Diseño integral de soluciones para reducir vibraciones y mejorar la calidad y vida útil del transporte ferroviario

Juan Ignacio Lazcano González

Pandrol / Sustainable Resilien Systems

26 de octubre de 2022

EXPORAIL 2022

Diseño integral de soluciones para reducer vibraciones y mejorar la calidad y vida útil de la vía

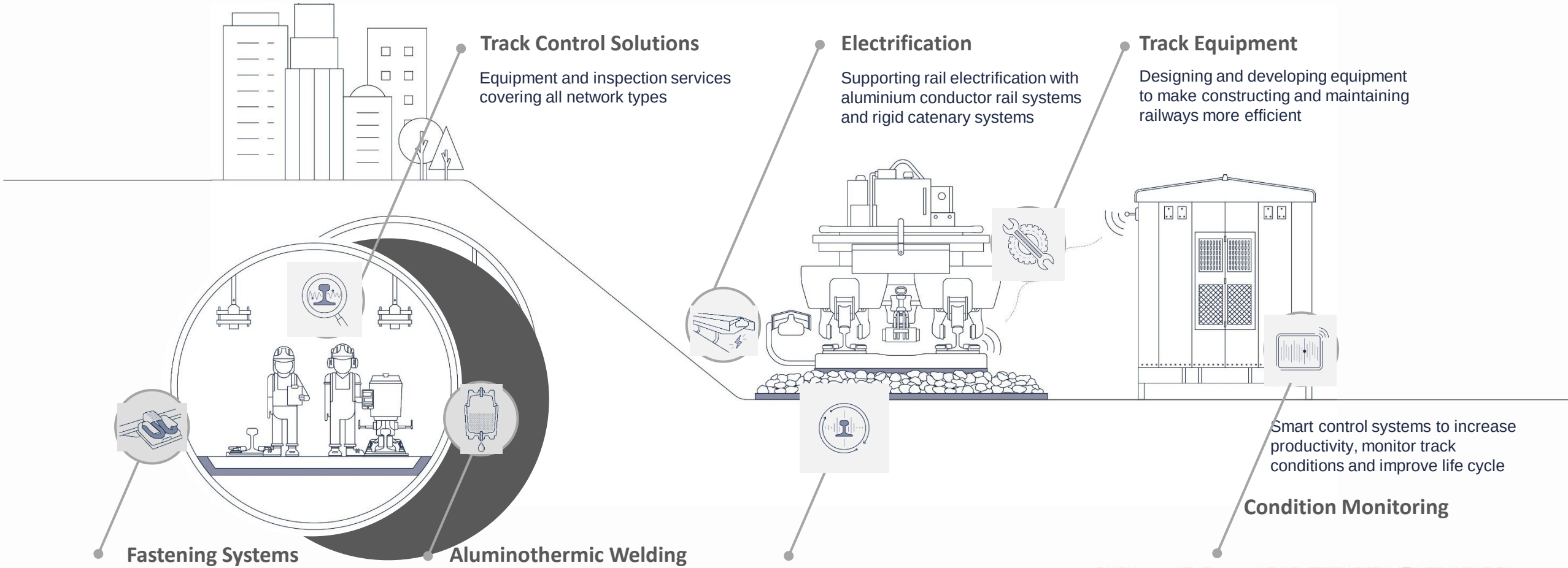
Juan Lazcano

Exporail 2022 – Panel Ruido y vibraciones en la infrestructura ferroviaria

PANDROL

Partners in excellence

Pandrol range of services



Track Control Solutions

Equipment and inspection services covering all network types

Electrification

Supporting rail electrification with aluminium conductor rail systems and rigid catenary systems

Track Equipment

Designing and developing equipment to make constructing and maintaining railways more efficient

Condition Monitoring

Smart control systems to increase productivity, monitor track conditions and improve life cycle

Fastening Systems

Specialist in track engineering, track maintenance and analysis and noise and vibration attenuation

Aluminothermic Welding

Delivering technical expertise, innovative solutions and in-track services

Sustainable Resilient Systems

Environmentally sustainable systems to improve the life cycle of track components and treat structural noise and vibrations

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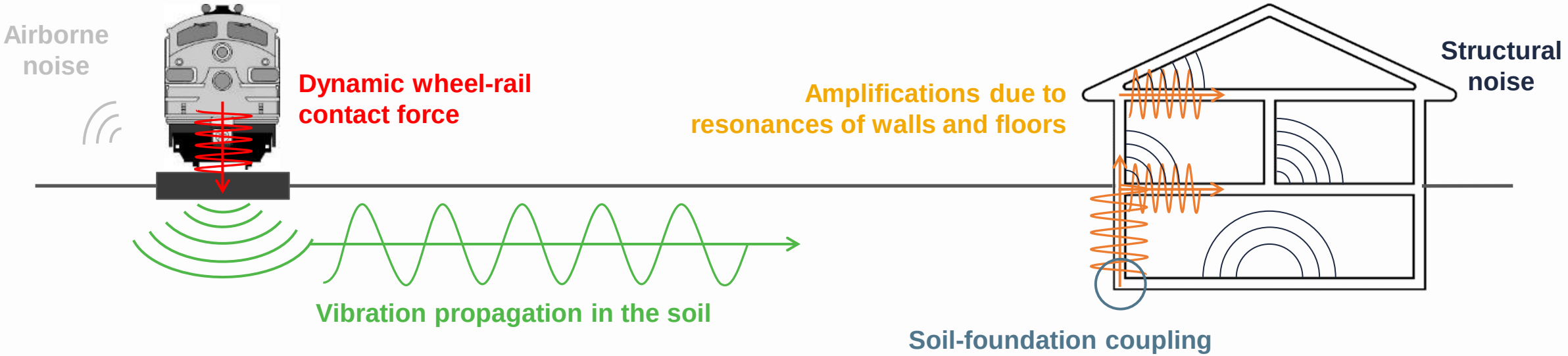
Definiendo el origeng problema: Ruido estructural y vibraciones



Problemas en la vía derivados de un incorrecto diseño de la interacción de componentes ferroviarios

