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MATHEMATICAL MODELING OF ARTICULATED PASSENGER TRAIN SPATIAL VIBRATIONS

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The problem of high-speed railway transport development is important for Ukraine. In many countries articulated trains are used for this purpose. As the connections between cars in such a train differ from each other, to investigate its dynamic characteristics not a separate car, but a full train vibrations model is necessary. The article is devoted to the development of the mathematical model for articulated passenger train spatial vibrations. The considered train consists of 7 cars: one motor-car, one transitional car, three articulated cars, one more transitional car and again one motor-car. Differential equations of the train motion along the track of arbitrary shape are set in the form of Lagrange's equations of the second kind. All the necessary design features of the vehicles are taken into account. Articulated cars have common bogies with adjoining cars and a transfer car and the cars are united by the hinge. The operation of the central hinge between two cars is modeled using springs and dampers acting in the horizontal and vertical directions. Four dampers between two adjacent car-bodies act as dampers for pitching and hunting and are represented in the model by viscous damping. The system of 257 differential equations of the second order is set, which describes the articulated train motion along straight, curved, and transitional track segments with taking into account random track irregularities. On the basis of the obtained mathematical model the algorithm and computational software has been developed to simulate a wide range of cases including all possible combinations of parameters for the train elements and track technical state. The study of the train self-exited vibrations has shown the stable motion in all the range of the considered speeds (40 km/h – 180 km/h). The results obtained at the train motion along the track maintained for the speedy motion have shown that all the dynamic characteristics and ride quality index insure train safe motion and comfortable conditions for the travelling passengers.

Keywords: *mathematical model, articulated train, spatial vibrations, dynamic characteristics*.

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