



BSI Standards Publication

Geosynthetic barriers - Characteristics required for use in the construction of solid waste storage and disposal sites

National foreword

This British Standard is the UK implementation of EN 13493:2018. It supersedes BS EN 13493:2013, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee B/553, Geosynthetics.

A list of organizations represented on this committee can be obtained on request to its secretary.

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English Version

Geosynthetic barriers - Characteristics required for use in the construction of solid waste storage and disposal sites

Géomembranes et géosynthétiques bentonitiques
- Caractéristiques requises pour l'utilisation
dans la construction des ouvrages de stockage
et d'enfouissement de déchets solides

Geosynthetische Dichtungsbahnen -
Eigenschaften, die für die Anwendung beim
Bau von Deponien und Zwischenlagern für
feste Abfallstoffe erforderlich sind

This European Standard was approved by CEN on 5 November 2017.

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European foreword

This document (EN 13493:2018) has been prepared by Technical Committee CEN/TC 189 “Geosynthetics”, the secretariat of which is held by NBN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2018, and conflicting national standards shall be withdrawn at the latest by December 2019.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 13493:2013.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

For relationship with Regulation (EU) No. 305/2011, see informative [Annex ZA](#), which is an integral part of this document.

The main changes with respect to the previous edition are listed below:

- the list of normative references has been updated;
- in [3.1](#) three terms have been added;
- in [3.2](#) list of abbreviations has been updated;
- in [4.3](#), [Table 1](#), has been modified to comply with the modified mandate M/386 (inclusion of elongation in separation and filtration functions) and has been technically revised, all H-coded characteristics have been replaced by “A”;
- [Clause 5](#) “Evaluation of conformity” has been superseded by new [Clause 5](#) “Assessment and verification of constancy of performance (AVCP)”;
- [Annex A](#) “Factory production control – Factory production control scheme” has been deleted;
- former Annex B “Durability” becomes [Annex A](#) and has been totally revised;
- [Annex ZA](#) has been updated according to new template to fulfil requirements of CPR, also examples for CE-marking have been deleted.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

This document allows manufacturers to describe geosynthetic barriers on the basis of declared values for characteristics relevant to the intended use and if tested to the specified method. It also includes procedures for assessment and verification of constancy of performance (AVCP) including the factory production control.

This document can also be used by designers, end-users and other interested parties as a tool to define relevant and appropriate characteristics for specifications.

Tests for some non-mandated characteristics are still under study and will be included when the standard is revised.

The term “product” used in this standard refers to a geosynthetic barrier, including polymeric geosynthetic barriers, clay geosynthetic barriers and bituminous geosynthetic barriers.

This document is part of a group of standards, addressing the requirements for geosynthetic barriers when used in a specific application.

Particular application cases can contain requirements about additional properties and - preferably standardized - test methods, if they are technically relevant and not conflicting with European Standards.

The design life of the product should be determined, since its function can be temporary, as construction expediency, or permanent, for the lifetime of the structure.

1 Scope

This European Standard specifies the characteristics of geosynthetic barriers, including polymeric geosynthetic barriers, clay geosynthetic barriers and bituminous geosynthetic barriers, when used as fluid barriers and separation layer in the construction of solid waste storage and disposal sites, and the appropriate test methods to determine these characteristics.

The intended use of these products is to control the leakage of fluids through the construction.

This European Standard is not applicable to geotextiles or geotextile-related products as defined in EN ISO 10318-1.

This European Standard provides for the assessment and verification of constancy of performance (AVCP) of the product to this European Standard including factory production control procedures.

This European Standard defines characteristics to be considered with regard to the presentation of performance.

