BS EN 15382:2013

BSI Standards Publication

Geosynthetic barriers — Characteristics required for use in transportation infrastructure

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National foreword

This British Standard is the UK implementation of EN 15382:2013. It supersedes BS EN 15382:2008 which is withdrawn.

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

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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English Version

Geosynthetic barriers - Characteristics required for use in transportation infrastructure

Barrières géosynthétiques - Caractéristiques requises pour l'utilisation dans l'infrastructure des voies de transport

Geosynthetische Dichtungsbahnen - Eigenschaften, die für die Anwendung in Verkehrsbauten erforderlich sind

This European Standard was approved by CEN on 16 May 2013.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (EN 15382:2013) 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of an identical text or by endorsement, at the latest by January 2014, and conflicting national standards shall be withdrawn at the latest by January 2014.

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

This document supersedes EN 15382:2008.

Annex C provides details of significant technical changes between this European Standard and the previous edition.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive.

For relationship with EU Directive, see informative Annex ZA, which is an integral part of this document.

According to the CEN-CENELEC Internal Regulations, the national standards organisations 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, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

This European Standard 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 evaluation of conformity and factory production control.

This European Standard may also be used by designers, end-users and other interested parties as a tool to define relevant and appropriate characteristics for specifications and on-site quality control. It should be emphasised however that not all characteristics and test methods quoted in this European Standard are suitable for the purpose of on-site quality control.

Tests for several 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 European Standard is part of a group of standards, addressing the requirements for geosynthetic barriers when used in a specific application.

Particular application cases may contain requirements about additional properties and – preferably standardised – 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 may be temporary, as a construction expediency, or permanent, for the lifetime of the structure.

1 Scope

This European Standard specifies the relevant characteristics of geosynthetic barriers (polymeric, clay and bituminous geosynthetic barriers), used as fluid barriers in infrastructure works, e.g. roads, railroads, runways of airports, and the appropriate test methods to determine these characteristics. Tunnels and underground structures are addressed in EN 13491.

The intended use of these products is to control the pathway of liquids through the construction and to limit any contamination, e.g. by de-icing products, of groundwater or water sources.

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

This European Standard provides for the evaluation of conformity of the product to this European Standard.

This European Standard defines requirements to be met by manufacturers and their authorised representatives with regard to the presentation of product properties.

This European Standard does not cover applications where the geosynthetic barrier will be in contact with water that has been treated for human consumption. In these cases other relevant standards, requirements and/or regulations should be observed.

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

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

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

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

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

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

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

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

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

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

EN 13361, *Geosynthetic barriers — Characteristics required for use in the construction of reservoirs and dams*

EN 13362, *Geosynthetic barriers — Characteristics required for use in the construction of canals*

EN 13491, *Geosynthetic barriers — Characteristics required for use as a fluid barrier in the construction of tunnels and underground structures*

EN 13492, *Geosynthetic barriers — Characteristics required for use in the construction of liquid waste disposal sites, transfer stations or secondary containment*

EN 13493, *Geosynthetic barriers — Characteristics required for use in the construction of solid waste storage and disposal sites*

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

EN 14196, *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, *Geosynthetic barriers — Test method for determining the resistance to leaching*

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

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

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

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

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

EN 16416, *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 orthotopic fibre-reinforced plastic composites (ISO 527-4:1997)*

EN ISO 9862, *Geosynthetics — Sampling and preparation of test specimens (ISO 9862)*

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

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

EN ISO 10318:2005, *Geosynthetics —Terms and definitions (IS0 10318:2005)*

EN ISO 10319, *Geotextiles — Wide-width tensile test (ISO 10319)*

EN ISO 10320, *Geotextiles and geotextile-related products — Identification on site (ISO 10320)*

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

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

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

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

ISO 34-1:2010, *Rubber, vulcanized or thermoplastic — Determination of tear strength — Part 1: Trouser, angle and crescent test pieces*

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

ASTM D 696, *Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C With a Vitreous Silica Dilatometer*

ASTM D 1434, *Standard test method for determining gas permeability characteristics of plastic film and sheeting*

ASTM D 5890, *Standard test method for swell index of clay mineral component of geosynthetic clay liners*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 10318:2005 and the following apply.

3.1.1
product
geosynthetic barrier, including polymeric, bituminous and clay barriers

3.1.2
specification
document in which the works, functions, specific conditions and required material property values of the geosynthetic barrier of use are described

3.1.3
infrastructure
basic transportation system that is necessary for the operation of any kind of traffic

3.1.4
embankment shoulder
slope extending from the edge of a pavement to a linear ditch made of packed soil built above the natural ground

3.2 Abbreviations

For the purposes of this document, the abbreviations given in EN ISO 10318:2005 and the following apply.

GBR-P: polymeric geosynthetic barrier

GBR-B: bituminous geosynthetic barrier

GBR-C: clay geosynthetic barrier

4 Required characteristics and corresponding methods of test

4.1 General

The main function of geosynthetic barriers used in these types of application is to control the pathway of liquids through the construction and to limit contamination of groundwater or water sources. Damage during installation has not been addressed in this document.

4.2 Types of applications

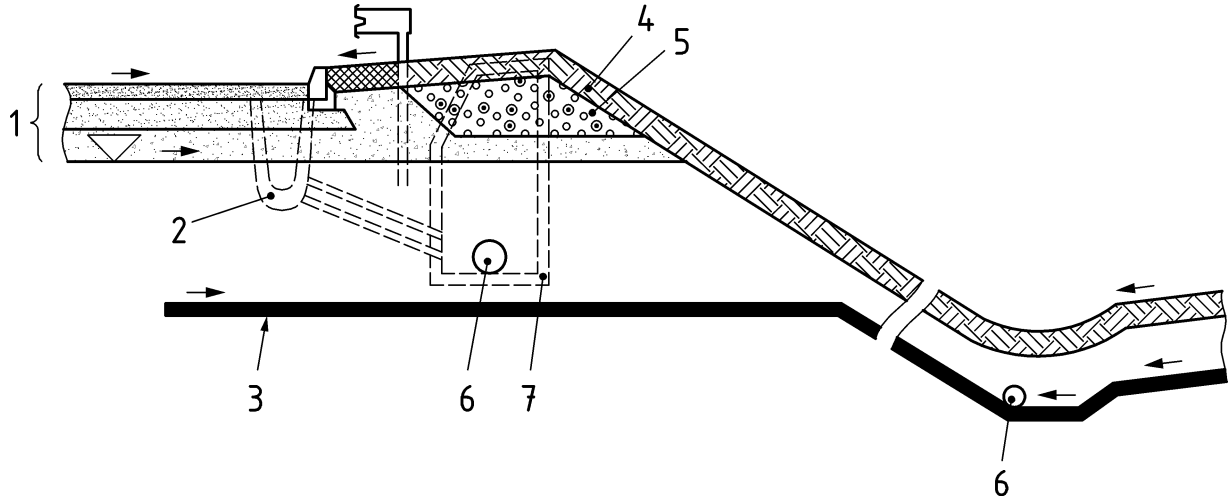
The following types of application can be distinguished:

— deep laying GBR on side slopes: application where the GBR is installed under the drainage collection system and covers the entire slope as well as the ditch area (see Figure 1);

— high laying GBR on side slopes: application where the GBR is installed above the drainage collection system as a high laying sealing system and covers the opposite side slope of the road to prevent an overflow of the road surface run-off (see Figure 2);

— deep laying GBR between two roads: application where the GBR is installed under the drainage collection system and covers the section between two roads, where a sealing is required (see Figure 3);

