

Eurocode 2: Design of concrete structures

**Part 1.3 General rules —
Precast concrete elements and structures**

**(together with United
Kingdom National Application
Document)**

ICS 91.040; 91.080.40

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/525/2, Structural use of concrete, upon which the following bodies were represented:

- Association of Consulting Engineers
- British Cement Association
- British Precast Concrete Federation Ltd.
- Department of the Environment (Property and Buildings Directorate)
- Department of Transport (Highways Agency)
- Federation of Civil Engineering Contractors
- Institution of Civil Engineers
- Institution of Structural Engineers
- Steel Reinforcement Commission

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National foreword

This Draft for Development was prepared by Subcommittee B/525/2 and is the English language version of ENV 1992-1-3 : 1994 *Eurocode 2: Design of concrete structures Part 1.3: General rules — Precast concrete elements and structures*, as published by the European Committee for Standardization (CEN). This Draft for Development also includes the United Kingdom (UK) National Application Document (NAD) to be used with the ENV in the design of buildings to be constructed in the UK.

ENV 1992-1-3 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 building and civil engineering works.

This publication should not be regarded as a British Standard.

An ENV 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. The publication of this ENV and its National Application Document should be considered to supersede any reference to a British Standard in previous DD ENV Eurocodes concerning the subject covered by these documents.

The values for certain parameters in the ENV Eurocodes may be set by individual CEN Members so as to meet the requirements of national regulations. These parameters are designated by $\lfloor \rfloor$ in the ENV.

During the ENV period of validity, reference should be made to the supporting documents listed in the National Application Document (NAD).

The purpose of the NAD is to provide essential information, particularly in relation to safety, to enable the ENV to be used for buildings constructed in the UK and the NAD takes precedence over corresponding provisions in the ENV.

The Building Regulations 1991, Approved Document A 1992, draws attention to the potential use of ENV Eurocodes as an alternative approach to Building Regulation compliance. ENV 1992-1-3 is considered to offer such an alternative approach, when used in conjunction with its NAD.

Users of this document are invited to comment on its technical content, ease of use and any ambiguities or anomalies. 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 to an EN.

Comments should be sent in writing to the Secretary of Subcommittee B/525/2, BSI, 389 Chiswick High Road, London W4 4AL, quoting the document reference, the relevant clause and, where possible, a proposed revision, by 31 October 1996.

National Application Document

**for use in the UK with
ENV 1992-1-3 : 1994**

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National Application Document

Introduction

This National Application Document (NAD) has been prepared by Subcommittee B/525/2. It has been developed from the following.

- a) A textual examination of ENV 1992-1-3;
- b) A parametric calibration against BS 8110, supporting standards and test data;
- c) Trial calculations.

1 Scope

This NAD provides information to enable ENV 1992-1-3 (hereafter referred to as EC2 : Part 1.3) to be used for the design of buildings to be constructed in the UK. It will be assumed that it will be used in conjunction with DD ENV 1992-1-1, the NAD of which refers to BSI publications for values of actions.

2 Partial factors, combination factors and other values

- a) The values for combination coefficients (ψ) should be those given in table 1 of the NAD for EC2 : Part 1.1.
- b) The values for partial factors for normal temperature design should be those given in EC2 : Part 1.1 except where modified by the NAD for that code.
- c) Other values should be those given in EC2 : Part 1.1, except where modified by the NAD for that code, and EC2 : Part 1.3 except for those given in table 1 of this NAD.

Table 1. Values to be used in referenced clauses instead of boxed values		
Reference in EC2 : Part 1.3	Definition	UK values
4.2.3.5.4 P(102) Eq (4.105)	Values of $\sigma_{o,max}$ related to f_{pk} and $f_{p0.1k}$	0.8 not 0.85, 0.9 not 0.95
4.2.3.5.4 P(103) Eq (4.106)	Values of $A_p \sigma_{pm,o}$ related to $f_{pk} A_p$ and $f_{p0.1k} A_p$	0.75 not 0.80, 0.85 not 0.90
4.4.1.1 (102)	Limiting stress for pretensioned elements	0.6 not 0.7
4.5.2 (103)	Limiting average bearing stress in dry joints	0.75 not 0.4
4.5.5.2 (101)	Value σ_{Rd} for dry concrete to concrete bearings	0.75 not 0.4. Also alter corresponding values in headings to tables 4.117 and 4.118.
5.2.3.2 (106)	Minimum value of joint dimension	Last sentence not applicable
5.4.10 (105)	Limiting value of l for pocket foundations with smooth joint surfaces	1.5 not 1.2, but not less than 200 mm

