SINTEF Community
Høgskoleringen 7b
7465 Trondheim
NORWAY

Project Manager: Christoph Hessing
Telephone: +49 151 720 43588
Email: christoph.hessing@sintef.no

Technical Note 3

NorGeoSpec

Examples for definition of specification for geotextile filter in drainage systems

Introduction

This technical note presents examples illustrating the specification criteria for geotextile filters used in various drainage systems, in accordance with NorGeoSpec, Rev. 02, Part 2 – Product Specification (PS), Annex I.

The examples show:

- a filtration geotextile used in a drainage trench
- a filtration geotextile used under a drainage mattress over soft soil
- a filtration geotextile used under a drainage mask on a slope

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Content

1 Example of filtration geotextile in a drainage trench

The in-situ soil is a medium soft, well graded silty soil in which it is planned to realise a small drainage trench filled with crushed rock (H ≤ 1.0 m).

According to **Annex I, Section 2.**, the process starts with defining the granularity class of the in-situ soil and its hydraulic properties to define the *Filter profile* of the geotextile:

1.1 Definition of the Filter profile of the geotextile

1.1.1 Determination of the Granularity class of the in-situ soil

The Granularity class of the in-situ soil is defined based on NGS Part 2, Annex I, Table 11.

NGS Part 2, Annex I, Table 11			
G1	**G2**	**G3** Well graded granularity [1]	**G4** Uniform granularity [1]
Clean sand & gravels [2]	Fine soils [3]	Mixed soils $C_U \geq 5$	Mixed soils $C_U < 5$
$C_U = D_{60} / D_{10}$			

Example drainage trench
The in-situ soil is a medium soft well graded silty soil, which can be classified in **G3** **well graded**

1.1.2 Determination of Hydraulic class of the in-situ soil

The Hydraulic class of the in-situ soil is defined based on NGS Part 2, Annex I, Table 12.

NGS Part 2, Annex I, Table 12			
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*

Example drainage trench
The in-situ soil is a soft well graded silty soil, which can be classified reasonably in **H3**

This allows to define the *Filter profile* of the geotextile to be used.

[1] acc. to EN ISO 14688-1

[2] Clean gravels and sands & gravels and sands with some fines but passing 63 µm < 12 %

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

1.1.3 Determination of the Filter profile of the geotextile

The *Filter profile* of the geotextile is defined based on NGS Part 2, Annex I, Table 13

NGS Part 2, Annex I, Table 13				
In-situ soil granularity	**In-situ soil permeability**			
	H1 Very permeable	**H2** permeable	**H3** Low permeable	**H4** Very low permeable
G1 clean sand & gravels	**Fp 6**	-	-	-
G2 Fine soils	-	-	-	**Fp 3** [4]
G3 Mixed soils $C_U \geq 5$	-	-	**Fp 4**	**Fp 5**
G4 Mixed soils $C_U < 5$	-	-	**Fp 1**	**Fp 2**

Example drainage trench
*Considering the in-situ soil with a granularity Class **G3** & a hydraulic Class **H3**, the "Filter" profile is **Fp 4***

According to **Annex I, Section 2**, the process continues with defining the "Mechanical" profile of the geotextile. It is 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)

1.2 Definition of the Mechanical profile of the geotextile

The *Mechanical profile* of the filtration geotextile is defined based on NGS Part 2, Annex I, Table 14.

NGS Part 2, Annex I, Table 14				
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**

Example drainage trench
*Considering that the in-situ soil is: Medium soft ➔ **S1**, the drainage material is crushed rock ➔ angular and the depth is ≤ 1 m, the "Mechanical" profile is* **Mp 3**

[4] passing 63 µm > 35 % and D_{max} ≤ 45 mm (I_p > 12 %)

1.3 Specification Profile of the filtration geotextile in a drainage trench.

For an in-situ soil which is a medium soft well graded silty soil in which it is planned to realise a small drainage trench filled with crushed rock (H ≤ 1.0 m), the geotextile filter specification is defined by

NorGeoSpec certified geotextile for drainage systems
Fp 4 / Mp 3

Which can be also written:

NorGeoSpec certified geotextile for drainage systems

Nominal water permeability (EN ISO 11058) (velocity index V_{H50})	**$V_{H50} \geq 5$ l/(m²·s)**
Nominal opening size (EN ISO 12956)	**63 µm ≤ O_{90} ≤ 300 µm**
Min. Energy Index	**≥ 3.2 kN/m**

2 Example of filtration geotextile under a drainage mattress over soft soil

The in-situ soil is a soft clay with a very low permeability on which it is planned to realise an embankment over a drainage mattress realised with rounded gravel from the nearby river ($D_{max} \leq 56$ mm); the installation conditions are unknown.

