

Eurocode 8:

Design provisions for earthquake resistance of structures

Part 1.2 General rules — General rules for buildings

ICS 91.120.20

Committees responsible for this Draft for Development

The preparation of this Draft for Development was entrusted by Technical Committee B/525, Building and civil engineering structures, to Subcommittee B/525/8, Structures in seismic regions, upon which the following bodies were represented:

- Association of Consulting Engineers
- British Geological Survey
- Department of the Environment (Building Research Establishment)
- Department of the Environment (Property and Building Directorate)
- Federation of Civil Engineering Contractors
- Institution of Civil Engineers
- Steel Construction Institute

This Draft for Development, having been prepared under the direction of the Sector Board for Building and Civil Engineering, was published under the authority of the Standards Board and comes into effect on 15 May 1996

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Amendments issued since publication

Amd. No.	Date	Text affected

The following BSI reference relates to the work on this Draft for Development:
Committee reference B/525/8

ISBN 0 580 25733 9

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National foreword

This Draft for Development has been prepared by Subcommittee B/525/8 and is the English language version of ENV 1998-1-2 : 1994 *Eurocode 8: Design provisions for earthquake resistance of structures Part 1-2: General rules — General rules for buildings* published by the European Committee for Standardization (CEN).

ENV 1998-1-2: 1994 results from a programme of work sponsored by the European Commission to make available a common set of rules for the structural and geotechnical design of buildings and civil engineering works. The full range of codes covers the basis of design and actions, the design of structures in concrete, steel, composite construction, timber, masonry and aluminium alloy, and also geotechnical and seismic design.

This publication is not to be regarded as a British Standard.

An ENV or European Prestandard is made available for provisional application, but does not have the status of a European Standard. The aim is to use the experience gained to modify the ENV so that it can be adopted as a European Standard (EN).

There is no existing British Standard equivalent to ENV 1998-1-2 and there is no requirement in the Building Regulations to consider seismic actions on buildings and civil engineering works in the UK.

ENV 1998-1-1 states that the provisions of Eurocode 8 may be simplified or not observed in regions of low seismicity. Within the UK, the application of Eurocode 8 should not be necessary, unless the client or user of the works assesses that the associated seismic risk is such that it needs to be addressed.

Users of this document are invited to comment on its technical content, ease of use and any ambiguities or anomalies, both with respect to use in the UK and also in other more actively seismic areas. These comments will be taken into account when preparing the UK national response to CEN on the question of whether the ENV can be converted into an EN.

Comments should be sent in writing to the Secretary of B/525/8 at BSI, 389 Chiswick High Road, London W4 4AL, quoting the document reference, the relevant clause and, where possible, a proposed revision, by 30 April 1997. Comments after this time will still be possible through corporate bodies, such as the engineering institutions.

ICS 91.120.20

Descriptors: Civil engineering, buildings, structures, earthquake resistant structures, earthquake-resistant design, computation

English version

**Eurocode 8 —
Design provisions for earthquake resistance of structures —
Part 1-2: General rules —
General rules for buildings**

Eurocode 8 — Conception et dimensionnement
des structures pour la résistance aux séismes —
Partie 1-2: Règles générales — Règles générales
pour les bâtiments

Eurocode 8 — Auslegung von Bauwerken gegen
Erdbeben —
Teil 1-2: Grundlagen — Allgemeine Regeln für
Hochbauten

This European Prestandard (ENV) was approved by CEN on 1993-12-17 as a prospective standard for provisional application. The period of validity of this ENV is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the ENV can be converted into an European Standard (EN).

CEN members are required to announce the existence of this ENV in the same way as for an EN and to make the ENV available promptly at national level in an appropriate form. It is permissible to keep conflicting national standards in force (in parallel to the ENV) until the final decision about the possible conversion of the ENV into an EN is reached.

CEN members are the national standards bodies of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

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Ref. No. ENV 1998-1-2 : 1994 E

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FOREWORD

Objectives of the Eurocodes

(1) The "Structural Eurocodes" comprise a group of standards for the structural and geotechnical design of buildings and civil engineering works.

(2) They cover execution and control only to the extent that is necessary to indicate the quality of the construction products, and the standard of the workmanship needed to comply with the assumptions of the design rules.

(3) Until the necessary set of harmonized technical specifications for products and for the methods of testing their performance are available, some of the Structural Eurocodes cover some of these aspects in informative Annexes.

Background of the Eurocode Programme

(4) The Commission of the European Communities (CEC) initiated the work of establishing a set of harmonized technical rules for the design of building and civil engineering works which would initially serve as an alternative to the different rules in force in the various Member States and would ultimately replace them. These technical rules became known as the "Structural Eurocodes".

