*Proof of Evidence (Evidence in Chief)*
*20 December 2017*

**THE CITY OF BRADFORD METROPOLITAN DISTRICT COUNCIL (A650 HARD INGS ROAD IMPROVEMENT, KEIGHLEY) COMPULSORY PURCHASE ORDER 2017**

**THE CITY OF BRADFORD METROPOLITAN DISTRICT COUNCIL (A650 HARD INGS ROAD IMPROVEMENT, KEIGHLEY) (SIDE ROADS) ORDER 2017**

**THE HIGHWAYS ACT 1980**

**-and-**

**THE ACQUISITION OF LAND ACT 1981**

**THE HIGHWAYS (INQUIRIES PROCEDURE) RULES 1994**

**COMPULSORY PURCHASE (INQUIRIES PROCEDURE) RULES 2007**

**National Transport Casework Team (REFERENCE: NATTRAN/YH/LAO/130)**

**In the matter of**

**a highway improvement scheme involving highway alterations to facilitate and widen the A650 Hard Ings Road, Keighley, from its junction with the A629 Beechcliffe Roundabout, generally eastwards to a point 75 metres west of its junction with Bradford Road, Roundabout, Bradford in the County of West Yorkshire**

**Proof of Evidence**

**of**

**Timothy Summers**

**Dip Ac, AMIOA**
**Environmental Studies Officer, Leeds City Council**

**presented as evidence in chief**
**on behalf of**
**The City of Bradford Metropolitan District Council**

**to**

**Local Public Inquiry – 30th January 2018**

**Contents**

## 1. Personal Details

1.1 My name is Timothy Summers and I hold the position of Environmental Studies Officer in the City Development Department of Leeds City Council. I have a Diploma in Acoustics and Noise Control and I am an Associate Member of the Institute of Acoustics. I have worked in the field of noise and vibration measurement and prediction for 28 years.

## 2. Scope of Evidence

2.1 The evidence which I shall present will examine the current noise and vibration climate adjacent to Hard Ings Road in Keighley – with particular reference to the 'Fibreline' building, situated at 'Victoria Park Mills', and will further report on the predicted change in these environmental factors as both a consequence of forecast traffic growth, and the proposed road widening scheme.

## 3. Main Evidence

3.1 Up until the 1990's, the local authorities of the 5 districts of West Yorkshire (Bradford, Calderdale, Kirklees, Leeds and Wakefield) used the specialist technical services of 'West Yorkshire Highways Engineering and Technical Services' (HETS) which comprised of the technical wing of the disbanded West Yorkshire County

Council, specialising in (amongst other services) noise and vibration measurement and prediction. Following the de facto absorption of HETS into Leeds City Council, the other 4 districts continued to 'hire in' the services provided by HETS on an ad hoc basis, as required. This is the basis for my being commissioned by The City of Bradford Metropolitan District Council to provide noise and vibration expertise with regard to this proposed road scheme.

3.2 Arrangements were made with 'Fibreline' to measure current levels of noise and vibration both inside and outside their premises, with levels also monitored at the current roadside. The results were then used together with current and future traffic flows provided by City of Bradford MDC to both assess the current noise climate and to predict noise values after the completion of the proposed carriageway improvements.

3.3 All on-site measurements were made on 6th July 2016 between 10 and 11 am whilst traffic was flowing normally on Hard Ings Road; this was felt to be representative of the worst-case scenario in terms of road traffic noise (as free-flowing vehicles generate more noise than queuing ones).

3.4 Noise measurements were made in accordance with the methodology described in BS 7445 - Description and measurement of environmental noise (1991). [Appendix 1]

3.5 Criteria for the assessment of vibration effects on buildings are given in BS 7385-2:1993 Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from ground borne vibration. [Appendix 2]

3.6 30 minute duration $L_{Aeq}$ noise levels measured within an office inside the 'Fibreline' building (facing onto Hard Ings Road) were 41.0 dB with the window closed, and 44.5 dB with the window open. These noise levels are within the standard deemed appropriate for staff and meeting rooms in BS 8233:2014 Guidance on sound insulation and noise reduction for buildings. [Appendix 3]

3.7 Simultaneous to the indoor measurements, 30 minute duration readings were also taken immediately outside the office, at the foot of the embankment between the 'Fibreline' building and Hard Ings Road, the $L_{Aeq}$ noise level was measured as being 64.7 dB, whilst at the roadside it was 70.8 dB. As the road traffic noise from Hard Ings Road was a fairly steady and constant noise source, the 30 minute sampling period was deemed representative of the daytime inter-peak noise climate.

3.8 Ground borne vibration measurements were taken as a mix of different vehicle types passed by the building on Hard Ings Road. The highest recorded level within the 'Fibreline' office occurred when an HGV passed by on the nearside carriageway, and this generated a Peak Particle Velocity (PPV) vibration event of 0.06 mm/sec. Vibration readings were also taken on the wall at the back of the footpath of Hard Ings Road as it passes the 'Fibreline' building, the highest recorded level here was again an HGV passing by on the nearside carriageway, which gave a PPV reading of 0.29 mm/sec. The different distances of the measurement positions from the carriageway suggest that a reasonably linear relationship exists between the vehicle-generated vibration levels and distance – i.e. that vibration levels drop in relation to distance, such that a doubling of the distance between the source of the vibration and the measurement position would lead to a halving of the vibration level, for example. This relationship between ground borne vibration and distance is supported by assumptions made in BS 5228 (Code of practice for noise and vibration control on open sites). [Appendix 4]

3.9 Noise calculations were made in accordance with the methodology outlined in 'Calculation of Road Traffic Noise' (Department of Transport Welsh Office, 1988) [Appendix 5] based on traffic figures supplied by Bradford MDC for Hard Ings Road with and without the scheme, in order to assess its noise impact.

