INTERNATIONAL STANDARD

ISO 10137

Second edition
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Bases for design of structures — Serviceability of buildings and walkways against vibrations

Bases du calcul des constructions — Aptitude au service des bâtiments et des passerelles sous vibrations

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 10137 was prepared by Technical Committee ISO/TC 98, *Bases for design of structures*, Subcommittee SC 2, *Reliability of structures*.

This second edition cancels and replaces the first edition (ISO 10137:1992) and differs from the previous edition as follows:

— information on relevant International Standards have been updated;

— treatment of vibrations from rock bursts has been added;

— actions due to human activities have been updated (Annex A);

— serviceability criteria for occupants of buildings subjected to wind-induced vibrations have been added (Annex D);

— the bibliography has been revised and updated;

— editorial changes and clarifications of text have been made.

Introduction

Economic use of high-strength and lightweight materials has resulted in a trend towards more dynamically responsive structures. This trend is exacerbated by the emergence of new sources of vibration acting on buildings and walkways, and is compounded by an increasing demand for “vibration free” environments for proper functioning of industrial and laboratory processes and instruments, and for work efficiency and personal comfort. In the past, vibrations in buildings have largely been controlled by specified loads or limitation of static deflections, or they have simply not occurred because of the massive nature of buildings. A number of unsatisfactory vibration levels in buildings have been observed, however, and this seems to indicate that the indirect criteria are no longer adequate. Hence, this International Standard was developed with the objective of presenting the principles for predicting vibrations at the design stage, in addition to assessing the acceptability of vibrations in existing structures.

The recommendations presented here are for serviceability and not for safety. It is, however, possible that some vibrations (usually associated with resonance) can become a safety hazard. Therefore, for severe dynamic loading, a check on the possible occurrence of resonance and associated limit stresses, deflections and fatigue effects shall be carried out. The vibration effects discussed here represent a serviceability limit state in accordance with ISO 2394.

The serviceability limit state for vibrations is described by constraints, generally consisting of vibration values (displacement, velocity or acceleration), usually in combination with frequency or a frequency range and possibly with other parameters. The constraints can also be connected to stress, strain, cracking occurrence and duration. The constraints can be determined statistically, but are generally prescribed in codes deterministically.

The design or evaluation criteria employed for achieving satisfactory vibration behaviour of buildings and walkways in the serviceability limit state should consider, among others, the following aspects:

a) variability of tolerance of human occupants due to cultural, regional or economic factors;

b) sensitivity of building contents to vibrations and changing use and occupancy;

c) emergence of new dynamic loadings which are not explicitly addressed by this International Standard;

d) use of materials whose dynamic characteristics may change with time;

e) impracticality of analysis due to the complexity of the structure or complexity of the loading;

f) social or economic consequences of unsatisfactory performance.

Bases for design of structures — Serviceability of buildings and walkways against vibrations

1 Scope

This International Standard gives recommendations on the evaluation of serviceability against vibrations of buildings, and walkways within buildings or connecting them or outside of buildings.

It covers three recipients of vibrations:

a) human occupancy in buildings and on walkways;

b) the contents of the building;

c) the structure of the building.

It does not include bridges that carry vehicular traffic, even in conjunction with pedestrian traffic, nor the design of foundations or supporting structures of machinery.

For the purposes of this International Standard it is assumed that the building structure responds linearly to the applied loads. This means that the structure does not yield or fail, nor is it subject to significant non-linear effects.

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.

ISO 2041, *Mechanical vibration, shock and condition monitoring — Vocabulary*

ISO 2372, *Mechanical vibration of machines with operating speeds from 10 to 200 rev/s — Basis for specifying evaluation standards*

ISO 2394:1998, *General principles on reliability for structures*

ISO 2631-1:1997, *Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration — Part 1: General requirements*

ISO 2631-2:2003, *Mechanical vibration and shock — Evaluation of human exposure to whole-body vibration — Part 2: Vibration in buildings (1 Hz to 80 Hz)*

ISO 3010:2001, *Basis for design of structures — Seismic actions on structures*

ISO 3898, *Bases for design of structures — Notations — General symbols*

ISO 4354, *Wind actions on structures*

ISO 4866:1990, *Mechanical vibration and shock — Vibration of buildings — Guidelines for the measurement of vibrations and evaluation of their effects on buildings*

ISO 6897, *Guidelines for the evaluation of the response of occupants of fixed structures, especially buildings and off-shore structures, to low-frequency horizontal motion (0,063 to 1 Hz)*

ISO 8041, *Human response to vibration — Measuring instrumentation*

ISO 8569, *Mechanical vibration and shock — Measurement and evaluation of shock and vibration effects on sensitive equipment in buildings*

ISO 8930, *General principles on reliability for structures — List of equivalent terms*

ISO/TS 10811-1, *Mechanical vibration and shock — Vibration and shock in buildings with sensitive equipment — Part 1: Measurement and evaluation*

ISO/TS 10811-2, *Mechanical vibration and shock — Vibration and shock in buildings with sensitive equipment — Part 2: Classification*

ISO 10816 (all parts), *Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts*

ISO 14837-1, *Mechanical vibration — Ground-borne noise and vibration arising from rail systems — Part 1: General Guidance*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2041 and ISO 8930 and the following apply.

NOTE See also ISO 3898 and ISO 2394.

3.1
amplification
increase of vibration amplitudes relative to a reference amplitude

3.2
attenuation
loss of vibration energy along a transmission path

3.3
broadband spectrum
spectrum with the vibration distributed over broad frequency bands (e.g. octave-band spectrum, one-third-octave band spectrum)

3.4
damping
dissipation of energy in a vibrating system

3.5
dynamic actions
actions varying so quickly that they give rise to vibrations

3.6
dynamic forces
forces varying so quickly that they give rise to vibrations

3.7
Fourier transformation
mathematical procedure that transforms a time record into a complex frequency spectrum (Fourier spectrum) without loss of information