



# Under Sleeper Pads

Sustaining Lifetime Value of the Railway

**PANDROL**

Partners in excellence



# What is an Under Sleeper Pad



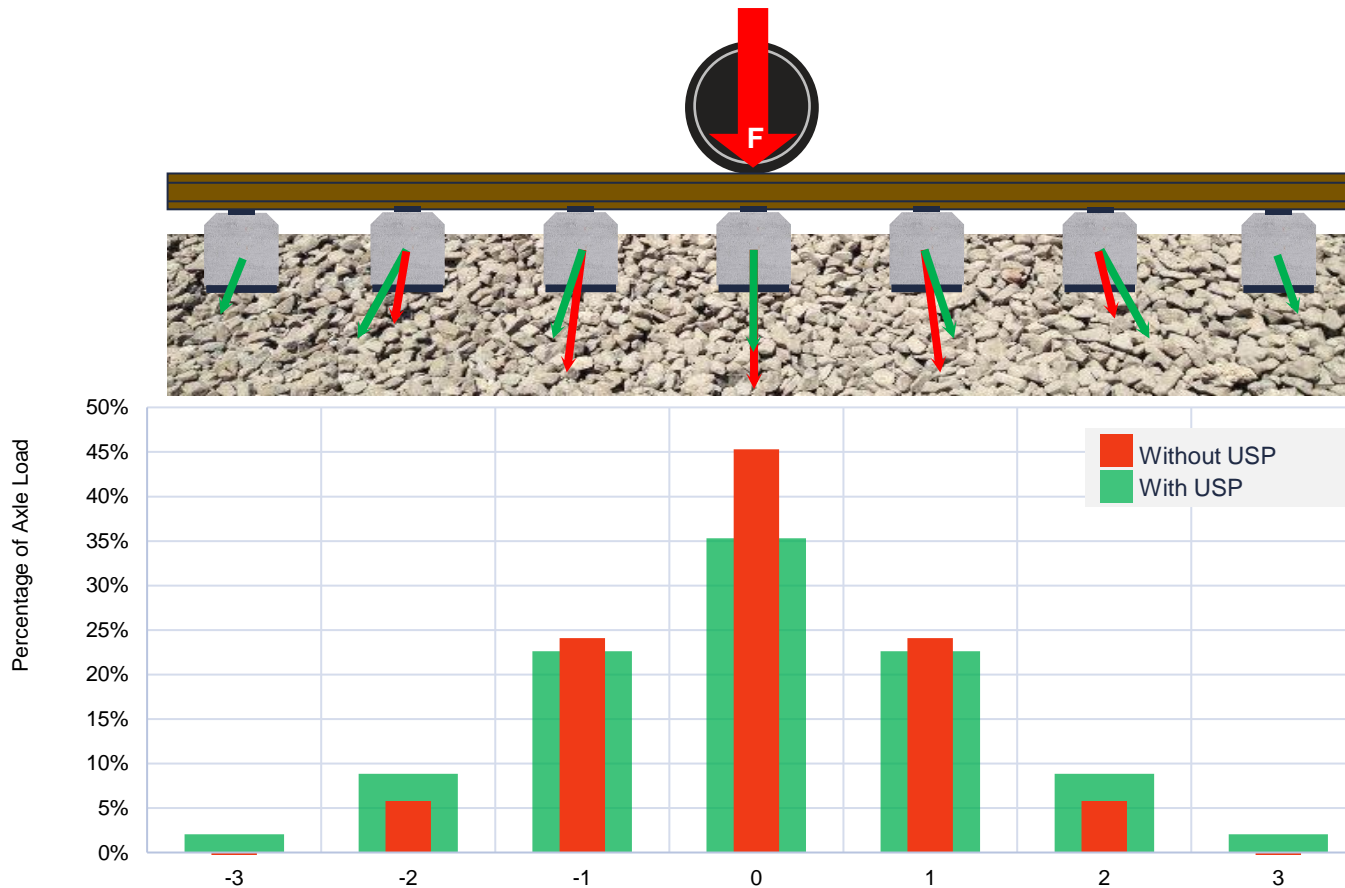
Under Sleeper Pads (USPs) are elastic elements placed on the underside of Sleepers, designed to add an additional layer of resilience into the track.



