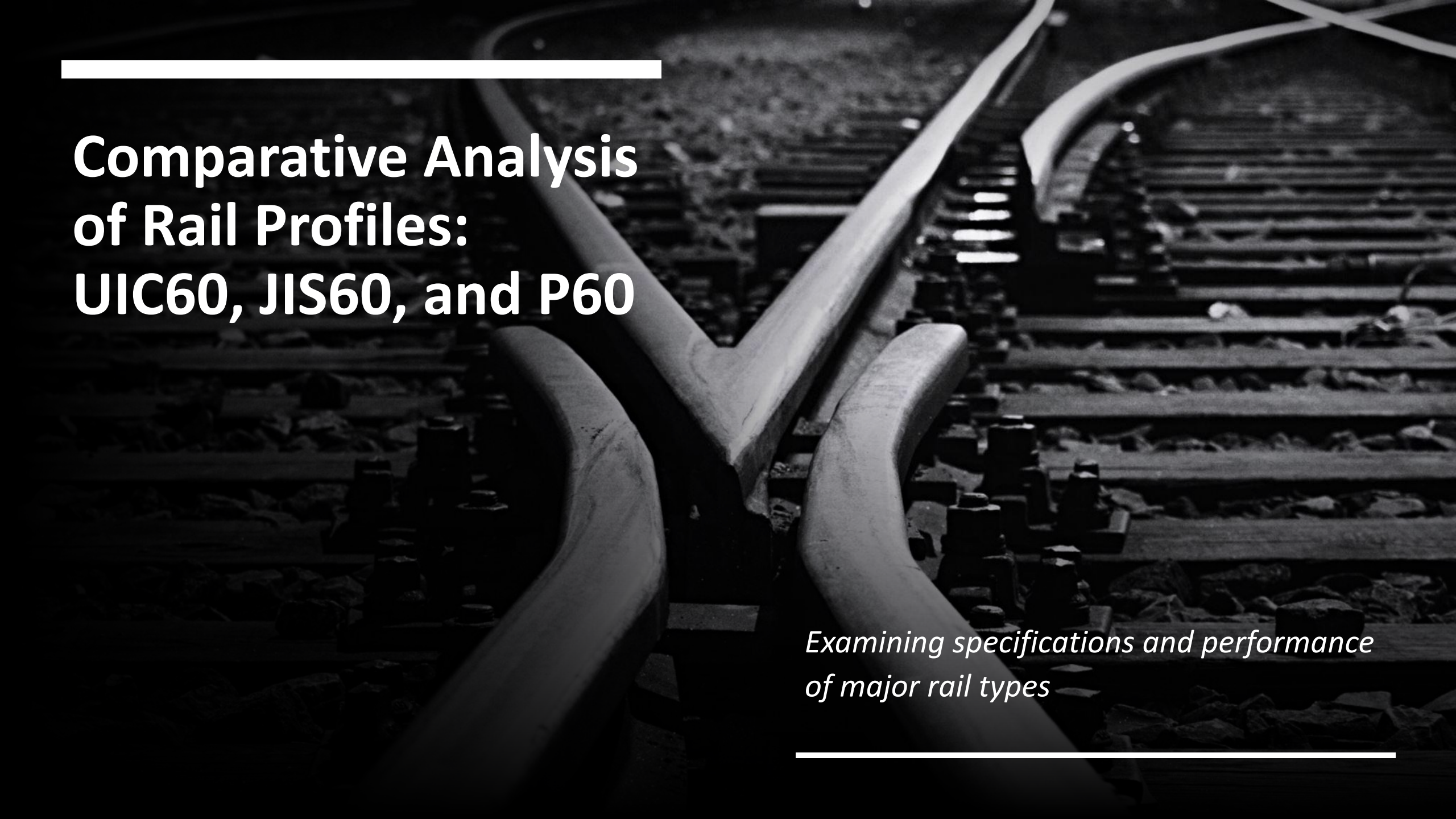


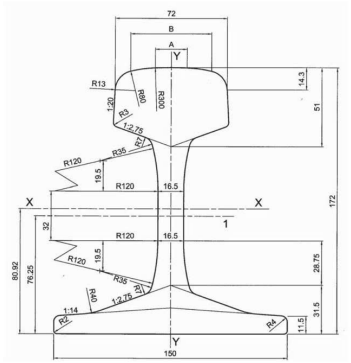
Comparative Analysis of Rail Profiles: UIC60, JIS60, and P60

Examining specifications and performance of major rail types

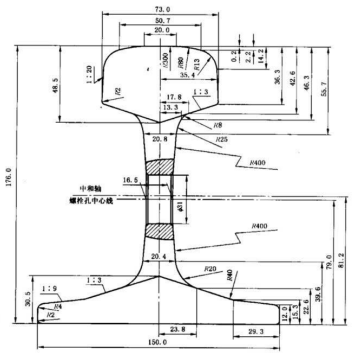
Meeting Program

- Introduction to Rail Profiles and Their Importance
- Detailed Specifications of UIC60, JIS60, and P60 Rail Profiles
- Comparative Analysis of Design and Performance
- Global Applications and Case Studies
- Asset management
- Interchangeability of components

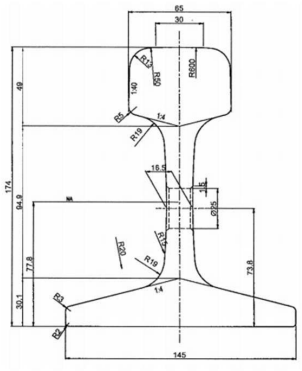
Introduction to rail profiles and their importance



UIC 60



P60



JIS 60

Definition and Function of Rail Profiles

Rail Profile Components

Rail profiles specify the shape and dimensions of the rail head, web, and foot components essential for rail structure.

Wheel-Rail Contact

Proper rail profiles ensure optimal wheel-rail contact to improve ride quality and reduce wear.

