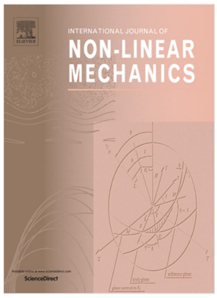
Accepted Manuscript



Instability phenomenon associated with two typical high speed railway vehicles

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PII: S0020-7462(18)30052-0
DOI: https://doi.org/10.1016/j.ijnonlinmec.2018.06.006
Reference: NLM 3041

To appear in: *International Journal of Non-Linear Mechanics*

Received date : 1 February 2018
Revised date : 12 June 2018
Accepted date : 12 June 2018

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Abstract: From the numerous field and roller rig tests, we observe one type of high speed railway vehicle has a small amplitude periodical oscillation and another one has a large amplitude periodical oscillation at loss of stability. The lateral dynamic models of the high speed bogies are established with the nonlinearity of wheel-rail contact and the non-smoothness of yaw damper taken into consideration. Following the bifurcation approach, simulation results of the two bogies are extensively computed with use of the path-following method. They demonstrate the supercritical and subcritical bifurcations exist in the different types of the considered vehicle systems. The application of Hopf normal theory makes a weak way to mathematically prove the bifurcation types for the two types of high speed railway vehicles. Therefore, the influence of parameters variation on the deduced function in normal form is further studied and the numerical method is also used for verification. The bifurcation analysis demonstrates that the yaw damper is one of the key parameters that can change the Hopf bifurcation type.

Keywords: High speed bogie; Bifurcation type; Periodical Solution; Yaw Damper; Normal Form Theory; 16th Hilbert problem.

1. Introduction

1.1 The application of Hopf bifurcation

The Hopf bifurcation is also called the Poincare-Andronov-Hopf bifurcation to give credit to the works of Poincare and Andronov that preceded the work of Hopf. Poincare was aware of the conditions for this bifurcation to occur (Poincare studied such bifurcations in the context of lunar orbital dynamics). Andronov and his co-workers studied Hopf bifurcations in planar systems before Hopf studied such bifurcations in general n-dimensional systems. In aero elasticity, the consequence of a Hopf bifurcation is known as galloping or flutter [1].