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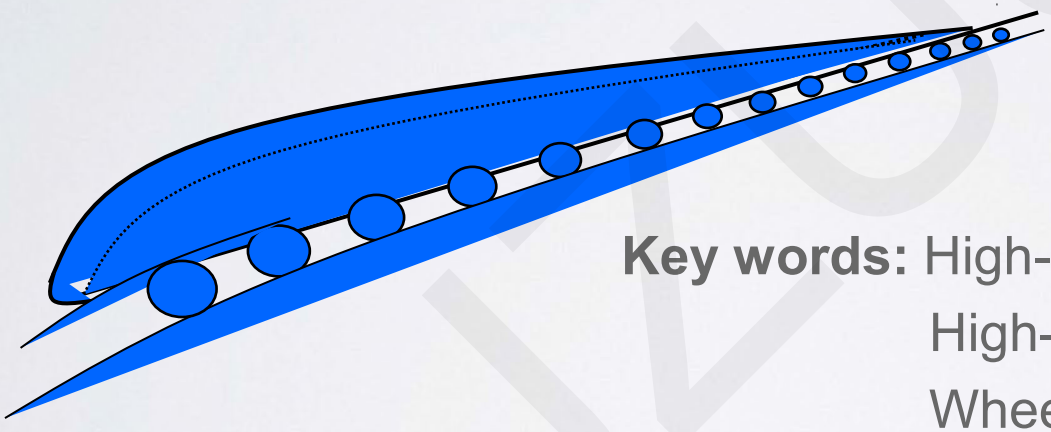
Key problems faced in high-speed train operation



Key words: High-speed railway,
High-speed train,
Wheel/rail wear,
Train/Track big coupling system dynamic model,
Wheel/Rail rolling contact theory,
Vibration-noise reduction technology

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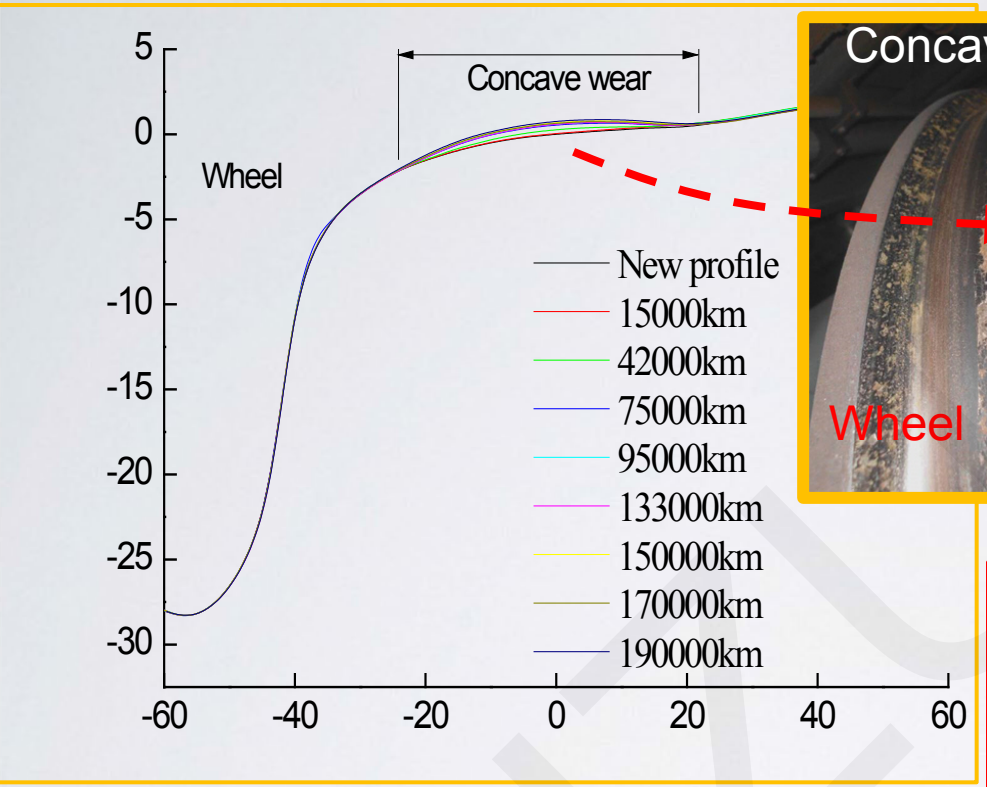
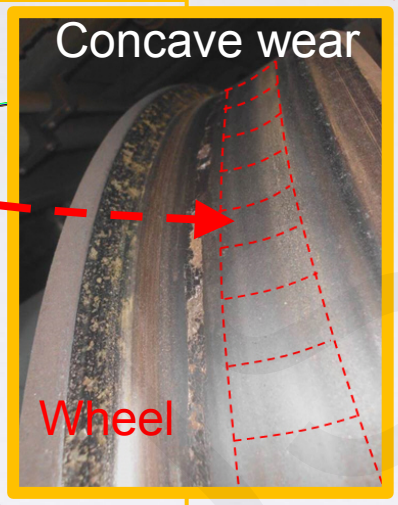
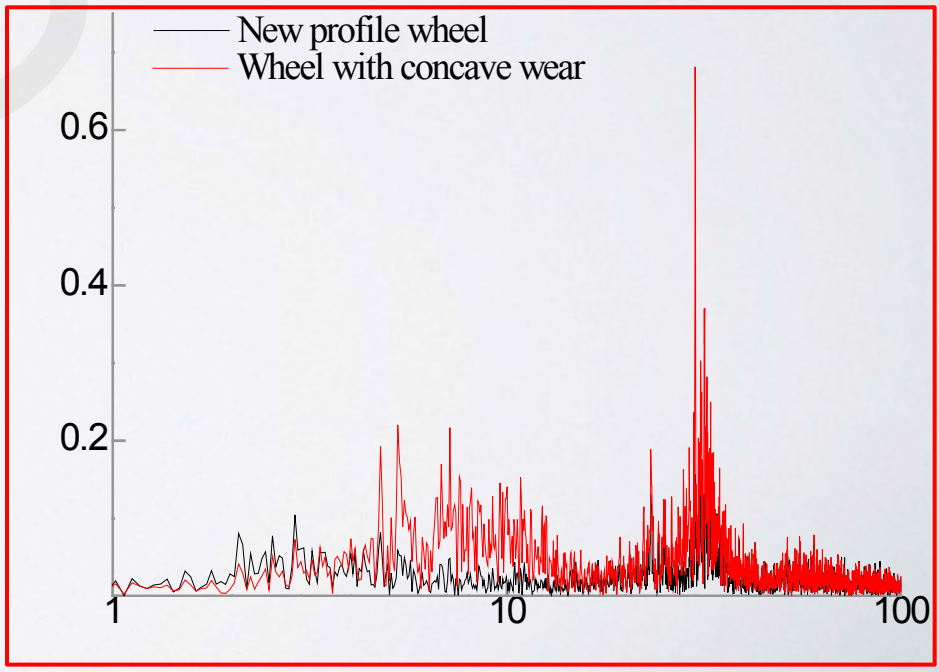
Fast wheel tread concave wear causing an oscillation of vehicle