The assessment for both the short term i.e. opening year 2017 and long term 2032, typically 15 years after opening, in accordance with the Highways England's DMRB (Design Manual for Roads and Bridges Volume 11, Section 3) [Appendix 6] (and Core Document 4.5 refers) indicates that as a result of the proposed Scheme, $L_{10\ 18\ hour}$ Basic Noise Levels (6 am to midnight) will increase by 0.2 dB(A) in the short term and 0.4 dB(A) in the long term – a negligible change in the opening year and design year. Comparing 2032 'do something' with 2017 'do nothing', $L_{10\ 18\ hour}$ Basic Noise Levels increase by 0.9 dB(A), also a negligible change in accordance with the DMRB in the long term. $L_{A10\ 18\ hour}$ Basic Noise Level is the average noise level exceeded for just 10% of the time for each of the eighteen one-hour periods between 0600 to 2400 hours. In accordance with the DMRB, a change in road traffic noise of 1 dB $L_{A10,18h}$ in the short term (e.g. when a project is opened) is the smallest that is considered perceptible. In the long term (typically 15 years after project opening), a 3 dB $L_{A10,18h}$ change is considered perceptible.

3.10 The Control of Noise at Work Regulations (2005) requires employers to take action to protect the well-being of their employees when their daily noise exposure within the workplace exceeds an LAeq value of 80 decibels. The current and predicted future noise levels within the 'Fibreline' building with regards road traffic noise fall well below this level.

3.11 Vibration calculations were made using the logic described above to assess the change in the highest measured ground borne vibration levels due to the road moving 3 metres closer to the 'Fibreline' building. It was calculated that the highest recorded vibration level within the building (0.06 mm/sec PPV) would increase to 0.08 mm/sec PPV if the carriageway was 3 metres closer (as it would be after the scheme completion). 0.08 mm/sec PPV is a vibration level which is below the threshold of human perception, and far below the level at which even cosmetic damage can be caused to an otherwise sound structure (0.6mm/sec – Appendix 2).

3.12 Vibration/noise predicted increases take no account of new road surface, which could lead to a slight reduction in both. Similarly, the proposed replacement wall (at the back of footpath, at the top of the embankment between the 'Fibreline' and the carriageway) is half a metre higher than the current one, and as such the calculated increases represent a worst-case scenario, whilst the actual increases may be lower than those reported.

3.13 The calculated future noise and vibration levels as a consequence of the scheme are not of a magnitude to cause any significant deterioration in working conditions within the 'Fibreline' premises.

3.14 A copy of the results of the noise and vibration assessment is included in Appendix 7.

## 4. Conclusion

4.1 The noise and vibration measurement and prediction exercise undertaken adjacent to Hard Ings Road found that as a result of the implementation of the proposed road widening scheme, there will at worst be a slight increase in both noise and vibration, but that the magnitude of these increases will be imperceptible.

4.2 In summary, I am of the view that I have advanced a compelling case to justify the Orders being confirmed in the public interest to ensure that the Council, acting on its behalf, will be able to use compulsory purchase powers, should the use of such powers be required as a last resort, to acquire for the purposes of the Orders, all the land and rights needed to promote, deliver and facilitate the proper construction to improve and widen the A560 Hard Ings Road, Keighley in the County of West Yorkshire, from its junction with the A629 Beechcliffe Roundabout, generally eastwards to a point 75 metres west of its junction with Bradford Road Roundabout.

## 5. Expert Declaration

5.1 I confirm that my duty to the Inquiry as an expert witness overrides any duty to those instructing or paying me, that I have understood this duty and complied with it in giving my evidence impartially and objectively and that I will continue to comply with that duty.

5.2 I confirm that my expert evidence includes all facts which I regard as being relevant to the opinions I have expressed and that attention has been drawn to any matter that would affect the validity of those opinions.

5.3 I am not instructed under any conditional fee arrangement and have no conflict of interest.

5.4 I confirm that I have made clear which facts and matters referred to in this proof of evidence are within my own knowledge and which are not. Those that are within my own knowledge I confirm to be true. The opinions I have expressed represent my true and complete professional opinions on the matters to which they refer.

5.5 I confirm my report complies with the requirements of The Institute of Acoustics.

## APPENDICES – Technical Documents Referred To Within Evidence

BRITISH STANDARD

BS 7445-1:2003

# Description and measurement of environmental noise —

## Part 1: Guide to quantities and procedures

ICS 13.140; 17.140.01



British Standards

## 5 Measurements

### 5.1 General

The results of the measurements described in this British Standard may be used for the purposes described in detail in the relevant standards. It is important that pertinent details of the measurement instrumentation, measurement procedure and conditions prevailing during the measurements are carefully recorded and kept for reference purposes. Reference to the pertinent standards shall also be given.

NOTE 1 When the measured signals are recorded on magnetic tape for control and reference purposes it should be borne in mind that even with studio-quality (non-digital) recorders the dynamic range may fall short of that necessary when instrumentation of the types mentioned in 4.1a) and 4.1b) is used.

NOTE 2 In some circumstances the frequency-weighting network "A" is inadequate for filtering out high level infrasound which occurs near some industrial locations and some forms of transport as well as near buildings due to wind turbulence. This may cause overload and, if not detected, distortion produced at higher frequencies may be inaccurately attributed to audible sound.

### 5.2 Measurement positions

#### 5.2.1 *General*

The choice of the actual measurement positions depends on the purpose of the measurements as specified in the pertinent standard.

#### 5.2.2 *Outdoor measurements*

When it is desired to minimize the influence of reflections then measurements should, whenever possible, be carried out at least 3.5 m from any reflecting structure other than the ground. When not otherwise specified, the preferred measurement height is 1.2 m to 1.5 m above the ground. Other measurement heights may be specified in pertinent standards.

#### 5.2.3 *Outdoor measurements near buildings*

These measurements shall be carried out at places where the noise to which a building is exposed is of interest. If not otherwise specified, the preferred measurement positions are 1 m to 2 m from the facade and 1.2 m to 1.5 m above each floor level of interest.

#### 5.2.4 *Measurements inside buildings*

These measurements shall be carried out in enclosures where the noise is of interest. If not otherwise specified, the preferred measurement positions are at least 1 m from the walls or other major reflecting surfaces, 1.2 m to 1.5 m above the floor and approximately 1.5 m from windows.

