Development of methodology for continuous measurement of wheel-rail contact forces at Faculty of Mechanical and Civil Engineering in Kraljevo

Abstract: The key influential parameters and indicators of the quality of the dynamic behavior and stability of movement of railway vehicles are the lateral force Y and the vertical force Q in the wheel-rail interaction, i.e. their ratio *Y*/*Q*. The focus of this lesson is the development of a unique method for the experimental determination of wheel-rail interaction forces using an instrumented wheelset. In addition to determining forces in the process of certification and testing of running stability of railway vehicles which is defined by the relevant international standards UIC 518 and EN 14363, developed method enables experimental determination of the contact point position between wheel and rail. Based on the formed numerical model of the wheel, the ways of solving of key problems in development of instrumented wheelsets are defined. They are related to the determination of optimal locations, layout, number and connection of strain gauges, as well as the development of the inverse identification algorithm. Based on the results of testing using a numerical model of the wheel, the high accuracy of the developed method and inverse identification algorithm which is based on the method of blind signal separation (BSS) using independent component analysis (ICA), is founded. Deviations between the wheel-rail interaction parameters obtained using the developed algorithm and really placed parameters in the numerical model are in range of 2 %, while the measurement error that stems from the imperfections of the algorithm lies in the range of 0.5 %. In order to validate the developed method and inverse identification algorithm, the experimental tests on the real object are also performed. The instrumented wheelset of measuring system MEROSA and special test stand M10.09 production OSS (Optical sensor systems, Belgrade, Serbia) are used. Signal-to-noise ratio is identified as the main parameter influencing the accuracy of experimental determination of the wheel-rail interaction forces and contact point position using the developed method. The developed method enables measurement of vertical force *Q*, lateral forces *Y*, as well as the ratio *Y*/*Q*, with an errors that are in the range of 10 %, while the error of measurement of contact point position is in the range of 15 %. At the flange contact and the higher values of ratio *Y*/*Q* or *Y* force, these measurement errors are reduced, which is extremely important for reliability and quality of assessment of safety against derailment according to the standards mentioned. Experimental tests confirm that developed method is very applicable in the development of instrumented wheelsets and enables highly accurate determination of parameters in the wheel-rail interaction, with measurement accuracy that is in the range of the most contemporary world solutions.

Keywords: Wheel-rail interaction; dynamic behavior; running stability; forces measurement; instrumented wheelset; safety against derailment; railway vehicles.