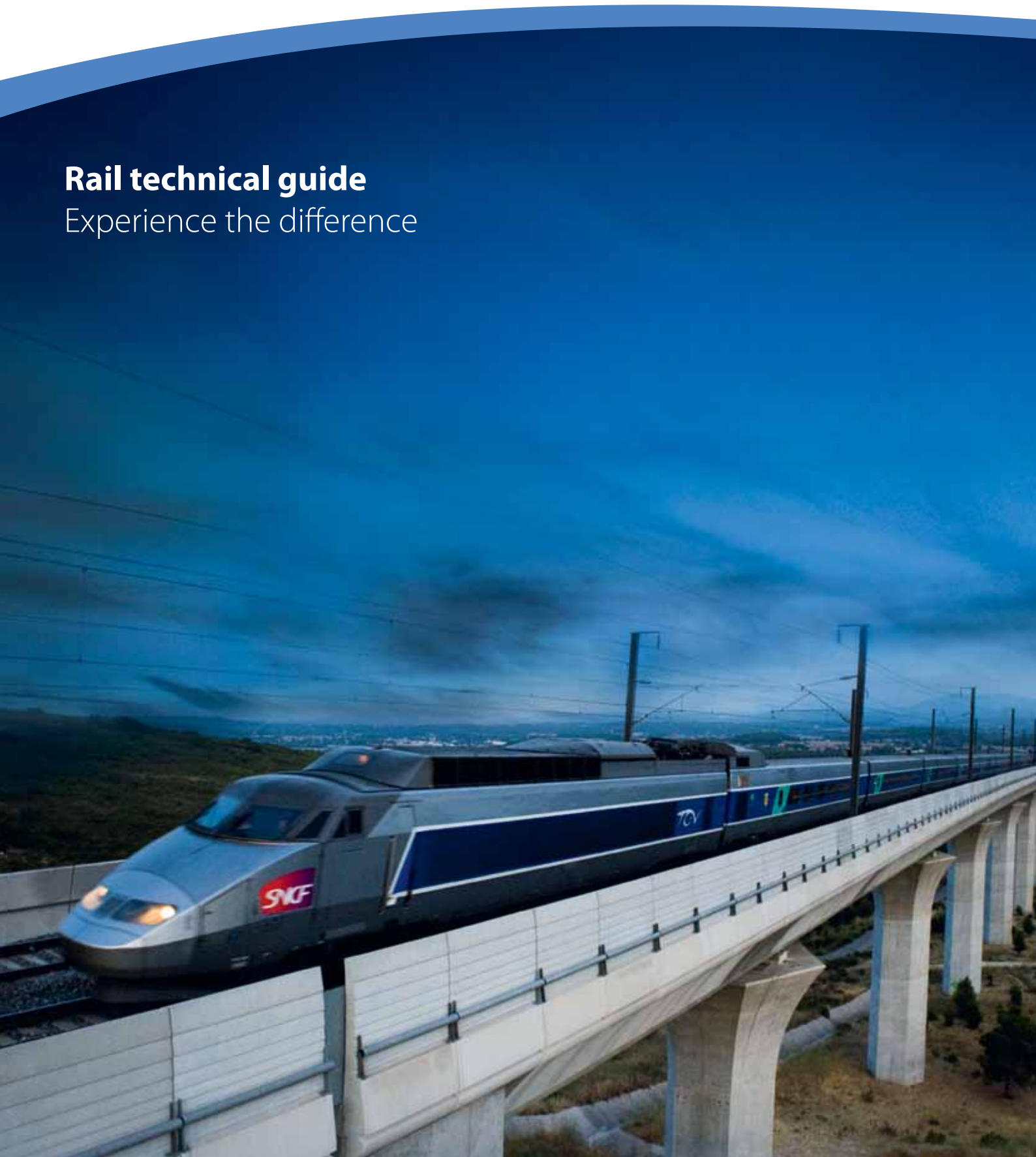
TATA STEEL

TATA

Rail technical guide

Experience the difference



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INTRODUCING TATA STEEL

As a leading global steelmaker, Tata Steel combines metallurgical expertise with rail-industry knowledge and a collaborative ethos, enabling it to manufacture finished steel products that directly address customer needs.

Tata Steel – setting the global standard in steelmaking

Tata Steel, formerly known as Corus, is one of Europe's largest steel producers. We serve many different and demanding markets worldwide, including rail, aerospace, automotive, construction, energy and power, and packaging. Our primary steelmaking operations in the UK and the Netherlands are supported by a global sales and distribution network.

Innovation and continuous improvement are at the heart of our performance culture. We aim to create value by offering a sustainable and value-added steel product range supported by unrivalled customer service. By working in partnership with you, we find the best solutions to meet your needs and help your business to perform.

Our European operations are a subsidiary of Tata Steel Group, one of the world's top ten steel producers. With a combined presence in nearly 50 countries, the Tata Steel Group including the Europe operations, Tata Steel Thailand and NatSteel Asia, has approximately 80,000 employees across five continents and a crude steel production capacity of over 28 million tonnes.

Supporting rail industry growth and development

The company's drive for innovation and market leadership is clearly manifested in its rail manufacturing operations. Building on 140 years of rail production expertise, the company today works closely with rail customers to understand the demands of the sector and develop products that directly address those needs. That means Tata Steel is playing a central role in helping the rail industry rise to the challenges of higher traffic volumes, heavier axle loads and faster train speeds.

As a diversified steel manufacturer, Tata Steel not only supplies specially designed, high-performance rail products, but also a wealth of structural steel components to support all rail sector construction and engineering projects.

INVESTMENT AND INNOVATION

Continuous investment in plant, technology, research and development, combined with our unrivalled metallurgical knowledge and track design expertise, ensure that Tata Steel delivers the high-performance rail demanded by today's rail operators.

