Chapter 2
Conceptual Terminology of HSR

As a safe, reliable, fast, comfortable, large-capacity, low-carbon and environmentally-friendly transportation vehicle, HSR has become the mainstream transportation in the world, leading humanity to a new era. According to the statistics of the International Railway Union, as of December 31, 2021, the total operating mileage of HSR in all countries of the world was 50,000 km, the mileage under construction was 10,000 km, and the planned mileage was 20,000 km. The operation mileage of HSR in some countries is as shown in Table 2.1.

There is no uniform definition of the term "high-speed rail", and different organizations or countries have different definition standards for it. However, in recent years, the standards of various places have been close to each other. The International Railway Union advised to set a standard definition that the high-speed rail refers to the line whose design speed is 200 km/h by transforming the original line, or the new line whose design speed is more than 250 km/h. This book defines "high-speed rail" based on the 3S theory (Speed, Space and Service). HSR should meet the 3S theory: speed is high, space is large and service quality is high. China's WHSR train is as shown in Fig. 2.1.

HSR is a system, called HSR system for short. It includes the narrow definition of HSR and the broad definition of HSR.

① HSR in the narrow sense refers to the traditional WHSR transportation system, which is also the most common understanding known as conventional HSR.
② HSR in the broad sense includes the traditional WHSR transportation system, the MHSR transportation system and the SSR transportation system. The classification of the broad HSR system is shown in Table 2.2.

2.1 Overview of HSR

HSR plays a pivotal role in the development of the economy around the world. This is determined by two reasons: On the one hand, HSR has greatly expanded the capacity

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Table 2.1 Operation mileage of HSR in some countries

Countries	Chinese mainland	Japan	France	Germany	Spain	Italy	Korea
Operation mileage/km	40,941	3446	2793	3368	4900	1432	1530

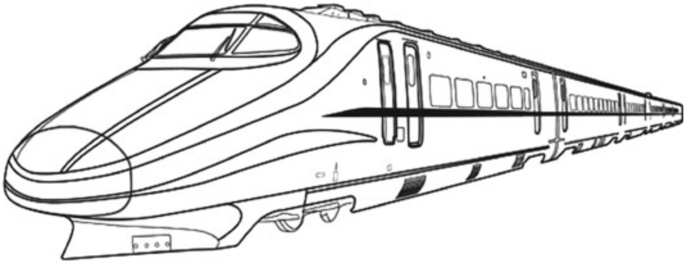


Fig. 2.1 China's WHSR train

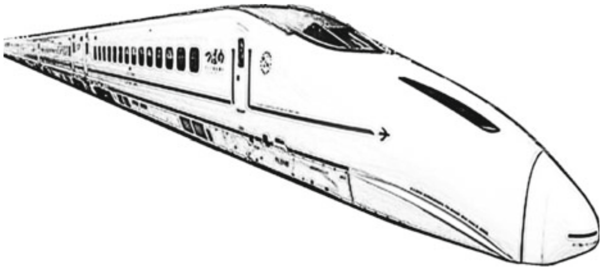
Table 2.2 Types of HSR

Number	Types	Name		Speed/(km/h)	Remarks
1.	First	WHSR	Low-speed WHSR	200–300	Wheel High-speed Rail
			Normal-speed WHSR	300–350	
			High-speed WHSR	350–400	
2.	Second	MHSR	Low-temperature MHSR	400–500	Magnetic High-speed Rail
			Normal-temperature MHSR	500–800	
			High-temperature MHSR	800–1000	
3.	Third	SSR	Low-sonic SSR	1000–1200	Vacuum pipe magnetic suspension high-speed rail
			Normal-sonic SSR	1200–10,000	
			Super-sonic SSR	>10,000	

of rails and greatly reduced the time between cities. It has brought great convenience to people when they travel. On the other hand, HSR has greatly improved the transport capacity and further improved the quality of service. However, there are two basic conditions for the formation of HSR. Only meet these two conditions can HSR appear and survive. The first one is a densely populated city with a high standard of living, which can withstand relatively expensive fares and multiple stops. For example, European continents such as Paris, France and Berlin, Germany and the dense cities of Japan are the birthplace of HSR. The second one is a higher social-economic and scientific basis that guarantees the construction, operation and maintenance needs of

HSR, such as Japan, Germany. Through years of development, the HSR has formed its own development modes in Japan, France, Germany and China.

