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ЭКОНОМИКА МЕЖДУНАРОДНЫХ ПЕРЕВОЗОК И ЛОГИСТИКИ: ИНТЕЛЛЕКТУАЛЬНЫЕ И ЦИФРОВЫЕ РЕШЕНИЯ И ПРАКТИКА

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High-Speed Railways in the BRICS Countries

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ABSTRACT Today, about 59,000 km of specialised high-speed railway lines are in operation worldwide, about 20,000 km are under construction, and more than 50,000 km are planned to be commissioned. The maximum commercial speed of passenger trains has increased to 350 km/h. The world's first high-speed freight trains have been designed and put into trial operation. Mastering advanced technologies in the field of high-speed railway transport, as before, is an indicator of the country's development level. The construction of high-speed lines (HSL), along with others, solves an important problem on a global scale — it makes a significant contribution to environmental protection.

We used the materials of reports and papers published on foreign information platforms; the results of the research work of Russian scientists and engineers in the field of increasing train speeds.

In the BRICS countries, construction and design work on high-speed railways is underway, but given the unique conditions of each country, the pace of development is different. China is the leader of scientific progress in this sector of the railway industry, which attracts the attention of the world scientific community, including the Russian one.

In Russia, according to the Transport Strategy up to 2030 with a forecast for the period up to 2035, it is envisaged to develop a network of high-speed railway lines with the unification of the largest agglomerations of the European part of the country into zones of two-hour accessibility.

It is necessary to continue study and improve knowledge in the field of high-speed railway transport development.

KEYWORDS: the BRICS countries; Brazil; Russia; India; China; the Republic of South Africa; high-speed railway transport; high-speed railway lines; HSL; high-speed passenger train; high-speed freight train; passenger traffic; and speed

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Научная статья

Высокоскоростные железные дороги в странах БРИКС

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АННОТАЦИЯ Сегодня в мире эксплуатируется около 59 тыс. км специализированных высокоскоростных железнодорожных магистралей, строится около 20 тыс. км, планируется ввести в эксплуатацию более 50 тыс. км. Максимальная коммерческая скорость пассажирских поездов увеличилась до 350 км/ч. Сконструированы и запущены в опытную эксплуатацию первые в мире высокоскоростные грузовые поезда. Освоение передовых технологий в области высокоскоростного железнодорожного транспорта, как и ранее, является показателем уровня развития страны. Строительство высокоскоростных магистралей (ВСМ), наряду с другими, решает важную проблему мирового масштаба — вносит весомый вклад в защиту окружающей среды.

Использовали материалы отчетов и докладов, опубликованных на зарубежных информационных платформах; результаты научно-исследовательской работы российских ученых и инженеров в области повышения скоростей движения поездов.

В странах БРИКС ведутся строительство и работы по проектированию ВСМ, однако с учетом уникальности условий каждой страны темпы развития различны. Китай является лидером научного прогресса в данном секторе железнодорожной отрасли, что приковывает взгляды мировой научной общественности, в том числе российской.

В России, согласно Транспортной стратегии до 2030 года с прогнозом на период до 2035 года, предусмотрено развитие сети ВСМ с объединением крупнейших агломераций европейской части страны в зоны двухчасовой доступности.

Необходимо продолжение исследований и совершенствование знаний в области развития высокоскоростного железнодорожного транспорта.

КЛЮЧЕВЫЕ СЛОВА: страны БРИКС; Бразилия; Россия; Индия; Китай; Южно-Африканская Республика; высокоскоростной железнодорожный транспорт; высокоскоростные железнодорожные магистрали; ВСМ; высокоскоростной пассажирский поезд; высокоскоростной грузовой поезд; пассажиропоток; скорость

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INTRODUCTION

Fifty-nine years have passed since the first high-speed line (HSL) was opened. On October 1, 1964, the 515 km long Tokyo-Osaka High-Speed Line (Japanese: Shinkansen — New Big Road, New Main Line) with a maximum train speed of 210 km/h was commissioned in Japan. There was a paradigm shift in railway transport: the first specialised railway line designed exclusively for mass passenger transportation by trains moving at speeds of over 200 km/h was created. Prior to that, railway lines were multi-purpose and were mainly used for mixed traffic of relatively light passenger trains and freight trains, including heavy trains.

