

The European Union

EDICT OF GOVERNMENT

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EN 1996-2 (2006) (English): Eurocode 6: Design of masonry structures - Part 2: Design considerations, selection of materials and execution of masonry [Authority: The European Union Per Regulation 305/2011, Directive 98/34/EC, Directive 2004/18/EC]



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English Version

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

Eurocode 6 - Calcul des ouvrages en maçonnerie - Partie 2: Conception, choix des matériaux et mise en oeuvre des maçonneries

Eurocode 6 - Bemessung und Konstruktion von Mauerwerksbauten - Teil 2: Planung, Auswahl der Baustoffe und Ausführung von Mauerwerk

This European Standard was approved by CEN on 24 November 2005.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

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Contents	Page
Background of the Eurocode programme.....	4
Status and field of application of Eurocodes.....	5
National Standards implementing Eurocodes	6
Links between Eurocodes and harmonised technical specifications (ENs and ETAs) for products	7
Additional information specific to EN 1996-2.....	7
National annex for EN 1996-2	7
1 General	8
1.1 Scope of Part 2 of Eurocode 6.....	8
1.2 Normative references	9
1.3 Assumptions	9
1.4 Distinction between principles and application rules.....	9
1.5 Definitions.....	10
1.5.1 General	10
1.5.2 Terms and definitions relating to communication of design	10
1.5.3 Terms relating to climatic factors and exposure conditions.....	10
1.5.4 Term relating to masonry units.....	10
1.5.5 Other terms	11
1.6 Symbols.....	11
2 Design Considerations	11
2.1 Factors affecting the durability of masonry.....	11
2.1.1 General	11
2.1.2 Classification of environmental conditions	11
2.1.2.1 Micro conditions of exposure.....	11
2.1.2.2 Climatic factors (macro conditions of exposure)	12
2.1.3 Aggressive chemical environments	12
2.2 Selection of materials.....	13
2.2.1 General	13
2.2.2 Masonry units	13
2.2.3 Masonry mortar and concrete infill.....	14
2.2.3.1 General	14
2.2.3.2 Selection of factory made masonry mortar and concrete infill.....	14
2.2.3.3 Selection of site-made masonry mortar and concrete infill	14
2.2.4 Ancillary components and reinforcement	15
2.3 Masonry.....	15
2.3.1 Detailing.....	15
2.3.2 Joint finishes.....	15
2.3.3 Masonry movement	15
2.3.4 Movement joints	16

2.3.4.1	General.....	16
2.3.4.2	Spacing of movement joints.....	17
2.3.5	Permissible deviations.....	17
2.3.6	Resistance to moisture penetration through external walls	18
3	Execution.....	18
3.1	General	18
3.2	Acceptance, handling and storage of materials	18
3.2.1	General.....	18
3.2.2	Reinforcement and prestressing materials	18
3.3	Preparation of materials.....	19
3.3.1	Site-made mortars and concrete infill	19
3.3.1.1	General.....	19
3.3.1.2	Chloride content	19
3.3.1.3	Strength of mortar and concrete infill.....	19
3.3.1.4	Admixtures and additions	19
3.3.1.5	Gauging	19
3.3.1.6	Mixing method and mixing time	20
3.3.1.7	Workable life of mortars and concrete infill containing cement	20
3.3.1.8	Mixing in cold weather	20
3.3.2	Factory made mortars, pre-batched mortars, pre-mixed lime sand mortars and ready mixed concrete infill	20
3.4	Permissible deviations.....	21
3.5	Execution of masonry.....	23
3.5.1	General.....	23
3.5.2	Laying masonry units.....	23
3.5.3	Pointing and jointing for masonry other than thin layer masonry	24
3.5.3.1	Pointing	24
3.5.3.2	Jointing.....	24
3.5.4	Incorporation of damp proof course membranes	24
3.5.5	Movement joints	24
3.5.6	Incorporation of thermal insulation materials	24
3.5.7	Cleaning facing masonry	24
3.6	Curing and protective procedures during execution	24
3.6.1	General.....	24
3.6.2	Protection against rain.....	25
3.6.3	Protection against freeze/thaw cycling	25
3.6.4	Protection against effects of low humidity	25
3.6.5	Protection against mechanical damage	25
3.6.6	Construction height of masonry.....	25
A.1	Classification.....	26
A.2	Exposure to wetting.....	27
B.1	Selection of masonry units and mortar.....	29
C.1	Exposure classes	31
C.2	Selection of materials	31

Foreword

This document EN 1996-2 has been prepared by Technical Committee CEN/TC250 “Structural Eurocodes”, the secretariat of which is held by BSI.

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 July 2006, and conflicting national standards shall be withdrawn at the latest by March 2010.

CEN/TC 250 is responsible for all Structural Eurocodes.

This document supersedes ENV 1996-2:1998

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

Background of the Eurocode programme

In 1975, the Commission of the European Community decided on an action programme in the field of construction, based on Article 95 of the Treaty. The objective of the programme was the elimination of technical obstacles to trade and the harmonisation of technical specifications.

Within this action programme, the Commission took the initiative to establish a set of harmonised technical rules for the design of construction works which, in a first stage, would serve as an alternative to the national rules in force in the Member States and, ultimately, would replace them.

For fifteen years, the Commission, with the help of a Steering Committee with Representatives of Member States, conducted the development of the Eurocodes programme, which led to the first generation of European codes in the 1980s.

In 1989, the Commission and the Member States of the EU and EFTA decided, on the basis of an agreement¹⁾ between the Commission and CEN, to transfer the preparation and the publication of the Eurocodes to the CEN through a series of Mandates, in order to provide them with a future status of European Standard (EN). This links de facto the Eurocodes with the provisions of all the Council’s Directives and/or Commission’s Decisions dealing with European standards (eg. the Council Directive 89/106/EEC on construction products - CPD - and Council Directives 93/37/EEC,

¹⁾ Agreement between the Commission of the European Communities and the European Committee for Standardisation (CEN) concerning the work on EUROCODES for the design of building and civil engineering works (BC/CEN/03/89).

92/50/EEC and 89/440/EEC on public works and services and equivalent EFTA Directives initiated in pursuit of setting up the internal market).

The Structural Eurocode programme comprises the following standards generally consisting of a number of parts:

EN 1990, *Eurocode: Basis of structural 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.*

Eurocode standards recognise the responsibility of regulatory authorities in each Member State and have safeguarded their right to determine values related to regulatory safety matters at national level where these continue to vary from State to State.

Status and field of application of Eurocodes

The Member States of the EU and EFTA recognise that Eurocodes serve as reference documents for the following purposes:

- as a means to prove compliance of building and civil engineering works with the essential requirements of Council Directive 89/106/EEC, particularly Essential Requirement N°1 — Mechanical resistance and stability — and Essential Requirement N°2 — Safety in case of fire;
- as a basis for specifying contracts for construction works and related engineering services;
- as a framework for drawing up harmonised technical specifications for construction products (ENs and ETAs).

The Eurocodes, as far as they concern the construction works themselves, have a direct relationship with the Interpretative Documents²⁾ referred to in Article 12 of the CPD, although they are of a

²⁾ According to Article 3.3 of the CPD, the essential requirements (ERs) shall be given concrete form in interpretative documents for the creation of the necessary links between the essential requirements and the mandates for harmonised ENs and ETAGs/ETAs.

different nature from harmonised product standards³⁾. Therefore, technical aspects arising from the Eurocodes work need to be adequately considered by CEN Technical Committees and/or EOTA Working Groups working on product standards with a view to achieving full compatibility of these technical specifications with the Eurocodes.

The Eurocode standards provide common structural design rules for everyday use for the design of whole structures and component products of both a traditional and an innovative nature. Unusual forms of construction or design conditions are not specifically covered and additional expert consideration will be required by the designer in such cases.

