NorGeoSpec

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A Nordic system for the certification and specification of geosynthetics and geosynthetic-related products

This document presents a Nordic system for the certification and specification of geosynthetics and geosynthetic-related products for separation, filtration and/or reinforcement.

NorGeoSpec defines a system for the certification and control testing of geosynthetics and geosynthetic-related products and defines requirements related to the intended purpose (function) of the products. NorGeoSpec is implemented as a complete system as a revision and extension of the NorGeoSpec 2002 and NorGeoSpec 2012.

The Nordic system NorGeoSpec (NGS) has been developed by users from several countries (Norway, Sweden, Finland and Estonia) to help the users of geosynthetics, especially in Europe, in their specific projects, to fulfil local regulations and guidelines. All users (owners, specifiers, manufacturers) are part of the definition and the development of the NorGeoSpec.

NorGeoSpec helps:

- to design their specific project in strict respect of competition rules
- to ensure the quality of incoming products by defining the requirements and levels of performance justified by their specific project needs

These requirements may concern either

- the frequency and the level of the verifications for the performance of the products corresponding to these specific project needs
- additional characteristics compared to the harmonised standard justifiable for this specific project and in strict respect of competition rules
- additional characteristics for product identification

NorGeoSpec is not intended to cover in any way the requirements linked to the CE marking and the provision of CPR.

NorGeoSpec role is to give answers and tools to designer, specifiers and users of geosynthetics in specific occasions based on justified needs.

NorGeoSpec proposes additional features which should be considered to ensure sustainability of the geosynthetics during installation and for the lifetime of the project. It also proposes a specific evaluation of the suitability for installation at negative temperature down to -10°C.

NorGeoSpec is a voluntary system, which helps to improve the functionality and reduce the costs of

- the design of simple structures
- the surveillance and control of each specific project

by the mean of fair and strict respect of competition rules.

The NorGeoSpec System includes two parts:

- Part 1 - Product Certification (PC), page 3-36, presents current product requirements for three different functions and frequent uses of geosynthetics for specific projects. A corresponding evaluation of the geosynthetics quality regarding fitness for purpose for these functions is stated by a certificate on Product Certification
- Part 2 - Product Specification (PS), page 37-50, covers some special areas of application, current cases of use, requirements and levels of performance which may be requested for such specific projects. A corresponding evaluation of the geosynthetic regarding fitness in use for such purposes is stated by a certificate on Product Specification

The NorGeoSpec system is intended to be compatible with the provisions of CPR, in particular with CPR Article 8(3) and not to contravene EU legislations.

Compliance with the NorGeoSpec requirements is declared by the NorGeoSpec Certification Body (NCB) to any manufacturer who applies for it, or to his authorized representative, on condition that the product concerned satisfies the rules currently published on the website www.norgeospec.org.

The NCB administers the procedures of both "Product Certification" and "Product Specification" and is advised by the TC.

The rules of NorGeoSpec and the responsibilities of the parties involved are described in Part 1 - Product Certification and Part 2 - Product Specification of this Guideline.

The guideline is supplemented by so-called *Certification notes* and *Technical notes*. The notes provide support in case of ambiguities in the certification process (e.g. necessary additions or explanations) without the need to change the guidelines every time. The *Certification* and *Technical notes* are published on the NorGeoSpec website www.norgeospec.org.

The following organisations have been active in the Revision of NorGeoSpec:

Statens vegvesen	Norwegian Public Roads Administration
Trafikverket	Swedish Transport Administration
FTIA	Finnish Transport Infrastructure Agency
Transpordiamet	Estonian Transport Administration

and the work is carried out by

Berthe Dongmo-Engeland	Norwegian Public Roads Administration
Fredrik Griwell	Swedish Transport Administration
Veli-Matti Uotinen	Finnish Transport Infrastructure Agency
Minna Leppänen	Tampere University representing Finnish Transport Infrastructure Agency
Simmo Talpas-Taltsepp	Estonian Transport Administration
Christian Recker	SINTEF Certification
Arnstein Watn	SINTEF (Advisor)
Philippe Delmas	SINTEF (Advisor)

Administration

Christoph Hessing	SINTEF Certification (NorGeoSpec Secretary)

Part 1 - Product Certification (PC) Functions: Separation and Filtration, Reinforcement

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1. General

1.1. Scope

This part of the document presents the Nordic system for certification and control of geosynthetics and geosynthetic-related products (NorGeoSpec) used for the functions separation, filtration and/or reinforcement, in roads and trafficked areas or in drainage systems. The aim of NorGeoSpec Product Certification is to assess that the products are fit for purpose for specific projects within the areas of use specified in this part of the document, including installation under Nordic conditions down to -10°C.

1.2. Ongoing quality compliance

The applicant must ensure that appropriate NGS Specific Quality Controls are in place to:

- demonstrate that the product continuously complies with the requirements of the NGS certificate which has been issued for the product
- provide records for inspection during audits; these must document the test results achieved, and the inspections carried out to ensure ongoing quality compliance

Note: The goal of the NGS Specific controls is to ensure the quality of the product used in specific projects (e.g. verification of values).

1.3. Responsibility

Any manufacturing faults or errors of marking and/or labelling are the responsibility of the applicant. Under no circumstances does the granting of the NorGeoSpec Certificate transfer any liability to the NorGeoSpec Certification Body (the abbreviation NCB, “NorGeoSpec-mandated Certification Body” is used in the following); the applicant remains legally responsible in all respects relating to the placement of the product in the market.

1.4. Assignment and Transfer

Under no circumstances may the right to use the NorGeoSpec Certificate be transferred or assigned to another party.

In the case of a change of corporate status (e.g. merger, takeover, bankruptcy), the manufacturer of the certified product shall inform the NCB, who will verify whether all the conditions for the original approval are still satisfied. If this is not the case, the right to use the Certificate will be cancelled once the remaining stock of certified product has been sold (within a period of no more than 6 months).

1.5. Product / Product range

Product

A geosynthetic, or geosynthetic-related product, is defined by a commercial designation which includes both a name and reference number or descriptor (e.g. “Unitex 25a”, “Unitex Filterplus”).

Product range

The products of a product range resemble one another and are manufactured by the same manufacturing process, in the same production facility, and from the same raw material(s). However, they differ e.g. in the size and cross-section of the elements, in unit weight and in their mechanical and hydraulic properties.

1.6. Languages

The language used in all matters relating to NorGeoSpec certificates and certification shall be English.

2. References

This document also contains provisions from other publications, such as dated or undated references. The normative references are cited at the relevant places in the text, and publications are listed in the following. If dated references are changed or revised, the changes or revision will not be valid in the NorGeoSpec system. They will only become valid through the publication of an amendment or a revised edition of NorGeoSpec system. For undated references, the latest edition of the cited publication is valid.

Normative References

ISO	9001	Quality management systems – Requirements
EN ISO	9862	Geosynthetics - Sampling and preparation of test specimens
EN ISO	9864	Geosynthetics - Test method for the determination of mass per unit area of geotextiles and geotextile-related products
EN ISO	10318	Geosynthetics - Part 1 Terms and definitions and part 2 symbols and pictograms
EN ISO	10319	Geosynthetics - Wide-width tensile test
EN ISO	10320	Geotextiles and geotextile-related products - Identification on site
EN ISO	10722	Geosynthetics - Index test procedure for the evaluation of mechanical damage under repeated loading - Damage caused by granular material
EN ISO	11058	Geotextiles and geotextile-related products - Determination of water permeability characteristics normal to the plane, without load (velocity index V_{H50})
EN	12224	Geotextiles and geotextile-related products - Determination of the resistance to weathering
EN ISO	12236	Geosynthetics – Static puncture test (CBR test)
EN	12447	Geotextiles and geotextile-related products – Screening test method for determining the resistance to hydrolysis in water
EN ISO	12956	Geotextiles and geotextile-related products – Determination of the characteristic opening size
EN ISO	12957	Geosynthetics – Part 1: Direct shear test
EN ISO	12960	Geotextiles and geotextile-related products – Screening test method for determining the resistance to acid and alkaline liquids
EN	13242	Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction
EN	13249	Geotextiles and geotextile -related products. Required characteristics for use in the construction of roads and other trafficked areas
EN	13250	Geotextiles and geotextile-related products. Required characteristics for use in the construction of railways
EN	13251	Geotextiles and geotextile-related products. Required characteristics for use in earthworks, foundations and retaining structures
EN	13252	Geotextiles and geotextile-related products. Required characteristics for use in drainage systems
EN	13253	Geotextiles and geotextile-related products. Required characteristics for use in external erosion control systems
EN	13254	Geotextiles and geotextile-related products. Required characteristics for use in the construction of reservoirs and dams
EN	13255	Geotextiles and geotextile-related products. Required characteristics for use in the construction of canals
EN	13256	Geotextiles and geotextile-related products – Characteristics required for use in the construction of tunnels and underground structures
EN	13257	Geotextiles and geotextile-related products. Required characteristics for use in solid waste disposals

Normative References		
EN	13265	Geotextiles and geotextile-related products. Required characteristics for use in liquid waste containment projects
EN ISO	13431	Geotextiles and geotextile-related products – Determination of the tensile creep and creep rupture behaviour
EN ISO	13433	Geosynthetics – Dynamic perforation test (cone drop test)
ISO/TS	13434	Geosynthetics – Guidelines for the assessment of durability
EN ISO	13438	Geotextiles and geotextile-related products – Screening test method for determination the resistance to oxidation
ISO	14025	Environmental labels and declarations - Type III environmental declarations - Principles and procedures
EN ISO	14688-1	Geotechnical investigation and testing - Identification and classification of soil - Part 1: Identification and description
EN	15381	Geotextiles and geotextile-related products – Characteristics required for use in pavements and asphalt overlays
EN ISO/IEC	17025	General requirements for the competence of testing and calibration laboratories
ISO/TR	20432	Guidelines for the determination of the long-term strength of geosynthetics for soil reinforcement
Other references		
Vegbygging Håndbok N200 (Road Construction Handbook N200), Statens vegvesen, Norway, 2018-07		
InfraRYL - Infrarakentamisen yleiset laatuvaatimukset (General quality requirements for infrastructure construction), Rakennustieto, Finland		
AMA Anläggning (AMA Civil works - General material and work specification for civil engineering works), Svensk Byggtjänst, Sweden, 2023		
Guidelines for the Use of Geosynthetics in Nordic conditions (ROUGH), 04.09.2023, Finnish, Norwegian and Swedish infrastructure authorities		

3. Terms, definitions and abbreviations

In general all terms are referred to EN ISO 10318 (Part 1 and Part 2)

In the specific requirements the following terms are used:

Term / abbreviation	**Definition**
Nominal value	Value of a material property as declared by the producer/supplier of the material for the purpose of NGS.
Nominal tensile strength	The value of the tensile strength of the product as defined by the manufacturer
NGS confidence limit	The nominal value plus or minus the NGS declared tolerance is defined as the one / both sided NGS-confidence limit
NGS declared tolerance	The NGS declared tolerance for a characteristic is to be stated by the manufacturer in compliance with the NGS requirements.
Nordic installation conditions	In the present guidelines “installation under Nordic conditions” means installation at sub-zero temperatures (down to -10°C), in-situ soil is totally or partly frozen, aggregate is crushed rock (e.g. 0/56), drop height 1.0 to 2.0 m and compaction is acc. Finnish (InfraRYL) road construction guidelines or Swedish (AMA Anläggning) or Norwegian (N 200).
ROUGH	Guidelines for the Use of Geosynthetics in Nordic conditions

Term / abbreviation	Definition
Sample	A sample consists of several single specimens. The number of tests on single specimens for a specific characteristic is specified in the test standards
Strain at nominal strength	The value of the strain at nominal strength as defined by the manufacturer
Test result	The average value of the tests on single specimens from the sample
AB	Advisory Board
TC	Technical Committee
MD	Machine Direction
CMD	Cross-Machine Direction
C_U	Uniformity coefficient of soil
c_u	Shear resistance of soil in the undrained condition
D_{10}	Particle size of soil such that 10 % of the particles by weight are smaller than those sizes
D_{60}	Particle size of soil such that 60 % of the particles by weight are smaller than those sizes
D_{max}	Maximum particle size of soil
EAGM	European Association of Geosynthetic product Manufacturers
F	Maximum tensile strength (kN/m)
I_p	Plasticity index
NCB	NorGeoSpec Certification Body
PC	Product Certification
PS	Product Specification
R	Energy index, $R = 1/2 \cdot F \cdot \varepsilon$
RF_{CH}	Reduction factor for environmental effects
RF_{CR}	Reduction factor for creep and creep-rupture
RF_{ID}	Reduction factor for installation damage
RF_W	Reduction factor for weathering
T_i	The tolerance of the characteristic in engineering units
TL	NCB-mandated testing laboratory
U	Uniformity requirement - Some products may have a large difference in strength and strain between machine and cross-machine direction. A uniformity requirement of U = 1.5 is included in order not to give credit for strain at failure higher than 1.5 times the direction with the smaller value
ε	Strain at maximum tensile strength

4. Technical and Management administration

4.1. Technical Committee (TC)

The TC represents partners involved in NorGeoSpec, including representatives from the National Transport Administrations in the countries where NorGeoSpec is applied and the NorGeoSpec Certification Body.

