



# SLOVENSKI STANDARD

## SIST EN 1536:2011

01-februar-2011

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### Izvedba posebnih geotehničnih del - Uvrtani piloti

Execution of special geotechnical work - Bored piles

Ausführung von Arbeiten im Spezialtiefbau - Bohrpfähle

Exécution des travaux géotechniques spéciaux - Pieux forés

Ta slovenski standard je istoveten z: **EN 1536:2010**

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#### **ICS:**

93.020	Zemeljska dela. Izkopavanja.	Earthworks. Excavations.
	Gradnja temeljev. Dela pod	Foundation construction.
	zemljo	Underground works

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English Version

## Execution of special geotechnical work - Bored piles

Exécution des travaux géotechniques spéciaux - Pieux  
forés

Ausführung von Arbeiten im Spezialtiefbau - Bohrpfähle

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EUROPEAN COMMITTEE FOR STANDARDIZATION  
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EUROPÄISCHES KOMITEE FÜR NORMUNG

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**EN 1536:2010 (E)****Foreword**

This document (EN 1536:2010) 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of an identical text or by endorsement, at the latest by March 2011, and conflicting national standards shall be withdrawn at the latest by March 2011.

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 1536:1999.

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 1536:1999, with the subject area of bored piles, including barrettes, but not "micro piles" of diameter less than 0,3 m.

The design, planning and execution of bored piles 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 contractor.

The document has been prepared to complement 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*. Clause 7 "Considerations related to design" of this European Standard expands on design only where necessary (e.g. the detailing of reinforcement), but provides full coverage of the construction and supervision requirements.

This standard contains additional requirements on concrete complementing the respective provisions of EN 206-1 and of EN 13670. The three standards are not yet fully accorded. It is anticipated that during future revisions several provisions now contained in EN 1536:2010, e.g. in 6.1, 6.3, 8.3 and 8.4 could be transferred to EN 206-1 and EN 13670.

The document has been revised by a working group comprising delegates from eleven European countries and the comments from ten European countries have been received and taken into account.

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, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

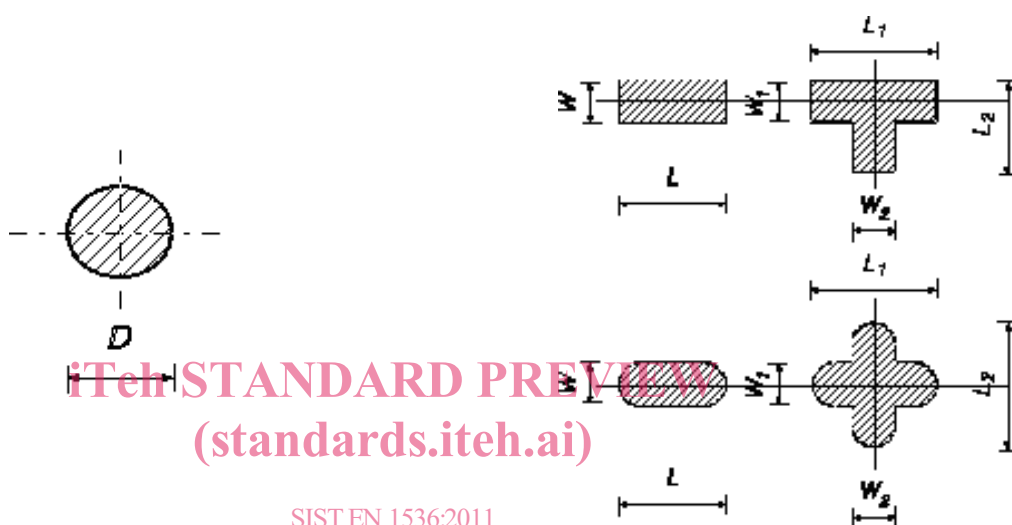
## 1 Scope

1.1 This European Standard establishes general principles for the execution of bored piles (see 3.2).

NOTE 1 This standard covers piles or barrettes which are formed in the ground by excavation and are structural members used to transfer actions and/or limit deformations.

