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MIDLAND CRESCENT
PLANNING CONDITION 9 – DISCHARGE REPORT

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1. EXECUTIVE SUMMARY

Planning permission has been granted for a predominantly residential development known as Midland Crescent in London. The planning permission contains a condition requiring the developer to submit details of how the building will be built so that internal noise and vibration levels are commensurate with suitable guidelines, namely BS 8233 and BS 6472.

A vibration survey has been conducted at the proposed site of Midland Crescent on land between two active railway lines and Finchley High Road, London.

The vibration levels measured on site indicate that vibration would be perceptible within the development and therefore without suitable mitigation there could be a possibility of adverse comments during the daytime and night time.

Vibration isolation has been proposed, based on isolating the main structure from the ground using an elastomeric bearing, and this mitigation measure should reduce noise and vibration to acceptable levels within occupied areas of the building.

Structure borne noise is predicted to be no higher than $21dB_{LAeq}$, and vibration levels would be reduced to a level below the ‘low probability of adverse comment’ range.

It is concluded that the proposed mitigation measures are suitable to satisfy the requirements of Condition 9 of the planning permission.

2. INTRODUCTION

A development site currently owned by Stadium Capital Holdings and Network Rail, is located just off Finchley Road and between two active railway lines.

Figure 1 Proposed development known as Midland Crescent

Planning permission is granted by Camden Council for the development of a part 3 and part 5 storey building with 2 further levels below street level comprising flexible commercial space at lower basement and ground floor. Above this will be 60 Student bedrooms arranged in clusters and studio units with communal kitchen, lounge and dining areas. There will also be 9 private residential units of 1, 2 and 3 bedrooms.

Condition 9 of the planning permission requires that details of how the building will be constructed to ensure good levels of noise and vibration are achieved within the main structure.

Ramboll Acoustics has been appointed to measure and assess the vibration levels produced by passing trains on the rail lines adjacent to the proposed development at the Midland Crescent site in London. We have assessed vibration levels of passing trains to determine human response and structural borne noise within the proposed development. We have also proposed mitigation as needed.

This report presents the baseline vibration survey, an assessment of the results and proposed mitigation in order to discharge the planning condition Other acoustic aspects relating to the façade noise impact, ventilation strategy, and glazing requirements etc are being dealt with by others. This report deals only with the vibration impacts from the railway and how to mitigate these impacts.

3. PLANNING CONDITIONS

The pre-commencement planning conditions relating to noise and vibration are as follows:

3.1 Condition No. 9

'Prior to commencement of development, details shall be submitted to and approved in writing by the local planning authority of how the building would be constructed and fitted out in order that the noise and vibration from neighbouring railway lines and Finchley Road that would be experienced by occupiers of the development would achieve 'good' internal room noise standards in accordance with the criteria of BS8233:1999 and vibration levels will meet a level that has a low probability of adverse comment and the assessment method shall be as specified in BS 6472:2008. The development shall thereafter not be carried out other than in complete compliance with the approved scheme and no unit shall be occupied until the mitigation measures relevant to that unit have been installed.'

3.2 Criteria

The planning condition states that a good internal rooms noise standard is required following the guidance in BS8233:1999, and a low probability of adverse comments is desired following guidance in BS6472:2008.

This translates to an internal noise criteria of **30dB$_{LAeq}$ in residential rooms**.
The vibration criterion for a low probability of complaints is a **VDV of 0.2 – 0.4 ms$^{-1.75}$ during the daytime and 0.1 – 0.2 ms$^{-1.75}$ at night time**.

4. BASELINE VIBRATION SURVEY

4.1 Site Description

The site is located next to Finchley Road in Finchley, London.

The site is bounded by two railways to the north and south which adjoin each other at the western end of the site. Finchley Road is to the east of the site and provides the only access point. The boundaries form a triangular shaped site.

Trains were noted to be using both the lines to the north and the south of the site approximately every 2-3 minutes. The trains noted during the survey are mainly Electrical or Diesel Multiple Unit commuter services, 8 or 12 car Thameslink services, Diesel 'Intercity' services, and some Freight services.

The site is currently unoccupied and overgrown scrub land.

