SLOVENSKI STANDARD
oSIST prEN 18344:2026

01-junij-2026

Izvedba posebnih geotehničnih del - Umetno zamrzovanje tal

Execution of special geotechnical works - Artificial ground freezing

Ausführung von Arbeiten im Spezialtiefbau - Künstliche Bodenvereisung

Exécution des travaux géotechniques spéciaux - Congélation artificielle des sols

Ta slovenski standard je istoveten z: **prEN 18344**

ICS:

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

oSIST prEN 18344:2026 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

DRAFT
prEN 18344

April 2026

ICS 93.020

English Version

Execution of special geotechnical works - Artificial ground freezing

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Ausführung von Arbeiten im Spezialtiefbau - Künstliche Bodenvereisung

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

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Ref. No. prEN 18344:2026 E

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European foreword

This document (prEN 18344:2026) has been prepared by Technical Committee CEN/TC 288 “Execution of special geotechnical work”, the secretariat of which is held by AFNOR.

This document is currently submitted to the CEN Enquiry.

This document has been prepared under a Standardization Request given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s) / Regulation(s).

1 Scope

This document establishes general principles for the execution, testing and monitoring of Artificial Ground Freezing (AGF) works.

AGF is the process of changing the water in the ground from liquid to solid state in a controlled way by artificial means.

This document is applicable to:

— civil works (tunnels, shafts, retaining walls, plugs, underpinning, ...);

— environmental works (remediation, cut-off walls, ...).

This document does not apply to:

— permafrost;

— seasonal frost;

— mining applications.

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 1990-1, *Eurocode — Basis of structural and geotechnical design — Part 1: New structures*

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

EN 1997-2, *Eurocode 7 — Geotechnical design — Part 2: Ground properties*

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

3 Terms and definitions

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

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

— ISO Online browsing platform: available at https://www.iso.org/obp/

— IEC Electropedia: available at https://www.electropedia.org/

3.1
artificial ground freezing (AGF)
ground improvement technique consisting in extracting heat from any kind of ground, to temporarily change the pore water from liquid to solid state

Note 1 to entry: The aim is to achieve impermeability and/or to improve the mechanical properties of the ground.

Note 2 to entry: This freezing process is reversible. However, after thawing initial ground parameters could be affected.

Note 3 to entry: AGF works include all ancillary activities needed for the execution of AGF (e.g. drillings).

3.2
coolant
fluid used to extract heat from the ground (e.g. brine, liquid nitrogen, glycol, carbon dioxide)

3.3
cryogenic fluid
liquified gases at very low temperature that are used as coolant

3.4
distribution circuit
circuit distributing the coolant from the freeze plant to the freeze pipes through the freeze heads

Note 1 to entry: It consists of a supply line (feeding line) and a return line.

Note 2 to entry: While for closed circuit the return line is connected to the freeze plant, for open circuit it is open to the atmosphere (exhaust line).

Note 3 to entry: For more information, see Annex A.

3.5
freeze design criteria
shape, thickness, temperature of the frozen ground to be achieved according to the design

3.6
freeze head
connection device installed between the distribution circuit and the freeze pipes

Note 1 to entry: For more information, see Annex A.

3.7
freeze pipe
pipe installed in the ground, allowing the flow of the coolant to exchange heat with the ground

Note 1 to entry: “freeze probe” or “freeze lance” are terms admitted instead of “freeze pipe”.

3.8
freeze plant
part of a freeze system capable to supply the cold coolant necessary to freeze the ground in a closed or open circuit

Note 1 to entry: The freeze plant is connected to the distribution circuit.

3.9
freeze system
system capable of freezing the ground using a closed or open circuit. Sum of freeze plant, distribution circuit, freeze heads and freeze pipes

3.10
freeze unit
unitary equipment able to lower the temperature of a coolant

Note 1 to entry: In a closed circuit freeze system it is part of the freeze plant.

Note 2 to entry: “chiller” is a term admitted instead of “freeze unit”.

3.11
freezing, closed circuit
(indirect method)
freezing method where the coolant is re-used in a closed loop after heat exchange with the ground

Note 1 to entry: After this heat exchange, the temperature of the coolant is lowered again passing through the freeze unit, where a refrigerant is used.

