



DYNAMIC LOADING OF THE RAILWAY TANK CONTAINER ON A FLAT WAGON CONSIDERING FITTINGS DISPLACEMENT RELATING TO THE STOPS

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ABSTRACT

The mathematical modelling of the dynamic loading of the container-tank during maneuvering collision of the flat wagon has made it possible to obtain an accurate value of the accelerations acting on its supporting structure. At the same time, possible movements of the tank-container relative to the frame of the flat wagons due to the presence of a technological gap in the pair "fitting stop-fitting" are taken into account.

Introduction

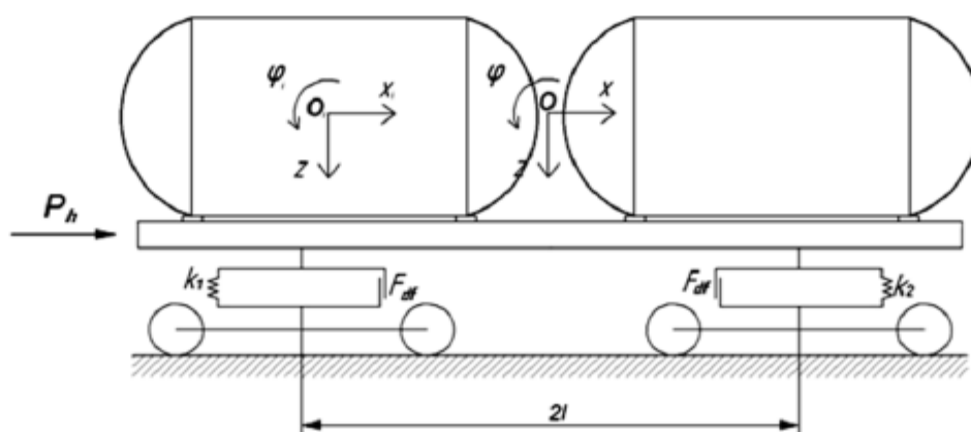
Ensuring the effectiveness of the developing economic ties between the states of Europe and Asia calls for the introduction of combined transport operations. To date, one of the most promising vehicles that have found application in combined transport is a container, and for the carriage of fluid cargo – a container-tank.

The increase in the volume of fluid cargo transportations towards the international transport corridors foreshows an increase in the level of demand for container-cisterns. In connection with this, there is a need to develop and put into operation new tank-containers with improved technical and economic indicators [1].

Analysis of recent research and publications A study of the dynamic loads acting on the tank-container placed on the flat wagon during the manoeuvring collision is presented in [6]. The determination of the accelerations acting on the tank-container was

carried out taking into account the gaps between the fitting stops of the flat wagon and the fittings of the tank-container. The longitudinal force acting on the flat wagon from the wagon-striker was about 2200-2800 kN, depending on the capacity of the tank container. It is important to note that the maximum value of the longitudinal impact force, which can act on the flat wagon with the cargo placed on it, including the tank containers, with a shunting collision, is 3.5 MN . Therefore, in order to obtain an accurate value of the accelerations acting on the container-tank in operation, additional studies are needed.

The structural features of tank-containers for transportation of liquefied gases are discussed in . The material of the supporting structure of the container is stainless steel. To limit the thermal impact of the environment on the container, it is proposed to encapsulate it with an insulating system. Features of computer modelling of



the supporting structure of a tank-container are given in . The finite element method is used as the calculation method. A study of the transfer of heat flow through the internal supports of cylindrical vessels using the example of a tank-container was considered in . The paper simulates the heat flow through a multilayer support made of plastic. Tests of metal and composite containers under the impact of low temperatures are given in . It determines what types of containers it is expedient to use for transportation of the specified nomenclature of cargoes taking into account low ambient temperature. Questions about the creation of ideal load-bearing structures of railway vehicles and the requirements that they must meet at the current stage of development are covered in . To determine the operational values of the dynamic loads acting on the supporting structure of the tankcontainer placed on the flat wagon during manoeuvring collision, the mathematical model given in [6] was used. This model takes into account that three tank containers are placed on a long-based flat wagon, and the connection between them was simulated as an elastic-friction one, that is, each tank-container has its own degree of freedom in the vertical plane.

