Ineqarnermut, Attaveqaasersuutinut Isorliunerusunullu Naalakkersuisoqarfik
Ministry of Housing, Infrastructure and Outlying Districts

EN 1997-2 GL NA:2025

National Annex to
Eurocode 7: Geotechnics –
Part 2: Ground investigation and testing

Foreword

This Greenlandic National Annex (GL NA) is based on DS/EN 1997-2 DK NA:2013 and provides Greenlandic national choices and complementary information.

Scope

This Annex is adapted to geographical and climatic conditions as well as national legislation and specifies how EN 1997-2 + AC:2011 is to be applied in Greenland.

The Annex provides Greenlandic national choices and complementary information For any complementary information, it is specified whether it is normative or informative. Normative information comprises requirements to be followed.

The numbering in the Annex refers to the numbering in EN 1997-2 + AC:2011 or DS/EN 1997-2 DK NA:2013.

Overview of Greenlandic national choices and complementary information

DS/EN 1997-2 DK NA:2013 is applicable with the following national choices and complementary information:

Clause	Subject	Change
DK NA	References in DK NA	National choice
1.5.3.16 – 1.5.3.24	Definitions	National choices
2.1.1	General, existing information	Complementary information, informative
2.1.1(2)	Objective of geotechnical investigations	Complementary information, normative
2.1.2(2)	Ground	Complementary information, normative
2.1.5(1)-(3)	Permafrost	Complementary information, normative
2.4.2.5(1) + (3) and Table 2.2b GL NA	Classification tests for frozen soil	Complementary information, normative
Section 3	Title is modified	Complementary information, normative
3.2(2)	Sampling by drilling	Complementary information, normative
3.4.1(6) incl. Table 3.1 GL NA	Categories of sampling methods and laboratory quality classes of samples	Complementary information, normative
3.4.2(1) incl. Table 3.4.2 GL NA	Soil identification	Complementary information, normative
3.4.3(4) incl. Table 3.2 GL NA	Sampling by drilling in frozen soil	Complementary information, normative
3.4.4(1)-(4)	Handling, transport and storing of samples	Complementary information, normative
3.5.1(7)	Categories of sampling methods. Depth	Complementary information, normative
3.5.2(1)P	Rock identification	Complementary information, normative
3.7.1	Permafrost investigations in soil and rock. General	Complementary information, normative
3.7.2	Planning and determination of temperature conditions	Complementary information, normative
3.7.3	Planning and determination of properties of frozen soil and rock	Complementary information, normative

Clause	Subject	Change
3.7.4	Documentation of temperature measurements	Complementary information, normative
3.7.5	Documentation of sampling	Complementary information, normative
4.1(4) Note	Additional investigation methods	Complementary information, normative
5.5.1(1)	Tests for classification, identification and description of soil – General	Complementary information, normative
Annex A incl. Table A.2 GL NA	List of test results of geotechnical test standards	Complementary information, normative
Annex B	Planning of geotechnical investigations	Complementary information, normative
Annex E	Pressure meter test (PMT)	Complementary information, normative
Annex G	Dynamic probing test (DP)	Complementary information, normative
Anneks G.1	Total sounding	Complementary information, normative
Annex H	Weight sounding test (WST)	Complementary information, normative
Annex J	Flat dilatometer test (DMT)	Complementary information, normative
Annex K	Plate loading test (PLT)	Complementary information, normative
X.4.9.1	Classification testing of rock materials – General	Complementary information, normative
Annex X	Bibliography	Complementary information Informative

National choices

References in DK NA
References in DS/EN 1997-2 DK NA:2013 to other Danish National Annexes are replaced by references to corresponding Greenlandic National Annexes. Where these do not exist, the Danish National Annexes apply.

1.5.3.16
Active layer
The upper zone above the permafrost in which the temperature annually fluctuates above and below 0 °C.

1.5.3.17
Active layer thickness
Maximum thickness of the active layer in a given year.

1.5.3.18
Freezing point
Temperature at which the free pore water in a soil sample changes phase from water to ice.

1.5.3.19
Freezing point depression
Difference between 0 °C and the freezing point of the soil.

NOTE: If the freezing point of a soil sample is determined to be -1,2 °C, the freezing point depression will be 1,2 °C.

1.5.3.20
Ice content
Volumetric or gravimetric fraction of a soil sample that consists of ice.

NOTE: The gravimetric ice content is often measured by thawing and drying the frozen sample, assuming full ice saturation.

