RBA ACOUSTICS

317 FINCHLEY ROAD
LONDON
NW3 6EP

Vibration Assessment

REPORT 7475/VIB
Prepared: 5 July 2017
Revision Number: 0

317 Finchley Road Ltd

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Revision	Comment	Date	Prepared By	Approved By
Zero	First issue of report	5 July 2017	Andrew Heath	Ignacio Alonso

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1.0 INTRODUCTION

The re-development of the building at 317 Finchley Road is proposed. The ground floor is to be converted into retail space and 22 residential units are proposed in the basement and first to ninth floors.

The site is located in central London on Finchley Road with Finchley Road & Frognal train station to the north. Please also see attached Figure 7475/SP1.

RBA Acoustics has been commissioned to undertake a vibration survey in order to ascertain whether the proposed structures of the building are likely to be affected by train induced vibration.

This report presents the results of the vibration survey undertaken at the site and associated conclusions and provides information towards the discharge of Planning Condition 35 for the development.

2.0 ASSESSMENT CRITERIA

When assessing vibration levels generated by either surface or underground train movements reference should be made to the following guidelines.

2.1 Planning Condition 35

Planning Condition 35 for the development is reproduced below:

> *Prior to occupation of the development, details shall be submitted to and approved in writing by the Council, of building vibration levels and, together with appropriate mitigation measures where necessary. Details shall demonstrate that vibration will met a level that has a low probability of adverse comment and the assessment method shall be as specified in BS 6472:2008. No part of the development shall be occupied until the approved details have been implemented. Approved details shall be thereafter permanently retained.*

2.2 BS 6472

BS 6472-1:2008 "Guide to Evaluation of Human Exposure to Vibration in Buildings Part 1: Vibration sources other than blasting", provides guidance on predicting human response to vibration in buildings over the frequency range 0.5Hz to 80Hz.

BS6472 is based on the evaluation of vibration measurements with regards to adverse comment from occupants.

In terms of assessing what impact the perceptibility of vibration has on a person the standard promotes the use of the vibration dose value (VDV). The VDV determines an overall dose value accounting for intermittent, impulsive or continuous vibration experienced by a person and rates the level in terms of subjective response. The following Table 7475/T1 details the relationship between vibration dose and human annoyance:

Table 7475/T1 – VDV Values

Place and Time	Low probability of adverse comment ($m/s^{1.75}$)	Adverse comment possible ($m/s^{1.75}$)	Adverse comment probable ($m/s^{1.75}$)
Residential Buildings (16h day)	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential Buildings (8h night)	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

The above values can be used for both vertical and horizontal vibration, provided that they are calculated according to the appropriate frequency weightings.

The above have been adopted for the residential areas, the standard also outlines suitable limits for commercial areas which suggests values twice as high. Relevant limits for commercial areas are therefore outlined in Table 7475/T2 below.

Table 7475/T2 – VDV Values

Place and Time	Low probability of adverse comment ($m/s^{1.75}$)	Adverse comment possible ($m/s^{1.75}$)	Adverse comment probable ($m/s^{1.75}$)
Commercial Buildings (16h day)	0.4 to 0.8	0.8 to 1.6	1.6 to 3.2

3.0 TRAIN MOVEMENTS

3.1 London Overground

London Overground trains operate through Finchley Road & Frognal station to the north of the development site between Clapham Junction, Richmond and Stratford.

Timetable information published by Transport for London suggests the following approximate operations occur on the lines during weekday daytime (07:00 – 23:00 hours) and night-time (23:00 – 07:00 hours) periods.

Table 7475/T3 – London Overground train movements through Finchley Road & Frognal station

Period	Number of Passenger Trains
Daytime	192
Night-time	16

3.2 Freight Trains

A number of freight trains were also observed travelling through the site during the survey. The trains were noted to use both eastbound and westbound tracks. The freight trains varied in length and were noted to be both laden and empty.

Timetable information for freight services suggests that approximately 100 freight services operate through Finchley Road & Frognal every week day. Our assessment has assumed the following worst-case number of freight trains as summarised in the table below (based on the Network Rail timetable):

Table 7475/T4 – Freight Train Movements

Period	Number of Freight Trains
Daytime (07:00 23:00)	60-70
Night-time (23:00 - 07:00)	30-40

3.3 Track Conditions

During our time on site we did not note any particular track irregularities being present on parts of the tracks.

4.0 VIBRATION MEASUREMENTS

4.1 Instrumentation

The equipment consists of two uniaxial accelerometers, which are connected via a 01dB Symphonie system to a laptop PC.

Table 7475/T5 – Instrumentation

Equipment	Type	Serial Number	Calibration date	Calibration Certificate
01dB Symphonie data acquisition unit	-	01743	-	-
DJB accelerometers	Type A/121/V	1213 & 1264	1 August 2012	138883 & 138884
Vibration Calibrator	Type AT01	2003	20 July 2012	1207316

The accelerometers were calibrated both prior to and on completion of the survey with no calibration drifts observed.

