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JUSTIFYING THE EXPEDIENCY OF USING COMPOSITE COMPONENTS IN THE LONG-WHEELBASE PLATFORM CAR

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This paper reports the improved load-bearing design of a long-wheelbase platform car for the transportation of containers. The improvement involves the construction of a special structure to accommodate fitting stops made from composite material. The design of the add-on structures provides an opportunity to reduce dynamic loads between containers and the platform car at the expense of elastic friction bonds.

The dynamic load on the bearing structure of the platform car was determined. To this end, a mathematical model was built that takes into consideration its movement in the vertical plane. The results of resolving the mathematical problem established that the derived values of accelerations were 5.3 % and 6.2 %, respectively, lower than those acting on the platform car and container, taking into consideration the typical scheme of their interaction.

To ensure the strength of the add-on structure, the calculation was performed using a finite-element method. It was established that the maximum stresses occurred in the inclined parts of the add-on structure and were 113.6 MPa, which is much lower than the permissible ones.

In addition, within the framework of this study, a dynamic load on the improved design of the platform car was determined when it moves empty. The calculation results showed that the defined indicators of dynamics were within the permissible limits while the ride of the platform car was "good".

The coefficient of resistance to fatigue of the load-bearing structure of the platform car was determined, taking into consideration the new scheme of interaction with containers. Taking the proposed solutions into account, it becomes possible to increase the resistance coefficient of fatigue of the load-bearing structure of the platform car by 8 % compared to the typical scheme.

The study reported here could help reduce the cost of maintaining combined transport vehicles, as well as improve the efficiency of their operation

Keywords: transport mechanics, platform car, container, load-bearing structure, composite material, fatigue resistance

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1. Introduction

One of the priority directions in the development of transportation industry is to improve the efficiency of operation of combined transport vehicles. Its most promising component is container transportation, which is due to the mobility of the container as a vehicle. Containers are transported by rail mainly on platform cars.

To increase the volume of container transportation by rail, long-wheelbase structures of platform cars are used. Such cars can simultaneously transport four containers the size of 1CC or two containers the size of 1AA. At the same time, given the increased length of such cars, they are additionally loaded during operation due to the presence of the natural movements of the frame in the vertical plane. This contributes to the accumulation of stresses both in the supporting structure of the platform car and containers that perceive dynamic loads from the platform car.

As a result of operational load modes, including non-standard, there is damage to the components of the structures of the combined transport means. In this regard, there is a need for additional costs for keeping them in operation. In addition, damage to the means of combined transport on the way threatens the safety of their movement as part of the train. It also threatens the environmental friendliness of cargo transportation [1, 2], including liquid, the transportation of which is carried out in tank containers [3–5]. Therefore, studies addressing the improvement of bearing structures of platform cars, as well as the nodes of their interaction with containers to improve the efficiency of operation, are relevant.

2. Literature review and problem statement

Improving the efficiency of the use of vehicles is possible by introducing promising materials into the components of their supporting structures. Composite materials are among the most relevant and promising ones.

Analysis of the use of composite materials in vehicle designs is highlighted in [6]. The main prospects and disadvantages of using this material are given. The main directions of creation of new generation cars with the use of composite materials are determined.

Determining the components of railroad transport vehicles for optimal load reduction with the use of composite materials is reported in paper [7]. It is noted that the structural components of the body of the railroad car are the most optimal for improvement through the use of composite materials. At the same time, there are no examples of the introduction of this material on freight cars in the cited works.

Study [8] investigates the features of the load on the railroad tank car with compositional components under the most unfavorable load modes. The main disadvantages of the use of a composite reinforced with fiber as a material of the car design are determined. At the same time, it is interesting to introduce this material into the components of the load-bearing structure of the platform car.

Features of the use of panels made of composite material on freight cars are analyzed in [9]. The use of panels on railroad cars is proposed to be carried out in such a way that it is possible to modernize the existing rolling stock, and not only in the manufacture of a new one. In paper [10], the authors conduct endurance tests of composite panels, which are proposed to be used on railroad cars. The procedure for testing panels is given; the expediency of their use on freight cars is substantiated. However, the authors did not consider the possibility of using composite materials on platform cars as one of the most popular types of cars in international traffic.

Paper [11] highlights the features of optimizing the design of components of railroad vehicles. In the process of optimization, a composite structure was developed with a projected mass reduction of 33 % compared to the existing steel structure. It is important to say that at the same time there is simultaneous compliance with the requirements of compliance, manufacturing, and failure criteria of the components of the vehicle design.

