



SLOVENSKI STANDARD

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Nadomešča:
SIST EN 14199:2005

Izvedba posebnih geotehničnih del - Mikropiloti

Execution of special geotechnical work - Micropiles

Ausführung von besonderen geotechnischen Arbeiten (Spezialtiefbau) - Pfähle mit kleinen Durchmessern (Mikropfähle)

Exécution des travaux géotechniques spéciaux - Micropieux

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EUROPEAN STANDARD

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Execution of special geotechnical works - Micropiles

Exécution des travaux géotechniques spéciaux - Micropieux

Ausführung von Arbeiten im Spezialtiefbau - Mikropfähle

This European Standard was approved by CEN on 12 March 2015.

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EN 14199:2015 (E)**Foreword**

This document (EN 14199:2015) 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of an identical text or by endorsement, at the latest by November 2015, and conflicting national standards shall be withdrawn at the latest by November 2015.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 EN 14199:2005.

The technical changes in comparison to EN 14199:2005 are:

- Driven piles are excluded from EN 14199 and transferred to EN 12699;
- sections describing concrete and testing have been minimised;
- EN 14199:2015 has been harmonized with EN 1536.

The general scope of CEN/TC 288 is the standardization of the execution procedures for geotechnical works, including testing and control methods, and the required material properties. WG 16 has been charged with the subject area of micropiles.

This document has been prepared to stand alongside EN 1997-1. Clause 7 of this Standard covers design aspects of micropiles.

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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 establishes general principles for the execution of micropiles.

They are for drilled piles constructed using a drilling tool with a diameter less than 300 mm.

NOTE 1 This European Standard is not applicable to driven piles, the execution of which is governed by EN 12699.

NOTE 2 For a definition of shaft diameter see 3.3.

1.2 Micropiles are structural members to transfer actions to the ground and can contain bearing elements to transfer directly or indirectly loads and or to limit deformations. For examples of micropiles see Figure 1, Figure 2 and Figure 3. Their shaft and base resistance can be improved (mostly by grouting) and they can be constructed with (see Figure 4):

- uniform cross section (straight shaft); or
- telescopically changing shaft dimensions;
- shaft enlargements; and/or
- base enlargement.

1.3 Other than practical considerations, there are no limitations regarding, length, inclination (definition of inclination, see Figure 5), slenderness ratio or shaft and base enlargements.

1.4 The provisions of this European Standard apply to (see Figure 6):

- single micropiles;
- micropile groups;
- reticulated micropiles;
- micropile walls.

1.5 The material of micropiles covered by this European Standard can be:

- steel or other reinforcement materials;
- grout, mortar or concrete;
- a combination of above.

1.6 Micropiles can be used for:

- working under restricted access and/or headroom conditions;
- foundations of new structures (particularly in very heterogeneous soil or rock formations);
- reinforcing or strengthening of existing structures to increase the capacity to transfer load to depth with acceptable load settlement characteristics, e.g. underpinning works;
- reducing settlements and/or displacements;
- forming a retaining wall;

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- reinforcing of soil to form a bearing and/or retaining structure;
- improving slope stability;
- securing against uplift;
- other applications where micropile techniques are appropriate.

1.7 Deep mixing columns according to EN 14679 are not included in this European Standard. Columns constructed by jet grouting are covered by EN 12716. Ground anchors are covered by EN 1537.

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 206:2013, *Concrete - Specification, performance, production and conformity*

EN 445, *Grout for prestressing tendons - Test methods*

EN 447:2007, *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 1090-2, *Execution of steel structures and aluminium structures — Part 2: Technical requirements for steel structures*

EN 1536:2010, *Execution of special geotechnical work - Bored piles*

EN 1990, *Eurocode - Basis of structural design*

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

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

EN 1993 (all parts), *Eurocode 3: Design of steel structures*

EN 1994-1-1, *Eurocode 4: Design of composite steel and 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 non-alloy structural steels*

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

prEN 10138-4:2001, *Prestressing steels — Part 4: Bars*

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

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

EN 12390-3, *Testing hardened concrete - Part 3: Compressive strength of test specimens*

EN 16228 (all parts), *Drilling and foundation equipment — Safety*

EN ISO 2560, *Welding consumables - Covered electrodes for manual metal arc welding of non-alloy and fine grain steels - Classification (ISO 2560)*

EN ISO 4063, *Welding and allied processes - Nomenclature of processes and reference numbers (ISO 4063)*

EN ISO 5817, *Welding - Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) - Quality levels for imperfections (ISO 5817)*

EN ISO 9692-1, *Welding and allied processes - Types of joint preparation - Part 1: Manual metal arc welding, gas-shielded metal arc welding, gas welding, TIG welding and beam welding of steels (ISO 9692-1)*

EN ISO 9692-2, *Welding and allied processes - Joint preparation - Part 2: Submerged arc welding of steels (ISO 9692-2)*

EN ISO 11960, *Petroleum and natural gas industries - Steel pipes for use as casing or tubing for wells (ISO 11960)*