# How do Under Sleeper Pads Work: Elasticity



Increasing elasticity of the track, leading to improved force distribution along its length



For a 225 kN Axle load

Peak Rail Seat force:

**Without USP  $\approx 50,6\text{kN}$**

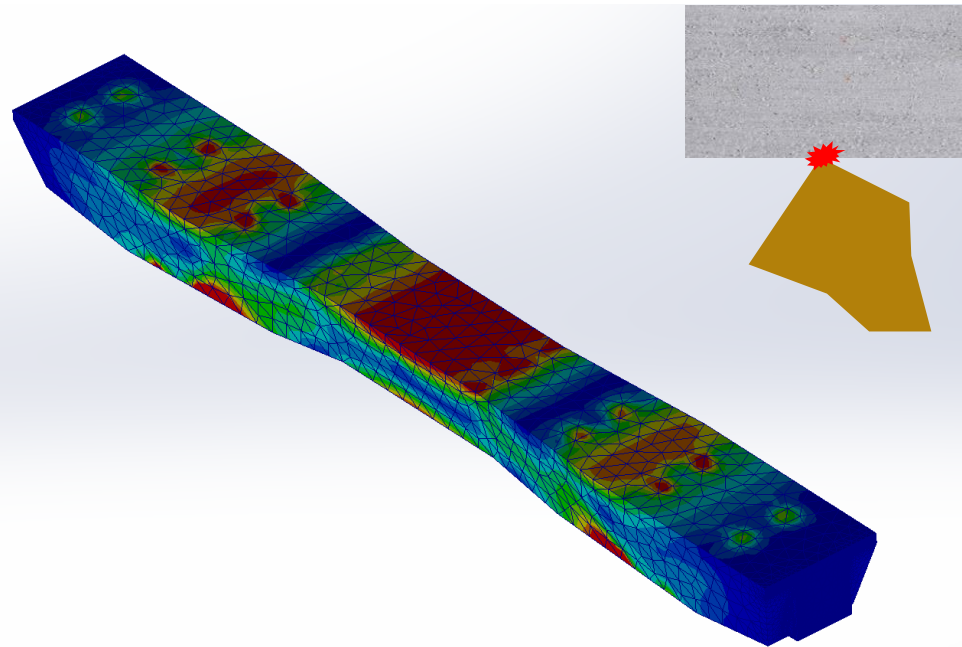
**With USP  $\approx 39,4\text{kN}$**

# How do Under Sleeper Pads Work: Contact Area



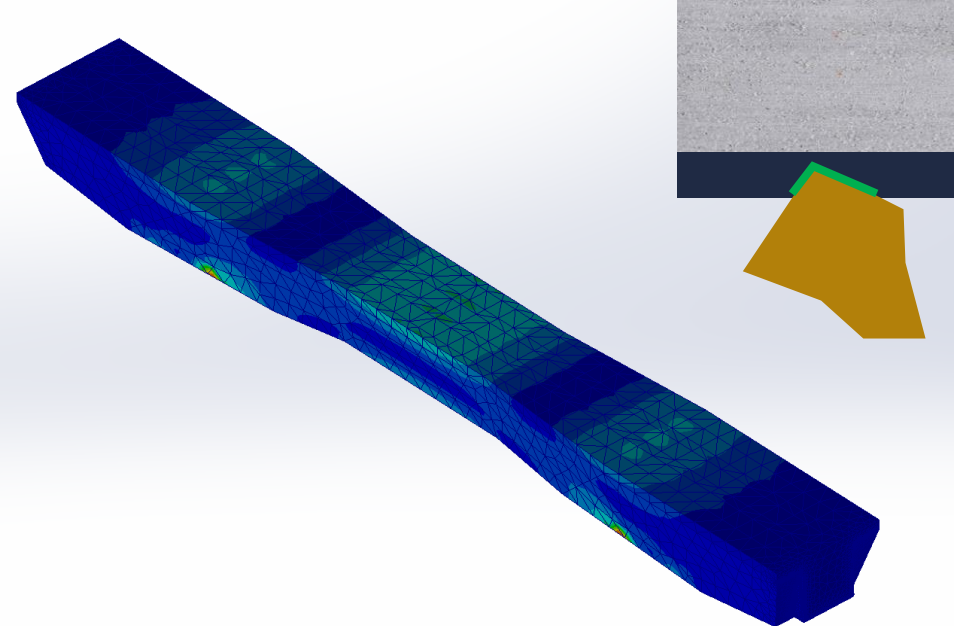
Increasing contact area between the sleeper and ballast, reducing contact pressure

