Maglev

**Maglev** (derived from [*magnetic levitation*](https://en.wikipedia.org/wiki/Magnetic_levitation)), is a system of [train](https://en.wikipedia.org/wiki/Train) transportation that uses two sets of [electromagnets](https://en.wikipedia.org/wiki/Electromagnet): one set to repel and push the train up off the [track](https://en.wikipedia.org/wiki/Track_(rail_transport)), and another set to move the elevated train ahead, taking advantage of the lack of [friction](https://en.wikipedia.org/wiki/Friction). Such trains rise approximately 10 centimetres (3.9 in) off the track.[[1]](https://en.wikipedia.org/wiki/Maglev#cite_note-1)[[2]](https://en.wikipedia.org/wiki/Maglev#cite_note-2) There are both high speed, intercity maglev systems (over 400 km/h or 250 mph), and low speed, urban maglev systems (80–200 km/h or 50–124 mph) being built and under construction and development.

## **Development**

In the late 1940s, the British electrical engineer [Eric Laithwaite](https://en.wikipedia.org/wiki/Eric_Laithwaite), a professor at [Imperial College London](https://en.wikipedia.org/wiki/Imperial_College_London), developed the first full-size working model of the [linear induction motor](https://en.wikipedia.org/wiki/Linear_motor). He became professor of heavy electrical engineering at Imperial College in 1964, where he continued his successful development of the linear motor.[[11]](https://en.wikipedia.org/wiki/Maglev#cite_note-11) Since linear motors do not require physical contact between the vehicle and guideway, they became a common fixture on advanced transportation systems in the 1960s and 1970s. Laithwaite joined one such project, the [Tracked Hovercraft](https://en.wikipedia.org/wiki/Tracked_Hovercraft) RTV-31, based near Cambridge, UK, although the project was cancelled in 1973.

## **History**

### First maglev patent

High-speed transportation patents were granted to various inventors throughout the world.[[14]](https://en.wikipedia.org/wiki/Maglev#cite_note-ReferenceA-14) The first relevant patent, [U.S. Patent 714,851](https://patents.google.com/patent/US714851) (2 December 1902), issued to Albert C. Albertson, used magnetic levitation to take part of the weight off of the wheels while using conventional propulsion.

## **Technology**

In the public imagination, "maglev" often evokes the concept of an elevated [monorail](https://en.wikipedia.org/wiki/Monorail) track with a [linear motor](https://en.wikipedia.org/wiki/Linear_motor). Maglev systems may be monorail or dual rail—the [SCMaglev](https://en.wikipedia.org/wiki/SCMaglev" \o "SCMaglev) MLX01 for instance uses a trench-like track—and not all monorail trains are maglevs. Some railway transport systems incorporate linear motors but use electromagnetism only for [propulsion](https://en.wikipedia.org/wiki/Propulsion), without levitating the vehicle. Such trains have wheels and are not maglevs. Maglev tracks, monorail or not, can also be constructed at grade or underground in tunnels. Conversely, non-maglev tracks, monorail or not, can be elevated or underground too. Some maglev trains do incorporate wheels and function like linear motor-propelled wheeled vehicles at slower speeds but levitate at higher speeds. This is typically the case with [electrodynamic suspension](https://en.wikipedia.org/wiki/Electrodynamic_suspension) maglev trains. [Aerodynamic](https://en.wikipedia.org/wiki/Aerodynamic) factors may also play a role in the levitation of such trains.

## **Systems**

#### High speed

##### Shanghai Maglev (2003)

The [Shanghai Maglev Train](https://en.wikipedia.org/wiki/Shanghai_Maglev_Train), also known as the [Transrapid](https://en.wikipedia.org/wiki/Transrapid" \o "Transrapid), has a top speed of 430 km/h (270 mph). The line is the fastest, first commercially successful, operational Maglev train designed to connect [Shanghai Pudong International Airport](https://en.wikipedia.org/wiki/Shanghai_Pudong_International_Airport) and the outskirts of central [Pudong](https://en.wikipedia.org/wiki/Pudong), [Shanghai](https://en.wikipedia.org/wiki/Shanghai). It covers a distance of 30.5 km (19.0 mi) in 7 or 8 minutes

#### Low speed

##### Linimo (Tobu Kyuryo Line, Japan) (2005)

Linimo train approaching Banpaku Kinen Koen, towards Fujigaoka Station in March 2005

*Main article: [Linimo](https://en.wikipedia.org/wiki/Linimo" \o "Linimo)*

The commercial [automated](https://en.wikipedia.org/wiki/Automation) "Urban Maglev" system commenced operation in March 2005 in [Aichi](https://en.wikipedia.org/wiki/Aichi), Japan. The Tobu Kyuryo Line, otherwise known as the [Linimo](https://en.wikipedia.org/wiki/Linimo" \o "Linimo) line, covers 9 km (5.6 mi). It has a minimum operating radius of 75 m (246 ft) and a maximum gradient of 6%. The linear-motor magnetically levitated train has a top speed of 100 km/h (62 mph). More than 10 million passengers used this "urban maglev" line in its first three months of operation. At 100 km/h, it is sufficiently fast for frequent stops, has little or no noise impact on surrounding communities, can navigate short radius rights of way, and operates during inclement weather. The trains were designed by the Chubu HSST Development Corporation, which also operates a test track in Nagoya