Measurements on Correlation between Rail Corrugation and Vertical Loads

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This study focuses on metro rail corrugation, particularly roaring rails, and proposes solutions to mitigate their impact. We explore the potential of varying vehicle speeds to reduce the harmonic load on rails caused by corrugation. Measurements of vertical loads and rail strains in a metro line in Vienna show that while lower speeds decrease their amplitudes, a deeper rail corrugation does not always increase them.

Introduction

Rail corrugation poses challenges to safety, operational costs, and travel comfort in railways [1,2]. This study addresses these issues by investigating ways to decrease the noise, vibrations, and loads caused by rail corrugation. In metro lines, the problem is exacerbated due to consistent speed and direction of travel [3]. The standard solution involves frequent rail grinding or milling, which necessitates track closures. We propose exploring the impact of varying vehicle speeds to reduce harmonic loads caused by rail corrugation and validate this approach through measurements.

Methods

Measurement Site: A curved section of a metro line with a radius of 232m and cant of 150mm. The track features a bi-block concrete structure with S48U rails and check rail on the inner side.

Measurement Setup: Installed sensors included linear and shear strain gauges to measure rail stresses. Over 400 train passings were recorded, but trains accelerating or decelerating were neglected in the evaluation.

Vehicle Characteristics: Trains of types U2 and V, equipped with 24 wheelsets mounted in bogies, operating mostly at speeds between 18 and 21 m/s. Further, an empty U2 train passed at various speeds for excluding the influence of different vehicles.