Tata Steel has rail manufacturing expertise stretching back 140 years. Today the company manufactures the highest quality steel rails for some of the most arduous service conditions in the rail sector.

Since 2000, we have invested more than £150m (€200m) in our advanced rail manufacturing facilities at Scunthorpe in the UK and Hayange in France – ensuring that we remain at the forefront of rail innovation, performance and value, always working in close partnership with our customers.

Both of our mills feature state-of-the-art equipment including servo-stands allowing high dimensional accuracy rotary stampers to uniquely identify each rail. This allows complete traceability, from steelmaking to the finished product. Computer-controlled cambering operations installed on precision-engineered cooling banks, and dual plate roller straighteners ensure excellent straightness and flatness while maintaining low residual stress within the rail.

Scunthorpe invests in steelmaking, rolling and finishing

Investments in steelmaking and casting at Scunthorpe enable us to produce the quality and quantity of bloom feedstock required for both of our rail rolling mills.

At Scunthorpe, a major enhancement to the existing rolling mill saw the introduction of a new furnace and a close-coupled seven-stand finishing mill train – a world first for rail rolling.

A new Rail Service Centre has been constructed to carry out essential rail finishing operations using the world's best available technology, including a full range of non-destructive testing (NDT) systems to ensure exceptional dimensional accuracy and rails totally free of surface or metallurgical defects. The service centre enables us to produce rails up to 120m long with precisely controlled properties that meet our customers' stringent specifications. A state-of-the-art welding plant means we can produce rails up to 216m long for delivery and installation in one piece – meeting the industry's need for longer rails and simplified supply chains.

Hayange invests in long length rail capability

Investments at Hayange in France have enabled this dedicated rail manufacturing facility to produce 108m-long rails. Advanced heat treatment machinery is able to produce our ultra wear-resistant micro head hardened (MHH) rail, designed for heavy haul and high-duty track environments, as well as standard heat treated grades according to the European or American standards. Rails with hardness values above 400HB can now be manufactured here, while the unique patented heat treatment creates rails with exceptionally low residual stress levels.

The technique for universal rolling of rails was invented at Hayange to deliver the precise dimensional consistency and accuracy required for high-speed tracks, as well as complex-shaped grooved rails for urban networks. The technique has been adopted and further developed at Scunthorpe. It has proved so successful that, in April 2007, SNCF broke the world train speed record on the new French TGV Est line constructed using Tata Steel universal-rolled rails.

Process innovations and product development initiatives at Tata Steel are focused unwaveringly on delivering the high-performance rails required to support advances in train technology, as well as meeting the longer in-service product life and reduced maintenance costs demanded by rail network operators.

STEELMAKING AND ROLLING

Steelmaking

The Scunthorpe integrated steelmaking plant produces feedstock for a diverse range of steel products. The precision-controlled steelmaking process delivers only the highest-grade, consistent-quality steel blooms for our rail rolling mills.

1

Blast furnace
Iron ore is reduced with coke in blast furnaces. The liquid iron is treated in desulphurisation units. Hot liquid iron with low levels of residual elements is the essential feedstock for heavy-duty rail steel.

2

Basic Oxygen Steelmaking (BOS) converters
Liquid iron is refined through the controlled oxidation of carbon and other elements in 300-tonne capacity oxygen steelmaking vessels called converters.

The entire steelmaking operation is precisely controlled using advanced computer software and intelligent process-control systems.

3

Secondary steelmaking
Secondary steelmaking takes place in three ladle arc furnaces and two RH degassers. The desired steel chemistry is achieved by the careful addition of alloying elements to the molten steel. Temperature control is essential to ensure low levels of segregation in the cast bloom.

The RH recirculating degassers reduce hydrogen and oxygen content in the steel.

4

Continuous casting
Continuous bloom casting, combined with tight control over alloy additions, ensure the internal integrity of the steel by eliminating oxide inclusions.

Recent investments in mould electromagnetic stirring and dynamic spray control ensure cast bloom consistency, with minimal segregation and no hinge, side or corner cracks.

5

Quality control
Quality is assured by closely controlling every stage of steel making and casting, with regular sampling and analysis of steel chemistry and other properties.

Rolling

The Tata Steel rolling mills at Scunthorpe and Hayange use the latest process technology, computer modelling, computer-controlled heating and cooling, and novel roll-pass design to produce exceptional quality rails.

1

Re-heating
Blooms are re-heated in natural gas furnaces. Consistent product dimensions and surface quality are assured by tight control of rolling temperatures.

2

Descaling
High-pressure descaling before and during rolling ensures a high standard of surface finish. Surface quality is monitored using a hot surface inspection machine.

3

Rolling
Rolling begins in two accurately controlled roughing and intermediate stands, followed by a multi-stand universal finishing train (see diagram below).

4

Branding and stamping
During the final rolling pass, rails are relief-branded with the rail profile, steel grade and year and site of manufacture. After leaving the finishing stand, the rails are hot stamped with a unique identification mark – for permanent traceability.

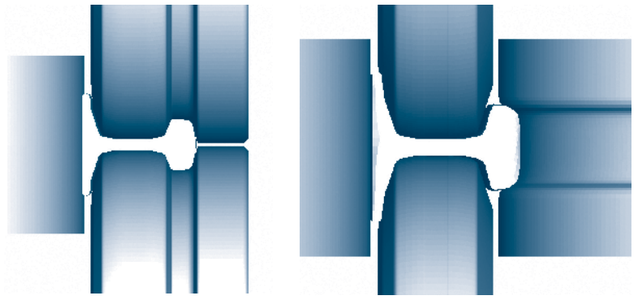
5

Sawing and cooling
Rolled profiles are hot cut to standard lengths, then transferred to cooling banks. They are pre-cambered to compensate for the natural curvature that occurs during the cooling process.