The concept of "high-speed" railway is conventional and historically established, for example, unlike the concept of "supersonic aviation", it is not associated with any physical quantity, as in this case – the speed of sound. At the beginning of the twentieth century, high-speed railway traffic included speeds of the order of 180–190 km/h, which today have increased to 300–350 km/h.

Today, high-speed railway transport continues to develop. Currently, 58,800 kilometres of high-speed railways are in operation, and 20,000 kilometres are under construction (see *Table* below).

In the long term, it is planned to build more than 50,000 kilometres of high-speed lines, increasing the length of the global network to more than 130,000 kilometres. High-speed railways may appear in such countries as Canada, Mexico, Brazil, Chile, Israel, Qatar, Iran, Egypt, the Republic of South Africa, Thailand, Vietnam, Norway, the Czech Republic and Hungary. These data were reported at the 11th World Congress on High-Speed Rail Transport, which was held in March 2023 in Marrakech, Morocco [1–3].

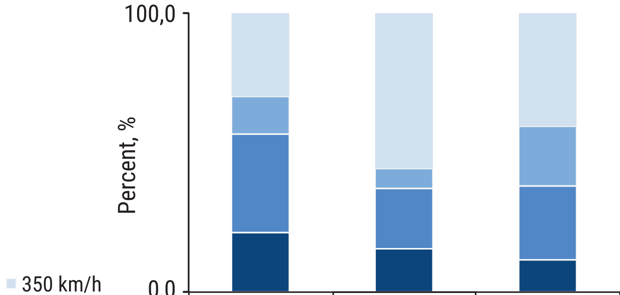
According to the accepted international classification, on high-speed railway lines the speed of passenger trains is more than 250 km/h, with combined freight and passenger traffic — 200 km/h. These are not speed limits in commercial operation. The maximum speed of passenger trains of 350 km/h is realised in the People's Republic of China, the share of such highways is 29.9 % of the total HSL network in the world. There is not a single HSL in the world designed for commercial operation with a speed of more than 350 km/h. As studies have shown, when travelling at speeds over 350 km/h, energy consumption increases dramatically due to the need to overcome the sharply increasing aerodynamic resistance, noise generation from the moving train increases significantly, especially in the zone of interaction between the current collector

Table

Length of HSL in the world in 2022 (in commercial operation and under construction) [1]

Area	Length of the high-speed network, km	
	In commercial operation	Under construction
Europe	11 990	3062
Asia Pacific[1]	44 428	14 416
Middle-East[2]	1501	2006
Africa	186	0
North America	735	274
Total:	58 840	19 758

Note: [1] – Asia Pacific: China, India, Indonesia, Japan, South Korea, Thailand, Vietnam, Australia; [2] – Middle-East: Qatar, Bahrain, Iran, Israel, Saudi Arabia, Turkey.



	In commercial operation	Under construction	Planned
350 km/h	29,9	55,7	40,6
300÷320 km/h	13,5	7,2	21,4
250 km/h	35,3	21,6	26,5
200 km/h	21,3	15,5	11,5

Fig. 1. Share of the world's HSL length depending on the range of maximum speed in commercial operation (for 2022) [2]

and the contact wire, and a number of other negative phenomena occur. The increase in each kilometre of speed in this range results in an increase in operating costs that is disproportionately large compared to the resulting reduction in travel time. In the coming years, the maximum speed in commercial operation will remain around 350 kilometres per hour. The dynamics of indicators of the share of high-speed railways in the world depending on the maximum commercial speed of the lines under construction and planned are shown in *Fig. 1* [2].

According to studies, a speed of about 350 km/h guarantees a safe and comfortable journey, and allows competing with air travel at distances of up to 800 km in cars with seats, and up to 1,500–2,000 km when including sleeping cars in high-speed trains, as the first experience of the People's Republic of China has shown. The implementation of high-speed railway passenger projects with speeds exceeding 350 km/h requires significantly higher costs for the construction and development of rolling stock, and currently there are no offers of a transport service called "high-speed railway traffic with speeds exceeding 350 km/h" on the international market [1–12].

