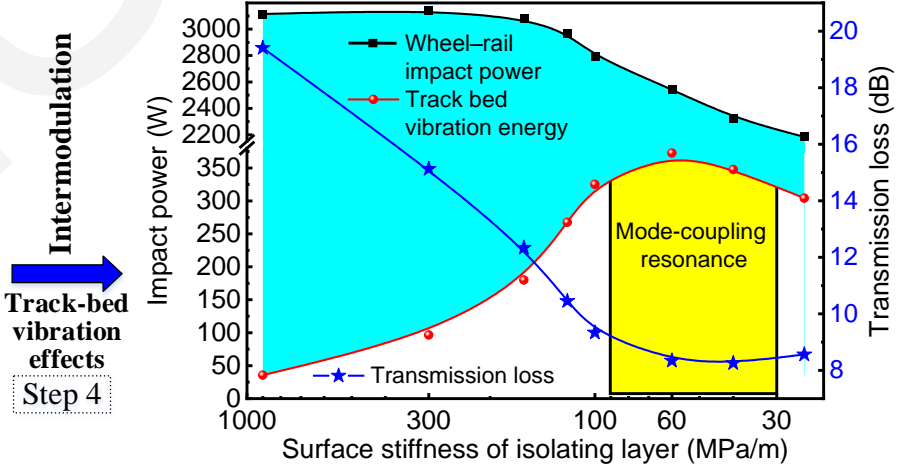
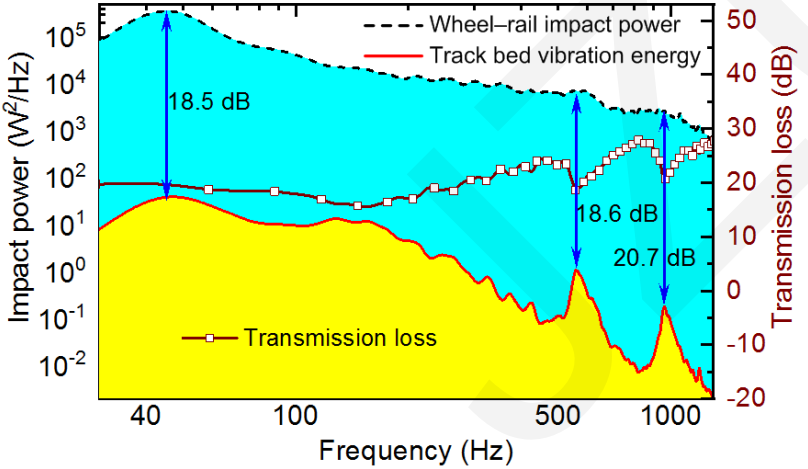
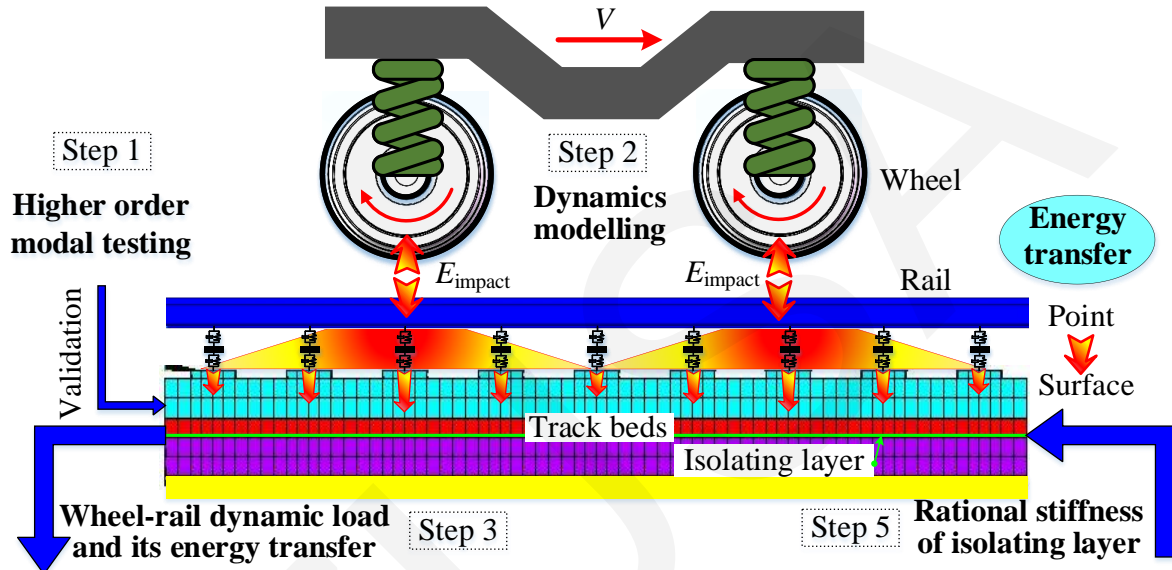