National Standards implementing Eurocodes

The National Standards implementing Eurocodes will comprise the full text of the Eurocode (including any annexes), as published by CEN, which may be preceded by a National title page and National foreword, and may be followed by a National Annex (informative).

The National Annex may only contain information on those parameters which are left open in the Eurocode for national choice, known as Nationally Determined Parameters, to be used for the design of buildings and civil engineering works to be constructed in the country concerned, i.e.:

- values and/or classes where alternatives are given in the Eurocode,
- values to be used where a symbol only is given in the Eurocode,
- country specific data (geographical, climatic etc), eg. snow map,
- the procedure to be used where alternative procedures are given in the Eurocode

and it may also contain:

- decisions on the application of informative annexes,
- references to non-contradictory complementary information to assist the user to apply the Eurocode.

³⁾ According to Article 12 of the CPD the interpretative documents shall:

- a) give concrete form to the essential requirements by harmonising the terminology and the technical bases and indicating classes or levels for each requirement where necessary;
- b) indicate methods of correlating these classes or levels of requirement with the technical specifications, e. g. methods of calculation and of proof, technical rules for project design, etc.;
- c) serve as a reference for the establishment of harmonised standards and guidelines for European technical approvals. The Eurocodes, *de facto*, play a similar role in the field of ER 1 and a part of ER 2.

Links between Eurocodes and harmonised technical specifications (ENs and ETAs) for products

There is a need for consistency between the harmonised technical specifications for construction products and the technical rules for works⁴⁾ Furthermore, all the information accompanying the CE Marking of the construction products which refer to Eurocodes shall clearly mention which Nationally Determined Parameters have been taken into account.

This European Standard is part of EN 1996 which comprises the following Parts:

Part 1-1: General - *Rules for reinforced and unreinforced masonry*

Part 1-2: General rules - *Structural fire design.*

Part 2: *Design considerations, selection of materials and execution of masonry.*

Part 3: *Simplified calculation methods for unreinforced masonry structures*

EN 1996-2 describes the principles and requirements for design considerations, selection of materials and execution of masonry structures.

For the design of new structures, EN 1996-1-1 is intended to be used, for direct application, together with ENs 1990, 1991, 1992, 1993, 1994, 1995, 1997, 1998 and 1999.

EN 1996-2 is intended to be used together with EN 1990, EN 1991-1-2, EN 1996-1-1, EN 1996-1-2 and EN 1996-3.

Additional information specific to EN 1996-2

The scope of Eurocode 6 is defined in EN 1996-1-1, and this includes information on the other parts of Eurocode 6.

National Annex for EN 1996-2

This standard gives alternative procedures, values and recommendations for classes with notes indicating where national choices may have to be made. Therefore the National Standard implementing EN 1996-2 should have a National Annex containing all Nationally Determined Parameters to be used for the design of buildings and civil engineering works to be constructed in the relevant country.

National choice is allowed in EN 1996-2 through clauses:

— 2.3.4.2(2)

— 3.5.3.1(1)

⁴⁾ see Article 3.3 and Article 12 of the CPD, as well as clauses 4.2, 4.3.1, 4.3.2 and 5.2 of ID 1.

In addition to general references to non-contradictory complementary information specific references may be made through clauses:

- $\boxed{\text{AC}_1}$ 1.1(2)P
- 2.3.1(1)
- 3.4(3) $\boxed{\text{AC}_1}$

1 General

1.1 Scope of Part 2 of Eurocode 6

(1)P The scope of Eurocode 6 for Masonry Structures as given in 1.1.1 of EN 1996-1-1:2005 applies also to this EN 1996-2.

(2)P EN 1996-2 gives basic rules for the selection of materials and execution of masonry to enable it to comply with the design assumptions of the other parts of Eurocode 6. With the exception of the items given in 1.1(3)P, the scope of Part 2 deals with ordinary aspects of masonry design and execution including:

- the selection of masonry materials;
- factors affecting the performance and durability of masonry;
- resistance of buildings to moisture penetration;
- storage, preparation and use of materials on site;
- the execution of masonry;
- masonry protection during execution;

NOTE 1. Where general guidance only is given, additional guidance based on local conditions and practice may be made available in non contradictory complementary documents which may be referred to in the National Annex.

NOTE 2. The scope of Eurocode 6 excludes seismic, thermal and acoustic functional performance of masonry structures;

(3)P EN 1996-2 does not cover the following items:

- those aspects of masonry covered in other parts of Eurocode 6;
- aesthetic aspects;
- applied finishes;
- health and safety of persons engaged in the design or execution of masonry;
- the environmental effects of masonry buildings, civil engineering works and structures on their surroundings.

1.2 Normative references

(1)P This European Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication applies (including amendments).

- EN 206-1, *Concrete -Part 1: Specification, performance, production and conformity*
- EN 771 (all parts), *Specification for masonry units*
- EN 998-2, *Specification for mortar for masonry – Part 2: Masonry mortar*
- EN 845 (all parts), *Specification for ancillary components for masonry*
- EN 1015-11, *Methods of test for mortar for masonry - Part 11: Determination of flexural and compressive strength of hardened mortar*
- EN 1015-17, *Methods of test for mortar for masonry – Part 17: Determination of water-soluble chloride content of fresh mortars*
- EN 1052 (all parts), *Methods of test for masonry*
- EN 1990, *Eurocode: Basis of structural design*
- EN 1996-1-1, *Eurocode 6: Design of masonry structures - Part 1: General rules for reinforced and unreinforced masonry structures*
- EN 13914-1, *The design, preparation and application of external rendering and internal plastering - Part 1: External rendering*

1.3 Assumptions

(1)P In addition to the assumptions given in 1.3 of EN 1990:2002 the following assumptions apply in this EN 1996-2:

- Design shall be in accordance with Section 2 taking into account Section 3.
- Execution shall be in accordance with Section 3 taking into account Section 2.

(2) The design Principles are valid only when the Principles for execution in Section 3 are complied with.

1.4 Distinction between Principles and Application Rules

(1)P The rules in 1.4 of EN 1990:2002 apply to this EN 1996-2.

1.5 Definitions

1.5.1 General

(1) The terms and definitions given in 1.5 of EN 1990:2002 apply to this EN 1996-2.

(2) The terms and definitions used in EN 1996-1-1 apply to this EN 1996-2.

(3) Additional terms and definitions used in this EN 1996-2 are given the meanings contained in 1.5.2 to 1.5.5, inclusive.

1.5.2 Terms and definitions relating to communication of design

1.5.2.1

design specification

documents describing the designer's requirements for the construction, including drawings, schedules, test reports, references to parts of other documents and written instructions

1.5.3 Terms relating to climatic factors and exposure conditions

1.5.3.1

macro conditions

climatic factors depending on the general climate of the region in which a structure is built, modified by the effects of local topography and/or other aspects of the site

1.5.3.2

micro conditions

localised climatic and environmental factors depending on the position of a masonry element within the overall structure and taking into account the effect of protection, or lack of protection, by constructional details or finishes

1.5.4 Term relating to masonry units

1.5.4.1

accessory masonry unit

a masonry unit which is shaped to provide a particular function, e.g. to complete the geometry of the masonry

1.5.5 Other terms

1.5.5.1

applied finish

a covering of material bonded to the surface of the masonry

1.5.5.2

cavity width

the distance perpendicular to the plane of the wall between the cavity faces of the masonry leaves of a cavity wall or that between the cavity face of a veneer wall and the masonry backing structure

1.5.5.3

cladding

a covering of material(s) fastened or anchored in front of the masonry and not in general bonded to it

1.6 Symbols

(1)P For the purpose of this standard the symbols in accordance with 1.6 of EN 1996-1-1:2005 apply.

(2)P Other symbols used in this EN 1996-2 are:

d_p minimum depth for pointing

l_m maximum horizontal distance between vertical movement joints in external non-loadbearing walls;

2 Design considerations

2.1 Factors affecting the durability of masonry

2.1.1 General

(1)P Masonry shall be designed to have the performance required for its intended use.

