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PROPOSALS ON A PROSPECTIVE HOME DESIGN FOR A SWAP-BODY FREIGHT CAR

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The importance of this work for Ukraine stems from the need for efficient freight transportation technologies, freight car fleet renewal, introducing swap-body freight cars, and increasing their operating safety. Swap-body cars are an innovation in freight services. Traditionally, versatile and specialized freight cars consist of an undercarriage part (running gear, automatic couples, and automatic braking devices), which, as a rule, is versatile, and a body part (an underframe and a body). The cost of the former and the latter is 80 and 20 per cent, respectively, of the total car cost. The idea of a swap-body car is to separate the underframe from the car body and include the former into the undercarriage part, thus leaving only the car body in the body part. Thus, the undercarriage part of a car of this type is a flat car for swap bodies, which consists of an underframe, running gear, automatic couples, automatic braking devices, and body fasteners. A new type of freight rail vehicles for unimodal railway transportation is the swap-body car, whose bodies can be replaced according to seasonal freights. For the Ukrainian railways, it is expedient to develop a swap-body car design of their own. This calls for scientific and technical support at the design and the operational development stage. The aim of this work is to determine the maximum loads on the load-bearing structural elements of swap-body cars in normal operation and to work out recommendations on a prospective home design of a swap-body freight car. This paper presents a mathematical model of 3D vibrations of a swap-body freight car in its normal motion along a track of arbitrary alignment, which accounts for the technical condition of the car undercarriage and the track. This model underlies the scientific and technical novelty of the paper. The analytical model of a swap-body car moving along a track is a mechanical system of rigid bodies. For each wheel, the track is simulated as an equivalent mass, which can move only in a vertical and a lateral horizontal direction and bears in these directions on springs and viscous dampers, which model the elastoviscous properties of the rails and the underrail base. The nonlinear differential equations of the system's dynamics are solved by the Adams−Bashforth method. The paper presents a numerical estimate of the dynamics of motion of cars with swap bodies of different length and mass. For all the car motion variants considered, the maximum forces in the fitting supports whereby the body is supported on the undercarriage do not exceed their permissible values. The calculated values of the flat car's dynamic parameters show that in terms of safety a car speed higher than 80 km/h is not safe for all the body-on-undercarriage layouts considered. Practically important recommendations on a prospective home design of a swap-body freight car are presented. The innovative technology of freight transportation with the use of swap-body cars will allow one to avoid car demurrage caused by seasonal variations in freight shipment and speed up the replacement of damaged bodies. Besides, the service life of a body may differ from that of an undercarriage, which allows one to reduce acquisition, operation, and maintenance costs.

Keywords: *swap-body freight car, body-on-undercarriage fasteners, mathematical simulation, car dynamics, normal motion.*

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