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**PROPOSED HOUSING DEVELOPMENT
TOYNBEE ROAD, EASTLEIGH**

VIBRATION ASSESSMENT

Technical Report: R10184-2-3 Rev 1

Date: 20th November 2023

For: Foreman Homes
Yarmouth House
1300 Parkway
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1.0 INTRODUCTION

- 1.1 24 Acoustics Ltd has been instructed by Foreman Homes to undertake a vibration assessment for a residential development located at Toynbee Road in Eastleigh.
- 1.2 Planning approval has been granted for the proposed development, and a number of conditions relate to vibration from the nearby railway line. Accordingly, this assessment has included measurement of vibration levels and consideration of the impact of vibration on the future occupiers of the site.
- 1.3 An explanation of acoustical terms used in this report is provided in Appendix A. All sound pressure levels in this report are given in dB re: 20 μ Pa.

2.0 SITE DESCRIPTION

- 2.1 The site is located off Toynbee Road in Eastleigh and currently comprises derelict buildings and large areas of hardstanding. The north of the site is bounded by the branch railway line between Eastleigh and Chandlers Ford. Analysis of the train running timetable shows an upper level of 36 train movements per 24 hour period, with typically 2 trains per hour.
- 2.2 The proposed development comprises 105 residential units with a mix of houses and flats. Plots 66-77 are located closest to the railway line.
- 2.3 The existing site and vibration survey location are shown in Figure 1. The proposed site layout is shown in Figure 2.

3.0 CRITERIA

Local Authority

- 3.1 Planning approval was granted for the proposed development in October 2022 (Planning Reference F/21/91686). Conditions 7, 8 and 9 relate to vibration and state the following:

7. No above ground works other for the purpose of remediation of any contamination on site shall commence prior to a detailed vibration assessment being submitted in writing to the Local Planning Authority for approval. When approved, site works excluding works related to building foundations may commence. The vibration impact assessment shall be carried out by a suitable qualified and experienced acoustician and shall comprise sufficient measurement and testing of railway induced vibration, propagation of vibration through the ground and testing or investigation of ground conditions and geology. Numerical calculation of vibration in and through the site and propagating within proposed buildings for dwelling use shall be undertaken using finite element analysis to solve complex simulations of foundation and structural design include for vibration isolation measures. Vibration levels should be no greater than 0.2 mm/s peak particle velocity in any habitable room of the development. The calculation shall include for uncertainty and refer to ISO/TS 14837 series on mechanical vibration from rail systems and professional practice including the Association of Noise Consultants 'Measurement & Assessment of Groundborne Noise & Vibration (3rd Edition) for measurement and calculation of vibration.

Reason: To protect the amenity of future occupiers from the impact of the adjacent railway line.

8. Prior to commencing enabling and foundation works onsite, using the same detailed method of calculation and analysis, a design for mitigating vibration in the ground and upper floors of the dwellings shall be proposed and submitted in writing for approval by the Local Planning Authority. As well as to prevent vibration levels no greater than 0.2 mm/s peak particle velocity in any habitable room, the design including isolating bearings, elastomers etc shall include for relevant longevity for the lifetime of the dwelling and shall be demonstrated as such to the satisfaction of the Local Planning Authority, including Building Control.

Reason: To protect the amenity of future occupiers from the impact of the adjacent railway line.

9. Prior to occupation of those dwellings shown to be effected a vibration measurement survey shall be carried out according to a method submitted to the Local Planning Authority for approval and shall include sufficient representative dwellings and locations within dwelling rooms to verify the effectiveness of the detailed vibration mitigation design. Where required, the applicant shall undertake further measurements to the satisfaction of the Local Planning Authority. The development hereby permitted shall not be brought into use until the scheme for vibration mitigation has been implemented in accordance with approved details and shown through verification measurement survey to be effective.

Reason: To protect the amenity of future occupiers from the impact of the adjacent railway line.

- 3.2 It is important to note that these conditions are a significant deviation from what is typically used to assess human response to vibration in the UK. The use of PPV does not account for the frequency content of the vibration, nor the frequency of occurrence, and is typically used to assess human response to short term construction vibration sources and building damage.
- 3.3 Human response to vibration is most commonly assessed in the UK using BS 6472-1:2008, which uses the appropriately weighted Vibration Dose Value (VDV) parameter.
- 3.4 Following a review of the first version of this report, the LPA agreed that VDV is the correct parameter for assessing vibration. The LPA proposed alternative thresholds, which are detailed below.

