

BRITISH STANDARD

Guide to evaluation of human exposure to vibration in buildings

Part 1: Vibration sources other than blasting

ICS 13.160



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Summary of pages

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Foreword

Publishing information

This part of BS 6472 was published by BSI and came into effect on 30 June 2008. It was prepared by Subcommittee GME/21/6, *Human exposure to mechanical vibration and shock*, under the authority of Technical Committee GME/21, *Mechanical vibration, shock and condition monitoring*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

Together with BS 6472-2:2008 this part of BS 6472 supersedes BS 6472:1992, which is withdrawn.

Information about this document

This British Standard contains guidance on the evaluation of vibration with respect to human response not available in ISO 2631-2:2003.

The frequency weighting function for vertical vibration has changed from W_g to W_b compared with BS 6472:1992 (withdrawn) and hence vibration evaluations will not be the same as those made previously. The differences depend on the vibration spectrum and may be small, but a difference of a factor of two is possible. This difference could be a factor of 1.4 lower for vibrations that are predominantly at the lowest frequency, or could be a factor up to two higher for vibrations with dominant components at the top end of the frequency range. The frequency weightings introduced for vertical and horizontal vibration mean that the effective frequency range is 0.5 Hz to 80 Hz.

The standard no longer uses basi-centric coordinates that move with the orientation of the human body but uses the geocentric coordinate system in which the vertical and horizontal axes are earth-centred and hence the weightings for supine subjects exposed to motion in the back-to-chest and foot-to-head axes are exchanged compared with previous versions of the standard.

BS 6472-1 and BS 6472-2 contain guidance that takes account of recent developments in the subject. The layout of the standards differs substantially from previous editions. These present versions are intended to be more logical and approachable in their presentation of the background to human perception, in their descriptions of the assessment procedures involved, and in the measurement and evaluation guidance offered.

BS 6472-1 offers guidance on how people inside buildings respond to building vibration: the judgement criteria are more stringent at higher frequencies than in the superseded standard due to changes in the vertical frequency weighting.

BS 6472-2 deals with the particular problems associated with periodic blasting within range of inhabited buildings: the guidance is a formalization of established, widely recognized techniques common in industry.

BS 6472-1 advises use of the estimated vibration dose value *only* as an approximation to the vibration dose value for vibration that is not time-varying in magnitude and has a crest factor which is below about six. Use of the estimated dose value is not recommended for vibration with time-varying characteristics or shocks.

A bibliography of appropriate supporting data published elsewhere is included.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

Introduction

Structural vibration in buildings can be detected by the occupants and can affect them in many ways; their quality of life can be reduced, as can their working efficiency.

The first overt sign of an unfavourable reaction to building vibration is adverse comment, whereby occupants express negative responses to the vibration. The prevalence of adverse comment depends on specific circumstances, which can include parallel effects such as re-radiated noise. The acceptable magnitudes for building vibration might depend similarly on these parallel effects. This British Standard provides best available information on the application of methods of measuring and evaluating vibration in order to assess the likelihood of adverse comment.

1 Scope

This part of BS 6472 provides guidance on predicting human response to vibration in buildings over the frequency range 0.5 Hz to 80 Hz. Frequency weighting curves for human beings exposed to whole-body vibration are included, together with advice on measurement methods to be employed. Methods of assessing continuous, intermittent and impulsive vibration are presented.

This part of BS 6472 describes how to determine the vibration dose value, VDV, from frequency-weighted vibration measurements. The vibration dose value is used to estimate the probability of adverse comment which might be expected from human beings experiencing vibration in buildings. Consideration is given to the time of day and use made of occupied space in buildings, whether residential, office or workshop.

NOTE 1 In critical work areas, where vibration criteria more stringent than those for human perception are appropriate, this British Standard does not apply.

NOTE 2 Annex A outlines the way in which methods, results and assessments are to be reported, since great care is needed if satisfactory, repeatable conclusions are to be obtained. Annex B provides worked examples of how measurements and predictions might be interpreted in terms of human reaction. Annex C provides examples of the derivation of values appropriate to this British Standard from historic data.