According to **Annex I, Section 2**, the process starts with defining the Granularity class of the in-situ soil and its hydraulic properties to define the *Filter profile* of the geotextile:

2.1 Definition of the Filter profile of the geotextile

2.1.1 Determination of the Granularity class of the in-situ soil

The Granularity class of the in-situ soil is defined based on NGS Part 2, Annex I, Table 11.

NGS Part 2, Annex I, Table 11			
G1	**G2**	**G3** Well graded granularity [5]	**G4** Uniform granularity [5]
Clean sand & gravels [6]	Fine soils [7]	Mixed soils $C_U \geq 5$	Mixed soils $C_U < 5$
$C_U = D_{60} / D_{10}$			

Example drainage mattress
The in-situ soil is a soft clay, which can be classified in fine soils **G2** *(See also Section 2.2)*

2.1.2 Determination of Hydraulic class of the in-situ soil

The Hydraulic class of the in-situ soil is defined based on NGS Part 2, Annex I, Table 12.

NGS Part 2, Annex I, Table 12			
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*

Example drainage mattress
The in-situ soil has a very low permeability, which can be classified reasonably in **H4** *(See also Section 2.2)*

This allows to define the *Filter profile* of the geotextile to be used.

[5] acc. to EN ISO 14688-1

[6] Clean gravels and sands & gravels and sands with some fines but passing 63 µm < 12 %

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

2.1.3 Determination of the Filter profile of the geotextile

The *Filter profile* of the geotextile is defined based on NGS Part 2, Annex I, Table 13

NGS Part 2, Annex I, Table 13				
In-situ soil granularity	**In-situ soil permeability**			
	H1 Very permeable	**H2** permeable	**H3** Low permeable	**H4** Very low permeable
G1 clean sand & gravels	**Fp 6**	-	-	-
G2 Fine soils	-	-	-	**Fp 3** [8]
G3 Mixed soils $C_U \geq 5$	-	-	**Fp 4**	**Fp 5**
G4 Mixed soils $C_U < 5$	-	-	**Fp 1**	**Fp 2**

Example drainage mattress
Considering the in-situ soil with a granularity Class G2 & a hydraulic Class H4, the "Filter" profile is **Fp 3** *(See also Section 2.2)*

According to **Annex I, Section 2**, the process continues with defining the *Mechanical profile* of the geotextile. It is based on:

- the Mechanical Class of the in-situ soil (soft or medium)
- the type of drainage material used in the trench (rounded or angular)
- the installation conditions (*Normal or favourable*)

2.2 Definition of the Mechanical profile of the geotextile

The *Mechanical profile* of the filtration geotextile is defined based on NGS Part 2, Annex I, Table 15.

NGS Part 2, Annex I, Table 15				
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**

Example drainage mattress
Considering that the in-situ soil is Soft ➔ ***S0*** *The drainage material is rounded and the construction conditions are unknown* ➔ *Normal the "Mechanical" profile is* **Mp 4**

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

2.3 Specification Profile of the filtration geotextile under a drainage mattress over soil

For in-situ soil which is a soft clay with a very low permeability on which it is planned to realise an embankment over a drainage mattress realised with crushed rocks (Dmax ≤ 56 mm); the installation conditions are unknown, the geotextile filter specification is defined by

NorGeoSpec certified geotextile for drainage systems
Fp 3 / Mp 4

Which can be also written:

NorGeoSpec certified geotextile for drainage systems

Nominal water permeability (EN ISO 11058) (velocity index V_{H50})	**$V_{H50} \geq 0.5$ l/(m²·s)**
Nominal opening size (EN ISO 12956)	**63 µm ≤ O_{90} ≤ 200 µm**
Min. Energy Index	**≥ 4.5 kN/m**

3 Example of filtration geotextile under a drainage mask on a slope

The in-situ soil is a firm marly clay with some cracks with possible water. It is planned to realise a drainage mask to collect the water and help the stabilisation of the slope. The stability studies show that the thickness of the mask shall be 2.5 m at the bottom. The drainage aggregate available is crushed rock ($D_{max} \leq 56$ mm).