NOTE Where potable water is or can be in direct contact with the product, other relevant standards, requirements and/or regulations can be considered for the design.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 495-5:2013, *Flexible sheets for waterproofing — Determination of foldability at low temperature — Part 5: Plastic and rubber sheets for roof waterproofing*

EN 1109:2013, *Flexible sheets for waterproofing — Bitumen sheets for roof waterproofing — Determination of flexibility at low temperature*

EN 1110:2010, *Flexible sheets for waterproofing — Bitumen sheets for roof waterproofing — Determination of flow resistance at elevated temperature*

EN 1296:2000, *Flexible sheets for waterproofing — Bitumen, plastic and rubber sheets for roofing — Method of artificial ageing by long term exposure to elevated temperature*

EN 1427:2015, *Bitumen and bituminous binders — Determination of the softening point - Ring and Ball method*

EN 1844:2013, *Flexible sheets for waterproofing — Determination of resistance to ozone — Plastic and rubber sheets for roof waterproofing*

EN 1849-1:1999, *Flexible sheets for waterproofing — Determination of thickness and mass per unit area — Part 1: Bitumen sheets for roof waterproofing*

EN 1849-2:2009, *Flexible sheets for waterproofing — Determination of thickness and mass per unit area — Part 2: Plastic and rubber sheets*

EN 12224:2000, *Geotextiles and geotextile-related products — Determination of the resistance to weathering*

EN 12225:2000, *Geotextiles and geotextile-related products — Method for determining the microbiological resistance by a soil burial test*

EN 12226:2012, *Geosynthetics — General tests for evaluation following durability testing*

EN 12310-1:1999, *Flexible sheets for waterproofing — Part 1: Bitumen sheets for waterproofing — Determination of resistance to tearing (nail shank)*

EN 12311-1:1999, *Flexible sheets for waterproofing — Part 1: Bitumen sheets for roof waterproofing — Determination of tensile properties*

EN 12311-2:2013, *Flexible sheets for waterproofing — Determination of tensile properties — Part 2: Plastic and rubber sheets for roof waterproofing*

EN 12447:2001, *Geotextiles and geotextile-related products — Screening test method for determining the resistance to hydrolysis in water*

EN 13249:2016, *Geotextiles and geotextile-related products — Characteristics required for use in the construction of roads and other trafficked areas (excluding railways and asphalt inclusion)*

EN 13250:2016, *Geotextiles and geotextile-related products — Characteristics required for use in the construction of railways*

EN 13251:2016, *Geotextiles and geotextile-related products — Characteristics required for use in earthworks, foundations and retaining structures*

EN 13252:2016, *Geotextiles and geotextile-related products — Characteristics required for use in drainage systems*

EN 13253:2016, *Geotextiles and geotextile-related products — Characteristics required for use in erosion control works (coastal protection, bank revetments)*

EN 13254:2016, *Geotextiles and geotextile-related products — Characteristics required for the use in the construction of reservoirs and dams*

EN 13255:2016, *Geotextiles and geotextile-related products — Characteristics required for use in the construction of canals*

EN 13256:2016, *Geotextiles and geotextile-related products — Characteristics required for use in the construction of tunnels and underground structures*

EN 13257:2016, *Geotextiles and geotextile-related products — Characteristics required for use in solid waste disposals*

EN 13265:2016, *Geotextiles and geotextile-related products — Characteristics required for use in liquid waste containment projects*

EN 14150:2006, *Geosynthetic barriers — Determination of permeability to liquids*

EN 14151:2010, *Geosynthetics — Determination of burst strength*

EN 14196:2016, *Geosynthetics — Test methods for measuring mass per unit area of clay geosynthetic barriers*

EN 14414:2004, *Geosynthetics — Screening test method for determining chemical resistance for landfill applications*

EN 14415:2004, *Geosynthetic barriers — Test method for determining the resistance to leaching*

CEN/TS 14416:2014, *Geosynthetic barriers — Test method for determining the resistance to roots*

CEN/TS 14417:2014, *Geosynthetic barriers — Test method for the determination of the influence of wetting-drying cycles on the permeability of clay geosynthetic barriers*

CEN/TS 14418:2014, *Geosynthetic Barriers — Test method for the determination of the influence of freezing-thawing cycles on the permeability of clay geosynthetic barriers*

EN 14575:2005, *Geosynthetic barriers — Screening test method for determining the resistance to oxidation*

EN 14576:2005, *Geosynthetics — Test method for determining the resistance of polymeric geosynthetic barriers to environmental stress cracking*

EN 16416:2013, *Geosynthetic clay barriers — Determination of water flux index — Flexible wall permeameter method at constant head*

EN ISO 527-1:2012, *Plastics — Determination of tensile properties — Part 1: General principles (ISO 527-1:2012)*

EN ISO 527-3:1995, *Plastics — Determination of tensile properties — Part 3: Test conditions for films and sheets (ISO 527-3:1995)*

