

Intern rapport

**Intern rapport
nr. 2080**



**Bentonittmembraner til
fuktsikring av vegtunneler og
kulverter**



**Statens vegvesen
Vegdirektoratet**

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Vegteknisk avdeling

Bentonittmembraner til fuktsikring av vegtunneler og kulverter

Sammendrag

Som et ledd i utviklingsarbeidet med forskrifter for vannsikring av vegtunneler er også bentonittmembraner inkludert. Denne rapporten gir en oversikt over de tilgjengelige produkter på markedet. Slike membraner er for tiden i utstrakt bruk for tunnelportaler, overbygg og kulverter, og erfaringene er delte.

Bentonitt består for en stor del av smektitter, dvs leirmineraler som kan oppta store mengder vann med tilhørende volumøkning. De produseres av spesielle forekomster av vulkanske asker. Den opprinnelige bentonittmembran besto av innlegg av tørr bentonittleire i papp. De membraner som for tiden er aktuelle består av geotekstiler eller geomembraner belagt med bentonitt.

Innenfor rammen av dette prosjektet er det ikke foretatt noen vurdering av brukbarheten til bentonitt som membran for vegtunneler.

Emneord: *vegtunneler, vannsikring, frostsikring, tunnelhvelv*

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1. INNLEDNING

Denne rapport er laget på oppdrag fra Statens vegvesen, Vegdirektoratet, Vegteknisk avdeling ved Arne Grønhaug. Arbeidet inngår i en større sammenheng i forbindelse med Tunnellkledninger: Delprosjekt fuktsikring. Det er en utredning om bruk av bentonitt i tettesjikt med grunnlag i tilgjengelig litteratur, aktuelle materialer, CEN standarder og generell erfaring om utførelse av vanntetting på konstruksjoner.

2. GENERELT OM BENTONITT

Råvare

For 50 til 130 millioner år siden ble aske kastet ut av vulkaner og falt ned i havet eller innsjøer som askeavleiringer. I tidens løp ble disse avsetningene dekket av silt og det foregikk en kjemisk reaksjon som førte til at bentonitt leire ble dannet. Bentonitt har fått navn etter Fort Benton, Wyoming, USA hvor den ble oppdaget ca 1890. Hovedkomponenten i bentonitt er et mineral som kalles montmorillonitt etter en avleiring ved Montmorillon i Sør Frankrike.

Fremstilling

Bentonitt fremskaffes ved gruvedrift i de geografiske områder hvor avleiringene fant sted. Første fase er som regel tørking for å fjerne vann til ønsket nivå. Deretter blir materialet sortert eller siktet for å fjerne urenheter. I denne oppredningsfasen blir størrelsen på partiklene bestemt og det blir foretatt prøving av relevante egenskaper. Til slutt blir tørr bentonitt levert til de forskjellige bruksformål i form av pulver eller granulat.

Typiske egenskaper

Leirmaterialer har spilt en viktig rolle gjennom menneskehetens historie. I tusenvis av år er leire blitt brukt til keramikk og teglstein. I dag er det hundrevis av anvendelser. Bentonitt leire blir brukt i et stort antall industriprodukter fra hundeskåler via farmaceutiske varer til vanntetting i jordlag .

Bentonitt er et forholdsvis dyrt materiale som karakteriseres av lav permeabilitet og stor evne til adsorpsjon.

En god kvalitet av materialet har en andel av montmorillonitt i størrelse fra 70 til 95%.

Til bruk i industrielle formål som vanntetting sammen med syntetiske tekstiler (GCL) kan bentonitt deles inn i tre hovedgrupper:

- naturlig natrium (Na) bentonitt (avsetninger i salt vann)
- naturlig kalsium (Ca) bentonitt og (avsetninger i ferskt vann)
- aktivert bentonitt

Tradisjonell anvendelse

Tetting av jordlag foregår vanligvis ved bruk av tette jordarter. Avhengig av ønsket grad av tetting og forekomst brukes ofte leire som legges ut i et relativt tykt lag og komprimeres.

Etter hvert som omfanget av deponering økte og kravene til sikring mot forurensning av grunnvann ble skjerpet ble tilgangen til naturlig forekommende tette jordarter i store mengder utilstrekkelig.

En oppgradert leire i tynnere lag med forskjellige former for beskyttelse på undersiden og oversiden kunne bli vurdert som likeverdig i funksjon med tradisjonelle løsninger og samtidig være konkurransedyktig på pris og byggetid.

I de seneste år har utviklingen av industrielt produserte produkter skutt fart. Bruk av tørr eller spesial preparert bentonitt av høy kvalitet i kombinasjon med syntetiske tekstiler og syntetiske membraner har gitt en ny dimensjon til tetting av jordlag.

3. GEOSYNTETISKE BENTONITT TETTESJIKT (GCL)

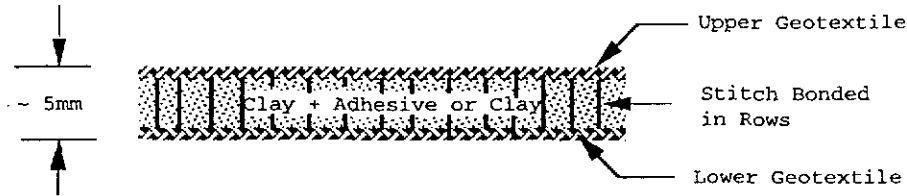
Typer

Det vil bli for omfattende å beskrive alle mulige former for kommersielle produkter på dette området i detalj. I hovedsak kan man imidlertid samle utbudet i følgende hovedgrupper:

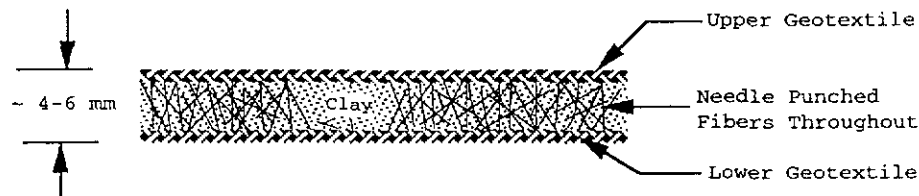
- a) Tørr bentonitt mellom to geotekstiler og det hele bundet sammen med lim (Fig 1).
- b) Tørr bentonitt mellom to geotekstiler som er bundet sammen ved hjelp av sying (Fig 2).
- c) Tørr bentonitt mellom to geotekstiler og bundet sammen med en nålestukket fiberarmering over hele flaten (Fig 3).
- d) Tørr bentonitt klebet til en geomembran (Fig 4).
- e) Tørr bentonitt holdt sammen i en geotekstil av typen b) eller c) som igjen er laminert til en geomembran (Fig 5).
- f) Spesial preparert bentonitt med geotekstil på begge sider (Fig. 6).



Figur 1. Tørr bentonitt bundet til geotekstil med lim



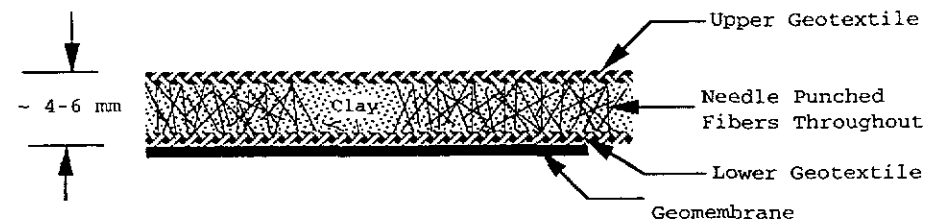
Figur 2. Tørr bentonitt mellom to lag geotekstiler bundet sammen med sying



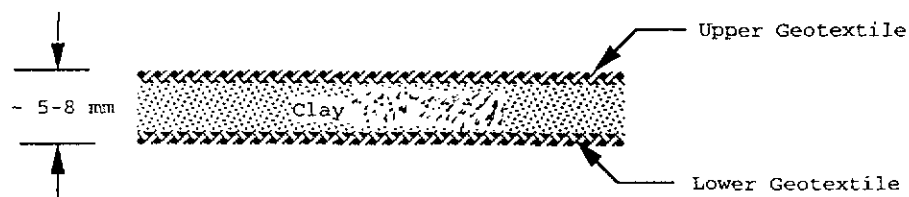
Figur 3. Tørr bentonitt mellom to lag geotekstiler bundet sammen med nålestukket fibre