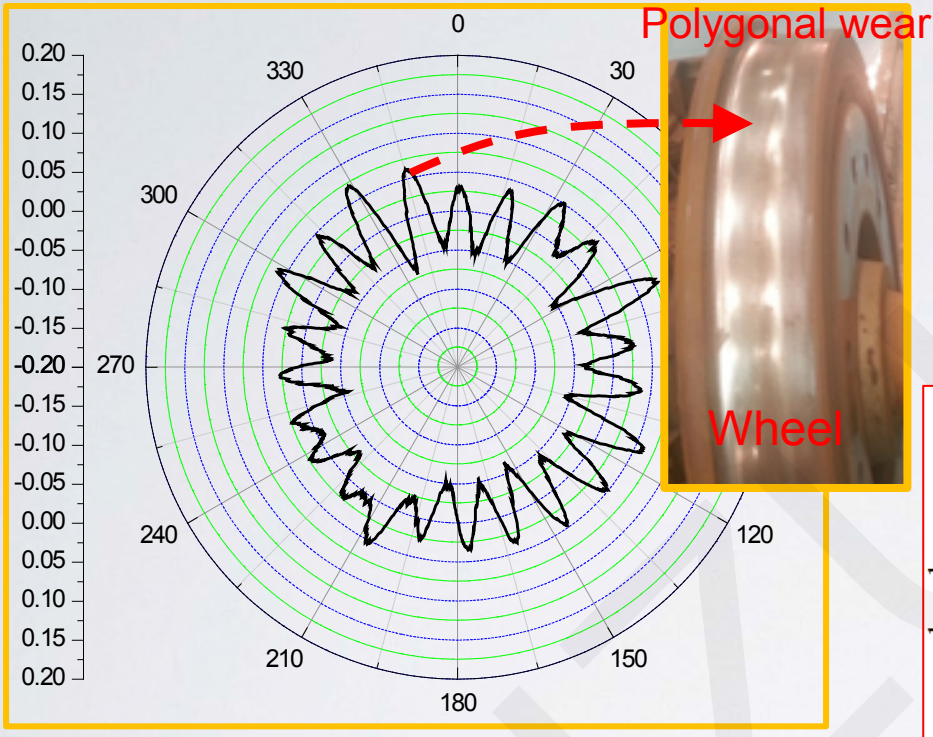


Measured accumulated concave wear



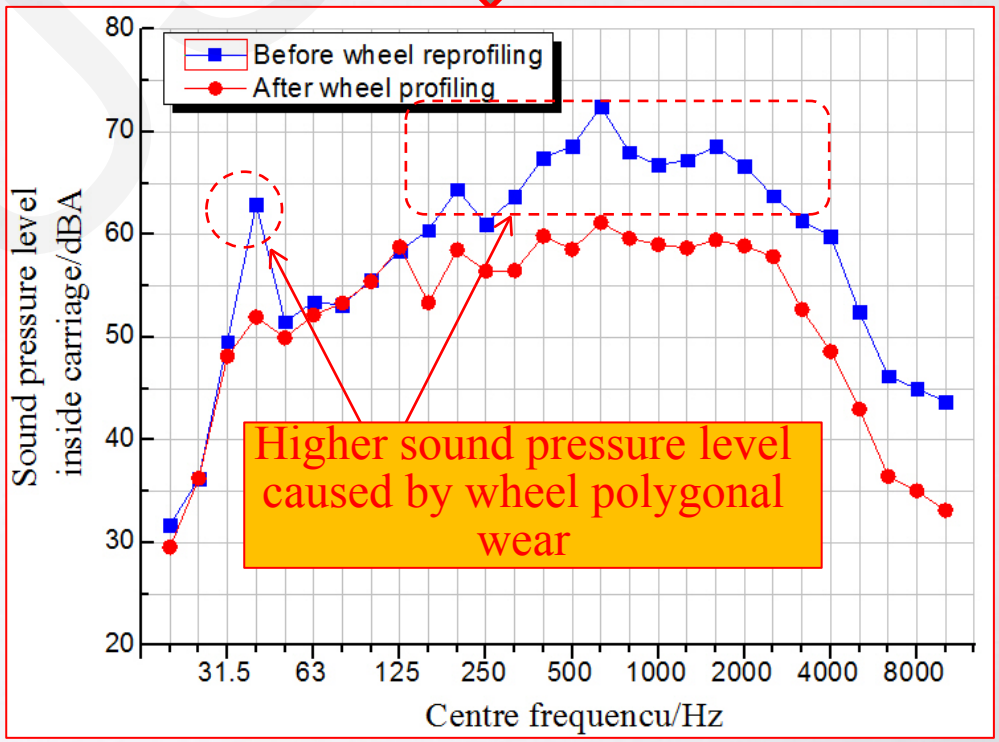
Measured lateral oscillation caused by concave wear

