BS EN 1996-3:2023

BSI Standards Publication

Eurocode 6 — Design of masonry structures

Part 3: Simplified calculation methods for unreinforced masonry structures

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National foreword

This British Standard is the UK implementation of EN 1996-3:2023. It supersedes BS EN 1996-3:2006, which will be withdrawn on 30 March 2028.

The UK participation in its preparation was entrusted to Technical Committee B/525/6, Use of masonry.

A list of organizations represented on this committee can be obtained on request to its committee manager.

National choice is allowed in this standard where explicitly stated within notes. The National Annex to this standard contains the national choices to be used for buildings and civil engineering works constructed in the UK.

The first generation of EN Eurocodes was published between 2002 and 2007, with conflicting British Standards withdrawn in 2010. This document forms part of the second generation of EN Eurocodes.

The second generation of EN Eurocodes is expected to be published between 2023 and 2026. These documents are being published as soon as they are available. This is being done to enable users to prepare for the transition from the first generation to second generation of EN Eurocodes.

UK adoptions of the first generation of EN Eurocodes will be withdrawn by BSI on 30 March 2028. Until that date, the first generation documents should be considered as the applicable standards for buildings and civil engineering works constructed in the UK unless otherwise specified by the relevant authority or in the specification for a particular project.

This standard is intended to be used with its National Annex and other referenced documents, including other second generation Eurocodes, as an interdependent suite of documents.

While the use of provisions in this standard in conjunction with first generation Eurocodes is not precluded, it should be undertaken with care and should only be done when users are satisfied that it will not result in a lower level of reliability than the minimum level set in the first generation Eurocodes and associated UK National Annexes.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

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November 2023

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Eurocode 6 - Design of masonry structures - Part 3: Simplified calculation methods for unreinforced masonry structures

Eurocode 6 - Calcul des ouvrages en maçonnerie - Partie 3: Méthodes de calcul simplifiées pour les ouvrages en maçonnerie non armée

Eurocode 6 - Bemessung und Konstruktion von Mauerwerksbauten - Teil 3: Vereinfachte Berechnungsmethoden für unbewehrte Mauerwerksbauten

This European Standard was approved by CEN on 23 July 2023.

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European foreword

This document (EN 1996-3:2023) has been prepared by Technical Committee CEN/TC 250 “Structural Eurocodes”, the secretariat of which is held by BSI. CEN/TC 250 is responsible for all Structural Eurocodes and has been assigned responsibility for structural and geotechnical design matters by CEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2027 and conflicting national standards shall be withdrawn at the latest by March 2028.

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

This document supersedes EN 1996-3:2006, including EN 1996-3:2006/AC:2009.

The first generation of EN Eurocodes was published between 2002 and 2007. This document forms part of the second generation of the Eurocodes, which have been prepared under a Mandate M/515 given to CEN by the European Commission and the European Free Trade Association.

The Eurocodes have been drafted to be used in conjunction with relevant execution, material, product and test standards, and to identify requirements for execution, materials, products and testing that are relied upon by the Eurocodes.

The main changes compared to the previous edition are listed below:

— update of rules to ensure compatibility with EN 1996-1-1;

— replacing the duplication of shear rules from EN 1996-1-1 by a simplified method in Annex A;

— new design concept for basement walls regarding the actual earth pressure coefficient;

— simplification of the design rules for walls under concentrated loads;

— improvement of the design rules for walls under mainly bending due to horizontal loads (required minimum normal force).

The Eurocodes recognize the responsibility of each Member State and have safeguarded their right to determine values related to regulatory safety matters at national level through the use of National Annexes.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

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0 Introduction

0.1 Introduction to the Eurocodes

The Structural Eurocodes comprise the following standards generally consisting of a number of Parts:

— EN 1990 Eurocode — Basis of structural and geotechnical design

— EN 1991 Eurocode 1 — Actions on structures

— EN 1992 Eurocode 2 — Design of concrete structures

— EN 1993 Eurocode 3 — Design of steel structures

— EN 1994 Eurocode 4 — Design of composite steel and concrete structures

— EN 1995 Eurocode 5 — Design of timber structures

— EN 1996 Eurocode 6 — Design of masonry structures

— EN 1997 Eurocode 7 — Geotechnical design

— EN 1998 Eurocode 8 — Design of structures for earthquake resistance

— EN 1999 Eurocode 9 — Design of aluminium structures

— New parts are under development, e.g. Eurocode for design of structural glass

The Eurocodes are intended for use by designers, clients, manufacturers, constructors, relevant authorities (in exercising their duties in accordance with national or international regulations), educators, software developers, and committees drafting standards for related product, testing and execution standards.

