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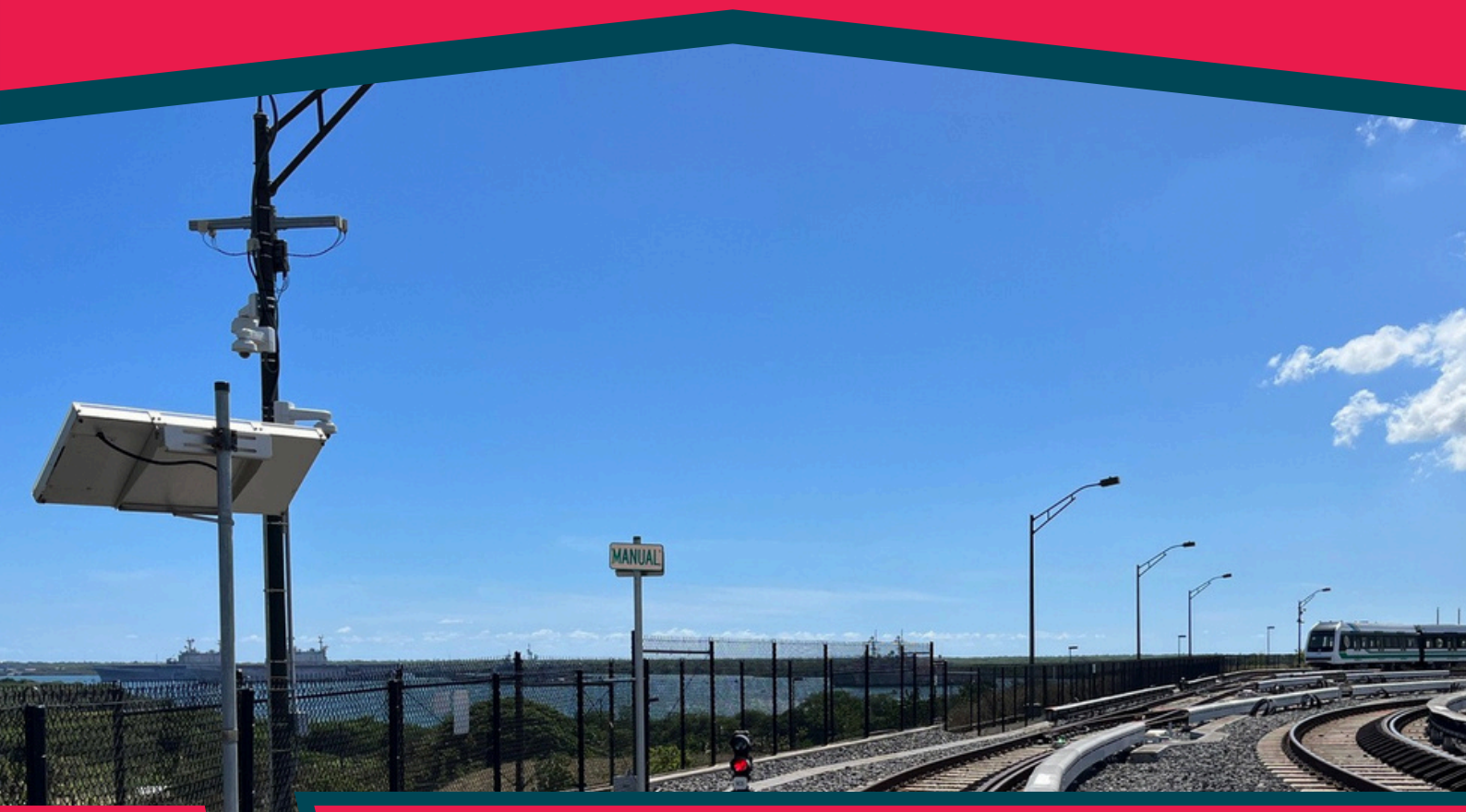
2024 WHITE PAPER



THE EFFECTIVENESS OF GAUGE FACE, RESTRAINING RAIL AND TOR FM IN MITIGATING CURVING NOISE

PREPARED BY

Marco Santoro
Global Friction Management
Applications Manager Vancouver, BC
msantoro@lbfoster.com

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The issue

Noise pollution from railways is a serious environmental and health issue that affects millions of people in Europe and across the world. According to the European Environment Agency (EEA), railways are the second most dominant source of environmental noise in Europe, with nearly 14 million people exposed to high levels of railway noise in 2014 . The main sources of railway noise are the rolling noise from the wheels and rails, the aerodynamic noise from the train body and pantograph, and the propulsion noise from the engine and brakes .