Each member of the TC must sign a secrecy declaration; this is re-signed in regular intervals and continues in force after membership of the committee has expired.

The chairperson of the TC is elected amongst its members for a period of 5 years. He is also the chairperson of the AB.

An NCB representative manages the secretariat of the TC and the AB.

For the TC, a minimum of one physical meeting per year shall be organized. Day-to-day information is handled by digital communication.

Responsibilities of TC

The TC is responsible for:

- final approval of NorGeoSpec document, technical and certifications notes (e.g. revisions and new editions)
- advice and decisions in case of an appeal regarding the guideline or an applicant disagrees with a certification related decision
- approval of experts nominated by NCB

The TC is composed of:

- representatives nominated from the public administrations (one vote for each country)
- one representative from the NCB
- other representatives may be appointed at the discretion of the TC

A simple majority decides in cases of issuing certification or approval of a product. In cases of a hung vote, the chairperson has the casting vote.

4.2. Advisory Board (AB)

In addition to the TC there is an AB whose membership is extended to include representatives of the producers and the testing laboratories.

For the AB, a minimum of one physical meeting per year shall be organized. Day-to-day information is handled by digital communication. Where feedback is required, no feedback within two weeks constitutes consent.

Responsibilities of AB

The task of the AB is to give advice for:

- defining the strategic development and supporting the promotion of the system
- contributing to drawing up and revising the NorGeoSpec document
- ensuring that the NorGeoSpec document is harmonized with European and national regulations
- helping to resolve any conflicts out of court between involved parties by setting up Working Groups if necessary

The Advisory Board (AB) is composed of:

- the members of the TC
- representatives from the manufacturers nominated by the European Association of Geosynthetic product Manufacturers (EAGM). The number of representatives is equivalent to the number of NorGeoSpec member states. Only manufacturers having product(s) certified according to NorGeoSpec certification should be nominated to the AB. Manufacturers' representatives are nominated by the EAGM for a period of 3 years. To ensure the continuity of the work in the AB, only one manufacturers' representative may be replaced after the 3-year period.
- two representatives from the testing laboratories. These are appointed by the NCB-mandated testing laboratories for a period of 3 years. To ensure the continuity of the work in the AB, only one testing laboratory representative may be replaced after the 3-year period.

  Recommendations of the AB require a majority of 2/3 of the members present (Example: 6 of 9, or 7 of 10 members). Should no majority be possible, for whatever reason, the chairperson has the casting vote. The weighting of the votes is defined as follows: national transport administrations have one vote per country; the

NCB, every manufacturer and every testing laboratory have one vote each.

4.3. NorGeoSpec Certification Body (NCB)

The NorGeoSpec Certification Body is mandated by the NorGeoSpec Technical Committee. At present SINTEF AS, represented by its institute SINTEF Community, is the NorGeoSpec Certification Body. The NCB receives the request from an applicant, is responsible for the subsequent certification process, and awards certification, taking advice from the TC.

Responsibilities of NCB

The NCB is responsible for the following:

- the application of the rules set out in this document
- carry out all evaluation activities
- review of information and inspection results (checklist, inspection report and test results)
- decisions for the certification of single products in acc. with the requirements of EN ISO/IEC 17065 General requirements for bodies certifying products, processes and services
- be responsible for, and shall retain authority for decisions relating to certification
- the implementation of decisions recommended by the TC / AB
- arrange meetings of the TC and AB
- keep TC informed on synthesis of certification activities
- ensuring that the TC properly performs its tasks in accordance with the rules laid down in the NorGeoSpec document
- organizing and running the administrative and technical secretariat
- investigations of files of certification requests, of inspections and verifications, of complaints, etc.
- preparation of and attendance at meetings of the TC/ AB and the group of technical experts
- organization and management of all inspections and verifications
- mandating the inspection agents (inspectors / sampler)
- continual improvement of the quality of the test results of participating testing laboratories
- publication of certificates and other relevant information on the website
- proposing experts to the TC (see: Role of experts)

Requirements of NCB

The NCB must:

- be an organization following the principles of EN ISO/IEC 17065
- be accredited for Product Certification by an accreditation body involved in European Accreditation
- be a notified certification body under the CPR for product area geosynthetics and geosynthetic related products
- be completely impartial
- operate independently of the testing laboratories used for testing

4.3.1. Inspection Body

The inspection body is mandated by the NCB. The inspection body can act as an inspector and/or a sampler.

4.3.1.1. Inspector

Responsibilities of inspector

The Inspector conducts an inspection of the producer´s manufacturing facility to assess whether the requirements of the NorGeoSpec rules are met. To do so, he conducts an audit inspection of the producer's manufacturing process. The basis for the inspection audit is a checklist provided by the NCB which is completed jointly by the Inspector and the producer. The questionnaire places particular emphasis on the following points:

- organisation
- quality management
- NorGeoSpec products and functions
- incoming goods control
- finished goods control
- control of NGS non-conform products
- type and spot testing

The Inspector prepares a report based on a checklist on the result of the inspection and gives this to the NCB.

Requirements of inspector

The Inspector must be of recognized competence, especially in geosynthetics and geosynthetic related products. The Inspector shall be competent according to the requirements of EN ISO/IEC 17020. Proof of the appropriate training must be demonstrated to the NCB.

4.3.1.2. Sampler

Responsibilities of sampler

The sampler shall take samples to be sent to the testing laboratory for testing. In doing so, he must observe the requirements of EN ISO 9862 and must take particular care to ensure that the product is marked in accordance with EN ISO 10320.

Requirements of sampler

The sampler must possess appropriate experience in the taking of samples and must know and apply the provisions of EN ISO 9862 and NorGeoSpec.

The sampler shall be impartial and independent of the applicant.

4.4. Testing Laboratory (TL)

General

The testing laboratories are mandated by the NCB. The mandate is reviewed annually by the NCB in accordance with the requirements defined in the NorGeoSpec document. Hereafter, the term “testing laboratory” refers to an “NGS-mandated testing laboratory”.

The testing laboratories perform tests on samples received from the inspection body. The results of the tests are sent to the NCB.

No direct contact is permitted between the testing laboratory and the producer in connection with an application for NorGeoSpec certification. Testing laboratories which contravene this rule will be excluded from further testing for a period decided in consultation with the TC.

Responsibilities of Testing Laboratory (TL)

- the TL is responsible for testing the product in accordance with the test plan prepared by the NCB
- the TL prepares a report on the results of the tests and submits this to the NCB. Interpretation of test results related to NorGeoSpec requirements may be given in an informative annex to the report

Requirements of TL

The TL shall fulfil the following requirements:

- the TL has an accreditation according to EN ISO/IEC 17025 covering the test performed
- the TL is independent and impartial (not owned by a manufacturer of geosynthetics or by a holding company which also owns such a manufacturer)
- the TL operating independently of the NCB
- the TL participates in the programme of continuous improvement of testing quality organised by the NCB.

4.5. Confidentiality clause

All individuals involved in the certification process must maintain absolute confidentiality about all matters to which they may become party. These are all information in matter of certification and specification processes of NGS certification and specification requests regarding producers and products and all specific matters mentioned as confidential in TC meetings.

To this end, all members of the TC, the NCB, the TL involved in testing and the persons assigned to collecting test samples sign a document in which they undertake to keep secret all information they receive relating to a specific manufacturer and/or his products. This confidentiality agreement continues in force while the individual is working for or represents NorGeoSpec as a member, and for a period of five years after the individual concerned has ceased his activities for NorGeoSpec.

5. Certification Process

Introduction

Compliance with the NorGeoSpec requirements is declared by the NCB to any manufacturer who applies for it, or to his authorized representative, on condition that the product concerned satisfies the rules currently published on the website www.norgeospec.org. *(see Annex B: Principle of the certification procedure)*

Compliance with the requirements can be achieved by:

- a Product Certification (PC)

The NCB is the prime contact of the manufacturer, or the manufacturer´s authorized representative.

5.1. Product Certification (PC)

To ensure that products are of the required quality, and to guarantee that this quality is maintained for a product lifetime equal to or greater than 25 years the PC procedure includes:

- initial inspection of the production process (validation of the values)
- initial product testing of the products in an NCB-mandated testing laboratory
- an estimation of their functionality for the declared service life
- continuous surveillance including unannounced random product sampling and control checks

These activities are complemented by repeating the production inspection, and by re-taking samples and carrying out material testing, at regular intervals.

The applicant receives a certificate with the results of the procedure.

5.2. Certification request

General Requirements

The geotextiles and geotextile-related products must comply with the requirements as set down in the relevant hEN application standards.

Compliance of a product with the NGS system can only be confirmed for manufacturers:

- who fulfil NGS Specific Quality Control requirements
- whose product characteristics comply with the requirements stated in Table 1

The values called for in the Product Certification depend on the function and the declared product lifetime.

Irrespective of the function, a minimum lifetime of 25 years is required.

The product values called for (or the procedure to be followed in estimating their lifetime), their relevance to the conditions of use, and the test methods to be used are detailed in *Annex C (Scope of testing for Product Certification)*.

5.2.1. Responsibilities of the applicant

The applicant is responsible for any manufacturing faults, and for errors of marking and labelling. The right to use the NorGeoSpec certificate does not transfer the applicant's liability to the NCB or TC under any circumstances. The manufacturer remains legally responsible in all respects relating to the placement of the product in the market.

The products for which approval is requested must have CE Marking in accordance with the relevant hEN Application Standards.

The manufacturer of the product(s) must have a documented system for the factory production control.

Any changes in raw materials, in production methods or in the methods used to monitor production quality (such as characteristics declared for CE marking, or those required by NorGeoSpec, e.g. mass per unit area and dimensions) must be made known to the NCB immediately. Such changes could automatically induce the withdrawal of NorGeoSpec certification for this product and must be discussed with the NCB.

The applicant accepts all the conditions imposed by the current issue of the NorGeoSpec and its annexes.

5.2.2. Responsibilities of the NCB

The NCB is responsible for the application of the PC as defined in the NorGeoSpec and its annexes. In addition, the NCB

- receives requests from the applicants and, dependent on the level of documentation,

declares compliance with the NorGeoSpec requirements for the Product Certification

- guarantees that all applicants are treated equally
- mandates the inspection agent

5.3. Requirements

Compliance with the NorGeoSpec requirements is declared by the NCB to any applicant (manufacturer, importer or distributor acc. Article 15 CPR or manufacturer´s authorised representative), who applies for it, on condition that the product concerned satisfies the rules set out herein.