4.2 Methodology

Vibration measurements were undertaken for a number of passenger trains (London Overground) at three measurement positions between 10:30 and 12:30 hours on Tuesday 24 May 2017.

Measurement Position 1 was measured inside the lower ground floor of the existing building, measurement Positions 2 and 3 were measured externally and selected to approximately represent the closest point of vibration entry to the proposed building foundations.

Position 1: Measurements were undertaken with the accelerometers fixed to the lower ground floor slab and masonry wall within the existing WCs approximately 8m from the edge of the adjacent rail lines.

Position 2: Measurements were undertaken with the vertical axis accelerometer bonded to a paving slab close to the boundary wall and the horizontal axis accelerometer fixed to the boundary wall of the London Overground station. This location was approximately 3m from the edge of the adjacent rail lines approximately mid-way along the proposed building line.

Position 3: Measurements were undertaken with the vertical and horizontal axes accelerometers fixed to the boundary wall of the London Overground station. This location was approximately 3m from the edge of the adjacent rail lines close to the north-west end of the proposed building.

For reference the new building line is proposed to be approximately 7m from the edge of the nearest track.

The approximate locations of the vibration measurement positions are shown on the attached Figure 7475/SP1.

Vertical axis and horizontal axis (perpendicular to the tracks) simultaneous measurements were undertaken at all positions.

5.0 PREDICTION ASSUMPTIONS

Vibration levels are as measured within the ground or within the existing building (described in Section 4.2). In order to estimate the resultant vibration levels within the proposed building we have made the following assumptions:

5.1 Prediction Procedures

Our calculations have been based on the following:

(i) Empirical prediction procedures as detailed within the following references:

- "A Prediction Procedure for Rail Transportation Ground-borne Noise and Vibration" – Nelson and Saurenman : Transportation Research Record 1143.
- "Handbook of Urban Rail Noise and Vibration Control" – Nelson, Saurenman, Wilson : US Department of Commerce – National Technical Information Services – February 1982.

(ii) Previous research undertaken by RBA Acoustics on building response to ground-borne vibration within a variety of different building frame types.

5.2 Proposed Building Structures

Based on information from Webb Yates Engineers we understand the following:

Substructure:

Foundations will be piled.

Superstructure:

It is understood that the superstructure will be formed from a stone exoskeleton.

6.0 PREDICTED LEVELS OF VIBRATION

6.1 Tactile Vibration

Table 7475/T6 details the predicted Vibration Dose Values for both the daytime and night-time periods. Levels have been predicted within the first suspended floor slab, which is generally acknowledged as having the highest levels of vibration. Only the vertical axis has been considered as the floor structures will vibrate predominantly in this axis.

Table 7475/T6 – Predicted VDV_b, day and VDV_b, night

Measurement Position	Floor Level	Period	Vertical	BS 6472 'Low Probability of Adverse Comment' Range
1	First suspended slab	Day	0.039	0.2 – 0.4
		Night	0.03	0.1 – 0.2
2	First suspended slab	Day	0.066	0.2 – 0.4
		Night	0.05	0.1 – 0.2
3	First suspended slab	Day	0.06	0.2 – 0.4
		Night	0.05	0.1 – 0.2

Please note that vibration levels would typically decrease as one moves up through the building (when considering the lower floor levels).

Our calculations indicate that the Vibration Dose Values associated with train and freight movements during both the day and night-time periods will be below the "low probability of adverse comment" range as defined by BS 6472 within all areas of the development. Adverse comment should therefore not be expected from the future occupants on the basis of tactile vibration.

The results predict that vibration levels satisfy the requirements of Planning Condition 35 for the development and we therefore do not consider vibration mitigation measures (such as building isolation) to be necessary.

