

**SLOVENSKI STANDARD**  
**oSIST prEN 12716:2017**  
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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 - Colonnes, panneaux et structures de sol-ciment réalisés par jet

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## Execution of special geotechnical work - Jet grouting

Exécution des travaux géotechniques spéciaux - Jet  
grouting

Ausführung von Arbeiten im Spezialtiefbau -  
Düsenstrahlverfahren

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

**CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels**

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## European foreword

This document (prEN 12716:2017) has been prepared by Technical Committee CEN/TC 288 “Execution of special geotechnical works”, the secretariat of which is held by AFNOR.

This document is currently submitted to the CEN Enquiry.

This document will supersede 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 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 cement complementing the respective provisions of EN 197-1 and of EN 1008.

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## 1 Scope

This European Standard 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, 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 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 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 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 12504-1, *Testing concrete in structures - Part 1: Cored specimens - Taking, examining and testing in compression*

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 1993-1-5, *Eurocode 3 - Design of steel structures - Part 1-5: Plated structural elements*

EN 1997 (all parts), *Eurocode 7 - Geotechnical design - Part 2: Ground investigation and testing*

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

ASTM D6910, *Standard Test Method for Marsh Funnel Viscosity of Clay Construction Slurries*

ASTM C1741, *Standard Test Method for Bleed Stability of Cementitious Post-Tensioning Tendon Grout*

## 3 Terms and definitions

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

### 3.1

#### **jet grouting**

hydraulic disaggregation of the soil or weak rock and its mixing with, and partial replacement by grout

Note 1 to entry: The disaggregation is achieved by means of a high energy jet of a fluid which can be the grout itself. The minimum operating pressure to create the jet energy shall be greater than 25 MPa.

<sup>1</sup> As impacted by EN 1997-1:2004/A1:2013 and EN 1997-1:2004/AC:2009.

**prEN 12716:2017 (E)****3.2****jet grouted element**

volume of soil 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****treatment zone**

area treated by jet grouting where uniform soil properties prevail and uniform jet grout parameters are applied

**3.10****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.

**3.11****jet grouting rig**

rotary rig able to automatically regulate the rotation and translation of the jet grouting string and tool

**3.12****jet grouting string**

jointed rods, with single, double or triple inner conduit, which convey the jet grouting fluid(s) to the monitor

**3.13****monitor**

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



**3.14****nozzle**

device attached to the monitor to generate the high velocity jet

**3.15****radius of influence**

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

**3.16****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

**3.17****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.

**3.18****prejetting or precutting (multiple-phase jet grouting)**

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

**3.19****jet grouted material**

material which constitutes the body of a jet grouted element

**3.20****reinforced jet grouting**

jet grouted columns reinforced by steel or other high strength material

**3.21****grout**

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

**3.22****hydraulic binder**

cement or similar product used in aqueous suspensions to produce grout

**3.23****jet pile**

element where the cavity created by jetting is filled with concrete through a separate tremie pipe replacing the materials contained in the cavity

**3.24****sample quality class**

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

**3.25****equivalent zone**

ground zone comprising one or several layers, clearly distinguished from the neighbour zones by a range of properties relevant for jet grouting application

**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.

**4.1.2** This information shall include:

- any legal or statutory restrictions;
- the location of acceptable 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;
- 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.);
- available space for storage, treatment and/or disposal of spoil;
- the existing underground structures, services, known contaminations, 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
- previous use of the site;

- adjacent foundations (types, 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 archaeological remains;
- presence of natural and/or man-made cavities (mines, etc.);
- presence of polluted ground and type, extent and degree of pollution;
- 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 on or adjacent to the site;
- proposed adjacent enabling or advance works such as underpinning, pre-treatment of soil, dewatering;
- the extent and type of instrumentation and monitoring required for potentially affected structures
- the degree of water tightness required;
- the required properties of the material between the jet grouting elements in the case of jet grouting walls.

**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 falling within the scope of 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 grouting materials;
- special anchorage or connection of jet grouting elements to underlying rock;
- reinforcement;
- cut-off levels;

- extensive manual excavation.

## 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 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 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 (reference to relevant experience is permitted if appropriate means of verification are taken, e.g. by penetration, pressuremeter or other tests).

**NOTE** Guidance is given in EN 1997-2 on the depth, extent and number of drillings or test pits as well as the contents of a site investigation.

**5.1.4** The geotechnical 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.

### 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:

- 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;