1.5.3.21
Ice saturation
Fraction of a soil sample that consists of ice.

NOTE: Ice saturation is often calculated on the basis of the water content of the frozen sample, assuming that all of the water is present as ice

1.5.3.22
Ice structure
Geometric distribution of ice in a frozen soil sample.

NOTE: Geometic distribution may consist of layers, grains, lenses etc.

1.5.3.23
Permafrost
Soil and rock with temperatures below 0 °C for at least 2 consecutive years.

NOTE: The definition of permafrost is based on material temperature only and is not related to the phase of pore water (water or ice).

1.5.3.24
Total sounding
Method for conducting sounding in soil and rock combining rotary drilling and rock drilling.

NOTE: Total sounding is carried out in accordance with (NGF 2018).

1.5.3.25
Winter frost
The winter condition of the upper zone of the ground, in which the temperature fluctuates annually above and below 0 °C, in areas without permafrost.

Complementary information
Normative

2.1.1(2) Objective of geotechnical investigations
The text is modified to:
The objective of a geotechnical investigation is to determine the soil, rock, groundwater and permafrost conditions, to establish the properties of the soil and rock, and to collect any additional relevant information about the site.

2.1.2(2) Ground
The following is added:
- consequences of climate change at and near the site, including permafrost

The following new subsection is added:
2.1.5 Permafrost
(1)P The purpose of permafrost investigations is to provide all relevant information on permafrost conditions necessary for the design and execution of geotechnical structures.

(2) Permafrost investigations should provide information on:
- temperature as a function of depth;
- active layer thickness;
- ice content and saturation;
- freezing point depression.

(3) The information collected should be sufficient to assess the following aspects, where relevant:
- foundation solution as well as any necessary permafrost-preserving and/or thaw-inducing measures;
- any necessary precautions to protect the structure (e.g. against settlement, failure and overall stability)
- the effects of climate change on the permafrost conditions;
- the impact of the proposed structure on the permafrost conditions.

NOTE: Assessment of the effects of climate change on permafrost conditions may be supported by (CAN/BNQ, 2017).

2.4.2.5(1) Classification tests
The following is added:
For frozen soil, description and classification tests should also determine the ice content and ice structure of the soil.

2.4.2.5(3) Classification tests
The following is added:

For frozen soil, in addition to the usual relevant classification tests for unfrozen soil, tests in accordance with Table 2.2.b GL NA should be carried out.

NOTE: Note that if the same soil sample is used for tests in accordance with both Table 2.2 and Table 2.2.b, it shall be taken into account which parts of the tests are to be carried out on the frozen soil sample and which on the thawed material.

Table 2.2b GL NA Classification tests for frozen soil

Parameter	**Type of sample**		
	Undisturbed	Disturbed	Remoulded
Visual description of ice content and structure	X	(X)	-
Ice content	X	X	(X)
Ice saturation	X	(X)	-
Freezing point depression	X	X	(X)
Salinity	X	X	(X)
X = can normally be determined (X) = possible to determine, not necessarily representative - = not relevant			

Note to table: Determination of ice content, freezing-point depression and salinity on disturbed samples may, depending on the sampling conditions, be subject to considerable uncertainty.

Section 3
The title is modified to:
Sampling of soil and rock an as well as groundwater measurements and permafrost investigations

3.2(2) Sampling by drilling
The following is added:
For frozen soil: however, see 3.4.4(4).

3.4.1(6) Categories of sampling methods and laboratory quality classes of samples
Table 3.1 is replaced by:

Table 3.1 GL NA Quality classes of soil samples for laboratory testing and sampling categories

Soil properties/quality class	1	2	3	4	5
Unchanged soil properties					
– Particle size	x	x	x	x	
– Water content	x	x	x		
– Salinity	x	x	x		
– Freezing point depression	x	x	x		
– Ice content (gravimetric)	x	x	x		
– Ice content (volumetric), ice saturation	x	x			
– Density, density index, permeability	x	x			
– Compressibility, shear strength	x				
Properties that can be determined					
– Sequence of layers	x	x	x	x	x
– Boundaries of strata – broad	x	x	x	x	
– Boundaries of strata – fine	x	x			
– Atterberg limits, particle density, organic content	x	x	x	x	
– Water content	x	x	x		
– Density, density index, porosity, permeability	x	x			
– Compressibility, shear strength	x	x			
Sampling category according to EN ISO 22475-1 or Table 3.2 GL NA	A				
			B		
					C

3.4.2(1)P Soil identification

Soil identification is carried out in accordance with EN ISO 14688-1:2018. Complementary information for the application of EN ISO 14688-1 is given in Table 3.4.2 GL NA.

