
Izvedba posebnih geotehničnih del - Injektiranje

Execution of special geotechnical work - Grouting - Grouting

Ausführung von Arbeiten im Spezialtiefbau - Injektionen - Injektionen

Execution des travaux géotechniques spéciaux - Injection - Injection

Ta slovenski standard je istoveten z: prEN 12715

ICS:

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

oSIST prEN 12715:2019

en,fr,de

ITeH STANDARD PREVIEW
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EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

DRAFT
prEN 12715

May 2019

ICS 93.020

Will supersede EN 12715:2000

English Version

Execution of special geotechnical work - Grouting - Grouting

Execution des travaux géotechniques spéciaux -
Injection - Injection

Ausführung von Arbeiten im Spezialtiefbau -
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European foreword

This document (prEN 12715:2019) 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 12715:2000.

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. WG18 has been charged to revise EN 12715:2000, with the subject area of grouting.

The design, planning and execution of grouting call for experience and knowledge in this specialized field. The execution phase requires skilled and qualified personnel and the present document 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.

Until EN 1997-3 is published, the design of grouting works is not clearly defined. In particular, the boundary between design under the proposed EN 1997-3 and design as part of the execution of grouting works has not been determined. This document has, therefore, adopted a distinction between execution design, i.e. the design of grouting methodology and the other phases of design.

Clause 7 “Execution Design” of this document expands on design only where necessary for the execution.

This document provides coverage of the construction and supervision requirements for grouting works.

1 Scope

This document is applicable to the execution, testing and monitoring of geotechnical grouting work.

Grouting for geotechnical purposes (geotechnical grouting) is a process in which the remote placement of a pumpable material in the ground is indirectly controlled by adjusting its rheological characteristics and by the manipulation of the placement parameters (pressure, volume and the flow rate).

The following principles and methods of geotechnical grouting are covered by this document:

- displacement grouting (compaction and compensation grouting);
- grouting without displacement of the host material (permeation, fissure/rock grouting, bulk filling).

The principal objectives of geotechnical grouting are:

- the modification of the hydraulic/hydrogeological characteristics the ground;
- the modification of the mechanical properties of the ground;
- the filling of natural cavities, mine workings, voids adjacent to structures;
- inducing displacement to compensate for ground loss or to stabilize and lift footings, slabs and pavements.

Specialized grouting activities, generally associated with structural and/or emergency works, are not covered by this document.

The execution, testing and monitoring of jet grouting work is not covered by this document and is covered by EN 12716.

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

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

EN 197-1:2011, *Cement — Part 1: Composition, specifications and conformity criteria for Common cements*

EN 197-2, *Cement — Part 2: Conformity evaluation.*

EN 934-1, *Admixtures for concrete, mortar and grout — Part 1: Common requirements*

EN 934-3, *Admixtures for concrete, mortar and grout — Part 3: Admixtures for masonry Mortar — Definitions, requirements, conformity, marking and labelling*

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

EN 934-6, *Admixtures for concrete, mortar and grout — Part 6: Sampling, assessment and verification of the constancy of performance*

EN 480-1, *Admixtures for concrete, mortar and grout — Part 1: Test methods. Reference concrete and reference mortar for testing*

EN 480-2, *Admixtures for concrete, mortar and grout — Part 2: Test methods. Determination of setting time*

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

EN 480-5, *Admixtures for concrete, mortar and grout — Part 5: Test methods. Determination of capillary absorption*

EN 480-6, *Admixtures for concrete, mortar and grout — Part 6: Test methods. Infrared analysis*

EN 480-8, *Admixtures for concrete, mortar and grout — Part 8: Test methods. Determination of the conventional dry material content*

EN 480-10, *Admixtures for concrete, mortar and grout — Part 10: Test methods. Determination of water soluble chloride content*

EN 480-11, *Admixtures for concrete, mortar and grout — Part 11: Test methods. Determination of air void characteristics in hardened concrete*

EN 480-12, *Admixtures for concrete, mortar and grout — Part 12: Test methods. Determination of the alkali content of admixtures*

EN ISO 22282-2, *Geotechnical investigation and testing — Geohydraulic testing — Part 2: Water permeability tests in a borehole using open systems (ISO 22282-2)*

EN ISO 22282-3, *Geotechnical investigation and testing — Geohydraulic testing — Part 3: Water pressure tests in rock (ISO 22282-3)*

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

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>

NOTE The definitions given in this chapter cover only the most important terms involved in geotechnical grouting. Further definitions are given in the glossary in Annex A.

