

Specialized railway carriage for grain

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Abstract. This article deals with the worked out specialized railway carriage for grain for the transportation process throughout the Republic of Uzbekistan railway network, with the unconditional provision of train traffic safety, which is one of the most important components of the rolling stock of railway transport.

The features of the load-bearing structure of the railway carriage for grain are that it is made based on a four-axle platform and a universal container. Evaluation of the strength of the metal structure of the grain car was carried out following the requirements of the "Standards for the calculation and design of new and modernized cars of the railways of the Ministry of Railways with a gauge of 1520 mm (non-self-propelled)".

Based on theoretical studies, it was justified that the design of a railway carriage for grain with a capacity of 83.6 m³ and a carrying capacity of 65 tons. For the first test of a railway carriage for grain, the number 43925684 was assigned.

The proposed new grain carriage will reduce operating costs and reduce rolling stock downtime during reloading operations. It will create the possibility of fulfilling contractual agreements drawn up for small volumes of traffic within the country.

1 Introduction

The unremitting functioning of the transportation process throughout the railway network of the Republic of Uzbekistan, with unconditional provision of train traffic safety, significantly depends on the serviceable car fleet, which is one of the most important components of the rolling stock of railway transport [1-3].

The balance of the freight car fleet of JSC "Uzbekistan Railways" for the period 2017-2025, which for predicting period was determined based on the expected indicators of freight turnover and the volume of freight traffic by rail in the Republic of Uzbekistan, as well as taking into consideration the daily turnover of wagons, shows that the railways of Uzbekistan are currently experiencing a shortage of a working fleet of freight cars [4-7].

In view of the fact that the transportation process constantly requires a serviceable rolling stock, and the process of building freight cars is not able to meet the requirement fully for freight cars, work is underway to modernize cars at the enterprises of JSC "Uzbekistan Railways" [8-9].

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2 Materials and Methods

Working out and valuation of the deformed condition of the body of a railway carriage for grain.

Meeting the requirement of local transportation of grain cargoes ordered by JSC "Uzbekistan Railways," it was developed the design documentation and manufactured a prototype of a grain carriage (Figure 1) by the specialists of the department "Cars and carriage facilities" of Tashkent State Transport University on the basis of CP "Uztemiryulmashtamir"



Fig.1. Railway carriage for grain worked out based on CP "Uztemiryulmashta'mir"

The features of the load-bearing structure of the railway carriage for grain is that it is made based on a four-axle platform and a universal container [10-11]. Evaluation of the strength of the metal structure of the grain car was carried out following the requirements of the "Standards for the calculation and design of new and modernized cars of the railways of the Ministry of Railways with a gauge of 1520 mm (non-self-propelled)" [12].

For theoretical studies, according to the valuation reformed strained condition of railway carriage's metal structure, it was worked out the computer model of a railway carriage for grain in the SolidWorks software environment (Figure 2, a). A computer model of a railway carriage for grain is a body with real inertial and geometric characteristics.

The structure of a railway carriage for grain has four upper loading hatches and eight unloading hatches and 4 steering wheels for seals and 1 mechanism for closing all the upper four hatches.

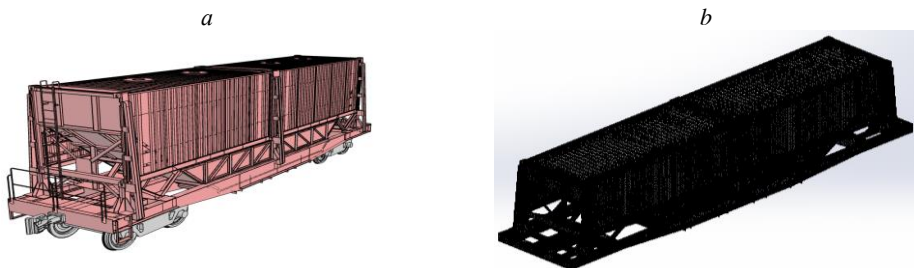


Fig. 2 Computer model (a) and finite element model (b) of the body structure of a railway carriage for grain

Investigations of the strained deformed condition of the metal structure of a railway carriage for grain were carried out using the finite element method on the SolidWorks Simulation platform. The characteristics of the finite element grid of the computational model of a grain carriage (Figure 2, b) are presented in Tables 1 and 2.

Table 1. Grid Information (Table Fragment)

Type of the grid	Solid mesh
Using splitting:	Curvature-based mesh
Jacobian points	4 Points
Maximum size of item	100,788 mm
Minimum size of element	20,1575 mm
Mesh quality plot	High

Table 2. Grid Information - Detailing (Table Fragment)

Total nodes	3686062
Total items	1880037
Maximum aspect ratio	57 330
% of elements with an aspect ratio <3	15,5
% of elements with aspect ratio > 10	28,7
% distorted elements (Jacobian)	5,32e-05

When modeling the dynamic characteristics of a railway carriage for grain, it was considered the options of the loaded and empty condition of the car, which is represented by the bulk. Kinematic and boundary conditions for loading the structure of a railway carriage for grain are shown in Figure 3.

