DSTA 2021 dys-ta.com
16th INTERNATIONAL CONFERENCE
Dynamical Systems – Theory and Applications
December 6-9, 2021, On-line

Determination of the loading of an open car with filler in the center sill

ALYONA LOVSKA[1*], OLEKSIJ FOMIN[2], GRZEGORZ M. SZYMANSKI[3], DMYTRO SKURIKHIN[4]

1. Ukrainian State University of Railway Transport, Department of Wagon Engineering and Product Quality, Kharkiv, Ukraine [0000-0002-8604-1764]
2. State University of Infrastructure and Technologies, Department of Cars and Carriage Facilities, Kyiv, Ukraine [0000-0003-2387-9946]
3. Poznan University of Technology, Institute of Transport, Poznan, Poland [0000-0002-2784-9149]
4. Ukrainian State University of Railway Transport, Department of Wagon Engineering and Product Quality, Kharkiv, Ukraine [0000-0002-3746-5157]

* Presenting Author

Abstract: The dynamic loading in the bearing structure of an open car can be decreased with the application of fillers in the center sill. The research included the mathematic modelling of the dynamic loading of an open car. The calculation was made for elastic, viscous, and elastic-viscous fillers. The results of the calculation demonstrated that the application of viscous or elastic-viscous fillers is the most optimal technological solution in terms of decreasing the dynamic loading of an open car. The article presents the results of the computer modelling of the dynamic loading on the bearing structure of an open car. The authors determined the numerical values and the acceleration fields for the open car frame. The dynamic loading models of a car were verified with an F-test. It was found that the hypothesis on adequacy was not rejected. The research also included the strength calculation for the bearing structure of an open car. The maximum equivalent stresses were in the interaction zone between the center sill and the body bolster beam; they were 298.5 MPa, i.e. 9% lower than the stresses in the frame without filler. The research can be used by those who are concerned about designing the innovative structures of freight cars and improving their operational efficiency.

Keywords: transport mechanics, open car, bearing structure, dynamic loading, dynamic modelling, acceleration of the structure.

1. Introduction

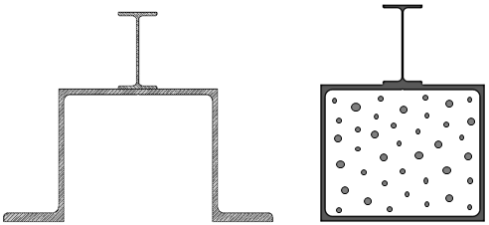
Railway transportation plays an important role in the transport complex of many countries. And improvements in the rolling stock, modernization of existing structures, and a decrease of the coefficient of material capacity are the factors which can guarantee the maintenance of the leading position for any big rail operator in Eurasia. Therefore, the introduction of modern rolling stock with improved technical and economic characteristics is an urgent and promising task.

2. Results and Discussion

The dynamic loading on the bearing structure of an open car during operational loading modes can be decreased with some improvements in the frame, which is the main bearing element of the body. It implies the use of a box-section center sill formed with two profiles instead of the standard center sill (fig. 1, a). This solution can decrease the frame mass by about 4% in comparison to that in the stand-

Feuerbakh sq., 7, Kharkiv, Ukraine, 61050, E-mail: alyonaLovskaya.vagons@gmail.com

ard structure. Here, it is possible to use filler in the center sill (fig. 1, b). The material of elastic or elastic-viscous characteristics can be used as the filler.



a b

Fig. 1. Section of the center sill with filler a – standard; b – with filler

The loading of the improved bearing structure of an open car was determined with the computer modelling. It was found that the most efficient way is the application of viscous filler. The maximum accelerations to the bearing structure of an open car was 36.8 m/s^2. This value was 4% lower than that obtained for the bearing structure without filler. The acceleration fields in an open car frame were determined with the computer modelling of the dynamic loading. The calculation was made with the finite element method in SolidWorks Simulation [1, 2]. The dynamic loading models were verified with an F-test [3]. It is found that the hypothesis on adequacy was not rejected. Besides, the research was made for the basic strength characteristics of the open car frame. The maximum equivalent stresses were in the interaction zone between the center sill and the body bolster beam; they were 298.5 MPa, i.e. 9% lower than the stresses in the frame without filler. The maximum displacements were in the middle part of the frame; they were 7.6 mm that was 11% lower than the displacements in the frame without filler.

3. Concluding Remarks

The results of the research can be used by those who are concerned about decreasing the damage in the bearing structure of an open car in operation, reducing the maintenance costs, collecting the data on the designing of the innovative structures of the rolling stock with enhanced operation characteristics.

Acknowledgment: The presented results have been co-financed from the subsidies appropriated by the Ministry of Education and Science - 0416 / SBAD / 0001 and 0416 / SBAD / 000. The authors also gratefully acknowledge supporting from specific research “Innovative principles for creating resource-saving structures of railroad cars based on the refined dynamic loads and functionally adaptive flash-concepts” by the Ministry of Education and Science of Ukraine 2020.

References

[1] HARAKA S. S., SHARMA S. C., HARSHA S. P.: Structural dynamic analysis of freight railway wagon using finite element method. *Procedia Materials Science* 2014, 6:1891–1898.

[2] CHEN CHAO, HAN MEI, HAN YANHUI: Study of Railway Freight Vehicle Body’s Dynamic Model Based on Goods Loading Technical Standards. *Procedia Engineering* 2012, 29: 3572–3577.

[3] FOMIN O., LOVSKA A.: Improvements in passenger car body for higher stability of train ferry. *Engineering Science and Technology an International Journal* 2020, 23, 6: 1455–1465.