3.1

bulk filling

placement of grout to fill subterranean cavities

3.2

compaction grouting

displacement grouting method which is the injection of a low slump mortar into the soil to compact/densify it by expansion alone

prEN 12715:2019 (E)**3.3****contact grouting**

injection of grout into the interface between man-made structures and the ground

3.4**displacement grouting**

injection of grout into a host medium in such a manner as to deform, compress, or displace the ground

3.5**effective pressure**

pressure governing the flow in the ground, calculated from the sum of all head losses and head gains in the injection system and the ground

3.6**fissure grouting**

injection of grout into fissures, joints, fractures and discontinuities in rock

3.7**grout**

pumpable material (suspension, solution, emulsion or mortar), introduced into soil or rock, which stiffens and sets with time

3.8**grouting pressure**

pressure applied during the grouting process and measured at defined locations, usually at the pump or the borehole collar (also known as “working pressure”)

3.9**hydraulic fracturing**

injection of water or grout that creates a new localized fracture in the ground

3.10**hydraulic jacking**

injection of water or grout within existing fractures in the ground to enhance the grout spread and penetrability; also called hydrojacking

3.11**penetration grouting**

grout injection of joints or fractures in rock, or pore spaces in soil, without displacing the ground

Note 1 to entry: The term includes permeation (impregnation), fissure and contact grouting.

3.12**permeation grouting**

replacement of interstitial water or gas of a porous medium with a grout, also known as “impregnation” grouting

3.13**non-displacement grouting**

injection of grout into a host medium in such a manner as not to deform, compress, or displace the ground

Note 1 to entry: The term includes penetration grouting and bulk filling.

3.14**bleed**

process by which water forms a separate segregation phase from the grout under gravity or pressure

3.15**stable suspension**

ability of a suspension to minimise bleed and segregation and retain its original properties under pressure

3.16**field grouting trials**

field grouting trials are executed in order to define or validate a grouting methodology

3.17**hydraulic binders**

all cements and similar products used in aqueous suspensions to produce grout

3.18**fine cement**

hydraulic binders or cements that are characterized by a particle size d_{95} of less than 40 μm

3.19**microfine**

hydraulic binders or cements that are characterized by a particle size d_{95} of less than 20 μm

3.20**ultrafine**

hydraulic binders or cements that are characterized by a particle size d_{95} of less than 10 μm

3.21**admixtures**

one or more materials added to the grout or mortar to alter its properties

3.22**mortars**

highly particulate grout containing sand and fine aggregates, commonly a concrete with an aggregate size of less than 4 mm

3.23**split spacing**

procedure by which additional grout injection holes are located midway between previously grouted holes

3.24**sleeved pipe**

injection pipe perforated at regular intervals where the perforations are covered externally by sleeves acting as non-return valves

4 Information needed for the execution of work

4.1 General

4.1.1 Prior to the execution of the work, all necessary information shall be provided. This information should include the following, where relevant:

- any legal or statutory restrictions;
- 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;
- the geometry of the site (boundary conditions, topography, access, slopes, headroom restrictions, etc.);
- the existing underground structures, services, known contaminations, and archaeological constraints;
- the environmental restrictions, including noise, vibration, pollution; and
- the future or ongoing activities such as dewatering, tunnelling, deep excavations.

4.2 Specific information

4.2.1 The specific information 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 obstructions in the ground (old masonry, anchors, concrete, blocks and boulders etc.);
- presence of headroom restrictions;
- presence of archaeological remains;
- presence of natural and/or manmade cavities (mines, etc.);
- presence of polluted ground and type extent and degree of pollution;
- any specific requirements for the grouting works, in particular those pertaining to tolerances, quality of materials, methods and frequency of testing;
- where available, previous experience with grouting works on or adjacent to the site;
- proposed adjacent enabling or advance works that may affect the grouting works;
- functional requirements for instrumentation and monitoring of potentially affected structures;
- necessity, extent, procedure and content for any survey on the conditions of structures, roads, services, etc. adjacent to the works area.