6

Straightening
Computer-synchronised horizontal and vertical straightening machines produce the ultra-straight, ultra-flat rails with low residual stresses that are essential for high-speed rail tracks.

Universal rolling
Universal rolling of rails was pioneered by Tata Steel's Hayange works. Four rollers are positioned on all four sides of the steel feedstock, rather than the conventional pair of rollers in a two-high rolling stand – delivering exceptional dimensional accuracy and strengthening of the rail head.



TESTING, INSPECTION AND FINISHING

The advanced testing and finishing systems that complete the Tata Steel rail manufacturing process ensure that all rail products meet the high standards required for all rail applications – from high-speed and heavy-haul networks to urban and industrial railways.

Rigorous tests for complete quality assurance
An array of technically advanced testing and inspection equipment ensures that every rail meets customer specifications and is free from any internal or surface imperfections that could impede performance or reduce service life.

Eddy current testing is used to detect any surface imperfections that exceed specification limits. Rails also require a uniform internal metallurgical structure to ensure strong performance, and any irregularities that could adversely affect the rail's in-service life are detected using in-line ultrasonic testing. Any defects identified are checked manually using portable ultrasonic equipment.

A cold profile gauge, installed in the non-destructive testing (NDT) lines, continuously measures rail dimensions. Laser beams are used for optical sectioning of the rail, and sophisticated software analyses pictures taken of all rail dimensions by an array of cameras so that dimensions can be carefully controlled.

To meet the extreme straightness requirements of high-speed tracks we use laser technology to measure rail surface and side-of-head flatness and straightness, ensuring rails meet all customer and statutory specifications.

Finished to individual customer specifications
Rails are finished by cutting to length for each customer order. Sawing and drilling are carried out by high-speed combined machines that give the greatest accuracy. Other finishing processes include:

- **rail coating for corrosion protection**
  Rail destined for corrosive or harsh environments, such as coastal routes, tunnels, level crossings or marine environments can be protected using corrosion-resistant rail coatings to deliver an extended service life.

- **extensive acceptance testing**
  Acceptance tests can be carried out to individual customer specifications, in the presence of the customer if requested. These tests can include hardness, tensile, decarburisation, segregation and steel cleanness assessments.

- **seamless rail welding**
  Tata Steel leads the market in rail welding expertise, having developed and patented the 'invisible' narrow heat affected zone weld. In the UK, the Rail Service Centre's integral welding plant enables rail lengths of up to 216m to be produced as part of the rail finishing process. The flash butt welding method used creates a strong weld made purely of the parent material, providing consistent steel properties along the entire 216m length.

Reliable, on-time delivery – worldwide
Tata Steel plants are strategically located for fast, efficient delivery of rail products worldwide, using road, rail, river or marine transport.

Welded rails up to 216m long are despatched from Scunthorpe on specially designed trains able to handle and directly offload these extended rail lengths.

Our proven and efficient despatch processes ensure that delivery costs are minimised. Complete supply chain control enables us to make just-in-time deliveries that facilitate efficient and timely track replacement and minimise disruption to rail users.

PRODUCT RANGE AND APPLICATIONS

The wide spectrum of track and traffic conditions found in the modern railway environment is matched by Tata Steel's comprehensive range of steel rail products – fulfilling every demand of the international railway industry.

Our technical team is available to provide advice and support, helping you to optimise your rail selections. Rail products and grades can be matched precisely to track conditions, track types, environmental conditions and a host of other variables to ensure that every rail we deliver provides optimum performance throughout its service life.

High-speed railways

Long, straight, flat, fatigue-resistant rail for record-breaking performance.

High-speed railways offer benefits in safety, environmental performance and passenger comfort over road and air transport. Tracks are usually dedicated to high-speed traffic, comprising predominantly tangent and large radius curves. The challenge for rail manufacturers is to provide consistency in long, straight and flat rails, combined with dimensional accuracy and steel integrity to deliver trouble-free, decades-long service life.

The principal causes of degradation in high-speed rail are:
- Vertical and side wear
- Rolling contact fatigue (RCF)
- Discrete defects such as squats or belgrospies

The Tata Steel products suitable for high-speed railways are:

Tata Steel product grade	Key attributes	Customer benefits
R260 (and other standard grades)	Class A straightness. Class X dimensions.	Cost-effective standard rail with typical service life of approximately 30 years.
Heat treated grades R350HT/ R350LHT	Increased resistance to wear and RCF compared to R260.	Increased life in track with tighter curves.
HPrail	Increased resistance to wear and RCF.	Wear and RCF resistance where this impacts rail life. Reduced grinding frequency.
Bainitic rail B320/B360	Highest resistance to RCF.	Controls RCF with reduced grinding frequency. Used for switches and crossings and other high RCF areas.
Sogenox	Achieves perfect electrical contact between rail and train wheel in areas of low traffic.	Maintains robust signalling and prevents premature rusting of the rail head.

Heavy-duty railways

Hardened rails for unrivalled wear resistance in extreme conditions.

High-strength rails are required for tracks subject to very high loads and extreme wear stresses. These tracks include those used by trains with very high axle loads (25-35 tonnes) and high annual gross tonnage. Many heavy-haul rail operators have recognised the need to introduce high-performance rail to deliver longer life and reduce lifetime costs. Speeds on these tracks are relatively low and so wear resistance determines the frequency of rail replacement.