### 5.3 Meteorological effects

#### 5.3.1 *General*

Sound levels are affected by meteorological conditions, especially when the transmission distance is large. Where levels are likely to be affected by meteorological conditions they should be measured in one of the two ways described below.

#### 5.3.2 *Measurements averaged over a range of meteorological conditions*

The measurement time intervals are chosen in such a way that the long-term average sound level is determined over the range of meteorological conditions found at the measurement position(s).

#### 5.3.3 *Measurements made under specific meteorological conditions*

The measurement time intervals are chosen so that measurements are taken only under carefully specified meteorological conditions. Normally, the conditions chosen will be those which result in the most stable sound propagation, that is, with a significant positive wind component from source to measurement position(s).

NOTE In some cases it may be possible to determine a sound pressure level equivalent to that obtained under the conditions of 5.3.2 by applying a correction to the values obtained by using the method of 5.3.3.

BRITISH STANDARD

BS 7385-2: 1993

# Evaluation and measurement for vibration in buildings —

## Part 2: Guide to damage levels from groundborne vibration

**7.4.2** ***Guide values for transient vibration relating to cosmetic damage***

Limits for transient vibration, above which cosmetic damage could occur are given numerically in Table 1 and graphically in Figure 1. In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for the building types corresponding to line 2 are reduced. Below a frequency of 4 Hz, where a high displacement is associated with a relatively low peak component particle velocity value a maximum displacement of 0.6 mm (zero to peak) should be used.

Minor damage is possible at vibration magnitudes which are greater than twice those given in Table 1, and major damage to a building structure may occur at values greater than four times the tabulated values.

NOTE Damage categories are defined in 9.9 of BS 7385-1:1990.

**7.4.3** ***Guide values for continuous vibration relating to cosmetic damage***

The guide values in Table 1 relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in Table 1 may need to be reduced by up to 50 %.

NOTE There are insufficient cases where continuous vibration has caused damage to buildings to substantiate these guide values but they are based on common practice.

**7.5 Special cases**

**7.5.1** ***Fatigue considerations***

There is little probability of fatigue damage occurring in residential building structures due to either blasting [3, 21, 22], normal construction activities or vibration generated by either road or rail traffic. The increase of the component stress levels due to imposed vibration is relatively nominal and the number of cycles applied at a repeated high level of vibration is relatively low. Non-structural components (such as plaster) should incur dynamic stresses which are typically well below, i.e. only 5 % of, component yield and ultimate strengths [14]. Thus unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the guide values in Table 1 should not be reduced from fatigue considerations.

**7.5.2** ***Important buildings***

Important buildings which are difficult to repair may require special consideration on a case-by-case basis. A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive.

**7.5.3** ***Alternative evaluation technique***

In some cases in a detailed engineering analysis, the response spectrum technique [3,13] may be useful in evaluating the vibration of a building. This technique includes the effect of frequency and damping and can be used for any type of time history but has so far been applied mainly to seismic effects and shock.

**7.5.4** ***Indirect damage due to soil compaction***

Damage to buildings can sometimes arise indirectly from vibration in certain ground conditions where the vibration is of sufficient magnitude to cause soil compaction (see annex C).

**7.5.5** ***Underground constructions***

Structures below ground are known to sustain higher levels of vibration and are very resistant to damage unless in very poor condition.

**Table 1 — Transient vibration guide values for cosmetic damage**

| Line (see Figure 1) | Type of building | Peak component particle velocity in frequency range of predominant pulse | |
|---|---|---|---|
| | | 4 Hz to 15 Hz | 15 Hz and above |
| 1 | Reinforced or framed structures Industrial and heavy commercial buildings | 50 mm/s at 4 Hz and above | |
| 2 | Unreinforced or light framed structures Residential or light commerical type buildings | 15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz | 20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above |

NOTE 1 Values referred to are at the base of the building (see 6.3).

NOTE 2 For line 2, at frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) should not be exceeded.

BS 8233:2014

BSI Standards Publication

# Guidance on sound insulation and noise reduction for buildings

bsi.

...making excellence a habit.™

Table 6 **Typical noise levels in non-domestic buildings**

| Activity | Location | Design range dB $L_{Aeq,\,T}$ |
|---|---|---|
| Speech or telephone communications | Department store<br>Cafeteria, canteen, kitchen | 50 – 55 |
| | Concourse<br>Corridor, circulation space | 45 – 55 |
| Study and work requiring concentration | Library, gallery, museum | 40 – 50 |
| | Staff/meeting room, training room | 35 – 45 |
| | Executive office | 35 – 40 |
| Listening | Place of worship, counselling, meditation, relaxation | 30 – 35 |

## 7.7.5 Hotels and rooms for residential purposes

### 7.7.5.1 Design criteria for intrusive external noise

#### 7.7.5.1.1 General

The recommendations for ambient noise in hotel bedrooms are similar to those for living accommodation (see **7.7.2**).

*NOTE 1 In addition to hotels, rooms for residential purposes include, among others, student halls of residence, school boarding houses, hostels, hospices and residential care homes. Approved Document E to the Building Regulations [1] might not be applicable to such premises as they are to dwellings. Occupants of rooms for residential purposes, although transitory rather than permanent, might typically reside for longer periods than hotel guests.*

In hotels and other multi-occupancy premises containing rooms for residential purposes, it is desirable to avoid intrusive noise, both airborne and impact, in bedrooms, especially when occupants are sleeping (typically assumed to be at night-time).

Intrusive noise can arise from other rooms or uses within the building, from external sources through facades and from internal building services, including heating, ventilation and air conditioning plant.

Consideration should be given to adjacencies, both horizontal and vertical, between bedrooms, and between bedrooms and rooms used for other purposes. Particular attention should be paid to noise from corridors, door closers, adjoining bathrooms, stairwells, lifts and lift lobbies.

