Extract from ISO14837-1 1995

$S(f)$ will form the basis of predictions. It may be the forcing function at the wheel/rail interface or, alternatively, it may be a vibration response (velocity or acceleration) at a defined location (e.g. tunnel invert, tunnel wall or in the ground to the side of the tunnel, or to the side of the track at grade).

8.2 Stages of assessment

8.2.1 General requirements for models

Generally it is only necessary to predict absolute levels of vibration for new rail systems. Where alteration of an existing rail system, or a new building constructed over an existing railway, is proposed, it will usually be only necessary to predict changes in levels of ground-borne vibration and/or ground-borne noise compared to a measured base case.

For new rail systems, the requirements for the model will vary during the different stages of the scheme's development.

8.2.2 New rail systems

8.2.2.1 General

The type, form and accuracy of the model used shall reflect the stage of a new rail system's development and therefore the design information available.

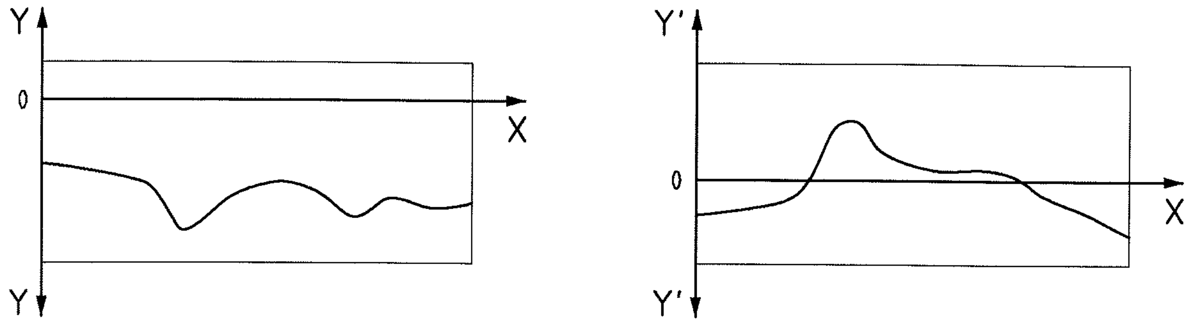
A single model may be used for all stages with appropriate selection of input parameters (e.g. worst case for scoping assessment). Otherwise, three types of ground-borne vibration and/or ground-borne noise prediction model should be considered, as follows.

a) **Scoping model**: to be used at the very earliest stages of development of a rail system to identify whether ground-borne vibration and/or ground-borne noise is an issue and, if so, where the "hot spots" along the length of the system's alignment are located. This type of model should be used to generate input to either environmental comparative frameworks (as part of the selection of a mode of transport) or the scoping stage of an environmental assessment.

b) **Environmental assessment model**: to be used to quantify more accurately the location and severity of ground-borne vibration and/or ground-borne noise effects for a rail system and the generic form and extent of mitigation required to reduce or to remove the effects. This type of model should form part of the planning process for a scheme, developing the environmental statement where required and supporting preliminary design.

c) **Detailed design model**: to be used to support the detailed design and specification of the generic mitigation identified as being required by the environmental assessment model. This type of model should form part of the design and construction stages of a scheme, with particular focus on the rolling stock and permanent-way design.

At each stage, the requirements for the models in terms of complexity, speed of use and accuracy differ (see Figure 5 and 8.2.2.2 to 8.2.2.4).



a) Propagation

b) Receiver

Key

X frequency (logarithmic)

Y ΔP (decibels)

Y' ΔR (decibels)

NOTE 1 Spectral shapes are indicative for new systems only.

NOTE 2 Δ functions are relative to source reference parameter values given in Figure 3 a).

Figure 4 — Indicative model components for propagation path (see 4.3) **and receiver** (see 4.4)

8.2.2.2 Scoping models

The model should be quick and simple to use. It should rely on very few generic input parameters; i.e. only those that will be available at the very earliest stage of a project's development, namely:

— type of rail system: light-railway tram (LRT), mass transit, heavy rail, freight, high-speed train,

— alignment (e.g. distance between rail system/receiver and depth of tunnel: shallow, medium or deep),

— typical ground conditions: hard, medium or soft ground, and

— sensitivity of receiving building: high (e.g. recording studio, auditorium), medium (e.g. residential) or low (e.g. industrial).

The model should estimate the radial distance between the centreline of the rail system and the nearest point of a receiver beyond which it is highly unlikely that the levels of ground-borne vibration and/or ground-borne noise would exceed the criteria set for the project.

Given the limited design information available at the outset of a project, scoping models should predict the "worst case" overall levels of ground-borne vibration and/or ground-borne noise only and, by preference, be founded on measurements from representative rail systems.

8.2.2.3 Preliminary design and environmental assessment models

Environmental assessment models should be more complex than scoping models to reflect the increased detail of the project's design available at this stage of a project (see Figure 5). The model should quantify more accurately the location and severity of ground-borne vibration and/or ground-borne noise impacts/effects and the generic form and approximate extent of any mitigation required to remove or reduce the predicted effects. The method will therefore need to consider all the parameters that are critical to determine the absolute levels of ground-borne vibration and/or ground-borne noise, and the benefits (or otherwise) of different design and mitigation options. The parameters that require consideration are detailed in Annex A. The key types of mitigation options that, where required, need to be considered (see also Annex B) are

— permanent-way (track form) design and maintenance,

— rolling stock design (where possible) and maintenance,

— track alignment (vertical and horizontal),

— supporting infrastructure design (e.g. tunnel, at grade formation, or elevated structure), and

— design of receiving building.

Suitable methods may be developed using either empirical (including experimental) or theoretical approaches, or a mix of both. The models should consider the frequency content of the vibration.

8.2.2.4 Detailed design models

Detailed design models will consider either the absolute values or changes in levels of ground-borne vibration and/or ground-borne noise. Detailed design models are often used to provide more detailed analysis for one or more of the fundamental components of the system; i.e. source, propagation path or receiver of ground-borne vibration and/or ground-borne noise.

The output of detailed design models may be input to environmental assessment models to identify the changes in overall levels of ground-borne vibration and/or ground-borne noise associated with design development. The models should consider the frequency content of the vibration in octaves, one-third-octave or narrow bands.

Given that the detailed design models will support the design and specification of parts of either the railway's permanent works or a receiving building, they will need to consider the influence of all of the relevant parameters defined in Annex A. Suitable methods can be developed using empirical or theoretical approaches, or a mix of both.