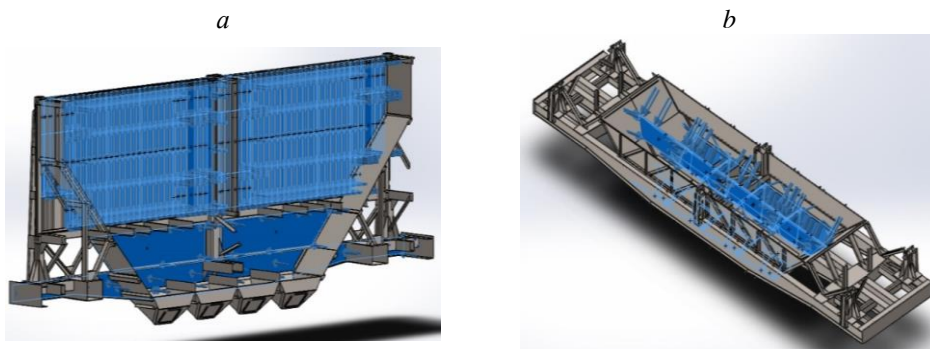


Fig. 3 Loading of the structure of a railway carriage for grain by the forces of grain cargo

As a result of calculations by the finite element method, the resulting distribution fields of strains and deformations by the structure of a railway carriage for grain are shown in Figure 4.

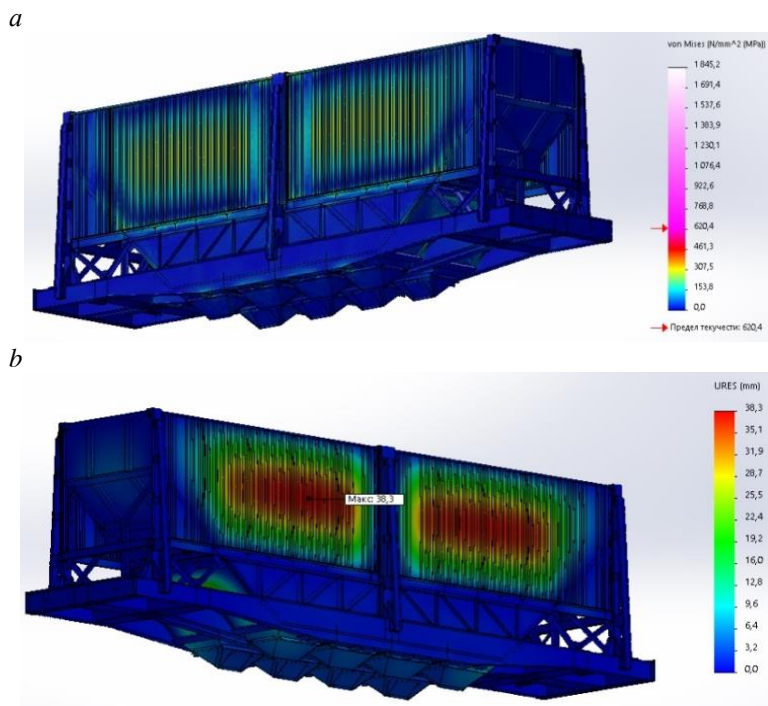


Fig.4 The results of the analysis of the strained reformed condition in accordance with the specified conditions: a are strains; b is deformation

The analysis of the consistency of the computer model of a railway carriage for grain with the "Norm" [12] was carried out by comparing the calculated equivalent strain of railway carriage body with the permissible strains. The results of a comparative analysis of the data obtained during the calculation with the standard values showed that the worked out design of a railway carriage for grain meets the appropriate requirements.

Thus, on the basis of theoretical studies, it was justified that the design of a railway carriage for grain with a capacity of 83.6 m³ and a carrying capacity of 65 tons. For the first test of a railway carriage for grain, the number 43925684 was assigned. On both sides of a railway carriage for grain with a stencil "Experienced" was applied.

3 Results and Discussion

Production tests and verification of the reliability of the obtained research results

The first experimental loading of wheat was carried out at the grain elevator loading area adjacent to the Chinaz station. The railway carriage for grain with the number 43925684 was submitted for loading wheat on the access road of "Tashkent donmahsulotlari" JSC Chinoz branch (Figure 5, a). Before loading, a control reweighing of containers was carried out on wagon scales for 150 tons. In the process of reweighing the container of the car turned out to be 26.1 tons instead of the declared 26.3 tons.



Fig. 5.Wheat loading test

After loading wheat, the upper loading hatches were checked for tightness of closure (Figure 5, b).

After loading the wheat it was carried out a control reweighing where 80 900 kg were detected, a container was 26 100 kg, a transport batch of wheat was 54 800 kg. Five lead seals were placed on the shipper of the "Toshkent donmahsulotlari" Chinoz branch. During shunting operations from the lower unloading hatches of the grain carrier, no wheat scattering was found. After that, the cargo was accepted for transportation according to the road sheet № A574295 for its destination at the Tashkent-Tovarnaya railway station.

It was carried out the unloading at the grain elevator unloading area adjacent to the Tashkent-Tovarnaya station. The grain car with the number 43925684 according to the road sheet number A574295 was delivered for unloading wheat to the access road of JSC "Toshkent donmahsulotlari" (Figure 6).



Fig. 6. Wheat unloading test

Before unloading, a control reweighing of containers was carried out on wagon scales at JSC "Toshkent donmahsulotlari", where 80,880 kg were detected. After unloading the wheat, the car was reweighed, at which the container of the grain car was 26 100 kg. Total transport consignment of wheat 54,780 kg. Experimental transportation of grain cargo in a

grain carriage was carried out three more tests between the stations Chinaz - Tashkent-Tovarnaya.

4 Conclusion

Thus, based on theoretical studies and tests, a new design of a grain carriage with a capacity of 83.6 m³ and a carrying capacity of 65 tons was justified. The proposed new grain carriage will reduce operating costs and reduce rolling stock downtime during reloading operations. It will create the possibility of fulfilling contractual agreements drawn up for small traffic volumes within the country.

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