According to **Annex I, Section 2**, the process starts with defining the Granularity class of the in-situ soil and its hydraulic properties to define the *Filter profile* of the geotextile:

3.1 Definition of the Filter profile of the geotextile

3.1.1 Determination of the Granularity class of the in-situ soil

The Granularity class of the in-situ soil is defined based on NGS Part 2, Annex I, Table 11.

NGS Part 2, Annex I, Table 11			
G1	**G2**	**G3** Well graded granularity [9]	**G4** Uniform granularity [9]
Clean sand & gravels [10]	Fine soils [11]	Mixed soils $C_U \geq 5$	Mixed soils $C_U < 5$
$C_U = D_{60} / D_{10}$			

Example drainage mask
The in-situ soil is a firm marly clay, which can be classified in **G3** *(The soil G2 would not be stable at long term, see Section 2.3)*

3.1.2 Determination of Hydraulic class of the in-situ soil

The Hydraulic class of the in-situ soil is defined based on NGS Part 2, Annex I Table 12.

NGS Part 2, Annex I, Table 12			
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*

Example drainage mask
The in-situ is a firm marly clay with some cracks with possible water. This means that it can be classified reasonably low permeable. **H3**

This allows to define the “Filter” profile of the geotextile to be used:

[9] acc. to EN ISO 14688-1

[10] Clean gravels and sands & gravels and sands with some fines but passing 63 µm < 12 %

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

3.1.3 Determination of the Filter profile of the geotextile

The *Filter profile* of the geotextile is defined based on NGS Part 2, Annex I, Table 16

NGS Part 2, Annex I, Table 16				
In-situ soil granularity	**In-situ soil permeability**			
	H1 Very permeable	**H2** permeable	**H3** Low permeable	**H4** Very low permeable
G1 clean sand & gravels	**Fp 6**	-	-	-
G3 Mixed soils $C_U \geq 5$	-	-	**Fp 4**	**Fp 5**
G4 Mixed soils $C_U < 5$	-	-	**Fp 1**	**Fp 2**

Example drainage mask
*Considering the in-situ soil with a granularity Class **G3** & a hydraulic Class **H3**, the "Filter" profile is **Fp 4***

According to **Annex I, Section 2**, the process continues with defining the *Mechanical profile* of the geotextile. It is based on:

- the Mechanical Class of the in-situ soil is considered *firm:* it is considered that the natural soil shall be firm enough to insure 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*)

3.2 Definition of the Mechanical profile of the geotextile

The *Mechanical profile* of the filtration geotextile is defined based on NGS Part 2, Annex I, Table 17.

NGS Part 2, Annex I, Table 17				
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**

Example drainage mask
*Considering that the in-situ soil is: Firm → **S2** The drainage material is crushed è angular & the mask thickness is 2.5 m the "Mechanical" profile is* **Mp 5**

3.3 Specification Profile of the filtration geotextile under a drainage mask on a slope

Considering that, the in-situ soil is a firm marly clay with some cracks with possible water and that it is planned to realise a drainage mask to collect the water and help the stabilisation of the slope; that the stability studies show that a mask of 2.5 m thickness is at the bottom; and knowing that the drainage aggregate available is crushed rock ($D_{max} \leq 56$ mm); and that the installation conditions are unknown, the geotextile filter specification is defined by

NorGeoSpec certified geotextile for drainage systems
Fp 4 / Mp 5

Which can be also written:

NorGeoSpec certified geotextile for drainage systems

Nominal water permeability (EN ISO 11058) (velocity index V_{H50})	**$V_{H50} \geq 5$ l/(m²·s)**
Nominal opening size (EN ISO 12956)	**63 µm ≤ O_{90} ≤ 300 µm**
Min. Energy Index	**≥ 6.5 kN/m**