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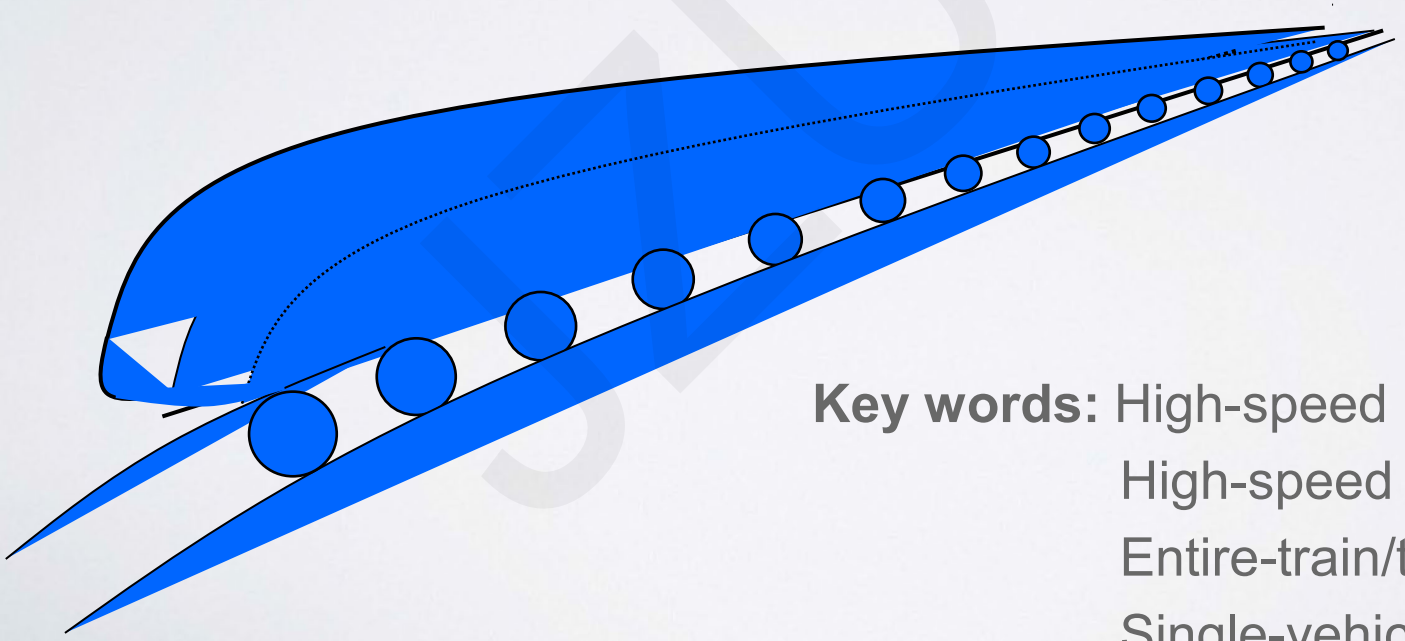
A 3D model for coupling dynamics analysis of high-speed train/track system



Key words: High-speed railway, High-speed train, Track, Entire-train/track model, Single-vehicle/track model