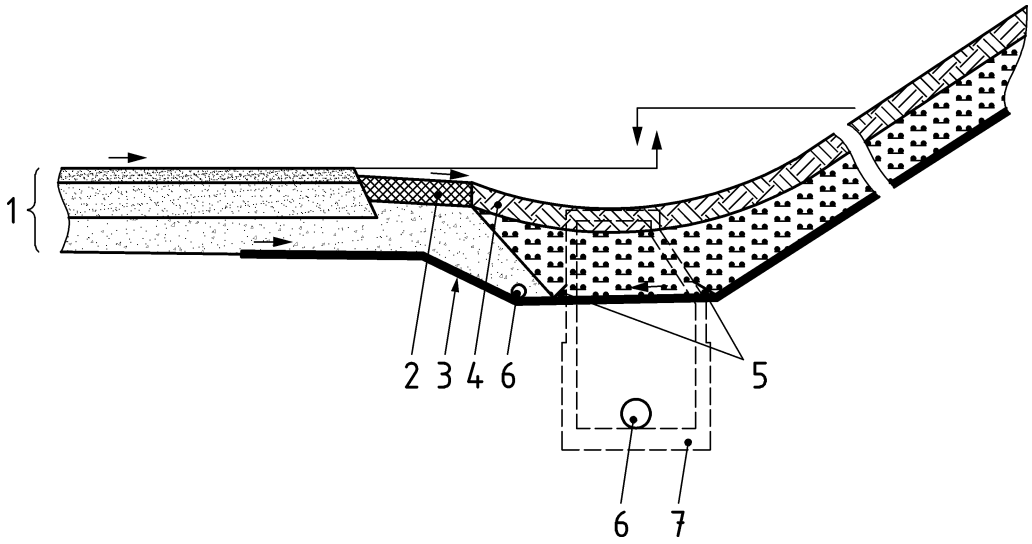
— high laying GBR between two roads: application where the GBR is installed above the drainage collection system as a high laying sealing system and covers the section between two roads where sealing is required (see Figure 4).



Key

1 pavement and/or track bed
2 rain water collection
3 geosynthetic barrier (GBR)
4 cover soil
5 fill soil
6 collection pipe
7 manhole

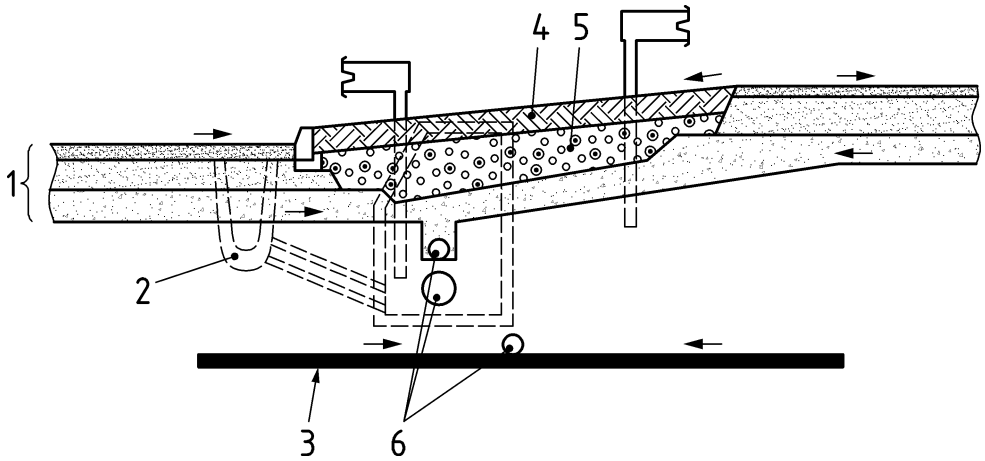
Figure 1 — Deep laying GBR on side slopes



Key

1 pavement and/or track bed
2 side embankment
3 geosynthetic barrier (GBR)
4 cover soil
5 sealing connection
6 collection pipe
7 manhole

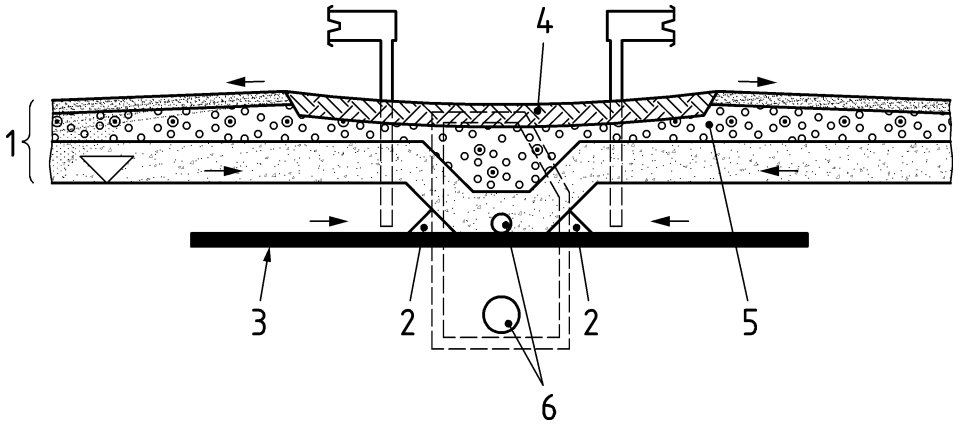
Figure 2 — High laying GBR on side slopes



Key

1 pavement and/or track bed
2 rain water collection
3 geosynthetic barrier (GBR)
4 cover soil
5 fill soil
6 collection pipe

Figure 3 — Deep laying GBR between two roads



Key

1 pavement and/or track bed
2 sealing connection
3 geosynthetic barrier (GBR)
4 cover soil
5 fill soil
6 manhole

Figure 4 — High laying GBR between two roads

4.3 Relevant characteristics

The characteristics and the test methods to be used are given in Table 1. The list of characteristics in Table 1 includes those relevant to all conditions of use and subject to regulation (H), those relevant to all conditions of use and not subject to regulation (A), and those relevant to specific conditions of use and not subject to regulation (S).

The functions and conditions of use, corresponding with the characteristics, marked with “S” in Table 1, are specified in 4.4.

The manufacturer shall provide the data based on the results of tests specified in this standard and where relevant, in accordance with 5.1.

The manufacturer shall provide information on how functioning joints can be made. Where products are jointed in the factory the water permeability and, if relevant, the strength of the joints shall be tested and data presented.

Table 1 — Geosynthetic barriers used in transportation infrastructure - Functions, function-related characteristics and test methods (including durability requirements)

		Requirement			Test methods			Remarks
No.	**Property to be tested**	**GBR-P**	**GBR-B**	**GBR-C**	**GBR-P**	**GBR-B**	**GBR-C**	
Physical properties								
1	Thickness	A	A	A	EN 1849-2	EN 1849-1	EN ISO 9863-1	
2	Mass per unit area	A	A	A	EN 1849-2	EN 1849-1	EN 14196	
Hydraulic properties								
3	Water permeability (liquid tightness)	H	H	H	EN 14150	EN 14150	EN 16416	
4	Swell Index	-	-	A	-	-	ASTM D 5890	
Mechanical properties								
5	Tensile strength	H	H	H	EN ISO 527-1, EN ISO 527-3 EN ISO 527-4 or EN 12311-2	EN 12311-1	EN ISO 10319	For non reinforced GBR-P use EN ISO 527-1 and EN ISO 527-3:1995, test specimen type 5 at a speed of 100 mm/min. For reinforced GBR-P use EN ISO 527-1 and EN ISO 527-4:1997, specimen type 2 with width 50 mm, at a speed of 5 mm per minute. EN 12311-2 should only be used for non-polyolefinic GBR-P. Report in all cases the maximum strength measured according to the test method

Table 1 *(continued)*

No.	Property to be tested	Requirement GBR-P	GBR-B	GBR-C	Test methods GBR-P	GBR-B	GBR-C	Remarks
6	Elongation	A	A	A	EN ISO 527-1, EN ISO 527-3 EN ISO 527-4 or EN 12311-2	EN 12311-1	EN ISO 10319	For non reinforced GBR-P use EN ISO 527-1 and EN ISO 527-3:1995, test specimen type 5 at a speed of 100 mm/min. For reinforced GBR-P use EN ISO 527-1 and EN ISO 527-4:1997, specimen type 2 with width 50 mm, at a speed of 5 mm per minute. Calculation of elongation as defined in EN ISO 527-1:2012, 10.2, using grip separation measurement. EN 12311-2 should only be used for non-polyolefinic GBR-P.
7	Static puncture	H	H	H	EN ISO 12236	EN ISO 12236	EN ISO 12236	
8	Tear strength	S	S	-	ISO 34-1	EN 12310-1	-	For GBR-P use ISO 34-1:2010, method B, angle specimen (Figure 2) without nick at a speed of 50 mm/min
9	Friction direct shear	S	S	S	EN ISO 12957-1	EN ISO 12957-1	EN ISO 12957-1	

