

ESTIMATION OF DYNAMIC LOADS ON TRAIN VEHICLES WITH PASSIVE SAFETY SYSTEM ELEMENTS IN A COLLISION WITH AN OBSTACLE

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A topical problem for the Ukrainian railway transport is replacement of obsolete and outdated locomotive-hauled passenger trains with new high-speed trains equipped with active protection means and passive safety systems (PSSs) to provide safety in emergency collisions with various obstacles. PSSs serve to protect the passengers and the train crew, provide vehicle load-bearing structure safety, and reduce the cost of recovery work. In an emergency collision, the controlled plastic deformation of the PSS elements absorbs the kinetic energy of the impact and reduces the longitudinal forces in the intercar couplers and the car accelerations. In the EU countries, the passive safety of passenger trains in collisions is regulated by the European Standard EN 15227, which since 2016 has been in force in Ukraine as the Ukrainian State Standard DSTU EN 15227:2015. The Standard EN 15227 specifies reference trains, four collision scenarios, passive safety requirements, and criteria for assessing the compliance of the designs of PSS-equipped vehicles with the specified requirements. This paper considers Scenario 3, which characterizes an impact between a passenger train moving at a speed of 110 km/h and a large road vehicle of 15 t, which is a large-size deformable obstacle (LSDO) standing freely at a grade crossing. The aim of this work is to estimate dynamic loads on the PSS-equipped vehicles of a locomotive-hauled passenger train in a collision with an LSDO at a grade crossing. The paper presents a new refined mathematical model for the solution of the nonlinear dynamic problem of a reference train – LSDO collision at a grade crossing with account for the operation of the center coupler draft gears, the possibility of the draw-buffing gears shifting into the undercar space, the plastic deformation of energy-absorbing devices, the possibility of plastic deformations in the locomotive and car structures, and the interaction of the LSDO with the front part of the locomotive. The model gives the average values of the vehicle accelerations and plastic deformations to compare them with their permissible values. As shown by the studies conducted, the DSTU EN 15227:2015 requirements are met if a 123 t locomotive has a collapse zone of capacity 0.3 MJ in the front part of the cab frame and is equipped on both sides with two energy-absorbing devices of capacity 0.95 MJ each, and 64 t passenger cars are equipped on both sides with two energy-absorbing devices of capacity 0.3 MJ each. The proposed mathematical model and the results obtained may be used in the design of home railway vehicles for locomotive-hauled passenger trains according to the DSTU EN 15227:2015 requirements.

Keywords: *passenger train; collision at a grade crossing; large-size deformable obstacle; passive safety system.*

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