NOTE 2 This standard covers piles with circular cross-section (see Figures 1 and A.1a)) and barrettes (see 3.3) with rectangular, T or L or any other similar cross-section (see Figure 2) concreted in a single operation.

NOTE 3 In the standard the term pile is used for circular cross-section structure and the term barrette for other shapes. Both are bored piles.



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### Key

$D$  Shaft diameter

### Key

$L$  Barrette length

$W$  Barrette thickness

$A$  Cross-sectional area of the shaft

Figure 1 — Bored pile with circular cross-section

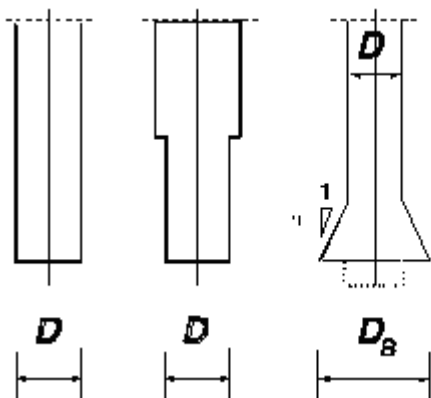
Figure 2 — Bored pile with non circular cross-section (barrettes)

1.2 This European Standard applies to bored piles (see Figure 3) with:

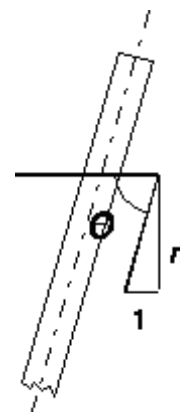
- uniform cross-section (straight shaft);
- telescopically changing shaft dimensions;
- excavated base enlargements; or
- excavated shaft enlargements.

NOTE The shape of a pile base and of an enlargement depends on the tool used for the excavation.

## EN 1536:2010 (E)

**Key**

- $D$  Shaft diameter  
 $D_B$  Base enlargement diameter  
 $D_E$  Shaft enlargement diameter

**Key**

- $n$  Rake

**Figure 3 — Examples for straight shaft piles and piles with shaft and base enlargement**      **Figure 4 — Definition of the rake**

1.3 This European Standard applies (see Note) to:

- bored piles with a depth to width ratio  $\geq 5$ ;
- piles (see Figures 1 and 3) with a shaft diameter  $0,3 \text{ m} \leq D \leq 3,0 \text{ m}$ ;
- barrettes (see Figure 2) with the least dimension  $W_i \geq 0,4 \text{ m}$ , a ratio  $L_i / W_i$  between its largest and its least dimensions  $\leq 6$  and a cross-sectional area  $A \leq 15 \text{ m}^2$ ;
- piles with circular precast elements used as structural member (see Figure 7) with a least dimension  $D_p \geq 0,3 \text{ m}$ ;
- barrettes with rectangular precast elements used as structural member with a least dimension  $W_p \geq 0,3 \text{ m}$ .

NOTE The standard covers a large range of diameters. For small diameter bored piles less than 450 mm, the general specification can be adapted to cater for the lack of space (e.g. minimum bars number and spacing).

1.4 This European Standard applies to piles with the following rake (see Figure 4):

- $n \geq 4$  ( $\theta \geq 76^\circ$ );
- $n \geq 3$  ( $\theta \geq 72^\circ$ ) for permanently cased piles.

