

# High strength steels for higher payload on railway wagons

“Extra-high strength steels enable the weight of a bogie wagon to be cut by two tonnes. This can yield transport benefits of the order of over €20 000 in its lifetime,” says Göran Uhlin, business development specialist at SSAB Tunnplåt.

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The heavy goods vehicle industry has been able to achieve lower total costs, improved efficiency and lower environmental impact of its products by putting to use the properties of high strength steels. In combination with design improvements, high strength steels have lowered the deadweight of modern goods vehicles and enabled them to carry more payload. A further outcome is lower fuel consumption of the vehicles.

"The benefits of high strength and extra-high strength steels can also be put to use in the railway rolling stock sector," considers Göran Uhlin. "The chassis of a railway wagon, for example, can be made 25 percent lighter. There is also ample scope for reducing the weight of the railway wagon superstructure. Transport gains of more than €10 000 can be made merely by reducing the deadweight of a wagon by one tonne."

### Higher axle load

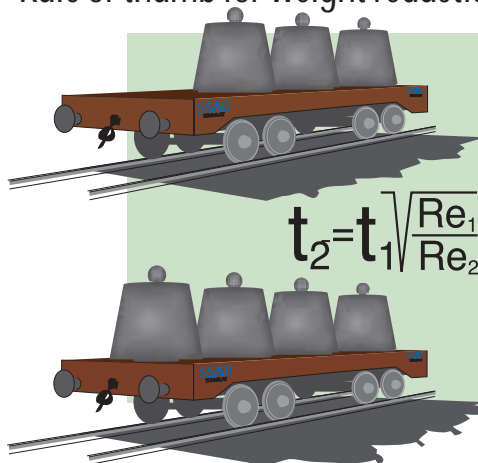
The possibility of increasing the axle load in order to improve the competitiveness of the railways is the subject of lively discussion today. The weights of railway wagons can also be cut, while maintaining their payload carrying capacity. A 10 percent weight reduction on a bogie wagon represents around two tonnes. This may seem modest on a wagon that can carry 80 tonnes, but if the annual distance travelled by the wagon is 50 000 kilometres and its useful life is 25 years, the result would be an additional freight-carrying capacity of 2.5 million tonne-kilometres per wagon. Reduced deadweight also yields other benefits: improved load/train length efficiency, reduced energy cost and lower maintenance costs.

"Reduced deadweight is also very important on railway wagons built for stretches designed for higher axle load, since they would otherwise have lower load-carrying capacity on stretches on which the permissible axle load is restricted," explains Göran Uhlin.

### Environmental loading

Environmental loading is becoming an increasingly important argument in comparisons bet-

## Rule of thumb for weight reduction by using high strength steels



$t_1$	=	thickness of mild steel
$t_2$	=	thickness of high strength steel
$Re_1$	=	yield strength of mild steel
$Re_2$	=	yield strength of high strength steel

ween various transport alternatives. The high environmental impact of road traffic is a fact. Moreover, the road network in Europe is overloaded in many places, and Switzerland has already introduced restrictions on truck traffic through the country. Rail transport causes lower environmental loading than other means of transport, and both railway companies and transport purchasers are continuously endeavouring to improve this position. Environmental loading is also reduced, since more products can be obtained with the least possible consumption of natural resources. The quantity of raw materials needed in steelmaking for producing high strength steels is the same as that for mild steels. But less high strength steel will be required for a given task and less raw materials will therefore be needed, and the energy consumption will thus also be lower.

### Weight benefits

An early example of the great competitive benefits that can be achieved by the use of high strength steels is the weight reduction of one tonne achieved on a refuse collection truck in a project run jointly by a refuse collection truck manufacturer and SSAB Tunnplåt. The result was that the truck used less fuel, paid lower road tax, could carry



Göran Uhlin, Business development at SSAB Tunnplåt.

more refuse, and its production costs were cut. Other examples:

- A container manufacturer succeeded in lowering the weight of a 45-foot container by 600 kg or around 13 percent.
- A manufacturer of container lifting beams lowered the weight of the beam by 40 percent by changing over to high strength steels.
- The weights of the seats in the Oslo Airport shuttle trains were cut by almost 60 percent.
- New stakes of ultra-high strength steel for existing railway wagons enable every wagon to carry an additional payload of 1 tonne.

The list could be made much longer, and innumerable examples could be quoted in which major benefits have been achieved by upgrading to high strength steels. Development work has been in progress for many years.

