



# SLOVENSKI STANDARD

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### Izvedba posebnih geotehničnih del - Geotehnična sidra

Execution of special geotechnical work - Ground anchors

Ausführung von besonderen geotechnischen Arbeiten (Spezialtiefbau) - Verpreßanker

Exécution des travaux géotechniques spéciaux - Tirant d'ancrage

Ta slovenski standard je istoveten z: **EN 1537:2013**

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EUROPEAN STANDARD

EN 1537

NORME EUROPÉENNE

EUROPÄISCHE NORM

July 2013

ICS 93.020

Supersedes EN 1537:1999

English Version

## Execution of special geotechnical works - Ground anchors

Exécution des travaux géotechniques spéciaux - Tirants  
d'ancrage

Ausführung von Arbeiten im Spezialtiefbau - Verpressanker

This European Standard was approved by CEN on 8 May 2013.

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## EN 1537:2013 (E)

## Foreword

This document (EN 1537:2013) 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of an identical text or by endorsement, at the latest by January 2014, and conflicting national standards shall be withdrawn at the latest by January 2014.

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 EN 1537:1999.

The remit of CEN/TC 288 is the standardisation of the execution procedures for geotechnical works (including testing and control methods) and of the required material properties. CEN/TC 288/WG 14 has been charged with the revision of EN 1537:1999 in the subject area of ground anchors, which includes all anchors that are bonded to the ground by grout and are stressed and tested.

This standard has been prepared to stand alongside EN 1997-1, *Eurocode 7: Geotechnical design — Part 1: General rules*, and prEN ISO 22477-5, *Geotechnical investigation and testing — Testing of geotechnical structures — Part 5*. Design, safety aspects and testing, which were included as the informative Annexes D and E in the previous issue of this standard (EN 1537:1999), were consequently taken out of this present issue. Clause 7, “Considerations related to design” of this standard deals only with those design matters that should be taken into account during the execution stage of ground anchors so that the design of the anchor system may be fulfilled. In addition, this standard provides full coverage of the construction and supervision requirements.

The revision of this standard was effected by a working group comprising of delegates from ten countries and the comments of these countries have been taken into account. The main amendments are:

- definitions and terminology brought into accordance with the definitions and terminology of EN 1997-1:2004, *Eurocode 7*, in particular with Section 8;
- alignment of this European Standard with prEN ISO 22477-5;
- structural revisions to match the structure of this standard with that of other standards for special geotechnical works, e.g. EN 1536, *Execution of special geotechnical work — Bored piles* and EN 1538, *Execution of special geotechnical work — Diaphragm walls*;
- general revision in accordance with comments received during the CEN Enquiry, 2010;
- update of references.

As long as EN ISO 22477-5 is not available, national solutions should be implemented for the testing of anchors.

According to the CEN-CENELEC Internal Regulations, the national standards organisations 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

1.1 This European Standard covers ground anchors grouted into the ground which are stressed and tested. They can be used for permanent or temporary applications.

NOTE For the purpose of this standard the term 'anchor(s)' refers to 'ground anchor(s)'.