1.5 This European Standard applies to bored piles with the following dimensions of the shaft or base enlargements (see Figure 3):

- a) base enlargements:
  - 1) in non-cohesive ground:  $D_B / D \leq 2$ ;
  - 2) in cohesive ground:  $D_B / D \leq 3$ ;
- b) shaft enlargements in any ground:  $D_E / D \leq 2$ ;



c) slope of the enlargement in non-cohesive ground  $m \geq 3$ ;

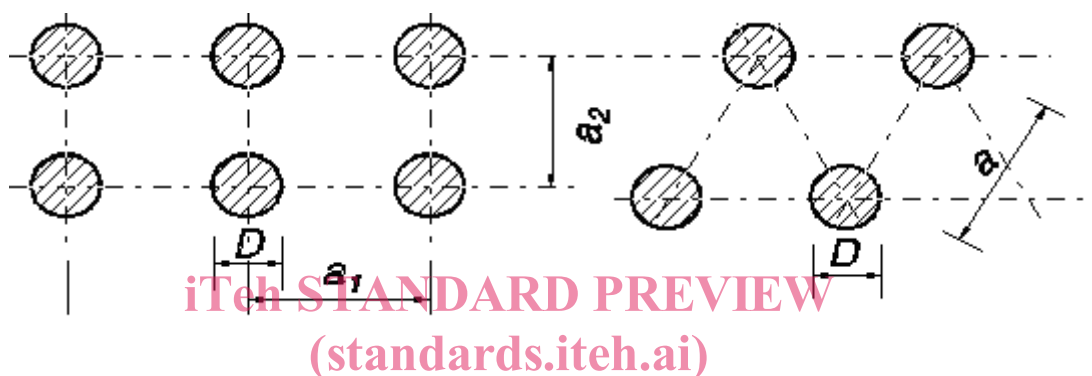
1) in non-cohesive ground:  $m \geq 3$ ;

2) in cohesive ground:  $m \geq 1,5$ ;

d) base enlargements area of barrettes:  $A \leq 15 \text{ m}^2$ ;

**1.6** The provisions of this European Standard apply to:

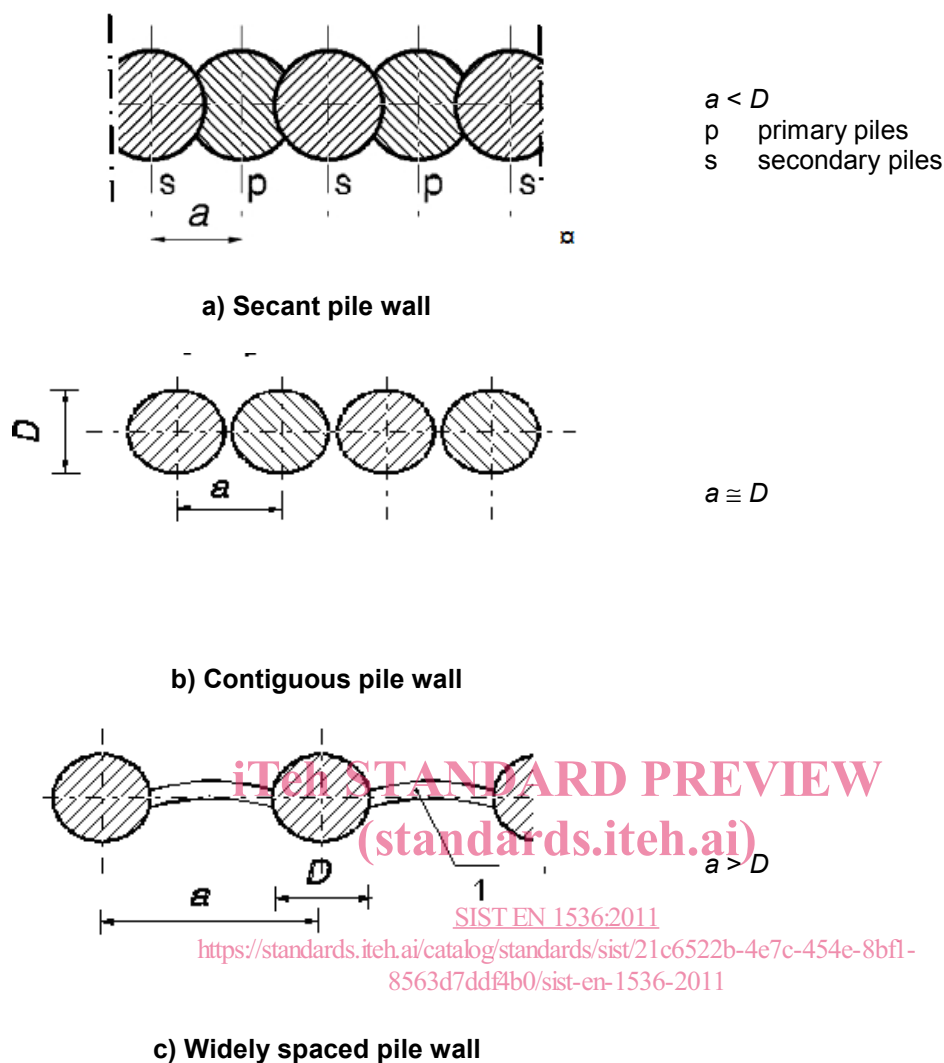
- single bored piles;
- bored pile groups (see Figure 5);
- walls formed by piles (see Figure 6).