EN ISO 527-4:1997, *Plastics — Determination of tensile properties — Part 4: Test conditions for isotropic and orthotropic fibre-reinforced plastic composites (ISO 527-4:1997)*

EN ISO 1133-1:2011, *Plastics — Determination of the melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics — Part 1: Standard method (ISO 1133-1:2011)*

EN ISO 1183-1:2012, *Plastics — Methods for determining the density of non-cellular plastics — Part 1: Immersion method, liquid pycnometer method and titration method (ISO 1183-1:2012)*

EN ISO 1183-2:2004, *Plastics — Methods for determining the density of non-cellular plastics — Part 2: Density gradient column method (ISO 1183-2:2004)*

EN ISO 1183-3:1999, *Plastics — Methods for determining the density of non-cellular plastics — Part 3: Gas pycnometer method (ISO 1183-3:1999)*

EN ISO 3696:1995, *Water for analytical laboratory use — Specification and test methods (ISO 3696:1987)*

EN ISO 9863-1:2016, *Geosynthetics — Determination of thickness at specified pressures — Part 1: Single layers (ISO 9863-1:2016)*

EN ISO 9864:2005, *Geosynthetics — Test method for the determination of mass per unit area of geotextiles and geotextile-related products (ISO 9864:2005)*

EN ISO 10318-1:2015, *Geosynthetics — Part 1: Terms and definitions (ISO 10318-1:2015)*

EN ISO 10319:2015, *Geosynthetics — Wide-width tensile test (ISO 10319:2015)*

EN ISO 10773:2011, *Clay geosynthetic barriers — Determination of permeability to gases (ISO 10773:2011)*

EN ISO 11357-6:2013, *Plastics — Differential scanning calorimetry (DSC) — Part 6: Determination of oxidation induction time (isothermal OIT) and oxidation induction temperature (dynamic OIT) (ISO 11357-6:2008)*

EN ISO 12236:2006, *Geosynthetics — Static puncture test (CBR test) (ISO 12236:2006)*

EN ISO 12957-1:2005, *Geosynthetics — Determination of friction characteristics — Part 1: Direct shear test (ISO 12957-1:2005)*

EN ISO 12957-2:2005, *Geosynthetics — Determination of friction characteristics — Part 2: Inclined plane test (ISO 12957-2:2005)*

EN ISO 13438:2004, *Geotextiles and geotextile-related products — Screening test method for determining the resistance to oxidation (ISO 13438:2004)*

ISO 34-1:2015, *Rubber, vulcanized or thermoplastic — Determination of tear strength — Part 1: Trouser, angle and crescent test pieces*

ISO 11465:1993, *Soil quality — Determination of dry matter and water content on a mass basis — Gravimetric method*

ASTM D696, *Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C with a Vitreous Silica Dilatometer*

ASTM D1434, *Standard Test Method for Determining Gas Permeability Characteristics of Plastic Film and Sheeting*

ASTM D4603, *Standard Test Method for Determining Inherent Viscosity of Poly(Ethylene Terephthalate) (PET) by Glass Capillary Viscometer*

ASTM D5890, *Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners*

ASTM D7409, *Standard Test Method for Carboxyl End Group Content of Polyethylene Terephthalate (PET) Yarns*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

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

3.1.1

product

geosynthetic barrier, including polymeric, bituminous and clay barriers

3.1.2

geosynthetic barrier

barrier with at least one of whose components is made from a synthetic or natural polymer, in the form of a sheet, a strip or a three dimensional structure, used in contact with soil and/or other materials in geotechnical and civil engineering applications

3.1.3

project specification

document in which the works, functions, specific conditions and required material property values of the geosynthetic barrier are described

3.1.4

waste disposal site

site for the deposit of waste (landfills), including facilities where solid waste is unloaded and stored in order to permit its preparation for further transport for recovery, treatment or disposal elsewhere

3.1.5

solid waste

waste in solid form including liquid-solid mixtures having capability to be handled as, or mixed with solid waste for storage purposes

3.1.6

basal liner

material which forms the main barrier to prevent the escape of contained fluids from the base of the facility

3.1.7

side liner

material which forms the main barrier to prevent the escape of contained fluids from the sides of the facility

3.1.8

capping liner

material placed above the waste or contaminated material to prevent the ingress of water and the uncontrolled escape of fluids and/or gases

3.1.9

fluid

gas, liquid and vapour in its pure phase as well as mixtures thereof

[SOURCE: EN 764-1:2015+A1:2016, 3.1.5]

3.1.10

rework material

RWM

material that is generated in a process and capable of being reclaimed within the same process that generated it

[SOURCE: EN 13249:2016, 3.1.3]

3.1.11

post-consumer material

PCM

material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product which can no longer be used for its intended purpose

NOTE This includes returns of material from the distribution chain.

