

*This study investigates the process of loading the body of a covered hopper railroad car, modernized for container transportation. The task addressed is to improve the efficiency of container transportation by rail. To this end, it is proposed to use covered wagons taking into account the modernization of their structure. The modernization involves dismantling the roof and placing fitting stops on the floor for fastening containers.*

*The study was conducted using a universal covered wagon, model 11-217, as an example. The strength of the covered wagon body was calculated when it is subjected to vertical loads from containers, as well as the simultaneous action of vertical and longitudinal loads. It was established that when the body of the covered wagon is subjected to vertical loads, the maximum stresses in its structure are 8.3% lower than the permissible ones. When vertical and longitudinal loads are simultaneously applied, the maximum stresses in the body are 4% lower than the permissible ones. The calculation results prove that the strength of the covered wagon body, taking into account the proposed modernization, is maintained.*

*A feature of the proposed modernization is the fact that, if necessary, the design of the covered wagon body can be returned to its original state.*

*The scope of practical application of the results is railroad transport.*

*A condition for using the findings is the symmetrical placement of the fitting stops relative to the transverse axis of the covered wagon body, which is due to the need to ensure uniform loading of both car bogies.*

*This study will contribute to increasing the efficiency of container transportation by rail and container transportation in general*

**Keywords:** *railroad transport, covered wagon, modernization of car body structure, body strength, container transportation*

# DETERMINING THE LOADING ON THE BODY OF A COVERED WAGON MODERNIZED FOR CONTAINER TRANSPORTATION

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## 1. Introduction

Container transportation is the most common type of cargo transportation between European countries. The mobility of containers provides the possibility of using almost all types of transport for their transportation. At the same time, rail transportation of containers is one of the most promising. Usually, specialized platform cars equipped with fitting stops are used for this purpose. The lack of such cars in operation led to the intensification of modernization of universal cars for these purposes. However, this did not completely solve the problem of the lack of railroad vehicles for container transportation.

In this regard, the search for alternative options for transporting containers by rail began. One of such options is the use of gondola cars for transporting containers. But such a solution requires not only the need to equip them with fitting stops for fastening containers but also an additional device to prevent damage to their floor (manhole covers). Therefore, this option does not solve the issue of technical equipment for container transportation by rail.

A possible solution to this task is the use of covered wagons for container transportation. In this case, there is a need to modernize their structure to adapt to container usage. Note that the existence of a roof does not make it possible to load a covered wagon with containers. Therefore, research

into the adaptation of a covered wagon body for container transportation is relevant and requires further development.

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## 2. Literature review and problem statement

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To clarify the current state of the issue related to adapting covered wagons to container transportation, we have reviewed recent publications in this area.

Thus, in work [1], the justification for the use of gondolas for container transportation is provided. For this purpose, it is proposed to install fitting stops on the floor of the gondola. For uniform distribution of the vertical load from the longitudinal beams of the container behind the floor of the gondola, the use of a removable module is proposed. Such a solution actually allows for the adaptation of the gondola to container transportation. However, it requires additional capital investments for technical re-equipment of the gondola.

In [2], the possibility of using a RgS type car for container transportation was investigated. For this purpose, it was proposed to fasten them in the car using special bolts. The rational parameters of the bolts were determined. However, the authors did not consider the possibility of using such a scheme for fastening containers in a covered wagon. Perhaps this can be explained by the fact that the covered wagon is not intended for these purposes since it has a roof. This prevents its use for container transportation.

Measures to improve the design of a BCNHL type covered wagon are highlighted in work [3]. This improvement involves using a new door design. This makes it possible to improve the efficiency of the loading and unloading process by mechanizing it. At the same time, the authors did not study the possibility of transporting containers in this type of car. Perhaps this is explained by the fact that the authors considered the use of a covered wagon for transporting the most common range of goods.

In [4], solutions are proposed to improve the efficiency of railroad cars operation. These solutions involve using new progressive materials for the manufacture of car bodies. The justification for the use of such materials in the design of cars is given. The effectiveness of the implementation of such a solution is proven. However, the possibility of transporting containers by such a car was not considered.

Similar studies are also reported in [5]. The authors proposed the use of aluminum panels as a lining for the walls of the car body. That allowed them to reduce the car's container and increase its carrying capacity. The calculations proved the effectiveness of this solution. However, the authors did not study the possibility of transporting containers by such a car.

