Transrapid

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Transrapid at the Emsland test facility

Transrapid is a German high-speed monorail train using magnetic levitation. Based on a patent from 1934, planning of the Transrapid system started in 1969. The test facility for the system in Emsland, Germany was completed in 1987. In 1991 the technical readiness for application was approved by the Deutsche Bundesbahn in cooperation with renowned universities.

In 2004, the first commercial implementation was completed. The Shanghai Maglev Train connects the rapid transit network 30.5 km (19.0 mi) to the Shanghai Pudong International Airport. The Transrapid system has not yet been deployed on a long-distance intercity line.

The system is developed and marketed by Transrapid International, a joint venture of Siemens AG and ThyssenKrupp AG. Critical voices, such as Sir Rod Eddington [1] refer to recent developments of railway and other competing technologies and draw parallels between Transrapid and previous high technology hypes without broad market impact outside niche applications.

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Technology

See also: Technology in the Magnetic levitation train article.

The synchronous longstator linear motor of the Transrapid maglev system is used both for propulsion and braking. It functions like a rotating electric motor whose stator is cut open and stretched lengthways along the underside of the guideway. Inside the motor windings, alternating current generates a magnetic traveling field which moves the vehicle without contact. The support magnets in the vehicle function as the excitation portion (rotor). The respective magnetic traveling field works in only one direction, and therefore makes moving train collisions less likely; if there were several trains on the track section, they would travel in the same direction.

The superspeed maglev system has no wheels, axles, transmissions, or pantographs. It does not roll, it hovers. Electronic systems guarantee that the clearance remains constant (nominally 10 mm). The Transrapid requires less power to hover than is used by its air conditioning equipment. The levitation system and all on board electronics are supplied by the power recovered from harmonic oscillations of magnetic field of the track's linear stator (those oscillations being parasitic cannot be used for propulsion) at speeds above 80 km/h, while at lower speeds power is obtained through physical connections to the track. In case of power failure of the track's propulsion system, the Transrapid car can use on-board backup batteries to power the levitation system.

Energy requirements

The normal energy consumption of the Transrapid is approximately 50–100 kW per section for levitation and travel, and vehicle control. The drag coefficient of the Transrapid is about 0.26. The air resistance of the vehicle, which has a frontal cross section of 16 m², requires a power consumption, at 400 km/h (111 m/s) cruising speed, given by the following formula:

$$P = c_w \cdot A_{\mathrm{Front}} \cdot v^3 \cdot (\mathrm{Density\ of\ surrounding\ air})/2$$
$$P = 0.26 \cdot 16\,\mathrm{m}^2 \cdot (111\,\mathrm{m/s})^3 \cdot 1.24\,\mathrm{kg/m}^3/2$$
$$P = 3.53 \cdot 10^6\,\mathrm{kg} \cdot \mathrm{m}^2/\mathrm{s}^3 = 3.53 \cdot 10^6\,\mathrm{N} \cdot \mathrm{m/s} = 3.53\,\mathrm{MW}$$

Power consumption compares favorably with other high-speed rail systems. With an efficiency of 0.85, the power required is about 4.2 MW. Energy consumption for levitation and guidance purposes equates to approximately 1.7 kW/t. As the propulsion system is also capable of functioning in reverse, energy is transferred back into the electricity network during braking. An exception to this is when an emergency stop is performed using the emergency landing skids beneath the vehicle, although this method of bringing the vehicle to a stop is intended only as a last resort should it be impossible or undesirable to keep the vehicle levitating on back-up power to a natural halt.

Market segment, ecological impact and historical parallels

Compared to classical railway lines, Transrapid allows higher speeds and gradients with lower wear and tear and even lower energy consumption and maintenance needs. The Transrapid track is more flexible adapted to specific geographical circumstances than a classical train system. Cargo is restricted to a maximum payload of 15 metric tonnes per car. Transrapids allows maximum speeds of 550 km/h, placing it between conventional High Speed Trains (200–320 km/h) and Air Traffic (720-990 km/h). The magnetic field generator, an important part of the engine being a part of the track, limits the system capacity.

From a competition standpoint, the Transrapid is a proprietary solution. The track being a part of the engine, only the single-source Transrapid vehicles and infrastructure can be operated. There is no multisourcing foreseen concerning vehicles or the highly complicated crossings and switches. Unlike classical railways or other infrastructure networks (as jointly administrated by the Bundesnetzagentur in Germany) a Transrapid system does not allow any direct competition.

Ecological impact

The Transrapid itself is an electrically driven, clean, high-speed, high-price, high-capacity means of transport able to build up point-to-point passenger connections in geographically challenged surroundings. This has to be set in comparison with the impact on heritage and or landscape protection areas (compare Waldschlößchenbrücke). Any impact of emissions has to take into account the source of electrical energy. The reduced expense, noise and vibration of a people-only Transrapid versus a cargo train track is not directly comparable. The reuse of existing tracks and the interfacing with existing networks is limited. The Transrapid indirectly competes for resources, space and tracks in urban and city surroundings with classical urban transport systems and high speed trains.

