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Modelling and modal properties of the railway vehicle bogie with two individual wheelset drives

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Abstract

The paper deals with mathematical modelling of vibration and modal analysis of two-axled bogie of a railway vehicle. In comparison with recent publications introducing mathematical models of an individual wheelset drive, this paper is focused on modelling of complex bogie vibration. The bogie frame is linked by primary suspension to the two wheelset drives with hollow shafts and by secondary suspension to the car body. The method is based on the system decomposition into three subsystems – two individual wheelset drives including the mass of the rail and the bogie frame coupled with a half of the car body – and on modelling of couplings among subsystems. The eigenvalues of a linearized autonomous model and stability conditions are investigated in dependence on longitudinal creepage and forward velocity of the railway vehicle. The nonlinear model will be used for investigating the dynamic loading of bogie components caused by different types of excitation.

Keywords: railway vehicle bogie, two-axled bogie, bogie vibration, eigenvalues, stability

1. Introduction

Dynamic properties of individual wheelset drives of railway vehicles are usually investigated using torsional models, as it was shown e.g. in [4], [6] and for drives with a hollow shaft in [8]. These models however do not enable investigation of spatial vibration of drives components caused by the track irregularities, wheelsets unbalance and by polygonalized running surface of the wheels. Hence, new and complex models of railway vehicles or of their components, presented e.g. in books [3], [7], in the latest works [2], [5] and there cited papers, were developed. None of mentioned works contains detailed models of wheelset drive components and of couplings among them e.g. gearing, clutches, elastic supports of engine stators and of gear housings to the bogie frame etc. From this point of view, individual wheelset drives with a hollow shaft embracing the wheelset axle (fig. 1) indicate some specific features. Their dynamic properties were investigated in [10] and the extended model including bending vibration of the wheelset supported by elastic ballast is studied in [1]. The excitation caused by track irregularities and wheel running surface is transmitted from both wheelsets through the primary and secondary suspension elements to the car body and to the bogie frame, whose vibration retroactively influences the motion of both individual wheelsets. The influence of visco-elastic couplings among mentioned subsystems on modal properties of wheelset drives was not yet investigated.

The aim of this article is to develop an original mathematical model of the whole bogie including two individual wheelset drives with a hollow shaft and to parametrize the model for

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