VALLOUREC RAILWAY AXLE

TECHNOLOGY AT THE SERVICE OF PRODUCTIVITY.

vallourec

MARKET

In Brazil, railways are mainly used to transport heavy loads over long distances, aiming low maintenance costs, low carbon emission, high energy efficiency and excellent safety.

To achieve that, heavy haul current trends include increased freight capacity per wagon ratio, reduced costs and technological renewal.

BRAZILIAN RAILROAD SYSTEM

EXTENSION:
30,129 km.

REACH:
22 states.
Federal District.

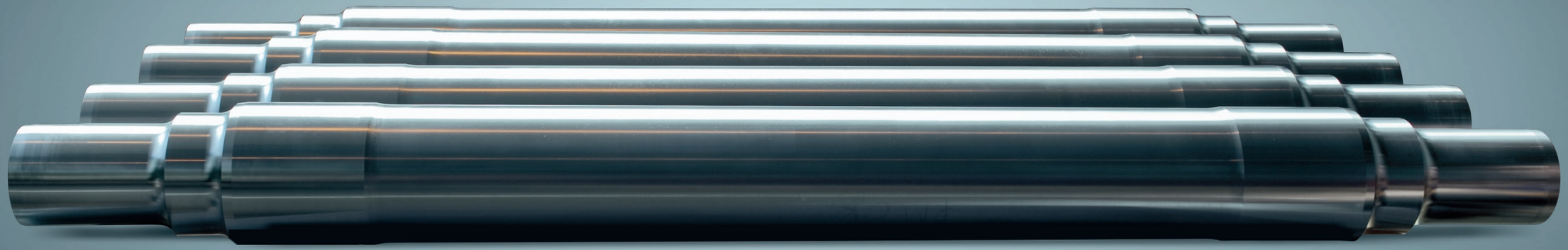
MAIN CARGO:
Iron ore, coal, fuel, fertilizer and agricultural, steel and industry products.

MAIN PORTS:
Santos (SP), Paranagua (PR), Rio de Janeiro (RJ), Itajai (SC), Sao Francisco do Sul (SC), Vitoria (ES) and Sao Luis (MA).

CONNECTIONS:
Argentina, Bolivia and Uruguay.

TUBULAR RAILWAY AXLE

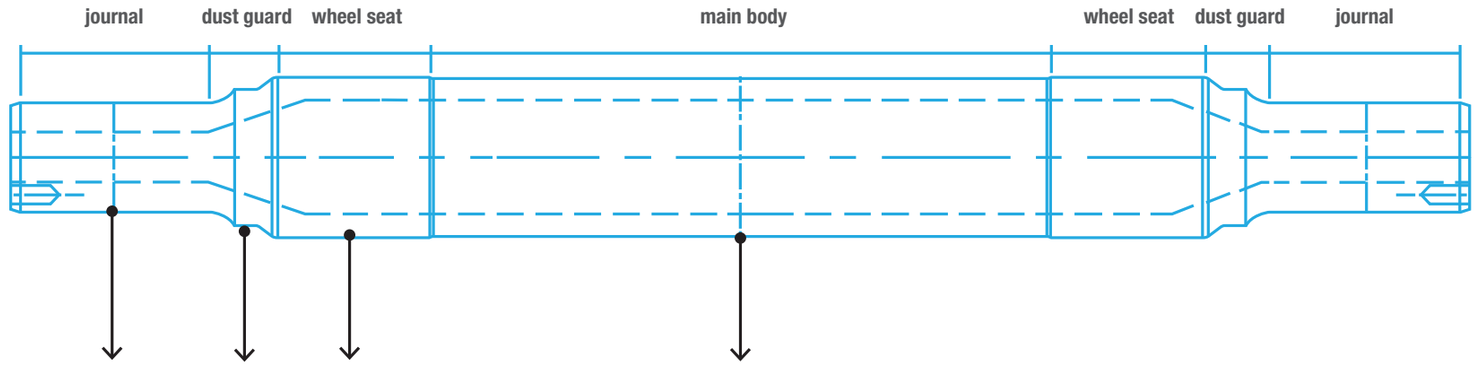
Vallourec's exclusive technology



A world leader in the production of seamless steel tubes, Vallourec has developed the tubular railway axle as a solution to increase the amount of cargo transported per wagon. Reducing weight up to 250 kg per axle comparing to the conventional solid axle, it reduces the tare of the wagons by one tonne. The weight reduction was possible with the use of high-carbon steel grade, capable of guaranteeing the mechanical properties necessary for its application.