**Key**

- $D$  Shaft diameter <https://standards.iteh.ai/catalog/standards/sist/21c6522b-4e7c-454e-8bfl-8563d7ddf4b0/sist-en-1536-2011>
- $a$  Centre to centre spacing of the piles [8563d7ddf4b0/sist-en-1536-2011](https://standards.iteh.ai/catalog/standards/sist/21c6522b-4e7c-454e-8bfl-8563d7ddf4b0/sist-en-1536-2011)

**Figure 5 — Examples of pile groups**



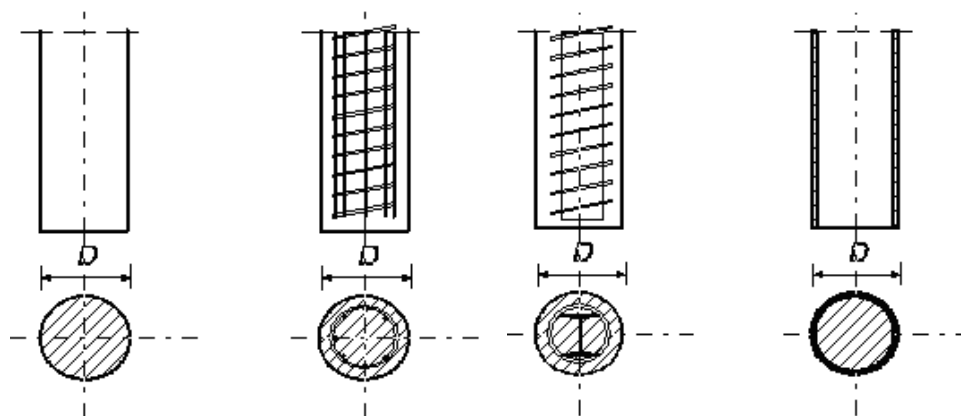
**Figure 6 — Examples of pile walls**

**1.7** The bored piles which are the subject of this European Standard can be excavated by continuous or discontinuous methods using support methods for stabilizing the excavation walls where required.

**1.8** This European Standard applies only to construction methods that allow the designed cross-sections to be produced.

