Journal of Zhejiang University-SCIENCE A

Study on the safety of operating high-speed railway vehicles subjected to crosswinds

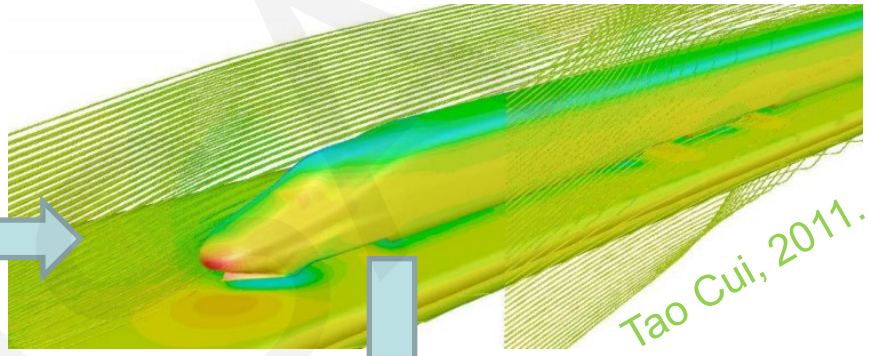
Key words: Railway, Railway safety, High-speed train, Crosswind, Safety boundary, Dynamics

Cite this as: Xinbiao XIAO, Liang LING, Jiayang XIONG, Li ZHOU, Xuesong JIN, 2014. Study on the safety of operating high-speed railway vehicles subjected to crosswinds. *Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)*, 15(9):694-710. [doi:10.1631/jzus.A1400062]

