Life cycle analysis of railway noise and vibration mitigation methodologies with respect to curve squeal noises

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ABSTRACT

Wheel/rail interface inevitably induces a travelling source of sound and vibration, which spread over a long distance of rail network and neighborhood corridor. The sound and vibration can be generated in various forms and spectra. The undesirable sound and vibration, is often called 'noise', includes rolling noise, impact noise, curve noise, mechanical noise, airborne noise, wheel/rail noise, structure- and ground-borne noises. The noise and vibration that is transferred back through the vehicle body mainly affects ride quality, customer experience, and structural integrity of the rolling stocks, whereas the vibration that is transmitted from the rails to the supporting structure of the track plays a main role in rapid track degradation and potentially affects the surrounding structures. This paper focuses on the effectiveness of noise mitigation measures on curved tracks located in urban environments. It highlights the practical methods for mitigating curve squeals and flanging noises, which are often observed along freight corridors and track infrastructures with nonlinear geometries. It is important to note that rail freight curve noises, especially for curve squeals, can be observed almost everywhere and every type of track structures. The most pressing noise appears at sharply curved tracks where excessive lateral wheel/rail dynamics resonate with falling friction states, generating a tonal noise problem, so-call 'squeal'. Therefore, this paper is devoted to systems thinking approach and life cycle assessment in resolving railway curve noise problems. The life cycle of fifty years has been selected as it is coincide with the majority of common design life for railway tracks catering freights, heavy haul trains, mixed traffics and heavy suburban trains globally. Based on assumptions commonly derived in rail industry, the life cycle analyses under variant extreme weather conditions reveal that the jetting method (or on-board wheel-based friction modifier) seems to be the most efficient method for mitigating curve noises, whilst the noise barrier seems to be the worst counterpart in a long curve section but this case is untrue for a sharp short curved track.

Keywords: railway noises, systems thinking approach, life cycle analysis, railway noise monitoring and mitigation, curve squeal, flanging noise, top of rail friction modifier, jetting method, rail damper, noise barrier.

1. INTRODUCTION

Advances in research and development to mitigate railway noise and vibration have resulted in a wide variety of measures used in rail industry today. The progression of technology in noise and vibration mitigation and its improvement could be observed by many practical implementations. Although there have been a lot of efforts in such improvements by both industry and academia, the implementation of different methods portrays limitations due to the practical and physical constrains, tight budgets and timeframe, and the trade-off priority. In many cases, each implementation must strike the balance between the costs for maintenance and inspection activities and the need for environmental benefits, which sometimes creates a transient situational conflict. With respect to curve squeals, there are several methodologies that have been trialed and implemented in practice, including

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5. CONCLUSION

This paper present noise mitigation methods on curved track in urban area by focus on squeals and flanging noise, it important to note that curve squeals generate high level of noise that easily be observed all around the track. This paper focus on 4 mitigation methods; noise barrier, rail damper, track-based top of rail friction modifier, and on-board jetting method. The track-based top of rail friction modifier, and on-board jetting method have benefit from reduce wheel/rail wear whereas noise barrier and rail damper not have this benefit. On the other hand, noise barrier and rail damper have longer life cycle and lower maintenance cost. This paper present NPV analysis of cost and benefit of each method, separate in long curve section and short curve section, 50 years' life cycle is selected by based on design life span of track. The analysis also includes the influence from extreme heat condition and flooding which reduce life cycle of the infrastructure and equipment. Based on assumptions commonly derived in rail industry, jetting method is the most effective method for both short curve and long curve and rail damper is the worst method for short curve whereas the noise barrier method is the worst method for long curve but effective as good as jetting method for the short curve. Future work will include the sensitivity analysis of assumptions and the potential of global warming on the life cycle assessments of railway noise and vibration mitigation methods.

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