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Izvedba posebnih geotehničnih del - Diafragme

Execution of special geotechnical work - Diaphragm walls

Ausführung von Arbeiten im Spezialtiefbau - Schlitzwände

Exécution des travaux géotechniques spéciaux - Parois moulées

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EUROPEAN STANDARD

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June 2015

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Execution of special geotechnical work - Diaphragm walls

Exécution des travaux géotechniques spéciaux - Parois
moulées

Ausführung von Arbeiten im Spezialtiefbau - Schlitzwände

This European Standard was approved by CEN on 2 July 2010 and includes Amendment 1 approved by CEN on 17 April 2015.

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Page

Foreword	4
1 Scope.....	5
2 Normative references	7
3 Terms and definitions.....	8
4 Information needed for the execution of the work	10
4.1 General	10
4.2 Special features.....	10
5 Geotechnical investigation	11
5.1 General	11
5.2 Specific requirements.....	12
6 Materials and products.....	13
6.1 Constituents	13
6.1.1 General	13
6.1.2 Bentonite.....	13
6.1.3 Polymers	13
6.1.4 Cement	13
6.1.5 Aggregates.....	14
6.1.6 Water	14
6.1.7 Additions.....	14
6.1.8 Admixtures.....	14
6.2 Support fluids.....	14
6.2.1 Bentonite suspensions.....	14
6.2.2 Polymer solutions	15
6.2.3 Fresh hardening slurries	16
6.3 Concrete.....	16
6.3.1 General	16
6.3.2 Aggregates.....	16
6.3.3 Cement contents	16
6.3.4 Water/cement ratio	16
6.3.5 Admixtures.....	16
6.3.6 Fresh concrete	17
6.3.7 Sampling and testing on site	17
6.4 Plastic concrete.....	17
6.5 Hardening slurry	18
6.6 Reinforcement	18
6.7 Additional inserted products	19
7 Considerations related to design	19
7.1 General	19
7.2 Panel stability	20
7.2.1 General considerations	20
7.2.2 General principle of design.....	20
7.2.3 Comparable experience.....	20
7.2.4 Stability considerations.....	21
7.2.5 Trial excavation(s).....	21
7.3 Socketing into rock.....	21
7.4 Precast concrete panels.....	22
7.5 Reinforcement cages	22
7.5.1 General considerations	22
7.5.2 Design principles	22
7.5.3 Vertical reinforcement	23
7.5.4 Horizontal reinforcement.....	23
7.5.5 Multiple cages and joints	23

7.6	Recesses and perforations	24
7.7	Minimum and nominal cover	24
8	Execution	24
8.1	Construction phases	24
8.2	Construction tolerances	25
8.2.1	Panel	25
8.2.2	Retaining walls	25
8.2.3	Cut-off walls	26
8.2.4	Reinforcement cage	26
8.3	Preliminary works	26
8.3.1	Working platform	26
8.3.2	Guide-walls	26
8.4	Excavation	27
8.4.1	Supporting the walls of the excavation	27
8.4.2	Excavation sequence	28
8.4.3	Loss of support fluid	28
8.5	Cleaning the excavation	28
8.6	Forming the joints	28
8.7	Placing the reinforcement or other elements	29
8.8	Concreting and trimming	29
8.8.1	General	29
8.8.2	Concreting in dry conditions	30
8.8.3	Concreting under support fluid	30
8.8.4	Loss of immersion of tremie pipe	31
8.8.5	Trimming	31
9	Supervision, testing and monitoring	31
10	Records	32
11	Special requirements	32
Annex A (informative)	Glossary	34
Annex B (informative)	Control schedules during the execution	36
Annex C (informative)	Sample concreting record forms for diaphragm walls	42
Annex D (informative)	Degree of obligation of the provisions	43
	Bibliography	47

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2015

EN 1538:2010+A1:2015 (E)**Foreword**

This document (EN 1538:2010+A1:2015) has been prepared by Technical Committee CEN/TC 288 “Execution of special geotechnical works”, the secretariat of which is held by AFNOR.

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 December 2015, and conflicting national standards shall be withdrawn at the latest by December 2015.

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

This document supersedes A1 EN 1538:2010 A1.

This document includes Amendment 1 approved by CEN on 2015-04-17.