NOTE: A detailed subdivision of soil types and descriptions thereof may be relevant; see EN ISO 14688-1:2018, Section 1, Scope.

Table 3.4.2 GL NA Complementary information for the application of EN ISO 14688-1.

Section/Ref.	Subject	Complementary information
5.1.1, Table 1	Column "Particle size fractions"	In Greenlandic drilling profiles, the main designations used in sample descriptions are those specified in (DGF 2021). The main denomination is always indicated first and written in capital letters according to the Table; in addition, the designations FILL, as well as TILL CLAY, TILL SILT, TILL SAND and TILL GRAVEL are permitted.
5.1.2.3	Description order	Greenlandic drilling profiles always state the main designation first, in capital letters, see (DGF 2021).
5.9	Origin of deposit	The geological origin should always be indicated when evaluating samples.

6.1.6	Determination of consistency	Sample descriptions do not include consistency descriptions of individual samples taken, as the consistency of the samples may have changed during sampling. Instead the firmness/consistency is assessed on the basis of the classification tests performed in boreholes, the results of which are given in the bore diagram. Thus, the procedure differs from the procedure suggested in section 6.1.6.
A.3.4 Table A.1	Low or high plasticity	For sample descriptions in Greenland, a more detailed division of low, medium, high and very high plasticity is used, cf. (DGF 2021).
A.3.4	Determination of plasticity	In sample descriptions, the guide provided in (DGF 2021) is used for the determination of plasticity.

3.4.3(4) Sampling by drilling in frozen soil
The following is added:

When sampling in frozen soil, the requirements of EN ISO 22475-1 may be waived, so that the drilling and sampling methods are suitable for the purpose. Methods given in Table 3.2 GL NA may be used:

During sampling in frozen soil, care shall be taken to ensure that no water enters the borehole or excavation.

Table 3.2 GL NA Sampling by drilling in frozen soil

Row		1	2	3	4	5	6	7	8	9	10
		Drilling method		**Equipment**		**Application and limitations**		**Sample categories**		**Remarks**	
		Lowering technique	**Use of circulation medium**	**Samples shall be taken with**	**Designa-tion**	**Tool**	**Guide values for borehole diameter [mm]**	**Unsuitable for**	**Preferred method for**	**Typical sample categories**	**Remarks**
1	a	Rotary drilling	No	Drilling equipment	Drilling with hollow auger	Hollow auger with cutter	50 to 200	Coarse gravel, stones, blocks	Clay, silt, sand, fine gravel, topsoil	A[1)]/B/C	
	b		No	Drilling equipment	Diamond core drilling	Hollow drill stem or core bit with a diamond-impregna-ted drill crown.	45 to 200	Blocks	Clay, silt, sand, fine gravel, topsoil	A[1)]/B/C	Water may be added as lubricant/re frigerant but continuous rinsing shall be avoided
	c		No	Drilling equipment	Auger drilling	Drill rods with flight auger	50 to 1 000	Stones and blocks larger than De/3	All soil types	B/C	Only disturbed samples can be taken

2	a	Impact drilling	No	Drilling equipment	Small diameter impact drilling	Steel tube with a sharp cutting edge	30 to 80	Coarse gravel, stones, blocks	Topsoil, clay, silt, fine sand	A[1)]/B/C	Sample quality class 2 can be achieved and used to determine properties such as bulk density, ice content and ice saturation
3	a	Compres-sed air drilling	Yes (air)	Manual sampling	DTH drilling	DTH hammer chisel	80 to 300		All materials	B/C	Cuttings may be used as sample material for an initial assessment of certain soil properties

NOTE 1: Class A samples may be obtained under the best possible conditions, but there is a risk of disturbance or damage to the sample.

3.4.4(1) Handling, transport and storing of samples
Modified to:
(1)P Handling, transport and storage of samples of unfrozen soil is carried out in accordance with EN ISO 22475-1.

3.4.4(2) Handling, transport and storing of samples
The following is added:
(2)P Handling, transport and storage of samples of frozen soil shall ensure that the ice content and the ice structure remain intact.

3.4.4(3) Handling, transport and storing of samples
The following is added:
(3) Samples of frozen soil should be sealed to be moisture-tight and with as little air as possible inside the seal in order to avoid sublimation.