Figur 4. Tørr bentonitt klebet til en geomembran

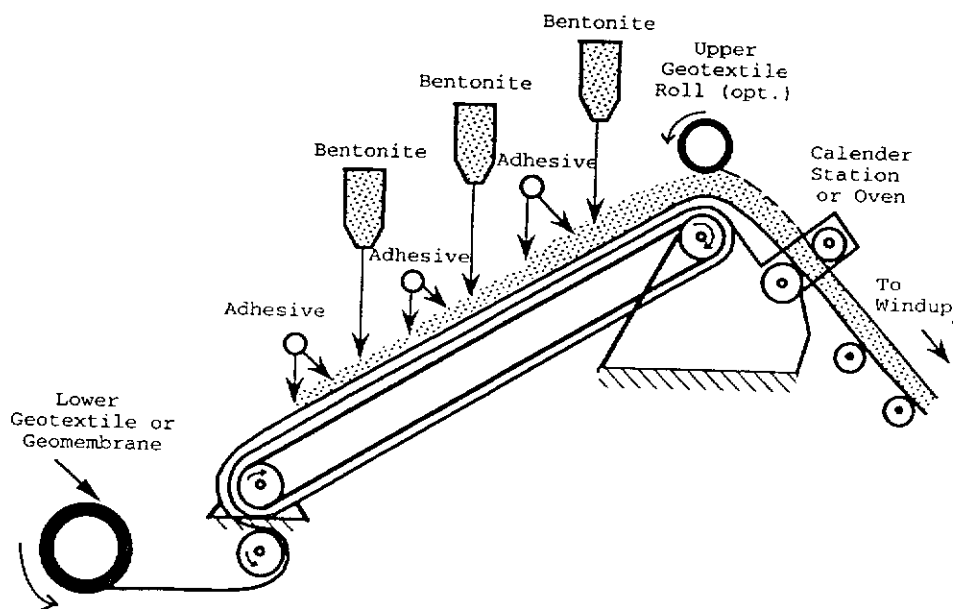


Figur 5. Tørr bentonitt bundet i en geotekstil som er laminert til en geomembran

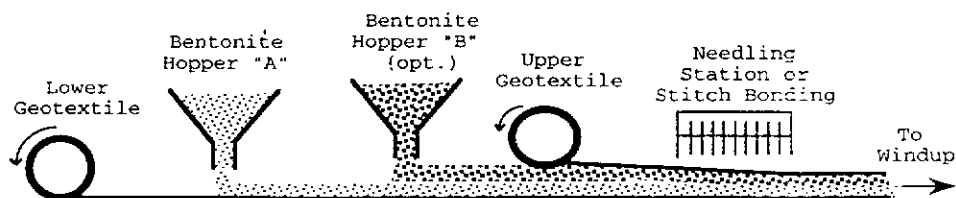


Figur 6. Spesial preparert bentonitt mellom geotekstiler

Produksjonsprosessen for disse materialer med tørr bentonitt er skjematisk vist i Fig 6 og 7.



Figur 6. Produksjon av tørr bentonitt tettesjikt hvor lagene bindes med lim



Figur 7. Produksjon av tørr bentonitt tettesjikt hvor lagene bindes med fiber

Anvendelse

Produkter som består primært kun av tørr bentonitt eller tørr bentonitt sammen med en geotekstil i en eller annen form regnes å ha sitt primære bruksområde som flerlags tetting mellom jordlag. Denne utredningen er i første rekke rettet inn mot tetting av en konstruksjon med overdekning på den ene siden. I og med denne begrensningen i arbeidsomfang vil det derfor være et naturlig skille ikke å behandle disse ovennevnte bentonittprodukter videre.

De kategorier som i utgangspunktet er relevant for bruk til vanntetting av konstruksjoner er alternativene e) og f);

e) Tørr bentonitt bundet i en geotekstil og laminert til en geomembran.

Denne kategori kan nærmest betraktes som "standard" løsning hvor geomembranen er den primære tetting. Et slikt kombinert bentonitt tettesjikt vil bli lagt til grunn for den videre behandling.

f) Spesial preparert bentonitt med geotekstil på begge sider må vurderes mer på individuell basis.

Produkter i denne kategori hvor også de såkalte pre-hydrerte bentonitter tilhører bør typeklarerer med attestering for egnethet til gitte bruksområder.

4. BENTONITT MEMBRANER FOR TUNNELLER OG KULVERTER

Påkjenning

Første trinn av analysen vil naturlig være å se på aktuelle påkjenninger.

Hvis konstruksjonen utsettes for vanntrykk midlertidig eller permanent må tettingen primært vurderes utført med vanntrykkmembran.

Muligheten for strømmende vann vil også være avgjørende for valg av utførelse.

Utforming av konstruksjon

I henhold til de begrensninger som ligger til grunn for dette oppdrag behandles kun drenerte konstruksjoner med overdekning på den ene siden.

Hvis man tillater bruk av tettesjikt som er avhengig av at vannet ledes bort må bruken begrenses til konstruksjoner med fall.

Betongkonstruksjoner som er støpt horisontale har som regel setninger etter herding. I praksis får man motfall og partier med stående vann. Risikoen for lekkasje øker betraktelig hvis man på slike partier ikke foreskriver en skjøteteknikk som tåler vanntrykk fra starten uavhengig av tilfeldigheter ved installasjonen.

Arbeidsutførelse

Fremdriften av anleggsarbeidene har stor innflytelse på utførelsen av tettesjiktet. En hel rekke faktorer kan ha avgjørende innflytelse på kvaliteten av utført arbeid; så som værforhold, personale, maskiner, type overdekking, fremdriftsplan etc.

Grad av tetthet

Et viktig element som kanskje ikke har vært plassert riktig på verdiskalaen er vurdering av ønsket grad av tetthet. Eller sagt på en annen måte; hvor mye lekkasje kan man tolerere?

Her er man ved et av de vanskelige valgene som også må veies opp mot kostnad.

Vannlekkasje er ikke bare et estetisk problem. Den kan fort skade konstruksjonen. Får man drypp i vegbanen har man derimot en klar risiko for skade på mennesker ved uhell i trafikken.

Med økende trafikkvolum og økende hastighet bør kravet til tetthet vurderes mer kritisk enn tidligere. I dag finnes det et godt utbud av fleksible membraner. Tilhørende kvalifisert personale er absolutt mulig å innpasse i hovedentreprenørens fremdriftsplaner. Det skulle derfor ikke være noe teknologisk eller økonomisk hinder for å legge mer vekt på en sikker tetting.

Med dette som utgangspunkt foreslås derfor følgende grunnleggende sikkerhetskrav til tettesjikt med bentonitt.

Grunnleggende krav

Som før nevnt anbefales tørr bentonitt kun brukt i et sammensatt tettesjikt med geotekstil og geomembran som er minst 0,5 mm tykk.

Skjøt med omlegg skal være minimum 150 mm bred og brukes kun på fullt drenerte konstruksjoner med fall $\geq 1 : 20$.

I drenerte konstruksjoner med fall $< 1 : 20$ eller med fyllmasse som gir risiko for oppdemming av vann skal skjøtene utføres med sveis av geomembranen.

Hvis fyllmassen inneholder skarpe partikler eller hvis det kjøres med maskiner før 0.3 m fyllmasse eller annen tilfredsstillende overdekking er på plass skal membranen beskyttes på oversiden med en filt som veier 250 g/m².

Materialegenskaper

Når man i utgangspunktet har valgt et kombinert tettesjikt med tørr bentonitt bundet i en geotekstil som er laminert til en geomembran vil det være naturlig å se på komponentene enkeltvis først og samlet til slutt.

Bentonitt

Masse per flateenhet i tørr tilstand	min.	4 kg/m ²
Andel av Montmorillonitt	min.	70 %
Fuktinnhold	maks	10 %
Svelleindeks	min.	25 ml
Fuktadsorpsjon	min.	600 %

Geotekstil

Type (øvre, nedre og sammenbinding)
Masse per flateenhet
Tykkelse
Strekkstyrke
Rivestyrke
Punkteringsmotstand

Geomembran

Type (Basispolymer; PP, PE etc.)		
Tykkelse	min.	0,5 mm
Strekkstyrke		
Rivestyrke		
Punkteringsmotstand		

Bentonitt kombinert tettesjikt

Masse per flateenhet	min.	5 kg/m ²
Tykkelse		
Fuktinnhold		
Bentonitt i form av ; (Granulat, pulver etc.)		

Bestandighet må vurderes opp mot forholdene i brukssituasjonen for de materialene som inngår i produktet.

