FreightRail showcases ultra high strength steel potential in rail wagon applications

The greenest freight transport solution just got stronger and lighter

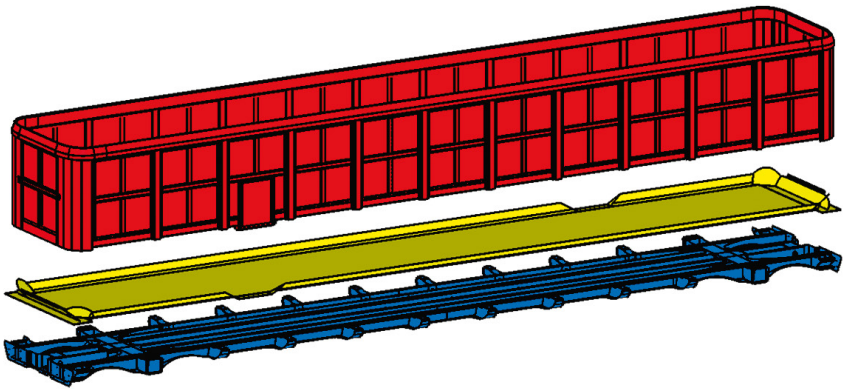
Rail is already the most environmentally friendly way to transport goods across countries and continents. But could ArcelorMittal's modern high strength low alloy steels be used to make rail freight even greener? Engineers from ArcelorMittal's R&D Industry division thought so and set out to demonstrate that ultra high strength steel (UHSS) solutions could be used to lighten the weight of freight wagons, and reduce maintenance costs for operators.

Reducing weight, improving performance

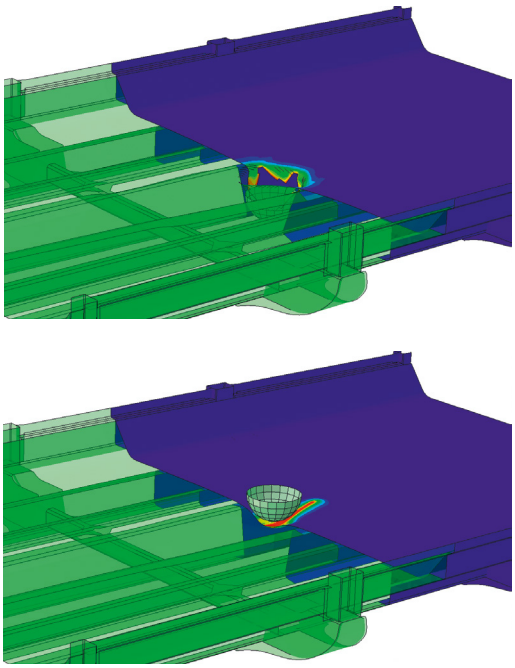
European freight wagons have a useful life of between 30 and 50 years. However, the wear and tear on the wagon will require most of the wagon to be rebuilt during its lifetime. That is a significant cost burden for rail freight operators.

Damage to gondolas typically occurs when they are being loaded and unloaded. Cargo hitting the inside of the wagon causes dents and fractures in the floor and wall panels and can, in extreme cases, entirely destroy the wagon.

ArcelorMittal's R&D Industry engineers selected a typical gondola wagon as a reference, built using grade S235JR, a structural steel. The goal was to find a UHSS solution that would reduce tare weight while allowing the potential load to be increased.



Usage of grades selected for the new high strength gondola wagon



Results of impact tests on S235JR (left) and Amstrong® Ultra 700MC (right)

Advanced steels selected

Three high strength low alloy steel grades were selected for the new wagon: Amstrong® 420MC, Amstrong® 500MC and Amstrong® Ultra 700MC. All three steels demonstrate an excellent strength-to-weight ratio and offer good potential for lightweighting (see table).

Using ultra high strength steel to build the wagons leads to substantial savings in CO_2-equivalent emissions. As the wagons are lighter, fewer emissions are produced during use. The wagons also require less steel which reduces emissions during production of the steel and transportation to the wagon-maker.

Industrial feasibility proved, costs lowered

Full industrial feasibility studies were carried out to ensure the new wagon met formability and sheet forming requirements. The R&D engineers also rebuilt the wall panel of an existing open wagon in one of the UHSS steels to test its performance in a real-life situation. After two years of constant use, no damage has been noted to the panel or the welds.

Overall, material costs of the new wagon were lower than for a conventional wagon. Although the price of the advanced steels is higher than S235JR, less steel is required. Industrial formability is also improved, leading to further cost reductions.