The start and finish of text introduced or altered by amendment is indicated in the text by tags A1 A1.

The general scope of TC 288 is the standardisation of the execution procedures for geotechnical works (including testing and control methods), and of the required material properties. WG15 has been charged to revise EN 1538:2000, with the subject area of both retaining and cut-off diaphragm walls. This standard does not address the execution of barrettes, which is covered by EN 1536, *Execution of special geotechnical work — Bored piles*.

The design, planning and execution of retaining and cut-off diaphragm walls call for experience and knowledge in this specialised field. The execution phase requires skilled and qualified personnel and the present standard cannot replace the expertise of specialist contractors.

The document has been prepared to stand alongside EN 1997-1, *Eurocode 7: Geotechnical design — Part 1: General rules* and EN 1997-2, *Eurocode 7: Geotechnical design — Part 2: Ground investigation and testing*. This standard expands on design only where necessary (e.g. the detailing of reinforcement) and provides full coverage of the construction and supervision requirements.

A2 The amendment became necessary to accord the Standard EN 1538:2010 with EN 206:2013, *Concrete – Specification, performance, production and conformity*. EN 206:2013 has been revised to contain also the specific requirements for concrete for applications for special geotechnical works, making redundant respective provisions in EN 1538 (e.g. 6.1, 6.3 and 8.8).

Full according with EN 13670, *Execution of concrete structures* is however still pending. EN 1538:2010+A1:2015 therefore still contains specific requirements for bored piles as a concrete structure, such as the detailing of the reinforcement, the concrete placement and the supervision of concreting process which are complementing the provisions of EN 13670.

In addition, some editorial corrections were made in this amended Standard. A1

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

1 Scope

This European Standard establishes general principles for the execution of diaphragm walls as either retaining walls or cut-off walls.

NOTE 1 This standard covers only structures constructed in a trench excavated with a support fluid or in dry conditions, where soil is removed and replaced by concrete or slurry and with wall thickness $B \geq 40$ cm.

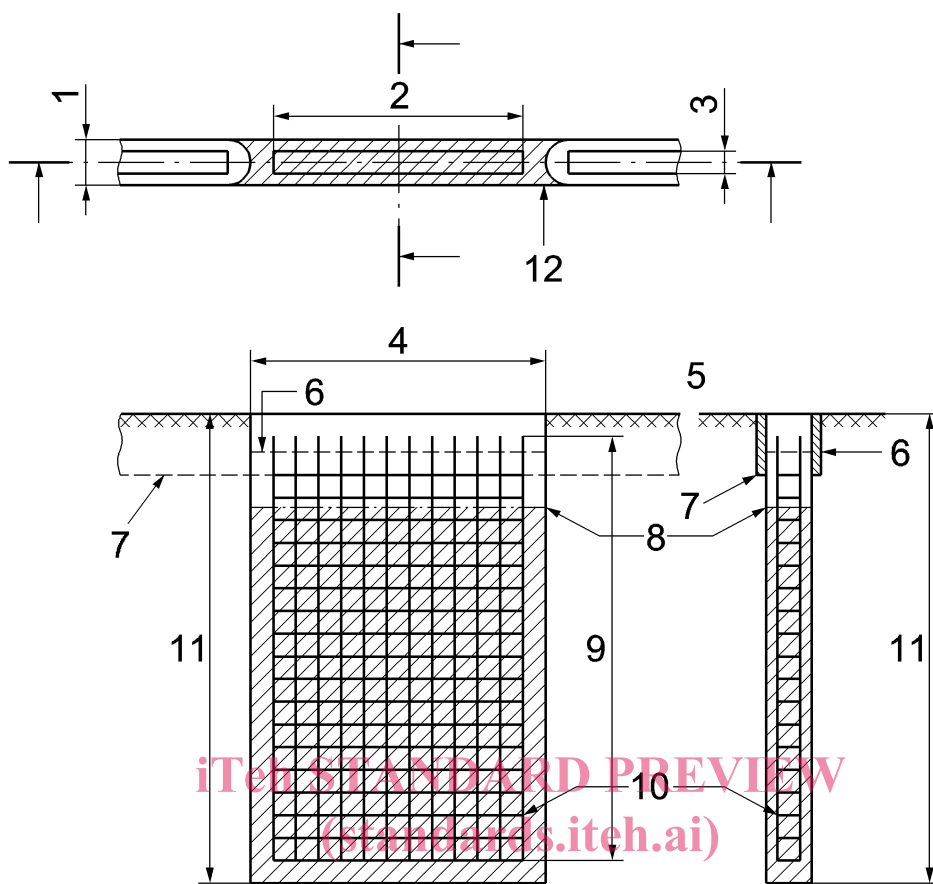
NOTE 2 Diaphragm walls can be permanent or temporary structures.