The authors of [6] proposed a solution to adapt a universal railroad car to the transportation of containers by installing fitting stops on its frame. To substantiate such an improvement, an experimental study of the car's strength during shunting collisions was conducted. The results of the studies proved the feasibility of such an improvement. At the same time, the authors did not conduct studies on such modernization of covered wagons. This is probably due to the fact that the authors focused on the most common type of car for transporting containers – a platform car.

In work [7], a solution was proposed to improve the covered wagon to adapt its design to the transportation of various types of cargo. At the same time, the feasibility of dividing the body into separate sections was considered. This allows for the simultaneous transportation of cargo with different characteristics in

the car. However, the authors did not pay attention to the issues of adapting the car to the transportation of containers. This can be explained by the fact that at the time of the research, the issues related to technical equipment of the railroad industry for container transportation were not as acute as they are now.

In order to adapt the universal car to the transportation of containers, paper [8] proposed a solution to improve it. It is envisaged to use a special removable frame that is attached to the frame of the railroad car and is intended to accommodate containers. The corresponding justification for the proposed solution is given. It should be said that it could also be applied to a covered wagon. However, the authors did not conduct such research. This can be explained by the fact that the study was conducted using the example of a flatbed car, the most common type of car used for container transportation.

Our review of the literature [1–8] proves that the issue of improving the structure of covered wagons with the aim of their use for the transportation of containers has not been given proper attention. Therefore, there is a need to conduct research in this area.

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## 3. The aim and objectives of the study

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The purpose of our study is to determine the loading on the body of a covered wagon, modernized for the transportation of containers. This will make it possible not only to improve the efficiency of container transportation by rail but also container transportation in general.

To achieve this goal, the following tasks were set:

- to calculate the strength of the body of a covered wagon subjected to vertical loads from containers;
- to calculate the strength of the body of a covered wagon subjected to vertical and longitudinal loads from containers.

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## 4. The study materials and methods

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The object of our study is the loading process on the body of a covered wagon, modernized for container transportation.

The principal hypothesis assumes that the modernization of the body of a covered wagon could make it possible to adapt its structure for container transportation.

When performing strength calculations, it was assumed that there are no friction forces between the body flanges and the bogie flanges.

The main simplification of the study is that when building a spatial model of the body of a covered wagon, structural elements that interact by hinges or with rivets were not taken into account. That is, the model takes into account only elements that interact rigidly with each other. Therefore, double-leaf doors are absent in the model.

For the transportation of containers by rail, it is proposed to use covered wagons, taking into account their modernization. This modernization involves dismantling the roof and installing fitting stops on the floor for fastening containers (Fig. 1).

To determine the feasibility of such modernization, a calculation was performed for the strength of a covered wagon body subjected to vertical loads from the container. The loading scheme of the covered wagon body under the simultaneous action of vertical and longitudinal loads was also taken into account. Such a loading scheme applies when the friction force between the container fittings is less than the dynamic load acting on the container.

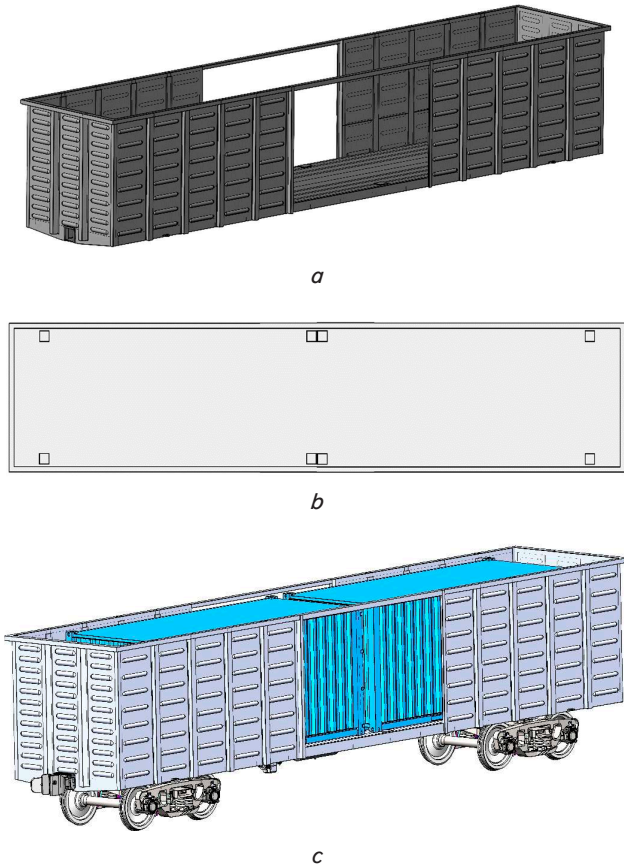


Fig. 1. The body of a covered wagon, modernized for container transportation: *a* – general view of the body; *b* – top view; *c* – arrangement of containers in the car

The study was conducted on the example of a covered wagon body, model 11-217, loaded with two containers of size 1CC. Its spatial model was reproduced in SolidWorks (France). The strength calculation was implemented by finite element modeling in SolidWorks Simulation (France) [9–11].