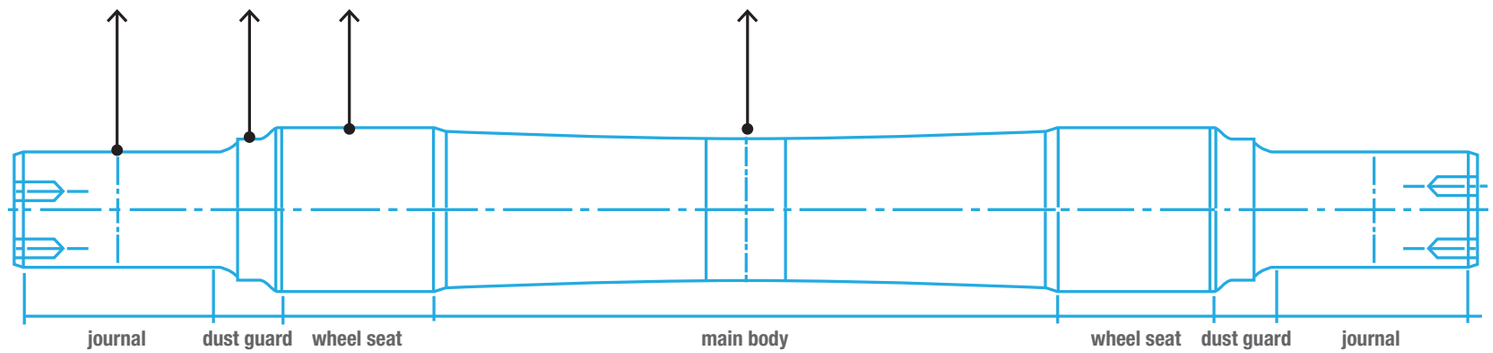
UP TO 40% LIGHTER THAN THE CONVENTIONAL SOLID AXLE

TUBULAR RAILWAY AXLE



The journals, dust guards and the wheel seata have the same dimentions

The tubular diameter is greater than the solid



SOLID RAILWAY AXLE

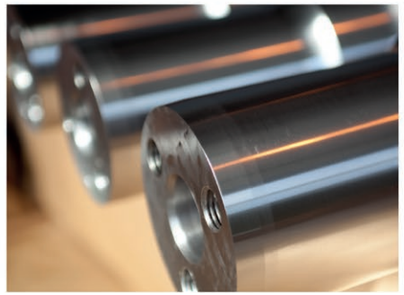
CHALLENGE

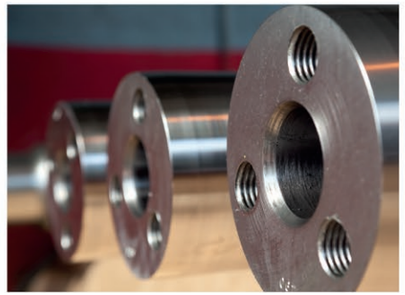
Because it is subjected to dynamic non-damped forces due to its location below the wagon’s suspension, the railway axle is key for railway safety and performance. The component works in an aggressive environment due to variations in temperature, humidity, corrosion and impacts. It also is influenced by mechanical aspects, due to the mounting interference with the bearing and the wheel.