Table 1 *(continued)*

		Requirement			Test methods			Remarks
No.	**Property to be tested**	**GBR-P**	**GBR-B**	**GBR-C**	**GBR-P**	**GBR-B**	**GBR-C**	
Physical properties								
10	Friction Inclined Plane	S	S	S	EN ISO 12957-2	EN ISO 12957-2	EN ISO 12957-2	
Thermal properties								
11	Low temp behaviour (flexure)	S	S	-	EN 495-5	EN 1109	-	
12	Thermal expansion	A	-	-	ASTM D 696	-	-	
Durability and chemical resistance								
13	Weathering	H	H	-	EN 12224	EN 12224	EN 12224	GBR-C: see 4.4.6
14	Micro organisms	A	A	A	EN 12225	EN 12225	EN 12225	
15	Oxidation	H	H	H	EN 14575	EN 14575	EN ISO 13438	EN ISO 13438 is applicable for the geotextile elements and reinforcement yarns of GBR-C barriers
16	Environmental stress cracking	H	-	H	EN 14576	-	EN 14576	EN 14576 is not applicable to GBR-P with a non-crystalline structure If GPR-P is greater 0,5 mm and less 1,0 mm the test EN 14576 shall be performed with the same composition at a thickness between 1,0 and 1,5 mm. In order to estimate exposure durability of thermoset elastomers, as non-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 B.4.1.

Table 1 (*concluded*)

		Requirement			Test methods			Remarks
No.	**Property to be tested**	**GBR-P**	**GBR-B**	**GBR-C**	**GBR-P**	**GBR-B**	**GBR-C**	
17	Leaching (water soluble)	A	A	A	EN 14415	EN 14415	EN 14415	
18	Wetting/drying	-	-	A	-	-	CEN/TS 14417	
19	Freezing / thawing	-	-	A	-	-	CEN/TS 14418	
20	Root penetration	A	A	A	CEN/TS 14416	CEN/TS 14416	CEN/TS 14416	
21	Chemical resistance	S	S	S	EN 14414, Annex B	EN 14414, Annex B	EN 14414, Annex B	
Relevancy: H: required for harmonisation; A : relevant to all conditions of use; S : relevant to specific conditions of use; -: not relevant								

Particular application cases may call for additional requirements, e.g. due to specific design features or conditions of use. These additional requirements should be technically relevant and preferably be measured by standardised test methods, described in European or International Standards.

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

4.4 Characteristics relevant to specific conditions of use

4.4.1 General

The specification shall define which conditions of use are relevant (see Table 1). The producer of the product shall provide the necessary data based on the requirements and test methods described in this European Standard.

The list of characteristics in Table 1 includes those required for regulatory purposes (H), those relevant to all conditions of use (A), and those relevant to specific conditions of use (S). These specific conditions of use are listed from 4.4.2 to 4.4.9.

4.4.2 Tear strength

Data on the tear strength of polymeric and bituminous barriers are required when they are laid on slopes or inclined surfaces or otherwise exposed to mechanical stress.

4.4.3 Friction characteristics (direct shear and inclined plane tests)

Data on friction characteristics are required in all applications where differential movement may take place between the product and adjacent materials including, but not by way of limitation, geosynthetic barriers applied to slopes and certain types of anchoring arrangements.

In addition to the friction characteristics information on the internal bonding strength of GBR-C in the direction of the actual stress may be relevant. A shear (EN ISO 12957 and ASTM D 6243) or peel (EN ISO 13426-1 and EN ISO 13426-2 and/or ASTM D 6496 (for needle punched GBR-C)) test may be appropriate, particularly on slopes or in applications where shear stress may occur (i.e. during installation).

Site specific testing should be carried out to establish the friction characteristics between all the materials used.

4.4.4 Chemical resistance

Depending on the application and the liquids involved, chemical testing according to EN 14414 may be applicable.

4.4.5 Low temperature behaviour

Data on low temperature behaviour are required for applications where polymer and bituminous products may be exposed to low temperatures in storage, construction and use.

Tests which set simple pass/fail criteria at a single temperature condition may not be appropriate for this purpose.

Prehydrated GBR-C should not be stored or installed when the ambient temperature is below 0° C.

4.4.6 Weathering

Data on weathering (combined effects of cycles of wetting, temperature change, and exposure to UV light) are required for applications where a GBR-C will be exposed to weathering without adequate protective cover. It should be noted that in all normal situations GBR-C barriers should be covered with soil on the same working day or prior to any circumstances which could cause a hydration of the clay component.

4.4.7 Resistance to wetting and drying

Data on the resistance of GBR-C to repeated wetting and drying is required when the conditions of use will subject the product to this sequence of actions.

NOTE Installations close to the surface will always be subjected to drying periods.

4.4.8 Freeze-thaw cycle resistance

Data on the resistance of GBR-C to freeze/thaw is required when the conditions of use will subject the product to this sequence of actions.

4.4.9 Resistance to root penetration

Data on root penetration are required in all applications where the geosynthetic barrier is exposed to soils containing restorative vegetation.

NOTE 1 Slopes in infrastructure will usually be vegetated. Therefore an "A", as defined in 4.2, is recommended.

NOTE 2 Only applications underneath embankments of infrastructure or in the central area of multilane highways form an exception: no frost, no roots, no drying effects, no traffic loads after installation.

4.5 Release of dangerous substances

National regulations on dangerous substances may require verification and declaration on release, and sometimes content, when construction products covered by this standard are placed on those markets.

In the absence of European harmonised test methods, verification and declaration on release/content should be done taking into account national provisions in the place of use.

NOTE An informative database covering European and national provisions on dangerous substances is available at the Construction web site on EUROPA accessed through: http://ec.europa.eu/enterprise/construction/cpd-ds/

5 Evaluation of conformity

5.1 General

The compliance of the geosynthetic barriers with the requirements of this European Standard and with the stated values shall be demonstrated by:

— Initial type testing (5.3);

— Factory production control (5.4) by the manufacturer, including product assessment.

The characteristics specified in Table 2, except for durability, expressed as mean values and tolerance limit(s) corresponding to the 95 % confidence level, shall be provided by the manufacturer, based on the statistical interpretation of his internal quality control measurements.

Physical examination or preliminary testing, according to one of the test methods referenced in Table 1, may indicate that values obtained for a product lie below (or above) the sensitivity threshold established for that test method. In these particular circumstances the manufacturer may declare a value as being less (or greater) than this sensitivity threshold value.

Information about durability shall be expressed in accordance with Annex B.

5.2 Verification of values

The marking and labelling of the rolls and of the products shall be checked. The marking of the products shall be according to EN ISO 10320.

NOTE The method described in this clause is not compulsory for an on-site control procedure.

The compliance of characteristics with the values defined in 5.1 shall be based on measurements made on two representative samples (A and B), taken from two different rolls. Sampling shall be made in accordance with EN ISO 9862.

The characteristics given in Table 2 shall be measured in accordance with the corresponding European standards on specimens prepared from sample A.

If the test result(s) for a particular characteristic is (are) within the tolerance limit(s) given by the manufacturer, the product is accepted as complying with respect to this characteristic.

If the test result(s) for a particular characteristic is (are) outside the tolerance limit(s), specimens prepared from sample B shall be tested.

If the test result(s) of the sample B specimens for the same characteristic are within the given tolerance limit(s), the product is accepted as complying with respect to that characteristic. If the test result(s) is (are) outside the tolerance limit(s), the product is not accepted.

5.3 Initial type tests

Initial type tests shall be carried out by the manufacturer to define the values of the properties to be declared for the product to satisfy the requirements of this European Standard.