[SOURCE: EN 13249:2016, 3.1.4]

3.1.12

post-industrial material

PIM

material diverted from the waste stream during a manufacturing process

[SOURCE: EN 13249:2016, 3.1.5]

3.2 Abbreviations

For the purposes of this document, the abbreviations given in EN ISO 10318-1 and the following apply:

CWFT: classification without further testing

EPDM: ethylene propylene diene monomer

EVA: ethylene vinyl acetate

FPO: flexible polyolefine

FPP: flexible polypropylene

GBR-P: polymeric geosynthetic barrier

GBR-B: bituminous geosynthetic barrier

GBR-C: clay geosynthetic barrier

HP-OIT: high pressure – oxidation induction time

OIT: oxidation induction time

PE-HD: high density polyethylene

PE-LLD: linear low density polyethylene

PE-VLD: very low density polyethylene

PVC-P: flexible polyvinylchloride

4 Characteristics and corresponding methods of test

4.1 General

The main function of geosynthetic barriers used in the construction of solid waste storage and disposal sites, is to prevent the movement of fluids through the construction and to prevent the leachate of the stored materials from moving into the surrounding ground. This includes the use of a geosynthetic barrier as a basal, side or capping liner. Damage during installation has not been addressed in this document.

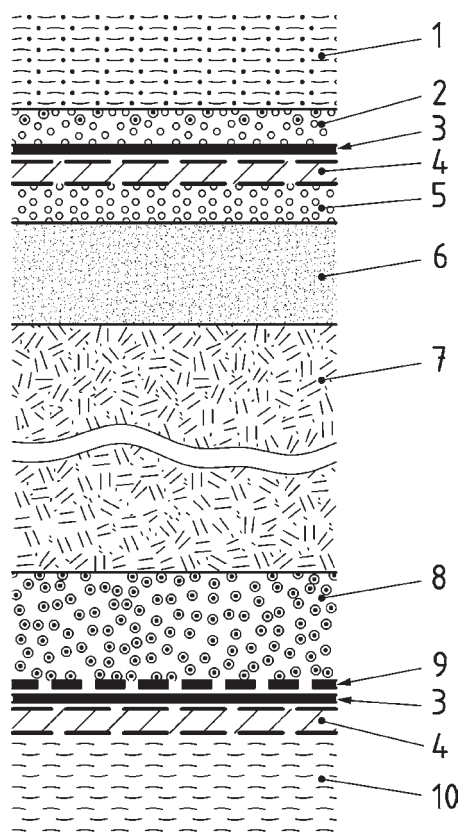
4.2 Types of application

4.2.1 General

The main function of geosynthetic barriers used in the construction of solid waste disposal sites is to prevent or reduce the flow of fluid through the structure.

4.2.2 Application 1: “Composite lining system”

In this application, GBR is used as a composite lining system in the base and/or cover. [Figure 1](#) shows a typical cross-section.



