

Vibration Survey and Assessment



Site: Land East of Tulleys Cottage, Toddington
Lane, Wick, Littlehampton, BN17

Client: Stuart Tulley

Job No.: J2370

Date: 20/12/2017



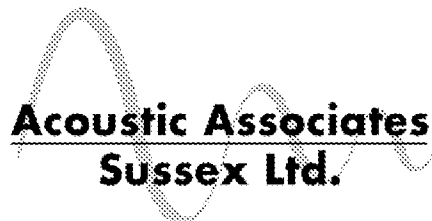
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Acoustic Associates Sussex Ltd

Measurement and Assessment of Ground-borne Vibration

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Client: Stuart Tulley



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1 Introduction

Acoustic Associates have been appointed to undertake a ground-borne vibration assessment relating to part of the proposed residential development at land east of Tulleys Cottage, Toddington Lane, Wick, Littlehampton.

The purpose of this assessment is to assess levels of vibration associated with the near by railway in order to satisfy a planning condition.

A vibration survey was carried out between the 6th and 8th December 2017 in order to measure ground-borne vibration levels associated with the nearby railway.

The survey and assessment have been carried out following the guidelines of BS6472 (Part 1 – 2008)

Measurements were taken in 3 axes and the correct frequency weighting was applied to all measurements.

The measurements were used to calculate the VDV_{day} & VDV_{night} values for all three axes. The magnitude of weighted acceleration is greatest in the vertical Z-axis. However, the VDV_{day} and VDV_{night} levels are such that adverse comment is not expected.

The report concludes that if the suggested traditional strip or trench-fill type foundations, or similar, was used there would be no need for vibration mitigation measures.

2 Planning Policy, Context & Noise Assessment Criteria

2.1 Context

The land east of Tulleys Cottage is proposed to have a new development of three houses upon it: One detached house and a pair of semi-detached houses. These houses are to sit a minimum of 10m from the nearby railway line which passes East-West, south of the site.

2.2 Planning Policy Guidance 24 (Planning and Noise)

Planning policy guidance notes set out the Government's policies on different aspects of planning. Local authorities must take their content into account in preparing their development plans. They may be material to decisions on individual planning applications and appeals.

With regard to ground-borne vibration PPG24 states the following (Annex 3, paragraph 4)

The likelihood of significant ground-borne vibration will depend on the nature of the ground and the types of train. The possibility of vibration and re-radiated noise caused by trains running in tunnels should not be overlooked. Advice on acceptable levels of vibration can be found in BS 6472.

2.3 BS6472 (New edition - 2008)

Part 1 of BS 6472 provides guidance on predicting human response to vibration in buildings over the frequency range 0.5 Hz to 80 Hz. Frequency weighting curves for human beings exposed to whole-body vibration are included, together with advice on measurement methods to be employed. Methods of assessing continuous, intermittent and impulsive vibration are presented. This part of BS 6472 describes how to determine the vibration dose value, VDV, from frequency-weighted vibration measurements. The vibration dose value is used to estimate the probability of adverse comment which might be expected from human beings experiencing vibration in buildings. Consideration is given to the time of day and use made of occupied space in buildings, whether residential, office or workshop.

2.4 BS6472 Criteria

In homes, adverse comment about building vibrations is likely when the vibration levels to which occupants are exposed are only slightly above thresholds of perception. When the appropriately-weighted vibration measurements or predictions have been used to derive the VDV for either 16h (daytime) or 8h (night-time) at the relevant places of interest, their significance in terms of human response for people in those places can be derived from the table below which has been taken from BS6472:

<i>Place & Time</i>	<i>Low probability of adverse comment¹ $ms^{-1.75}$</i>	<i>Adverse comment possible $ms^{-1.75}$</i>	<i>Adverse comment Probable² $ms^{-1.75}$</i>
Residential Building 16h Day	0.2 - 0.4	0.4 - 0.8	0.8 - 1.6
Residential Building 8h Night	0.1 - 0.2	0.2 - 0.4	0.4 - 0.8

Table 1: BS6472 Criteria

2.5 ANC Guidelines for Measurement & Assessment of Groundborne Vibration

These guidelines, published in 2012 aim to provide additional guidance in relation to all aspects of vibration monitoring and assessment in line with BS6472, BS7385 and BS5228. Its aim is to provide interpretation and useful practical methods to assist the assessor in real-terms.

Were possible, this assessment has followed these guidelines.

¹ Below these ranges adverse comment is not expected.

² Above these ranges adverse comment is very likely.

3 Vibration Survey Baseline Conditions & Results

A vibration survey was carried out between the 6th and 8th December 2017 in order to measure ground-borne vibration levels associated with the nearby railway.