Initial type tests shall also be carried out on existing products when a change in the basic materials or manufacturing procedures affects the declared properties or the use of a product. In these cases the appropriate initial type tests are those for the properties which are affected or need confirming and new properties introduced by a change of use.

The tests to be conducted shall be reference tests as specified in this European Standard and shall be selected for the characteristics specified in Table 2, consistent with the product's intended use:

Table 2 — Characteristics required for initial type testing and evaluation of conformity

Characteristic[a]	**Functions**
tensile strength	fluid barrier
static puncture (CBR test)	fluid barrier
liquid tightness	fluid barrier
durability	fluid barrier
[a] For the durability aspects of these characteristics, see Table 1, 4.4 and Annex B.	

The results of initial type tests shall be recorded and be available for inspection.

The sample for the type tests shall be drawn according to EN ISO 9862 from a normal production run using the materials and forming processes to be used for the full production process. The size of the sample shall be big enough to allow the determination of the characteristics specified in Table 2. Handmade samples, short trial batches and other development prototypes may be tested by the same methods, but shall not be used for establishing characteristic values in type tests.

5.4 Factory production control

A factory production control scheme shall be established and documented in a manual prior to a product type being placed on the market. Subsequently, any fundamental changes in raw materials and additives, manufacturing procedures or the control scheme that affects the properties or use of a product shall be recorded in the manual.

The manual shall include the factory production control procedures relevant to the declared properties, as confirmed by the initial type tests.

The factory production control procedures shall consist of a system for the permanent internal control of the production of the products to ensure that such products comply with this standard and that the measured values conform with the declared values.

Annex A (normative) lists all the items that shall be considered to determine which is appropriate for the control exercised for a product. The manufacturer shall establish the applicable items and record them in his factory production control manual.

When relevant the procedure given in 5.2 shall be used to check the conformity of the product, for one or more of the characteristics.

5.5 Inspection

When required, inspection of the factory and of the factory production control shall be made on the provisions contained in 5.4 and Annex A.

6 Marking

The manufacturer shall clearly and indelibly mark the geosynthetic barrier with the information specified in EN ISO 10320.

NOTE For CE Marking, see ZA.3.

Annex A
(normative)

Factory production control – Factory production control scheme

A.1 General

The items to be addressed in the factory production control manual relating to the system of control determined from 5.4 are given in Annex A.

A.2 Product design

The manufacturer shall describe how design requirements and criteria are identified, checked, controlled and updated to be unambiguous and relevant to the use of the product and its specification.

The manufacturer shall describe the communication of the design to the internal production departments or external sub-contractors.

A.3 Production

A.3.1 Raw or incoming materials

The manufacturer shall define the acceptance criteria of incoming materials and the procedures that he operates to ensure that these are met.

A.3.2 Production process

The relevant features of the plant and production process shall be defined giving the frequency of the inspections, checks and tests, together with the values or criteria required both on equipment and on work in the process. The action to be taken when control values or criteria are not obtained shall be recorded. These records shall be available for inspection by relevant parties.

A.4 Finished products

A.4.1 Raw or incoming materials

The manufacturer shall define the acceptance criteria of incoming materials and the procedures that he operates to ensure that these are met. Tables A.1 to A.3 specify testing frequencies for harmonised (mandatory) properties; for other purposes than CE-marking other frequencies may be appropriate.

Table A.1 — Polymeric GBRs

Property	Test method	Test frequency	Remarks
Water permeability	EN 14150	One per formulation but not less than one test every five years [a, b]	Test lowest manufactured thickness only
Tensile strength	EN ISO 527-1, EN ISO 527-3 EN ISO 527-4	One per production day	—
Static puncture	EN ISO 12236	One per production day	—
Weathering	EN 12224	One per formulation but not less than one every five years [b]	Test lowest manufactured thickness only
Oxidation	EN 14575	One per formulation but not less than one every five years [b]	Test lowest manufactured thickness only
Environmental stress cracking (Polyolefinic GBR-P only subject to requirements of B.3.4)	EN 14576	One per 1 000 t product or on change of formulation [b]	EN 14576 is not applicable to GBR-P with a non-crystalline structure

[a] For other purposes than CE-marking other frequencies may be appropriate. For instance, by increasing the frequency of the gas permeability test, consistency may support the existing frequency for water permeability test.

[b] "Formulation" includes specific raw material type/manufacturer, and type and proportion used for all additives or other components.

NOTE Where a manufacturer operates more than one production line at the same manufacturing location the above testing frequencies means "per production line".

Table A.2 — Bituminous GBRs

Property	Test method	Test Frequency	Remarks
Water permeability	EN 14150	One per formulation but not less than one test every five years [a, b]	Test lowest manufactured thickness only
Gas permeability	ASTM D 1434	One per formulation but not less than one test every five years [b]	Test lowest manufactured thickness only
Tensile strength	EN 12311-1	One per production day	—
Static puncture	EN ISO 12236	One per production day	—
Weathering	EN 12224	One per formulation but not less than one every five years [b]	Test lowest manufactured thickness only
Oxidation	EN 14575	One per formulation but not less than one every five years [b]	Test lowest manufactured thickness only

[a] For other purposes than CE-marking other frequencies may be appropriate. For instance, by increasing the frequency of the gas permeability test, consistency may support the existing frequency for water permeability test.

[b] "Formulation" includes specific raw material type/manufacturer, and type and proportion used for all additives or other components.

NOTE Where a manufacturer operates more than one production line at the same manufacturing location the above testing frequencies means "per production line".

Table A.3 — Clay GBRs

Property	Test method		Test Frequency
Water permeability	EN 16416		One per 25 000 m² or on change of formulation [a]
Gas permeability	—		—
Tensile strength	EN ISO 10319		One per 20 000 m² or on change of formulation [a]
Static puncture	EN ISO 12236		One per 50 000 m² or on change of formulation [a]
Oxidation	EN ISO 13438	EN ISO 13438 is applicable for the geotextile elements and reinforcement yarns of GBR-C barriers	One every five years or on change of formulation [a]
[a] "Formulation" includes specific raw material type/manufacturer, and type and proportion used for all additives or other components.			
NOTE Where a manufacturer operates more than one production line at the same manufacturing location the above testing frequencies means "per production line".			

A.4.2 Alternative tests

Where alternative tests to the reference tests are used, details of the alternative tests and procedures together with their correlation with the reference tests shall be recorded and shall be made available upon request from a relevant party.

A.4.3 Equipment

Test equipment having a bearing on test results shall be calibrated to traceable National or International Standards.

The manufacturer shall have or have available the installations, equipment and personnel which enable him to carry out the necessary verifications and tests. He may meet this requirement by concluding a subcontracting agreement with one or more organisations or persons having the necessary skills and equipment.

The manufacturer shall calibrate or verify and maintain the control, measuring or test equipment in good operating condition, whether or not it belongs to him.

The appropriate calibrations shall be carried out on defined measuring and test instruments according to standards or manufacturer's test procedures.

The equipment shall be used in conformity with the specification or the test reference system to which the specification refers.

A.5 Provisions applicable to A.2, A.3 and A.4 (to be used where appropriate)

A.5.1 Records

The dates, together with details and results of inspections, checks and tests carried out during the factory production control shall be properly recorded. These records shall be maintained for 10 years.

The product description, the date of manufacture, test method adopted, test results and acceptance or rejection criteria shall be entered under the signature of the person responsible for control who carried out the verification.

A.5.2 Assessment of results

Where possible and applicable, the results of inspections, checks and tests shall be interpreted statistically by attributes or by variables to determine whether the corresponding production conforms with the requirements and the declared values for the products.

A.5.3 Traceability

Systems of traceability and control of designs, incoming materials, and the use of materials shall be given in the manual. The stock control system of manufactured products shall be given in the manual.

A.5.4 Corrective action for non-conforming materials and products

The immediate actions to be taken when incoming materials or finished products do not conform to the requirements of this standard shall be described and recorded. These actions shall include the steps necessary to rectify the deficiency, modify the manual if required, identify and isolate the deficient raw or incoming materials and finished products and determine whether they shall be discarded or re-specified.