Load Distribution and Stability

Correct rail profiles aid load distribution across the rail and enhance track stability and maintenance.

Overview of Rail Profile Standards Globally

UIC Standards

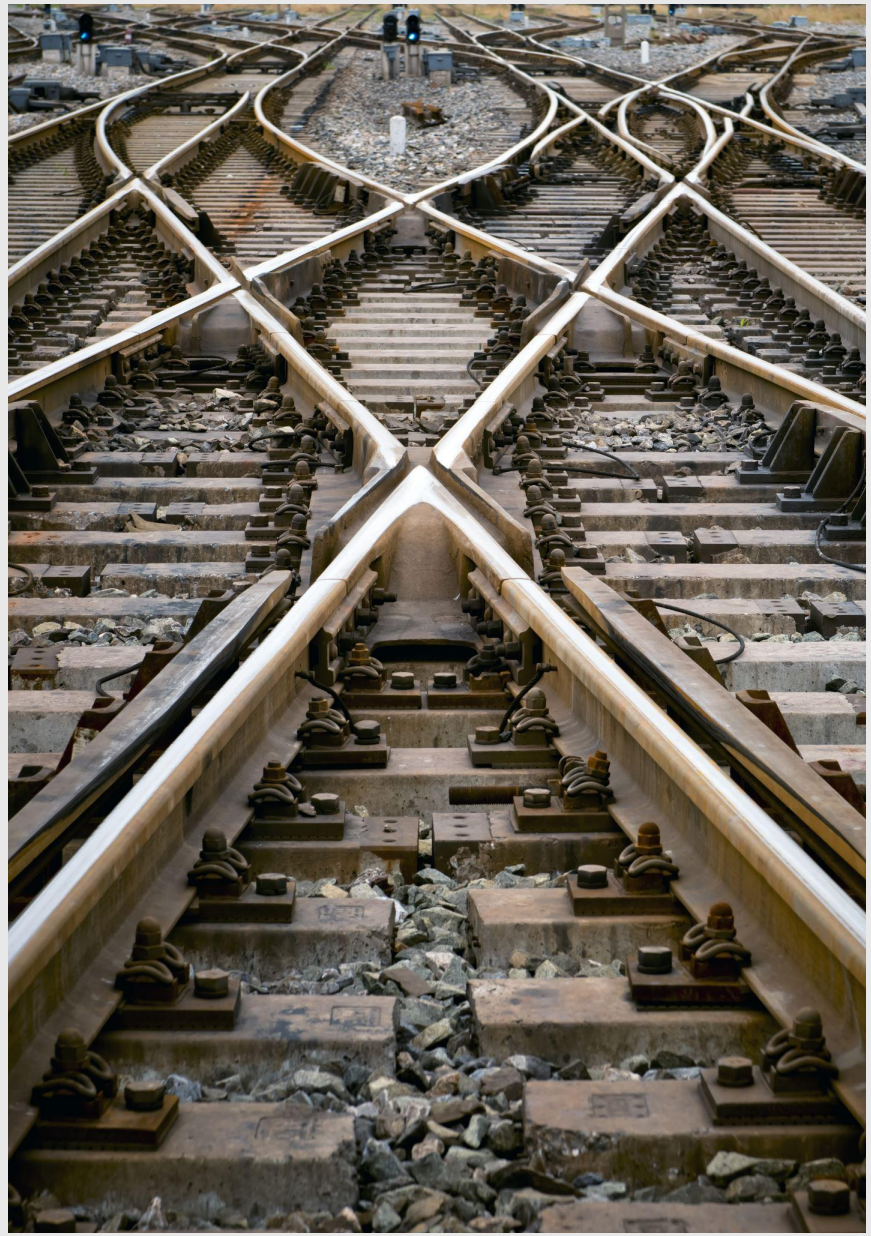
UIC standards are widely adopted internationally, specifying rail dimensions and performance for interoperability.

Japanese Industrial Standards

JIS defines rail profiles and material specifications tailored for Japan's rail systems and performance needs.

Proprietary Profiles

The Chinese P60 profile appears to be proprietary and not governed by any recognized standard. No standardized metallurgical properties are available, but it is reportedly designed for specific performance and durability needs.



Criteria for Selecting Appropriate Rail Profiles

Key Selection Factors

Choosing rail profiles depends on track gauge, train speed, axle loads, design, and environmental factors.

Performance and Durability

Proper rail profiles ensure optimal performance, durability, and reduce maintenance efforts over time.

Balancing Maintenance Needs

Selecting the right profile balances maintenance requirements with operational efficiency for rail systems.

Detailed Specifications of UIC60 (60 EN1), JIS60, and P60 Rail Profiles

UIC60: Dimensions, Material Properties, and Usage

Standard Dimensions

UIC60 rails have a height of 172 mm and a head width of 72 mm, ensuring uniformity across European railways. It is widely used in the Middle East, in India, China and several Asian countries.

Material Properties

Manufactured from high-strength steel, UIC60 rails are durable and capable of handling heavy loads and stress.

Usage in Railways

UIC60 rails are designed for heavy freight and all kind of passenger services, including high-speed, making them versatile for multiple rail transport needs; the profile is manufactured according to the European standard EN 13674-1.

JIS60: Dimensions, Material Properties, and Usage

Rail Profile Dimensions

The JIS60 rail profile is characterized by a height of 174 mm and a relatively narrow head performing a width of 65 mm, offering standardization for rail construction within Japan. Developed during the construction of the Tokaido Shinkansen in the 1960s, the 60 kg rail design was initially specified in the Japanese Railway Standards (JRS) in 1961 and subsequently formalized without modifications under the Japanese Industrial Standards (JIS) in 1974.

Specialized Steel Grades

The rail uses steel grades designed for durability and performance.

Rail Network Usage

JIS60 rails are widely used for Japan’s rail networks, Japanese high-speed lines and metros as well.

