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Effect of the first two wheelset bending modes on wheel-rail contact behavior

Key words:

High-speed railway vehicle, Wheel-rail contact behavior, Rigid wheelset, Flexible wheelset, Modal analysis, random track irregularity.

Vehicle-track Dynamic System Model

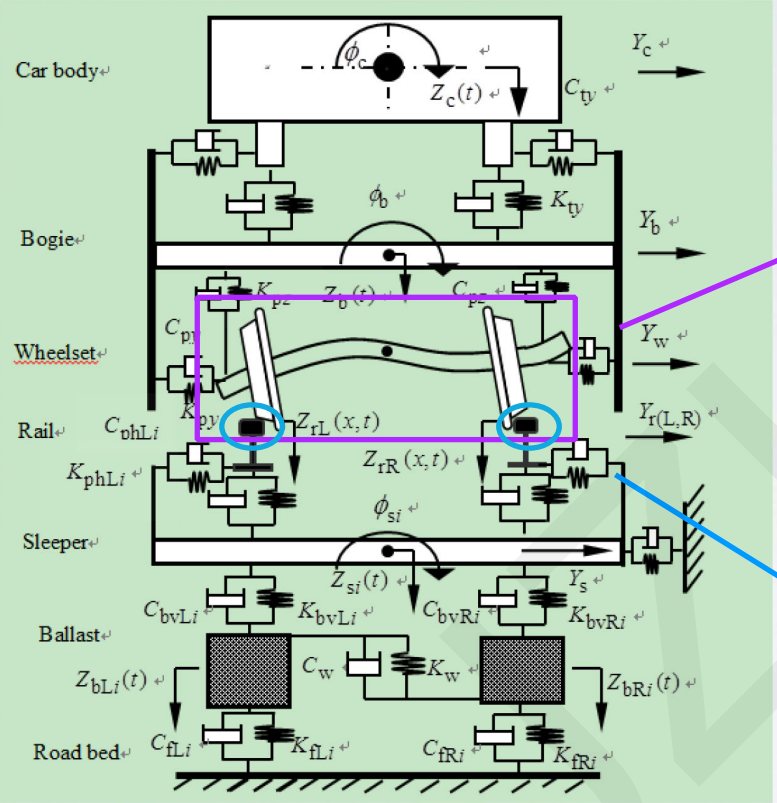


Fig. 1. Vehicle-track coupling model (Elevation)

