BELGIAN GEOSYNTHETICS SOCIETY

WORKSHOP - DRAINAGE EN GRONDWATERBEHEERSING MET GEOKUNSTSTOFFEN

21 november

- Drainage en waterdichtheid van ingegraven constructies
- **INFILTRATIETUNNELS** - optimale infiltratie van regenwater
- **FOLIECONSTRUCTIE** om ondergrondse constructies uit te voeren met een beperkte hoeveelheid opgepompt bemalingswater

GBMS BGGG

Buildwise

grondwaterindebouw.be

16u00: Ontvangst
16u10: **Nicolas Denies** (BGS) - *Introduction*
16u20: **Marc Demanet** (SECO) - *Géosynthétiques : fonctions de drainage et d'étanchéité*
16u50: **Karin Eufinger** (CENTEXBEL) – *Water en geokunststoffen in de normalisatie*
17u10: **Kevin Janssens** (Buildwise) - *Drainage et étanchéité des constructions enterrées - détails de référence*

17u30: **David Shercliff** (ABG Geosynthetics filiaal BONTEXGEO)
Structural drainage and Consolidation – Environmental and Cost Savings
17u50: **Francesco Masola** (MACCAFERRI/Texion) – *Drainage geocomposites: application design and environmental aspects*

18u10: BREAK

19u00: **Jasmine Thienpont** (PLUVIO)
Duurzaam regenwaterbeheer met Pluvio infiltratietunnels

19u20: **Carlo Scheerder** (Genap) – *Toepassingen en uitvoering van folieconstructies in verdiepte Infrastructuur*
20u00: Einde

www.bgsvzw.be

Belgian Geosynthetics Society - Mission

Promouvoir la connaissance et l'application des géosynthétiques en Belgique, ceci dans l'intérêt de ses membres : producteurs et fournisseurs de géosynthétiques, entrepreneurs, maîtres d'ouvrage, instituts de recherche, ingénieurs-conseils…

La BGS est la branche belge de l'IGS, l'International Geosynthetics Society.

INTERNATIONAL GEOSYNTHETICS SOCIETY

www.geosyntheticssociety.org

BELGIAN GEOSYNTHETICS SOCIETY

Chaired by

Nicolas Denies, Chairman
Jan Maertens, Vice President
Noël Huybrechts & Gemmina Di Emidio, board members
2Mpact Gent, secrétariat

BELGIAN GEOSYNTHETICS SOCIETY

www.bgsvzw.be

Membres

Buildwise

Beaulieu International Group

Technical Textiles

BontexGeo

Leading in Geosynthetics

AEXROCH BVBA

Vlaanderen

is mobiliteit & openbare werken

UNIVERSITEIT GENT

Firestone

BUILDING PRODUCTS

SECO

Texion

BELGIAN GEOSYNTHETICS SOCIETY

Activités

Groupes de travail de l'IGS

Organisation d'événements

Groupe de travail normalisation CEN TC 189

Groupe de travail normalisation CEN TC 250/SC7

in particular Eurocode 7-3 CLAUSE Reinforced fill structures

Collaboration avec l'ISSMGE TC 218 – Reinforced fills

Subcommittees 'Marginal fills' and 'Bridge abutment'

SOLRENF II – matériaux de remplissage alternatifs

- les **terres (sols) cohésives** trouvées sur place, pendant les travaux de terrassement, ou récoltées sur d'autres sites et devant être revalorisées
- les **granulats recyclés**, principalement les granulats mixtes
- la partie fine des **boues de dragage** après filtration, séchage et compactage?

éventuellement mélangés et/ou stabilisé à la chaux et / ou au ciment

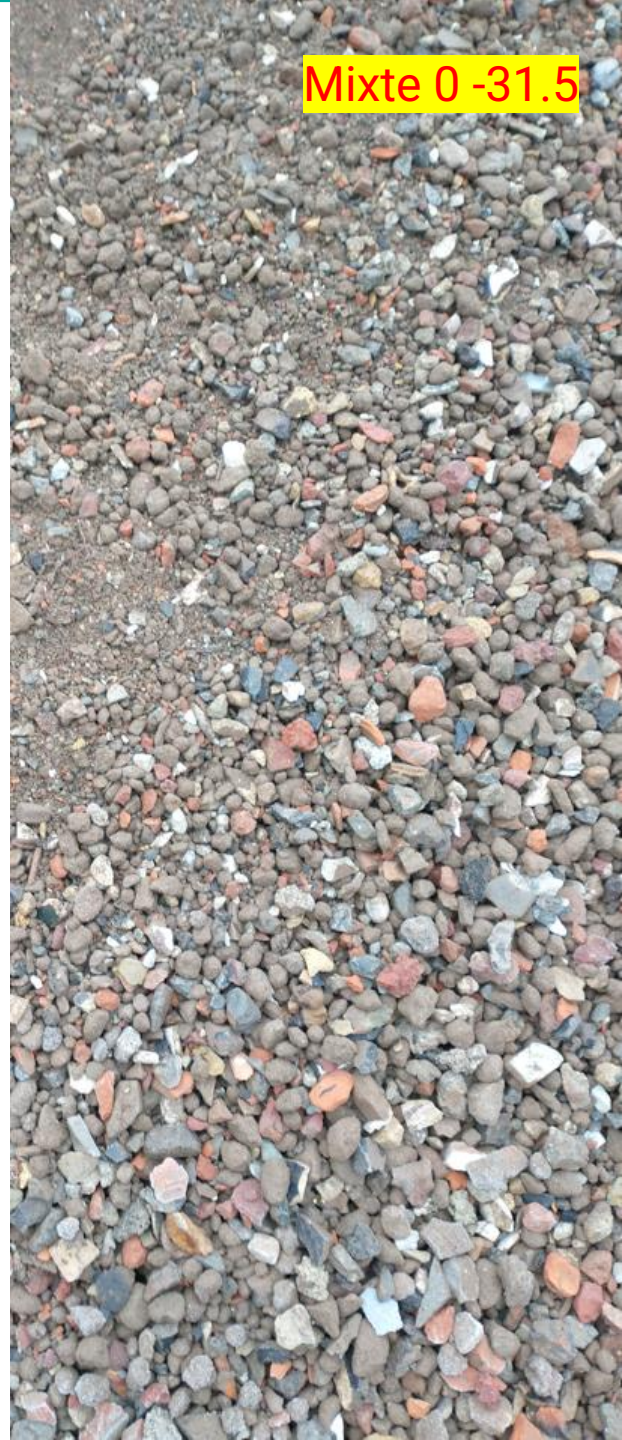
Tradecowall
La valorisation de vos ressources

Recynam
Lives-sur-Meuse
IA n°0016

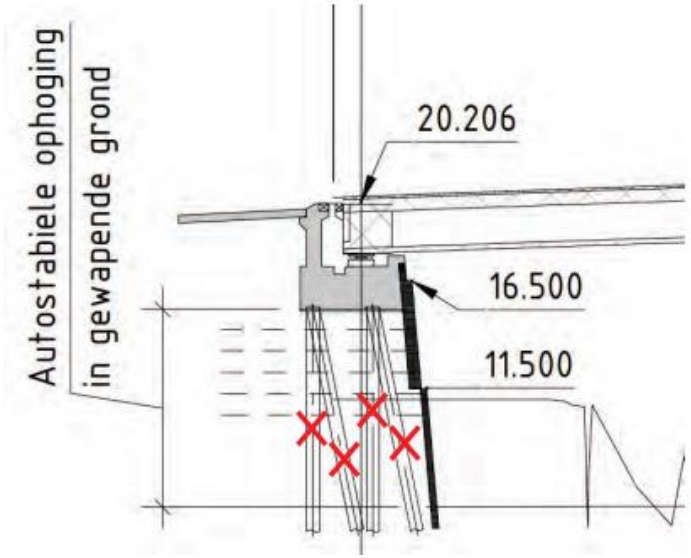
Cibles: les mixtes et Teracalco

Teracalco

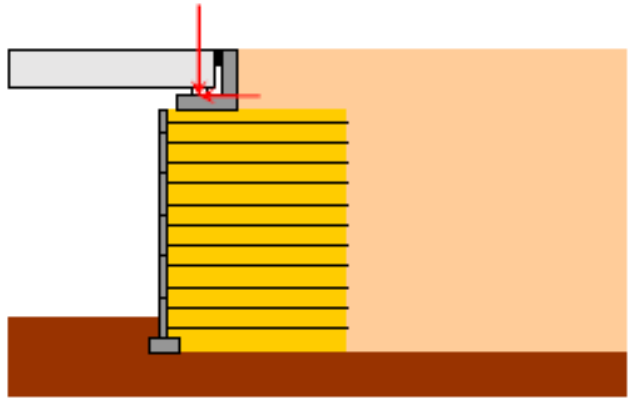
Mixte 0 -31.5



Activités

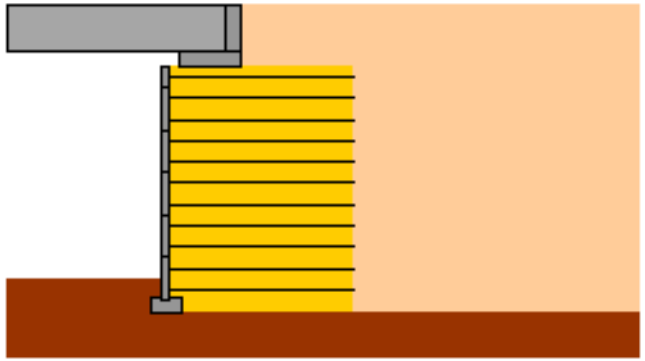


- Reinforced fill structures which support **directly** one end of a bridge deck



YES

- Reinforced fill structures which support **directly** one end of a bridge deck



YES

BELGIAN GEOSYNTHETICS SOCIETY

Activités

Groupes de travail de l'IGS

Organisation d'événements

Groupe de travail normalisation CEN TC 189

Groupe de travail normalisation CEN TC 250/SC7

in particular Eurocode 7-3 CLAUSE Reinforced fill structures

Collaboration avec l'ISSMGE TC 218 – Reinforced fills

Subcommittees 'Marginal fills' and 'Bridge abutment'

Thèse de doctorat d'Ahsan Khan (UGent)

Creep behavior of the geogrid-aggregates interface

There are 45 IGS Chapters. The North American and the Nordic Chapters cover several countries. In total IGS Chapters represent 50 Countries spanning all regions.

IGS Digital Library

Proceedings | Educational Documents | Society Documents

Photos | Videos | Journals

IGS Digital Library

Proceedings | Educational Documents | Society Documents

Photos | Videos | Journals

OPEN ACCESS

Book

Geosynthetics: Leading the Way to a Resilient Planet

PROCEEDINGS OF THE 12TH INTERNATIONAL CONFERENCE ON GEOSYNTHETICS (12ICG), SEPTEMBER 17-21, 2023, ROMA, ITALY.

Edited By Giovanni Biondi, Daniele Cazzuffi, Nicola Moraci, Claudio Soccodato

There are 45 [illegible] American and the Nordic Chapters cover several countries. In total IGS Chapters represent 50 Countries spanning all regions.

Géosynthetiques – forme, matériel & fabrication

Geotextiles (woven or non woven), geogrids, geostrips, geonets, geotubes, geobags, geomembranes…

PET, PP, PE, PAV, AR, PA…

Géosynthetiques – fonctions & applications

Separation - Filtration

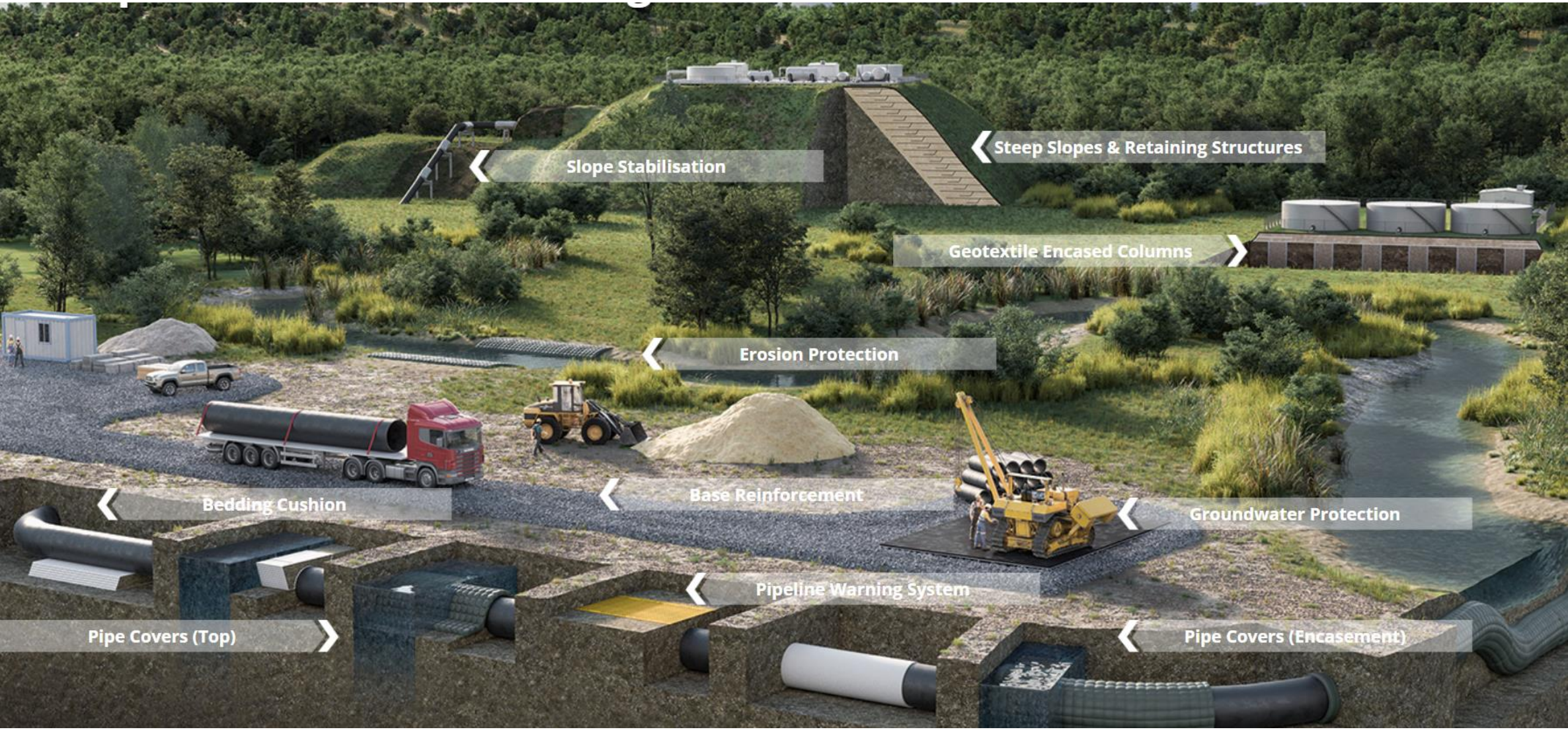
Protection - **Waterproofing**

Drainage - Erosion control

Reinforcement

Géosynthetiques – fonctions & applications

HUESKER



BELGIAN GEOSYNTHETICS SOCIETY

SECO

Geosynthetics: drainage and waterproofing functions

BGS : Drainage en grondwaterbeheersing met geokunsstoffen / Drainage et gestion des eaux souterraines au moyen de géomatériaux

1. GEOMBRANE – Waterproofing
2. Drainage with geosynthetics

”All geomembranes are punched – all geotextiles are clogged”

Why not to use geomembrane for geotextiles application and geotextiles for waterproofing »

May be, the reason it linked with a correct use of the product ?