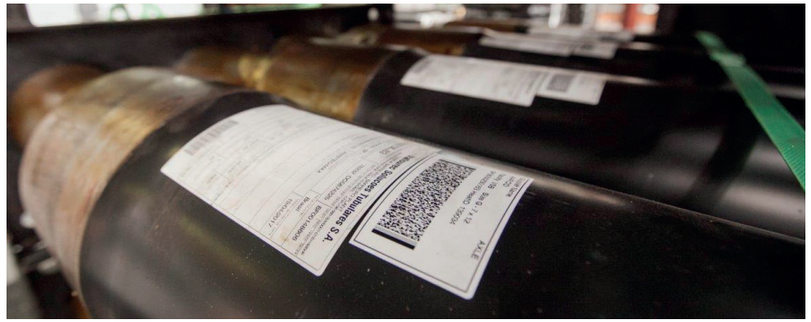
Lean and innovative design

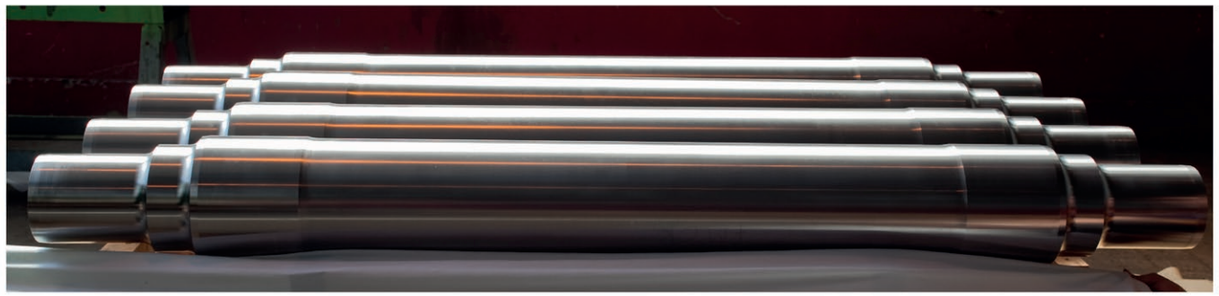
Steel with higher mechanical properties

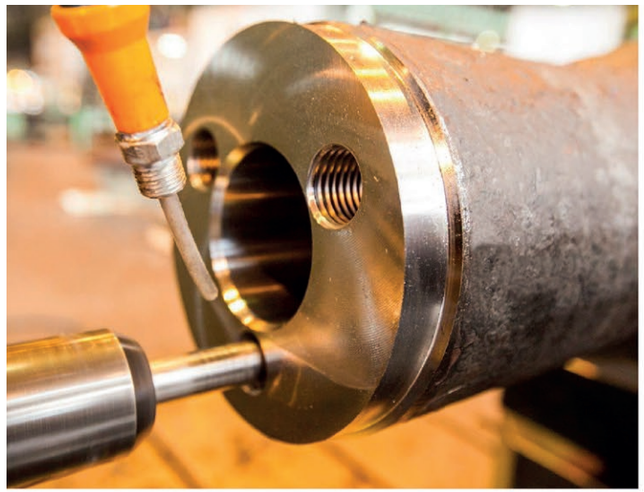
Completely interchangeable with the conventional solid axle











PILOT PROJECT

The know-how acquired over 60 years of experience in material design for the the oil & gas and automotive markets has contributed to the development of a new steel grade now used in the tubular railway axle.

The first axle prototypes were manufactured after the initial material tests made in Brazil in 2005. Additional tests of the material were made in France and England until the product validation in 2010.

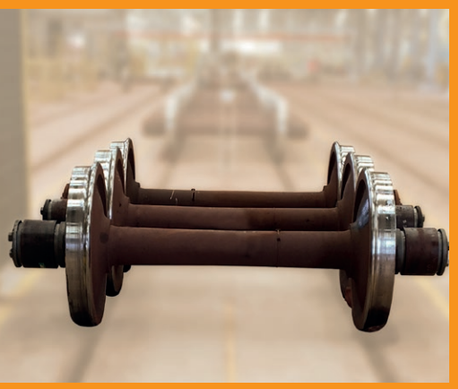
Before the tubular railway axle was launched, many endurance tests were carried out - by the Technological Research Institute of the University of São Paulo, hired by Vallourec - with full-scale prototypes for two years.