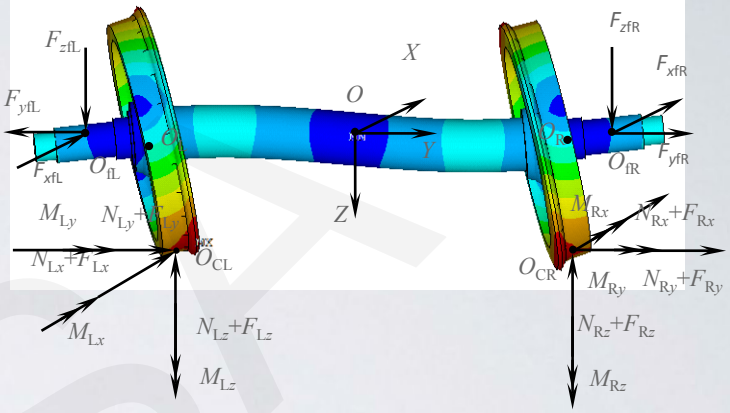


Fig. 3. Force analysis diagram of the flexible wheelset

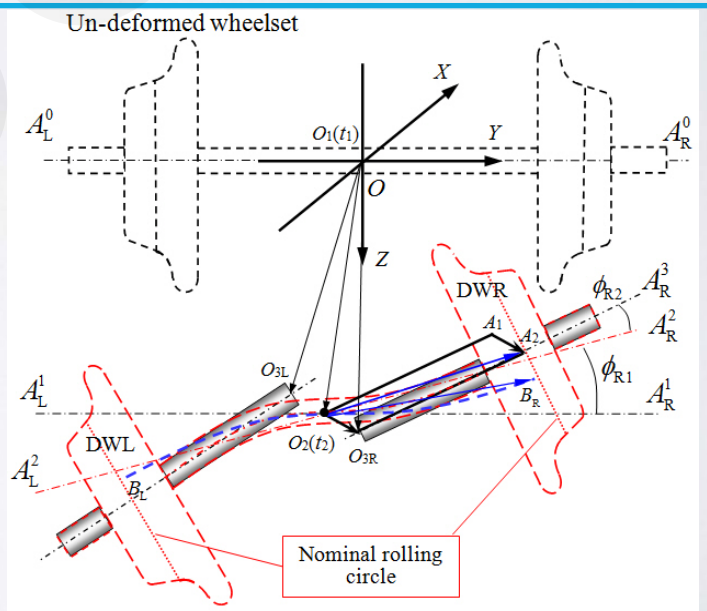


Fig. 7. A flexible wheelset moving from its initial reference state ($O_1(t_1)$) to its any status ($O_2(t_2)$) in the plane of *O-YZ*.

