.

Japan operates two independently developed maglev trains. One is HSST (and its descendant, the Linimo line) by Japan Airlines and the other, which is more well-known, is SC Maglev by the Central Japan Railway Company.

South Korea, Germany, England, japan and China are some the countries which are improving superfast in this technology.

### B. Technology

The two notable types of maglev technology are:

Electromagnetic suspension (EMS), electronically controlled electromagnets in the train attract it to magnetically conductive (usually steel) track.

Electrodynamic suspension (EDS) uses superconducting electromagnets or strong permanent magnets that create a magnetic field, which induces currents in nearby metallic conductors when there is relative movement, which pushes and pulls the train towards the designed levitation position on the guide way.

## III. PRINCIPLE OF MAGLEV TRAIN

### A. Electromagnetic suspension (EMS)

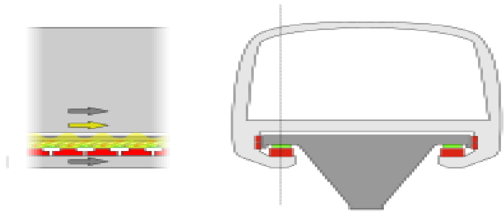


Fig. 1: Electromagnetic suspension (EMS) systems

In electromagnetic suspension (EMS) systems, the train moves above 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 inside the C, between the upper and lower edges. Magnetic attraction changes inversely with the cube of distance, so minor changes in distance between the magnets and the rail create greatly varying forces. These changes in force are dynamically unstable – a slight deviation from the optimum position tends to grow, requiring sophisticated feedback systems to maintain a constant distance from the track, (approximately 15 mm (0.59 in)). The major advantage to suspended maglev systems is that they work at all speeds, unlike electrodynamic 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 track layout. On the downside, the dynamic instability demands fine track tolerances, which can offset this advantage. Eric Laithwaite was concerned that to meet required tolerances, the gap between magnets and rail would be increased to the point where the magnets would be unreasonably large. In practice, this problem was addressed through improved feedback systems, which support the required tolerances.[1]

B. **Electrodynamic suspension (EDS)**

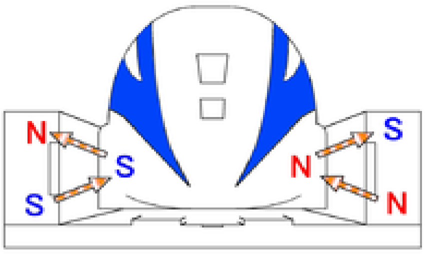



Fig. 2: Electrodynamic suspension (EDS)

The Japanese SCMaglev's EDS suspension is powered by the magnetic fields induced either side of the vehicle by the passage of the vehicle's superconducting magnets.

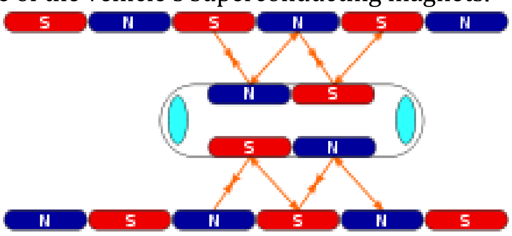
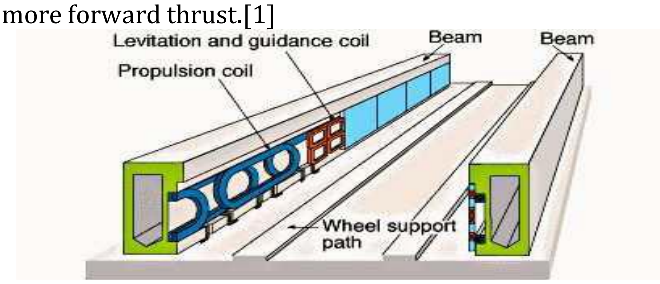