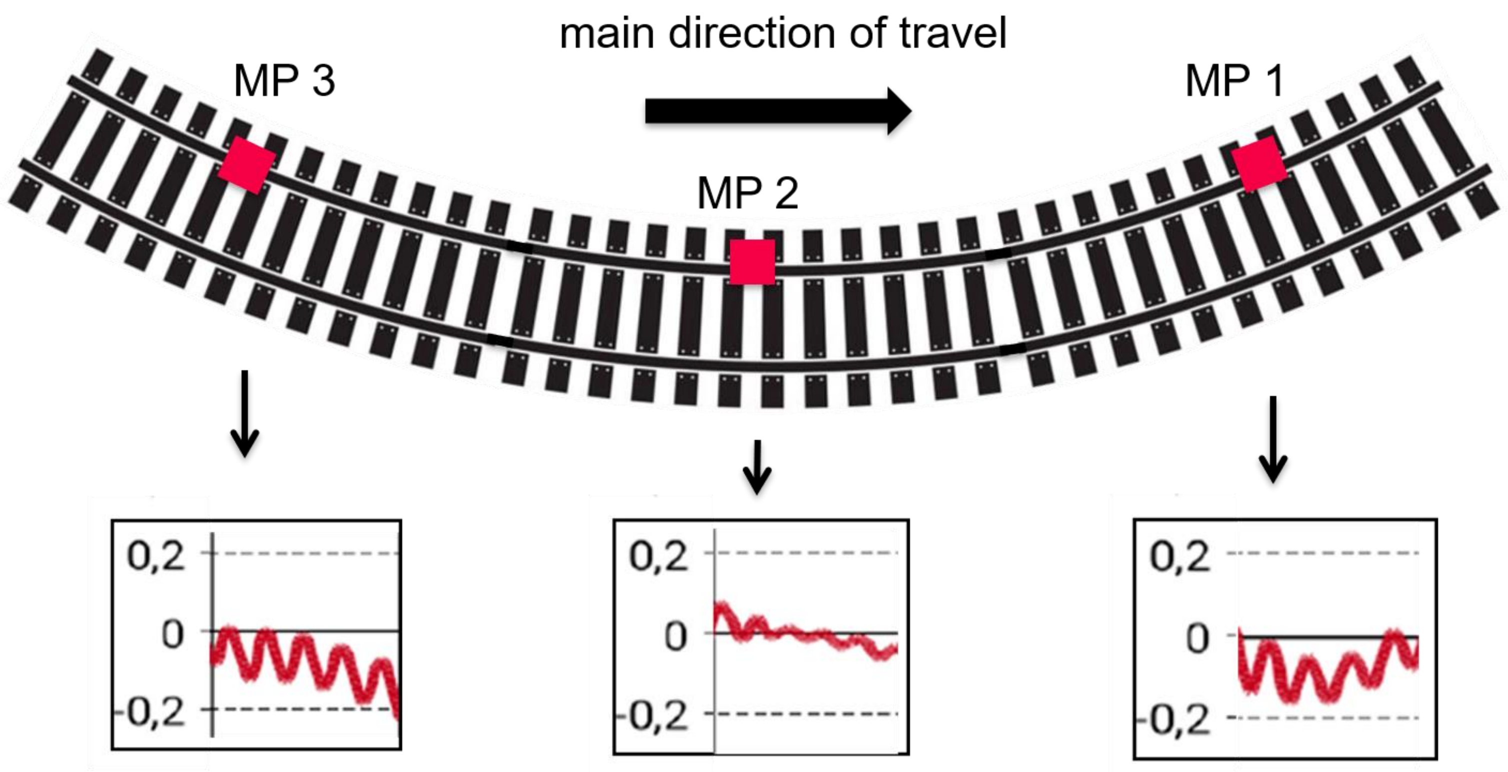

Fig.1: Overview of measurement site with existing rail corrugation in mm

Results

The harmonic part of the rail foot strain amplitude increased up to a speed of 18 m/s. After a speed of 18 m/s there was no further significant increase of the amplitude. This can be seen both for a single vehicle passing at different speeds, in Figure 2, but the same effect is also visible in the overall trend (shown in Paper).

Lower corrugation depths lead only to lower vertical load and rail foot strain amplitudes at lower speeds. At higher speeds the effect almost disappears in our measured data. This comparison of the vertical load amplitudes at different speeds and measurement sites, the latter corresponding to different corrugation depths, can be seen in Figure 3.