The principal causes of rail degradation are:
- Side and vertical wear
- Plastic deformation
- Rolling contact fatigue (RCF)
- Discrete defects such as squats

The Tata Steel products suitable for heavy-duty railways are:

Tata Steel product grade	Key attributes	Customer benefits
AREMA 325 HB intermediate strength	Good wear resistance.	Proven, predictable performance – widely used on heavy-haul tracks.
HPrail	Improved wear resistance and RCF resistance compared to AREMA 325HB.	Extended rail life in areas where RCF or wear are the main causes of degradation.
MHH	Highest resistance to wear and plastic deformation, with very low residual stress.	MHH provides the most wear-resistant rail for the most arduous conditions.

Mixed traffic railways

Full range of rail grades each tailored for specific track conditions.

Conventional speed mixed traffic railways have the difficult task of optimising track performance for the mix of relatively high-speed passenger trains and slower, high axle weight freight services. Nevertheless, infrastructure managers need to reduce the life cycle costs of track maintenance by extending rail component life.

The key causes of rail degradation in mixed-use railways are:
- Side and vertical wear – rate increases with decreasing track radius
- Rolling contact fatigue (RCF)
- Discrete defects such as squats
- Plastic deformation of low rail

The Tata Steel products suitable for mixed-use railways are:

Tata Steel product grade	Key attributes	Customer benefits
R200	Relatively soft grade promoting rapid wheel-rail profile conformity to reduce contact stresses.	May reduce susceptibility to discrete defects such as squats on tangent track.
R260	Increased rail life compared to R200.	Used on tangent, large radius and low-tonnage track.
Heat treated R350HT/R350LHT	Increased resistance to wear and RCF compared to R260.	Increased life in track with tighter curves.
HPrail	Increased resistance to wear and RCF compared to R260.	Ideal for transitions and curves of less than 3,000m for: – wear and RCF resistance – control of low rail plastic deformation – reduced grinding frequency
MHH	Finest pearlitic microstructure with high resistance to wear and RCF. Very low residual stress.	Ideal for tight radius curves for: – wear and RCF resistance – control of low rail plastic deformation – reduced grinding frequency
Sogenox	Achieves perfect electrical contact between rail and train wheel in areas of low traffic.	Maintains robust signalling and prevents premature rusting of the rail head.

Metro railways

Resilient rail grades to withstand high-frequency traffic and tight curves.

Although metro systems are characterised by lighter axle loads than their mainline counterparts, they generally comprise larger proportions of tighter radius curves, more frequent stations, a larger number of axle passes and greater traffic density. The combination of these track and traffic characteristics creates very complex and demanding stress conditions at the wheel-rail interface.

The key causes of rail degradation in metro railways are:
- Side and vertical wear – rate increases with decreasing track radius
- Corrugation
- Rolling contact fatigue (RCF)
- Plastic deformation of low rail

The Tata Steel products suitable for metro railways are:

Tata Steel product grade	Key attributes	Customer benefits
R200	Relatively soft grade promoting rapid wheel-rail profile conformity to reduce contact stresses.	Suited to tangent or shallow radius curve track experiencing little or no corrugation, low vertical wear but susceptible to discrete squat defects.
R260	Increased rail life compared to R200.	Used on tangent, large radius and low-tonnage track.
HPrail	Increased resistance to wear and RCF compared to R260.	Ideal for transitions and curves of less than 3,000m for: – wear and RCF resistance – control of low rail plastic deformation – reduced grinding frequency
MHH	Finest pearlitic microstructure with high resistance to wear and RCF. Very low foot residual stress.	Transition and tight radius curves, generally <1,000m, where rail life is curtailed by wear and RCF.

Tramway systems

Specialist rails for quiet, wear-resistant operation and easy maintenance.

Most modern tramway networks comprise both embedded and ballasted track in which the benefits of the much lower axle loads are more than eroded by very tight curve radii, as low as 15m, and steep gradients. Equally, the frequency of passenger service and the need to share parts of the infrastructure with other road users places unusually demanding conditions on the rail.

The key causes of degradation to grooved and flat-bottomed rails in tramway systems are:
- Side wear (in addition to gauge corner and side wear on tight radius curves, grooved rails also experience wear to the keeper section of the adjacent rail)
- Vertical wear – since side wear is weld restorable, rail life is determined by the magnitude of vertical wear
- Corrugation – influenced by a range of track system features

The Tata Steel products suitable for tramway systems are:

Tata Steel product grade	Key attributes	Customer benefits
Grooved rails:		
R200 and R220G1	Relatively soft grades with baseline level of wear resistance.	Traditionally used for tangent track or very shallow radius curve track experiencing little or no corrugation and low rates of vertical or side wear.
R260	Standard grade with greater wear resistance than R200 and R220G1 with the added benefit of being weld restorable using the Tata Steel process.	Improved life cycle cost option (with weld restoration) for all track of <100m radius. Weld reparable for second or third life extension.
Weldable extra life rail	Microstructurally engineered steel giving higher resistance to wear than grades with higher levels of hardness.	Lowest life cycle cost option (with weld restoration) for all track of <100m radius. Increased wear resistance and weld repairability provides the most cost-effective solution for tight curves. Also suitable for all larger radius track.
Flat-bottom rail (Vignole):		
R260	Standard grade with a hardness level to give baseline wear resistance and rail life.	Generally suitable for all larger radii or tangent track.
HPrail	Increased resistance to wear and rolling contact fatigue.	Lower life cycle cost option for all track of <100m radius, but also suitable for larger radii track.

Crane rail

Strong, hard-wearing special rail profiles.

Tata Steel supplies a range of special crane rail profiles, manufactured to DIN 536 part 1. Six sizes of rail are available in three different specifications to meet customer tensile strength requirements – with minimum strengths ranging from 690N/mm to 880N/mm.