P60: Dimensions, Material Properties, and Usage

Profile Dimensions

The P60 profile has a height of 176 mm and a head width 73 mm, suitable for various applications. It has been replaced in China for the high-speed lines with the profile 60N (N for “New”), which is geometrically slightly different.

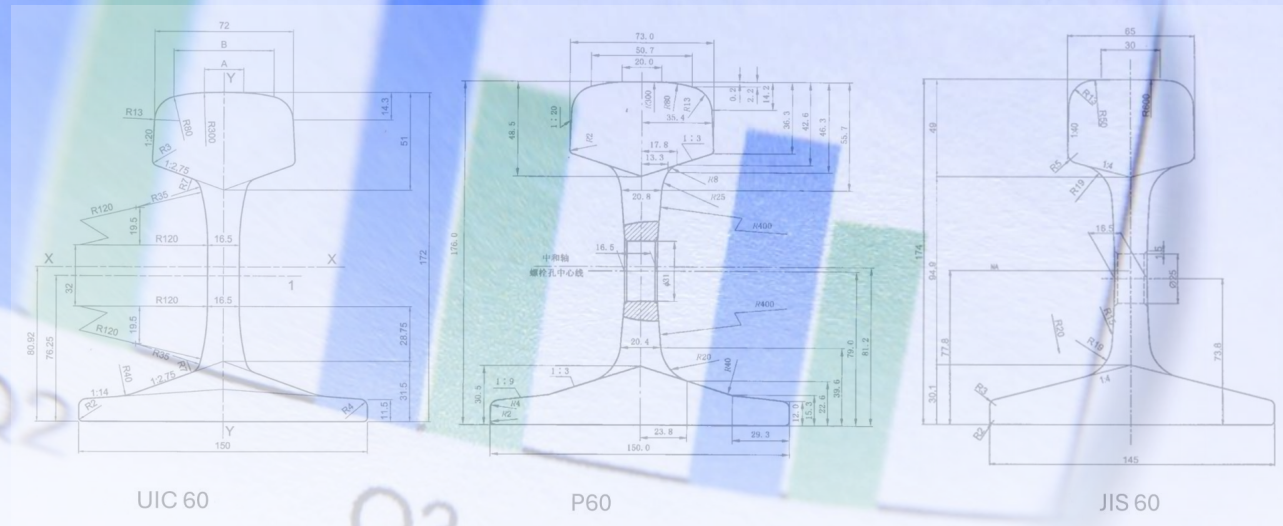
Material Properties

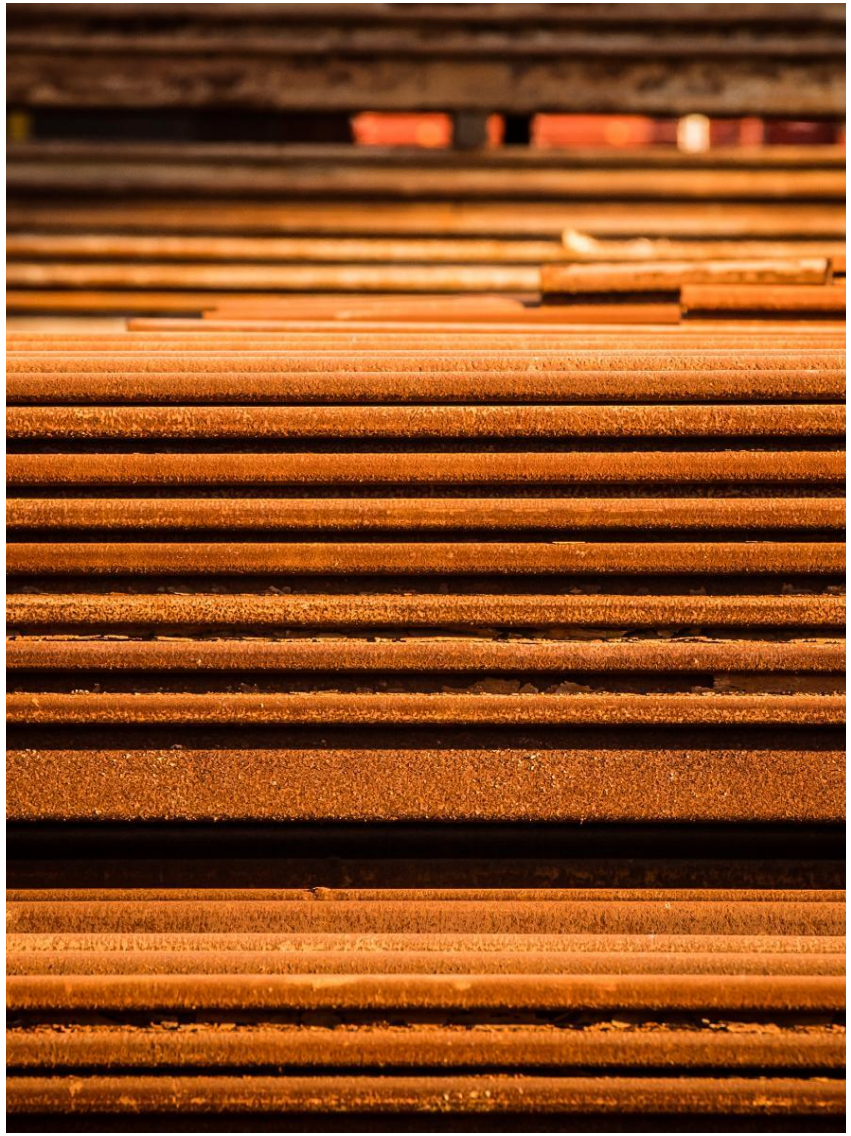
P60 rails are designed to withstand mixed traffic loads and adapt to variable environmental conditions effectively.

Usage Environment

P60 rails are used in China, along with the UIC 60 profile, for mixed traffic operations and under various weather conditions. The two profiles are geometrically almost identical, however the metallurgical properties of the P60 appears not being standardized.