Railway noise can have negative impacts on human health, such as sleep disturbance, annoyance, cardiovascular diseases, cognitive impairment, and hearing loss . The World Health Organization (WHO) recommends that the average sound level during the night should not exceed 40 decibels (dB) for outdoor exposure, and 30 dB for indoor exposure, to protect public health . However, in most European countries, more than 50% of people living in urban areas are exposed to railway noise levels above 55 dB during the day-evening-night period, and more than 20% are exposed to levels above 50 dB during the night period .

White Paper: Mitigating Curving Noise in Rail Systems with Friction Modifiers

Executive Summary

This white paper explores the effectiveness of gauge face grease (GF), restraining rail (RR), and top of rail friction modifiers (TOR FM) in mitigating curving noise in rail systems. The study encompasses a comprehensive review of curving noise, mitigation strategies, and presents the results of field tests comparing different friction modifiers.

Introduction

Curving noise in rail systems, especially in curves exceeding 350 meters, presents a significant challenge. Various noise types, such as flanging noise, restraining rail noise, and top of rail squeal, contribute to the overall noise pollution. This paper investigates the potential of GF grease, restraining rail, and TOR FM in addressing these noise issues.

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Preventative measures

To reduce railway noise, various measures can be taken at the source, along the propagation path, or at the receiver. For example, retrofitting existing freight wagons with low-noise brakes, installing noise barriers or earth berms along the tracks, applying noise insulation or ventilation systems to buildings, or implementing noise action plans and noise charges . The European Union has adopted several policies and regulations to address railway noise, such as the Environmental Noise Directive, the Technical Specifications for Interoperability, and the Shift2Rail initiative .

Railway noise is a complex and multifaceted problem that requires coordinated actions from different stakeholders, such as railway operators, infrastructure managers, manufacturers, regulators, researchers, and citizens.

By implementing effective noise reduction measures and promoting the environmental benefits of rail transport, railways can become more sustainable and attractive for passengers and freight customers.

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Curving Noise Phenomena

1. Flanging Noise

- "Buzzing/hissing" sound characterized by broadband high-frequency components (>5000 Hz).
- Influenced by lateral forces, flanging forces, and friction at the flange/gauge face interface.

2. Restraining Rail Noise

- Frequencies vary with the type and design of restraining rail.
- Affected by back of flange contact force and lubrication.

3. Top of Rail Squeal Noise

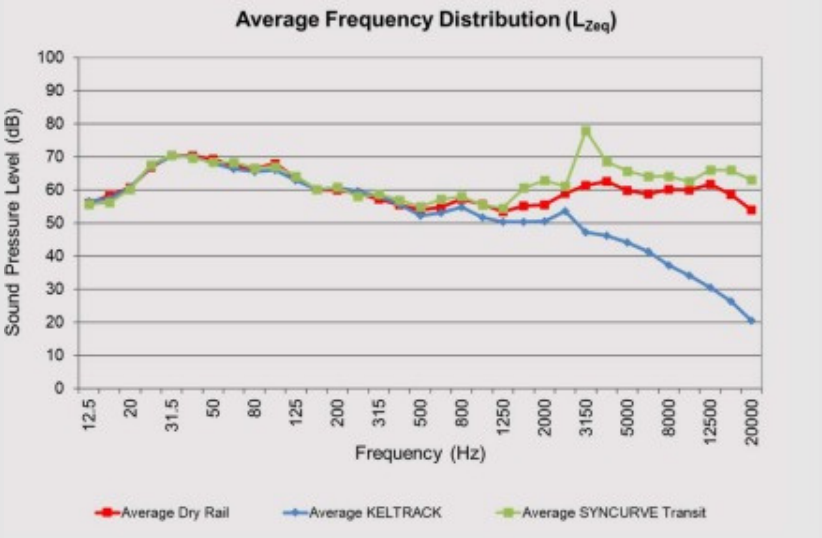
- High-pitched, tonal squeal (800 – 5000 Hz).
- Prevalent in problem curves, related to negative friction characteristics at tread/top of rail interface.