SECO

GEOSYNTRHETICS ⊃ GEOMEMBRANE & GEOTEXTILES
Function GEOMEMBANES > < FunctionS GEOTEXTILES

- ”All geomembranes are punched – all geotextiles are clogged”
- Why not to use geomembrane for geotextiles application and geotextiles for waterproofing »

- May be, the reason is linked with a correct use of the product : DESIGN & EXECUTION!

SECO

Geomembrane - Waterproofing

SECO

The function of a geomembrane is exclusively waterproofing

Some basic rules

- About the design :
  - Function = waterproofing > < stabilization ➔ limit the strength & deformation

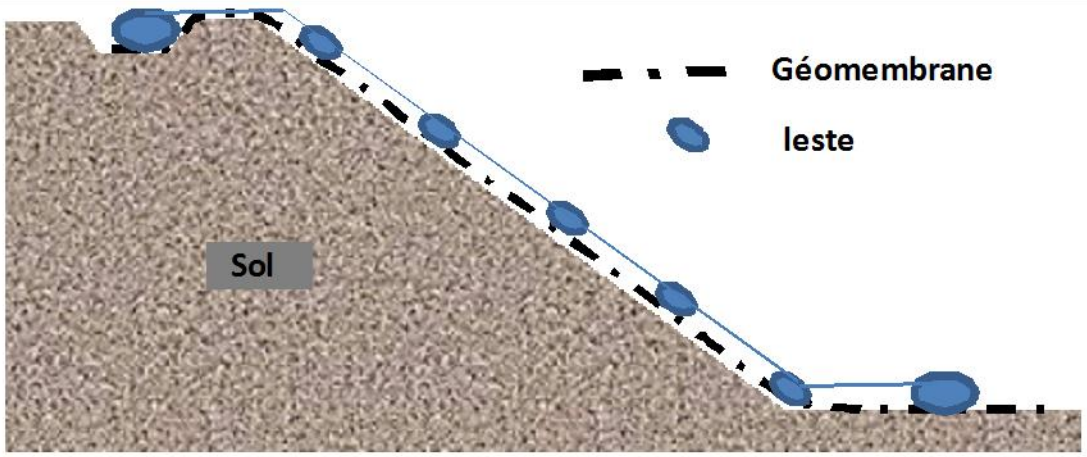
  - ❑ The bottom, capping must have enough bearing capacity
  - ❑ The slope must be stabilized
  - ❑ Avoid pressure of water/ gas under the geomenbrane
  - ❑ In case of settlement or temperature effect , limit the deformation (HDPE +/-5%)

SECO

The function of a geomembrane is exclusively waterproofing

Some basic rules

- About the design :
  - Design on slope :
  - Designing the anchorage against :
    - Mainly wind effect :



Type de géomembrane	Densité de la géomembrane $\rho_{géom}$ [T/m³]	Epaisseur de la géomembrane $t_{géom}$ [mm]	Masse par unité de surface $\mu_{géom}$ [kg/m²]	Vitesse minimale de soulèvement à z = 200 m [km/h]
P.V.C.	1,25	0,5	0,625	11
		1,0	1,25	15,8
H.D.P.E.	0,94	1,0	0,94	13,7
		1,5	1,41	16,8
		2,0	1,88	19,4
		2,5	2,35	21,7
Bitume	variable	3	3,5	26,5
		5	6	34,7

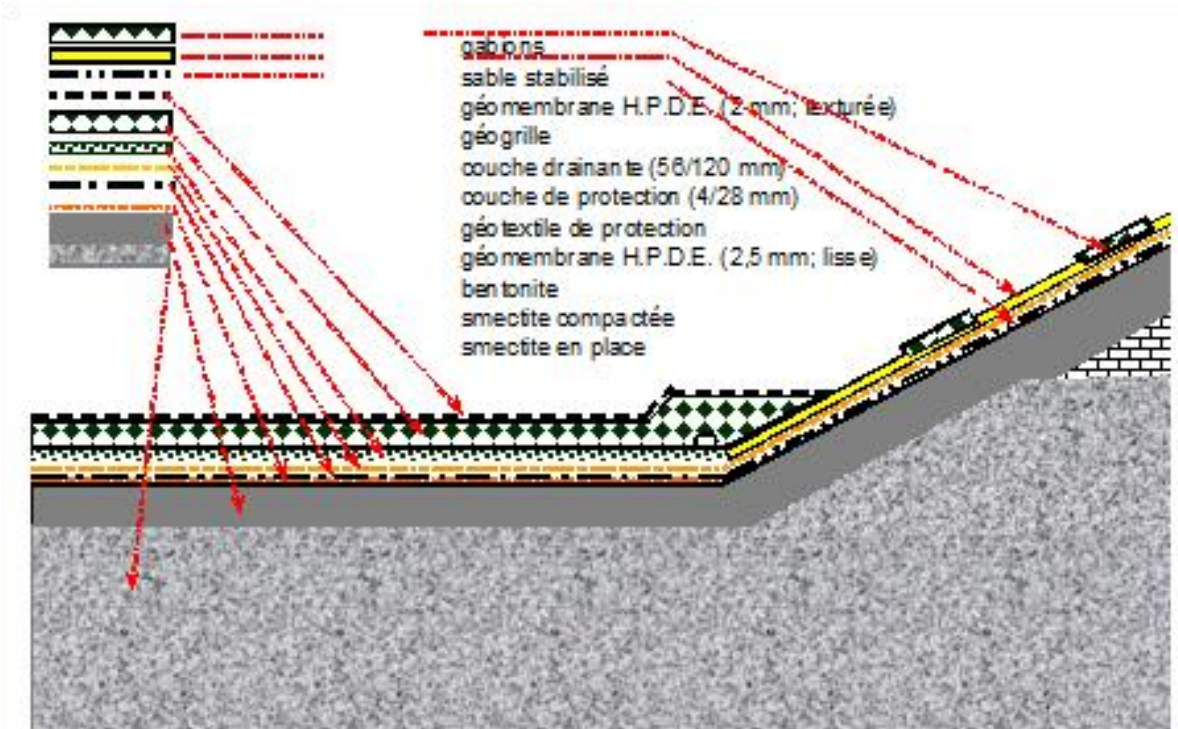
SECO

The function of a geomembrane is exclusively waterproofing

About the design on slope

- ❑ Designing the anchorage against :
  - ❑ Friction effect : (with a correct design, this effect is limited)
- ❑ Designing to limit the tensile stress in the geomembrane :

friction angle under side > upper side / sliding geotextile / counter mass at the bottom

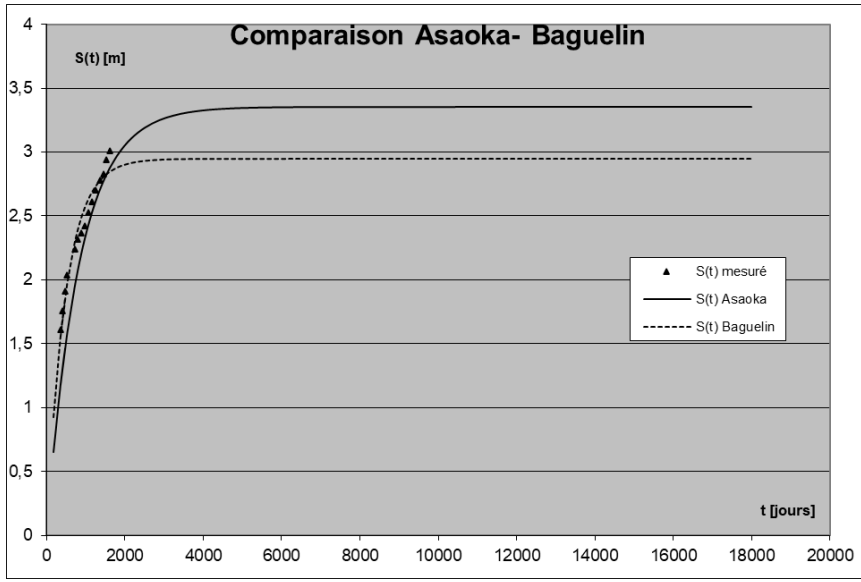


SECO

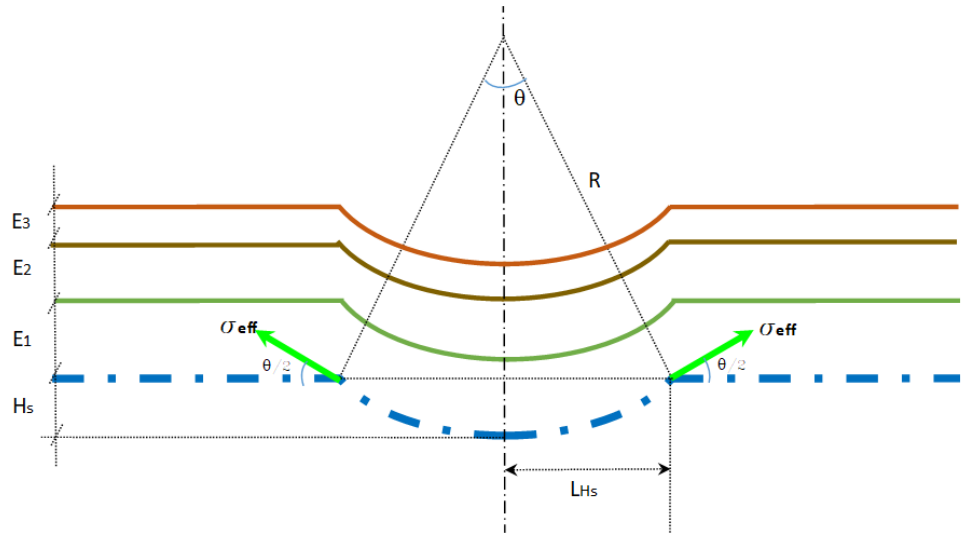
The function of a geomembrane is exclusively waterproofing

About the design on the bottom or for capping

- Designing to prevent effect of the deformation :
  - Capping : Limit the deformation in case of settlement ?
  - ➔ Put the geomembrane when settlement are limited



  - Bottom : use system in case of possible cavities



The function of a geomembrane is exclusively waterproofing

Some basic rules

- About the execution : *Point of attention: Wind effect, temperature, humidity, protection*
  - Wind effect : don’t place geomembrane when wind velocity is high
  - Protection :The support must be clear of any punching element ➔ geotextile to protect

SECO

The function of a geomembrane is exclusively waterproofing

- About the execution : *Point of attention: Wind effect, temperature & humidity, protection*
  - Temperature and humidity have to be acceptable ➔ dilatation effect & welding issue
    - Temperature > 5°
    - Play attention to differential temperature
    - Support must be dry
    - Necessity of testing of the possibility of welding (+ resistance)

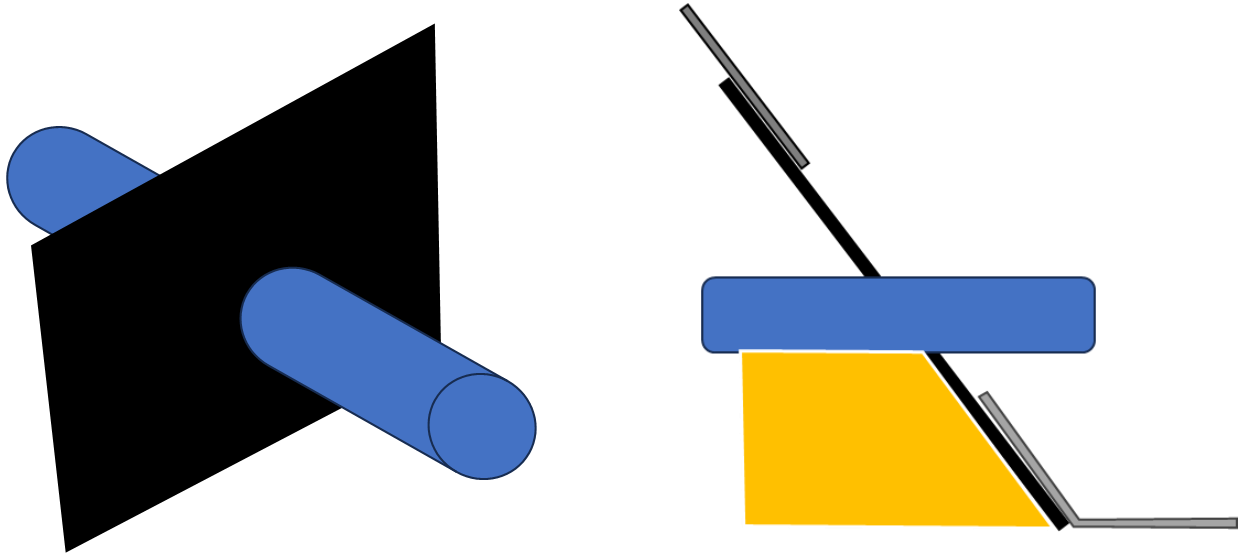
SECO

The function of a geomembrane is exclusively waterproofing

Some basic rules

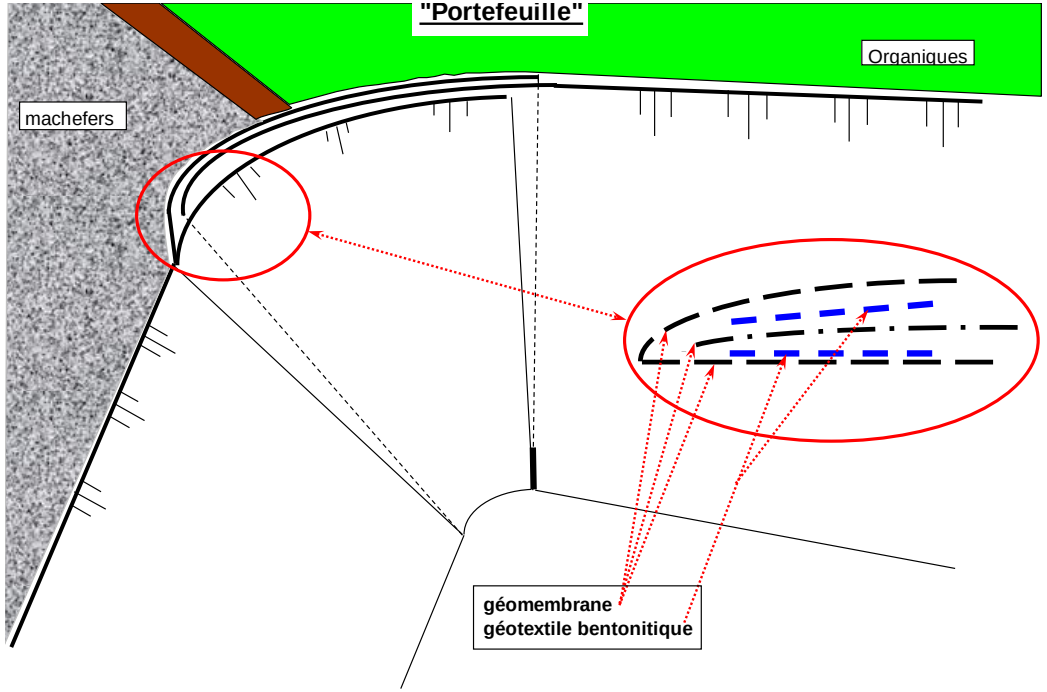
➢ About the execution : *Points of attention:*

