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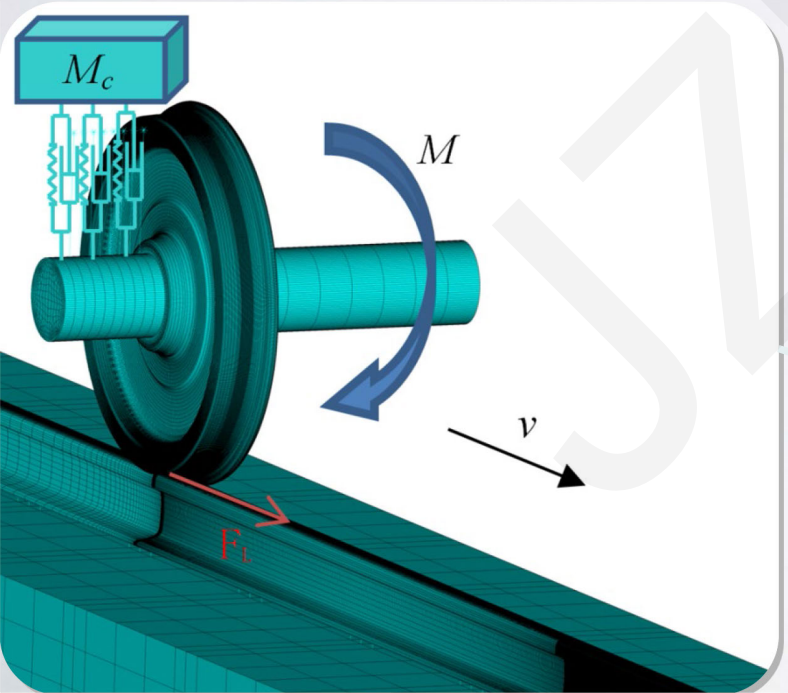
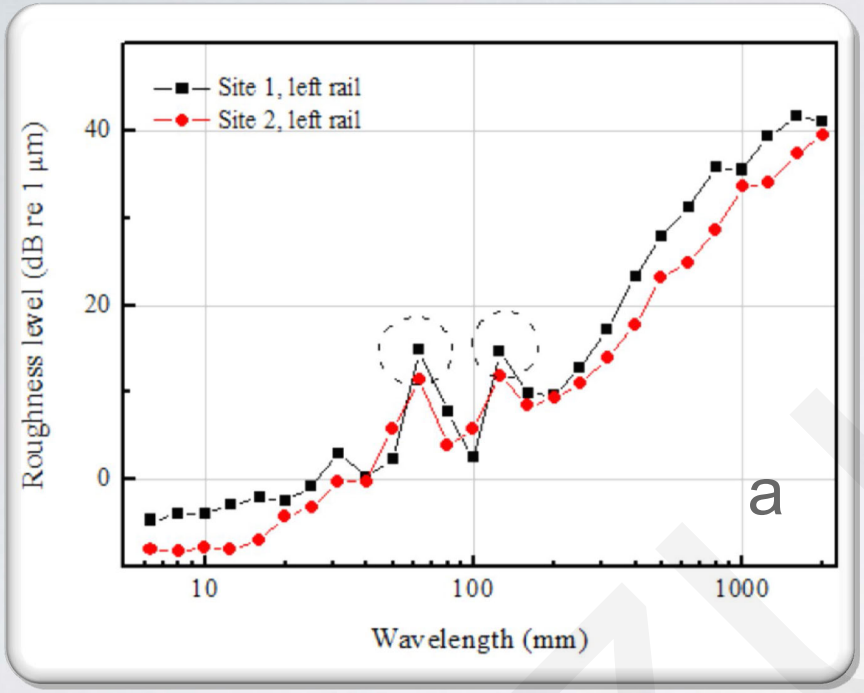
Modeling of high-speed wheel-rail rolling contact on a corrugated rail and corrugation development

