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Development and validation of a model for predicting wheel wear in high-speed trains

Key words: High-speed train; Wheel profile; Wheel/Rail contact; Wheel wear prediction

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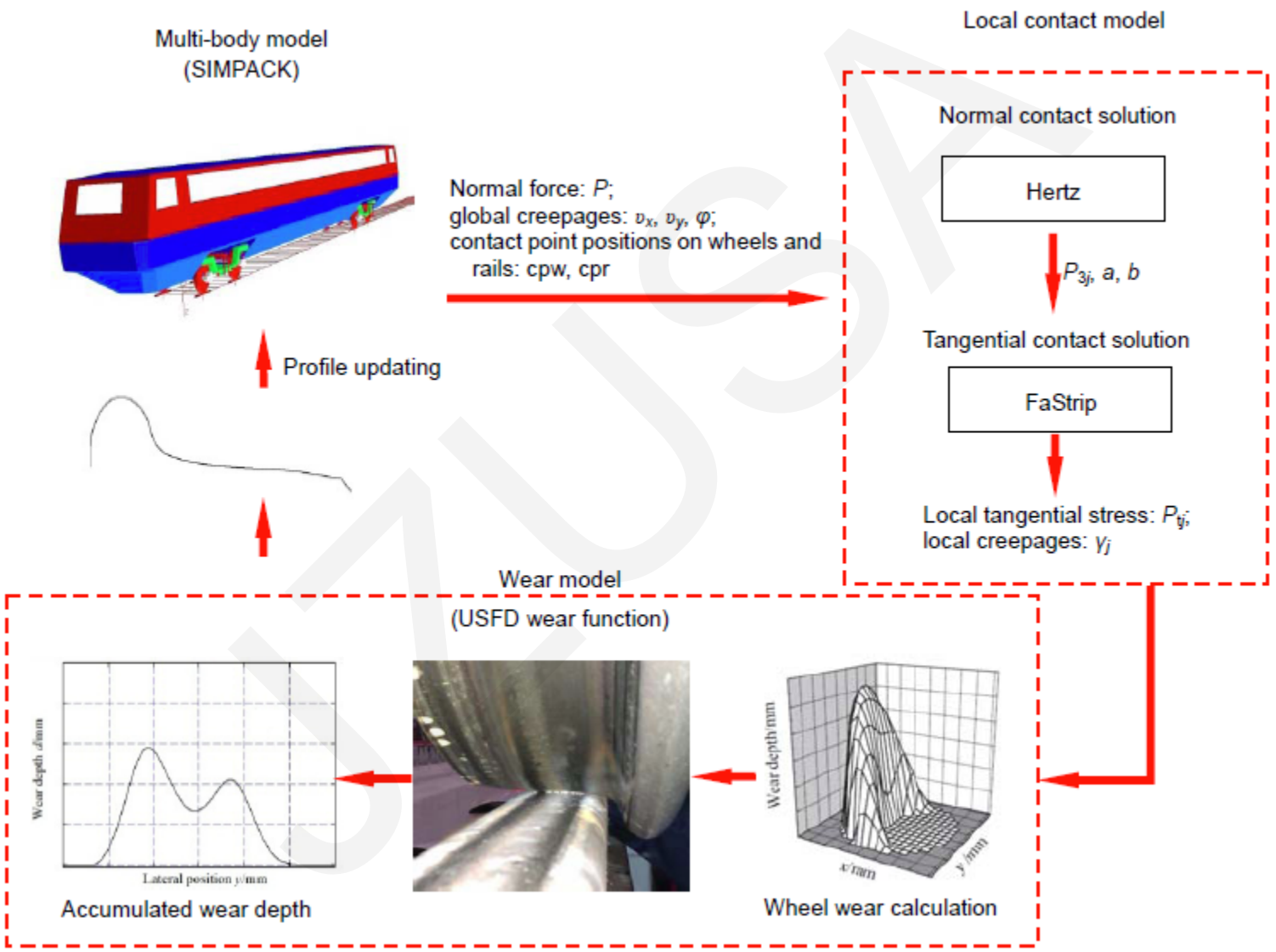
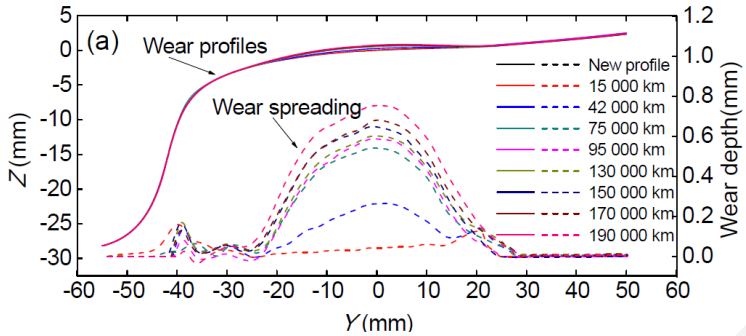
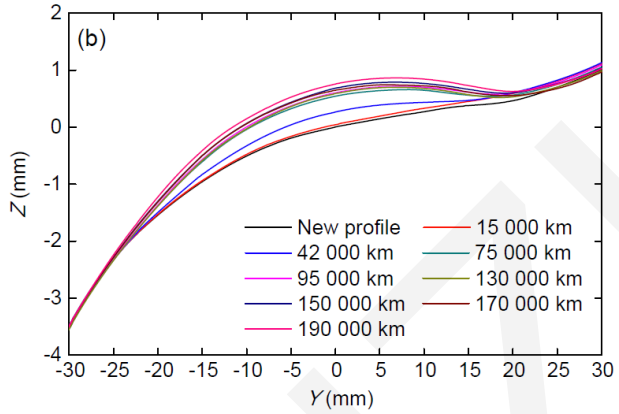
Wheel wear prediction model