British Standard BS 6472-1:2008

- 3.5 The assessment of human response to vibration within buildings is currently guided by British Standard BS 6472-1:2008 [Reference 1]. The relevant criteria are summarised below.

- 3.6 Where vibration occurs as a series of events, as in the case of train pass-bys, BS 6472-1 indicates that Vibration Dose Values should be used. Human response to vibration in buildings is assessed in terms of VDV's defined over daytime and night-time periods.
- 3.7 The human body is most sensitive to vibration in the vertical direction (head to foot). The standard defines values of VDV which are likely to cause varying degrees of adverse comment and these are summarised in Table 1.

Place and Time	Vibration Dose Value, $\text{m/s}^{1.75}$		
	Low Probability Of Adverse Comment	Adverse Comment Possible	Adverse Comment Probable
Residential 16 hr day (07:00 to 23:00)	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential 8 hr night (23:00 to 07:00)	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

Table 1: Vibration Dose Values and Subjective Response

- 3.8 Mr Neil Scott provided a review of the first version of this report on 18th October 2023. As part of the review, reference was made to using guidance from the High Speed 2 rail line project (HS2), which specifies limits for VDV corresponding to the lowest values in Table 1, i.e., $0.2 \text{ m/s}^{1.75}$ for daytime and $0.1 \text{ m/s}^{1.75}$ for night-time.
- 3.9 Although the LPA has confirmed that it is more appropriate to use VDV rather than PPV to assess vibration in this case, the assessment herein presents measured levels in terms of both parameters for completeness.

4.0 VIBRATION MEASUREMENTS

Measurement Instrumentation and Procedure

4.1 Vibration measurements were undertaken at the site between 25th and 30th August 2023. The following equipment was used:

- Svantek (Class 1) precision sound & vibration level meter Type 958;
- Dytran tri-axial accelerometer Type 3233A;
- Svantek portable vibration calibrator Type SV111.

4.2 Vibration measurements were obtained at Location 1, shown in Figure 1 and described below:

- Location 1 – In the north-east portion of the site, at the approximate location of the northern façade of Plot 66 (closest to the track).

4.3 The accelerometer was mounted on the ground and well coupled using a thick stainless steel disc and spikes (in accordance with guidance from BS ISO 14837-1 [Reference 2]). Measurements were undertaken in three axes of motion, defined as X (horizontal, parallel to the railway), Y (horizontal, perpendicular to the railway) and Z (vertical).

4.4 The vibration data has been used to determine the overall daytime and night-time VDV_s in accordance with the methodology in BS 6472-1. These values are shown in Table 2 below.

Date	Direction of Motion and Vibration Dose Value, $\text{m.s}^{-1.75}$					
	Daytime (07:00 to 23:00)			Night-time (23:00 to 07:00)		
	X	Y	Z	X	Y	Z
Friday 25/8/2023	0.004	0.015	0.012	0.003	0.011	0.007
Saturday 26/8/2023	0.004	0.007	0.008	0.003	0.006	0.002
Sunday 27/8/2023	0.003	0.006	0.013	0.003	0.006	0.008
Monday 28/8/2023	0.003	0.006	0.013	0.003	0.005	0.009
Tuesday 29/8/2023	0.003	0.006	0.014	0.003	0.006	0.008
Wednesday 30/8/2023	0.002	0.003	0.008	--	--	--

Table 2: Location 1 Daytime and Night-time Vibration Survey Results - VDV

4.5 Measured unweighted PPV values are shown below in Table 3.

Date	Direction of Motion and PPV, mm/s					
	Daytime (07:00 to 23:00)			Night-time (23:00 to 07:00)		
	X	Y	Z	X	Y	Z
Friday 25/8/2023	0.08	0.09	0.11	0.02	0.10	0.12
Saturday 26/8/2023	0.03	0.04	0.12	0.02	0.05	0.02
Sunday 27/8/2023	0.05	0.10	0.14	0.03	0.08	0.13
Monday 28/8/2023	0.09	0.11	0.15	0.04	0.08	0.12
Tuesday 29/8/2023	0.05	0.08	0.14	0.05	0.09	0.11
Wednesday 30/8/2023	0.06	0.09	0.14	--	--	--

Table 3: Location 1 Daytime and Night-time Vibration Survey Results - PPV

4.6 It should be noted that the VDV parameter accounts for the number of train passes within a time period, unlike the PPV which will be associated with a single train pass-by within the period.