Work [12] substantiates the use of composite materials with fiber reinforcement for the manufacture of light structures and reducing the total weight of rail vehicles. The prospects for the use of composites in freight car building are given. However, the cited paper does not provide an example of the use of this material in the components of freight cars, including platform cars.

Analysis of the dynamic load on the floor of the composite multilayer material of a high-speed train is carried out in [13]. The results of a comprehensive analysis of dynamic load established the feasibility of using composite material on rolling stock. It is important to say that the issues of expediency of introducing composite material on platform cars have been left out of the attention of researchers.

To increase the efficiency of operation of vehicles, it is possible to devise measures aimed at reducing their damage. This can be achieved not only by strengthening the components of structures but also by reducing their dynamic load.

To reduce the dynamic load on vehicles under operational load modes, paper [14] proposed the introduction of flexible connections into their supporting structures. The results of the mathematical and computer modeling confirmed their feasibility. However, at the same time, no attention was paid to the issues of reducing the dynamic load on long-base structures of platform cars under operational modes.

In [15], to reduce the dynamic load on the gondola car, the authors proposed the use of energy-absorbing material in its design. Calculations were performed on the example of the use of aluminum foam. It is established that such advancement helps reduce the dynamic load on the supporting structure by 8 % compared to the typical one. At the same time, the authors did not conduct research to reduce the load on the load-bearing structure of a long-wheelbase platform car.

Our review of literary sources [6–15] makes it possible to conclude that the issues of improving vehicles to reduce their tare, as well as dynamic load, require further research and development in order to increase the efficiency of operation of the transportation industry.

3. The aim and objectives of the study

The purpose of this study is to substantiate the feasibility of using composite components in a long-wheelbase platform car. This will help reduce the cost of maintaining combined transportation vehicles, as well as increase the efficiency of their operation.

To accomplish the aim, the following tasks have been set:

– to determine the dynamic load on the bearing structure of the platform car, taking into consideration the new scheme of interaction with containers;

– to determine the strength of the add-on structure to accommodate fitting stops of containers;

– to determine the dynamic load on the improved structure of the platform car when moving empty.

4. The study materials and methods

The object of our research is the processes of occurrence, perception, and redistribution of loads in the supporting structure of the platform car, taking into consideration the new scheme of interaction with containers.

In this case, the main hypothesis of the study assumes that reducing the load on the bearing structure of the platform car with containers is possible through the introduction of elastic friction bonds in the nodes of their interaction.

To determine the dynamic load on the platform car taking into consideration the new scheme of interaction with containers, a mathematical model of its movements in the vertical plane was built. The model takes into consideration the fluctuations in the platform car bouncing. At the same time, it is taken into consideration that the platform car is loaded with four containers the size of 1CC. When the platform car jumps, the containers placed on it move in the vertical plane and have the same degree of freedom. The track, in this case, acquires elastic-viscous properties [16, 17]. The reactions of the track are proportional to both its deformation and the speed of this deformation. The mathematical model was solved according to the Runge-Kutta method in the Mathcad software package (USA) [18–21].

At the same time, the starting conditions are accepted as zero [22–24].

To determine the strength of the add-on structures for arranging fitting stops of containers, we performed calculation. In this case, a finite-element method [25–28] was used, implemented in the SolidWorks Simulation software package (France). The criterion of maximum normal stresses was applied as the estimation criterion [29, 30]. The material of the add-on structures is a composite that has a strength limit in the direction of fibers of 1,100–1,300 MPa, across the fibers – 650 MPa.

When building the finite-element model, isoparametric tetrahedrons were used [31–34]. The number of tetrahedra was determined by the graph-analytic method [35, 36]. The number of nodes in the model was 9,564, elements – 19,124. The size of the elements was 8.15 mm.

To determine the main indicators for the dynamics of the platform car taking into consideration the proposed improvement, a mathematical model was used given in [16, 17]. The model takes into consideration the movement of the empty car over a butt irregularity while the track is considered viscoelastic. It is taken into consideration that the platform car consists of three components – a load-bearing structure and two bogies of the model 18-100. Our studies were carried out in the vertical plane. The calculation was performed using the Runge-Kutta method. Starting conditions are taken equal to zero.