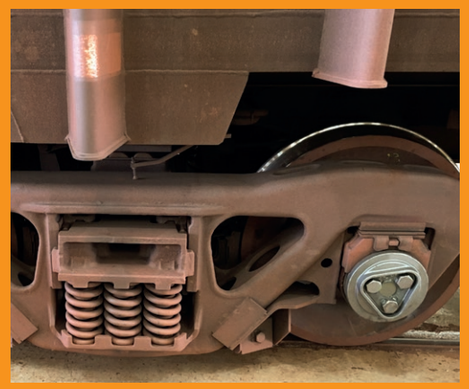
FIELD TESTS

Between 2007 and 2010, one of the largest mining companies in the world - in partnership with Vallourec - conducted field tests with stress, temperature and vibration measurements, using telemetry, for more than seven months on the latest generation of prototypes.

In response to a customer request, Vallourec contracted the Transportation Technology Center Inc. (TTCI), a technological subsidiary company of the Association of American Railroads (AAR), a world-wide reference in railroad standardization and technology, for technical support during the tests.

The treatment and analysis of the data according to specific standards - combining the endurance curve obtained in the laboratory and the stresses histogram - testified that the tubular axle did not accumulate any fatigue damages, which in engineering terms means a component with unlimited life span. A rail axle is designed for use for over 25 years, even under cyclical fatigue-leading stresses.



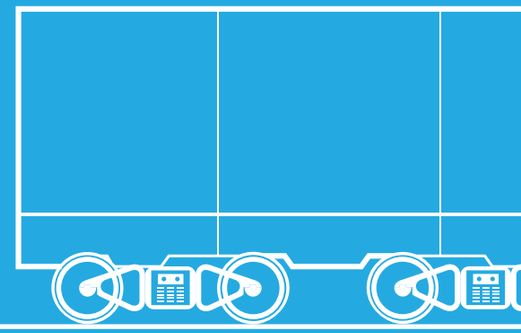


ADDITIONAL INSTRUMENTED TESTS

In 2014, instrumented tests similar to the ones ran in 2010 were carried out in another railroad of shoutheastern Brazil, achieving the same positive results. Throughout the testing period, Vallourec adapted the existing maintenance processes and developed a specific type of inspection for the tubular component. The new inspection method was developed by an engineering task force that gathered Vallourec's R&D sites in Brazil and France, being patented afterwards.

The proposal of ABNT Standard for the new component and its inspection requirements is being elaborated in CB06, the Brazilian Metro-Railroad Committee (Comitê Metroferroviário Brasileiro).

THE EVOLUTION OF THE COMPONENT'S USE



2010

Sale of 200 axles of broad gauge. Still in operation in nothern Brazil.

2011

Sale of 400 axle of metric gauge for a railroad in southern Brazil.

2016

Sale of 120 greater capacity axles for the evaluation of potential in an expansion project.

2017

Closing of the first consistent contract deal.

2018

Tubular axles supplied for more than 1,500 wagons.

BENEFITS

INCREASED CAPACITY OF SHIPPED CARGO

It enlarges the load capacity, maintaining the number of trips and wagons, leading to an increase on the revenues with transportation.

CHECK THIS OUT

- *Up to 40% lighter than the conventional solid axle, reducing wagon tare by up to 1 ton.*
- *It does not require wagons replacement or the increase of the capacity of the permanent route. Fully interchangeable, it can be retrofitted on old wagons.*

Types of axles and their weights

Maximum gross weight per wagon	t	150	130	130	110
Rail gauge	m	1.6	1.6	1.6	1.0
Journal	-	G – 7” X 12”	F – 6½” X 12”	K – 6½” X 9”	K – 6½” X 9”
Tubular axle weight	kg	420	400	395	260
Solid axle weight	kg	670	562	558	360
Reduction of each tubular axle weight	kg	250	162	163	100
Total wagon weight reduction with 4 tubular axles rather than solid ones	kg	1000	648	652	400

Even with the reduction of the weight of the tubular axle to 420kg (OFT 39U), which corresponds to the reduction of 250kg on the weight of a solid axle of 670kg, it is still expected the same performance from the 7 “X 12” broad gauge solid axle.

