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SIMULATION OF THE SPATIAL OSCILLATIONS OF A TRAIN MOVING OVER CHANGES OF GRADIENT

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The issues related to the evaluation of forces arising in the inter-car connections for a freight train moving at a constant speed over changes of gradient are considered. A mathematical model of a freight train motion along a track of arbitrary alignment and profile was constructed. The design model of one part of the cars takes into account only their longitudinal motion, and for the other part of the cars, a full spatial model of their oscillations is used. The cars of the train considered whose motion is modeled by the spatial design scheme have bogies of model 18-7020 in which the elements proposed by the Institute of Technical Mechanics of the National Academy of Sciences of Ukraine and the State Space Agency of Ukraine are used. Differential equations of the freight train motion were obtained in the form of the Lagrange equations of the second kind. The modelling took into account rail track irregularities and the shape of the path along which the train moves. The model describes the train motion along straight and curvilinear (transitional and circular curves) sections of rail track and over changes of track gradient (motion along descending and ascending grades). Based on the mathematical model obtained, an algorithm and a program were developed for evaluating the dynamic characteristics of a moving train. The effect of the track parameters, the train mass, the train makeup, and the conditions of the automatic coupling devices initial state on the forces in the inter-car connections was evaluated. It was shown that in all cases, larger values of both tensile and compressive forces occur in the connections of those cars whose model is represented by the design scheme that takes into account their spatial oscillations.

Keywords: *freight train, mathematical simulation, spatial oscillations, longitudinal forces, motion in concave curves.*

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