1.2 The anchors are designed in accordance with EN 1997-1 and are tested in accordance with prEN ISO 22477-5.

1.3 Typical bond and compression type anchors are shown in Figure 1 and Figure 2.

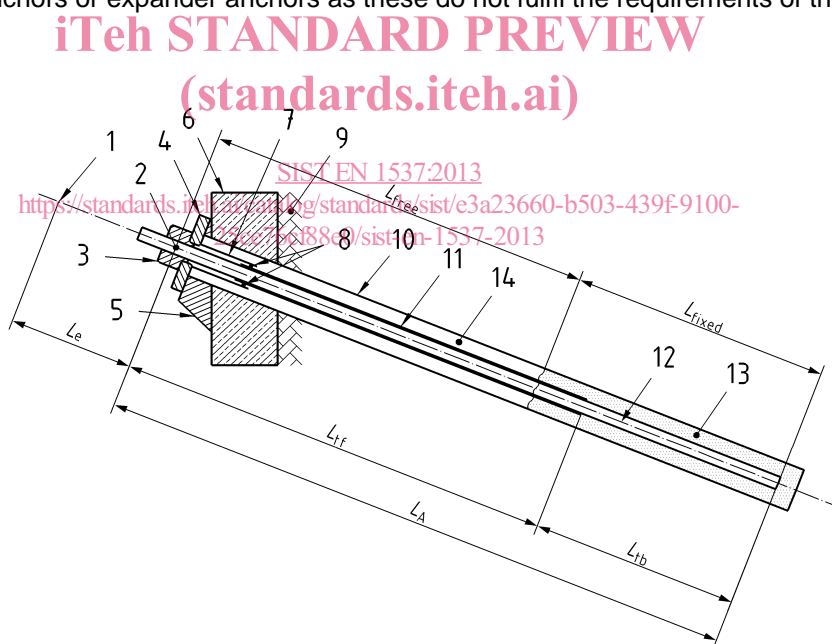
1.4 The term "ground" is taken to encompass soil, rock and fill already in place or existing prior to the execution of the construction work.

1.5 The planning and design of ground anchors calls for experience and knowledge in this specialised field.

1.6 The installation and testing phases require skilled, qualified labour and supervision.

1.7 This standard cannot replace the knowledge of specialist personnel and the expertise of experienced contractors required to apply this standard.

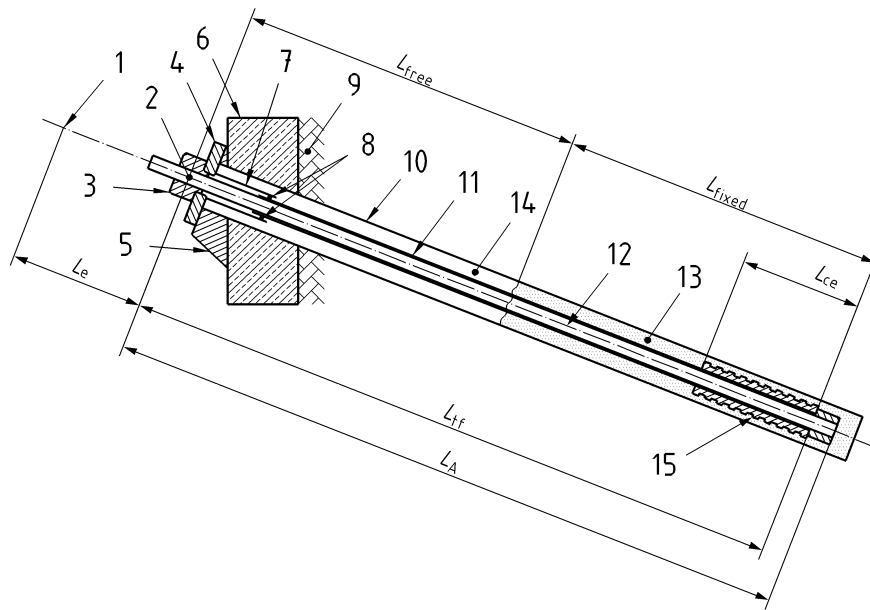
1.8 This standard does not address systems such as tension piles, screw anchors, mechanical anchors, soil nails, dead-man anchors or expander anchors as these do not fulfil the requirements of this standard.



