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Design using geosynthetics —

Part 2: Separation

Conception utilisant des géosynthétiques —

Partie 2: Séparation

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 221, *Geosynthetics*.

A list of all parts in the ISO/TR 18228 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The ISO/TR 18228 series provides guidance for designs using geosynthetics for soils and below ground structures in contact with natural soils, fills and asphalt. The series contains 10 parts which cover designs using geosynthetics, including guidance for characterization of the materials to be used and other factors affecting the design and performance of the systems which are particular to each part, with ISO/TR 18228-1 providing general guidance relevant to the subsequent parts of the series.

The series is generally written in a limit state format and guidelines are provided in terms of partial material factors and load factors for various applications and design lives, where appropriate.

This document includes information relating to the separation function. Details of design methodology adopted in a number of regions are provided.

Design using geosynthetics —

Part 2:
Separation

1 Scope

This document provides general considerations to support the design guidance to geotechnical and civil engineers involved in the design of structures in which a geotextile is used to fulfil the function of separation of soils and below ground structures in contact with natural soils and fills.

These considerations are always based on installed soils, the installation process and on the strength and/or deformation behaviour of geosynthetics.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 10318-1, *Geosynthetics — Part 1: Terms and definitions*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 10318-1 apply.

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

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

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

4 Different concepts

4.1 General

There are several different concepts available worldwide for the design and application of geosynthetics for separation; several are presented in this document. The contents of the original documents are reproduced. However other concepts and approaches might also be available or applicable. The user of this document is intended to always refer to the most up to date version of the documents quoted.

4.2 GRK classification

4.2.1 General

This subclause presents a summary of the German GRK (Geotextilrobustheitsklasse)[22] guidance for the use of geosynthetics and geosynthetic-related products mainly in separation.

The GRK is based on two characteristics, mass per unit area and strength. The development of this system is based on on-site testing and evaluation of robustness.

The mass per unit area is usually determined in accordance with ISO 9864.

In the case of non-woven geotextiles, the puncture force is usually measured in accordance with ISO 12236. In the case of woven geotextiles, the strength is usually measured in accordance with ISO 10319 in the weakest direction.

4.2.2 Stresses resulting from fill material

The GRK evaluation of which product to use is undertaken on the basis of several site-specific factors. This considers the type of soil that is used as fill material, the bearing capacity of the subgrade soil, as well as effects resulting from construction/installation operations.

The rut depth is not reduced substantially by the choice of a higher geotextile robustness class or a layer of fill material with increased thickness or shear parameters. Extreme stresses, resulting for example, from angular fill material and site traffic, which exceed the specifications of Table 1, can lead to more stringent requirements and would normally be considered on the basis of local experience or by preliminary tests.

Table 1 is applicable to fine grained, sandy subgrade soils (SW, SE, SI, SU*, SU).

Table 1 — Stress to geotextiles resulting from fill material [a]

Appreciation level	Rounded fill material	Angular fill material
AS 1	Applications where mechanical stresses resulting from the fill material have no influence on the selection	
AS 2	Coarse or mixed granular soils according to DIN 18196 (SW, SE, SI, GW, GE, GI, SU, SU*, GU, GU*)	
AS 3	Coarse or mixed granular soils ≤ 40 % stones and cobbles	Coarse or mixed granular soils according DIN 18196 (SW, SE, SI, GW, GE, GI, SU, SU*, GU, GU*)
AS 4	Coarse or mixed granular soils > 40 % stones and cobbles	Coarse or mixed granular soils ≤ 40 % stones and cobbles
AS 5		Coarse or mixed granular soils > 40 % stones and cobbles

[a] Processed fill material (e.g. crushed stone, recycled material) is classified according to particle size and shape.

* Indicates "very" silty.

NOTE For definitions of soil types, please refer to the original GRK document [22].

When the geotextile is placed on top of coarse or mixed granular subgrade soils (GW, GE, GI, GU, GU*, GT, GT*) the application level AS 2 to AS 4 would normally be increased by one level.

4.2.3 Stresses resulting from installation and construction operation

Rutting on the surface of a trafficked fill layer is caused by site traffic loading, which is counteracted by the resistance of the "fill material and subgrade soil" system. The resistance arises from the interaction of stiffness and deformability of the subgrade soil, as well as from the thickness and shear strength of the fill material. The rut depth cannot be influenced by the separation layer. The rut depth is a measure of the stress level applied to separation layers.

The geotextile robustness classes resulting from fill material and construction operation stresses given in Table 2 describe the stress level applied to the separation layer. If a separation product with corresponding geotextile robustness class is applied, it can be assumed that it will withstand these stresses and thereby maintains its separation function.