5. The results of studying the load on a bearing structure of the platform car taking into consideration the new scheme of interaction with containers

5. 1. Determining the dynamic load on the bearing structure of the platform car taking into consideration the new scheme of interaction with containers

One of the most promising types of platform cars for the transportation of containers on wide-gauge railroads is the long-wheelbase platform car, model 13-7024 (Fig. 1).

Given the variable height of the profile for the longitudinal beams of the frame, fitting stops are arranged on special add-on structures (Fig. 2).

To reduce the dynamic load on the bearing structure of the platform car, and as a result, the containers placed on it, we propose using an improved design of add-on structures (Fig. 3). The peculiarity of the improvement is that in the middle of add-on structure 1, cup 2 is placed, which hosts spring 4. At bouncing fluctuations in the case when the vertical dynamic load P_v exceeds the rigidity of the spring C, the fitting stop plate 3 moves relative to cup 2. In this case, the dynamic load on the container is reduced due to the friction forces P_{fr} that occur between cup 2 and fitting plate 3.

Fig. 1. Platform car, model 13-7024

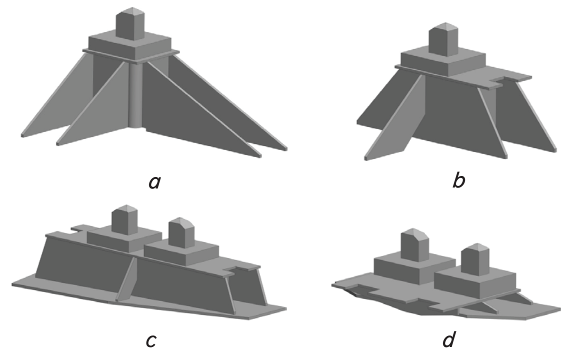

Fig. 2. Add-on structures for arranging fitting stops on the platform car: *a* – angular; *b* – the second on the side of the console; *c* – the third from the console; *d* – central

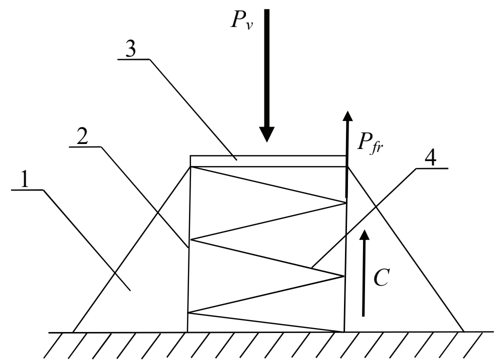

Fig. 3. Estimation scheme of the add-on structure to accommodate fitting stops

To justify the proposed solution, a mathematical model of the dynamic load on the platform car loaded with containers was constructed. Since the proposed improvement is aimed at reducing the load on the platform car with containers in the vertical plane, the estimation scheme shown in Fig. 4 was drawn subject to bouncing fluctuations.

The system of differential equations of motion is as follows:

$$\begin{cases} M_1 \cdot \ddot{q}_1 + C_{1,1} \cdot q_1 + C_{1,2} \cdot q_2 + C_{1,3} \cdot q_3 = \\ = -F_{fr} \cdot \left(\mathrm{sign}\left(\dot{\delta}_1\right) + \mathrm{sign}\left(\dot{\delta}_2\right)\right) - F_z, \\ M_2 \cdot \ddot{q}_2 + C_{2,1} \cdot q_1 + C_{2,2} \cdot q_2 + B_{2,2} \cdot \dot{q}_2 = \\ = F_{fr} \cdot \mathrm{sign}\left(\dot{\delta}_1\right) + k\left(\eta_1 + \eta_2\right) + \beta\left(\dot{\eta}_1 + \dot{\eta}_2\right), \\ M_3 \cdot \ddot{q}_3 + C_{3,1} \cdot q_1 + C_{3,3} \cdot q_3 + B_{3,3} \cdot \dot{q}_3 = \\ = F_{fr} \cdot \mathrm{sign}\left(\dot{\delta}_2\right) + k\left(\eta_3 + \eta_4\right) + \beta\left(\dot{\eta}_3 + \dot{\eta}_4\right), \\ M_4 \cdot \ddot{q}_4 = F_z - M_4 \cdot g - F_{fr}^c \cdot \left(\mathrm{sign}\left(\dot{q}_1\right) + \mathrm{sign}\left(\dot{q}_4\right)\right), \end{cases} \quad (1)$$

$$F_z = -k_k'\left(y_1 - y_4\right), \quad (2)$$

where M_1 is the mass of the load-bearing structure of the platform car; M_2, M_3 is the weight, respectively, of the first and second bogie; M_4 – the mass of the container; C_{ij} is the characteristics of elasticity of the elements of the oscillatory system, which are determined by the values of the coefficients of rigidity of springs k_B; B_{ij} is the scattering function; k – track stiffness; β – damping factor; F_{fr} is the friction force in the spring kit of the bogie; δ_i is the deformation of the elastic elements of spring suspension; η_i is the track irregularity; F_{fr}^c is the friction force that occurs between the fitting plate and cup.