(5) In 1990, after consulting their respective Member States, the CEC transferred the work of further development, issue and updating of the Structural Eurocodes to CEN, and the EFTA Secretariat agreed to support the CEN work.

(6) CEN Technical Committee CEN/TC250 is responsible for all Structural Eurocodes.

Eurocode Programme

(7) Work is in hand on the following Structural Eurocodes, each generally consisting of a number of parts:

EN 1991 Eurocode 1 Basis of design and 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 structures
EN 1998 Eurocode 8 Design provisions for earthquake resistance of
EN 1999 Eurocode 9 Design of aluminium alloy structures

(8) Separate sub-committees have been formed by CEN/TC250 for the various Eurocodes listed above.

(9) This Part 1-2 of Eurocode 8 is being published as a European Pre-standard (ENV) with an initial life of three years.

(10) This Prestandard is intended for experimental application and for the submission of comments.

(11) After approximately two years CEN members will be invited to submit formal comments to be taken into account in determining future actions.

(12) Meanwhile feedback and comments on this Prestandard should be sent to the Secretariat of CEN/TC250/SC8 at the following adress:

IPQ c/o LNEC
Avenida do Brasil 101
P - 1799 LISBOA Codex
PORTUGAL

or to your national standards organization.

National Application Documents (NAD's)

(13) In view of the responsibilities of authorities in member countries for safety, health and other matters covered by the essential requirements of the Construction Products Directive (CPD), certain safety elements in this ENV have been assigned indicative values which are identified by [] ("boxed values"). The authorities in each member country are expected to review the "boxed values" and may substitute alternative definitive values for these safety elements for use in national application.

(14) Some of the supporting European or International standards may not be available by the time this Prestandard is issued. It is therefore anticipated that a National Application Document (NAD) giving any substitute definitive values for safety elements, referencing compatible supporting standards and providing guidance on the national application of this Prestandard, will be issued by each member country or its Standards Organization.

(15) It is intended that this Prestandard is used in conjunction with the NAD valid in the country where the building or civil engineering works is located.

Matters specific to this Prestandard

(16) The scope of Eurocode 8 is defined in ENV 1998-1-1 clause 1.1.1; the scope of this Part of Eurocode 8 is defined in clause 1.1.1. Additional Parts of Eurocode 8 which are planned are indicated in ENV 1998-1-1 clause 1.1.3.

(17) This Prestandard was developed from one of the Parts that was included in the Draft of Eurocode 8 dated May 1988 published by the CEC and subjected to public enquiry. Such Draft contained also Parts 1-2 and 1-3 which are now presented as separate Prestandards.

(18) As mentioned in clause 1.1.1, attention must be paid to the fact that for the design of structures in seismic regions the provisions

of Eurocode 8 are to be applied in addition to the provisions of the other relevant Eurocodes.

(19) In using this Prestandard in practice, particular regard should be paid to the underlying assumptions given in clause 1.3 of Part 1-1.

(20) This Prestandard includes three Appendices which develop some aspects of clauses presented in the main part of the text. They are useful for the conceptual design of buildings and for the analysis of specific cases which allow some simplifications.

1 GENERAL

1.1 Scope

(1)P Part 1-2 is concerned with buildings. It contains general rules for the earthquake-resistant design of buildings and shall be used in conjunction with Parts 1-1 and 1-3.

(2)P Whereas guidance on base-isolated buildings is not given in the code, the use of base-isolation is not precluded, provided special studies are undertaken.

1.2 Symbols

In addition to the symbols listed in Part 1-1, the following symbols are used in Part 1-2 with the following meanings:

E_E	effect of the seismic action
E_{Edx} , E_{Edy}	design values of the action effects due to the horizontal components of the seismic action;
E_{Edz}	design value of the action effects due to the vertical component of the seismic action;
F	horizontal seismic force;
F_a	horizontal seismic force acting on a non-structural element (appendage);
H	building height;
R_d	design resistance;
T_1	fundamental vibration-period of a building;
T_a	fundamental vibration-period of a non-structural element (appendage);
W	weight;
W_a	weight of a non-structural element (appendage);
d	displacement;
d_r	design interstorey drift;
e_1	accidental eccentricity of a storey mass from its nominal location;
h	interstorey height;

m	mass;
q_a	behaviour factor of a non-structural element;
q_d	displacement behaviour factor;
s	displacement of a mass m in the fundamental mode shape of a building;
z	height of the mass m above the level of application of the seismic action;
γ_a	importance factor of a non-structural element;
θ	interstorey drift sensitivity coefficient.