This British Standard does not give guidance on the probability of equipment malfunction, structural damage or injury to occupants in buildings subject to vibration. Neither is guidance given on legal liability or methods of vibration limitation, although beneficial means to the latter are often implied.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 6841, *Guide to Measurement and evaluation of human exposure to whole-body mechanical vibration and repeated shock*

BS EN ISO 8041, *Human response to vibration – Measuring instrumentation*

3 Evaluation of building vibration with respect to human response

3.1 General

In homes, adverse comment about building vibrations is likely when the vibration levels to which occupants are exposed are only slightly above thresholds of perception. In workplaces, adverse comment often arises at rather higher levels, although people in sedentary occupations respond more like home residents. In general, the satisfactory magnitudes referred to in this standard relate to adverse comments by building occupants and are not determined by factors such as short-term health hazard or working efficiency.

Vibration magnitudes that would normally result in adverse comment can sometimes be tolerated, particularly for temporary disturbances or infrequent brief events; an example would be a construction project. However, to reduce adverse comment, the affected community would usually need to be advised of the likely effects, the duration of the activity and that the likelihood of building damage is very low even when vibration levels are well above perception thresholds. This is usually best carried out by a formal programme of public liaison, often in conjunction with the local authority. In cases of long term vibration, adverse comments can be modified by familiarization.

The criteria to be used when assessing human response require consideration of the expected building occupation (homes, offices or workshops) and the activity of the occupants. The criteria should be applied to each occupied room of a building.

Whether at home or at work, the vibration tolerance of people varies over a wide range. As well as a large range of individual vibration sensitivity over the population, specific values depend on social and cultural factors, psychological attitudes and the expected degree of intrusion.

Building vibrations as they affect people can be classified usefully according to a combination of descriptions. The time history of the vibration input to the subject can be:

- continuous;
- intermittent; or
- occasional.

Each of these categories of time history can have one of the following characteristics of vibration:

- constant amplitude;
- variable amplitude; or
- impulsive.

Impulsive vibration is most likely to startle subjects, particularly if irregularly or rarely occurring.

The vibration dose summation procedure, as described in 3.5, allows comparison of all types of vibration exposure on a common basis, i.e. the severity of impulsive and/or intermittent vibration is evaluated on a basis applicable equally to continuous vibration.

3.2 Frequency weighting

3.2.1 General

The way in which people perceive building vibration depends on various factors, including the vibration frequency and direction. Different frequency weightings are required for different axes of motion. 3.2.2 describes frequency weighting curves to be applied to vibration so that the resulting overall levels can be interpreted in terms of perception, comfort or adverse comment for whole-body vibration. The frequency range concerned is 0.5 Hz to 80 Hz for the three translational axes: fore-and-aft, lateral and vertical.

NOTE In previous versions of the standard, the frequency weightings have been specified with reference to the basi-centric coordinate system. The current view is that the vibration weightings appropriate to the geocentric coordinate system (earth-centred vertical and horizontal) should be applied (see BS 6841) and hence the weightings for supine subjects exposed to motion in the back-to-chest and foot-to-head axes are exchanged compared with previous versions.

3.2.2 Frequency weighting curves

The weighting curve modulus for vertical acceleration is shown in Figure 1. A different weighting curve applies for horizontal vibration. Its modulus is shown in Figure 2. The weightings W_b (for vertical motion) and W_d (for horizontal motion) are defined in BS 6841. The weightings demonstrate maximum sensitivity to vertical acceleration in the frequency range 4 Hz to 12.5 Hz and to horizontal acceleration in the range 1 Hz to 2 Hz.

The mathematical definitions of the frequency weightings are given in BS 6841.

NOTE W_b is the most appropriate frequency weighting network for use with vertical vibration when the levels of vibration are clearly above the threshold of perception. At and just above the threshold of perception it seems that even W_b gives insufficient weight to vibration at the higher frequencies of the range considered.