3.1 Survey Details

3.1.1 Equipment

- Vibrock V901 3-Axis Vibration Meter
- Vibrock VDV Tri-Axial Accelerometer

3.1.2 Personnel

Survey carried out by: Simon Barrett BSc(Hons) MSc MIOA

3.1.3 Site/Survey Drawings

The site location and accelerometer position used during the vibration survey are shown in the figure below:

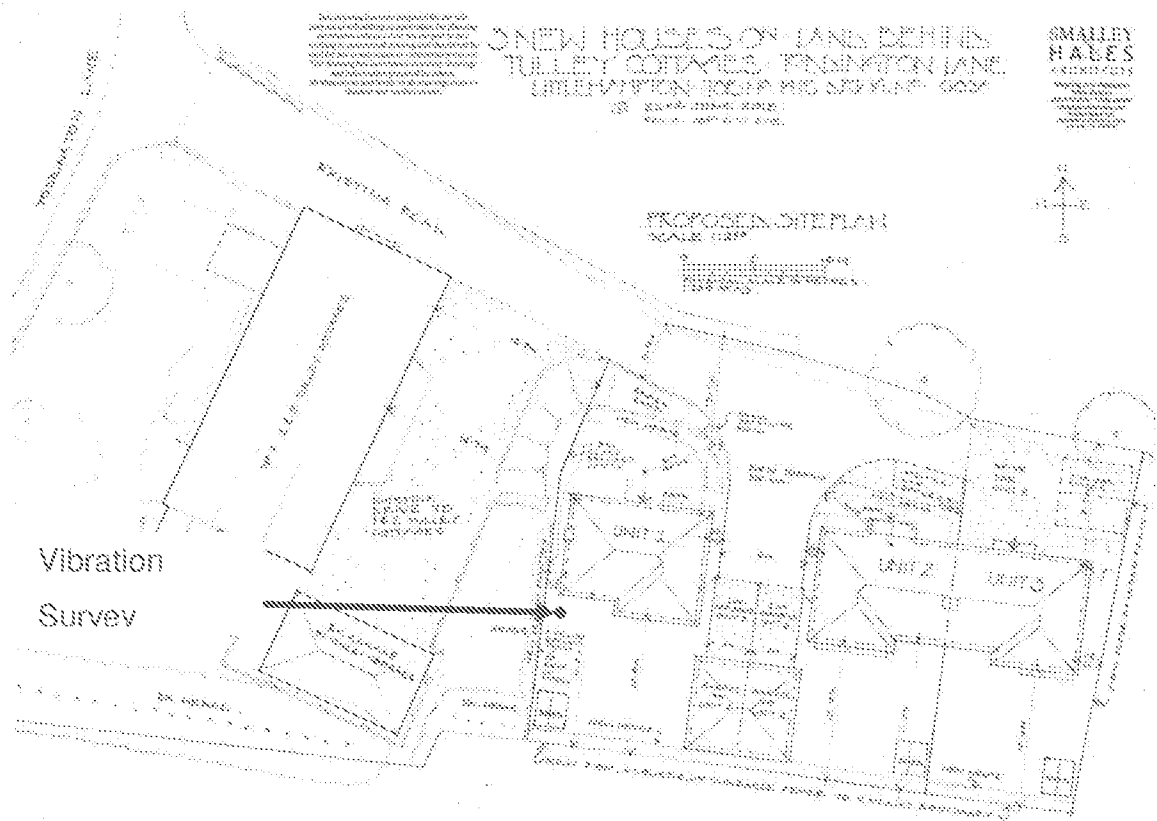


Figure 1: Survey Location Plan

3.1.4 Measurement Position/Details

The Vibrock tri-axial accelerometer was embedded in to the hard-packed soil in line with the proposed building façade of Unit 1 that is closest to the railway line and was held in place with a sandbag to ensure a good connection to the ground. Axis X was perpendicular to the railway, Axis Y was parallel to the railway and axis Z was the vertical axis. The Vibrock V901 was set up to continuously monitor vibration levels over the whole measurement period in hourly intervals.

3.2 Frequency Weighting

The way, in which people perceive building vibration depends on various factors, including the vibration frequency and direction. Different frequency weightings are required for different axes of motion. BS6472 states which frequency weightings should be used for each axis. The weighting curve modulus for vertical acceleration is W_b and W_d for horizontal motion. The weighting curves are defined in BS 6841. The Vibrock V901 was set up so that the correct frequency weightings were applied to the measurements.

3.3 Noise Survey Results

3.3.1 All VDV Measurements

The effect of building vibration on the people within is assessed by finding the appropriate vibration dose. Present knowledge shows that this type of vibration is best evaluated with the vibration dose value (VDV). The VDV is given by the fourth root of the time integral of the fourth power of the acceleration after it has been frequency-weighted. The Vibrock V901 calculates the hourly VDV values internally and also provides a summed value for the full 16 or 8 hour periods.

