

# Railway R&D in China

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## General Description

The China Academy of Railway Sciences (CARS) is the only comprehensive and multidiscipline research institution for railways in China. It was founded on 1 March 1950 and reformed as an enterprise in April 2002. With 2317 employees (including 1613 technicians), CARS has nine institutes, six centres, one state engineering research centre, and two metrological stations authorized by the State Quality Inspection Bureau (Table 1). The total state-owned assets amount to Yn1.92 billion (Yn1 = \$0.12) of which Yn550 million are fixed assets. There are a total of 5401 infrastructure facilities including Asia's largest railway test loop. Sixty laboratories with 21 test cars cover a variety of specialties.

The Academy has four missions listed below based on the key government policies of 'following a green transport industry,' and 'establishing a technical development base for the railway industry while serving society.'

- To act as development base for key railway technologies
- To foster innovative and creative talent
- To promote new high-tech progress
- To promote culture of science and innovation

CARS mainly undertakes R&D in a variety of railway fields, including transport economics, rolling stock, track infrastructure, signalling and telecommunications, new materials, information technology (IT), artificial intelligence (AI), labour health and safety, and environmental protection. The Academy also undertakes railway quality inspection both in China and abroad.

## Present Projects

### Safety technology

We have developed a system for monitoring train safety consisting of four parts: trackside to train, train to train, train to trackside, and trackside to trackside. It has monitoring, control, management and

decision-making functions. Safety information related to rolling stock, tracks, power supply, etc., is transferred to a control centre by wired, wireless, and computer networks. The system is currently installed on the Shanghai-Nanjing line and has 16 main sub-systems including a freight wagon test system, passenger train black-box system, track inspection cars, on-train dynamic inspection devices, etc.

It will be installed on the Jing-Ha (including Jing-Qin), Jing-hu, Jing-Guan, Jing-Jiu (including Guang-Shen), Long-Hai, Zhe-Gan (including Hu-Hang) and other main lines.

### Speeding up passenger and freight trains

Present research in this field is focused on:

- Calculating line capacity
- Developing 200-km/h EMU using distributed AC power
- Increasing average speeds of freight wagons to 120 km/h
- Developing semi-active suspension control technologies
- Increasing average speeds of passenger trains by eliminating successive braking operations
- Eliminating rail deformation
- Welding bainitic rails
- Controlling noise of high-speed trains

### High-speed passenger trains

The key projects include developing technical specifications for trains operating at 300 km/h including: bogies and braking systems, pantograph and catenary current collection, ballastless track and 50-m rails, track crossovers, motor traction characteristics, operations and dispatch simulation systems, noise and vibration control, commissioning tests, etc.

### IT and AI

Modernization of Chinese railway will

Table 1 China Academy of Railway Sciences

#### Research Institutes

- Locomotive and Car Research Institute
- Signal & Communication Research Institute
- Railway Engineering Research Institute
- Computer Technology Research Institute
- Metals and Chemistry Research Institute
- Transportation and Economics Research Institute
- Environmental Control and Labor Hygiene Research Institute
- Scientific and Technological Research Institute
- Standards and Metrology Research Institute

#### Centers

- Railway Science & Technology Research and Development Center
- Quality Supervision and Inspection Center for Railway Products, Railway Scientific, Technological and Economics
- Information Research Center
- Inspection and Measurement Center for Railway Infrastructure
- State Railway Test Center
- Railway Technology Training Center

#### State Engineering Research Center

- National Center of Railway Intelligent Transportation System Engineering and Technology

#### Metrological Stations

- State Track Scale Station, State Railway Tank Car Volume Measurement Station

rely heavily on IT and AI and the main research fields include railway cost accounting and income reckoning, radio communications, safety information, e-business, passenger traffic information, train dispatch, sales support, and simulation systems. In these fields we are studying an overall framework for the China train operation control system (CTCS), a comprehensive passenger information system, and key technologies for the Railway Intelligent Transportation System (RITS).

### **Construction of Qinghai–Tibet railway**

Due the severe weather and high geography of the Tibetan plateau, R&D supporting the Qinghai–Tibet railway includes use of low-temperature, early-strength and corrosion-resistant concrete, weather- and lightning-resistant signalling and communications, snow-clearing and antifreeze technologies, mechanized track maintenance, locomotive combustion and oxygen addition, treatment of solid waste, etc.

### **New materials**

Bainitic steel wheels, wagon roller bearings, corrosion evaluation and protective coatings for reinforced concrete bridges are all subjects of long-term R&D projects. The main areas cover rail heat treatment, welding, and application of nanotechnology.

### **Environmental protection**

The main research focuses on cleaning rolling stock, biological sewage treatment, health and safety of employees, treatment systems for passenger toilets.

### **Basic science**

In addition to applied R&D, we are also undertaking some basic and theoretical work on simulating the dynamic interaction between rolling stock, tracks, points, bridges, etc., analyzing the failure

of major equipment such as wheels, axles and tracks, modelling and control of fuzzy hybrid systems, and simulating the environmental impact of railway noise and vibration.

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## **Future Research**

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To build a nationwide high-speed passenger and freight network centred on Beijing, Shanghai, Guangzhou the main research aims are to increase speeds on existing lines by simulating increased traffic; evaluate and reinforce track beds, tracks, bridges and tunnels; install automatic train control (ATC) systems using duplex transmission technologies; and develop multimodal container transport systems.

The research includes railway development strategies, passenger and freight flows and train operations, rolling stock management databases, etc.

### **Key technologies**

The key technologies to be developed include high-speed computerized electropneumatic through braking systems, lightweight airtight carriages, tight-lock automatic couplers, high-speed AC motors, computerized train-diagram and dispatch, track and infrastructure design systems, digital ATC, etc.

### **Heavy freight haulage**

To improve freight capacity, the main research includes testing heavy locomotives with 25-tonne axle loads, strengthened bogies and more powerful

electropneumatic brakes, strengthened rails and bridges, as well as life evaluation of heavy wagons, and construction of flat cars for double containers.

### **Urban railways**

Congested urban cities will need urban railways to carry large numbers of people quickly with low energy consumption and less pollution. Our main research includes feasibility studies of urban railways, new track technologies, noise control, signalling and safety technologies, AC motors, new bogies, computerized braking systems, etc.

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## **Research Prospect**

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To kick-start modernization of Chinese railways, research should focus on basic research and innovation with the aim of complete adoption of high-speed and IT in passenger and freight services nationwide by 2015. The first part of this goal was achieved with the restructuring of CARS in 2002 and the revitalized institutes, centres, etc., will form the scientific basis of future railway development. ■

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## **Chen Guofang**

Mr Chen is President of CARS. He has held senior posts in both the maintenance and transportation bureaus of the Ministry of Railways.

## **Shi Tianyun**

Dr Shi is Deputy Director of the R&D Management Department at CARS. He worked as a researcher at the Signal and Communication Research Institute and the Electrical Computing Technology Institute. He obtained a doctorate degree from the Beijing Institute of Technology in 1998.