4.2 Methodology

Groundborne vibration measurements were undertaken by Phil Mudge (BSc MIOA) and Eric Bustemante MSc AMIOA of Ramboll Acoustics during the daytime on Thursday 12th October 2017.

Vibration measurements were taken at the north and south site boundaries nominally 7m from the railway line. This is understood to be the building footprints closest point to the railway. Figure 2 shows a plan of the site with the measurement locations shown.

A 3 axis orthogonal array of accelerometers was securely mounted to the ground using a magnetic block and steel ground spike driven into the ground. The two horizontal axes were aligned to the railway lines (parallel and perpendicular) with the third axis monitoring in the vertical plane.

A series of 1/3 octave band measurements were conducted of typical train events. A significant representative sample of train events was captured; these were a mix of Electrical Multiple Units (EMU's), Diesel Multiple Units (DMU's), 'Intercity' services, and some freight trains. There were also a number of 'ambient' measurements conducted with no trains in the immediate vicinity.

These measurements are considered sufficient to determine the vibration impact upon the building structure caused by the trains and to establish the typical vibration levels and structure borne noise impacts.

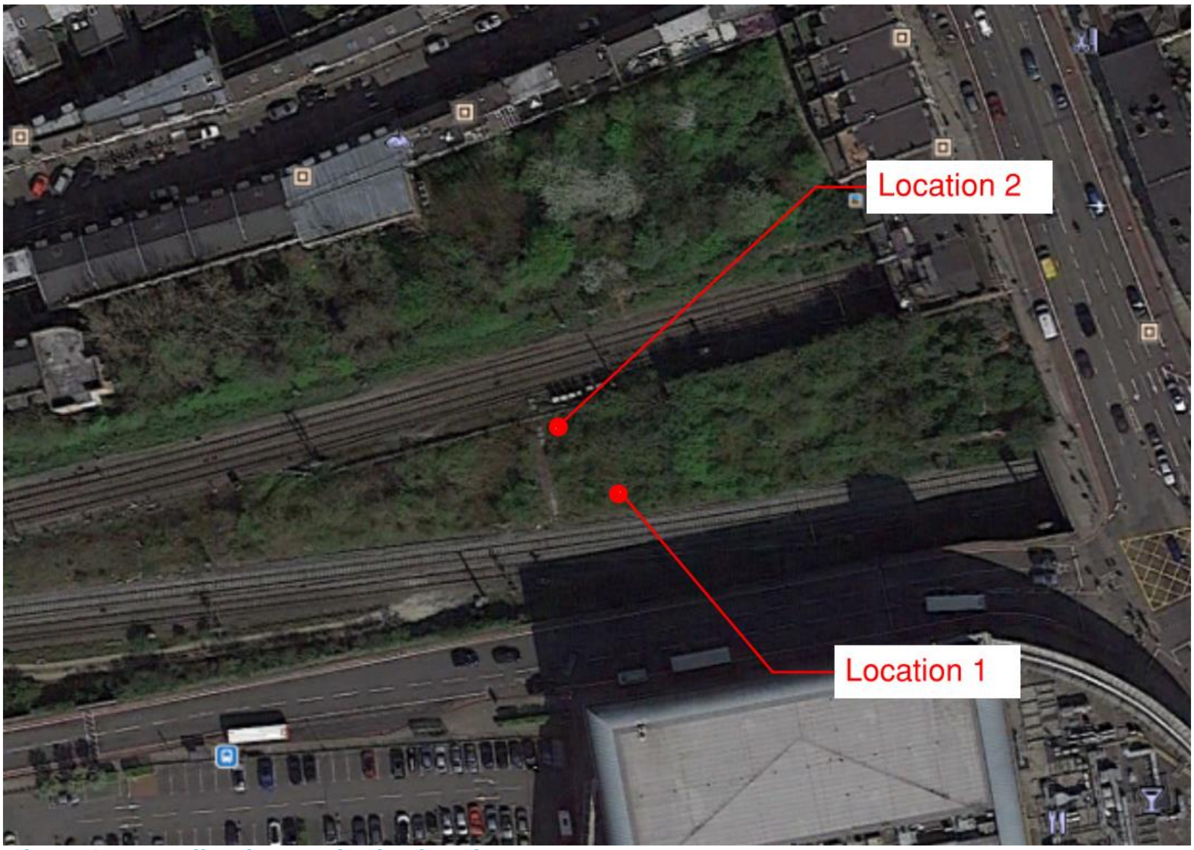

Figure 2 Vibration monitoring locations

4.3 Measurement Equipment

The following measurement equipment was used to conduct the vibration survey.