When the body is subjected to vertical loads from containers, it was taken into account that it has its natural weight, as well as subjected to the weight of containers. The vertical load  $P_v$  also took into account the dynamic component of the load  $P_v^d$  on the body when it moves along the rail track. It is defined by the classical formula

$$P_v^d = P_v^{st} \cdot \frac{k_{dv}}{\beta} \sqrt{\frac{4}{\pi} \cdot \ln \cdot \frac{1}{1 - \left( 1 - \exp \left( -\frac{\pi}{4} \cdot \frac{k_{dv}^2}{k_{dv}^2} \cdot \beta^2 \right) \right)}}, \quad (1)$$

where  $P_v^{st}$  – vertical static load acting on the body;  $\overline{k_{dv}}$  – average value of the coefficient of vertical dynamics (probable);  $\beta$  – distribution parameter.

Formula (1) is given in DSTU 7598:2014. Freight cars. General requirements for calculations and design of new and modernized 1520 mm gauge cars (non-self-propelled). This standard has an analog: “EN 12663-2. Railroad applications – structural requirements of railroad vehicle bodies – Part 2: Freight cars”.

A longitudinal load  $P_l$  was applied to the rear stop of the autocoupler. On the opposite side, this load was balanced by reaction  $P_r$ . Taking this into account, the design scheme of the body takes the form shown in Fig. 2.

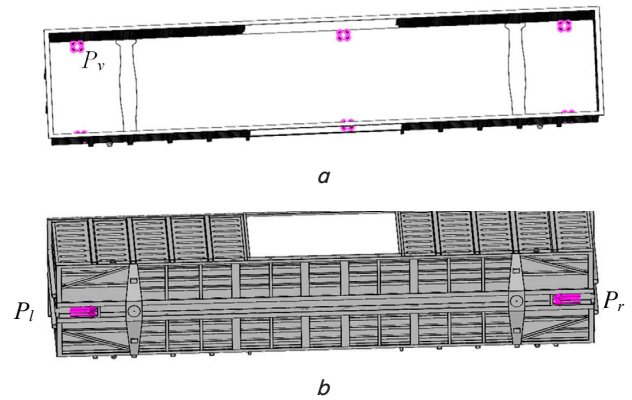


Fig. 2. Design scheme of the covered wagon body subjected to vertical loads from containers: *a* – action of vertical loads; *b* – action of longitudinal loads on the rear stops of autocouplers

The spatial model of the hopper car body was formed by curvilinear isoparametric tetrahedra. This type of element was chosen due to the fact that the finite element mesh was built on a solid body. The number of mesh elements was determined from variational calculations using the graph-analytical method [12–15]. The calculation results allowed us to determine the optimal number of model elements (Fig. 3): 630038 elements and 221546 nodes. The maximum element in the mesh had a size of 100 mm and the minimum – 20 mm.

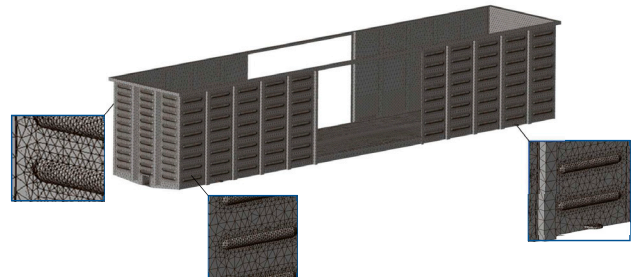


Fig. 3. Finite element model of a covered wagon body

To simulate the interaction of the body with the bogies, rigid connections were installed on the body posts (Fig. 4).

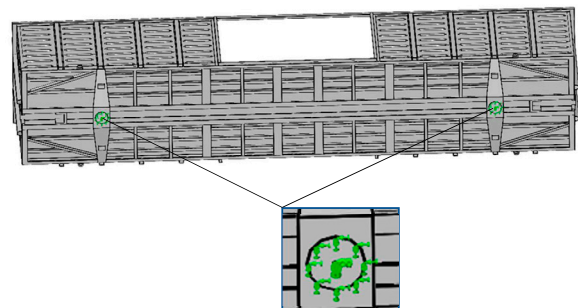


Fig. 4. Body fastening areas

The material of the covered wagon body is steel of grade 09G2S. It has permissible stresses for design mode I of 310.5 MPa, and for III – 210 MPa. The Mises criterion was chosen as the estimation criterion. This is explained by the fact that steel is an isotropic material; for such materials, this criterion is usually used.

