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Haweswater Aqueduct Resilience Programme - Proposed Bowland Section– Proposed Bowland Section

Environmental Statement

Volume 4

Appendix 17.4: Construction Vibration and Blasting

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United Utilities

Water for the North West

Haweswater Aqueduct Resilience Programme - Proposed Bowland Section

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Contents

1. Construction Vibration and Blasting

1) This appendix is in two parts. Part 1 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], while part 2 considers vibration and noise associated with blasting.

2) Groundborne Noise and Vibration (GBNV) impacts associated with the tunnelling works for the Proposed Bowland Section cannot currently be undertaken as the necessary ground investigation information is not yet available. The outstanding GBNV assessment will be reported under a separate cover in due course.

1.1 Vibratory Compaction and Piling

1.1.1 Compaction

3) Groundborne vibration levels during soil compaction have been predicted 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.

4) 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.

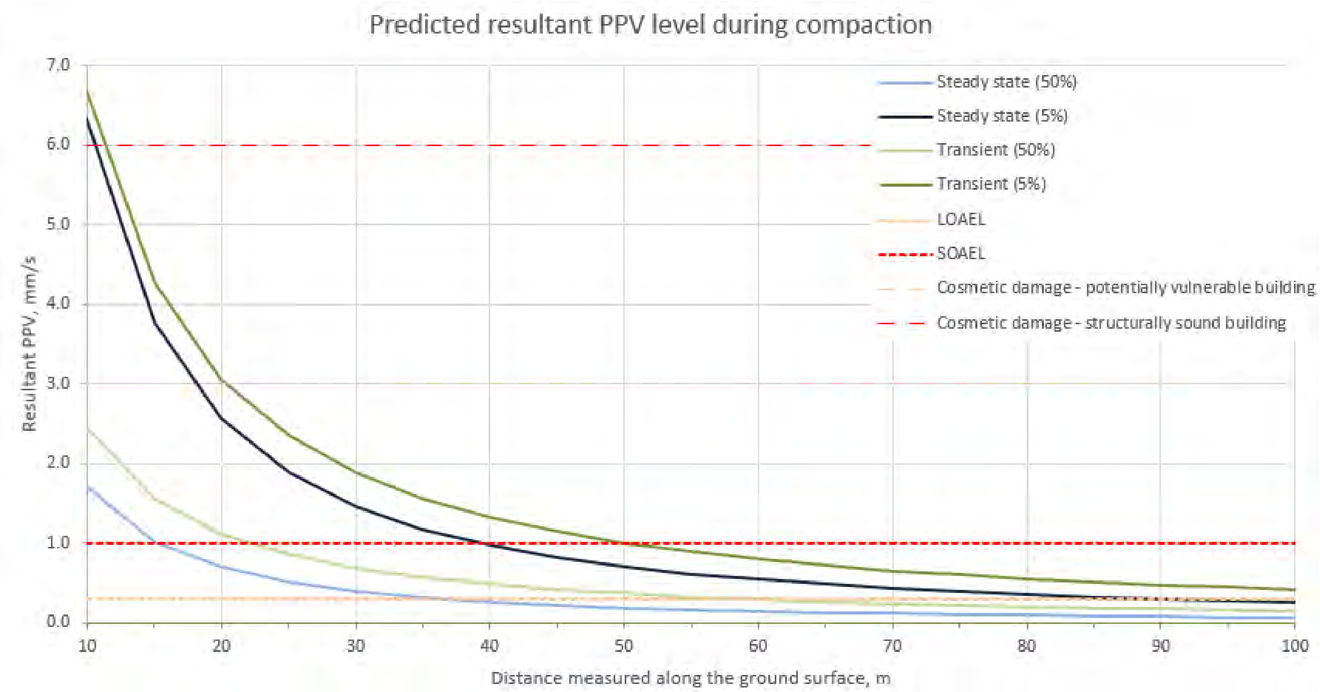
5) The input parameters for the prediction method adopted (Table E.1 of BS 5228-2) comprise:

- 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.

