

SVENSK STANDARD

SS-ISO 10137:2008

Fastställt/Approved: 2008-03-17

Publicerad/Published: 2008-04-17

Utgåva/Edition: 1

Språk/Language: engelska/English

ICS: 91.070.10; 91.080.01; 91.120.25

**Grundläggande dimensioneringsregler för bärverk –
Byggnaders samt gång- och cykelbroars brukbarhet med hänsyn
till svängningar och vibrationer (ISO 10137:2007, IDT)**

**Bases for design of structures – Serviceability of buildings and
walkways against vibration (ISO 10137:2007, IDT)**

This preview is downloaded from www.sis.se. Buy the entire standard via <https://www.sis.se/std-65530>



SWEDISH
STANDARDS
INSTITUTE

Hitta rätt produkt och ett leveranssätt som passar dig

Standarder

Genom att följa gällande standard både effektiviserar och säkrar du ditt arbete. Många standarder ingår dessutom ofta i paket.

Tjänster

Abonnemang är tjänsten där vi uppdaterar dig med aktuella standarder när förändringar sker på dem du valt att abonnera på.

På så sätt är du säker på att du alltid arbetar efter rätt utgåva.

e-nav är vår online-tjänst som ger dig och dina kollegor tillgång till standarder ni valt att abonnera på dygnet runt. Med e-nav kan samma standard användas av flera personer samtidigt.

Leveranssätt

Du väljer hur du vill ha dina standarder levererade. Vi kan erbjuda dig dem på papper och som pdf.

Andra produkter

Vi har böcker som underlättar arbetet att följa en standard. Med våra böcker får du ökad förståelse för hur standarder ska följas och vilka fördelar den ger dig i ditt arbete. Vi tar fram många egna publikationer och fungerar även som återförsäljare. Det gör att du hos oss kan hitta över 500 unika titlar. Vi har även tekniska rapporter, specifikationer och "workshop agreement".

Matriser är en översikt på standarder och handböcker som bör läsas tillsammans. De finns på sis.se och ger dig en bra bild över hur olika produkter hör ihop.

Standardiseringsprojekt

Du kan påverka innehållet i framtida standarder genom att delta i någon av SIS ca 400 Tekniska Kommittéer.

Find the right product and the type of delivery that suits you

Standards

By complying with current standards, you can make your work more efficient and ensure reliability. Also, several of the standards are often supplied in packages.

Services

Subscription is the service that keeps you up to date with current standards when changes occur in the ones you have chosen to subscribe to. This ensures that you are always working with the right edition.

e-nav is our online service that gives you and your colleagues access to the standards you subscribe to 24 hours a day. With e-nav, the same standards can be used by several people at once.

Type of delivery

You choose how you want your standards delivered. We can supply them both on paper and as PDF files.

Other products

We have books that facilitate standards compliance. They make it easier to understand how compliance works and how this benefits you in your operation. We produce many publications of our own, and also act as retailers. This means that we have more than 500 unique titles for you to choose from. We also have technical reports, specifications and workshop agreements.

Matrices, listed at sis.se, provide an overview of which publications belong together.

Standardisation project

You can influence the content of future standards by taking part in one or other of SIS's 400 or so Technical Committees.

Den internationella standarden ISO 10137:2007 gäller som svensk standard. Detta dokument innehåller den officiella engelska versionen av ISO 10137:2007.

The International Standard ISO 10137:2007 has the status of a Swedish Standard. This document contains the official English version of ISO 10137:2007.

! © Copyright/Upphovsrätten till denna produkt tillhör SIS, Swedish Standards Institute, Stockholm, Sverige. Användningen av denna produkt regleras av slutanvändarlicensen som återfinns i denna produkt, se standardens sista sidor.

■ © Copyright SIS, Swedish Standards Institute, Stockholm, Sweden. All rights reserved. The use of this product is governed by the end-user licence for this product. You will find the licence in the end of this document.

Upplysningar om sakinnehållet i standarden lämnas av SIS, Swedish Standards Institute, telefon 08-555 520 00.

Standarder kan beställas hos SIS Förlag AB som även lämnar allmänna upplysningar om svensk och utländsk standard.

Information about the content of the standard is available from the Swedish Standards Institute (SIS), tel +46 8 555 520 00.

Standards may be ordered from SIS Förlag AB, who can also provide general information about Swedish and foreign standards.

SIS Förlag AB, SE 118 80 Stockholm, Sweden. Tel: +46 8 555 523 10. Fax: +46 8 555 523 11.

