Haweswater Aqueduct Resilience Programme – Proposed Marl Hill Section

Environmental Statement

Volume 4

Appendix 17.4: Construction Vibration

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1. Construction Vibration

1) This appendix presents the predicted construction vibration levels during piling and compaction surface works using the empirical predictors presented in Table E.1 of BS 5228-2[1].

1.1 Vibratory Compaction and Piling

1.1.1 Compaction

2) Groundborne vibration levels during soil compaction have been made using the Caterpillar soil compactor CS78B as a candidate plant item. This is a large single drum compactor with an operating weight of 18.7 kg, a gross power of 130 kW and a compaction width of 2.1 m. The compactor can be operated at either a low or high nominal vibration amplitude (1.0 or 2.1 mm) with a standard vibratory frequency of 28 Hz.

3) Illustration 1 presents the resultant Peak Particle Velocity (PPV) vibration levels predicted for steady state and start up / run down (transient) compaction with 50 % and 5 % scaling factors, denoting the probability of the predicted value being exceeded. Predictions have been made for the Caterpillar CS78B compactor operating with a low vibration amplitude (0.98 mm). Predictions at high vibration amplitude (2.1 mm[2]) have also been made and are presented in illustration 2. It is anticipated that high vibration amplitude setting will only be used when works are not undertaken in close proximity to sensitive properties.

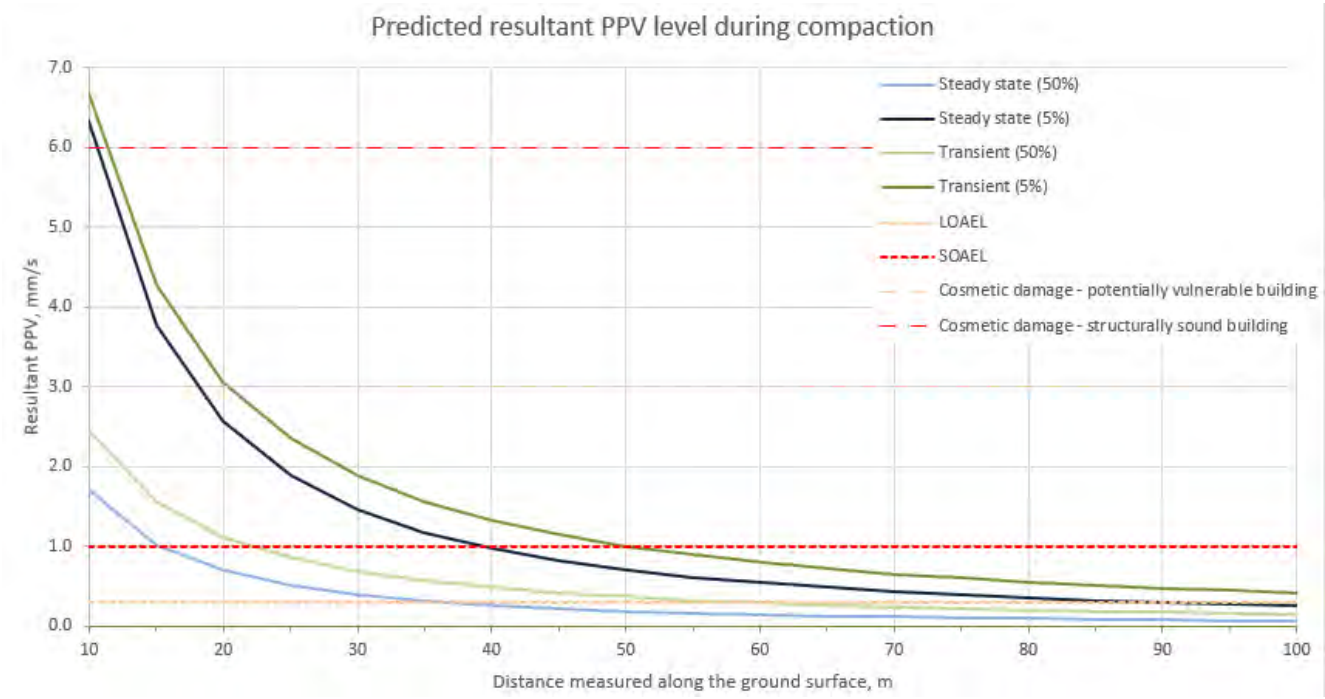
4) The input parameters for the prediction method adopted (Table E.1 of BS 5228-2) comprise:

- The number of vibrating drums (1 or 2)
- The maximum vibration amplitude (0.4 to 1.72 mm)
- The width of the vibrating drum(s) (0.75 to 2.2 m)
- The distance measured along the ground surface.

