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PREFACE

Research on the mechanics of high speed rails

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In the preceding theme issue on "Current research progress on mechanics of high speed rails" (*Acta Mechanica Sinica*, 30: 846–909 (2014)), we invited several authors in the field to present their research on high speed rails (HSR), including work on dynamic derailment analysis (Ling et al. [1]), load spectra on bogie frame (Zhu et al. [2]), high-speed vehicle dynamics model (Ren et al. [3]), hunting stability analysis for the safety bound of speeds (Zeng et al. [4]), harvest kinetic energy of rail vibration by using piezoelectric circular diaphragm (Wang et al. [5]), and welding distortion for double floor structure of high speed train (Dong et al. [6]).

In order to develop a comprehensive understanding about the dynamics and long-term durability of HSR systems, there is a prevailing need for new research from multidisciplinary groups. The theme articles published in this issue are the result of our continual endeavors to introduce cutting-edge research on the mechanics of HSR, from researchers of different backgrounds and working on different aspects of the system.

One focus of the theme articles is on the aerodynamic design of high speed trains. In the paper by Guo et al. [7], the effects of affiliated components and train length on train wind are analyzed. As trains run on track, more severe aerodynamics may be encountered when two trains pass by; the work by Li et al. [8] captured the dynamic responses of a carriage under the combined excitation from the track spectrum and air pressure pulse in that scenario. One of the chief engineers from CSR Qingdao Sifang Locomotive & Rolling Stock Co., Dr. Ding and coauthors [9] summarized the critical optimizing factors for better aerodynamic performance of high speed trains (HSTs). They constructed the optimization strategy among the aerodynamic design principle, aerodynamic performance indexes, and design variables. The method has been successfully employed to the design of various HSTs, including CRH380A, CRH380AM, CRH6, CRH2G, and the standard electric multiple unit (EMU).

The second focus of the theme articles is on the dynamics of train–wheel–track interaction. The study by Han et al. [10] presented their model to understand the nonlinear water–soil interaction during HST–track coupling, in particular when the slab track is under the influence of subgrade deformation. The work of Xu et al. [11] analyzed the torque transmitting performance during regenerative braking and proposed a novel methodology to detect the wheel–rail adhesion stability. Their analysis for the wheel–rail adhesion control for regenerative braking systems of HSTs is crucial to maintaining stability, improving adhesion use, and achieving high efficiency energy recovery. The model by Zhong et al. [12] was developed to investigate how the flexibility of a train's wheelset may impact vehicle–track dynamics. Within the speed range of 200–400 km/h, their model can characterize the effects of flexible wheelset deformation on the wheel–rail rolling contact behaviour very well. We also have one piece of paper on fault diagnosis for bearings—a critical component of trains. A work by Wang et al. [13] showed a strategy to monitor potential bearing faults. Their experimental techniques, combined with numerical analysis, could be applied to differentiate relevant signals to operational conditions of bearings from noises emitted from the surrounding environment.

As discussed before, there is tremendous progress in the research of HSR systems within the past decade, boosted by the huge marketing growth in China and worldwide. With

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increasing population to use HSTs for long-distance travelling, we expect there could be growing research opportunities on the safety, durability, energy efficiency, and environmental friendliness for HSRs, and we look forward to seeing continual research progress on such directions.

References

1. Ling, L., Xiao, X.-B., Jin, X.-S.: Development of a simulation model for dynamic derailment analysis of high-speed trains. Acta Mech. Sin. **30**, 860–875 (2014)
2. Zhu, N., Sun, S.-G., Li, Q., et al.: Theoretical research and experimental validation of quasi-static load spectra on bogie frame structures of high-speed trains. Acta Mech. Sin. **30**, 901–909 (2014)
3. Ren, Z.-S., Yang, G., Wang, S.-S., et al.: Analysis of vibration and frequency transmission of high speed EMU with flexible model. Acta Mech. Sin. **30**, 876–883 (2014)
4. Zeng, X.-H., Han, W., Lai, J., et al.: Influences of aerodynamic loads on hunting stability of high-speed railway vehicles and parameter studies. Acta Mech. Sin. **30**, 889–900 (2014)
5. Wang, W., Huang, R.-J., Huang, C.-J., et al.: Energy harvester array using piezoelectric circular diaphragm for rail vibration. Acta Mech. Sin. **30**, 884–888 (2014)
6. Dong, W.-C., Lu, S.-P., Lu, H., et al.: Numerical simulation and control of welding distortion for double floor structure of high speed train. Acta Mech. Sin. **30**, 849–859 (2014)
7. Guo, D., Shang, K., Zhang, Y., et al.: Influences of affiliated components and train length on the train wind. Acta Mech. Sin. (2015). doi:10.1007/s10409-015-0553-z
8. Li, S., Zheng, Z., Yu, J., et al.: Dynamic simulation and safety evaluation of high-speed trains meeting in open air. Acta Mech. Sin. (2015). doi:10.1007/s10409-015-0471-0
9. Ding, S.-S., Li, Q., Tian, A.-Q., et al.: Aerodynamic design on high-speed trains. Acta Mech. Sin. (2015). doi:10.1007/s10409-015-0546-y
10. Han, J., Zhao, G.-T., Sheng, X.-Z., et al.: Study on the subgrade deformation under high-speed train loading and water–soil interaction. Acta Mech. Sin. (2015). doi:10.1007/s10409-015-0522-6
11. Xu, K., Xu, G.-Q., Zheng, C.-H.: Analysis of torque transmitting behavior and wheel slip prevention control during regenerative braking for high speed EMU trains. Acta Mech. Sin. (2015). doi:10.1007/s10409-015-0544-0
12. Zhong, S., Xiao, X., Wen, Z., et al.: Effect of wheelset flexibility on wheel-rail contact behavior and a specific coupling of wheel-rail contact to flexible wheelset. Acta Mech. Sin. (2015). doi:10.1007/s10409-015-0441-6
13. Wang, W.-J., Cui, L.-L., Chen, D.-Y.: Multi-scale morphology analysis of acoustic emission signal and quantitative diagnosis for bearing fault. Acta Mech. Sin. (2015). doi:10.1007/s10409-015-0529-z