Without USP:  
4 - 8% Contact



Contact pressure ~ 5 MPa

With USP:  
~ 30% Contact



Contact pressure ~ 0,5 MPa

Sleeper

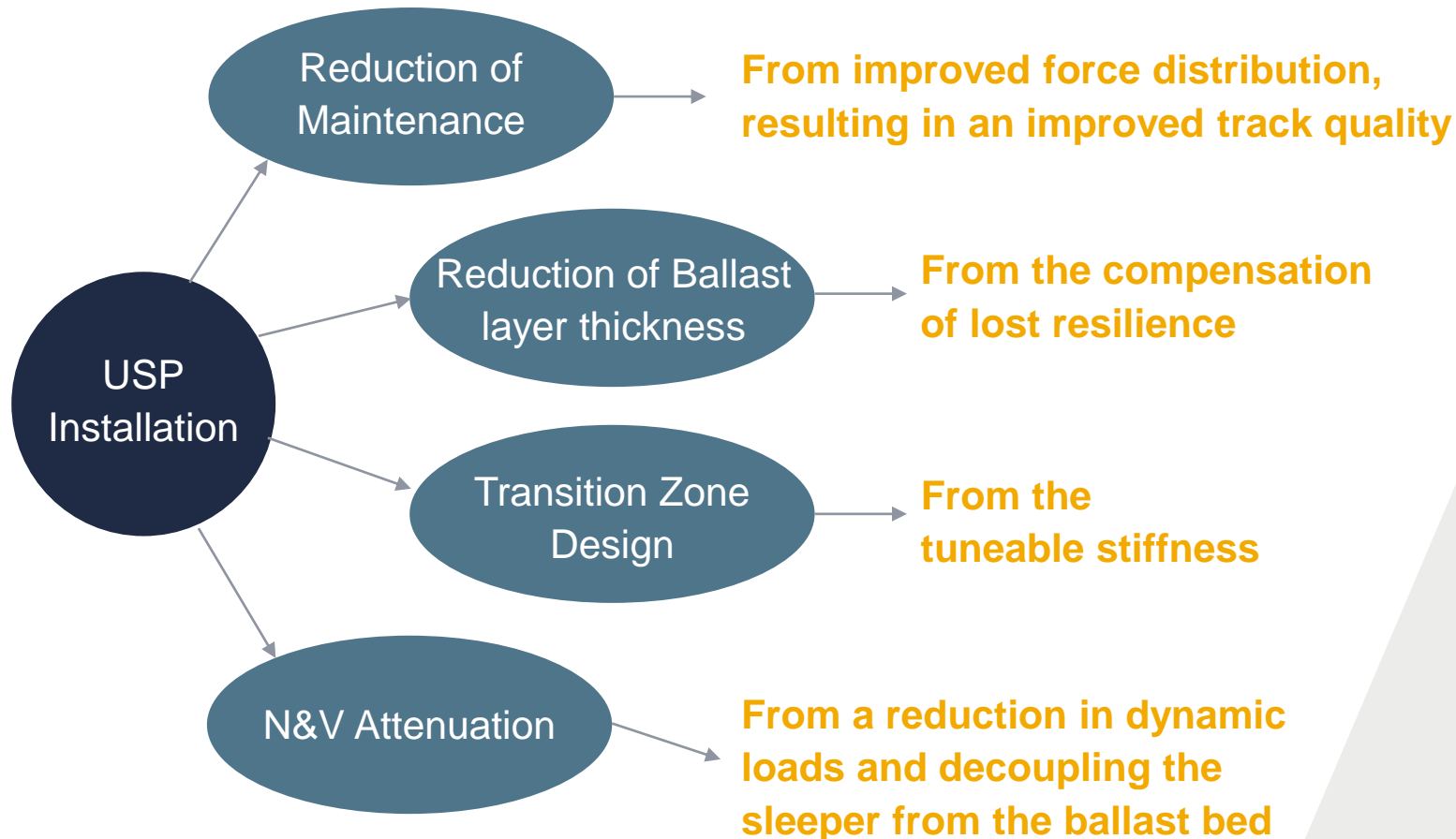
USP

Ballast Stone

# What are the benefits of installing an Under Sleeper Pad?



Under Sleeper Pads can be used in a variety of different scenarios, providing numerous tangible benefits to the track depending on their stiffness, such as:



## Current Market Trends



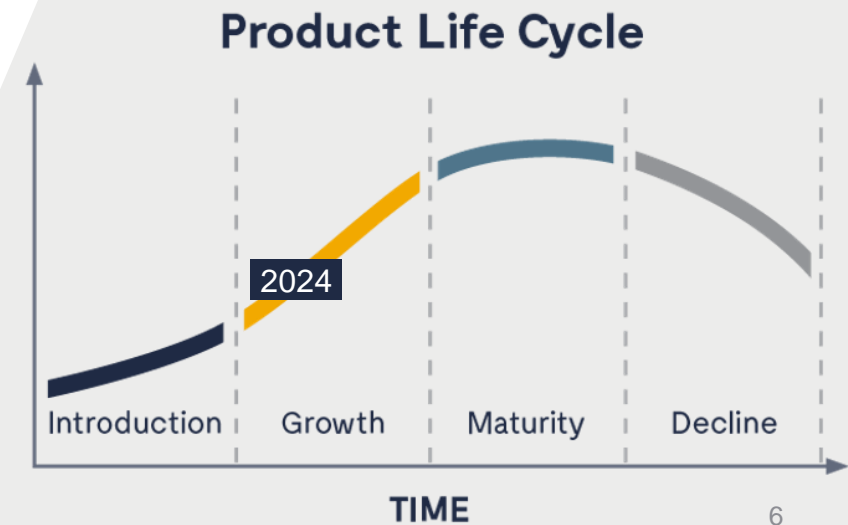
At their conception, USPs were typically installed as a means to mitigate noise and vibration.

Now, many Networks are recognising the biggest advantage of this technology is the improvement to long term behaviour of the track.

### According to IRS 70713-1:2019:

- The initial track quality with USPs is 18% higher than without
- Track geometry degradation is reduced by 63%
- LLT (Tamping) Cycle is prolonged by a factor 2,75
- Track lifetime is extended by a factor 1,6

When considering the product life cycle, we can consider USPs to be beginning their **growth**:

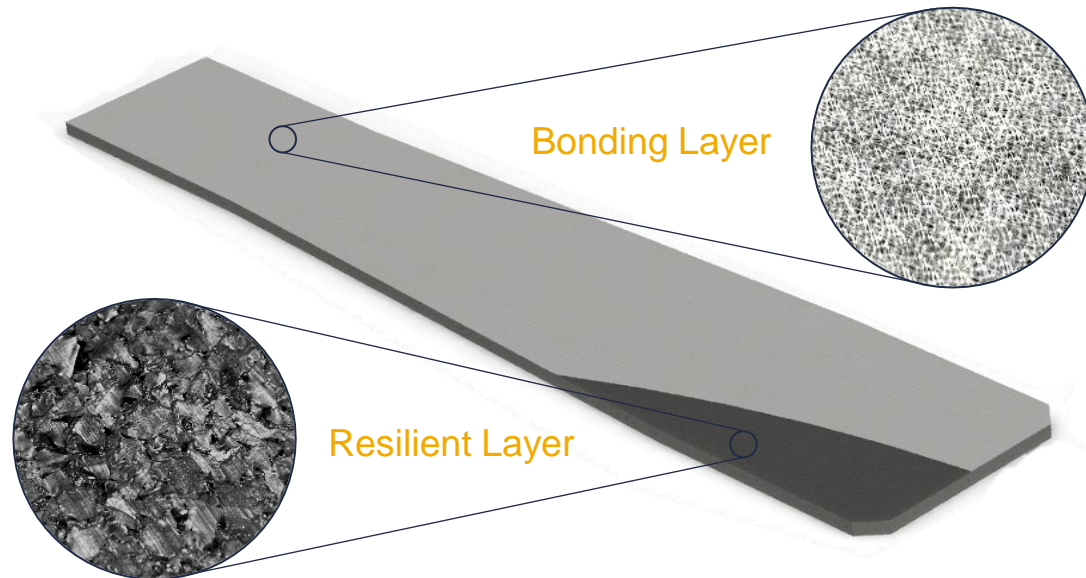


# The Pandrol USP Solution: Overview



Pandrol USPs are composed of two layers:

- **Resilient Layer:** Providing the static and dynamic properties (stiffness) of the pad
- **Bonding Layer:** Providing fixation onto the Sleeper



# The Pandrol USP Solution: Resilient Layer

The resilient layer of Pandrol USP solutions is constructed from **PRR (Pandrol Recycled Rubber)** material:

Resilient properties are defined by fine tuning the following aspects:

- Origin/type of the granules
- Granule dimensions
- Binder type and content
- Density of the final product
- Thickness of the final product



## Key Question

Why have car tyres been made from rubber since the late 1800s?

To increase contact area between the tyre and road surface  
→ the fundamental principle of USPs in ballast!