In cases in which the applicant is not the producer

- the applicant has the right to use the NorGeoSpec under his own brand name if the producer maintains the NorGeoSpec certificate for this product
- compliance can only be declared for a product with the same name as on the document accompanying its CE Marking

The applicant applying for compliance with the NorGeoSpec rules must:

- have a contract with the NCB, which will be responsible for the certification process and for conducting continuous surveillance. This involves unannounced sampling at production sites, at the warehouse, and on construction site (rules and number of samplings are given in *Annex E: Sampling and sampling procedure)*
- publish the same nominal value for each required characteristic for the NorGeoSpec as for the DoP (Declaration of Performance) at the time of certification
- inform the NCB of any fundamental modifications made to the production process, like a change in the DoP
- facilitate the assignments of the inspection agent described in the present rules
- accept without objection decisions taken in accordance with the present rules
- inform the NCB in cases where manufacturing or the manufacturing control process has ceased
- inform the NCB of all production facilities and stock locations operated by the manufacturer for the products for which certification has been requested
- accept publication of the list of its certified or attested products and their NorGeoSpec product certificates
- ensure that there is no association of the NorGeoSpec certificates with information not covered by the certificate

5.3.1. Requirements: Service life up to 25, 50 and 100 years

If a product service life up to 25, 50 and 100 years is to be certified for a product, the product or product family must fulfil all the conditions and requirements set out in relevant hEN application standards (functions separation and filtration, filtration in drainage system) and additional requirements of ISO/TR 20432 and ISO/TS 13434 (Function reinforcement), (see ANNEX C).

The NCB can issue a product certificate according to the following requirements:

- the geosynthetic or the geosynthetic-related product must fulfil all the conditions and requirements set out in relevant hEN application standards
- the manufacturer shall provide values and tolerances for the characteristics according to Table 1[1)] of this document.
- the declared tolerance shall be within the tolerance limits given in Table 1
- the production facility and the factory production control must have successfully passed inspection by the NCB or an inspector designated by the NCB
- when requesting certification, initial product testing must be performed on all products and for all characteristics according to Table 1
- sampling and testing must be organised by the NCB. The testing must be performed in an NCB-mandated testing laboratory (TL)
- the results of initial product testing must be available and fulfil the requirements of the NorGeoSpec guideline

5.3.2. Requirements: Suitability for installation at negative temperatures down to -10°C

If a product suitability for installation at negative temperature down to -10°C is to be certified, the product or product family must fulfil all the conditions and requirements showing that, if the product is correctly designed (acc. design/specification reference) for positive temperature (e.g. +20°C) for the defined geotechnical Nordic conditions of installation no additional installation damage is observed on the key characteristics when product is installed under same Nordic conditions at -10°C.

The NCB can issue a product certificate according to the following requirements:

- the manufacturer shall provide all relevant information according to Table 1, Table 2 and Table 3 and to *Annex G.2* of this document.
- the in-situ damage test *(Annex G.2)* shall be carried out under the surveillance of an independent third party.
- the corresponding sampling and testing must be organised by an independent third party and the testing must be performed in an NCB-mandated testing laboratory.

5.4. Decision procedure: Product Certification

Service life up to 25 years

- if the test result(s) (average of the sample tested) for the characteristic(s) is (are) within the 95% NGS-confidence limits, the product is accepted
- if the test results for one or more of the characteristics are outside 1.5 times the tolerance values provided by the manufacturer, the product does not comply with the requirements and the NCB contacts the manufacturer. The manufacturer can accept the non-compliance or ask for the A-Sample to be re-tested in a different testing laboratory
- if the test results for one or more of the characteristics are between 1 and 1.5 times the tolerance values given by the manufacturer, the B-Sample shall be tested in a different laboratory
- if the test results of B-Sample for one or more of the same characteristics are within the tolerance values provided by the manufacturer, the product is accepted as complying with respect to that (those) characteristic(s)
- if the test results of B-Sample for one or more of the same characteristics are outside the tolerance values given by the manufacturer, the product does not comply with respect to that (those) characteristic(s)

Service life up to 50 and 100 years

Same requirements as for 25 years, plus

- an estimate of the product lifetime for the foreseen function must be provided and accepted by the NCB
- a system for the ongoing monitoring of the long-term properties must be agreed between the producer and the NCB according to the present system and be implemented

The certification decision process is shown graphically in Annex B.

5.4.1. Suitability for installation at negative temperatures down to -10°C.

The results will be evaluated for key characteristics on the base of the relevant design and/or specification references *(Table 3)*.

- if the values obtained for the product show that for **all key characteristics** no additional installation damage is observed when installed under Nordic conditions at -10°C *(Annex G.2)*, the product can be considered *"Suitable for installation under Nordic conditions at negative temperatures (down to -10°C)"*
- if the test results of all key characteristics are inside the tolerance values provided by the manufacturer, the product does comply with the requirements

5.5. Non-conformity

In case of non-conformity of a product, the NCB, with advice of the TC, reaches and communicates a decision; this may be a suspension of between 3 and 12 months, or complete cancellation of the NorGeoSpec product certificate. Other reactions may be decided based on advice from the TC.

Non-conformity is declared when test results from random sampling and testing are outside the declared NGS-confidence limits.

5.6. Validity of the certificate

The NorGeoSpec product certificate is valid in all countries in which NorGeoSpec applies.

The NCB distributes the information on the website

NorGeoSpec product certificates remain valid if the re-certification process after 2 years is passed successfully.

The certificate states:

- the name of the NCB which has issued the certificate
- the declared values fulfilled by the product (function: separation and filtration, reinforcement, combinations of these and filtration in drainage systems)
- information related to the product durability
- the certificate is only valid, provided it is published on www.norgeospec.org

5.7. Renewal of a request

A request that has been refused cannot be renewed within a period of six months after the refusal.

6. Verifications

6.1. Verifications performed by the applicant

The applicant is responsible for controlling the equipment, raw materials and manufacturing of products to benefit from the right to use the NorGeoSpec. He must ensure a continued verification of the production and must maintain reliable records of the results.

On request, he must present these to the inspector and facilitate the accomplishment of the inspector's mission.

6.2. Verifications performed by the inspection agent

Verifications are made at the production location of the products to be certified.

The inspector conducts the inspection following the points mentioned in point 5.1 of this document and takes samples for all tests stated in the present rules.

6.3. Verification of PC, continuous surveillance

Verification of NGS Specific Control samplings of all certified products and testing of all characteristics are undertaken every second year by the NCB at the production location and performed in an NCB-mandated testing laboratory, on the NCB's initiative.

Annex E: Scope of random control-check testing gives an indication of some of the aspects of such a programme.

6.4. Unannounced random product sampling and control checks

The NCB organizes random control checks.

Sampling can be done from:

- Producer's stock
- Distributer's stock
- Construction site

Principle: The stock of the producer and the stock of the distributer are equal for the client; the producer is responsible to guide and train the distributer to handle and store the products in a proper way to maintain the properties and service life.

Case 1 - NCB Sampling from stock

If samples taken from stock fail to pass: See point 7.1 of this document.

Case 2 - NCB Sampling from a construction site

If samples taken from a construction site fail to pass: NCB organizes announced random sampling from stock ("new B-sample") and checks the factory production control data.

The announcement to the producer and/or the applicant [1] is made three working days prior to the check. If the samples are taken from the distributor's warehouse, or from a construction site, the distributor is also informed.

Case 3 - Sampling from construction site by the project owner e.g. National Transport Agency

Project owner can do random sampling or sampling is done according to quality requirements of project.

Project owner or its representative may send test results to NCB or inform NCB of non-conformity of product. If failed, the project owner decides on consequences (e.g. economical).

Follow up sampling by NCB in Case 3: Based on results, NCB may organize announced random sampling or checks on the factory production control data.

The NCB reserves the right to perform one announced or unannounced random control check within the certification period of two years. Not necessarily all characteristics will be tested.

Note: A full audit, sampling and testing will be performed every two years (re-certification).

The selection of products for random sampling takes into account information as to which products have already been produced and are available at the time of the audit. Excluded from this rule are products of which less than 2,000 m² have been produced in the previous 12 months. In this case, the producer must notify the NCB in writing that less

[1] In cases in which the applicant is not the manufacturer of the product or manufacture takes place outside the European economical area EEA, sampling may be carried out at the applicant´s warehouse.

than 2,000 m² have been produced, and sampling is then carried out as soon as manufacture of this product is re-started.

Notes on sampling and on the tests carried out during the random control checks, are given in *Annex E*.

6.5. Extraordinary verifications

On request, the NCB will investigate all abnormal occurrences (e.g. objections, complaints).

If no solution is found the TC shall be involved. The costs of such verifications must be borne by the applicant for the NorGeoSpec product certificate if product non-conformities are found.

6.6. Additional possibilities for sampling and testing

The following possibilities are:

- not applicable to the initial Product Certification and the first product re-certification
- only valid for the functions separation and filtration

To apply these additional possibilities a written request must be sent to the NCB by the applicant. The NCB then examines the data situation and informs the applicant whether the additional possibilities are applicable or not.

The additional possibilities for sampling and testing are:

- reduced number of product samplings
- reduced scope of testing

The detailed requirements are set out in the relevant technical and/or certification notes (www.norgeospec.org).

7. Certification

The NCB, if necessary, with advice from the TC, decides whether a product complies with the NorGeoSpec requirements and authorises the issuing of a product certificate for that product, or for the family of products represented by the product tested.

The award, renewal, suspension or cancellation of certification takes effect from the date of receipt of the decision by the applicant. However, the obtaining of the NorGeoSpec is dependent on the payment of all the related costs (see 7.3 below).

Product certificates are published on the NorGeoSpec website: www.norgeospec.org. These certificates are valid unless they are suspended or cancelled as outlined below.

7.1. In case of non-conformity of a product

Where an inspection, whether announced or unannounced, reveals non-conformity of a product, the NCB decides what action needs to be taken e.g. whether certification for that product, and any product family represented, should be suspended or cancelled with immediate effect. In this case, a notice is posted on the NorGeoSpec website. The manufacturer is informed by the NCB in writing within 10 days of the steps which need to be taken to re-instate the certification. In case of disputes between the applicant and the NCB, the TC will be consulted to find a solution.

If certification has been cancelled, the manufacturer, or his authorised representative, must re-apply for certification. If the certification has been suspended, the manufacturer has a period of 60 days from receipt of the NCB's communication in which to demonstrate compliance with the steps required. At the end of this period, if the NCB is not convinced that compliance has been adequately demonstrated, the NCB recommends cancellation of certification. In case of disputes between the applicant and the NCB, the TC will be consulted to find a solution.

7.2. In case of voluntary withdrawal of a product

Voluntary withdrawal of a product is possible after a minimum period of 2 years from the date of issue of the certification. The cancellation is announced by the NCB and any remaining stock of the product, or of the related product family, may be sold under the NorGeoSpec within a period of 6 months from the date of cancellation.

7.3. In case of non-payment of the fees

If, after the customary warning notice, the applicant has failed to pay the fees due, the NCB rules on cancellation of certification. From the date of cancellation, no further sale of product in stock may be made under the NorGeoSpec system. A notice regarding the cancellation is published on the NorGeoSpec website.

7.4. In case of non-compliance by the applicant in respect of the responsibilities

Where an inspection, whether announced or unannounced, reveals deficiencies in the Factory Production Control systems relating to the certified product, certification for that product, and any product family represented, is suspended with immediate effect. A notice to this effect is published on the NorGeoSpec website. The manufacturer is informed by the NCB in writing within 10 days of the steps which must be taken to re-instate the certification.

The manufacturer has a period of 60 days from the date of the inspection in which to demonstrate compliance with the steps required by the NCB. At the end of this period, if the NCB decides that compliance has not been adequately demonstrated, the NCB cancels the certificate. The suspension remains in force until the NCB has reached its decision.

7.5. Suspension or cancellation consequences

The certified or attested products affected by a suspension or a cancellation are removed immediately from the list of NorGeoSpec certified products on the website.

7.6. Change in the commercial reference of certified product

A change in the commercial reference of certified products can take place under the following conditions:

- all properties remain unchanged
- the applicant does not manufacture under the old reference from the date from which the new reference applies
- the validity of old certificates is limited to 6 months after the change of reference

- the applicant does not publish both references on the technical data sheets or commercial documents
- the applicant does not re-use the names of products previously certified or attested

7.7. Appeals

Where the applicant disagrees with a certification-related decision, he may lodge one, and only one, appeal with the TC. The appeal must be presented within a period of 30 days from the date of receipt of the notification of the corresponding decision. All costs related to the appeal must be borne by the applicant.

Three different types of appeal are possible:

I. on the test results recorded by the testing laboratory

II. for non-compliance with the applicant's responsibilities

III. for non-payment of costs

In case number I, additional tests are carried out on specimens retained from the original sample in an alternative testing laboratory mandated and chosen by the NCB. If the results are in accordance with the values indicated by the applicant, the TC is consulted by e-mail for final decision. If the results are not in accordance with the values, the case is considered at the next TC meeting and a decision recommended to the NCB.