Vibration characteristics of ballastless track and its effect on wheel–rail broadband dynamic interaction

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Graphical Abstracts



Highlight 1: Higher order modes of track beds are experimentally identified for the first time.

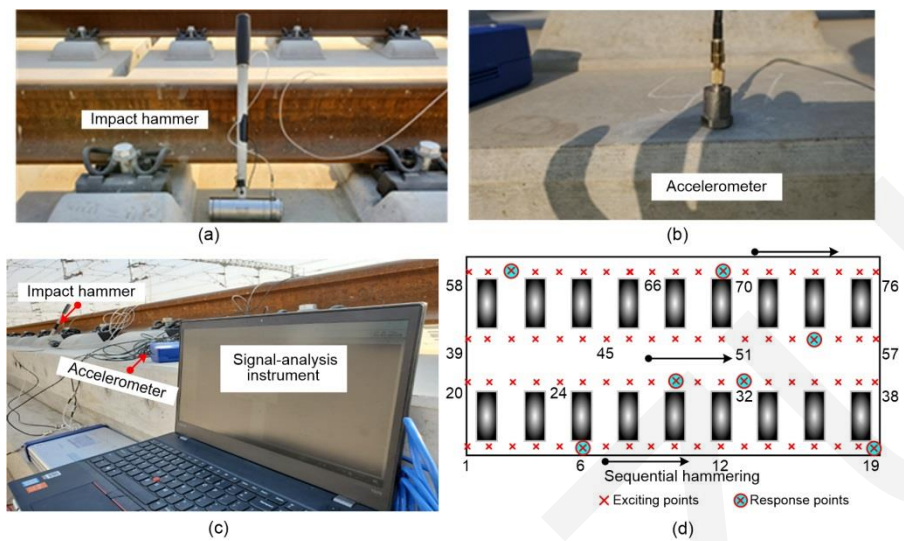


Fig. 1 Modal identification experiment for the CRTS-III ballastless track: (a) excitation devices; (b) accelerometer; (c) measurement scenario; (d) excitation input–response output point arrangement

- ❑ A dense arrangement of excitation points.
- ❑ A multiple asymmetric arrangement of response points.
- ❑ Real-time determination of the coherence function of each response point.