MATERIALS AND METHODS

The materials of reports and papers published on foreign information platforms (websites of the International Union of Railways, foreign scientific journals on the development of the railway industry in the world, and the results of world congresses on high-speed railways) were analysed. The results of the research work of Russian scientists and engineers in the field of increasing train speeds, including the results of the last few years, were used in the study of the topic of high-speed railway traffic development in the Russian Federation. The key objectives of the development of the high-speed railway network in Russia according to the Transport Strategy of the Russian Federation until 2030 with a forecast until 2035 have been reflected.

RESULTS OF THE STUDY

The paper analyses the development of high-speed railway service in the BRICS countries for each country separately (Brazil, Russia, India, China, and the Republic of South Africa)[1].

The People's Republic of China

As of 2022, the world leader in high-speed railway transport is the People's Republic of China. The development of China's national high-speed rail network is the result of research and development work by Chinese scientists and engineers, as well as the adaptation of the best international experience and practices carried out in 1980–1990. In 1985, the Research and Development Centre for High-Speed Railway and Urban Rail Technology was established, and in 1995, China began operating an experimental test bed to simulate travel speeds of up to 400 km/h. By 1997, a programme to increase train speeds on major trunk lines had been developed. In 2004, the State Council of the People's Republic of China approved a plan to build at least 12,000 km of new high-speed railway lines by 2020 (*Fig. 2, 3*) [5–9].

Significant state funding was provided for research projects to create high-speed rolling stock (from 1994 to 2004, China developed more than 20 types of high-speed trains [9]), foreign experience was studied and technologies were introduced (cooperation with such major engineering companies as Alstom, Bombardier, Siemens, etc.). The training of personnel with the necessary competences made it possible to set up the production of its own high-speed rolling stock [1].

The PRC has the highest rates of HSL construction (*Fig. 4*). In 2014, a record length of 5,900 kilometres of high-speed rail was commissioned). *Fig. 5* shows the length of the high-speed rail network in China de-

[1] The material was prepared prior to the XV BRICS Summit held on August 22–24, 2023 in Johannesburg (South Africa), where it was decided that six countries — Argentina, Egypt, Ethiopia, Egypt, Iran, Saudi Arabia, UAE and Saudi Arabia — would join BRICS in 2024.

Fig. 2. The world's first Chinese high-speed freight train with a design speed of 380 km/h, based on the latest generation of Fuxing high-speed passenger trains, is seen during a presentation at the Tangshan factory of CRRC Tangshan Co, Ltd. in Tangshan, Hebei province, on December 23, 2020 (Railway Transport. 2021. No. 11. P. 69)

pending on the realised maximum speed in commercial operation of passenger traffic: 200–300 km/h and 350 km/h, respectively. During the COVID-19 pandemic period 2020–2021, the construction rate remained high, at 2,200–2,500 kilometres per year. In 2022, 4,000 kilometres of high-speed railways were commissioned (the share of high-speed railways with a maximum commercial speed of 350 km/h was 75 % of the total high-speed rail network in China). By the end of 2023, 3,600 kilometres of highways are expected to be put into operation, of which 81.2 % are for speeds of 350 km/h [1–3].

The development of high-speed railway traffic in the People's Republic of China today is marked by unprecedented success, with 40,500 kilometres of high-speed lines commissioned over 29 years (69 % of the total HSL network in the world). High-speed railway routes are designed in difficult engineering conditions.

Chinese railway workers have critically reflected on what happened, learnt lessons and overcome the consequences of a severe — the world's first high-speed railway accident, which occurred on July 23, 2011[2]. Following these events, a decision was made to tighten the requirements for controlling design decisions and the quality of construction of new lines, and for additional safety, the maximum permissible speed on all HSLs was lowered by 50 km/h. These speed limits started to be selectively lifted in 2017.

The country has established its own production of high-speed rolling stock for both passenger and

a

b

c

Fig. 3. Chinese high-speed electric train for different track gauges with a design speed of 380 km/h during a presentation in Changchun, Jilin province, October 21, 2020: a — exterior view of the train standing on the gauge changeover device (URL: https://www.crrcgc.cc/g7992.aspx); b — operator's cab (URL: http://www.xinhuanet.com/english/2020-10/29/c_139476182.htm); c — business class car interior (URL: http://www.xinhuanet.com/english/2020-10/29/c_139476182.htm)

[2] On July 23, 2011, near Wenzhou, due to the failure of signalling devices and erroneous actions of personnel, one train was overtaken by another; as a result of the collision at a speed of about 200 km/h, 33 people were killed and more than 190 were injured.