### Key

1	anchorage point at jack during stressing	8	O-Ring
2	anchorage point at anchor head in service	9	soil/rock
3	tensioning element at anchor head	10	borehole
4	bearing plate	11	debonding sleeve
5	load transfer block	12	tendon
6	structural element	13	fixed length grout body
7	trumpet or anchor head tube	14	free length filling where appropriate

**Figure 1 — Sketch of a bond type ground anchor — Details of anchor head and head protection omitted**

**Key**

- 1 anchorage point at jack during stressing
- 2 anchorage point at anchor head in service
- 3 tensioning element at anchor head
- 4 bearing plate
- 5 load transfer block
- 6 structural element
- 7 trumpet or anchor head tube
- 8 O - Ring
- 9 soil/rock
- 10 borehole
- 11 debonding sleeve
- 12 tendon
- 13 fixed length grout body
- 14 free length filling where appropriate
- 15 compression element

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**Figure 2 — Sketch of a compression type ground anchor — Details of anchor head and head protection omitted**



## 2 Normative references

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

EN 206-1, *Concrete — Part 1: Specification, performance, production and conformity*

EN 447, *Grout for prestressing tendons — Basic requirements*

EN 934-2, *Admixtures for concrete, mortar and grout — Part 2: Concrete admixtures — Definitions, requirements, conformity, marking and labelling*

EN 1992-1-1, *Eurocode 2: Design of concrete structures — Part 1-1: General rules and rules for buildings*

EN 1997-1:2004, *Eurocode 7: Geotechnical design — Part 1: General rules*

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

EN 10025 (all parts), *Hot-rolled products of structural steels*

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

prEN 10138-1, *Prestressing steel — Part 1: General requirements*

EN 10210-1, *Hot finished structural hollow sections of non-alloy and fine grain steels — Part 1: Technical delivery conditions*

EN 10219-1, *Cold formed welded structural hollow sections of non-alloy and fine grain steels — Part 1: Technical delivery conditions*

EN 10219-2, *Cold formed welded structural hollow sections of non-alloy and fine grain steels — Part 2: Tolerances, dimensions and sectional properties*

EN ISO 12944-5, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 5: Protective paint systems (ISO 12944-5)*

prEN ISO 22477-5, *Geotechnical investigation and testing — Testing of geotechnical structures — Part 5: Testing of anchorages (ISO/DIS 22477-5)<sup>1)</sup>*

ETAG 013, *Post-tensioning kits for prestressing of structures*

## 3 Terms, definitions and symbols

### 3.1 Terms and definitions

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

#### 3.1.1

**anchor head**

**fr:** tête d'ancrage

**de:** Ankerkopf

element of a ground anchor which transmits the tensile load from the tendon to the bearing plate or the structure

<sup>1)</sup> In preparation.

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## 3.1.2

**anchor system**

fr: système d'ancrage

de: Ankersystem

system comprising specific components and materials which collectively form the ground anchor

## 3.1.3

**acceptance test**

fr: essai de réception

de: Abnahmeprüfung

load test to confirm that each anchor conforms with the acceptance criteria

## 3.1.4

**apparent tendon free length**

fr: longueur libre équivalente de l'armature

de: Rechnerische freie Stahllänge

length of tendon which is estimated to be fully decoupled from the surrounding grout and is calculated from the load-elastic displacement data following testing

## 3.1.5

**borehole diameter**

fr: diamètre de forage

de: Bohrlochdurchmesser

diameter of a borehole as defined by the drill bit or casing diameter, excluding any enlargements

## 3.1.6

**compression type anchor**

fr: tirant à élément de compression

de: Druckrohranker

ground anchor, the load of which is transferred via a decoupled steel tendon down to the bottom of the borehole, and from there via a compression element and the borehole grout into the ground

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## 3.1.7

**compression element length**

fr: longueur d'élément de compression

de: Druckrohrlänge

length of the compression element for load transfer of a compression type anchor

## 3.1.8

**coupler**

fr: coupleur

de: Koppelement

device for joining the lengths of bar or strand which comprise an anchor tendon

## 3.1.9

**critical creep load**

fr: traction critique de fluage

de: Kritische Kriechkraft

anchor load corresponding to the end of the first linear part of a plot of anchor load against creep rate

## 3.1.10

**datum load**

fr: traction de référence

de: Vorbelastung

level of anchor load from which the anchor head displacement is measured during a stress test

**3.1.11****encapsulation****fr:** protection**de:** Korrosionsschutzumhüllung

corrosion protection barrier which is typically a plastic or metallic tube applied to the tendon