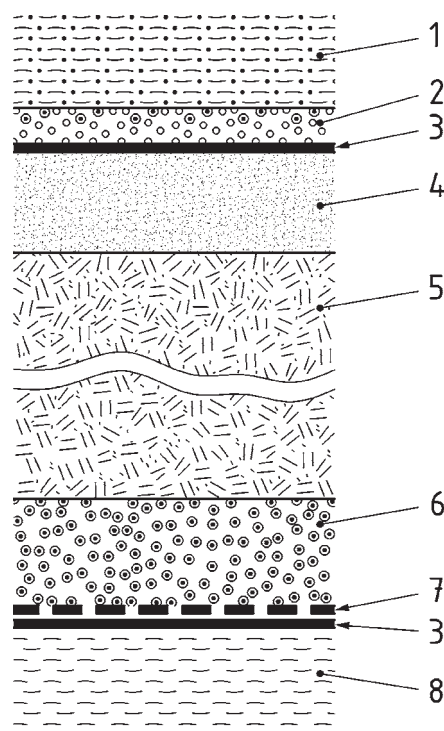
Key

- 1 top soil
- 2 rain water collection layer; optional with geosynthetic protection layer (optional geosynthetic drainage system)
- 3 geosynthetic barrier (GBR-P or GBR-B)
- 4 geosynthetic barrier (GBR-C)
- 5 gas drainage layer (optional geosynthetic venting system)
- 6 levelling layer
- 7 waste body
- 8 leachate collection system (optional geosynthetic drainage system)
- 9 protection layer e.g. geosynthetic
- 10 subgrade

Figure 1 — Geosynthetic barrier as a typical high performance composite lining system for municipal solid waste disposal sites

4.2.3 Application 2: “Single lined system”

In this application, the single GBR is used in the base and/or cover. [Figure 2](#) shows a typical cross-section.



Key

- 1 top soil
- 2 rain water collection layer
- 3 geosynthetic barrier
- 4 levelling layer
- 5 waste body
- 6 leachate collection system (optional geosynthetic drainage system)
- 7 protection layer e.g. geosynthetic
- 8 subgrade

Figure 2 — Geosynthetic barrier as a single lined system for solid waste disposal sites

4.3 Relevant characteristics

The characteristics, their relevance to the conditions of use, and the test methods to be used, are specified in [Table 1](#). The list of characteristics in [Table 1](#) includes those relevant to all conditions of use (A) (essential characteristics are listed in [Table ZA.1](#)), and those relevant to specific conditions of use (S). The indication “–” means that the characteristic is not relevant for that function.

Where, for the same property, data for more than one function shall be provided, the following ranking order shall be observed: A overrides S, and S overrides “–”.

The functions and conditions of use, corresponding with the S-coded characteristics in [Table 1](#), are specified in [4.4](#).

The performances of the characteristics are given on basis of the results of tests specified in this document and, where relevant, in accordance with [5.1](#).

Information on how functioning joints can be made should be provided.

Where products are jointed in the factory the liquid tightness and if relevant the strength of the joints shall be tested and data presented.

Table 1 — Geosynthetic Barriers used in the construction of solid waste storage and disposal sites - Functions, function-related characteristics and test methods to be used

		Geosynthetic barrier			Test methods			Remarks
No	Property to be tested ^a	GBR-P	GBR-B	GBR-C	GBR-P	GBR-B	GBR-C	
	Physical properties							
1	Thickness	A	A	A	EN ISO 9863-1	EN 1849-1	EN ISO 9863-1	For products which cannot be tested according to EN ISO 9863-1, such as geotextile backed GBR-P, EN 1849-2 is applicable.
2	Mass per unit area	A	A	A	EN 1849-2	EN 1849-1	EN 14196	
	Hydraulic properties							
3	Liquid tightness ^a	A	A	A	EN 14150	EN 14150	EN 16416	Test liquid is water. Report value index flux for GBR-C and permeability for GBR-P and GBR-B.
4	Gas permeability (gas tightness)	A	A	A	ASTM D1434	ASTM D1434	EN ISO 10773	
5	Swell index	—	—	A	—	—	ASTM D5890	
	Mechanical properties							

Table 1 (continued)

No	Property to be tested ^a	Geosynthetic barrier				Test methods		Remarks
		GBR-P	GBR-B	GBR-C	GBR-P	GBR-B	GBR-C	
6	Tensile strength	A	A	A	PE-HD and PE-LL-DEN ISO 527-3, specimen type 5 FPO, PVC-P homogenous EN ISO 527-3, specimen type 5 (reference test method) equivalent to EN 12311-2, method B FPO, PVC-P multicomponent EN 12311-2 method A (reference test method) equivalent to EN ISO 527-4; specimen type 2; width: 50 mm, EPDM homogenous EN 12311-2, method B EPDM multicomponent EN 12311-2, method A	EN 12311-1	EN ISO 10319	PE-HD and PE-LLD $v = 100$ mm/min Tensile stress at break in N/mm² to be reported FPO, PVC-P homogenous $v = 100$ mm/min if elongation at break is > 400 % the test speed is 500 mm/min maximum tensile strength in N/mm² to be reported FPO, PVC-P multicomponent $v = 100$ mm/min maximum tensile force in N/50 mm to be reported EPDM homogenous $v = 100$ mm/min if elongation at break is > 400 % the test speed is 500 mm/min maximum tensile strength in N/mm² to be reported EPDM multicomponent $v = 100$ mm/min maximum tensile force in N/50 mm to be reported