*NOTE 2 Several large chains of hotels have developed their own criteria for insulating rooms against intrusive noise. Examples of design criteria adopted by various hotel groups are included for reference in Annex H. These examples reflect commercial judgements dependent on the nature of the accommodation provided, e.g. budget or luxury. They are included in this British Standard not as recommendations but as preliminary guidance and, where appropriate, specialist advice ought to be sought.*

## 7.7.6 Offices

### 7.7.6.1 General

General acoustic guidance for offices is available from the British Council for Offices [38, 39] and the Association of Interior Specialists [40].

BS 5228-2:2009+A1:2014

BSI Standards Publication

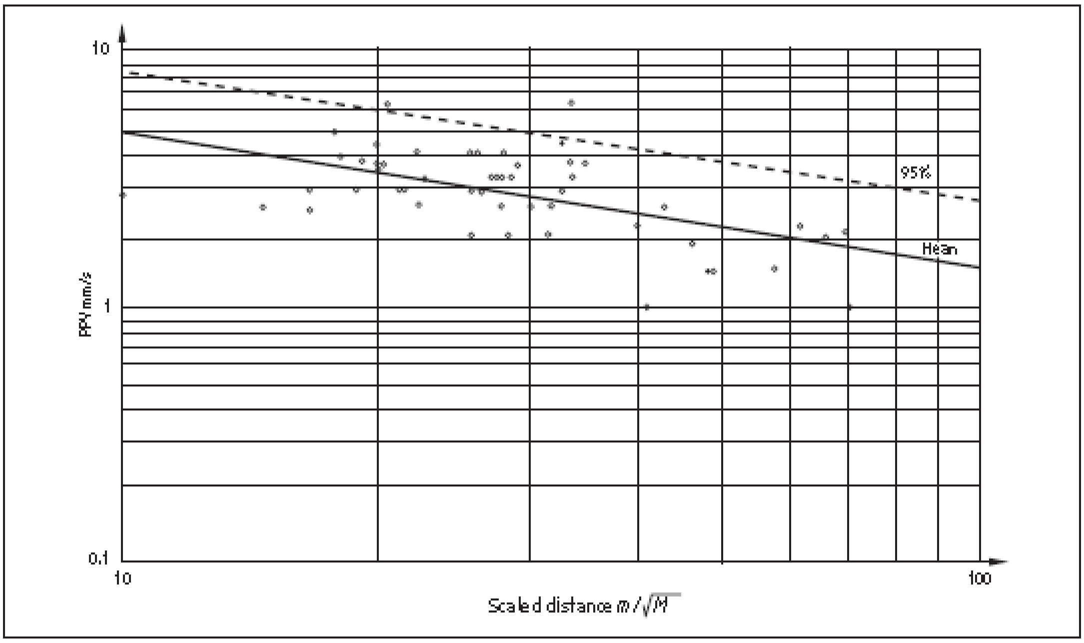
# Code of practice for noise and vibration control on construction and open sites –

## Part 2: Vibration

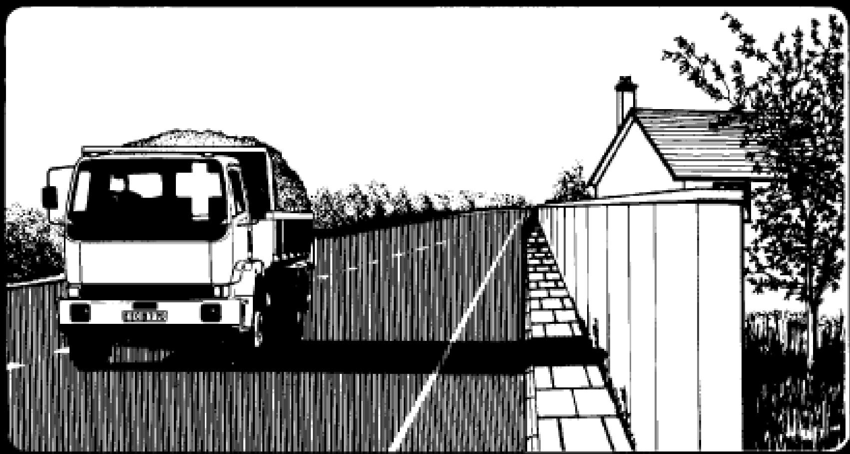
bsi.

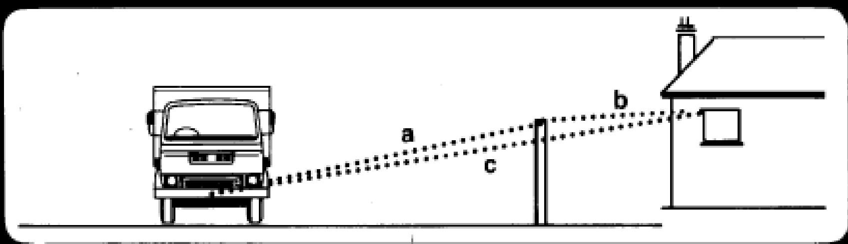
...making excellence a habit.™

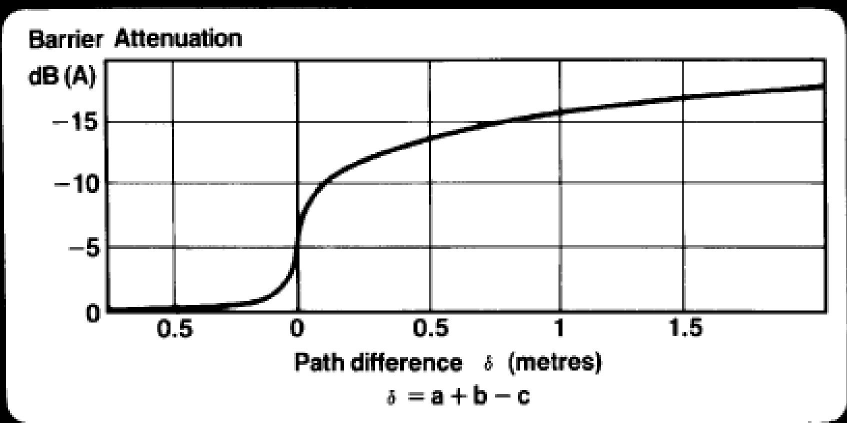
Figure E.1 **Scaled distance graph**



# Calculation of Road Traffic Noise






Department of Transport
Welsh Office

HMSO

# Section I – The prediction method (general procedures)

**10.** The method of predicting noise at a reception point from a road scheme consists of five main parts:

(i) divide the road scheme into one or more segments such that the variation of noise within the segment is small (para 11 refers);

