

Multibody Simulation of Roller Coaster Vehicle–Track Interaction and Vibration Response

Graduate



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Introduction: Roller coaster vehicles are highly complex, kinematically overconstrained systems. Their dynamic interaction with the track involves multiple excitation mechanisms, leading to a broadband vibrational response of the vehicle. The representation of this interaction in dynamic vehicle–track multibody model represents a challenging task.

Definition of Task: In this work, a multibody simulation model of a modern steel roller coaster by Intamin Amusement Rides is developed to investigate the dynamic response of the vehicle–track system. The model is implemented in the simulation software SIMPACK and includes a representation of the vehicle suspension, wheel–rail contact based on elastic contact theory, and selected flexible structural components. Experimental acceleration measurements obtained from onboard sensors are used as reference data for qualitative comparison. The simulation results are evaluated in the frequency domain and compared to the measured responses for different track sections. The model captures several qualitative characteristics of the measured vibration behaviour.

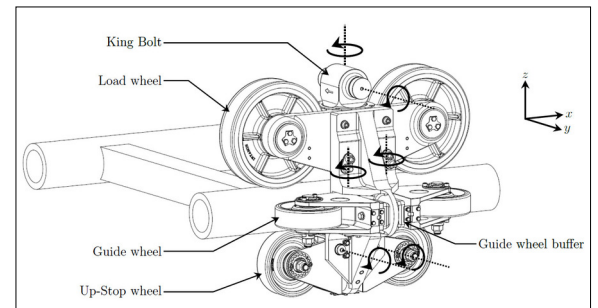
Conclusion: The analysis suggests that the observed dynamic response is influenced by the combined effects of wheel–rail contact stiffness and structural coupling within the vehicle. High-frequency vibration components observed in the measurements are sensitive to local excitation mechanisms, such as rail irregularities, and cannot be attributed to a single isolated resonance. Remaining differences in amplitude and low-frequency content can be related to the applied modeling assumptions, including the rigid track representation and the prescribed vehicle velocity. Within these constraints, the developed

model allows a structured analysis of wheel–rail induced vibrations in roller coaster vehicles and provides a reference point for further investigations with extended track and excitation formulations.

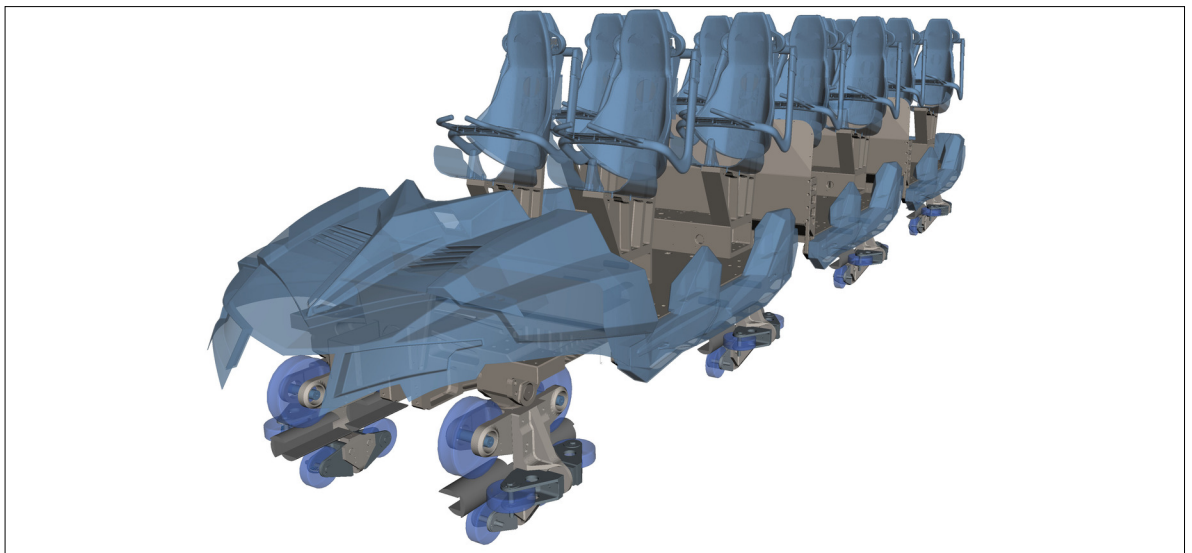
Multi-LSM Launch Coaster – Test Vehicle
Own presentation



Bogie Assembly with Wheel Arrangement.
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Multibody Simulation Model (MBS)
Own presentation



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