Fast wheel polygonal wear causing strong vibration and noise of vehicle

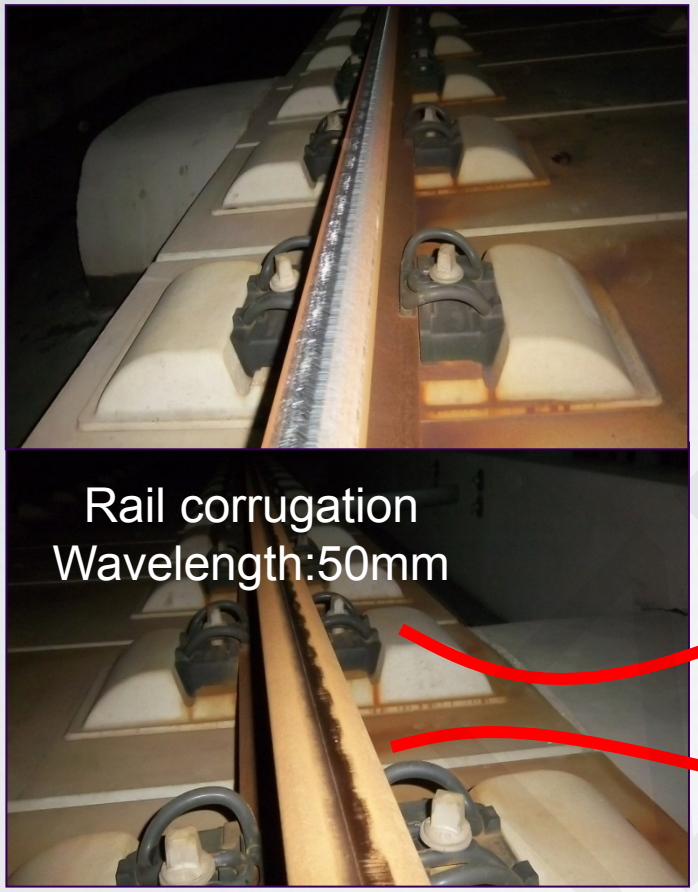


Measured polygonal wear

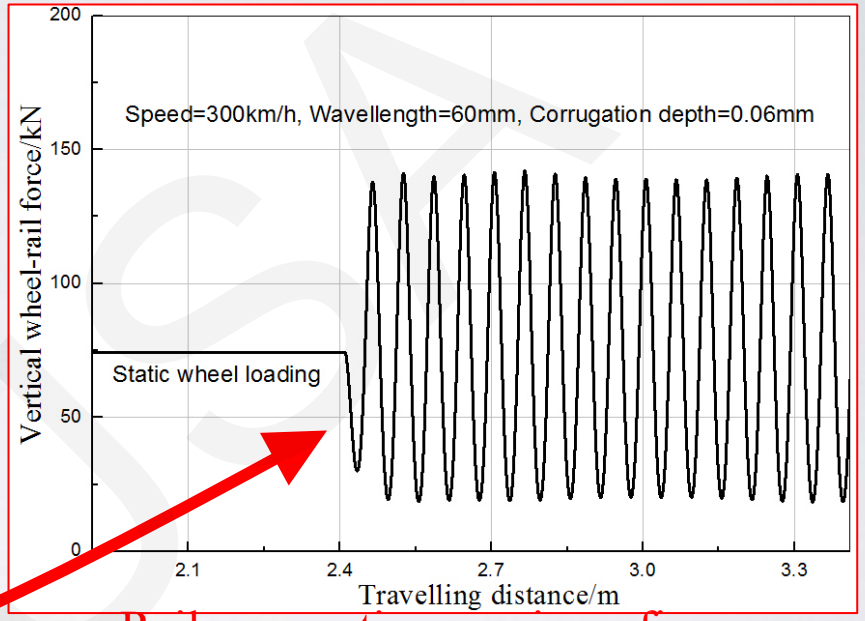
Measured sound pressure level inside carriage



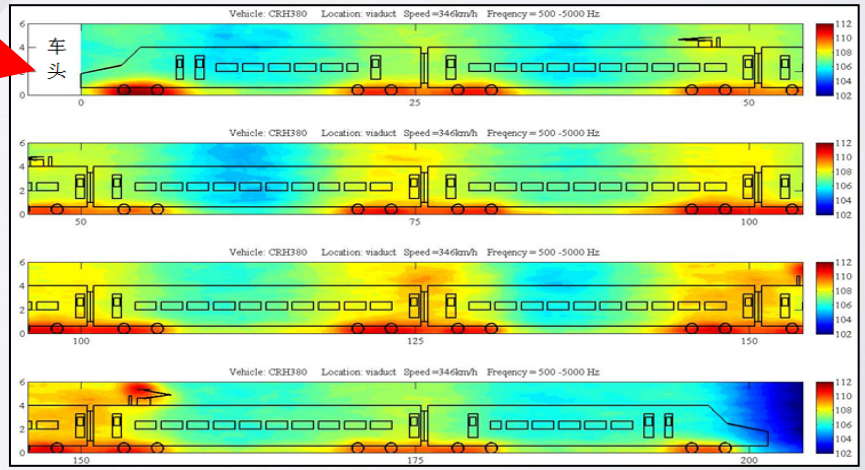
Rail corrugation causing strong vibration and noise of wheel/rail



