



SLOVENSKI STANDARD

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Izvedba posebnih geotehničnih del - Injektiranje pod visokimi pritiski

Execution of special geotechnical work - Jet grouting

Ausführung von Arbeiten im Spezialtiefbau - Düsenstrahlverfahren

Exécution des travaux géotechniques spéciaux - Jet-grouting

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Ta slovenski standard je istoveten z: ~~SIST EN 12716:2018~~ EN 12716:2018

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EUROPEAN STANDARD

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Execution of special geotechnical work - Jet grouting

Exécution des travaux géotechniques spéciaux - Jet-grouting

Ausführung von Arbeiten im Spezialtiefbau - Düsenstrahlverfahren

This European Standard was approved by CEN on 28 September 2018.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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

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EN 12716:2018 (E)**European foreword**

This document (EN 12716:2018) 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of an identical text or by endorsement, at the latest by June 2019, and conflicting national standards shall be withdrawn at the latest by June 2019.

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

This document supersedes EN 12716:2001.

The general scope of TC 288 is the standardization of the execution procedures for geotechnical works (including testing and control methods) and of the required material properties. WG 17 has been charged to revise EN 12716:2001, with the subject area of jet grouting.

The design, planning and execution of jet grouting call for experience and knowledge in this specialized 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 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 document expands on design only where necessary (e.g. the detailing of reinforcement), but provides full coverage of the construction and supervision requirements.

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This standard contains additional requirements on cement complementing the respective provisions of EN 197-1 and of EN 1008.

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1 Scope

This document establishes general principles for the execution of jet grouting works.

NOTE The jet grouting processes is distinguished from the grouting processes covered by EN 12715.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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, *Cement — Part 1: Composition, specifications and conformity criteria for common cements*

EN 206, *Concrete — Specification, performance, production and conformity*

EN 480-4, *Admixtures for concrete, mortar and grout — Test methods — Part 4: Determination of bleeding of concrete*

EN 934-4:2009, *Admixtures for concrete, mortar and grout — Part 4: Admixtures for grout for prestressing tendons — Definitions, requirements, conformity, marking and labelling*

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 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 12390-2, *Testing hardened concrete — Part 2: Making and curing specimens for strength tests*

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

EN 16228-1:2014, *Drilling and foundation equipment — Safety — Part 1: Common requirements*

EN 16228-6, *Drilling and foundation equipment — Safety — Part 6: Jetting, grouting and injection equipment*

EN ISO 10414-1:2008, *Petroleum and natural gas industries — Field testing of drilling fluids — Part 1: Water-based fluids (ISO 10414-1:2008)*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

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- 3.1
jet grouting**
process of hydraulic disaggregation of the soil or weak rock, which is achieved by a high energy jet of a fluid, which can be the cementing agent itself, and its concurrent mixing with, and partial replacement by grout, to create a jet grouted element after hardening of the hydraulic binder
- 3.2
jet grouted element**
volume of soil or weak rock treated through a single borehole
- 3.3
jet grouted structure**
assembly of jet grouted elements which are partially or fully interlocked
- 3.4
sub-vertical jet grouting**
treatment performed from a vertical or sub-vertical borehole (within $\pm 20^\circ$ from the vertical plane)
- 3.5
sub-horizontal jet grouting**
treatment performed from a horizontal or sub-horizontal borehole (within $\pm 20^\circ$ from the horizontal plane)
- 3.6
inclined jet grouting**
treatment performed at inclinations other than sub-vertical or sub-horizontal
- 3.7
single system**
jet grouting with a single fluid which is the grout itself
- 3.8
double system**
single system with the addition of an air shroud around the jet
- 3.9
triple system**
double system using water for the jet with the optional addition of an air shroud around the jet and the concurrent addition of grout through a separate opening below the jet
- Note 1 to entry: In some cases the addition of air can be fully or partially omitted.
- 3.10
jet grouting rig**
rotary rig able to automatically regulate the rotation and translation of the jet grouting string and monitor
- 3.11
jet grouting string**
jointed rods, with single, double or triple inner conduit, which convey the jet grouting fluid(s) to the monitor

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3.12**monitor**

tool mounted close to the end of the jet grouting string holding the nozzle(s)

3.13**nozzle**

device attached to the monitor to generate the high velocity jet

3.14**radius of influence**

distance of hydraulic disaggregation of soil by the jet, measured from the axis of the monitor

3.15**spoil return**

surplus mixture of hydraulically disaggregated soil or weak rock and introduced fluids arising from the jet grouting process, and normally flowing to the ground surface via the annulus of the jetting borehole

3.16**jet grouting parameters**

parameters defined as:

- number and diameter of nozzle(s);
- pressure of the fluid(s);
- flow rate of the fluid(s);
- pressure and flow of the air (if used);
- grout or fluid composition;
- rotation speed of the jet grouting string;
- rate of withdrawal or insertion of the jet grouting string