With the simultaneous action of vertical and longitudinal loads from containers on the covered wagon body through the fitting stops, the design scheme takes the form shown in Fig. 5. In this case, a vertical load  $P_v$  was applied to the fitting stop plate, and a longitudinal load  $P_{fs}$  was applied to its pin (Fig. 6).

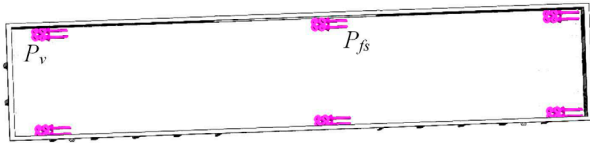


Fig. 5. Design scheme of the covered wagon body subjected to vertical and longitudinal loads from containers

The load  $P_{fs}$  was determined under the condition that the container is subjected to a load of  $0.2g \cdot P_k$ , where  $P_k$  is the weight of the container. The loads indicated in Fig. 2, *b* were applied to the rear stops of the auto coupler.

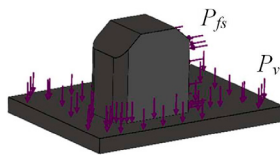


Fig. 6. Fitting stop load diagram

## 5. Results of determining the loading on the body of a covered wagon modernized for container transportation

### 5.1. Results of calculating the strength of the body of a covered wagon subjected to vertical loads

According to the calculation scheme shown in Fig. 2, the strength of the body of a covered wagon was calculated. The results of these calculations are shown in Fig. 7–9. The most loaded areas of the body are the areas of interaction between the girdle beam with the pivots. These areas are indicated by dark blue in Fig. 7. There, the maximum stresses were 284.6 MPa (Fig. 8).

But these stresses are less than the permissible ones by 8.3%. In the areas of fitting stops, the maximum stresses were recorded in the middle part of the frame – 3.1 mm (Fig. 9).

Such a dislocation of the displacement fields is explained by the body loading scheme and its fastening: the middle part of the body is free from support and is subjected to a vertical load.

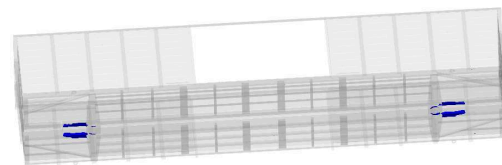


Fig. 7. The most loaded areas of the covered wagon body

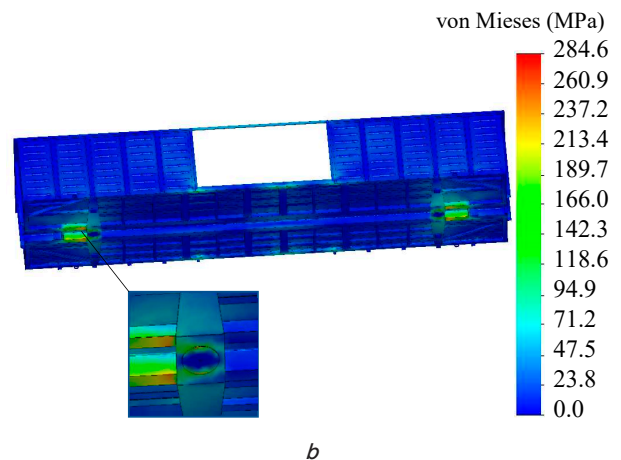
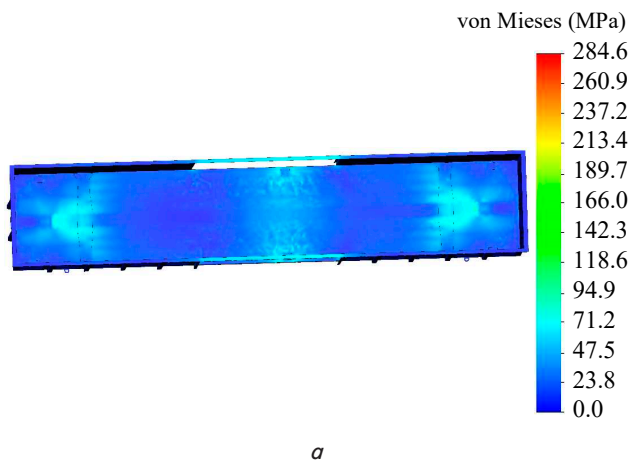