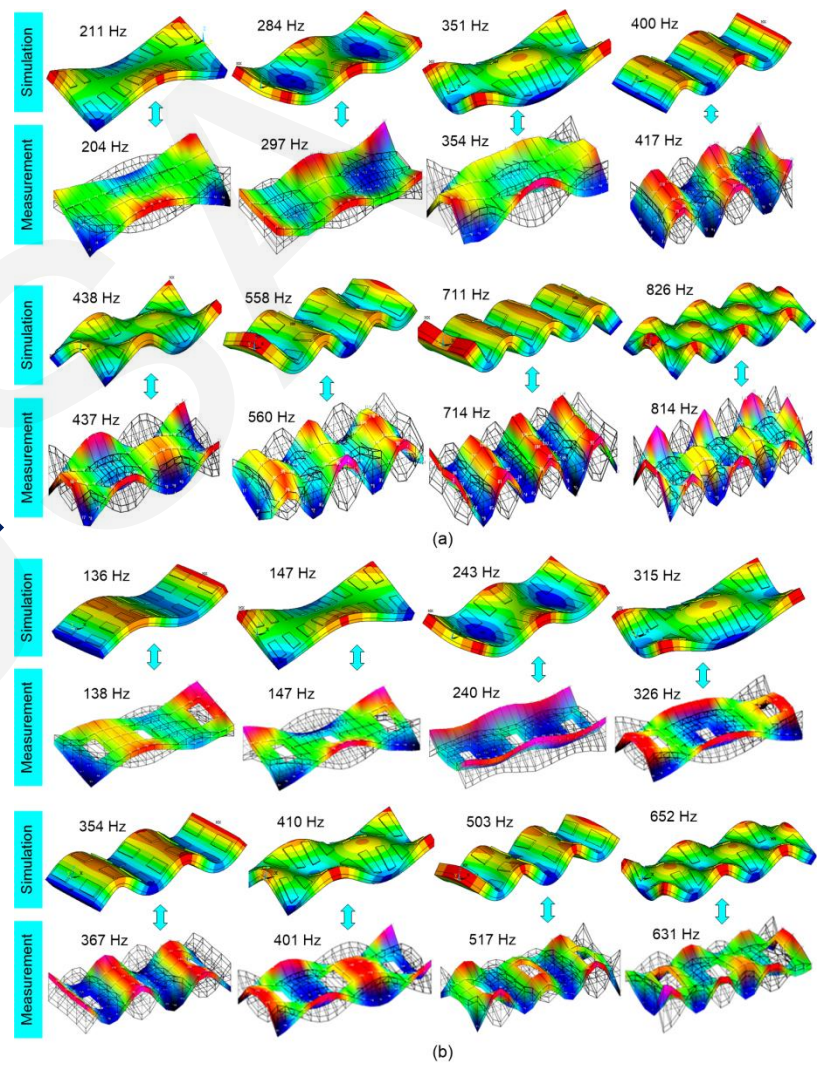


Fig. 2 Results of simulation and measurement comparisons for various track bed modes with different isolating layers: (a) isolating layer with geotextile; (b) isolating layer with cushion

Highlight 2: Refined modelling of broadband vibrations of track beds and coupling with vehicles.