Geomembranen regnes her som den primære tetting og det er viktig at det framlegges dokumentasjon ved prøving og referanser fra bruk i kontakt med jord, betong eller forventet forurensing av det vannet som skal ledes bort. Det er en kjent sak at ved saltholdig vann (brakkvann) må det for eksempel brukes en spesiell type bentonitt.

Kvalitetssikring

Sikring av kvaliteten i alle deler fra fremstilling av hver materialkomponent til ferdig utført konstruksjon må inngå i et fast mønster og gjerne med ekstern overvåking.

Et kritisk stadie er selve utførelsen av en vanntetting entreprise med et kombinert bentonitt tettesjikt.

Her er noen av de viktigste sjekkpunktene:

- a) Underlaget skal være fritt for snø, is eller stående vann. Skarpe kanter og utspring over 5 mm må fjernes samt at hulrom over 5 cm³ må fylles med sparkel.
- b) Tettesjiktet legges ut med bentonitt siden mot underlaget og geomembranen mot overdekningen.

Skjøt med omlegg uten sveising er sårbar for uønsket svelling før tilstrekkelig ballast er på plass eller utvasking i kanten fra rennende vann i bruksfasen. Norske værforhold i alminnelighet skulle tilsi beskyttelse av kant og at skjøtekanter som ligger i fallretningen burde beskyttes uansett.

Tverskjøter bør forskyves slik at man ikke får for mange lag oppå hverandre.

Detaljer ved gjennomføring og eventuell mekanisk fastspenning ved omleggskjøt på flater men stort fall må utføres nøyaktig og etter produsentens forskrifter.

- c) Geomembranen er den primære tetting og man bør sikre seg at den ikke skades under arbeidet med å dekke den til. Skarpe gjenstander, tømning fra stor høyde eller tung trafikk bør unngås. Normalt bør en filtmatte på ca 250 g/m² legges over membranen som beskyttelse mot mekanisk påkjenning.

Tørr bentonitt har vanligvis et svelletrykk på 3000 N/m² (Pa). Overdekningen bør derfor minst utøve et trykk i denne størrelsesorden for at omleggsskjøten skal virke etter hensikten. 30 cm fyllmasse av grus vil gi dette minimum av trykk.

Fordeler og ulemper

Ulemper

Bruk av tørr bentonitt forutsetter at man bygger på et prinsipp hvor man først oppnår full funksjon av tettesjiktet etter at tildekkingen er foretatt. Det gir primært en usikkerhet for tilfredsstillende sikring mot lekkasje fra første vannpåkjenning.

Skal man i tillegg være avhengig av rimelige værforhold og ikke ha for vått underlag tilsier det at for store deler av Norge blir det uakseptabel risiko for svelling før mottrykk er etablert.

Hydreringen av tørr bentonitt i bruksfasen er ikke alltid uproblematisk. Mange typer tilsetninger i dreneringsvannet kan føre til ionevandring og nedsatte svulle egenskaper.

Ved å bruke tørr bentonitt i et kombinert tettesjikt med geomembran samt å ta til følge de foreslåtte anbefalinger er sjansen for feil i utførelse redusert. Bentonitt i granulat form som holdes på plass mekanisk i en geotekstil øker håndterbarheten og minsker risikoen for sviktende svelling på grunn av limstoff.

Fordeler

Den ekstra sikring mot utilsiktet punktering av geomembranen må ansees som en fordel.

Noen hevder at muligheten for bruk av mindre kvalifisert arbeidskraft og lettere tilpassing til hovedentreprenørens fremdrift er en fordel. Men disse forhold er usikre og beror kanskje i større grad på varierende vurdering av risikofaktorene.

Argumentene for den kompakte tetting mot betong og dermed ingen spredning ved punktering kan i vårt tilfelle være lite relevant hvis ikke geotekstilen mot underlaget er spesielt utformet.

Erfaring fra bruk

Noen av de nye kombinerte tettesjiktene med bentonitt har vært brukt i Norge eller under tilsvarende forhold i noen år.

Referanseliste bør etterspørres.

Innenfor rammen av dette utredningsprosjektet har det imidlertid ikke vært mulig å foreta en systematisk og objektiv analyse, inspeksjon eller vurdering av erfaring eller egnethet til bruk av bentonitt tettesjikt som fuktsikring av vegtunneler eller kulverter.

Trondheim, 28. oktober 1998.


Einar M Paulsen

5. LITTERATUROVERSIKT

- [1] ASTM Special Testing Publication (STP) No 1308. Testing and Acceptance Criteria for Geosynthetic Clay Liners. USA, 1997.
- [2] KOERNER, R. M., GARTUNG, E., ZANZINGER, H. Geosynthetic Clay Liners (GCL) *Proceedings of an International Symposium in Nürnberg, 1994.*
- [3] ASTM Special Testing Publication (STP) No 1076. Geosynthetics: Microstructure and Performance. *Proceedings of an International Symposium in Orlando, Florida, 1989.*
- [4] Forslag til Norsk standard NS 3420-13. Beskrivelsestekster for bygg og anlegg – Del 13: Geotekstiler og geotekstilrelaterte produkter. Versjon: Juni 1998.
- [5] WATN, A., Armert jord. Definisjoner og symboler. SINTEF rapport STF69 A92039, Trondheim, 1992

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

JWG DRAFT N 113

WI 00254056

March 1998

UDC.

Descriptors:

English version

Geomembranes - Product specification

This draft European Standard is submitted to the CEN members for CEN enquiry. It has been drawn up by Technical Committee CEN/TC 189.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

This draft European Standard was established by CEN in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

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Ref. No pr EN 254056:1998

98/100782

Foreword

This European Standard has been prepared by CEN/TC 254 „Flexible sheets for waterproofing“ the secretariat of which is held by BSI. It is now submitted to the CEN enquiry procedure.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of the EU Construction Products Directive. For relationship with the EU Construction Products Directive, see informative Annex ZA, which is an integral part of this standard.

This European Standard has been prepared on the basis of European Standards from CEN Technical Committee 189 „Geotextiles and Geotextile-related products“ and CEN Technical Committee 254 Waterproofing Membranes.

This European Standard includes provisions for the evaluation of conformity of the products.

No existing European Standard is superseded.

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 ZZ 19**, and conflicting national standards shall be withdrawn at the latest by YYY, 199**.

In accordance with CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, The Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

98/100782

1 Scope

This European Standard specifies the relevant characteristics and corresponding test methods for factory made geomembranes, used as a fluid or vapour barrier in civil engineering or environmental applications, e.g. reservoirs, dams, canals, tunnels, underground structures, storage and disposal sites for liquid or solid waste.

This standard covers all types of geomembranes: thermoplastic or elastomeric sheets, bituminous sheets, geosynthetic clay liners.

2 Normative references

This European Standard includes by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references subsequent amendments to, or revisions of, any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

prEN 495-5	Thermoplastic and elastomeric roofing and sealing sheets - Low temperature folding test
EN 964-1	Geotextiles and geotextile-related products - Determination of thickness at specified pressures - Part 1: single layers
EN 965	Geotextiles and geotextile-related products - Determination of mass per unit area
prEN 1107-1	Flexible sheets for roofing - Determination of dimensional stability at elevated temperature - Part 1: Bitumen sheets
prEN 1107-2	Flexible sheets for roofing - Determination of dimensional stability at elevated temperature - Part 2: thermoplastic and elastomeric sheets
prEN 1109	Flexible sheets for roofing - Bitumen sheets - Determination of flexibility at low temperatures
prEN 1297-1	Flexible sheets for roofing - Determination of resistance to water ageing - Part 1: Bitumen sheets
prEN 1848-1	Flexible sheets for waterproofing - Determination of length, width, straightness and flatness - Part 1: bitumen sheets
prEN 1848-2	Flexible sheets for waterproofing - Determination of length, width, straightness and flatness - Part 2: thermoplastic and elastomeric sheets
prEN 1849-1	Flexible sheets for waterproofing - Determination of thickness and mass per unit area - Part 1: bitumen sheets
prEN 1849-2	Flexible sheets for waterproofing - Determination of thickness and mass per unit area - Part 2: thermoplastic and elastomeric sheets
prEN 1851-2	Flexible sheets for waterproofing - Determination of joint strength - Part 2: thermoplastic and elastomeric sheets
prEN 1928	Flexible sheets for waterproofing - Determination of watertightness
prEN 1931	Flexible sheets for waterproofing - Determination of water vapour transmission properties