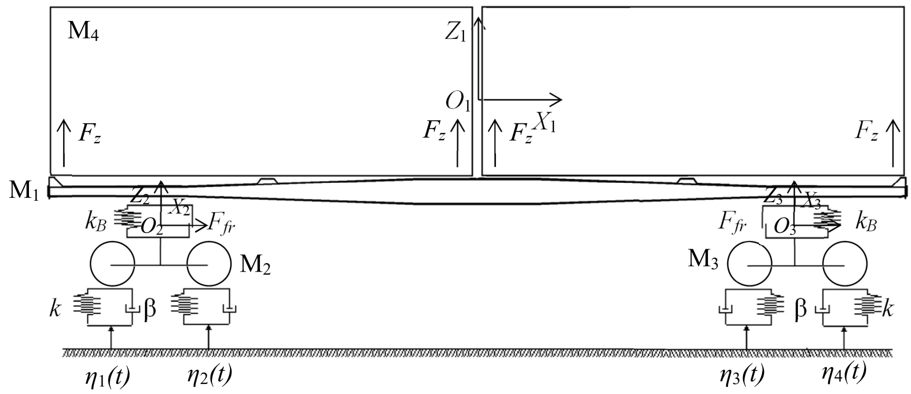

Fig. 4. Estimation scheme of the platform car

In the equations of motion (1) to (4), it is accepted that:

– $Z_1 \sim q_1$ is the coordinate characterizing the translational movements of the supporting structure of the platform car relative to the vertical axis;

– $Z_2 \sim q_2$ is the coordinate characterizing the translational movements of the first bogie relative to the vertical axis;

– $Z_3 \sim q_3$ is the coordinate characterizing the translational movements of the second bogie relative to the vertical axis;

– $Z_4 \sim q_4$ is the coordinate characterizing the translational movements of the container relative to the vertical axis.

$$F(t,y)=\begin{bmatrix} y_2 \\ y_4 \\ y_6 \\ \dfrac{-F_{fr}\cdot\left(\operatorname{sign}(\dot{\delta}_1)+\operatorname{sign}(\dot{\delta}_2)\right)-F_z-C_{1,1}\cdot y_1-C_{1,2}\cdot y_3-C_{1,3}\cdot y_5}{M_1} \\ \dfrac{F_{fr}\cdot\operatorname{sign}(\dot{\delta}_1)+k(\eta_1+\eta_2)+\beta(\dot{\eta}_1+\dot{\eta}_2)-C_{2,1}\cdot y_1-C_{2,2}\cdot y_3-B_{2,2}\cdot y_4}{M_2} \\ \dfrac{F_{fr}\cdot\operatorname{sign}(\dot{\delta}_2)+k(\eta_3+\eta_4)+\beta(\dot{\eta}_3+\dot{\eta}_4)-C_{3,1}\cdot y_1-C_{3,3}\cdot y_3-B_{3,3}\cdot y_6}{M_3} \\ \dfrac{F_z-M_4\cdot g-F_{fr}^{c}\cdot\left(\operatorname{sign}(y_2)+\operatorname{sign}(y_6)\right)}{M_4} \end{bmatrix}, \quad (3)$$

$$Z = rkfixed(Y0, tn, tk, n, F).$$

In this case, $y_1=q_1$, $y_3=q_3$, $y_5=q_5$, $y_2=\dot{y}_1$, $y_4=\dot{y}_3$, $y_6=\dot{y}_5$. The results of our calculation are shown in Fig. 5, 6.

The input parameters of the model are the specifications of the supporting structure of the platform car, spring suspension, containers, as well as perturbing action (Table 1).