Can be minimised by the implementation of correct resilient supports

Track Degradation

AIRBORNE NOISE

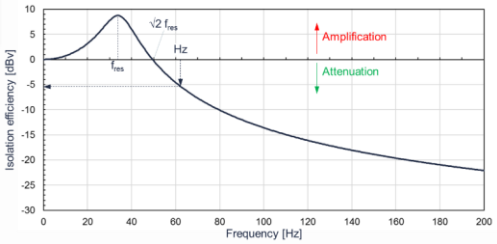
WHEEL-RAIL INTERACTION

VIBRATIONS

STRUCTURAL NOISE

Rail Corrugation

N&V Mitigation



Can be controlled by correct management of track elasticity

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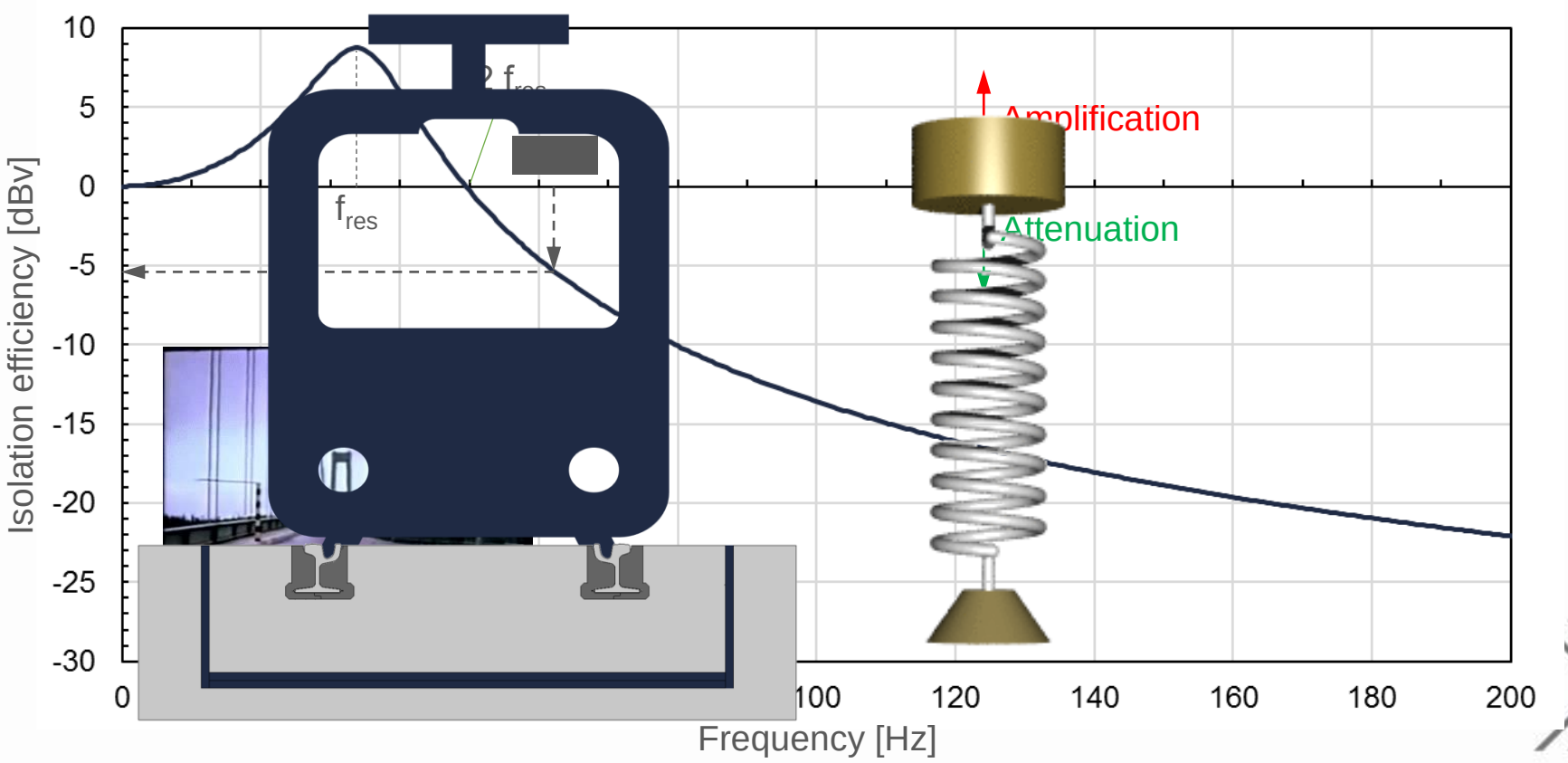
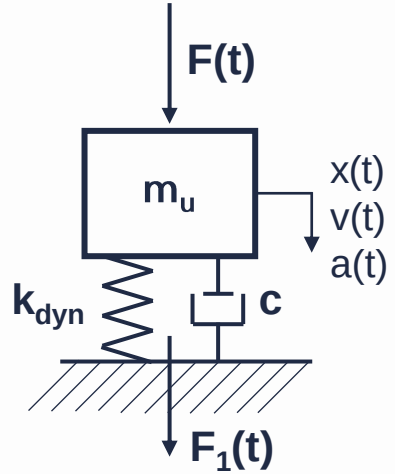
N&V – Track isolation principles

- The track can be simplified as a 1 DOF system consisting in a mass on an elastic medium with specific spring and damping characteristics





$$f_{res} = \frac{1}{2\pi}\sqrt{\frac{k_{dyn}}{m_{unsprung}}}$$

Track Elastic Model (TEM) software

Inputs

PANDROL
Partners in excellence

Track Elastic Model

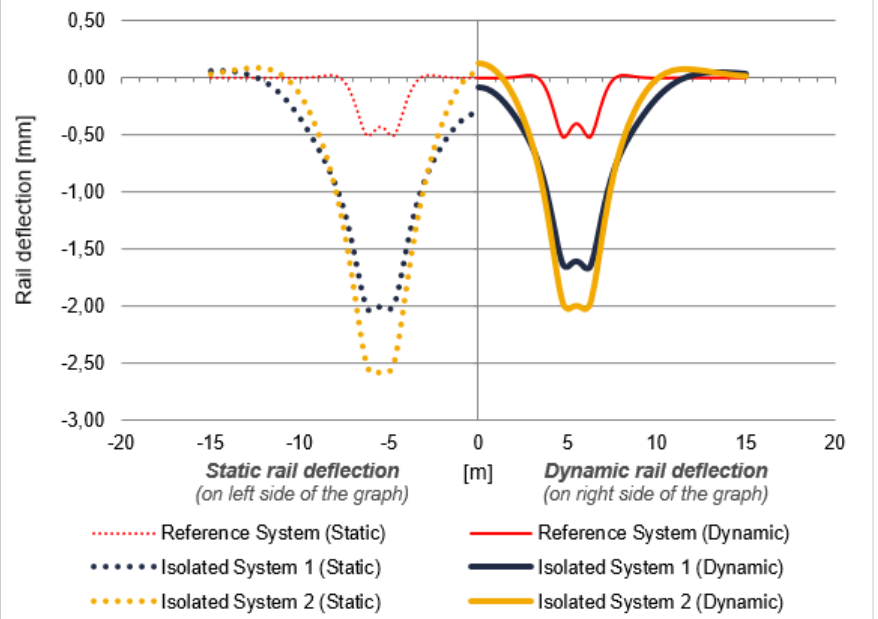
General Project information							
Project Number	300000	Country	Country	Project Name	Project Name	Customer	Customer
Author	___	Date	01/01/2018	Calculation Case	Calculation Case	Program Version	3.1.1
Basic Inputs							
Rolling stock parameters							
Type of rolling stock	Tramway						
	Axle load	120 kN/axle		Unsprung mass coef.	10 %	Bogie-bogie dist.	11,00 m
	Speed	60 km/h		Unsprung mass	1.223 kg/axle	Axle-axle dist.	1,60 m

Track parameters	***Reference System***	***Isolated System 1***	***Isolated System 2***
Given name	Reference System	Isolated System 1	Isolated System 2
Track type	Continuously Supported Embedded Rail	Continuously Supported Embedded Rail	Continuously Supported Embedded Rail
			