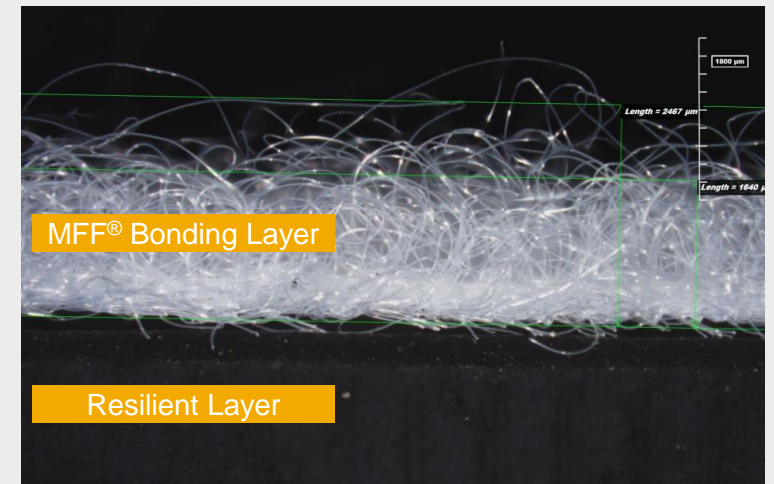
# The Pandrol USP Solution: Bonding Layer



Pandrol USP MFF® is a patented technology for the bonding of USPs to Sleepers

This technology is used in all cases where the USP is installed on fresh concrete during Sleeper production

Pandrol USP MFF® technology achieves an industry standard bond strength, even with very minimal embedment into the concrete



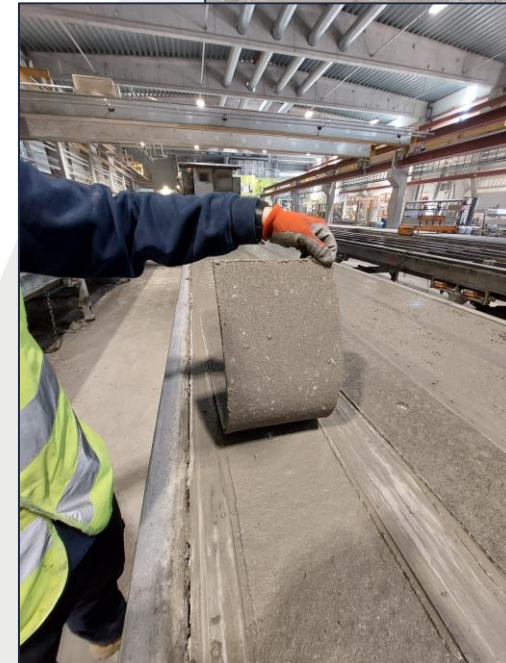
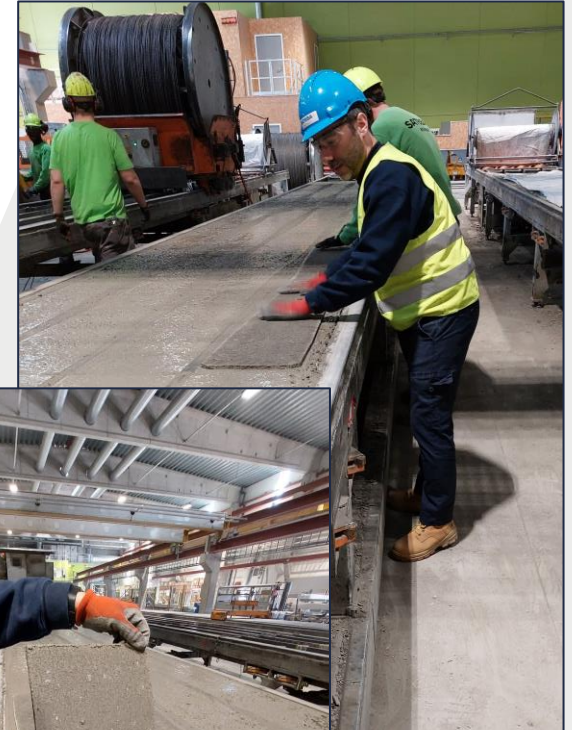
# The Pandrol USP Solution: Installation



With use of Pandrol USP MFF® technology, USPs are installed onto fresh concrete during sleeper production.

This technology is compatible with all concrete types, and requires minimal extra processing to install.

Just a light tap by hand is sufficient to ensure full bonding of the USP, without the need for additional vibration.



[Video](#)