Comparative Analysis of Design and Performance





Geometric Differences and Compatibility with Tracks

UIC60 Profile

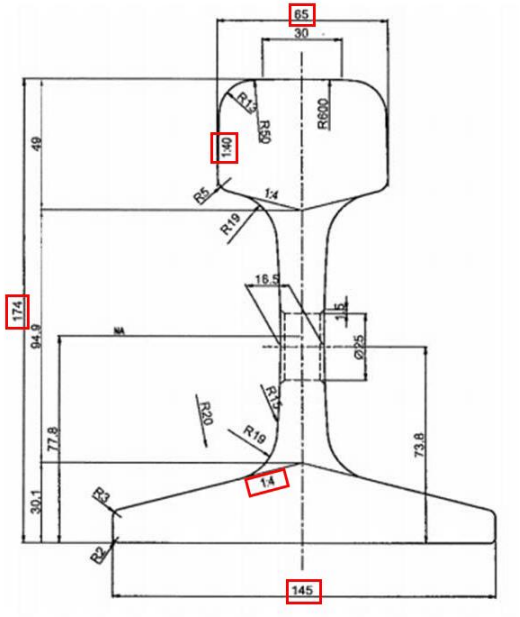
UIC60 rails have a wider profile enhancing stability for the heavy load of railway tracks. The foot width 150 mm fits in an ideal manner with all the most common and established fastener systems by enhancing stability under load.

JIS60 Profile

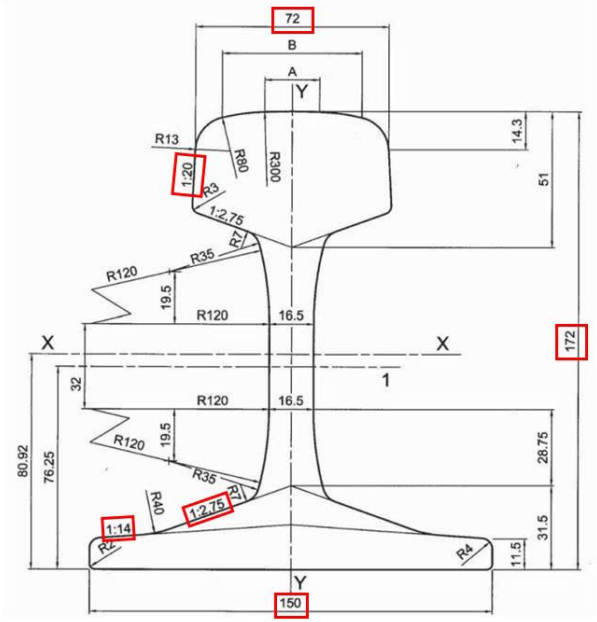
JIS60 rails were initially developed for the Shinkansen bullet train in the 1960's. Subsequent testing, conducted over a ten-year period beginning in 1974, demonstrated a significant reduction in the frequency of rail breaks that had previously occurred in Japan.

P60 Profile

P60 rails are designed for use on lines that accommodate both freight and passenger traffic and a variety of load requirements. The profile resembles the UIC 60 profile, and both are commonly used in China.



JIS 60



UIC 60

Geometrical and metallurgical properties of UIC60 and JIS60

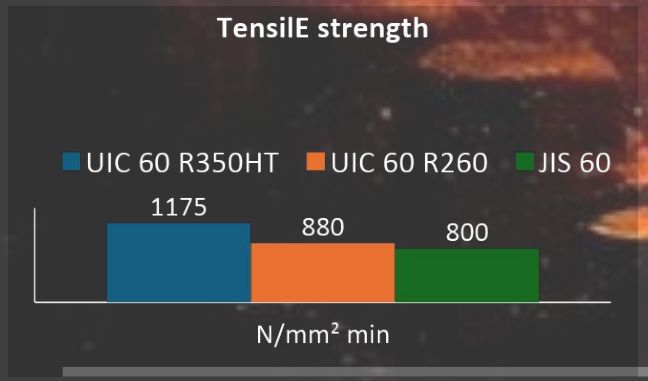
- The JIS60 rail is slightly taller than the UIC60 (174 mm versus 172 mm), which makes it somewhat stiffer. This slightly increased stiffness allows for potentially closer fastener spacing but might reduce ride comfort and slightly increase air-borne noise.
- The UIC60 rail has a foot width of 150 mm, wider than the JIS60's 145 mm, offering improved stability under both vertical and especially lateral loads (curves). Modern fastening systems, such as those from Vossloh and Pandrol, are designed mainly to fit this dimension.
- Compared to the JIS60's foot slope of 1:4, the UIC60 has a flatter foot slope of 1:14, compatible with the clips used in current fasteners. This allows for adequate toe load adjustment, which can be advantageous on viaducts due to their typical contraction and expansion, potentially reducing rail stress and minimizing the risk of rail fractures or damaging of other track components.
- The UIC60 rail also features a quite wider head (72 mm versus 65 mm for the JIS60) and a less steep head lateral slope (1:20 compared to 1:40). These improvements enhance the wheel-to-rail contact, leading to better ride comfort, reduced wear, and a longer service life.

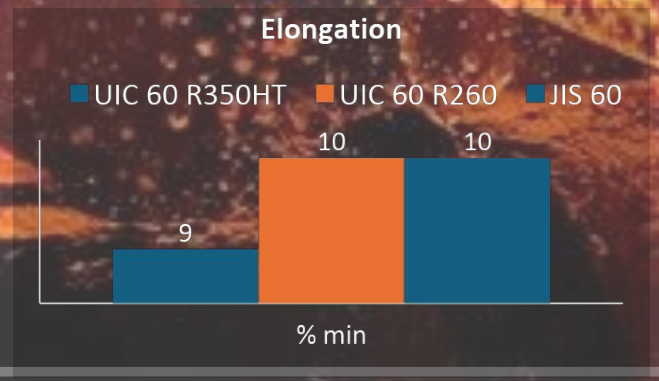
The EN and JIS standards define the chemical composition of UIC60 and JIS60, respectively. These chemical properties govern important mechanical and metallurgical features of the rail profiles (next slide).