Photos of high-speed track

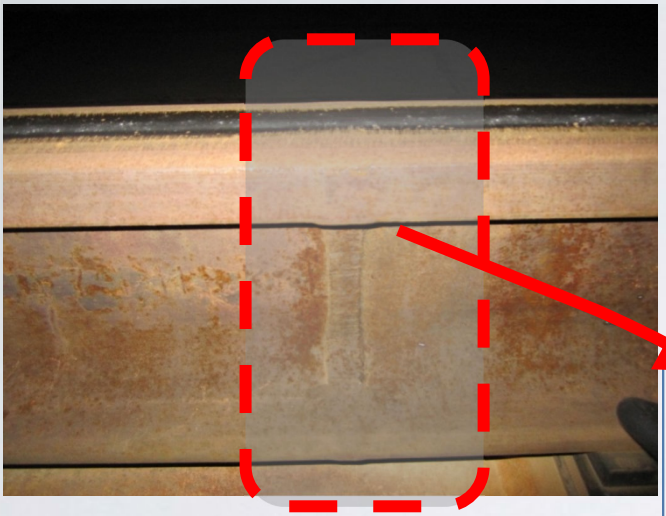


Rail corrugation causing a fierce oscillating of vertical wheel/rail force



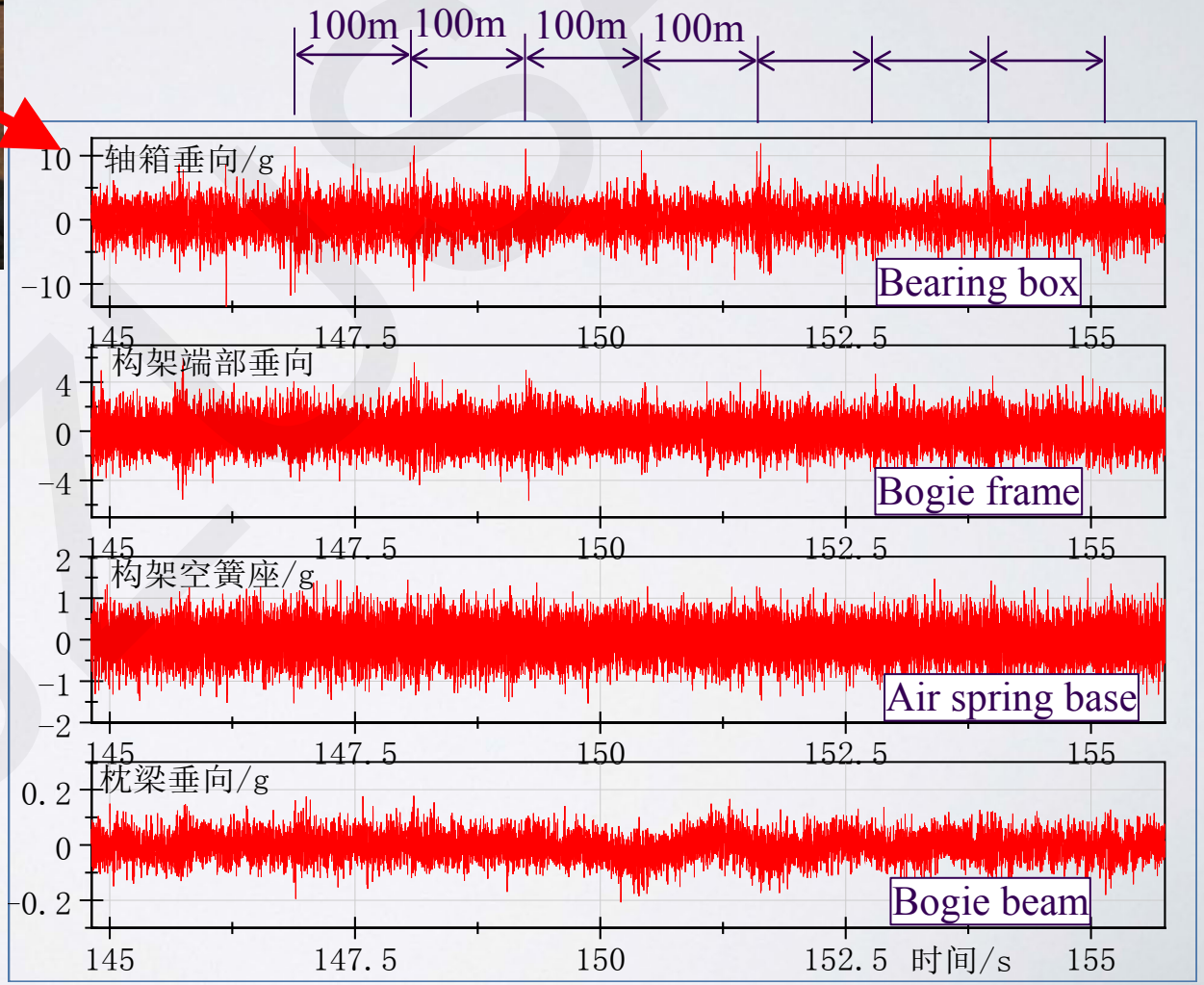
Measured result:
Main noise souces —— Wheels/rails

Rail welding causing vibration of high-speed trian



Rail welding
Rail length:100m

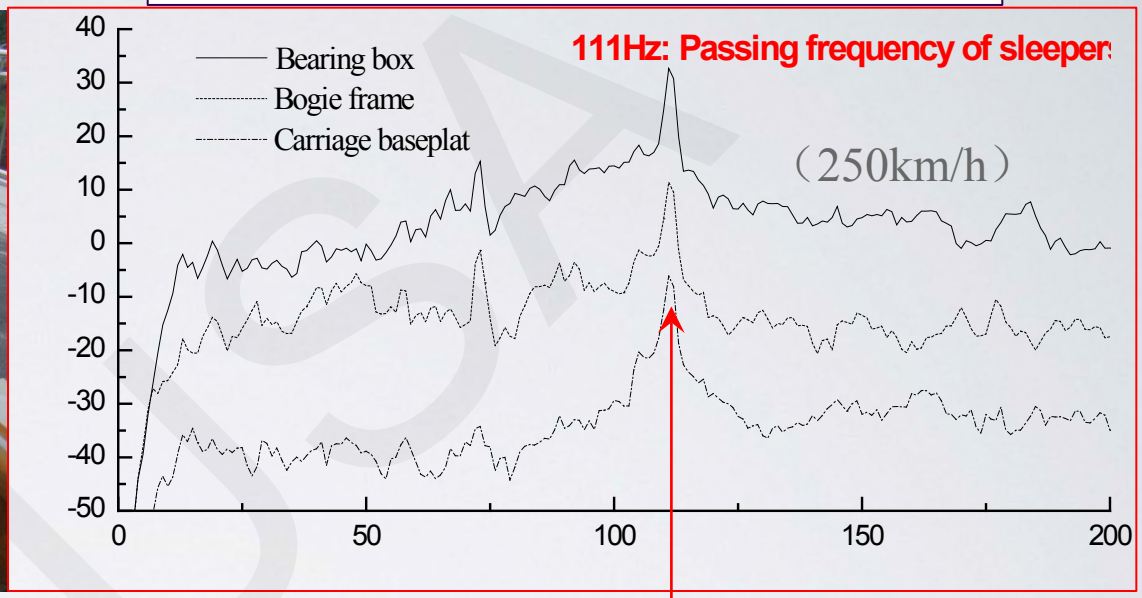
Measured accelerations of bogie
Speed:300km/h