❑ pipe passage through geomembrane



❑ From rigid support to moving support:

“Portefeuille” transition



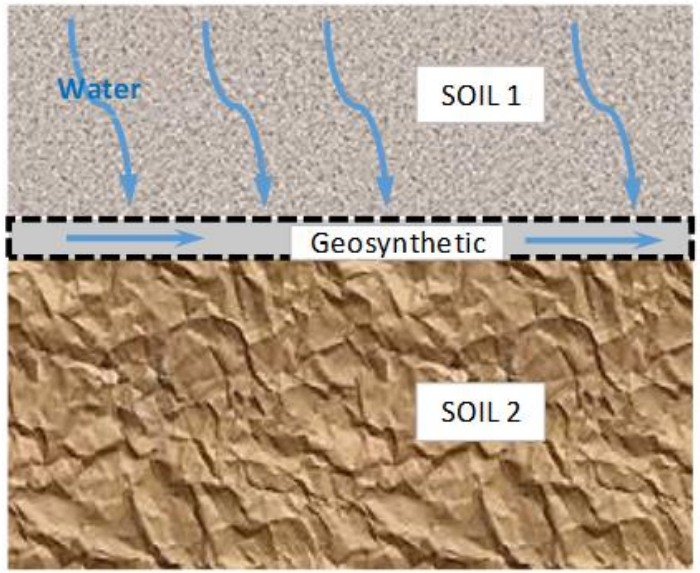
Drainage with geosynthetics

SECO

2 Mains systems when using of geotextiles for drainage function

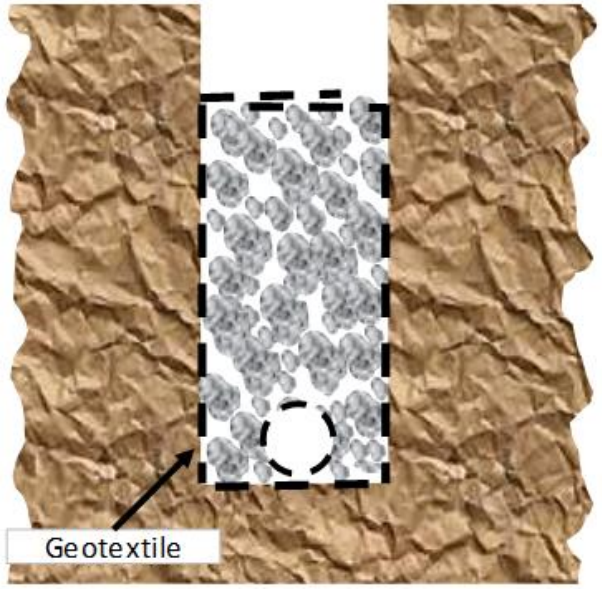
Geotextile as drainage & filtration system

➔ Permitivity / filtration - transmisivity



Geotextile as filtration function

➔ Permitivity / filtration

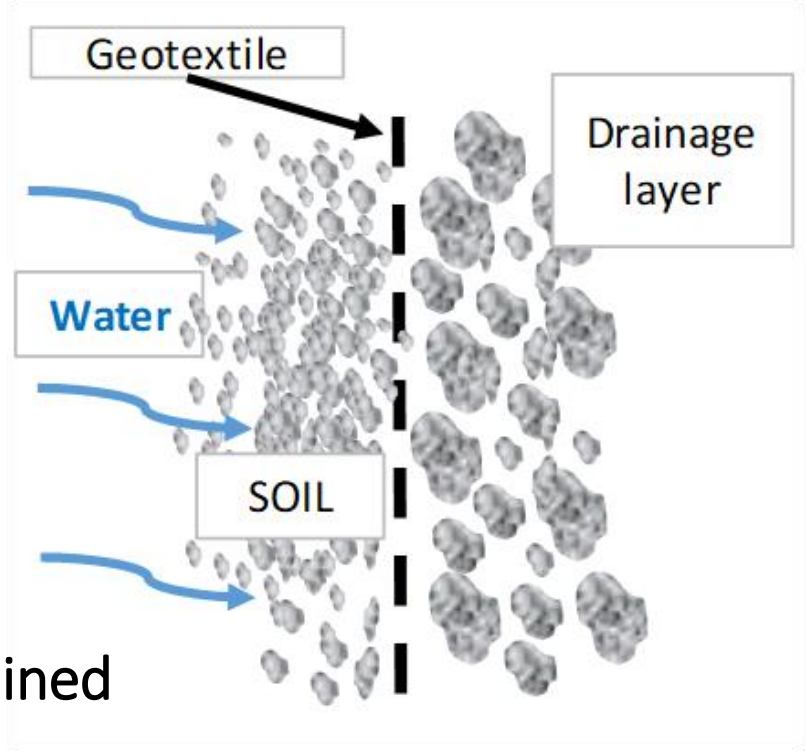


SECO

Geotextile as filtration function

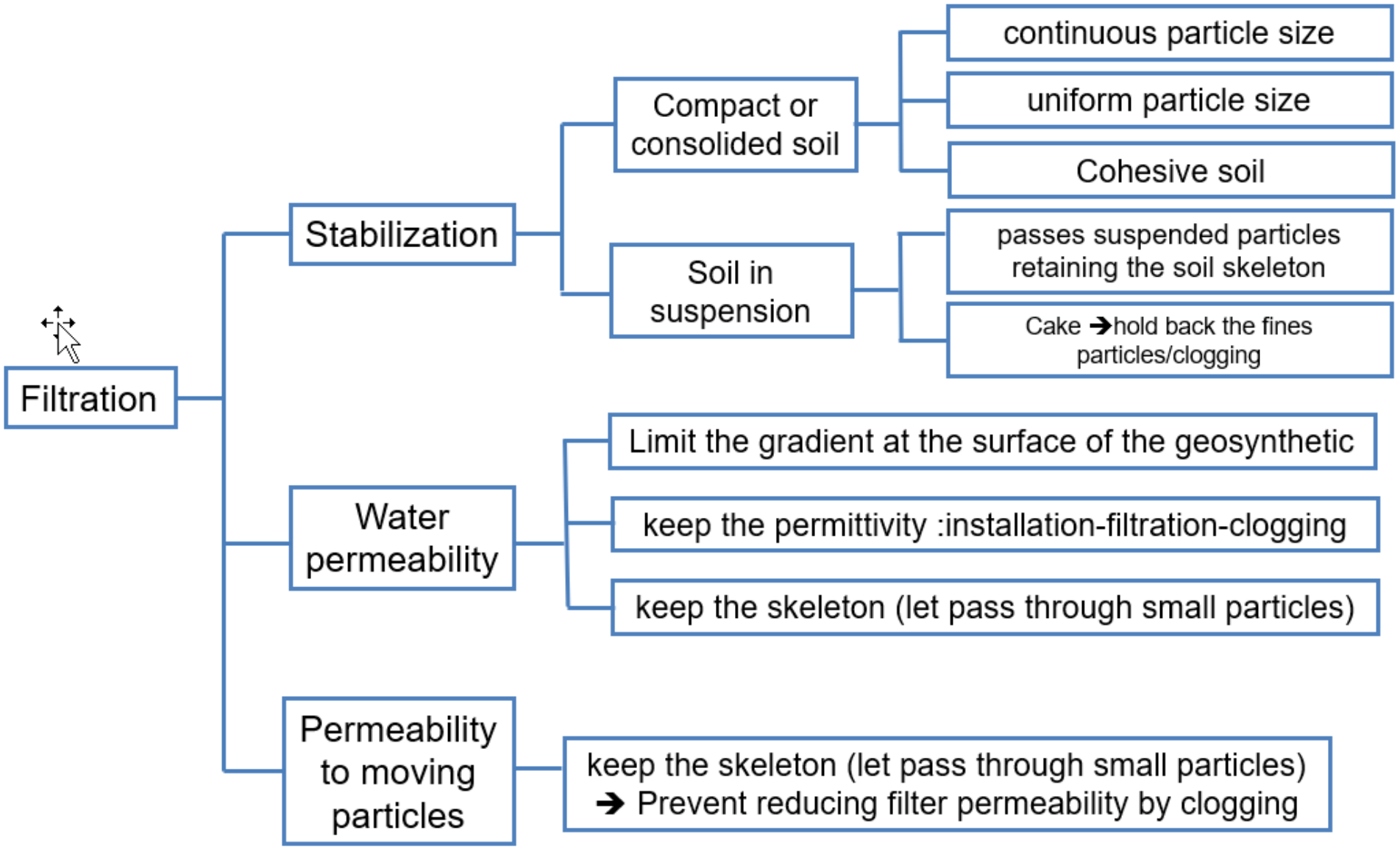
3 roles for the geotextile :

- ❑ Stabilization role: Hold the soil as a whole in place by stabilizing the particles constituting its skeleton;
- ❑ Role of water permeability: Maintain the free circulation of water throughout the life of the structure;
- ❑ Role of permeability to moving particles: Allow fine particles entrained to pass in order to prevent the clogging.



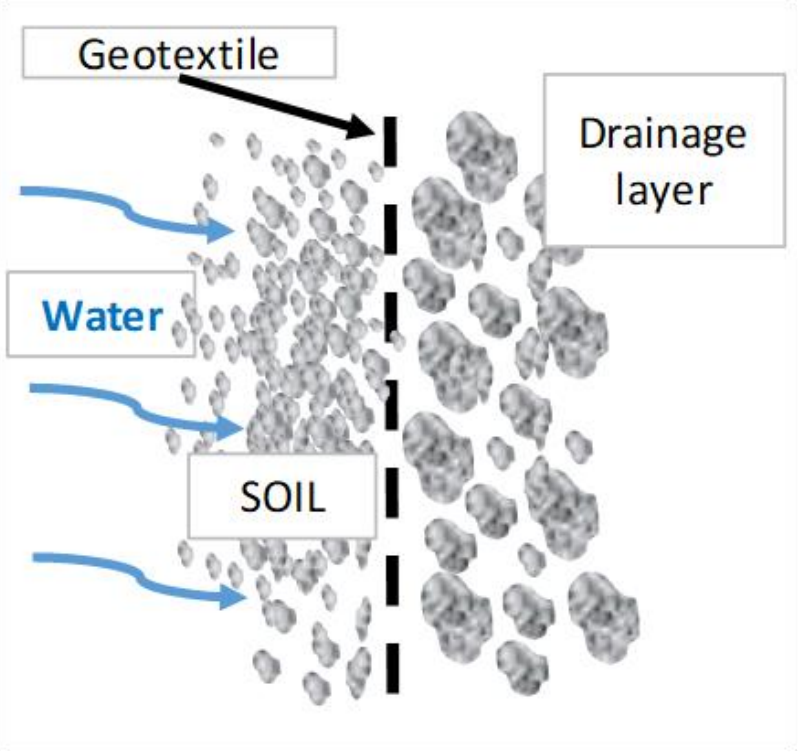
SECO

The filtration in short



SECO

Designing the geotextile as filtration function



- Permeability - permitivity criteria : $\psi \geq C.\ Ks$

permittivity $\perp$ Kn: $\Psi = Kn/e$ [s-1]

➔ Allowing water **to go through** the geotextile

- Filtration criteria: Comparison between the opening of the filtration of the filter and the dimension of the largest particles likely of the cross the geotextile

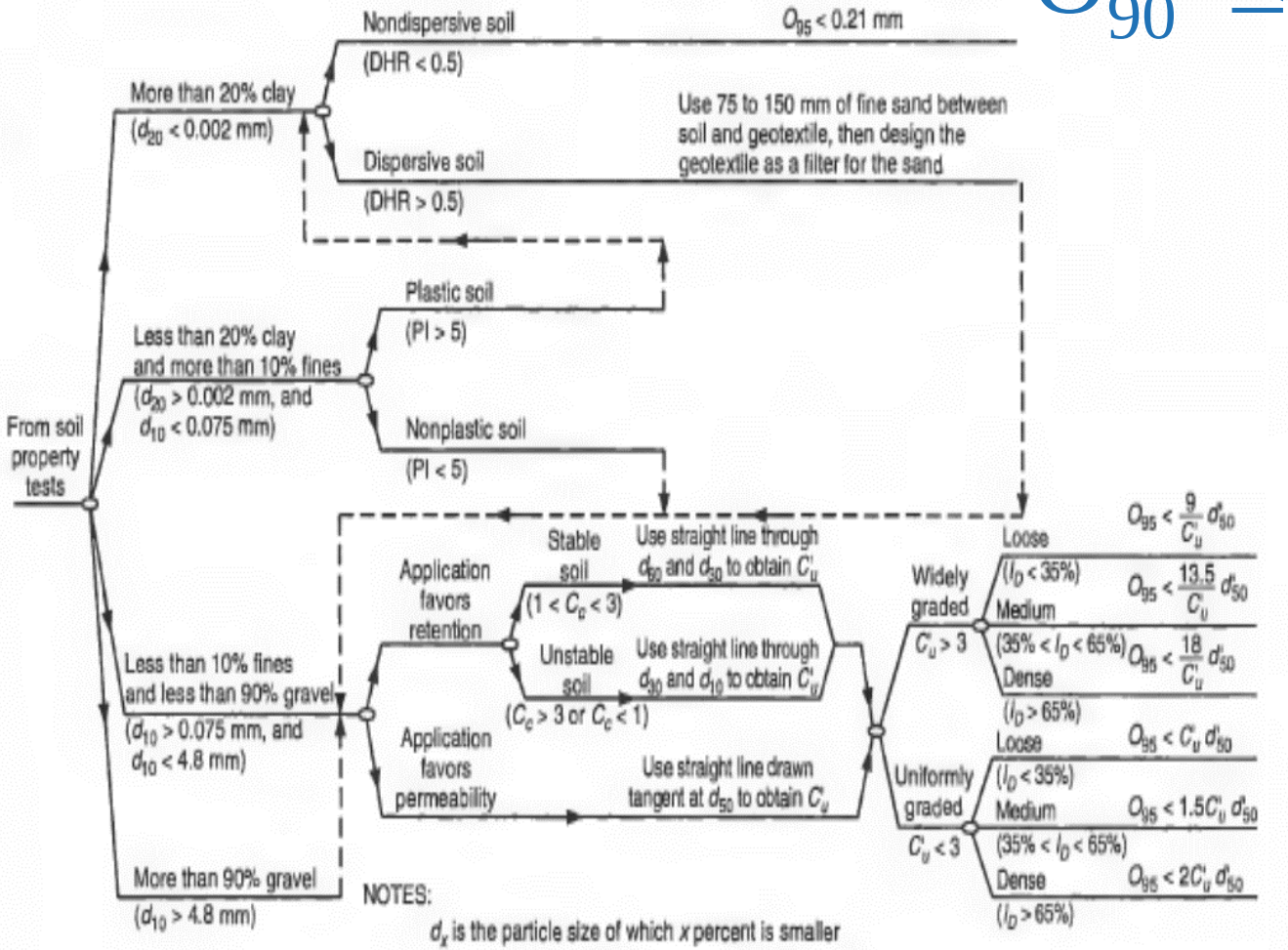
$$O_f < \lambda_r \cdot d_x$$

SECO

The filtration criteria

Belgium : (NBN 29001)

$$O_{90} \leq 2 \cdot d_{90}$$



NOTES:

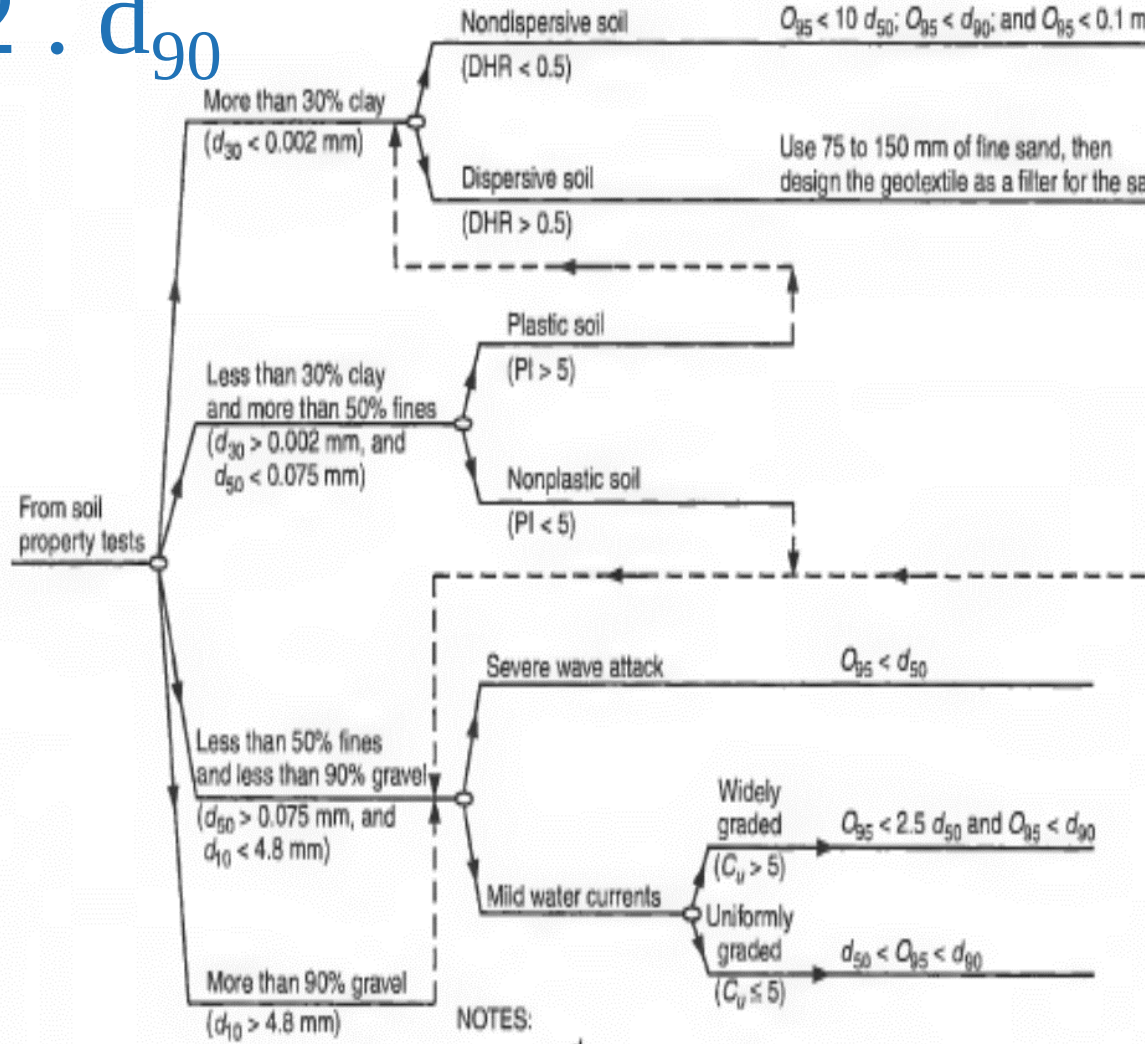
d_x is the particle size of which x percent is smaller

$$C_u' = \sqrt{\frac{d'_{100}}{d'_0}}$$

where d'_{100} and d'_0 are the extremities of a straight line drawn through the particle-size distribution, as directed above; and d'_{50} is the midpoint of this line.

$$C_c = \frac{(d_{30})^2}{d_{60} \times d_{10}}$$

I_D = relative density of the soil
PI = plasticity index of the soil
DHR = double-hydrometer ratio of the soil



NOTES:

$$C_u = \frac{d_{60}}{d_{10}}$$

d_x = particle size of which x percent is smaller
PI = plasticity index of the soil
DHR = double-hydrometer ratio of the soil
O_{95} = geotextile opening size

Designing the geotextile as drainage function

- Permeability - permitivity criteria : $\psi \geq C.\ Ks$

permittivity $\perp$ ‹n: Ψ = Kn/e [s-1]

➔Allowing water **to go through** the geotextile

- Filtration criteria: $O_{90} \leq 2\ .\ d_{90}$

- Drainage : *Most of the case use as geocomposite:*

transmissivity // : θ: drainage in the plan: θ = Kp . e [m³/m/s]

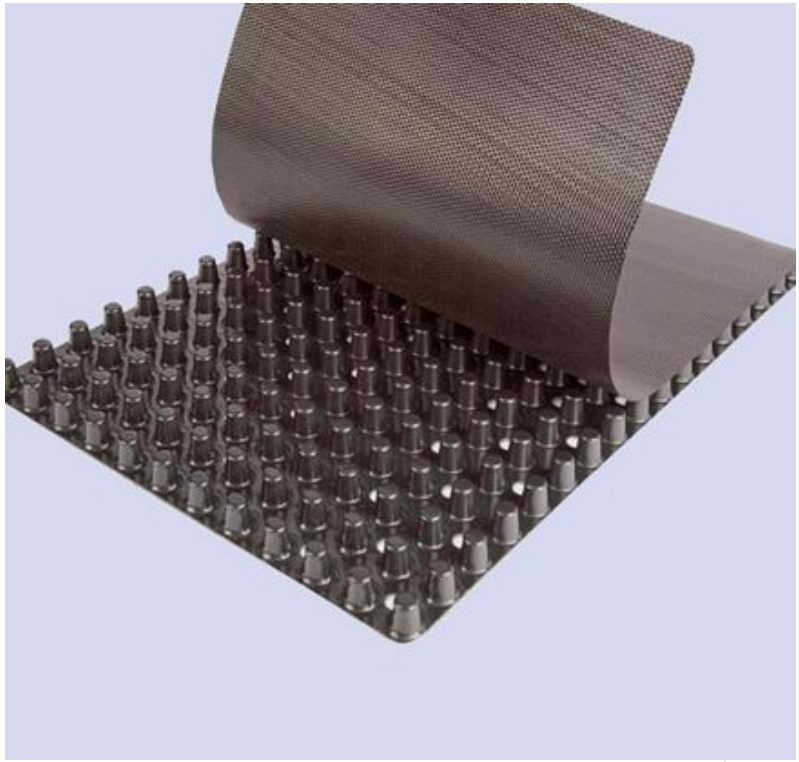
$$\theta_{requ} = K_p\ .\ e \quad > f\ .\ Q$$

SECO

Designing the geotextile as drainage function

The available transmissivity depends on :

- ❑ The compressive stress applied
- ❑ The gradient
- ❑ The slope of the support
- ❑ The allowable hydraulic flow in the geosynthetic
- ❑ The long term behaviour of the geosynthetic

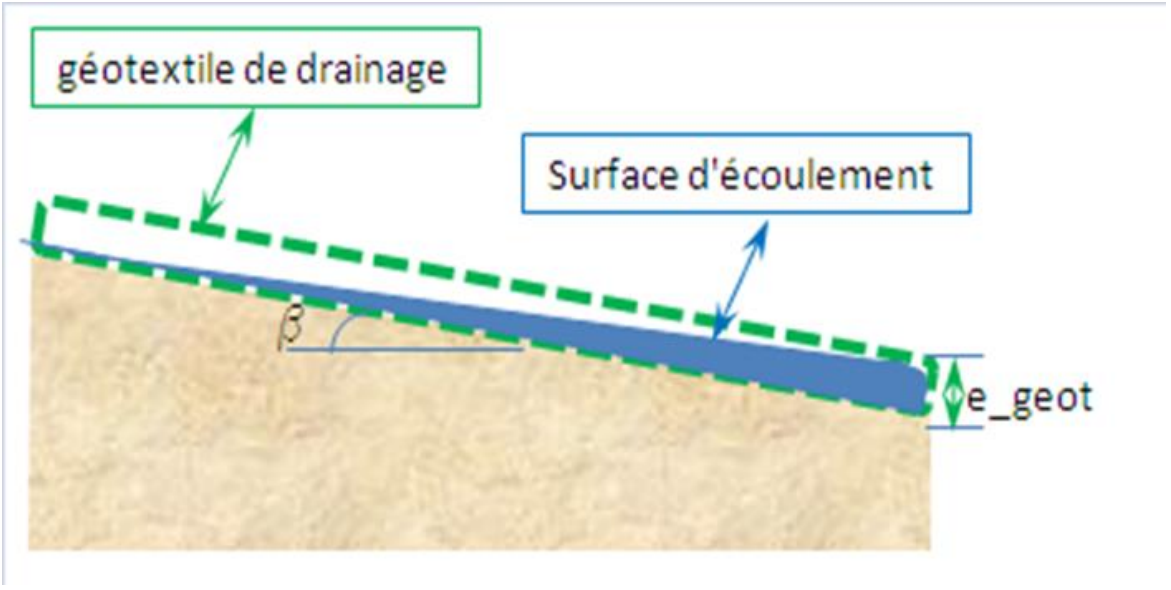


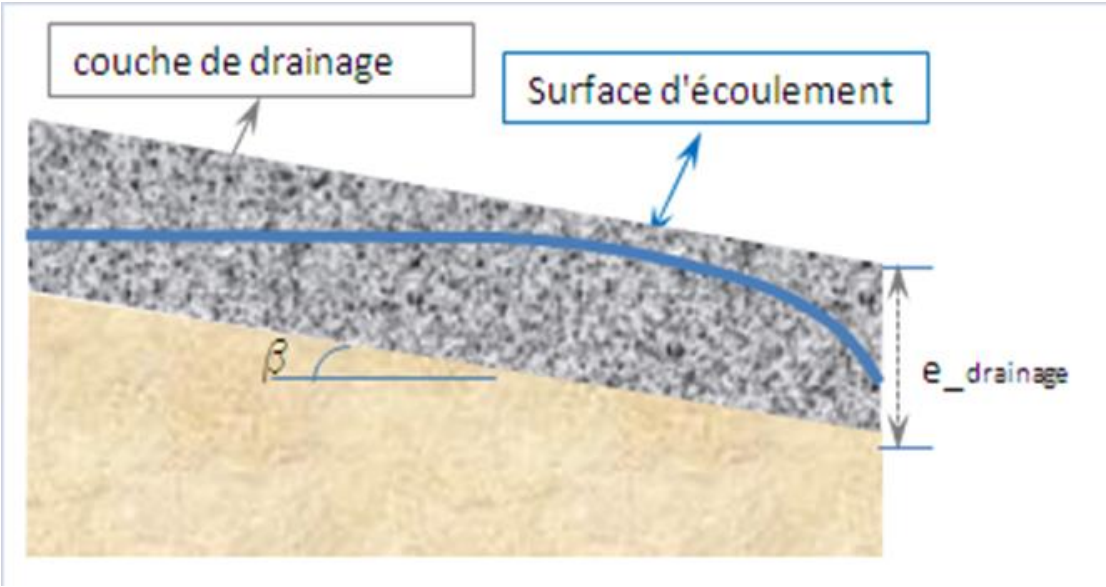
SECO

Designing the geotextile as drainage function

Points of attention about geosynthetic transmissivity :

1) Giroud : $\theta_{corrigée} = E \,.\, \Theta_{requ}$ $\quad E \approx \frac{1}{0{,}88}\left[1 + \left(\frac{e}{0{,}88\,.L}\right).\left(\frac{\cos\beta}{\tan\beta}\right)\right]$



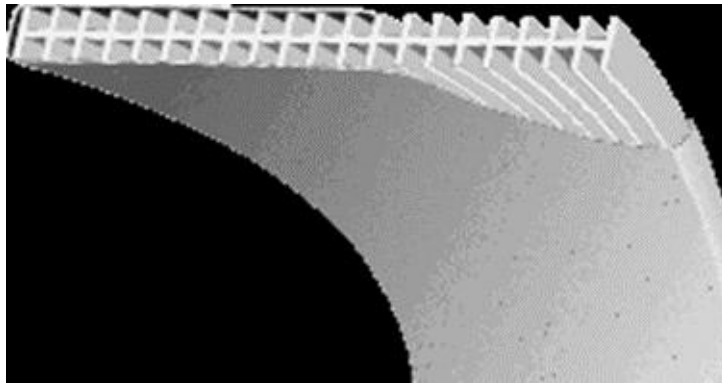


2) Effect of the compressive stress

SECO

Designing the geotextile as drainage function

Other systems : *Most of the case use as geocomposite:*



SECO

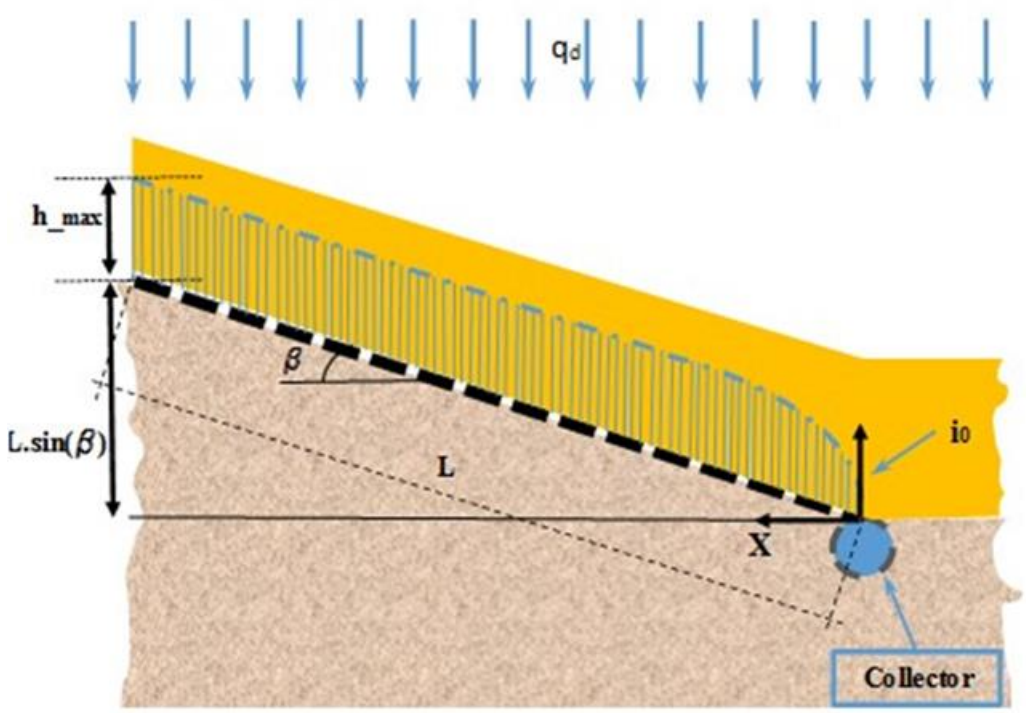
Designing the geotextile as drainage function