In case number II the appeal is studied by the TC and recommendations are made to the NCB. The NCB prepares the file and meets the applicant if possible. A final decision is reached by the NCB and communicated to the applicant.

Appeals do not delay the application of the decision.

7.8. Unauthorised use of the certificate

In case of unauthorised use of a NorGeoSpec product certificate, the NCB in consultation with the TC can decide and take any action it deems necessary.

8. Contentious matters

The law and tribunals of the country of the NCB apply regarding contentious matters.

How to refer to the current and earlier versions of NorGeoSpec:

- NorGeoSpec, Rev. 02, Issue: 01.09.2025, *A Nordic system for the certification and specification of geosynthetics and geosynthetic-related products*
- NorGeoSpec 2012, Rev. 01, Issue: 14.12.2016, *A Nordic system for the certification and specification of geosynthetics and geosynthetic-related products*
- NorGeoSpec 2002, Issue: 30.06.2004, *A Nordic system for specification and control of geotextiles in roads and other trafficked areas*

Annex A: Role of experts

General

In all areas in which the behaviour of NorGeoSpec certified products is important, the NCB avails itself of external experts with the relevant experience.

The NCB will provide the applicants with a list of approved experts.

The applicant is free to choose the expert. In individual cases, a connection between the expert and the applicant is not permissible. Such a case exists, for example, when a test result differs from that obtained in the initial type testing and the expert was involved in the original assessment of long-term behaviour.

Tasks of the experts

The tasks of the experts are:

- to give expert advice to the TC / AB

Qualification of the experts

Experts must prove their experience in the relevant area. The following qualifications should be considered in their evaluation:

- at least 10 years of experience in the field of geosynthetics
- publications in the field of geosynthetics
- member of CEN TC 189

Remarks:

Experts must refer to the latest state of the art in their assessments.

Meetings organised annually by the NCB are designed to promote a harmonised approach of experts in their assessment of lifetime expectancy.

Experts must sign a confidentiality agreement with the NCB.

Annex B: Principle of the certification procedure

Certification process: The certification process comprises of the phases 1 to 5.

Surveillance process: The surveillance process is a repetition of phases 2 to 5.

Note: The surveillance process is also referred to as re-certification.

1. Application phase (initial certification only)

The Application phase begins with the submission of a request for certification being made by the manufacturer or his authorized representative. The manufacturer, or his authorized representative, applies for a particular NorGeoSpec Product certification for one or more of his products. The application form should be accompanied by a list of the products with the required functions as well as a statement relating to the required product lifetime.

The applicant enters a third party-audit and product-control contract with the TC mandated NorGeoSpec Certification Body (NCB).

The NCB considers the application and, bearing in mind the certification applied for, stipulates the properties for which evidence must be provided.

Alternatively, the NCB can offer the applicant a coordinating discussion on the certification procedure and the properties for which evidence is to be provided.

The NCB checks whether all documents received are complete and correct.

2. Evaluation phase

In the second phase, the NCB or its designated representative examines the applicant's production facilities and takes samples of the products for which an application has been made. These are subsequently tested in an NCB-mandated testing laboratory in accordance with the NGS requirements. The results of the evaluation and the tests are documented in a report.

3. Review phase

The NCB reviews the documentation presented by the applicant and the results of the inspection and tests (compliance with the NorGeoSpec requirements). Based on the review results the NCB makes a recommendation for certification.

4. Certification phase

The NCB decides whether the request should be refused or compliance should be declared.

5. Publication phase

The NCB issues the NorGeoSpec product certificate and publishes it on the website.

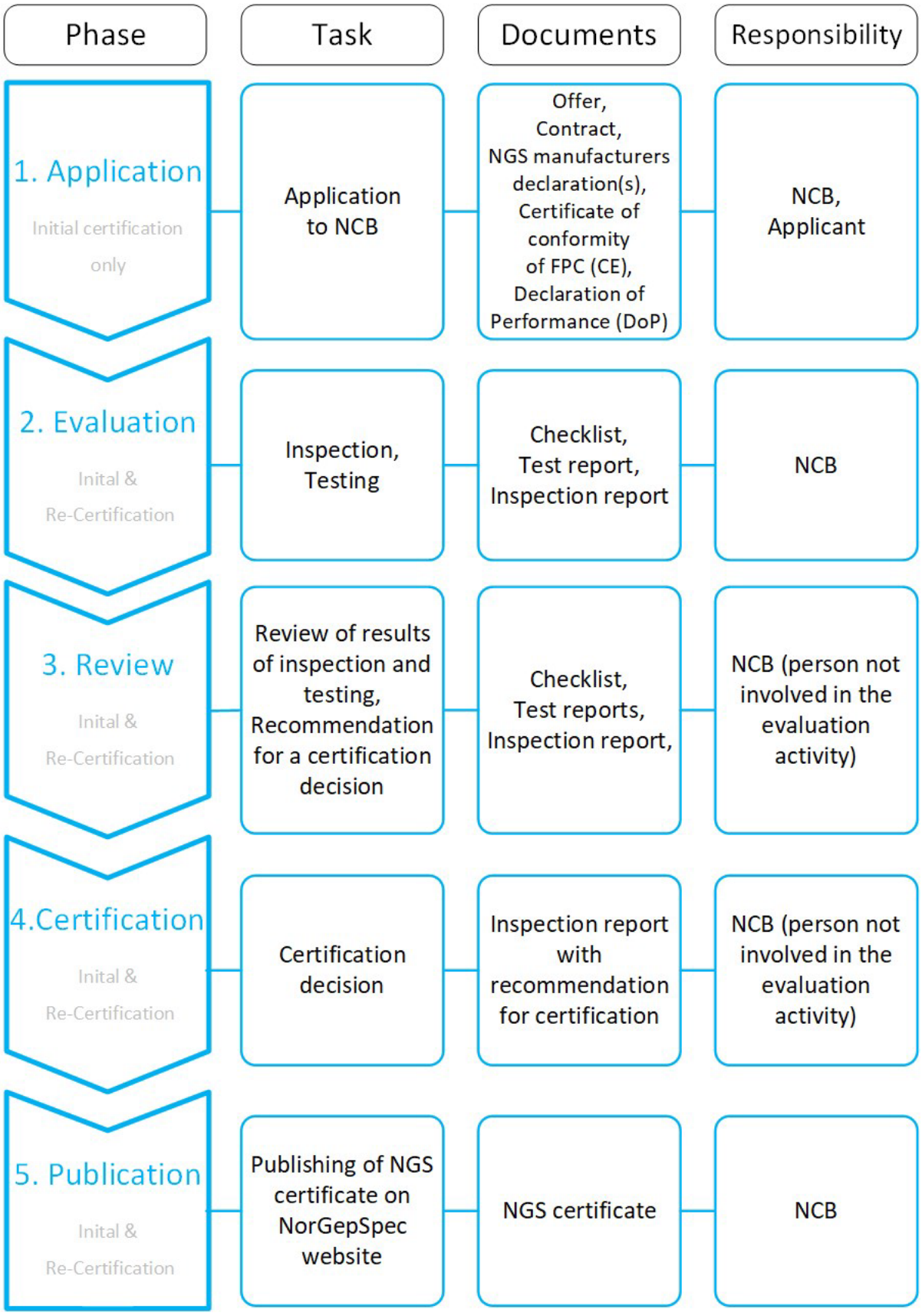


Figure 1: Certification process

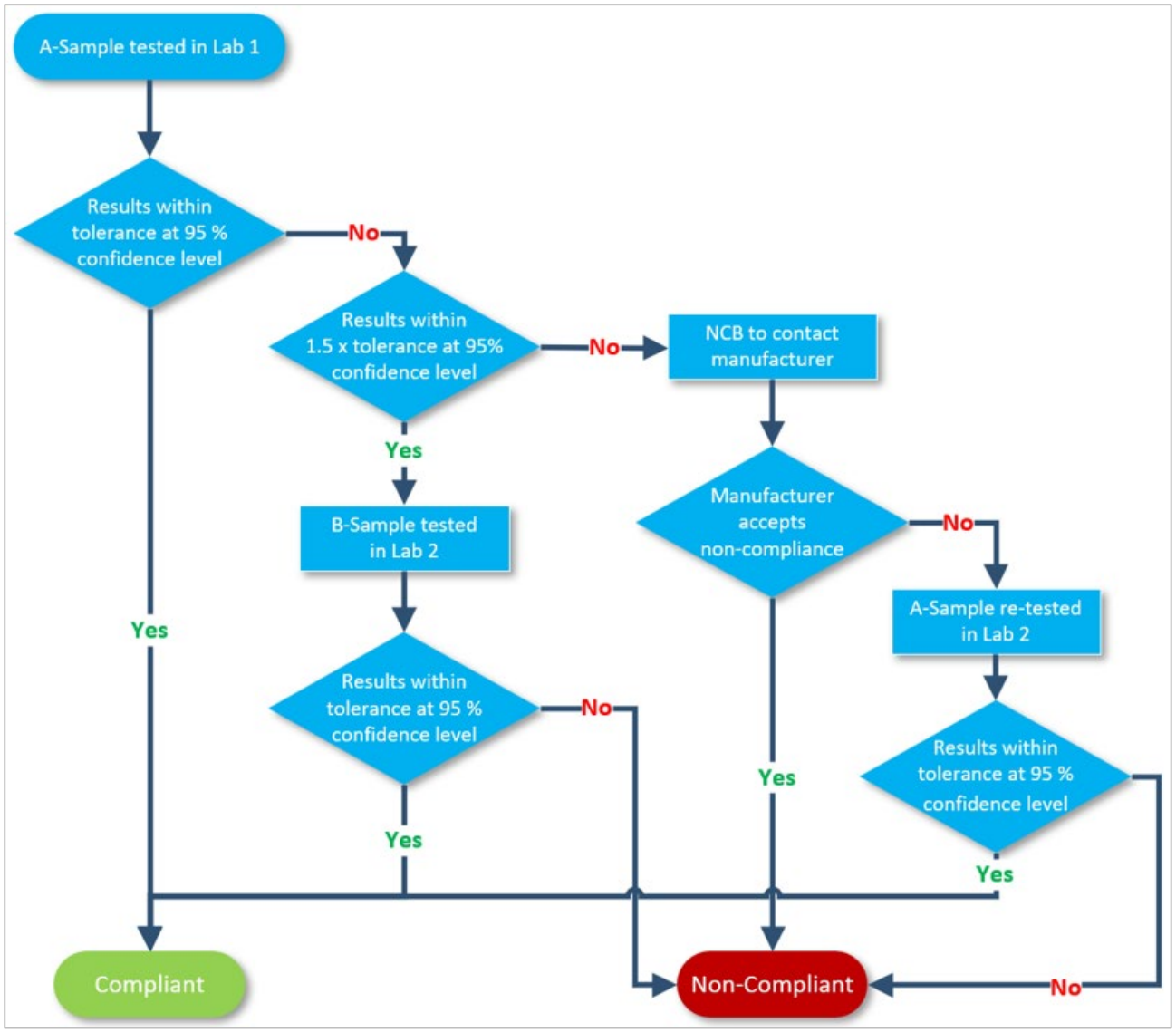


Figure 2: Certification decision process

Annex C: Scope of testing for Product Certificate (PC)

The properties which must be tested for the Product Certification are listed in Table 1 and Table 2 and described in the clause “Performance assessment” of this Annex.