Table 1

Input parameters that are taken into consideration when simulating the dynamic load on the platform car

Parameter name	Numerical value
The mass of the supporting structure of the platform car, t	10.4
Weight of the container, t	24
Mass of the cart, t	4.3
Spring suspension stiffness, kN/m	8,000
Coefficient of relative friction	0.1
Track stiffness, kN/m	100,000
Damping coefficient	200
Stiffness of elastic elements in the add-on structure, kN/m	2,000

When solving the mathematical model (1), we reduced it to the normal Cauchy form [37, 38] and integrated it then according to the Runge-Kutta method.

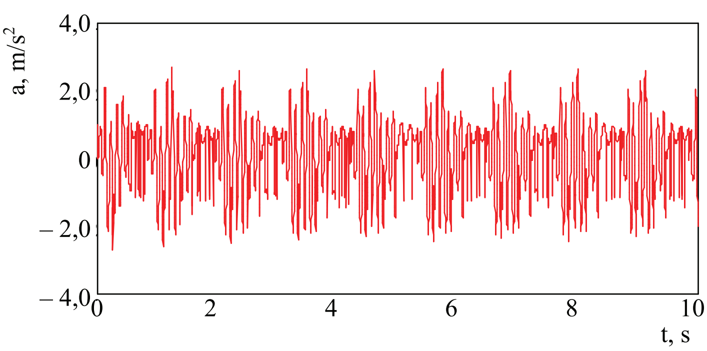

Fig. 5. Acceleration of the load-bearing structure of the platform car

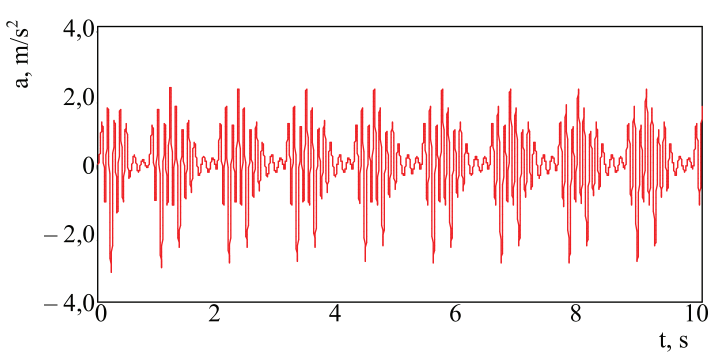

Fig. 6. Acceleration of the container placed on the platform car

Thus, the maximum acceleration that acts on the platform car was 2.67 m/s^2, the container – 3.15 m/s^2. The derived acceleration values are, respectively, 5.3 % and 6.2 % lower than those that act on the platform car and container taking into consideration the regular scheme of their interaction.

5. 2. Determining the strength of the add-on structure to accommodate fitting stops of containers

To determine the strength of the add-on structure to accommodate a fitting stop, a spatial model of its design was built. The calculation was performed on the example of an angular add-on structure (Fig. 7).

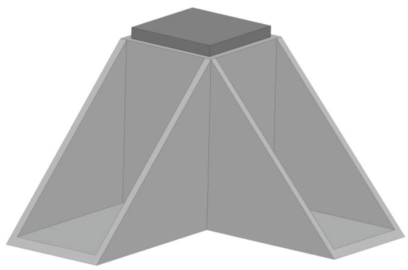

Fig. 7. Spatial model of the add-on structure to accommodate a fitting stop

When drawing up the estimation scheme, it is taken into consideration that the fitting plate is exposed to a vertical load P_v, which accounts for the acceleration obtained from resolving the mathematical model (1). The model also takes into consideration the friction forces P_{fr} between the vertical parts of the cup and plate (Fig. 8).

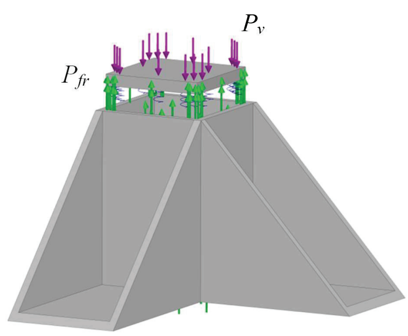

Fig. 8. Estimation scheme of the add-on structure to accommodate a fitting stop

Between the horizontal part of the fitting plate and the bottom of the cup, elastic bonds were established with a rigidity of 2000 kN/m. The model was fixed in the regions of its resting on the frame of the platform car. The material of the structure is a composite that has orthotropic properties. We calculated the add-on structure taking into consideration the fact that it consists of thin-walled shells.