2.1.2 Classification of environmental conditions

2.1.2.1 Micro conditions of exposure

(1)P The micro conditions to which the masonry is expected to be exposed shall be taken into account in the design.

(2) When deciding the micro conditions of exposure of the masonry, the effect of applied finishes, protective claddings and details should be taken into account.

(3) Micro conditions of exposure of completed masonry should be categorised into classes, as follows:

MX1 - In a dry environment;

MX2 - Exposed to moisture or wetting;

MX3 - Exposed to moisture or wetting plus freeze/thaw cycling;

MX4 - Exposed to saturated salt air or seawater;

MX5 - In an aggressive chemical environment.

NOTE When necessary, more closely defined conditions within these classes may be specified using the sub-classes in Annex A (e.g. MX2.1 or MX2.2 and M X 3.1 or M X 3.2).

(4) To produce masonry that meets specified performance criteria and withstands the environmental conditions to which it is exposed, the determination of the exposure class should take into account:

- climatic factors;
- severity of exposure to moisture or wetting;
- exposure to freeze/thaw cycling;
- presence of chemical materials that may lead to damaging reactions.

2.1.2.2 Climatic factors (macro conditions of exposure)

(1)P The effect of the macro conditions on the micro conditions shall be taken into account when determining the wetting of masonry and its exposure to freeze/thaw cycling.

(2) Concerning the macro conditions the following should be taken into account:

- rain and snow;
- the combination of wind and rain;
- temperature variation;
- relative humidity variation.

NOTE It is acknowledged that climates (macro conditions) vary considerably throughout Europe and that certain aspects of climate can influence the risk of exposure of masonry to wetting and/or freeze/thaw cycling. However, it is the classification of the micro conditions that is relevant for determining the durability of masonry rather than the ranking of the macro conditions. Examples of relative exposure to wetting of masonry elements in a typical building are shown in Annex A.

2.1.3 Aggressive chemical environments

(1) In coastal areas the exposure of masonry to airborne chlorides or seawater should be taken into account.

(2) Possible sources of sulfates include the following:

- natural soils;
- groundwater;
- waste deposits and filled ground;
- construction materials;
- airborne pollutants.

(3) Where the presence of aggressive chemicals in the environment, other than airborne chlorides or seawater, can affect masonry, class MX5 should be assumed. Where salts can be transported by water moving through the masonry, the potential for increased concentrations and quantities of available chemicals should be taken into account.

2.2 Selection of materials

2.2.1 General

(1)P Materials, where incorporated in the works, shall be able to resist the actions to which they are expected to be exposed, including environmental actions.

(2)P Only materials, products, and systems with established suitability shall be used.

(3) Where the selection of materials for masonry is not otherwise covered in Part 2, it should be done in accordance with local practice and experience.

NOTE 1 Established suitability may result from conformity to a European Standard that is either referred to by this standard or that specifically refers to uses within the scope of this standard. Alternatively, where either there is no appropriate European Standard, or the material or product deviates from the requirements of an appropriate European Standard, established suitability may result from conformity to either:

- a Technical Approval, or
- a national standard, or
- other provisions,

any of which refer specifically to uses within the scope of this standard and are accepted in the place of use of the material or product.

NOTE 2 Acceptable masonry unit specifications and mortar may be selected from Annex B, Table B.1 and B.2, in relation to durability.

2.2.2 Masonry units

(1) The requirements for masonry units should be specified in accordance with the following parts of EN 771 relating to the type of material:

- EN 771-1 for clay masonry units;
- EN 771-2 for calcium silicate masonry units;
- EN 771-3 for aggregate concrete masonry units;

- EN 771-4 for autoclaved aerated concrete masonry units;
- EN 771-5 for manufactured stone masonry units;
- EN 771-6 for natural stone masonry units.

(2) For products not in accordance with EN 771 (e.g. reclaimed products) the design specification should state the required product performance characteristics and the means of their verification including the requirements for sampling and frequency of testing.

2.2.3 Masonry mortar and concrete infill

2.2.3.1 General

(1) Masonry mortar should be selected according to the exposure condition of the masonry and the specification of the masonry units. Until a European Standard method of test for durability is available, the suitability of masonry mortars should be determined on the basis of established local experience of the performance of the particular materials and mix proportions.

2.2.3.2 Selection of factory made masonry mortar and concrete infill

(1) When factory made masonry mortar or concrete infill is considered for use in exposure classes MX4 or MX5 the manufacturer's advice should be sought as to its suitability.

NOTE Until a European Standard method of test for durability is available, the suitability of masonry mortars conforming to EN 998-2 is based on the manufacturer's experience appropriate to the intended use.

2.2.3.3 Selection of site-made masonry mortar and concrete infill

(1) For site-made masonry mortar and concrete infill the design specification should state the required product performance characteristics and the means of their verification including the requirements for sampling and frequency of testing. In addition, where the designer is satisfied that a prescriptive specification will provide the required performance, a detailed specification of the constituent materials, their proportions and the method of mixing may be given either on the basis of tests carried out on trial mixes and/or on the basis of authoritative publicly available references acceptable in the place of use.

(2) The guidance in 3.3.1 should be taken into account particularly where admixtures, additions and pigments are to be used.

(3) In exposure classes MX1, MX2 or MX3, the masonry mortar should be specified for durability using the terms defined in EN 998-2:

- masonry subjected to passive exposure;
- masonry subjected to moderate exposure;
- masonry subjected to severe exposure.

NOTE 2.2.3.3(1) requires performance characteristics to be specified in all cases. For durability, 2.2.3.3(3) requires it to be done by reference to the stated terminology. It is then an option for the designer to give a prescriptive specification

that will fulfil the performance requirements, or alternatively, it can be done as an execution task in accordance with 3.3.1.1(2). For general applications mortar durability designations may be selected from table B.2.

(4) When site-made masonry mortar or concrete infill is to be specified for use in exposure classes MX4 or MX5, the mix proportions to provide adequate durability for the particular conditions should be selected on the basis of authoritative publicly available references acceptable in the place of use.

(5) Where adhesion between masonry units and mortar (bond strength) is a particular design requirement, the mix proportions should take this into account.

NOTE The manufacturer of masonry units may give advice on the type of masonry mortar to be used or tests may be carried out in accordance with relevant parts of EN 1052.

2.2.4 Ancillary components and reinforcement

(1)P Ancillary components and their fixings shall be corrosion resistant in the environment in which they are used.

NOTE 1 Annex C gives guidance on materials and corrosion protection systems for ancillary components in relation to exposure classes.

NOTE 2 Reinforcing steel should be selected following the recommendations given in 4.3.3 of EN 1996-1-1:2005

2.3 Masonry

2.3.1 Detailing

(1) Where the detailing of masonry is not otherwise covered in this EN 1996-2, it should be done in accordance with local practice and experience.

NOTE The local practice and experience may be given in non-contradictory complementary information and referenced in the National Annex

2.3.2 Joint finishes

(1) Pointing mortar should be compatible with the jointing mortar.

2.3.3 Masonry movement

(1)P The possibility of masonry movement shall be allowed for in the design such that the performance of the masonry in use is not adversely affected by such movement.

(2) Where intersecting walls do not all have effectively similar deformation behaviour, the connection between such walls should be able to accommodate any resulting differential movement.

(3) Movement tolerant ties should be provided where required to accommodate relative in-plane movements between masonry leaves or between masonry and other structures to which the masonry is attached.

(4) Where cavity wall ties that are not movement tolerant are used, the uninterrupted height between horizontal movement joints in the outer leaf of external cavity walls should be limited to avoid the loosening of the wall ties.

(5) Movement joints should be used, or reinforcement should be incorporated into the masonry, in order to minimise cracking, bowing or distortion caused by expansion, shrinkage, differential movements or creep.