Table 1: Certified values with tolerance (in % of values) depending on the function fulfilled by the product

Characteristic	**Standard**	**Unit**	**Function**		
			Filtration	Separation	Reinforcement
Product identification					
Mass per unit area [2]	EN ISO 9864	g/m²	± 10 %	± 10 %	± 10 %
Tensile elements in MD & CMD	Annex F [3]	elements/m	n.r. [4]	n.r.	± 3 %
Grid apertures	Annex F [3]	mm	n.r.	n.r.	± 15 %
Mechanical tests					
Tensile strength	EN ISO 10319	kN/m	-10 %	-10 %	n.r.
Elongation at max. load	EN ISO 10319	%	-20 %	-20 %	n.r.
Nominal tensile strength	EN ISO 10319 [5]	kN/m	n.r.	n.r.	-5 %
Tensile strain at nominal strength	EN ISO 10319 [5]	%	n.r.	n.r.	± 20 %
Tensile stiffness at 2, 5, 10 % tensile strain	EN ISO 10319 [5]	kN/m	n.r.	n.r.	-20 %
Static puncture test	EN ISO 12236	kN	-10 %	-10 %	-10% [6]
Dynamic perforation resistance	EN ISO 13433	mm	+25 %	+25 %	+25% [6]
Hydraulic tests					
Water permeability normal to the plane, without load (velocity index V_{H50})	EN ISO 11058	l/(m²·s)	-30 %	-30 %	-30 % [6]
Characteristic opening size	EN ISO 12956	µm	± 30 %	± 30 %	± 30 % [6]
Suitable for installation under Nordic conditions and temperatures					
Proven for installation under low temperatures	NorGeoSpec, Annex G.2	-	* [7]	* [7]	* [7]

[2] We regard the plus/minus NGS-tolerance on the mass per unit area as an indication of the process stability. Process stability means that the process delivers constant, predictable results.
[3] Applicable only for geogrids (definition acc. EN ISO 10318).
[4] n.r. = not required
[5] MD and CMD direction. For uniaxial products, test only the direction of load uptake
[6] Voluntary
[7] Proven for installation under low temperatures “down to -10°C” and/or “down to 0°C”

Performance assessment

Service Life (Service Life up to 25, 50 and 100 years)

If a product service life up to 25, 50 and 100 years is to be certified for a product, the product or product family must fulfil all the conditions and requirements set out in relevant hEN application standards

Reduction factors (function reinforcement)

The reduction factors must follow the principles of ISO/TR 20432 and ISO/TS 13434

- the reduction factor determination should be made by an expert recognised by the NCB
- the tests forming the basis of the service life and reduction factor determination may not be older than 5 years and must have been carried out in accordance with, or based on, the procedures detailed in Table 2, Reduction factors determination. If the tests are older than 5 years, confirmation testing on validity shall be provided
- the tests forming the basis of the product service life and reduction factor determination shall be carried out in laboratories which are accredited in accordance with EN ISO/IEC17025 and / or recognised by the NCB

Should any doubt exist regarding the competence of individual laboratories, the NCB reserves the right to reject the results of such laboratories. In individual cases, testing may be carried out in the producer's laboratory (if this laboratory is appropriately equipped). In such cases, the NCB will convince itself of the competence of the producer's laboratory.

The producer must regularly update the data which formed the basis for the product lifetime estimate.

The nature and extent of this testing are agreed between the producer and the NCB, and form part of the certification.

Table 2: Reduction factor determination

Characteristic	**Standard**	**Requirements**
Resistance to weathering	EN 12224	RF_W [-] Reduction factor for weathering
Chemical resistance [8]	EN 12447 EN ISO 13438 EN ISO 12960	RF_{CH} [-] Reduction factor for environmental effects
Tensile creep rupture	EN ISO 13431 ASTM D 6992	RF_{CR} [-] Reduction factor for creep-rupture
Damage during installation	Annex G	RF_{ID} [-] Reduction factor for installation damage on tensile strength
		$RF_{ID, J}$ [-] Reduction factor for installation damage on tensile stiffness
Direct shear test [9]	EN ISO 12957-1	Manufacturer declaration

The tests listed in Table 2 can be performed on type representative of the product group.

[8] Depending on raw material
[9] Voluntary

Table 3: Design and/or specification references and key characteristics for evaluation of damage test during installation under Nordic conditions at negative temperatures (according to Annex G)

Application	**Design and/or specification reference(s)**	Tensile strength EN ISO 10319	Tensile strain EN ISO 10319	Tensile stiffness (2, 5, 10%) EN ISO 10319	Robustness factor NGS, Annex H	Characteristic opening size EN ISO 12956	Water Permeability (velocity index) EN ISO 11058
Separation / filtration in trafficked areas	NGS, Annex H	T_{max}			EI	O_{90}	V_{H50}
Filtration in drainage systems	NGS, Annex H				EI	O_{90}	V_{H50}
Reinforcement applications	NGS, Table 2	T_{max}		J [10]			

[10] Stiffness J should be added on the Table 2 (RF_{ID}, J) (according to ROUGH Guidelines paragraph 1.4.6)

Annex D: Sampling and sampling procedure

General

Samples are taken in accordance with EN ISO 9862 - Geosynthetics: Sampling and preparation of test specimens. Two samples (A- and B-Sample) are taken from two different rolls [11] [12]. The sample lengths are:

- for the Separation and Filtration functions: 5 m (over the whole width of the roll)
- and for the Reinforcement function: 2 m (over the whole width of the roll)

Samples A and B are sent to the testing laboratory mandated by the NCB. In case B-sample testing is necessary, the tests are carried out in a different testing laboratory as the A-Sample.

To reduce the number of sampled rolls, the B-Sample roll can be sealed. In case B-Sample testing is necessary, the sealed part of the roll must be cut of and send to the testing laboratory mandated by the NCB.

In case of B-Sample testing, only the failed characteristic(s) and the identification tests must be repeated. The producer is free to take additional samples for his own Factory Production Control. The producer is responsible for the dispatch of samples.

The samples must be identified in an unmistakable manner and the following minimum information must be provided:

a. description of the sample (A- or B-Sample)
b. product name and type
c. production direction
d. roll number and date of sampling
e. signature of person responsible for sampling

The person responsible for sampling must write a report, sign it, and have it countersigned by the producer or the producer's representative. The report must contain at least the following information:

a. producer and factory
b. location of sampling
c. product name and type
d. roll number
e. product function (Separation and Filtration, Reinforcement, …….)
f. product description in accordance with EN ISO 10320
g. details of all variances from the defined sampling procedure, including observations made during selection and sampling (e.g. faulty areas)
h. number of rolls in the warehouse or on site of each product due for testing
i. place and date
j. signatures (Producer/Representative, Person responsible for sampling)

A copy of the report is given to the producer immediately after sampling; the original is retained by the person responsible for sampling.

The following minimum number of rolls of each NorGeoSpec-certified product must be available in the producer's or the dealer's warehouse, or on site, for initial product testing and for regular sampling for continuous monitoring:

- for the Separation and Filtration function 10 rolls
- and for the Reinforcement function 5 rolls

Shipment:

Products for function separation and filtration should be fold not smaller than 1m x 1m.

Products for function reinforcement should (depends on product) preferably shipped winded on a solid core.

[11] To sample as wide a cross-section of the production as possible, rolls should be selected whose numbers are spaced as far apart as possible.

[12] Samples are taken from the max. width which is delivered to the market.

Unannounced random product sampling

The selection of products for random sampling may be based upon information as to which products have already been produced and are therefore available at the time of the audit.

For products of which less than 2,000 m² have been produced in the previous 12 months, no sampling is required. In this case, the producer must notify the NCB in writing that less than 2,000 m² have been produced. Sampling is then carried out as soon as manufacture of the product is restarted. For these products, the NCB is informed in advance on production dates of materials requested for sampling.

Table 4: Definition of representative stock and number of products to be sampled based on the numbers of products in the range (unannounced random product sampling)

No. of products certified [13]	Number of products on stock	Number of products sampled
n = 1	1	1
n ≤ 5	at least 2 or 80 % of n [14]	at least 2
5 < n ≤ 10	at least 6 or 80 % of n [14]	at least 50% of n [13]
n > 10	at least 8 or 80 % of n [14]	at least 50% of n [13]

[13] Valid for one product range

[14] If the result of multiplying by 50 % or 80 % is a fraction, the number is rounded up

Annex E: Scope of Random Control-Check Testing

Random control

The properties to be tested in the random control checks can be selected from Table 5.

Table 5: List of possible tests for random control-check [15]

Characteristic	Standard	Unit	Function		
			Filtration	Separation	Reinforcement
Mass per unit area	EN ISO 9864	g/m²	+	+	+
Tensile elements in MD & CMD	Annex F	elements/m	n.r.	n.r.	+
Dimensions	Annex F	mm	n.r.	n.r.	+
Mechanical tests					
Max. tensile strength	EN ISO 10319	kN/m	+	+	
Tensile strain at max. load	EN ISO 10319	%	+	+	n.r.
Nominal tensile strength	EN ISO 10319	kN/m	n.r.	n.r.	+
Tensile strain at nominal strength	EN ISO 10319	%	n.r.	n.r.	+
Tensile Stiffness at 2, 5, 10% strain	EN ISO 10319	kN/m	n.r.	n.r.	+
Static-puncture test	EN ISO 12236	kN	+	+	see Table 1
Dynamic perforation resistance	EN ISO 13433	mm	+	+	see Table 1
Hydraulic tests					
Water permeability normal to the plane, without load (velocity index V_{H50})	EN ISO 11058	l/(m²·s)	+	+	+
Characteristic opening size	EN ISO 12956	µm	+	+	n.r.

[15] Not all properties are required to be tested during the random control testing.

Performance assessment

The assessment of product reduction factors is valid for five years starting from the date of issue of the certificate. Throughout this period it must be ensured that the test values on which the assessment is based remain valid, and that they reflect the behaviour of the product at the time of first certification.

The testing programme required to ensure this is determined and monitored by the NCB (and the independent expert, if required). The NCB ensures that all applicants are treated equally in this regard.

Among other items, the test programme to ensure maintenance of long-term properties will

- determine test regimes and frequency of testing
- establish how many products are required to represent a product family
- stipulate which tests are to be performed and how the results are to be interpreted/evaluated
- determine what action is to be taken when results do not correspond with the pre-determined values

Annex F: Test procedure for the number of tensile elements and dimensions of grid apertures

- **Tensile elements in MD**

The test method is used to determine the tensile elements/m in MD.

Test set-up

The test set-up must allow measurement of the dimensions to an accuracy of ± 1 mm.

Testing

Count the numbers of tensile elements in MD over a width of minimum 1,000 mm [16]. State the number *n* of counted elements. Measure the distance *d* in mm from the edge of the first element to the edge of counted element number *n*. Divide 1,000 [mm] by *d* [mm] and multiply with (*n*-1) elements. The measurement must take place in the middle of the mesh.

Repeat this procedure at three different locations over the production width and calculate the average.

Remarks:
The result is rounded to one decimal point.

- **Tensile elements in CMD**

The test method is used to determine the tensile elements/m in CMD.

Test set-up

The test set-up must allow measurement of the dimensions to an accuracy of ± 1 mm.

Testing

Count the numbers of tensile elements in CMD over a length of minimum 1,000 mm. State the number n of counted elements. Measure the distance d in mm from the edge of the first element to the edge of counted element number n. Divide 1,000 [mm] by d [mm] and multiply with (n-1) elements. The measurement must take place in the middle of the mesh. See Figure 3

Repeat this procedure at three different locations over the production length and calculate the average.

Remark:
The result is rounded to one decimal point.

[16] For materials with less than 1,500 mm roll width, it is recommended to measure over the entire width of the material and repeat the process at three different locations over the production length.