(ii) calculate the basic noise level at a reference distance of 10 m away from the nearside carriageway edge for each segment (paras 12–16 refer);

(iii) assess for each segment the noise level at the reception point taking into account distance attenuation and screening of the source line (paras 17–24 refer);

(iv) correct the noise level at the reception point to take into account site layout features including reflections from buildings and facades, and the size of the source segment (paras 25–28 refer);

(v) combine the contributions from all segments to give the predicted noise level at the reception point for the whole road scheme (para 29 refers).

The above steps in the procedures are described in detail below and are shown diagrammatically in Chart 1.

## Dividing the road scheme into segments

**11.** In practice, situations will be encountered where, due to changes in traffic variables, road gradient and curvature or due to progressive variation in screening, the generated noise varies significantly along the length of the road. In such cases the road is initially divided into a small number of separate segments so that within any one segment the noise level variation is less than 2 dB(A). Each segment is then treated as a separate road source and the noise contribution evaluated according to the method given below. Whilst it is not possible to give precise guidance on the procedure to adopt to determine segment boundaries for all road schemes the Annexes contain several examples of calculations on complex road schemes with multi-segment solutions which serve to illustrate the basic principles to be adopted.

## Calculating the basic noise level for a road segment

**12.** The basic noise level at a reference distance of 10 m away from the nearside carriageway edge* is obtained from the traffic flow, the speed of the traffic, the composition of the traffic, the gradient of the road and the road surface. On any given road the traffic flow, mean speed and composition are interdependent; for example, increasing the traffic flow may cause a reduction in the mean speed so that the net increase in noise level may be comparatively small. Similar effects are observed with changes in composition. When estimating noise levels for projected road schemes, the values adopted for the traffic parameters should be compatible. When dealing with existing roads it may sometimes be desirable to make observations of these traffic parameters.

**13. Traffic flow**

13.1 On normal roads the flow of traffic in both directions shall be aggregated to obtain the total flow. But in cases where the two carriageways are separated by more than 5 metres or where the heights of the outer edges of the two carriageways differ by more than 1 metre, the noise level produced by each of the two carriageways shall be evaluated separately and then combined using Chart 11. In the case of the far carriageway the source line will be assumed to be 3.5 metres in from the far kerb and the effective edge of the carriageway used in the distance correction is 3.5 metres nearer than this, i.e. 7 metres in from the edge of the farside carriageway (see Annex 2).

13.2 Chart 2 gives the basic noise level hourly $L_{10}$ in dB(A) for a given hourly traffic flow (q) at a mean speed of 75 km/h, with zero percentage of heavy vehicles (p), and zero gradient (G). Chart 3 gives the basic noise level $L_{10}$ (18-hour)* in dB(A) for given traffic flows (Q) at a mean speed of 75 km/h, with zero percentage of heavy vehicles and zero gradient.

NB where hourly traffic flows are available the value of $L_{10}$ (18-hour) should be determined using Chart 2 to obtain the eighteen, one-hour, $L_{10}$ values over the prescribed period. Where 18-hour traffic flows only are available then Chart 3 applies.

13.3 When calculating noise levels from roads where the flow is low, i.e. below 200 veh/h or 4000 veh/18-hour day an additional correction may be required. Section II para 30 gives the procedure to be adopted to determine the correction for road schemes containing low traffic flows.

**14. Percentage heavy vehicles and traffic speed**

The correction for percentage heavy vehicles (p) and traffic speed (V) is determined using Chart 4.

14.1 The value of p is given by

$$p = \frac{100f}{q} \quad \text{or} \quad \frac{100F}{Q}$$

depending on whether the correction applies to hourly $L_{10}$ dB(A) or $L_{10}$ (18-hour) dB(A) respectively,

f and F are the hourly and 18-hour flows of heavy vehicles respectively, ie all vehicles with an unladen weight exceeding 1525 kg,

q and Q are the hourly and 18-hour flows respectively of all light and heavy vehicles. (NB Where motorcycle and moped flows are known then they should be included in the light vehicle group).

---

* Census data collected on a 16-hour day basis may be converted to 18-hour flows by the addition of 5 per cent.

14.2 The value of V to be used in Chart 4 depends upon whether the road is level or on a gradient. For *level* roads the traffic speed to be used in the calculation is as set out below for the appropriate class of road (for exceptions see para 14.4).

| Road classification | Traffic speed |
|---|---|
| **Roads not subject to a speed limit of less than 60 mph** | |
| Special roads (rural) excluding slip roads | 108 km/h |
| Special roads (urban) excluding slip roads | 97 km/h |
| All-purpose dual carriageways excluding slip roads | 97 km/h |
| Single carriageways, more than 9 metres wide | 88 km/h |
| Single carriageways, 9 metres wide or less | 81 km/h |
| (Slip roads are to be estimated individually) | |
| **Roads subject to a speed limit of 50 mph** | |
| Dual carriageways | 80 km/h |
| Single carriageways | 70 km/h |
| **Roads subject to a speed limit of less than 50 mph but more than 30 mph** | |
| Dual carriageways | 60 km/h |
| Single carriageways | 50 km/h |
| **Roads subject to a speed limit of 30 mph or less** | |
| All carriageways | 50 km/h |

14.3 For roads *with a gradient* traffic speeds will be reduced from the values given above for level roads (for exceptions see para 14.4 below). The reduction in traffic speed ($\Delta V$) depends upon the percentage gradient (G) and the percentage heavy vehicles (p) according to the formula given on Chart 5. The value of traffic speed to be used in Chart 4 for roads with a gradient is obtained by determining the appropriate traffic speed from the road classification table and reducing this value by the amount $\Delta V$ (see Annex 3). In the case where carriageways are treated separately or for one way traffic schemes the speed correction should not be applied to the downward flow.

