

A

Seminar report

On

**MAGLEV TRAIN**

Submitted in partial fulfillment of the requirement for the award of degree  
Of Mechanical

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## Preface

I have made this report file on the topic **MAGLEV TRAIN**; I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude to .....who assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

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## **Acknowledgement**

I would like to thank respected Mr..... and Mr. ....for giving me such a wonderful opportunity to expand my knowledge for my own branch and giving me guidelines to present a seminar report. It helped me a lot to realize of what we study for.

Secondly, I would like to thank my parents who patiently helped me as i went through my work and helped to modify and eliminate some of the irrelevant or un-necessary stuffs.

Thirdly, I would like to thank my friends who helped me to make my work more organized and well-stacked till the end.

Next, I would thank Microsoft for developing such a wonderful tool like MS Word. It helped my work a lot to remain error-free.

Last but clearly not the least, I would thank The Almighty for giving me strength to complete my report on time.

## THE MAGLEV TRAIN

### 1. *Introduction*

The MAGLEV train stands for magnetic levitation train and is a system of transportation that suspends guides and propels vehicles, predominantly trains, using magnetic levitation from a very large number of magnets for lift and propulsion. This method has the potential to be faster, quieter and smoother than wheeled mass transit systems. The power needed for levitation is usually not a particularly large percentage of the overall consumption; most of the power used is needed to overcome air drag, as with any other high speed train.

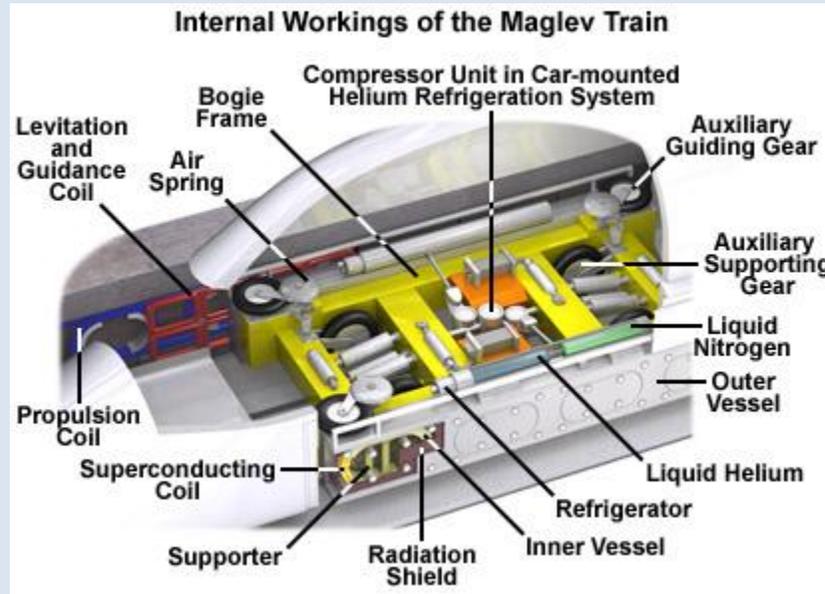
The highest recorded speed of a Maglev train is 581 kilometers per hour (361 mph), achieved in Japan in 2003, 6 kilometers per hour (3.7 mph) faster than the conventional TGV wheel-rail speed record.

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.<sup>[2]</sup>

Perhaps the most well known implementation of high-speed maglev technology currently operating commercially is the Shanghai Maglev Train, an IOS (initial operating segment) demonstration line of the German-built Transrapid train in Shanghai, China that transports people 30 km (19 mi) to the airport in just 7 minutes 20 seconds, achieving a top speed of 431 km/h (268 mph), averaging 250 km/h (160 mph).

## 2. Technology

### 2.1. Overview



The term "maglev" refers not only to the vehicles, but to the railway system as well, specifically designed for magnetic levitation and propulsion. All operational implementations of maglev technology have had minimal overlap with wheeled train technology and have not been compatible with conventional rail tracks. Because they cannot share existing infrastructure, these maglev systems must be designed as complete transportation systems.

There are two particularly notable types of maglev technology:

- For electromagnetic suspension (EMS), electromagnets in the train attract it to a magnetically conductive (usually steel) track.
- Electrodynamic suspension (EDS) uses electromagnets on both track and train to push the train away from the rail.

Another experimental technology, which was designed, proven mathematically, peer reviewed, and patented, but is yet to be built, is the magnetodynamic suspension (MDS), which uses the attractive magnetic force of a permanent magnet array near a steel track to lift the train and hold it in place. Other technologies such as repulsive permanent magnets and superconducting magnets have seen some research.