3 Reference standards

Supporting standards including materials specifications and standards for construction are listed in table 2 of this NAD.

Table 2. Reference in EC2 Part 1.3 to other codes and standards				
Reference in EC2 Part 1.3	Document referred to	Document title or subject area	Status	UK document
Various	ENV 1992-1-1	Design of concrete strucures. General rules and rules for buildings	Published 1991	DD ENV 1992-1-1 : 1992
2.3.3.2 (104)	ENV 1991-1	Basis of design	Published 1994	DD ENV 1991-1 : 1996
6.2.1 (104)	Relevant CEN Product Standards	Tolerances	In preparation	BS 8110 : Part 1 : 1985
6.3.5 P(101)	Relevant CEN Product and other Standards	Construction and workmanship	In preparation	BS 8110 : Part 1 : 1985 and BS 5328 : 1990/91
A.105.2 (102)	ENV 1991-1 Basis of Design	Values of coefficients of variation	Published 1994	DD ENV 1991-1 : 1996

ICS 91.040.00; 91.080.40

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English version

Eurocode 2: Design of concrete structures — Part 1-3: General rules — Precast concrete elements and structures

Eurocode 2: Calcul des structures en béton —
Partie 1-3: Règles générales — Eléments et
structures en béton préfabriqués

Eurocode 2: Planung von Stahlbeton- und
Spannbetontragwerken —
Teil 1-3: Allgemeine Regeln — Bauteile und
Tragwerke aus Fertigteilen

This European Prestandard (ENV) was approved by CEN on 1993-06-25 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 1992-1-3 : 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 Appendices.

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
EN 1998 Eurocode 8	Design provisions for earthquake resistance of structures
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 1-3 of Eurocode 2 is being published as a European Prestandard (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/SC2 at the following address:

Deutsches Institute für Normung e.V. (DIN)
Burggrafenstrasse 6
D-10787 Berlin
phone:(+49) 30 - 26 01 - 25 01
fax:(+49) 30 - 26 01 - 12 31

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 assign definitive values to these safety elements.
- (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 definitive values for safety elements, referencing compatible supporting standards and providing national guidance on the 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 2 is defined in 1.1.1 of ENV 1992-1-1 and the scope of this Part of Eurocode 2 is defined 1.1.2. Additional Parts of Eurocode 2 which are planned are indicated in 1.1.3 of ENV 1992-1-1; these will cover additional technologies or applications, and will complement and supplement this Part.
- (17) In using this Prestandard in practice, particular regard should be paid to the underlying assumptions and conditions given in 1.3 of ENV 1992-1-1.
- (18) The seven chapters of this Prestandard are complemented by

four Appendices which have the same normative status as the chapters to which they relate. These Appendices have been introduced by moving some of the more detailed Principles/Application Rules, which are needed in particular cases, out of the main part of the text to aid its clarity.

- (19) As indicated in paragraph (14) of this Foreword, reference should be made to National Application Documents which will give details of compatible supporting standards to be used. For this Part of Eurocode 2, particular attention is drawn to the approved Prestandard ENV 206 (Concrete - performance, production, placing and compliance criteria), and the durability requirements given in 4.1 of this Prestandard.
- (20) The provisions of this Prestandard are based substantially on the 1978 edition of the CEB Model Code and other more recent CEB and FIP documents.
- (21) In developing this Prestandard, background documents have been prepared, which give commentaries on and justifications for some of the provisions in this Prestandard.
- For ENV 1992-1-3, the following additional sub-clause apply:
- (22) This Part 1-3 of Eurocode 2 complements ENV 1992-1-1 for the particular aspects of precast concrete elements and structures.
- (23) The framework and structure of this Part 1-3 correspond to ENV 1992-1-1. However, Part 1-3 contains Principles and Application Rules which are specific to precast concrete elements and structures.
- (24) This Part 1-3 of Eurocode 2 includes one Informative Appendix, Appendix 105.
- (25) Where a particular sub-clause of ENV 1992-1-1 is not mentioned in this ENV 1992-1-3, that sub-clause of ENV 1992-1-1 applies as far as deemed appropriate in each case.