5.0 ASSESMENT

5.1 The VDV values shown in Table 2 indicate that the measured vibration levels are comfortably below the 'low probability of adverse comment' threshold defined by BS 6472-1, as well as within the revised thresholds from the HS2 guidance, as recently proposed by the LPA. Therefore, it is considered that vibration from the railway will not cause an adverse impact on the future occupiers of the proposed development.

5.2 Table 3 shows that all measured PPV levels are below the 0.2 mm/s criterion specified in the planning conditions. Given the duration of the survey, the dataset adequately covers variability in train type and speed, and any variation between the two tracks.

5.3 Condition 7 of the planning consent calls for analysis of propagation within the building structures. Spectral analysis of the measured vibration data showed a consistent driving frequency (for a train pass-by) in the range 19-22 Hz, which is consistent with measurements obtained at other sites locally.

5.4 It is appropriate to consider the proposed floor structures which will comprise pre-cast concrete floor planks with a screed in the flats, and timber posi-joists in the houses.

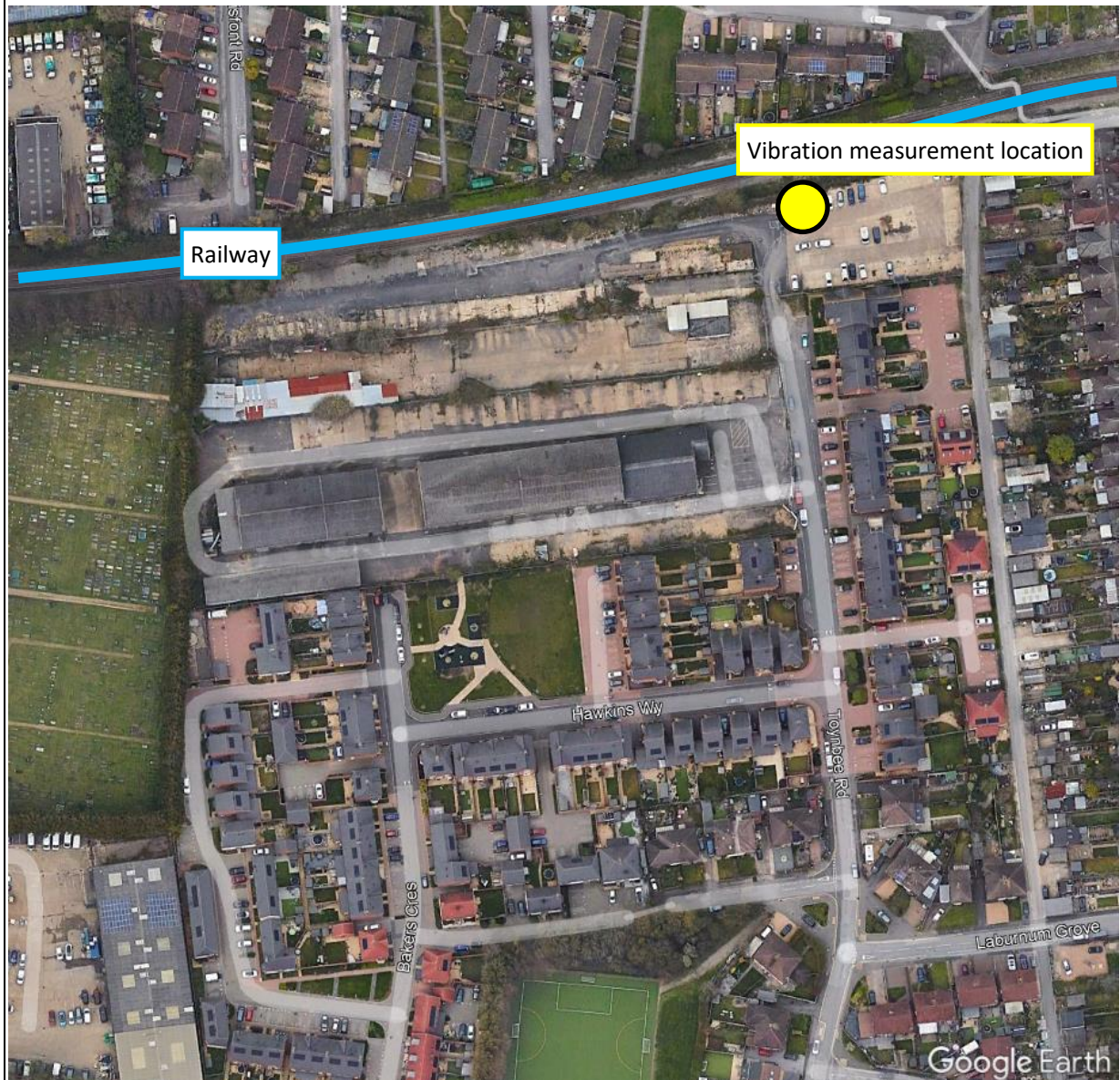
- 5.5 The human body is most sensitive to vibration frequencies in the range 4-8 Hz. Similarly, A value of 8Hz has been suggested by the Eurocode 5 as being the lower limit natural frequency for floors to avoid poor vibrational comfort due to footsteps. Timber posi-joists typically have a natural frequency around 10-11 Hz (lower than solid timber joists). Pre-cast concrete floors for the spans proposed will have a fundamental frequency around 10 Hz. Neither of these values coincide with the measured driving frequency, therefore, no mitigation will be necessary.