	Summary of the advanced grades selected for the FreightRail gondola	% used (in weight)	Yield strength (MPa)	Ultimate tensile strength (MPa)	Type
Amstrong® 420MC	Selected for the chassis of the gondola, primarily for its rigidity, but also due to its high strength-to-weight ratio and fatigue resistance. Rigidity was an important consideration as the chassis of the gondola is subjected to significant bending stress, particularly during loading.	30	≥ 420	480-620	High strength, low alloy
Amstrong® 500MC	Chosen for the walls of the gondola for its outstanding mechanical properties, particularly, its toughness and ability to withstand the stresses to which the gondola walls are subjected during loading and unloading.	53	≥ 500	550-700	High strength, low alloy
Amstrong® Ultra 700MC	Of all the parts of the gondola, the floor panel is subject to the most damage. For this application, ultra high strength Amstrong® Ultra 700MC was selected due to its ability to resist impacts and absorb energy (see figure above). The ultra high strength of this grade makes it possible to achieve substantial weight reductions by reducing the thickness of the steel while maintaining overall performance and safety.	17	≥ 700	750-950	Ultra high strength, low alloy

Case study: Ermewa makes FreightRail 30% larger

With over 60,000 rail freight wagons in stock, the Ermewa Group is one of the largest rail-equipment hire companies in Europe. As well as hiring and servicing wagons, the Group also builds freight wagons for its own fleet and other rail freight operators.

With more than 50 years of experience in the sector, Ermewa is constantly seeking the best environmental and most economical solutions for freight transport. With this in mind, the company approached ArcelorMittal with the idea of increasing the capacity of the FreightRail wagon by around 30%.

Using the same advanced steels selected for the new FreightRail wagon, Ermewa managed to increase the maximum load weight of the wagon by 27% to 67.5 tonnes. Yet the fully loaded weight of the wagon only increased by 12.5% to 90 tonnes, thanks to the lower thickness of the UHSS steels utilised. Maximum load volume rose from 70 to 100 m^3, an increase of 43% (see table).

While load weight and volume were increased significantly, the material cost of the larger Ermewa FreightRail wagon is 5% cheaper than the existing reference wagon. The ultra high strength of the steels ensures less material is required to build the wagon.

ArcelorMittal estimates that the larger Ermewa wagon solution will lead to a reduction of around 40% in CO_2-equivalent emissions per tonne of goods transported.

Specification	Reference	Solution 1 (volume unchanged)	Ermewa Group solution (43% increase in volume)
Weight of wagon empty	27 t	18 t (-33%)	22.5 t (-17%)
Weight of load (max)	53 t	53 t	67.5 t (+27%)
Total weight	80 t	71 t (-11%)	90 t (+12.5%)
Load volume (max)	70 m3	70 m3	100 m3 (+43%)
Material costs	Reference	-34%	-5%

Comparison of the upscaled Ermewa Group FreightRail wagon

Lighter solutions bring ecological advantages

High strength low alloy steel solutions provide ecological advantages for manufacturers and users in the transport business because:

- **Less steel is needed**, saving resources for future generations.
- **Fuel consumption** on empty trips is **reduced** as the application is lighter.
- **Payloads** can be **increased** due to the low weight of the carrying application.
- **CO_2-equivalent emissions** are **reduced** over the life of the application due to its lower weight.

Why rail is the greenest transport solution for freight

The transport sector contributes around 27% of all CO_2-equivalent emissions globally. Road transport accounts for 72% of emissions, while rail contributes just 1.6%. The difference is remarkable and the main reason why rail is already considered to be the most environmentally friendly mode of freight transport.

The Ecological Transport Information Tool (www.ecotransit.org) provides a quick way to calculate emissions for different transport solutions. EcoTransIT uses existing data on wagon weight in its calculations. With the lighter FreightRail solutions detailed in this leaflet, it is conceivable that even lower emission figures could be obtained for rail transport.

Using the example of a 100 tonne load of bulk heavy goods being transported from Amsterdam to Madrid shows that rail is the best option. Despite the rail route being almost 200 km longer than by road, the journey generates just 1.2 tonnes of CO_2-equivalent emissions. Moving the same load by road would generate 10.5 t of emissions, while transporting the load by air would produce almost 197 t.

	Truck	Train	Aircraft	Ship (sea)
Truck	10.52		0.22	2.73
Train		1.22		
Aircraft			196.65	
Ship (sea)				3.20
Modal transfer			0.12	0.12
Total tonnes CO_2-eq	10.52	1.22	196.99	6.05

Environmental cost of transporting 100 t of bulk heavy goods from Amsterdam to Madrid (Source: www.ecotransit.org)

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Contact us at flateurope.technical.assistance@arcelormittal.com
Or contact your local account manager or technical representatives.

Find out more

For more information on our Amstrong® high strength and Amstrong® Ultra superior ultra high strength steel product range please consult our online product catalogue (data sheets A20 and A22) or our product document centre on industry.arcelormittal.com

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