Chemical composition and mechanical properties

Standards	Type of Rail		C	Si	Mn	P	S	Yield Strength	Tensile Strength	Elongation	Test
			%	%	%	%	%	N/mm²	N/mm²	%	m
AREMA 2016 Chapter 4 RAIL	High Strength	(Carbon)	0.74-0.86	0.10-0.60	0.75-1.25	0.020 max.	0.020 max.	828 min.	1,179 min.	10 min.	
		(Low Alloy)	0.72-0.82	0.10-1.00	0.70-1.25	0.020 max.	0.020 max.				
	Inter-mediate	(Carbon)	0.74-0.86	0.10-0.60	0.75-1.25	0.020 max.	0.020 max.	724 min.	1,069 min.	10 min.	Diam.=1
		(Low Alloy)	0.72-0.82	0.10-1.00	0.70-1.25	0.020 max.	0.020 max.	552 min.	1,014 min.	8.0 min.	GL=50.8
	Standard	(Carbon)	0.74-0.86	0.10-0.60	0.75-1.25	0.020 max.	0.020 max.	511 min.	983 min.	10 min.	
		(Low Alloy)	0.72-0.82	0.10-0.50	0.80-1.10	0.020 max.	0.020 max.				
EN13674-1:2011 Standard for UIC 60	R350HT		0.72-0.80	0.15-0.58	0.70-1.20	0.020 max.	0.025 max.	-	1,175 min.	9 min.	Diam.=1
	R260		0.62-0.80	0.15-0.58	0.70-1.20	0.025 max.	0.025 max.	-	880 min.	10 min.	GL=50
UIC860-0	Grade1100		0.60-0.82	0.30-0.90	0.80-1.30	0.03 max.	0.03 max.	-	1,080 min.	9 min.	Diam.=1
	Grade900A		0.60-0.80	0.10-0.50	0.80-1.30	0.04 max.	0.04 max.	-	880-1,030	10 min.	GL=50
AS1085.1-2002	Head-Hardened		0.65-0.82	0.15-0.58	0.70-1.25	0.025 max.	0.025 max.	780 min.	1,130 min.	9 min.	Diam.=1
	Standard							420 min.	880 min.	8 min.	GL=50
IRS-T-12-2009	1080 HH		0.60-0.80	0.10-0.50	0.80-1.30	0.030 max.	0.030 max.	460 min.	1,080 min.	10.0 min.	Diam.=6
	880		0.60-0.80	0.10-0.50	0.80-1.30	0.030 max.	0.030 max.	460 min.	880 min.	10.0 min.	Diam.=1
JIS E 1120-2007	HH370		0.72-0.82	0.10-0.65	0.80-1.20	0.030 max.	0.020 max.	-	1,130 min.	8 min.	
	HH340		0.72-0.82	0.10-0.55	0.70-1.10	0.030 max.	0.020 max.	-	1,080 min.	8 min.	Diam.=1
JIS E 1101-2001	Standard (40N,50N,60)		0.63-0.75	0.15-0.30	0.70-1.10	0.030 max.	0.025 max.	-	800 min.	10 min.	GL=50
	Standard (37A)		0.55-0.70	0.15-0.35	0.60-0.90	0.045 max.	0.050 max.	-	690 min.	9 min.	

The table is sourced from JFE Steel Corporation, Japan.





Carbon – Carbon is the most important alloying element in steel and can be present up to 0.9% in train rails. Increased quantities of carbon increase hardness and tensile strength as well as response to heat treatment (hardenability). On the other hand, increased quantities of carbon reduce weldability.

Silicon – Only small quantities are normally present in rolled steel when silicon is used as a deoxidizer. Silicon dissolves in iron and tends to strengthen it.

Manganese – Steels normally contain at least 0.3% manganese, which acts in a two-fold manner. It (1) assists in deoxidation of the steel, and (2) promotes higher strength by increasing the hardenability of the steel. Quantities up to 1.5% are normally found in carbon steels, for example in a turnout's crossing (frog).

Phosphorus – Phosphorus is an undesirable impurity in steels. It is normally found in quantities up to 0.04% in most of the carbon steels. In hardened steels, it tends to cause embrittlement.

Sulphur – This is an undesirable impurity in steel rather than an alloying element. Special effort is made to eliminate or minimize sulphur during steelmaking. In quantities exceeding 0.05%, it tends to cause brittleness and reduce weldability.


Global
Applications and
Case Studies

Regions and Networks Favouring UIC60, JIS60, and P60

UIC60 Standard Region

UIC60 rail profile is widely used in Europe, Middle East and most parts of Asia, including India and China, for standardized railway infrastructure.

JIS60 Regional Usage

JIS60 rail profile is primarily used in Japan, supporting the national railway systems.

P60 Adapted Networks

P60 rail is adapted for selected railway networks in China; the slightly modified profile 60N (N for new) has been developed for the Chinese high-speed infrastructure (350 km/h).