The six crane rail sizes we supply are shown in the table:

The Tata Steel products suitable for cranes in all applications

Rail	Kg/m	K	B3	B1	H1	H2	F3	R1	R6
A65	43.1	65	38	175	75	34	10	6	5
A75	56.2	75	45	200	85	39.5	11	8	6
A100	74.3	100	60	200	95	45.5	12	10	6
A120	100.0	120	72	220	105	55.5	14	10	6
A150	150.3	150	80	220	150	64.5	14	10	6
MRS87A	86.8	101.6	34.9	152.4	152.4	50.8	31.75	8	12.7

All dimension are in mm. Quotations for other sizes and specifications available on request.
Crane rails are normally supplied in 12m cold sawn lengths, with a cutting tolerance of + 100 / – 0 mm.
Other lengths are available.

Diagram for A65, A75, A100, A120, A150

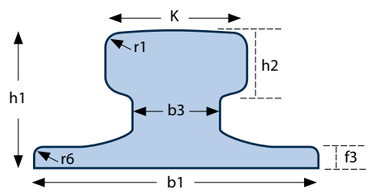
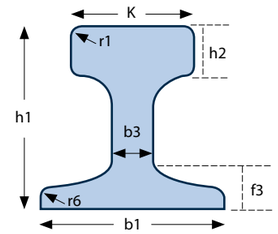


Diagram for MRS87A



MUCH MORE THAN RAIL

SilentTrack®

Reduces overall train pass-by noise by 3-7 dB (A).

Tata Steel has developed SilentTrack® to help rail operators save costs on lines that pass through urban areas where noise levels must be minimised. SilentTrack® uses sound absorbers on the rail web and upper part of the foot to reduce noise – eliminating the need to construct expensive noise-abatement walls alongside the tracks.

Railcote®

Corrosion-resistant rail coating for harsh environments.

For harsh environments where tracks could be subject to heavy wear or corrosion, Tata Steel can supply rails treated with Railcote – a high-purity zinc coating ideal for tracks in tunnels, at level crossings and in marine environments.

As a major steel manufacturer, Tata Steel produces a host of steel products for construction and engineering applications in the rail industry.

Steel sleepers

Cost-effective, long-life, easy-install steel sleepers.

Steel sleepers offer savings on installation time and cost due to their low weight, stackable design and reduced ballast requirement. They offer improved in-service performance too, through enhanced lateral stability and reduced maintenance requirements.

Steel sleepers have a typical lifetime of 50 years and generally have lower maintenance costs over this time. They can be designed to overcome some major engineering challenges. For example, lower height construction can be achieved by eliminating level-adjustment problems in tunnels, as well as over underpasses and can accommodate platform constraints.

Tata Steel sleepers are compatible with all modern fastening systems, including Pandrol, Vossloh and Nabla.

Railway structures

Precision-manufactured components for construction and engineering projects.

As a major, diversified steel producer, Tata Steel manufactures a vast array of steel products used throughout the rail industry.

Structural sections, tubes and steel cladding can be used to construct the full range of railway buildings, from stations to office blocks. These essential structural components offer all the benefits of long life, high strength, dimensional accuracy and ease of installation that make steel the first-choice building material for today's sustainable construction industry.

Steel sections are also used to construct catenary gantries on electrified railway lines, as well as signalling gantries, bridges and other track-side structures.

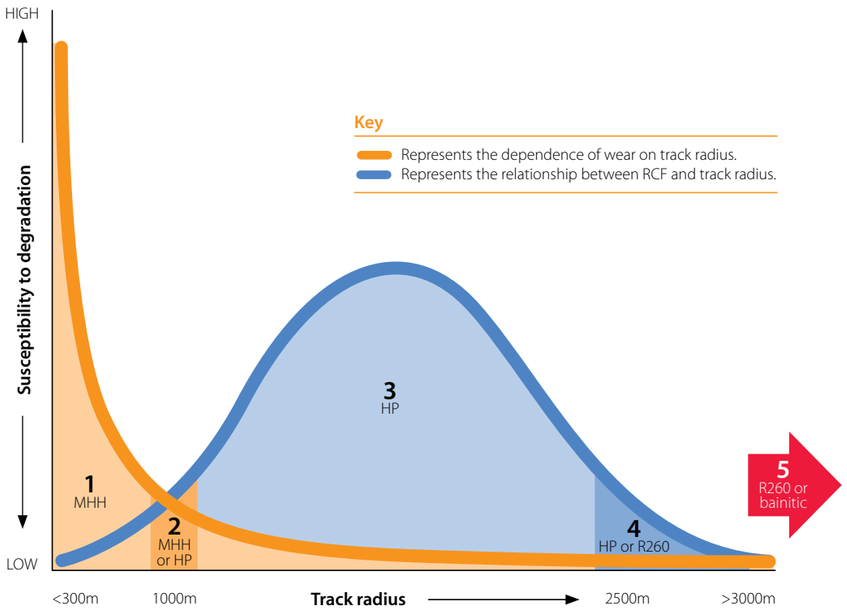
Modular steel platforms provide a fast, cost-effective way to construct train platforms, even in the most challenging site conditions. The use of standardised, lightweight galvanised steel components allows these systems to be installed quickly and with minimal noise and waste – creating a robust, long-lasting solution suitable for all platform profiles. Modular steel construction can also be used to create entire stations quickly, cost effectively and sustainably.

Please contact us at rail@tatasteel.com for more information about any of our rail and related steel products.

GRADE SELECTION

Tata Steel took a leading role in Innotrack, a European project that produced a comprehensive guideline for the selection of rail grades. We have further developed the rail grade selection process by combining knowledge of degradation mechanisms with the metallurgical attributes of rail grades, helping customers to maximise rail life.