EN ISO 10319	Geotextiles - Wide-width tensile test (ISO 10319:1993)
prEN ISO 10320	Geotextiles and geotextile-related products - Identification on site
prEN 12112-2	Flexible sheets for waterproofing - Determination of tear properties - Part 2: thermoplastic and elastomeric sheets
prEN 12113-2	Flexible sheets for waterproofing - Determination of tensile properties - Part 2: thermoplastic and elastomeric sheets
EN ISO 12236	Geotextiles and geotextile-related products - Static puncture test (CBR test)
prEN 12310-1	Flexible sheets for waterproofing - Determination of nail shank tear resistance - Part 1: Bitumen sheets
prEN 12311-1	Flexible sheets for waterproofing - Determination of tensile properties - Part 1: Bitumen sheets
prEN 12316-1	Flexible sheets for waterproofing - Determination of the peel resistance of joints - Part 1: Bitumen sheets
prEN 12317-1	Flexible sheets for waterproofing - Determination of the shear resistance of joints - Part 1: Bitumen sheets
ENV 12224	Geotextiles and geotextile-related products - Determination of the resistance to weathering
ENV 12225	Geotextiles and geotextile-related products - Method for determining the microbiological resistance by a soil burial test
prENV 10722-1	Geotextiles and geotextile-related products - Procedure for simulating damage during installation - Part 1: installation in granular materials.
PrEN ISO 12957-1	Geotextiles and geotextile-related products - Determination of the friction characteristics - Part 1: Direct shear test.
ISO WD 13438	Geotextiles and geotextile-related products - Screening test method for determining the resistance to oxidation
prENV ISO 12960	Geotextiles and geotextile-related products - Screening test method for determining the resistance to liquids
ISO WD 13426-2	Geotextiles and geotextile-related products - Determination of the strength of structural junctions - Part 2: Geocomposites
prEN ISO 12957-2	Geotextiles and geotextile-related products - Determination of friction characteristics - Part 2: Inclined plane test.

3 Definitions

4 Relevant characteristics and test methods

Geomembranes shall be tested in accordance with the test methods specified in table 1 for the characteristics relevant to their intended use. An overview of characteristics and intended uses is given in table 2.

Table 1: Relevant characteristics and test methods for geomembranes

Characteristic	Test method		
	Thermoplastic and elastomeric geomembranes	Bituminous geomembranes	Geosynthetic clay liners
Product designation			
Dimensional characteristics (length, width) of rolls	prEN 1848-2	prEN 1848-1	prEN ISO 10320
Thickness	prEN 1849-2	prEN 1849-1	EN 964-1
Mass per unit area	prEN 1849-2	prEN 1849-1	EN 965
Swell index montmorillonite	NA	NA	ASTM D 5890°
Montmorillonite content	NA	NA	ASTM D 837°
Water absorption	NA	NA	DIN 18132°
Hydraulic properties			
Water tightness	prEN 1928	prEN 1928	ASTM D 5887°
Water vapour transmission	prEN 1931	prEN 1931	NA
Gas tightness	ASTM D 1434°	PG 4.2 JWG	New test
Mechanical properties			
Tensile strength	prEN 12113-2	prEN 12311-1	EN ISO 10319
Elongation at maximum load	prEN 12113-2	prEN 12311-1	EN ISO 10319
Peel resistance of joints	prEN 1851-2	prEN 12316-1	NA
Shear resistance of joints	prEN 1851-2	prEN 12317-1	NA
Joint overlap efficiency	NA	NA	New test
Static puncture resistance	EN ISO 12236	EN ISO 12236	EN ISO 12236
Flexibility at low temperature	prEN 495-5	prEN 1109	NA
Burst strength	WI 189058 (from ASTM D 5617)	WI 189058 (from ASTM D 5617)	WI 189058 (from ASTM D 5617)
Tear strength	prEN 12112-2	prEN 12310-1	NA
Friction direct shear	prEN ISO 12957-1	prEN ISO 12957-1	prEN ISO 12957-1
Friction tilting plane	prEN ISO 12957-2	prEN ISO 12957-2	prEN ISO 12957-2
Damage during construction	prENV 10722-1	prENV 10722-1	prENV 10722-1
Impact resistance	189 new WI	189 new WI	189 new WI
Delamination	ISO WD 13426-2	ISO WD 13426-2	ISO WD 13426-2
Thermal properties			
Dimensional stability at elevated temperature	prEN 1107-2	prEN 1107-1	new test
Durability and chemical resistance			
Ageing by UV radiation (short term)	ENV 12224	ENV 12224	ENV 12224
Ageing by UV radiation (long term)	TC 254 WG 10 N 33	prEN 1297	NA
Chemical resistance (normal applications)	prENV ISO 12960	prENV ISO 12960	prENV ISO 12960*
Chemical resistance (landfills)	189 new WI	189 new WI	189 new WI
Resistance to micro-organisms	ENV 12225	ENV 12225	ENV 12225*
Resistance to oxidation/heat ageing	ISO WD 13438	ISO WD 13438	ISO WD 13438
Stress cracking	ASTM D 5397°	NA	NA
Leaching of water soluble components	SIA 280-13°	to check	new test
wetting-drying cycles	to be discussed	to be discussed	new test
freezing-thawing cycles	to be discussed	to be discussed	new test

NA: not applicable

°: to be converted into a European standard

*: this test method is only suitable to evaluate the geotextile component

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5 Relevant characteristics of geomembranes per intended use

Information on the characteristics specified in table 2 shall be obtained in accordance with the test methods from table 1. If information on additional characteristics is required, only the test methods specified in table 1 shall be used.

Table 2: Relevant characteristics of geomembranes per intended use

Characteristic	Reservoirs and dams	Canals	Tunnels and underground structures	Liquid and solid waste
Product designation				
Dimensional characteristics (length, width) of rolls	X	X	X	X
Thickness	X	X	X	X
Mass per unit area	X	X	X	X
Swell index	X			X
Montmorillonite content	X			X
Water absorption	X	X	X	X
Hydraulic properties				
Water vapour transmission	X	X	X	X
Water tightness	X	X	X	X
Gas tightness				X
Mechanical properties				
Tensile strength	X	X	X	X
Elongation at maximum load	X	X	X	X
Peel resistance of joints	X	X	X	X
Shear resistance of joints	X	X	X	X
Joint overlap efficiency	X			X
Static puncture resistance	X	X	X	X
Flexibility at low temperature	X	X	X	X
Burst strength				X
Tear strength	X	X	X	X
Friction direct shear	X	X		X
Friction tilting plane	X	X		X
Anchorage	X	X		X
Damage during construction	X	X	X	X
Impact resistance	X	X	X	X
Delamination	X	X	X	X
Thermal properties				
Dimensional stability at elevated temperature	X	X		X
Durability and chemical resistance				
Ageing by UV radiation (short term)	X	X		
Ageing by UV radiation (long term)				X
Chemical resistance (normal applications)			X	X
Chemical resistance (landfills)				X
Resistance to micro-organisms	X	X		
Resistance to oxidation/heat ageing				X
Stress cracking				X

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EUROPEAN STANDARD
NORME EUROPEENNE
EUROPÄISCHE NORM

Draft
pr EN (WI 00254031)

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ICS

Descriptors: Roof waterproofing, roofing, flexible sheets, plastic, rubber, definitions, characteristics

English version

**Flexible sheets for waterproofing
Plastic and rubber sheets for roof waterproofing.
Product specification**

Feuilles souples d'étanchéité -
Feuilles d'étanchéité de toiture plastiques et
élastomères -
Spécification de produit

Abdichtungsbahnen -
Kunststoff- und Elastomerbahnen für
Dachabdichtung -
Produktspezifikation

This draft European Standard is submitted to CEN members for CEN enquiry.

It has been drawn up by Technical Committee CEN/TC 254 "Flexible sheets for waterproofing".

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

This draft European Standard was established by CEN in the three official versions (English, French and German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CEN

European Committee for Standardisation
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

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Foreword

This European Standard has been prepared under the Mandate given to CEN by the Commission of the European Communities and the European Free Trade Association and supports Essential Requirements of the Council Directive of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products (Directive 89/106/EEC)-CPD in the following text.

This European Standard has been prepared by CEN TC 254 "Flexible sheets for waterproofing" generally in accordance with the BT Resolutions 128/1990. It received approval from the CEN Technical Board at the 23rd meeting on 8 June 1990.

This European Standard is a general product standard for plastic and rubber sheets of the type defined in clause 3 of this standard and commonly used in a number of applications for roofing used in buildings. This standard is one of a series of product standards for factory made flexible sheets for roofing used in buildings.