2.3.4 Movement joints

2.3.4.1 General

(1) Vertical and horizontal movement joints should be provided to allow for the effects of thermal and moisture movement, creep and deflection and the possible effects of internal stresses caused by vertical or lateral loading, so that the masonry does not suffer damage.

(2) The position of movement joints should take into account the need to maintain structural integrity of the wall.

(3) Movement joints should be designed and positioned having regard to:

- the type of masonry unit material taking into account the moisture movement characteristics of the units;
- the geometry of the structure taking into account openings and the proportions of panels;
- the degree of restraint;
- the response of the masonry to long and short term loading;
- the response of the masonry to thermal and climatic conditions;
- fire resistance;
- sound and thermal insulation requirements;
- the presence or not of reinforcement.

(4) The detailing of a movement joint should enable the movement joint to accommodate the anticipated movements, both reversible and irreversible, without damage to the masonry.

(5) All movement joints should pass through the full thickness of the wall or the outer leaf of a cavity wall and through any finishes that are insufficiently flexible to be able to accommodate the movement.

(6) Slip planes should be designed to allow parts of the construction to slide, one in relation to the other, to reduce tensile and shear stresses in the adjacent elements.

(7) In external walls, movement joints should be designed to allow any water to flow off without causing harm to the masonry or penetrating into the building.

2.3.4.2 Spacing of movement joints

(1) The horizontal spacing of vertical movement joints in masonry walls should take into account the type of wall, masonry units, mortar and the specific construction details.

(2) The horizontal distance between vertical movement joints in external non-loadbearing unreinforced masonry walls should not exceed l_m .

NOTE 1 The value for l_m to be used in a Country may be found in its National Annex. Recommended values for l_m for unreinforced non-loadbearing walls are given in the table:

Maximum recommended horizontal distance, l_m , between vertical movement joints for unreinforced, non-loadbearing walls

Type of masonry	l_m (m)
Clay masonry	12
Calcium silicate masonry	8
Aggregate concrete and manufactured stone masonry	6
Autoclaved aerated concrete masonry	6
Natural stone masonry	12

NOTE 2 The maximum horizontal spacing of vertical movement joints may be increased for walls containing bed joint reinforcement conforming to EN 845-3. Guidance may be obtained from the manufacturers of bed joint reinforcement

(3) The distance of the first vertical joint from a restrained vertical edge of a wall should not exceed half the value of l_m .

(4) The need for vertical movement joints in unreinforced loadbearing walls should be considered.

NOTE No recommended values for the spacing are given as they depend on local building traditions, type of floors used and other construction details.

(5) The positioning of movement joints should take into account the need to maintain structural integrity of load bearing internal walls.

(6) Where horizontal joints are required to accommodate vertical movement in an unreinforced veneer wall or in an unreinforced non-loadbearing outer leaf of a cavity wall, the spacing of horizontal movement joints should take into account the type and positioning of the support system.

2.3.5 Permissible deviations

(1) Permissible deviations of the constructed masonry from its intended position should be specified.

(2) The permissible deviations should be specifically stated as values in the design specification or in accordance with locally accepted standards.

NOTE Compliance with tolerances is necessary in order to ensure that, despite the inevitable inaccuracies at each stage in the building process, the functional requirements are satisfied and the correct assembly of structures and components takes place without the need for adjustment or reworking. The permissible tolerances for dimensions of masonry units are specified in EN 771.

(3) Unless otherwise allowed for in the structural design, the permissible deviations should not be greater than the values given in Table 3.1. Where the design allows for deviations in excess of the

values in Table 3.1, the permissible deviations should be specifically stated in the design specification.

NOTE Table 3.1 gives the maximum deviations that have been taken into account in EN 1996-1-1

2.3.6 Resistance to moisture penetration through external walls

(1) Where there is a need for greater resistance to moisture penetration than can be provided by the masonry alone, the application of a suitable rendering, ventilated cladding or other suitable surface treatment should be used.

NOTE Guidance on the use of external renderings is given in EN 13914-1, The design, preparation and application of external renderings. Where a total barrier to rain penetration is required, a ventilated waterproof cladding system may be applied to the masonry.

3 Execution

3.1 General

(1)P All materials used and all work constructed shall be in accordance with the design specification.

(2)P Precautions shall be taken to ensure the overall stability of the structure or of individual walls during construction.

3.2 Acceptance, handling and storage of materials

3.2.1 General

(1)P The handling and storage of materials and masonry products for use in masonry shall be such that the materials are not damaged so as to become unsuitable for their purpose.

(2) Where required by the design specification, materials should be sampled and tested.

(3) Different materials should be stored separately.

3.2.2 Reinforcement and prestressing materials

(1)P The surface condition of reinforcement and prestressing materials shall be examined prior to use and it shall be free from deleterious substances, which may affect adversely the steel, concrete or mortar or the bond between them.

(2) Damage or deformation of reinforcement should be avoided during storage and handling. Steel reinforcing bars, steel prestressing bars and/or tendons and prefabricated bed joint reinforcement should be clearly identified, and stored off the ground, well away from mud, oil, grease, paint or welding operations.

(3) During storage and handling of prestressing steel, welding in the vicinity of tendons without the provision of special protection (from welding splatter) should be prevented.

(4) For sheaths, the following should be taken into account:

- local damage and corrosion inside should be avoided;
- water-tightness should be ensured.

3.3 Preparation of materials

3.3.1 Site-made mortars and concrete infill

3.3.1.1 General

(1) Site-made mortars and concrete infill should be produced using a mix prescription that will result in the required performance characteristics. When the mix prescription is not given in the design specification, the detailed specification of constituent materials, their proportions and the method of mixing should be selected on the basis of tests carried out on trial mixes and/or on the basis of authoritative publicly available references acceptable in the place of use.

(2) When tests are required they should be carried out in accordance with the design specification. When test results indicate that the mix prescription is not giving the required performance characteristics, the mix prescription should be amended and if it is part of the design specification any amendments should be agreed with the designer.

3.3.1.2 Chloride content

(1) When sampled in accordance with EN 998-2, and tested in accordance with EN 1015-17 or when using a calculation method based on measured chlorine ion content of the constituents of the mortar, the maximum value permitted in EN 998-2 should not be exceeded.

3.3.1.3 Strength of mortar and concrete infill

(1) When the properties of mortar need to be verified, specimens should be prepared and tested in accordance with EN 1015-11.

(2) When the properties of concrete infill need to be verified, specimens should be prepared and tested in accordance with EN 206 -1.

3.3.1.4 Admixtures and additions

(1)P Unless permitted by the design specification, admixtures, additions or pigments shall not be used.

3.3.1.5 Gauging

(1)P Materials for mortar and concrete infill shall be measured by weight or by volume into the specified proportions in clean suitable measuring devices.

(2) In the proportioning of the materials for concrete infill, account should be taken of the amount of water that will be absorbed by the masonry units and mortar joints.

3.3.1.6 Mixing method and mixing time

- (1) The mixing method and the time of mixing should ensure consistent production of the correct mix proportions. Mortar should not be contaminated during subsequent handling.
- (2) Unless hand mixing is permitted by the design specification, a suitable mechanical mixer should be used.
- (3) The mixing time should be counted from the time when all constituent materials have been added to the mixer. Wide variation in the mixing time of different batches should be avoided.

NOTE In general, a machine mixing time of 3 minutes to 5 minutes after all the constituents have been added is suitable and, except in the case of retarded mortars, the mixing time should not exceed 15 minutes. Prolonged mixing where air-entraining agents are used can lead to excessive air entrainment and thus to a reduction in adhesion and durability.

- (4) The mortar or concrete infill should be mixed so as to have sufficient workability for it to fill the spaces into which it is placed, without segregation, when it is compacted.

3.3.1.7 Workable life of mortars and concrete infill containing cement

- (1) Mortars and concrete infill containing cement should be ready for use when they are discharged from the mixer, and no subsequent additions of binders, aggregates, admixtures, or water should be made.

NOTE Water may be added to site-made mortars to replace water lost by evaporation.