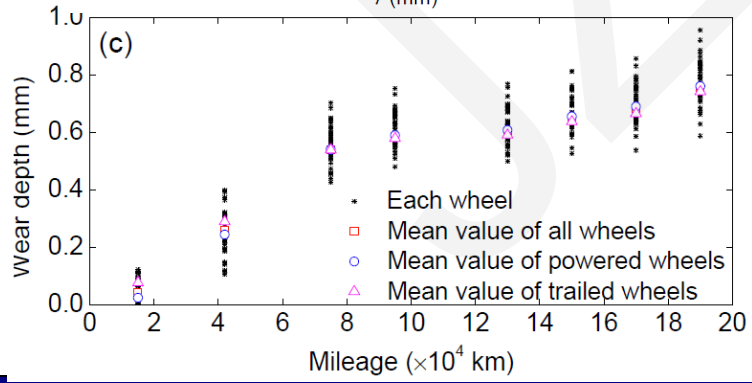


Model validation

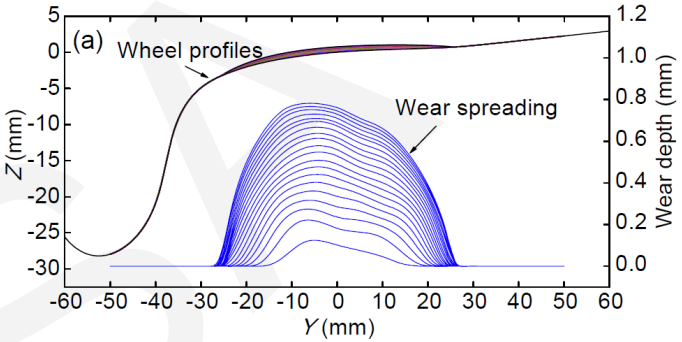
Measurement

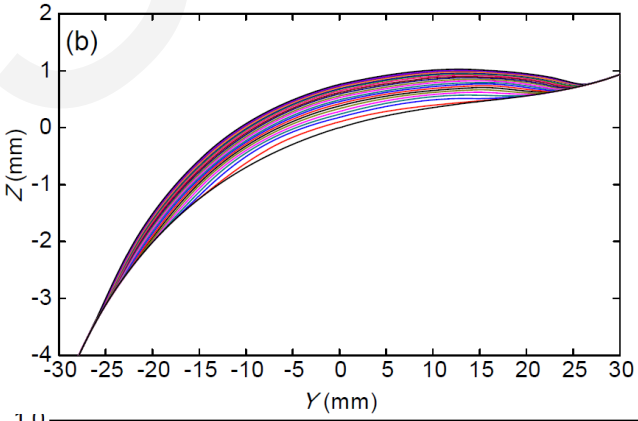


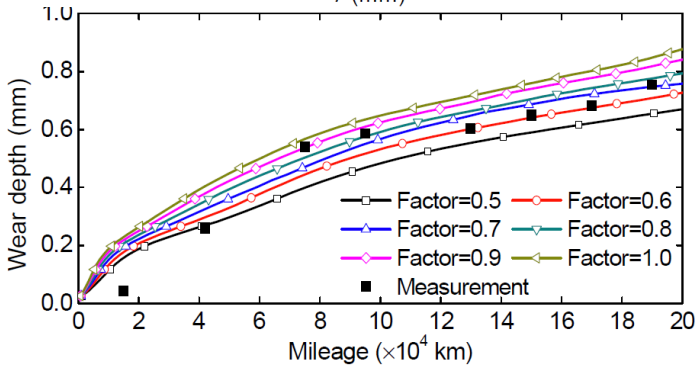




Simulation







Conclusion

- A comprehensive wear model for the prediction of the evolution of high-speed train wheel profiles due to wear is presented in this paper. The specially developed model consists of four modules: a multi-body model implemented with the commercial multi-body software SIMPACK to evaluate the dynamic response of the vehicle and track; a local contact model with Hertzian theory and a novel and versatile method, named FaStrip, to calculate the normal and tangential forces, respectively; a wear model proposed by the University of Sheffield (known as the USFD wear function) to estimate the amount of removed material and its distribution along the wheel profile; and a smoothing and updating strategy.

- Simulation of the wheel wear of the CRH3 high-speed train in service on the Wuhan-Guangzhou high-speed railway line was carried out. A virtual railway line based on the statistics of the line was used to represent the entire real track. The model was validated using wheel wear data of the CRH3 high-speed train operating on the same line, monitored by the authors' research group. The outputs of the wear model with the corrected USFD wear function were very consistent with field measurements, both for wear depth and wear spreading.

- Some aspects still need improvement. Firstly, the flexibility of the track is ignored in the current model. Some previous research indicated that it has a significant influence on wheel/rail contact behavior, such as wheel/rail contact positions, creepages, spin, and creep forces. These quantities are closely related to wear estimation. Secondly, the versatile contact model FaStrip was used in post-processing rather than online dynamic solutions, and Kalker's simplified theory FASTSIM was used in dynamic simulation. This may cause discrepancies, because the contact stiffness at the wheel/rail interface is dependent on the contact model in use. Thirdly, a new rail profile rather than worn profiles measured on the real tracks was adopted in the simulation, which may have affected the predictions, especially for wear spreading. Finally, measurement of the friction coefficient is necessary. Consideration of the dispersion of possible values of the friction coefficient based on the field measurements will make the simulation more realistic. In future, a more complete wear model should be considered, which includes a coupling vehicle/track model taking track flexibility into account, and a versatile contact model implemented with an online solution.