Fig 3: EDS Maglev propulsion via propulsion coils

In electrodynamic suspension (EDS), both the guideway and the train exert a magnetic field, and the train is levitated by the repulsive and attractive force between these magnetic fields. In some configurations, the train can be levitated only by repulsive force. In the early stages of maglev development at the Miyazaki test track, a purely repulsive system was used instead of the later repulsive and attractive EDS system. The magnetic field is produced either by superconducting magnets (as in JR–Maglev) or by an array of permanent magnets (as in Inductrack). The repulsive and attractive force in the track is created by an induced magnetic field in wires or other conducting strips in the track. A main advantage of EDS maglev systems is that they are dynamically stable – changes in distance between the track and the magnets creates strong forces to return the system to its original position. In addition, the attractive force varies in the opposite manner, providing the same adjustment effects. No active feedback control is needed. However, at slow speeds, the current induced in these coils and the resultant magnetic flux is not large enough to levitate the train. For this reason, the train must have wheels or some other form of landing gear to support the train until it reaches take-off speed. Since a train may stop at any location, due to equipment problems for instance, the entire track must be able to support both low- and high-speed operation. Another downside is that the EDS system naturally creates a field in the track in front and to the rear of the lift magnets, which acts against the magnets and creates magnetic drag. This is generally only a concern at low speeds (This is one of the reasons why JR discarded a purely repulsive system and adopted the sidewall levitation system.) At higher speeds other modes of drag dominate. The drag force can be used to the electrodynamic system's advantage, however, as it creates a varying force in the rails that can be used as a reactionary system to drive the train, without the need for a separate reaction plate, as in most linear motor systems. Laithwaite led development of such "traverse-flux" systems at his Imperial College laboratory. Alternatively, propulsion coils on the guideway are used to exert a force on the magnets in the train and make the train move forward. The propulsion coils that exert a force on the train are effectively a linear motor: an alternating current through the coils generates a continuously varying magnetic field that moves forward along the track. The frequency of the alternating current is synchronized to match the speed of the train. The offset between the field exerted by magnets on the train and the applied field creates a force moving the train forward.[2]

C . **Maglev Track**

The magnetized coil running along the track, called a guideway, repels the large magnets on the train's under carriage, allowing the train to levitate between 0.39 and 3.93 inches(1 to 10 centimeters) above the guideway. Once the train is levitated, power is supplied to the coil within the guideway walls to create a unique system of magnetic fields that will pull and Push the train along the guideway. The electric current supplied to the coil in guideway walls is constantly alternating to change the polarity of the magnetized coils. This change in polarity causes the magnetic field in front of the train to pull the vehicle forward, while the magnetic field behind the train adds more forward thrust.[1]




4. Fig: Maglev Track

## IV. Design Consideration and Comaprison

There are three main methods of transportation used by Society today. These include automobiles, airplanes and trains. Technology in these fields has advanced greatly in the last 40 years making the world a much smaller place. With the modern methods of transportation of today, one can be almost anywhere in the world within a day. Design of vehicle, Fuel efficiency, speed and price vary between each.

### A. Vehicle Design

maglev is similar to other transport technology, but the implementation varies considerably according to the application. Choice of vehicle, weight, shape and length dominate transport system design. There are 3 key issues that affect the EI of a transport system and are primarily determined

### B. Fuel Efficiency

Unlike the previous forms of transportation, Maglev trains run on electricity rather than fossil fuels. Electricity is a renewable source of energy and can be produced in several different ways including nuclear, hydro and solar plants. Fossil fuels are non-renewable sources of energy. They must be burnt, releasing carbon emission in the atmosphere in order to produce energy. Travelling at a speed of 300 mph and 150 mph. Maglev trains use 0.4 mega joules and 0.1 mega joules per passenger mile respectively. An automobile travelling at a speed of 60 mph with 20-mpg fuel efficiency uses 4 mega joules per passenger per mile. Using these numbers, Maglev trains moving at half this speed attains efficiency 40 times greater than that of an automobile.

### C. speed and cost

When commuting in a car one's average arrival time can be hard to calculate due to traffic and driving conditions. Everyone has been struck in traffic. Unannounced construction, gaper delays, sometimes nothing at all can create massive delays on the roadway.

Car also requires a big maintenance. Automobiles must meet state standards in order to be legal for the roads and all cars must be insured. This constant maintenance and legal coverage becomes very costly for any common citizen.

Planes as well experience delays. Prime weather and air traffic condition are essential in insuring passenger a safe flight. However, when these criteria are not made, delays occur.

In life, just as in driving, there is no way to forecast what will happen in future. What we can do is to put the odds in our favour is to minimize risk. That's where maglev train come into play. Maglev trains have a dedicated infrastructure solely for the train itself. No other vehicles are compatible with their magnetic guide ways and so no other vehicles travel on it. This means there is no traffic and no collisions. Weather conditions have little to no effect on maglev trains except under severe conditions. So a train can travel even when the weather is subpar. In an automobile or conventional locomotive wet conditions decreases friction between the vehicle and ground. This increases stopping time and the probability that a vehicle may slip. The magnetic forces at hand are unaffected by such condition. Since no contact is made between the maglev train and the railway. Less wear is put on each. This means less maintenance. Less maintenance creates fewer delays while allowing lower ticket prices.

## V. COnclusion

- For three decades Maglev Train has seen dramatic Changes that makes them more efficient and cost effective
- Travel time: Maglev, despite higher speeds and greater acceleration, has little travel time which is has much advantage in real-world applications.
- electrodynamic suspension has plenty of advantages over electromagnetic suspension

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