**1.9** The provisions apply to bored piles (see Figure 7) constructed of:

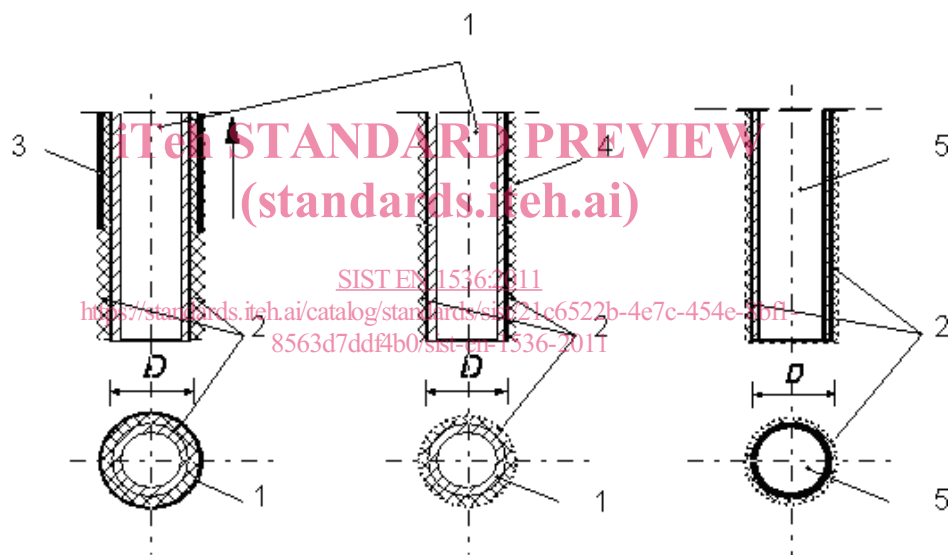
- unreinforced (plain) concrete;
- reinforced concrete;
- concrete reinforced by means of special reinforcement such as steel tubes, steel sections or steel fibres;
- precast concrete (including prestressed concrete) elements or steel tubes where the annular gap between the element or tube and the ground is filled by concrete, cement or cement-bentonite grout.



a) Use of plain concrete

b) Use of concrete with bar reinforcement

c) Use of special reinforcement (steel section or tube)



d) Use of precast concrete element as main or supplementary structural member

e) Use of steel tube as main or supplementary structural member

**Key**

- 1 Precast concrete element
- 2 Grout
- 3 Temporary casing (extracted)
- 4 Uncased excavation
- 5 Unreinforced or reinforced concrete or cement grout
- $D$  Shaft diameter

**Figure 7 — Examples of bored piles with circular cross-section**

**1.10** Micropiles, mixed-in-place columns, columns constructed by jet grouting, ground improvement for piling, mixed-in-place pile bases and diaphragm walls are not covered by this European Standard.

**EN 1536:2010 (E)****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.

EN 197-1:2000, *Cement — Part 1: Composition, specifications and conformity criteria for common cements*

EN 206-1:2000, *Concrete — Part 1: Specification, performance, production and conformity*

EN 791, *Drill rigs — Safety*

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

EN 996, *Piling equipment — Safety requirements*

EN 1008, *Mixing water for concrete — Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete*

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

EN 1994 (all parts), *Eurocode 4: Design of composite steel and 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 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*

EN 12620, *Aggregates for concrete*

EN 12794, *Precast concrete products — Foundation piles*

EN 13670, *Execution of concrete structures*

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

### 3 Terms and definitions

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

NOTE 1 The following definitions are used for the construction of bored piles covered by this European Standard. Additional explanations of piling terms are listed in Annex A.

NOTE 2 In these definitions the term pile is used for circular cross-section structures and the term barrette for other shapes. Both are bored piles.

#### 3.1

##### **pile**

**fr** pieu

**de** Pfahl

slender structural member in the ground for the transfer of actions

#### 3.2

##### **bored pile**

**fr** pieu foré

**de** Bohrpfehl

pile or barrette formed with or without a pile casing by excavating or boring a hole in the ground and filling with plain or reinforced concrete

#### 3.3

##### **barrette**

**fr** barrette

**de** Schlitzwandelement

discrete length of diaphragm wall or a number of interconnecting lengths cast simultaneously (e.g. L-, T- or cruciform shapes) used to support vertical and/or lateral loads

#### 3.4

##### **continuous flight auger pile**

##### **CFA-pile**

**fr** pieu à la tarière continue creuse (CFA)

**de** Schneckenbohrpfahl

pile formed by means of a hollow stemmed continuous flight auger through the stem of which concrete or grout is pumped as the auger is extracted

NOTE See Figure A.4.