Some Principles and Application Rules of ENV 1992-1-1 are modified or replaced in this Part, in which case they are superseded.

Where a Principle or Application Rule in ENV 1992-1-1 is modified or replaced, the new number is identified by the addition of 100 to the original number. Where a new Principle or Application Rule is added, it is identified by a number which follows the last number of ENV 1992-1-1 with 100 added to it.

A subject not covered by ENV 1992-1-1 is introduced in this Part by a new sub-clause. The sub-clause number for this follows the most appropriate clause number in ENV 1992-1-1.

- (26) The numbering of equations, figures, footnotes and tables in this Part follow the same principles as the clause numbering in (25) above.
- (27) In this Part 1-3 of Eurocode 2, reference is also made to relevant CEN Standards for precast products.

1 INTRODUCTION

This clause of ENV 1992-1-1 applies except as follows:

1.1 SCOPE

1.1.2 SCOPE OF PART 1-3 OF EUROCODE 2

Addition after Principle P(5):

P(106) Part 1-3 gives a general basis for the design and detailing of concrete structures in buildings made partly or entirely of precast elements.

P(107) Precast structures are characterised by the presence of joints which provide connections between elements.

(108) This Part 1-3 provides Principles and Application Rules which complement those given in ENV 1992-1-1. Matters related to the production and assembly of structures are covered by other CEN standards.

(109) In precast concrete structures special consideration should be given to:

- detailing of bearings
- detailing of joints/connections
- structural safety and stability during multi stage construction
- pre-tensioning.

1.4 DEFINITIONS

1.4.2 SPECIAL TERMS USED IN PART 1-3 OF EUROCODE 2

Addition after Principle P(2):

P(103) The following terms are used in this Part 1-3 with the following definitions:

- A precast element is one that is manufactured in a factory or place other than the final position in the structure, protected from adverse weather conditions.
- A composite element comprises insitu and precast concrete with or without reinforcement connectors.
- Rib and block floors consist of precast ribs (or beams) with an infill between them made of blocks, hollow clay pots or other forms of permanent shuttering, with or without an insitu topping

- A sandwich panel normally consists of two layers of concrete with a thermal insulation sandwiched between them.
- Diaphragms are plane members which are subjected to in-plane forces. A diaphragm may consist of several precast units connected together.
- Ties are tensile members, effectively continuous, in floors, walls or columns.
- Isolated precast members are those for which, in the case of failure, no secondary means of load transfer, e.g. due to redistribution of internal forces and moments, is available.

(104) The following types of reinforced or prestressed precast elements are commonly used:

- Linear elements (e.g. beams, joists, columns)
- Slab elements (e.g. solid slabs fully or partially precast, ribbed slabs, ribs and blocks, hollow core units)
- Wall elements (e.g. solid, ribbed or sandwich)
- Other elements (e.g. foundations, stairs)

(105) Transient situations: In precast concrete construction transient situations include the following:

- Demoulding
- Transport to the storage yard;
- Support and load conditions during storage;
- Transport to site;
- Erection (hoisting) and construction.

2 BASIS OF DESIGN

This clause of ENV 1992-1-1 applies except as follows:

2.1 FUNDAMENTAL REQUIREMENTS

Addition after Principle P(4):

P(105) The layout of the structure and the interaction between the structural members shall be such as to ensure a robust and stable behaviour.

(106) The necessary interaction between elements is obtained by tying the structure together using a) peripheral ties, b) internal ties, c) horizontal ties to columns and walls and d) where required, vertical ties.

