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ADVANTAGE OF BASEPLATE WITH TWO RESILIENT LAYERS FOR RAILWAY SLAB

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ABSTRACT

Vibration from trains may give rise to two distinct environmental nuisances: vibration may propagate to buildings and produce ground borne noise; vibrations of the vehicle, track, and supporting structure radiate airborne noise. Resilient baseplates are a popular means of tackling the first problem. However, an undesirable by-product of their low track stiffness may be that it can lead to high vibration levels of track components, and in particular the baseplate itself, which exacerbate the second problem. The paper describes measurements which demonstrate that a design of baseplate which include two layers of resilience can produce acceptable levels of ground borne vibration, while the baseplate itself is isolated from the rail vibrations. Compared baseplate system with a similar overall dynamic stiffness but only one resilient layer, the vibration level of the new baseplate was reduced by more than 8 dB.

1 - INTRODUCTION

This paper describes vibration measurements carried out on 20m trial length of the Pandrol Double FASTCLIP (DFC) baseplate system installed on a 300m radius curve in a tunnel in place of the existing track fastenings. Both fasteners had nominally similar dynamic stiffness, through the more modern DFC design eliminated threaded components, and importantly in this context, incorporated a resilient rail seat pad between the rail and the baseplate. Measurements were made both before and after rail support was transferred from the existing fastening system to the new assemblies. The tests were required to show that the DFC assembly satisfied the requirements for new track construction. The measurements demonstrated this to be the case. As expected, rail vibrations transmitted to the slab were attenuated by both baseplates. There was, however, as significant difference in the vibration levels of the two baseplates, and this is discussed below.

2 - TRACKS/TRAFFIC AND MEASUREMENTS

The existing track consisted of Pandrol brand clips with 4.5 mm thick rail pads, cast baseplates and resilient 15 mm thickness baseplate pads on cast-in concrete sleepers. The rail was UIC60 section. The new DFC system was installed between the existing assembly. The rail pads, clips and insulators of the existing fastening system were removed, and the rail load transferred from the existing fastening system to the DFC system. The DFC system incorporates a 10 mm Pandrol studded rubber rail pad, a cast baseplate and a 10 mm Pandrol studded rubber baseplate pad. The original rail remained in place throughout the tests. A significant difference between the assemblies was therefore that the DFC assembly had a rail seat pad with a static stiffness of only about 30 MN/m compared to approximately 400 MN/m on the existing plate.

Normal service passenger trains were recorded under normal peak traffic conditions, with a train speed of around 55 km/h.

Vibrations on the rails and baseplate were measured using Kistler K-shear type 8702 accelerometers. Concrete slab vibrations were measured on the center line of the track and at mid-span relative to the existing assemblies using Kistler K-shear type 8712 accelerometers. A Kistler type 5128AM 16-channel coupler was used to condition the signal from all the accelerometers. The analogue outputs from the acceleration measuring equipment were recorded on a TEAC RD200 digital tape recorder.

3 - RESULTS AND DISCUSSIONS

Vibration records were transferred to a computer and analyzed to obtain the frequency spectrum, and the linear and A-weighted levels. As is usual [1] vibration levels of the track are presented in term of the velocity levels. Accelerations were converted to velocities in the frequency domain after spectral analysis. All the measured results presented here were averaged on three successive days each for more than 25 trains within the evening traffic peak.

There are a number of potential noise sources on the railway tunnel. These include the rail, baseplate and slab. Vibration levels of these components under traffic can indicate the radiated noise power from the corresponding elements. We can compare the levels with different fastening systems installed in the track.

Slab Vibration

The slab velocity data was analyzed to give a frequency spectrum. The frequency range of greatest interest for the slab vibration is about up to 500 Hz. Vibrations in this frequency range for the slab vibration are not usually A-weighted, because the A-filter applies attenuation at the low frequencies. The average linear velocity levels for both existing and DFC tracks in the vertical direction at the track center is shown in Figure 1. The slab velocity with DFC system is significantly lower. This shows that the DFC plate fulfilled its primary purpose of attenuating slab vibration levels. Figure 1 also shows the vertical velocity spectra of slab. This indicates that the baseplate assembly resonance frequency under traffic was around the 63 Hz band. The peak vibration around 315 Hz band is probably dependent on the resonance of the mass of baseplate on the baseplate pad.

