

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

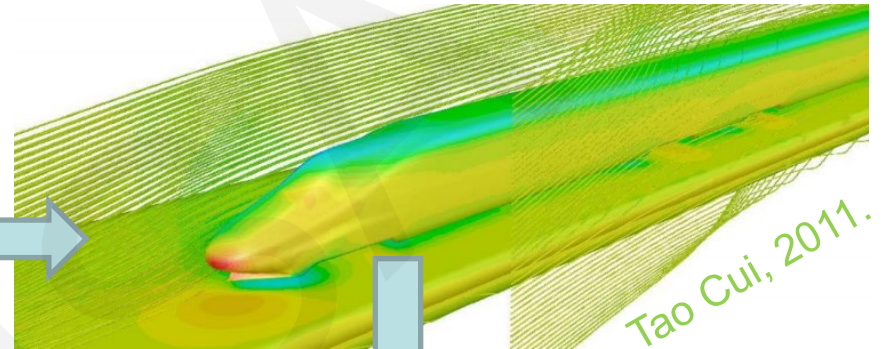
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Crosswind stability of railway vehicles

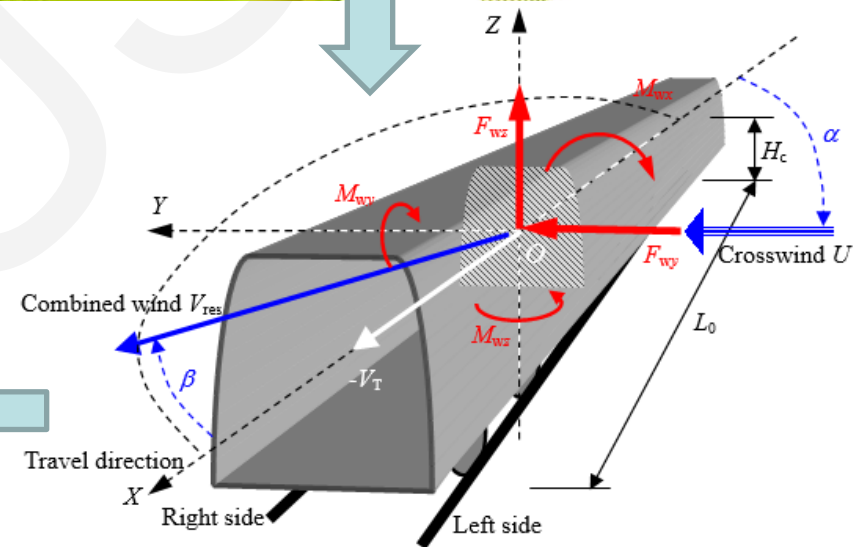
Crosswinds on high-speed train



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

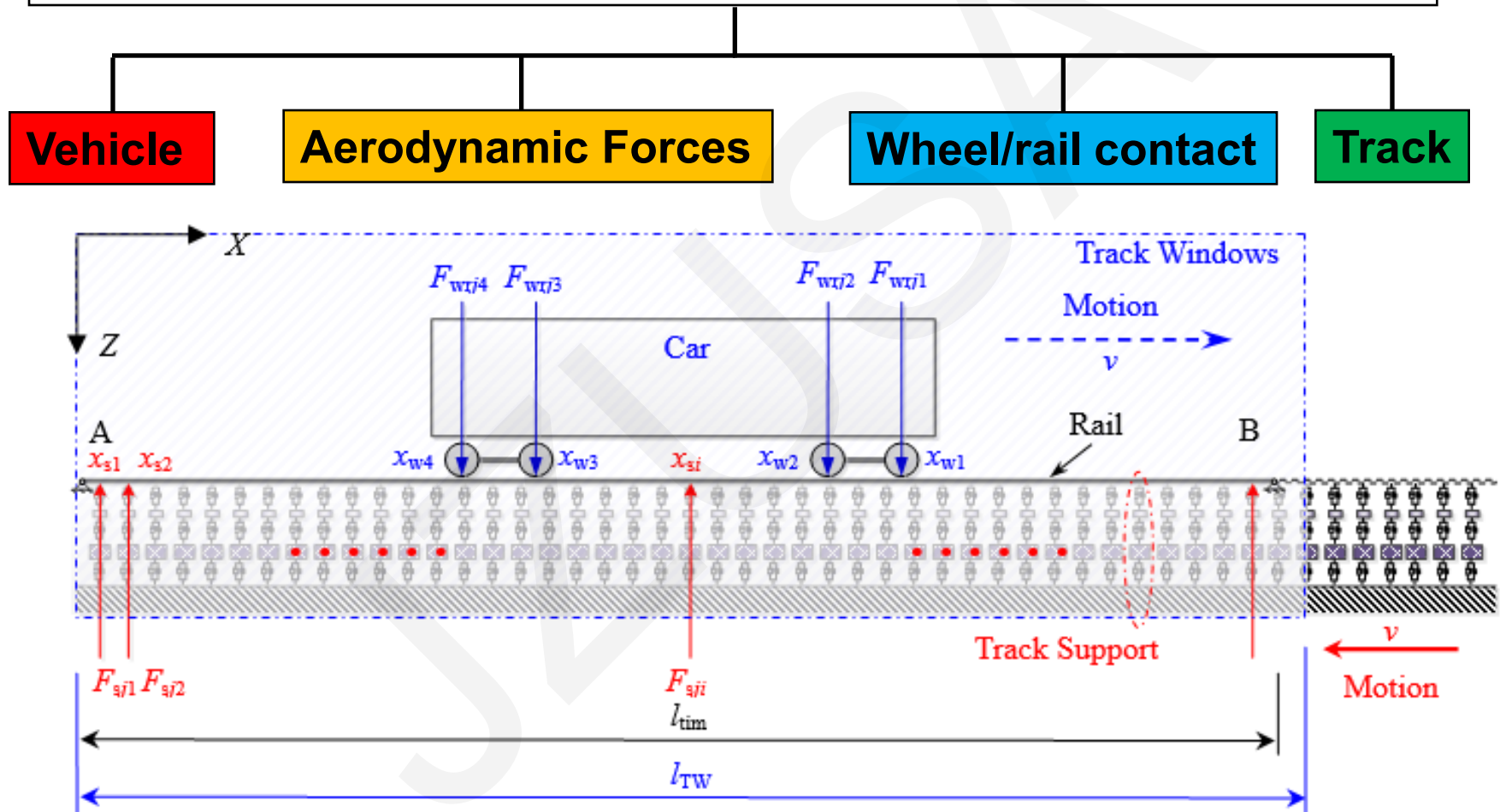


Fig. 2. Vehicle-track model.