Where a building is divided by joints into structurally independent parts, each part should have an appropriate tying system.

(107) Ease of assembly and maintenance should be considered in design.

(108) Where required appropriate mechanical devices should be detailed to allow ease of inspection and replacement.

2.2 DEFINITIONS AND CLASSIFICATIONS

2.2.3 MATERIAL PROPERTIES

2.2.3.1 Characteristic values

Addition after Application Rule (4):

(105) In precast construction it is necessary to check the concrete compressive strength, f_c , at a number of stages of construction (e.g. demoulding, transfer of prestress, see Clause 3.1.2.2 of ENV 1992-1-1).

2.3 DESIGN REQUIREMENTS

2.3.1 GENERAL

Addition after Principle P(4):

(105) Where relevant, consideration should be given in design to the effects of dynamic actions (e.g. impulse) during transient situations. In the absence of a more rigorous analysis this may be allowed for by multiplying the relevant static effects by an appropriate factor.

2.3.3 **PARTIAL SAFETY FACTORS FOR ULTIMATE LIMIT STATES**
2.3.3.1 **Partial safety factors for actions on building structures**

Replacement of Application Rule (1) by:

(101) Partial safety factors for the persistent and transient design situations are those given in Table 2.2 of ENV 1992-1-1. However for precast elements, in transient situations, a lower factor may be acceptable provided:

a) the behaviour of the completed structure in the permanent condition is not adversely affected; and

b) it is permitted by relevant documents.

2.3.3.2 **Partial safety factors for materials**

Replacement of Application Rule (4) by:

(104) Higher or lower values of γ_c and γ_s may be used for precast elements if these are justified by adequate control procedures and relevant documents.¹

2.5 **ANALYSIS**
2.5.1 **GENERAL PROVISIONS**
2.5.1.1 **General**

Addition after Application Rule (6):

P(107) In addition to satisfying the requirements of ENV 1992-1-1 the analysis of precast concrete structures shall take into account the behaviour of the joints between elements.

An analysis shall be made for each relevant stage of construction using the appropriate geometry and properties for that stage.

(108) The analysis of precast concrete structures should account for:

- the behaviour of the structural units at all stages of construction and their interaction with other elements (e.g. composite actions with insitu concrete, other precast units);
- the behaviour of the structural system, with particular regard to actual deformations and strength of connections;

¹

see ENV 1991-1 "Basis of Design" and Informative Appendix 105 to this Part 1-3 of ENV 1992

- the uncertainties influencing restraints and force transmission between elements arising from deviations in geometry and in the positioning of units and bearings.
- (109) Horizontal restraint caused by friction due to the weight of any supported element may only be considered for non seismic zones (using $\gamma_{G,inf}$). In addition it may only be considered where
- the friction is not solely relied upon for overall stability of the structure; and
 - the bearing arrangement precludes the possibility of accumulation of irreversible sliding of the elements, such as caused by uneven behaviour under alternate actions (cyclic thermal effects on the contact edges of simply supported elements).
- (110) The effects of horizontal movements should be considered in design with respect to the resistance of the structure and the integrity of the joints. Proper bearing devices should be provided where necessary.

2.5.2 IDEALISATION OF THE STRUCTURE

2.5.2.1 Structural models for overall analysis

Addition after Application Rule (6):

- (107) In prefabrication the following structural systems are commonly used to ensure the overall stability. These and other systems may act alone or in combination:
- a) Frame structures (Figure 2.106a), composed of linear precast elements (beams and columns). They may be designed either as cantilevering continuous columns (mainly for low rise buildings), or partly or wholly as a continuous framework.
 - b) Cross wall structures or panel structures (Figure 2.106b) characterised by stiff in plane behaviour (shear walls) and hinged connections perpendicular to the plane direction (cross slabs). Longitudinal stability is obtained by walls or frames perpendicular to the cross walls.
 - c) Braced structures (Figure 2.106c) in which the beams and columns may have hinged joints. The horizontal stability is provided by bracing elements.
 - d) Floor or roof diaphragms (Figure 2.106d). Floors and roofs used to transfer horizontal forces to the bracing elements.