Generic grade selection graph



The graph opposite illustrates the Tata Steel grade selection process.

Area 1 represents very tight curves requiring the most wear-resistant steel combined with effective lubrication to maximise rail life. The recommended grade is MHH.

Area 2 is where both wear and rolling contact fatigue are relevant degradation mechanisms. The recommended grade for this region is either MHH or HPrail. The choice will be governed by the observed severity of wear and RCF and the traffic characteristics.

Area 3 represents the area where RCF is the dominant degradation mechanism. The total width of this area is between track radii of 1,000m and 2,500m and would represent a range of vehicle types. The height of this area will largely depend on the proportion of more damaging stiffer vehicles in the traffic mix. Although the recommended grade is HPrail, use of MHH in part of this area would be technically plausible.

Area 4 is an overlap area, since RCF susceptibility is observed in track radii up to 2,500m in some European mixed traffic networks, while in others RCF susceptibility can extend to 3,000m radius or beyond. Hence, a degree of flexibility in the recommendation of the optimum rail grade is desirable. Thus, HPrail grade should be preferred if the track is known to be susceptible to RCF. The additional cost of this premium grade can be easily offset by savings in the required frequency of grinding to control RCF propagation.

Area 5 represents standard rail grades which usually provide a cost effective solution. However where there is a high susceptibility to rolling contact fatigue then bainitic rail offers an effective solution that reduces the need for grinding.

MHH
A patented heat treatment process at Hayange creates a range of rail products with enhanced hardness, including the world's most wear-resistant micro head hardened (MHH) grade. As well as increasing steel hardness, the heat treatment creates rail with extremely low residual stresses delivering a step change in resistance to foot fatigue.

HPrail
A metallurgically engineered steel with superb resistance to wear and rolling contact fatigue, to maximise rail life and reduce grinding requirements.

Bainitic rail
Low carbon carbide-free bainitic rail offers excellent resistance to rolling contact fatigue. It is proven for switch and crossing applications and shallow radius track with high susceptibility to rolling contact fatigue.

Tata Steel makes the full range of steel grades in compliance with euronorms, AREMA and the specifications of all major railways.

TECHNICAL SERVICES

The rail technology specialists at Tata Steel offer a comprehensive range of services to help improve operational efficiency and network integrity on both light rail and heavy rail networks.

Our unrivalled rail and metallurgical knowledge, combined with world-class on-site laboratory facilities, enable us to conduct detailed materials and product testing on behalf of customers. Our investigations can provide rail operators with the necessary approvals and information to guide future development.

The range of rail technical and consultancy services available includes:

Light rail
Tata Steel carries out detailed condition surveys and provides reports covering all aspects of fixed infrastructure. This effectively benchmarks the assets by, for example, assessing rail degradation due to wear and corrugation.

Heavy rail
We can advise network operators on the most cost-effective material selection and design for new track installations, as well as adding value to maintenance strategies for existing infrastructure.

Metallurgy and materials technology
Experienced metallurgists and materials technologists help to design and select track system components to meet specific duty requirements. The team works closely with network operators and maintainers to enhance network performance and safety.

Failure analysis
Our extensive knowledge of rail steel metallurgy and understanding of fracture mechanics enables us to provide a comprehensive range of investigative services to establish the root causes of failure, as well as recommending corrective and preventative actions.

Track system modelling
Tata Steel modelling specialists combine site information with proven track behaviour data, offering a fast, cost-effective method of track modelling. Our sophisticated modelling tools enable us to determine future defects and consequences of future track degradation, helping customers to develop cost-effective maintenance and renewal policies.

Track monitoring
Our multi-disciplined team has many years' experience of monitoring the in-service performance of rail networks. Monitoring techniques range from detailed visual inspections to using precise instrumentation and non-destructive testing. The findings can be used to identify causes and rates of degradation, helping rail operators to develop appropriate techniques for controlling track quality.

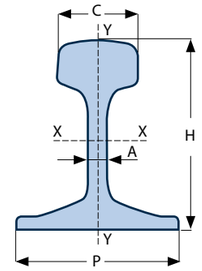
Welding technology
Our welding technology consultancy service helps customers to reduce weld maintenance costs and extend rail life. We can develop welding schedules designed to control weld geometry, optimise weld process control and enhance process monitoring and analysis.

Laboratory testing
We can conduct a range of standard laboratory tests to international standards, as well as designing and building bespoke test arrangements. These provide customers with independent certification of the performance of safety-critical railway components. Laboratory testing can also be used to investigate the performance of worn components.

Noise and vibration monitoring
Noise and vibration is a concern for many tramway systems that operate in urban environments. Tata Steel specialists can carry out detailed noise and vibration analyses, provide detailed reports and, where appropriate, recommend solutions for reducing noise or vibration.

Asset management
Our theoretical and practical investigative techniques can be applied to enhance understanding of the in-service performance of complete railway systems. This asset data can be used to support informed decisions about inspection maintenance and renewal activities.