### 2.2. 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.

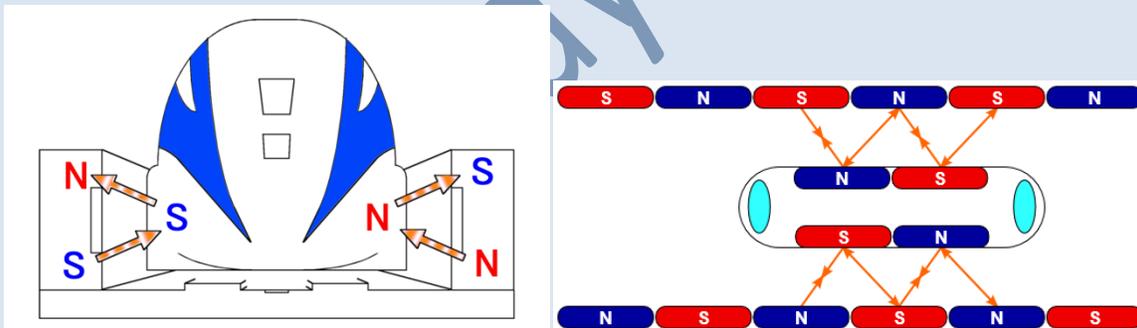
Magnetic attraction varies inversely with the cube of distance, so minor changes in distance between the magnets and the rail produce greatly varying forces. These changes in force are dynamically unstable - if there is a slight divergence from the optimum position, the tendency

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 (0.6 in)).<sup>[20][21]</sup>

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. 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 demands high tolerances 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.<sup>[19]</sup> In practice, this problem was addressed through increased performance of the feedback systems, which allow the system to run with close tolerances.

### 2.3. Electrodynamic suspension

In electrodynamic suspension (EDS), both the rail and the train exert a magnetic field, and the train is levitated by the repulsive force between these magnetic fields. The magnetic field in the train is produced by either superconducting magnets (as in JR-Maglev) or by an array of permanent magnets (as in Inductrack). The repulsive force in the track is created by an induced magnetic field in wires or other conducting strips in the track. A major advantage of the repulsive maglev systems is that they are naturally stable – minor narrowing in distance between the track and the magnets creates strong forces to repel the magnets back to their original position, while a slight increase in distance greatly reduces the force and again returns the vehicle to the right separation.



Repulsive systems have a major downside as well. At slow speeds, the current induced in these coils and the resultant magnetic flux is not large enough to support the weight of the train. For this reason the train must have wheels or some other form of landing gear to support the train until it reaches a speed that can sustain levitation. Since a train may stop at any location, due to equipment problems for instance, the entire track must be able to support both low-speed and high-speed operation. Another downside is that the repulsive system naturally creates a field in the track in front and to the rear of the lift magnets, which act against the magnets and create a form of drag. This is generally only a concern at low speeds, at higher speeds the effect does not have time to build to its full potential and other forms of drag dominate.<sup>[19]</sup>

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. Alternately, 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 flowing 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.

#### 2.4. Pros and cons of different maglev technologies

The pros of the electromagnetic suspension (EMS) are:

- The magnetic fields exerted by this type of technology are weaker than other type of technology;
- Trains using this type of suspension have no need of wheels or secondary propulsion systems.

The cons of the electromagnetic suspension (EMS) are:

- The separation between the vehicle and the guideway must be constantly monitored and corrected by computer systems to avoid collision due to the unstable nature of electromagnetic attraction;
- Due to the system's inherent instability and the required constant corrections by outside systems, vibration issues may occur.

The pros of the electrodynamic suspension (EDS) are:

- Onboard magnets and large margin between rail and train enable highest recorded train speeds (581 km/h) and heavy load capacity;
- This type of suspension can be cooled with inexpensive liquid nitrogen.

The cons of the electrodynamic suspension (EDS) are:

- Strong magnetic fields onboard the train would make the train inaccessible to passengers with pacemakers or magnetic data storage media such as hard drives and credit cards, necessitating the use of magnetic shielding;
- Vehicles using this type of suspension must be wheeled for travel at low speeds.

The pros of the Inductrack System (MDS) are:

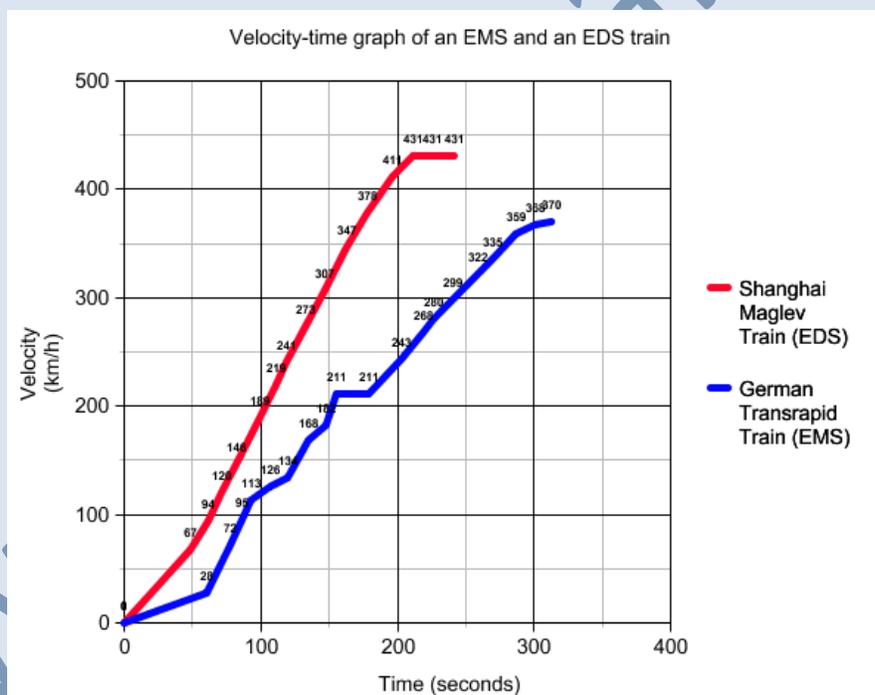
- Failsafe Suspension – no power required to activate magnets;
- The magnetic field is localized below the car;
- This system can generate enough force at low speeds (around 5 km/h) to levitate maglev train;
- In case of power failure, the cars slow down on their own safely.

The cons of the Inductrack System (MDS) are:

- The system requires either wheels or track segments that move for when the vehicle is stopped;
- The technology is new and still under development (as of 2008) and as yet has no commercial version or full scale system prototype.

## 2.5. Comparison between two different maglev technologies

The graph below illustrates a comparison between EDS and EMS technologies, in terms of acceleration. We can see that the Shanghai Maglev Train, which uses EDS technology reaches its top speed at about 211 seconds after leaving the station, while the German Transrapid, using EMS technology, attains its maximum speed in about 310 seconds, but the Transrapid's top speed is considerably lower than the Shanghai Maglev's top speed.



## 3. Power and energy usage

The energy used for maglev trains is electrical energy, and therefore maglev trains are more environmentally friendly than other transportation systems nowadays. The electrical energy is converted into electromagnetic energy.

Most of the energy is used to accelerate the train, and may be regained when the train slows down. This technology is called regenerative braking. The energy is also used to make the train

levitate and to stabilize the movement of the train. The main part of the energy is needed to force the train through the air, therefore to overcome air drag. A big advantage of the magnetic levitation systems is the lack of friction between the tracks and wheels. Also some energy is used for air conditioning, heating, lighting and other miscellaneous systems.

At very low speeds the percentage of power (energy per time) used for levitation can be significant. Also for very short distances the energy used for acceleration might be considerable. But the power used to overcome air drag increases with the cube of the velocity, and hence dominates at high speed (note: the energy needed per mile increases by the square of the velocity and the time decreases linearly.).

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## ADVANTAGES

- 1) The foremost advantage of maglev trains is the fact that it doesn't have moving parts as conventional trains do, and therefore, the wear and tear of parts is minimal, and that reduces the maintenance cost by a significant extent.
- 2) More importantly, there is no physical contact between the train and track, so there is no rolling resistance. While electromagnetic drag and air friction do exist, that doesn't hinder their ability to clock a speed in excess of 200 mph.
- 3) Absence of wheels also comes as a boon, as you don't have to deal with deafening noise that is likely to come with them.
- 4) Maglevs also boast of being environment friendly, as they don't resort to internal combustion engines.
- 5) These trains are weather proof, which means rain, snow, or severe cold don't really hamper their performance.
- 6) Maglev systems are energy efficient. For long distance travel they use about half the energy per passenger as a typical commercial aircraft.
- 7) Experts are of the opinion that these trains are a lot safer than their conventional counterparts as they are equipped with state-of-the-art safety systems, which can keep things in control even when the train is cruising at a high speed.

## **DISADVANTAGES**

### **1)Cost**

While the advantages of Maglev Train System may seem quite promising in themselves, they are not enough to overshadow the biggest problem with the maglev trains: the high cost incurred on the initial setup. While the fast conventional trains that have been introduced of late, work fine on tracks which were meant for slow trains, maglev trains require an all new set up right from the scratch. As the present railway infrastructure is of no use for maglevs, it will either have to be replaced with the Maglev System or an entirely new set up will have to be created—both of which will cost a decent amount in terms of initial investment. Even though inexpensive as compared to EDS, it is still expensive compared to other modes.

### **2)Impact**

Although the tracks could be elevated, there would still be the addition of guideways crossing great amounts of land.

### **3)Energy Consumption**

Larger train cars are tougher to levitate and require quite a bit more energy, making them less efficient.

### **4)Safety**

While the MagLev can be safer overall, any infrequent accidents that do occur are likely to be more catastrophic due to the elevated guideways and incredible speeds..

## **Reference**

[www.google.com](http://www.google.com)

[www.wikipedia.org](http://www.wikipedia.org)

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