14.4 The traffic speed values obtained under paras 14.2 and 14.3 do not apply when data based on particular local conditions (including the criteria for speed limits) indicate a traffic speed significantly different from the prescribed mean speed for the type of road. In these cases the highway authority's estimate or measurement of speed based on a representative sample shall be used.

**15. Gradient**

Chart 6 provides the adjustment for the extra noise from traffic on a gradient (G) expressed as a percentage. It should be noted that corrections for traffic speed on a gradient have already been taken into account under paragraph 14. In the case of carriageways treated separately (see para 13.1) or one-way traffic schemes, the correction to the basic noise level applies only for the upward flow. (In the case of one-way traffic schemes where the flow is downhill and the gradient exceeds 10 per cent it may be appropriate to use the measurement method).

**16. Road surface**
The correction for road surface depends upon a number of factors, eg. the amount of texture on the road surface, whether this texture is random distributed chippings (as in bituminous surfaces) or transversely aligned (as for concrete surfaces) and, for bituminous surfaces, whether they are essentially impervious to surface water or have an open structure with rapid drainage qualities.

For roads which are impervious to surface water and where the traffic speed (V) used in Chart 4 is $\geq 75$ km/h the following correction to the basic noise level is required;

for concrete surfaces

$$\text{Correction} = 10 \, \text{Log}_{10} \, (90 \, \text{TD} + 30) - 20 \, \text{dB(A)};$$

for bituminous surfaces

$$\text{Correction} = 10 \, \text{Log}_{10} \, (20 \, \text{TD} + 60) - 20 \, \text{dB(A)};$$

where TD is the texture depth*.

For road surfaces and traffic conditions which do not conform to these requirements a separate correction to the basic noise level is required.

16.1 *Impervious road surfaces*
For impervious bituminous and concrete road surfaces, 1 dB(A) should be subtracted from the basic noise level when the traffic speed (V) used in Chart 4 is $< 75$ km/h.

16.2 *Pervious road surfaces*
Roads surfaced with pervious macadams have different acoustic properties from the surfaces described above. For roads surfaced with these materials 3.5 dB(A) should be subtracted from the basic noise level for all traffic speeds.

## Propagation

**17.** The level obtained by applying paragraphs 12–16 is the basic noise level for a specific road segment. Further corrections are now needed to take into account, as appropriate, the effects of distance from the source line, the nature of the ground surface, and screening from any intervening obstacles. At this stage no account needs to be taken of the size of the road segment in relation to the total road length or of the effects of reflections from nearby buildings and other site layout features etc. The method of calculating the effects of propagation and screening can generally be broken down into separate parts – (see Chart 1).

(i) Calculate the correction for distance disregarding the presence of ground or intervening obstacles.

(ii) Decide whether the road segment is obstructed or unobstructed.

(iii) For unobstructed road segments calculate the effect of absorbing ground where necessary. For obstructed road segments apply a screening correction.

Details of the calculation process are given in the following paragraphs (18–24).

---

* Texture depth (TD) measured by the sand-patch test.

**18. Distance correction**

For reception points located at distances greater than or equal to 4 metres from the edge of the nearside carriageway, the distance correction given in Chart 7 is to be applied to the basic noise level. For distances less than 4 metres from the carriageway edge, the distance correction should be determined assuming the reception point is located at 4 metres from the nearside carriageway edge and Chart 7 applied. For the purposes of the Noise Insulation Regulations, the measurement method should be used when the predicted level at distances less than 4 metres is within 3 dB(A) of the specified level. The distance correction is calculated along the shortest slant distance signified (d') from the source line to the reception point. This value is determined from the shortest horizontal distance (d) from the edge of the nearside carriageway to the reception point and the height (h) of the reception point relative to the source line at the point where the slant line intersects the source line at the effective source position, S, (see Fig 1). For some segments it may be necessary to extend the source line so that d' is calculated along the line which passes through the reception point and is perpendicular to the extended source line. In such cases, the value of h is the height of the reception point relative to the source line at the effective source position where the slant line intersects the *extended* source line (see Annex 4).

18.1 Extending the source line as described above may exceptionally cause it to pass directly through or within 7.5 metres of the reception point, thereby precluding the use of Chart 7 since the reception point would then be less than 4 metres from the carriageway edge. In such cases, the noise level is to be calculated for at least two positions located nearby and either side of the reception point for which this anomaly does not occur and the mean value adopted (see Annex 5).

**19. Unobstructed propagation**

Having applied the distance correction it is necessary to decide whether the source line of the road segment is obstructed or unobstructed. In general, road segments will have been chosen such that within any segment the source line is either clearly obstructed or unobstructed in order to comply with the basic rules regarding segmentation – see paragraph 11. In some cases, however, the source line may be partially obscured by intervening obstacles or the degree of screening may be slight. For these cases, it is necessary to calculate the noise levels assuming both unobstructed and obstructed propagation taking the lower of the two resulting levels (see para 22.3). For unobstructed propagation a correction for the prevailing ground cover shall be applied.

**20. Ground cover correction**

If the ground surface between the edge of the nearside carriageway of the road or road segment and the reception point is totally or partially of an absorbent nature, (eg grass land, cultivated fields or plantations) an additional correction for ground cover often referred to as ground absorption needs to be taken into account. The correction is progressive with distance and particularly affects reception points close to the ground. Chart 8 gives the correction for ground absorption in terms of the mean height of propagation (H) the distance (d) and the proportion of absorbing ground (I) between the edge of the nearside carriageway and the segment boundaries leading to the reception point **R**, see fig 2(a). To avoid the difficulty of defining adequately the many other more absorbent types of ground cover, the correction shown in Chart 8 is to be used for all predominantly absorbent surfaces. Thus the calculations will slightly underestimate attenuation effects, particularly where the intervening ground is intensively cultivated or planted.