Rail type	54G2 (Ri54G2)	54G2 (Ri54G2)	54G2 (Ri54G2)
Spacing fastenings			
Level 1	***ERS*** EN 13146-9 / kstat / kdyn,df / kdyn,vbr [kN/mm/lm]	***ERS*** EN 13146-9 / kstat / kdyn,df / kdyn,vbr [kN/mm/lm]	***ERS*** EN 13146-9 / kstat / kdyn,df / kdyn,vbr [kN/mm/lmr]
	QT-SP-S C 90,0 120,0 150,0	QT-SP-R C 80,0 110,0 130,0	QT-SP-R C 80,0 110,0 130,0
Level 2			
Level 3			
	FSM/FSP horizont.	***FSM/FSP horizont.*** DIN 45673-7 / Cstat / Cdyn,df / Cdyn,vbr [MN/m³]	***FSM/FSP horizont.*** DIN 45673-7 / Cstat / Cdyn,df / Cdyn,vbr [MN/m³]
	Nothing C	FSM-L13 C 9 15 21	FSM-L13 C 8 14 21

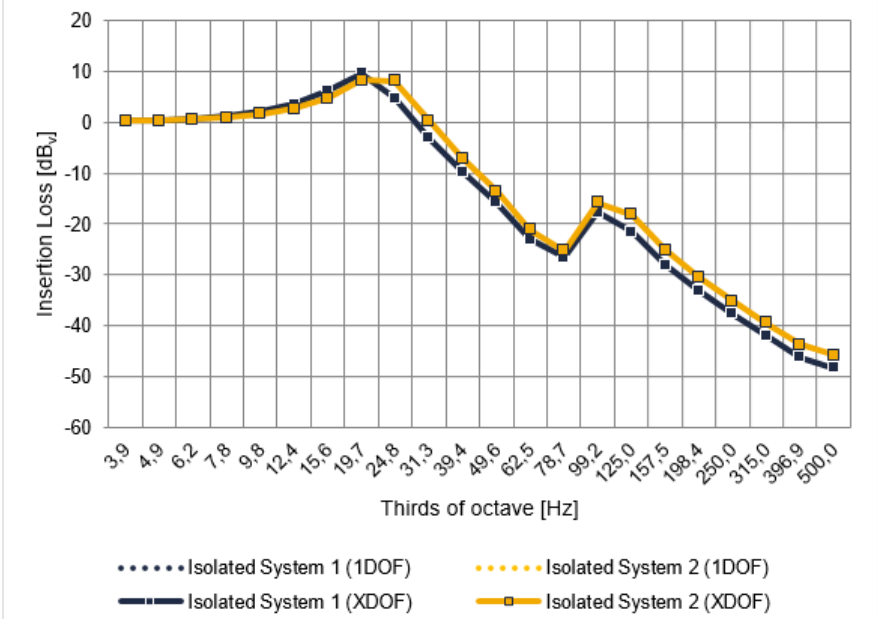
Track Elastic Model (TEM) software

Outputs

Rail deflection



Insertion Loss



Eisenmann parameters for dynamic deflection calculations

Standard deviation, t	3,0	2,0	2,0
Track condition, φ	10 %	10 %	10 %
Dyn. Amplication Factor	1,30	1,20	1,20

Equivalent track stiffness *(seen by one single axle)*

Static	235,15 kN/mm	58,61 kN/mm	46,27 kN/mm

Total deflection at rail head

Static	0,51 mm	2,05 mm	2,59 mm
Dynamic	0,52 mm	1,66 mm	2,03 mm

Results vibration

			1DOF	XDOF	1DOF	XDOF
First resonance frequency				20,3 Hz		22,7 Hz
Insertion loss at		80 Hz		-28,2 dB_v		-26,7 dB_v
Insertion loss between	30	and 150 Hz		-19,9 dB_v		-17,5 dB_v

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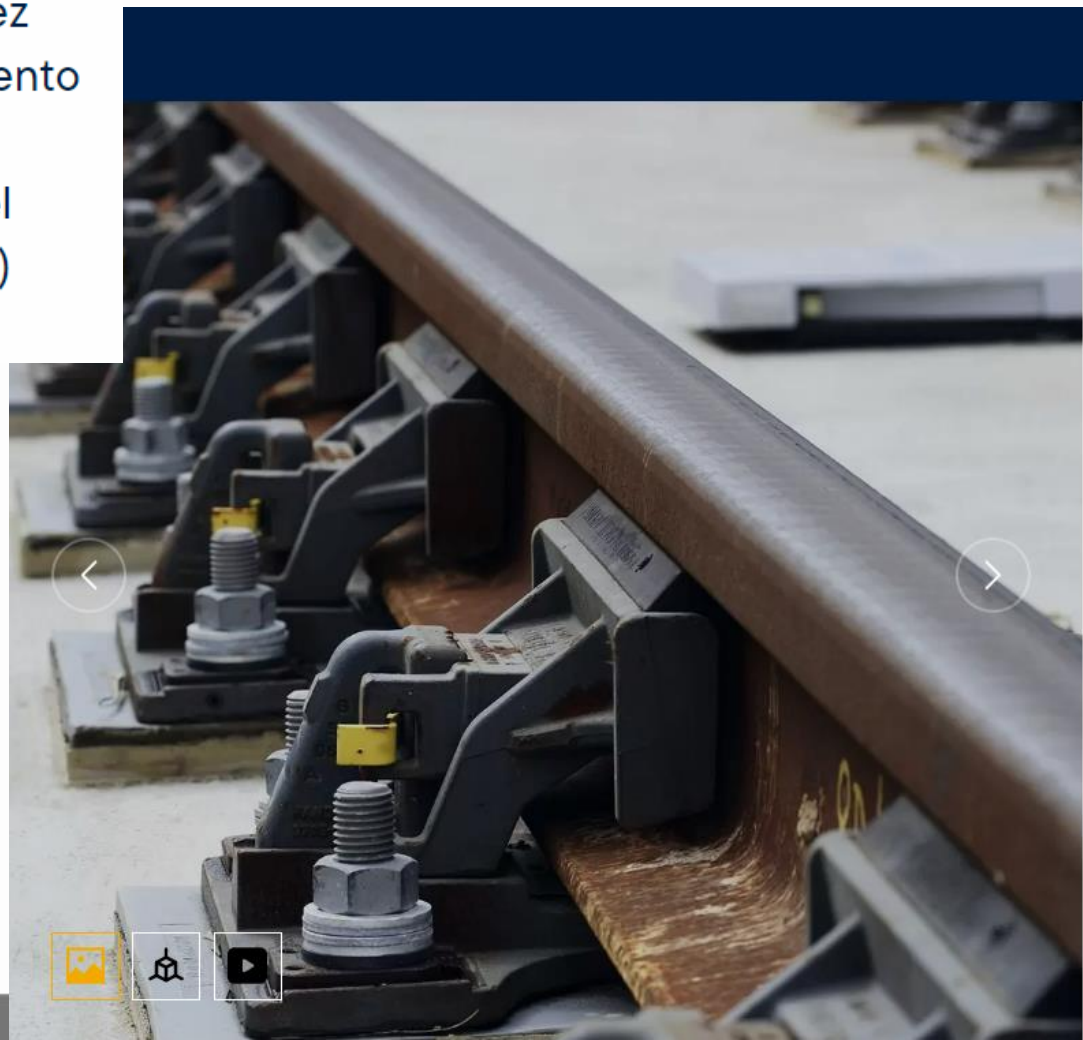
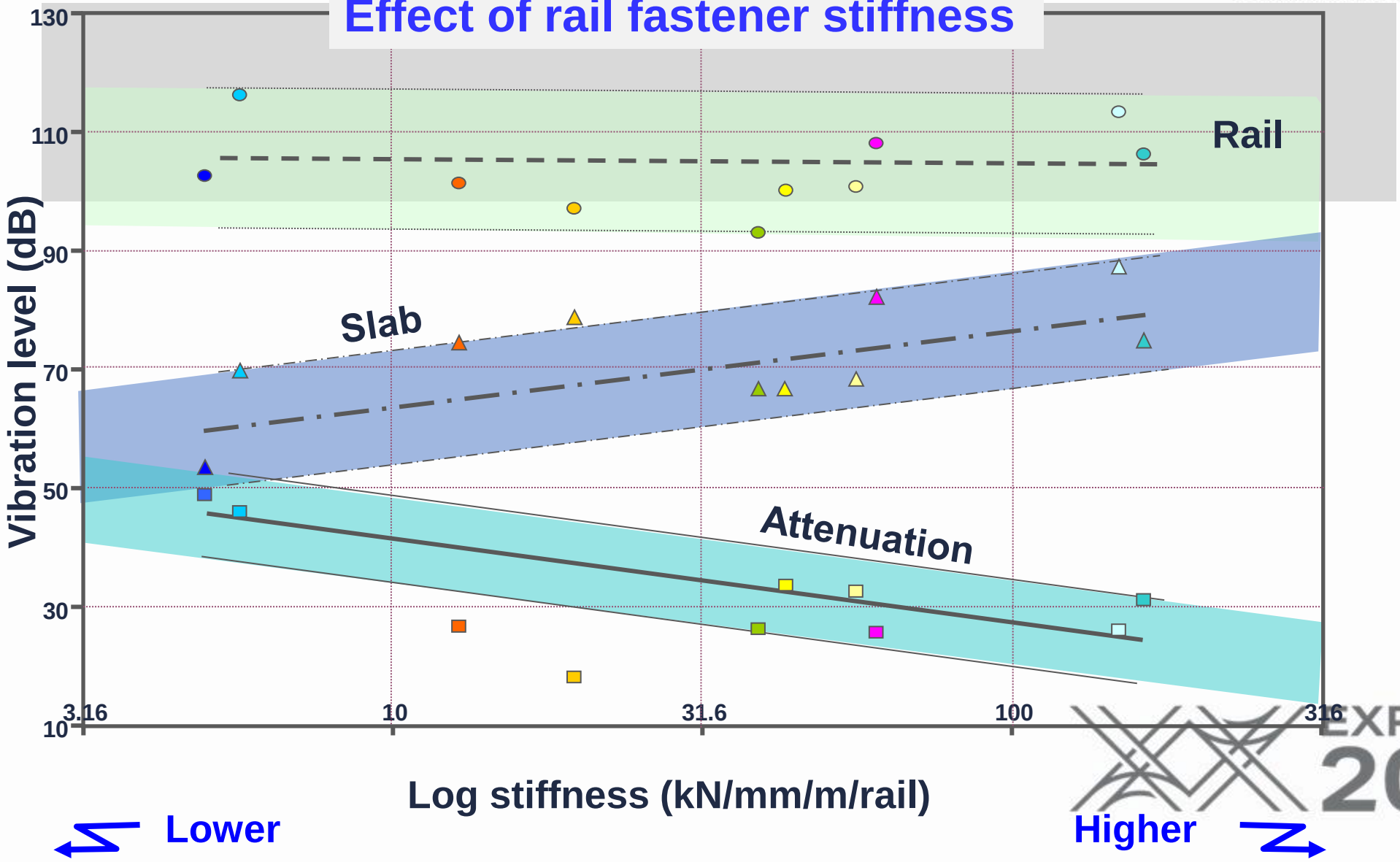
Pandrol: Fijación Vanguard