Fig. 4. High-speed railway network of the PRC [2]

freight transport. In 2020, CRRC Tangshan created the world's first freight train capable of reaching speeds of 350 km/h with cars equipped with equipment for fast loading and unloading of special containers and delivery of goods with a total weight of 110 tonnes of cargo over distances of 600 to 1,500 km [13, 14].

The technologies of automated laying and welding of rail tracks are used in the construction of high-speed railways (the productivity of one machine is 2 km of track per day, 24 hours a day, 7 days a week). Recently, the process of introducing robotic machines with control systems (artificial intelligence) for the installation of the contact network (from the transport of materials and components, to the installation of supports and installation of contact suspension with spatial position accuracy of 1 mm) has been launched. The complex allows to perform work continuously even in unfavourable weather conditions [15].

First of all, the state is interested in high-speed railway projects, but the results of their implementation have a favourable impact on millions of residents of the Celestial Empire. There is continuous support, including financial support, throughout the entire life cycle — from the scientific concept to commissioning and maintenance. According to the approved short-term and long-term programmes for the development of high-speed railways in China, 13,000 kilometres of highways are currently under construction, and it is planned to build about 11,000 kilometres more [1].

For the first time in China, trains with sleeper cars have been put into operation on high-speed highways, which significantly expands the range of comfortable transportations on high-speed lines. All this explains the great interest of the international scientific community in projects to develop high-speed railway lines in the People's Republic of China.

India

India today has one of the fastest growing economies in the world. According to experts [16], this is largely due to the high growth of agriculture and industry, in particular, such an important sector as pharmaceuticals. There is also a number of serious problems for the country: the shortage of energy resources, poverty of a significant part of the population and overpopulation.

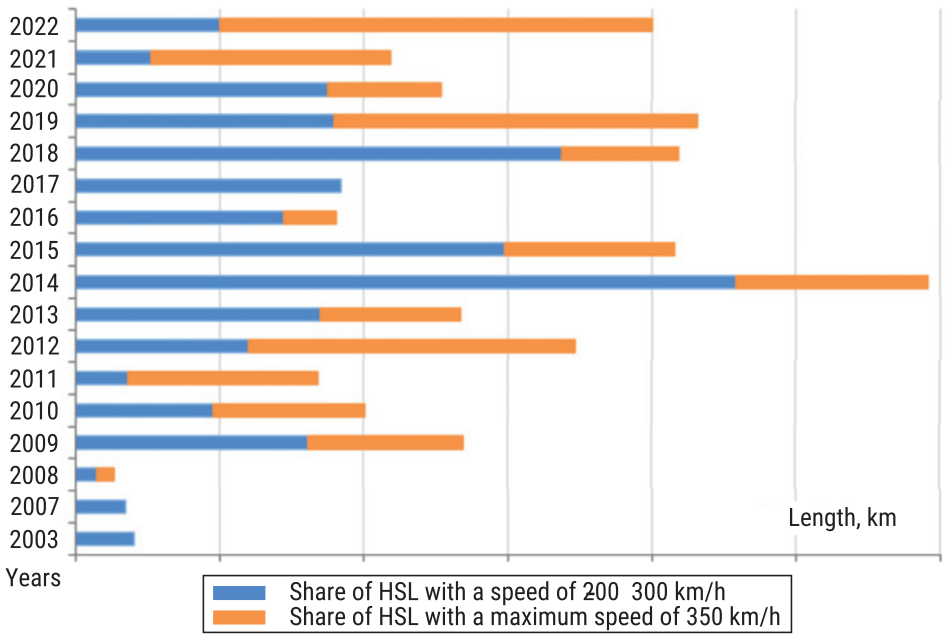


Fig. 5. Time progress of HSL construction in the PRC [2]

Fig. 6. High-speed rail network in India (under construction and long-term planning) [2]

Railway transport in India has the fourth longest network in the world and is a popular means of transport for both passengers and freight. The railway industry (Indian Railways (IR) is the largest employer in the country, the fourth largest rail freight carrier in the world, and the world's longest green network (the share of electrified sections was 77 % in 2022, with plans to convert all passenger transport to electric traction by 2025–2026) [17].