TECHNICAL DATA



EN13674-1 2011 Flat bottom rails >46kg/m

Rail profile	Equivalent profile name	Section weight kg/m	Rail height mm (H)	Head width mm (C)	Web thickness mm (A)	Foot width mm (P)	Moment of inertia Ixx, cm^4	Moment of inertia Iyy, cm^4
46E1	SBB I	46.17	145	65	14	125	1,641	298
46E2	U33	46.27	145	62	15	134	1,643	329
46E3	NP 46	46.66	142	73.72	14	120	1,606	308
49E1	DIN S49	49.39	149	67	14	125	1,817	319
50E1	U50E	50.37	153	65	15.5	134	1,988	365
50E2	50EB-T	49.97	151	72	15	140	1,989	408
50E3	BV 50	50.01	155	70	14	133	2,058	351
50E5	50 UNI	49.94	148	67	14	135	1,844	362
50E6	U 50	50.9	153	65	15.5	140	2,018	397
52E1	52 RTP	52.15	150	65	15	150	1,971	434
54E1	UIC 54	54.77	159	70	16	140	2,338	419
54E2	UIC 54 E	53.82	161	67.01	16	125	2,308	342
54E3	DIN S54	54.57	154	67	16	125	2,074	355
54E4	–	54.31	154	67	16	125	2,056	353
54E5	54E1HC	54.42	159	70.2	16	140	2,308	416
55E1	U55	56.03	155	62	19	134	2150.4	418.4
56E1	BR113A	56.27	158.75	69.85	20	140	2320.9	421.6
60E1	UIC 60	60.21	172	72	16.5	150	3,038	512
60E2	–	60.03	172	72	16.5	150	3021.5	510.5

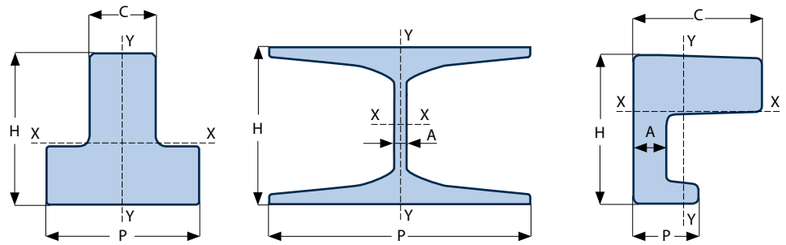
AREMA

Rail profile	Equivalent profile name	Section weight kg/m	Rail height mm (H)	Head width mm (C)	Web thickness mm (A)	Foot width mm (P)	Moment of inertia Ixx, cm^4	Moment of inertia Iyy, cm^4
100 RE	–	50.4	152.4	65.45	14.29	136.53	2,021	387
100 CP-RE	–	50.86	153.99	65.6	14.29	136.53	2,065	387
115RE	–	56.82	168.28	68.04	15.88	139.7	2,726	446
115 RE 10	–	56.98	168.28	68	15.88	139.7	2,742	447
119RE	–	58.96	173.04	66.5	15.88	139.7	2,972	452
132 RE	–	65.39	180.98	75.17	16.67	152.4	3,658	598
133 RE	–	66.19	179.39	73.02	17.46	152.4	3,589	601
136 OP	–	67.26	185.74	74.01	17.46	152.4	3,910	598
136 RE	–	67.49	185.74	73.74	17.46	152.4	3,921	602
136 RE 10	–	67.49	185.74	73.77	17.46	152.4	3,923	601
136 RE 14	–	67.76	185.74	73.71	17.46	152.4	3,955	604
136 CN04	–	67.71	186.53	73.74	17.46	152.4	3,949	602
141 RE	–	69.88	188.91	74.32	17.46	152.4	4,181	621

Other rail profiles are available please contact us and we would be pleased to discuss your requirements.

UIC, ASCE & other specifications

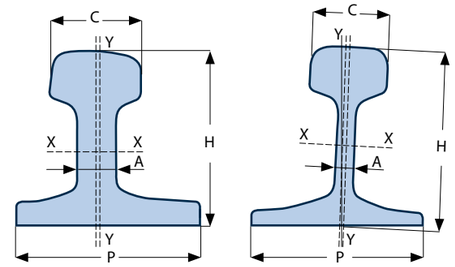
Rail profile	Equivalent profile name	Section weight kg/m	Rail height mm (H)	Head width mm (C)	Web thickness mm (A)	Foot width mm (P)	Moment of inertia Ixx, cm^4	Moment of inertia Iyy, cm^4
BCK 40	40KDL	39.76	130	62	13	120	1,139	243
80 ASCE	–	39.87	127	63.5	13.89	127	1,101	220
85 ASCE	–	42.19	131.76	65.09	14.29	131.76	1,256	288
90 RAA	–	44.48	142.88	62.81	14.29	130.18	1,567	308
BS 90R	–	44.59	142.88	66.68	13.89	136.53	1,588	335
43 CHINE	–	44.6	140	70	14.5	114	1,481	258
BS 90 AM	–	44.91	142.88	67.17	13.89	127	1,551	284
BS 95 N	–	47.26	147.64	69.85	13.89	139.7	1,790	354
SAR 48	–	48.07	150	127	14	68	1,855	323
50 CHINE	–	51.5	152	70	15.5	132	2,027	375
IRS 52	–	51.74	155.97	67.07	15.48	136.13	2,108	357
SAR 57	–	57.44	165	71.31	16	140	2,648	442
AS 60	–	60.64	170	70	16.5	146	2,926	490
60 CHINE	–	60.8	176	70.79	16.5	150	3,217	524
122 CB	–	60.98	172.24	72.53	16.67	152.4	3,065	528
124 JK	–	61.47	174.63	73.48	15.88	139.7	3,164	482
R 65	–	64.87	180	73	18	150	3,543	568



Special rail sections

Rail profile	Equivalent profile name	Section weight kg/m	Rail height mm (H)	Head width mm (C)	Web thickness mm (A)	Foot width mm (P)	Moment of inertia Ixx, cm^4	Moment of inertia Iyy, cm^4
BS95RBH	–	47.07	145.26	69.85	19.05	69.85	1458	171
Section 75 Conductor	–	75.17	138	89	22.5	140	2164.08	891.64
Section 65 Conductor	–	65.41	102	89	70	70	677	484
T 52	–	52.41	100.5	45	–	101	543.8	376.2
MATRA	–	62.85	120	–	12	250	1998	2887
RATP	–	68.33	140	–	12	230	2518.9	2926.6
33C1	U69, UIC33, RL 1-60	33	92.81	80	20	40	297	219

Other rail profiles are available please contact us and we would be pleased to discuss your requirements.