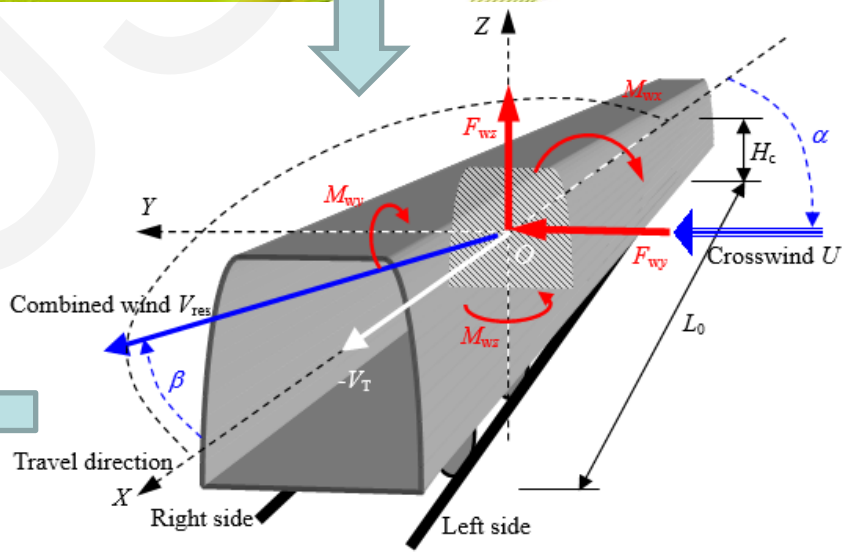
Crosswind stability of railway vehicles

Crosswinds on high-speed train

CFD simulations



Train blown over by crosswinds



Muti-body dynamic simulations

Fig. 1. Crosswind stability analysis of railway vehicles

Numerical Method

Three dimensional vehicle-track model in crosswind

- **Vehicle**
- **Aerodynamic Forces**
- **Wheel/rail contact**
- **Track**

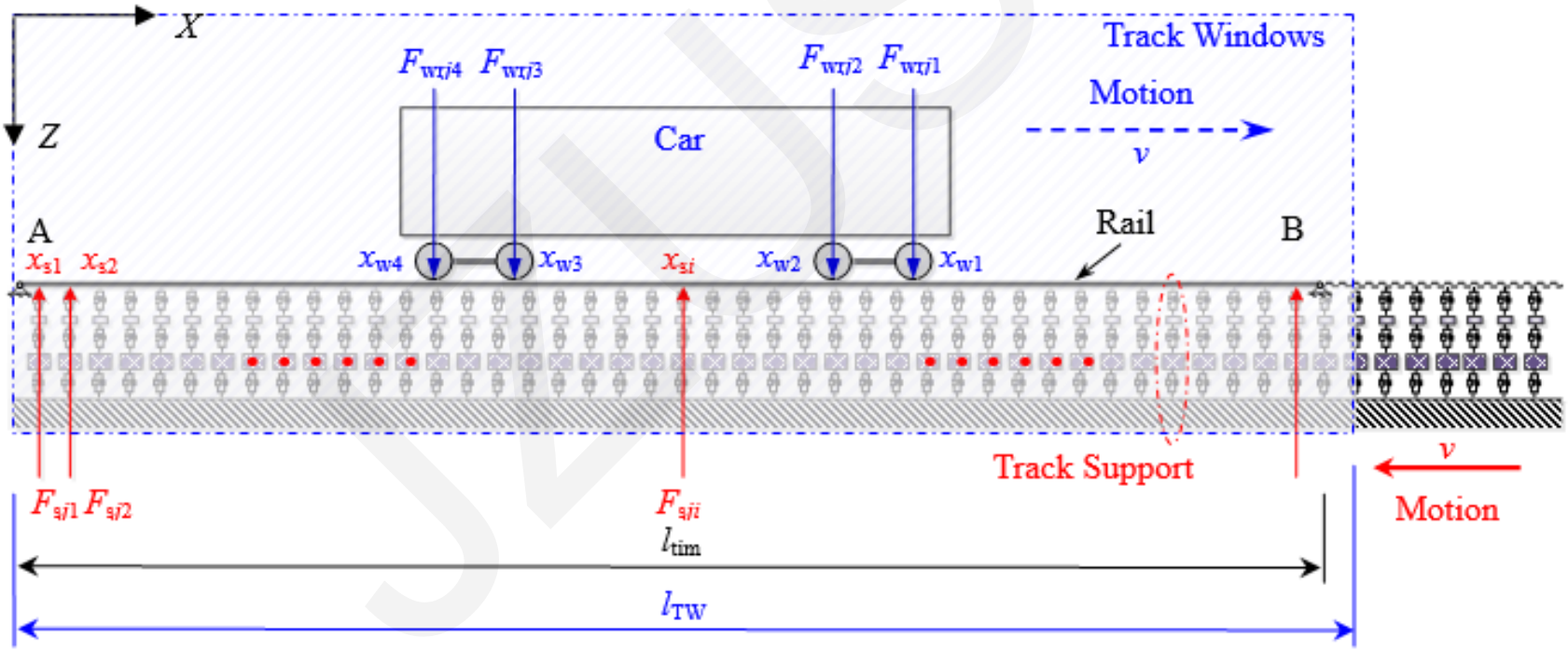


Fig. 2. Vehicle–track model.

Analytical Method

Strategy of study on safety operation boundaries

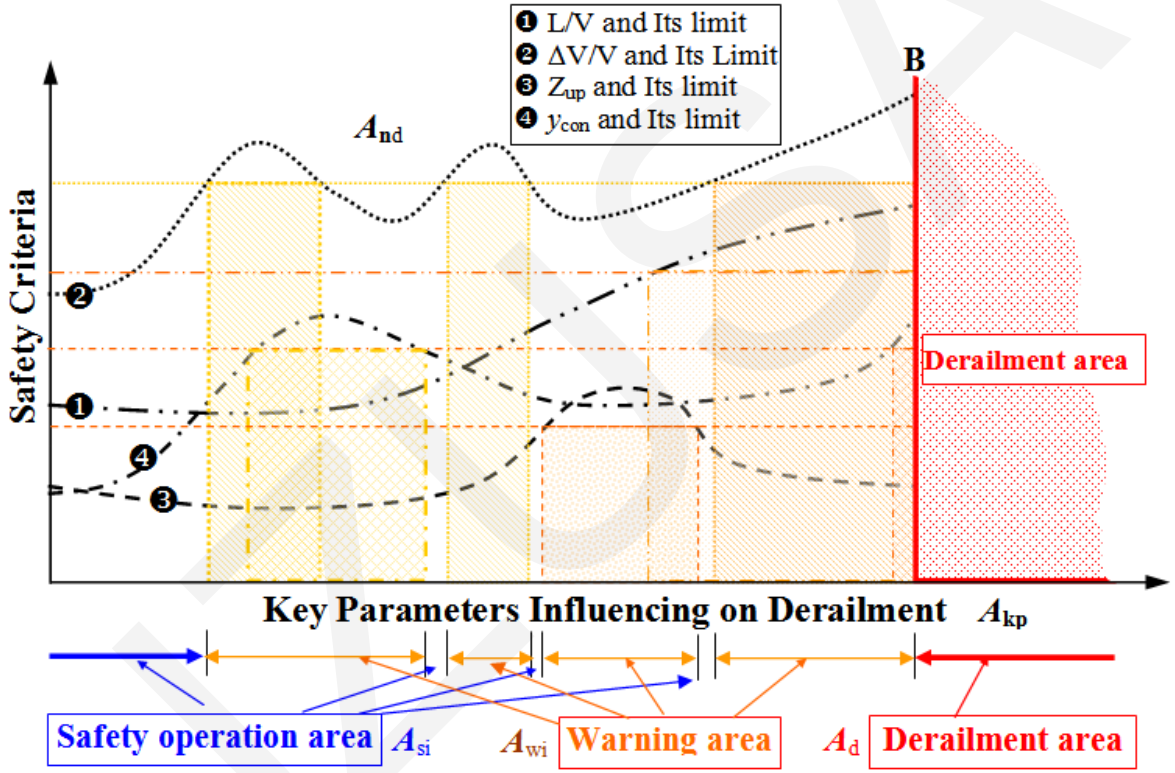


Fig. 3. Schematic of safety operation boundaries of high speed trains.

