Construction Groundborne Noise Impact Assessment

Construction Noise Impact Assessment Methodology

A.1.1.1.1 The method used to predict construction groundborne noise is based on the U.S. Department of Transportation "High-Speed Ground Transportation Noise and Vibration Impact Assessment", 1998.

A.1.1.1.2 The vibration level Lv,rms at a distance R from the source is related to the vibration source level at a reference distance Ro. The conversion from vibration levels to groundborne noise levels is determined by the following factors:

- C_{dist}: Distance attenuation
- $C_{damping}$: Soil damping loss across the geological media
- $C_{building}$: Coupling loss into building foundation
- C_{floor}: Coupling loss per floor
- C_{noise}: Conversion factor from floor vibration levels to noise levels
- C_{multi}: Noise level increase due to multiple sources
- C_{cum}: Cumulative effect due to neighbouring sites
- The predicted groundborne noise level L_p inside the noise sensitive rooms is given by the following equation.
- $L_p = L_{v,rms} + C_{dist} + C_{damping} + C_{building} + C_{floor} + C_{noise} + C_{multi} + C_{cum}$

Reference Vibration Sources

A.1.1.1.3 The geology of Tung Chung is mainly composed of alluvium and decomposed granite porphyry. The vibration measurements for the TBM will be extracted from the in-situ measurements during the bored tunneling of Kwai Tsing Tunnel of the West Rail project. These measurements were adopted in previous approved EIA study (e.g. Kowloon South Link: Environmental Impact Assessment, AEIAR-083/2005). Kwai Tsing Tunnel, being a hard rock tunnel, is also composed of alluvium, residual soils, marine deposits and reclamation fill, which has similar geological characteristics as that of Tung Chung.

Distance Attenuation

A.1.1.1.4 The vibration level would be decrease with the distance increase. Distance attenuation of $20\log(d/d_o)$ is adopted in current assessment. This approach was also adopted in the approved EIA Shatin to Central Link – Tai Wai to Hung Hom (AEIAR-167/2012).

Soil Damping Loss

A.1.1.1.5 Internal losses of soil would cause the vibration amplitude to decay against the propagation distance and the decay relationship is based on the equation set out in the Transportation Noise Reference Book:

$$V(R) = V(R_o) \times e^{-2\pi f \eta R / 2c}$$

A.1.1.1.6 The velocity amplitude V is dependent on the frequency f in Hz, the soil or rock loss factor η, the wave speed c in m/s, the distance R from the source to the NSR. The properties of soil materials are based on Ungar and Bender and reproduced in the table below. No soil damping loss is applied for conservative assessment.

Table A1.1 Wave propagation properties of soils

Soil Type	Longitudinal Wave Speed c, m/s	Loss Factor, η	Density, g/cm^3
Rock	3500	0.01	2.65
Clay, clayey soil	1500	0.5	1.7

Coupling Loss into Building Structures

A.1.1.1.7 This represents the change in the incident ground-surface vibration due to the presence of the piled building foundation. The empirical values based on the guidance set out in the Transportation Noise Reference Book are given in the table below. Correction of 10dB is assumed for conservative approach.

Table A1.2 Loss factor for coupling into building foundation

Frequency	Octave Band Frequencies, Hz							
	20	25	32	40	50	63	80	100
Loss coupling factor, dB	-7	-7.5	-8	-9	-10	-11	-12	-13
Frequency	**125**	**160**	**200**	**250**	**315**	**400**	**500**	
Loss coupling factor, dB	-14	-14.5	-14.5	-14.5	-14.5	-14.5	-14.5	

Coupling Loss Per Floor

A.1.1.1.8 This represents the floor-to-floor vibration transmission attenuation. In multi-storey buildings, a common value for the attenuation of vibration from floor-to-floor is approximately 1dB attenuation in the upper floor regions at low frequencies and greater than 3dB attenuation at lower floors at high frequencies. Coupling loss of 2dB reduction per floor is assumed for conservative assessment.

Conversion from Floor Vibration to Noise Levels

A.1.1.1.9 Conversion from floor vibration levels to indoor reverberant noise levels is based on standard acoustic principles. The conversion factor is dependent on the surface area S of the room in m^2, the radiation efficiency η, the volume of the room V in m^3 and the room reverberation time RT in seconds. Analyses had been carried out for concert hall, theatres, lecture hall and recording studios for the Kwun Tong Line Extension: Environmental Impact Assessment, these values are summarized in the table below and adopted for the present study.

Table A1.3 Conversion factors from floor vibration levels to indoor reverberant noise levels

NSR	Conversion C_{noise} (dB re $1x10^{-6}$ mm/s)
Hotel guestrooms and residential units	-27

Noise level increase due to multiple sources

A.1.1.1.10 Summation of noise level from multiple sources is based on equation of basic acoustic principles:

$$L_{eq\ 30mins} = 10log\left[10^{\frac{L_{eq}\ Source\ A}{10}} + 10^{\frac{L_{eq}\ Source\ B}{10}} + \cdots\right]$$

Cumulative effect due to neighbouring sites

A.1.1.1.11 Cumulative effect is obtained by summation with the noise level generated by other neighbouring sites, based on equation of basic acoustic principles:

$$L_{eq\ 30mins} = 10log\left[10^{\frac{L_{eq}\ Site\ A}{10}} + 10^{\frac{L_{eq}\ Site\ B}{10}} + \cdots\right]$$