Vanguard constituye el sistema de fijación ideal cuando es preciso reducir la transmisión de vibraciones y ruido de la vía a los edificios próximos. Este sistema logra este objetivo al proporcionar una rigidez vertical excepcionalmente baja y, por tanto, un alto nivel de aislamiento de las vibraciones entre el carril y la placa de vía o la traviesa (durmiente). Al mismo tiempo, no pone en compromiso el control del movimiento lateral de la cabeza del carril y del ancho de vía (trocha) dinámico.

- El sistema Vanguard se puede suministrar en una diversidad de configuraciones, incluidos diferentes niveles de rigidez, tipos de anclajes y posiciones de anclaje
- Se pueden realizar ajustes laterales y verticales de la posición del carril. Las configuraciones estándar con pernos de anclaje habitualmente permiten +/-20mm de ajuste lateral por carril y un rango de ajuste vertical de 30 mm
- En comparación con muchos otros sistemas de fijación de baja rigidez, el sistema Vanguard queda montado en una posición baja en el carril respecto al plano superior de la placa de la vía o de la traviesa (durmiente).
- Frecuencia natural de aproximadamente 20-25 Hz



Effect of rail fastener stiffness



AMF
ASOCIACIÓN MEXICANA DE FERROCARRILES, A.C.

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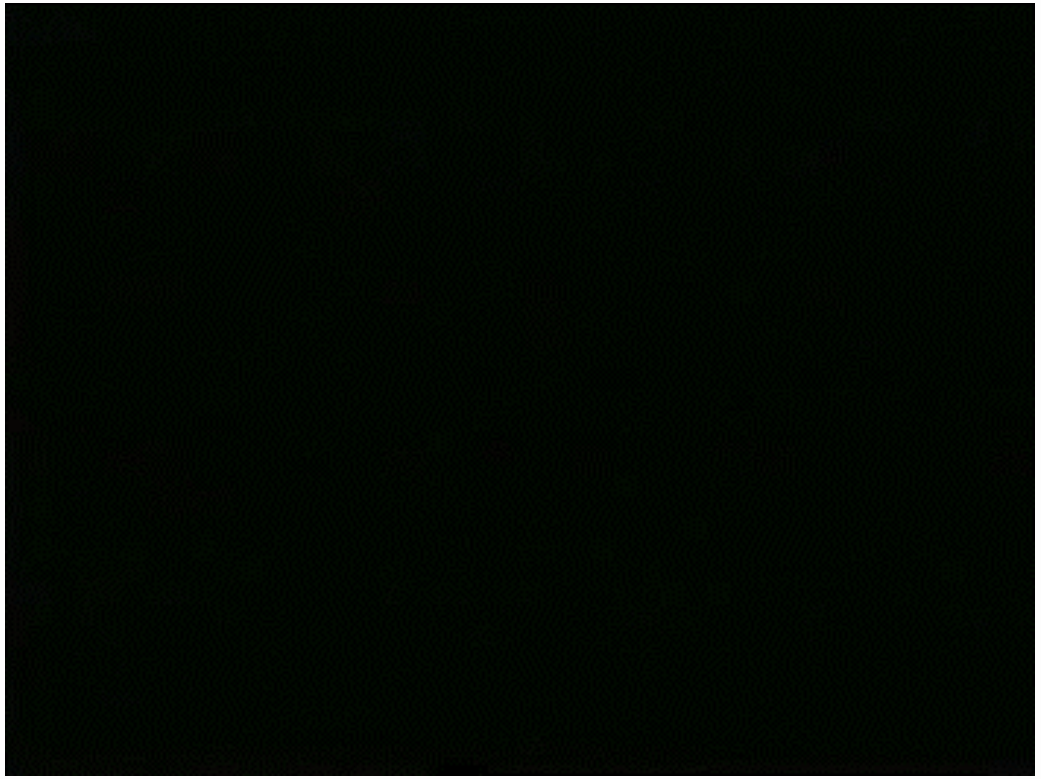
2022

