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Experimental study on vibration source characterization from wheel–rail impacts in urban rapid rail transit turnouts

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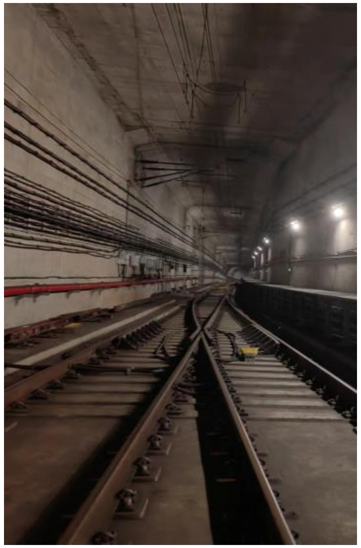
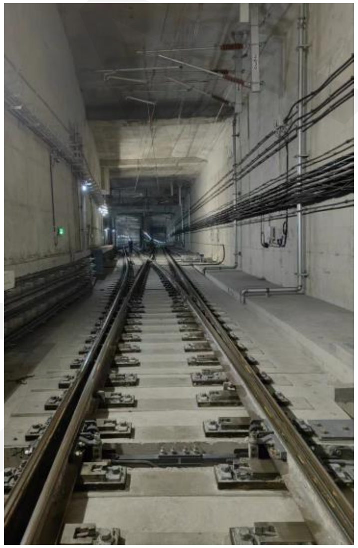
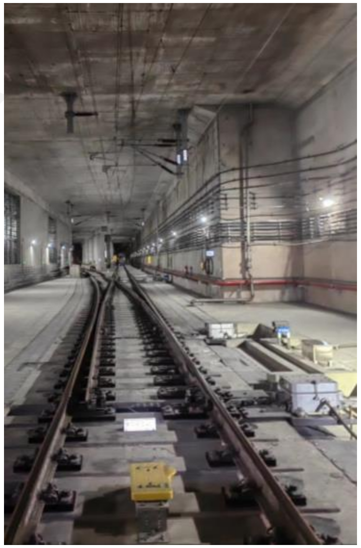
Urban rapid rail transit turnouts



Turnout A	Turnout B	Turnout C	Turnout D	Turnout E
No. 9	**No. 9**	**No. 12**	**No. 12**	**No. 12**
Fixed frog	Fixed frog	Fixed frog	Movable-point frog	Movable-point frog
Ordinary	Damping fastener	Floating slab	Ordinary	Floating slab
V=(84→58) km/h	V=100 km/h	V=100 km/h	V=150 km/h	V=150 km/h
8-car Type A trains	8-car Type A trains	8-car Type A trains	4-car Type A trains	4-car Type A trains

Field tests with operational trains measured vibrations at turnout rails and tunnel walls.

Conclusions

- **At speeds >100 km/h, leading and trailing cars induce strong low-frequency (0–20 Hz) vibrations at turnouts**