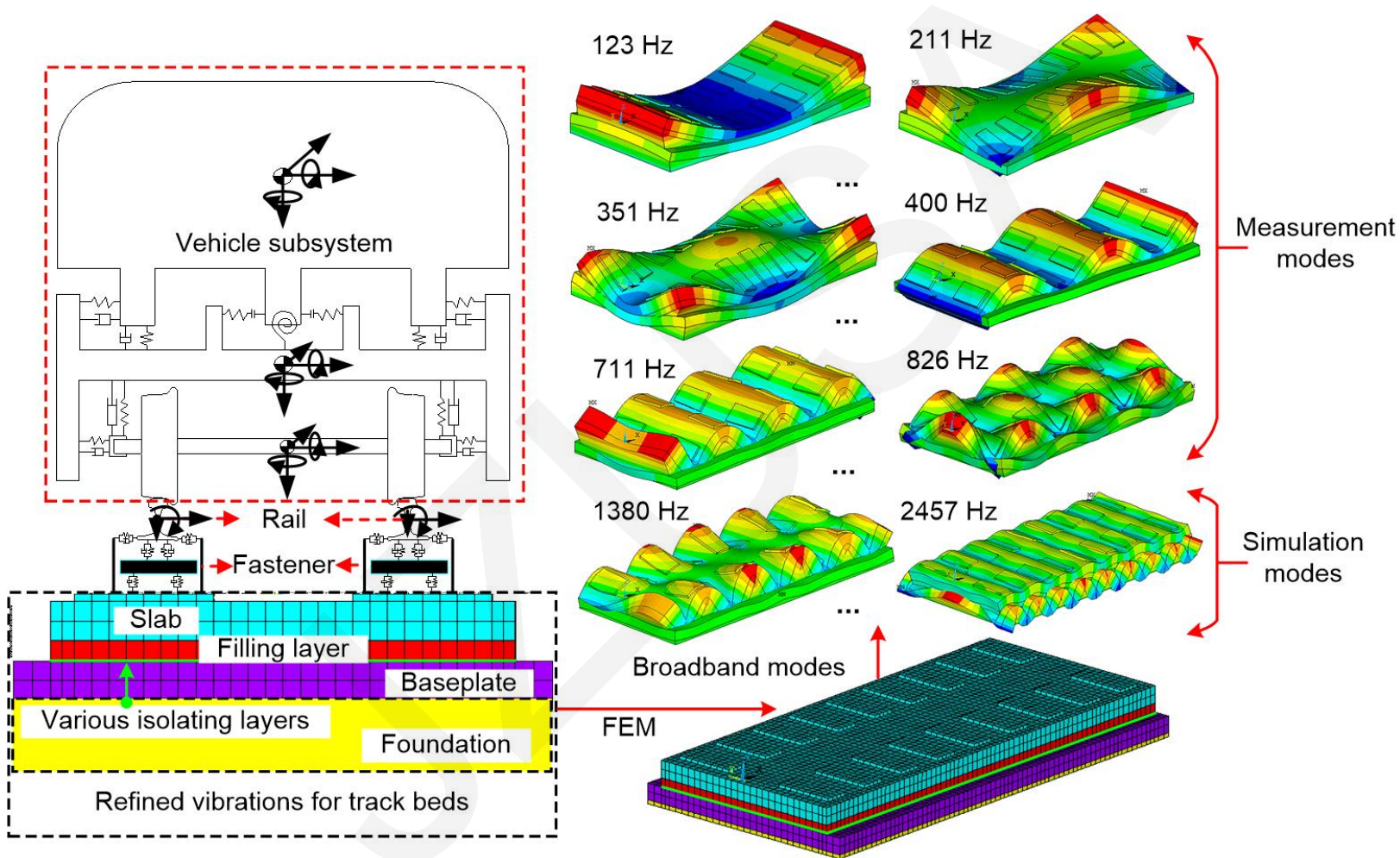


Fig. 3 Vehicle–ballastless track dynamic interaction model with refined consideration of track-bed broadband vibrations.

Highlight 3: Intense low-frequency and weak high-frequency intermodulation effects between the wheel–rail and track beds are observed.

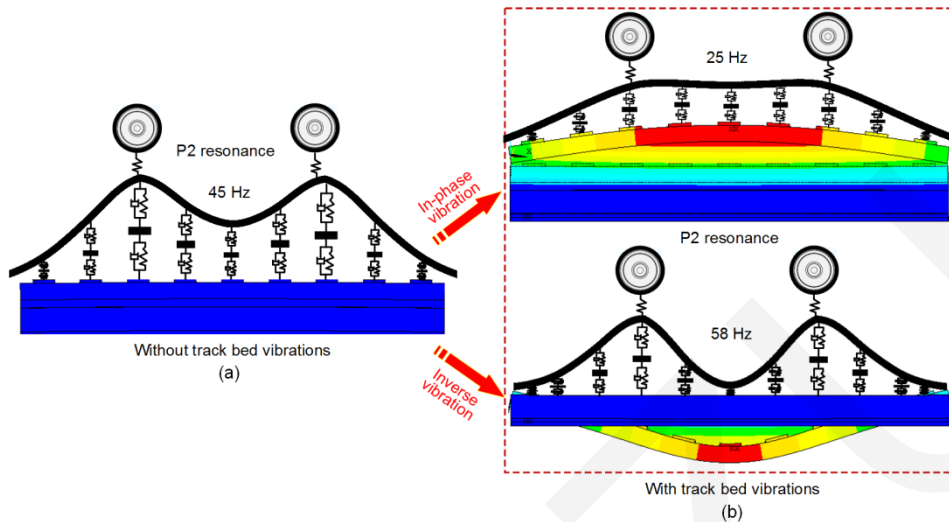


Fig. 4 Wheel–rail P2 resonance mode: (a) without effects of track beds; (b) with effects of track beds

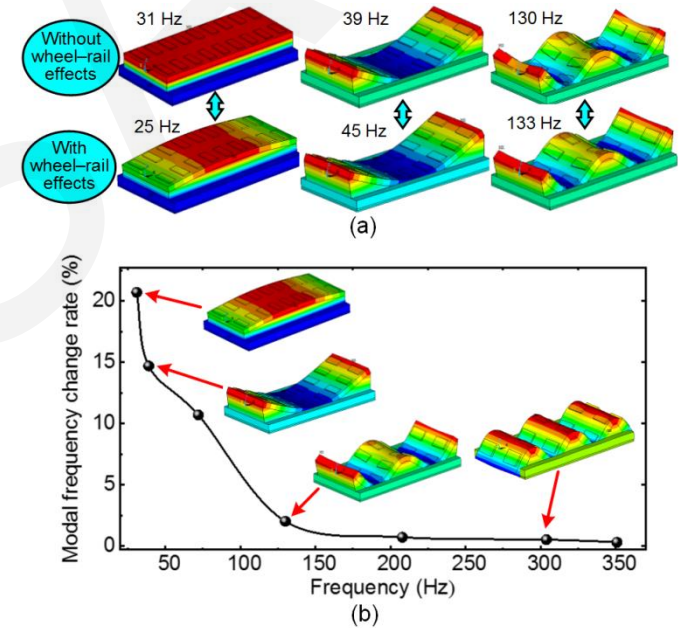


Fig. 5 Track bed modes with effects of the wheel–rail system: (a) difference of track bed modal shapes with and without wheel–rail effects; (b) difference of track bed modal frequencies with and without wheel–rail effects.