Other systems : *Water in the geosynthetic and the upper layer:*

$$q(\sigma_n, i_0, \text{long terme}) = q(\sigma_n, i_0) / (\alpha \,.\, F\,) \geq q_d\, L \cos(\beta)$$

α : coefficient de réduction de débit dû au colmatage interne (1 – 2.5)

F : coefficient de réduction d'épaisseur NF EN ISO 25619-1



SECO Belgium nv/sa

Hermeslaan, 9
BE-1831 Diegem
www.groupseco.be

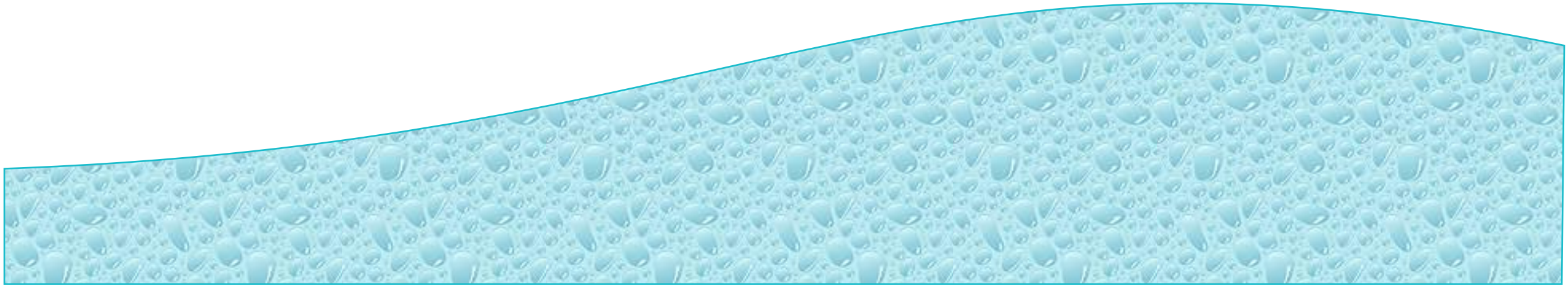
BELGIAN GEOSYNTHETICS SOCIETY

Water and geosynthetics in standardization

BGS info sessie "Drainage en grondwaterbeheersing met geokunststoffen" – 21/11/2023

Karin Eufinger, Centexbel

Background



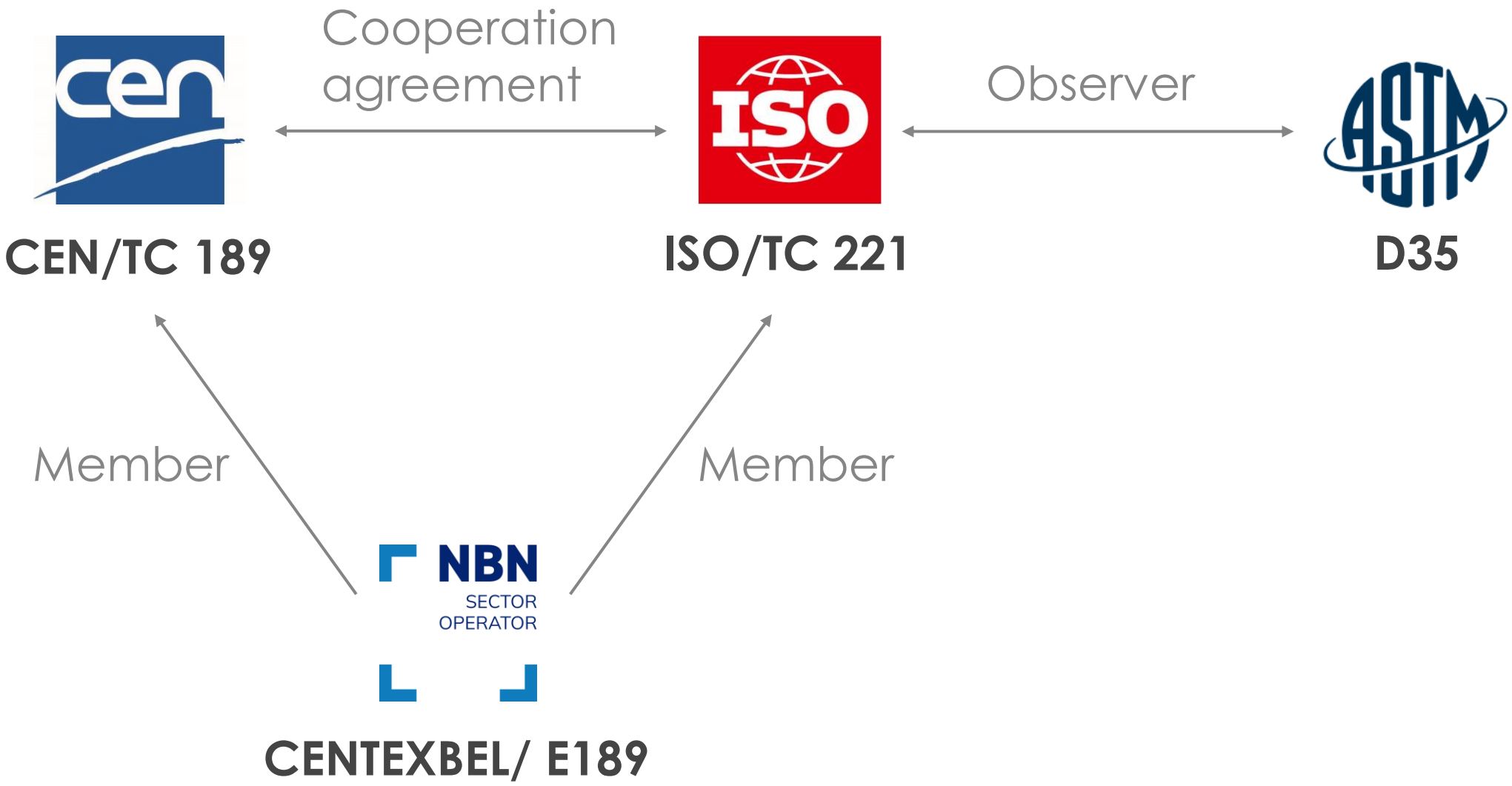
Developing standards for Geosynthetics

Belgium: CENTEXBEL/ E189 Geosynthetics
Managed by NBN Sector operator CENTEXBEL

Mirror committee to:
CEN/TC 189 Geosynthetics (Europe)
ISO/TC 221 Geosynthetics (International)

Other:
ASTM D35 Geosynthetics

Relationships



CENTEXBEL/ E189 Geosynthetics

- Belgian National Mirror committee, managed by NBN Sector operator CENTEXBEL
- Discusses & follows the work CEN/TC189 and ISO/TC 221
- Sends national delegates and experts to the European and International meetings

CEN/TC 189 Geosynthetics

Working groups:

WG 1 Geotextiles and geotextile-related products - General and specific requirements

WG 2 Terminology, identification, sampling and classification

WG 3 Mechanical testing

WG 4 Hydraulic testing

WG 5 Durability

WG 6 Geosynthetic barriers - General and specific requirements

ISO/TC 221

Working groups

WG 1 (NONE)
WG 2 Terminology, identification and sampling => CEN
WG 3 Mechanical properties => CEN
WG 4 Hydraulic properties => CEN
WG 5 Durability => CEN
WG 6 Design using geosynthetics (only ISO)

CEN/TC 189 Geosynthetics

Working groups:

WG 1 Geotextiles and geotextile-related products - General and specific requirements

WG 2 Terminology, identification, sampling and classification => ISO

WG 3 Mechanical testing => ISO

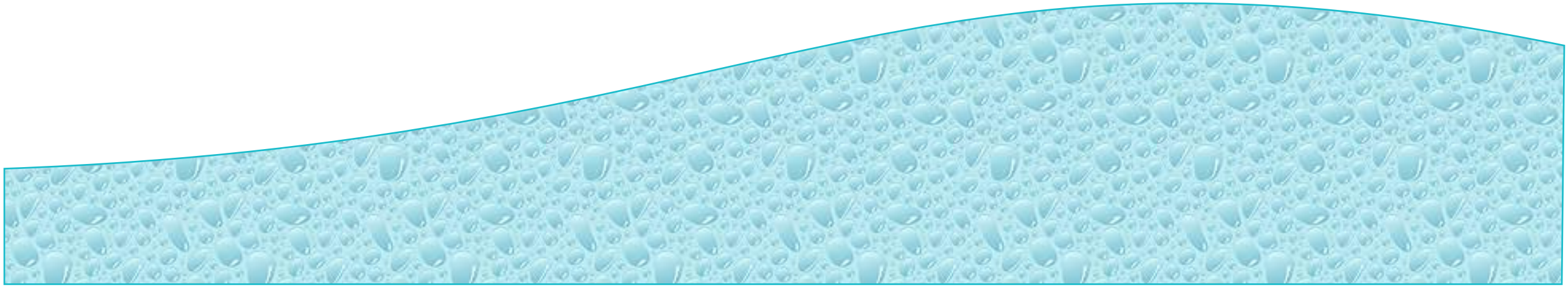
WG 4 Hydraulic testing => ISO

WG 5 Durability => ISO

WG 6 Geosynthetic barriers - General and specific requirements

WG1 and WG6 develop the harmonized standards required for CE marking

Standards for Geosynthetics in hydraulic (and other) applications



Test methods

CEN/TC 189 & ISO/TC 221 WG4: Hydraulic properties

CEN standards

CEN/TS 14416:2014	Geosynthetic barriers - Test method for determining the resistance to roots
CEN/TS 14417:2014	Geosynthetic barriers - Test method for the determination of the influence of wetting-drying cycles on the permeability of clay geosynthetic barriers
CEN/TS 14418:2014	Geosynthetic Barriers - Test method for the determination of the influence of freezing-thawing cycles on the permeability of clay geosynthetic barriers
CEN/TS 17445:2021	Geosynthetics - Standard test for the simulation of rainfall-induced erosion on the surface of a slope protected by geosynthetic erosion control products
EN 13562:2000	Geotextiles and geotextile-related products - Determination of resistance to penetration by water (hydrostatic pressure test)
EN 14150:2019	Geosynthetic barriers - Determination of permeability to liquids
EN 16416:2023	Geosynthetic clay barriers - Determination of water flux index - Flexible wall permeameter method at constant head

CEN-ISO common standards

EN ISO 11058:2019	Geotextiles and geotextile-related products - Determination of water permeability characteristics normal to the plane, without load
EN ISO 12956:2020	Geotextiles and geotextile-related products - Determination of the characteristic opening size
EN ISO 12958-1:2020	Geotextiles and geotextile-related products - Determination of water flow capacity in their plane - Part 1: Index test
EN ISO 12958-2:2020	Geotextiles and geotextile-related products - Determination of water flow capacity in their plane - Part 2: Performance test
EN ISO 10776:2012	Geotextiles and geotextile-related products — Determination of water permeability characteristics normal to the plane, under load
EN ISO 10773:2011	Clay geosynthetic barriers — Determination of permeability to gases
EN ISO 10772:2012	Geotextiles - Test method for the determination of the filtration behaviour of geotextiles under turbulent water flow conditions
EN ISO 10769:2011	Clay geosynthetic barriers — Determination of water absorption of bentonite

ISO standards

ISO 18325:2015	Geosynthetics — Test method for the determination of water discharge capacity for prefabricated vertical drains

Specification standards

CEN/TC 189/WG 1 Geotextiles

CEN/TC 189/WG 6 Geosynthetic barriers

ISO/TC 221/WG6 Design using Geosynthetics

CE-marking: Harmonised standards

Standard (dated version!) cited in the Official Journal of the European Union (OJEU) for supporting European legislation.

Under the CPR (Construction products regulation) use of the harmonized standards is mandatory

Care must be taken to use the version of the standard cited in the OJEU; this may not necessarily be latest version published by CEN.

CEN/TC 189/WG 1 Geotextiles and geotextile-related products – Characteristics

Published and cited standards

EN 13249:2016	Construction of roads and other trafficked areas (excl. railways and asphalt inclusion)
EN 13250:2016	Construction of railways
EN 13251:2016	Earthworks, foundations and retaining structures
EN 13252:2016	Drainage systems
EN 13253:2016	Erosion control works (coastal protection, bank revetments)
EN 13254:2016	Construction of reservoirs and dams
EN 13255:2016	Construction of canals
EN 13256:2016	Construction of tunnels and underground structures
EN 13257:2016	Solid waste disposals
EN 13265:2016	Liquid waste containment projects
EN 15381:2008	Pavements and asphalt overlay

CEN/TC 189/WG 6 – Geosynthetic Barriers - Characteristics

Published standards

EN 13361:2018	Construction of reservoirs and dams
EN 13362:2018	Construction of canals
EN 15382:2018	Transportation infrastructure
EN 13491:2018	Construction of tunnels and associated underground structures
EN 13492:2018	Construction of liquid waste disposal sites, transfer stations or secondary containment
EN 13493:2018	Construction of solid waste storage and disposal sites
EN 16993:2018	Construction of storage lagoons, secondary containment (above and below ground) and other containment applications for chemicals, polluted water and produced liquids
EN 16994:2018	Construction of underground structures (other than tunnels and associated structures)

CEN/TC 189/WG 6 – Geosynthetic barriers - Characteristics

Cited standards

EN 13361:2004 + A1:2006	Construction of reservoirs and dams
EN 13362:2005	Construction of canals
EN 13491:2004 + A1:2006	Fluid barrier in the construction of tunnels and underground structures
EN 13492:2004 + A1:2006	Construction of liquid waste disposal sites, transfer stations or secondary containment
EN 13493:2005	Construction of solid waste storage and disposal sites
EN 15382:2013	Transportation infrastructure

=> only the cited version can be used for CE marking

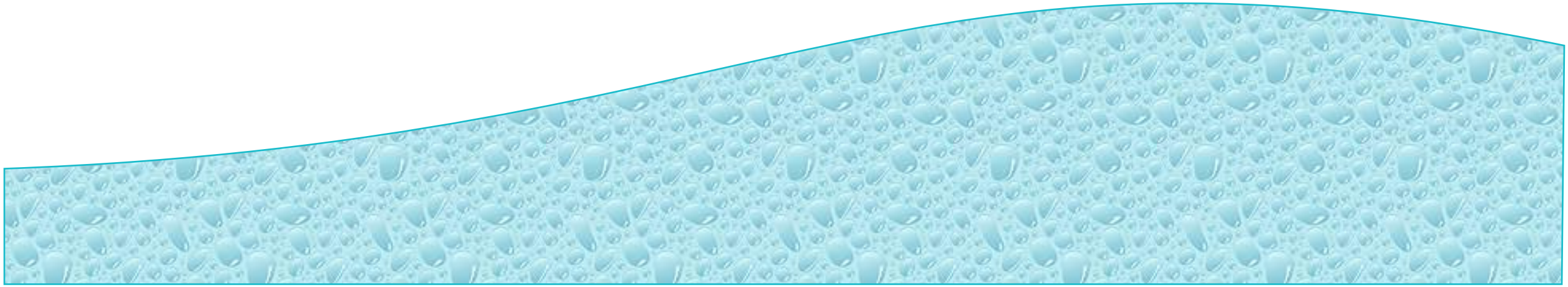
https://single-market-economy.ec.europa.eu/single-market/european-standards/harmonised-standards/construction-products-cpdcpr_en

ISO/TC 221/ WG6 Design using geosynthetics

ISO/TR 18228-1:2020	General
ISO/TR 18228-2:2021	Separation
ISO/TR 18228-3:2021	Filtration
ISO/TR 18228-4:2022	Drainage
ISO/CD TR 18228-5	Stabilization
ISO/PRF TR 18228-6	Protection (*under publication*)
ISO/TR 18228-7:2021	Reinforcement
ISO/DTR 18228-8	Part 8: Surface erosion control (*under development*)
ISO/TR 18228-9:2022	Barriers
ISO/DTR 18228-10	Asphalt pavements (*under development*)

Interested in joining the work?