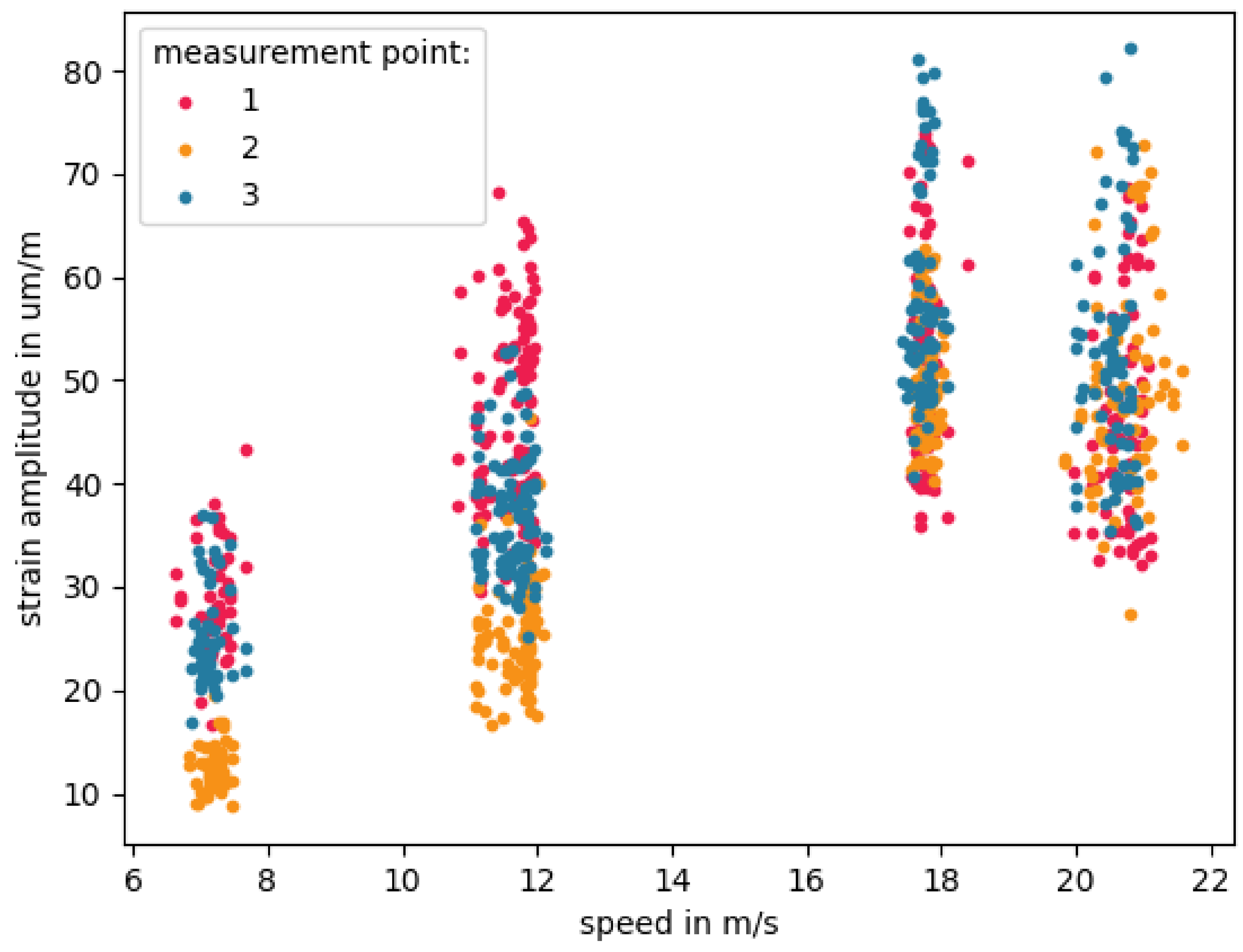

Fig.2: Harmonic rail foot strain amplitude at different speeds of a vehicle

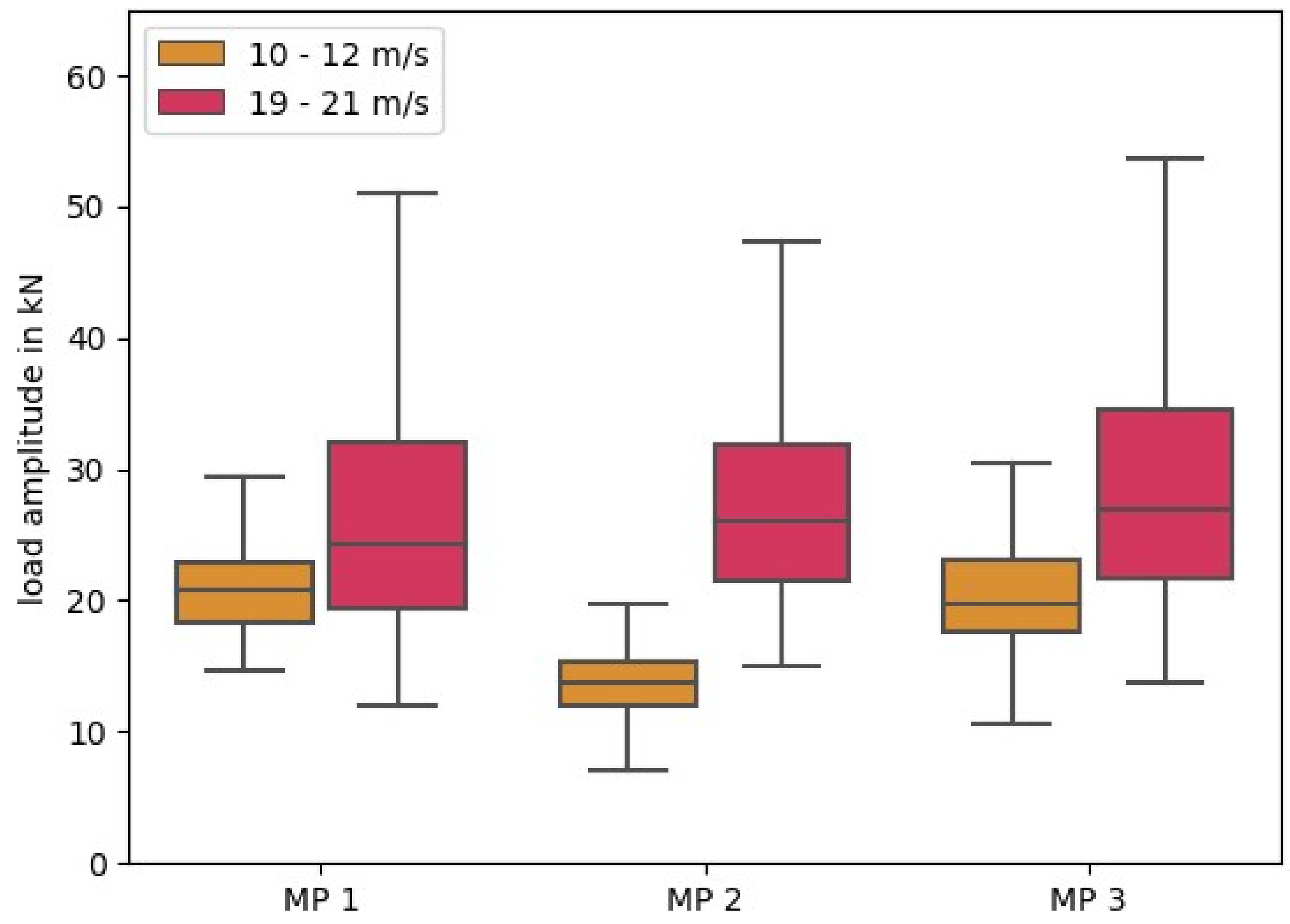

Fig.3: Comparison of different load amplitudes, corrugation and speeds

Discussion

Lowering vehicle speeds can reduce harmonic load amplitudes, but the correlation is nonlinear.

Corrugation depth affects harmonic excitation differently at various speeds, suggesting potential complexities in implementing speed-based strategies.

Changing train directions to counteract corrugation was not easily possible due to infrastructure limitations in the studied metro line.

Conclusion

While varying vehicle speeds holds promise in mitigating the effects of rail corrugation, operational constraints and complexities may limit its implementation [3]. Current solutions like rail grinding and milling remain practical for managing corrugation, but other approaches preventing corrugation such as using hardened rails, show promising results [4]. Future studies should look deeper into the interaction between corrugation depth and vehicle speed.

References

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