

Recommendations on manufacturing head car passive protection devices with the use of different materials

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High-speed multiple-unit trains in Ukraine must be developed according to the Ukrainian Standards DSTU EN 12663 and DSTU EN 15227, which specify the car crashworthiness and active and passive safety. This paper addresses issues involving the development of recommendations on the passive safety of a multiple-unit head car in emergency collisions with obstacles, the determination of the parameters of the energy-absorbing devices (EADs) that are a part of the passive safety system (PSS) of the head car, and the possibility of using aluminum alloys in the EAD manufacturing. Researchers of the Institute of Technical Mechanics of the National Academy of Sciences of Ukraine and the State Space Agency of Ukraine developed a passive protection concept for home high-speed passenger trains in emergency collisions according to the DSTU EN 15227 requirements and methods and finite-element models for the study of the impact plastic deformation of the EAD honeycomb structures. It was proposed that lower- and upper-level energy-absorbing devices EAD 1 and UL EAD, respectively, be used at head car front end and low-level energy-absorbing devices be used at the head car rear end in place of buffers (EAD 2 or EAD 3 if the intermediate cars have a mass of 50 t or 64 t, respectively). EAD 1 includes two tandem elements. Element 1 is a box with a single-layer pack of hexagonal honeycombs inside. Element 2 is a truncated pyramid made up of honeycombs with triangular cells. The UL EAD has three stages in the form of Element 2. EAD 2 and EAD 3 were designed based on Element 1. The parameters of EAD 1, EAD 2, and EAD 3 of energy capacity 0.95 MJ, 0.25 MJ, and 0.3 MJ, respectively, made of type 08Yu steel were determined. A 3D geometrical model of the home head car front end was developed, and an EAD placement scheme was proposed. It was recommended to install two EAD 1 devices at the head car front end and two UL EAD and two EAD 2 or two EAD 3 devices at the head car rear end and at the ends of the intermediate cars. The aim of this paper is to develop recommendations on manufacturing head car passive protection devices with the use of different materials. A comprehensive study was conducted to choose advisable parameters of a UL EAD made of 08Yu steel and to analyze the possibility of replacing 08Yu steel in the EAD 1, EAD 2 (EAD 3), and UL EAD manufacture with AMr2 and AMr6 aluminum alloys, which have high plastic properties, a low density, and a high resistance to an aggressive environment. As a result, it was shown that 08Yu steel can be replaced with AMr6 aluminum alloy in the EAD 1 and EAD 3 manufacture and with AMr6 or AMr2 aluminum alloys in the UL EAD manufacture. The parameters of the above-mentioned EADs made of the aluminum allows were determined. Recommendations on head car passive protection according to the DSTU EN 15227 were developed. The methods, mathematical models, and recommendations developed may be used in the design of a new-generation head car according to the DSTU EN 15227 requirements.

Keywords: multiple-unit train, head car, emergency collision, passive safety system, energy-absorbing devices, aluminum alloys.

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