(1) Japan's Shinkansen is the single line mode. The single line mode is to build all new lines dedicated to passenger trains. Mainly operated by single line but failed to form a network. As shown in Fig. 2.2. On October 1, 1964, the Tokaido



(a) Typical train vehicle

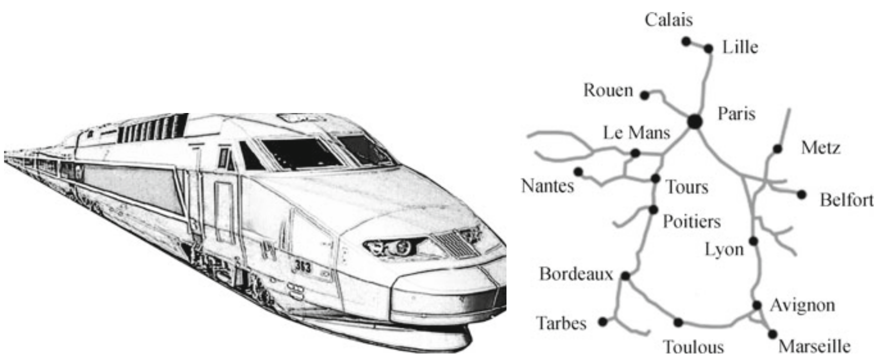
(b) Operating lines

Fig. 2.2 Single line mode of Japan's HSR

Shinkansen was officially opened with operating speed of 210 km/h. It transports 360,000 passengers per day and has annual passengers of 120 million. This electrified standard gauge two-lane rail, dedicated to passenger transport, represented the first-class HSR technology in the world at that time. Between 1975 and 1985, HSR lines such as the Sanyang Shinkansen, the Tohoku Shinkansen, and the Joetsu Shinkansen were opened. In 1997, the Hokuriku Shinkansen was opened and a complete domestic high-speed rail lines was formed in Japan. However, Japan failed to form a network for the limitation of land area, and it operates mainly in a single line. Figure 2.2 shows the single line mode of Japan's HSR.

(2) The French TGV is the multi-line mode. The multi-line mode is to build some new lines and to renovate some of the old lines for passenger transportation. The lines have a core point and the shape of the lines is like the shape of "+". In 1971, the French government approved the construction of the southeast line of TGV (from Paris to Lyon). It had been built from October 1976, and was completed in September 1983. In 1989, France built the Atlantic high-speed rail line and in 1993, France's third HSR, the Nordic line of TGV was opened from Paris as the starting point through the Channel Tunnel to London. It connected with the northern European countries, and it is an important international channel. In 1999, the Mediterranean line was completed. From then the existing lines of French TGV can cover more than half of the French territory as shown in Fig. 2.3. However, France also failed to form a network for the limitation of land area. It is mainly operated in a multi-line format in the shape of " + ".

(3) The Germanic ICE is the mixed-line mode. Regarding the mixed line mode, all routes are newly built and shared by passengers and freight. The German high-speed rail ICE was first commissioned in 1985. In 1991, the Mannheim-Stuttgart line was opened. In 1992, the Hannover-Wurzburg line was completed and opened. In 1992, Germany purchased 60 ICE trains, 41 of which were operated on the number 6th of high-speed rail, respectively connecting Hamburg,



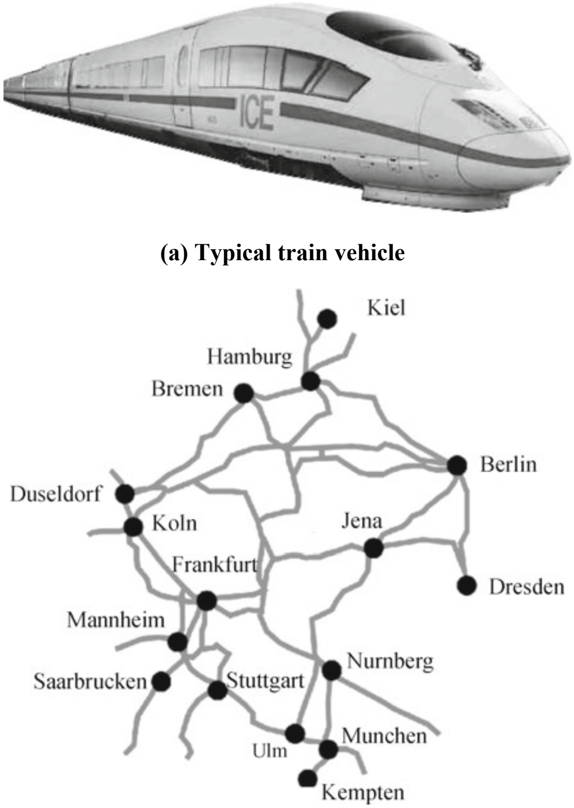
(a) Typical train vehicle **(b) Operating lines**

Fig. 2.3 Multi-line mode of French TGV

Frankfurt and Stuttgart. At present, Germany's pan-European HSR and the third phase of HSR have been built one after another, achieving the international direct transportation of HSR as shown in Fig. 2.4.

(4) China Railways High-speed (CRH) is a network model. The network mode is to establish some new lines and partially transform the old lines for passenger transportation. It has formed a HSR network for convenient transfer. On August 1, 2008, the first HSR was operated from Beijing to Tianjin. Since then, China's HSR has developed rapidly. By the end of December 2015, CRH has the longest operating mileage and the largest scale under construction. China is the only country that has the network of "four vertical lines and four horizontal lines". By December 2020, China's HSR will have a mileage of more than 30,000 km and China will form a HSR network with the "eight vertical lines and eight horizontal lines". CRH adheres to the combination of original innovation, integrated innovation, introduction, digestion, absorption and re-innovation. It has built a HSR technology system with independent intellectual property rights. CRH has reached the world's advanced level, as shown in Fig. 2.5.