=> become a member of CENTEXBEL/ E 189 !



Contact

Karin Eufinger

Manager Standards & Technical Regulations

Coordinator
NBN Sector Operator CENTEXBEL

National Secretary CENTEXBEL/ E189

ke@centexbel.be

CONNECT

INSPIRE

SOLVE

CREATE

Buildwise

Drainage et étanchéité des constructions enterrées

Détails de référence

Kevin JANSSENS – Conseiller aux Avis Techniques

BELGIAN GEOSYNTHETICS SOCIETY

Buildwise

Centre de recherche collective et d'innovation
secteur de la construction

3 missions

1. **Mener des recherches scientifiques et techniques** prénormatives et innovantes
2. **Contribuer à l'innovation et au développement**
3. **Diffuser les résultats de recherches** et apporter un **soutien technique et organisationnel** à nos membres

centrées sur

3 axes

1. **Transformation digitale**
2. **Transition écologique et durable**
3. **Piloté par les entreprises** (comités techniques)

Détails de référence

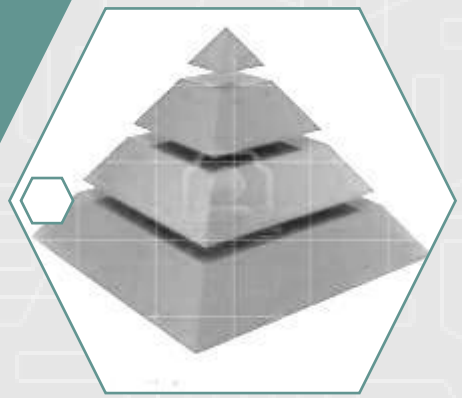
Avant …

Stabilité

Durabilité

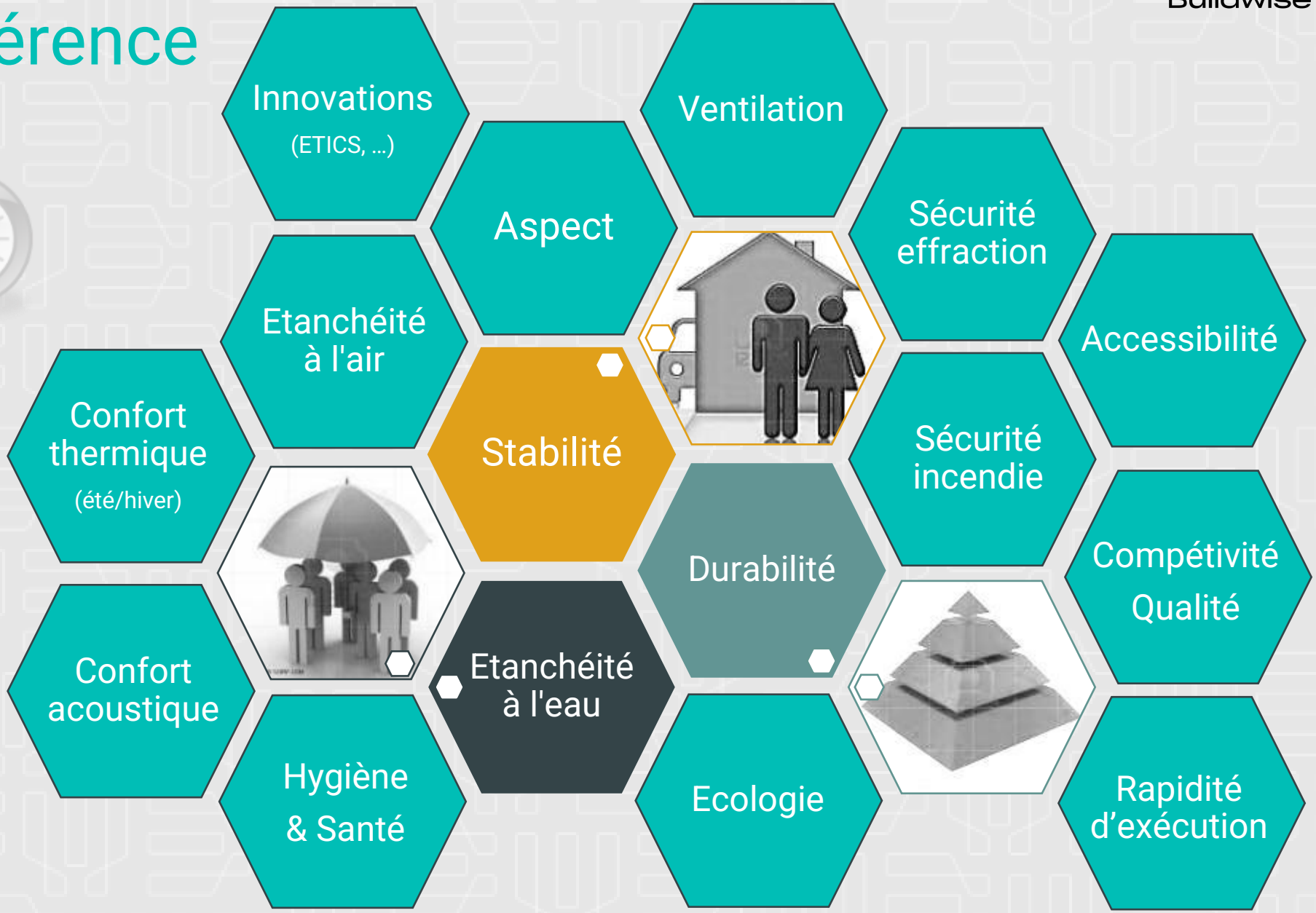
Etanchéité à l'eau

Min. 10 ans



Détails de référence

Depuis ...



Buildwise

Que cherchez-vous ?

Compte

Connaissances | Métiers | Thèmes | Innovation | Agenda | Help Center | À propos de nous | FR

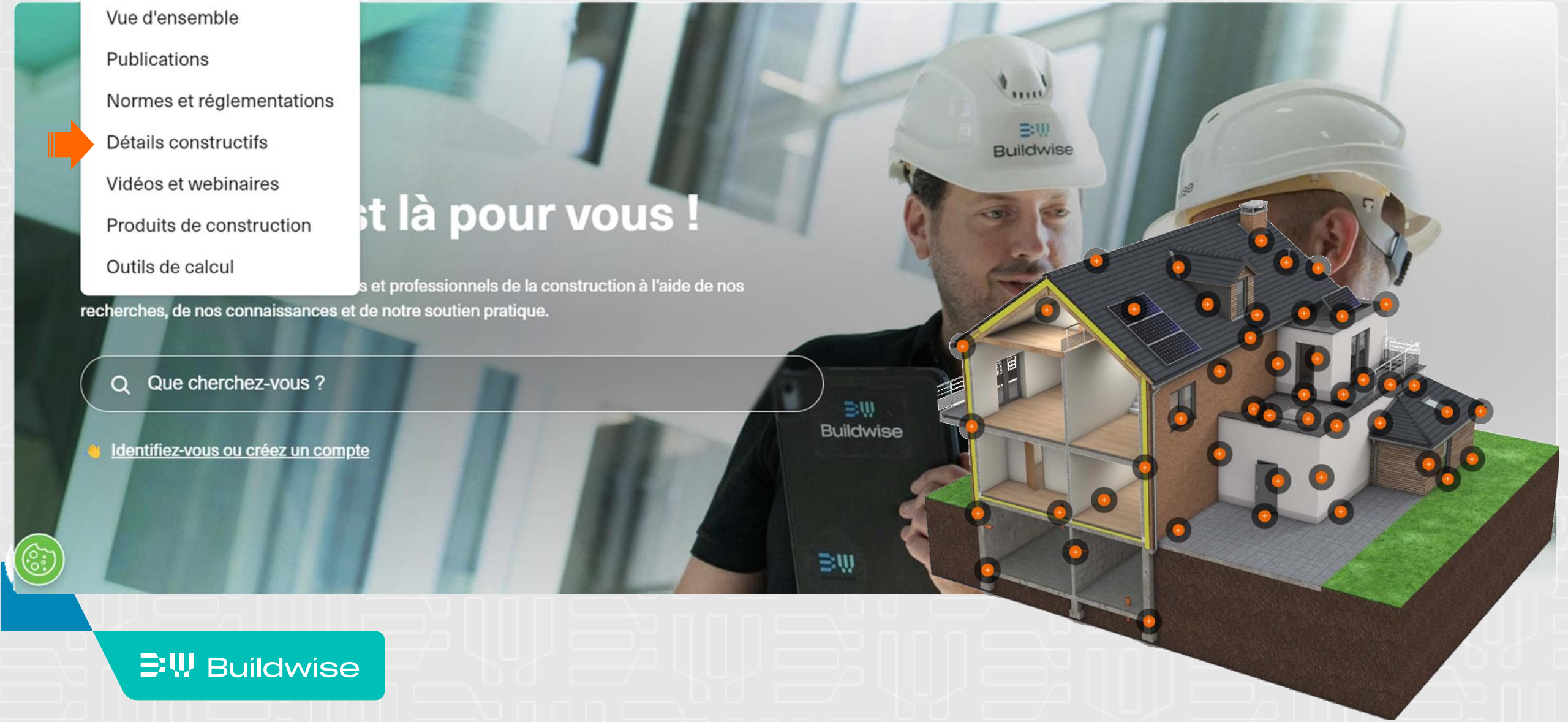
- Vue d'ensemble
- Publications
- Normes et réglementations
- Détails constructifs
- Vidéos et webinaires
- Produits de construction
- Outils de calcul

st là pour vous !

s et professionnels de la construction à l'aide de nos recherches, de nos connaissances et de notre soutien pratique.

Que cherchez-vous ?

Identifiez-vous ou créez un compte



Buildwise

Détails de référence

Buildwise

Que cherchez-vous ?

Compte

Connaissances · Métiers · Thèmes · Innovation · Agenda · H · À propos de nous · FR

Vue d'ensemble

Publications

Normes et réglementations

Détails de référence

Vidéos

Produits

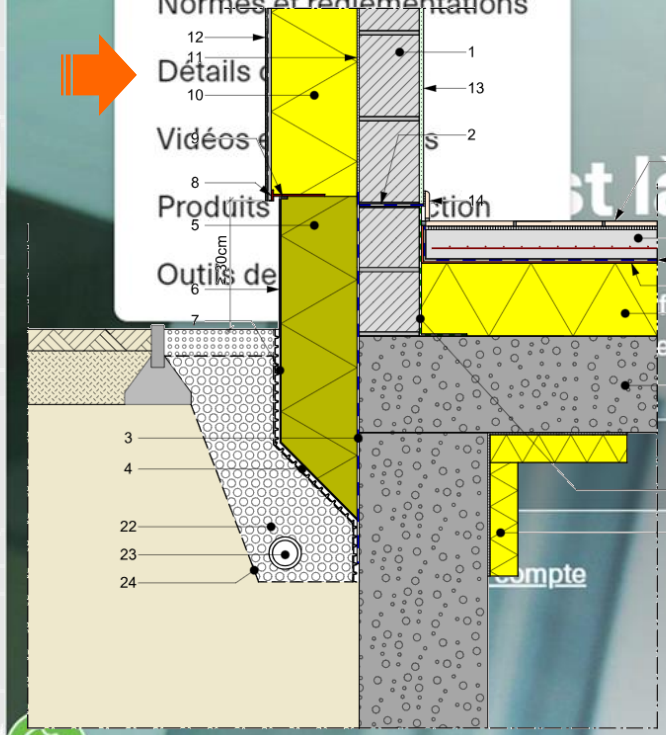
Outils de

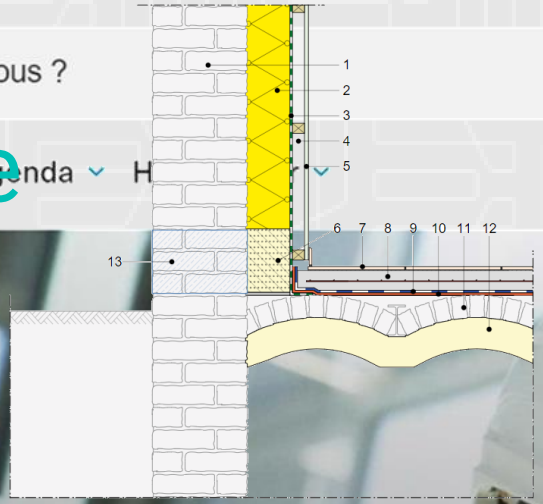
st là pour vous !

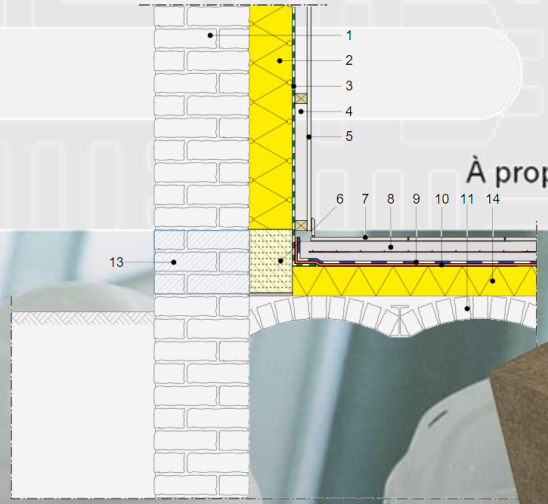
fessionnels de la construction à l'aide de nos

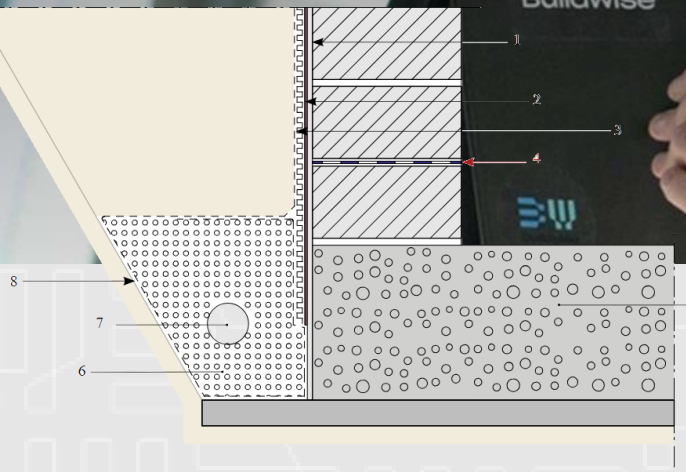
e soutien pratique.