In 2017, jointly with Japan, the implementation of the project for the construction of an HSL along the Arabian Sea Mumbai-Ahmedabad with a length of 508 kilometres and a set maximum speed of 320 km/h was launched. The travelling time in this direction will be reduced from 6 h 45 min to 2 h (*Fig. 6*).

For the new high-speed railway, it is planned to supply rolling stock manufactured by Hitachi and Kawasaki, used on the Shinkansen lines in Japan [18]. The Mumbai-Ahmedabad railway has a standard European gauge of 1435 mm. In India, the railways have four types of incompatible gauges (1676, 1000, 762 and 610 mm). Over the last two decades, Indian railways have made significant progress in the Unigauge programme to convert the railway network to a single 1667 mm gauge over the last two decades. In 2022, the Indian railway network had 65,094 kilometres or 95.7 per cent of its total length on 1667 mm broad gauge. This has paved the way for the creation of a modern unified railway transport system and its optimal interaction with other modes of transport.

The route of India's first HSL includes 318 km of embankment track, 162 km of bridge crossings (one of which is 18 km long), 11 tunnels with a total length of 27 km, including an underwater seven-kilometre tunnel under the Gulf of Thana Creek (a bay on the coastline of the Arabian Sea, which isolates the city of Mumbai from the mainland of India) [19].

At present, the pace of construction of the Mumbai-Ahmedabad section of the Mumbai-Ahmedabad HSL has slowed down for a number of reasons (COVID-19 pandemic, problems with land acquisition in the area of the HSL route, etc.), and the date of commissioning has been postponed from the previously scheduled 2023. [20].

Having studied the foreign experience of HSL operation, India has taken a course for the development of relatively short routes. For example, the long-term perspective includes a network of high-speed railways with a total length of 7,500 kilometres with sections from 190 to 850 kilometres, covering the entire territory of the country (*Fig. 6*) [2]. Chinese experience has shown that on long lines, such as Wuhan–Guangzhou (1,079 km, maximum commercial speed 350 km/h), Beijing–Shanghai (1,318 km, 350 km/h), Lanzhou–Urumqi (1,785 km, 250 km/h), a smaller percentage of passengers travel between the end points (despite the impressive population and stable passenger traffic) compared to those travelling shorter distances on the same high-speed train, i.e. between intermediate points. i.e. between intermediate points [18].

The Government of India is continuing its drive to grow the economy, which is increasing demand for transport services. India is a participant in the UN-coordinated programme to reduce greenhouse emissions. It is important to redistribute passengers and freight in favour of environmentally friendly modes of transport, one of them being railways. Due to the growing freight traffic, there is an urgent need to increase the capacity of railways. This is not the case in the passenger sector, where there is a tendency for rail passenger traffic to decline due to the strongest competition of low-cost airlines and bus companies depending on the distance travelled [21].

There are good prerequisites for the design of the HSL network in India (promising passenger traffic, high population density in the area of gravitation to the HSL, with the distance between major cities up to 1,000 km — great competition of aviation and road transport, high percentage of employment in the railway industry, prospects of growing volumes of freight traffic on railway transport, etc.). However, the financial component raises doubts among experts [16, 21] regarding the priority programmes approved by the management for the implementation of the project for the construction of the high-speed rail network in the country. This is largely attributed to the unstable financial situation of IR and growing debt obligations to the corporation. Currently, the high-speed railway project is planned to be put into operation in 2026 [22].

Brazil

Brazil is a developing country. It has a strong industrial and agricultural potential and unique natural opportunities. At the same time, Brazil has underdeveloped health care and education, as well as a high poverty rate.

Most of the transport network is made up of road transport — the result of the decision of the governmental structures made in the 1950s, as it is now considered a mistake, to reduce the railway network and accelerate the development of road connections following the example of the USA. Over half a century, according to different sources, between 8,000 and 10,000 km of railways were closed in Brazil. Road transport accounts for 60 per cent of the total volume of goods transported and 90 per cent of passengers. Railway service is underdeveloped; despite the large territory, 30,000 km of tracks are in operation, of which only 6% are electrified. The tracks have four types of gauges, 79 % of which are of metre gauge (1000 mm). Rail transport is operated by private companies.

Most of the previously operating passenger railway lines are now closed. This affects the shortage of passenger trains in some of Brazil's densely populated coastal areas, such as the Rio de Janeiro-São Paulo agglomeration.