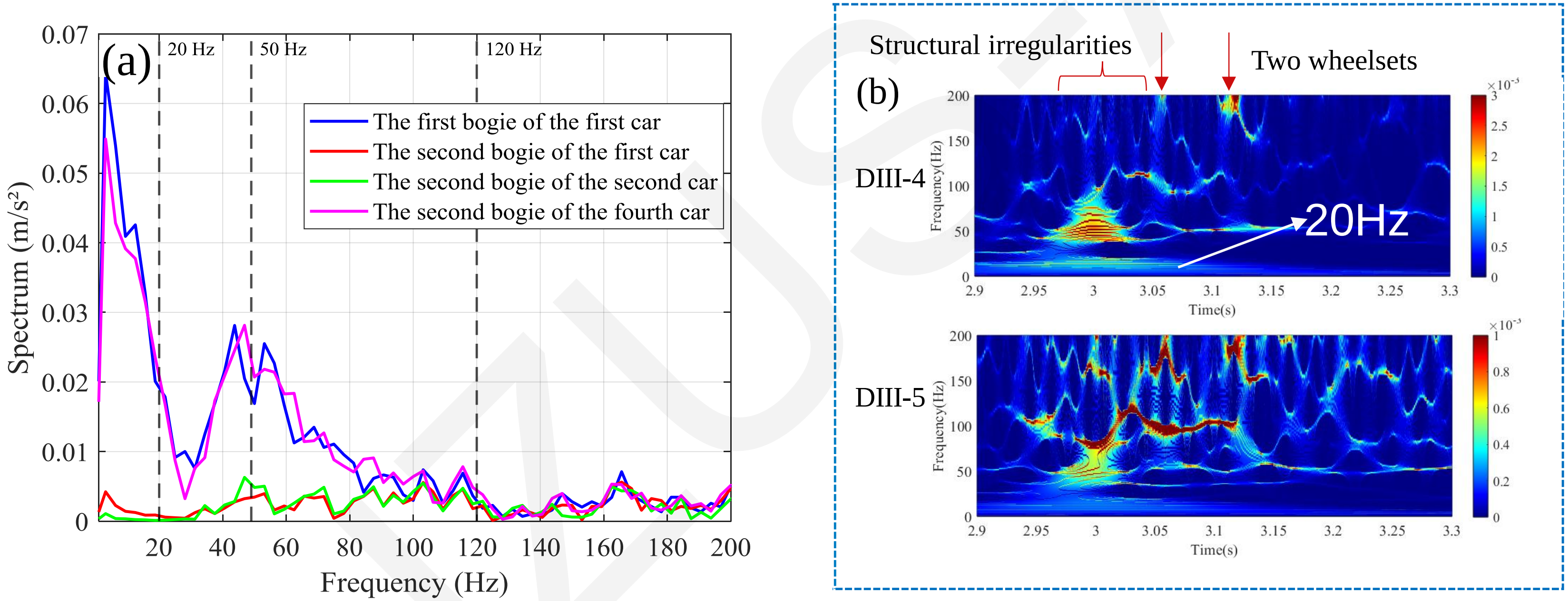


Fig. 1. (a) Acceleration spectra of different cars;
(b)Time–frequency results of tunnel wall vibrations.

Conclusions

- **At speeds >100 km/h, vibration levels induced by different cars at turnouts can vary by up to 50 dB**

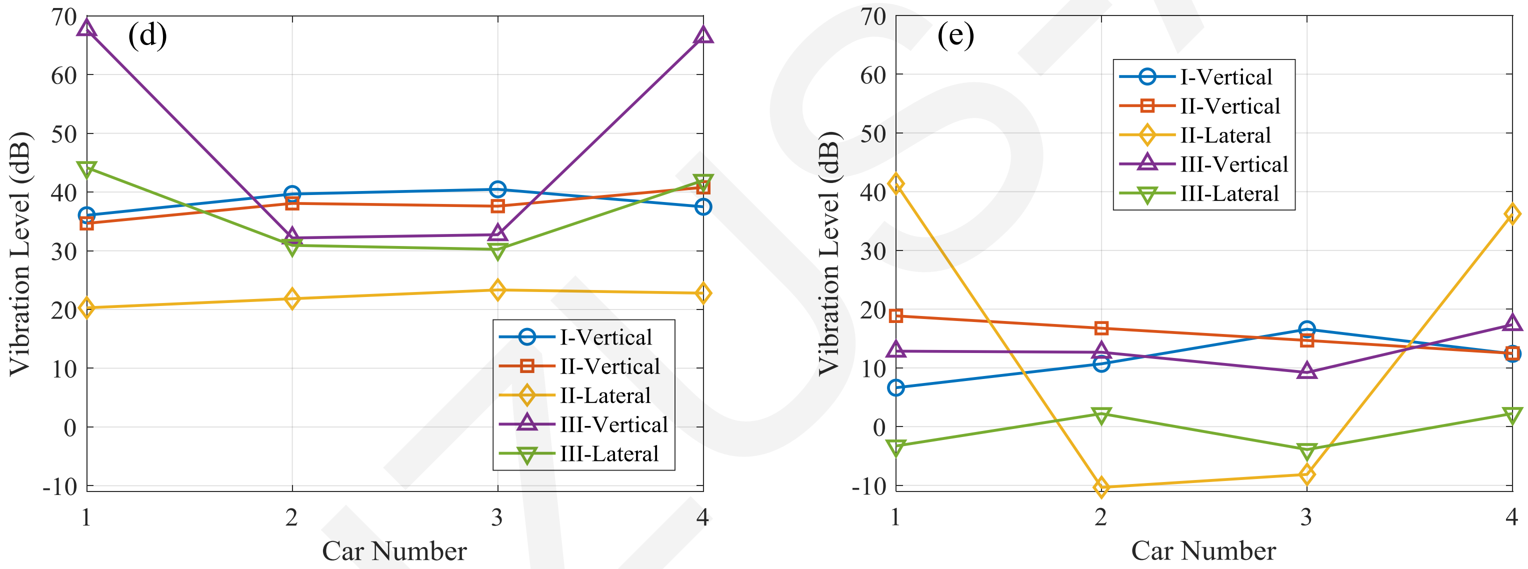


Fig. 2. Vibration levels on the tunnel wall caused by different carriages passing through the turnout, where (d)-(e) represent turnouts D-E respectively.