Due to the survey setup time being part way through the hour and also midway through the day, this event is incomplete in itself. Likewise, the event on the survey collection date was stopped mid-hour and before the daytime period was up. However, the two events together allow for a full daytime period to be made and thus adding all the full-hour measurements for these two events, will provide a full “VDV_{day}” value. The events affected are 001 and 005.

Measurements started at approximately 14:00hrs on the 06/12/2017 and finished at approximately 15:00hrs on the 08/12/2017. The measurements were conducted for 49hrs in total. The VDV values have been summed to show the VDV_{day} and VDV_{night} values:

$$VDV_{day} = \left(\sum_{23:00hrs}^{07:00hrs} VDV_{hr}^4 \right)^{0.25}$$

$$VDV_{night} = \left(\sum_{07:00hrs}^{23:00hrs} VDV_{hr}^4 \right)^{0.25}$$

The table below shows the day and night time period VDV levels that were measured during the survey.

The frequency weighting (F_w) applied to each axis is also shown:

Time Period	X-Axis		Y-Axis		Z-Axis	
	F_w	$VDV\ ms^{-1.75}$	F_w	$VDV\ ms^{-1.75}$	F_w	$VDV\ ms^{-1.75}$
07:00-23:00hrs	W_d	0.039	W_d	0.026	W_b	0.069
23:00-07:00hrs	W_d	0.033	W_d	0.022	W_b	0.059
07:00-23:00hrs	W_d	0.038	W_d	0.029	W_b	0.075
23:00-07:00hrs	W_d	0.034	W_d	0.022	W_b	0.055

Table 2: Measured Day & Night time VDV levels

N.B. The graphs in the Appendices show the raw vibration level data for each of the three axes per measurement period per day. Please note that Event 001 and Event 005 have been stitched together to provide a full daytime period, ignoring the first hour of Event 001 and the last hour of Event 005.

3.4 Transfer Function

BS6472 states that when vibration transfers from one medium to another, a transfer function should be applied to the measured levels to indicate the factor of change created by the change in medium. This is important as the measurements of vibration need to be assessed for the point where vibration enters the human body, in this case, the building where a person is located.

As the measurements were taken in what would effectively be free-field conditions (within the soil) a transfer function to convert the vibration to how it would be felt within a building will need to be applied.

The ANC Guidelines for the Measurement and Assessment of Groundborne Noise and Vibration provides a table (table 14.3 on page 121 of the document). This has been repeated below for completeness:

Ground Surface to building slab (in contact with the ground)	Ground surface to foundation	Floor to Floor	Floor Resonance
0 dB at low frequencies (from Reference [46])	woodframe: -5dB 1-2 storey commercial: -7dB 2-4 storey masonry: -10dB Large masonry on Spread footings: -3dB Foundation in Rock: 0dB (from Reference [46] & [17])	1 – 5 floors: -2dB/floor 5 – 10 floors: -1dB/floor (from Reference [17]) -3dB/floor (from Reference [46])	= 5 to 15dB over 16-80 Hz (from Reference [46]) = 6dB (from Reference [17])

Table 3: ANC Guidelines - Groundbourne Vibration Transfer Functions

In summary, as the vibration enters the foundation from the ground surface, there will be a large reduction in the vibration level, followed by a smaller reduction per storey that the vibration travels through. This will be offset by the resonance of each floor (which will increase the vibration magnitude).

This ultimately means that the vibration reduction due to building structure will be cancelled out by mid-floor resonances and thus there will be no change in vibration level to be applied.

It should also be noted that the measured vibration levels, even for the most affected Z axis, are significantly below even the criterion values for “Low Probability of Adverse Comment” that even with uncertainties in the transfer function guidelines, there would need to be at least a four-fold increase in measured vibration values to even come close to the lowest criterion values shown in Table 1.

4 Conclusion

BS6472 states that the vibration is to be evaluated for the single axis, determined by tri-axial measurement, in which the magnitude of weighted acceleration is greatest.

The table above demonstrates that the magnitude of weighted acceleration is greatest in the vertical Z-axis. However, the VDV_{day} and VDV_{night} levels are such that adverse comment is not expected.

Even if the VDV levels were subject to a 4-fold increase, adverse comment would still not be expected.

Measurements of vibration should normally be taken on a building structural surface supporting a human body. Where measurements are made other than at the point of entry of vibration to the body an allowance should be made for the transfer function between the measurement point and the point of entry to the body. It has been determined that whilst there will be a large vibration reduction as the vibration enters the building via the foundations and up through the structure per floor, the floor resonances will cancel these reductions out and thus there will ultimately be no change in vibration from the measured levels.

Therefore, it is considered that if the suggested traditional strip or trench-fill foundations or similar, were to be utilised, there would be no need for vibration mitigation measures.

Appendices:

Graphical Representation of RAW Vibration Measurement Data