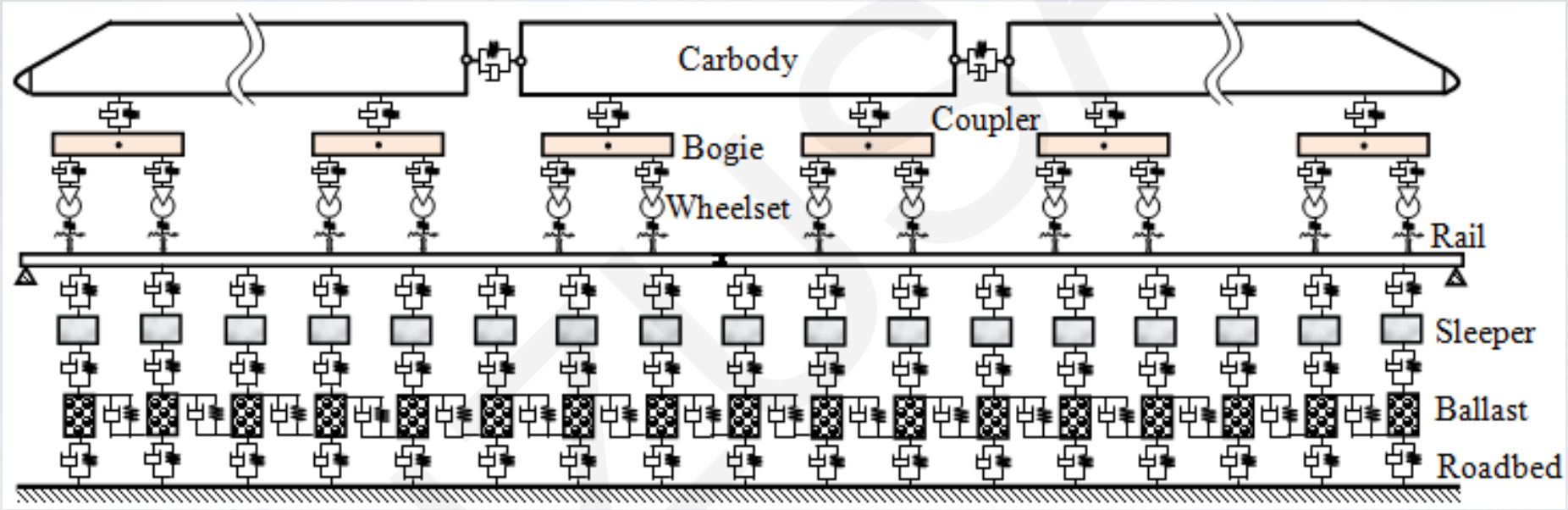
Chinese High-speed railways and its challenge