Sleepers causing vibration of high-speed trian

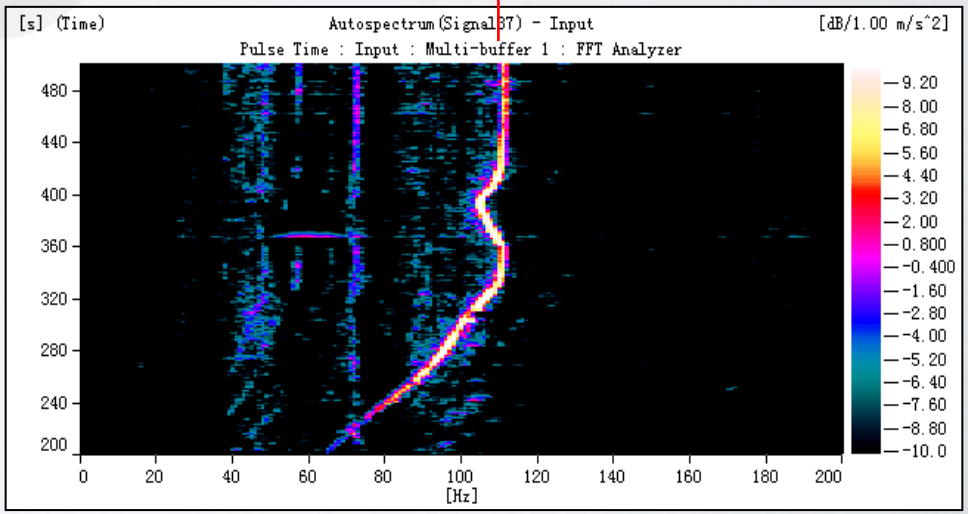


Measured acceleration of vehicle



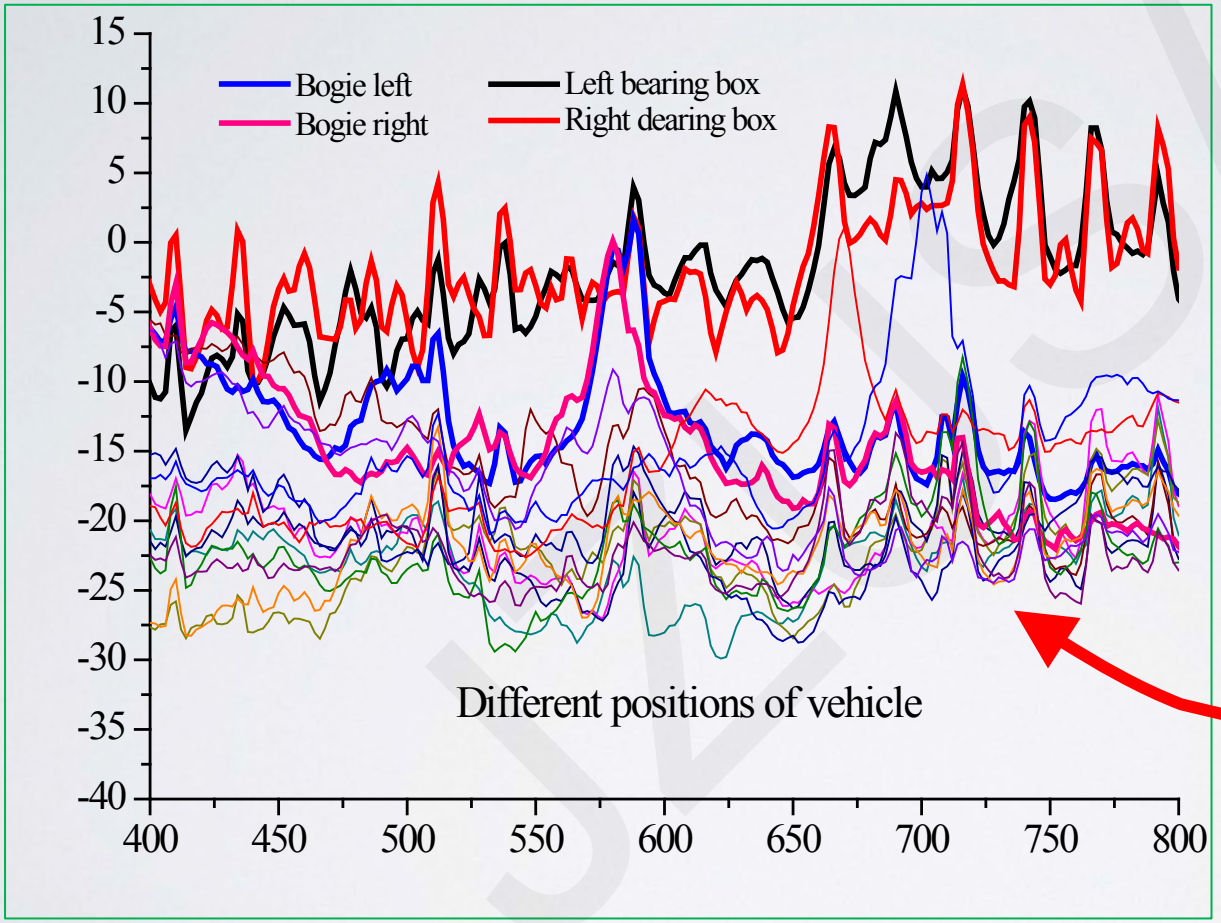
Effect of characteristics of track with high stiffness on vehicle's behavior

