

7 March 2019

10-1581 Mobile Plant Trial 20190307

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Attention: Ms Alyce Smith

Dear Alyce

**Windsor Bridge - Heritage Brick Barrel Drain
Mobile Plant Trial - Vibration Monitoring Results
28 February 2019**

1 Introduction

VMS Australia Pty Ltd (VMS) was engaged by Georgiou Group to undertake vibration measurements during ground compaction works on 28 February 2019.

The purpose of the monitoring was to measure the vibration levels in the ground adjacent to the Heritage Brick Barrel Drain during the compaction activities being conducted by a number of plant items to determine the nearest offset distance each plant can safely operate in the vicinity of the drain.

2 Site Description and Work Operations

Ground compaction vibration trials were on the following plant:

- Wacker Neuson RC110 12 tonne single drum vibratory roller
- Mikasa MT-65HA 70kg tamper rammer (wacker packer)
- Wacker Neuson RT82 1.5 tonne remote controlled dual drum padfoot trench compactor roller

Vibration measurements were carried out directly on the ground with each plant item operated at various offset distances from the monitoring location.

Photographs of each tested plant item are shown in **Figure 1** to **Figure 3**.

Figure 1 Wacker Neuson RC110 12t Single Drum Vibratory Roller



Figure 2 Mikasa MT-65HA Tamper Rammer



Figure 3 Wacker Neuson RT82 Trench Roller



3 Vibration Monitoring Results

Table 1 presents a summary of the measured maximum vibration velocity levels (in any orthogonal direction) for the plant trials.

Table 1 Summary of Maximum Vibration Levels on Ground

Plant	Distance	Measured Maximum Vibration Levels	Frequency
12t Roller (Static)	4 m to 15 m	0.1 mm/s to 2.3 mm/s	11 Hz to 42 Hz
12t Roller (Vibratory)	4 m to 15 m	1.5 mm/s to 8.1 mm/s	19 Hz to 42 Hz
12t Roller (Oscillating)	4 m to 15 m	0.6 mm/s to 9.5 mm/s	17 Hz to 42 Hz
Tamper Rammer	1 m to 5 m	2.1 mm/s to 6.0 mm/s	50 Hz to 83 Hz
Trench Roller	1 m to 5 m	1.3 mm/s to 6.1 mm/s	25 Hz to 42 Hz

4 Comments and Recommendations

4.1 Discussion of Results

The maximum recorded vibration level which can be attributed directly to the roller soil compaction works was 8.1 mm/s (at 42 Hz), measured at an offset distance of 4 m from the compaction area during the operation of the 12t vibratory roller. In oscillating mode, the 12t roller produced a maximum vibration level of 9.5 mm/s (at 42 Hz) at an offset distance of 4.0 m. Under static operation, the 12t roller produced a maximum vibration level of 2.3 mm/s (at 42 Hz) at an offset distance of 4 m.

The Tamper Rammer produced a maximum vibration level of 6.0 mm/s (at 83 Hz) at an offset distance of 1 m.

The Trench Roller produced a maximum vibration level of 6.1 mm/s (at 42 Hz) at an offset distance of 1.5 m.

It was observed that the vibration levels increased when there was a change in the direction (forward/reverse) for both of the rollers. Further, the vibration level also increased for all plant items during the start-up and shut-down of the vibrator, which also produced the vibrations at the lower frequencies.

The measured maximum vibration levels measured for each plant tested also coincided with the highest frequency of vibration and corresponded to the full power operation of each plant.

4.2 Comparison Against Vibration Damage Criteria

The Stage 1 Pile testing report identified German Standard DIN4150 as containing the most stringent, applicable and recent vibration criteria which may be adopted for the protection of the Heritage Brick Barrel Drain from potential vibration induced damage associated with the site activities. An extract of the relevant frequency dependent vibration limits for heritage structures is presented in **Table 2**.

Table 2 DIN 4150 Safe Vibration Limits for Heritage Structures

Group	Type of Structure	Peak Particle Velocity (mm/s)		
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz ¹
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (eg buildings that are under a preservation order)	3	3 at 10 Hz increasing to 8 at 50 Hz	8 at 50 Hz increasing to 10 at 100 Hz and above

Review of the vibration limits presented in **Table 2** shows that the vibration criteria are more stringent at lower frequencies, with a minimum (most stringent) vibration limit of 3 mm/s for frequencies below 10 Hz, increasing to 10 mm/s at 100 Hz and above. Plant specific vibration criteria are recommended in **Section 4.3** below.

4.3 Recommended Vibration Limits for Heritage Brick Barrel Drain

For all subsequent attended monitoring, if required, particularly for any works being undertaken closer than 2 m to the Heritage Brick Barrel Drain, the DIN4150 frequency dependent vibration criteria for heritage structures (**Table 2** above) will continue to be adopted for the drain.

For other ongoing compaction works, vibration monitoring would be undertaken using unattended vibration monitors with local alarm notification (flashing lights and siren). For all unattended monitoring, two control limits are recommended:

- “Operator Warning Level” of 6 mm/s
- “Operator Halt Level” of 8 mm/s

The nominated control limits would apply to vibration monitoring conducted on the ground surface directly above the Heritage Brick Barrel Drain and at the near point to the compaction works. The control limits have been nominated based on the typical ground surface vibration frequency range of 40 Hz to 50 Hz, a minimum vibration attenuation from the ground surface to the drain of 50 % (which also increases with increasing surface vibration level) and a predicted maximum vibration level on the Heritage Brick Barrel Drain of 3 mm/s corresponding to the 8 mm/s “Operator Halt Level” applied to the ground surface above the drain.

4.4 Recommended Compaction Controls

The following operational controls are recommended in order to minimise the ground vibration when working adjacent to the Heritage Brick Barrel Drain:

- The vibrator or oscillator on the 12t roller is not to be started or stopped within 10 m of the drain.
- The vibrator on the trench roller is not to be started or stopped within 4 m of the drain.
- The 12t roller (static only), tamper rammer and trench roller can be operated within the zone of influence and directly over the drain, pending confirmation that the static weight of the 12t roller and dynamic weight of the tamper rammer and trench roller does not exceed the load rating for the drain.
- The 12t roller in vibratory and oscillating mode is not to be operated within 4.5 m of the drain.
- Attended vibration monitoring is recommended if the 12t roller (vibratory or oscillating) is operated within 6 m of the drain.
- Progressively relocate the vibration monitor to the nearest ground surface point above the Heritage Brick Barrel Drain for each compaction area.

I trust the above meets your current requirements. Please feel free to contact me if you require any additional information.

Regards,



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