- (2) Mortar and concrete infill should be used before its workable life has expired. Any mortar or concrete infill left after the initial set has commenced should be discarded and should not be reconstituted.

3.3.1.8 Mixing in cold weather

- (1)P Water, sand or premixed lime:sand mortars containing ice particles shall not be used.
- (2) Unless specifically permitted by the design specification, de-icing salts or other antifreezing agents should not be used.

3.3.2 Factory made mortars, pre-batched mortars, pre-mixed lime sand mortars and ready mixed concrete infill

- (1)P Factory made mortars and pre-batched mortars shall be used in accordance with the manufacturer's instructions, including mixing time and type of mixer.
- (2) Mortar should be mixed effectively so that a uniform distribution of the constituents is ensured.
- (3) The site mixing equipment, procedures, including mixing in cold weather and care of mixing plant and mixing time specified by the manufacturer, should be used.
- (4) Pre-mixed lime:sand mortars should be mixed with the binder according to AC1 3.3.1AC1.
- (5)P Ready-to-use factory made mortars shall be used before the expiry of the workable life stated by the manufacturer.

(6) Ready mixed concrete infill should be used according to the design specification.

3.4 Permissible deviations

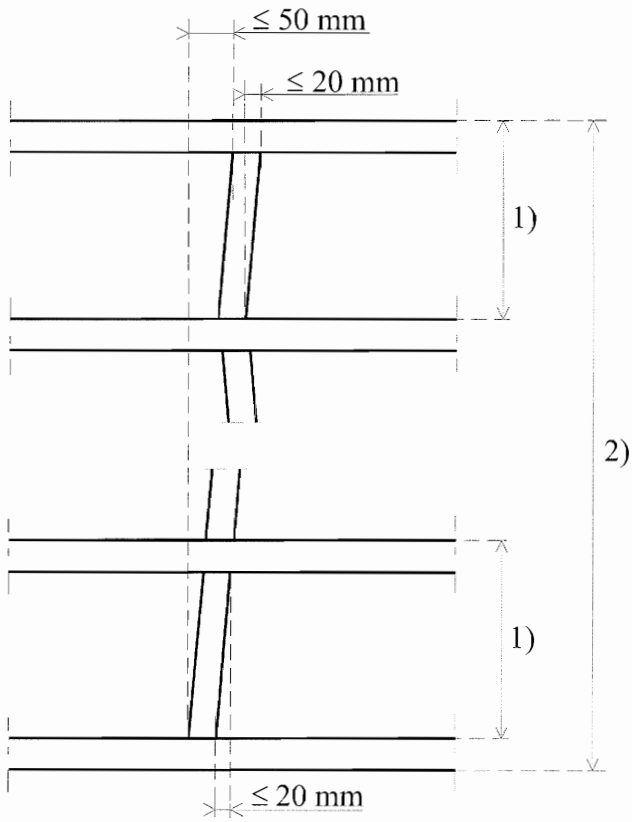
(1)P All work shall be constructed in accordance with the specified details within permissible deviations.

(2) Dimensions and planeness should be checked as the work proceeds.

(3) Deviations of the constructed masonry from its intended position should not exceed the values given in the design specification. Where values are not given in the design specification for any of the deviations listed in Table 3.1, flatness tolerances or angular tolerances then the corresponding permissible deviations should be the lesser of:

- the values given in Table 3.1, see also Figure 3.1;
- the values in accordance with locally accepted practice.

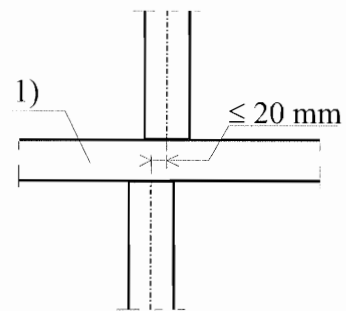
NOTE Such locally accepted practice can be given in non-contradictory complementary information and referenced in the National Annex.



Key

- 1) storey height
- 2) building height

a) Verticality



Key

- 1) intermediate floor

b) Vertical alignment

Figure 3.1 — Maximum vertical deviations

Table 3.1 – Permissible deviations for masonry elements

Position	Maximum deviation
Verticality	
in any one storey	± 20 mm
in total height of building of three storeys or more	± 50 mm
vertical alignment	± 20 mm
Straightness^a	
in any one metre	± 10 mm
in 10 metres	± 50 mm
Thickness	
of wall leaf ^b	± 5 mm or ± 5 % of the leaf thickness whichever is the greater
of overall cavity wall	± 10 mm.
^a Deviation from straightness is measured from a straight reference line between any two points.	
^b Excluding leaves of single masonry unit width or length, where the dimensional tolerances of the masonry units govern the leaf thickness.	

(4) Unless otherwise specified, the first course of masonry should not overhang the edge of a floor or foundation by more than 15 mm.

3.5 Execution of masonry

3.5.1 Adhesion

(1) Satisfactory adhesion should be achieved by proper preparation of the masonry units and mortar. The necessity for wetting masonry units before use should be obtained from the design specification. Where there are no requirements in the design specification, the recommendations from the manufacturer of the units and, where appropriate, from the manufacturer of factory made mortar, should be followed.

(2) Unless otherwise specified, joints should not be recessed to a depth more than 5 mm in walls of thickness 200 mm or less.

(3) When using perforated masonry units, the mortar joints should not be recessed more than 1/3 of the shell thickness unless otherwise specified.

3.5.2 Laying masonry units

(1) Unless otherwise stated in the design specification, masonry units with frogs should be laid so that they are fully filled with mortar.

3.5.3 Pointing and jointing for masonry other than thin layer masonry

3.5.3.1 Pointing

(1) Where joints are to be pointed, the unhardened mortar joints should be raked out so as to have clean sides to a depth of at least d_p , but no more than 15% of the wall thickness, measured from the finished surface of the joint. Loose material should be brushed out.

NOTE The value for d_p to be used in a Country may be found in its National Annex. The recommended value for d_p is 15 mm for a wall thickness of 100 mm.

(2) Before pointing the whole area should be cleaned and if necessary wetted to give the best practicable adhesion for the subsequent pointing.

3.5.3.2 Jointing

(1) Where masonry is finished by jointing during execution, the mortar should be compacted before it has lost its plasticity.

3.5.4 Incorporation of damp proof course membranes

(1) Where no instructions are available, laps at corners and intersections of walls should extend the full width of the wall and all other laps should be not less than 150 mm.

3.5.5 Movement joints

(1) Except for slip ties, components including copings and cappings should not bridge movement joints.

3.5.6 Incorporation of thermal insulation materials

(1) Where insulation is installed by injecting or blowing materials into the cavity, the masonry leaves should have sufficient strength to resist the pressures imposed during and after installation.

3.5.7 Cleaning facing masonry

(1) Splashes of mortar, grout or other stains should be cleaned off as soon as practicable after they occur and preferably by brushing before cementitious based materials have hardened.

(2) The cleaning method should be one recommended by the manufacturer of the masonry units taking into account the kind of staining or efflorescence.

3.6 Curing and protective procedures during execution

3.6.1 General

(1)P Suitable precautions shall be taken to avoid damage to newly constructed masonry.

(2) During mortar hydration, newly constructed work should be suitably protected against excessive moisture loss or uptake.

3.6.2 Protection against rain

(1) Completed masonry should be protected from rain falling directly onto the construction until the mortar has matured. It should be protected from mortar being washed out of the joints and from cycles of wetting and drying.

(2) In order to protect the completed masonry, sills, thresholds, gutters and provisional rain water downpipes should be installed as soon as practicable after finishing the bricklaying and pointing.

(3) Bricklaying and pointing should be stopped during periods of heavy rain and the masonry units, mortar and the fresh pointing should be protected.

(4) Freshly pointed masonry should be protected from spells of heavy rain.

3.6.3 Protection against freeze/thaw cycling

(1) Precautions should be taken to avoid damage to freshly completed masonry and pointing from freezing and thawing cycles.