In 2008, the country's leadership announced a high-speed rail project along the Rio de Janeiro-São Paulo-Campinas route. The high-speed railway line was planned to be commissioned by the FIFA World Cup in Brazil in 2014, and later by the 2016 Summer Olympics. However, due to a number of reasons, construction did not start [23].

The revival of the BRT project in Brazil is currently under discussion. Negotiations are underway to build a 378 km long Rio de Janeiro-São Paulo section with two intermediate stops, a maximum train speed of 300 km/h and a reduction in journey time to 1.5 hours. It is planned to start construction in 2025–2026 and to put it into operation in 2032. The route of the future HSL runs in difficult topographical conditions and will include a large number of bridge crossings, viaducts and long tunnels, which increases the cost of the project. Large cities with millions of people are located in the zone of gravitation of the HSL, between which there are no railway lines, air and bus connections are organised. The preliminary forecast of passenger traffic attributable to the new HSL is 40 million people per year [24].

According to the data published at the World Congress on High-Speed Rail Transport 2023 in Morocco

Fig. 7. HSL network in Brazil (in long-term planning stage) [2]

[1], the future high-speed rail network with a total length of 511 kilometres includes the Rio de Janeiro-São Paulo section with its extension to Campinas (*Fig. 7*) [2].

The Republic of South Africa

The Republic of South Africa is one of the most developed countries in Africa. The country is rich in minerals, especially diamonds, gold, platinum, copper and coal. Another lucrative component of the South African economy is tourism. The transport industry includes air, rail, road and sea modes of transport. Passenger traffic between major cities is mainly redistributed between aviation and railway modes of transport, bus service on the same directions is available, but it is poorly developed.

Suburban railway service is considered to be the most affordable for passengers in terms of fares. By 2025. The South African Department of Transport plans to increase the capacity of the railway passenger sector (modernisation of tracks and stations, renewal of the rolling stock fleet) on 10 priority routes, 5 of which are operational and the main ones in the Mabopane–Pretoria–Johannesburg–Naledi corridor. On the railway lines today there is rolling stock, created jointly with Alstom, designed for a maximum speed of 120 km/h [25].

The South African government first mentioned high-speed railway projects back in 2010. Together with the Chinese Railway Corporation, it was planned to build the Johannesburg-Durban High-Speed Railway and reduce the journey time from 12 hours to three. The route was to run through the mountain ranges of the Drakensberg Park, a UNESCO World Heritage Site, which complicated the approval and design process. Due to the high cost and a number of other reasons, the project was not realised [26].

According to [1–3], the following HSL routes are included in the long-term perspective: Durban–Jo-

Fig. 8. HSL network in South Africa (in the long-term planning stage) [2]

hannesburg (610 km, 300 km/h), Johannesburg–Musina (480 km, 300 km/h), Johannesburg–Cape Town (1,300 km, 300 km/h) (*Fig. 8*).

The Russian Federation

According to the accepted international classification [1], there is no high-speed railway service in Russia today. The highest speed of passenger trains is realised on the Moscow–St. Petersburg route (trains "Sapsan" by Siemens, speed up to 250 km/h, journey time 3 h 45 min, "Nevsky Express" up to 200 km/h, journey time 4 h 10 min). Alstom's Allegro high-speed trains, which had been running at speeds of up to 220 km/h on the St. Petersburg-Helsinki line since 2010, will be discontinued in March 2022 due to the sanctions imposed on Russia.

Ideas of the need to increase train speeds in Russia were expressed at the beginning of the last century. The first scientific projects in the USSR were implemented in the 70s — "Moscow–South", "Uskorenie" (Acceleration), "Progress", "Skorost" (Speed). In 1988 the state scientific and technical programme "High-speed environmentally friendly transport" was approved, which envisaged the creation of highways with speeds of 300–350 km/h. It was planned to create a high-speed corridor Centre-South, as well as to build a trans-European network of high-speed lines Moscow–Minsk–Brest and Moscow–Minsk–Warsaw–Berlin. In the 1990–2000s, Russia developed a feasibility study for the Moscow–St. Petersburg High-Speed Railway, and a domestic high-speed train "Sokol" was being developed. Unfortunately, the projects were never continued [4, 10].