Plastic and rubber sheets of the type defined in this European Standard are deemed to be construction products in accordance with article 1 of the CPD.

The general test methods referred to in this product standard are common to all waterproofing products used as roof finishing falling within the scope of the CEN TC 254 unless otherwise stated in this product standard. The specific test method standard referred to in the standard are common to the specific types of plastic and rubber sheets for roofing falling within the scope of CEN TC 254 unless otherwise stated in this product standard.

No existing European Standard is superseded.

Introduction

Article 2 of the CPD requires that construction products be fit for intended use, that is to say that the products shall have the characteristics enabling the works incorporating such products to satisfy the Essential Requirements referred to in Article 3 of the CPD, in addition to any other technical requirement that may be specified by the user.

Product characteristics and the manner of their installation and use are inseparable elements, which together determine fitness for purpose. For this reason this standard lists in clause 4.0 the principal user applications for the product types concerned. The test methods referred to in this European Standard relate primarily to the use of plastic and rubber sheets roofing, applications generally in accordance with the provisional mandate to CEN in the area of flexible sheets for roof finishes, 15/33, WI 00254031.

The list of test methods may require extension to meet the specific needs of other product applications and uses not covered by this European Standard.

Plastic and rubber sheeting products of various types have been in use in Europe over the years in the principal user applications listed in this European Standard. The fitness for purpose of such products in the relevant applications is to a certain extent known by virtue of experience. The products, to which this European Standard applies, though varied in composition and dimensions, are those which are known and which comply with the product definition and characteristics given in this European Standard.

The characteristics of this European Standard are divided into harmonised characteristics and voluntary characteristics. The harmonised characteristics relate to those mentioned in Mandate 15; Roof finishes. Harmonised characteristics are indicated in Annex ZA of this European Standard.

Plastic and rubber sheets complying with this European Standard and applied, used and maintained in accordance with national application standards or industry-acknowledged rules of technology for such products, which standards and rules take into account the geographical and local climatic conditions as well as different levels of protection, are deemed to satisfy the Essential Requirements of the Construction Products Directive for an economically reasonable working life.

1 Scope

This European Standard specifies the characteristics of plastic and rubber sheets for which the main intended use is roofing.

It specifies the system for the attestation of conformity of the product to this European Standard and includes the conditions for CE marking.

This European Standard does not consider bitumen sheets.

2 Normative references

This European Standard incorporates, by dated or undated references, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references, the latest editions of the publication referred to apply.

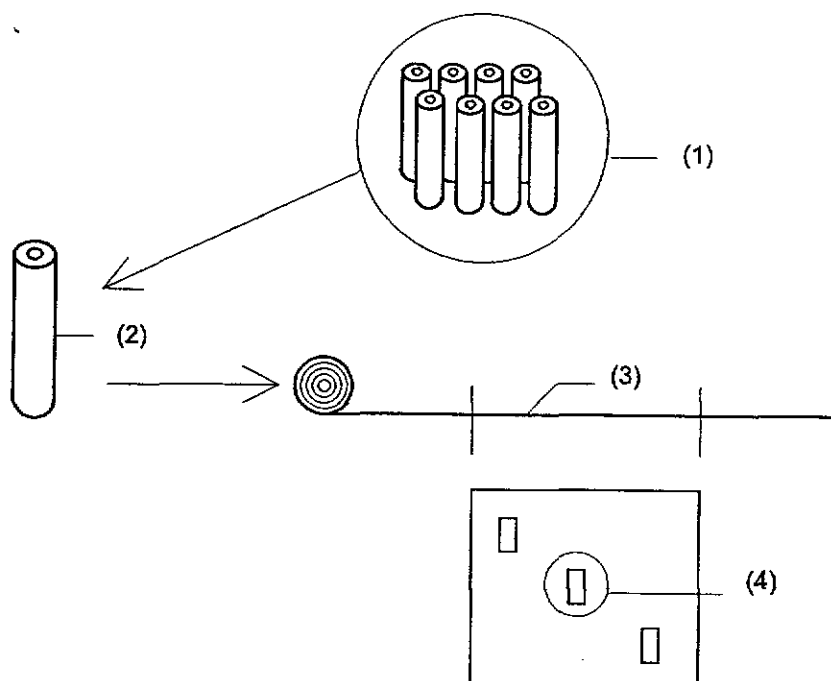
- | | |
|---------------|--|
| pr EN 495-5 | Flexible sheets for waterproofing - Part 2: Plastic and rubber sheets for roof waterproofing - Determination of foldability at low temperature |
| pr EN 1107-2 | Flexible sheets for waterproofing - Part 2: Plastic and rubber sheets for roof waterproofing - Determination of dimensional stability |
| pr EN 1297 | Flexible sheets for waterproofing - Bitumen, plastic and rubber sheets for roof waterproofing - Artificial ageing by long term exposure to the combination of UV radiation, elevated temperature and water |
| pr EN 1548 | Flexible sheets for waterproofing - Part 2: Plastic and rubber sheets for roof waterproofing - Determination of compatibility with bitumen |
| pr EN 1844 | Flexible sheets for waterproofing - Part 2: Plastic and rubber sheets for roof waterproofing - Determination of resistance to ozone |
| pr EN 1847 | Flexible sheets for waterproofing - Part 2: Plastic and rubber sheets for roof waterproofing - Method for exposure to liquid chemicals, including water |
| pr EN 1848-2 | Flexible sheets for waterproofing - Part 2: Plastic and rubber sheets for roof waterproofing - Determination of length, width, straightness and flatness |
| pr EN 1849-2 | Flexible sheets for waterproofing - Part 2: Plastic and rubber sheets for roof waterproofing - Determination of thickness and mass per unit area |
| pr EN 1850-2 | Flexible sheets for waterproofing - Part 2: Plastic and rubber sheets for roof waterproofing - Determination of visible defects |
| pr EN 1928 | Flexible sheets for waterproofing - Bitumen, plastic and rubber sheets for roof waterproofing - Determination of water tightness |
| pr EN 1931 | Flexible sheets for waterproofing - Bitumen, plastic and rubber sheets for roof waterproofing - Determination of water vapour transmission properties |
| pr EN 12112-2 | Flexible sheets for waterproofing - Part 2: Plastic and rubber sheets for roof waterproofing - Determination of resistance to tearing |
| pr EN 12311-2 | Flexible sheets for waterproofing - Part 2: Plastic and rubber sheets for roof waterproofing - Determination of tensile properties |
| pr EN 12316-2 | Flexible sheets for waterproofing - Part 2: Plastic and rubber sheets for roof waterproofing - Determination of peel resistance of joints |

pr EN 12317-2	Flexible sheets for waterproofing - Part 2: Plastic and rubber sheets for roof waterproofing - Determination of shear resistance of joints
pr EN 12691	Flexible sheets for waterproofing - Bitumen, plastic and rubber sheets for roof waterproofing - Determination of resistance to impact
pr EN 12730	Flexible sheets for waterproofing - Bitumen, plastic and rubber sheets for roof waterproofing - Determination of resistance to static loading
pr EN WI 00254027	Flexible sheets for waterproofing - Bitumen, plastic and rubber sheets for roof waterproofing - Determination of resistance to root penetration
pr EN WI 00254029	Flexible sheets for waterproofing - Bitumen, plastic and rubber sheets for roof waterproofing - Determination of hail resistance
pr EN WI 00254030	Flexible sheets for waterproofing - Part 2: Plastic and rubber sheets for roof waterproofing - Determination of resistance to micro- organisms
pr EN WI 00254040	Flexible sheets for waterproofing - Bitumen, plastic and rubber sheets for roof waterproofing - Rules for sampling and preparing test specimens
pr EN WI 00254044	Flexible sheets for waterproofing - Bitumen, plastic and rubber sheets for roof waterproofing - Determination of material properties with respect to wind uplift resistance
ISO 472: 1988	Plastics - Vocabulary
ISO 1043 - 1: 1987	Plastics - Symbols - Part 1: Basic polymers and their characteristics (DIS 1043 - 1: 1992)
ISO 1382: 1982	Rubber - Vocabulary
ISO 1629: 1995	Rubber and lattices - Nomenclature + 1629 DAM 1:1991 Thermoplastic rubbers

3 Definitions

For the purpose of this standard the following definitions apply:

- 3.1 **waterproofing:** Action concerned to prevent or control the passage of water or moisture from one plane to another.
- 3.2 **waterproofing system:** Assembly of one or more roof waterproofing sheets in its applied and jointed form, which has certain performance characteristics, to be assessed as a whole.
- 3.3 **roofing:** Waterproofing used in the roof of a building.
- 3.4 **roofing sheet:** Factory made flexible sheet including any internal layer, emboss and/or backing.
- 3.5 **sampling:** Procedure used to select or constitute a sample.
- 3.6 **sample:** Plastic or rubber sheet from which a test piece is taken.
- 3.7 **test piece:** Part of the sample from which test specimens are taken
- 3.8 **test specimen:** Piece of accurate dimensions taken from the test piece.
- 3.9 **surface:** The upper side of the sheet, as used in situ; it is usually the inside of the roll.
- 3.10 **emboss:** Textured pattern impressed into one or both surfaces of the sheet so that the difference between the effective and overall thickness does not exceed 0.1 mm (see Figure 2c and e)
- 3.11 **internal layer:** A layer of woven or non-woven fabric of synthetic or mineral fibres incorporated in the polymeric material (see Figure 2g). This layer may or may not constitute reinforcement.
- 3.12 **backing:** A layer of woven or non-woven fabric of synthetic or mineral fibres, fixed to the bottom of the sheet (see Figure 2f)
- 3.13 **overall thickness (e):** Thickness of the sheet, including a any internal layer, emboss, and backing but excluding any surface profile (see Figure 2).
- 3.14 **effective thickness (e_{eff}):** The thickness of the layer providing the waterproofing function, excluding any emboss surface profile and backing (see Figure 2)
- 3.15 **welding:** Process of bonding by softening the surfaces to be united, either by heat or with the aid of a solvent (solvent welding, solvent bonding), pressing the softened surfaces together.
- 3.17 **adhesive bonding:** Process of bonding by coating the surfaces to be united with an adhesive or by applying an adhesive tape, and then applying pressure.
- 3.18 **manufacturers limiting value:** Minimum or maximum value as stated by the manufacturer to be met during testing of type, internal quality control or external supervision with a confidence level of 95%.



(1) – Consignment; (2) – Sample; (3) – Test piece; (4) – Test specimen

Figure 1: Sampling

4 Product designation

4.1 Typical materials

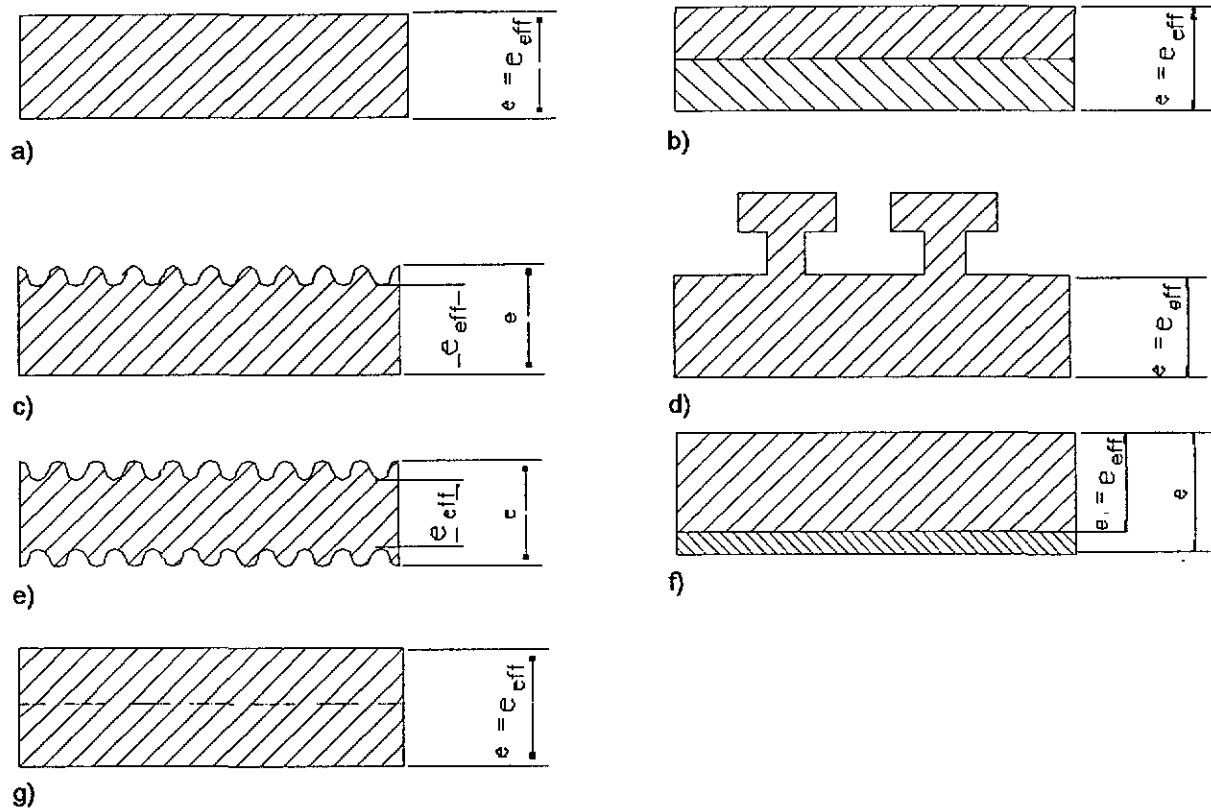
4.1.1 Plastics

C-PE	Chlorinated polyethylene
EEA	Ethylene/ethyl acetate
EVAC	Ethylene/vinyl acetate
ECB	Ethylene, copolymer, bitumen
FPP	Flexible polypropylene
PE	Polyethylene
PP	Polypropylene
PIB	Polyisobutylene
PVC	Polyvinylchloride

4.1.2 Rubbers

BR	Butadiene rubber
CSM	Chlorosulfonyl polyethylene
CR	Chloroprene rubber
EPDM	Terpolymer of ethylene, propylene and a diene with the residual unsaturated portion of the diene in the side chain
IIR	Isobutene-isoprene rubber (butyl rubber)
NBR	Acrylonitrile-butadiene rubber (nitrile rubber)

4.2 Structure of the sheet



- | | |
|---|---|
| a) Homogenous single layer sheet without internal layer, backing, emboss or surface profile | b) Multi-layer sheet |
| c) Sheet with emboss (less than 0.1 mm) on one side | d) Sheet with surface profile (exc. 0.1 mm) |
| e) Sheet with emboss (less than 0.1 mm) in total | f) Sheet with backing |
| g) Sheet with internal layer | |

Figure 2: Illustration of some definitions

4.3 Installation

Plastic and rubber sheets for roof waterproofing are normally installed as a single layer roof waterproofing membrane. The joints between sheets are often welded by the action of heat or solvent but they may also be sealed using adhesive or adhesive tape. In all cases it is important that the sheets are jointed by the method recommended by the manufacturer.

The roof waterproofing sheet may be fastened to the substructure with adhesive, be mechanically fixed, or can be ballasted. The sheet has different requirements for each method of application and it is important that the manufacturer's advice is sought as to the suitability of the sheet for the application.

At perimeter details it is normal to use special trims and these are often made from metal, which can be laminated with a material compatible with the main roof membrane, to enable the trim to be jointed to the main membrane.

However the sheet is applied, it is important that the system can withstand the expected wind uplift forces and it is important that calculations are carried out to confirm this. With mechanically fastened membranes this is particularly important and the number of fastenings can be varied to meet the exposure conditions.

With ballasted roofs, the membrane is loose laid, with only the perimeter being fastened, which allows for maximum movement of the substrate. The weight of the ballast (eg. pebbles or paving) has to provide the resistance to wind uplift forces. Separation layers are sometimes needed to prevent reaction between the insulation and the roof waterproofing sheet (see Figure 3).

With ballasted roofs the thermal insulation can be placed above the waterproofing membrane, avoiding the need for a separate vapour control layer and providing protection from mechanical damage. In these so called 'inverted roof' systems it is usual to provide a filter layer over the insulation to prevent fine particles from the ballast penetrating down to the membrane, where it could cause damage. A protection layer of fleece can also be used beneath the membrane to prevent puncturing from below. This is particularly important when overlaying rough substrates (see Figure 4).

With mechanically fastened roof systems, the fastenings (usually screws with plate washers), are fixed through the roof waterproofing sheet and covered with another layer of sheet. This can conveniently be done where the sheet is jointed (see Figure 5) but if more secure fastening is required it may be necessary to use fastenings through the main sheet, which are then covered with taping strips.