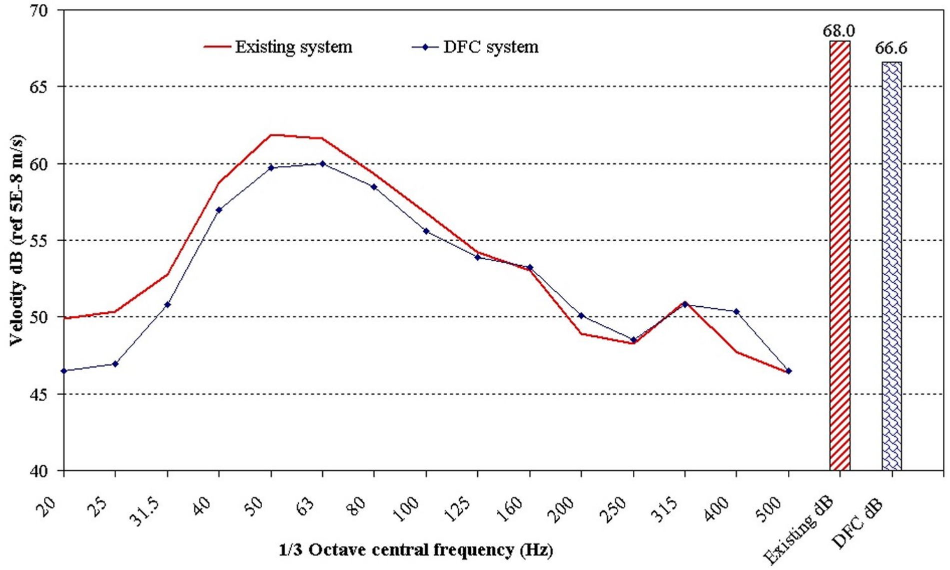

Figure 1: Comparison of slab vertical vibration.

Baseplate/Rail Vibration

Because there are potential noise sources, the frequency range of greatest interest for the rail and baseplate vibration is up to 2500 Hz. Figure 2 shows the vibration levels on the baseplate. The vibration level on the rail with the existing baseplate was 103.2 dB(A), and this was marginally lower, by 0.2 dB(A), with the DFC system. The baseplate vibration level for DFC system has been reduced about 8.4 dB(A) compared with the existing system, and was about 2 dB(A) lower than the rail vibration level. Figure 2 also shows a comparison of the baseplate velocity spectra in the vertical direction. This indicates that the vibration levels on the existing baseplate in the frequency range about from 200 Hz to 800 Hz were much higher than that on the rail, and may contribute significantly to airborne noise affecting the noise level inside the train and on the platform. The significant reduction achieved with the DFC system is due to the use of dual resilient pads in this system. Because of the short length of the test installation, it was not possible to make meaningful direct measurements of noise in the trains at the trial site.

4 - CONCLUSIONS

Baseplate vibration levels were much lower for a fastening system incorporating a resilient rail seat pad than for one without. The peak vertical vibration of the later baseplate occurs between 200 Hz and 800

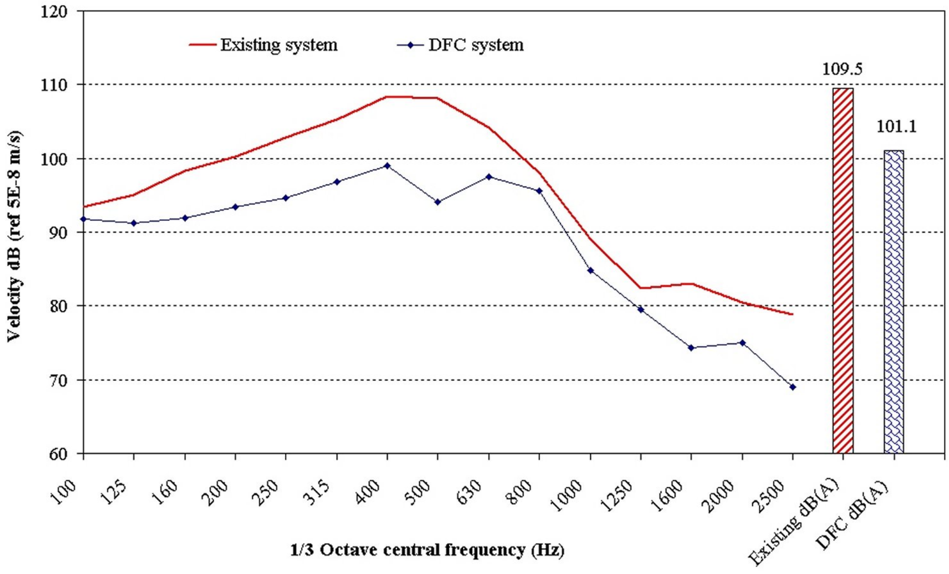

Figure 2: Comparison of baseplate vertical vibration.

Hz. The total level was reduced by about 8.4 dB(A) when the new fastener was introduced. This reduce airborne noise from track and the noise level inside of train.

REFERENCES

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