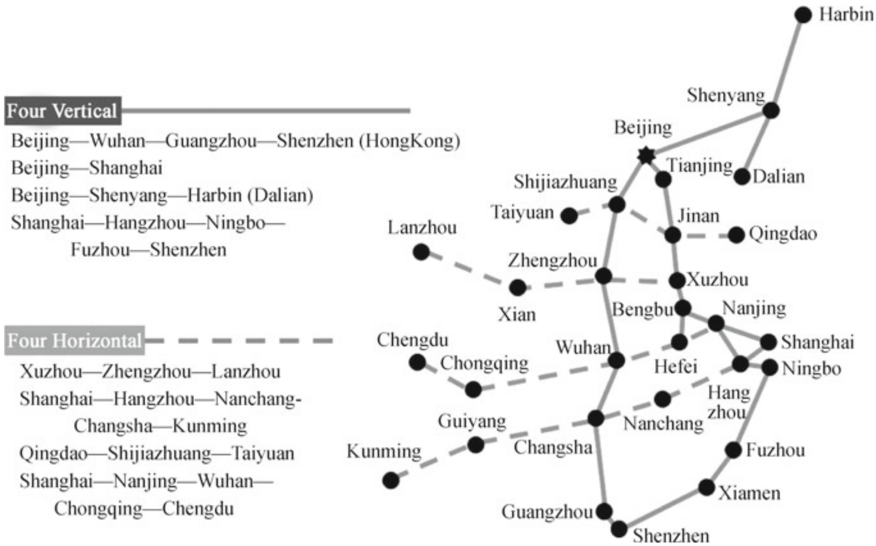
Fig. 2.4 Mixed line mode of Germanic ICE



(a) Typical train vehicle

(b) Operating lines

(a) Typical train vehicle



(b) Operating lines

Fig. 2.5 Network model of China's HSR (CRH)

2.2 The Definition of HSR

HSR is highly praised by the public and governments around the world for its high speed, convenience, safety and punctuality. It is also an important part of current transportation research. The HSR is defined as a rail line with an operating speed of more than 200 km/h. However, due to the characteristics of HSR itself, the definition of it in the world is not unified. According to the HSR technology used over the world, the definition can mainly be divided into three criteria: the European Union, the UN Economic Commission and the International Railway Federation. At the same time, different countries have different definitions of HSR. China adopts the

Table 2.3 Definition of HSR

Name		WHSR		HSR trains
First	International railway federation	New lines	Design speed 250 km/h or more	Trains with commercial operation above 250 km/h
		Transform old lines	Design speed 250 km/h or more	Trains with commercial operation above 200 km/h and high quality of service
Second	European Union	New lines	Allowable speed 200 km/h or more	Operation speed above 250 km/h and can reach 300 km/h
		Transform the old lines	Allowable speed 200 km/h or more	Trains with operation speed above 200 km/h
Third	UN economic commission	New lines	Allowable speed 200 km/h or more	Trains with design speed above 250 km/h
		Transform the old lines	Allowable speed 200 km/h or more	Trains with design speed above 250 km/h
Fourth	Japanese standard	New lines	Allowable speed 200 km/h or more	Trains with design speed above 250 km/h
		Transform the old lines	Allowable speed 200 km/h or more	Trains with design speed above 250 km/h
Fifth	Chinese standard	New lines	Line speed 200–250 km/h	Trains with operating speed above 250 km/h and high-speed rail trains with operating speed above 300 km/h
		Transform the old lines	Line speed 20–250 km/h	

definition of HSR made by International Railway Union. The various standards are shown in Table 2.3.

2.2.1 The Definition of WHSR

The International Railway Federation is a non-government rail joint organization involving some railway institutions and related organizations in some European countries and other continents. Later, it recruited some organization of non-European countries. Its purpose is to promote the development of international railway transportation, promote international cooperation and improve railway technical equipment and operation methods. It carries out scientific research on related issues and realizes the unification of technical standards for railway buildings and equipment. The definition of WHSR in this book is made by Chinese standards.

(1) International Railway Federation Standards. According to the definition of the International Railway Federation, the WHSR refers to the rail system with an operation speed above 200 km/h by transforming the old line (linearization, gauge standardization) or the rail system with new lines' operating speed is above 250 km/h. In addition to the speed standards for train operation, the vehicles, rails and operations also need to be upgraded.

   ① HSR requires that the design speed of the new lines is above 250 km/h or the transformed old lines (linearization, gauge standardization) have a design speed above 200 km/h or even reach 220 km/h.
   ② HSR motor train is the train which has a commercial operating speed above 250 km/h or has a commercial operating speed of 200 km/h but has high service quality such as tilting trains.