NOTE 3 The following types of structure are considered:

- a) retaining walls: usually constructed to support the sides of an excavation in the ground. They include:
 - 1) cast in situ concrete diaphragm walls;
 - 2) precast concrete diaphragm walls;
 - 3) reinforced slurry walls;
- b) cut-off walls: usually constructed to prevent migration of groundwater, clear or polluted, or of other contaminants present in the ground. They include:
 - 1) slurry walls (possibly with membranes or sheet piles);
 - 2) plastic concrete walls.

NOTE 4 Walls formed shallow vertical trenches (typically excavations with a ratio of depth over thickness $D/B < 5$ or $D < 5$ m) are not covered by this standard.

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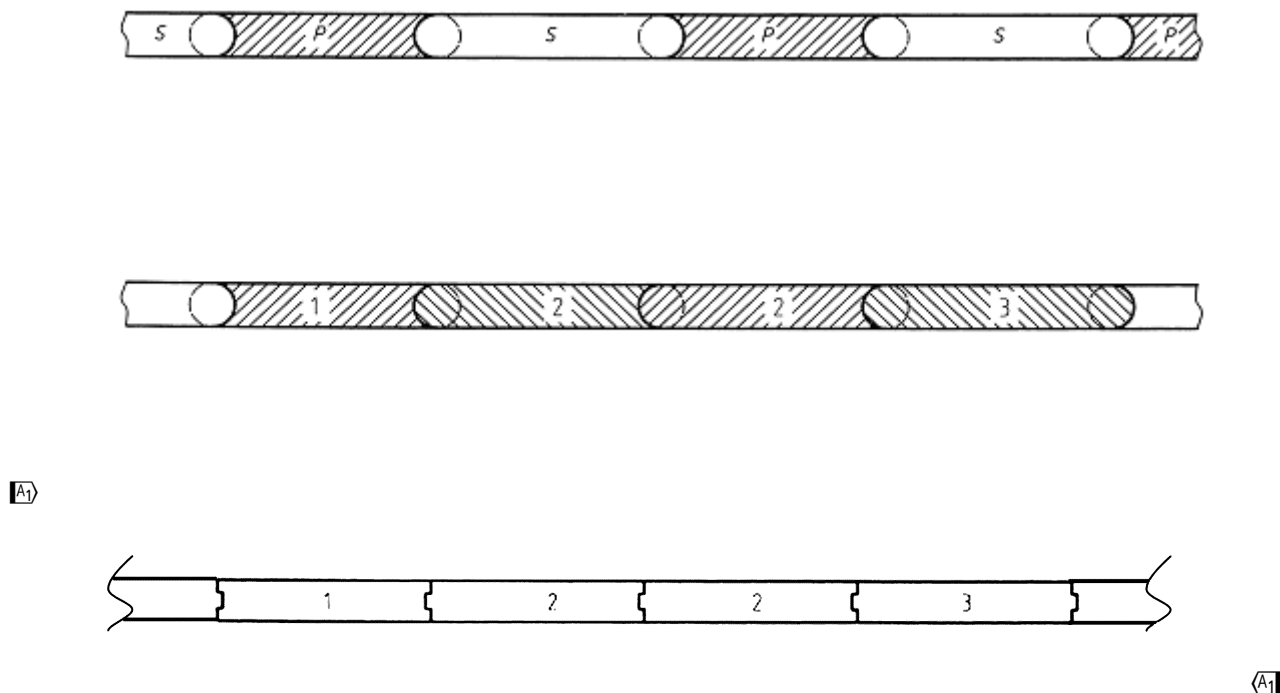
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Key