# Growth of rail transport and pathway to net zero emissions

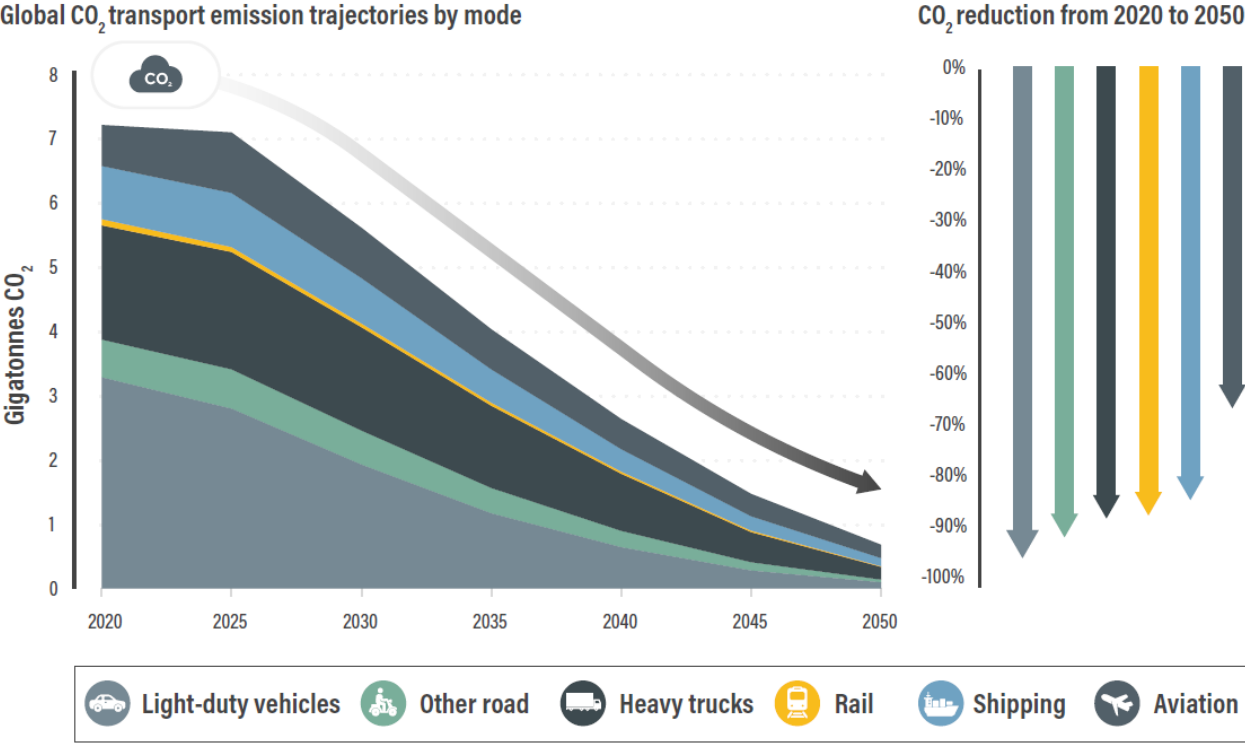


## The big challenges:

- With **urban-dwellers predicted to account for 75% of the global population by 2050**, urban rail transport is critical to help cities grow successfully.
- At the same time, even rail being today one the most sustainable modes of transport, it must **decrease its CO<sub>2</sub> emissions by 85%** in order to reach IEA net zero emissions scenario by 2050.

**FIGURE 9.** Global CO<sub>2</sub> transport emission trajectories by mode required to achieve IEA net zero emissions scenario

Source: See endnote 87 for this section.