(2) Masonry should not be laid on or with frozen materials.

3.6.4 Protection against effects of low humidity

(1) Newly constructed masonry should be protected from low humidity conditions including the drying effects of wind and high temperatures. It should be kept moist until the cement in the mortar has hydrated.

3.6.5 Protection against mechanical damage

(1) Masonry surfaces, vulnerable arrises at corners and openings, plinths and other projecting features should be protected as appropriate from damage and disturbance taking into account:

- other works in progress and subsequent construction operations;
- activities of construction traffic;
- concrete being poured above;
- use of scaffoldings and the construction processes carried out from them.

(2) Completed masonry should be protected from construction operations that would stain fair-faced masonry or affect bonding with future work such as rendering.

3.6.6 Construction height of masonry

(1) The height of masonry to be built in one day should be limited so as to avoid instability and overstressing of the fresh mortar. The wall thickness, the type of mortar, the shape and density of the units and the degree of exposure to the wind should be taken into account in determining an appropriate limit.

ANNEX A
(informative)

Classification of micro conditions of exposure of completed masonry

A.1 Classification

(1) Table A.1 gives a subdivision of the basic classification given in sub-clause 2.1.2.1(3) with examples.

Table A.1 – Classification of micro conditions of exposure of completed masonry

Class	Micro condition of the masonry	Examples of masonry in this condition
MX1	In a dry environment	Interior of buildings for normal habitation and for offices, including the inner leaf of external cavity walls not likely to become damp. Rendered masonry in exterior walls, not exposed to moderate or severe driving rain, and isolated from damp in adjacent masonry or materials.
MX2	Exposed to moisture or wetting	
MX2.1	Exposed to moisture but not exposed to freeze/thaw cycling or external sources of significant levels of sulfates or aggressive chemicals	Internal masonry exposed to high levels of water vapour, such as in a laundry. Masonry exterior walls sheltered by overhanging eaves or coping, not exposed to severe driving rain or frost. Masonry below frost zone in well drained non-aggressive soil.
MX2.2	Exposed to severe wetting but not exposed to freeze/thaw cycling or external sources of significant levels of sulfates or aggressive chemicals	Masonry not exposed to frost or aggressive chemicals, located: in exterior walls with cappings or flush eaves; in parapets; in freestanding walls; in the ground; under water.
MX3	Exposed to wetting plus freeze/thaw cycling	
MX3.1	Exposed to moisture or wetting and freeze/thaw cycling but not exposed to external sources of significant levels of sulfates or aggressive chemicals	Masonry as class MX2.1 exposed to freeze/thaw cycling.
MX3.2	Exposed to severe wetting and freeze/thaw cycling but not exposed to external sources of significant levels of sulfates or aggressive chemicals	Masonry as class MX2.2 exposed to freeze/thaw cycling.
MX4	Exposed to saturated salt air, seawater or de-icing salts	Masonry in a coastal area. Masonry adjacent to roads that are salted during the winter
MX5	In an aggressive chemical environment	Masonry in contact with natural soils or filled ground or groundwater, where moisture and significant levels of sulfates are present. Masonry in contact with highly acidic soils, contaminated ground or groundwater. Masonry near industrial areas where aggressive chemicals are airborne.

NOTE In deciding the exposure of masonry the effect of applied finishes and protective claddings should be taken into account.

A.2 Exposure to wetting

(1) Figures A.1 and A.2 give examples of relative exposure to wetting.

NOTE The figures are based on typical modern construction but for clarity they do not show all detailing of cavities and damp proofing.

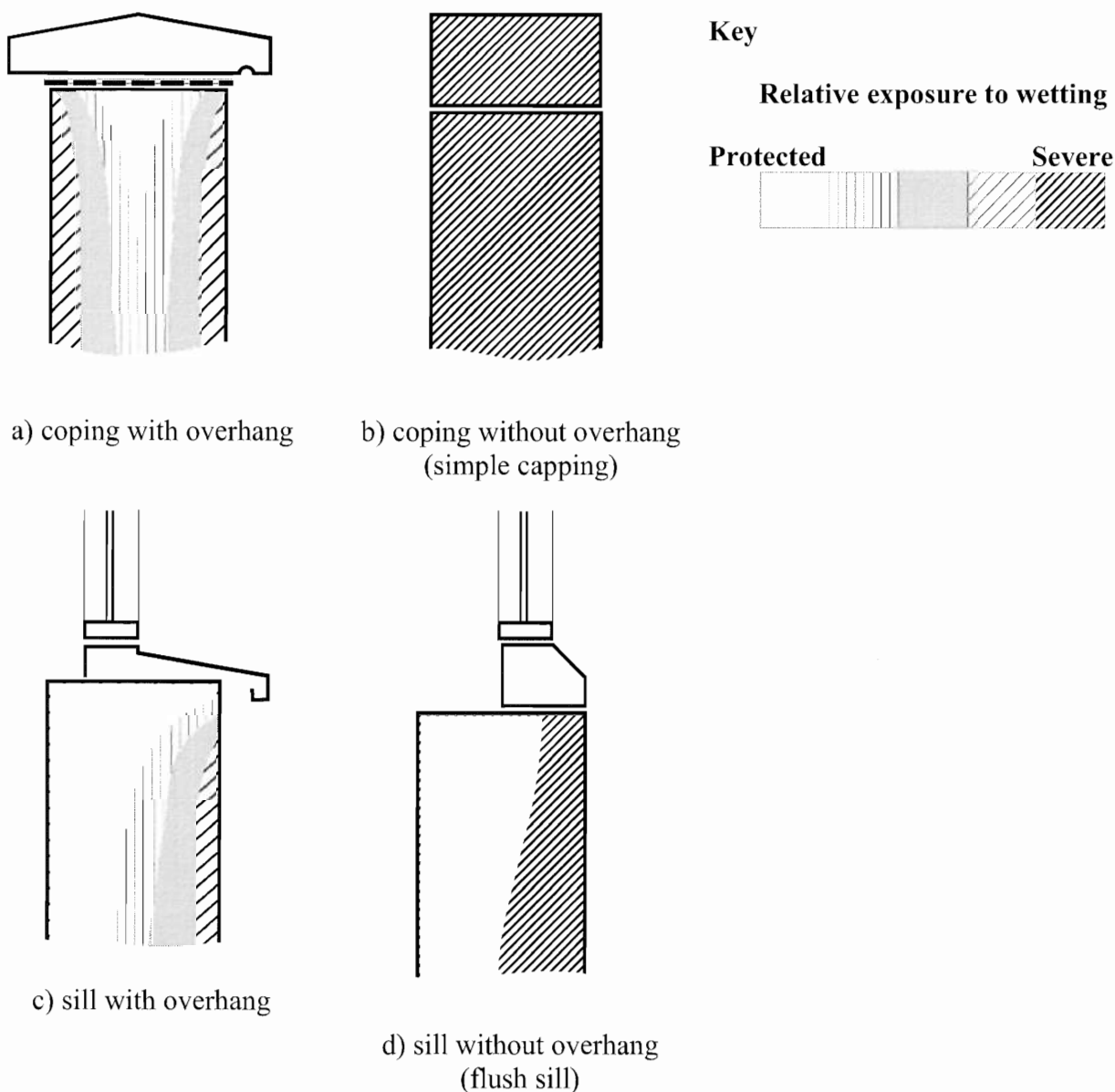


Figure A.1 — Examples of the effect of building detail on relative exposure to wetting of masonry

Key

Relative exposure to wetting



NOTE The extent of the zones of relative wetting will be affected by the macro climate

- 1) flush eaves
- 2) balcony
- 3) coping
- 4) render
- 5) parapet
- 6) overhanging eaves
- 7) inspection chamber
- 8) freestanding wall
- 9) paving
- 10) earth retaining wall