(2) European Union standards. In the process of establishing the Trans-European High-speed Rail Network (TENR) system, the European Union proposed the definitions of "high-speed rail" "high-speed rail motor trains" and issued the Directive "96/48/EC". The Directive (D + IRECTIVE 96/48/EC) gives the standards for both "high-speed rail" and "high-speed rail motor trains". This standard is now generally applicable to European Union member states.

   ① HSR has a design speed above 250 km/h for the new lines or has a design speed above 200 km/h for transformed old lines.
   ② HSR motor train has the running speed above 250 km/h and sometimes the speed can reach up to 300 km/h on the new lines and on the existing rails, the running speed can reach 200 km/h.

(3) Standards of the UN Economic Commission. According to the United Nations Economic Commission for Europe (UNECE) Transport Statistics Working Group, the standards of "high-speed rail" and "high-speed rail trains" have been set like the European Union. In 1985, "International Railway Route Agreement" signed by the United Nations Economic Commission for Europe in Geneva stipulated that the new lines for mixed passenger transportation and freight transportation (refer to as passenger and cargo line) should have a speed above 250 km/h, and the new lines for passenger transportation (referred to as passenger lines) should have a speed above 350 km/h.

   ① HSR has a design speed above 250 km/h for the main lines or has a design speed above 200 km/h for transformed old lines.
   ② HSR motor train has a design speed above 250 km/h or a design speed above 200 km/h for transformed old lines or the fastest speed of 200 km/h of traditional HSR train.

(4) Japanese standards. Japan was the first country in the world to develop the HSR. The Japanese government issued Decree No.71 in 1970, which defined HSR as: where the main section of a railway has a maximum speed of 200 km/h or more, it can be called the high-speed rail.

① HSR has an allowed speed for the main lines above 250 km/h or has an allowed speed above 200 km/h for transformed old lines.
② HSR motor train has a design speed above 250 km/h on special lines or a design speed of titling trains above 200 km/h for transformed old lines or the fastest of speed 200 km/h for traditional HSR motor train.

(5) Chinese standards. China has become a country owing the most complete technology, the strongest integration capability, the longest operating mileage, the highest operating speed and the largest scale of construction around the world. The “High-speed Rail Design Code (TB10621-2014)”, which was piloted in 2009, stipulates that HSR refers to a new rail with a maximum speed above 250 km/h for passenger transportation. The Regulations on Railway Safety Management (Supplementary Provisions) which was implemented on January 1, 2014 stipulates that HSR refers to rails with an operating speed above 250 km/h (including reservations) and an initial operating speed above 200 km/h for passenger transportation (refer to as passenger lines).

① HSR has a design speed for the new lines above 250 km/h or has a design speed above 200 km/h for transformed old lines. The trains operating on the lines with a speed below 250 km/h are called “trains”. The trains with a speed from 300 to 350 km/h on the lines are called “high-speed rail trains”. China’s HSR construction has advanced by leaps and bounds, and the scale of the HSR network has expanded rapidly (Fig. 2.6).

Fig. 2.6 China’s HSR network topological graph

Fig. 2.7 CRH train

② The types of China's HSR motor trains are as follows: CRH1, CRH2, CRH3, CRH5, CRH6, CRH380A, CRH380B, CRH380C, CRH380D, CR200, CR300, CR400, etc. (Fig. 2.7).

2.2.2 The Definition of MHSR

MHSR train is a modern high-technique vehicle that uses the electromagnetic force to realize the contactless suspension between the train and the track and guidance. And then it uses the electromagnetic force generated by the linear motor to pull the train. Therefore, this book refers to the magnetic suspension rail as the MHSR. MHSR trains and motors work exactly in the same way. The "rotor" of the motor is placed on the train and the "stator" of the motor is laid on the track. Through the interaction between the "rotor" and the "stator", electrical energy is converted into forward kinetic energy. When the "stator" of the motor is energized, the "rotor" can be rotated by the action of the current on the magnetic field. When the power is transmitted to the "stator" of the orbit, the train acts like a "rotor" of the electric motor to do a linear motion by the effect of the current on the magnetic field. Figure 2.8 shows the Japan's MHSR train.

The MHSR train is mainly composed of three parts: the suspension system, the propulsion system and the guiding system. Although it is possible to use a propulsion system that is independent of the magnetic force, in most of the current designs, the functions of these three parts are all done by magnetic force.