Example

Over a distance *d* = 1,045 mm, *n* = 25 CMD tensile elements are counted:

$$\text{tensile elements CMD} = \frac{1{,}000\ \text{mm}}{\text{d}} \cdot (\text{n-1}) = \frac{1{,}000\ \text{mm}}{1{,}045\ \text{mm}} \cdot (25\text{-}1) = 22.96 \approx 23.0\ \text{elements/m}$$

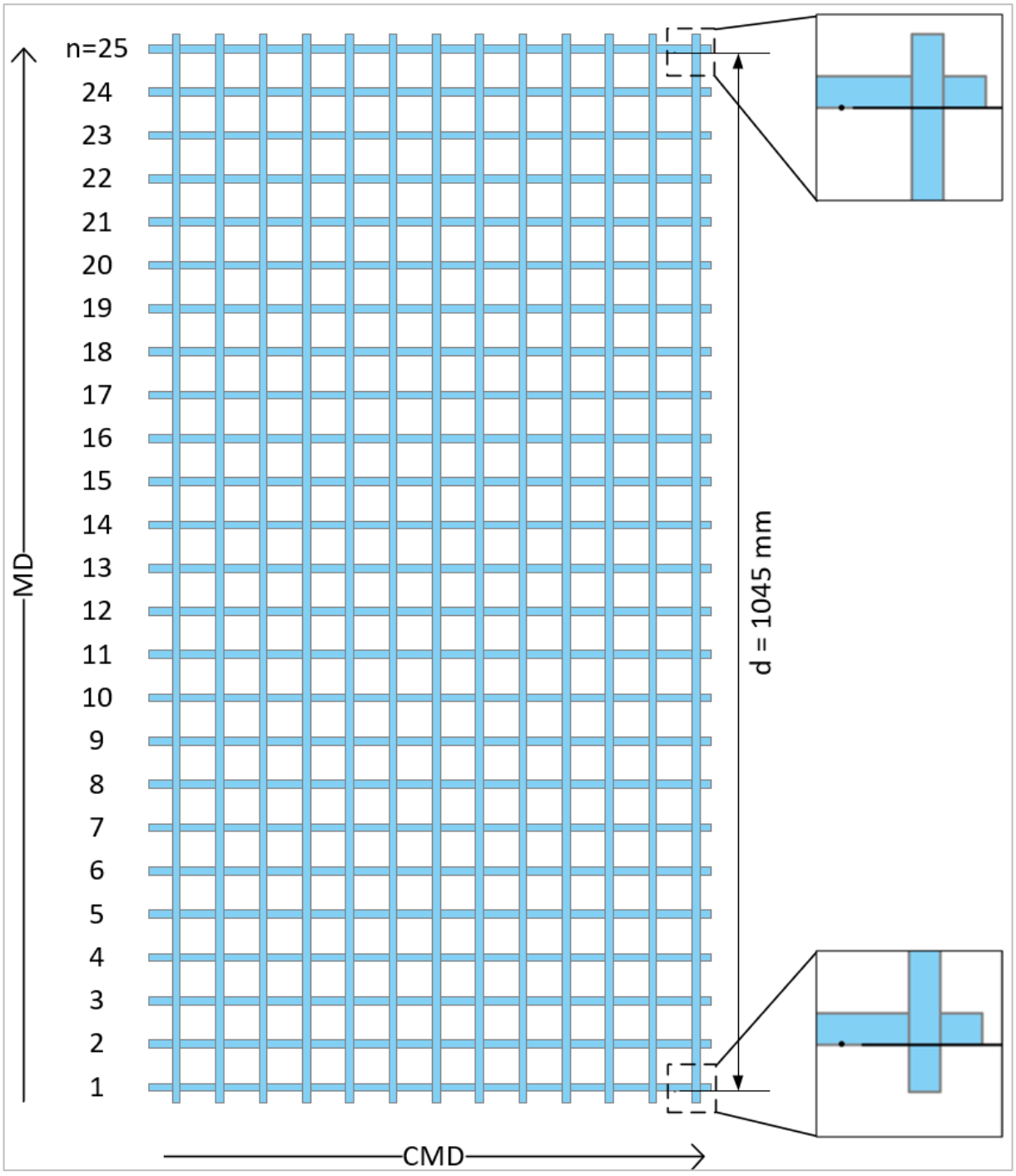


Figure 3: Example of tensile elements in CMD

- **Dimensions of grid apertures**

The test method is used to determine the dimensions of the grid apertures and is only to be used for geogrids (GGR).

The report shall specify the following: Mean value, standard deviation and coefficient of variation

Test set-up

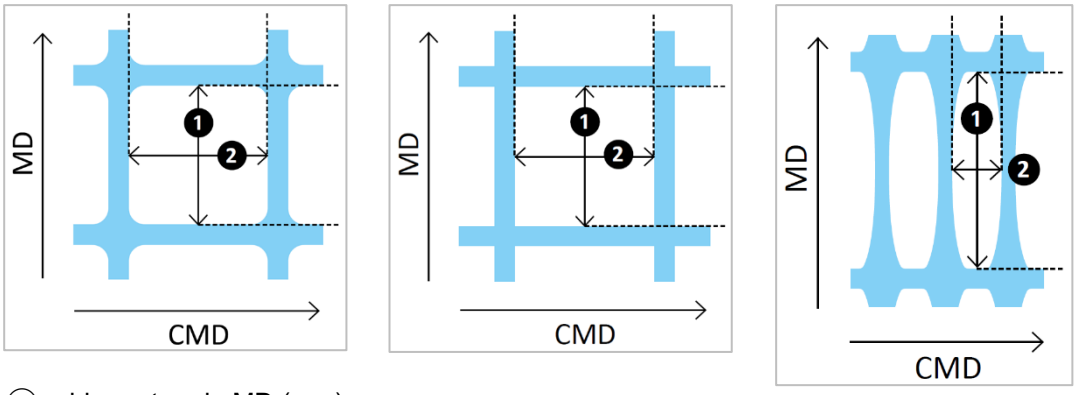
The test set-up must allow measurement of the dimensions of the grid apertures, to an accuracy of ± 0.1mm.

Test pieces

Cut at least 10 test pieces (dimensions min. 200 x 200 mm or use the specimen of the mass per unit area test) spaced over the full width of the sample. The test pieces must be conditioned for 24 h under standard-climate conditions in accordance with ISO 554 (20 ± 2°C, RH 65 ± 5%).

Testing

The tests must be performed on one mesh per specimen and specified in mm, with one decimal point. The measurement must take place in the centre of the mesh.



① grid aperture in MD (mm)

② grid aperture in CMD (mm)

Annex G: Test procedure damage during installation

G.1 - Test procedure for damage during installation at positive temperature

Additional to the index tests in accordance with EN ISO 10722 large scale tests must be carried out to determining the reduction factor for damage during installation.

The testing procedure for large scale tests for determining the reduction factor damage during installation is described below.

From the roll of geosynthetic, cut a test sample of sufficient size to serve as reference material for at least 5 wide-width tensile-strength tests according to EN ISO 10319. When performing the tests, deviate from EN ISO 10319 in ensuring that the free gauge length is 300 mm and that, in the case of geogrids, at least 2 complete grid apertures in test direction are tested. If necessary, protection of the clamping area can be used.

The product to be tested is laid out on a defined surface, aggregate is placed and compacted. The aggregate is excavated and the product removed, taking care that no additional damage is caused during removal.

A 250 mm thick layer of the appropriate aggregate is placed and compacted on a subgrade which is firm enough to permit proper compaction. The bearing capacity and the aggregate used must be stated. The geosynthetic to be tested is then laid on this compacted formation. Before the upper aggregate layer is placed, the areas to be used as test pieces are marked on the geosynthetic. The 10 test pieces (500 x 200 mm plus 100 mm in each direction) must be evenly distributed over the loaded area. The edges of the 10 samples to be tested must be defined in such a way that they can be positively identified after the samples have been excavated.

The tests must be carried out in the same manner as the reference tests, on the same testing machine with the same clamps and under the same test conditions. All 10 test pieces must be tested and the results included in the test evaluation. The upper 250 mm thick aggregate layer should ideally be placed using a vibratory compactor with a weight between 10 and 12 tonnes. Dynamic compaction should be carried out until a standard Proctor density D_{pr} of 95 % is achieved. After compaction, the degree of compaction of the fill must be determined.

Three different aggregate particle sizes (fine, medium, coarse) should be used.

The test report must describe the soil and/or aggregate types used including their origin and angularity, the installation and the type of equipment used. In addition, the number of roller passes and the degree of compaction of the aggregate must be stated.

The reduction factor is stated as the reciprocal of the average value exhumed /average value reference of the residual tensile strength.

G.2 – Requirements for test procedure for damage during installation under Nordic conditions at negative temperatures (down to -10°C)

The evaluation of the suitability of the product for an installation under Nordic conditions at negative temperature (down to -10°C) is based on the results of the ROUGH project and subsequent *Guidelines for the Use of Geosynthetics in Nordic conditions (ROUGH)*. The project has shown that, if the geosynthetic is correctly designed according to the relevant design/specification reference for positive temperature (e.g., +20°C) for the defined geotechnical Nordic conditions no additional installation damage is observed on the key characteristics when product is installed under same Nordic conditions at -10°C.

Also if the results have been established for already 13 products tested in the ROUGH project, this does not answer the question of whether every material can be installed at low temperatures.

Therefore, appropriate approval should be available before installing the materials at cold temperatures.

NorGeoSpec proposes the corresponding certification for “Suitable for installation under Nordic conditions and temperatures down to -10°C”.

Such approval shall be achieved through performance tests carried out and documented in advance under predefined Nordic conditions. The requirements for a full-scale preliminary installation procedure under Nordic conditions at negative temperature are described in the Table 6. The test shall be carried out under the surveillance of an independent third party.

The results will be evaluated for key characteristics on the base of the relevant design and/or specification references *(Table 3)*. If the values obtained for the product show that for all key

characteristics no additional installation damage [17] is observed when installed under same Nordic conditions at -10°C, the product can be considered “Suitable for installation under Nordic conditions and temperatures down to -10°C”.

Note: The full scale realised during the ROUGH project is considered as answering all requirements of the Table 6.

[17] evaluation is based on the NorGeoSpec method

Table 6: Requirements for full-scale installation test procedure under Nordic conditions.

Parameters	Controlled item	Comments
Average temperature during installation and compaction	-10°C (± 5°C) [18]	Shall be monitored (as far as possible by an official institute), during installation of the geosynthetics, during the compaction & during the removal periods.
In-situ soil (foundation soil)	Class	Geotechnical characterisation (at least particle size, strength and stiffness)
	E_{V2} (MN/m²)	Average bearing capacity modulus
Aggregate	Crushed rock	Geotechnical characterisation (at least aggregate size and angularity e.g., 0/56) acc. to EN 13242
	Drop height	According to function (reinforcement DH = 1.0 m, filtration DH = 1.0 & 2.0 m, drainage DH = 1.0 m)
	Thickness of layer	Thickness = 30 cm
	E_{V2} (MN/m²)	Compaction acc. Finnish (InfraRYL) road construction guidelines or Swedish (AMA Anläggning) or Norwegian (N200)
Geosynthetic	Test specimens pre-marking before installation	Locations of specimens for further laboratory testing shall be pre-marked on the product according to the planned functional characteristics to be evaluated.
	Recovery of samples	To avoid additional damage to the samples during the recovery, a vacuum / sucking lorry should be used.
	Laboratory testing of the recovered samples	Shall be performed at +20°C on the relevant characteristic according to the function (Table 1)
	Performance under Nordic conditions	Expressed as Vulnerability Index (VI) on the relevant characteristic(s) according to the function
	Laboratory testing on virgin samples	Complementary testing at negative reference temperatures (e.g., -10°C, -20°C) on relevant functional characteristic(s) may usefully complete the evaluation of performance under Nordic conditions.

[18] Other reference temperatures may be chosen depending on the location (e.g., -15°C, -20°C)

Part 2 - Product Specification (PS)
Function: Separation and Filtration – roads and other trafficked areas, Filtration in drainage systems

Table of contents

1. General

This part of the guideline presents the Nordic system for specification of geosynthetics, and geosynthetic-related products used for

- separation and filtration in roads and trafficked areas

  in areas covered by the relevant hEN application standards (EN 13249 road and trafficked areas, EN 13250 railways).

- Filtration in drainage system

  in areas covered by the relevant hEN application standard (EN 13252)

Products which are intended to be specified in accordance with a specification require a NorGeoSpec product certificate in accordance with Part 1 of these Guidelines.

Product specifications acc. to Part 2 of the NorGeoSpec guideline are voluntary.

2. Specification process

Compliance with the NorGeoSpec specifications is declared by the NorGeoSpec Certification Body (NCB) to any manufacturer who applies for it, or to his authorized representative, on condition that the product concerned satisfies the rules currently published on the website www.norgeospec.org.

Compliance with the requirements can be achieved by a

- Product Specification (PS)

The NCB is the prime contact of the manufacturer, or the manufacturer´s authorized representative. The NCB administrates the procedures of both " Product Certification" and "Product Specification" and is advised by the TC.

2.1. Function: separation and filtration in roads and other trafficked areas

The specification part of the function separation and filtration includes five specification profiles based on seven characteristics measured with test methods defined by CEN and ISO. The system also includes guideline for selection of the relevant specification profile.