Rubber and plastic roof waterproofing sheets can be incorporated in to suitable designs for roof gardens (see Figure 6).

With bonded plastic and rubber roof waterproofing, the membranes are often backed with a layer of other material (eg. polyester fleece) in order to provide a good key for the adhesive, to help smooth out steps in the insulation and to allow for a degree of movement (see Figure 7). With appropriate membranes these roof waterproofing sheets with backing can be applied as overlays to old bitumen roofs (see Figure 8).

4.4 Typical roofing systems

In the following Figures example of the most common roofing systems are shown

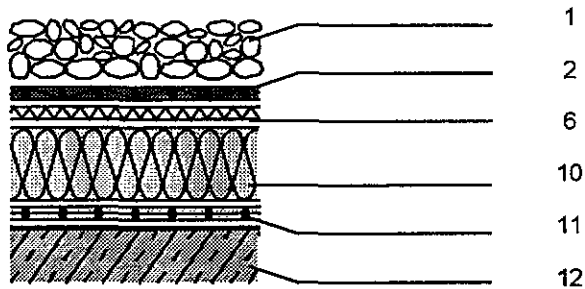


Figure 3: Ballasted roof

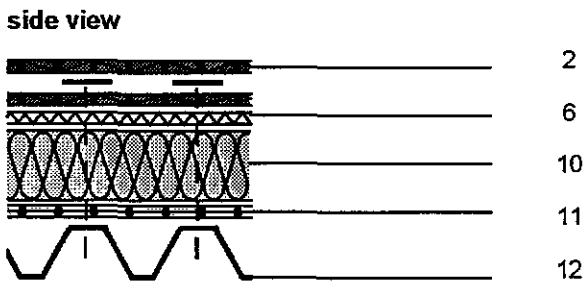
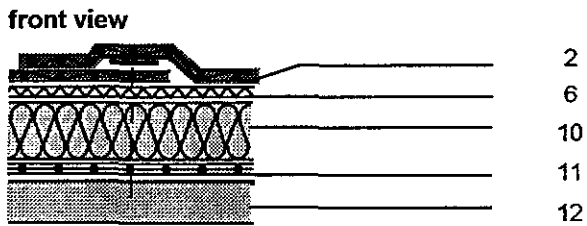


Figure 5: Mechanically attached roof

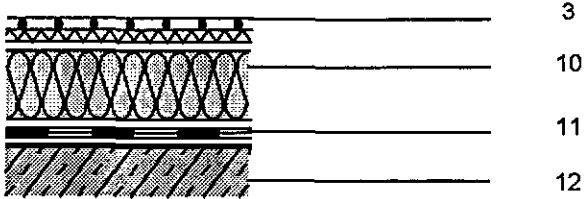


Figure 7: Bonded roof

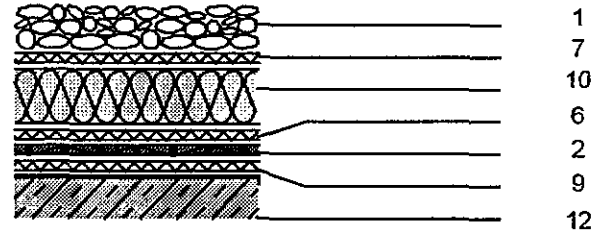


Figure 4: Inverted roof

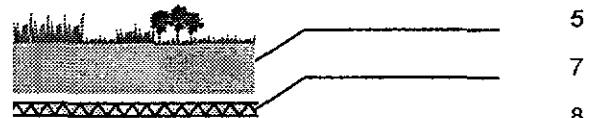


Figure 6: Roof garden

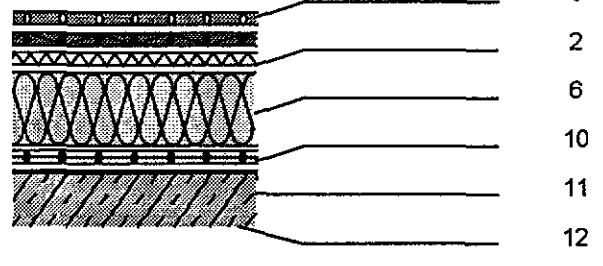


Figure 8: Bonded roof - reroofing

- 1 - Gravel, 50 mm
- 2 - Roofing sheet
- 3 - Roofing sheet with backing
- 4 - Bitumen roofing sheet

- 5 - Garden substrate
- 6 - Separation layer
- 7 - Trickling filter
- 8 - Drainage and water storage

- 9 - Protection layer
- 10 - Thermal insulation
- 11 - Vapour layer
- 12 - Substrate

5 Product characteristics

5.1 General

The relationship to the EU Construction Products Directive is indicated in Annex ZA.

5.2 General characteristics

5.2.1 Visible defects

The product shall be free of visible defects in accordance with pr EN 1850-2

5.2.2 Dimensions and tolerances

The length, width, straightness and flatness shall be determined in accordance with pr EN 1848-2.
Length; the measured length shall be within -0.5% and +1% of the value stated by the manufacturer
Width; the measured mean width shall be within -0.5% and +1% of the value stated by the manufacturer
Straightness: $g \leq 50$ mm
Flatness: $p \leq 10$ mm
These limiting values only apply to sheets in the form of rolls.

Thickness and mass per unit area shall be determined in accordance with pr EN 1849-2
The measured overall and effective thickness shall be within -5 and +10 % of the value stated by the manufacturer
Each single measurement value shall be within ± 10 % of the value stated by the manufacturer.
The mass per unit area shall be within ± 5 % of the value stated by the manufacturer

5.2.3 Watertightness

The product shall be watertight as determined by the method pr EN 1928.

5.2.4 Effects of liquid chemicals including water

When the specifier requires information on resistance to liquid chemicals, test shall be conducted according to pr EN 1847 under conditions agreed between all parties and the test results evaluated.

5.2.5 Resistance to external fire

If used as a top layer of a waterproofing system, the resistance of the product shall be stated in terms of

- penetration of fire and
- spread of flame

as appropriate when tested in accordance with corresponding national regulations.

5.2.6 Hail resistance

The hail resistance of the sheet shall be determined in accordance with pr EN (WI 00254029).

5.3 Application related characteristics

5.3.1 Joint strength

The peel resistance of joints shall be determined in accordance with pr EN 12316-2 and shall correspond to the manufacturers limiting value (MLV).

The shear resistance of joints shall be determined in accordance with pr EN 12317-2 and shall correspond to the manufacturers limiting value (MLV).

5.3.2 Water vapour properties

The water vapour transmission shall be determined in accordance with pr EN 1931.

5.3.3 Tensile properties

The tensile properties determined in accordance with pr EN 12113-2 shall be expressed as the manufacturers limiting value (MLV) for the longitudinal and transverse direction of the sheet.

5.3.4 Resistance to impact

The resistance to impact shall be determined in accordance with pr EN 12691 and shall correspond to the manufacturers limiting value (MLV).

5.3.5 Resistance to static loading

The resistance to static loading of the sheet shall be determined in accordance with pr EN 12730 and shall correspond to the manufacturers limiting value (MLV).

5.3.6 Tear resistance

The tear resistance determined in accordance with pr EN 12112-2 shall be expressed as the manufacturers limiting value (MLV) for the longitudinal and transverse direction of the sheet.

5.3.7 Resistance to root penetration (only for gardens/vegetation)

The resistance to root penetration determined in accordance with pr EN (WI 00254027) shall give a pass result. The results are valid for a period of 10 years provided that no change in product formulation or specification has taken place.

5.3.8 Material properties related to wind uplift resistance (only for mechanically fastened applications)

Membrane fastener strength shall be determined in accordance with pr EN (WI 00254044)

5.4 Specific characteristic for plastic and rubber sheets for roof waterproofing

5.4.1 Dimensional stability at elevated temperature

Dimensional stability at elevated temperature shall be determined in accordance with pr EN 1107-2 and expressed as the manufacturers limiting value. The absolute limits for the change in longitudinal and transversal dimensions (ΔL and ΔT) shall be as follows:

0.5 % for PVC, EVAC or C- PE sheets with backing or internal layer.

1 % for ECB, elastomeric and SEBS sheets and for PIB sheets with backing and CSM sheets with internal layer or backing and reinforced PP.

2 % for homogeneous PVC, EVAC and PP sheets.

5.4.2 Foldability at low temperature

Foldability at low temperature shall be determined in accordance with pr EN 495-5 and shall correspond to the *manufacturers limiting value (MLV)*.