2 CHARACTERISTICS OF EARTHQUAKE RESISTANT BUILDINGS

2.1 Basic principles of conceptual design

(1)P The aspect of seismic hazard shall be taken into consideration in the early stages of the conceptual design of the building.

(2) The guiding principles governing this conceptual design against seismic hazard are

- structural simplicity,
- uniformity and symmetry,
- redundancy,
- bidirectional resistance and stiffness,
- torsional resistance and stiffness,
- diaphragmatic action at storey level,
- adequate foundation.

(3) Commentaries to these principles are given in Annex B.

2.2 Structural regularity

2.2.1 General

(1)P For the purpose of seismic design, building structures are distinguished as regular and non-regular.

(2) This distinction has implications on the following aspects of the seismic design:

- the structural model, which can be either a simplified planar or a spatial one,
- the method of analysis, which can be either a simplified modal or a multi-modal one,
- the value of the behaviour factor q , which can be decreased depending on the type of non-regularity in elevation, i.e.
 - geometric non-regularity exceeding the limits given in 2.2.3.(4),
 - non-regular distribution of overstrength in elevation exceeding the limits given in 2.2.3.(3).

(3)P With regard to the implications of structural regularity on the design, separate consideration is given to the regularity characteristics of the building in plan and in elevation, according to table 2.1.

Table 2.1: Consequences of structural regularity on seismic design

REGULARITY		ALLOWED SIMPLIFICATION		BEHAVIOUR
PLAN	ELEVATION	MODEL	ANALYSIS	FACTOR
YES	YES	PLANAR	SIMPLIFIED*	REFERENCE
YES	NO	PLANAR	MULTIMODAL	DECREASED
NO	YES	SPATIAL**	MULTIMODAL**	REFERENCE
NO	NO	SPATIAL	MULTIMODAL	DECREASED

* If the condition of 3.3.2.1.(2)b) is also met.

**Under the specific conditions given in clause A1 of Annex A simpler models and methods of analysis, described in Annex A, may be used.

(4) Criteria describing regularity in plan and in elevation are given in 2.2.2 and 2.2.3; rules concerning modelling and analysis are given in 3; the relevant behaviour factors are given in Part 1-3.

(5)P The regularity criteria given in 2.2.2 and 2.2.3 are to be considered as necessary conditions. The designer shall verify that the assumed regularity of the building structure is not impaired by other characteristics, not included in these criteria.

2.2.2 Criteria for regularity in plan

- (1) The building structure is approximately symmetrical in plan with respect to two orthogonal directions, in what concerns lateral stiffness and mass distribution.
- (2) The plan configuration is compact, i.e. it does not present divided shapes as H, I, X, etc. The total dimension of re-entrant corners or recesses in one direction does not exceed 25 % of the overall external plan dimension of the building in the corresponding direction.
- (3) The in-plane stiffness of the floors is sufficiently large in comparison with the lateral stiffness of the vertical structural elements, so that the deformation of the floor has a small effect on the distribution of the forces among the vertical structural elements.
- (4) Under the seismic force distribution given in 3.3.2.3, applied with the accidental eccentricity given in 3.2, at any storey the maximum displacement in the direction of the seismic forces does not exceed the average storey displacement more than 20 %.

2.2.3 Criteria for regularity in elevation

- (1) All lateral load resisting systems, like cores, structural walls or frames, run without interruption from their foundations to the top of the building or, when setbacks at different heights are present, to the top of the relevant zone of the building.
- (2) Both the lateral stiffness and the mass of the individual storeys remain constant or reduce gradually, without abrupt changes, from the base to the top.
- (3) In framed buildings the ratio of the actual storey resistance to the resistance required by the analysis should not vary disproportionately between adjacent storeys. Within this context the special aspects of masonry infilled concrete frames are treated in clause 2.9 of Part 1-3.
- (4) When setbacks are present, the following additional provisions apply:
 - a) in case of gradual setbacks preserving axial symmetry, the setback at any floor is not greater than 20 % of the previous plan dimension in the direction of the setback (see fig. 2.1.a and 2.1.b),
 - b) in case of a single setback within the lower 15 % of the total height of the main structural system, the setback is not greater than 50 % of the previous plan dimension (see fig. 2.1.c). In that case the structure of the base zone within the vertically projected perimeter of the upper stories shall be designed to resist at least 75 % of the horizontal shear forces that would develop in that zone in a similar building without the base enlargement.