Table 2 — Stress level resulting from installation and construction operation to the geotextile

Stress level	Installation of fill material	Compaction	Stress resulting from site traffic (fill above geotextile separation layer)
AB 1	Manual	No influence	No site traffic
AB 2	Equipment	Equipment	Estimated rut depth < 5 cm
AB 3	Equipment	Equipment	Estimated rut depth 5 cm ≤ 15 cm
AB 4	Equipment	Equipment	Estimated rut depth 15 cm ≤ 30 cm
AB 5	Equipment	Equipment	Estimated rut depth > 30 cm

4.2.4 Determination of required geotextile robustness class "GRK"

The robustness classes GRK 1 and GRK 2 will never result from the evaluation in Table 3. Therefore, these two classes have been deleted in the latest revision of the GRK system. The required geosynthetic characteristics are provided for each class in Tables 4, 5 and 6.

Table 3 — Determination of required geotextile robustness class resulting from fill material and construction operation stresses

Application	Stress condition construction operation				
	AB 1	**AB 2**	**AB 3**	**AB 4**	**AB 5**
AS 1	GRK 3				
AS 2	GRK 3	GRK 3	GRK 3	GRK 4	GRK 5
AS 3	GRK 3	GRK 3	GRK 4	GRK 5	[a]
AS 4	GRK 4	GRK 4	GRK 5	[a]	[a]
AS 5	GRK 5	GRK 5	[a]	[a]	[a]

[a] To reduce the rut depth either the fill height and/or the shear strength is to be increased and/or the system needs to be reinforced. To safeguard the separation function at large rut depths (AB 4, AB 5) products with large strains (elongation at break ε > 50 %) would normally be used. The efficiency of the procedures would normally be verified by field trials.

Table 4 — Robustness class (GRK) for non-woven geosynthetics

GRK	Static puncture force (CBR) in accordance with ISO 12236	Mass per unit area in accordance with ISO 9864
3	≥ 1,5 kN	≥ 150 g/m^2
4	≥ 2,5 kN	≥ 250 g/m^2
5	≥ 3,5 kN	≥ 300 g/m^2

Table 5 — Robustness class (GRK) for woven geosynthetics from tapes or yarns (PP or PE)

GRK	Tensile strength[a] in accordance with ISO 10319	Mass per unit area in accordance with ISO 9864
3	≥ 35 kN/m	≥ 180 g/m^2
4	≥ 45 kN/m	≥ 220 g/m^2
5	≥ 50 kN/m	≥ 250 g/m^2

[a] Defined with the lower value from "machine direction (MD)" or "cross machine direction (CD)".

Table 6 — Robustness class (GRK) for woven geosynthetics from multifilaments (mostly PET)

GRK	Tensile strength[a] in accordance with ISO 10319	Mass per unit area in accordance with ISO 9864
3	≥ 150 kN/m	≥ 320 g/m^2
4	≥ 180 kN/m	≥ 400 g/m^2
5	≥ 250 kN/m	≥ 550 g/m^2

[a] Defined with the lower value from "machine direction (MD)" or "cross machine direction (CD)".

NOTE Tables 2 to 6 are based on FGSV [22].

4.3 American Association of State Highway and Transportation Officials (AASHTO) M288

4.3.1 General

This subclause presents a summary of the part of AASHTO M288[8] applicable to separation-only applications for the use of geotextiles.

M288 is a material purchasing specification and is based on geotextile survivability from installation stresses. The classes shown in Table 7 reflect this basic premise.

M288 is applicable to the use of a geotextile to prevent mixing of a subgrade soil and an aggregate cover material (subbase, base, select embankment, etc.). M288 can also apply to locations other than beneath trafficked areas where separation of two dissimilar materials is required, but where water seepage through the geotextile is not a critical function.

The separation application is appropriate for trafficked areas constructed over soils with a California Bearing Ratio equal to or greater than 3 % (CBR ≥ 3). The M288 correlation suggests that this relates to a shear strength greater than approximately 90 kPa. However, other countries guidance documents can suggest that a CBR value of 3 % correlates to a lower shear strength. It is appropriate for unsaturated subgrade soils. The primary function of a geotextile in this application is separation.

4.3.2 General properties

Table 8 provides properties for three separation geotextile classes. The geotextile is normally required to conform to the properties of Table 8 based on the geotextile class required in Table 7. All numerical values in Table 8 except apparent opening size (AOS) represent minimum average roll value (MARV) in the weakest principal direction. Values for AOS represent maximum average roll values.