The separation function is always used in conjunction with filtration; accordingly the separation will never be specified alone.

This specification should not be applied in cases where high water flow is expected, such as in ditches. In such cases other specifications based on a site-specific design should be used.

With the specification procedure, the products under examination can be allocated to one of the 5 different specified profiles in NorGeoSpec, Table 7 of this document. Guidelines for evaluation of the relevant specification profile dependent on the application are given in NorGeoSpec, *Annex I.*

The applicant receives a certificate of the profile achieved (NorGeoSpec product certificate).

2.2. Function: filtration in drainage systems

The specification part of the function filtration includes six specification profiles based on three characteristics measured with test methods defined by CEN and ISO. The system also includes guidelines for selection of the relevant specification profile and depending on the type of application: drainage trench, drainage mattress or drainage mask.

With the specification procedure, the products under examination can be allocated to one of the different specified profiles in NorGeoSpec, *Table 8 & Table 9* of this document. Guidelines for evaluation of the relevant specification profile dependent on the application are given in NorGeoSpec, *Annex I*.

2.3. Decision procedure: Product Specification

Function: separation and filtration roads and other trafficked areas

- the results of initial product testing must comply with the requirements of the profile applied for *(Table 7)*

Function: filtration in drainage systems

the results of initial product testing must comply with the requirements of

- the *Filter profile* applied for *Table 8*
- and the *Mechanical profile* applied for *Table 9*

2.4. Validity of the certificate

The NorGeoSpec Product Specification is valid in all countries in which NorGeoSpec is applied.

The NCB distributes the information on the website www.norgeospec.org.

NorGeoSpec product certificates are valid permanently if the re-certification process after 2 years is passed successfully.

The NorGeoSpec product certificate state:

- the name of the NCB which has issued the PC
- signature of responsible persons in the NCB and head of TC

Function: separation and filtration in road and trafficked areas

- the profile number of the product

Function: filtration in drainage systems

- the *Filter profile* number of the product
- the *Mechanical profile* number of the product

Annex H: Required values – Product Specification

1. Function: separation and filtration in roads and other trafficked areas

Table 7: Required values – Product Specification

Characteristic	Testing standard	Unit	Maximum tolerance [19]	Function: separation and filtration (Roads and other trafficked areas)				
				Required [20] values corresponding to 95% confidence limit				
				Product Specification profiles				
				1	2	3	4	5
Min. tensile strength	EN ISO 10319	kN/m	-10%	6	10	15	20	26
Min. tensile strain at max. load	EN ISO 10319	%	-20%	15	20	25	30	35
Max. cone drop diameter	EN ISO 13433	mm	+25%	44	38	28	22	13
Min. energy index [21]		kN/m		1.2	2.1	3.2	4.5	6.5
Min. water permeability normal to the plane, without load (velocity index V_{H50})	EN ISO 11058	l/(m²·s) [22]	-30%	3	3	3	3	3
Max. char. Opening size, O_{90}	EN ISO 12956	µm	+30%	200	200	200	150	150
Max. tolerance for mass per unit area	EN ISO 9864	g/m²	±10%					
Max. tolerance for static puncture strength	EN ISO 12236	kN	-10%					

[19] The tolerance shall be stated by the manufacturer; this table gives the maximum allowable tolerance
[20] The tolerances are not to be added to the required values. The nominal values ± the tolerance is defined as the 95%-confidence limit and shall fulfil the requirement.
[21] The certificate holder declares the Energy Index. The Energy Index does not necessarily have to correspond to the values (tensile strength and tensile strain) indicated on the certificate.
[22] The velocity index for a head loss of 50 mm (V_{H50}) may be expressed in l/(m²·s) or in m/s. For conversion use: 1 l/(m²·s) = 0.001 m/s.

2. Function: filtration in drainage systems

The products used for filtration in drainage systems are defined by the combination two components:

- one or more of the six *Filter profiles* **(Fp)** *(Table 8)*
- and one of the four *Mechanical profiles* **(Mp)** *(Table 9)*

Table 8: Required values for the Filter profile (Fp) – Product Specification

	Function: filtration (drainage system)								
Characteristic	**Testing standard**	**Unit**	**Maximum tolerance** [23]	**Required** [24] **NGS declared mean values**					
				Product Specification Filter profiles					
				Fp 1	**Fp 2**	**Fp 3**	**Fp 4**	**Fp 5**	**Fp 6**
Min. water permeability normal to the plane without load (velocity index V_{H50})	EN ISO 11058	l/(m²·s) [25]	-30%	5	0.5	0.5	5	0.5	30
Max. char. Opening size, O_{90}	EN ISO 12956	µm	+30%	150	150	200	300	300	500
Min. char. Opening size, O_{90}		µm	-30%	63	63	63	63	63	63
Max. tolerance for mass per unit area	EN ISO 9864	g/m²	±10%						

Table 9: Required values for the Mechanical profile (Mp) - Product Specification

Function: filtration (drainage system)								
Characteristic	**Testing standard**	**Unit**	**Maximum tolerance** *26*	**Required** [27] **values corresponding to 95% confidence limit**				
				Product Specification Mechanical profiles				
				Mp 1	**Mp 2**	**Mp 3**	**Mp 4**	**Mp 5**
Min. energy index		kN/m	-	not in use	2.1	3.2	4.5	6.5
Max. tolerance for mass per unit area		g/m²	±10%					

[23] The tolerance shall be stated by the manufacturer; this table gives the maximum allowable tolerance
[24] The NGS declared mean values must fulfil the filtration requirements.
[25] The velocity index for a head loss of 50 mm (V_{H50}) may be expressed in l/(m²·s) or in m/s. For conversion use: 1 l/(m²·s) = 0.001 m/s.
[26] The tolerance shall be stated by the manufacturer; this table gives the maximum allowable tolerance
[27] The tolerances are not to be added to the required values. The nominal values ± the tolerance shall fulfil the requirement.

Strength and strain properties, 95% confidence limits

The 95% confidence limits for strength and strain characteristics are calculated as:

$$F_{MD,95} = \{F_{MD} - T_{F,MD}\}, \quad F_{CMD,95} = \{F_{CMD} - T_{F,CMD}\}$$

$$\varepsilon_{MD,95} = \{\varepsilon_{MD} - T_{\varepsilon,MD}\}, \quad \varepsilon_{CMD,95} = \{\varepsilon_{CMD} - T_{\varepsilon,CMD}\}$$

For the tensile strength and tensile strain at maximum load the specification profiles are related to average characteristics in machine and cross machine direction (MD and CMD). To give limited credit for significant differences in strength in MD and CMD, a uniformity requirement (U= 1.5) is included in this specification. Strength values higher than 1.5 times the minimum of the MD and the CMD are not accounted for. The 95% confidence limits for the average characteristics are then calculated as:

$$F_{a,95} = \frac{1}{2} \cdot \{F_{MD,95} + F_{CMD,95}\}, \quad \left[F_{a,95} \leq \frac{1}{2} \cdot (1+U) \cdot Min(F_{MD,95}, F_{CMD,95})\right]$$

$$\varepsilon_{a,95} = \frac{1}{2} \cdot \{\varepsilon_{MD,95} + \varepsilon_{CMD,95}\}$$

Strain energy index, 95% confidence limit

The strain energy index R is defined as the product of the maximum tensile strength multiplied with the strain at maximum strength divided by two. The average of MD and CMD is used for both strength and strain.

$$R_a = \frac{1}{2} \cdot F_a \cdot \varepsilon_a$$

The manufacturers are not obligated to state the tolerance value for the strain energy index R. T_R is therefore estimated on basis of the tolerances for strength and strain. The average tolerances in machine and cross machine direction are calculated as:

$$T_{F,a} = \frac{1}{2}(T_{F,MD} + T_{F,CMD}), \qquad T_{\varepsilon,a} = \frac{1}{2} \cdot (T_{\varepsilon,MD} + T_{\varepsilon,CMD})$$

The nominal values for the average strength and strain properties are calculated as:

$$F_a = \frac{1}{2} \cdot \{F_{MD} + F_{CMD}\}, \quad F_a \leq \frac{1}{2} \cdot (1+U) \cdot Min(F_{MD}, F_{CMD})$$

$$\varepsilon_a = \frac{1}{2} \cdot \{\varepsilon_{MD} + \varepsilon_{CMD}\}$$

Assuming that the tensile strength and the strain at maximum tensile strength are independent variables, the tolerance of the strain energy index can be estimated with the following formula [28]:

$$T_{R,a} = \frac{1}{2}\sqrt{T_{F,a}^2 \cdot \varepsilon_a^2 + F_a^2 \cdot T_{\varepsilon,a}^2}$$

The 95% confidence limit for R is expressed as:
$R_{a,95} = \frac{1}{2} \cdot F_a \cdot \varepsilon_a - T_{R,a}$

[28] The calculation must be done with the tolerances in engineering units.

Annex I: Guidelines for selection of specification profile

1. Application roads and trafficked areas: function separation/filtration

The selection of specification profile may be based on subsoil conditions, aggregate grain size and a combination of construction conditions and quality requirements for the road. For conditions not covered by these guidelines, a special evaluation of required specification profile should be done.

The construction conditions and road-quality requirements are combined into traffic classes *Normal* and *High* according to the following:

Subsoil:

The subsoil is divided into two groups, *Soft* respectively *Medium & Firm*; these groups can be categorised according to soil type and shear strength:

- *Soft* - clay with undrained shear strength $c_u \leq 25$ kPa and peat
- *Medium - clay with undrained shear strength* $25 < c_u < 50$ *kPa*
- *Firm* - clay with undrained shear strength ≥ 50 kPa and sand or gravel

Construction conditions:

- *Normal* - Two or more of the following conditions: Heavy construction traffic, angular and sharp aggregate e.g. crushed rock, compaction with heavy and vibrating equipment, construction traffic running on aggregate layers with a thickness less than 300 mm
- *Favourable* - For rounded aggregate with maximum grain size < 200 mm and layer thickness > 1.5 x max. grain size

Traffic:

- *High* - medium and high-volume roads (> 500 vehicles per day)
- Low - access roads, lightly trafficked roads (≤ 500 vehicles per day)

Based on these input parameters, the selection of relevant specification profile can be made according to Table 10.

Table 10: Selection of relevant specification profile

Subsoil	**Construction conditions**	**Traffic**	**Maximum grain size (D_{max}) in aggregate (mm)**			
			$D_{max} \leq 63$	**$63 < D_{max} \leq 200$**	**$200 < D_{max} \leq 500$**	**$D_{max} > 500$**
Soft	Normal	High Low	3 3	4 4	5 4	5 5
	Favourable	High Low	3 2	3 3		
Medium & Firm	Normal	High Low	2 2	3 2	3 3	4 3
	Favourable	High Low	2 2 [29]	2 2		

[29] Specification profile 1 may be used for roads with temporary traffic, access roads or similar.