(1) The suspension mode of MHSR train. When the magnet passes over a piece of metal, the electrons on the metal begin to move as the magnetic field changes. The electrons form a loop and then produce their own magnetic field. Because the same electric charge mutual repulsion, and opposite electric charge attract, moving the magnet over metal results in a push-up force on the moving magnet. If the magnet moves fast enough, this force will be large enough to overcome the gravity and lift the moving magnet. Among them, the superconducting MHSR

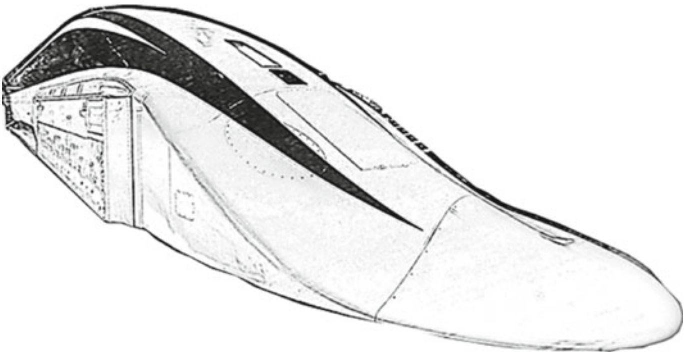


Fig. 2.8 Japan's MHSR train

uses the strong repulsive force between the electromagnetic field formed by the superconducting electromagnets and the electromagnetic field formed by the coil on the rail to levitate the vehicle (Fig. 2.9).

(2) The guiding method of MHSR train. MHSR train uses the action of electromagnetic force to guide. There are a constant-conduction magnetic guiding system and a superconducting magnetic repulsive guiding system.

① The constant-conduction magnetic guiding system is similar to the suspension system. It installs a set of electromagnets on the side of the trains to guide. There is a certain gap between the train body and both sides of the guide rail. When the train is offset to the left or right, the guiding electromagnet on the train interacts with both sides of the guide rail to return the train to its correct position. The control system maintains this lateral clearance by controlling the current in the guiding magnets to achieve the purpose of controlling the direction of train's travel (Fig. 2.10).

② The guiding system of superconducting magnetic repulsion guiding system can be constituted in three ways. (a) The first mode is to install

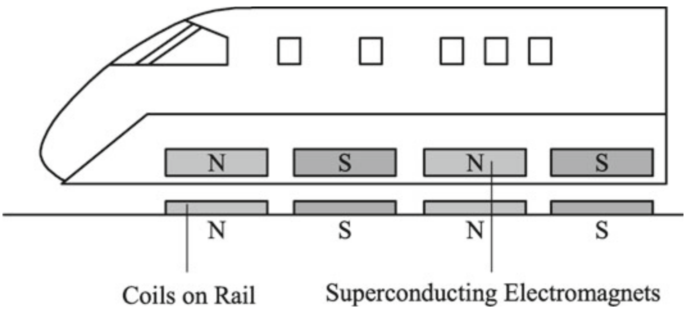


Fig. 2.9 Levitation mode of MHSR

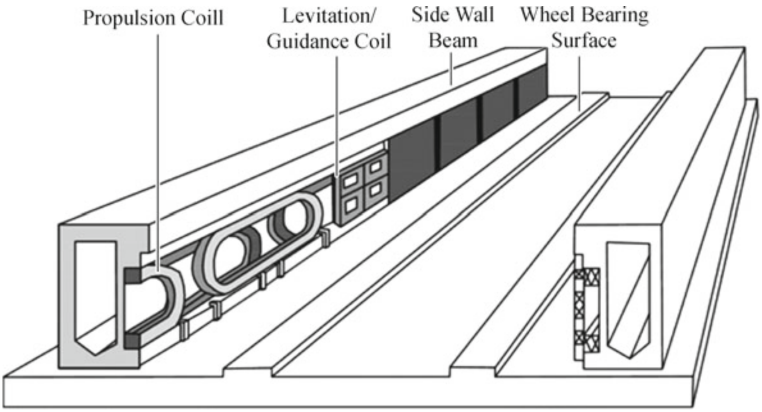


Fig. 2.10 Guiding method of normal conduction magnetic train

a mechanical guide on the train to achieve guidance. This device typically employ a side-guided auxiliary wheel on the train that interacts with the side of the guide rail (rolling friction) to create a restoring force that balances the lateral forces generated by the train as it travels along the curve, thereby making the train to run along the guide rail. (b) The second mode is installing a special guiding superconducting magnet on the train to generate a magnetic repulsion force with the ground coil and the metal belt on the side of the guide rail, and the force is balanced with the lateral force of the train to keep the train in the correct state. This guiding method avoids mechanical friction and allows the train to maintain a certain lateral clearance as long as it controls the current in the lateral ground-guiding coil. (c) The third mode is guided by magnetic force. The “zero magnetic flux” guide is a closed coil with a shape of “8”. When the superconducting magnet set on the train is located on the symmetrical center line of the coil, the magnetic field in the coil is zero. When the train has a lateral displacement, the magnetic field in the “8” shaped coil is zero and then generates a reaction force to balance the lateral force of the train and return the train to the center of the line (Fig. 2.11).

(3) The propulsion mode of MHSR train. The most critical technology of MHSR train propulsion system is to expand the rotating electric machine into a linear motor. Its basic structure and working principle are similar to those of ordinary rotating electric machines. After expanding, its transmission mode changes from rotary motion to linear motion. The linear motor includes the short stator asynchronous linear motor and the long stator synchronous linear motor. The working mode of long stator synchronous linear motor is shown in the Fig. 2.12.