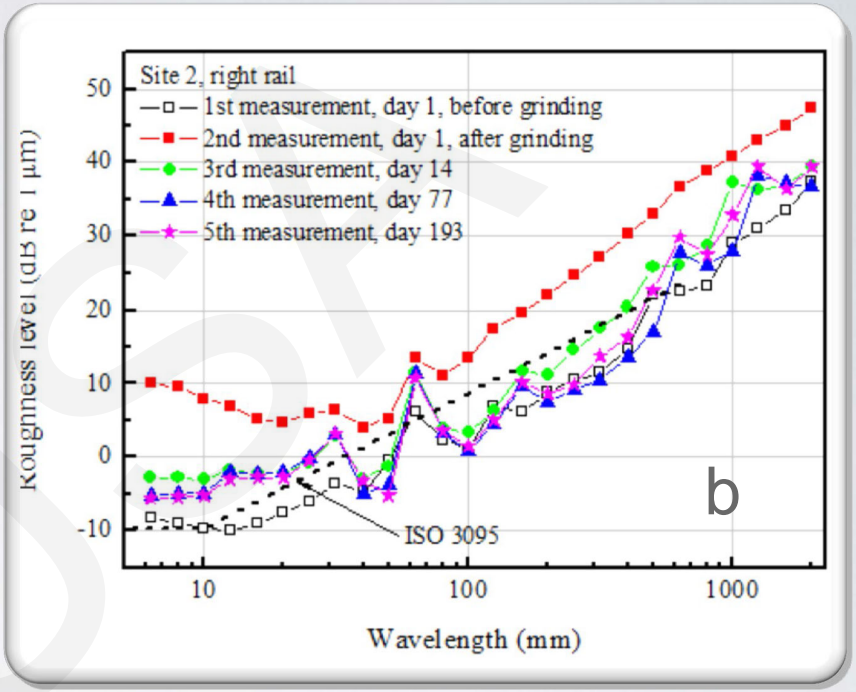


Key words:

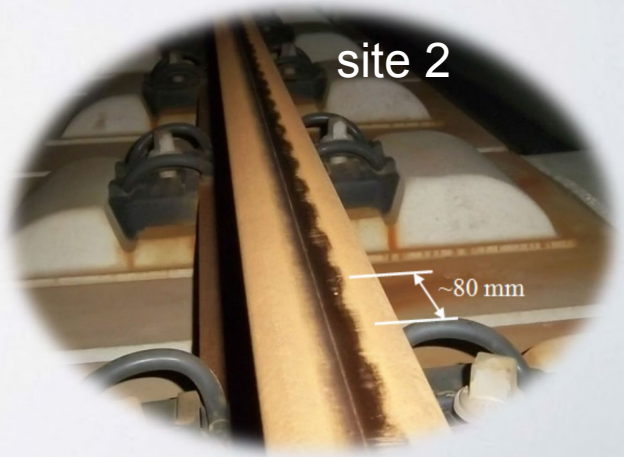
Rail corrugation, Frictional rolling contact, Vehicle-track interaction, Friction exploitation level, Explicit finite element method