Case Studies of Successful Implementations

European High-Speed Rail

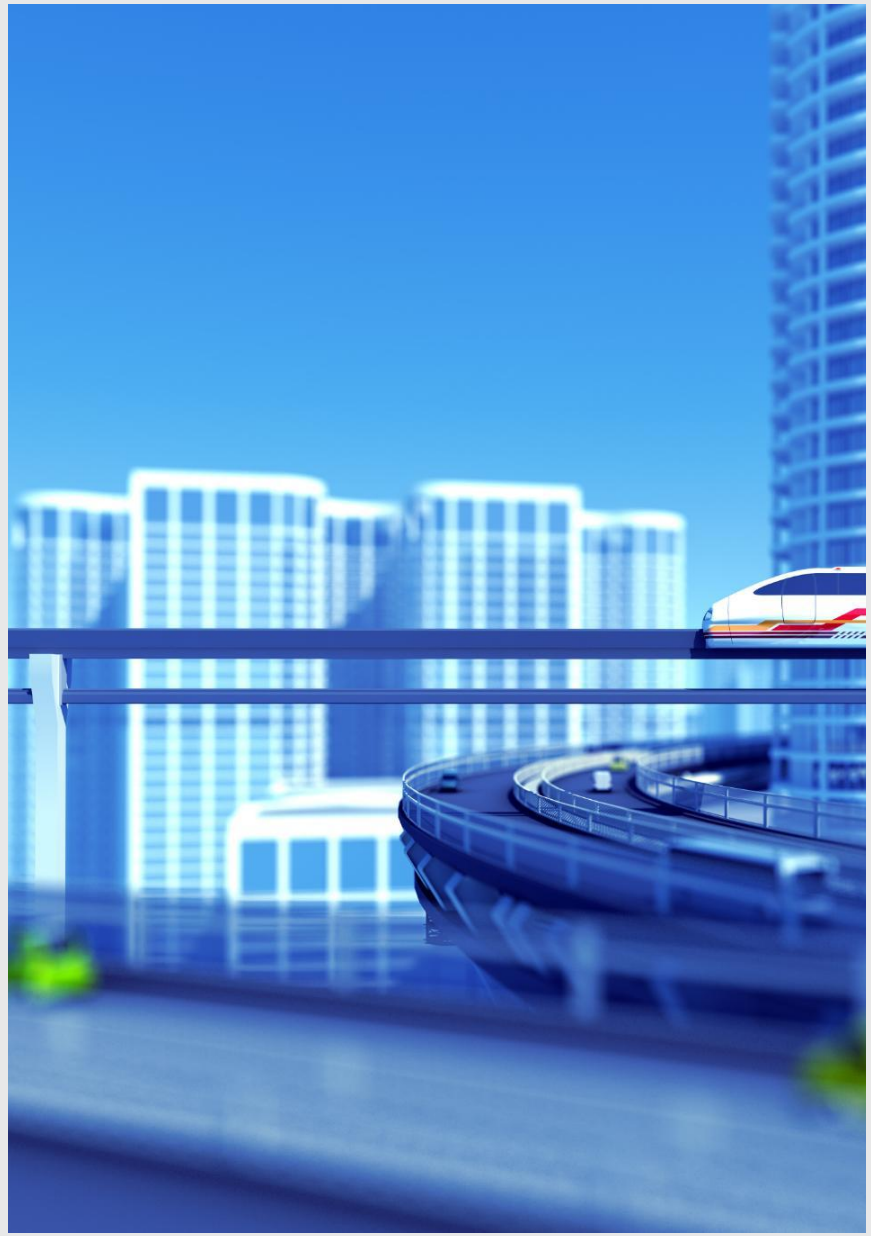
Europe’s high-speed rail utilizes the UIC60 rail profile, enabling efficient and reliable fast train travel. This profile is used in possibly all Indian and Middle East’s Metro railways as well as in China, along with the profile P60.

Japan’s Shinkansen Rail Profile

Japan’s Shinkansen as well as the Japanese metropolitan rail network employ JIS60, for dedicated speed and safety in its rail system.

South American Regional Rail

Regional rail enhancements across South America have adopted the P60 rail profile to enhance durability and operational performance in response to the continent's varied environmental conditions. Nonetheless, the metropolitan rail network in South America remains relatively limited in scope at present.



Challenges Encountered and Lessons Learned

Track Wear Issues

Track wear is a significant challenge impacting railway safety and efficiency, requiring regular monitoring and repair.

Rail Replacement Costs

High rail-replacement costs necessitate budget-conscious strategies and effective planning to maintain infrastructure.

Profile Adaptation for Rolling Stock

Adapting track profiles to new rolling stock designs ensures compatibility and smooth operation across regions.

Tailored Maintenance Plans

Customized maintenance plans effectively address regional challenges and extend the lifespan of railway assets.

The global prevalence of UIC60 and JIS60 is a pertinent topic for analysis by Artificial Intelligence.

Google

are UIC rail profiles more common than JIS rail profiles?

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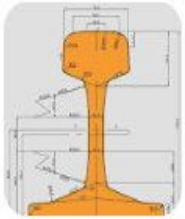
AI Overview

Yes, UIC rail profiles are generally more common than JIS rail profiles, particularly in mainline railway systems and high-speed rail networks worldwide. While JIS (Japanese Industrial Standard) rails are prominent within Japan, UIC (International Union of Railways) standards are more widely adopted internationally.



Here's why:

Global Adoption:

UIC standards, especially the UIC60 profile, are a de facto standard for many high-speed and heavy-haul railway lines globally, making them more prevalent.

International Union of Railways (UIC):

The UIC is a global organization that sets unified railway standards, promoting interoperability and facilitating international train travel.

High-Speed Rail:

UIC60 is a common profile for high-speed railway lines, further contributing to its widespread use.

JIS in Japan:

JIS standards are primarily used within Japan, with some limited use elsewhere, making them less common globally.

Technical Properties:

UIC60 rails are known for their good comprehensive mechanical properties and suitability for complex stress situations on railway lines, according to a rail parts provider.

Summary

The 60E1 (UIC60) rail profile is the global standard for 60 kg/m rails due to its balanced strength, durability, and versatility. Its widespread use and comprehensive EN 13674-1 documentation make it the most common rail type in its class. Maintained by the International Union of Railways, the 60E1/UIC60 profile is trusted for a wide range of railway applications worldwide.

Asset management

Asset lifecycle renewal is central to asset management, requiring timely replacement of equipment. Effective parts inventory management ensures spare parts are available for repairs, while minimizing excess stock. MRO (Maintenance Repair Operation) teams must balance inventory levels to avoid shortages and reduce costs.