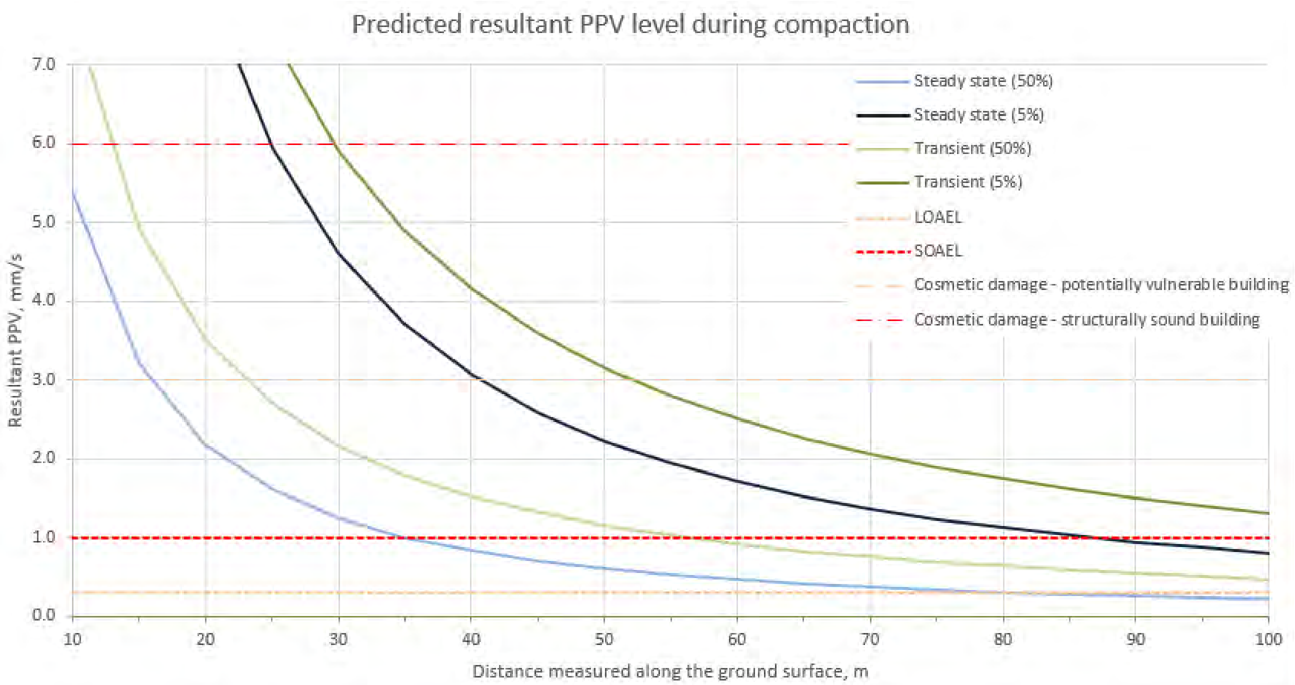
[2] 2.1 mm vibration amplitude is approximately 0.4 mm above the maximum parameter range for the prediction method but has been adopted as a worst-case prediction assumption.

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



6) 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)



7) 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).