Pandrol Vanguard

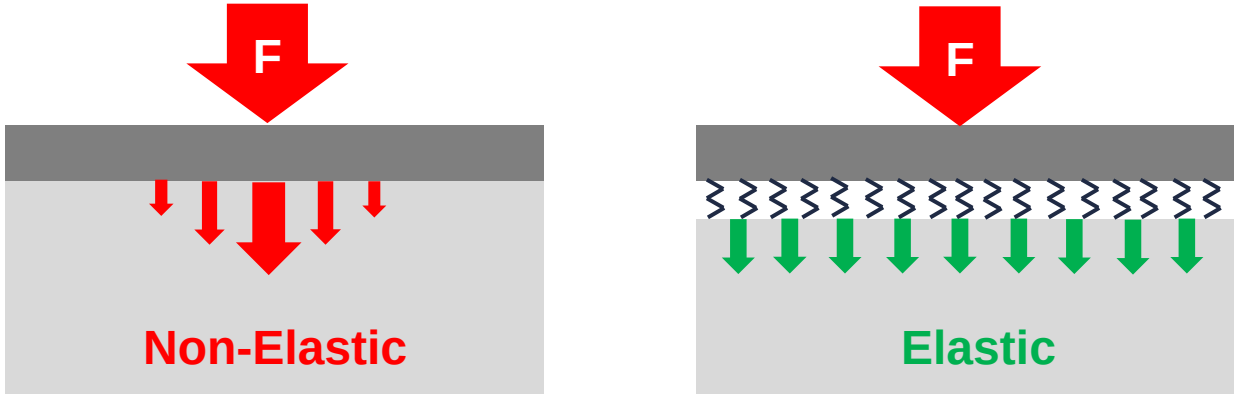


Pandrol Vanguard Installation

Benefits of an Elastic Track

The addition of resilience into the track helps to better distribute the huge dynamic forces associated with modern railway.

If we use the Beam on Elastic Foundation model, we see that the addition of elasticity greatly improves force distribution:



This principle when applied to the track results in similar effects

Solutions

Pandrol can provide the optimized solution for each case

SLAB TRACK

INDIRECT RAIL FASTENING ASSEMBLIES

Medium and High vibration isolation systems

or

FLOATING SLAB TRACK

High vibration isolation systems

BALLASTED TRACK

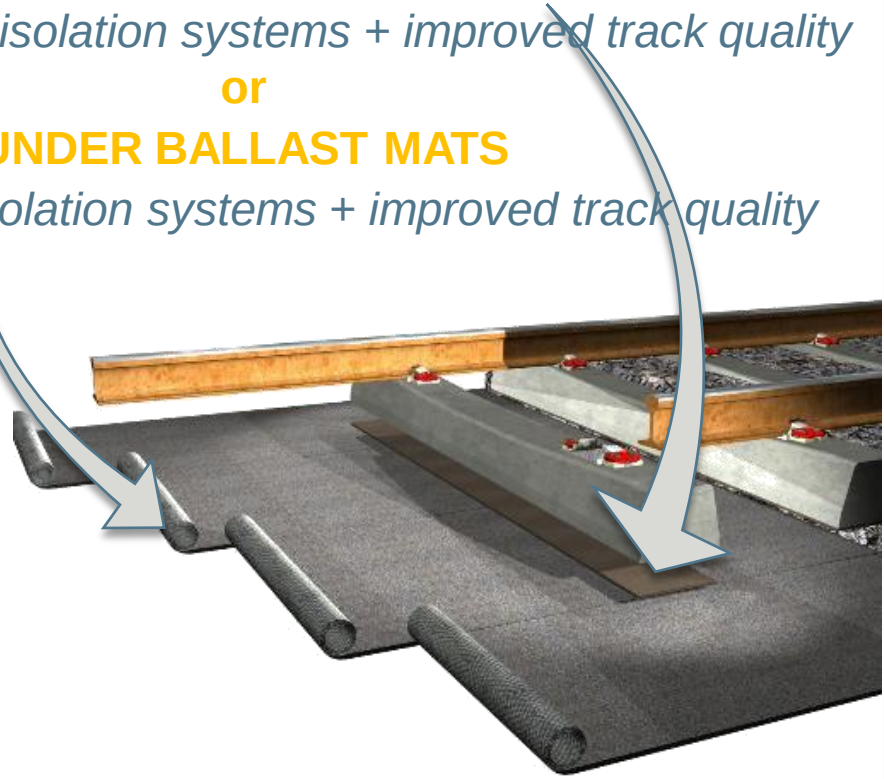
UNDER SLEEPER PADS

Medium vibration isolation systems + improved track quality

or

UNDER BALLAST MATS

High vibration isolation systems + improved track quality



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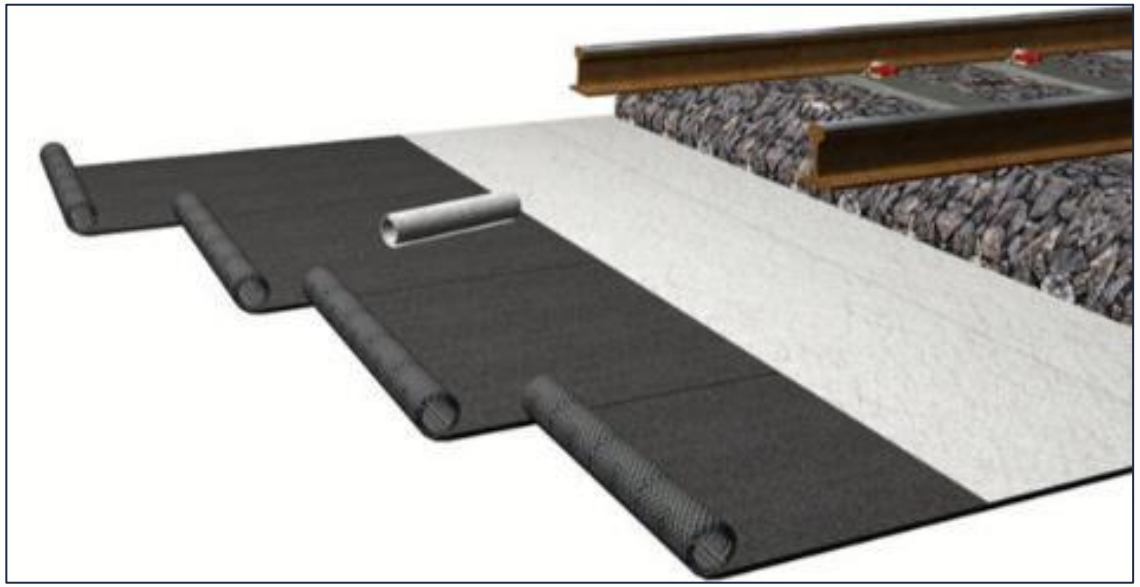
PANDROL UBM: Definición

- Las Mantas Bajo Balasto (Under Ballast Mats) son capas resilientes de material instaladas debajo de la vía de balasto. Las soluciones de PANDROL UBM se pueden utilizar para combinar la atenuación de las vibraciones y la protección de la subestructura.

