The influence of the perturbation of the wheel rotation speed on the stability of a railway bogie on steady curve sections of a track

Based on the theory of non-linear dynamic systems, the influence of the perturbation of the wheel rotation speed on the quasi-steady curved motions of a two-axle railway bogie system with a realistic wheel/rail contact relation is investigated in this paper. Since the wheel/rail contact relation is non-linear, it is tabulated in a wheel/rail contact table. The bifurcation diagram of the bogie system is constructed with gradually increasing and decreasing speed in the speed range $V = 60$–$100$ m/s. A supercritical Hopf bifurcation, where the stable non-trivial stationary solution loses its stability, is found in both models with and without perturbation of the wheel rotation speed. In the model without perturbation of the wheel rotation speed, the first chaotic motions develop at the speed where the wheel flange contact starts. A period-doubling cascade of the bogie system through pitchfork bifurcations, which explains the transition from periodic solutions to chaotic motions of the bogie system, is found. Several jumps happen at higher speeds because of the coexistence of multiple attracting solutions, which should be avoided. A comprehensive investigation of the hysteresis phenomena is made. However, in the model with a perturbation of the wheel rotation speed, no chaotic motions are found.

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