#### 3.5

##### **prepacked pile**

**fr** pieu ballasté injecté

**de** Prepacked-Pfahl

pile where the completed excavation is filled with coarse aggregate which is subsequently injected with grout from the bottom up

#### 3.6

##### **end bearing pile**

**fr** pieu travaillant en pointe

**de** Spitzendruckpfahl

bored pile transmitting actions to the ground mainly by compression on its base

#### 3.7

##### **friction pile**

**fr** pieu flottant

**de** Reibungspfahl

bored pile transmitting actions to the ground mainly by friction and adhesion between the lateral surface of the pile and the adjacent ground

**EN 1536:2010 (E)****3.8****pile base grouting**

fr injection sous la base

de Pfahlfußverpressung

pressure injection of grout below the base of an installed bored pile base in order to enhance performance under load

**3.9****pile shaft grouting**

fr injection au niveau du fût

de Pfahlmantelverpressung

injection of grout carried out after bored pile concrete has set for the enhancement of skin friction accomplished by the use of grouting pipes which are installed down the shaft, normally placed with the bored pile reinforcement

**3.10****working pile**

fr pieu de fondation

de Bauwerkspfahl

bored pile for the foundation of a structure or as part of a bored pile wall

**3.11****raking pile**

fr pieu incliné

de Schrägpfahl

pile installed at an inclination related to the horizontal

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NOTE See Figure 4.

**3.12****shaft diameter**

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fr diamètre du fût

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de Pfahlschaftdurchmesser

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

- for piles constructed with casings: equal to the external diameter of the casing;
- for piles constructed without a casing: equal to the maximum diameter of the boring tool

**3.13****enlarged base**

fr base élargie

de Fußaufweitung

base of a bored pile formed to have an area greater than that of its shaft

NOTE For bored piles, normally constructed by the use of special underreaming or bellling-out tools (see Figure 3).

**3.14****casting level**

fr niveau de bétonnage

de Betonierhöhe

upper level to which concrete is cast in a bored pile excavation

NOTE It is above the cut-off level by a margin depending on the execution procedure.

**3.15****cut-off level (trimming)**

fr niveau d'arase (recépage)

de planmäßige Pfahlkopfhöhe; Kapphöhe

prescribed level to which a bored pile is trimmed before connecting it to the substructure

**3.16****empty bore****fr** forage vide**de** Leerbohrung

length of excavation from the working level to the cut-off level

**3.17****temporary casing****fr** tubage**de** Verrohrung

steel tube used to maintain stability of a pile excavation (e.g. in unstable ground) which is withdrawn during or after concrete placement

**3.18****permanent casing****fr** tubage permanent**de** bleibende Verrohrung; dauerhafte Verrohrung

steel tube used to maintain stability of a pile excavation (e.g. in unstable ground) which is not withdrawn but remains as permanent continuous surround

NOTE It becomes part of the pile and may also act as a protective or load bearing unit.

**3.19****lead-in tube****fr** virole**de** Führungsrohr

short temporary casing put in place to secure the side of the excavation against collapse at the bore top close to working platform level

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(standards.iteh.ai)**3.20****liner****lining****fr** gaine, chemise**de** Hülse; Hülsenrohr

tube, generally of thin steel plate, forming part of the pile shaft (e.g. used for the protection of pile shafts in soft grounds or to reduce negative skin friction)

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<https://standards.iteh.ai/catalog/standards/sist/21c6522b-4e7c-454e-8bfl-8563d7ddf4b0/sist-en-1536-2011>**3.21****support fluid****fr** fluide stabilisateur**de** Stützflüssigkeit

fluid used during excavation to support bore hole walls and for flushing

NOTE It is usually a bentonite suspension or a polymer solution.

**3.22****concreting pipe****fr** colonne de bétonnage**de** Betonierrohr, Schüttrohr

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

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

concreting pipe, with watertight joints for submerged concrete placement