NOTE Some aspects of design are most appropriately specified by relevant authorities or, where not specified, can be agreed on a project-specific basis between relevant parties such as designers and clients. The Eurocodes identify such aspects making explicit reference to relevant authorities and relevant parties.

0.2 Introduction to EN 1996 Eurocode 6

EN 1996 Eurocode 6 standards, applies to the design of building and civil engineering works, or parts thereof, in unreinforced, reinforced, prestressed and confined masonry.

EN 1996 deals only with the requirements for resistance, serviceability and durability of structures. Other requirements, for example, concerning thermal or sound insulation, are not considered.

EN 1996 does not cover the special requirements of seismic design. Provisions related to such requirements are given in EN 1998, which complements, and is consistent with EN 1996.

EN 1996 does not cover numerical values of the actions on building and civil engineering works to be taken into account in the design. They are provided in EN 1991.

0.3 Introduction to EN 1996-3

This document describes simplified calculation methods to facilitate the design of unreinforced masonry walls based on the principles from EN 1996-1-1.

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0.4 Verbal forms used in the Eurocodes

The verb “shall" expresses a requirement strictly to be followed and from which no deviation is permitted in order to comply with the Eurocodes.

The verb “should” expresses a highly recommended choice or course of action. Subject to national regulation and/or any relevant contractual provisions, alternative approaches could be used/adopted where technically justified.

The verb “may" expresses a course of action permissible within the limits of the Eurocodes.

The verb “can" expresses possibility and capability; it is used for statements of fact and clarification of concepts.

0.5 National Annex for EN 1996-3

National choice is allowed in this standard where explicitly stated within notes. National choice includes the selection of values for Nationally Determined Parameters (NDPs).

The national standard implementing this document can have a National Annex containing all national choices to be used for the design of buildings and civil engineering works to be constructed in the relevant country.

When no national choice is given, the default choice given in this standard is to be used.

When no national choice is made and no default is given in this standard, the choice can be specified by a relevant authority or, where not specified, agreed for a specific project by appropriate parties.

National choice is allowed in EN 1996-3 through notes to the following:

4.4.4(1) 6.2(1) – 2 choices D.3(1) – 6 choices D.4(1) – 2 choices

National choice is allowed in EN 1996-3 on the application of the informative annexes:

Annex A Annex B Annex C

The National Annex can contain, directly or by reference, non-contradictory complementary information for ease of implementation, provided it does not alter any provisions of the Eurocodes.

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1 Scope

1.1 Scope of EN 1996-3

(1) This document provides simplified calculation methods to facilitate the design of the following unreinforced masonry walls, subject to certain conditions of application:

— walls subjected to vertical and wind loading;

— walls subjected to concentrated loads;

— shear walls;

— basement walls subjected to lateral earth pressure and vertical loading;

— walls subjected to lateral loading but not subjected to vertical loading.

NOTE 1 For those types of masonry structures or parts of structures not covered by (1), the design can be based on EN 1996-1-1.

NOTE 2 The rules given in this document are consistent with those given in EN 1996-1-1 but are more conservative in respect of the conditions and limitations of their use.

(2) This document applies only to those masonry structures, or parts thereof, that are described in EN 1996-1-1 and EN 1996-2.

(3) The simplified calculation methods given in this document do not cover the design of double-leaf walls.

(4) The simplified calculation methods given in this document do not cover the design for accidental situations.

1.2 Assumptions

(1) The assumptions of EN 1990 apply to this document.

(2) This document is intended to be used, for direct application, together with EN 1990, the EN 1991 series, EN 1996-1-1, EN 1996-1-2 and EN 1996-2.

(3) The rules given in this document assume that concrete floors are designed according to EN 1992-1-1.

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.

EN 998-2, *Specification for mortar for masonry — Part 2: Masonry mortar*

EN 1990, *Eurocode — Basis of structural and geotechnical design*

EN 1991 (all parts), *Eurocode 1 — Actions on structures*

EN 1996-1-1:2022, *Eurocode 6 — Design of masonry structures — Part 1-1: General rules for reinforced and unreinforced masonry structures*

EN 1996-2, *Eurocode 6 — Design of masonry structures — Part 2: Design considerations, selection of materials and execution of masonry*

EN 1997-1, *Eurocode 7 — Geotechnical design — Part 1: General rules*

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3 Terms, definitions and symbols

For the purposes of this document, the terms and definitions given in EN 1990, EN 1996-1-1 and the following apply.

3.1 Terms relating to wall types

3.1.1
basement wall
retaining masonry wall constructed partly or fully below ground level

3.2 Symbols

For the purposes of this document, the material-independent symbols given in EN 1990, the material-dependent symbols given in EN 1996-1-1 and the following material-dependent symbols apply.