3.4.4(4) Handling, transport and storing of samples
The following is added:
Samples of frozen soil should be handled, transported and stored at a temperature not exceeding their in-situ temperature.

3.5.1 Categories of sampling methods
The following is added:
(7) Rock samples shall be taken at a depth that is assessed based on the local geological, geotechnical and topographical conditions.

NOTE: Relevant local geological, geotechnical and topographical conditions may include, for example, rock types, fracturing, weathering, slopes, ravines and the stability of the rock mass.

3.5.2(1)P Rock identification
Table with complementary information for the application of EN ISO 14689-1 is deleted.

3.7 Permafrost investigations in soil and rock
The following new chapter is added:

3.7.1 General
(1)P The objective of permafrost investigations in soil and rock is to determine:
- temperature conditions, and thereby assess the presence of permafrozen soil and rock;
- properties of any permafrozen soil and rock present

(2) Assessment of whether permafrozen soil and rock may be present is based on screening of local conditions.

NOTE: See EN 1997-1 GL NA:2024, Annex D1, clause (9) NOTE 1.

3.7.2 Planning of investigations to determine temperature conditions

(1)P Determination of temperature conditions is based on temperature measurements. The purpose of the temperature measurements shall be defined.

(2) Temperature measurements should at a minimum include measurements to determine:

- Active layer thickness
- Depth to the base of the permafrost (where relevant)
- Project-specific issues

NOTE: Active layer thickness and the depth to the base of the permafrost may be determined by methods other than temperature measurements.

(3) Instrumentation and execution of the temperature measurements shall be planned with due regard to the purpose. The plan shall include:

- depths of each individual temperature measurement;
- time of installation of the temperature string;
- start time, frequency and, where applicable, end time of the temperature measurements;
- requirements for accuracy and precision of measurements;
- project-specific issues.

NOTE: Accuracy requirements may be expressed as requirements for the maximum scatter of the measurement results. Precision requirements may be expressed as requirements for the maximum deviation of the average of the measurement results from the true value.

(4) Temperature measurements in boreholes shall be carried out over a period long enough to ensure that effects from the drilling work and from the instrumentation of the boreholes do not influence the measurement results.

NOTE: The effects of the drilling work and the instrumentation of the boreholes depend on the drilling method and the site geology, and it may take months before the measured temperatures are accurate.

(5) The drilling method, borehole configuration and sealing should be chosen with consideration for subsequent instrumentation with a temperature string and with a minimum impact on temperature around the borehole.

3.7.3 Planning of investigations to determine properties of frozen soil and rock

(1)P Properties are determined on the basis of tests. The purpose of the test shall be established.

(2) Sampling in frozen soil and rock shall be planned and carried out with due regard to the purpose and shall determine:

- composition and properties in accordance with 3.4.1(6); and

- mechanical properties

NOTE: Sampling may be done by drilling and shall be carried out in accordance with 3.4.3(4).

3.7.4 Documentation of temperature measurements

(1)P Temperature measurements shall be documented.

(2) Documentation of temperature measurements shall include descriptions of:

- the execution, configuration and instrumentation of the borehole;
- measurement setup and verification thereof;
- the execution of temperature measurements according to its schedule;
- the measured temperatures with the corresponding measurement times, durations and depths;
- project-specific issues (if any).

NOTE 1: Documentation of the execution of the borehole should follow DS/EN ISO 22475-1 and describe the drilling method, borehole dimensions and any use of flushing or cooling fluid. Documentation of the borehole configuration should describe, for example, borehole depth, casing, sealing, cementing and the use of antifreeze. Documentation of the borehole instrumentation should describe, for example, the type and calibration of the sensors, the definition of measurement depth, the measurement accuracy, and the timing of the borehole execution and instrumentation.

NOTE 2: Regarding the plan for carrying out the temperature measurements, see 3.7.2(3).

3.7.5 Documentation of sampling

(1)P Sampling shall be documented.

(2) Documentation of sampling shall be in accordance with DS/EN ISO 22475-1. The documentation shall also include a description of:

- any inflowing water into the borehole or excavation;
- the ice content and ice structure immediately after sampling; including photo and visual description;
- weather conditions; including temperature and precipitation at the time of sampling;
- handling, transport and storing of samples.

NOTE: Regarding handling, transport and storing of samples, see 3.4.4(2)-(4).

4.1(4) Complementary investigation methods

The following is added:

NOTE: In areas with permafrost, the results of geophysical methods will often be affected by temperature conditions, ice content and salinity.