Table 7 — Degree of survivability as a function of subgrade conditions, construction equipment, and lift thickness for separation geotextiles[a]

Subgrade description	Low ground pressure equipment ≤ 25 kPa (3,6 psi)	Medium ground pressure equipment > 25 to ≤ 50 kPa (>3,6 to ≤ 7,5 psi)	High ground pressure equipment > 50 kPa (>7,3 psi)
Subgrade has been cleared of all obstacles except grass, weeds, leaves, and fine wood debris. Surface is smooth and level so that any shallow depressions and humps cannot exceed 450 mm (18 in.) in depth or height. All larger depressions are filled. Alternatively, a smooth working table can be placed.	Low (Class 3)	Moderate (Class 2)	High (Class 1)
Subgrade has been cleared of obstacles larger than small to moderate-sized tree limbs and rocks. Tree trunks and stumps are removed or covered with a partial working table. Depressions and humps cannot exceed 450 mm (18 in.) in depth or height. Larger depressions are to be filled.	Moderate (Class 2)	High (Class 1)	Not separation-only
Minimal site preparation is required. Trees can be felled, de-limbed, or left in place. Stumps are cut to project no more than ±150 mm (±6 in.) above subgrade. Geotextile can be draped directly over the tree trunks, stumps, large depressions and humps, holes, stream channels, and large boulders. Items are to be removed only if placing the geotextile and cover material over them will distort the finished road surface.	High (Class 1)	Not separation only	Not separation-only

[a] Guidance is for 150 mm to 300 mm (6 in. to 12 in.) initial lift thickness. For other initial lift thickness:

— 300 mm to 450 mm (12 in. to 18 in.): reduce survivability requirement one level;

— 450 mm to 600 mm (18 in. to 24 in.): reduce survivability requirement two levels;

— > 600 mm (24 in.): reduce survivability requirement three levels.

For special construction techniques such as pre-rutting, increase the geotextile survivability requirement one level. Placement of excessive initial cover material thickness can cause bearing failure of the soft subgrade.

The property values in Table 7 represent default values that provide for sufficient geotextile survivability under most construction conditions. The designer can also specify properties different from that listed in Table 7 based on engineering design and experience.

Table 8 — Different classes of geotextile separation-only

Geotextile property	Test methods	Units	Geotextile class[a,b]					
			Low (Class 1)		Medium (Class 2)		High (Class 3)	
			Elongation < 50 %[c]	Elongation ≥ 50 %[c]	Elongation < 50 %[c]	Elongation ≥ 50 %[c]	Elongation < 50 %[c]	Elongation ≥ 50 %[c]
Grab strength	ASTM D4632	N	1 400	900	1 100	700	800	500
Sewn seam strength	ASTM D4632	N	1 260	810	990	630	720	450
Tear strength	ASTM D4533	N	500[d]	350	400[d]	250	300[d]	180
Puncture strength	ASTM D6241	N	2 750	1 925	2 200	1 375	1 650	990
Permittivity	ASTM D4491	sec^{-1}	0,02[e]					
Apparent opening size	ASTM D4751	mm	0,60 max. average roll value					
Ultraviolet stability (retained strength)	ASTM D4355	%	50 % after 500 h of exposure					

[a] The engineer can also specify properties different from that listed in Table 8 based on engineering design and experience.

[b] The required geotextile class is designated in Table 7 for the indicated application. The severity of installation conditions for the application generally dictates the required geotextile class. Class 1 is specified for more severe or harsh installation conditions where there is a greater potential for geotextile damage, and Classes 2 and 3 are specified for less severe conditions.

[c] All numerical values represent MARV in the weaker principal direction.

[d] The required MARV for tear strength for woven monofilament geotextiles is 250 N.

[e] Default value. Permittivity of the geotextile is to be greater than that of the soil ($\Psi g > \Psi s$). The engineer can also indicate the permeability of the geotextile to be greater than that of the soil ($kg > ks$).

The property values in Table 8 represent default values that provide for sufficient geotextile survivability under most construction conditions. The designer can also specify properties different from those listed in Table 8 based on engineering design and experience.

NOTE Tables 7 and 8 are based on AASHTO M288[8].

4.4 Other concepts

Other available concepts include the recently published British Standard (BS 8661:2019), the Nordic System (NorGeoSpec) or the Australian Transport for NSW Specification R63:

— BS 8661:2019[20] is a guidance for specification for basic separation and filtration functions. This British Standard gives recommendations and guidance for the choice and specification of geotextiles for the functions of separation and filtration in contact with natural soils and fills.

— NorGeoSpec 2012[23] presents a system for the certification and specification of geosynthetics and geosynthetic-related products for separation, filtration and/or reinforcement in all applications for products covered by a number of European Standards. The specification of the function separation and filtration includes five specification profiles (N1…N5) based on seven characteristics measured with test methods defined by CEN and ISO. The system also includes guidelines for the selection of the relevant specification profile. The separation is always used in conjunction with filtration.

— TfNSW QA specification R63[24] describes the material and construction requirements for geotextiles used as separation and/or filtration elements in earthworks and road construction such as for bridging layers and subsoil drainage.

— PTV 829 2010[25] is a Belgian guide to assist designers in the choice of geotextile type.

For detailed information on these concepts the designer can check the relevant documents. Further concepts can be available in other locations and the designer is to always ensure local requirements are known, understood and followed.