- | | | | |
|---|--|----|---------------------------------------|
| 1 | Wall thickness (B) | 7 | Guide-wall |
| 2 | Horizontal length of reinforcement cage | 8 | Cut off level |
| 3 | Cage width | 9 | Vertical length of reinforcement cage |
| 4 | Length of panel | 10 | Reinforcement cage |
| 5 | \square_{A_1} Working platform level \square_{A_1} | 11 | Depth of excavation (D) |
| 6 | Casting level | 12 | Concave portion of curved joints |

Figure 1 — Geometry of a panel

**Key**

- P Primary
- S Secondary
- 1 Starter
- 2 Intermediate
- 3 Closure

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Figure 2 — Schematic examples of different types of panels and joints (plan view)

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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A1 EN 206:2013, *Concrete — Specification, performance, production and conformity* **A1**

EN 791, *Drill rigs — Safety*

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EN 1990, *Eurocode — Basis of structural design*

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

EN 1992 (all parts), *Eurocode 2: Design of concrete structures*

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

EN 1997-2, *Eurocode 7 — Geotechnical design — Part 2: Ground investigation and testing*

EN 1998 (all parts), *Eurocode 8: Design of structures for earthquake resistance*

EN 1538:2010+A1:2015 (E)

EN 10025-2, *Hot rolled products of structural steels — Part 2: Technical delivery conditions for non-alloy structural steels*

EN 10080, *Steel for the reinforcement of concrete — Weldable reinforcing steel — General*

EN 10210 (all parts), *Hot finished structural hollow sections of non-alloy and fine grain steels*

EN 10219 (all parts), *Cold formed welded structural hollow sections of non-alloy and fine grain steels*

EN 10248 (all parts), *Hot rolled sheet piling of non alloy steels*

EN 10249 (all parts), *Cold formed sheet piling of non alloy steels*

A1 deleted text **A1**

EN 13670, *Execution of concrete structures*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1**cast in situ concrete diaphragm wall**

fr paroi moulée en béton

de Ortbetonschlitzwand

wall made of plain or reinforced concrete, which is constructed in a trench excavated in the ground

NOTE The excavation is carried out in discrete length to form panels and the concrete is placed through tremie pipes immersed in the fresh concrete. In some cases the excavation and the concreting may be carried out in dry conditions.

3.2**plastic concrete wall**

fr paroi moulée en béton plastique

de Tonbetonschlitzwand

wall made of plastic concrete, which is constructed in a trench in the ground

NOTE The excavation is carried out in panels and the concrete is placed through tremie pipes most of the time immersed in a support fluid. In some cases the excavation and the concreting may be carried out in dry conditions.

3.3**precast concrete diaphragm wall**

fr paroi préfabriquée en béton

de Fertigteilschlitzwand

wall made of precast elements which are lowered into a trench excavated in the ground containing a hardening slurry

3.4**reinforced slurry wall**

fr paroi moulée en coulis armé

de bewehrte Einphasenschlitzwand

wall made from a hardening slurry reinforced by steel beams, steel mesh or other suitable elements

3.5**slurry wall**

fr paroi moulée en coulis

de Einphasenschlitzwand

wall made from a hardening slurry

NOTE In most cases, the excavation is carried out using a hardening slurry as the support fluid. Sealing elements such as membranes or sheetpiles may be inserted.

3.6**plastic concrete****fr** béton plastique**de** Tonbeton

low strength, low Young's modulus concrete capable of sustaining larger strains than normal concrete

NOTE It usually consists of low cement content concrete mixed at a high water cement ratio. It may include bentonite and/or other clay materials and/or other materials such as pulverized fuel ash (PFA) and admixtures.

3.7**hardening slurry****fr** coulis autodurcissant**de** selbsterhärtende Suspension

slurry which hardens with time

NOTE The slurry is a suspension which contains cement or another binder, and additional materials such as clay (bentonite), ground granulated blast furnace slag (GGBFS) or pulverized fuel ash (PFA), fillers, sand and admixtures. Hardening slurries are generally used in the precast concrete diaphragm wall technique and for slurry walls. They serve as support fluid during excavation, and, together with the fines from the natural ground, form the final, hardened material.

3.8**guide-walls****fr** murettes-guides**de** Leitwände

shallow depth, parallel temporary walls which are used to provide a guide for the excavating tool, to secure the sides of the trench against collapse at the trench top close to platform level, and to support and to facilitate the positioning of the reinforcement

3.9**panel****fr** panneau**de** Schlitzwandelement ^(A) / Schlitzwandlamelle ^(A)

section of a diaphragm wall which is concreted as a single unit

NOTE A diaphragm panel may be linear, T-shaped, L-shaped, or of other configuration.