EN 13674-2:2006+A1:2010 (E) Switch and crossing asymmetric rails

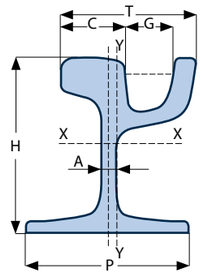
Rail profile	Equivalent profile name	Section weight kg/m	Rail height mm (H)	Head width mm (C)	Web thickness mm (A)	Foot width mm (P)	Moment of inertia Ixx, cm^4	Moment of inertia Iyy, cm^4
54E1A1	A69, UIC54B, Zu UIC54B	68.95	129	70	40	147	1,544	768
60E1A1	A73, UIC60B, Zu 1-60	72.97	134	72	44	140	1,727	741
50E6A1	U59	64.98	155	65	28	142	2,327	551
50E6A2	U60	54.21	155	65	16	148	2,213	497
54E1A3	54D20	68.62	129	69.91	32.5	145	1,553	773
54E1A4	54D40	68.72	129	69.98	32.5	145	1,562	771
60E1A4	60D	69.83	142	71.91	32.5	150	2,026	764
60E1A5	60D40	69.95	142	71.98	32.5	150	2,036	764
60E2A2	Zu60E2-40	72.82	134.07	72.03	44	140	1,718	740

EN 13674-2:2006+A1:2010 (E) Switch and crossing symmetric thick web rails

Rail profile	Equivalent profile name	Section weight kg/m	Rail height mm (H)	Head width mm (C)	Web thickness mm (A)	Foot width mm (P)	Moment of inertia Ixx, cm^4	Moment of inertia Iyy, cm^4
60E1T1	A61, UIC60C	61.1	142	72	28	150	1,867	520
50E2T1	A63, EB63T	62.97	151	72	30	140	2,166	493
54E1T1	A65, UIC54A	65.41	159	70	28	140	2,514	504
60E1T2	A74, UIC60A	74.24	172	72	30	150	3,301	615

EN 13674-4:2006+A1:2009 (E) – Flat bottom rails 27kg/m to 46kg/m

Rail profile	Equivalent profile name	Section weight kg/m	Rail height mm (H)	Head width mm (C)	Web thickness mm (A)	Foot width mm (P)	Moment of inertia Ixx, cm^4	Moment of inertia Iyy, cm^4
35E1	Xa	35.76	125	58	12	110	936	175
36E2	36 kg (S-40)	36.59	128	58.27	13	115	1,020	203
39E1	BS80A	39.77	133.35	63.5	13.1	117.47	1,205	220
40E1	S41 R14	40.95	138	67	12	125	1,367	262
41E1	S41 R10	41.24	138	67	12	125	1,382	265
45E1	BS 90A	45.11	142.88	66.67	13.89	127	1,564	285
45E2	DSB 45	45.51	141	69.3	13.76	126	1,536	297



EN 14811:2006+A1:2009 (E) Grooved rails

Rail profile	Equivalent profile name	Section weight kg/m	Rail height mm (P)	Head width mm (C)	Web thickness mm (A)	Foot width mm (P)	Moment of inertia, Ixx, cm^4	Moment of inertia, Iyy, cm^4	Groove Width G mm	Total head width T mm
46 G1	60 G G	46.03	150	53.76	11	140	1,615	611	58.85	125
G 51	–	50.79	152	51.92	12	149	1,870	712	62.24	126
	Ri54N	53.98	152.5	56.2	13	141.5	2,043	676	36	112.9
55G1	35GP G	54.78	152.5	56.23	13	141.5	2,076	682	35.94	111.82
	35 GPU	53.68	152.5	56.16	13	141.5	2,041	675	36.09	111.82
	35 G-A	54.6	151.5	56.85	13	141.5	2,013	670	34.7	111.32
	35 GP13	54.71	152.5	56.61	13	141.5	2,072	682	35.18	111.82
	35 G-TF	55.33	152.5	56.23	13	141.5	2,060	673	35.95	111.32
	35 G-SF	55.72	152.4	56.2	13	139.7	2,064	674	34	111.32
	35 Gm	55.78	152.5	56.23	13	141.5	2,088	690	35.95	111.82
55G2	41 GP G	55.33	152.5	56.23	13	141.5	2,082	741	40.94	116.82
	41 GP13	55.27	152.5	57.03	13	141.5	2,078	740	40.18	116.82
	41 GPi	54.09	152.5	56.22	13	141.5	2,037	734	40.83	116.82
	41 GPU	54.26	152.5	56.16	13	141.5	2,048	733	41.09	116.82
	41 G	56.28	152.5	56.2	13	141.5	2,095	749	34.7	111.32
59R1	Ri 59-R10, Ri 59 R	58.97	180	56	12	180	3,267	886	42	113
59R2	Ri 59-R13, Ri 59N R	58.19	180	55.83	12	180	3,214	877	42.35	113
60R1	Ri 60-R10, Ri 60 R	60.59	180	56	12	180	3,354	929	35	113
60R2	Ri 60-R13, Ri 60 N R	59.75	180	55.83	12	180	3,299	920	36.35	113
62R1	NP4aM R	62.37	180	56.03	12	180	3,536	1,042	34.44	116
62R2	NP4aS R	61.91	180	55.86	12	180	3,506	1,043	33.98	116
68G1	70 G G	68.3	200	58	13	180	4,448	1,356	69.57	146
	VKRi60M	73.04	180	0	12	180	3,961	1,060	0	114

Other rail profiles are available please contact us and we would be pleased to discuss your requirements.

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