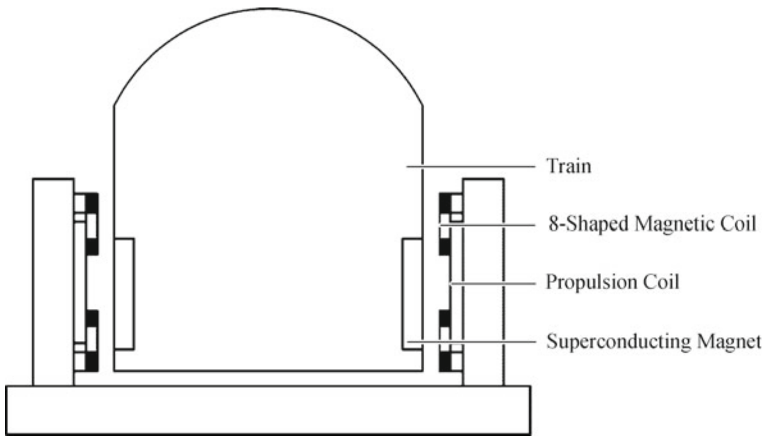


Fig. 2.11 Guiding method of superconducting magnetic train

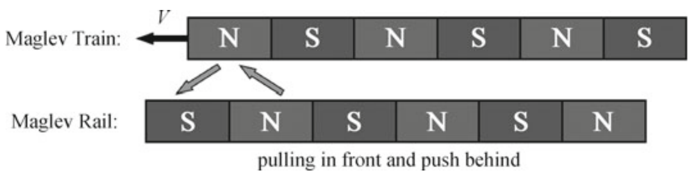


Fig. 2.12 Working mode of long stator synchronous linear motor

2.2.3 The Definition of SSR

Super-speed Rail (SSR) is a kind of transportation designed with the core principle of "vacuum pipeline transportation". It is also called Hyperloop or Pneumatic Tubes. SSR has the characteristics with ultra-speed, high safety, low energy consumption, low noise and low pollution. SSR trains may be a new generation of transportation vehicles after cars, ships, trains and airplanes. In 2013, Elon Musk proposed the "Hyperloop" program. He believes that the SSR can carriage passengers at an ultra-speed of 1200 km/h. Therefore, SSR is regarded as the development direction of future traffic, attracting more and more countries to research and develop. Figure 2.7 shows American SSR–Hyperloop.

The SSR system is to build a pipeline that is isolated from the outside air. After pumping the pipeline into a vacuum, the MHSR train is operated in it (Based on the idea of Musk, the schematic diagram of the SSR is shown in Fig. 2.13). In an environment with little friction, the trains in the low-pressure pipeline can operate at a speed of 1200 km/h. From the characteristics of the existing five modes of transportation (rail, aviation, water transport, roads, pipelines, etc.), the SSR has some characteristics of five kinds of vehicles:

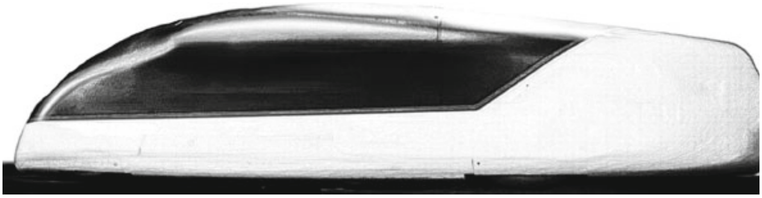


Fig. 2.13 American SSR—Hyperloop

① The first mode of transportation—pipeline transportation. SSR is traveling in pipelines and has the characteristics of pipeline traffic.
② The second mode of transportation—rail transportation. SSR uses magnetic levitation technology and has the features of rail transportation.
③ The third mode of transportation—road transportation. The transportation capacity of SSR is equivalent to the transport capacity of bus (20 to 50 passengers on the public bus) so SSR has the characteristics of road transportation.
④ The fourth mode of transportation—air transportation. SSR operates at a speed similar to that of an airplane so it has the characteristics of air transportation.
⑤ The fifth mode of transportation—water transportation. The SSR train floats in the air so it has the characteristics of water transportation.

Therefore, SSR is a brand new type of transportation that combines the characteristics of five existing modes of transportation. It may also be the sixth type of transportation. Figure 2.14 shows the structure of SSR.

(1) SSR train. SSR is a new type of transportation based on the concept of "vacuum pipe transportation". This kind of vehicle is a new generation after cars, ships, trains and airplanes. It has the characteristics of ultra-speed, high safety, low energy consumption, no noise and zero pollution. Due to the use of vacuum pipeline and magnetic levitation technology, this book suggests to call the vehicle as vacuum train or super-speed train. The simplified diagram of super-speed trains is shown in Fig. 2.15.

