

M. B. SOBOLEVSKA, D. V. HOROBETS

**FEATURES OF FASTENING A SWAP BODY ON THE UNDERCARRIAGE OF A
FREIGHT CAR**

*Institute of Technical Mechanics
of the National Academy of Sciences of Ukraine and the State Space Agency of Ukraine
15 Leshko-Popel St., Dnipro 49005, Ukraine; e-mail: sobmb@i.ua*

Freight car fleet renewal and the introduction of new efficient freight transportation technologies are topical problems of the Ukrainian railway transport. An innovation in the world's transport service is the use of swap-body freight cars. With seasonal variations in freight shipment, one empty car body can be replaced with another, and the undercarriage with the new body can then be used as a usual dedicated car. It is expedient for Ukraine to develop a swap-body car design of its own. In doing so, special attention must be paid to body-on-undercarriage fasteners. The goal of this paper is to estimate the stress and strain field of swap-body car components and develop recommendations on fasteners that would provide safe freight transportation in swap-body cars according to the Ukrainian State Standard EN 12663-2:2018. The paper considers a swap-body car whose undercarriage is a container flat car and whose body has the dimensions of a 45-foot container; the body mass plus the freight mass is equal to the carrying capacity of the flat car. Previous studies showed that four fitting joints in the presence of clearances therein cannot provide the required swap-body car service strength. The paper analyzes existing designs of body-on-undercarriage fasteners and identifies lines of their improvement: increasing the number of fasteners that transfer service loads from the body to the underframe and using additional grippers for clearance takeup. Finite-element models were developed to study the stress and strain field of swap-body car components at standard loads with account for different schemes of body-on-undercarriage fastening. Using them, it was shown that for the requirements of the Ukrainian State Standard EN 12663-2:2018 to be satisfied, it is sufficient to use eight body-on-undercarriage fitting fasteners with additional elements that make them clearance-free in a longitudinal direction and in a transverse direction on the outside of the underframe. The body-on-undercarriage fastening scheme that minimizes underframe stresses was identified. Recommendations were developed on fasteners that would provide safe freight transportation in swap-body cars.

Keywords: *swap-body freight car, body-on-undercarriage fasteners, finite-element simulation, stress and strain field, structural strength.*

1. National Economic Strategy 2030. URL: <https://nes2030.org.ua/#rec246067109> (Last accessed on November 1, 2023). (in Ukrainian).
2. Regulation of the Cabinet of Ministers of Ukraine No. 179 of March 3, 2021. On the Approval of the National Economic Strategy to 2030. URL: <https://www.kmu.gov.ua/npas/pro-zatverdzhennya-nacionalnoyi-eko-a179> (Last accessed on November 1, 2023). (in Ukrainian).
3. Orlova A. Swap and detachable freight car bodies: distinctions and advantages. URL: <https://wagon-cargo.ru/news/v-chem-otlichiya-i-preimushchestva-smennykh-i-semnykh-kuzovov-gruzovykh-vagonov/> (Last accessed on November 30, 2021). (in Russian).
4. Davidan A. Swap car body: a promising innovation in transport services. URL: <https://spec.rzd-partner.ru/page16921814.html> (Last accessed on November 30, 2021). (in Russian).
5. Davidan A. E., Boronenko Yu. P. Swap car body: a promising innovation in transport services. URL: <http://%D0%BC%D0%BE%D1%8F%D0%BA%D0%BE%D0%BB%D0%B5%D1%8F1520.%D1%80%D1%84/new/7411/> (Last accessed on November 30, 2021). (in Russian).
6. Swap-body cars. URL: https://www.uniwagon.com/multimedia/media_about_us/vagony-so-smennymi-kuzovami/ (Last accessed on November 30, 2021). (in Russian).
7. New body module for the WASCOSA flex freight system® in successful practical use. URL: https://www.wascosa.ch/en/media/press-releases/new-body-module-for-the-wascosa-flex-freight-systemr-in-successful-practical-use_m424 (Last accessed on November 1, 2023).
8. Innovations WASCOSA flex freight system® with timber cassette swap body. URL:

https://www.wascosa.ch/wagenpark/pdf/en/innovationen/inno_wascosa_flex_freight_system_timber_swap_body.pdf (Last accessed on November 1, 2023).

9. Innovations WASCOSA flex freight system@ with E-type swap body. URL: https://www.wascosa.ch/wagenpark/pdf/en/innovationen/inno_wascosa_flex_freight_system_e_type_swap_body.pdf (: 01.11.2023).

10. Wascosa introduces the Wascosa flex freight system for transporting chemical products. URL: <https://tanknewsinternational.com/wascosa-introduces-the-wascosa-flex-freight-system-for-transporting-chemical-products/> (Last accessed on November 1, 2023).

11. TransANT: innovative freight cars. URL: <https://www.railway.supply/transant-innovacionnye-gruzovye-vagonov/> (Last accessed on May 8, 2023). (in Russian).

12. Austria has produced a first batch of innovative modular freight cars. URL: https://logist.today/dnevnik_logista/2019-11-23/v-avstrii-izgotovlena-pervaja-partija-innovacionnyh-modulnyh-gruzovyh-vagonov/ (Last accessed on November 1, 2023). (in Russian).

13. Six-axle articulated swap-body flat car, Model 13-9994*. URL: <http://%D0%B2%D1%80%D0%B5%D0%BC%D1%8F%D0%BE%D0%B2%D0%BA.online/view/wagons/13-9994/> (Last accessed on November 30, 2021). (in Russian).

14. DB Cargo and VTG get a permit for producing m2 wagons. URL: <https://www.railtarget.eu/freight/db-cargo-and-vtg-get-a-permit-for-producing-m2-wagons-2097.html> (Last accessed on November 1, 2023).

15. Kiruna Wagon. URL : <https://kirunawagon.com/wagons/modular-system>

16. Modular System. URL : <https://adortech.com/products/railway/freight-wagons/modular-system>

17. Ukrainian State Standard ISO 668:2015 (ISO 668:2013, IDT) Series 1 Freight Containers. Classification, Dimensions, and Rated Data. URL: <http://csm.kiev.ua/nd/nd.php?b=1&l=3776> (Last accessed on November 1, 2023). (in Ukrainian).

18. Ukrainian State Standard EN 12663-2:2018 (EN 12663-2:2010, IDT) Railway Transport. Design Requirements for Rail Vehicle Bodies. Part 2. Freight Cars. URL: http://online.budstandart.com/ua/catalog/doc-page?id_doc=81572 (Last accessed on November 1, 2023). (in Ukrainian).

19. Kriukiv Railway Car Building Works. Model 13-7133 and 13-7133-01 flat car. URL: https://www.kvsz.com/index.php/ua/produksiya/vantazhne-vagonobuduvan_nya/vagoni-platformi/item/2415-vahon-platforma-model-13-7133-i-13-7133-01 (Last accessed on November 1, 2023). (in Ukrainian).

20. Sobolevska M. B., Horobets D. V. Mathematical simulation of the stress and strain field of swap-body freight car components at service loads. Teh. Meh. 2023. No. 2. Pp. 91 - 104. (in Ukrainian). <https://doi.org/10.15407/itm2023.02.091>

Received on October 27, 2023,
in final form on November 24, 2023