Fig. 8. Stressed state of the covered wagon body: *a* – top view; *b* – bottom view

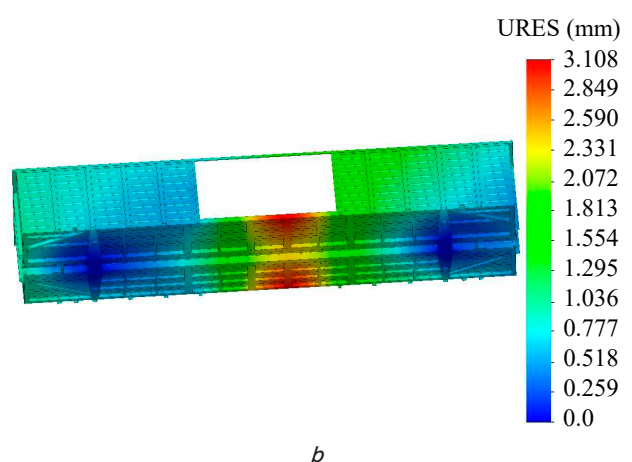
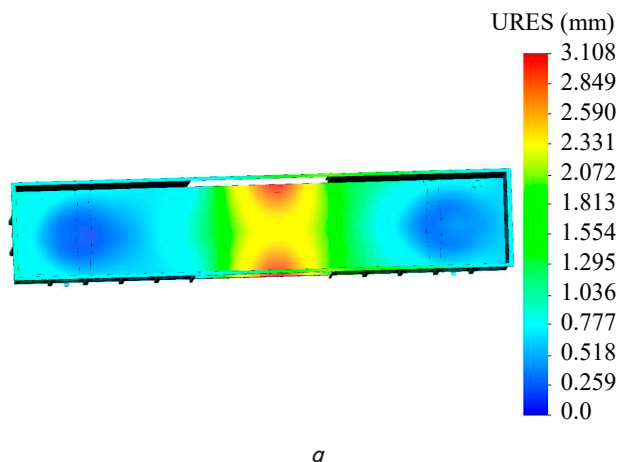


Fig. 9. Movement in the body assemblies of a covered wagon: *a* – top view; *b* – bottom view

### 5. 2. Results of calculating the strength of the body of a covered wagon subjected to vertical and longitudinal loads

The results of our calculations of the strength of the body of a covered wagon in accordance with the calculation scheme shown in Fig. 5 are shown in Fig. 10–12. It was established that the most loaded zones of the body, again, are the zones of interaction of the girdle beam with the pivots (Fig. 9). However, with this calculation scheme, there is an asymmetry in the distribution of stresses in these zones. This can be explained by the fact that the body structure is loaded asymmetrically.

The highest stresses in the body were 298.2 MPa, which is 4% lower than the permissible ones (Fig. 11). In the areas of fitting stops, the maximum stress values were about 130 MPa.

The maximum displacements were recorded in the areas of placement of the middle fitting stops and amounted to 3.4 mm (Fig. 12).

The results of our calculations prove that the use of covered wagons for transporting containers is possible.

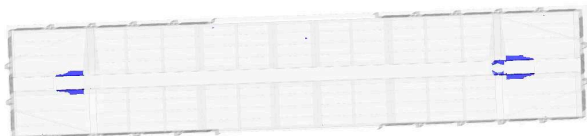


Fig. 10. The most loaded areas of the covered wagon body

### 6. Discussion of results based on determining the loading on the body of a covered wagon, modernized for container transportation

To adapt the covered wagon for the transportation of containers, its modernization has been proposed. It is assumed to dismantle the roof and install fitting stops on the floor (Fig. 1). To substantiate such modernization, a calculation was performed for the strength of the covered wagon body subjected to vertical loads from containers (Fig. 2), as well as the simultaneous action of vertical and longitudinal loads (Fig. 5). The results of our calculations showed that the strength of the car body is maintained under the considered loading schemes. When the body is subjected only to vertical loads, the maximum stresses were recorded in the zones of interaction of the girdle beam with the pivots (Fig. 7). These stresses amounted to 284 MPa (Fig. 8) and are less than the permissible ones. Such a dislocation of stresses is explained by the scheme of fastening the body and applying loads to it. That is, due to the fact that the body was fastened by the studs, and the frame was subjected to a vertical load, the maximum stresses were concentrated in the above-mentioned zones. In the zones of the fitting stops, the maximum stress values were about 100 MPa. The maximum displacements were recorded in the middle part of the frame and amounted to 3.1 mm (Fig. 9). This distribution of displacement fields can be explained by the fact that the middle part of the frame is free from support; therefore, the maximum displacements are concentrated in it.