3.17**precutting (multiple-phase jet grouting)**

method in which the jet grouting of an element is preceded by a preliminary phase of hydraulic disaggregation

3.18**jet grouted material**

material which constitutes the body of a jet grouted element

3.19**grout**

pumpable material (suspension, solution, emulsion) composed of water, binder and additives, that is used as high energy fluid or for cementing and which develops strength, e.g. measured as unconfined compressive strength, over time

3.20**hydraulic binder**

cement or similar product used in aqueous suspensions to produce grout

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3.21

jettted concrete pile

element where the jettted material is replaced with concrete through a separate tremie pipe replacing the materials contained in the cavity

3.22

sample quality class

classification of the samples extracted from the jet grouted element according to their surface, structure, amount of irregularities and composure

3.23

geotechnical equivalent zone

group of soil layers, clearly distinguished from the neighbour zones, that can be treated by a uniform set of jetting parameters

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 made available.

4.1.2 This information shall include:

- any legal or statutory restrictions;
- the location of main grid lines for setting out element positions;
- the locations and conditions of structures, roads, services, etc. adjacent to the work, including any necessary surveys; <https://standards.iteh.ai/catalog/standards/sist/0d13bb86-8b0c-4507-b882-11529e4f4cae/sist-en-12716-2019>
- a suitable quality management system, including supervision, monitoring and testing.
- the geometry of the site (boundary conditions, topography, access, slopes, etc.);
- available space for storage, treatment and/or disposal of spoil;
- the existing underground structures, services, and archaeological constraints; potential presence of unexploded ordnance and its location;
- the environmental restrictions, including noise, vibration, pollution;
- the future or ongoing activities such as dewatering, tunnelling, deep excavations.

4.2 Specific requirements

4.2.1 The specific requirements shall cover, where relevant:

- execution specifications;
- materials strength and stiffness required;
- the degree of water tightness required;
- previous use of the site;

- adjacent structures and their foundations (types, state, loads and geometry);
- geotechnical information and data as specified in Clause 5;
- presence of any obstructions in the ground (old masonry, anchors, concrete, blocks and boulders, etc.);
- certificate or written confirmation of removal of all unexploded ordnance;
- presence of headroom restrictions;
- presence of natural and/or man-made cavities (mines, etc.);
- presence of contaminated ground and type, extent and degree of contamination;
- any specific requirements for the jet grouting works, in particular those pertaining to tolerances, quality of materials and methods and frequency of testing;
- where available, previous experience with jet grouting or other grouting works pertinent or relevant to the site;
- proposed adjacent enabling or advance works such as underpinning, pre-treatment of soil, dewatering;
- the extent and type of instrumentation required for monitoring potentially affected structures.

4.2.2 Necessity, extent, procedure and content for any survey on the conditions of structures, roads, services, grid lines, 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 shall be established before the commencement of the works and the quality control system shall be suitably amended.

NOTE Such additional or deviating requirements can be e.g.:

- reduced or increased geometrical construction deviations;
- application of different or varying grouting materials;
- special anchorage or quality of contact of jet grouting elements to underlying rock;
- reinforcement;
- cut-off levels;
- extensive manual excavation.

5 Geotechnical investigation

5.1 General

5.1.1 The general requirements for site investigation are contained in EN 1997-2 and the relevant national documents.

5.1.2 The depth and the extent of the geotechnical investigation should be sufficient to identify all ground formations and layers affected by the jet grouting works, to determine the relevant properties of the ground and to determine the ground conditions.

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

5.1.4 The ground investigation report shall be available, to allow for reliable design and execution of the jet grouting works.

5.1.5 The sufficiency of the geotechnical investigation for the design and execution of the jet grouting works shall be verified.

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

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5.2 Specific Requirements

5.2.1 Particular attention shall be paid to the following aspects, which are relevant to the execution of jet grouting:

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- the ground level at any point of investigation or testing relative to the recognized national datum or to a fixed reference chart datum;
- piezometric levels of all water-tables and permeability of the soils;
- presence of coarse, highly permeable soils or cavities (natural or artificial), which can cause sudden losses of grout and instability of the borehole during jetting or which can cause a sudden drop of fluid level and thus can require special measures;
- presence, strength and deformation characteristics of cohesive soils, such as clay or peat, which can cause difficulties during jetting;
- presence of boulders or obstructions which can cause shadows during jetting and, an assessment of their size and frequency, when applicable;
- presence, position, strength of hard rock or other hard materials which can cause difficulties during drilling and may require the use of special tools;
- presence, extent and thickness of any strata that can be sensitive to water infiltration or additional hydrostatic pressure caused by jetting;
- strata where high ground-water velocities exist that could wash out the fresh jet grouted material;
- detrimental chemistry of groundwater, soil and rock, and water temperatures if required;