A.5.5 Personnel

The manufacturer shall ensure that the personnel involved in the process are suitably trained. The job description and responsibility of the operatives shall be given in the manual.

A.5.6 Quality management

The activities to ensure that all of the above requirements operate shall be described in the manual.

Annex B
(normative)

Durability of geosynthetic barriers

B.1 Introduction

B.1.1 Standards to which this annex is common

This annex provides information on the durability tests, evaluation criteria and levels of acceptability to be carried out in accordance with the following standards (and with the test methods defined in Table 1 thereof):

EN 13361, *Geosynthetic barriers — Characteristics required for use in the construction of reservoirs and dams.*

EN 13362, *Geosynthetic barriers — Characteristics required for use in the construction of canals*.

EN 13491, *Geosynthetic barriers — Characteristics required for use as a fluid barrier in the construction of tunnels and underground structures*.

EN 13492, *Geosynthetic barriers — Characteristics required for use in the construction of liquid waste disposal sites, transfer stations or secondary containment*.

EN 13493, *Geosynthetic barriers — Characteristics required for use in the construction of solid waste storage and disposal sites*.

EN 15382, *Geosynthetic barriers — Characteristics required for use in transportation infrastructure.*

B.1.2 Mechanisms of degradation

The durability of a geosynthetic barrier depends on various mechanisms that cause degradation, i. e. reduction of mechanical or hydraulic performance. These mechanisms may be summarised as the following:

a) oxidative attack accelerated by elevated temperature, exposure to UV light, or repetitive mechanical stress and possibly by chemicals e. g. heavy metals;

b) hydrolytic attack accelerated by elevated temperature, acid and alkaline conditions;

c) solvation, i.e. change in physical properties due to absorption of liquid chemicals;

d) environmental stress cracking, i.e. the mechanical failure of the geosynthetic barrier at stresses less than its yield strength in the presence of certain chemical species;

e) microbiological attack which includes the action of bacteria and fungi, and penetration by plant roots;

f) leaching of the soluble components of the geosynthetic barrier, thereby directly or indirectly affecting its mechanical properties or its resistance to other forms of degradation;

g) in the case of PVC, by the loss of plasticizers followed by dehydrochlorination.

B.1.3 Service life

The provisions and the verification methods of the annex are based upon an indicative service life of 25 years for the intended use of a product as indicated in the scope of the standard, when installed in the works. This is under the condition that the product is correctly installed, used and maintained. These provisions are based upon the current state of the art and the knowledge and experience gained.

The service life is intended to be a conservative minimum. The real working life may turn out to be considerably longer under normal conditions of use without major degradation affecting the essential requirements. The service life shall not be interpreted as a guarantee given by the manufacturer, but regarded only as a means for choosing a product appropriate to the service conditions and the intended life of the works.

B.1.4 Use of rework materials

Rework material can be used without limitations, if the original raw material meets the requirements of this annex and no pelletizing is done in the rework process.

If pelletizing is done in the rework process, rework material can be used if the final product meets the requirements of this annex.

Pelletizing is a thermal process whereby the polymer melt coming from an extruder is pressed through a die plate and cut by knives to make pellets. This process may affect the properties of the product. If the original raw material meets the requirements of this annex, a maximum of 10 % pelletized rework material may be acceptable without further proof.

B.2 Test requirements

B.2.1 General requirement

Except where specifically exempted, all GBR shall satisfy the requirements in B.2.3 for initial type testing (ITT).

B.2.2 Requirements for repeat testing

A product that is unchanged shall be tested again after the maximum interval (minimum test frequency) as shown in Tables A.1, A.2 and A.3. A product is regarded as unchanged if the raw material supply, the production technology and the process and stabilisation of the product have not been subject to a significant change. If a product has been subject to a significant process change then it shall be tested in the same manner as for a new product.

A significant change can include any of the following:

— a change in the chemical formulation (CAS No);

— reduced active ingredient concentration levels of raw materials in the polymer recipe;

— substitution of any polymer in the recipe with a replacement of the same chemical formulation from a different supplier, irrespective of any change in concentration.

Testing of a changed product may be exempted if the producer can demonstrate by means of regular assessment, including analyses of the process and long-term stabilizers, that the type of active ingredients has remained the same and that the content of these ingredients is no lower than that in the material used in the original ITT for durability.

B.2.3 Requirements for individual materials

B.2.3.1 Polyolefins

Polyolefin GBRs include HDPE, MDPE, LDPE, LLDPE, VLDPE, FPO and FPP. These can be reinforced or unreinforced, structured or smooth. The following test methods apply:

— weathering (B.3.2);

— resistance to leaching (B.3.5);

— resistance to oxidation (B.3.6);

— chemical resistance (B.3.7);

— environmental stress cracking (B.3.4): see paragraph below.

Evaluation and acceptance criteria shall be in accordance with B.4.2 and B.4.3. Both criteria shall be satisfied. Should tensile testing to B.4.2 not be feasible, for example for structured products without a smooth edge, then OIT (B.4.3) shall be used alone.

Testing for resistance to environmental stress cracking (B.3.4) does not apply to non-crystalline polymers (LDPE, LLDPE, VLDPE, FPO, FPP) nor to thin films less than 1 mm in thickness. For GBR with textured surfaces the test shall be performed on specimens taken from an adjacent area as specified in B.3.4.

B.2.3.2 Thermoset elastomers

Thermoset elastomers (e. g. EPDM) can be reinforced or unreinforced. The following test methods apply:

— weathering (B.3.2);

— resistance to leaching (B.3.5);

— resistance to oxidation (B.3.6);

— chemical resistance (B.3.7);

— ozone stress cracking test according to EN 1844.

Evaluation and acceptance criteria shall be in accordance with B.4.2.

B.2.3.3 Coated fabrics

This clause applies to coated fabrics consisting of a fibrous reinforcement coated with HDPE or LDPE. For those coated with PVC-P coated see B.2.3.4.

The following test methods apply:

— weathering (B.3.2);

— resistance to leaching (B.3.5);

— resistance to oxidation (B.3.6);

— chemical resistance (B.3.7).

Evaluation and acceptance criteria shall be in accordance with B.4.2.

B.2.3.4 PVC-P

PVC-P GBR can be reinforced, unreinforced, geotextile backed, structured or smooth. The following test methods apply:

— weathering (B.3.2);

— soil burial (B.3.3);

— resistance to leaching (B.3.5);

— resistance to oxidation (B.3.6).

Evaluation and acceptance criteria shall be in accordance with B.4.4 (loss of mass), although the tensile properties (B.4.2) may be used where appropriate.

B.2.3.5 Clay geosynthetic barriers (GBR-C)

Because GBR-C have to be covered within one day after installation weathering tests are not required.

The geotextile components shall satisfy the requirements of Annex B common to EN 13249 to 13257 and EN 13265 for a duration of 25 years. The GBR component alone shall be tested for chemical resistance (B.3.7) and evaluated according to B.4.2 and B.4.3.

B.2.3.6 Bituminous geosynthetic barriers (GBR-B)

No specific tests apply to GBR-B. Should any durability test be required, then it shall be evaluated by means of B.4.5.

B.3 Durability tests

B.3.1 Introduction

All testing to establish the durability of geosynthetic barriers is carried out by first exposing a specimen to simulated and/or accelerated environments under controlled conditions (the exposure test) followed by one or more tests of selected physical/mechanical tests on the exposed specimen (the evaluation test). A comparison of the evaluation test results with those obtained from the same test on an unexposed control sample provides a basis for acceptability. The only exception to this rule is the test for resistance to environmental stress cracking which includes both exposure and evaluation in a single procedure.

Specimens for evaluation testing shall in all cases be cut from the exposed test plate after exposure.

In cases where a particular geosynthetic barrier is manufactured in a variety of grades that differ only from one another in their thickness, then it will be acceptable only to test the grade with the least thickness. However if subsequently a thicker grade is selected in order to meet the recommended level of durability performance in the relevant test then that thickness grade shall also be tested.