**3.1.12****fixed anchor length****fr:** longueur de scellement du tirant**de:** Krafteintragungslänge

designed length of an anchor over which the load is transmitted to the surrounding ground, through a grout body

**3.1.13****free anchor length****fr:** longueur libre du tirant**de:** Freie Ankerlänge

distance between the proximal end of the fixed anchor length and the tendon anchorage point at the anchor head

**3.1.14****ground anchor****fr:** tirant d'ancrage**de:** Verpressanker

structural element capable of transmitting an applied tensile load to a load-bearing stratum; it consists of an anchor head, a free anchor length and a fixed anchor length

**3.1.15****grout****fr:** coulis**de:** Verpressgut

fluid mixture of a binding and/or setting agent (usually cement) and water that hardens after being placed in position

**3.1.16****investigation test****fr:** essai préalable**de:** Untersuchungsprüfung

load test to establish the ultimate load resistance of an anchor at the ground/grout interface and to determine the characteristics of the anchor in the working load range

**3.1.17****lock-off load****fr:** traction de blocage**de:** Festlegekraft

load transferred to an anchor head immediately on completion of a stressing operation

**3.1.18****permanent anchor****fr:** tirant d'ancrage permanent**de:** Daueranker

anchor with a design life in excess of two years

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## 3.1.19

**proof load**

fr: traction d'épreuve

de: Prüfkraft

maximum test load to which an anchor is subjected

## 3.1.20

**suitability test**

fr: essai de contrôle

de: Eignungsprüfung

load test to confirm that a particular anchor design will be adequate in particular ground conditions

## 3.1.21

**temporary anchor**

fr: tirant d'ancrage provisoire

de: Kurzzeitanker

anchor with a design life of two years or less

## 3.1.22

**tendon**

fr: armature

de: Zugglied

part of a ground anchor that is capable of transmitting the tensile load from the fixed anchor length to the anchor head

## 3.1.23

**tendon bond length**

fr: longueur de scellement de l'armature

de: Verankerungslänge des Zuggliedes

length of the tendon that is bonded directly to the grout and capable of transmitting the applied tensile load

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## 3.1.24

**tendon free length**

fr: longueur libre de l'armature

de: Freie Stahllänge

length of tendon between the anchorage point at the anchor head and the proximal end of the tendon bond length

## 3.2 Symbols

$A_t$	Cross sectional area of anchor tendon
$E_t$	Elastic modulus of anchor tendon
$f_{tk}$	Characteristic tensile strength of a tendon
$L_A$	Anchor length
$L_{app}$	Apparent tendon free length
$L_e$	External length of tendon measured from the tendon anchorage in the anchor head to the anchorage point in the stressing jack
$L_{ce}$	Length of compression element
$L_{fixed}$	Fixed anchor length

$L_{free}$	Free anchor length
$L_{tb}$	Tendon bond length
$L_{tf}$	Tendon free length
$P_a$	Datum load
$P_o$	Anchor lock-off load
$P_p$	Proof load

## 4 Information needed for the execution of the work

### 4.1 General

4.1.1 Prior to the execution of the work, all necessary information shall be provided and shall include:

- any legal or statutory restrictions;
- execution specifications (see Note);
- 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.

NOTE The execution specification consists of documents covering all drawings, technical data and requirements necessary for the execution of a particular project. The execution specification is not one document but signifies the total sum of documents required for the execution of the work. It includes the project specification prepared in order to supplement and qualify the requirements of this European Standard as well as to refer to the national provisions relevant in the place of use.

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

- the geometry of the site, including boundary conditions, topography, access, slopes, headroom restrictions;
- the existing underground structures, services and aerial photographs, known contaminations, and archaeological 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 Anchor testing and the verification of design parameters are necessary elements in the construction procedure.

4.2.2 Activities required for the design, execution, testing and maintenance of the ground anchors and the interface between these activities shall be defined before the start of the work.