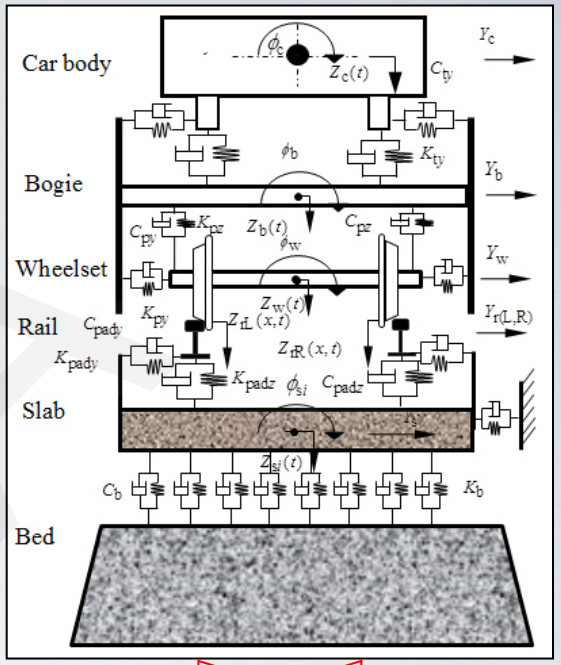
加速过程

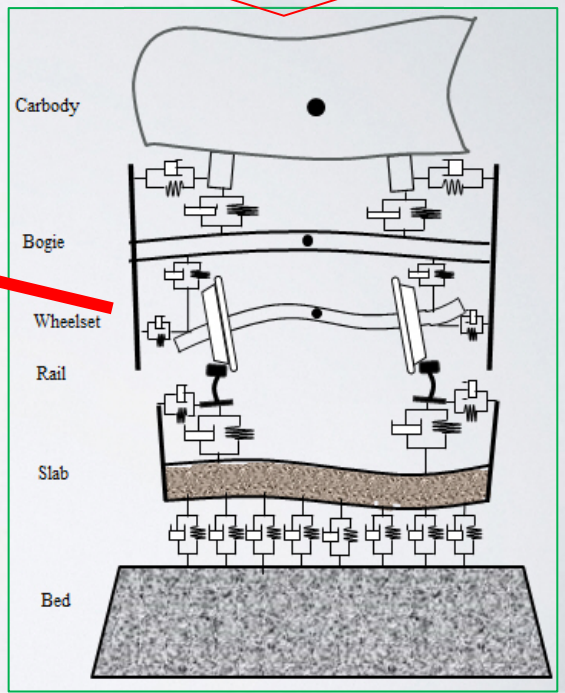


Vibration frequency increases as speed increases

- Train-track coupling big system dynamics model with considering influence of structure rigid-flexible coupling on train-track behavior







