TECHNICAL REPORT

ISO/TR 4553

First edition
2022-01

Deformations and displacements of buildings and building elements at serviceability limit states

Reference number
ISO/TR 4553:2022(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The underlying aim of this document is to provide guidance for the structural designer to identify those aspects of deformation that affect the suitability of a building for the purposes for which it was intended, and to suggest certain criteria by which the serviceability of the building in this respect can be assessed. In addition, numerical values for these criteria are provided to give some guidance where this might be appropriate.

Deformations of building structures can affect the serviceability of the building by causing damage to parts of the building and its finishes, by disturbing or harming users, or by preventing proper use of the building. Deformations can be caused by ground movements, by differential settlement of foundations, by environmental and occupational loads, by pre-stressing forces, and by movements of building materials due to creep under load, or changes in temperature, moisture content or chemical composition.

Prior to the 1960s, the allowable design stresses assigned to most engineering materials were low and design methods were conservative. This resulted in highly redundant building forms, typically with comparatively short spans and relatively massive elements. Such buildings were generally very stiff to the extent that deflection problems were uncommon. There was little need to realistically ascertain the actual deformation of elements since these seldom controlled design or element sizes.

In contrast, modern design methods result in structures that are generally lighter, possess less redundancy and are much more reactive to imposed loads. Modern structural design and material standards aim to realistically reflect the actual material properties and provide innovative designers with the tools to utilize the full potential of new materials. Material technology has also advanced, with higher strength materials allowing longer spanning elements, which are typically more susceptible to deformations and vibrations. Designers need to assess the response of each element to the appropriate combination of realistic actions, often modelling these using analytical and computer techniques. The engineering rationale inherent within such an approach is complex. Several assumptions are required to assess that response, both to reflect the actual condition of the element in service and to ascertain the response of that element to the applied action.

This document identifies and discusses many of the assumptions that are made when assessing elemental deformation control. This document provides more detailed background information to assist in assuring that these assumptions are appropriate and it provides guidance which allow the sensitivity of such assumptions to be assessed with regard to the member, its physical properties or its in-service condition.

Deformations and displacements of buildings and building elements at serviceability limit states

1 Scope

This document establishes the basic principles for the determination of deformations of buildings at the serviceability limit state when formulating national standards and recommendations. This document contains information on how serviceability for buildings and building elements is dealt with in some national standards.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 8930:2021, *General principles on reliability for structures — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8930:2021 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 Limit state design

A structure or part of a structure, including a building and building elements, is considered unfit for use or to have failed when it exceeds a particular condition, called a limit state, beyond which its performance or use is impaired (e.g. ISO 22111:2019[21]). Generally, all designs are governed by the ultimate limit state and serviceability limit state.

The ultimate limit state primarily focuses on the maximum load-bearing capacity beyond which failure occurs. The application of ultimate limit state in designs is commonly based on the assessment of either the impact of failure on loss of human life or personal injury, or both, and economic, social and/or environmental consequences. In major standards, different buildings and structures are assigned structural importance, consequence or risk classifications. Examples of these classifications can be found in the following standards:

a) AS/NZS 1170.0:2002, 3.3 for New Zealand, and Annex F: F2 for Australia[9];

b) prEN 1990:2020, 4.3, A.1.3, A.1.4[11];

c) ISO 2394:2015, F.2[17];

d) Table 2.4.1 of Reference [23];

e) ASCE 7-16, 2.2.1, Table 2.2.1[10].

These classifications are summarized in Table 1.