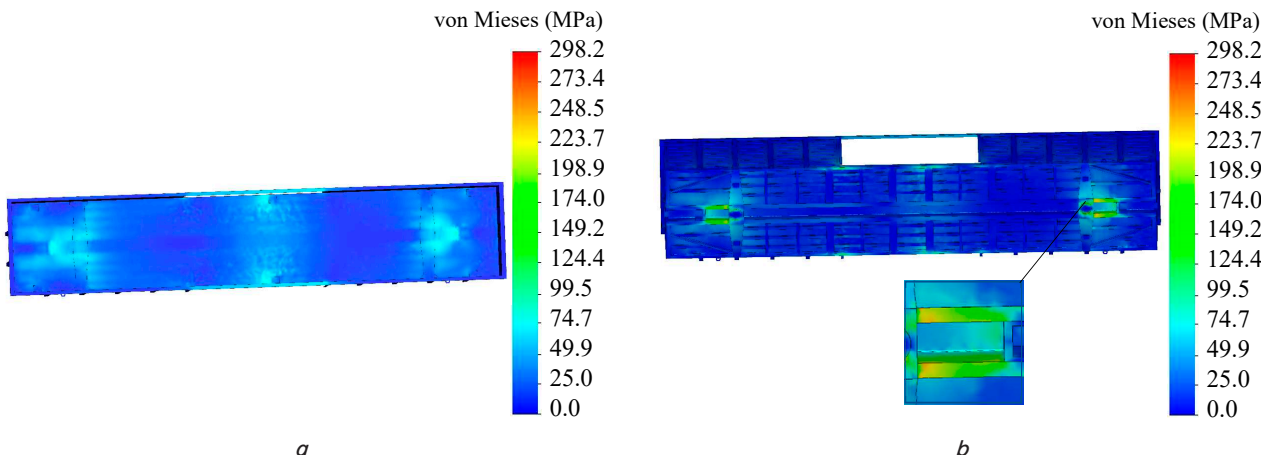


Fig. 11. Stressed state of the covered wagon body: *a* – top view; *b* – bottom view

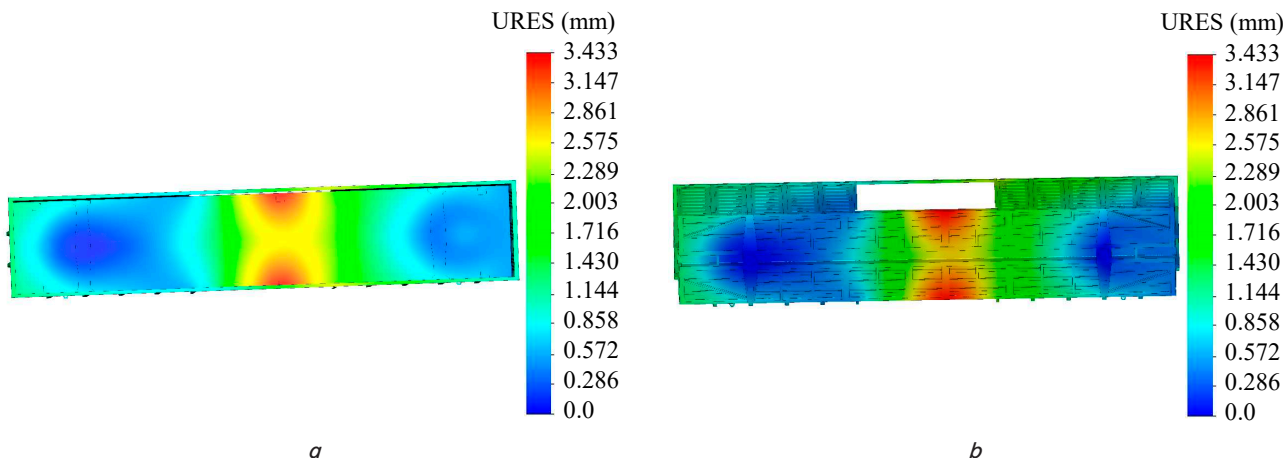


Fig. 12. Movement in the body assemblies of a covered wagon: *a* – top view; *b* – bottom view

With the simultaneous action of vertical and longitudinal loads, the maximum stresses arise in the zones of interaction of the girdle beam with the pin beams (Fig. 10). The value of these stresses was 298.2 MPa (Fig. 11). This can be explained in the same way as for the previous calculation scheme. In the zones of placement of the fitting stops, the maximum stresses were about 130 MPa. The maximum displacements were recorded in the zones of placement of the middle fitting stops and were 3.4 mm (Fig. 12). Such a dislocation of the displacement fields is explained not only by the fact that the middle part of the frame experiences a vertical load but also by the fact that the fitting stops are located in the middle part of the frame. They are affected not only by vertical but also by longitudinal loads.