4.2.2 The survey shall be carried out and be available prior to the commencement of the work, and its conclusions shall be used to define the threshold values for any movement which may affect adjacent structures by the works area constructions.

4.2.3 Any additional or deviating requirements to this document shall be established and agreed upon before the commencement of the work and the quality control system shall be suitably amended.

5 Geotechnical investigation

5.1 General

5.1.1 The geotechnical investigation shall fulfil the requirements of EN 1997-2 and the relevant national documents.

5.2 Specific requirements

5.2.1 Relevant experience of the execution of comparable 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 (reference to relevant experience is permitted if appropriate means of verification were taken).

5.2.2 The geotechnical investigation report shall be sufficient and available to allow for the reliable execution of the grouting works.

5.2.3 If during grouting the ground conditions differ from those in the geotechnical investigation report, this shall be reported.

5.2.4 For the execution of grouting works, the ground investigation report should contain the following specific information:

- the relevant physical and chemical characteristics of the ground and groundwater;
- the presence of any anisotropies or permeable horizons which could influence the grouting works;
- the orientation, frequency, and aperture of rock joints and the composition and nature of any infill material;
- the location and nature of filled or open cavities;
- the presence of obstructions that require special drilling and grouting methods or equipment;
- the presence and characteristics of ground that is likely to loosen, soften or become unstable, dissolve, collapse or swell as a result of drilling or grouting;
- the presence of strata with high groundwater velocities and permeabilities.

5.2.5 Where relevant, the following specific drilling information should be recorded:

- location and cause of core losses;
- unstable zones and stabilization measures taken;
- water level at the beginning and end of a run, zones of water loss and gain, measurements of return water, water colour and changes in colour;
- recording of drill parameters in the case of destructive boreholes;
- rate of advance.

5.2.6 Permeability testing shall be done in accordance with EN ISO 22282.

5.3 Field grouting trials and field tests

5.3.1 Field grouting trials should be executed where initial site investigations and local or comparable experience is insufficient to support or justify the effectiveness of the grouting project.

NOTE Some indication of *in situ* groutability can be obtained by permeating reconstituted soil samples with trial grouts under laboratory conditions.

5.3.2 The trials should provide information on borehole spacing, grout type, procedure and parameters.

5.3.3 Detailed records shall be kept of each operation performed during the grouting trials.

6 Materials and products

6.1 General

6.1.1 All grout components and grouts shall comply with the specifications for the works.

NOTE Where relevant, EN or national standards and/or EN or national regulations could apply.

6.1.2 The suitability of the grout constituents and their combination with the ground shall be considered and investigated if necessary.

6.1.3 Once established, the sources of grout materials shall not be changed without prior compliance verification or testing.

6.2 Grout materials

6.2.1 Cement and hydraulic binders

6.2.1.1 Cements shall comply with EN 197-1 and EN 197-2. Cements that do not comply with EN 197-1:2011, Table 1 may be used if considered acceptable for the grouting purpose envisaged.

6.2.1.2 Testing of cements and other binders shall be in accordance with their appropriate method.

6.2.1.3 When selecting the type of hydraulic binder for grout, its grain size distribution shall be evaluated in relation to the dimensions of the rock apertures or interstitial voids of the ground to be treated.

6.2.1.4 Pozzolans, blast furnace slag, silica fume and fly ash from thermal power plants or any other reactive material may be used in grouts.

6.2.2 Clay materials

6.2.2.1 Natural clays, activated or modified bentonites can be added to cement-based grouts in order to reduce bleeding and/or filtration under pressure, to vary the viscosity and cohesion (yield) of the grout, or to improve the pumpability and/or penetrability of the grout.

6.2.2.2 The mineralogy, particle size, water content, and Atterberg limits of the clay should be known