Noise type	***Frequency range, Hz***
Rolling	30 -2500
Rumble (including corrugations)	200 - 1000
Flat spots	50 -250 (speed dependent)
Ground Vibrations	30 - 200
Top of rail squeal	1000 - 5000
Flanging noise	5000 – 10000

Noise Control Strategies

1. Gauge Face Grease (GF)

- Whilst gauge face grease addresses flanging noise, alone it is not an effective solution for top of rail squeal.
- Overapplication with older equipment/greases may be detrimental.
- GF grease does not address noise related to top of rail.



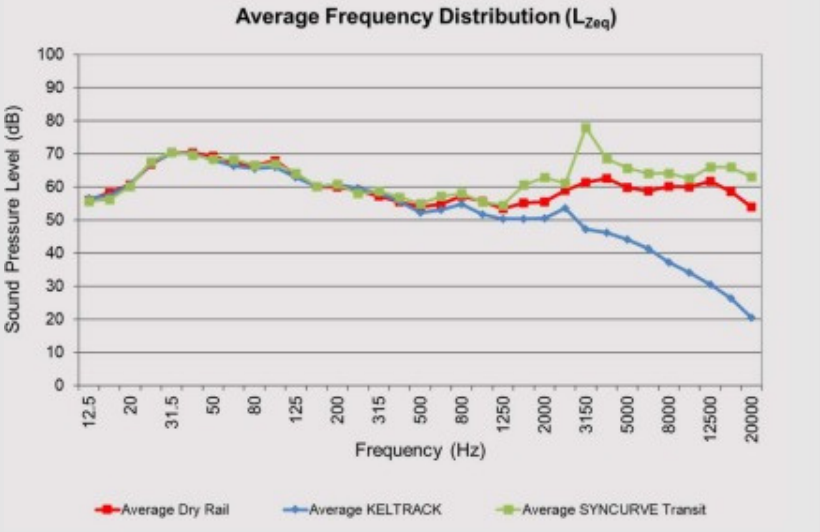
Noise Control Strategies

2. Restraining Rail Grease (RR)

• Restraining rail lubrication alone can reduce noise levels by 2-4 decibels but does not address noise caused by stick-slip.

• Over or inaccurate application can contaminate the top of rail around the application point, leading to low friction conditions which can negatively affect braking and traction.

• RR grease does improve vehicle steering and lateral forces and therefore does not address noise related to top of rail

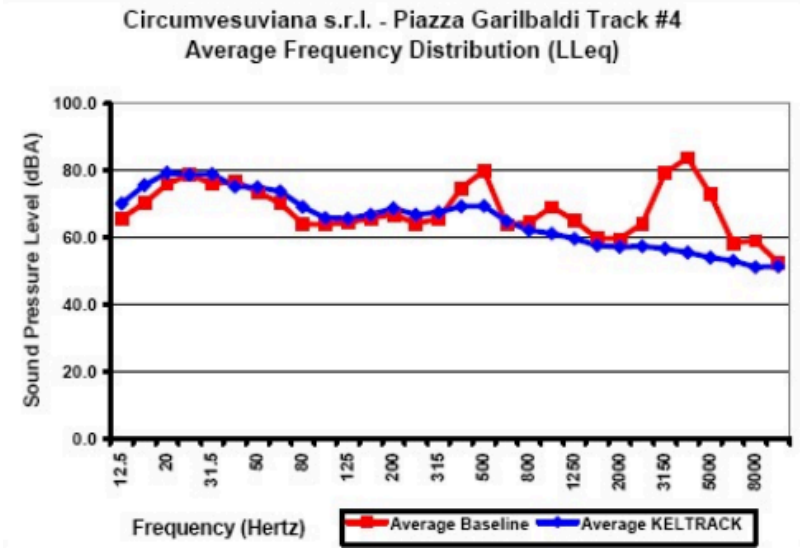


Noise Control Strategies

3. Top of Rail Friction Modifiers (TOR FM)

- Extensive data supports TOR FM effectiveness for over 20 years.
- Positive friction characteristics are crucial for controlling stick-slip.
- Light rail/Trams: distinct TOR squeal peaks, less flanging component

