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Review of the potential noise and vibration benefits of rail web dampers in Australia

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ABSTRACT

Rail vibration damping is an emerging noise mitigation technology in Australia. Despite their proven effectiveness internationally, adoption rates of rail web dampers in Australia are relatively limited. This paper reviews the situations in which rail web dampers offer significant benefits, particularly where conventional noise controls such as noise walls are impractical. It presents empirical data on typical noise reductions, explores compatibility with Australian trackforms and maintenance regimes, and compares the material efficiency of dampers versus traditional noise barriers. The findings support broader consideration of rail web dampers as a viable, scalable, and cost-effective solution for railway noise control, especially on direct fix track and some specific ballasted track applications.

1 INTRODUCTION

Rail web dampers are commercially available in Australia as a means of mitigating airborne noise generated by rail operations. Despite their proven effectiveness in international applications, their adoption within the Australian rail industry remains relatively limited.

This paper seeks to raise awareness of the specific operational contexts in which rail web dampers may offer substantial benefits, particularly in environments where conventional noise mitigation strategies are either impractical or insufficient. This includes a summary of key advantages and limitations, as well as a discussion of the practical considerations surrounding implementation, such as compatibility with local trackforms, terrain, and maintenance regimes. Special attention is given to how these benefits may vary depending on local infrastructure characteristics, including track geometry, sleeper type, and subgrade conditions.

1.1 What are rail web dampers

The majority of railway environmental noise emissions is called ‘rolling noise’, as it is generated from wheels rolling on rail with imperfect contact, causing the wheels and rails to vibrate. This vibration propagates along the rail and becomes radiated noise, contributing to environmental noise emissions and in-car noise levels.

One effective strategy for mitigating rolling noise, especially where the rail is the dominant source of radiated noise, is to increase damping in the rail itself. Increased damping reduces the spatial extent over which vibrational energy travels along the track, thereby limiting the area of the rail surfaces radiating noise. This results in a measurable reduction in overall sound pressure levels.

Rail web dampers (RWDs) are devices engineered to achieve this damping effect. RWDs typically consist of steel masses coupled with resilient elements such as polyurethane (PU), nitrile butadiene rubber (NBR) or styrene-butadiene rubber (SBR). The size and arrangement of these components are tuned to target specific vibrational modes of the rail, particularly those that contribute most significantly to noise radiation. Figures 1 and 2 present installed examples in Australia.

Figure 1: Rail web dampers trialled in Perth Tunnel 6, Fremantle Line up main, 2017.

Figure 2: Rail web dampers fitted to Sydney Metro, 2022 (Image credit Pyrotek Pty Ltd)

1.2 How do they work

Rail web dampers are designed to effectively dampen the critical vibrational modes that contribute to noise. The primary design objective is to maximise the rate of vibration attenuation with rail length, referred to here as the Track Decay Rate (TDR), at specific frequencies of interest (Asmussen et al. 2008).

TDR values can be determined either through controlled testing on isolated rail sections or via in-situ measurements, which typically require only a few hours to complete. Following installation, the performance of the dampers can be evaluated through modeling and empirical measurement to ensure that the desired vibrational attenuation has been achieved.

In addition to improving vibrational attenuation, rail web dampers have demonstrated significant benefits in mitigating the growth of rail surface roughness, particularly short-pitch corrugation. Field measurements conducted on metro train tracks in Hong Kong revealed that the installation of tuned mass dampers can suppress corrugation growth rates at key frequencies by the order of 40 to 70% (Ho et al. 2025).

This effect is attributed to the dampers' ability to reduce lateral rail vibration at specific resonant frequencies which are strongly associated with the formation and propagation of corrugation. By attenuating these lateral vibrational modes, the dampers disrupt the feedback mechanism that leads to wear-type corrugation. As a result, noise levels are reduced, and the interval between rail grinding cycles can be extended (typically doubled), offering both acoustic and maintenance cost benefits.

1.3 Use in Australia to date

The first rail damper trial in Australia was undertaken near Narwee, NSW in 2008 for ballasted track with "relatively stiff" rail pads (Parker and Weber 2010). Although a two to four decibel reduction in A-weighted noise emissions was expected, the actual reduction measured was closer to one decibel. The rail damper design worked in principle. However, overall noise was controlled by wheel sources and rollingstock. This was due to the relatively stiff trackform, relatively larger, less stiff wheels and significant onboard noise sources. Track decay rates were already quite high, so the potential for improvement (and therefore noise reduction) was relatively limited.

In 2009, dampers were fitted to the Epping to Chatswood Rail Link in response to in-car noise concerns (Coker and Anderson 2009).

A trial was undertaken in 2015 on the North Coast Line in NSW to investigate the benefit of rail dampers towards reducing curving noise. Despite a generally accepted theory that the wheels are typically the primary source of curving noise and unlikely to benefit from treatments to the rails, Hanson et al. (2016) found that specially designed rail web dampers supplied by Schrey und Veit reduced wheel squeal noise by 3 dB in terms of both A-weighted energy average and maximum noise levels, for both freight and passenger trains on ballasted track.