- The modes of the track bed and wheel–rail coupled subsystem are mutually affected in the low-frequency range, but no significant mutual effects are observed at high frequencies.

Highlight 4: Rational stiffness of the isolating layer should be selected to avoid mode-coupling resonance from track beds to the wheel-rail subsystem.

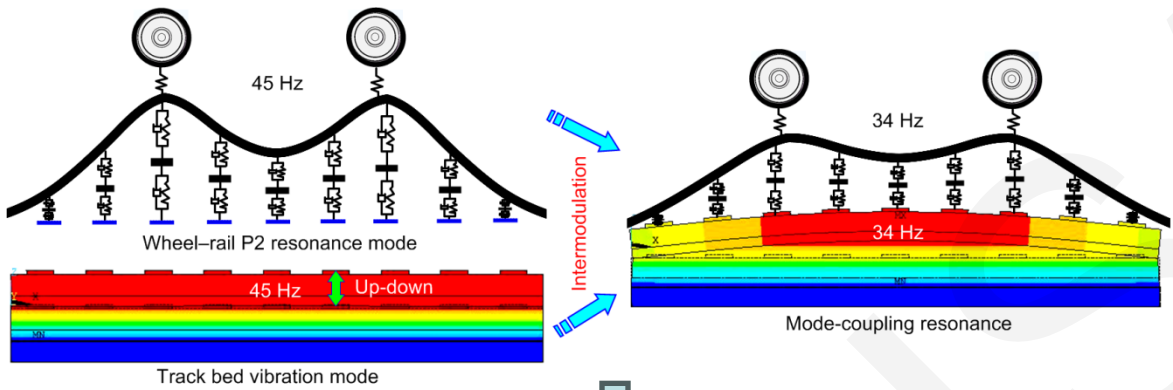


Fig. 6 Mode-coupling resonance between the wheel-rail coupled subsystem and track beds.

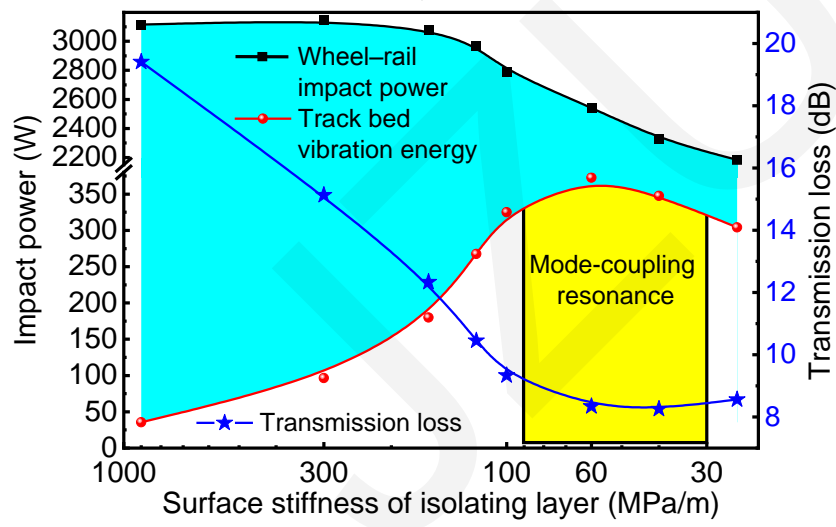


Fig. 7 Contribution of isolating layer stiffness to wheel-rail dynamic load and its vibration energy transfer.

- ❑ When the isolating layer stiffness is reduced from 1000 to 60 MPa/m, the wheel-rail impact energy is weakened by only 18%, while the track bed vibration energy is dramatically increased by 9.4 times.
- ❑ The mode-coupling resonance significantly intensifies the track bed vibration energy.