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**4.2.3** The following shall be provided prior to the initial supply and installation of the ground anchor system:

- details of the ground anchor project and the construction sequence and programme;
- a site investigation report incorporating a geotechnical classification and engineering properties of the ground in which the ground anchors are to be located;
- information on all other boundary conditions, including underground services, existing foundations and requirements relevant to the location and performance of the ground anchors;
- details of ownership of the ground into which the anchors are to be installed;
- details of any agreement required to gain access to ground into which the anchors are to be installed.
- details of requirements, where relevant, for destressing and/or removing anchors when they are no longer required.

**4.2.4** Environmental issues, including the use of grout, removal of soil, water recycling, noise and vibration shall be considered in the design and planning of the work.

## **5 Geotechnical investigation**

### **5.1 General**

**5.1.1** The geotechnical investigation shall fulfil the requirements of EN 1997-1.

**5.1.2** The geotechnical investigation report shall be made available in enough time to allow for the reliable design and execution of the special geotechnical works.

**5.1.3** The geotechnical investigation shall be checked to see whether it is sufficient for the design and execution of the special geotechnical works.

**5.1.4** If the geotechnical investigations are not sufficient, a supplementary investigation shall be conducted.

### **5.2 Specific requirements**

**5.2.1** All geotechnical investigations shall be undertaken in accordance with the requirements and recommendations of EN 1997-1 and EN 1997-2.

**5.2.2** This can be achieved through the execution of an appropriate ground investigation or by reference to pre-existing information of surrounding ground conditions.

**5.2.3** Since inclined ground anchors are installed commonly as vertical anchors, lateral variations in ground properties should be investigated as thoroughly as the vertical variations.

**5.2.4** Geotechnical investigations should be extended to site extremities and, where possible, extended to include ground formations outside the actual site if stresses induced by anchors extend beyond the site. This enables the strata profile to be interpolated between the investigation locations rather than extrapolated outside the area investigated.

**5.2.5** Where appropriate, the effects of deleterious stray currents should be investigated in accordance with EN 50162.

**5.2.6** Depths of the geotechnical investigation should be adequate to ensure that:

- a) the anticipated geological formation affected by changes in stresses induced by tensioning the anchor, is confirmed;

- b) no underlying stratum will affect design;
- c) groundwater conditions are well defined.

**5.2.7** From the geotechnical investigation, it should be possible to determine the likelihood of difficulties relating to:

- potential obstructions to drilling;
- the process of borehole drilling (drillability);
- borehole stability;
- flow of ground water in or out of the borehole;
- loss of grout from the borehole.

## 6 Materials and products

### 6.1 General

**6.1.1** Anchor systems shall be used for which there are documented successful tests and/or experience with respect to performance.

**6.1.2** All anchor systems shall have been subjected to relevant investigations to verify the competence of the anchor systems. The investigations shall be documented.

NOTE A relevant investigation of the anchor system includes the demonstration of the adequacy of the anchor system, or elements of the anchor system, acting individually or in combination with each other.

**6.1.3** The documented investigation of the anchor system shall be evaluated in accordance with the principles stated in this European Standard.

NOTE The evaluation of the anchor system investigation is undertaken by a suitably qualified and experienced anchor specialist or authority and may be defined in a national document.

**6.1.4** All materials used shall be mutually compatible.

NOTE This applies in particular to adjacent materials with a common interface.

**6.1.5** Material properties shall not change during the designed service life of the ground anchor in such a way that the anchor loses its serviceability.

NOTE An exception is corrosion inhibiting compound on restressable anchors that can require replenishment in service.

### 6.2 Anchor components subject to corrosion protection

#### 6.2.1 Tendon

**6.2.1.1** All steel tendons shall comply with the following European Standards, where appropriate:

- EN 10210-1, *Hot finished structural hollow sections of non-alloy and fine grain steels — Part 1: Technical delivery conditions*;
- EN 10219-1, *Cold formed welded structural hollow sections of non-alloy and fine grain steels: Technical delivery requirements*;