EN ISO 14341, *Welding consumables - Wire electrodes and weld deposits for gas shielded metal arc welding of non alloy and fine grain steels - Classification (ISO 14341)*

EN ISO 15630-3, *Steel for the reinforcement and prestressing of concrete - Test methods - Part 3: Prestressing steel (ISO 15630-3)*

EN ISO 15609-1, *Specification and qualification of welding procedures for metallic materials - Welding procedure specification - Part 1: Arc welding (ISO 15609-1)*

EN ISO 17632, *Welding consumables - Tubular cored electrodes for gas shielded and non-gas shielded metal arc welding of non-alloy and fine grain steels - Classification (ISO 17632)*

EN ISO 17660-1, *Welding - Welding of reinforcing steel - Part 1: Load-bearing welded joints (ISO 17660-1)*

EN ISO 18276, *Welding consumables - Tubular cored electrodes for gas-shielded and non-gas-shielded metal arc welding of high-strength steels - Classification (ISO 18276)*

prEN ISO 22477-1:2014, *Geotechnical investigation and testing — Testing of geotechnical structures — Part 1: Pile load test by static axially loaded compression (ISO/DIS 22477-1:2014)*

3 Terms and definitions

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

3.1

micropile

fr: micropieu

de: Mikropfahl

drilled piles which have a diameter smaller than 300 mm

3.2

enlarged base

fr: base élargie

de: Fußaufweitung

base of the micropile formed to have a cross section greater than that of its shaft

EN 14199:2015 (E)**3.3****shaft diameter****fr: diamètre du fût****de: Pfahldurchmesser**

diameter of the part of the micropile between the head and the base:

- a) for micropiles constructed with casing: equal to the external diameter of the casing;
- b) for micropiles constructed without casing: equal to the maximum diameter of the drilling tool

3.4**preliminary micropile****fr: micropieu préliminaire****de: Vorversuchs-Mikropfahl**

micropile installed before the commencement of the main piling works or section of the works for the purpose of establishing the suitability of the chosen type of micropile and/or for confirming the design, dimensions and bearing capacity

3.5**trial micropile****fr: micropieu de faisabilité****de: Eignungsversuchs-Mikropfahl**

micropile installed to assess the practicability and suitability of the construction method for a particular application

3.6**test micropile****fr: micropieu d'essai****de: Abnahmeversuchs-Mikropfahl**

micropile to which a load is applied to determine the resistance and/or deformation characteristics of the micropile and/or the surrounding ground

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3.7**working micropile****fr: micropieu de fondation****de: Bauwerksmikropfahl**

micropile which is part of a structure

3.8**integrity test****fr: essai d'intégrité****de: Integritätsprüfung**

test carried out on an installed micropile for the verification of soundness of micropile components

3.9**static load test****fr: essai de chargement statique****de: statische Probelastung**

loading test where a micropile is subjected to chosen axial and/or lateral forces for the analysis of its capacity and/or deformation characteristics

3.10**maintained load test (ML test)****fr: essai de chargement par palier****de: lastgesteuerte Probelastung**

static loading test in which a micropile has loads applied in incremental stages, each of which is held constant for a certain period or until micropile motion has virtually ceased or has reached a prescribed limit

3.11**constant rate of penetration test (CRP test)****fr: essai de chargement à vitesse d'enfoncement constante****de: weggesteuerte Probelastung**

static load test in which a micropile is forced into the ground at a constant rate and the force is measured

3.12**dynamic load test****fr: essai de chargement dynamique****de: dynamische Probelastung**

loading test where a dynamic force is applied on the micropile for analysis of micropile bearing capacity and deformation characteristics

3.13**grout****fr: coulis****de: Verpressmörtel**

homogenous mixture of cement and water to which admixtures, additions, filler or sand can be added

3.14**mortar****fr: mortier****de: Zementmörtel/Feinkornbeton**

concrete with an aggregate size of 4 mm or less

3.15**drilling / boring****fr: forage****de: Bohren**

method of removing the soil or rock in an intermittent or continuous process

3.16**casing****fr: tubage****de: Verrohrung**

tube used to support the micropile hole during the construction of a micropile

Note 1 to entry: The casing can be permanent or temporary. Permanent casing can act as a load bearing element and/or as a corrosion protection.

3.17**liner****fr: gaine, chemise****de: Hülse, Mantelrohr**

tube, generally of thin steel sheet or plastic, forming at least part of the shaft of a micropile

EXAMPLE: used for the protection of micropile shafts in soft or aggressive grounds or to reduce negative skin friction

3.18**micropile joint****fr: assemblage, connexion de micropieu****de: Verbindung**

means of joining lengths of bearing elements either by welding or by mechanical joints

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3.19

coupler

fr: manchon

de: Koppellelement / Muffe

external device for joining lengths of bar or tube which comprise reinforcement or bearing element

3.20

nipple

fr: mamelon

de: Nippel

internal device for joining lengths of tubes which comprise reinforcement or bearing element