**22. Barriers**



Where a barrier is interposed between the noise source and reception point (either a

DESIGN MANUAL FOR ROADS AND BRIDGES

**HD 213/11**
**Volume 11, Section 3,**
**Part 7**
**Revision 1**

THE HIGHWAYS AGENCY

TRANSPORT SCOTLAND

WELSH GOVERNMENT
LLYWODRAETH CYMRU

THE DEPARTMENT FOR REGIONAL DEVELOPMENT
NORTHERN IRELAND

# Noise and Vibration

**Summary:** This revised Standard provides guidance on the assessment of the impacts that road projects may have on levels of noise and vibration. This revision replaces the previous Standard, and includes updated advice on calculating night time noise levels, determining the extent of the study area and selecting appropriate traffic speed data. Where appropriate, this standard may be applied to existing roads.



n
of

**Magnitude of Impact**

3.36 Section 2 of Volume 11 includes HA 205/08. This provides a method for the classification of the magnitude of impact and the significance of an effect in order to arrive at an overall level of significance. In terms of road traffic noise, a methodology has not yet been developed to assign a significance according to both the value of a resources and the magnitude of an impact. However, the magnitude of traffic noise impact from a road project should be classified into levels of impact in order to assist with the interpretation of the road project. Therefore, for the assessment of traffic noise that is covered by this document, a classification is provided for the magnitude of impact.

3.37 A change in road traffic noise of 1 dB $L_{A10,18h}$ in the short term (e.g. when a project is opened) is the smallest that is considered perceptible. In the long term (typically 15 years after project opening), a 3 dB $L_{A10,18h}$ change is considered perceptible. The magnitude of impact should, therefore, be considered different in the short term and long term. The classification of magnitude of impacts to be used for traffic noise is given in Table 3.1 (short term) and Table 3.2 (long term).

| Noise change, $L_{A10,18h}$ | Magnitude of Impact |
|---|---|
| 0 | No change |
| 0.1 – 0.9 | Negligible |
| 1 – 2.9 | Minor |
| 3 – 4.9 | Moderate |
| 5+ | Major |

**Table 3.1 – Classification of Magnitude of Noise Impacts in the Short Term**

| Noise change, $L_{A10,18h}$ | Magnitude of Impact |
|---|---|
| 0 | No change |
| 0.1 – 2.9 | Negligible |
| 3 – 4.9 | Minor |
| 5 – 9.9 | Moderate |
| 10+ | Major |

**Table 3.2 – Classification of Magnitude of Noise Impacts in the Long Term**

3.38 Research into the response to changes in road traffic noise is largely restricted to daytime periods. Until further research is available only noise impacts in the long term is to be considered and Table 3.2 should be used to consider the magnitude of noise change at night. However, given the caution with predicting night time noise levels as traffic flow fall (see 3.24), only those sensitive receptors predicted to be subject to a $L_{night,outside}$ exceeding of 55 dB should be considered. The $L_{night,outside}$ of 55 dB corresponds to the Interim Target level specified in the WHO Night Noise Guidelines for Europe.

3.39 Methods are available for evaluating the significance of construction noise and vibration. These methods are described in Annex E of BS 5228 (Ref 9) and should be used unless an alternative method is agreed with the Overseeing Organisation.

3.40 Table 3.1 should be used in the assessment of noise impact associated with construction traffic on the local road network and from temporary diversion routes resulting from construction of the road project. For road projects where construction traffic and temporary diversions occur at night, the Overseeing Organisation should be consulted to agree a suitable methodology for assessing the associated noise impact.

3.41 The level of vibration at sensitive receptors has the potential to increase and decrease. If the level of vibration at a receptor is predicted to rise to above a level of 0.3 mm/s, or an existing level above 0.3 mm/s is predicted to increase, then this should be classed as an adverse impact from vibration.

**Uncertainty and validity**

3.42 During an assessment of the impacts from noise and vibration, the uncertainty associated with input data is an important factor in determining how confident the Overseeing Organisation's supply chain can be with the assessment results. As the road project progresses, the quality and accuracy of the assessment should normally improve. This in turn will influence the accuracy of designed mitigation measures, for example the height and positioning of any barriers. The most up to date scheme design and traffic flow information should be used in the final assessment.