Modal analysis of the flexible wheelset model

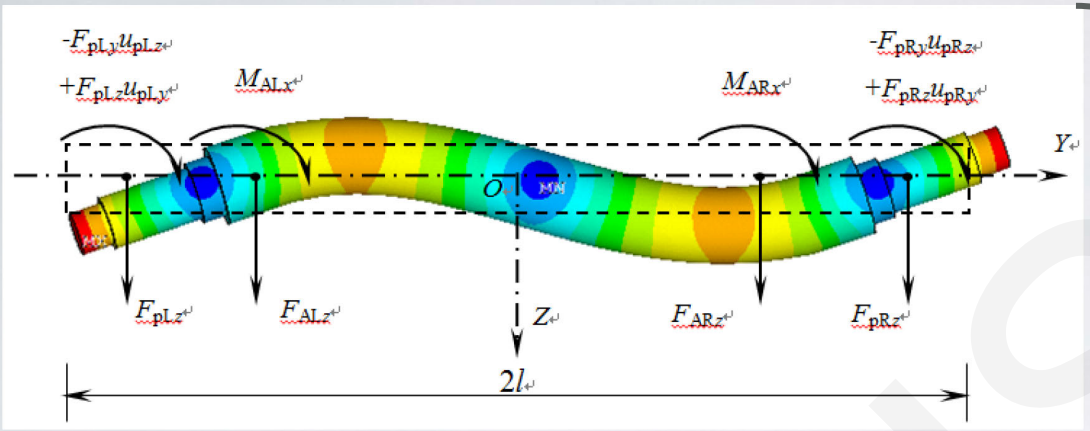


Fig. 4 (a) Force analysis diagrams in the plane *Z-Y*

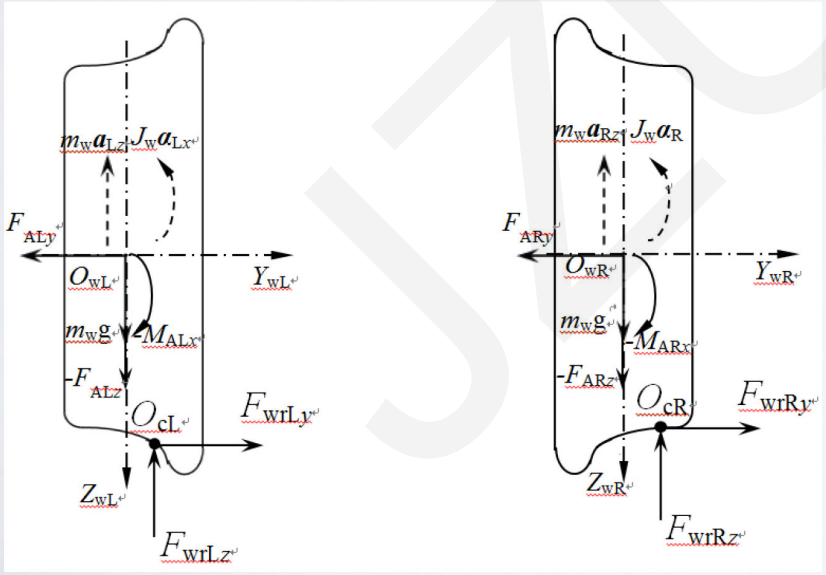
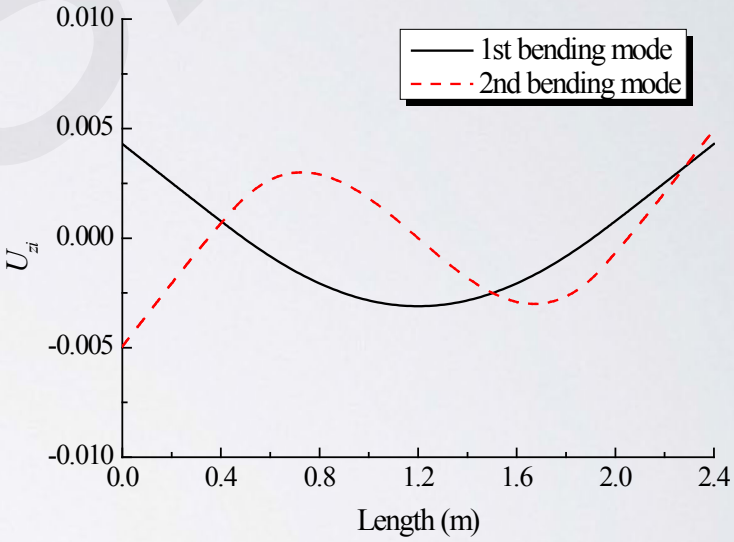


