

12 February 2019

10-1581 CC10 Trial 201900212

Georgiou Group
Level 3, 53 Berry Street
NORTH SYDNEY NSW 2060

Attention:

**Windsor Bridge - Heritage Brick Barrel Drain
Compaction Roller Trial - Vibration Monitoring Results
17 January 2019**

1 Introduction

VMS Australia Pty Ltd (VMS) was engaged by Georgiou Group to undertake vibration measurements during roller ground compaction works on 17 January 2019.

The purpose of the monitoring was to measure the vibration levels directly on the Heritage Brick Barrel Drain during the compaction activities being conducted in the vicinity of the drain.

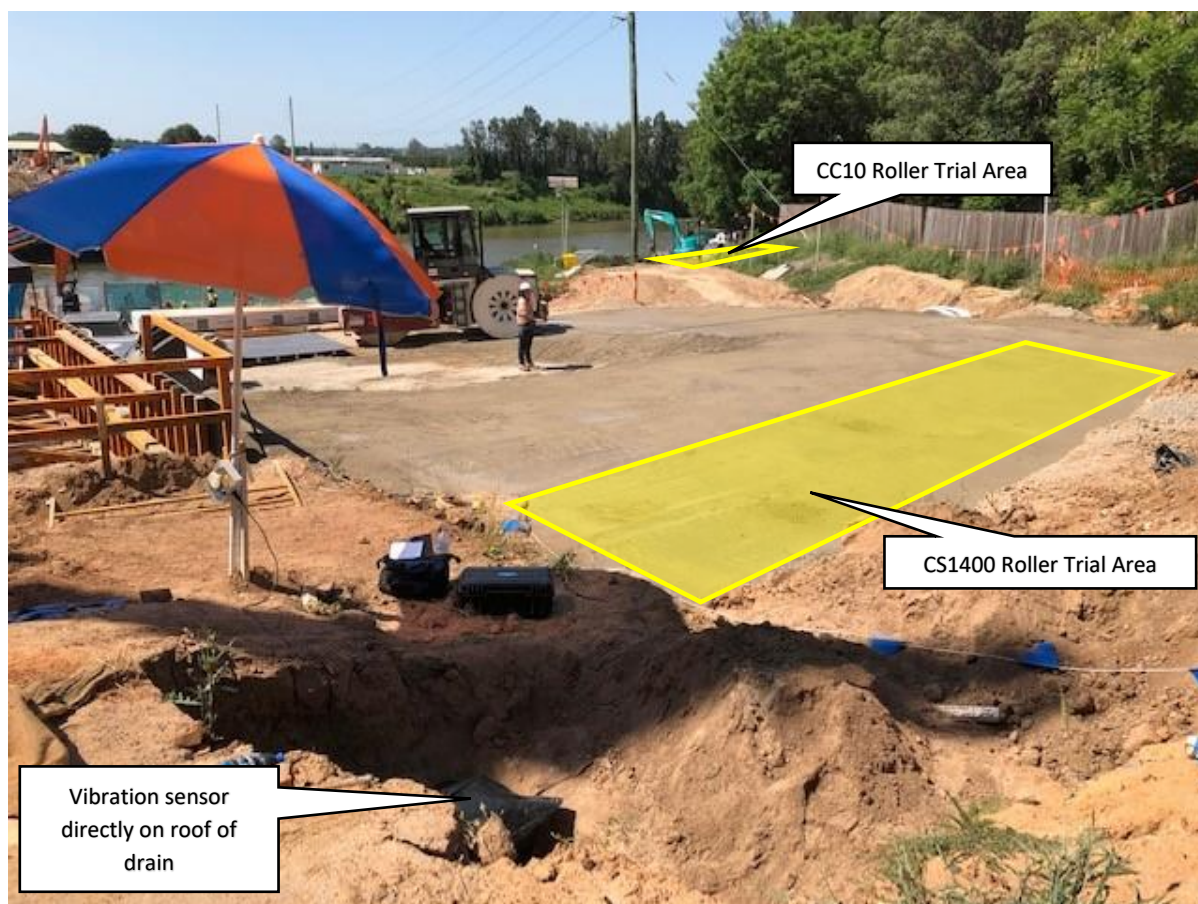
2 Site Description and Work Operations

Ground compaction works were undertaken using a Dynapac CC10 vibratory roller (2.5 tonne) and a Dynapac CS1400 static (non-vibratory) roller (13 tonne). The CC10 roller was operate between 45 m and 55 m northeast of the exposed Heritage Brick Barrel Drain monitoring location. The CS1400 roller was operated between 2 m and 10 m east of the exposed drain monitoring location.

Vibration measurements were carried out directly on the roof of the Heritage Brick Barrel Drain on the section previously exposed and approved by the Heritage Manager for the Stage 2 Test Piles Trial.

A photograph showing the setup of the vibration monitoring survey is shown in **Figure 1**.

Figure 1 Compaction Roller Monitoring



3 Vibration Monitoring Results

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

Table 1 Summary of Maximum Vibration Levels Measured on Roof of Exposed Drain

Roller	Distance	Measured Maximum Vibration Level	Frequency
CC10 (2.5t vibratory)	45 m to 55 m	0.1 mm/s to 0.2 mm/s	4 Hz to 15 Hz
CS1400 (13t static)	2 m to 10 m	0.2 mm/s to 0.3 mm/s	4 Hz to 13 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 0.3 mm/s, measured directly on the roof of the Heritage Brick Barrel Drain at an offset distance of 2m from the compaction area during the operation of the CS1400 static roller.

When the CC10 vibratory roller was used at a near point of 45 m from the drain, the maximum vibration level recorded on the drain was 0.2 mm/s.

It was observed that the maximum vibration level occurred when there was a change in the direction (forward/reverse) for both of the rollers. Additionally, for the CC10 roller, the vibration level also increased during the start-up and shut-down of the vibrator, which also produced the vibrations at a lower frequency.

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. A comparison of the maximum measured vibration level (0.3 mm/s) from the CS1400 roller against the DIN4150 vibration limits has found that the vibration levels induced on the Heritage Brick Barrel Drain from the rollers was well below even the most stringent vibration limit of 3 mm/s.

4.3 Recommend 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 4 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:

- Maintain constant roller speed when working within 5 m of, or above, the drain i.e. the roller is not to stop or reverse direction.
- The vibrator on the CC10 roller is not to be started or stopped within 10 m of the drain.
- Attended vibration monitoring is required if the CC10 roller is operated with the vibrator on within 5 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,



MARK BLAKE
Principal - Construction - Noise, Vibration and Blasting