7.0 CONCLUSIONS

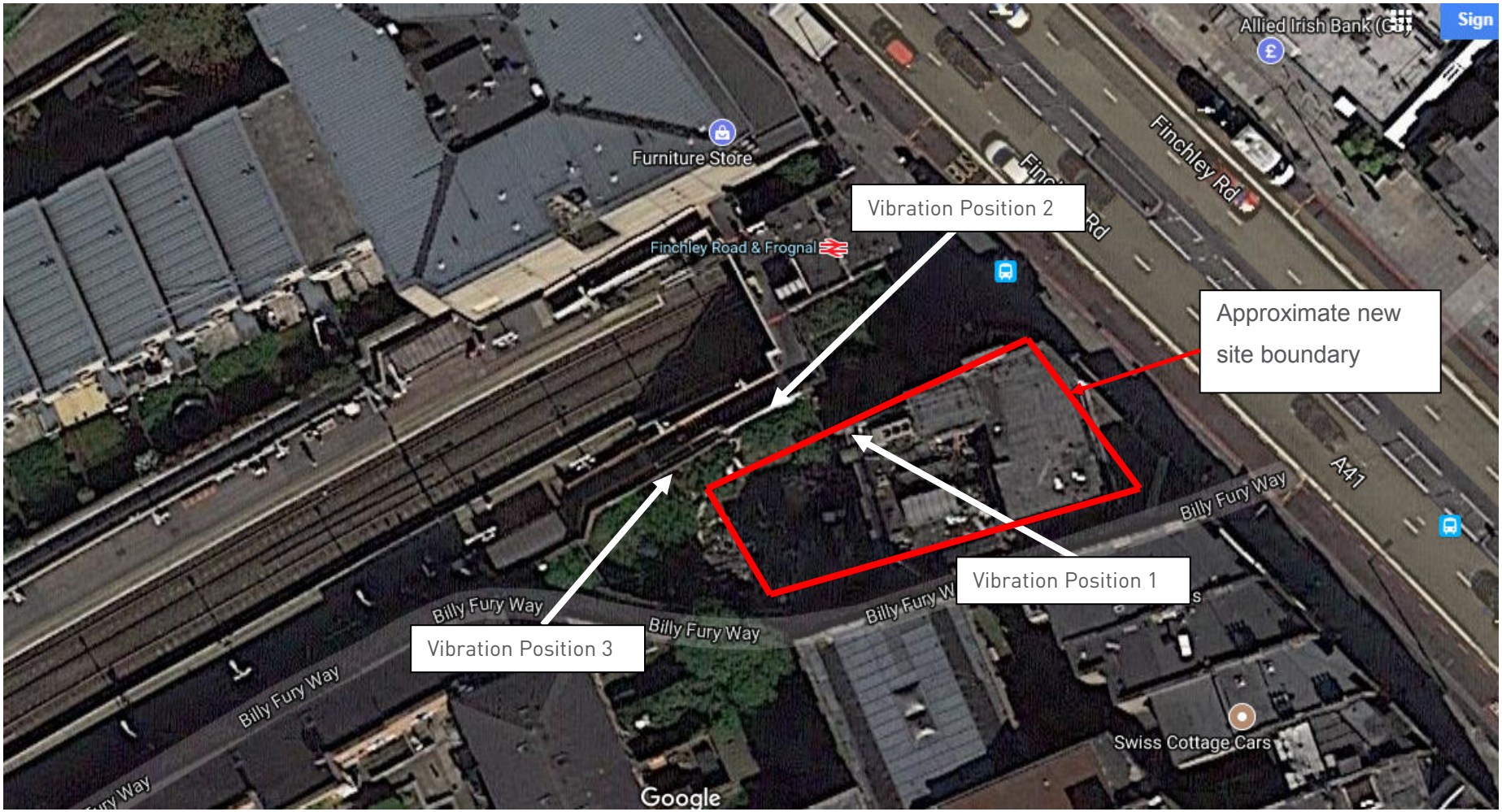
Detailed vibration measurements have been undertaken at the site of the proposed 317 Finchley Road, London.

The vibration measurements have been analysed to yield likely levels of tactile vibration within the worst affected habitable spaces within the proposed building affected by the adjacent rail lines.

Our predictions indicate that vibration mitigation measures (such as building isolation) should not prove necessary, with predicted levels of tactile vibration falling below the proposed criteria. We consider the conclusion of this report to satisfy the requirements of Planning Condition 35.

Appendix A - Acoustic Terminology

dB	Decibel - Used as a measurement of sound pressure level. It is the logarithmic ratio of the noise being assessed to a standard reference level.
Peak to peak	This values gives the total excursion of the oscillation about the zero datum. The unit is often used where the vibratory displacement of a component is critical for maximum stress or mechanical clearance calculations.
Peak	This value gives the maximum excursion of the oscillation above or below the zero datum. This value is useful for indicating the level of short duration shocks.
r.m.s.	This value gives the root mean square of the time history over a specific time interval (time constant). This value is useful for indicating the energy content of the vibration.
VDV	Vibration Dose Value (VDV) is a measure of vibration exposure recommended in BS6472-1:2008 'Guide to evaluation of human exposure to vibration in buildings' for assessing the severity of impulsive and intermittent vibration. It involves analysing the vibration signal using a "fourth power" time dependency, as opposed to the more usual "second power" time dependency used to produce the more familiar r.m.s. values used in noise measurement. A definition of VDV is: the fourth root of the integral, over the measurement period, of the fourth power of the frequency-weighted time-varying acceleration. An important feature of this time dependency is that it places greater emphasis on magnitude than on duration, as compared to r.m.s. measurements, so that, for example, a two-fold increase (or decrease) in vibration magnitude is equivalent to a 16-fold increase (or decrease) in the duration of the vibration. It is measured in $m/s^{1.75}$
$L_{max,T}$	The instantaneous maximum sound pressure level which occurred during the measurement period, T. It is commonly used to measure the effect of very short duration bursts of noise, such as for example sudden bangs, shouts, car horns, emergency sirens, etc., which audibly stand out from the general level of, say, traffic noise, but because of their very short duration, maybe only a very small fraction of a second, may not have any effect on the L_{eq} value.



317 Finchley Road, London

Figure 7475/SP1

Approximate Vibration Measurement Locations

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