# Growth of rail transport and pathway to net zero emissions



## Pandrol response through integral development approach

### Pandrol Recycled Rubber

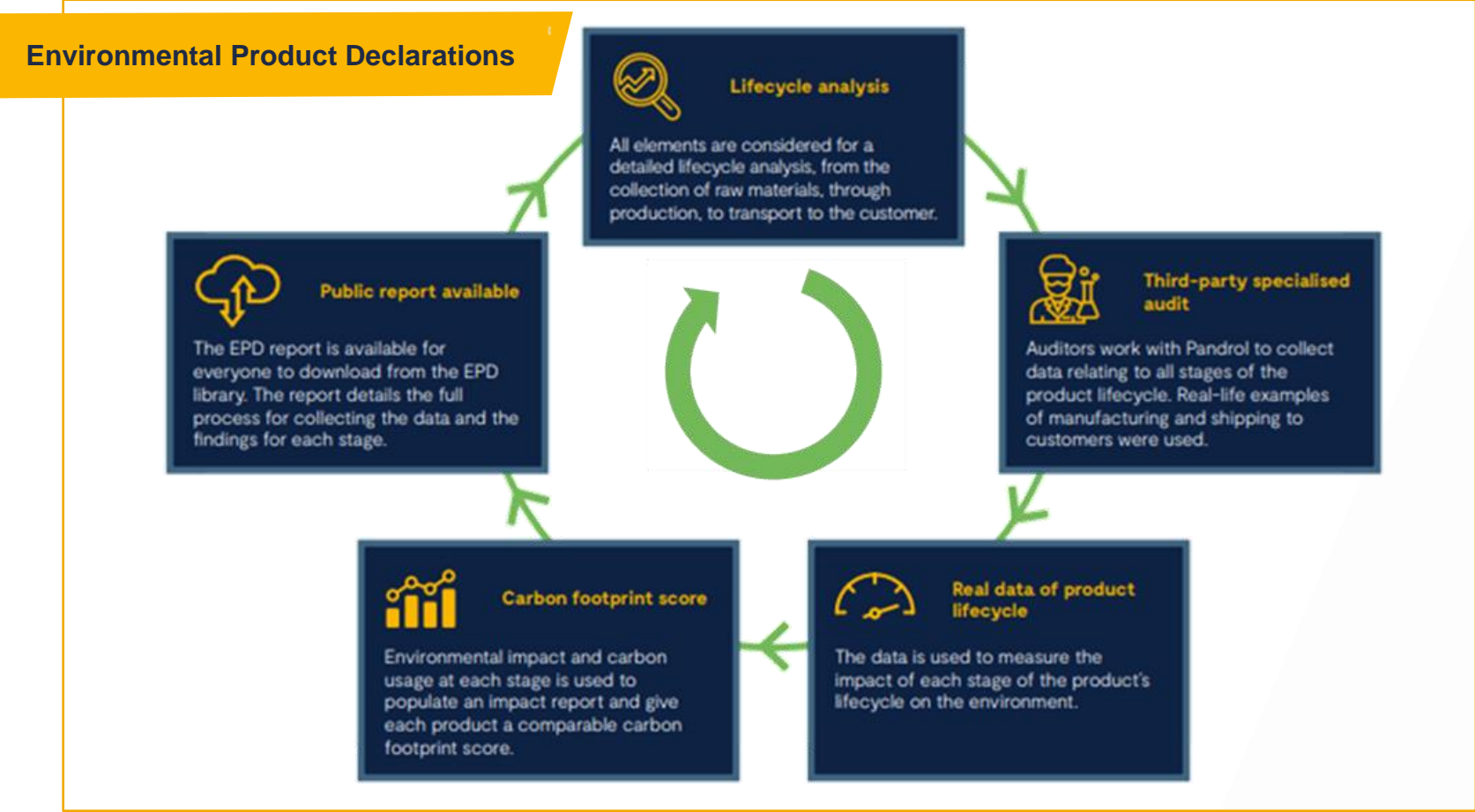
- **Core material**
  - Tyres = made of an engineered and **reliable material** used worldwide on a daily basis for any road traffic
  - End-of-Life tyres = because of wear (friction vs ground), not because of properties change
- **Resilient properties are defined by fine-tuning and research of the following aspects**
  - Origin/type of the granules
  - Granule dimensions
  - Binder type and content
  - Density of the final product
  - Thickness of the final product
- **Fully compliant systems**
  - **Continuous QC monitoring**
  - **EN fully tested**
  - Experienced in major rail networks
  - For all Track Loads & Applications
  - References for > **25 years** of service life across the globe
  - Dedicated engineering teams supporting



# Growth of rail transport and pathway to net zero emissions



## Pandrol response through integral development approach





# Life Cycle Analysis of USPs

## Recap of IRS 70713-1:2019:

- The initial track quality with USPs is 18% higher than without
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## Key Feedback from Networks with Pandrol USP:

- Infrabel (BE):
  - Pandrol USP reduces by a factor 2 rail corrugation
  - Ballast layer thickness can be reduced to 200 mm with Pandrol USP installed
- Amtrak (USA):
  - 300 - 400 MGT without tamping with Pandrol USP installed (factor 10 extension)

*To help our partners assess better the role of USPs, Pandrol proposes an LCC calculator based on each network track parameters*

# Pandrol LCC Calculator – Example



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**LIFE CYCLE ANALYSIS**  
LCC Example  
Heavy Freight  
Pandrol USP-R-07e

**Introduction of Pandrol USPs into the track:**  
Increases its lifetime value due to an extension of life cycle with reduced maintenance efforts  
Significantly reduces its carbon footprint throughout this extended life

**Calculation description and summary**  
The following pages detail calculations of both financial and environmental aspects of track equipped with Pandrol USPs, in comparison to plain, unpadded track. Factors for track improvement due to USP, plus financial and environmental data are based on numerous sources of which can be provided on request. All calculations are carried out per km of line (two tracks)

Environmental Savings  
In terms of pure CO<sub>2</sub>

Without USP: 3,145.20 ton CO<sub>2</sub>/km line  
With USP: 2,016.21 ton CO<sub>2</sub>/km line  
Savings: 1,129 ton CO<sub>2</sub>/km line saving

Financial Savings  
In terms of both CO<sub>2</sub> and track costs

Without USP: 1,888,920 €/km line  
With USP: 1,287,944 €/km line  
Savings: 600,976 €/km line saving  
Carbon costs: 110.077 €/km line saving  
Track costs: 196,580 €/km line