5.4.3 Behaviour following exposure to UV radiation, elevated temperature and water

When the product is subjected to exposure according to pr EN 1297 the duration of exposure and evaluation after exposure shall be as follows:

Exposure time:

5000 UV hours

Evaluation after exposure:

Non destructive techniques:

change in visual aspects

change in mass (%)

change in dimensions (%)

Destructive techniques:

change in foldability at low temperature

(5°C step on scale -40°C, -35°C, -30°C, ...etc. according to pr EN 495-5)

change in elongation for homogeneous materials (%)

5.4.4 Resistance to ozone

When tested according to pr EN 1844 the sheet shall show no cracks.

This test is only required for sheets made of rubber materials.

5.4.5 Bitumen compatibility

The bitumen compatibility of the sheet shall be determined in accordance with pr EN 1548.

5.4.6 Resistance to micro-organism

In applications when the roofing sheet is expected to be subjected to attack by micro-organism the product shall be tested in accordance with pr EN (WI 00254030).

5.5 Rules for sampling and preparing test specimens

Test specimens shall be prepared from the sample taken in accordance with pr EN (WI 00254040)

6 Attestation of conformity

6.1 Levels and classes for product performances

For the time being, the differences specified in Article 3(2) of the CPD does not seem to give rise to the need of a classification system for products.

Where for such needs it is recognised that classification of product performance is the means of expressing the range of requirement levels of the works, the Commission (CEC) will give the appropriate guidance or will request CEN/CENELEC to make the appropriate proposal through a modification of this mandate.

6.2 System of attestation of conformity

The relationship to the Construction Products Directive (CPD) is indicated in ZA.2

6.3 Conditions to be applied by CEN on the specifications of the attestation of conformity system.

The specification for the system should be such that it can be implemented even where performance does not need to be determined for certain characteristic, because at least one Member State has no legal requirement at all for such characteristic (see the no performance determined case under Article 2.1 of the CPD and when Article 3.2 classes apply, clause 1.2.3 of the Interpretative Documents).

In those cases the verification of such a characteristic must not be imposed on the manufacturer if he does not wish to declare the performance of the product in respect.

6.4 Factory production control and verification of manufacturers characteristic value.

The rules for factory production control and verification of manufacturers characteristic value are given in Annex A.

7 Product data sheet and designation

The manufacturer shall make available the following:

- the material from which the sheet is made, as well as the mass per unit area of a any internal layer and the mass per unit area of a any backing. In the case of a multi-layer sheet with different materials, the manufacturer shall state which set of test methods of this European Standard are applicable;
- instructions to repairing the sheet;
- for rolls: the manufacturers stated length and width in metres as determined in accordance with pr EN 1848-2;
- the overall or effective thickness of the sheet in millimetres as determined in accordance with pr EN 1849-2;
- the nominal mass per unit area as determined in accordance with pr EN 1849-2;
- the tensile properties of the sheet in each direction as determined in accordance with pr EN 12113-2, specifying the method used A or B;
- the resistance to static loading in accordance with pr EN 12691;
- the resistance to impact loading in accordance with pr EN 12730;
- the foldability at low temperature in accordance with pr EN 495-5;
- the behaviour following exposure to UV, elevated temperature and water for 5000 UV hours according to pr EN 1297;
- bitumen compatibility in accordance with pr EN 1548;
- hail resistance in accordance with pr EN (WI 29);

8 Marking, labelling and packaging

Rolls shall be marked continuously stating trade name and production code. The production code shall at least contain production date and material batch identification.

A label attached to each roll shall at least state:

- EN number
- Trade name + suppliers name and address
- Production code (1)
- Length, width and overall thickness of the roll.

An information sheet shall accompany each delivery and shall at least contain the following elements:

- EN number
- Trade name + suppliers name and address
- Production code (1)
- Statements required by clause 7
- Values for all the characteristics of clause 5

Annex A (normative)

Factory production control and verification of manufacturer's characteristic value

A.1 Rules for factory production control

The factory production control according to this standard covers all types of plastic and rubber sheets complying with this standard and the permanent factory production control of these sheets by the manufacturer according to the Construction Products Directive 88/106/Ecc, Annex III, Clause 1.

Plastic and rubber sheets comply with the characteristics of this standard if it is statistically verified that at least 95 % of the test specimens comply with the characteristics made for the individual type testing. The statistical evaluation will be effected according to A. 2.

A. 2 Verification of manufacturers characteristic value

A.2.1 Expression of the characteristic of the materials

Purpose: In a sampling, to be able to check by comparison with a value designated as the limiting value whether materials conform with their technical specification. These random samplings may be carried out either within the context of internal quality control or by an approved independent institute.

A.2.2 Methodology

By using an established statistical procedure the results of a test are analysed and a critical ~~and a critical~~ value of acceptance V_c is determined with 90 % level of confidence. This value shall be compared with the manufacturers limiting value.

Annex ZA (Informative)

Relationship to the EU Directives

ZA.1 Clauses of this European Standard addressing provisions of the Construction Products Directive (CPD)

This European Standard has been prepared under the Mandate 15/33 products used for Roof Finishes (M/102) given by the European Commission and the European Free Trade Association.

The clauses of this European standard shown in table ZA.1, meet the requirements of the Mandate given under the Council Directive of 21 December 1988 on the approximation of laws, regulations and administrative provisions of the Member States relating to construction products 89/106/EEC-CPD.

Compliance with these clauses confers the presumption of fitness of the construction product plastic and rubber sheet for roof waterproofing for its intended use.

Construction product: Plastic and rubber sheet.
Intended use: Roofing of roof finishes.

Table ZA.1: Characteristics meeting Mandate M 102 given under CPD

Characteristics from the Mandate	Clauses in this European Standard	Mandated level and/or class	NOTE
Watertightness	5.2.3	watertight	-
Tensile strength	5.3.3	MLV	-
Resistance to root penetration	5.3.7	Pass	2
Resistance to tearing	5.3.6	MLV	3
Resistance to static loading	5.3.5	MLV	3
Resistance to impact	5.3.4	MLV	3
Foldability at low temperature	5.4.2	MLV	3
Durability	5.4.3	MLV	a)
Reaction/resistance to fire - penetration - spread of flame	In accordance with the corresponding European Standard	all levels all levels	1 1

NOTE 1: The classes of reaction/resistance to fire in pr EN (to be developed by CEN/TC 127) are classes of convenience and are not part of the harmonised standard.

NOTE 2: Only for roof gardens

NOTE 3: Only for handling and installation

a) Change in; visual aspects, mass, dimensions and foldability at low temperature or elongation for homogeneous materials

ZA.2 Procedure for the Attestation of Conformity of plastic and rubber sheets

ZA.2.1 General

A copy of the decision of the Standing Committee of Construction Products Directive is indicated in Annex 3 of the Mandate.

For the product and intended use, listed in table ZA.2, CEN/CENELEC are requested to specify the following system of attestation and conformity.

Table ZA.2: System of attestation and conformity

Product	Intended use	Level/s or class/es	Attestation of conformity system
Roof sheets	In roofs	No	2 + ¹⁾

¹⁾ System 2 +: See CPD Annex III. 2 (ii), first possibility, including certification of the factory production control by an approved body on the basis of its continuous surveillance, assessment and approval.

ZA. 2.2 Conditions to be applied on attestation of conformity system

For the certification of factory production control, parameters related to the following characteristics being of interest of the approved body.

- 22g Resistance to fire-penetration
- 22h Resistance to fire-spread of flame

The initial inspection of factory and factory production control covers also characteristic

- 33a Watertightness

The evaluation of conformity of plastic and rubber sheets for roofing shall be assessed following clause 6 of this European Standard.

ZA. 3 CE marking and labelling.

The CE marking shall comply with the indications as defined in the Construction Products Directive (CPD) as amended by Directive 93/68/EEC.

The CE conformity marking shall consist of the initials "CE" taking the following form:



It is for the manufacturer or his authorised representative established within the Community to take responsibility for affixing the CE marking on

- the product itself or
- on a label attached to the product or
- on its packing or
- on the accompanying commercial documents.

Member States presume that products are fit for use if they enable works in which they are employed, provided the latter are properly designed and built, to satisfy the Essential Requirements, where such products bear the CE marking.

The CE mark shall be accompanied by:

- the name of identifying mark of the producer;
- the last two digits of the year in which the marking is affixed;
- the characteristics of the product;
- given intended uses (where appropriate).