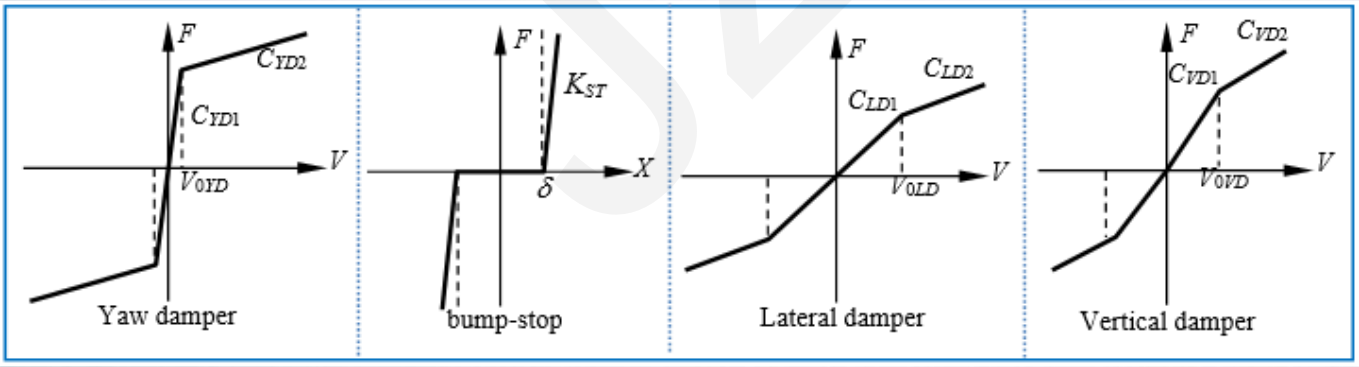
Opportunity

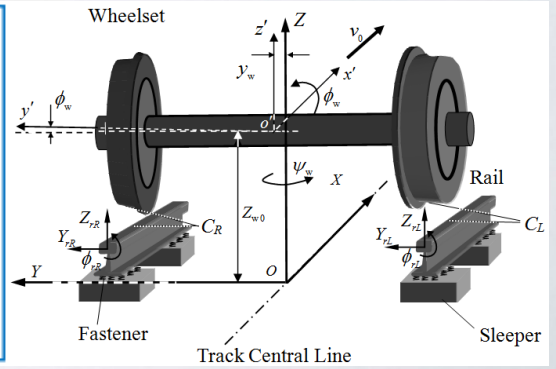
Challenge

Three dimensional train/track model

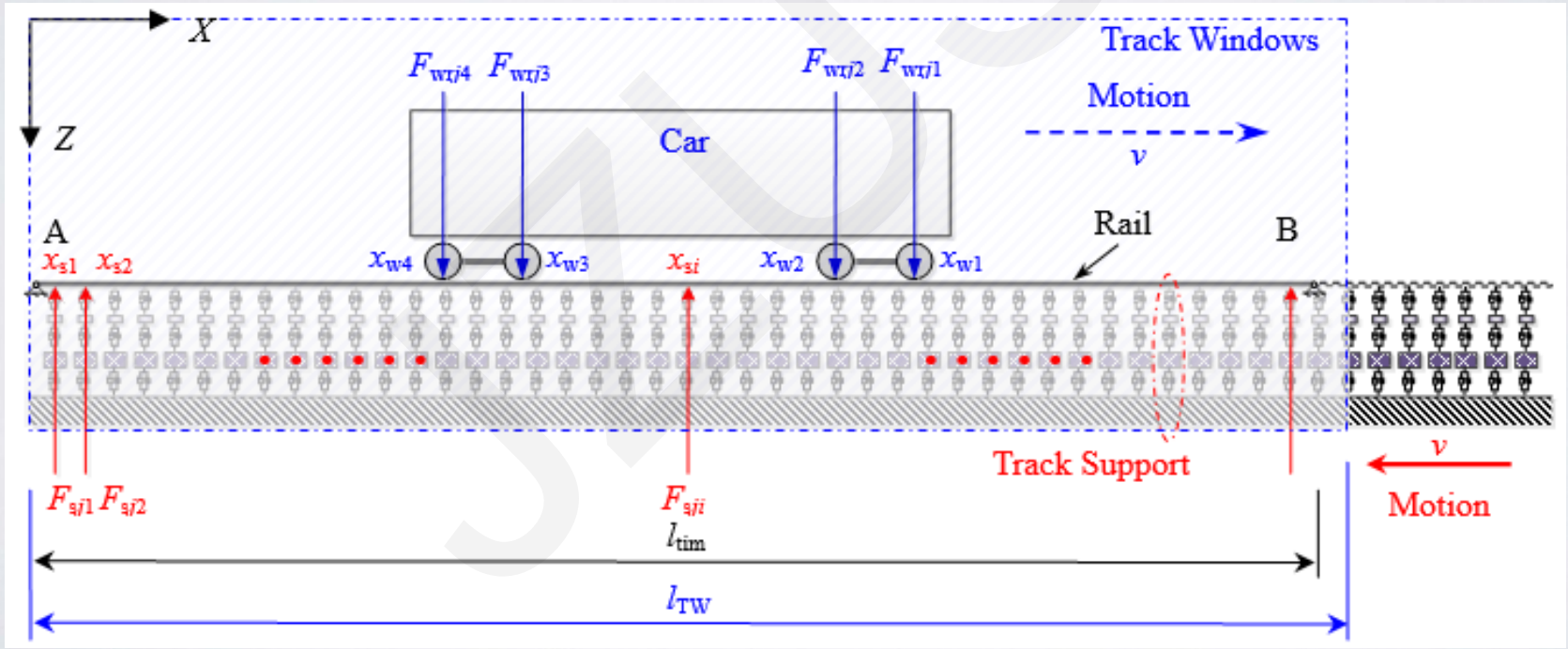
Vehicle | **Inter-vehicle connection** | **Wheel/rail contact** | **Track**