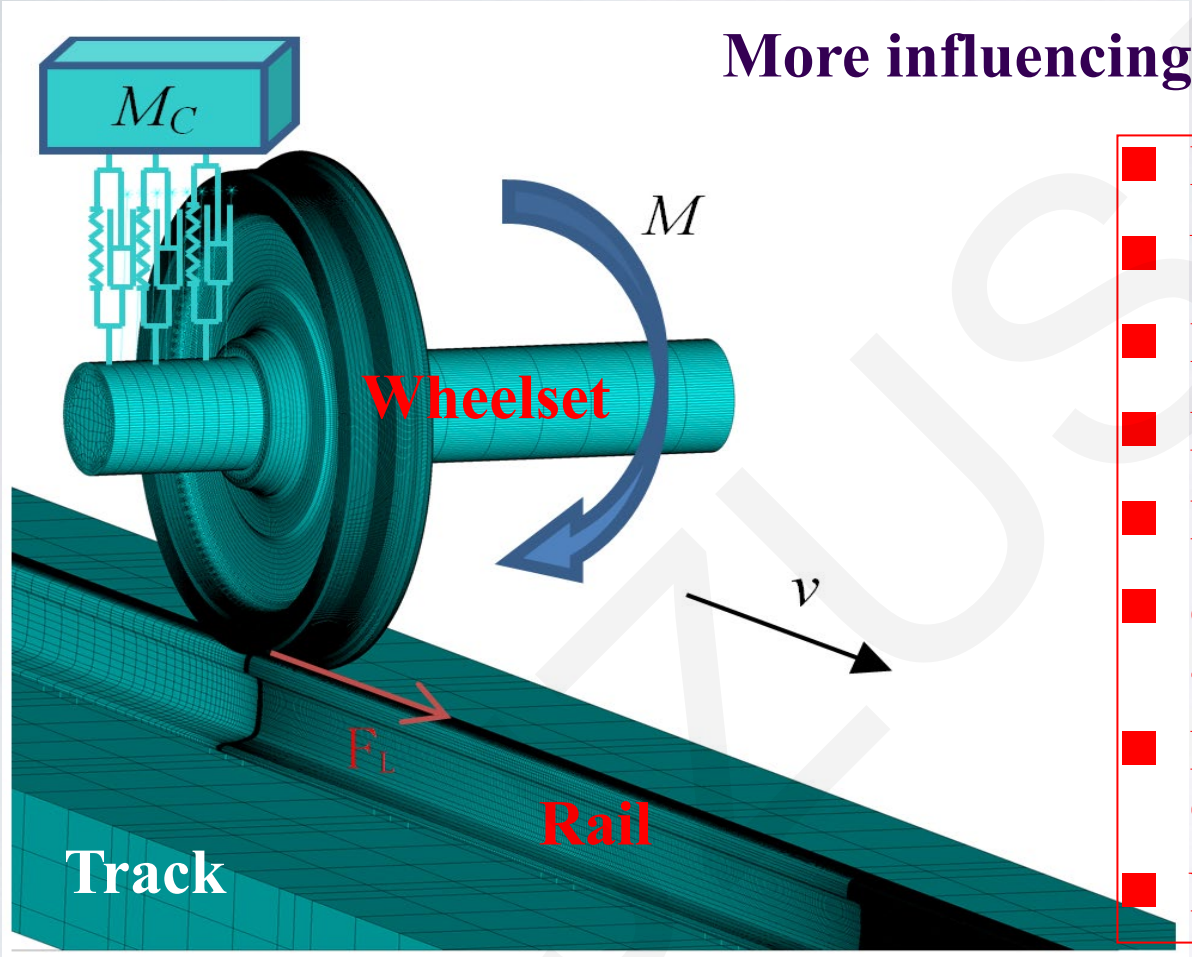
Measured vibration of vehicle parts with high frequencies due to flexible deformation of the parts

Purpose of the model

Train-track coupling big system dynamics model is developed to consider the influence of structure rigid-flexible coupling on train-track behavior. This model is used to help making optimization design of train and track structure matching to inhibit the lateral oscillation of the vehicle due to wheel tread concave wear. Also it is used to help understanding the mechanism of wheel polygonal wear of high-order.

High-speed wheel/rail rolling contact theory model

Bogie and carriage



More influencing factors to be considered

- High-speed rolling
- Unsteady behavior
- Effect of vehicle and track
- Real geometry
- Elastic-plastic coupling
- environment temperature and roughness
- Defects existing and their effects
- Noise generation

This model is used to understand damage mechanism of high-speed wheel/rail.

Conclusions

- For current and future operation of high-speed train, all-round tracking tests and statistical analysis should be carried out, in order to grasp the main factors influencing the wear and rolling contact fatigue of wheel-rail, and train-track behavior.
- Train-track coupling big system dynamics theory is developed to consider, in high speed running state, the influence of structure rigid-flexible coupling and fluid-structure interaction on train-track behavior.
- The design method for wheel/rail geometric profile matching needs to be improved. Research on new wheel/rail modification technology should be conducted. Comprehensive material testing for wheel/rail use should be carried out. Wheel/rail contact surface processing technology needs to be improved with corresponding field test research carried out at the same time.
- 3D elastic-plastic rolling contact model of wheel-rail should be improved. There should be focus on computational efficiency, wheel/rail material defect effect, contact surface state and wheel/rail environmental impact.
- Broad-based and in-depth theory, technology and measures of vibration attenuation and noise reduction for high-speed train and track coupling systems should be developed.