BENEFITS

UP TO 1% OF FUEL SAVINGS

With the tubular railroad axle, the train becomes lighter in the empty stretch of the cycle. There is economy also when the additional payload capacity is not used in the loaded stretch.

UNDERSTAND BETTER

Considering a return trip from the port to the mine, this difference adds up to 330 tons for a 330 wagon train. There are mathematical models and simulation tools that allow comparative analysis of gains with weight reduction with excellent accuracy.

BENEFITS

FEWER CYCLES TO SHIP THE SAME CARGO

Reduction of freight costs due to the reduction of the number of trips to ship the same volume of cargo/year.

CONSIDER THIS EXAMPLE

The freight economy can reach in some mining operations 0.8%, which represents, BRL 8 million per year.

BENEFITS

REDUCTION IN MAINTENANCE COSTS

Reduction in maintenance costs for the permanent rail, rolling stock and components. In this case, as the composition returns lighter, the tubular axle undergoes less impact of undamped weight on rails and wheels, increasing its life span.

MINIMIZED DAMAGE

The lighter load reduces bearing heat, wheel cracks, rail damage, ballast maintenance and more. In addition, it delays the need for repairs to the permanent rail and/or works of art in critical situations for structural reasons.

BENEFITS

GREATER RELIABILITY

The combination of Phased-Array technology and tubular axle geometry allows the detection of discontinuities of only 1 mm at any position.

It is a method six times superior comparing to the conventional technique, which helps to anticipate the detection of cracks that could propagate through fatigue mechanisms.

The inspection can also be done through the inner surface of the journal, directly under the groove region caused by the wearing ring or the bearing fretting, one of the main causes of axle breakdown and failures around the world.

Since its launch in 2010, tubular axles have been more resistant to groove than solid axles. This can be attributed to the surface hardness of the tubular axle, which is 40% greater than that of the solid one.

Mechanical and metallurgical properties

Axle	Solid	Tubular	Variation
Standard	AAR M-101	Vallourec	-
GRADE	F	RR1	-
YS (MPa)	345	552	+60%
TS (MPa)	607	689	+14%
Elongation (%)	16	14	-12%
ASTM Grain	>5 (<56 µm)	>7* (<28 µm)	50% lower**

(*) External Surface.
(**) Using the law “ASTM Grain = -3.2877 - [6.6439 x log(Lmm)]”.

MINIMIZED DAMAGE

Phased-Array Ultrasound Inspection Warranty in manufacturing.

Groove: *wear generated by the axle fretting with the bearings - in the shape of a darkened ring , groove or cavity in the bearings seat -, and in extreme cases can lead to nucleation and the propagation of fatigue cracks.*

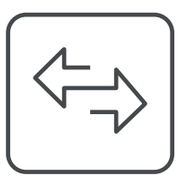
Fretting: *friction between two surfaces due to a microscopic relative movement for longer time, as happens between the bearing and the axle. The AAR Standard establishes a calculation formula for the “fretting index” of each type of axle.*

VALUE PROPOSITION:
PROVEN ADDED VALUE

In order to demonstrate the value of the products developed to its clients, Vallourec uses the Value Proposition methodology, which analyses several factors to quantify the real gains with the use of a product or service. Because the Vallourec tubular axle is an innovative model compared to the rest of the world, the efforts to demonstrate its value have been a major strategic challenge for the company.

Up to 1% of savings in fuel

Increase of capacity of cargo shipped



Fewer trips to transport the same load

Reduction of maintenance cost

Greater reliability

Are you interested in receiving a customized analysis for your railroad?

Contact us ***eixoferroviariotubular@vallourec.com****.*

If you prefer, call: ***+55 (31) 3328-2817.***