Magnetic Levitation Train Design Principles and Prototype Evaluation

Posted on October 11, 2022

View this essay online:
https://academic-master.com/magnetic-levitation-train-design-principles-and-prototype-evaluation/

Step 1

Option A

Side View



Top View



End View





Step 2

Pro: This prototype design is the easiest way to explain how magnetic levitation-based trains operate. It includes everything that is essential for the design, such as levitation, propulsion and guiding. Many essential details can be extracted from it, like the concept of life and drag, static and dynamic suspension, different types of magnets that can be used, electromechanical systems, induced currents, and many more.

Con:

The problem with this prototype is that there are no electromagnets and superconductors, which can easily interrupt its balance and cause several stability issues with its working. Here, we have used permanent magnets to show their basic working, but in doing so, there is a chance that the magnets could break their poles, causing disruption, which can eventually cause damage.

Step 3

Magnetic Levitation or Maglev is a method in which the vehicles move off the guided path (equivalent to conventional rail tracks) utilizing electromagnetic fields across superconducting magnets and coils on the concrete guide. In order to comprehend magnetic trains, we should first learn what magnetic levitation is. The process by which a subject is elevated without assistance apart from magnetic fields is magnetic levitation (Maglev) (Lee, 2006). Magnetic forces are utilized to offset the effects and other forces of the gravitational pull. The two major factors associated with maglev trains are uplifting forces, such as supplying upward strength to combat gravity and stability. This is to ensure that the system doesn't flip or slide spontaneously into a configuration that neutralizes the lift. For maglev trains, frictionless melting, magnetic bearings and product display applications, magnet levitation is utilized.

Magnetic levitation-based trains can trace their roots from Brookhaven National Laboratory. The very first patent for a magnetically levitated train was issued to James Powell & Gordon Danby of Brookhaven in the late 1960s. Powell came up with the concept that a better means of travelling on land than by vehicles or regular trains would have to be discovered. He thought of levitating a railway by employing superconducting magnets. Superconductive magnets are electro-magnets heated to high temperatures after usage and substantially boost the magnetic field's strength. The very first commercially operated Maglev high-speed superconductive train was launched in Shanghai in 2004, which proved to be a huge success, with others in South Korea and Japan (Yan, 2008).

Maglev employs two pairs of magnets: one tries to resist and propel the train through the track, and the other tries to take advantage of the absence of friction to drive the elevated train ahead. The magnet fields created by the magnets interact in the concrete walls of the guideway Maglev with

simple metallic loops. The loops are composed of conduction materials, such as aluminium, which create an electric current that creates another magnetic field when a magnetic field travels past it. With maglev technology, the train passes along a magnet guide to manage its stability and speed. Although propulsion and levitation are free of movement, bogies can move around the vehicle's main body, and some technologies require retractable wheels assistance at speeds below 150 kilometres per hour (Cassat, 2002). This is compared to numerous electric units with several dozen bogie components. In some circumstances, Maglev trains may be quieter and smoother than conventional trains and have a significantly higher speed potential. Maglev cars set several speed records, with Maglev trains accelerating and decelerating far faster than conventional trains; the safety and comfort of passengers are the only practical limit, although high-speed wind resistance can entail four to five times as much running costs as conventional high-speed rail. The power needed for levitation is generally not a substantial fraction of a high-speed maglev system's overall energy usage. Maglev systems have proven significantly more expensive than traditional train systems, while the simplified design of maglev cars makes their production and maintenance much cheaper.

Over time, conventional wheels and rails are subjected to considerable stress. They must be routinely maintained and fixed to remain working. In maglev, no contact is made between the train and the guideway, so wear and tear is significantly lower. Due to this, the life cycle of maglev components is considerably longer, therefore offering more longevity. It would require something like a total collapse of the guideway to separate a train from its track. Another advantage of levitation is that these trains do not waste any friction energy. Maglev can turn tighter than high-speed railways can. This enables the construction of guides that can explore the ground considerably better.

In this concept, the Maglev functionality has three important parts: levitation, propulsion and steering. Levitation is the train's ability to remain over the track. Permanent magnets create magnetic fields. This produces eddy currents that create a magnetic field that separates the two objects. This time can be generated by relative motion by different magnetic fields. Both northern poles would be confronted in such a way that they would resist each other, and the levitation phenomena would be produced.

Propulsion is the driving power for the train. Magnetic attraction and repulsion are utilised to move the railway car along the guideway. Imagine the four-magnet box, one at each corner. The front corners have magnets pointing north, and the rear corners have magnets facing south. The electrification of the propulsion loops creates magnetic fields which both drive the train forward and drag it backwards.

The guide keeps the train centred on the guideway. The prototype contains two electromagnetic tracks on each side of the train. These rails prevent the train from going too far or passing by.

Step 4

When the magnet is damaged or fractured, a new north and south pole develops, but each piece has a much lower magnetic field. This will have a major impact on the train's performance, but it depends on which magnet is broken. When sandwich strips are broken, for example, the overall influence on the train's performance will be extremely low. However, if disk drives or alternating magnets are broken down, they have a major impact on performance since the interactions of the magnetic field between the train and the concrete guides are minimal. The train will quickly slow down when magnetic field integration is reduced, but it gains its original speed as soon as it passes these shattered magnets. The broken magnets should be replaced for proper operation of the train as soon as feasible.

Step 5

I'll surely advise them to stop, as striking the magnetic strips thus disturbs the northern and southern poles of the magnet, resulting in a loss of magnetic qualities. If trains operate on such a track, they will just fall off rather than levitate on a track, as the magnetic characteristics of the magnetic strip have been lost, it will somewhere reject the train and at times attract the train. As soon as the train touches the magnets on the bottom, it may cause a catastrophe.

References

Cassat, A. &. (2002). MAGLEV projects technology aspects and choices. *IEEE Transactions on Applied Superconductivity, 12*(1), 915-925.

Lee, H. W. (2006). Review of maglev train technologies. *IEEE transactions on magnetics, 42*(7), 1917-1925.

Yan, L. (2008). Development and application of the maglev transportation system. *IEEE Transactions on Applied Superconductivity, 18*(2), 92-99.