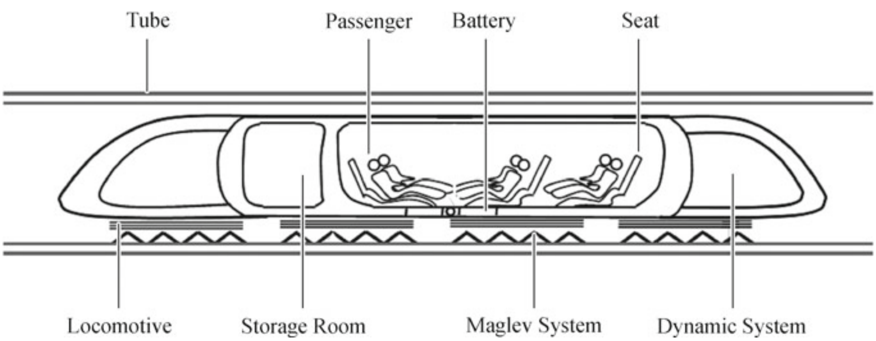


Fig. 2.14 The structure of SSR

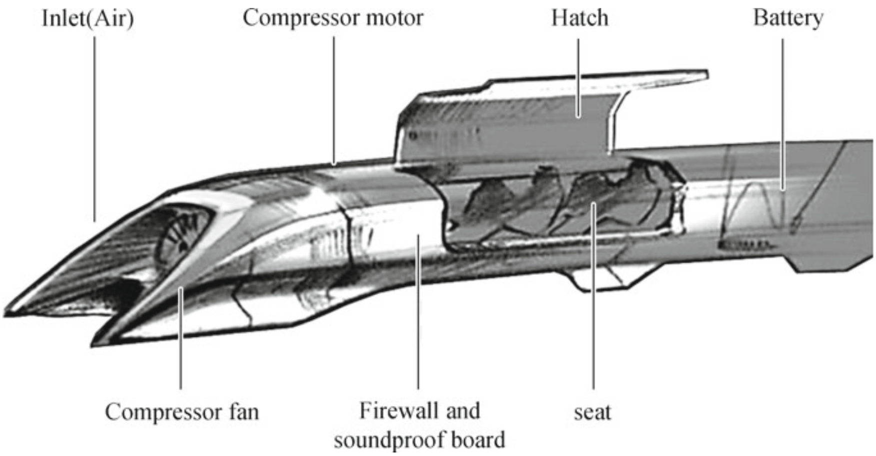


Fig. 2.15 Simplified diagram of SSR train

SSR is also called the vacuum pipeline magnetic train (refer to as the vacuum maglev train). It is a train that has not yet been built and may be the fastest transportation in the world. This kind of trains runs in a vacuum pipeline which is not affected by air resistance, friction and weather. The cost of SSR is lower than that of the traditional rail. The speed can reach 4000–20,000 km/h, which is several times fasten than the speed of aircraft, while the energy consumption is many times lower than that of the aircraft. In the future, SSR may become the fastest means of transportation in the twenty-first century. Figure 2.16 shows the simulation diagram of SSR train.

(2) Vacuum piping. Unlike the traditional rail, the SSR is a new vacuum suspension frictionless flight system. The super-speed rail system is consisted of transport pipelines, manned cabins, vacuum equipment, suspension components, ejection and braking systems as shown in Fig. 2.17.

① The operating characteristics of SSR: running in the pipeline suspended with no resistance and the speed can reach above 1000 km/h.

② Transmission method of SSR: The SSR train floats in the vacuum-treated pipeline because of the magnetic technology and then uses the catapult

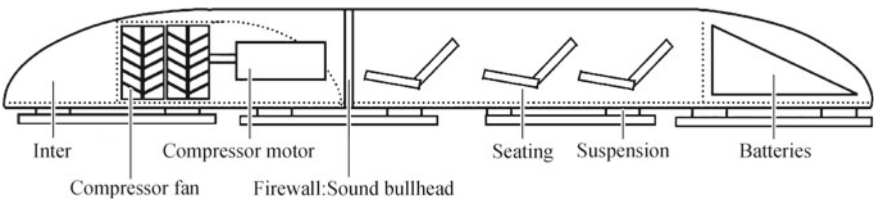


Fig. 2.16 Simulation diagram of SSR train

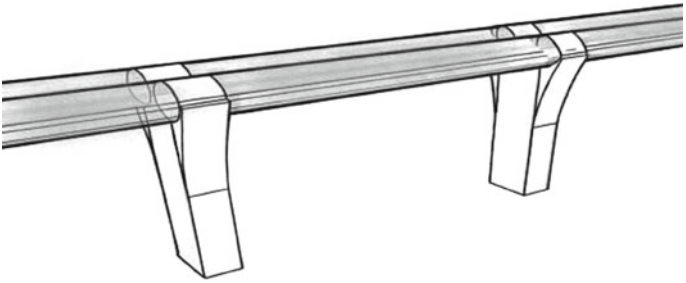


Fig. 2.17 Super pipeline

device to launch the SSR train to the destination without interruption. Figure 2.17 shows the super pipeline.