[1] BSI (2014). British Standard 5228 part 2 (BS 5228-1:2009+A1:2014), *Code of practice for noise and vibration control on construction and open sites, Part 2: Vibration*. London, the British Standards Institution.

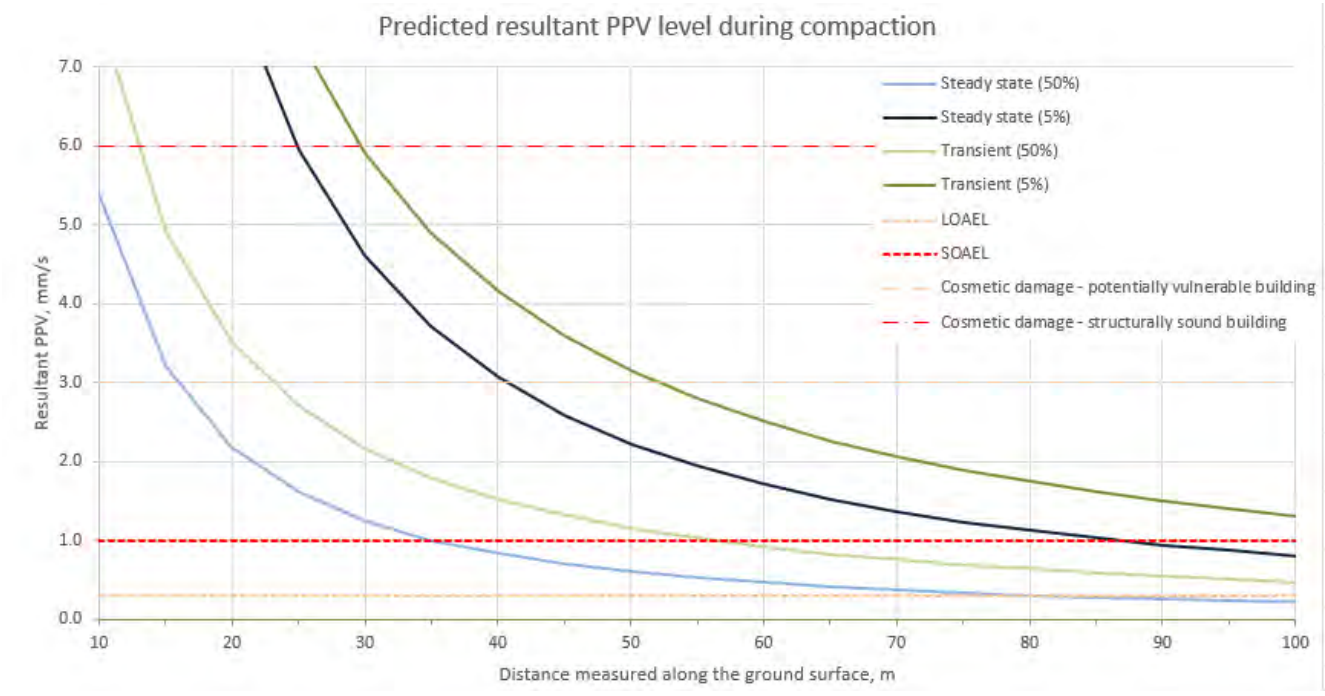
[2] 2.1 mm vibration amplitude is approximately 0.4 mm above the maximum parameter range for the prediction method but has been adopted as a worst-case prediction assumption.

Illustration 1: Predicted vibration levels during vibratory compaction (nominal vibration amplitude 0.98 mm)



5) When considering low vibration amplitude setting, during steady state working, and at a distance of approximately 15 m, there is a 50 % probability of 1.0 mm/s PPV being exceeded, with a 5 % probability of 1.0 mm/s PPV being exceeded at a distance of approximately 40 m. During the transient start up and run down conditions, the distances at which 1.0 mm/s PPV is predicted to be exceeded are approximately 25 m (50 % probability) and 50 m (5 % probability).