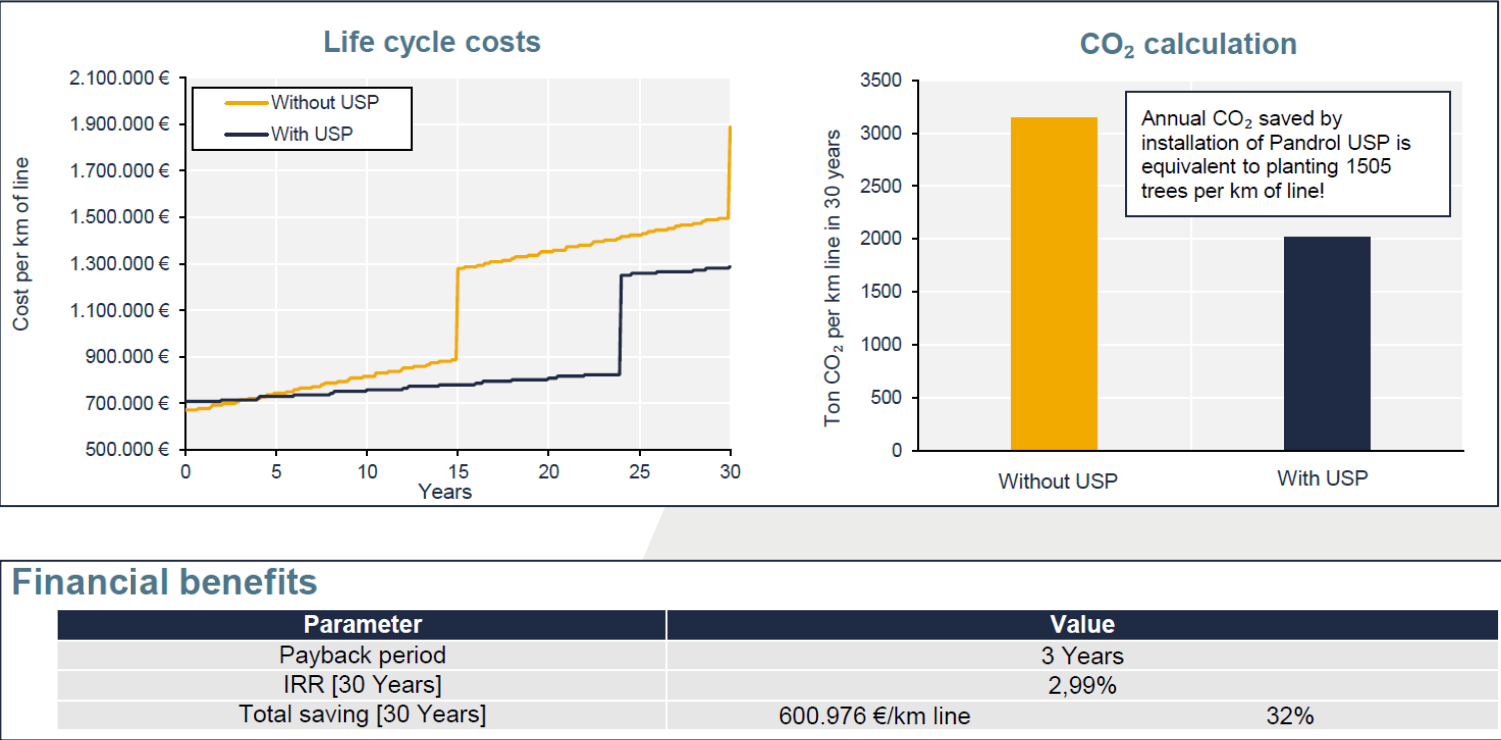
Over a period of 30 years, introduction of USP-R-07e into this track could save:

36 % cumulative emissions

32 % cumulative cost

LIFE CYCLE ANALYSIS | LCA-Heavy Freight-USP-R-07e-20220705-EN | 21 June 2023  
Pandrol N.V., Tervurenweg 50, 1550 Houtven, Belgium

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# Conclusions



- The addition of Pandrol USPs into the track significantly increases its quality, leading to:
  - *Extended Lifetime of the track components*
  - *Reduction in Maintenance*
  - *Greater Line Availability*
  - *Lower GWP associated with the track*
- Pandrol go above and beyond the mandated EN testing, providing in-track stiffness performance of their systems
- The use of recycled rubber for USPs offers a unique value proposition, with benefits to both direct cost and sustainability
- The guaranteed long-term performance of Pandrol USPs is advantageous to all track types