Corrugation on a Chinese high speed line

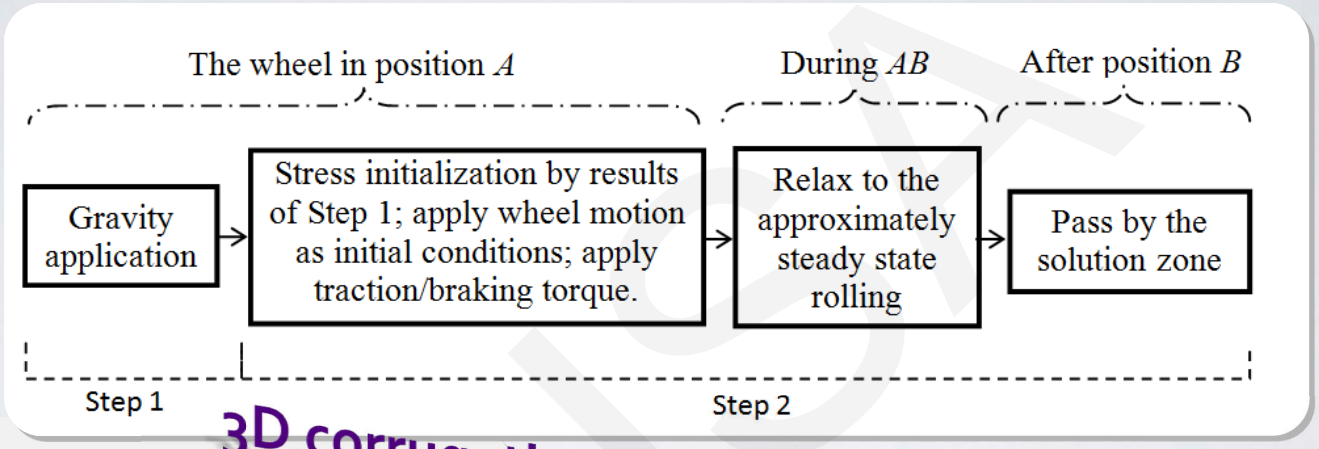




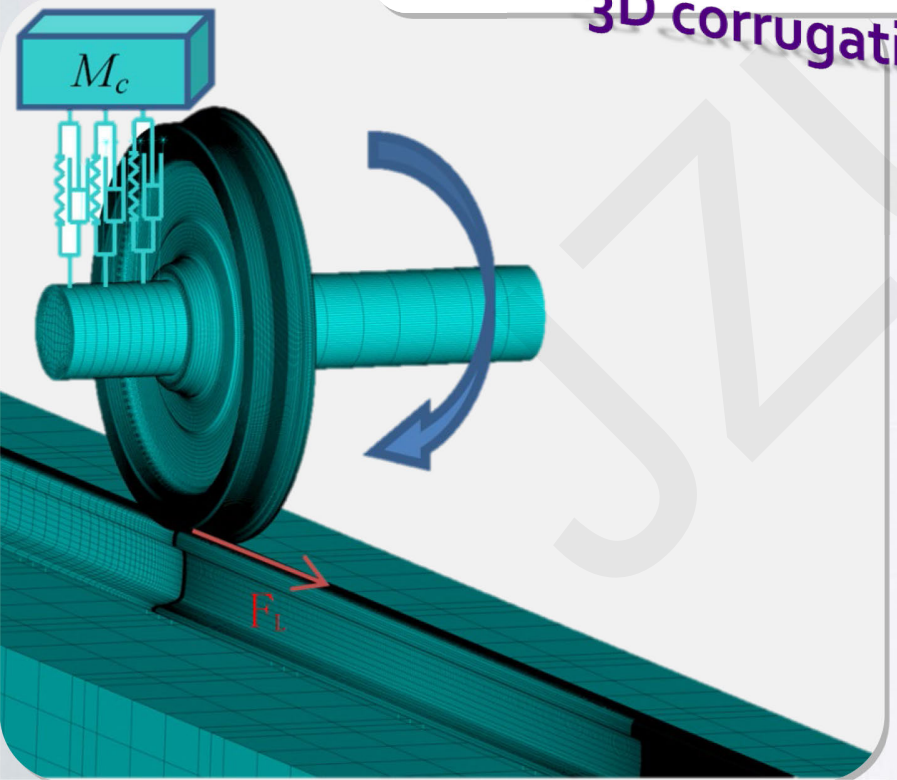
Roughness level spectra in 1/3 octave bands measured on a Chinese high-speed line, v = 300 km/h. (a) Typical measurements at two corrugation sites, (b) corrugation development with time (two measurements were conducted before and after a rail grinding on day 1)