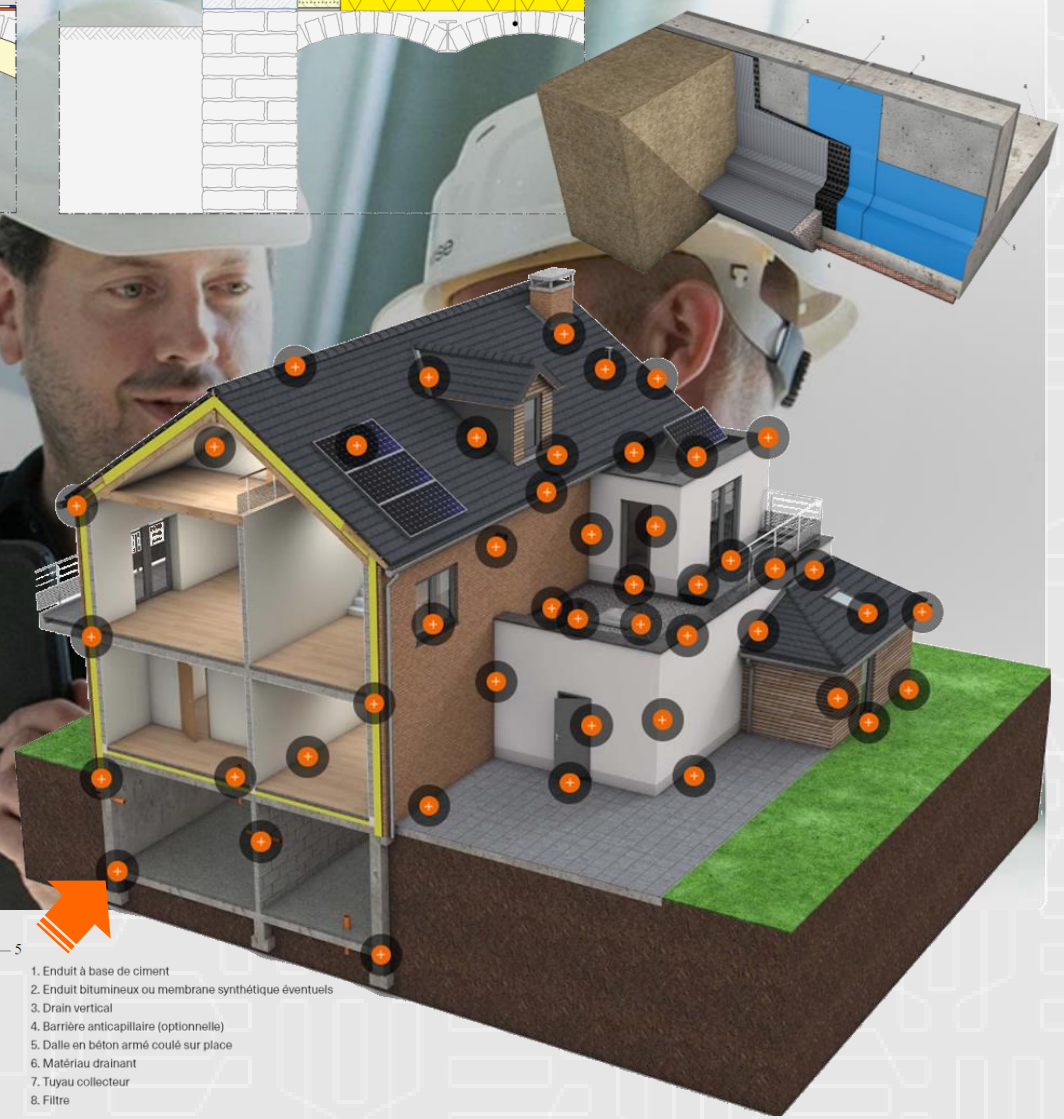
ompte







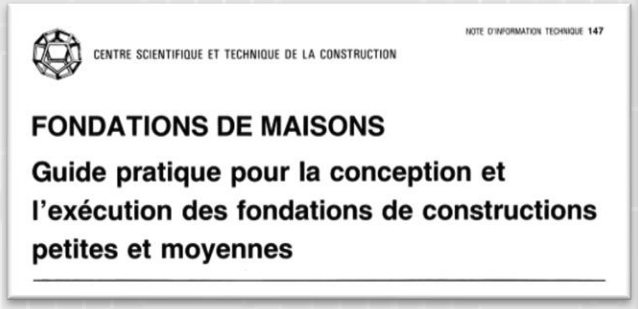


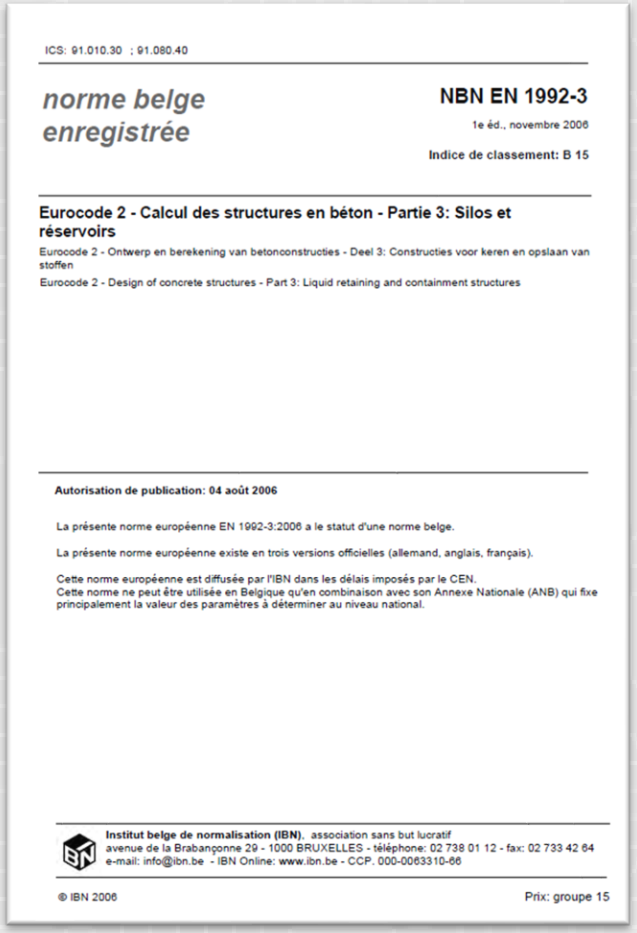


1. Enduit à base de ciment
2. Enduit bitumineux ou membrane synthétique éventuels
3. Drain vertical
4. Barrière anticapillaire (optionnelle)
5. Dalle en béton armé coulé sur place
6. Matériau drainant
7. Tuyau collecteur
8. Filtre

Buildwise

Choix du système





Choix du système

- Tableau 1 de la **NIT 250**
- **Solution minimale**, n'interdit pas de choisir une solution plus performante
- Pas d'infiltration ne signifie pas que l'ouvrage soit toujours complètement sec (« classes d'étanchéité »)

Paramètres à contrôler				Techniques de protection envisageables	
Reconnaissance du sol	Perméabilité du sol	Inclinaison du terrain autour du bâtiment	Finition intérieure sensible à l'humidité (*)		
Le niveau de la nappe phréatique se situe en permanence sous le plancher de la cave	Élevée (sol sablonneux sur une hauteur telle que tout risque de pression d'eau sur le mur est exclu; cette situation est rarement rencontrée en pratique)	Descendante à partir du bâtiment	Non (voir a)	(a) Enduit à base de ciment du côté extérieur + émulsion bitumineuse ou structure en béton coulé sur place (classe o)	a)
			Oui (voir e ou b + d)		
		Horizontale ou descendante vers le bâtiment	Non (voir b)	(b) Système de drainage horizontal et vertical + enduit à base de ciment du côté extérieur (pour les maçonneries)	b)
			Oui (voir e ou b + d)		
	Faible (sol argileux sur toute la hauteur de la cave ou sur une partie de celle-ci)	Descendante à partir du bâtiment	Non (voir b ou c)	(c) Cuvelage étanche composé d'un cuvelage rigide (2) du côté intérieur ou d'une structure en béton coulé sur place (classe 1) (3)	c)
			Oui (voir e)		
		Horizontale ou descendante vers le bâtiment	Non (voir b ou c)	(d) Structure en béton coulé sur place (classe 2) (4), éventuellement complétée par des injections	d)
			Oui (voir e)		
Le niveau de la nappe phréatique se situe (temporairement) au-dessus du plancher de la cave			Non (voir c)	(e) Cuvelage souple (5) ou structure en béton coulé sur place (classe 3). Cette dernière nécessite l'application de béton précontraint	e)
			Oui (voir e)		

(*) Les lettres entre parenthèses renvoient à la protection minimale qu'il y a lieu de prévoir. Il est évident que toute classe de protection plus performante est autorisée pour une sollicitation donnée. Les performances du système sont croissantes de la lettre 'a' à la lettre 'e'.
(2) Il s'agit d'un enduit en deux couches minimum qui reste continuellement visible afin de permettre des réparations (rendues nécessaires en raison d'un retrait, de tassements ou autres phénomènes inévitables). Le liant peut être à base de ciment ou de résine. Le support doit être sain et présenter une résistance mécanique suffisante.
(3) Dans les structures en béton de classe d'étanchéité 1, des fuites apparaissent parfois en nombre limité. Quelques taches ou plaques d'humidité en surface sont admises. Si l'on souhaite éviter ce phénomène, on optera pour une classe d'étanchéité supérieure.
(4) Dans les structures en béton de classe d'étanchéité 2, le nombre de fuites doit être minime. La surface ne peut présenter aucune tache.
(5) Dans ce cas, il convient d'utiliser des membranes étanches à l'eau et à la vapeur (à joints soudés, par exemple). Celles-ci peuvent être appliquées du côté extérieur contre l'ouvrage à rendre étanche à l'eau et doivent ensuite être protégées de toute dégradation due à l'apport de terres. Elles peuvent également être mises en œuvre du côté intérieur, auquel cas elles doivent être complétées par un contre-cuvelage permettant de reprendre la pression exercée par l'eau.

Choix du système

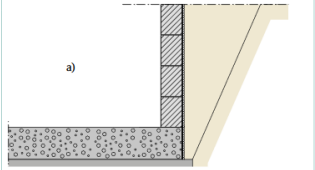
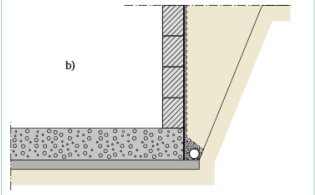
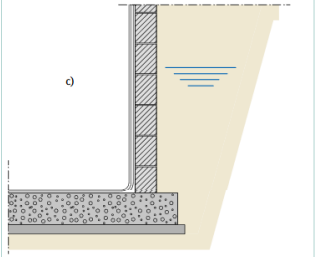
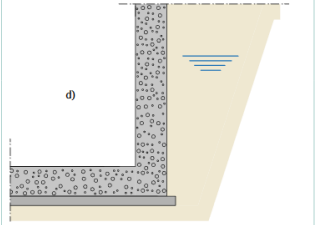
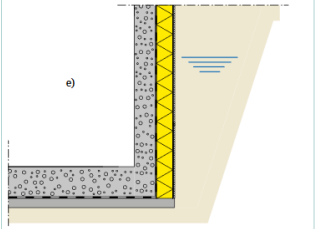
a) Cimentage + Emulsion bitumineuse (coaltar)
/ouvrage en béton (Classe 0)

b) … + Drainage horizontal et vertical

c) Cuvelage rigide (intérieur)
/ouvrage en béton (Classe 1)

d) Ouvrage en béton (Classe 2)

e) Cuvelage souple (extérieur)
/ouvrage en béton (Classe 3)

Paramètres à contrôler				Techniques de protection envisageables	
Reconnaissance du sol	Perméabilité du sol	Inclinaison du terrain autour du bâtiment	Finition intérieure sensible à l'humidité (*)		
Le niveau de la nappe phréatique se situe en permanence sous le plancher de la cave	Élevée (sol sablonneux sur une hauteur telle que tout risque de pression d'eau sur le mur est exclu; cette situation est rarement rencontrée en pratique)	Descendante à partir du bâtiment	Non (voir a)	(a) Enduit à base de ciment du côté extérieur + émulsion bitumineuse ou structure en béton coulé sur place (classe o)	
			Oui (voir e ou b + d)		
		Horizontale ou descendante vers le bâtiment	Non (voir b)	(b) Système de drainage horizontal et vertical + enduit à base de ciment du côté extérieur (pour les maçonneries)	
			Oui (voir e ou b + d)		
	Faible (sol argileux sur toute la hauteur de la cave ou sur une partie de celle-ci)	Descendante à partir du bâtiment	Non (voir b ou c)	(c) Cuvelage étanche composé d'un cuvelage rigide (2) du côté intérieur ou d'une structure en béton coulé sur place (classe 1) (3)	
			Oui (voir e)		
		Horizontale ou descendante vers le bâtiment	Non (voir b ou c)	(d) Structure en béton coulé sur place (classe 2) (4), éventuellement complétée par des injections	
			Oui (voir e)		
Le niveau de la nappe phréatique se situe (temporairement) au-dessus du plancher de la cave			Non (voir c)	(e) Cuvelage souple (5) ou structure en béton coulé sur place (classe 3). Cette dernière nécessite l'application de béton précontraint	
			Oui (voir e)		

(*) Les lettres entre parenthèses renvoient à la protection minimale qu'il y a lieu de prévoir. Il est évident que toute classe de protection plus performante est autorisée pour une sollicitation donnée. Les performances du système sont croissantes de la lettre 'a' à la lettre 'e'.
(1) Il s'agit d'un enduit en deux couches minimum qui reste continuellement visible afin de permettre des réparations (rendues nécessaires en raison d'un retrait, de tassements ou autres phénomènes inévitables). Le liant peut être à base de ciment ou de résine. Le support doit être sain et présenter une résistance mécanique suffisante.
(2) Dans les structures en béton de classe d'étanchéité 1, des fuites apparaissent parfois en nombre limité. Quelques taches ou plaques d'humidité en surface sont admises. Si l'on souhaite éviter ce phénomène, on optera pour une classe d'étanchéité supérieure.
(3) Dans les structures en béton de classe d'étanchéité 2, le nombre de fuites doit être minime. La surface ne peut présenter aucune tache.
(4) Dans ce cas, il convient d'utiliser des membranes étanches à l'eau et à la vapeur (à joints soudés, par exemple). Celles-ci peuvent être appliquées du côté extérieur contre l'ouvrage à rendre étanche à l'eau et doivent ensuite être protégées de toute dégradation due à l'apport de terres. Elles peuvent également être mises en œuvre du côté intérieur, auquel cas elles doivent être complétées par un contre-cuvelage permettant de reprendre la pression exercée par l'eau.