### Lower weight by design

"The first stage in lowering the weight is to examine the design and simply remove unnecessary material. The most common procedure then consists of replacing low strength materials by high strength steels, reducing the thickness and thus also lowering the weight, but without impairing the load-carrying capacity. A very useful aid is the rule of thumb formula used by SSAB Tunnplåt engineers for quick assessment of the approximate amount by which the weight could be cut by reducing the thickness (see the top of this page).

The formula often yields a realistic result. A



The weights of the seats in the Oslo Airport shuttle trains were cut by almost 60 percent thanks to extra high strength steel and optimized design.

calculation example for a railway wagon frame shows that a 25 percent weight saving can be achieved.

Modern high strength steels also offer opportunities for developing entirely new designs that would not have been possible in the past. The weight can then be reduced further.

However, if the material thickness in an existing design is reduced, consideration must be given to the increase in deflection and stress levels. If these factors are critical, they can be compensated by changing the cross-section or changing the design at junction points and mountings. SSAB Tunnplåt engineers would be pleased to offer advice for optimum design solutions.

### Fatigue

The load-carrying parts of a railway wagon must usually be designed to withstand fatigue. Since the stress-raiser effect of welded joints sets an upper limit to the strength that can be put to use, it is sometimes considered that there are limited opportunities for using high strength steels. But careful analysis of the fatigue load, i.e. the form of the collective load and the number of load reversals, together with a sound basic design, such as low stress-raiser effects in welded joints, often makes it possible to put to use the benefits offered by high strength steels.

"A railway wagon also includes many design features in which fatigue is not decisive and in which the properties of high strength steels could very well be put to full use," emphasizes Göran Uhlin. "This applies, for example, to the superstructure of the wagon – end and side walls, doors and roof, and also the load restraining components such as load posts, movable partitions and load anchorages."

### Simplified production

Designers have long been using the standardized structural steels that have been available for many years, such as those in EN 10025 and EN 10113. These steels limit the opportunities available for creating modern products and achieving cost-effective production. When these steels were developed, the requirements of the engineering industry were entirely different from those prevailing today, and these steels were not modernized in pace with other developments in industry.

For more than 20 years, SSAB Tunnplåt has been manufacturing and marketing the modern structural steels required for today's design and production, under the trade names of Domex, Docol and Dogal. In addition to guaranteed strength and weldability, these steels also offer guaranteed formability, reduced scatter of properties and, above all, much higher strength with

unimpaired weldability.

"Due to the good formability properties, welds can often be replaced by bending and pressing to the final shape," says Göran Uhlin. "This offers both economic and technical benefits. Any welding that must be done is simple, since the steels are of low-alloy type, in spite of their high strength. In addition, the welding economy is better, since thinner sheet needs a smaller volume of weld metal."

Due to its uniform strength properties, the steel always behaves consistently in all bending and pressing operations. This ensures high dimensional accuracy of the finished product.

After laser cutting, the sheet must have a good surface, good flatness and low built-in stresses. SSAB Tunnplåt steels meet all of these demands.

### Economy

"Many examples can be quoted of the cost benefits of modern high strength steels," says Göran Uhlin. "The use of high strength steels often lowers the total cost, since these steels can simplify production."

Last but not least, a lighter product requires less energy for transporting it and yields higher revenues for the haulier, since more payload can be carried.



*The interest in rail traffic is growing in pace with the increasingly obvious environmental impact of road traffic. Railways may become even more efficient than they are today if light materials are employed for the wagons and other smart transport economy solutions are adopted.*

SSAB Tunnplåt AB is the largest Scandinavian steel sheet manufacturer and a leader in Europe in the development of high strength, extra and ultra high strength steels.

SSAB Tunnplåt, which is a member of the SSAB Swedish Steel Group, has a turnover of SEK 9 billion and has around 4400 employees in Sweden. The company's annual production capacity is around 2.5 million tonnes of steel sheet.

Our environmental policy is focused on continual improvement of the environmental conditions of the manufacturing process and pollution control equipment. Our products are constantly being improved towards minimal environmental impact in a life cycle perspective.

We manufacture the following steels in our modern, highly efficient production lines and rolling mills for strip products:

<b>DOMEX</b>	hot-rolled steel sheet
<b>DOCOL</b>	cold-reduced steel sheet
<b>DOGAL</b>	hot-dip galvanized steel sheet
<b>ALUZINK</b>	aluminium-zinc coated steel sheet
<b>PRELAQ</b>	prepainted steel sheet
<b>DOBEL</b>	film-laminated steel sheet

We assist our customers in selecting the steels that are best able to improve their competitiveness. Our strength lies in the quality of our products, our reliability of supply, and our flexible technical customer service.



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