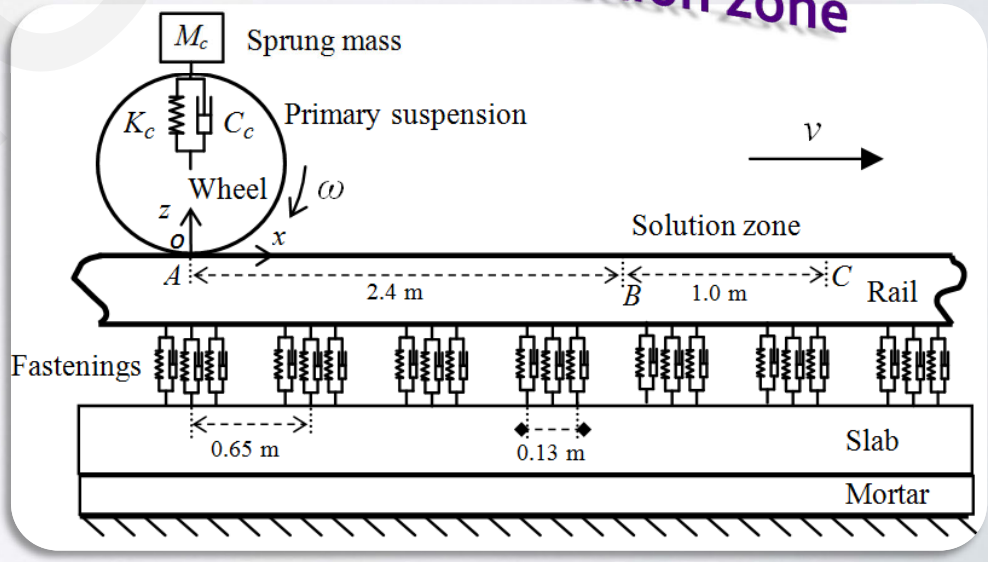


3D transient wheel-rail rolling contact FE model



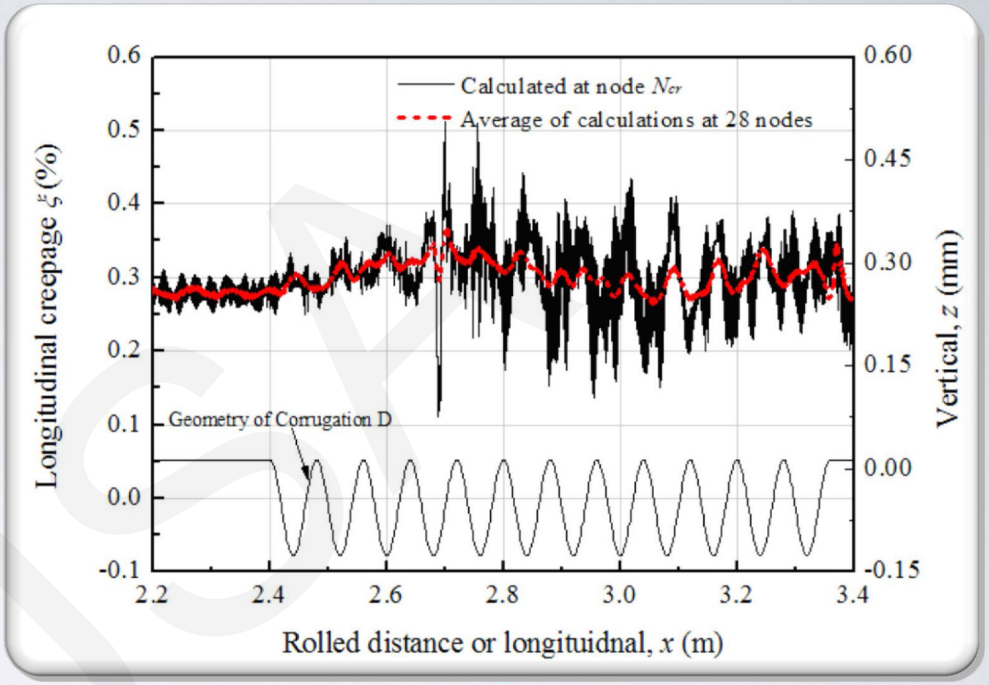
3D corrugation is applied to the solution zone