In the early 2000s, Russia underwent a number of reforms, including in the structures of the railway industry. The management of the transport process and all economic activities became the responsibility of the newly established in 2003 company "Russian Railways", JSC. The Ministry of Railways was abolished and the main management functions were transferred to the Russian Ministry of Transport, the Federal Service for Transport Supervision and the Federal Railway Transport Agency. In 2006, Russian Railways jointly with Siemens AG signed a contract for the supply of Sapsan trains. Since December 2009, high-speed trains have been running on the modernised tracks of the main line of the Oktyabrskaya Railway. The Sapsan passenger traffic began to grow rapidly, creating strong competition to air transport in this direction [10, 11, 27–30]. At the same time, the construction of a dedicated Moscow–St. Petersburg HSL remained among the discussed and promising tasks until 2013 [31, 32].

In May 2013, the President of the Russian Federation V.V. Putin announced the beginning of the design of the Moscow–Kazan HSL with further extension to Yekaterinburg with the delivery date in 2018. The Moscow–St. Petersburg HSL project was postponed [33]. It was supposed to operate along the dedicated high-speed railway Moscow–Kazan both passenger trains with a speed of up to 350 km/h and special cargo container trains with a speed of 160–250 km/h.

A team of scientists from the Emperor Alexander I St. Petersburg State Transport University together with specialists from a number of research and design organisations developed Special Technical Specifications (STS) for the design and construction of the Moscow–Kazan–Ekaterinburg high-speed railway line[3]. In accordance with the technical specifications, the parameters, characteristics and loads for the projected HSL are presented in complex combinations that have no analogues in the world. A total of 15 technical specifications were developed and approved by the Ministry of Construction, Housing and Utilities. They became the basis for the design of the High-Speed Railway.

In April 2019, Glavgosekspertiza approved several stages of construction [34], but a few days later, the media reported that "Vladimir Putin approved the HSL between Moscow and Saint Petersburg" [35]. A few months later, the Ministry of Finance of the Russian Federation blocked the financing of the Moscow–Kazan HSL project [36].

[3] Special technical specifications. Design of the Moscow– Kazan section of the Moscow–Kazan–Ekaterinburg high-speed railway line with traffic speeds of up to 400 km/h. St. Petersburg: Emperor Alexander I St. Petersburg State Transport University, 2017. 70 p.

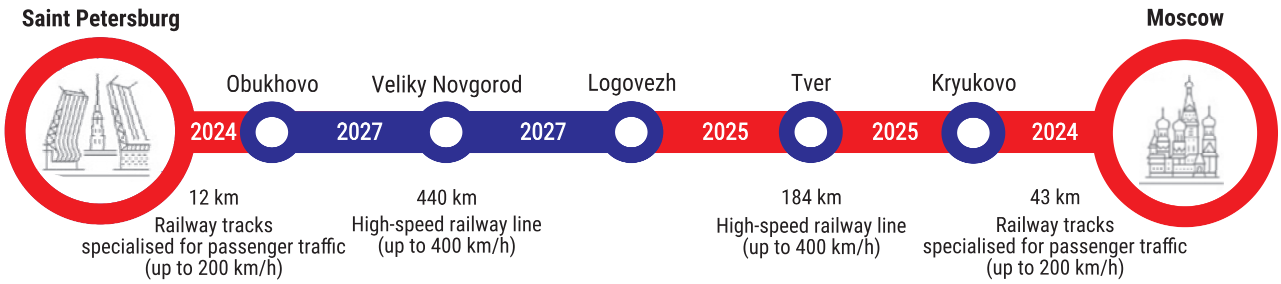


Fig. 9. Moscow–Saint Petersburg Hogh-speed Railway [37]

Today, according to the Transport Strategy of the Russian Federation until 2030, the task of creating high-speed railway traffic in the country remains relevant[4]. In the scheme of territorial planning of the Russian Federation, the Moscow–St. Petersburg High-Speed Railway is again named as a priority with commissioning in 2028. Engineering surveys are being carried out, as noted earlier, STSs have been developed[5] for the design and construction of the HSL [37].

On August 17, 2023 at the official opening of the Leningrad-Kazansky MCD-3 "Leningrad-Kazansky" [38] Russian President V.V. Putin noted that the country has approached the possibility of implementing the first project of the high-speed railway Moscow–Saint Petersburg, while the released transport capacity of the existing railway between the two capitals is necessary to ensure high-speed freight traffic, which is an important part of the development of the transport network of the European part of Russia[6].