- 1 of Svantek SVAN958 'Class 1' Real Time Analyser.
- 3 of PCB 393B31 seismic accelerometers.
- 3 axis orthogonal magnetic block.
- 300mm steel ground spike.

4.4 Train measurements

The types of trains measured at each location and direction of travel are summarised in Table 1 and Table 2 below.

Location 1		
Event No.	**Direction**	**Description**
1	Westbound	3 car electrical multiple unit
2	Westbound	5 car electrical multiple unit
3	Westbound	10 car electrical multiple unit
4	Westbound	12 car Thameslink
5	Westbound	5 car electrical multiple unit
6	Westbound	12 car Thameslink
7	Eastbound	5 car electrical multiple unit
8	Eastbound	Intercity 10 car diesel-electric
9	Eastbound	10 car diesel multiple unit
10	Eastbound	Intercity 10 car diesel-electric
11	Eastbound	6 car electrical multiple unit
12	Eastbound	5 car electrical multiple unit
13	Eastbound	8 car electrical multiple unit
14	Eastbound	10 car electrical multiple unit

Table 1 Type and direction of trains measured at Location 1

Location 2		
Event No.	**Direction**	**Description**
1	Westbound	8 car Thameslink
2	Westbound	8 car Thameslink
3	Westbound	8 car Thameslink
4	Westbound	8 car Thameslink
5	Westbound	8 car Thameslink
6	Eastbound	Freight Train
7	Eastbound	12 car Thameslink
8	Eastbound	12 car Thameslink
9	Eastbound	12 car Thameslink
10	Eastbound	8 car Thameslink
11	Eastbound	8 car Thameslink
12	Eastbound	8 car Thameslink
13	Eastbound	8 car Thameslink
14	Eastbound	8 car Thameslink
15	2 trains - eastbound and westbound	2 x 8 car Thameslink

Table 2 Type and direction of trains measured at Location 2

5. MEASUREMENT RESULTS

Figure 3 and Figure 4 present the measured peak third octave band peak vibration velocity results. These indicate the range of vibration levels measured on site at the two locations from the railway operations and compares them to the typical human threshold of perceptibility.

Figure 5 and Figure 6 show the RMS 1/3 octave band RMS vibration levels for the range of measured train operations at each location. These results are used to assess the likely structure borne noise radiated into the building.