B.3.2 Weathering

B.3.2.1 General

Weathering is the degradation of a geosynthetic barrier exposed to the atmosphere under natural conditions of sunlight, precipitation, etc. It is photo-oxidative in nature and the principal stimulant is the ultraviolet radiation. Tests that provide a measure of the durability of a geosynthetic barrier exposed to weathering can be direct or indirect in their relationship to the weathering process.

B.3.2.2 Direct tests and accelerated tests

Two types of direct test are used in practice. Real time exposure tests are used to determine the effects of UV light on various construction materials. These tests may provide useful information on the degradation of the exposed materials but have the disadvantage of extended testing periods, in uncontrolled and variable conditions. Such data may not be representative.

The alternative testing approach is to use an accelerated method. This typically involves a controlled environment in which specimens are exposed to alternative periods of ultraviolet light and spraying with water. Such a test is described in EN 12224.

The principal variables in this type of test are the following:

— wavelength and energy emitted by the lamps;

— temperature of the specimen surface (typically 50 °C to 75 °C at black standard temperature);

— frequency of the UV exposure/water spray cycle;

— total time of UV exposure and the total test time.

All of the foregoing factors affect the results obtained and are defined in EN 12224.

The relationship between exposure time under test method EN 12224 and the real time exposure to sunlight in a particular location is an important consideration in the evaluation of test results. The countries of Southern Europe experience an annual total radiant exposure of 3 GJ/m^2 to 6 GJ/m^2. A mean value of 4,5 GJ/m^2 is assumed. The UV radiant exposure (radiation with wavelength < 400 nm) is 6 % to 9 % of this or 350 MJ/m^2 per annum.

The radiant exposure in EN 12224 is limited to 50 MJ/m^2, corresponding to only about one summer month in Southern Europe. Since the test irradiance is about 40 W/m^2 and should be interrupted for one hour in six, the standard test duration is approximately 430 h. To effectively simulate average European conditions on site for a period of one year the required test period should be 3 000 h.

Comparison between accelerated and natural weathering based on radiant exposure has been shown to be broadly correct, although the error in individual cases can exceed 50 %. Temperature, altitude, humidity and the equipment used in real time tests have a significant effect on the correlation.

B.3.2.3 Period of exposure

In consideration of the six required characteristics standards listed above (see B.1.1), three categories of exposure can be identified. These are:

— Applications where there is either no exposure of the geosynthetic barrier material to sunlight or where the material will be covered within three days of deployment. It is assumed that such material of limited resistance to weathering will be suitably protected for transportation with a UV resistant packaging foil and such protection will not be removed other than at the point of application. Such applications would include the lining of tunnels and other underground structures. No weathering test is required for these applications.

— Applications where there will be limited exposure of the geosynthetic barrier material during construction for a maximum period of one year but the design will require fill or covering materials to be provided so that there is no exposure in normal use for the life of the facility. Such applications would be the lining of solid waste landfills and some reservoirs, dams, and canals. For all GBR-P which rely on carbon black for their UV resistance and which are intended for exposed storage, it will be useful to show that the formulation includes carbon black 2-3 % (ASTM D 1603 or ASTM D 4218 (muffle furnace)) and has a carbon black dispersion in CAT 1 or 2 according to ASTM D 5596 or to conduct a thermo gravimetric analysis according to EN ISO 11358. For these applications see B.3.2.4.

— Applications where the geosynthetic barrier material will be exposed during normal operation throughout the lifetime of the structure (assumed to be 25 years). These applications include reservoirs, canals, dams, and liquid waste disposals where covering protection of the geosynthetic barrier is not prescribed by the design. For these applications see B.3.2.5.

B.3.2.4 Requirements for periods of exposure up to one year

Specimens of GBR shall be tested according to EN 12224 extended to a radiant exposure of 350 MJ/m^2, requiring an estimated exposure time of 3 000 h. The evaluation tests and acceptance criteria shall be as specified for the relevant material in B.2.3. The duration of testing shall be reported in the CE documentation.

B.3.2.5 Periods of exposure greater than one year

In the case of exposures on site of more than one year, the manufacturer shall provide a statement of the claimed duration to weathering of 25 years in the application. This shall be supported by a technical justification.

B.3.3 Resistance to micro-organisms

A sample of GBR shall be tested according to EN 12225. The evaluation tests and acceptance criteria shall be as specified for the relevant material in B.2.3.

Where a geosynthetic barrier is to be installed in soils where anaerobic or bio-enhanced conditions exist an alternative test method should be considered.

B.3.4 Resistance to environmental stress cracking

A sample of GBR shall be tested in accordance with EN 14576 (Single Point Test, 30 % of tensile yield strength and 50 °C temperature). The acceptance criterion shall be a minimum duration of 336 h (2 weeks).

Specimens shall be taken in the weakest direction according to the measured tensile yield strength. Normally this will be the cross machine direction i.e. the direction of the notch will be aligned with the machine direction.

The test report shall state whether any failure to achieve 336 h (2 weeks) is due to elongation without break: such failure shall be taken as meeting the requirements.

In the case of GBR-P with textured surfaces the test shall be performed on a specimen of the same material with smooth surfaces. Such specimens shall be taken from one of the following sources:

— smooth surface GBR-P at the pre-textured stage of manufacture (if applicable);

— on a specimen taken from any smooth surface welding selvedge provided at the edge of the roll.

B.3.5 Resistance to leaching

A sample of GBR shall be tested for its resistance to leaching by specified liquids in accordance with EN 14415 with the following modifications:

— Method A will be modified to 80 °C and 90 d, except for PVC-P;

— For PVC-P Method A will be modified to 70 °C and 180 d;

— Method C is only required for applications covered by EN 13492, EN 13493 and EN 15382.

The evaluation tests and acceptance criteria shall be as specified for the relevant material in B.2.3. In addition, any visible signs of degradation shall be reported.

B.3.6 Resistance to oxidation

A sample of GBR-P shall be tested for its resistance to oxidation according to EN ISO 13438:2004, Method C1. Alternatively it shall be tested according to EN 14575 modified as follows:

— for GBR-P and GBR-B: 85 °C and 90 d;

— for FPO, FPP and TPE: 80 °C and 90 d;

— for PVC-P: 80 °C and 120 d.

For GBR-B, where the testing temperature and testing time is not suitable to test the oxidation resistance of the bitumen, an alternative test method should be considered.

The evaluation tests and acceptance criteria shall be as specified for the relevant material in B.2.3.

GBR-P materials (B.2.3.1 to B.2.3.4) that are not subject to oxidation shall be tested for thermal degradation using this test, but evaluation will be limited to changes in properties in accordance with B.4.2.

B.3.7 Chemical resistance

B.3.7.1 All applications

A sample of GBR shall be tested in accordance with EN 14414:2004, procedures A and B (dilute acid and alkali).

The evaluation tests and acceptance criteria shall be as specified for the relevant material in B.2.3. In addition, any visible signs of degradation shall be reported.

B.3.7.2 Liquid and solid waste storage (EN 13492 and EN 13493)

A sample of GBR for use in the lining of liquid and solid waste storage facilities (EN 13492 and EN 13493) shall be tested in accordance with B.3.7.1 above and in addition in accordance with EN 14414:2004, procedure C (organic solvents) and procedure D (synthetic leachate).

The evaluation tests and acceptance criteria shall be as specified for the relevant material in B.2.3.

Site specific conditions may affect the durability of the GPR and the design life, this can be tested using site specific leachate according to EN 14414:2004, procedure E.

B.4 Evaluation tests and acceptance criteria

B.4.1 General

The properties for evaluation of the different GBR are defined in B.4.2 to B.4.5.