Train/track excitation model: “Tracking Window”



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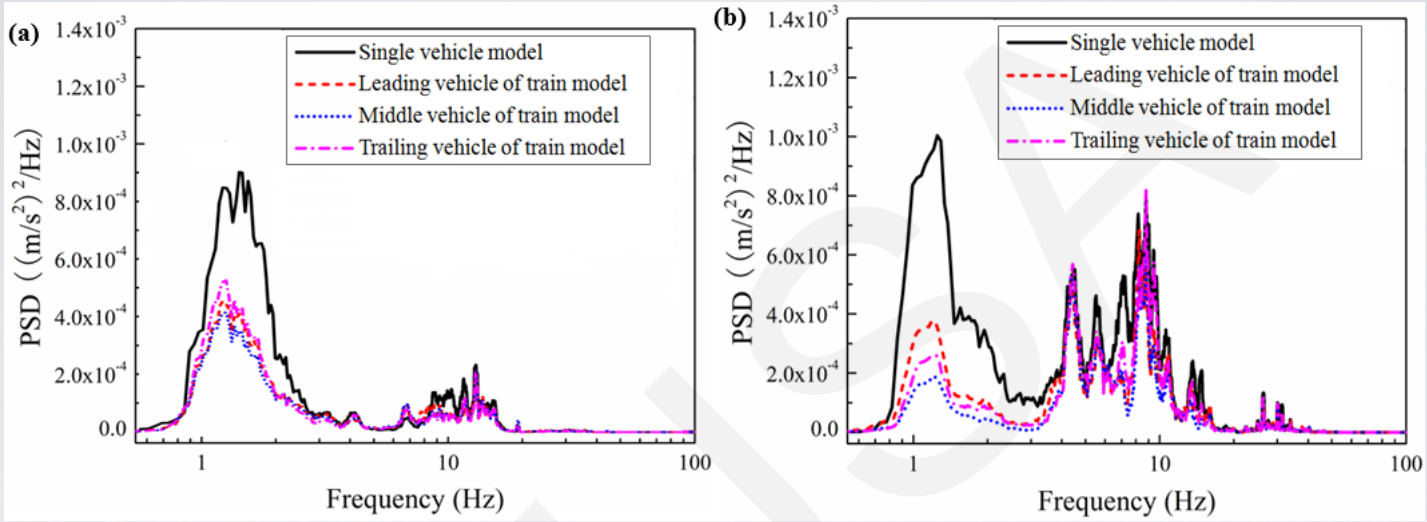
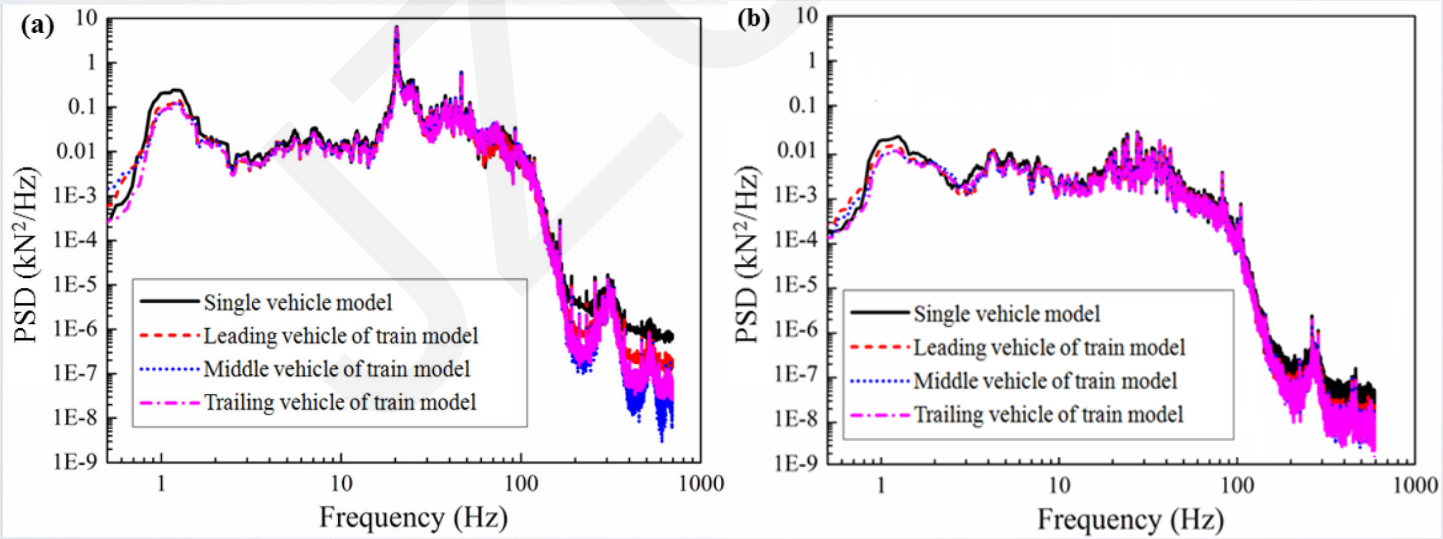
Numerical Results