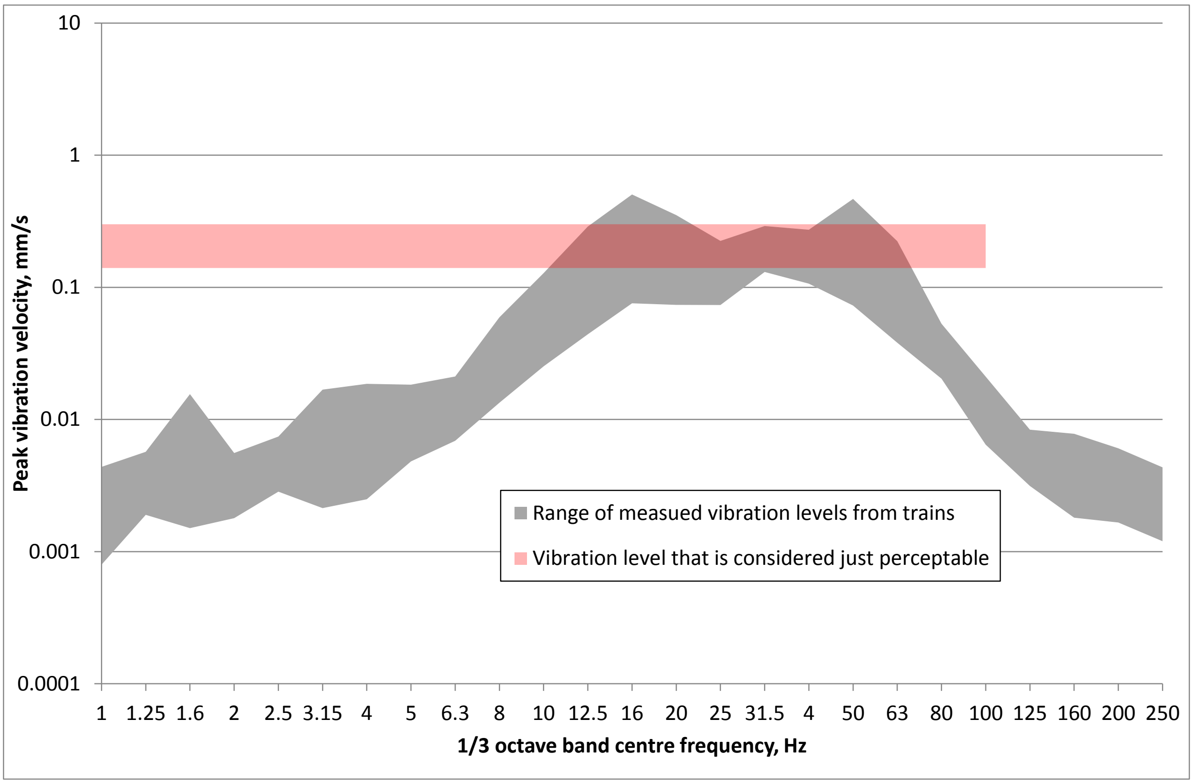

Figure 3 Peak vibration velocity measured at Location 1

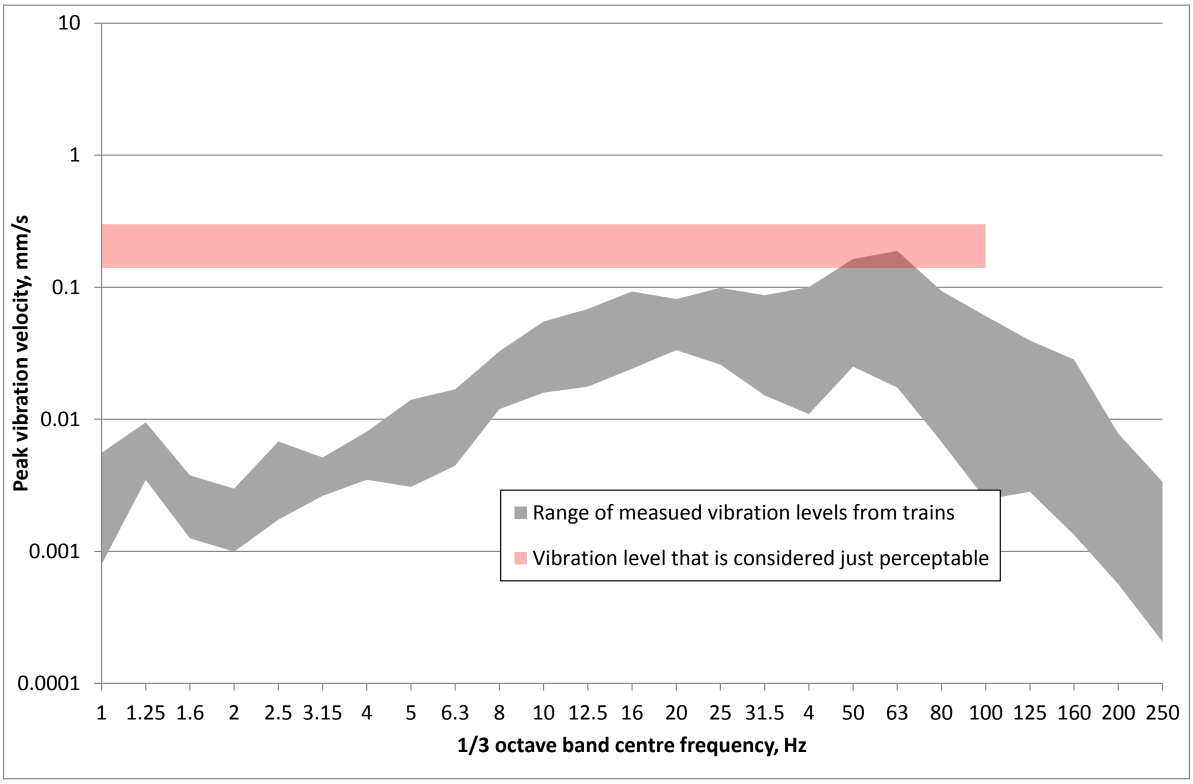

Figure 4 Peak vibration velocity as measured at Location 2

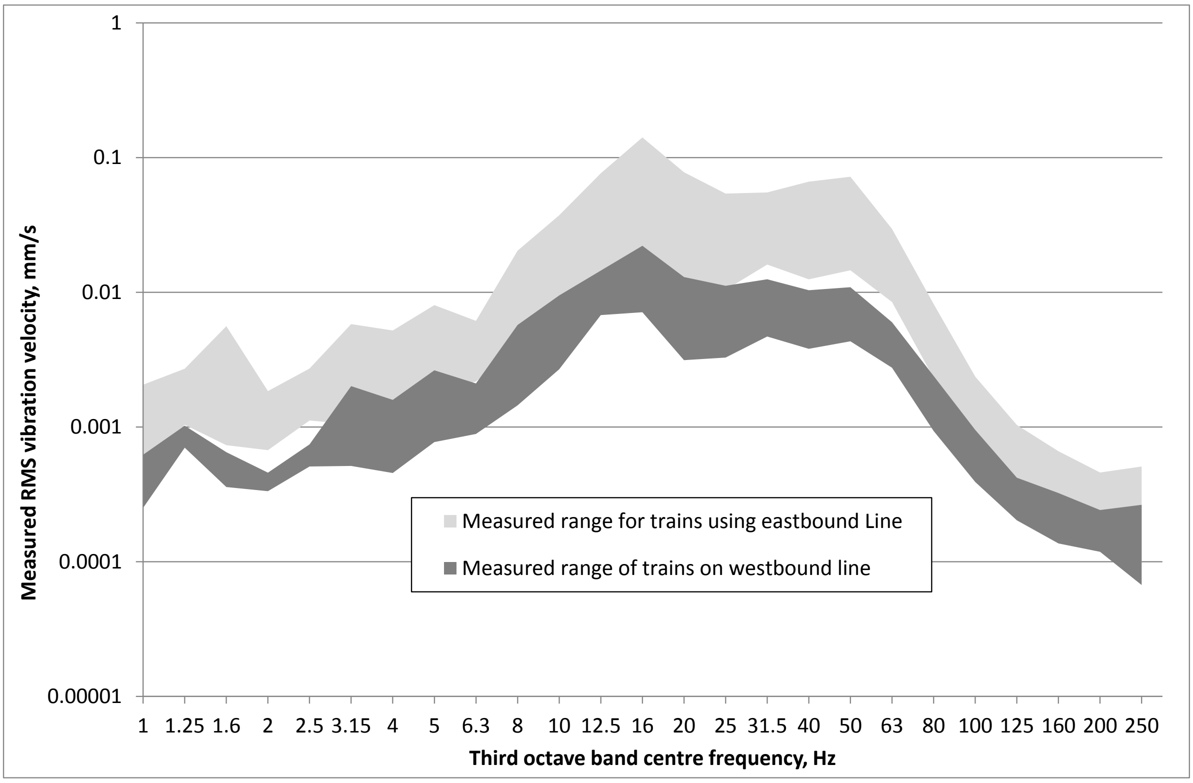

Figure 5 Measured RMS vibration velocity at location 1

Figure 6 Measured RMS vibration velocity at location 2

6. ASSESSMENT OF RESULTS

6.1 Vibration Perceptibility

The vibration levels measured on the site are dominated by the railway movements on the north and south railways bounding the site. The ground borne vibration measurements have indicated that the typical vibration levels from the railway operations are generally above the threshold of perceptibility. This is confirmed by measurement, and by the Ramboll engineers on site feeling the vibration during some train pass by events.

It was noted that train movements on the railway line on the southern boundary of the site typically generate less vibration than the trains on the northern boundary. This is likely due to the trains on the northern track being newer rolling stock and this generating less vibration from worn wheels. The only exception being the freight train on the northern tracks where vibration energy in some 1/3 octave bands were noted to be marginally higher than the typical range expected for passenger services.