Illustration 2: Predicted vibration levels during vibratory compaction (nominal vibration amplitude 2.1 mm)



6) At high vibration amplitude setting the potential for adverse impacts are greater. During steady state working, and at a distance of approximately 35 m, there is a 50 % probability of 1.0 mm/s PPV being

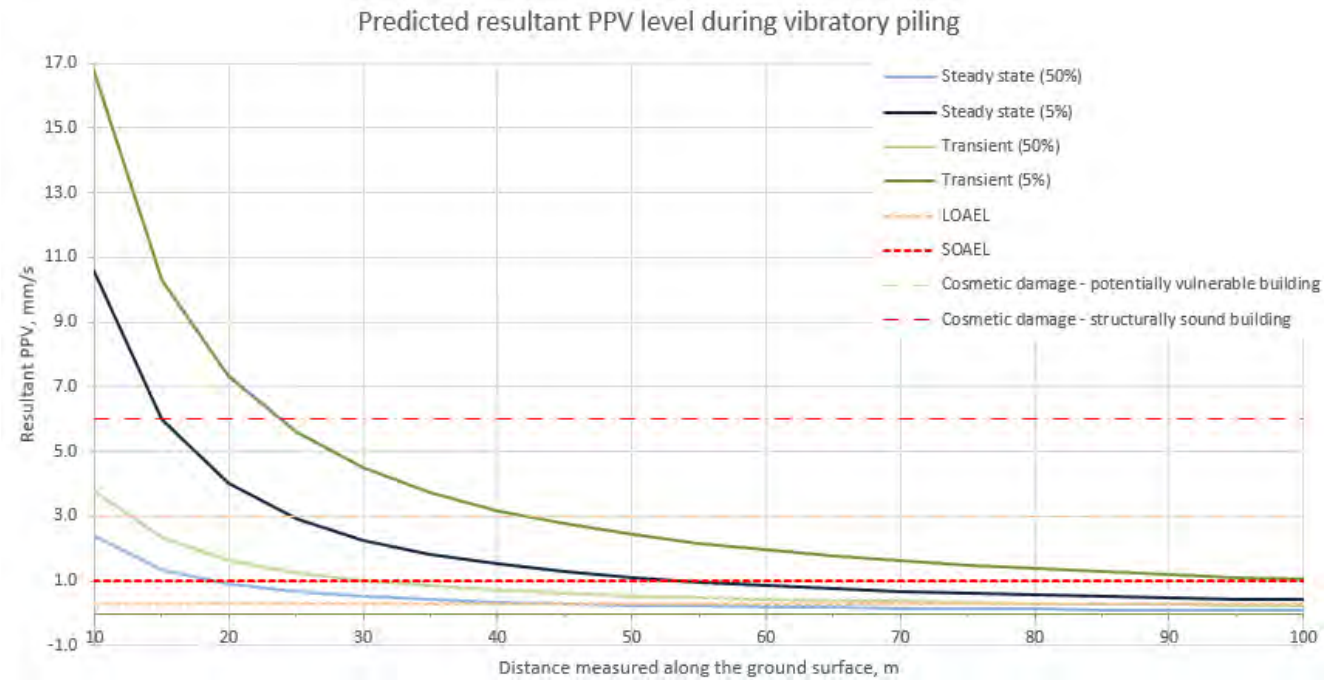
exceeded, with a 5 % probability of 1.0 mm/s PPV being exceeded at a distance of approximately 85 m. During the transient start up and run down conditions, the distances at which 1.0 mm/s PPV is predicted to be exceeded are approximately 55 m (50% probability) and 120 m [3] (5 % probability).

1.1.2 Vibratory Piling

7) Illustration 3 presents the resultant Peak Particle Velocity (PPV) vibration levels predicted for steady state and start up / run down (transient) vibratory piling with 50 % and 5 % scaling factors, denoting the probability of the predicted value being exceeded.

8) The only input parameter for the prediction method adopted (Table E.1 of BS 5228-2) was the distance measured along the ground surface. All other conditions are included in the constants and scaling factors within the empirical calculation.

Illustration 3: Predicted vibration levels during vibratory piling



9) During steady state working, and at a distance of approximately 18 m, there is a 50 % probability of 1.0 mm/s PPV being exceeded, with a 5 % probability of 1.0 mm/s PPV being exceeded at a distance of approximately 55 m. During the transient start up and run down conditions the distances at which 1.0 mm/s PPV is predicted to be exceeded are approximately 30 m (50 % probability) and 100 m (5 % probability).

10) The results presented in this appendix are intended to provide an indication of reasonable worst-case groundborne vibration levels during soil compaction and vibratory piling. Vibration levels experienced during construction will be influenced by factors including the number of surface layers, the thickness, density and stiffness of surface layers, the depth of the water table, the topography of the site and the operating frequency of the plant. For compaction plant, the speeds of the compactor will also influence vibration emissions[4].

[3] 120 m is outside the parameter range for the prediction method but has been included to provide indicative predicted levels to 1.0 mm/s.
[4] Hiller D. M. and Crabb G. I. Groundborne vibration caused by mechanised construction works. TRL Report 429. Wokingham: TRL, 2000.