2.3 Speed Definition of HSR

The operating speed of HSR has practical significance for passengers. Operating speed of HSR includes multiple concepts such as maximum operating speed, average travel speed and the speed of trains in the tunnel, and each concept has practical significance. The highest test speed should be at least 10% higher than the real maximum operating speed to ensure safety. Because of the different operation modes of HSR, the experimental speeds of HSR are also different.

(1) The highest test speed. For any transportation systems, the highest test speed is designed based on special planning and external conditions such as lines, power boosts, special signals and vehicle equipment. The speed is usually achieved under special operation methods and safety precautions.
(2) The highest operating speed. The highest operating speed is designed and operated under everyday conditions. This speed is such that the entire system of HSR–the structure, the vehicle, the control, the support, etc., can operate under everyday conditions and withstand passenger rides and weather changes, and must be handled by specialized personnel.
(3) The highest design speed. This speed is also known as the calculated driving speed. It refers to the maximum driving speed at which the driver of the medium driving technology can maintain the safe and comfortable driving when the climatic conditions are good and the high-speed rail train operation is only affected by the conditions of the track itself (geometric elements, tracks, ancillary facilities, etc.).

The highest test speed is important in the assessment of system characteristics and development potential. However, the maximum operating speed defines the actual, achievable performance of the system. The difference between the highest test speed and maximum operating speed is very large. The highest test speed may be 50%

Table 2.4 Test speed of HSR in some countries

Number	Countries	Time (Date)	Vehicles	Test speed/(km/h)	Remarks
1.	France	03-04-2007	TGV-V150	574.8	WHSR
2.	China	09-01-2011	CRH380BL	487.3	
	China	03-12-2010	CRH380AL	486.1	
	China	28-09-2010	CRH380A	416.6	
3.	Japan	26-07-1996	Type 955	443	
	Japan	04-12-1993	Type 952,Type 953	425	
4.	Germany	01-06-1988	ICE	406	
5.	Japan	21-04-2015	JR Maglev L0 Series	603	MHSR
	Japan	02-12-2003	JR Maglev MLX01	581	
6.	Germany	12-11-2003	TransrapidTR-08	501	

Table 2.5 Maximum operating speed of HSR in some countries

Number	Countries	Time (date)	Vehicles	Maximum operating speed/(km/h)	Remarks
1.	France	03-01-2007	TGV	320	WHSR
2.	China	01-08-2008	CRH	350	
3.	Japan	05-07-1967	Type 955	320	
4.	Germany	03-10-1999	ICE	300	

to 80% higher than the maximum operating speed. The test speed and maximum operating speed of some HSR trains in some countries are shown in Tables 2.4 and 2.5.

The maximum operating speed is the most important measure index of HSR. From the 1960s to the 1970s, the highest test speed increased from 250 km/h to 350 km/h. Germany achieved a major breakthrough in 1988. ICE train's test speed reached up to 406 km/h. Then, France achieved a leap in 1991. TGV train created a record speed of up to 515 km/h in the test. At present, among the hundreds of trains operating in many countries every day, the maximum operating speed is 250–350 km/h. The French TGV has recently created a record of 1000 km operating mileage at an average speed of 317 km/h.

Speed is the most comprehensive and critical indicator of HSR system. It is the main indicator to measure the HSR technical level of a country, because speed often refers to the operating speed under a series of indicators such as safety, reliability, economy, energy conservation and environmental protection. From these aspects, operating speed indicates whether HSR technology is at the world's leading level. The speed types of HSR are shown in Table 2.6.

Table 2.6 Speed types of HSR

Number	Types	Name		Speed/(km/h)
1.	First	Test speed	SSR	200–600
			MHSR	400–100
			SSR	1000–10,000
2.	Second	Design speed	SSR	200–500
			MHSR	500–800
			SSR	800–1200
3.	Third	Operating speed	SSR	200–400
			MHSR	400–800
			SSR	>1000

2.4 Summary

In 1964, the world's first HSR was opened in Japan and the first round of "high-speed rail heat" was launched worldwide. However, due to technical problems, HSR was not vigorously developed and the operating speed was lower than 300 km/h. In 1995, after the French HSR technology became the technical standard for all-European high-speed trains, the second round of "high-speed rail heat" was launched worldwide. Due to the economic downturn at that time, especially limited economic capacity of developing countries, HSR only took place among the developed countries. In 2008, due to China's HSR development, the world's third round of "high-speed rail heat" was launched. Since 2015, with the advanced, mature, economic, applicable and reliable HSR technology, HSR has been built and operated in developing countries. Then the fourth round of "high-speed rail heat" has been set up worldwide. Therefore, with the rapid development of HSR, the world will enter the "era of high-speed rail" in 2020 and the world will become a "global village" under the HSR.