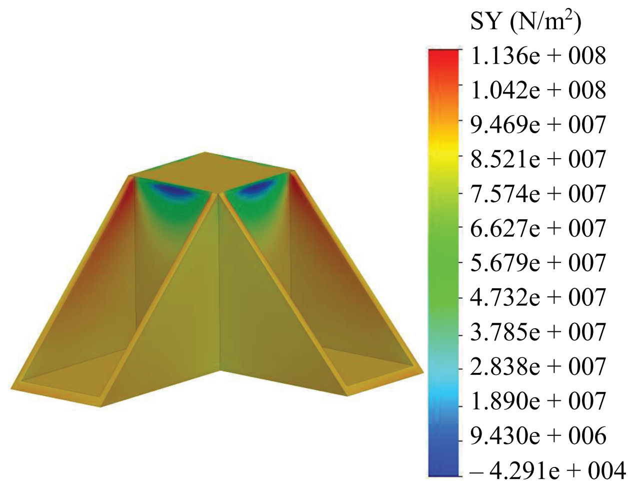

Fig. 9. The stressed state of the add-on structure to accommodate a fitting stop

The results of our calculation are shown in Fig. 9.

In this case, maximum stresses occur in the inclined parts of the add-on structure and are 113.6 *MPa*, which is much lower than the permissible values.

5. 3. Determining the dynamic load on the improved design of the platform car when moving empty

It must be said that the improvement of the design of add-on structures and the use of a composite as a material for their manufacture helps reduce the tare of the platform car by 2.5 % compared to a typical design. Therefore, we modeled the dynamic load on the bearing structure of the platform car. The estimation scheme of the platform car is shown in Fig. 10. Our studies were carried out in the vertical plane since the vibrations of the bouncing of the platform car are among the most frequent during operation.

The designations on the above estimation scheme are identical to those indicated in Fig. 4.

The input parameters that are taken into consideration when simulating the dynamic load on the platform car are given in Table 2.

The results of our calculations are shown in Fig. 11–13.

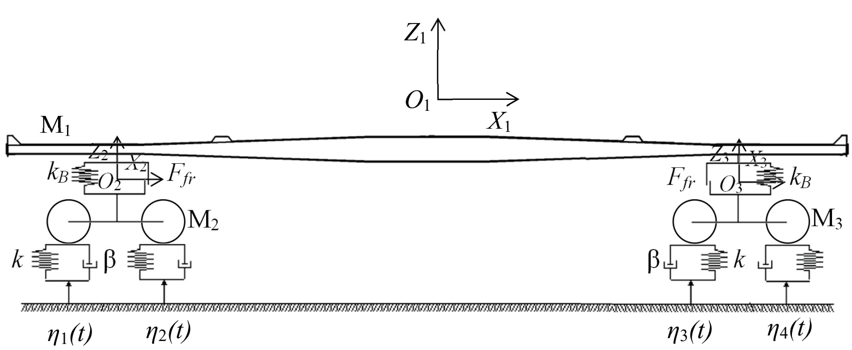

Fig. 10. Estimation scheme of the platform car

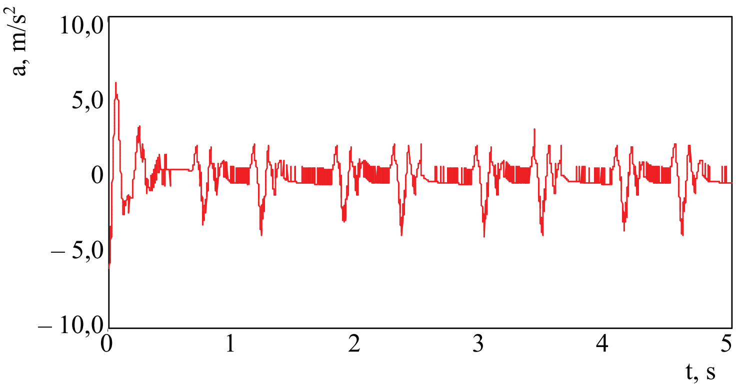

Fig. 11. Accelerations that act in the center of mass of the bearing structure of a platform car