Latin upper case letters

K_e earth pressure coefficient

$N_{Ed,max}$ design value of the maximum vertical load at mid height of the fill

$N_{Ed,min}$ design value of the minimum vertical load at mid height of the fill

Latin lower case letters

c_t dimensionless parameter depending on α_r

h clear height of the masonry wall

h_a average height of the building

h_e vertical distance between the ground level and the face of the bottom support of the wall

h_m maximum height of a building allowed with the simplified calculation method

l length of a wall (between other walls, between a wall and an opening, or between openings)

l_{bx} plan dimension of a building in the x-direction

l_{by} plan dimension of a building in the y-direction

l_{cw} spacing of cross walls or other buttressing elements

$l_{f,ef}$ is the difference of the effective span of the floors on both sides of the considered wall

$l_{f,i}$ span of floor i

$l_{f,ix}$ span of floor i perpendicular to the considered wall

$l_{f,iy}$ span of floor i parallel to the considered wall

$l_{ref,c}$ value for the span of the floor, depending on the characteristic compressive strength of masonry f_k

$l_{ref,t}$ value for the span of the floor, depending on the thickness of the wall t

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l_{sx} length of a shear wall orientated in the x-direction

l_{sy} length of a shear wall orientated in the y-direction

l_w length of the analysed wall loaded by wind

t_b bearing length of the floor or roof on the wall

w_{Ed} design wind load per unit area

w_{Ek} characteristic wind load per unit area

Greek upper case letters

Φ_s capacity reduction factor

Greek lower case letters

α_r is the ratio between the characteristic value of the permanent vertical load in a shear wall and the design value of the resistance $A\,f_d$ of a shear wall

β_e constant accounting for uniaxial or biaxial load transfer in basement walls

γ_{soil} bulk weight density of the soil

ρ_{sn} reduction factor for the effective height obtained from a simplified rule

4 Basis of design

4.1 General rules

4.1.1 Basic requirements

(1) The design of masonry structures shall be in accordance with the general rules given in EN 1990 and the specific design provisions for masonry structures given in EN 1996-1-1.

4.2 Principles of limit state design

(1) For masonry structures, the ultimate limit state and serviceability limit state shall be considered for all aspects of the structure including ancillary components in the masonry according to EN 1996-1-1.

4.3 Basic variables

4.3.1 Actions

(1) The characteristic values of actions shall be obtained from the relevant parts of the EN 1991 series.

4.3.2 Material, and product properties

(1) Properties of materials and construction products and their geometrical data to be used for design should be those specified in the relevant European Standards (EN), European Technical Specifications (TS) or according to a transparent and reproducible assessment that complies with all the requirements of a European Assessment Document (EAD), unless otherwise indicated in this document.

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4.4 Verification by the partial factor method

4.4.1 Design values of actions

(1) Partial factors for actions shall be obtained from EN 1990.

(2) Design values of indirect actions arising from interacting components of other materials shall be determined using the relevant code and applicable partial safety factors.

(3) For serviceability limit states, imposed deformations should be introduced as estimated (mean) values.

4.4.2 Design values of material properties

(1) The design value for a material property is obtained by dividing its characteristic or declared value by the relevant partial factor for materials, γ_M.

4.4.3 Combination of actions

(1) Combination of actions shall be in accordance with the general rules given in EN 1990.

4.4.4 Ultimate limit states

(1) The relevant values of the partial factor for materials γ_M shall be specified for the ultimate limit state either for persistent or transient design situations.

NOTE The value of γ_M is given in Table 4.1 (NDP) unless the National Annex gives different values.

Table 4.1 (NDP) — Partial factors on materials for masonry buildings

Material		γ_M
Masonry made with:		
A	Units of Category I, designed mortar [a]	2,0
B	Units of Category I, prescribed mortar [b]	2,2
C	Units of Category II, any mortar [a], [b], [c]	2,5

[a] Requirements for designed mortars are given in EN 998-2 and EN 1996-2.
[b] Requirements for prescribed mortars are given in EN 998-2 and EN 1996-2.
[c] When the coefficient of variation for Category II units is not greater than 25 %.

5 Materials

5.1 General

(1) The materials used in the masonry walls referred to in this document shall be in accordance with EN 1996-1-1:2022, Clause 5.

(2) Masonry units should be grouped as Group 1, Group 1S, Group 2, Group 3 or Group 4 according to EN 1996-1-1:2022, 5.1.2.

NOTE Normally the manufacturer will state the grouping of units in the product declaration.

(3) Annex D shall be used for the determination of material properties. These material properties are derived from the relevant rules given in EN 1996-1-1.

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