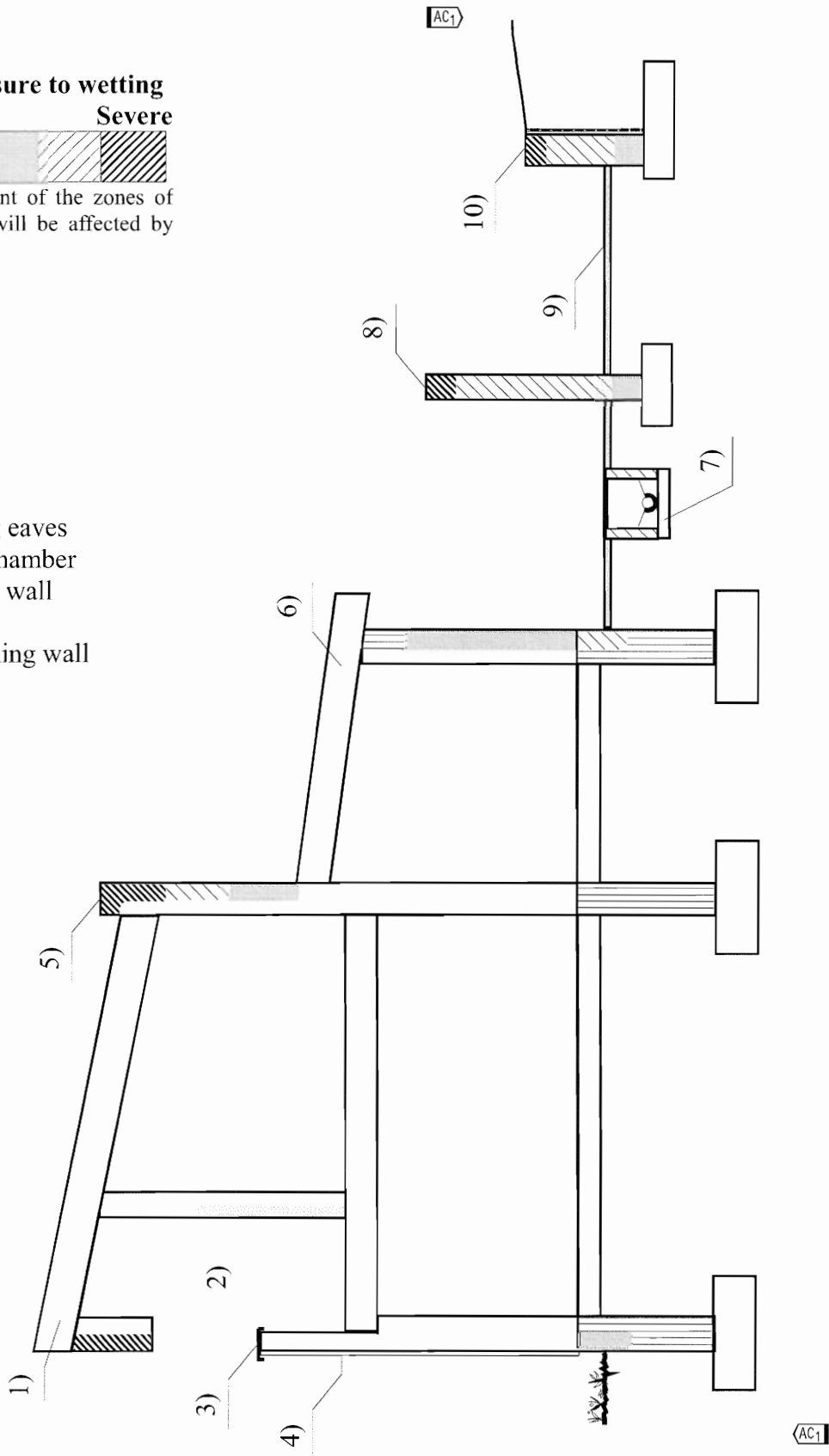


Figure A.2 – Examples of relative exposure to wetting of masonry (not protected by applied finishes or cladding except where indicated, foundation in well drained soil)

ANNEX B (informative)

Acceptable specifications of masonry units and mortar for durable masonry in various exposure conditions

B.1 Selection of masonry units and mortar

(1) Masonry units and mortar may be selected from Tables B.1 and B.2, according to the exposure class of the masonry determined from Table A.1.

(2) Masonry mortar is specified for durability using the terms defined in EN 998-2. For the purposes of Table B.2 they are abbreviated using the following symbols:

P - mortar for use in masonry subjected to passive exposure;

M - mortar for use in masonry subjected to moderate exposure;

S - mortar for use in masonry subjected to severe exposure.

(3) Until a European test method is available, the designation of site-made mortar mix prescriptions, for which authoritative data are available, may be related to the P, M, or S designations.

(4) In addition to selecting a mortar for durability, other performance characteristics such as compressive strength, bond strength, and water retentivity need to be taken into account so that the mortar is compatible with the selected masonry units and enables the masonry to satisfy all relevant design requirements.

(5) In the present state of the art guidance on the suitability of mortars will generally need to be obtained from the manufacturers of factory made mortars or in the case of site-made mortars from authoritative sources accepted in the place of use, see 2.2.3.

Table B.1 – Acceptable specifications of masonry units for durability

Exposure class (see Table A.1)	Clay masonry units conforming to EN771-1	Calcium silicate masonry units conforming to EN771-2	Aggregate concrete masonry units conforming to EN771-3		Autoclaved aerated concrete masonry units conforming to EN771-4	Manufactured stone masonry units conforming to EN771-5	Natural stone masonry units conforming to EN771-6
			Dense aggregate	Lightweight aggregate			
MX1^a	Any	Any	Any	Any	Any	Any	Any
MX2.1	F0, F1 or F2 / S1 or S2	Any	Any	Any	Any	Any	Any
MX2.2	F0, F1 or F2 / S1 or S2	Any	Any	Any	≥ 400 kg/m ³	Any	Any
MX3.1	F1 or F2 / S1 or S2	Freeze/thaw resistant	Freeze/thaw resistant	Freeze/thaw resistant	≥ 400 kg/m ³	Any	Consult manufacturer
MX3.2	F2 / S1 or S2	Freeze/thaw resistant	Freeze/thaw resistant	Freeze/thaw resistant	≥ 400 kg/m ³	Any	Consult manufacturer
MX4	In each case assess the degree of exposure to salts, wetting and freeze/thaw cycling and consult the manufacturer.						
MX5	In each case a specific assessment should be made of the environment and the effect of the chemicals involved taking into account concentrations, quantities available and rates of reaction and consult the manufacturer						

^a Class MX1 is valid only as long as the masonry, or any of its components, is not exposed during execution to more severe conditions over a prolonged period of time.

Table B.2 – Acceptable specifications of mortars for durability

Exposure class (see Table A.1)	Mortar in combination with any type of unit, classified according to B.1(2)
MX1^{a,b}	P,M,or S
MX2.1	M,or S
MX2.2	M or S ^c
MX3.1	M or S
MX3.2	S ^c
MX4	In each case assess the degree of exposure to salts, wetting and freeze/thaw cycling and consult the manufacturers of the constituent materials.
MX5	In each case a specific assessment should be made of the environment and the effect of the chemicals involved taking into account concentrations, quantities available and rates of reaction and consult the manufacturers of the constituent materials.

^a Class MX1 is valid only as long as the masonry, or any of its components, is not exposed during execution to more severe conditions over a prolonged period of time.

^b When designation P mortars are specified it is essential to ensure that masonry units, mortar and masonry under construction are fully protected from saturation and freezing.

^c When clay masonry units of Soluble Salts Content Category S1 is to be used in masonry where the Exposure Class is MX2.2, MX3.2, MX4 and MX5 the mortars should in addition be sulfate resisting

ANNEX C (informative)

Selection of material and corrosion protection specifications for ancillary components according to exposure class

C.1 Exposure classes

- (1) The range of environmental conditions encountered by ancillary components is classified into the five exposure classes MX1, MX2, MX3, MX4 and MX5 as given in Table A.1.
- (2) The choice of exposure class should take into account either the exposure of products during execution or in the finished work, whichever will be the more onerous.