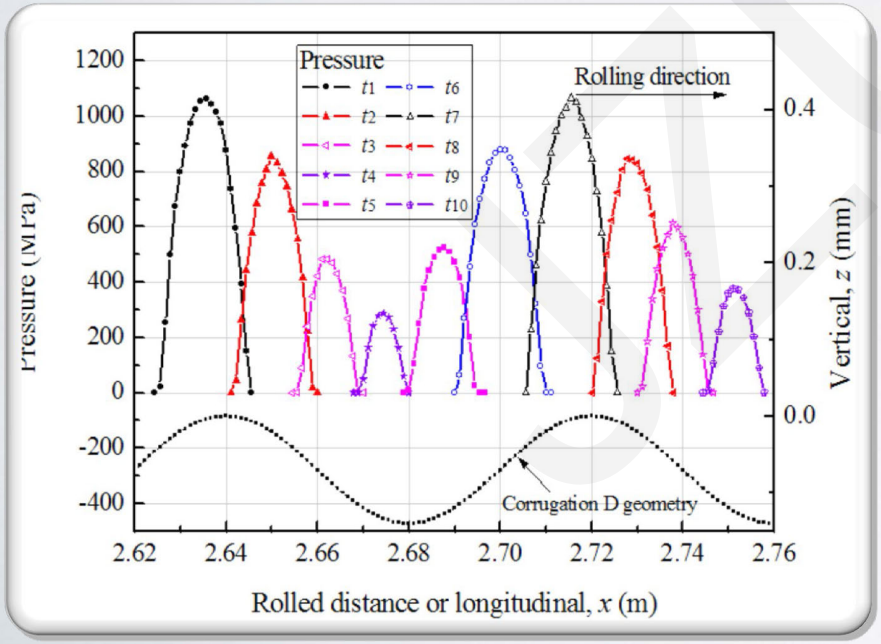


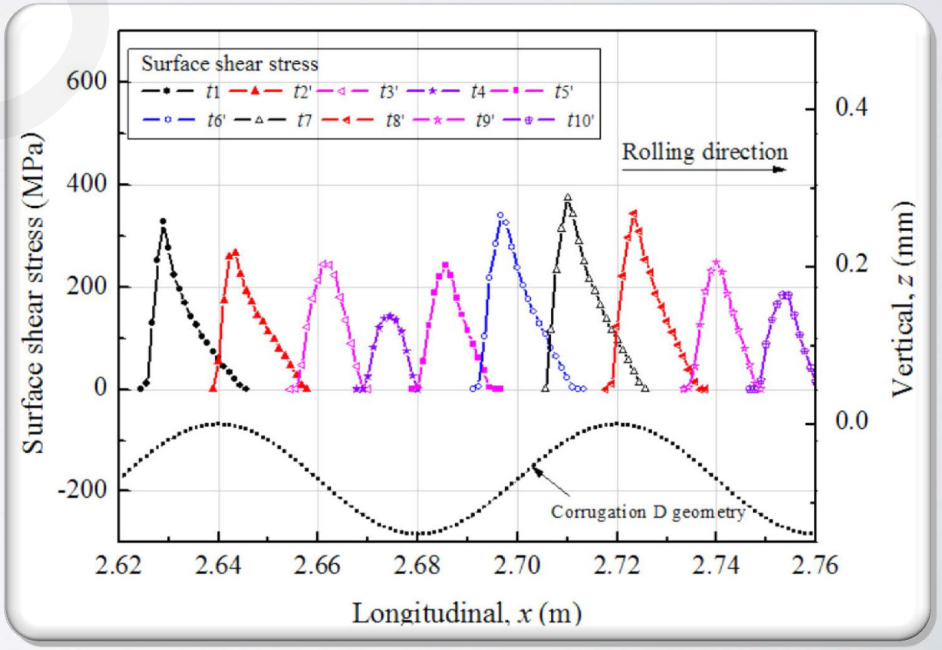


Transient contact solutions

Contact solutions vary following the pattern of corrugation, but with slightly different longitudinal phases.

