



## RESEARCH OF HIGH-SPEED MODES OF HIGH-SPEED ELECTRIC ROLLING STOCK

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### ABSTRACT

*The article shows the foreign experience of creating the electric traction rolling stock with asynchronous traction motors and offers the ways to improve their operational reliability.*

For high-speed rolling stock, the air resistance is of primary importance. Research shows that it has two main components: proportional to the velocity head of the air, so to the speed squared, and proportional to the friction of the train surfaces against the air, so, to the speed value in the first degree. The first component is determined by the shape of the head part of the first car (locomotive), and the second by the total surface area of the train, the smoothness of the car shell, the number and design of inter-car connections and transitions.

Thus, high-speed rolling stock must have engines that not only ensure starting from the ground and moving on the calculated elevation, but also overcome the ever-increasing resistance from friction against the air with increasing speed. This

requires somewhat lower specific energy costs than in competing modes of transport, but due to the considerable length of the trains, the absolute value of the required power is very high. In this regard, the problem of choosing the best type of engine and sufficient power has always confronted the creators of rolling stock.

At a certain stage, the dominant point of view, according to which it was sought to make the engine as powerful as possible, later the main attention of developers was aimed at creating economical designs. Tasks of increasing reliability, simplification of engine maintenance, decrease of damage to the environment appeared. These tasks could be solved at the new stage of technical development when commutator less three-phase traction motors were created, including synchronous traction motors with



permanent magnet excitation. New motors combine high specific power with sufficient reliability. However, to regulate the speed of their armatures (rotors), effective converter technology and complex control circuits were required, which were implemented in practice only in the last decades of the XX century. In these years, new generations of power semiconductor devices and microprocessor control systems were developed and mastered in mass

production, new magnetic materials were created. The main characteristics of high-speed rolling stock are its design speed and the sum of life cycle costs, which ultimately determine the competitiveness of high-speed railways in relation to aviation and automobile transport. Over the years, the design speed of high-speed trains (see Table 1) has increased from 230 km/h (1964) to 380 km/h (2010) [2,3].

**Design speed of some serial high-speed electric rolling stock .**

Table 1.

<b>Year of production</b>	<b>Country</b>	<b>Name of train</b>	<b>Structural speed</b>
1964	Japan	Series 0 (zero)	230 km/h
1978	France	TGVPSE	270 km/h
1984	Japan	Series 100	270 km/h
1989	France	TGVA	300 km/h
1989	Japan	Series 300	285 km/h
1990	Germany	ICE1	280 km/h
1995	Japan	Series 500	320 km/h
1997	Japan	Series 700	285 km/h
1998	Germany	ICE3	330 km/h
2000	Germany	1CE3 for Spain (Velaro E)	350 km/h
2009	France	AGV	360 km/h
2009	Germany	ICE3 for Russia (Velaro Rus, "Sapsan")	250 km/h
2010	KNR <i>Produced by China South Locomotive &amp; Rolling Stock Corporation Limited</i>	<i>CRH «Harmony»380» CRH380A: 8 railcars (6M2T) CRH380AL: 16 railcars (14M2T)</i>	380 km/h (track width 1435 mm)



2010	Japan	Series E5	350 km/h
On October 8, 2011, Afrosiyob started to perform commercial flights "Tashkent-Samarkand"	Uzbekistan <i>Produced by</i> "Patentes Talgo S.L. (Spain)	«Afrosiyob»	250 km/h

*Technical characteristics (according to CSR), there are ten main innovations introduced in the CRH380A high-speed electric train (PRC) [3]:*

- 1) low aerodynamic drag (the nose of the train has an aerodynamic drag coefficient  $<0.13$ , aerodynamic drag is reduced by 6.1%, aerodynamic noise is reduced by 7%, aerodynamic lift forces are reduced by 51.7%, transverse forces are reduced by 6.1%);

- 2) reduced vibration (the CRH380A body is made of light aluminum alloys, the weight of the car is no more than 9 tons, the design of the body has been comprehensively optimized, with the application of a significant number of new structural and vibration-absorbing materials, optimized bogies, optimized interior structure to improve the car performance in the natural vibration

frequency. What in total reduced the body vibrations and increased the comfort);

- 3) sealed housing (the rate of pressure change inside the housing is less than 200 Pa/s, with a maximum pressure change inside the housing up to 800 Pa, compared to the standard value of 1000 Pa. This means a comfortable ride at high speed);

- 4) Safe and reliable high-speed bogies SWMB-400/SWTB-400 (the design is based on the SWMB-350/SWTB-350 bogies of the CRH2C train, the critical speed is 550 km/h. The derail coefficient of the new trains is 0.34 at 386.3 km/h versus 0.73 for CRH2A trains);-

5) an advanced noise control system, reduction of noise sources and the use of new sound-absorbing materials ensures a noise level in the cabin of 67 - 69 DB at a speed of 350 km/h, which is comparable to CRH2A at 250 km/h.

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