Historic parallels

The debate and the development of Suspension railways before 1900 as well as Alweg around 1960 and monorails (e.g. Aerobus) in Germany have a variety of parallels:

- they were all developed in German-speaking countries and were deployed in limited capacities overseas
- they failed in the planned market segment but had an impact as "future technology" symbols in the media, politics and public debate

Supporters praise Transrapid and its predecessors as

- advanced technology per se
- a sign and guarantee of progress and innovation in Germany
- the mark of a new age or further Kondratiev wave

Opponents see the Transrapid and the predecessors as white elephants, wishful thinking based cargo-cult technology without real market chances and usability.

For advantages and disadvantages of maglev trains, see also: maglev.

Implementations

German high-speed competition

The Transrapid originated as one of several competing concepts for new land-based high speed public transportation developed in Germany. It also faced competition from the InterCityExpress (ICE), a high-speed rail system based on "traditional" railway technology. The ICE "won" in that it was adopted nationwide in Germany. A variety of studies for possible Transrapid systems was elaborated, including a long-distance line from Hamburg to Berlin. The last left was an airport connection track from Munich city to the Airport, which was finally canceled in early 2008 due to dramatically increasing cost projections.

China

The only success so far was in the year 2000, when the Chinese government ordered a Transrapid track to be built connecting Shanghai to its Pudong International Airport. It was inaugurated in 2002, and regular daily trips started in March 2004. The average number of riders per day (14 hours of operation) is about 7.500, while the maximum seating capacity per train is 440. A second class ticket price of about 50 RMB (Renminbi) (about 5 Euro) is 4 times the price of the Airport Bus and ten times more expensive than a comparable Underground ticket [2].

Transrapid magnetic levitation train in Shanghai, connecting the subway station to Pudong International Airport

An extension to the national Airport Hongqiao seems possible but has not been finally greenlighted. The travel speed is 430 km/h, which the Maglev train maintains for 50 seconds as the short track allows only a short time to keep the cruising speed before deceleration must begin.

The project was sponsored by the German Hermes loans with €200 million.

Germany

A 40-kilometre (25 mi) project between Munich Central and Munich Airport was close to being built, but was canceled on March 27, 2008, when the German government scrapped the Transrapid project because of a massive overrun in costs. Before, the Bavarian governing party CSU faced internal and local resistance, in particular by the communities between Munich and the airport. CSU planned to position Transrapid as a light house of future technology and innovation for the booming Freistaat. Now Traffic minister Wolfgang Tiefensee announced the decision after a crisis meeting in Berlin at which industry representatives reportedly revealed that costs had risen from 1.85 billion euros to well over 3 billion ($4.7 billion).[3]

United Kingdom

The Transrapid is being considered by the UK government as a 500 km/h (310 mph) link between London and Glasgow, via Birmingham, Manchester, Leeds, Teesside, Newcastle and Edinburgh. UK Ultraspeed, the name of the project, provides further information on their website. Further information is available in the High-speed rail in the United Kingdom article.

Projects elsewhere

Several European projects have been studied, but so far classical rail has been the preferred solution.

In the USA[4] there have been several evaluations. Again, so far, classical railway remains the suggested solution. No actual project has been started yet.

There have been first talks for a project in the Persian Gulf region, connecting Bahrain – Qatar – UAE. Iran had taken into account a 900 kilometres (560 mi) line to link Tehran with Mashhad.[5][6]

September 2006 accident

On September 22, 2006 a Transrapid train collided with a maintenance vehicle at 170 km/h on the test track in Lathen. The maintenance vehicle destroyed the first section of the train, and came to rest on its roof. This was the first major accident involving a Transrapid train. The news media reported 23 fatalities and several severely injured after end of salvage work, these being the first fatalities on any maglev.[7][8] The accident is reported to have been caused by a combination of human error and a technical flaw in the system supervision.

Alleged theft of Transrapid technology

Recently new announcements by Chinese officials planning on cutting maglev rail costs by a third have stirred some strong comments by various German officials and more diplomatic statements of concern from Transrapid officials. The Deutsche Welle reports that the China Daily quoted the State Council encouraging engineers to "learn and absorb foreign advanced technologies while making further innovations."[9]

The China Aviation Industry Corporation said in their defense that the new Zhui Feng maglev train is not based or dependent on foreign technology. They claim it is not only a much lighter train, but also has a much more advanced design.

See also

For an overview of competitors to this system, see High-speed rail.

Trains Portal

- Aérotrain
- JR-Maglev MLX01
- Land speed record for railed vehicles
- Magnetic levitation train
- Shanghai Maglev Train
- Shanghai-Hangzhou Maglev Train
- Linear motor
- Nagahori Tsurumi-ryokuchi Line
- Maglev

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9. ^ "China Masters German Train Technology, Will Cut Costs", Deutsche Welle, 2006-04-28. Retrieved on 2008-03-27.

External links

Official

- Transrapid homepage
- SIEMENS Transportation Systems
- ThyssenKrupp Transrapid GmbH
- UK Ultraspeed Project Homepage
- TVE

Other

- WikiMaglev
- Presentations on Dresden Transrapid Conferences, partially in English
- [1], * [2],

- [3],
- [4]
- German Museum, Bonn - The Transrapid is one of the exhibits
- Maglev video gallery
- Transrapid Pictures at Shanghai Pudong Airport
- Transrapid - Maglev in Asia (China, Shanghai), Japan (Yamanashi) and Germany (Munich; TVE)
- Google Map of Lathen-Doerpen test track facility