B.4.2 Evaluation by comparison of tensile properties

Specimens taken from exposed and unexposed samples shall be tested using the tensile test method appropriate to the geosynthetic barrier type as specified in Table 1 of this document. The acceptance criteria shall be retained values of at least 75 % of the original tensile strength and at least 75 % of the original elongation at break. Both criteria shall be satisfied. For GBR-C the acceptance criteria shall be at least 50 % retained strength (no criterion for elongation) and for thermoset elastomers (EPDM) at least 75 % retained strength and at least 60 % retained elongation at break. All tensile tests are to be performed in both directions. An in-plane reinforced product shall be tested diagonal to the mean reinforcement direction, providing that this

excludes the influence of the reinforcing fabric. If this is not feasible, then B.4.4 or B.4.5 may be used instead. Alternatively, the barrier layer may be separated from the fabric for durability testing.

B.4.3 Evaluation by comparison of Oxidative Induction Time (OIT) values

For GBR where tensile strength and elongation at break measurements are not sufficient for the evaluation of the durability as they rely on additional stabiliser materials to provide resistance to oxidation, evaluation of the following tests will also be carried out on the basis of the comparison of the oxidative induction time (OIT) of an exposed specimen to that of an unexposed specimen.

A specimen taken from the exposed sample shall be tested according to EN ISO 11357-6 (Standard OIT). The acceptance criterion is a retained OIT value of at least 55 % of the OIT value of an unexposed specimen. Alternatively the High Pressure OIT (HP-OIT) according to ASTM D 5885 can be used. In this case the retained HP-OIT value is at least 80 % of the HP-OIT value of an unexposed specimen.

B.4.4 Evaluation by change in mass

Specimens of GBR shall be evaluated by measurement of the loss of mass (after drying according to the appropriate test methods, e.g. before measuring the mass the samples have to be dried until the loss of mass does not exceed 0,1 %) of a single specimen according to EN ISO 9864, measured before and after exposure. The acceptance criterion is a minimum retained mass of 95 %, for PVC-P 90 %.

B.4.5 Evaluation by change in water permeability

Specimens of GBR shall be evaluated according to EN 14150.

The ratio of the water permeability of the exposed sample to that of an unexposed sample shall not exceed 5.

NOTE For example if the water permeability for GBR-B is 2×10^{-7} $m^3/m^2/d$ the acceptable criteria is 1×10^{-6} $m^3/m^2/d$.

Annex C
(informative)

Major technical changes to previous edition

Following technical changes were introduced in comparison with the previous edition:

- The normative references were updated;
- Table 1 was revised;
- "Chemical resistance" was added to Clause 4;
- "Release of dangerous substances" was added to Clause 4;
- Annex A revised: "raw or incoming material" and Tables A.1 to A.3 were added;
- Annex B was revised.

Annex ZA
(informative)

Clauses of this European Standard addressing the provisions of the EU Construction Products Directive

ZA.1 Scope and relevant characteristics

This European Standard has been prepared under Mandate M/107 “Geotextiles” amended by M386 and given to CEN by the European Commission and the European Free Trade Association.

The clauses of this European Standard shown in this annex meet the requirements of the mandate given under the EU Construction Products Directive (89/106/EEC).

Compliance with these clauses confers a presumption of fitness of the geosynthetic barriers covered by this annex for the intended uses indicated herein; reference shall be made to the information accompanying the CE marking.

This annex has the same scope as Clause 1 of this standard with regard to the products covered. It establishes the conditions for the CE marking of geosynthetic barriers intended for the use indicated below and shows the relevant clauses applicable (see Table ZA.1).

Table ZA.1 — Scope and relevant clauses

Product: geosynthetic barriers as covered in the scope of the standard **Intended use(s):** as fluid barriers for application in transportation infrastructure			
Essential characteristics	**Requirement clauses in this standard**	**Mandated level(s) or class(es):**	**Notes** (Units used for mean value and tolerances)
Tensile strength	4.4, Table 1 (5)-Tensile Strength	none	GBR-P: N/mm² GBR-B: N/mm² GBR-C: kN/m
Resistance to static puncture	4.4, Table 1 (7)-Static Puncture	none	all GBR: kN
Liquid tightness	4.4, Table 1 (3)- Water permeability	none	GBR-P: ($m^3 \times m^{-2} \times d^{-1}$) GBR-B: ($m^3 \times m^{-2} \times d^{-1}$) GBR-C: ($m^3 \times m^{-2} \times s^{-1}$)
Durability	4.4, Table 1 and Annex B (13)-Weathering (15)-Oxidation (16)-Environmental stress cracking	none	
Dangerous substances	4.5	none	

The requirement on a certain characteristic is not applicable in those Member States where there are no regulatory requirements on that characteristic for the intended end use of the product. In this case, manufacturers placing their products on the market of these Member States are not obliged to determine nor declare the performance of their products with regard to this characteristic and the option “No performance determined” (NPD) in the information accompanying the CE marking (see ZA.3) may be used. The NPD option may not be used, however, where the characteristic is subject to a threshold level.

For some products testing in only one direction may be applicable, in which case it should be clearly specified in the information accompanying the CE Marking.

NOTE The 95 % confidence level corresponds to the mean value minus (and/or plus) 1,0 tolerance value(s).

ZA.2 Procedure for the attestation of conformity for geosynthetic barriers used in transportation infrastructure

ZA.2.1 Systems of attestation of conformity

The system of attestation of conformity of the geosynthetic barriers indicated in Table ZA.1, established by EC Decision 96/581/EC of 24 June 1996 published in the OJ as document L 254 as given in Annex III of the mandate for Geotextiles, is shown in Table ZA.2 for the indicated intended uses and relevant level(s) or class(es).

Table ZA.2 — System of attestation of conformity

Product(s)	Intended uses	Level(s) or class(es)	Attestation of conformity systems
Geosynthetics (membranes and textiles), geotextiles,geocomposites,geogrids,geomemebranes and geonets used : - As fluid or gas barriers - As protective layer - For drainage and/or filtration - For reinforcement	In roads, railways, foundations and walls ,drainage systems, erosion control, reservoirs and dams, canals, tunnels and underground structures , liquid waste disposal or containment , for solid waste storage or waste disposal	-	2+
System 2+: See Directive 89/106/EEC (CPD) Annex III.2.(ii), First possibility, including certification of the factory production control by an approved body on the basis of initial inspection of factory and of factory production control as well as of continuous surveillance, assessment and approval of factory production control.			

The attestation of conformity of the geosynthetic barrier in Table ZA.1 shall be according to the evaluation of conformity procedures indicated in Table ZA.3 resulting from application of the clauses of this or other European Standard indicated therein.

Table ZA.3 — Assignment of evaluation of conformity tasks (for geosynthetic barriers under system 2+)

Tasks			Content of the task	Clauses to apply
Tasks for the manufacturer	Factory production control (F.P.C)		Parameters related to all characteristics of Table ZA.1	5.2, 5.4 and Annex A
	Initial type testing		All characteristics of Table ZA.1	5.1, 5.2, 5.3
	Further testing of samples		All characteristics of Table ZA.1	5.4
Tasks for the notified body	Certification of F.P.C on the basis of:	- initial inspection of factory and of F.P.C	Parameters related to the following characteristics of Table ZA.1: - tensile strength - water permeability	5.4 and Annex A
		- continuous surveillance, assessment and approval of F.P.C.	Parameters related to the following characteristics of Table ZA.1: - tensile strength - water permeability	5.4 and Annex A

ZA.2.2 Certificate and declaration of conformity

The system allows the non-determination of a certain characteristic where at least one Member State has no legal requirement at all for such characteristic and in this case the verification of such a characteristic is not imposed on the manufacturer if he does not wish to declare the performance of the product in that respect. In this case, the manufacturer willing to place his products in the market of this Member State is not obliged to

determine nor to declare the performance of his products with regard to this characteristic and the option "no performance determined" in the information accompanying the CE mark may be used.

When compliance with the system of attestation of conformity is achieved, the notified body shall draw up a certificate of the factory production control including the following information:

— name, address and identification number of the notified body;

— name and address of the manufacturer, or his authorised representative established in the EEA and place of production;

— description of the product (type, identification, use,...);

— provisions to which the product conforms (Annex ZA of this EN);

— particular conditions applicable to the use of the product;

— the certificate's number;

— conditions and period of validity of the certificate;

— name of, and position held by, the person empowered to sign the certificate.