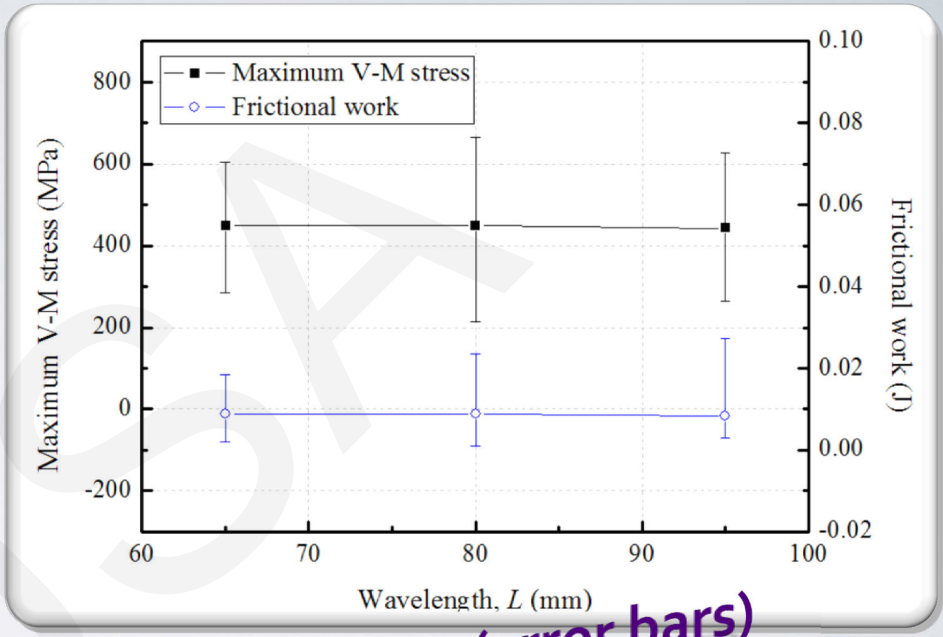




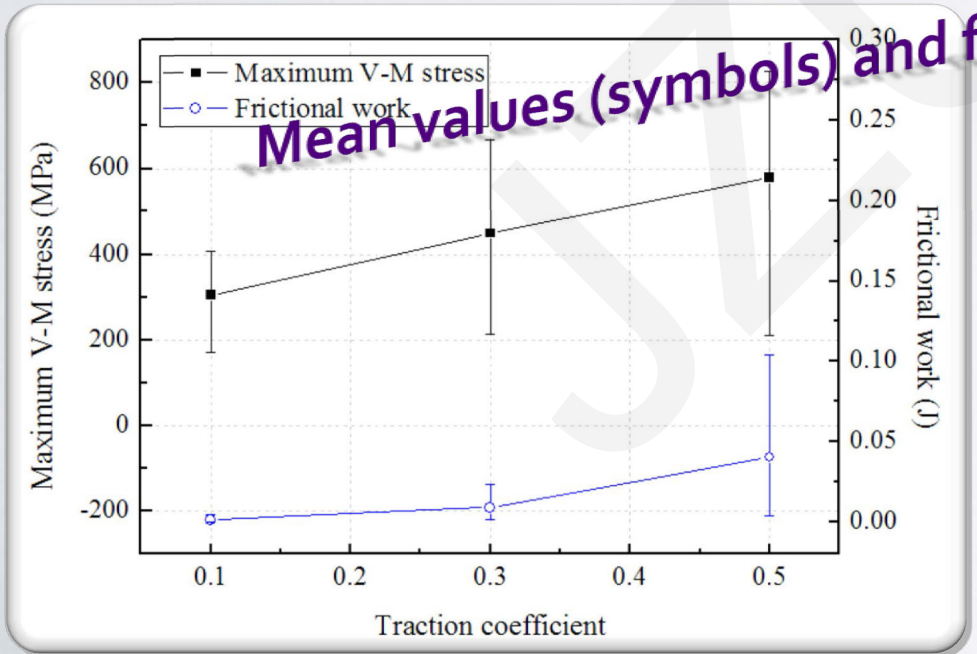


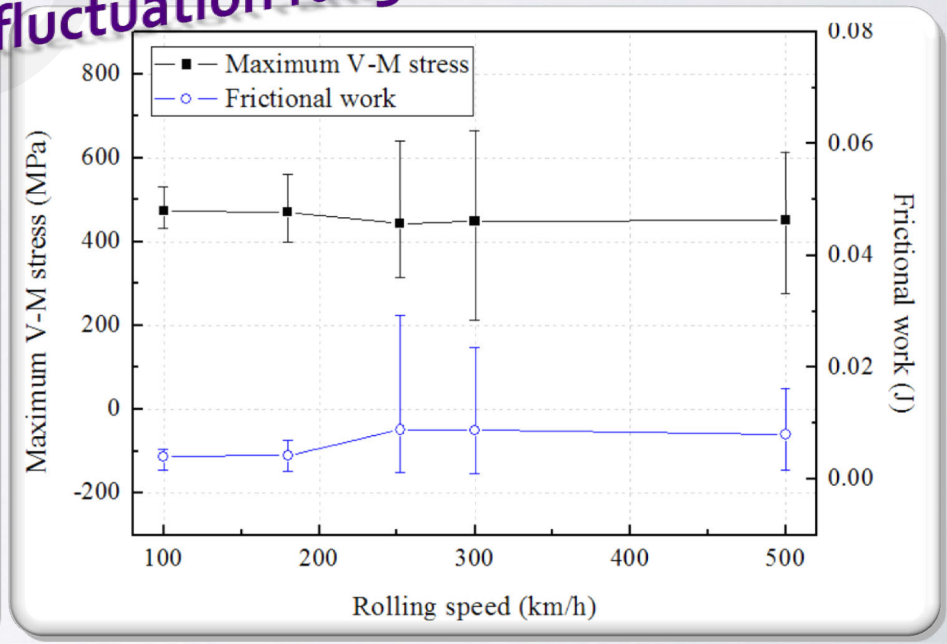
Parameter variation analysis

Fluctuation ranges of the V-M stress and the frictional work caused by a corrugation increase with