6.2 Structure borne noise

Calculations of structure borne noise within the rooms of the building are based upon a worst case scenario of a large masonry building on piled foundations and no coupling losses from the ground to the foundations. Noise levels have been predicted based on theory and guidance provided in the Transportation Noise Reference Book and ANC guidelines for the measurement and assessment of ground borne noise.

Table 4 and Table 4 summarises the predicted structure borne noise levels resulting from the average and the highest measured train event vibration levels. This equates to the typical noise level experienced for an average train event, and the highest measured train event that might be expected.

In these tables the term 'Ground floor' is used to indicate the floor level that is in contact with the ground/pile/foundations. In this building this could actually be the sub-basement levels as the ground floor may be at Finchley Road street level.

Floor	Predicted internal noise levels from trains, dB_{LAeq}	
	Typical event	Highest measured event
Ground	40	46
1	49	54
2	47	52
3	45	50
4	43	48
5	41	46
6	39	44

Table 3 **Predicted structure borne noise levels throughout proposed development based on measured data at location 1**

Floor	Predicted internal noise levels from trains, dB_{LAeq}	
	Typical event	Highest measured event
Ground	28	35
1	34	41
2	32	39
3	30	37
4	28	34
5	26	32
6	24	30

Table 4 **Predicted structure borne noise levels throughout proposed development based on measured data at location 2**

The results show the predicted noise levels in the ground floor from train events will be typically 40dBA and may reach up to 46dBA. On upper floors with suspended slabs the typical noise levels could be up to 49dBA with the highest noise levels up to 54dBA. A worst case scenario of 2dB losses per floor have been assumed, however, this could be as high as 5dB per floor.

These noise levels are significantly higher than the recommended 'good' night time noise levels in bedrooms according to BS8233:1999 and it is likely to be disturbing to sleep. These results indicate that the building structure will require vibration isolation or mitigation measures to control structure borne train noise.

7. VIBRATION ISOLATION

As discussed in Section 6 above, it is recommended to use vibration isolation measures for the building structure to reduce the structure borne room noise levels and perceptible vibration caused by train pass by events.

The vibration isolation will reduce the vibration levels within the structure and thus reduce the day and night time VDV results. It is expected that the level of isolation will be commensurate with achieving a reduction in the probability of adverse complaints to a low level.

Vibration isolation of the building can be achieved by supporting the structure on elastomeric bearings with a natural frequency of 8Hz or lower, although this should be confirmed by a design consultation with a vibration isolation manufacturer.

7.1 Structure borne noise with isolation

Based on a typical transmissibility and damping response for an elastomeric bearing the internal structure borne noise levels from train passby events are expected to be **no higher than 21 dB_{LAeq}** at the worst effected floor level.

7.2 Perceptible vibration

Based on a typical transmissibility and damping response for an elastomeric bearing the vibration levels generated internally from train passby events are expected to be below a Vibration Dose Value of $0.1ms^{-1.75}$ which would result in the **residential dwellings having low probability of adverse comment**.

7.3 Residual Effects

Following the incorporation of the above mitigation measures into the building design, the following residential effects are expected.

Structure borne noise:	Internal ambient noise levels in residential rooms caused by train passbys will are expected to be below 30 dBL_{Aeq}, in accordance with the guidance given in BS8233.
Vibration:	Levels of vibration are expected to be such that the 'probability of adverse complaints' would be low, as defined in BS6472.

8. CONCLUSIONS

A vibration survey has been conducted at the proposed site on land located between railway lines and Finchley High Road, London.

Vibration measurements have indicated that there is a significant level of vibration from the trains operating on the north and south boundary of the site.

The vibration levels measured on site have indicated that vibration would be perceptible within the development and therefore without suitable mitigation there could be a possibility of adverse comments during the daytime and night time.

Vibration isolation has been proposed, based on isolating the main structure from the ground using an elastomeric bearing, and should be incorporated into the design to reduce noise and vibration to acceptable levels within occupied areas.

It is concluded that this mitigation measure will reduce noise and vibration to acceptable levels within occupied areas of the building. Structure borne noise is predicted to be no higher than 21dBA during a train passby event on the worst effected floor, and vibration levels would be reduced to well below perceptible levels and thus a VDV level below the 'low probability of adverse comment' range.

It is concluded that these measures are suitable to satisfy the requirements of Condition 9 of the planning conditions.