C.2 Selection of materials

- (1) The material and protective coating, if any, for ancillary components can be selected from the relevant part of EN 845.
- (2) Materials for the manufacture of ancillary components and their corrosion protection systems are specified in full in the relevant part of EN 845 and each one is given a unique material/coating reference. This reference gives no indication of relative performance or quality.
- (3) Materials for ties, tension straps, hangers and brackets, conforming to EN 845-1, can be selected using Table C.1.
- (4) Materials for lintels, conforming to EN 845-2, can be selected using Table C.2.
- (5) Materials for bed joint reinforcement, conforming to EN 845-3 can be selected using Table C.3.
- (6) Tables C.1, C.2 and C.3 show the material/coating reference with a brief description of the materials and the exposure classes, in which the specification is suitable. This guidance is based on long term experience of the durability of such materials in a range of exposure conditions. Currently there is no accepted accelerated exposure test for measuring this parameter.
- (7) Materials allocated to each exposure class will be expected to have an economically reasonable working life under the conditions described, subject to specialist advice being obtained in some cases, as indicated in the table. The choice will be dependent upon the particular application, its location and the intended working life.
- (8) Where ancillary components need to be movement tolerant during installation or use, the ability of the materials and coatings to withstand the expected movement ought to be taken into account.

Table C.1 – Corrosion protection systems for ties, tension straps, brackets and hangers conforming to EN 845-1 in relation to exposure classes

Material ^a	Ref. No.	Exposure class				
		MX1	MX2	MX3	MX4	MX5
Austenitic stainless steel (molybdenum chrome nickel alloys)	1	U	U	U	U	R
Plastic used for the body of ties	2	U	U	U	U	R
Austenitic stainless steel (chrome nickel alloys)	3	U	U	U	R	R
Ferritic stainless steel	4	U	X	X	X	X
Phosphor bronze	5	U	U	U	X	X
Aluminium bronze	6	U	U	U	X	X
Copper	7	U	U	U	X	X
Zinc coated (940 g/m ²) steel wire	8	U	U	U	R	X
Zinc coated (940 g/m ²) steel component	9	U	U	U	R	X
Zinc coated (710 g/m ²) steel component	10	U	U	U	R	X
Zinc coated (460 g/m ²) steel component	11	U	R	R	R	X
Zinc coated (300 g/m ²) steel strip or sheet with organic coating over all outer surfaces of finished component	12.1	U	U	U	R	X
Zinc coated (300 g/m ²) steel strip or sheet with organic coating over all outer surfaces of finished component	12.2	U	U	U	R	X
Zinc coated (265 g/m ²) steel wire	13	U	R	R	X	X
Zinc coated (300 g/m ²) steel strip or sheet with all cut edges organic coated	14	U	R	R	X	X
Zinc pre-coated (300 g/m ²) steel strip or sheet	15	U	R	R	X	X
Zinc coated (137 g/m ²) steel strip or sheet with organic coating over all outer surfaces of finished component	16.1	U	U	U	R	X
Zinc coated (137 g/m ²) steel strip or sheet with organic coating over all outer surfaces of finished component	16.2	U	U	U	R	X
Zinc pre-coated (137 g/m ²) steel strip with zinc coated edges	17	U	R	R	X	X
Zinc coated (60 g/m ²) steel wire with organic coating over all surfaces of finished component	18	U	R	R	R	X
Zinc coated (105 g/m ²) steel wire	19	U	R	R	X	X
Zinc coated (60 g/m ²) steel wire	20	U	X	X	X	X
Zinc pre-coated (137 g/m ²) steel sheet	21	U	X	X	X	X
<p>KEY: U - unrestricted use of the material in listed class of exposure. R - restricted use; consult the manufacturer or a specialist consultant for advice for the specific design conditions. X - material not recommended for use in this exposure class.</p>						
<p>^a The full specification of the material and coating or concrete cover corresponding to the reference number or letter is given in EN 845-1. The coating weights shown are approximate values for one surface.</p>						

**Table C.2 — Corrosion protection systems for lintels
conforming to EN 845-2 in relation to exposure classes**

Material ^a	Ref. No.	Exposure class				
		MX1	MX2	MX3	MX4	MX5
Austenitic stainless steel (chrome nickel alloys)	L3	U	U	U	R	R
Zinc coated (710 g/m ²) steel component	L10	U	U	U	R	X
Zinc coated (460 g/m ²) steel component	L11	U	D	D	R	X
Zinc coated (460 g/m ²) steel component with organic coating on specified upper surfaces	L11.1	U	U	U	R	X
Zinc coated (460 g/m ²) steel component with organic coating on specified upper surfaces	L11.2	U	U	U	R	X
Zinc coated (300 g/m ²) steel strip or sheet with organic coating over all outer surfaces of finished component	L12.1	U	U	U	R	X
Zinc coated (300 g/m ²) steel strip or sheet with organic coating over all outer surfaces of finished component	L12.2	U	U	U	R	X
Zinc coated (300 g/m ²) steel strip or sheet with all cut edges organic coated	L14	U	D	D	R	X
Zinc coated (137 g/m ²) steel strip or sheet with organic coating over all outer surfaces of finished component	L16.1	U	D	D	R	X
Zinc coated (137 g/m ²) steel strip or sheet with organic coating over all outer surfaces of finished component	L16.2	U	U	U	R	X
Concrete ^b or concrete and masonry	A	U	U	R	R	R
Concrete ^b or concrete and masonry	B	U	U	R	R	X
Concrete ^b or concrete and masonry	C	U	U	R	X	X
Concrete ^b or concrete and masonry	D	U	U	X	X	X
Concrete ^b or concrete and masonry	E	U	X	X	X	X
Concrete ^b or masonry with stainless steel reinforcement	F	U	U	R	R	R
Autoclaved aerated concrete with reinforcement protected by a coating system	G	U	R	R	R	R
<p>KEY: U - unrestricted use of the material in listed class of exposure. R - restricted use; consult the manufacturer or a specialist consultant for advice for the specific design conditions. D - with a damp proof course on top of the lintel the use is unrestricted (U). Without a damp proof course on top of the lintel the use is restricted (R) X - material not recommended for use in this exposure class.</p>						
<p>^a The full specification of the material and coating or concrete cover corresponding to the reference number or letter is given in EN 845-2. The coating weights shown are approximate values for one surface.</p>						
<p>^b The manufacturer, or a specialist consultant, may permit a less restrictive use for prefabricated lintels, based on local experience'</p>						

Table C.3 – Corrosion protection systems for bed joint reinforcement conforming to EN 845-3 in relation to exposure classes

Material ^a	Ref. No.	Exposure class				
		MX1	MX2	MX3	MX4	MX5
Austenitic stainless steel (molybdenum chrome nickel alloys)	R1	U	U	U	U	R
Austenitic stainless steel (chrome nickel alloys)	R3	U	U	U	R	R
Zinc coated (265 g/m ²) steel wire	R13	U	R	R	X	X
Zinc coated (60 g/m ²) steel wire with organic coating over all surfaces of finished component	R18	U	U	U	R	X
Zinc coated (105 g/m ²) steel wire	R19	U	R	R	X	X
Zinc coated (60 g/m ²) steel wire	R20	U	X	X	X	X
Zinc pre-coated (137 g/m ²) steel sheet	R21	U	X	X	X	X
<p>KEY: U - unrestricted use of the material in listed class of exposure. R - restricted use; consult the manufacturer or a specialist consultant for advice for the specific design conditions. X - material not recommended for use in this exposure class.</p>						
<p>^a The full specification of the material and coating or concrete cover corresponding to the reference number or letter is given in EN 845-3. The coating weights shown are approximate values for one surface.</p>						