X. Jin et al., International Journal of Rail Transportation 1(1-2):87–108 (2013).

Numerical Results

■ Evaluation of operational safety area for high-speed vehicles under crosswind excitations

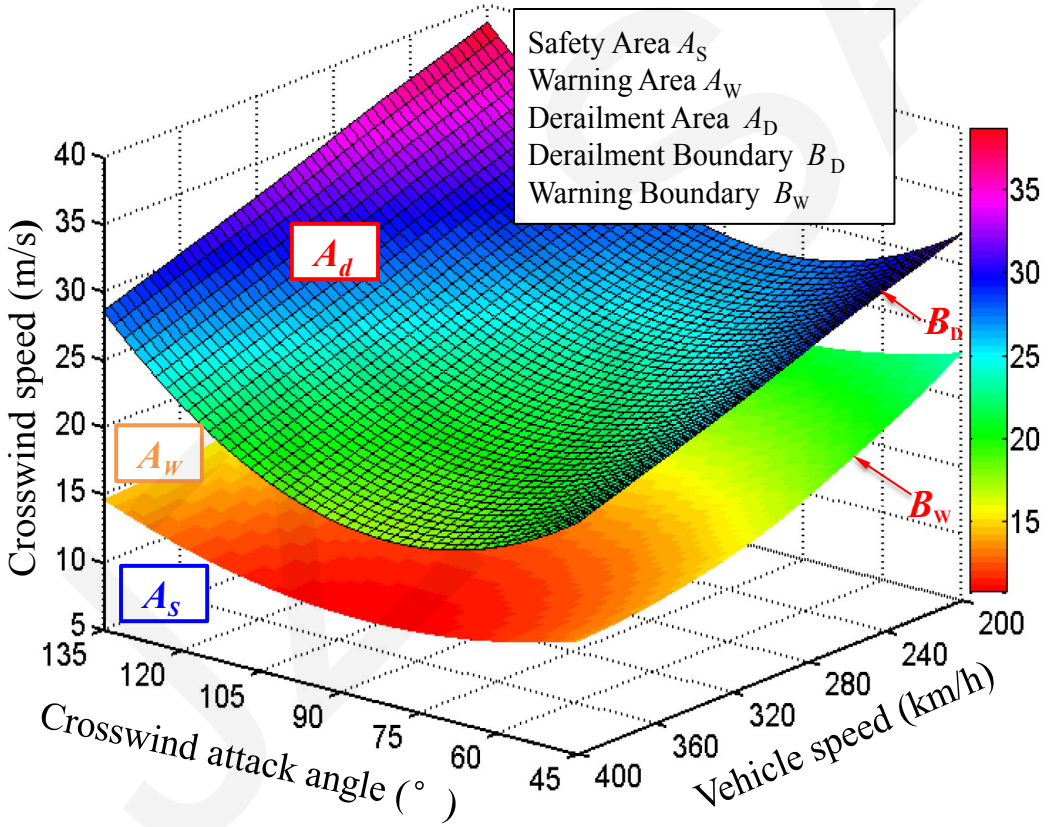


Fig. 4. Derailment and safe operation areas of high-speed vehicles in crosswinds.

Conclusions

- Flange climbing does not play a key role in the likelihood of derailment of high-speed railway vehicles subjected to strong crosswinds. Overturning usually occurs when a vehicle enters into a crosswind scenario.
- Crosswind attack angles of 75° to 90° correspond to the worst-case scenarios and have the greatest influence on the likelihood of derailment of railway vehicles.
- The wheelset loading reduction $\Delta V/V$ determines the boundary of the common safety area, which is the smallest area defined by the three key factors of influence. This area is considered the safety area for high-speed trains operating in crosswinds. The three key factors of influence are the vehicle speed, the crosswind speed, and the attack angle.
- Unsteady models, such as the "Chinese Hat" wind gust model (CEN, 2010) or the "stochastic process" crosswind model (Cheli et al., 2006; Xu and Ding, 2006; Railway Group standard, 2000), should be considered for use in future research.