Conclusions

- **The low-frequency energy is stronger at the beginning and end of the load transfer, rather than in the middle**

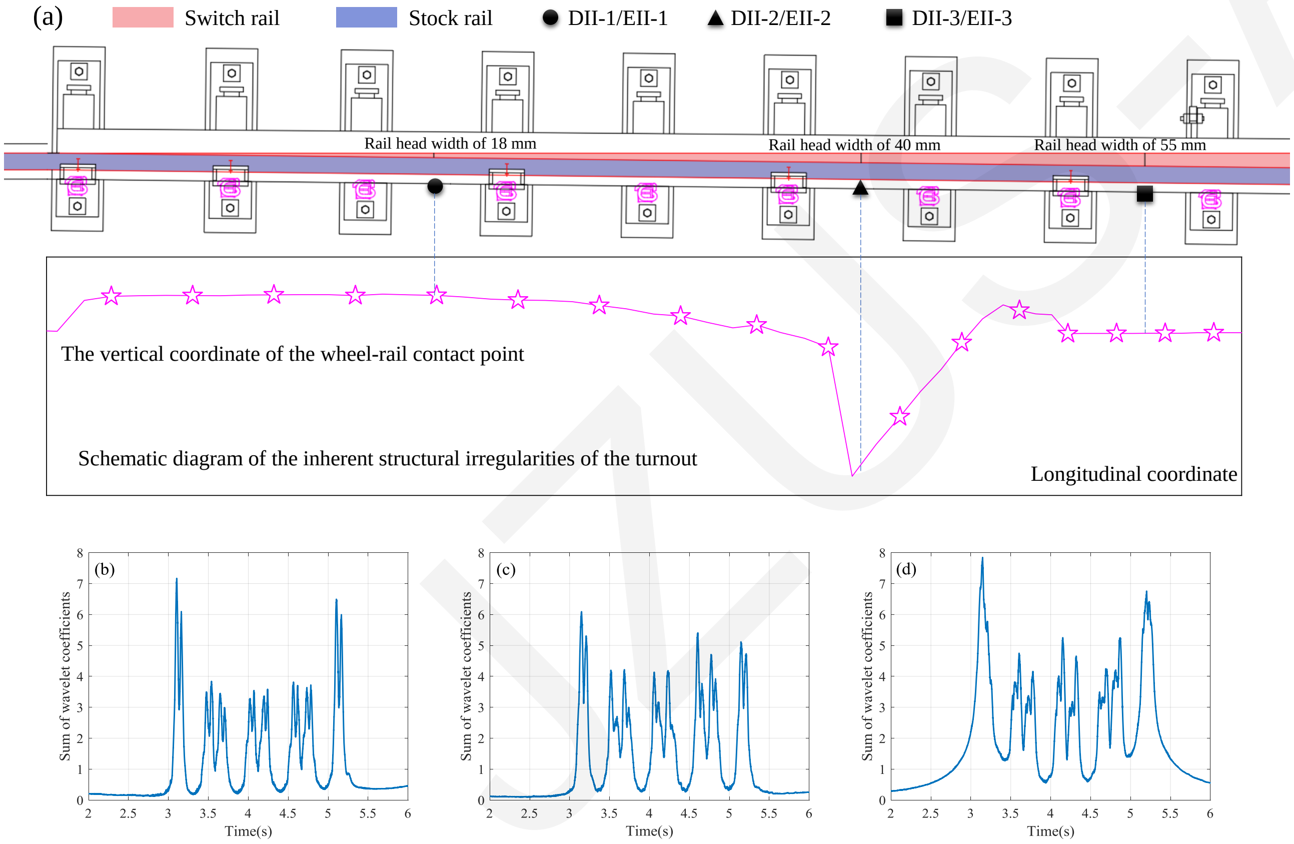
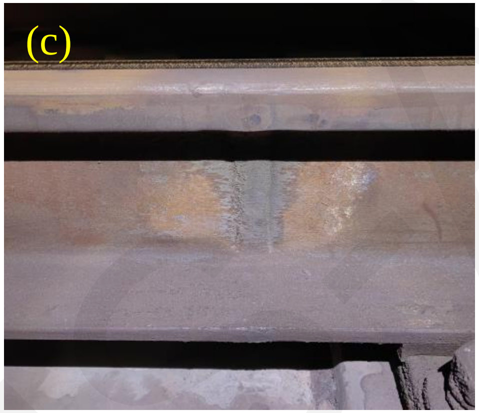


Fig. 3. Low-frequency vibration energy before, during, and after wheel-load transfer.

Vibration control in the turnout area should consider the entire wheel load transition process.

Insights

Experiments suggest using welded joints and movable-point frogs to reduce turnout vibrations, with focus on controlling <20 Hz vibrations at speeds >100 km/h.



Welded joints

Movable-point frogs

Future vibration mitigation