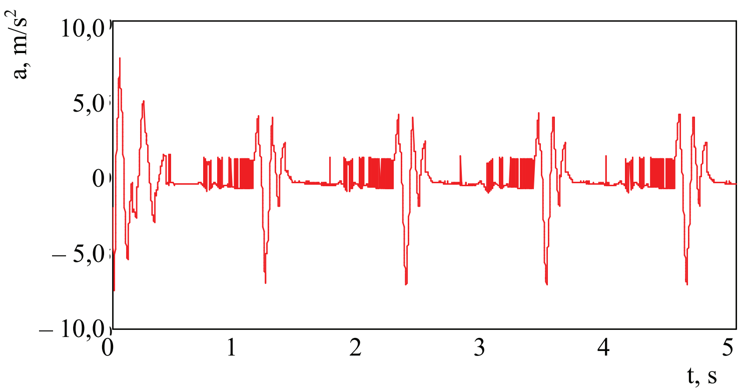

Fig. 12. Accelerations that act in the regions where the load-bearing structure of a platform car rests on bogies

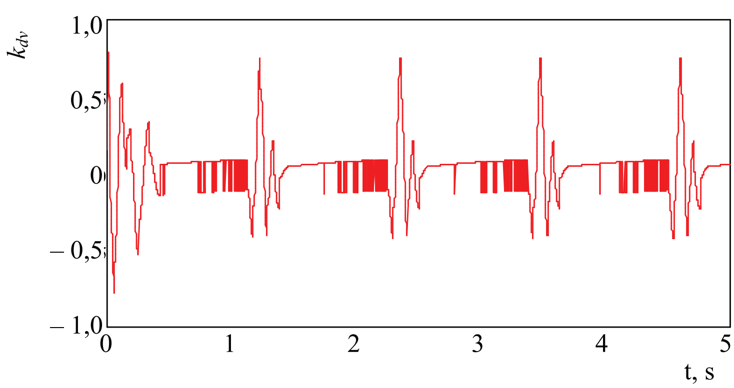

Fig. 13. Vertical dynamics coefficient

The results of our calculations of the dynamic load on the platform car have made it possible to establish that the defined indicators of the dynamics are within the permissible limits. The movement of the platform car is "good". In this case, the maximum acceleration in the center of mass of the bearing structure of a platform car was 5.9 m/s^2. The acceleration in the regions where the load-bearing structure of a platform car rests on bogies is 7.4 m/s^2. The vertical dynamics coefficient was 0.75.

In addition, within the framework of this study, the coefficient of resistance to fatigue of the load-bearing structure of the platform car was calculated.

The calculation of fatigue resistance is carried out taking into consideration the reserve coefficient n according to the formula [39]:

$$n = \frac{\sigma_{-1E}}{\sigma_{a,d}} \geq [n], \quad (4)$$

$\sigma_{a,d}$ is the estimated value of the amplitude of the dynamic stress of the conditional symmetric cycle, reduced to base N_0, equivalent in damage to the effect of the value of amplitudes under a real mode of operational random stresses during the design life, MPa;

$[n]$ is the permissible coefficient of fatigue resistance.

Table 2

Input parameters that are taken into consideration when simulating the dynamic load on the platform car

Parameter name	Numerical value
Mass, t	10.4
Moment of inertia, t·m^2	644.1
Half of the base of the platform car, m	7.36
Mass of the bogie, t	4.3
Bogie moment of inertia, t·m^2	3.0
Half of the bogie base, m	0.9
Spring suspension stiffness, kN/m	8000
Coefficient of relative friction	0.1
Track stiffness, kN/m	100000
Damping coefficient	200
Amplitude of irregularity, m	0.01
The length of the irregularity, m	3.0
Distance between irregularities, m	25.0
Speed of movement, km/h	80.0

The equivalent consolidated amplitude of dynamic stresses for the calculation of fatigue $\sigma_{a,d}$ in the case of a break function of the distribution of stress amplitudes is determined from [40]

$$\sigma_{a,d} = \sqrt[m]{\frac{N_c}{N_0}\sum_{i=1}^{k} P_{vi} f_v \sum_{i=1}^{k} \sigma_{ai}^{m} P_i}, \quad (5)$$

where N_c is the total number of cycles of dynamic stresses for the estimated service life; $p_{\sigma i}$ and p_{vi} are, respectively, the probability of the appearance of stresses at level σ_i in a given interval of speeds and the proportion of time on the operation of the car at speed v_i; σ_{ai} is the level (bit) of the amplitude of stresses, *MPa*; $k_{\sigma i}$ and k_{vi} are the number of sampling discharges, respectively, the amplitudes of stresses and the range of speeds.