2. Application drainage systems: function filtration

The specification profile of the products used for filtration in drainage systems are defined by the combination two components:

- one of the six *Filter profiles* **(Fp)** (Table 8)
- and one of the four *Mechanical profiles* **(Mp)** (Table 9)

The selection of specification profiles depends on the type of application of the drainage system:

- drainage trench

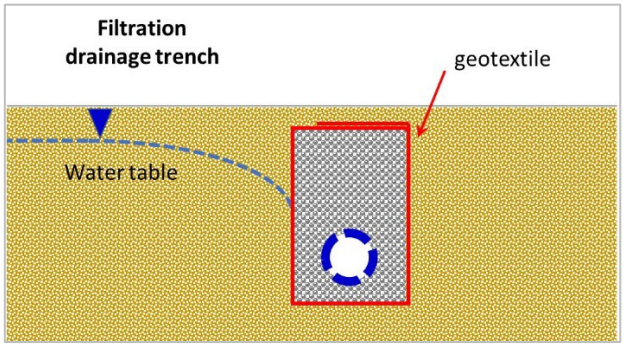


Figure 4: Schematical cross section of filtration function in drainage trench

- drainage mattress under embankment on soft soil

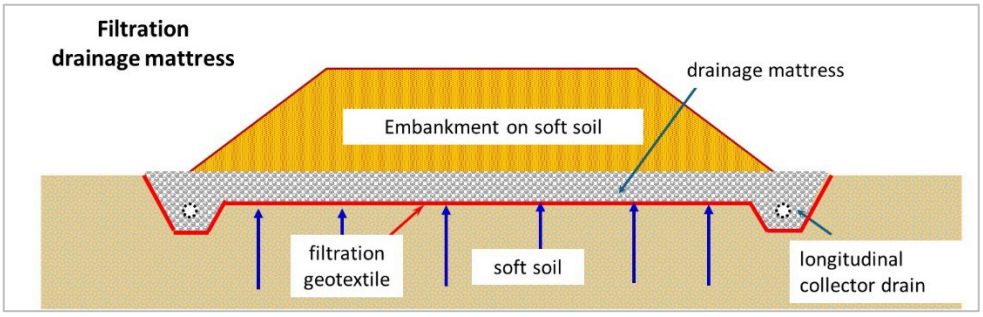


Figure 5: Schematical cross section of filtration function under drainage mattress

- drainage mask on slope

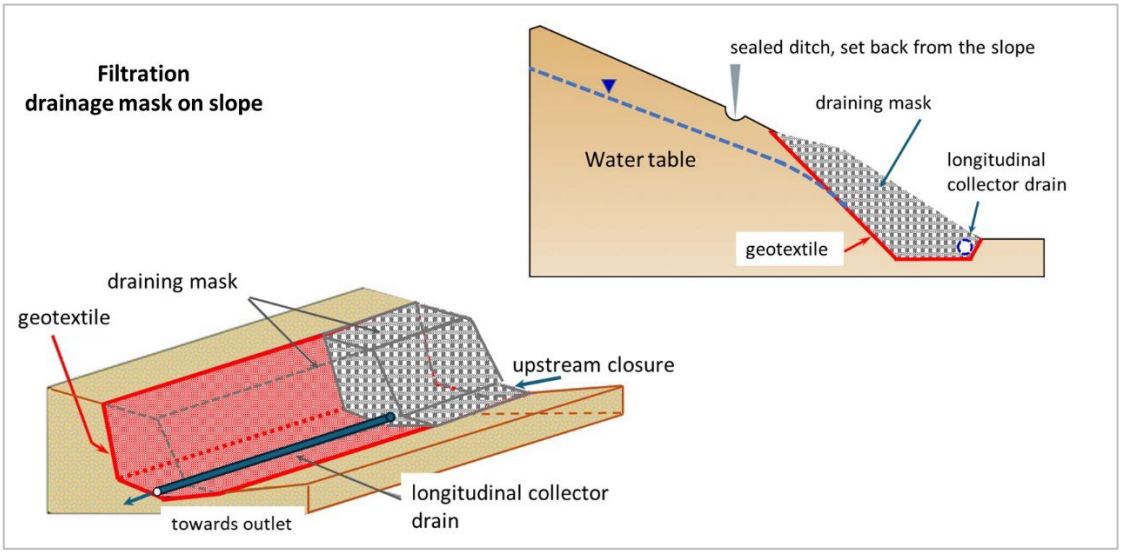


Figure 6: Schematical cross section of filtration function under drainage mask on slope

Nevertheless for all these 3 applications, the in-situ soil conditions need to be defined by its granularity and its hydraulic properties:

- the granularity allows to precise the capability of the in-situ soil skeleton to be stable up-stream of the geotextile and to avoid risk of piping or of clocking; this is controlled by the opening size of the geotextile (O_{90})
- the hydraulic properties of the in-situ soil allow to evaluate how water can pass through the geotextile without loss of charge; this is controlled by the water permeability of the geotextile (velocity index V_{H50})

To facilitate the design, granularity classes (Table 11) and hydraulic classes (Table 12) of the soil have been defined.

The Granularity classes are based on the Uniformity Coefficient $C_U = D_{60} / D_{10}$ of the in-situ soil.

Table 11: Soil granularity classes

G 1	**G 2**	**G 3** medium to well graded [30]	**G 4** uniformly graded to poorly graded [30]
Clean sand & gravels [31]	Fine soils [32]	Mixed soils $C_U \geq 5$	Mixed soils $C_U < 5$

$C_U = D_{60} / D_{10}$

Note: The case of the in-situ soils with internal erosion risks (e.g. granularity with concave curve) shall be designed and specified specifically for the site.

The Hydraulic classes of the in-situ soil are based on its permeability. Nevertheless, to facilitate the design, the classes are presented versus the usual permeability measured on current soils: gravel, sand, silt and clay (see Table 12).

Table 12: In-situ soil hydraulic classes

H1 Very permeable	**H2** Permeable	**H3** Low permeable	**H4** Very low permeable
k_s: 10^{-2} to 10^{-4} m/s	k_s: 10^{-4} to 10^{-5} m/s	k_s: 10^{-5} to 10^{-6} m/s	k_s: 10^{-6} to 10^{-12} m/s

Gravel	**Sand**	**Silt**	**Clay**

[30] acc. to EN ISO 14688-1
[31] clean gravels and sands & gravels and sands with some fines but passing 63 µm < 12%
[32] passing 63 µm > 35 % and $D_{max} \leq 45$ mm ($I_p > 12$ %)

2.1. Selection of specification profile of filtration products in drainage trench

The selection of the Filtration geotextile profile is based on 2 components.

2.1.1. The *Filter profile* **Fp** of the geotextile (as defined in Table 8) which is selected based on

- the characteristics of the in-situ soil (Granularity (as defined in Table 11) and
- the Hydraulic characteristic (as defined in Table 12))

For conditions not covered by these guidelines, a special evaluation of required specification profile should be done.

The Table 13 gives the *Filter profile* **Fp** depending on the Granularity & Hydraulic characteristic of the in-situ soil.

Table 13: Selection of Filter profile of the geotextile for drainage trench depending on the in-situ soil characteristics (Granularity & Hydraulic characteristic)

	In-situ soil permeability			
In-situ soil granularity	**H1** Very permeable	**H2** Permeable	**H3** Low permeable	**H4** Very low permeable
G1 Clean sand & gravels	**Fp 6**			
G2 Fine soils				**Fp 3** [33]
G3 Mixed soil $C_U \geq 5$			**Fp 4**	**Fp 5**
G4 Mixed soil $C_U < 5$			**Fp 1**	**Fp 2**

Note: Verification of durability performance of the geotextile shall be carefully checked in case of in-situ soil and/or granular drainage material having extreme alkaline or extreme acidic pH.

Note: Long term risk of biological clogging or calcification clogging shall be eventually evaluated when necessary.

2.1.2. The *Mechanical profile* **Mp** of the geotextile (as defined in Table 9) which is selected based on:

- the Mechanical Class of the in-situ soil (soft, medium or firm)
- the type of drainage material used in the trench (rounded or angular)
- the drainage trench depth (H ≤ 1 m or 1 m < H ≤ 2 m)

For conditions not covered by these guidelines, a special evaluation of required specification profile should be done.

The Table 14 gives the *Mechanical profile* **Mp** depending on the Mechanical class of the in-situ soil, the type of drainage material and the depth of the drainage trench.

[33] passing 63 µm > 35 % and $D_{max} \leq 45$ mm ($I_p > 12$ %)

Table 14: Selection of Mechanical profile of the geotextile for drainage trench

Drainage trench depth	**H ≤ 1 m**		**1 m < H ≤ 2 m**	
Drainage material	**rounded**	**angular**	**rounded**	**angular**
In-situ soil mech. class				
S0 Soft	Mp 3	Mp 4	Mp 4	Mp 5
S1 Medium	Mp 2	Mp 3	Mp 4	Mp 5
S2 Firm	Mp 2	Mp 3	Mp 3	Mp 4

Note: Verification of durability performance of the geotextile shall be carefully checked in case of in-situ soil and/or granular drainage material with extreme acidic or alkaline pH (4 > pH >9).

2.2. Selection of specification profile of filtration products in drainage mattress over soft soils

The selection of the filtration geotextile profile is based on 2 components:

2.2.1. The *Filter profile* Fp of the geotextile which is generally selected as Fp 3 as the in-situ soil is a soft soil (clay, with very low permeability) (Table 13);

Note: Verification of durability performance of the geotextile shall be carefully checked in case of in-situ soil and/or granular drainage material having extreme alkaline or extreme acidic pH.

Note: Long term risk of biological clogging or calcification clogging shall be eventually evaluated when necessary.

For conditions not covered by these guidelines, a special evaluation of required specification profile should be done.

2.2.2. The *Mechanical profile* Mp of the geotextile (as defined in Table 9) which is selected based on:

- the Mechanical Class of the in-situ soil (soft, medium)
- the type of drainage material used in the mattress (rounded or angular): a maximum size of $D_{max} \leq 200$ mm is considered
- the construction conditions (*Normal or favourable*) as defined in section 1. of this Annex.

For conditions not covered by these guidelines, a special evaluation of required specification profile should be done.

The Table 15 gives the *Mechanical profile* **Mp** depending on the Mechanical class of the in-situ soil, the type of drainage material and the installation conditions.

Table 15: selection of Mechanical profile of the geotextile for drainage mattress on soft soil.

Construction conditions	**Normal**		**Favourable**	
Drainage material	**rounded ($D_{max} \leq 200$ mm)**	**angular ($D_{max} \leq 200$ mm)**	**rounded ($D_{max} \leq 200$ mm)**	**angular ($D_{max} \leq 200$ mm)**
In-situ soil mech. class				
S0 Soft	Mp 4	Mp 5	Mp 3	Mp 3
S1 Medium	Mp 3	Mp 4	Mp 2	Mp 3

Note: Verification of durability performance of the geotextile shall be carefully checked in case of in-situ soil and/or granular drainage material with extreme acidic or alkaline pH (4 > pH >9).

2.3. Selection of specification profile of filtration products in drainage masks on slopes

The selection of the filtration geotextile profile is based on 2 components:

2.3.1. The *Filter profile* **Fp** of the geotextile (as defined in Table 8) is selected based on

- the characteristics of the in-situ soil (Granularity (as defined in Table 11) and
- the Hydraulic characteristic (as defined in Table 12)

Note: Slopes with soil type G2 are not considered in this guideline.

For conditions not covered by these guidelines, a special evaluation of required specification profile should be done.

The Table 16 gives the *Filter profile* **Fp** depending on the Granularity & Hydraulic characteristic of the in-situ soil.

Table 16: Selection of Filter profile of the geotextile for drainage masks on slopes depending on the in-situ soil characteristics (Granularity & Hydraulic characteristic)

	In-situ soil permeability			
In-situ soil granularity	**H1** Very permeable	**H2** Permeable	**H3** Low permeable	**H4** Very low permeable
G1 Clean sand & gravels	Fp 6			
G3 Mixed soil $C_U \geq 5$			Fp 4	Fp 5
G4 Mixed soil $C_U < 5$			Fp 1	Fp 2

Note: Verification of durability performance of the geotextile shall be carefully checked in case of in-situ soil and/or granular drainage material with extreme acidic or alkaline pH (4 > pH >9).

Note: Long term risk of biological clogging or calcification clogging shall be eventually evaluated if necessary.

2.3.2. The *Mechanical profile* Mp of the geotextile (as defined in Table 9) is selected based on:

- the Mechanical Class of the in-situ soil: in the case of mask on slope the in-situ soil is considered *firm* to ensure the stability of the slope
- the type of drainage material used in the mask (*rounded or angular*)
- the drainage mask thickness (*H ≤ 1 m or 1 m < H ≤ 3 m*)

For conditions not covered by these guidelines, a special evaluation of required specification profile should be done.

The Table 17 gives the *Mechanical profile* **Mp** depending on the Mechanical class of the in-situ soil, the type of drainage material and the drainage mask thickness

Table 17: selection of Mechanical profile of the geotextile for drainage masks on slopes

Drainage mask thickness	**≤ 1 m**		**1 m < H ≤ 3 m**	
Drainage material	**rounded**	**angular**	**rounded**	**angular**
In-situ soil mech. class				
S2 Firm	Mp 3	Mp 4	Mp 4	Mp 5

Note: Verification of durability performance of the geotextile shall be carefully checked in case of in-situ soil and/or granular drainage material with extreme acidic or alkaline pH (4 > pH >9).