3.12
freezing, open circuit
(direct method)
freezing method where the coolant is released to the atmosphere as a gas after heat exchange with the ground

3.13
freezing, combined method
freezing method where both open circuit and closed circuit methods are used, either at the same time, or in different phases

3.14
freezing phase
(freezing-up)
working phase where the frozen ground body grows until reaching the freeze design criteria

3.15
frost creep
increase in strain in the frozen ground body at constant effective stress during all AGF phases

Note 1 to entry: The creep depends on time, temperature, stress and ground type.

3.16
frost heave
swelling of ground due to the formation of ice caused by AGF

Note 1 to entry: That includes the formation of ice lenses at the freezing front as well as volumetric expansion due to phase change.

Note 2 to entry: Frost heave can affect ground surface and objects, on or in the ground.

3.17
frost pressure
positive pressure developed at ice-water interface in a ground as it freezes

3.18
frozen ground body
volume of frozen ground formed by means of AGF

3.19
maintenance phase
phase in the AGF process, following the freezing phase, during which the frozen ground body is maintained according to the freeze design criteria

3.20
monitoring system
system consisting of sensors and data acquisition system to monitor AGF and its effects

3.21
pressure test
test performed on the distribution circuit and freeze pipes to check their tightness

Note 1 to entry: Test pressure (TP) depends on the maximum system operating pressure (MSOP).

Note 2 to entry: For more information, see Annex E.

3.22
refrigerant
fluid circulating in the freeze unit to allow lowering the temperature of the coolant

Note 1 to entry: Refrigerant can also be used as a coolant.

Note 2 to entry: “cooling agent” is a term admitted instead of “refrigerant”.

3.23
thawing phase
phase in the AGF process, following the maintenance phase, when heat extraction has been definitively stopped

3.24
thaw deformation
deformation of the ground resulting from thawing of frozen ground body

4 Information needed for the execution of the works

4.1 General

Prior to the execution of the work, all necessary information shall be made available.

This information should include, where relevant:

— any legal or statutory restrictions (e.g. permissions for working and deliveries 24/7, setup and operation of a storage tank for cryogenic fluid);

— the locations and conditions of structures, roads, services, etc. adjacent to the work, including any necessary surveys;

— previous use of the site;

— the geometry of the site (boundary conditions, topography, access, slopes, etc.);

— available space for site installations and storage;

— headroom restrictions and confined spaces;

— geotechnical information and data as specified in Clause 5;

— presence of obstructions in the ground (underground structures, services old masonry, anchors, concrete, blocks and boulders, etc.);

— presence of natural and/or manmade cavities (caverns, mines, large voids, discontinuities and cracks, etc.);

— archaeological remains;

— possible presence of unexploded ordnance;

— the environmental restrictions, including noise, vibration, pollution;

— and all other information that may influence the execution.

4.2 Specific information

4.2.1 The specific information should cover, when relevant:

— objectives of AGF (impermeability and/or structural purposes);

— geotechnical and hydrogeotechnical information and date as specified in Clause 5;

— design report including mechanical and thermal analysis;

— need of a preliminary ground treatment;

— need of a specific AGF method;

— the location of main grid lines for setting out drilling positions;

— technical specifications;

— adjacent structures (types, loads, and geometry) and, sensitivity to movement and/or low temperatures;

— presence of utilities (cables, pipes, sewers, etc.) and sensitivity to movement and/or low temperatures;

— presence of polluted ground, type, extent and degree of pollution and possible presence of anything that may impact the freezing point;

— presence of products introduced into the ground (e.g. chemicals, insulating materials, foams) which could have a detrimental impact on AGF;

— any specific requirements for AGF works, in particular those pertaining to tolerances, quality of materials, methods and frequency of testing;

— where available, previous experience with freezing works on or adjacent to the site;

— proposed adjacent enabling or advance works that may affect the AGF works (e.g. dewatering works, excavation works and tunnelling);

— presence of any kind of heat source in the proximity of the ground to be frozen (e.g. heated buildings, district heating lines, sewers, energy piles);

— requirements for instrumentation and monitoring of potentially affected structures;