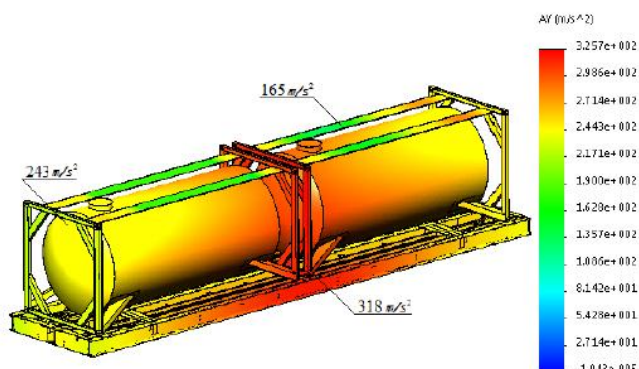
The tank-container was considered as an attached mass in relation to the flat wagon frame, having longdistance compliance due to

the presence of gaps between the fitting stops of the flat wagon and the container-tank fittings. That is, the tank-container has its own degree of freedom up to the moment of fitting in the fitting stop, after which the container-tank repeats the trajectory of moving the flat wagon (Fig. 1).

Fig. 1. Scheme of action of the longitudinal force on the flat wagon with the tank-containers placed on it.

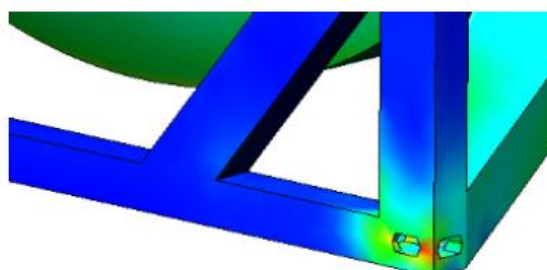
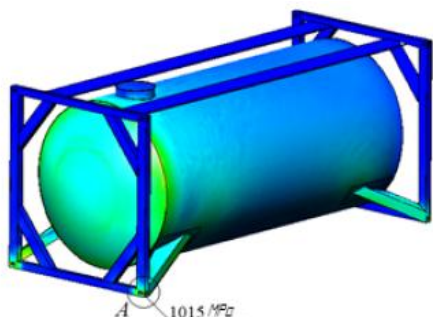
The connection between the frame of the flat wagon and the container-tank fittings was simulated as frictional. At the same time, it is taken into account that the tankcontainers placed on the flat wagon have the same boiler workload of the fluid cargo. The maximum element size was 50 mm, the minimum – 10 mm. The minimum number of elements in the circle was 9, the ratio of the increase in the dimensions of the elements in the grid is 1.7. The maximum aspect ratio is 689.01, the percentage of elements with aspect ratio of less than 3 – 52.1, more than 10 – 4.75.

Fig. 2. Spatial model of the flat wagon with tank containers placed on it.



The obtained results for the accelerations, as components of the dynamic load, are taken into account in the study of the strength of the load-bearing structure of the tank-container. The results of the calculations

Fig. 3. Results of the calculation of the strength of the loadbearing structure of the tank-container TK25.



Conclusion

The conducted research allowed us to define the specified value of acceleration, which acts on the supporting structure of the tank-container taking into account the movements of the fittings relative to the fitting stops of the flat wagon. Calculation of the strength showed that with possible movements of the tank container relative to the platform car frame in the conditions of the shunting

made it possible to conclude that the maximum equivalent stresses in the construction of a tank container arise in the zone of interaction between the boiler support and the fitting stop and are about 1015 MPa (Fig. 2), the maximum displacements in the structural units were 13.6 mm, the deformations – 6.08×10^3 [21]. The distribution of stresses along the length of the lower transverse belt of the tank-container frame is shown in Fig. 6. It can be seen from the figure that the maximum equivalent stresses are concentrated in the areas of placement of the container-tank fittings, and they decrease towards the central part of the belt.

collision and the underload of the boiler with the fluid load, the stresses in the load-bearing structure exceed the permissible ones. The results of the research will contribute to the creation of a new-generation tankcontainers with improved technical and economic parameters that will improve the efficiency of the transport process towards international transport corridors.



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