O.V. Belozerov, General Director and Chairman of the Management Board of "Russian Railways", JSC, said at the same event: *"In the North-West, we currently transport 145 million tonnes, which is more than we can carry... In the transport strategy approved by 2030, the figure is 220 million tonnes, which means that today's figure needs to be almost doubled. The optimum is the construction of the High-Speed Railway, which will provide an opportunity for development, including for shippers from the Urals and Siberia — those who "go" to the ports of the North-West"*[7].

"As for the movement of passengers, emphasised V.V. Putin, of course, the speed of traffic will increase significantly and the journey time for passengers will decrease from today's 4 hours and 5 minutes to 2 hours and 15 minutes between Saint Petersburg and Moscow. Between Tver and Moscow it will already be 39 minutes, and between Veliky Novgorod and St. Petersburg it will be 29 minutes instead of today's 3 hours 10 minutes. Then, of course, we should also move to Nizhny (Novgorod), to Voronezh, from Nizhny to Kazan, from Kazan to the Ural regions. This will significantly not only reduce the travel time of people, but will also improve the connectivity of the country, as well as push the development of such areas as education and science"[8].

Various sources are involved in financing the project: both state and non-budgetary sources, in particular, Sinara Group, JSC and Sberbank, PJSC.

The 679-km route is to link six constituent entities of the Russian Federation, which is home to about 30 million people. The non-stop travelling time between the federal cities of Saint Petersburg and Moscow will be 2 h 15 min (*Fig. 9*) [37].

Work is underway to design a Russian high-speed train with a maximum operating speed of 360 km/h under an agreement between Russian Railways, Sinara Group, Ural Locomotives and Siemens Mobility[9, 10].

[4] Transport Strategy of the Russian Federation until 2030 with a forecast for the period until 2035 (approved by the Order of the Government of the Russian Federation dated 27.11.2021 No. 3363-r).
[5] STSs for design, construction and operation of the Moscow-Saint Petersburg High-Speed Railway (VSZhM:1). Saint Petersburg: FSBEU VO PSUPS, 2021;284.
[6] Putin spoke about the advantages of a high-speed railway from Moscow to St. Petersburg. *RIA Novosti*, August 17, 2023. URL: https://ria.ru/20230817/doroga-1890638909.html
[7] Putin said that the Moscow-Saint Petersburg High-Speed Railway project has come close to being realised. *Interfax*. URL: https://www.interfax.ru/russia/916715
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CONCLUSION

According to UIC data [1–3], about 59,000 kilometres of high-speed railways are in operation in the world. About 20,000 kilometres are under construction, and another 53,000 kilometres are planned to be put into operation. The maximum commercial speed of passenger trains has increased significantly over the last ten years. The world's first high-speed freight trains have been designed and put into trial operation. This is especially relevant today, after the crisis covid period of 2020–2021, when the passenger transport sector was practically paralysed with simultaneous unprecedented growth of freight traffic in the world [27, 39]. Today, the mastery of advanced technologies in the development of high-speed railway transport, as before, is an indicator of the country's prestige. High-speed railways provide passengers with a fast, safe and comfortable journey. The construction of high-speed railways, among other things, solves an important problem on a global scale — a significant contribution to environmental protection.

As part of the analysis, we note that the BRICS countries are building and designing high-speed railway routes, but the pace of development is different given the unique conditions of each country. The world community and scientists, including Russian scientists, are now actively studying the experience of the implementation of high-speed railway projects in China, a country that is the leader in scientific and technological progress in this sector of the railway industry.

In Russia, according to the Transport Strategy, increasing the speed of both passenger and freight trains is one of the priority areas of research. Domestic scientific experience in the railway industry is the richest in the world; the first state programmes to organise high-speed railway traffic were approved in the country half a century ago. Domestic studies and foreign experience of high-speed railway operation [4–11, 27–32] prove the fact that Russia has a unique route for the creation of a dedicated high-speed railway. This is the Moscow–Saint Petersburg line, which is currently approved as a pilot project. The successful implementation of the Moscow–Saint Petersburg HSL project can play a key role in increasing the scientific and technical potential in the sphere of the transport system of Russia and international transport corridors, including those between the BRICS countries.

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