

OVERVIEW OF THE APPLICATION OF LIGHTWEIGHT MATERIALS IN RAILWAY STRUCTURAL APPLICATIONS

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Summary: The increasing demand for improved performance and efficiency in railway transport has driven the adoption of lightweight materials, such as aluminum alloys and high-strength steels (HSS). These materials enable weight reductions of up to 30% [1-2], which reduces the carbon footprint during vehicles operation. However, railway structural regulations impose strict stiffness and fatigue strength requirements, which are difficult to achieve with lightweight materials. In particular, the fatigue behavior of welded joints remains a critical concern. Understanding the influence of structural design on stiffness and fatigue performance is essential for expanding the use of lightweight materials in both passenger and freight railway vehicles. Additionally, the adoption of specific standards for lightweight materials could also contribute to improve their usage, particularly for the fatigue behavior of welded joints. This study reviews real-world applications of aluminum alloys and HSS in railway structures, identifying successful case studies and proposing design recommendations to support the integration of lightweight materials into railway standards. The outcomes of this research aim to optimize the design and maintenance of railway components, promoting broader adoption of these materials in the industry.

[1] FreightRail showcases ultra high strength steel potential in rail wagon applications.

https://industry.arcelormittal.com/repository2/fce/Brochures/FreightRail_leaflet_EN.pdf?flipbook=0

[2] Sharma V, Zivic F, Adamovic D, Ljusic P, Kotorcevic N, Slavkovic V, Grujovic N. Multi-Criteria Decision Making Methods for Selection of Lightweight Material for Railway Vehicles. *Materials*. 2023; 16(1):368. <https://doi.org/10.3390/ma16010368>

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