This approach:

- Simplifies parts ordering for scheduled maintenance
- Maintains compatibility with current assets
- Monitors component lifespans for timely replacements
- Facilitates bulk purchasing to lower costs
- Standardizes components across assets for interchangeability

Standardization and Harmonization Efforts

Rail Profile Harmonization

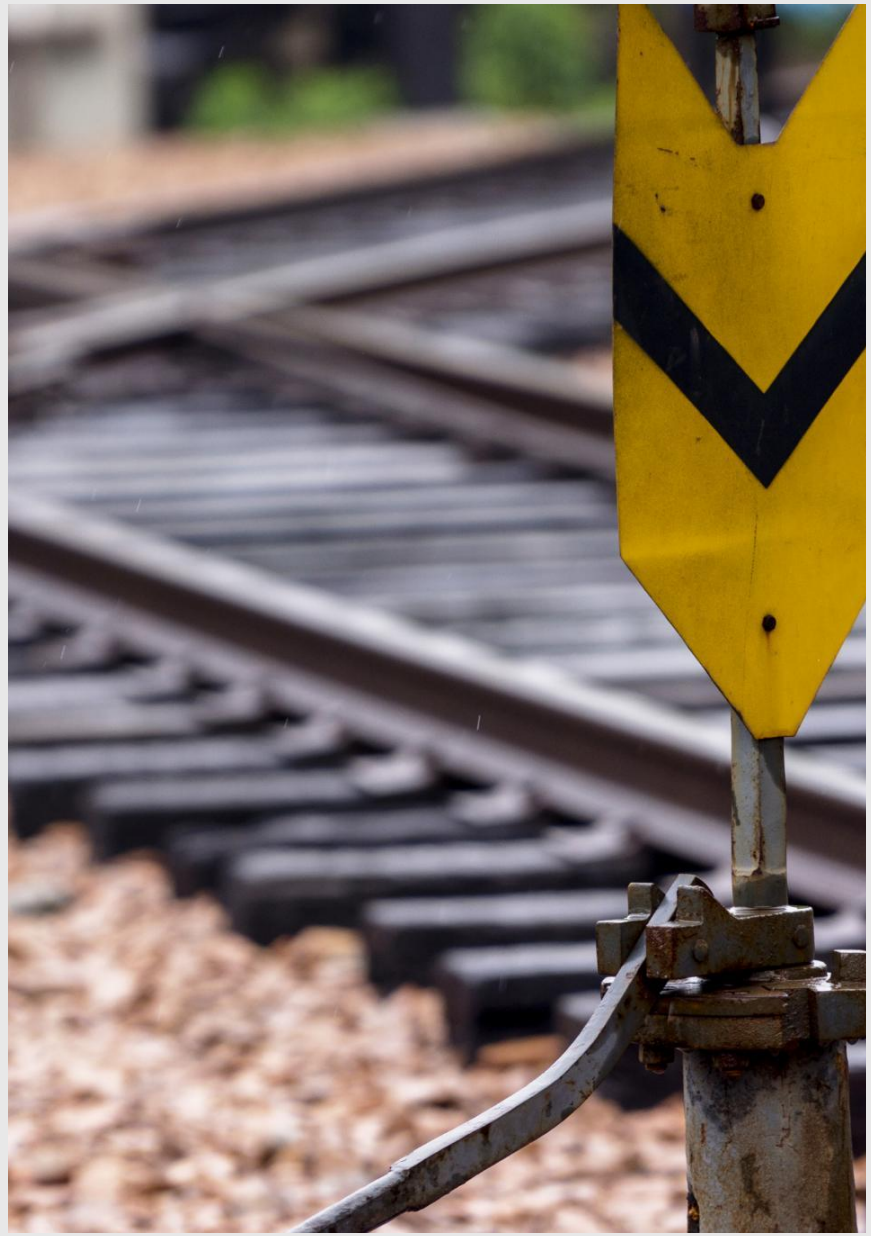
Harmonizing rail profiles promotes interoperability across different railway lines.

Cost Reduction Benefits

Standardization reduces manufacturing and maintenance costs by streamlining parts and processes.

Innovation Facilitation

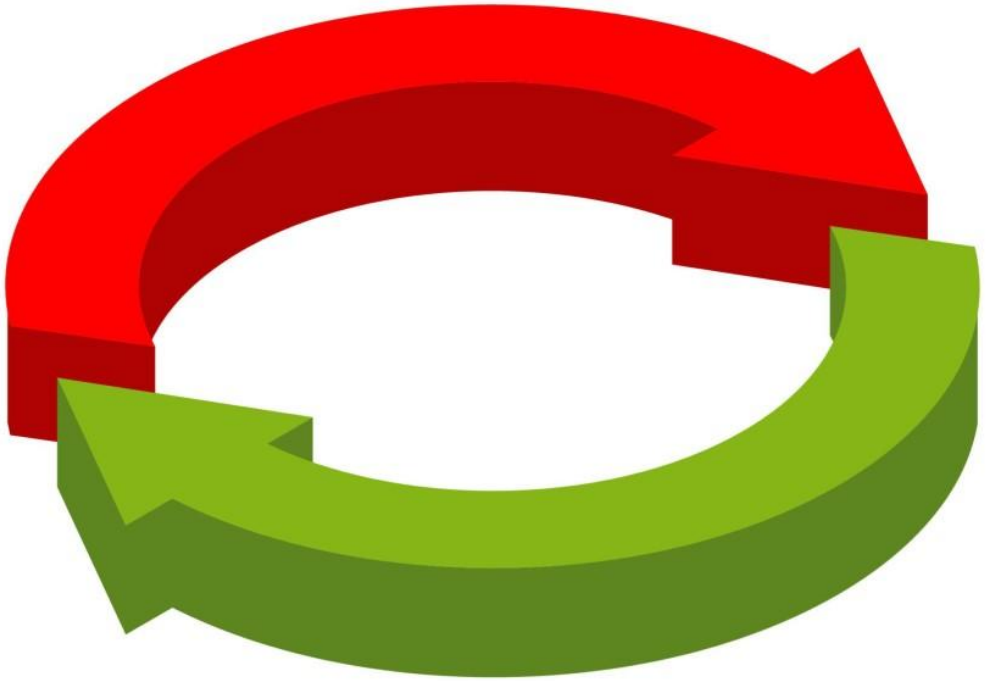
Globally established standards foster innovation by enabling consistent development and deployment of new technologies.