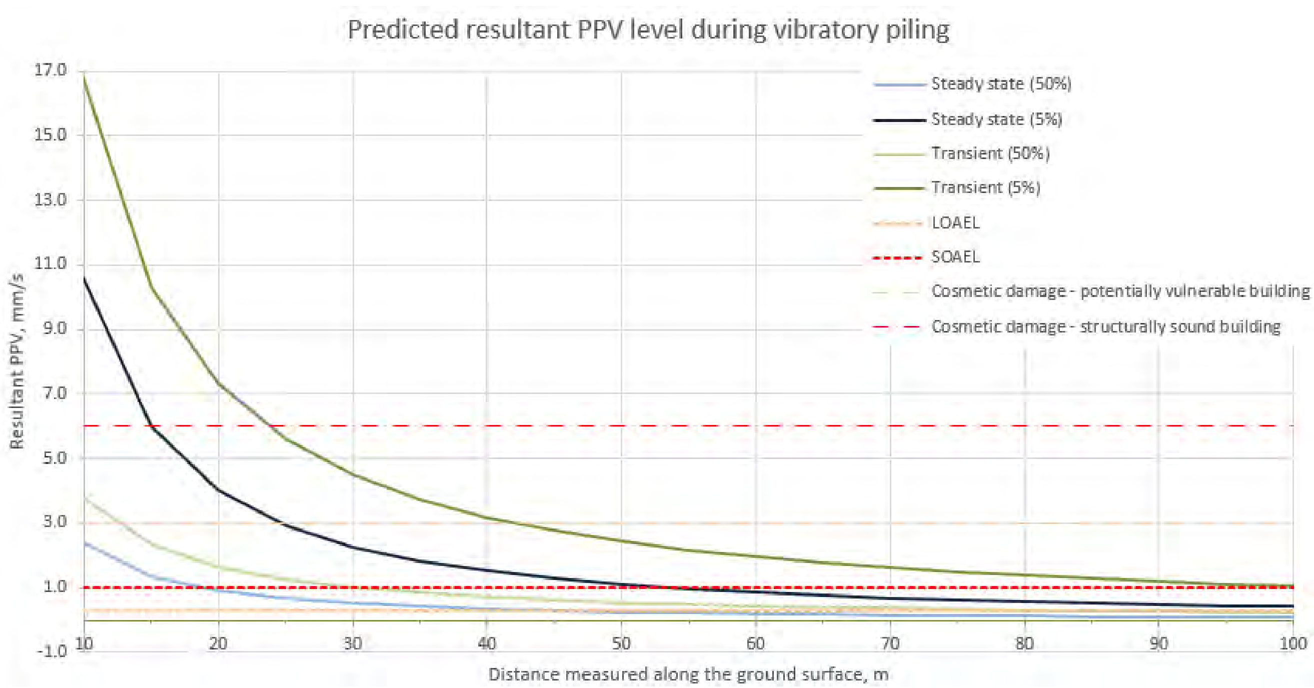
1.1.2 Vibratory Piling

8) 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.

9) 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.

[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.

Illustration 3: Predicted vibration levels during vibratory piling



10) 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).

11) 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].

1.2 Blasting

12) Blasting techniques would be used where high strength rock is encountered. This technique would involve drilling holes into exposed rock, into which explosive charges would be placed. The charges would then be detonated to break up the rock. This method would generate high noise and vibration events for very short periods of time. At this stage, the locations where blasting may be required are not defined and the details of blasting (including the mass of charges, hole spacing and detonation delay) are not known. However, it is likely that blasting would be undertaken in the following locations[5]:

- Shafts, where drill and blast techniques in hard rocks may be undertaken
- The Newton-in-Bowland Compound in order to excavate for the working platform
- At open cut sections where hard rocks are encountered.

13) Where blasting is required, and prior to the blasting being undertaken, an assessment would be carried out by the appointed contractor to determine the predicted groundborne vibration and air overpressure

[4] Hiller D. M. and Crabb G. I. Groundborne vibration caused by mechanised construction works. TRL Report 429. Wokingham: TRL, 2000.
[5] United Utilities, Haweswater Aqueduct Resilience Programme, Drive Strategy Optioneering Report. April 2020 Interim Update. Costain.

levels at the nearest sensitive receptors following the guidance contained in BS 6472-2[6]. The assessment approach, measurements and controls would be agreed with the local planning authority.

14) A maximum satisfactory vibration magnitude (for up to three blast events per day) of 6.0 to 10.0 mm/s outside the nearest residential properties should be adopted during blasting, as per BS 6472-2, Table 1. The maximum satisfactory vibration magnitude is the level below which the probability of adverse comment is low. BS 6472-2 states that adverse comment could result at double the maximum satisfactory vibration magnitudes. BS 6472-2 advises that 6.0 mm/s is the generally accepted maximum satisfactory magnitude for residential premises, however the standard also suggests that a limit value of up to 10.0 mm/s could be used where 6.0 mm/s is likely to be restrictive, with justification for a higher limit value provided on a 'case-by-case basis'. Blasts would be designed to meet a lower vibration limit value of 6.0 mm/s where reasonably practicable.

15) BS 6472-2 provides lower maximum satisfactory magnitudes of vibration for night-time working and during 'other periods', which would include extended weekend working.

16) BS 6472-2 does not provide maximum satisfactory magnitude for air overpressure; however, it does recommend that blasts should be designed to result in levels that do not exceed 120 dB(lin) at the nearest properties. PAN 50 Annex D[7] states that '*such magnitudes will be perceived by individuals although they are entirely safe*'.

17) All blasting would be carried out between the hours of 08:00 to 18:00 Monday to Friday and on Saturday between 08:00 to 13:00, and the number of blasts per day would be agreed with the relevant authorities, following the guidance in BS 6472-2.

[6] British Standard 6472-2: 2008 - Guide to evaluation of human exposure to vibration in buildings; Part 2 Blast-induced vibration
[7] Planning Advice Note 50 PAN50, Annex D. The Scottish Office, 2000