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Editorial

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High-speed railway transport technology

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1 Introduction

The high-speed railway is one of the most active technological fields in China. Since the opening of the high-speed line between Beijing and Tianjin in 2008, China has built the world's largest high-speed railway network with the highest average operating speed in the world (Bian et al., 2019; Cao et al., 2021; Chen et al., 2022). China has also created the world's largest, most advanced, and comprehensive scientific research system and industrial chain in the field of high-speed railways. Currently, China's high-speed railway operating mileage, the total number of research personnel related to high-speed railways, and the total research investment in them, all exceed the sum of those of all other countries. Therefore, China has the reason, responsibility, and capability to make contributions to the development of high-speed railway technology in the world that match its national status.

China's high-speed railway has the following characteristics: Firstly, it has a large scale and a significant one-time investment in equipment. As the equipment gradually enters the period of consumption and wear, the maintenance cost will become a core factor affecting its operational economy. Therefore, how to improve the level of maintenance has become an urgent core technical problem to be solved. Secondly, China has a vast territory with large climate variations. High-speed railway geological conditions, meteorological conditions, and passenger demand vary greatly, and they have posed requirements for design technology, maintenance technology, and management services that other countries have never encountered. Relevant research based on the above requirements and China's unique testing conditions will undoubtedly contribute to the expansion of high-speed railway technology (Chen et al., 2017; Dong et al., 2019, 2020). In addition, the high-speed railway is a comprehensive application of many advanced technologies. It is important, therefore, that we face the issue of integrating the latest advances in related fields such as artificial intelligence, electrical engineering, and material engineering, into the high-speed railway system. Unfortunately, there has been no dedicated special issue or workshop devoted to doing that.

This special issue contains original and hitherto unpublished work on the applications of high-speed railway transport technology. Focal points include, but are not limited to, innovative applications of: (1) development trends in international high-speed railway technology and road network planning; (2) basic theories related to the high-speed railway; (3) high-speed railway infrastructure; (4) high-speed train dynamics and the wheel-rail relationship; (5) high-speed train technology; (6) aerodynamics and drag reduction technology of high-speed trains; (7) traction power supply technology for the high-speed railway; (8) high-speed railway communication signaling and operational control; (9) high-speed railway transportation organization; (10) high-speed railway detection technology and operation maintenance.

In recent years, scientists and engineers have conducted extensive research and exploration around the challenges mentioned above. To fully showcase relevant innovative achievements, and to promote the development of related research through exchange, we have launched this third high-speed rail special issue, building on the success of the two previous issues (in 2011 and 2014 in *Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)*). On the one hand, this issue describes the latest achievements in recent years and, on the other hand, it also presents

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scholars' research and thinking on the future development direction of high-speed rail. Thus, we invited prestigious scientists in the field to share their expertise and perspectives. Herein, we briefly introduce tbe papers as follows:

Liu et al. (2023) conducted theoretical and experimental research on the relationship between ballast damage (the degradation of ballast is a critical parameter determining the maintenance cycle of ballasted track) and its particle shape, size, and stress state, and obtained the optimal value of ballast damage parameters, providing guidance for maintenance management.

The changes in the flow field characteristics around a train at low temperatures directly affect the flow resistance, aerodynamic safety, and aerodynamic noise. Miao et al. (2023) conducted a numerical simulation based on the shear-stress transport (SST) k-ω turbulence model to study the effect of low temperatures on the aerodynamic drag, the positive and negative pressure fields around the train body, the range of the train wind action, vorticity distribution area, wake velocity, etc., which have important significance for improving the safety of high-altitude and high-speed trains.

Unmanned aerial vehicles (UAVs) have great potential in railway infrastructure safety inspections, but improving their accuracy and the efficiency of processing large amounts of image data is a major technical bottleneck. Mu et al. (2023) proposed an adaptive image cropping method and a shallow attention network, which effectively improve the recognition accuracy of faults such as rust and missing parts in bridge steel structures and their connections.

As the requirements for the power quality of traction motors in high-speed trains increase, the harmonics of the common-mode component of the driving current become more complex, making the problem of axle current in traction motors and gearboxes more prominent. Based on the analysis of the causes, propagation paths, damage, and consequences of axle current, Li et al. (2023) identified the key parameters affecting axle current and proposed relevant solutions.

In addition to high-speed wheel-rail systems, magnetic levitation (maglev) is also a hot topic in high-speed rail research (Al-Qadi et al., 2010; Arivazhagan et al., 2015; Anbazhagan et al., 2016; Atapek et al., 2020). Sun et al. (2023) proposed a fault-tolerant control strategy that improves the tolerance of the suspension system of high-speed maglev trains to actuator faults.

Traction and transmission technology is crucial for rail transportation. Ma et al. (2023) analyzed and compared various factors that have impacted traction and transmission technology in recent years. Based on this analysis, they put forward ideas for the future development of traction technology.

Extreme weather and the coupling effect of train loads can cause track subgrade damage, which is frequently a major cause of accidents on high-speed railways. Wu et al. (2023) analyzed the research status and existing problems of short-term detection technology, long-term monitoring technology, and control and repair technology for typical subgrade damage. They proposed suggestions for the key technical issues that need to be tackled in the next step.

High-strength and high-conductivity copper alloy is a key technology for solving the problem of current-carrying capacity in high-speed trains (Batawi et al., 1990; Batra et al., 2005; Benosman and Lum et al., 2010; Banham-Hall et al., 2012; Bar-Gera, 2017). In recent years, important progress has been made in China's research on the preparation of high-strength and high-conductivity copper alloy using precipitation strengthening (precipitation hardening) technology. Yu et al. (2023) reviewed and summarized the research progress in China on the relevant alloy composition, preparation, and processing technology, and on emerging technologies such as big data processing related to high-strength and high-conductivity copper alloy and proposed alloy systems with good development potential.

In summary, the high-speed railway is a technology field that we have been focusing on for a long time, and we believe this special issue provides a special viewpoint for researchers and engineers to present and discuss recent developments in it. Due to space limitations, some manuscripts are still in the process of being processed and will be published in due course. We expect the selected will arouse the discussion of many scientific researchers and also bring new inspiration to readers. We sincerely want to express our gratitude to all the authors who are contributing to this project in our journal.

Author contributions

Youtong FANG conceived and edited the draft of manuscript. Jien MA performed the literature review and completed the draft of the manuscript.

Conflict of interest

Youtong FANG and Jien MA declare that they have no conflict of interest.

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Introducing Guest Editor-in-Chief and Guest Editor:

Guest Editor-in-Chief

Prof. Youtong FANG is an IET fellow. He obtained the special allowance of the government of the State Council of China. He is the director of the High-Speed Railway Research Center of Zhejiang University and deputy director of National Engineering Technology Research Center of Intelligent Train. He presided over the research and development of China's first permanent magnet traction motor for 350 km/h high-speed train, which has been loaded and put into actual line operation.

Guest Editor

Prof. Jien MA is a professor in College of Electrical Engineering at Zhejiang University, China, where she is working on electrical machines and drives. She received the PhD degree in Mechanical Engineering from Zhejiang University in 2009. She is the secretary of the High-Speed Railway Research Center of Zhejiang University. Her research interests include the permanent magnet (PM) machines, core loss estimation, and reliability.