Interchangeability

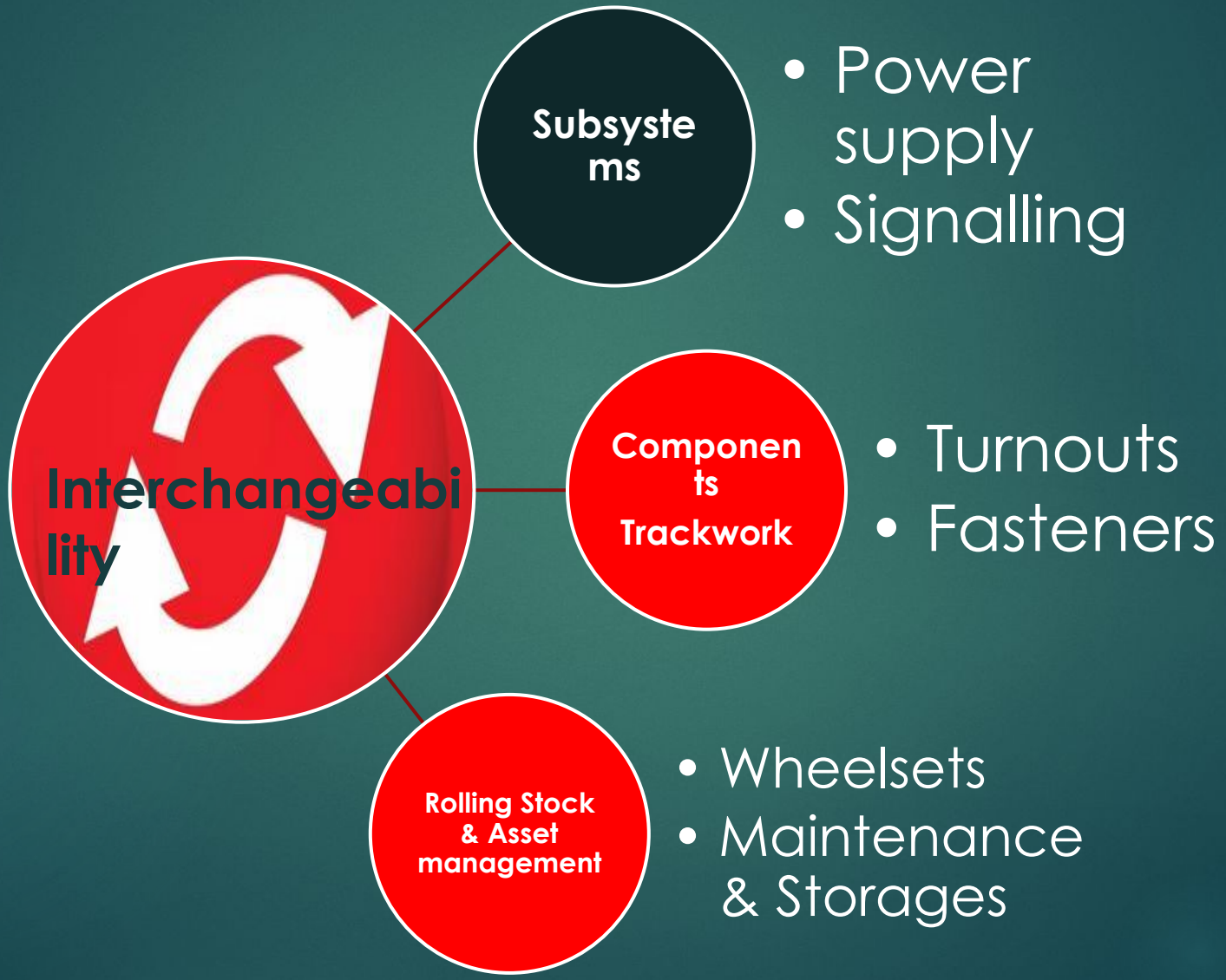
Simplifying Complexity in Modern Industries and Organizations

Interchangeability



- Interchangeability refers to the ability of items, parts, or systems to be substituted for one another without compromising functionality or performance. It implies that two or more components can be exchanged or replaced without needing any alteration to the items themselves or surrounding parts, except for minor adjustments.
- In manufacturing, interchangeable parts allow for mass production and easy replacement of components. For example, standardized screws or bolts that can be used in various machines.

Different rail profiles affect the interchangeability of relevant components (red colour).



- Power supply
- Signalling

- Turnouts
- Fasteners

- Wheelsets
- Maintenance & Storages

CONCLUSION

Unique Rail Profiles

UIC60, JIS60, and P60 rail profiles suit different railway needs, but UIC60 (60E1) stands out as the leading standard in the 60 kg/m category. It is widely used for heavy haul, high-speed, mainline railways, and metro lines globally.

Informed Infrastructure Decisions

A thorough understanding of rail profile specifications and their applications is essential for effective railway infrastructure planning. This knowledge facilitates asset compatibility, streamlines maintenance procedures, reduces the need for spare parts, and ultimately contributes to cost optimization.

Future Railway Developments

Upcoming innovations are designed to improve rail system performance and foster interoperability across networks. To achieve these objectives, it is essential to select norms and standards that undergo ongoing development and rigorous application testing.


Thank