5.5.1(1)P Tests for classification, identification and description of soil – General

Table with complementary information for the application of EN/ISO 14688-2 is deleted.

Annex A, List of test results of geotechnical test standards
Ordinary geotechnical field tests are generally not applicable in frozen soil.

The following Table A.2 GL NA is added

Table A.2 GL NA List of geotechnical test results for frozen soil

Laboratory tests	Test results
Ice content[a)]	w_i (gravimetric ice content), $W_{i,t}$ (volumetric ice content, thawed state, measured as supernatant water) or $W_{i,f}$ (volumetric ice content frozen state)
Ice saturation	$S_{r,i}$
Freezing point depression[b)]	ΔT_f (freezing point depression expressed in °C)
Salinity[c)]	S_p (salinity of the pore water expressed in PSU)
Oedometer test, temperature-controlled[d)]	− Compressibility curve with indication of test temperature (different options) − Consolidation curves (different options) − Secondary compression curve (creep curve) − Values of E_{oed} (stress interval) and σ'_p or C_s, C_c, σ'_p − Value of C_α
Triax, temperature-controlled triax	− Stress-strain curve(s) and pore pressure curve − Stress paths − Mohr circles − c', φ' or c_u − Variations c_u with σ'_c − Deformation parameter (E') or (E_u) − Strain weakening of glacial soil.[2)]
Frost heave[b)]	− frost heave curve − frost penetration curve − heave rate, 1st freeze − heave rate, 2nd freeze − Frost susceptibility, after 1st freeze − Frost susceptibility, after 2nd freeze

NOTE 1 to Table: References, see e.g. a) (Agergaard et al, 2012), b) (ASTM, 2018), c) (Scheer & Ingeman-Nielsen, 2023) and d) (Ingeman-Nielsen, 2017)
NOTE 2 to Table: For soils with high ice content and large stresses, determining strain weakening may be relevant.

Annex B, Planning of geotechnical investigations
Table B.1 Examples of the selection of methods for soil investigations at different stages: The total sounding test (Annex G.1) may be used for preliminary investigations in fine soil, coarse soil and rock.

The total sounding test can also be used for design and control investigations where the uncertainty of the method is to be assessed in the individual case.

Annex E, Pressuremeter test (PMT)
Application of the results of pressuremeter tests is to be documented by further testing (laboratory and/or field tests).

Annex G, Dynamic probing test (DP)
Use of dynamic probing test to derive ground parameters is not allowed, unless the method has been calibrated using local experience.

Annex G.1, Total sounding test
The total sounding test can be used as a preliminary geotechnical investigation method to determine soil stratification and depth to rock.

NOTE: The total sounding test can also be used to determine relative variations in the strength of sediments and to distinguish fine-grained sediments from layers containing coarse fractions such as gravel and stones.

The total sounding test shall be carried out in accordance with (NGF 2018).

The total sounding test shall not be used to derive geotechnical strength and stiffness parameters and cannot replace in-situ testing and sampling. Uncertainty of the total sounding test shall always be taken into account.

Annex H, Weight sounding test (WST)
Use of weight sounding test to derive ground characteristics is not allowed, unless the method has been calibrated using local experience.

Annex J, Flat dilatometer test (DMT)
Results of flat dilatometer tests shall be verified by further tests (laboratory and/or field tests).

Annex K, Plate loading test (PLT)
The following note is added:

NOTE: When planning and carrying out static plate loading tests on blasted rock fill, the test setup and execution shall be evaluated.

X.4.9.1 Classification testing of rock materials – General
The following is added:
(DGF 2021).

Complementary information
Informative

2.1.1 General, Existing information

Data from previous geotechnical investigations may be used on the basis of an assessment of their suitability for the intended application, and of whether they meet the required quality, including conformity of data to requirements in EN 1997-1 and EN 1997-2.

NOTE 1: From documentation of previous geotechnical investigations at the site, e.g. from the Greenland Technical Organization (GTO), geological and geotechnical information can often be obtained, which is useful especially in the planning phase. However, such data shall be critically assessed, as they may not necessarily be fully suitable for the intended application or meet the required quality, e.g. where previous investigations were aimed at a different purpose, were conducted under previous versions of standards, or produced data that are no longer valid, such as temperature data.

NOTE 2: For requirements concerning geotechnical data, see EN 1997-1, section 3.

Annex X Bibliography

The following contains essential information on geotechnical feasibility studies in arctic areas:

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