Analytical Method

■ Strategy of study on safety operation boundaries

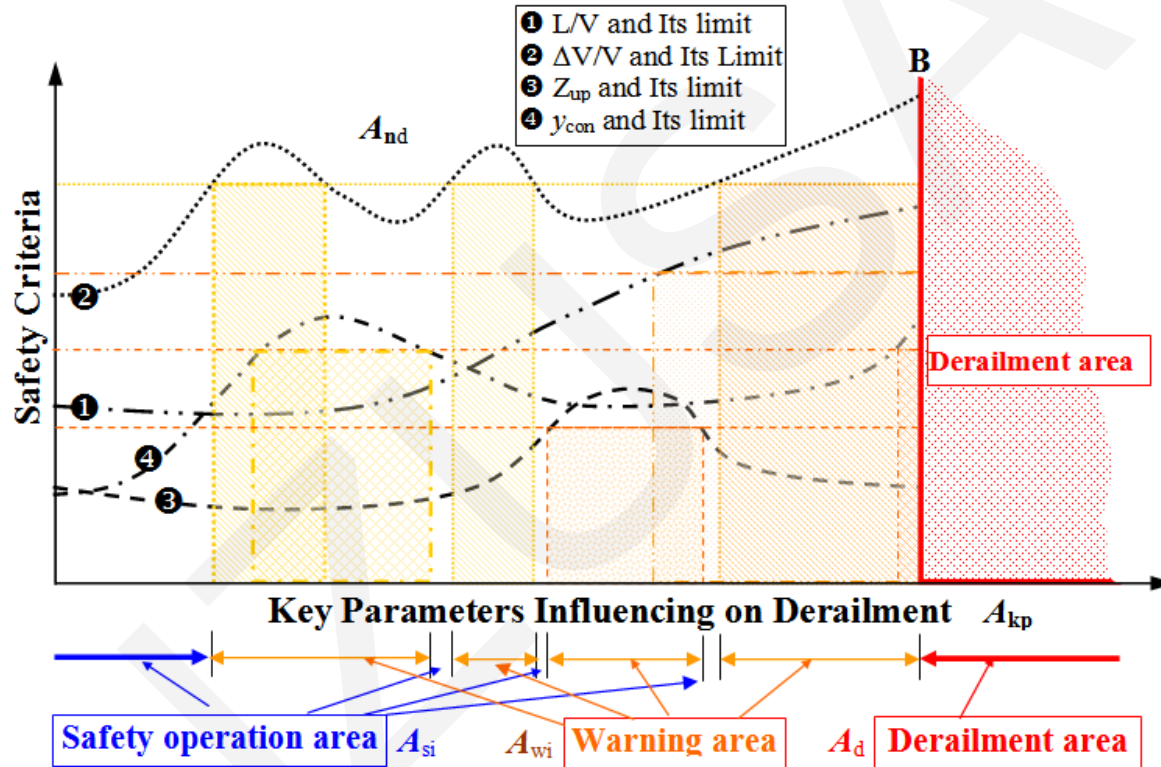


Fig. 3. Schematic of safety operation boundaries of high speed trains.

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

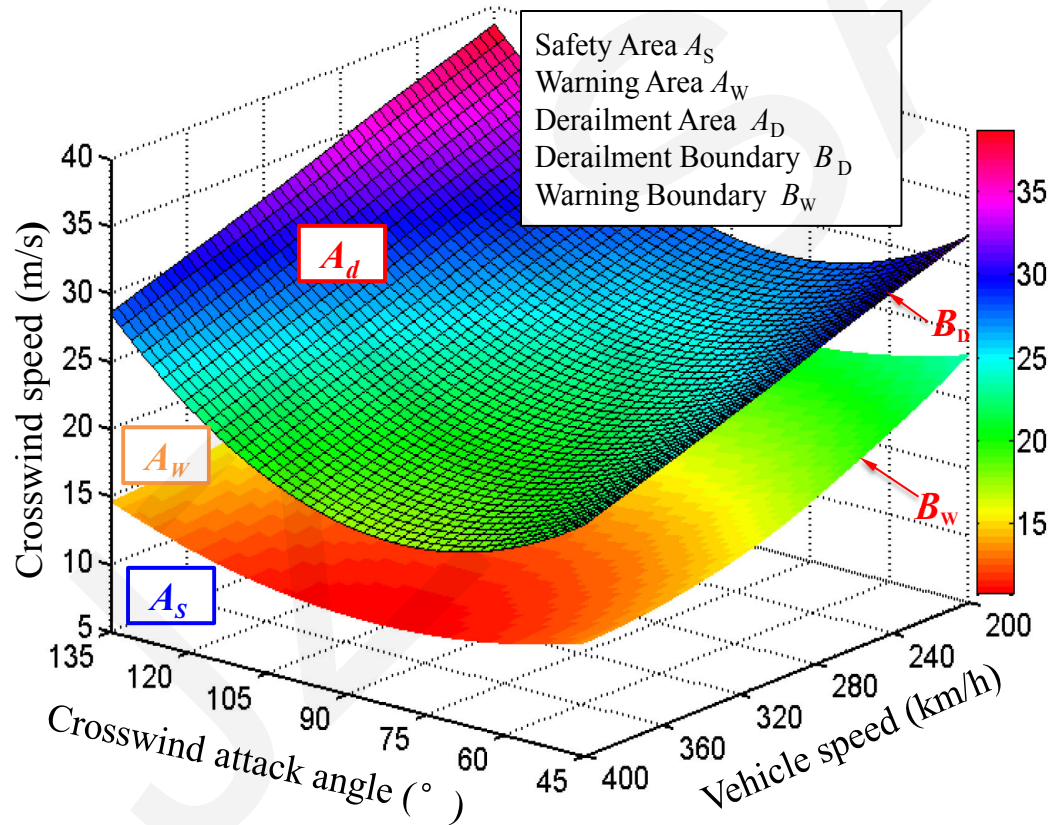


Fig. 4. Derailment and safe operation areas of high-speed vehicles in crosswinds.

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.