Site details: Circumvesuviana
- Track # 4 towards Terminale
- 90m radius / 70m length
- Level gradient / UNI 50 rail
- Onboard GF lubrication



Noise Control Strategies

4. Top of Rail Friction Modifiers (TOR FM)

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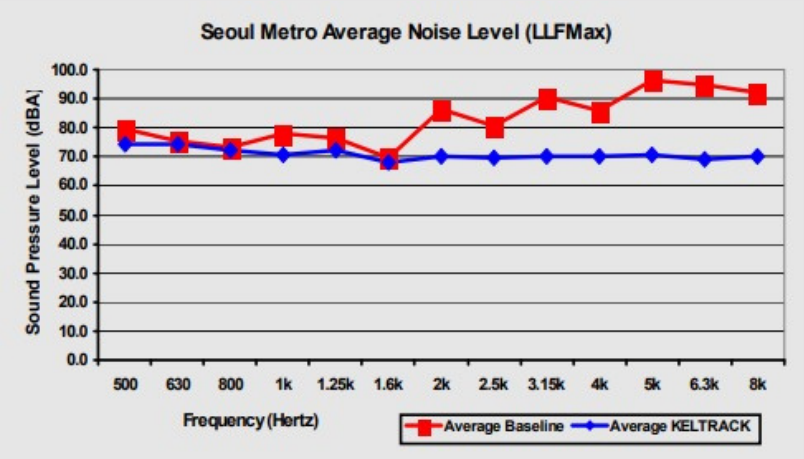
- Metro: heavier flanging component in addition to TOR squeal

Site details: Seoul Metro
Sanggye Station Uptown Track KM1
• 180m radius / 180m length
• 0.2% upgrade in curve body / 60kg rail
• Trackside GF lubrication

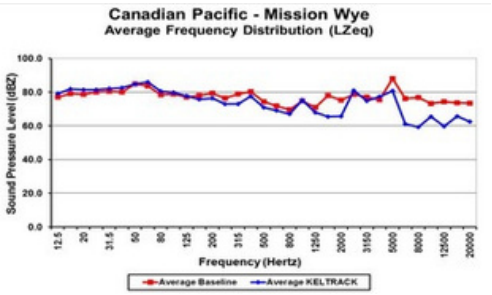


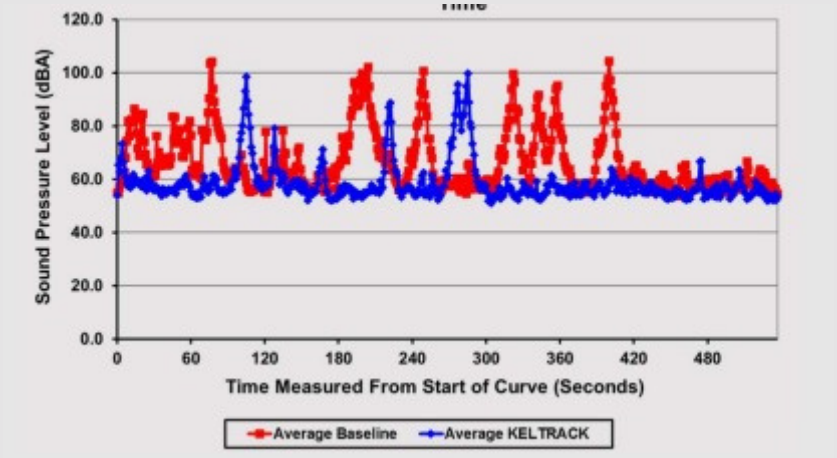
Noise Control Strategies

5. Noise Control for Freight Railroads

- Challenges in freight systems due to varied car designs, loads, and maintenance.
- ‘Bad actors” due to misaligned wheelsets, warped trucks, bearing issues, etc cause spikes in noise levels.
- Wider range in noise levels than transit where the vehicle are similar due to the higher forces, there is a strong flanging component.
- Friction modifiers successfully reduce overall noise levels but cannot address all mechanical noise
- The overall levels can be reduced, except for “bad actors” and the overall high frequency noise reduced.