In 2017, the Public Transport Authority in Western Australia undertook similar trials at two sites: on 100 metres of ballasted track located in Butler, 40 kilometres north of Perth on the Yanchep Line, and on direct fix slab track within Perth Tunnel 6, on the Fremantle Line. At time of writing, these rail web dampers are still in place. According to the study presented by Zoontjens et al. (2017), a four to five decibel reduction in A-weighed noise levels was predicted and measured on ballasted track, and an eight-decibel reduction was predicted and measured on the direct fix trackform.

Since these trials, production units are being implemented at increasing rates. Sydney Metro Northwest in 2024 is the most notable recent tunnelled example, with rail web dampers installed in multiple sections. The upcoming Cross River Rail in Brisbane and Parklife Metro in Sydney projects are also expected to make use of rail web dampers. It is noted that these projects are so far only new metro tunnelled projects, and not for existing mainline railway track. These projects are also all direct-fix slab track applications, except for approximately 1,500 dampers fitted to ballasted track near Claremont Station in Perth in 2022.

The Byford Rail Extension (due for completion in 2025) is understood to be the first greenfield major rail project to use rail web dampers as the principle noise mitigation option over traditional methods such as noise walls, for ballasted track.

2 KEY BENEFITS AND DRAWBACKS

2.1 Benefits

Against traditional noise mitigation controls such as noise walls, rail web dampers have particular benefits:

- Global reduction: As a source control, airborne noise reduction benefits are provided for receivers on both sides of the railway and over multiple floor levels.
- Proportionality: The installation density of dampers provides an ability to optimise extents and rationalise costs.
- Portability: The portable and removable nature of the product provides some level of insurance in situations where results are marginal.
- Reduced long term noise and vibration source emissions over time: Dampers assist in reducing the rate at which track surfaces degrade over time (Ho et al. 2025), with lower noise and vibration levels as a result, including in-car noise levels.
- Reduced maintenance costs, through reduced rates of roughness and corrugation growth, increasing time between grinding / rectification, increasing the life of rail stock and reducing maintenance costs.
- Substantial material savings over noise walls. Typical weights of rail web dampers for AS60 rail are about 25 kg per metre of rail, so 100 kg per metre with 2 tracks in each direction. A precast concrete wall of 2.4 metres height on just one side (the minimum usually accepted on a railway boundary) would be more

than ten times this mass rate. Embodied energy would also be significantly reduced through use of dampers.

- Potential for vibration mitigation. Some minor improvements in wayside vibration levels have been measured anecdotally, however further study is needed.
- Subjective improvements in noise content. The noise emission spectrum with dampers contains proportionately more low frequency content, which means a relatively lower noise rating level and improved subjective acceptability.

2.2 Drawbacks

- Rail dampers are not a universal solution. The performance of noise and vibration controls on one railway are not necessarily indicative of others. Performance is highly dependent on trackform and rolling stock. Generally, rail web dampers suit situations where the track decay rate is minimal, and there is relatively high mobility in the rail.
- Limited benefit in vibration mitigation. The potential for vibration mitigation is considered to be low as the frequencies of interest to vibration received at nearby building are substantially lower than that associated with the damper performance. From a limited set of measurements, dampers provide almost no reduction in vibration levels at the fastener / baseplate / sleeper as expected, but some improvements have been measured in groundsoil and nearby structures and this is an area of further research.
- Upfront tuning requirements. There may be additional upfront costs in designing and implementing an optimal damper.
- No benefit for onboard vehicle noise sources, such as diesel engines or cooling fans.
- Generally, dampers cannot be fitted near switches, turnouts or trackside equipment due to spatial requirements (decreased spacing between fasteners).
- Reduced ‘visibility’ to stakeholders. From a distance, rail web dampers can be difficult to spot, and in the author’s experience, residents who were expecting the visual scale of a noise wall tend to place less value on controls which do not help to visually screen noise sources.
- Potentially shorter design life of typically 25 years, compared to traditional masonry noise walls which tend to be offered with a 50-year design life.
- Potential fire hazard. Dampers contain rubber elements which represent minor but not insignificant fuel load which can be concern in enclosed areas such as stations and tunnels.

3 IMPLEMENTATION

3.1 Typical performance

As a starting point, rail dampers should provide at least three decibels of noise reduction in A-weighted terms where the dynamic track stiffness is less than 250 MN/m and wheels are regularly maintained.

Generally, for metro railways in Australia, rolling noise levels in A-weighted terms are most significant in the third octave bands with centre frequencies 400 to 2 kHz inclusive. Rolling noise is particularly dependent on various factors such as speed, rolling stock, rail profile and trackform, and the design of dampers can be tuned to suit each application.

In the experience of the author, the third octave band with 400 Hz centre frequency is typically the lowest band targeted by rail web damper designs currently on the market. The 2015 trial for curving noise involved dampers specifically designed for relatively high frequencies, i.e. the range “nominally 1.5 to 5 kHz” (Hanson et al. 2016).

Prediction tools based on the Track Wheel Interaction Noise Software (TWINS) model, such as Stardamp or Train Noise Expert, can be used to reduce the risks and costs of physical trials, provided that suitable inputs (wheel modal behaviour, rail roughness, track dynamic stiffnesses, track decay rates etc.) are available.