E-mail: sis.sales@sis.se Internet: www.sis.se

Contents	Page
Foreword.....	v
Introduction	vi
1 Scope	1
2 Normative references	1
3 Terms and definitions.....	2
4 Description of the vibration problem.....	4
4.1 General remarks.....	4
4.2 Vibration source.....	4
4.2.1 Vibration sources inside a building.....	5
4.2.2 Vibration sources outside a building.....	5
4.3 Transmission path.....	5
4.4 Receiver	5
5 Dynamic actions	5
5.1 General remarks.....	5
5.2 Machinery	6
5.2.1 Rotating machinery	6
5.2.2 Reciprocating machinery	6
5.2.3 Impacting machinery.....	6
5.2.4 Other machinery	6
5.3 Vehicular traffic (road and rail).....	6
5.3.1 General remarks.....	6
5.3.2 Motor vehicles.....	6
5.3.3 Railway trains.....	7
5.4 Impulsive sources.....	7
5.4.1 General remarks.....	7
5.4.2 Impulsive sources in the ground	7
5.4.3 Controlled intermittent and impulsive sources within a structure.....	7
5.4.4 Airborne or waterborne impulsive sources	8
5.5 Human activity	8
5.5.1 Repetitive coordinated activities over a fixed area.....	8
5.5.2 Persons traversing structures.....	8
5.5.3 Single pulses.....	8
5.6 Wind	8
5.7 Earthquakes	8
6 Evaluation of response	9
6.1 General remarks.....	9
6.2 Methods of analysis.....	9
6.2.1 General remarks.....	9
6.2.2 Actions that vary with time and space	9
6.2.3 Actions that vary with time	10
6.3 Evaluation of vibration levels by calculation.....	10
6.3.1 General remarks.....	10
6.3.2 Damping for the serviceability limit state	10
6.3.3 Vibrations propagating in continuous media	10
6.3.4 Vibrations of discrete media.....	11
6.4 Evaluation of vibration levels by measurement	11
6.4.1 General remarks.....	11
6.4.2 Quantities to be measured.....	11
6.4.3 Measuring apparatus and range of parameters	12

6.4.4	Arrangement of measurement points	12
6.4.5	Vibration measurement analysis and results.....	13
6.4.6	Measurement report.....	13
7	Vibration criteria for the serviceability limit state.....	13
7.1	General remarks	13
7.1.1	Criteria for human occupants	14
7.1.2	Criteria for building contents.....	14
7.1.3	Criteria for building structures	14
7.2	Vibration criteria for human occupancies	14
7.2.1	General remarks	14
7.2.2	Requirements for walkways.....	15
7.3	Vibration criteria for building contents.....	15
7.3.1	General remarks	15
7.3.2	Vibration criteria for equipment and processes in buildings under design	16
7.3.3	Evaluation of vibrations in existing buildings	16
7.4	Vibration criteria for building structures	16
7.4.1	General remarks	16
7.4.2	Criteria for vibrations from impacts/impulses	17
7.4.3	Criteria for vibrations from other actions.....	17
7.4.4	Empirical criteria	17
7.4.5	Application of vibration criteria to measured vibrations	17
8	Vibration control	17
9	Vibration mitigation	18
Annex A	(informative) Dynamic actions	19
Annex B	(informative) Examples of vibration analysis.....	26
Annex C	(informative) Examples of vibration criteria	33
Annex D	(informative) Guidance for human response to wind-induced motions in buildings	40
Annex E	(informative) Methods of vibration mitigation.....	42
Bibliography	44

SS-ISO 10137:2008 (E)

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*

SS-ISO 10137:2008 (E)

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

3.8

frequency components

centre frequencies of narrow bands in which the energy of a spectrum is concentrated

3.9

frequency response function

frequency spectrum function of the output signal divided by the frequency spectrum function of the input signal

NOTE The frequency response is usually given graphically by curves showing the amplitude relationship and, where applicable, phase shift or phase angle, as a function of frequency. Alternatively, it is the Fourier transformation of the response of the structure to an impulse.

3.10

geometric spreading

decay of vibration amplitudes with increasing distance from the source as the energy is spread over a larger volume

3.11

impulsive source

source which gives a dynamic action of a short duration compared with the natural period of the structure under consideration

3.12

mode of vibration

deflected shape at a particular natural frequency of a system undergoing free vibration

3.13

narrow-band spectrum

spectrum with the vibration concentrated in narrow frequency bands

3.14

natural frequency

frequency at which a mode of vibration will oscillate under free vibrations

3.15

octave-band spectrum

spectrum determined by means of a filter cutting off frequencies outside a band, where the maximum frequency in each band is equal to the minimum frequency multiplied by 2

3.16

receiver

person, structure or contents of a building subjected to vibrations

3.17

response spectrum

maximum responses of a series of single-degree-of-freedom systems subjected to a given dynamic base motion, plotted as a function of natural frequencies for specific values of damping

3.18

shock

dynamic action with a duration that is short compared to the natural period of the receiver

3.19

shock spectrum

response spectrum for a shock motion

3.20

source

origin of the vibration