site details: Canadian Pacific - Mission Wye





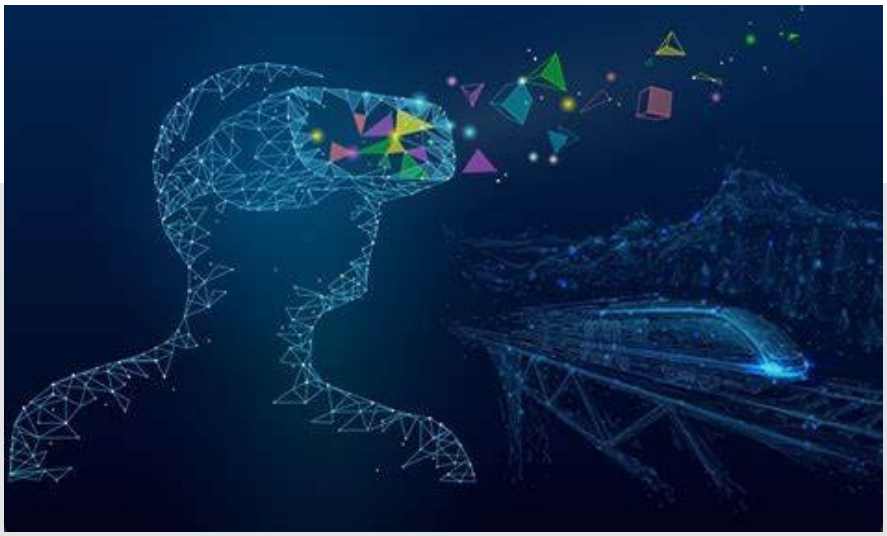
Technologies to measure railway noise levels

• Noise and vibration sensors that can be installed on trains or trackside to monitor the noise emission and performance of rolling stock and infrastructure in real time.

• Auralisation and visualisation tools that can create realistic and immersive soundscapes of railway noise for different scenarios and mitigation measures, and evaluate their impact on human perception and well-being.

• Ground vibration prediction software that can simulate the propagation and transmission of vibrations from railways to nearby buildings and structures, and assess their potential damage and annoyance.

These technologies are being developed and tested by various research projects and initiatives, such as Shift2Rail, FINE-2, TRANSIT, SILVARSTAR, and Assets4Rail.



Global Rail Review

International standards on railway noise

• ISO 3381:2021, which specifies the measurement method and conditions to obtain reproducible noise levels on-board all kinds of vehicles operating on rails or other types of fixed track.

• ISO 3095:2013, which specifies the measurement method and conditions to obtain reproducible and comparable exterior noise emission levels for all kinds of rolling stock.

• ISO 16254:2013, which specifies the measurement method and conditions to obtain reproducible and comparable interior noise emission levels for electric multiple unit trains and high speed trains .

The main difference between ISO 3381 and ISO 3095 is that ISO 3381 measures the noise level inside the train, while ISO 3095 measures the noise level outside the train. Both standards specify the measurement method and conditions to obtain reproducible and comparable noise emission levels for different types of rolling stock. However, they have different objectives and applications. ISO 3381 is mainly used to evaluate the comfort and health of passengers and staff on board the train, while ISO 3095 is mainly used to assess the environmental impact and noise exposure of people living near the railway.

Conclusion

This white paper highlights the complexity of curving noise in rail systems and the multifaceted approach required for effective mitigation.

The combination of GF grease, restraining rail, and TOR FM presents a promising strategy for reducing noise pollution in rail systems. Ongoing research and field testing are crucial for refining and optimizing these noise control measures.

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