Homologación de categorías:

- **Ferrocarril ligero y pesado**
- **Mercancías**
- **Metro**
- **Interurbano**
- **Alta velocidad**
- **Tranviario**



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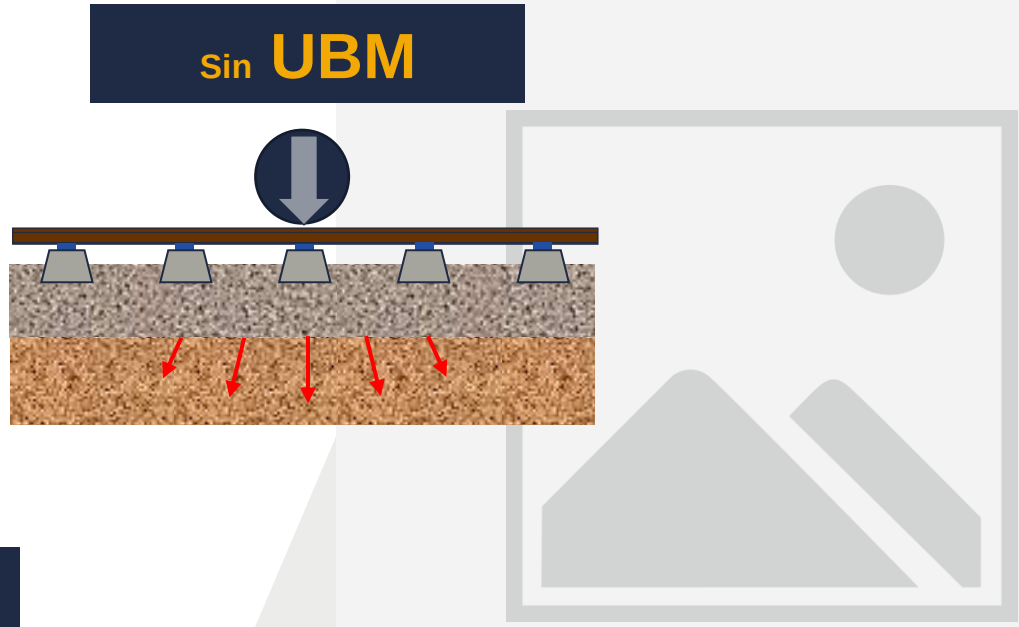
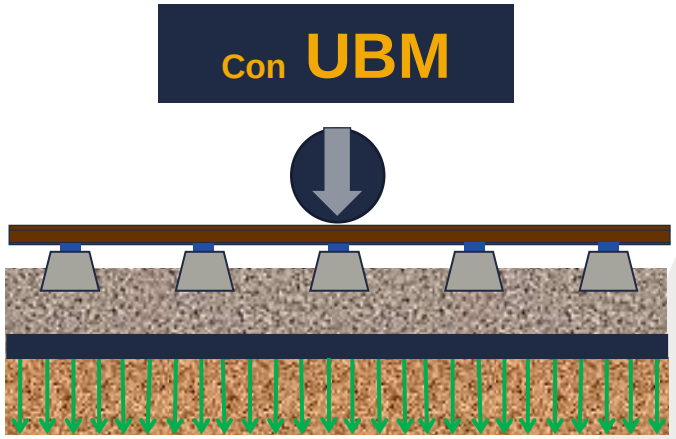
PANDROL UBM: Calidad y protección de la vía

- La presencia de **UBM aumenta el área de contacto con el balasto y mejora la distribución de cargas.**
- Lleva **menos estrés en el balasto y la subestructura que extende la vida de ambos.**





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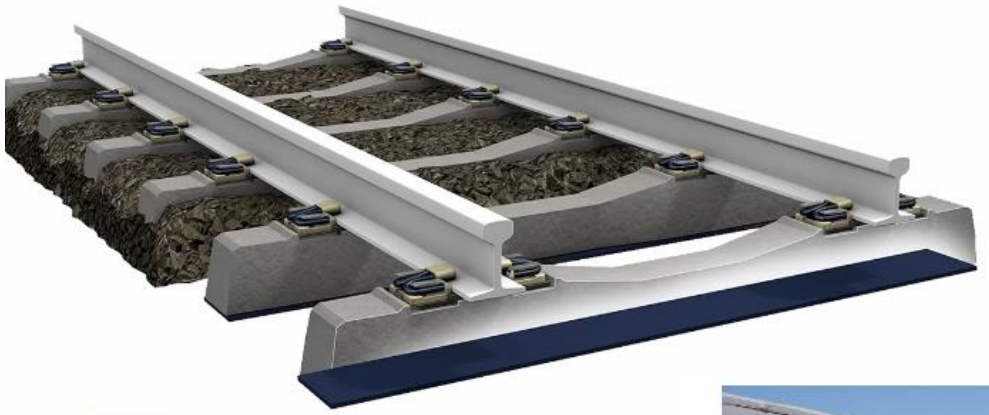
Sistemas de reducción de ruido y vibraciones en el siglo 21: Suelas bajo Traviesa // Pandrol USP

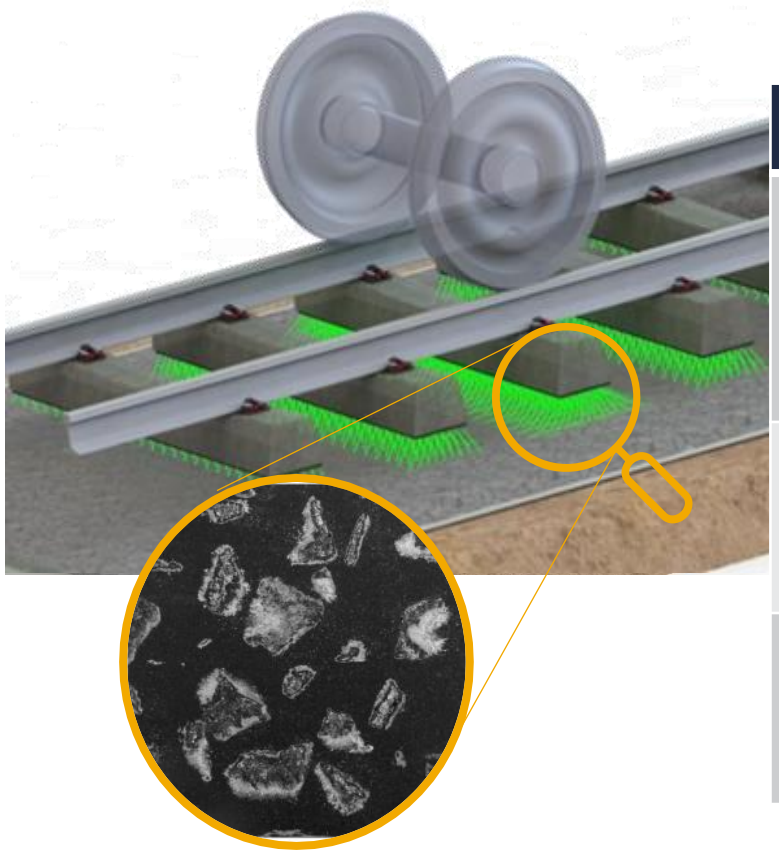


Las Suelas bajo traviesas (SBT) son sistemas elásticos confeccionados a medida y concebidos para reducir las necesidades de mantenimiento de la vía, aumentar la calidad de la vía y brindar una atenuación de vibraciones mediante la fijación de elementos elásticos a la superficie inferior de las traviesas.

Las suelas se han concebido para su sujeción durante la producción de las traviesas mediante tecnología de Sujeciones Micro-Filamentosas (MFF®) para suelas SBT de Pandrol.