the traction coefficient, reach maximums when the wavelength is around 80 mm and the speed is 250-300 km/h, being in line with the field observation.



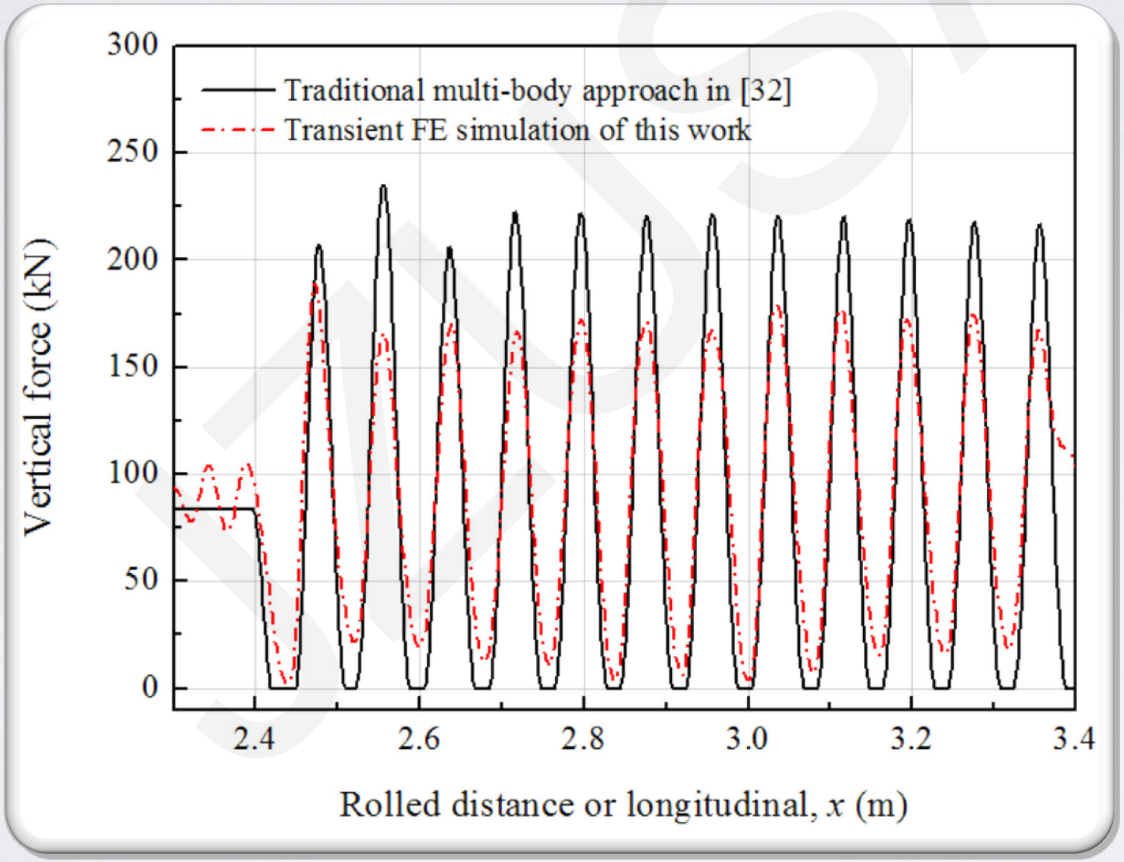
Mean values (symbols) and fluctuation ranges (error bars)