Table 1 (continued)

No	Property to be tested ^a	Geosynthetic barrier				Test methods		Remarks
		GBR-P	GBR-B	GBR-C	GBR-P	GBR-B	GBR-C	
7	Elongation	A	A	A	PE-HD and PE-LLD EN ISO 527-3, specimen type 5 FPO, PVC-P homogenous EN ISO 527-3, specimen type 5 (reference test method) equivalent to EN 12311-2, method B FPO, PVC-P multicomponent EN 12311-2 method A (reference test method) equivalent to EN ISO 527-4; specimen type 2; width: 50 mm EPDM homogenous EN 12311-2, method B EPDM multicomponent EN 12311-2, method A	EN 12311-1	EN ISO 10319	PE-HD and PE-LLD with reference length (l_0) 50 mm, $v = 100$ mm/min Elongation at break to be reported FPO, PVC-P homogenous $v = 100$ mm/min if elongation at break is > 400 % the test speed is 500 mm/min – Elongation at break to be reported FPO, PVC-P multicomponent $v = 100$ mm/min Elongation at maximum tensile force in % to be reported EPDM homogenous $v = 100$ mm/min if elongation at break is > 400 % the test speed is 500 mm/min Elongation at break to be reported EPDM multicomponent $v = 100$ mm/min Elongation at maximum tensile force in % to be reported
8	Static puncture	A	A	A	EN ISO 12236	EN ISO 12236	EN ISO 12236	
9	Burst strength and elongation	S	S	S	EN 14151	EN 14151	EN 14151	This test applies to GBR-C only if they contain a polymeric or bituminous barrier element.
10	Tear strength	S	S	—	ISO 34-1	EN 12310-1	—	For GBR-P use ISO 34-1:2015, Method B, angle specimen (Figure 2) without nick at a speed of 50 mm/min.
11	Friction direct shear	S	S	S	EN ISO 12957-1	EN ISO 12957-1	EN ISO 12957-1	For determining the bonding strength of GBR-C, an internal shear or peel bond test may be applicable.

Table 1 (continued)

		Geosynthetic barrier			Test methods			Remarks
No	Property to be tested ^a	GBR-P	GBR-B	GBR-C	GBR-P	GBR-B	GBR-C	
12	Friction inclined plane	S	S	S	EN ISO 12957-2	EN ISO 12957-2	EN ISO 12957-2	
	Thermal properties							
13	Low temperature behaviour (flexure)	S	S	—	EN 495-5	EN 1109	—	
14	Thermal expansion	A	—	—	ASTM D696	—	—	
	Durability							
15	Weathering	A	A	S	EN 12224	EN 12224	EN 12224	GBR-C: see 4.4.7 . In accordance with Annex A .
16	Microorganisms	A	A	A	EN 12225	EN 12225	EN 12225	In accordance with Annex A .
17	Oxidation	A	A	A	EN 14575	EN 14575	EN ISO 13438	In accordance with Annex A . EN ISO 13438 is applicable for the geotextile elements and reinforcement yarns of GBR-C.
18	Environmental stress cracking	A	—	S	EN 14576	—	EN 14576	In accordance with Annex A . EN 14576 is applicable to GBR-P with a semi-crystalline structure. If GPR-P is between 0,5 mm and 1,0 mm, the test EN 14576 shall be performed with the same composition at a thickness greater than 1,0 mm. In order to estimate exposure durability of thermoset elastomers, as semi-crystalline materials cannot be tested following the environmental stress cracking test (EN 14576), the ozone stress cracking test shall be performed according to EN 1844 and evaluated with tensile strength measurements of the reference and the exposed specimen in accordance with A.4.1 .
19	Leaching (water soluble)	A	A	A	EN 14415	EN 14415	EN 14415	In accordance with Annex A .