The results of our calculations prove that the proposed modernization is effective. It is important to say that it can also be applied to the structures of covered wagons that have exhausted their service life but taking into account the preliminary calculations for strength. Such a solution can be justified by the fact that when transporting containers, the carrying capacity of the covered wagon is not used completely, but only by 70% (for the covered wagon model 11-217).

The advantage of our study in comparison with works [1, 8] is that we have proposed adapting the covered wagon for container transportation without the need to use additional fastening devices (removable module or frame). Fastening containers in the modernized design of the covered wagon requires minimal time, unlike the solution given in work [2]. Unlike [4, 5], the proposed modernization does not require significant capital investments since it does not require the introduction of high-cost materials into the body structure. The modernization proposed in this study makes it possible to increase the segment of transported cargo in a covered wagon, in contrast to the solutions described in [3, 6, 7].

The basic condition for using our research results is the symmetrical placement of the fitting stops relative to the transverse axis of the covered wagon body. This condition is due to the need to ensure uniform loading of both car bogies.

The limitation of our research is that the friction forces between the container fittings and the fitting stops of the covered wagon were not taken into account when performing the calculations. That is, the load case was taken into account when the friction forces are greater than the dynamic load, which ensures the absence of container displacements by the technological gap between the fittings and the fitting stops.

The disadvantage of this research is that we did not take into account the above-standard load schemes of the fitting stops (asymmetry of the load, movement of the container by the technological gap, the influence of vibrations [16], etc.). These shortcomings are a prospect for future studies. In further research in this area, these issues will be resolved.

Our research will contribute to increasing the efficiency of container transportation by rail and container transportation in general.

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## 7. Conclusions

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1. The strength of a covered wagon body has been calculated when it is subjected to vertical loads from containers. It was found that the maximum stresses in the covered wagon body were 284.6 MPa and were 8.3% lower than the permissible ones. They are concentrated in the areas of interaction of the girdle beam with the pivots. In the areas of placement of fitting stops, the maximum stresses were about 100 MPa. The maximum displacements were recorded in the middle part of the frame – 3.1 mm.

2. The strength of a covered wagon body has been calculated when it is subjected to vertical and longitudinal loads from containers. The results of our calculations showed that the maximum stresses in the body were 298.2 MPa. The obtained stresses were 4% lower than the permissible ones. In the areas of placement of fitting stops, the maximum stresses were about 130 MPa. The maximum displacements occur in the areas where the middle fitting stops are located and amounted to 3.4 mm.

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## Conflicts of interest

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The authors declare that they have no conflicts of interest in relation to the current study, including financial, personal, authorship, or any other, that could affect the study and the results reported in this paper.

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## Funding

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The study was conducted without financial support.

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## Data availability

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All data are available in the main text of the manuscript.

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## Use of artificial intelligence

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The authors confirm that they did not use artificial intelligence technologies when creating the current work.

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## Authors' contributions

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**Sergii Panchenko:** Funding acquisition, Investigation, Validation, Software, Supervision, Visualization, Writing – original draft. **Alyona Lovska:** Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Data curation, Resources, Validation, Software, Supervision, Visualization, Writing – review & editing. **Arsen Muradian:** Data curation, Resources, Validation, Software, Supervision, Visualization, Writing – original draft. **Yevhen Pelypenko:** Formal analysis, Funding acquisition, Visualization, Writing – review & editing. **Valentyna Romakh:** Formal analysis, Funding acquisition, Investigation, Funding acquisition, Investigation.