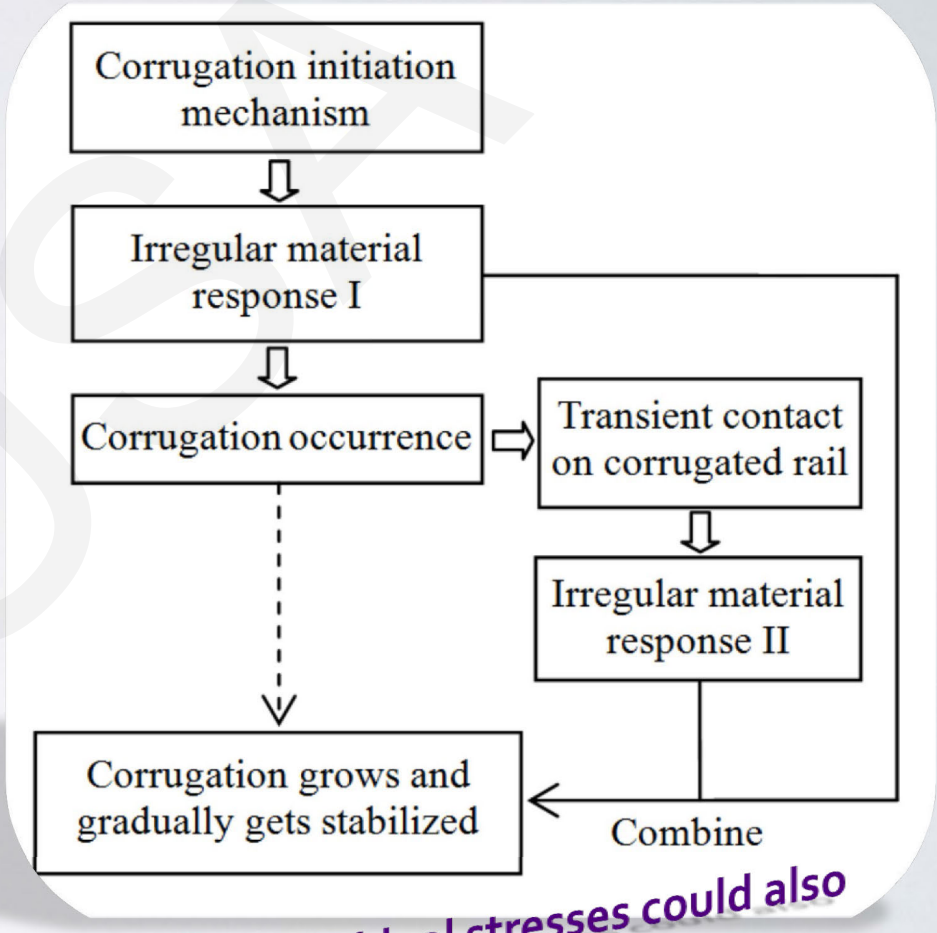
Transient FE model Vs. traditional multi-body model

The traditional multi-body approach overestimates the dynamic wheel-rail contact force on corrugated rails.



Why does the corrugation stabilize?

The irregular response II caused by the geometric variation at a corrugation is not in phase with the irregular material response I that results in corrugation occurrence. Hence, the response II will alleviate the response I, especially at high speeds. As the response II becomes stronger with the corrugation depth, the combined response (I+II) becomes regular at a certain depth, i.e. the corrugation stabilizes.



Other factors such as material work hardening and residual stresses could also play certain roles.

Perspectives and Research Priorities

Research Priorities:

- To include the influences of the lateral movement of the wheelset and the initiation mechanism of corrugation in the modeling.
- The 3-D transient FE model can be employed to further study the material damage mechanisms on corrugated rails