3.21

centraliser

fr: centreur

de: Zentrierer

device to locate reinforcement centrally in a borehole or casing

3.22

spacer

fr: écarteur

de: Abstandhalter

device to ensure the required grout, mortar or concrete cover or the internal spacing between reinforcing elements

3.23

load bearing element

fr: élément porteur

de: Tragglied

element of steel or other material that is capable of transmitting loads from the structure to the ground

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3.24

drilling fluid/mud

fr: fluide de forage, boue de forage

de: Spülflüssigkeit, Bohrspülung

water or a suspension of bentonite, polymers or clay, in water with or without cement and other additions, for stabilization of borehole walls and/or for flushing

3.25

tube-à-manchettes

fr: tube à manchettes

de: Manschettenrohr

regularly slotted or perforated sleeved tube through which grout injections are possible using a packer device

3.26

piling platform level

fr: niveau de travail

de: Arbeitsebene

level of the platform on which the piling rig works

3.27

grouting

fr: injection sous pression

de: Verpressen

pumping of grout or mortar into the borehole with a pressure which is higher than the hydrostatic pressure

3.28**single-step grouting****fr: injection en une seule passe****de: Verpressen in einem Schritt**

placement of grout or mortar in a single location, see Figures 11 and 12

3.29**multi-step grouting****fr: injection en plusieurs passes****de: Verpressen in mehreren Schritten**

placement of grout or mortar in two or more locations, see Figure 13

3.30**multi-stage grouting****fr: injection sous pression répétée****de: Mehrfachverpressen**

grouting at more than one occasion at different times such as initial grouting, second-stage grouting or post grouting

3.31**post grouting****fr: post-injection****de: Nachverpressen**

high pressure grouting through one or more tube-à-manchettes, special valves or post-grouting tubes after the grout, mortar or concrete previously placed in the bore has set

3.32**filling****fr: remplissage****de: Verfüllen**

placing under no applied fluid pressure other than the height of grout, mortar or concrete

3.33**execution specification****fr: spécifications d'exécution****de: Ausführungsspezifikationen**

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

3.34**project specification****fr: dossier technique du projet****de: Projektspezifikation**

project specific document describing the requirements applicable for the particular project

4 Information needed for the execution of the works**4.1 General****4.1.1** Prior to the execution of the work, all necessary information shall be available.**4.1.2** This information should include:

- a) any legal or statutory restrictions;
- b) the location of main grid lines for setting out;

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- c) the conditions of structures, roads, services, etc., adjacent to the work, including any necessary surveys;
- d) a suitable quality management system, including supervision, monitoring and testing.

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

- a) the geometry of the site (boundary conditions, topography, access, slopes);
- b) the existing underground structures, underground and arial services, obstructions and known contaminations;
- c) the environmental restrictions, including noise, vibration, pollution;
- d) the future or ongoing construction activities such as dewatering, tunnelling, deep excavations.

4.2 Special features

4.2.1 The special features shall cover, where relevant:

- execution specifications (see 3.33);
- 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 archaeological remains;
- presence of natural and/or man made cavities (mines, etc.);
- presence of polluted ground;
- any specific requirements for the micropiling works, in particular those pertaining to tolerances, quality of materials;
- quality and bearing capacity of the working platform;
- where available, previous experience with micropiles or other foundations or underground works on or adjacent to the site;
- proposed or ongoing adjacent activities such as underpinning, pre-treatment of soil, dewatering.

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 can affect adjacent structures by the works area constructions.

4.2.4 Any additional or deviating requirements falling within the permissions given in this 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;
- special anchorage or doweling of micropiles to underlying rock;
- special reinforcement such as the use of steel tubes, steel cores or sections or of steel fibres;
- grouting of micropile shafts or bases.

4.3 List of activities

Design and execution should include the following activities:

NOTE The order shown does not necessarily represent a time sequence.

- a) assessment of the design assumptions with respect to the site investigation data and construction feasibility;
- b) execution of preliminary or trial micropiles and of the tests on these micropiles;
- c) evaluation of the results obtained from preliminary and/or trial micropiles;
- d) definition of the construction sequence of a micropile taking account of c);
- e) directives regarding the construction sequence;
- f) instruction to all parties involved of key items in the design criteria to which special attention should be directed;
- g) specifications for monitoring the effects of micropile construction on underpinned and/or adjacent structures (type and accuracy of instruments, frequency of measurement) and for interpreting the results;
- h) definition of tolerable limits regarding the influence of micropile installation works on underpinned and/or adjacent structures;
- i) provision of construction drawings;
- j) specifications for control tests during execution and for micropile tests.

5 Geotechnical investigation

5.1 General

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

5.1.2 The depth and the extent of the geotechnical investigation should be sufficient to identify all ground formations and layers affecting the construction, to determine the relevant properties of the ground and to recognize the ground conditions (e.g. where end bearing is to be relied on, it should demonstrate that any possible founding stratum is not immediately underlain by a weaker stratum where there is a possibility of a punching failure or excessive movements).

5.1.3 Relevant experience of the execution of comparable foundation works under similar conditions and/or in the vicinity of the site should be taken into account when determining the extent of site investigation