3.10**support fluid****fr** fluide stabilisateur**de** Stützflüssigkeit

fluid used during excavation to support the sides of the trench

NOTE It is usually a bentonite suspension, a polymer solution or a hardening slurry.

3.11**concreting pipe****fr** colonne de bétonnage**de** Betonierrohr

metal pipe comprising several joined lengths, surmounted by a hopper or chute for concreting under dry conditions

3.12**tremie pipe****fr** tube plongeur**de** Kontraktorrohr

concreting pipe, with watertight joints for submerged concrete placement

EN 1538:2010+A1:2015 (E)**3.13****cover****fr** enrobage**de** Betonüberdeckung

distance between the outside of the reinforcement cage and the nearest concrete surface

NOTE The nearest concrete surface considered is the nearest excavated face as formed by the excavation tool.

3.14**execution specification****fr** spécifications d'exécution**de** bautechnische Unterlagen

set of documents covering all drawings, technical data and requirements necessary for the execution of a particular project

NOTE The execution specification is not one document but signifies the total sum of documents required for the execution of the work as provided by the designer to the constructor. It includes the project specification prepared to supplement and qualify the requirements of this European Standard, as well as referring the national provisions relevant in the place of use.

3.15**project specification****fr** spécifications de l'ouvrage**de** Projektspezifikationen

project specific document describing the requirements applicable for the particular project

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SIST EN 1538:2011+A1:2015

4.1.1 Prior to the execution of the work, all necessary information shall be provided.**4.1.2** This information should include:

- any legal or statutory restrictions;
- the location of main grid lines for setting out;
- the conditions of structures, roads, services, etc. adjacent to the work, including any necessary surveys;
- a suitable quality management system, including supervision, monitoring and testing.

4.1.3 The information regarding the site conditions shall cover, where relevant:

- the geometry of the site (boundary conditions, topography, access, slopes, headroom restrictions, etc.);
- the existing underground structures, services, known contaminations, and archeological constraints;
- the environmental restrictions, including noise, vibration, pollution;
- the future or ongoing activities such as dewatering, tunnelling, deep excavations.

4.2 Special features**4.2.1** The special features shall cover, where relevant:

- execution specifications (see 3.14);
- previous use of the site;

- adjacent foundations (types, loads and geometry);
- geotechnical information and data as specified in Clause 5;
- presence of obstructions in the ground (old masonry, anchors, etc.);
- presence of headroom restrictions;
- presence of archeological remains;
- presence of natural and/or man made cavities (mines, etc.);
- $\boxed{A_1}$ presence of contaminated ground; $\boxed{A_1}$
- any specific requirements for the diaphragm wall, in particular those pertaining to tolerances, quality of materials, watertightness, and type of joints;
- where available, previous experience with diaphragm walls or underground works on or adjacent to the site;
- for slurry walls, permeability, strength and deformation properties of the wall material;
- proposed adjacent enabling or advance works such as underpinning, pre-treatment of soil, dewatering;
- diaphragm wall function (i.e. end bearing, retaining wall, cut off wall, environmental barrier, etc.).

4.2.2 Necessity, extent, procedure and content for any survey of the conditions of structures, roads, services, etc. adjacent to the works area shall be established.

4.2.3 The survey shall be carried out and be available prior to the commencement of the works and its conclusions shall be used to define the threshold values for any movement which may affect adjacent structures by the works area constructions.

4.2.4 Any additional or deviating requirements falling within the permissions given in this European Standard shall be established and agreed before the commencement of the works and the quality control system shall be suitably amended.

NOTE Such additional or deviating requirements can be:

- reduced or increased geometrical construction deviations;
- application of different or varying construction materials;
- precast concrete elements;
- special anchorage or doweling of diaphragm walls to underlying rock;
- special reinforcement as the use of steel tubes or sections or of steel fibres;
- grouting of diaphragm walls shafts or bases;
- trimming of diaphragm walls heads by mechanical equipment.

5 Geotechnical investigation

5.1 General

5.1.1 The geotechnical investigation shall fulfil the requirements of EN 1997 (all parts).