In addition, for each product, the manufacturer shall draw up a declaration of conformity (EC declaration of conformity) including the following information:

— name and address of the manufacturer, or his authorised representative established in the EEA;

— name and address of the notified body;

— number of the attached certificate of factory production control;

— name of, and position held by, the person empowered to sign the declaration on behalf of the manufacturer or of his authorised representative.

This declaration of conformity entitles the manufacturer to affix the CE marking, as described in ZA.3.

The above mentioned certificate and declaration shall be available in the official language(s) of the Member State in which the product is to be used.

ZA.3 CE marking and labelling

The manufacturer or his authorised representative established within the EEA (EU and EFTA) is responsible for the affixing of the CE marking.

The CE marking symbol to affix shall be in accordance with Directive 93/68/EEC and shall be accompanied by the following information:

— identification number of the certification body;

— name or identifying mark of the producer;

— registered address of the producer;

— the last two digits of the year of affixing the CE marking;

— number of the Certificate of factory production control;

— reference to this annex and this European Standard;

— information on the mandated characteristics: values to declare presented as indicated in 5.2 of this standard.

NOTE 1 The purpose of this information is to identify the legal entity responsible for the manufacture of the product.

The affixing will be done on the packaging of the geosynthetic barriers in the way indicated in Figure ZA.1, which gives the simplified label to affix to the product. This figure contains the minimum set of information and the link to the accompanying document, where the other required information is given.

The complete information will be given on the accompanying documents in the way presented in Figure ZA.2.

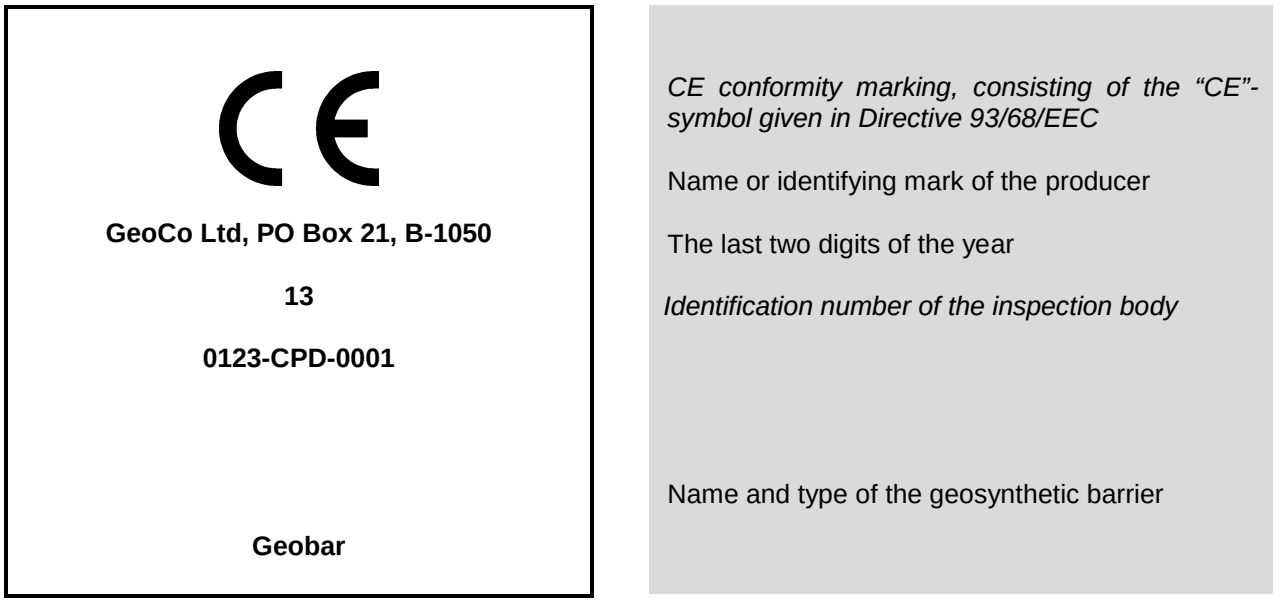


Figure ZA.1 — Example of CE marking on the packaging of a geosynthetic barrier

CE **0123-CPD** **Geobar**	CE conformity marking, consisting of the "CE"-symbol given in Directive 93/68/EEC. Identification number of the inspection body Name and type of the geosynthetic barrier
GeoCo Ltd, PO Box 21, B-1050 **13** **0123-CPD 004** **EN 15382:2013** **Polymeric geosynthetic barrier for use in transportation infrastructure** **Intended use: fluid barrier**	Name or identifying mark and registered address of the producer Last two digits of the year of affixing the CE marking Number of the FPC certificate No. of applicable European Standard(s) with date of version Identification of product, including type (polymeric, bituminous, clay)
Tensile strength (EN ISO 527-1 and EN ISO 527-3): MD: 12 N/mm² (-1 N/mm²) CMD: 10 N/mm² (-0,8 N/m²) **Resistance to static puncture (EN ISO 12236):** 1,2 kN (-0,1 kN) **Water permeability (liquid tightness): (EN 14150)** 4 x 10^{-6} m³/m² x d **Durability:** To be covered within 1 day after deployment Resistance to environmental stress cracking: ≥ 200 h (EN 14576)	Intended use (s) and information on regulated characteristics Example with values – average and tolerance value (note 3) Declaration on durability based on the provisions of Annex B

Figure ZA.2 — Example of accompanying documents

In the case of several standards being applicable for the CE marking of the same product, the accompanying document should contain the detailed information specified in Figure ZA.2 and in addition refer to all applicable standards and intended uses as shown in the following example:

EN 15382 and EN 13362

Polymeric geosynthetic barrier for use in infrastructure works and in canals

Intended use: fluid barrier

NOTE 2 Intended use(s) of geosynthetic barriers in reservoirs and dams: as a barrier to the movement of fluids.

If required in the Table ZA.1 the tolerance value(s) corresponding to the 95% confidence level, should be given by the manufacturer as follows:

Tensile strength	– α N/mm2 (GBR-P and GBR-B)	*example: (– 1 N/mm2)*
	– α kN/m (GBR-C)	*example: (–1 kN/m)*
Resistance to static puncture	– α kN	*example: (– 0,15 kN)*
Water permeability	– α $m^3 \times m^{-2} \times d^{-1}$ (GBR-P and GBR-B)	*example: (–10–6 $m^3/m2/d$)*
	– α $m^3 \times m^{-2} \times s^{-1}$ (GBR-C)	*example: (– 10–10 $m^3/m^2/s$)*

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[1] M/107 — *Mandate to CEN/CENELEC concerning the execution of standardisation work for harmonised standards on geotextiles* — European Commission —1996

[2] *Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption,* Official Journal L 330, 5.12.1998, pp. 32–54

[3] EN 806-1:2000, *Specifications for installations inside buildings conveying water for human consumption — Part 1: General*

[4] HSUAN, Y.G. (2000), *Data base of field incidents used to establish HDPE geomembrane stress crack resistance specifications, Geotextiles and Geomembranes 18, pp. 1-22*

[5] EN ISO 11358, *Plastics — Thermogravimetry (TG) of polymers — General principles (ISO 11358)*

[6] EN ISO 13426-1, *Geotextiles and geotextile-related products — Strength of internal structural junctions — Part 1: Geocells (ISO 13426-1)*

[7] EN ISO 13426-2, *Geotextiles and geotextile-related products — Strength of internal structural junctions — Part 2: Geocomposites (ISO 13426-2:2005)*

[8] ASTM D 1603, *Standard test method for carbon black content in olefin plastics*

[9] ASTM D 4218, *Standard test method for determination of carbon black content in polyethylene compounds by the muffle-furnace technique*

[10] ASTM D 5596, *Standard test method for microscopic evaluation of the dispersion of carbon black in polyolefin geosynthetics*

[11] ASTM D 5885, *Standard test method for oxidative Induction time of polyolefin geosynthetics by high-pressure differential scanning calorimetry*

[12] ASTM D 6243, *Standard Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method*

[13] ASTM D 6496, *Standard Test Method for Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners*

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