The results of our calculation showed that with the probability of the appearance of stresses at level σ_i, which is 0.95, the value $\sigma_{a,d}$=51.3 *MPa*. Hence the coefficient of resistance to fatigue is 4.6. In this case, due to the lack of experimental data, the permissible value of the fatigue resistance coefficient is taken to be equal to 2.2. Consequently, condition (4) is met and the fatigue strength of the supporting structure of the platform car is ensured. It is important to say that taking into consideration the proposed scheme of interaction of the container with the platform car, it becomes possible to increase the resistance coefficient of fatigue of the load-bearing structure of the platform car by 8 % compared to the typical scheme.

6. Discussion of results of the expediency of the use of composite components in a long-wheelbase platform car

To reduce the dynamic load on the platform car, the use of the improved design of add-on structures for placing containers is proposed. In this case, the add-on structures are made from composite material while their design reduces dynamic loads between containers and the platform car due to elastic friction bonds.

To substantiate the proposed solution, mathematical modeling of the dynamic load on the platform car was carried out. Our studies were performed in the vertical plane. The maximum acceleration that acts on the platform car was 2.67 m/s^2 (Fig. 5), and on the container – 3.15 m/s^2 (Fig. 6). The derived acceleration values are, respectively, 5.3 % and 6.2 % lower than those that act on the platform car and container, taking into consideration the typical scheme of their interaction.

It is important to note that the limitation of the mathematical model is that it does not take into consideration the angular movements of the platform car with containers in the vertical plane.

To determine the strength of the add-on structures for placing containers, a strength calculation was carried out. It is established that the maximum stresses occur in the inclined parts of the add-on structure and are 113.6 MPa, which is much lower than the permissible ones (Fig. 9). The limitation of the estimation model is that when making calculations, welding seams between the components of the add-on structure were not taken into consideration.

It must be said that the improvement of the design of add-on structures and the use of a composite as a material for their manufacture helps reduce the tare of the platform car by 2.5 % compared to a typical structure. Therefore, within the framework of this study, the dynamic load on the bearing structure of the platform car was determined when it moves empty. The results of our calculations have made it possible to establish that the defined indicators of dynamics are within the permissible limits (Fig. 11–13) while the ride of the platform car is "good".

The coefficient of resistance of fatigue of the bearing structure of the platform car was calculated taking into consideration the new scheme of interaction with containers. The results of our calculations showed that the coefficient of fatigue resistance is 4.6. That is, the resistance of fatigue of the load-bearing structure of the platform car is ensured. It is important to say that taking into consideration the proposed scheme of interaction of the container with the platform car, it becomes possible to increase the resistance coefficient of fatigue of the load-bearing structure of the platform car by 8 % compared to the typical scheme.

The advantage of this study in comparison with [6–15] is that we substantiated the feasibility of using composite components in a long-wheelbase platform car, taking into consideration the possibility of reducing its load, as well as containers placed on it.

The next stage of research in this area is to determine the longitudinal load on the bearing structure of the platform car with containers. It is also important to conduct experimental studies into loading the bearing structures of containers and platform cars. Those studies are planned to be carried out in the laboratory by the method of likeness.

Our studies could help reduce the cost of maintaining combined transportation vehicles, as well as improve the efficiency of their operation.

7. Conclusions

1. The dynamic load on the bearing structure of a platform car has been determined, taking into consideration the new scheme of interaction with containers. The maximum acceleration, which acts on the platform car, was 2.67 m/s^2, and on the container – 3.15 m/s^2. The obtained acceleration values are, respectively, 5.3 % and 6.2 % lower than those that act on the platform car and container, taking into consideration the typical scheme of their interaction.

2. The strength of an add-on structure for placing fitting stops of containers has been determined. As a calculation method, we used the method of maximum normal stresses. In this case, maximum stresses occur in the inclined parts of the add-on structure and are 113.6 MPa, which is much lower than the permissible ones.

3. The dynamic load on the improved design of the platform car when moving empty has been determined. The results of our calculations have made it possible to establish that the defined indicators of dynamics are within the permissible limits while the ride of the platform car is "good". In this case, the maximum acceleration in the center of mass of the bearing structure of a platform car was 5.9 m/s^2. Acceleration in the regions where the load-bearing structure of the platform car rests on bogies is 7.4 m/s^2. The vertical dynamics coefficient was 0.75.

It is established that taking into consideration the proposed scheme of interaction of the container with the platform car, it becomes possible to increase the coefficient of resistance to fatigue of the load-bearing structure of the platform car by 8 % compared to the typical scheme.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

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