6.0 CONCLUSIONS

- 6.1 24 Acoustics Ltd has been instructed by Foreman Homes to undertake a vibration assessment for a development located at Toynbee Road in Eastleigh. It is proposed to develop the site for housing.
- 6.2 Vibration measurements have been obtained to determine the level of vibration from the railway line affecting the site.
- 6.3 Measured PPV levels are below those stated in Conditions 7 to 9. The VDV levels of vibration within the proposed development are categorised as 'low probability of adverse comment' as defined in BS 6472, and therefore acceptable. Furthermore, the VDV levels are comfortably below the HS2 guidance thresholds as agreed with the LPA.
- 6.4 No mitigation will be necessary and the requirements of Conditions 7 to 9 of the planning consent have been satisfied.

REFERENCES

1. British Standards Institution. British Standard 6472: Guide to Evaluation of Human Exposure to Vibration in Buildings, Part 1: Vibration Sources Other than Blasting, 2008.
2. British Standards Institution. British Standard 14837: Mechanical vibration – Ground-borne noise and vibration arising from rail systems, Part 1: General Guidance, 2005.



Project:
Toynbee Road, Eastleigh

Title:
Existing Site and Vibration Measurement Location

DWG No: Figure 1

Scale: N.T.S.

Rev: 0

Date: September 2023

Drawn By: DC

Job No: 10184-2



Project: Toynbee Road, Eastleigh		Title: Proposed layout	 24Acoustics
DWG No: Figure 2	Scale: N.T.S.	Rev: 0	
Date: September 2023	Drawn By: DC	Job No: 10184-2	

APPENDIX A: VIBRATION TERMINOLOGY

Vibration can be described as a movement of a medium about an equilibrium point. Vibration may be periodic, such as the motion of a pendulum or random such as the response of ground to a force input on a construction or demolition site.

Vibration may be measured in terms of acceleration, velocity or displacement (most commonly acceleration or velocity) using either an accelerometer or a velocity transducer and suitable signal conditioning system.

The measured data may be analysed to identify frequency content and considered in terms of a number of different parameters, including the root mean square (RMS), maximum or peak.

In the UK British Standard 6472 Parts 1 and 2 provides methodology for measuring and assessing human exposure to vibration in buildings. The standard states that vibration should be measured in the three orthogonal axes of motion, two lateral and one vertical (with respective frequency weighting curves W_d and W_b), in terms of the vibration dose value (VDV) for overall daytime and night-time periods. Guidance is given on the relationship between daytime and night-time VDV exposures levels and the impacts on occupants.