1）Comparison of vibration frequency components



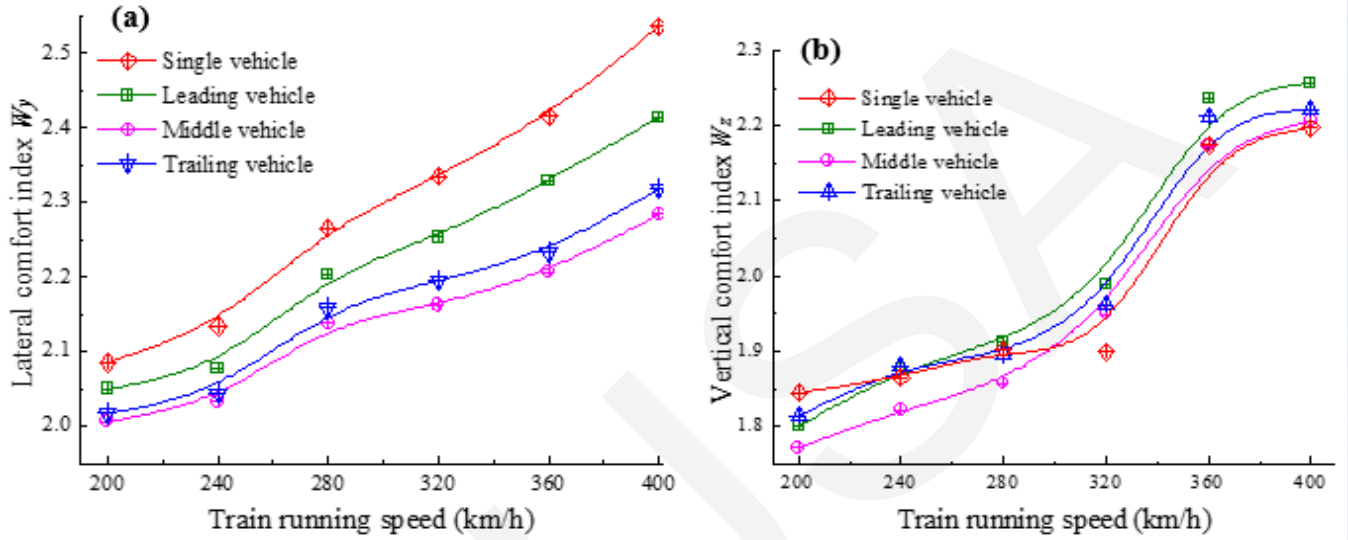
(a) Car body vertical acceleration PSD; (b) Car body lateral acceleration PSD



