

China's Magnificent High-Speed Rail System

by Michael Billington

March 19—That China has the most advanced and most extensive high-speed rail system in the world is well known. The Chinese system originally gained support and technology from Germany's Siemens, France's Alstom, Canada's Bombardier, and Japan's Kawasaki, but is now producing its own train sets of the highest quality. What is less well known are the numerous ingenious systems China has developed *de novo* in order to become the world leader in rail technology, and by far the largest and fastest producer of high-speed rail in the world. This includes production technologies, testing technologies, construction techniques, machinery, and more.

It is difficult to overstate the amazing scope of the system. As of early 2018, China has constructed 22,000 km of domestic high-speed rail track, which is nearly double the total for the rest of the world combined. Not a single kilometer of rail in the United States would be counted as "high-speed" by China's standard—minimally 250 km/hr. (The Acela Express on the U.S. Northeast Corridor has a maximum speed, seldom attained, of just under 250 km/hr.) New high-speed rail is coming on line in China at the rate of 2,000 km/yr.

The fastest passenger train in the world, which also



A high-speed train in Guangxi Zhuang Autonomous Region of China.

carries the most passengers per year, is the Beijing to Shanghai line. At 350 km/hr, it carries about 6 million passengers per year. The longest high-speed line in the world, to be completed in 2018, will run 2,230 km from Beijing to Guangzhou and Hong Kong.

The Beijing-Shanghai line was restricted to 300 km/hr after a major high-speed rail accident in 2011 in Wenzhou, Zhejiang Province, which killed 40 people and forced a re-evaluation and upgrading of the entire national system. In June 2017 the train sets running on the Beijing-Shanghai line were replaced by a higher standard system, fully designed and produced within China, called Fuxing (Rejuvenation), replacing the

Hexie (Harmony) trains which were commissioned in 2008. In early 2018, the speed limit for this line was raised back to 350 km/hr, and could eventually be raised to 400 km/hr, making the 1,318 km trip in just over three hours.

As recently as the 1990s, the average speed of China’s trains was less than 60 km/hr.

A high-speed line from Lanzhou in Gansu Province to Urumqi in the far western Xinjiang Uygur Autonomous Region was opened in 2014, reducing the travel time from 21 hours to 8. Together with the New Silk Road Economic Belt, connecting China through Central Asia to Europe and Southwest Asia, this modern fast rail system has facilitated the development of the vast, under-populated far west regions of China, just as the opening of the first rail connection to Lhasa in 2006 facilitated the economic development of Tibet.

The line to Urumqi passes through multiple extremes of weather conditions, from broiling desert to snow-capped mountains—an 80 degree Centigrade



High-speed train in an urban setting in China.

courtesy of China Railway

temperature differential, which required the development of new materials and machinery. It also passes through the “hundred-li wind zone” in Shanshan, part of the Taklamakan Desert in Xinjiang, where desert winds blow almost every day of the year. They even knocked over a train in 2007. A 462 km wind-protection barrier was constructed next to the tracks of the high-speed line as it passes through the Gobi and Taklamakan desert regions.

The high-speed routes are only one-sixth of the total rail track in the country, but already they carry 60% of the passengers. The original plan, called 4+4 for four north-south routes and four east-west routes, is essentially complete as of the beginning of 2018. Now in the planning stages is an 8+8 system.

Financing the System

Only a few of the high-speed routes are currently profitable. Although over time that will change, it is not the top priority. Keeping prices reasonable to facilitate travel for all, to “serve the people,” is far more important to the government. During the Spring Festival, the 40-day period in which millions of Chinese return to their home towns, 385 million people were traveling in China, many on the high-speed rail lines.



cc/Howchou



Machine in China enabling rapid placement of elevated trestles.

But it is also true that this system creates a dramatic boost in the productivity of the Chinese workforce due to enhanced mobility, which more than makes up for the lack of short-term profits for the fully government-owned system.

The famous magnetic levitation system which now connects Shanghai to its airport in Pudong using a German design—the only commercially active maglev in the world—has not been dramatically expanded for intercity travel as was once considered, but maglev is now being deployed for lower-speed intra-city transit, using a system entirely developed within China.

Innovation in Every Aspect

A 50-minute documentary produced in October 2006 by China's CCTV [on the high-speed rail system](#) provides a fascinating look at the many levels of innovation that are the basis of China's world leadership in high-speed rail.

In order to pass over many rivers and canals, and through many cities, especially on the densely populated eastern coast rail routes, it rapidly became apparent that, in many cases, nearly the entire route would need to be constructed on viaducts rather than on the ground. An ingenious machine was designed to place each bridge span into

place on the pillars for these viaducts, vastly reducing the time for construction. See it at work in the above link to the full video, or watch this [five minute excerpt](#).

The Beijing-Shanghai line includes the longest bridge in the world, the Danyang-Kunshan Grand Bridge, passing over land and water. It is a 164.8 km viaduct constructed with the machine described above, including a 9 km section across Yangcheng Lake in the beautiful city of Suzhou in Jiangsu Province.

The required smoothness of the rails for high-speed rail is far greater than for regular trains, as the speed intensifies the impact of any imperfection. To make virtually seamless rail, 12 welding facilities were constructed across China, which bring in 100-meter-long rail sections (eight times longer than traditional rails), welding five of them together by robotic welders to near-perfect smoothness. The 500-meter rails are then lifted by 36 synchronized cranes onto special trains and delivered to the construction sites for the final welding.



Danyang-Kunshan Grand Bridge in China.

Youtube



Xinhua

High-speed train in China.

Testing facilities for various aspects of the high-speed trains also required innovation. In addition to wind tunnels to test for aerodynamics, a system for testing the wheel and rail quality was constructed using a 10-ton, three-meter diameter steel flywheel to test the wear on wheels and rail at 500 km/hr. The CCTV video describes the facility as the “most advanced testing equipment for high-speed trains in the world.”

At another site, another large steel flywheel was constructed to test different qualities of metals to be used for the pantographs—the jointed framework above the train which conveys the electric current from overhead wires at speeds up to 500 km/hr.

And, described as the most secret of the innovations for the system, a “clean room” was constructed with a maximum of 10 mini-particles per cubic meter of air. In these rooms are produced the complex computer chips which run the trains and connect all the trains in

the entire system to control centers.

The Belt and Road

China’s world leadership in high-speed rail is not being kept for itself. As part of the Belt and Road Initiative, China is actively constructing or planning high-speed rail lines, as well as traditional rail lines, around the world. Laos, Thailand, Indonesia, Kenya, and Ethiopia already have systems in use or under construction. Trans-continental rail lines are in active planning stages in Africa and South America, as well as rail connections between the major cities in each of these two continents,

ending the European colonial policy, which only built rail lines from the mines to the ports to extract raw materials, while leaving the countries themselves undeveloped and unconnected to each other.

The Chinese saying, “If you want to be rich, first build a road,” characterizes their new paradigm approach: build the infrastructure as the necessary base for development. The proof is there for all to see in China.



Xinhua

High-speed trains in Wuhan prepared for the Spring Festival rush.