Sistemas de reducción de ruido y vibraciones en el siglo 21: Suelas bajo Traviesa

“Do you know many track components that, for a small fraction of the value, can decrease maintenance and increase lifetime this much?”



With USP
Contact between the Sleeper underside and ballast rises by up to 30%.
Load is now spread across 5 sleepers.
30%-40% load now in the central sleeper

Improvement of track quality

Lifetime track 5+ years

Reduction of maintenance efforts

Reduction maintenance by factor 2+

Transition zones construction

Compensation of sand ingress

Possibility to reduce ballast layer thickness

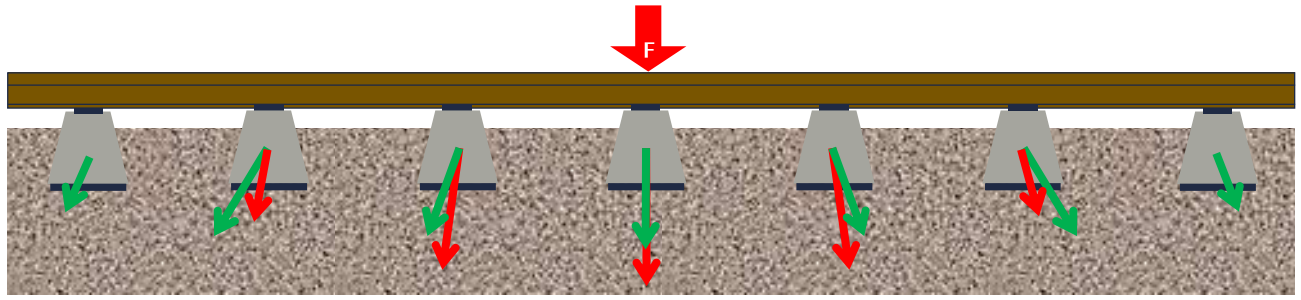
Up to 10 cm ballast reduction

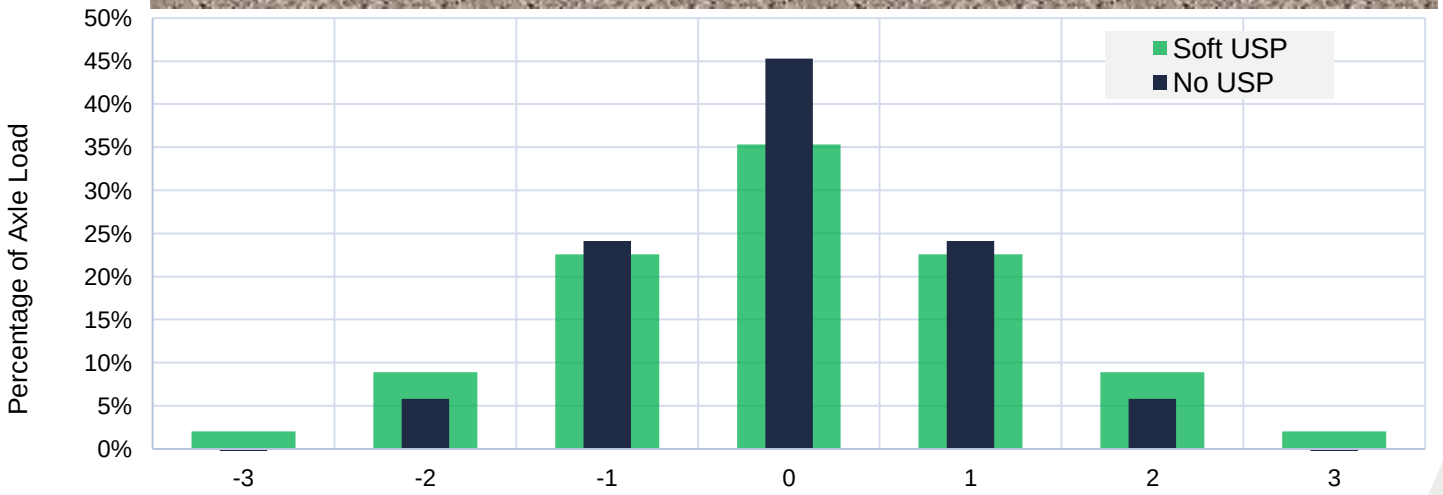
Reduction of ground-borne vibrations

Improved Force Distribution

Due to a reduction of overall stiffness, the effective elastic length of the track increases, therefore, force distribution is greatly improved:

Longitudinally





For a 225kN Axle load:

Peak Rail Seat force:

Without USP ≈ 50.6kN

With Soft USP ≈ 39.4kN

Under Sleeper Pads – Field of Application
Case Study

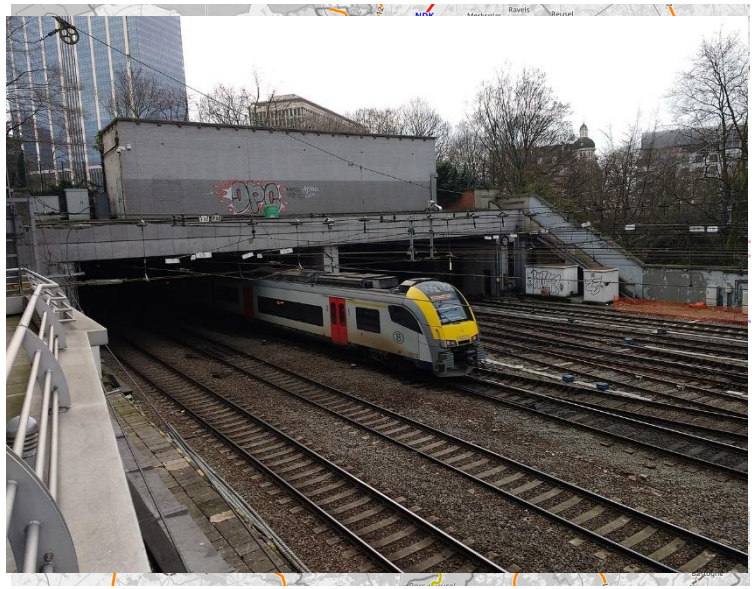
BE-Infrabel – since 2004

Brussel's North-South Junction challenges

- Capacity / Availability
- Corrugation / Switches / Vibration

✓ Solution : Intermediate USP + Ballast Mat

→ -10dBv + less corrugation/maintenance



SE-Trafikverket – since 2018

Mainline Track Protection + CO2 footprint

- Sustainable track

✓ Solution : Stiff USP

→ Reduction by ~20 kg CO2eq per sleeper compared to plastic USP

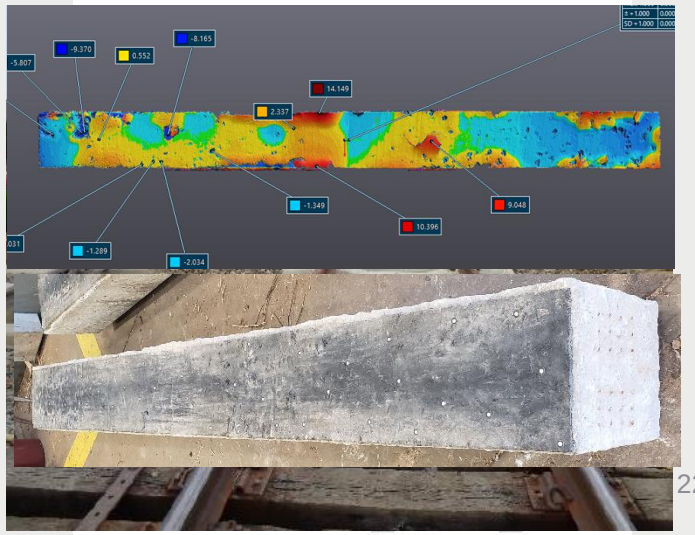
US-Amtrak – since 2014

Bridge Approach

- Switches and Mainline
- Maintenance

✓ Solution : Intermediate USP

→ Huge reduction maintenance so far

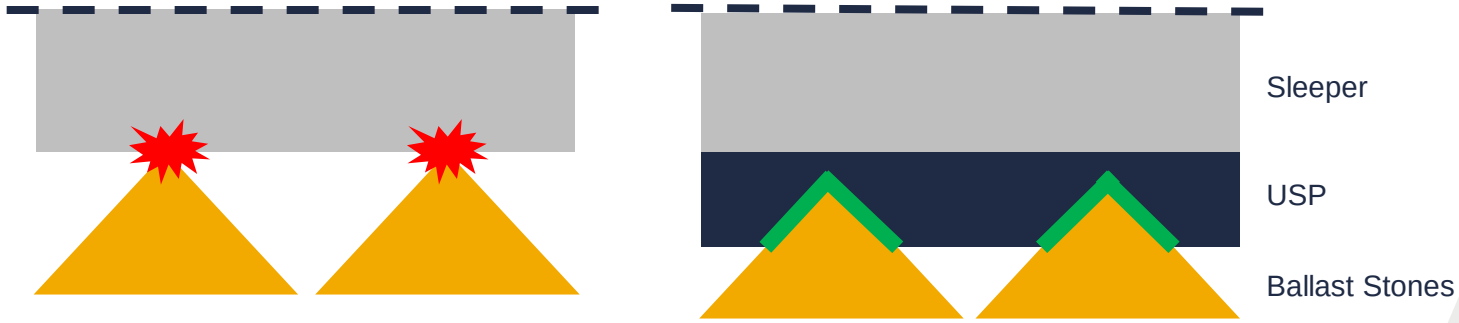


Increased Ballast Contact Area

On regular track with no USPs, the contact surface between ballast stones and the sleeper underside is approximately 5% - 8%.

This value is so small due to the relatively sharp ballast corners only being in contact with the flat sleeper surface.

With USPs installed, this value rises to approximately 30% due to embedment of the ballast stones into the USP.



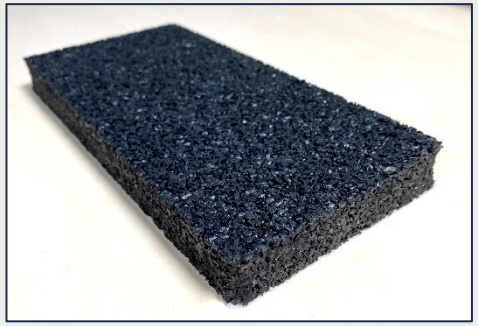
Binary Image of ballast contact impressions

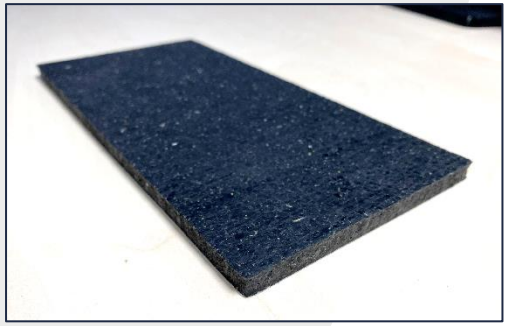
How can we make rail infrastructure greener?

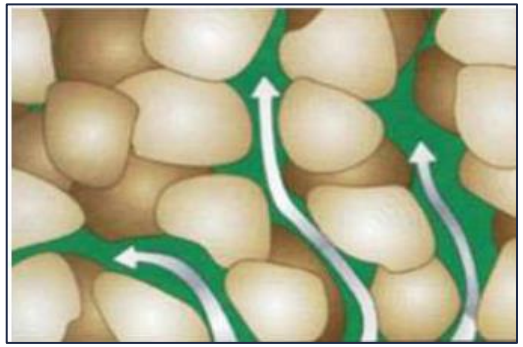
Meet Pandrol'Resin-Bonded Rubber (RBR)

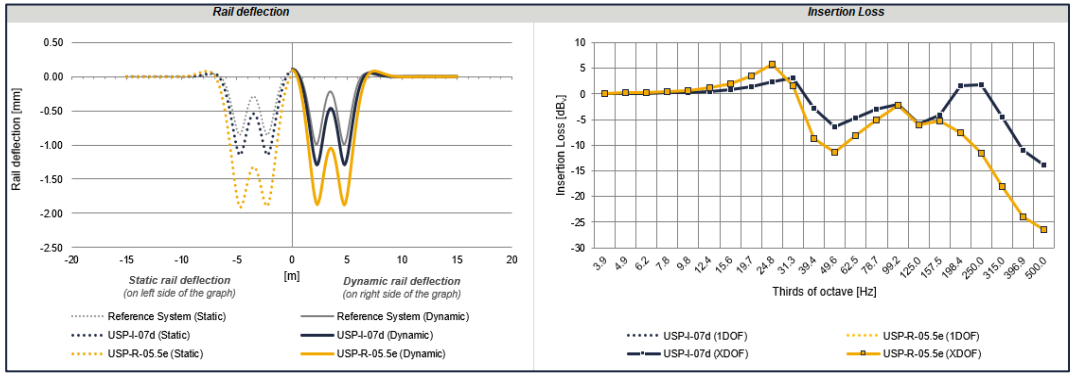
RESIN-BONDED RUBBER (RBR):

- is an engineered recycled rubber of uniform characteristics
- is made up of granular composites, with inner spaces in the material that allow for bulking out
- is compressible and soft
- allows the flow of water and air through the material whilst still maintaining durability
- has an ideal elasticity
- experiences minimal material settlement under service loads
- has durability in excess of typical track lifetime.







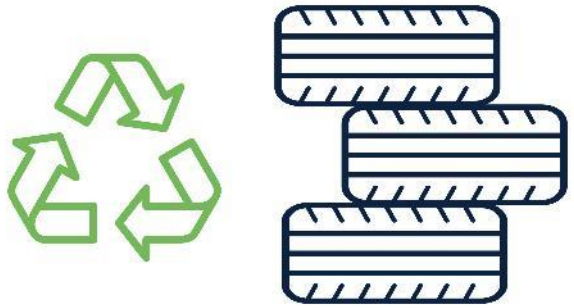


How can we make rail infrastructure greener?

EPD Analysis of Pandrol Sustainable Resilient Systems (SRS)

Saving tyres

Every kilometer of railway track installed with Pandrol SRS products saves a significant amount of tyres from landfill or burning.



Saving emissions

When compared to the industry average polyurethane solutions, our solutions massively reduce CO2 output.

Saving the planet

The overall carbon footprint of systems made from microcellular polyurethane is much higher that made with recycled rubber.

Juan Lazcano

Sales & Marketing Manager Pandrol SRS

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Pagina web: https://www.pandrol.com/es/product-lines/sistemas-resilientes-y-sostenibles/

25 / 26 de octubre de 2022

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