# NOISE AND VIBRATION
# ASSESSMENT
# AT
# 'FIBRELINE'
# HARD INGS ROAD
# KEIGHLEY

An Assessment on Behalf of

Bradford MDC

# NOISE AND VIBRATION
# ASSESSMENT
# AT
# ‘FIBRELINE’
# HARD INGS ROAD
# KEIGHLEY

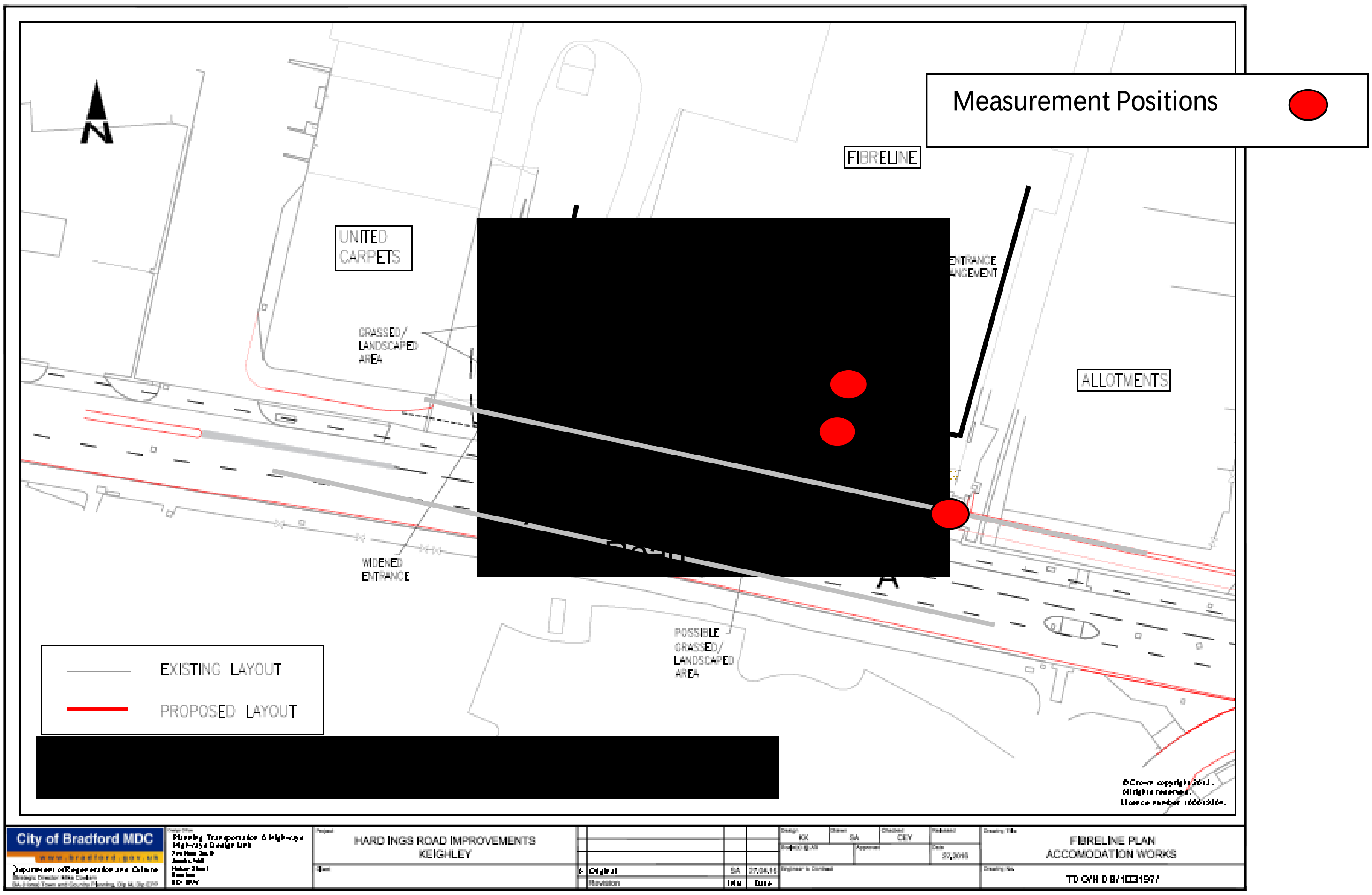
Environmental Studies
July 2016
Tel 0113 2476315

## 1. Background

Due to a proposed road improvement scheme on the A650 in Keighley, occupants of the 'Fibreline' premises have expressed concerns about the effect of changes on noise and vibration levels.

## 2. Methodology

Arrangements were made with 'Fibreline' to measure current levels of noise and vibration both inside and outside their premises, with levels also monitored at the current roadside. The results were then used to predict values after the carriageway improvements.



## 3. Results

All measurements were made on 6th July 2016 between 10 and 11 am.

The results of the $LA_{EQ}$ noise level measurements at the different measurement positions are shown below.

| Measurement Position | Noise Level dB |
|---|---|
| Inside Office (window closed) | 41.0 |
| Inside Office (window open) | 44.5 |
| Immediately Outside Office | 64.7 |
| Roadside (no barrier effect) | 70.8 |

Ground-borne vibration levels are given below (PPV m/s)

| Measurement Position | Vehicle Type/Carriageway | Vibration Level |
|---|---|---|
| Office Inside Window Sill | HGV / Nearside | 0.06 |
| Office Inside Window Sill | HGV / Far side | 0.04 |
| Office Inside Window Sill | S/Decker Bus/ Far Side | 0.03 |
| Office Inside Window Sill | Cars / either direction | 0.02 – 0.03 |
| Wall at back of Footpath | Coach / Nearside | 0.23 |
| Wall at back of Footpath | Van / Nearside | 0.15 |
| Wall at back of Footpath | HGV / Nearside | 0.29 |
| Wall at back of Footpath | HGV / Far Side | 0.26 |
| Immediately outside Office | HGV / Far Side | 0.18 |
| Immediately outside Office | HGV / Nearside | 0.20 |
| Immediately outside Office | Oil Tanker / Nearside | 0.13 |
| Immediately outside Office | HGV / Nearside (slow) | 0.10 |

## 4. Discussion

As a result of the proposed scheme, a new section of carriageway is to be introduced bringing vehicles approximately 3 metres closer to the 'Fibreline' premises.

Noise calculations based on the forecast traffic increases on Hard Ings Road and which take into account the new alignment of the carriageway show that road traffic noise levels at 'Fibreline' will increase by 1.8 dB(A) in 2017 and by 2.2 dB(A) (i.e.an additional 0.4 dB(A) ) by 2026.
To put these changes into perspective, an increase of 3 dB(A) is generally accepted as being 'barely perceptible' to the human ear.

In terms of ground borne vibrations levels, the measurement exercise indicated that an outside-to-inside reduction of around 50% occurs on levels generated by vehicles using the current road alignment. Whilst it is possible that the level of this reduction could fall as the source of the vibration moves closer to the building, even if it was at 25% then the majority of vibration events (based on those measured) would be below the threshold of human perception. Damage criteria levels (to a sound structure) are considerably higher than human perception levels, and there was nothing in the measurement exercise to suggest that anything approaching such levels would occur as a result of vehicles using the proposed new road alignment.

## 5. Conclusions

The noise and vibration measurements conducted at 'Fibreline' together with calculations based on forecast traffic flows for the proposed carriageway alignment indicate that whilst there will be increases in both noise and vibration levels, these will be largely imperceptible (notwithstanding the possible psychological effect sometimes associated with being able to see the traffic more clearly). Whilst it is possible that occasionally HGV vehicles might generate vibration levels which might be felt within the building, these are highly unlikely to be of a magnitude which can cause (even cosmetic) damage to a sound structure.

***Tim Summers AMIOA***

July 2016