



National Standards Authority of Ireland

STANDARD

ENV 1998-4:1998

ICS 91.120.25

National Standards
Authority of Ireland
Dublin 9
Ireland

Tel: (01) 807 3800
Fax: (01) 807 3838

**EUROCODE 8 : DESIGN OF STRUCTURES
FOR EARTHQUAKE RESISTANCE - PART 4 :
SILOS, TANKS AND PIPELINES**

*This Irish Standard was
published under the authority
of the National Standards
Authority of Ireland
and comes into effect on:*

June 30, 1998

**NO COPYING WITHOUT NSAI
PERMISSION EXCEPT AS
PERMITTED BY COPYRIGHT
LAW**

© NSAI 1998

Price Code T

Údarás um Chaighdeáin Náisiúnta na hÉireann

EUROPEAN PRESTANDARD
PRÉNORME EUROPÉENNE
EUROPÄISCHE VORNORM

ENV 1998-4

January 1998

ICS 91.120.25

Descriptors: civil engineering, constructions, structures, silos, pipelines, tanks, earthquake resistant structures, earthquake-resistant design, computation

English version

Eurocode 8: Design of structures for earthquake resistance - Part 4: Silos, tanks and pipelines

Eurocode 8: Conception et dimensionnement des
structures pour la résistance aux séismes - Partie 4: Silos,
réservoirs et canalisations

Eurocode 8: Auslegung von Bauwerken gegen Erdbeben -
Teil 4: Silos, Tankbauwerke und Rohrleitungen

This European Prestandard (ENV) was approved by CEN on 6 June 1997 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 a European Standard.

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, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.



EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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

Contents

Foreword

1 General

1.1 Scope	7
1.2 Safety Requirements	7
1.2.1 General	8
1.2.2 Serviceability limit state	8
1.2.3 Ultimate limit state	8
1.2.4 Reliability differentiation	9
1.2.5 System versus element reliability	9
1.2.6 Conceptual design	10
1.3 Seismic action	10
1.4 Analysis	10
1.4.1 General	10
1.4.2 Behaviour factors	11
1.4.3 Damping	11
1.4.4 Interaction with the soil	12
1.5. Safety verifications	12
1.5.1 General	12
1.5.2 Combinations of seismic action with other actions	12

2 Specific rules for silos

2.1 Reliability differentiation	13
2.2 Combination of ground motion components	13
2.3 Analysis	14
2.4 Verifications	14
2.4.1 Serviceability limit state	14
2.4.2 Ultimate limit state	14

3 Specific rules for tanks

3.1 Reliability differentiation	15
3.2 Compliance criteria	16
3.2.1 General	16
3.2.2 Serviceability limit state	16
3.2.3 Ultimate limit state	16
3.3 Combination of ground motion components	17
3.4 Methods of analysis	17
3.4.1 General	17
3.4.2 Behaviour factors	17
3.4.3 Hydrodynamic effects	18
3.5 Verifications	19
3.5.1 Serviceability limit state	19
3.5.2 Ultimate limit state	20
3.6 Complementary measures	20
3.6.1 Bunding	20
3.6.2 Sloshing	21
3.6.3 Piping interaction	21

4 Specific rules for pipelines	21
4.1 General	22
4.2 Requirements	22
4.2.1 Reliability differentiation	23
4.2.2 Serviceability requirements	23
4.2.3 Safety requirements	24
4.3 Seismic action	24
4.3.1 General	24
4.3.2 Earthquake vibrations	25
4.3.3 Modelling of seismic waves	25
4.3.4 Permanent soil movements	25
4.4 Methods of analysis	25
4.4.1 Buried pipelines	26
4.4.2 Above ground pipelines	26
4.5 Verifications	26
4.5.1 General	28
4.6 Design measures for fault crossings	28
Annexes	
Annex A (Informative) Seismic analysis procedures for tanks	30
Annex B (Informative) Underground pipelines	62

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 methods of testing their performance is available, some of the Structural Eurocodes cover some of these aspects in informative annexes.