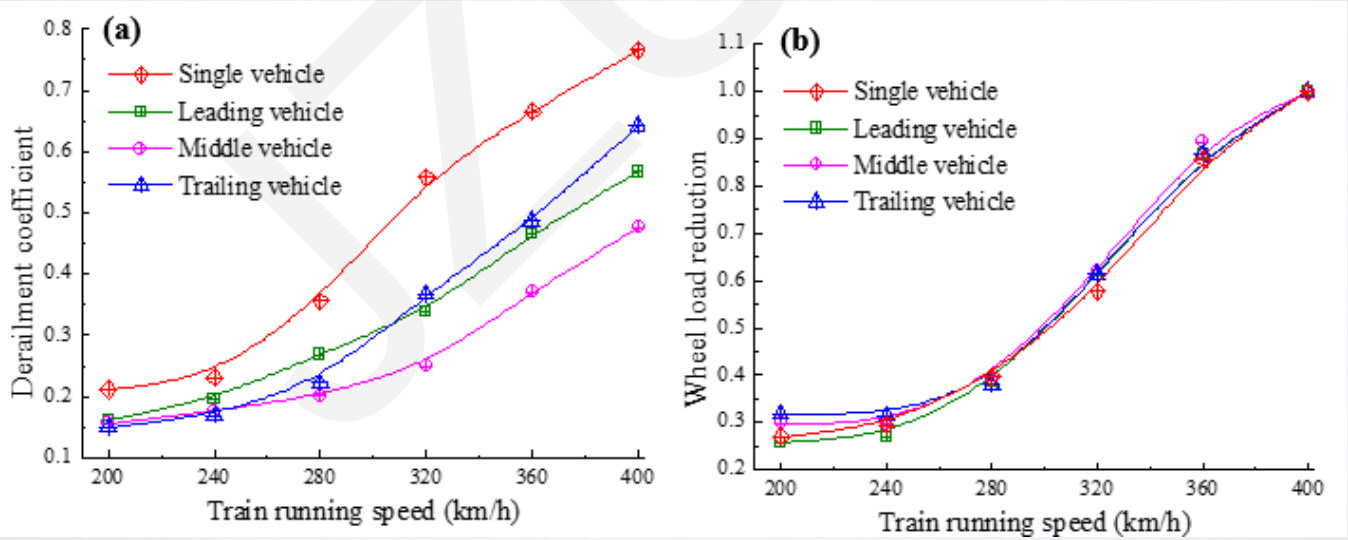
(a) Wheel/rail vertical force PSD; (b) Wheel/rail lateral force PSD

Numerical Results

2）Comparison of ride comfort and curving performance



(a) Lateral Sperling comfort index; (b) Vertical Sperling comfort index



(a) Derailment coefficient; (b) Wheel load reduction

Conclusions

- There is a distinct difference in the vibration frequency components calculated between VTM and TTM. The inter-vehicle connections of a train have an important influence on the dynamic behavior of a car body in the frequency range below 20 Hz.
- The lateral comfort index calculated by VTM is greater than that calculated by TTM. The vertical comfort indexes obtained by using the two models are close when the train operates on a curved track of large radius, but the difference is very large when the train operates on a small radius curved track.
- The difference of derailment coefficients obtained by the two models is very large when the train negotiates curved tracks with large radii. It is obvious that the derailment coefficient is overestimated by using VTM, and using TTM is more reasonable in practical engineering applications. The wheel load reductions obtained by the two models have a good agreement when the train operates on a curved track with a large radius. If the radius of the curved track is small, the difference is obvious.
- The difference in lateral dynamic behavior is relatively large when looking at different vehicle locations in a high-speed train, but the difference in vertical dynamic performance is relatively small when a high-speed train operates on a usually tangent track. Among the vehicles of a long train, the results calculated by TTM show that the ride comfort and curving performance of the intermediate vehicles is better than those of the leading and trailing vehicles because the two ends of the intermediate vehicles are restrained by their neighbors.