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## References

1. Panchenko, S., Lovska, A., Muradian, A., Pelypenko, Y., Rukavishnykov, P., Demydiukov, O. (2024). Identifying possible ways for adapting an open wagon for transporting containers. *Eastern-European Journal of Enterprise Technologies*, 5 (7 (131)), 6–14. <https://doi.org/10.15587/1729-4061.2024.311324>

2. Berescu, C., Fratila, C., Axinte, T., Diaconu, M., Cojocaru, R. (2020). The mechanism's study of fixing a container on a freight wagon type Rgs. IOP Conference Series: Materials Science and Engineering, 916 (1), 12010. <https://doi.org/10.1088/1757-899x/916/1/012010>
3. Chandra Prakash Shukla, Bharti, P. K. (2015). Study and Analysis of Doors of BCNHL Wagons. International Journal of Engineering Research And, 4 (04). <https://doi.org/10.17577/ijertv4is041031>
4. Lee, W. G., Kim, J.-S., Sun, S.-J., Lim, J.-Y. (2016). The next generation material for lightweight railway car body structures: Magnesium alloys. Proceedings of the Institution of Mechanical Engineers, Part F: Journal of Rail and Rapid Transit, 232 (1), 25–42. <https://doi.org/10.1177/0954409716646140>
5. Lee, H.-A., Jung, S.-B., Jang, H.-H., Shin, D.-H., Lee, J. U., Kim, K. W., Park, G.-J. (2015). Structural-optimization-based design process for the body of a railway vehicle made from extruded aluminum panels. Proceedings of the Institution of Mechanical Engineers, Part F: Journal of Rail and Rapid Transit, 230 (4), 1283–1296. <https://doi.org/10.1177/0954409715593971>
6. Reidemeister, O. H., Kalashnyk, V. O., Shykunov, O. A. (2016). Modernization as a way to improve the use of universal cars. Science and Transport Progress, 2 (62), 148–156. <https://doi.org/10.15802/stp2016/67334>
7. Fomin, O., Lovska, A., Klymash, A., Keremet, M. (2021). Improvement of covered wagons of the “East-West” type by sectioning with a partition. Eastern-European Journal of Enterprise Technologies, 5 (7 (113)), 36–43. <https://doi.org/10.15587/1729-4061.2021.239751>
8. Shaposhnyk, V., Shykunov, O., Reidemeister, A., Muradian, L., Potapenko, O. (2021). Determining the possibility of using removable equipment for transporting 20- and 40-foot-long containers on a universal platform wagon. Eastern-European Journal of Enterprise Technologies, 1 (7 (109)), 14–21. <https://doi.org/10.15587/1729-4061.2021.225090>
9. Blatnický, M., Dižo, J., Timoščuk, M. (2016). Design of a Three-Finger Robot Manipulator. Manufacturing Technology, 16 (3), 485–489. <https://doi.org/10.21062/ujep/x.2016/a/1213-2489/mt/16/3/485>
10. Dižo, J., Harušinec, J., Blatnický, M. (2015). Multibody System of a Rail Vehicle Bogie with a Flexible Body. Manufacturing Technology, 15 (5), 781–788. <https://doi.org/10.21062/ujep/x.2015/a/1213-2489/mt/15/5/781>
11. Dižo, J., Blatnický, M., Melnik, R., Karľa, M. (2022). Improvement of Steerability and Driving Safety of an Electric Three-Wheeled Vehicle by a Design Modification of its Steering Mechanism. LOGI – Scientific Journal on Transport and Logistics, 13 (1), 49–60. <https://doi.org/10.2478/logi-2022-0005>
12. Kowalski, S., Cieślowski, B., Barta, D., Dižo, J., Dittrich, A. (2023). Analysis of the Operational Wear of the Combustion Engine Piston Pin. Lubricants, 11 (3), 100. <https://doi.org/10.3390/lubricants11030100>
13. Goolak, S., Kyrychenko, M. (2022). Thermal Model of the Output Traction Converter of an Electric Locomotive with Induction Motors. Problems of the Regional Energetics, 3 (55), 1–16. <https://doi.org/10.52254/1857-0070.2022.3-55.01>
14. Goolak, S., Gorobchenko, O., Petrychenko, O., Holub, H., Kulbovskiy, I. (2025). Traction Drive Control System for Railway Electric Rolling Stock Based on the Application of Power Factor as an Optimization Criterion. Problems of the Regional Energetics, 3 (67), 1–12. <https://doi.org/10.52254/1857-0070.2025.3-67.01>
15. Kondratiev, A., Píštěk, V., Gajdachuk, V., Kharchenko, M., Nabokina, T., Kučera, P., Kučera, O. (2023). Effect of Ply Orientation on the Mechanical Performance of Carbon Fibre Honeycomb Cores. Polymers, 15 (11), 2503. <https://doi.org/10.3390/polym15112503>
16. Dižo, J., Steišunas, S., Blatnický, M. (2017). Vibration Analysis of a Coach with the Wheel-flat Due to Suspension Parameters Changes. Procedia Engineering, 192, 107–112. <https://doi.org/10.1016/j.proeng.2017.06.019>