Background to 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 updates of the Structural Eurocodes to CEN, and the EFTA Secretariat agreed to support the CEN work.
- (6) CEN Technical Committee CEN/TC 250 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 of structures for earthquake resistance of structures
 - EN 1999 Eurocode 9 - Design of aluminium alloy structures
- (8) Separate subcommittees have been formed by CEN/TC 250 for the various Eurocodes listed above.
- (9) This Prestandard is being published as an 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/SC8 at the following address:

IPQ c/o LNEC
Avenida do Brasil 101
P1799 LISBOA Codex
PORTUGAL

or to your national Standard Organization.

National Application Documents

(13) In view of the responsibilities of authorities in member countries for the 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 harmonized supporting 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 guidance on the application of this Prestandard, will be issued by each member country or its Standards Organisation.

(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 are located.

Matters specific to this Prestandard

(16) The scope of Eurocode 8 is defined in clause 1.1.1 of ENV 1998-1-1:1994 and the scope of this Prestandard is defined in 1.1. Additional Parts of Eurocode 8 which are planned are indicated in clause 1.1.3 of ENV 1998-1-1:1994.

(17) This Prestandard is divided into four sections. The first section presents the general rules applicable to the design for earthquake resistance of silos, tanks and pipelines. The other sections deal with the specific rules for silos (section 2), tanks (section 3) and pipelines (section 4).

(18) Attention shall be paid to the fact that this Prestandard has to be used in conjunction with ENV 1998-1-1 and in addition to the provisions of the other relevant Eurocodes.

(19) This Prestandard includes two informative annexes.

Intended future developments of this Prestandard

(20) An objective of this Prestandard is to ensure the consistency between seismic design rules used for silos, tanks and pipelines and rules used for other construction works. It should be understood that this is a longterm objective which demands a continuous progress and cannot be achieved in a single step.

(21) Parts in other Eurocodes dealing with the same structures as in this Prestandard are still in preparation.

(22) A number of aspects of the seismic behaviour of silos, tanks and pipelines are not yet well understood, and research on them is currently under way. It is expected that this Prestandard, and particular the design procedures and rules given in the Appendices will be updated in parallel with the advancement of the knowledge in the field.

1 General

1.1 Scope

(1) P This Prestandard aims at providing principles and application rules for the seismic design of the structural aspects of integrated facilities composed of pipeline systems and of storage tanks of different types and destinations, as well as for independent items, such as for example single water towers serving a specific purpose or groups of silos enclosing granular materials, etc. This Prestandard may also be used as a basis for evaluating the amount of strengthening needed by existing facilities to bring them up to present standards.

(2) P This Prestandard includes the additional criteria and rules required for the seismic design of these structures without restrictions on their size, structural types and other functional characteristics. For some types of tanks and silos, however, it also provides detailed methods of assessment and verification rules.

(3) P With reference to 1.1 of ENV 1998-1-1:1994, this Prestandard may not be complete for those facilities associated with large risks to the population or the environment, for which additional requirements shall be established by the competent authorities. This Prestandard is also not complete for those construction works which have uncommon structural elements and which require special measures to be taken and special studies are performed to ensure earthquake protection. In those two cases the present Prestandard gives general principles but not detailed application rules.

(4) The nature of lifeline systems which often characterises the facilities covered by this Prestandard requires concepts, models and methods that may differ substantially from those in current use for more common structural types. Furthermore, the response and the stability of tanks subjected to strong seismic actions may involve rather complex phenomena of soil-structure-fluid interaction, not easily amenable to simplified design procedures. Equally challenging may prove to be the design of a pipeline system having to cross areas with poor and possibly unstable soils. For the reasons given above, the organisation of this Prestandard is to some extent different from that of companion Parts of ENV 1998. This Prestandard is, in general, restricted to basic principles and methodological approaches, while detailed analysis procedures are given in Annexes for a number of typical situations.

(5) P For the formulation of the general requirements as well as for their implementation, a distinction is made among the facilities covered by the present Part 4, i.e.: independent structures and redundant networks.

(6) P A structure can be considered as independent when its behaviour during and after a seismic event is not influenced by that of other structures, and if the consequences of its failure relate only to the functions demanded from it.

This is a free preview. Purchase the entire publication at the link below:

[Product Page](#)

-
- [Looking for additional Standards? Visit Intertek Inform Infostore](#)
 - [Learn about LexConnect, All Jurisdictions, Standards referenced in Australian legislation](#)
-