Fig. 5. Force analysis diagram of the two wheels



The first two bending modes of the wheelset model

the excitation of the random irregularity

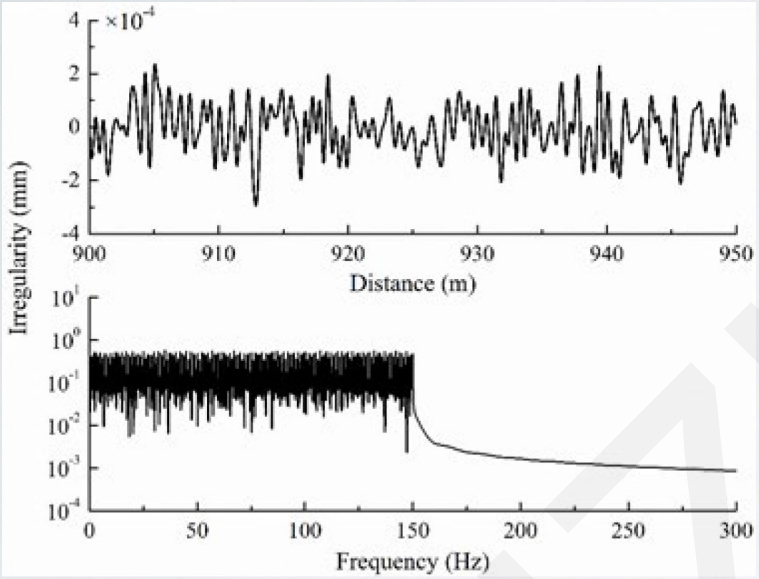


Fig. 10 Random irregularity on the rails

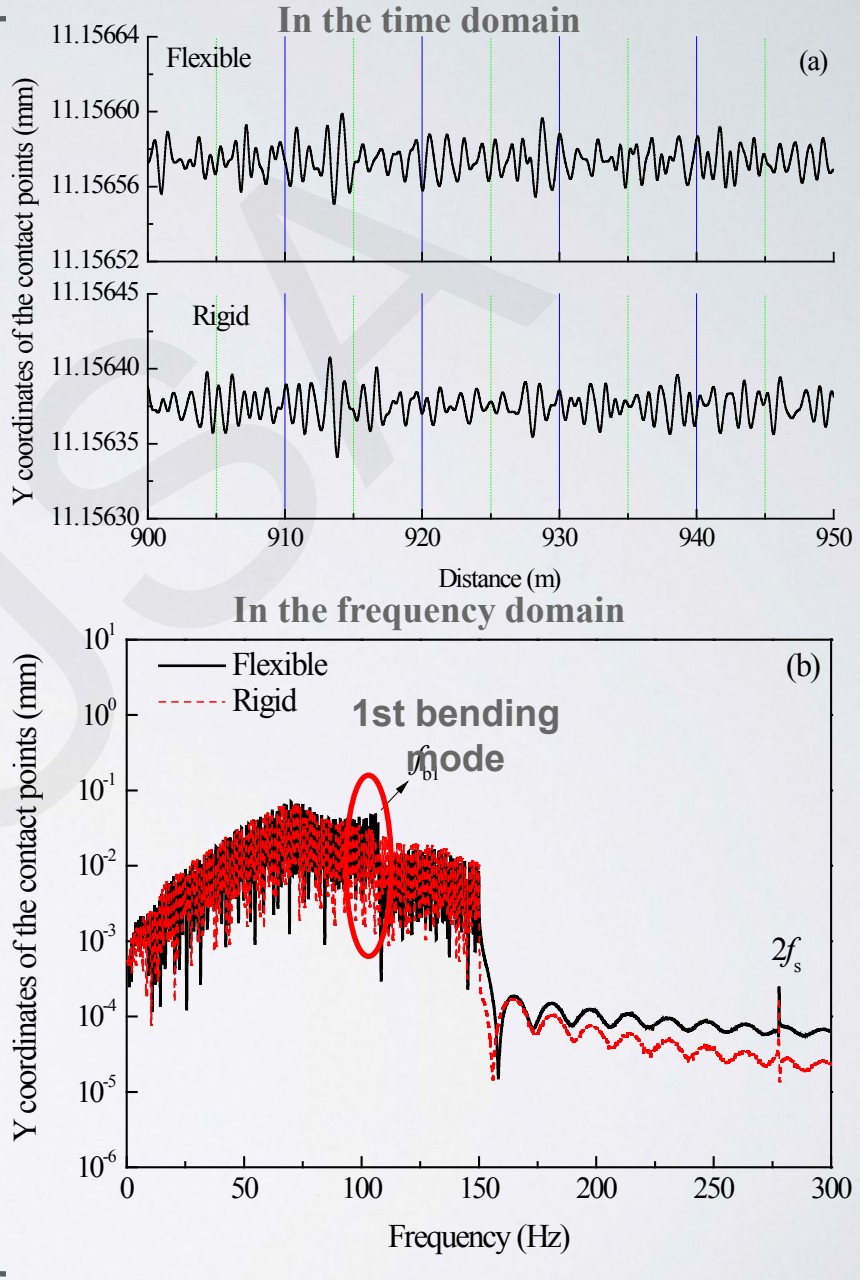


Fig. 13 The oscillation of contact points in lateral direction

Results under the excitation of the random irregularity

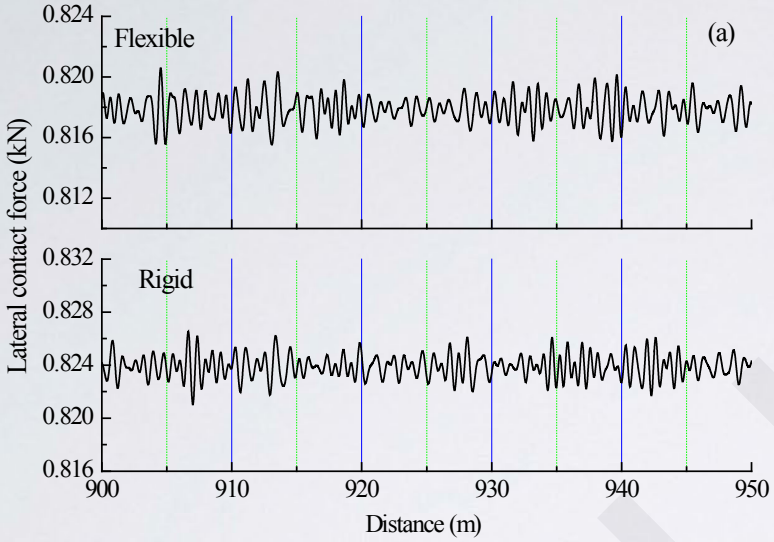


Fig. 11 Contact forces in the time domain

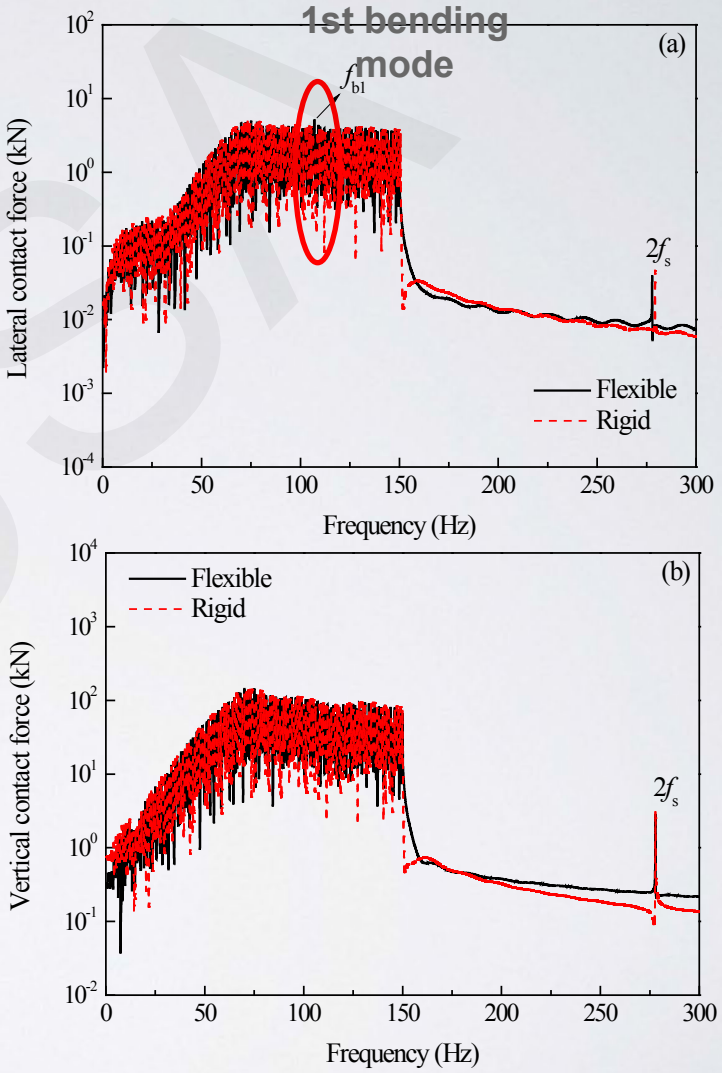


Fig. 12 Contact forces in the frequency domain

Conclusion

Based on the new vehicle-track model the effect of the first two bending modes of the wheelset on wheel-rail contact behavior is analyzed under the random irregularity in a frequency range of 0-150 Hz. The numerical results of the rigid wheelset model and the flexible wheelset model are compared in detail. The following conclusions can be drawn from the results:

(1) The present vehicle-track model considering flexible wheelsets can very well characterize the effect of the flexible wheelset on wheel-rail dynamic behavior.

(2) Under the excitation, the shapes of the oscillations of the wheel-rail contact forces and contact points for the new and conventional vehicle-track model are different. The difference is mainly caused by the excited first bending mode of the wheelset.