As a guide, Table 1 lists typical noise reduction levels provided by dampers as measured in practice. As can be seen from this table, the noise reduction potential is highest for tunnel and dive structures using direct fix slab track where the rail pad stiffness and untreated TDR are relatively low. A global reduction of eight decibels in A-weighted rolling noise levels is superior to all other path controls, especially within tunnel environments.

Table 1: Assessed reductions in rolling noise for selected trackforms, Western Australia

Aspect	General freight	Passenger (Perth metro)		
Application	Surface track	Surface track	Tunnels, viaducts, dive structures	Tunnels
Track structure	Ballasted	Ballasted	Direct fix to slab	Direct fix to slab
Rail pad support	10 mm HDPE	8mm rubber	Resilient rubber bonded baseplate	‘Highly resilient’ rubber bonded baseplate
Nominal worn wheel diameter, *d (m)*	0.92	0.84	0.84	0.84
Nominal dynamic vertical rail pad stiffness, $k_{dyn,v}$ (MN/m)	800	100	25	10
Typical assessed reduction in overall rolling A-weighted airborne noise emissions at 80 km/hr, dB	1.5	4.5	6.0	8.0

The installation density of dampers can be reduced to balance costs with performance. Care needs to be taken in modelling the effect of track with rail web dampers, particularly if they are used at less than 100% density (i.e. one in every bay between fasteners). The relationship between the wayside event noise level L_{AE} and maximum noise level L_{Amax} will vary depending on the local extent of dampers, since the local ‘size’ of the rail as a noise radiating source will be different to untreated conditions.

3.2 Suppliers

Examples of commercially available tuned mass rail web damper products include but are not limited to (alphabetical order):

- Decidamp RTD series (Pyrotek, Australia)
- Rigid Contact Tuned Mass Damper (RCTMD) (Wilson Ho and Associates Limited, Hong Kong)
- SilentTrack (Tata Steel, India)
- STRAILastic_A inox (KRAIBURG STRAIL GmbH & Co. KG, Germany)
- TMDs (Polycorp Ltd, Canada)
- VICON AMSA series (Schrey und Veit, Germany)

3.3 Mounting method

A rigid connection between the damper and the rail is ideal. Achieving this in practice is complicated by the profile of the rail and its surface condition. Most tuned mass rail web dampers seek to therefore maximise the contact area, however rail web surfaces will likely be rough and uneven, may have raised casting lettering, rust and stubborn debris.

To account for this, the design of dampers may use adhesives or thin resilient layers (e.g. rubber coating or overmoulding) to account for rough mounting surfaces. Adhesives present significant risks around odour, fire risk, vapours and general handling, particular in confined areas such as tunnels. Adhesives also increase complexity of implementation and maintenance and are generally not accepted by rail authorities. Most designs use heavy spring clips to hold the damper in place, which leads to relatively fast install rates using a special tool.

Resilient mounting layers tend to reduce the effectiveness of the damper through decoupling, particularly at lower frequencies. The Wilson RCTMD design uses a threaded bolt and no resilient contact layer, to maximise the clamping force on the rail. This can lead to improved connection between the rail and damper, leading to increased effectiveness potential at lower frequencies.

3.4 Common challenges with implementation

Hazards described in the following subsections should be considered as part of specification and procurement.

3.4.1 Sunlight

Ultraviolet light over time can degrade rubber and polymer components. This is particularly relevant to dampers with overmoulded designs (rubber encapsulated steel). The outer surfaces can be treated with suitable UV protective coatings.

3.4.2 Heat

In the author's experience, past studies of fuel loading associated with dampers did not result in any increased fire protection or services needed for tunnel applications. The VICON AMSA and Wilson RCTMD styles of tuned mass damper systems tend to have proportionally more steel and less material exposed which is burnable.

Where track is welded, only the two closest dampers from the weld point in each direction are removed to avoid damage from the heat.

3.4.3 Material handling

The typical maximum weight of a rail web damper (both halves, using steel and NBR, SBR or PU) is about 18 kg with AS60 profile track due to packaging requirements. The damper is limited to space below the rail head, and laterally within the rail web and adjacent fasteners, otherwise it can interfere with tamping and other track maintenance machines.

3.4.4 Maintenance

Most dampers are designed to clear all maintenance and inspection trains including tamping, profiling and rectification.

Where dampers are installed with specific positions or different types, bright coloured paints on sleepers or track slab can be used to show where the dampers (with the same matching colour) should be returned with new rail.

4 CONCLUSIONS

Rail web dampers present a compelling alternative to traditional noise mitigation strategies, particularly in environments where space, cost, or infrastructure constraints limit the use of noise walls.

Their ability to reduce rolling noise, suppress rail corrugation growth, and extend maintenance intervals offers both acoustic and operational benefits. While not universally applicable, their effectiveness is maximised in trackforms with low stiffness and high rail mobility, such as direct fix slab tracks.

Continued implementation in Australian projects is evidence of growing industry confidence. Further research into vibration mitigation and long-term performance benefits should help support broader adoption.

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