Choix du système

4 paramètres :

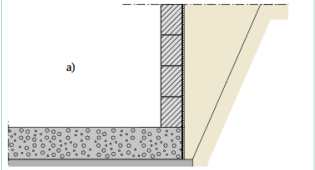
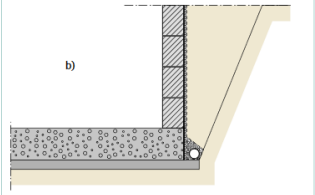
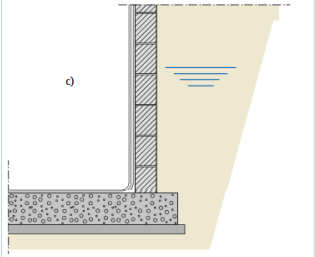
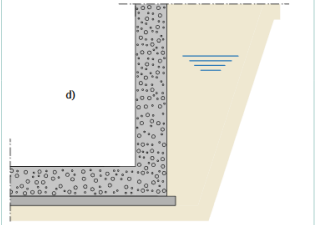
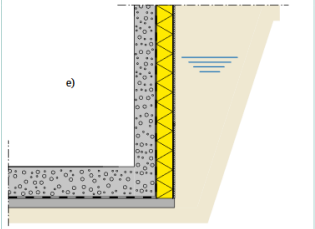
- Nappe phréatique
- Perméabilité du sol
- Pente du terrain

Connaissance du sol

- Sensibilité à l'humidité des finitions intérieures

Connaissance du projet
(destination des locaux)

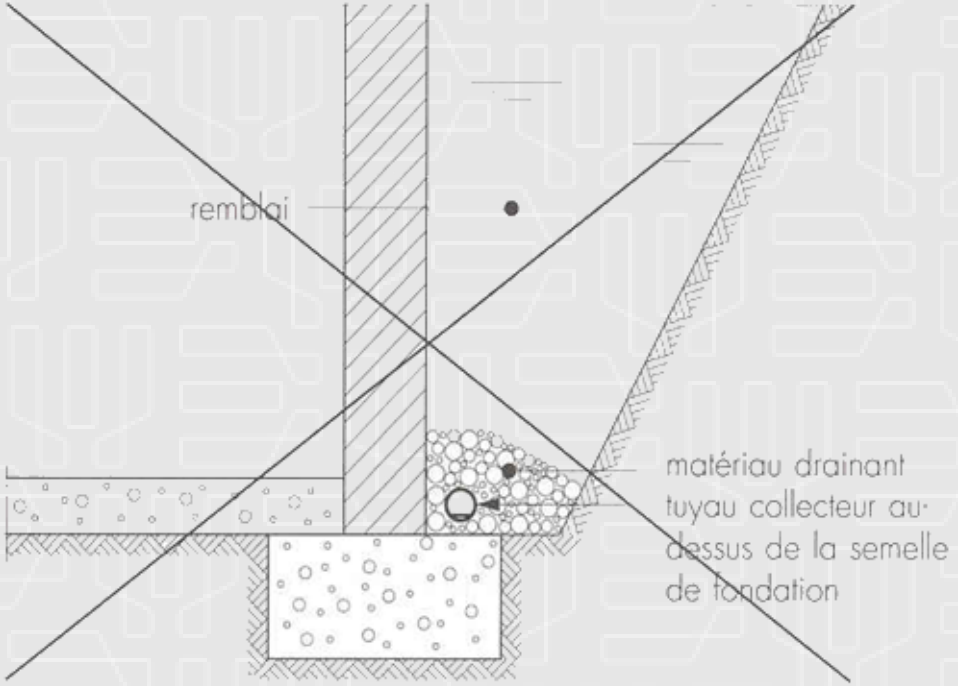
Buildwise

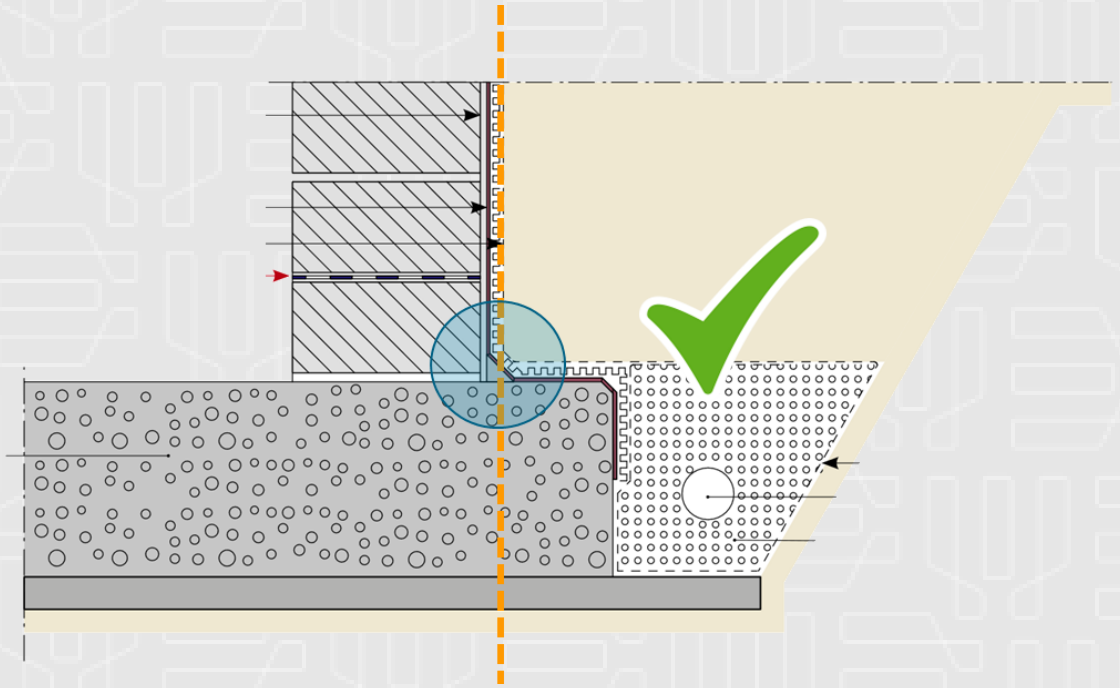
Paramètres à contrôler				Techniques de protection envisageables
Reconnaissance du sol	Perméabilité du sol	Inclinaison du terrain autour du bâtiment	Finition intérieure sensible à l'humidité (*)	
Le niveau de la nappe phréatique se situe en permanence sous le plancher de la cave	Élevée (sol sablonneux sur une hauteur telle que tout risque de pression d'eau sur le mur est exclu; cette situation est rarement rencontrée en pratique)	Descendante à partir du bâtiment	Non (voir a)	(a) Enduit à base de ciment du côté extérieur + émulsion bitumineuse ou structure en béton coulé sur place (classe o) 
			Oui (voir e ou b + d)	
		Horizontale ou descendante vers le bâtiment	Non (voir b)	(b) Système de drainage horizontal et vertical + enduit à base de ciment du côté extérieur (pour les maçonneries) 
			Oui (voir e ou b + d)	
	Faible (sol argileux sur toute la hauteur de la cave ou sur une partie de celle-ci)	Descendante à partir du bâtiment	Non (voir b ou c)	(c) Cuvelage étanche composé d'un cuvelage rigide (2) du côté intérieur ou d'une structure en béton coulé sur place (classe 1) (3) 
			Oui (voir e)	
		Horizontale ou descendante vers le bâtiment	Non (voir b ou c)	(d) Structure en béton coulé sur place (classe 2) (4), éventuellement complétée par des injections 
			Oui (voir e)	
Le niveau de la nappe phréatique se situe (temporairement) au-dessus du plancher de la cave			Non (voir c)	(e) Cuvelage souple (5) ou structure en béton coulé sur place (classe 3). Cette dernière nécessite l'application de béton précontraint 
			Oui (voir e)	

(*) Les lettres entre parenthèses renvoient à la protection minimale qu'il y a lieu de prévoir. Il est évident que toute classe de protection plus performante est autorisée pour une sollicitation donnée. Les performances du système sont croissantes de la lettre 'a' à la lettre 'e'.
(2) Il s'agit d'un enduit en deux couches minimum qui reste continuellement visible afin de permettre des réparations (rendues nécessaires en raison d'un retrait, de tassements ou autres phénomènes inévitables). Le liant peut être à base de ciment ou de résine. Le support doit être sain et présenter une résistance mécanique suffisante.
(3) Dans les structures en béton de classe d'étanchéité 1, des fuites apparaissent parfois en nombre limité. Quelques taches ou plaques d'humidité en surface sont admises. Si l'on souhaite éviter ce phénomène, on optera pour une classe d'étanchéité supérieure.
(4) Dans les structures en béton de classe d'étanchéité 2, le nombre de fuites doit être minime. La surface ne peut présenter aucune tache.
(5) Dans ce cas, il convient d'utiliser des membranes étanches à l'eau et à la vapeur (à joints soudés, par exemple). Celles-ci peuvent être appliquées du côté extérieur contre l'ouvrage à rendre étanche à l'eau et doivent ensuite être protégées de toute dégradation due à l'apport de terres. Elles peuvent également être mises en œuvre du côté intérieur, auquel cas elles doivent être complétées par un contre-cuvelage permettant de reprendre la pression exercée par l'eau.

Drainage

Sauf validation par un bureau d'études, **JAMAIS DANS UNE NAPPE PHRÉATIQUE**





Drainage

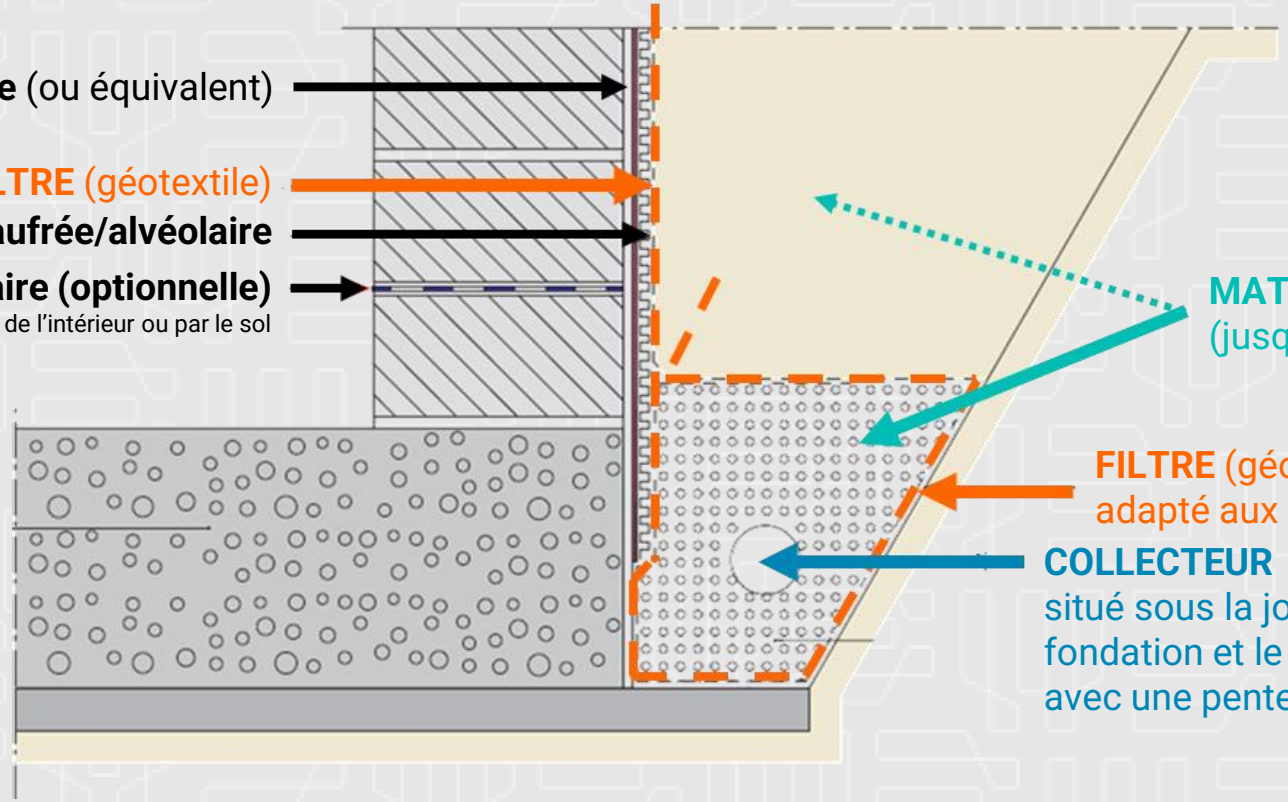
Sauf validation par un bureau d'études, **JAMAIS DANS UNE NAPPE PHRÉATIQUE**

Cimentage + Emulsion bitumineuse (ou équivalent)

FILTRE (géotextile)

Membrane gaufrée/alvéolaire

Barrière anticapillaire (optionnelle)
prévient l'humidité provenant de l'intérieur ou par le sol



MATÉRIAU DRAINANT
(jusqu'en tête du mur)

FILTRE (géotextile)
adapté aux propriétés du sol

COLLECTEUR
situé sous la jonction entre la fondation et le mur de cave, avec une pente ≥ 0,5 %

Drainage

Sauf validation par un bureau d'études, **JAMAIS DANS UNE NAPPE PHRÉATIQUE**

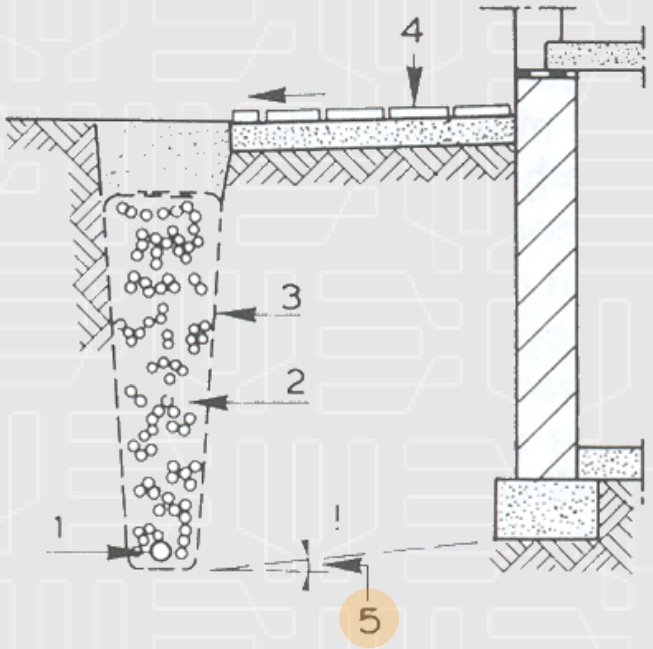
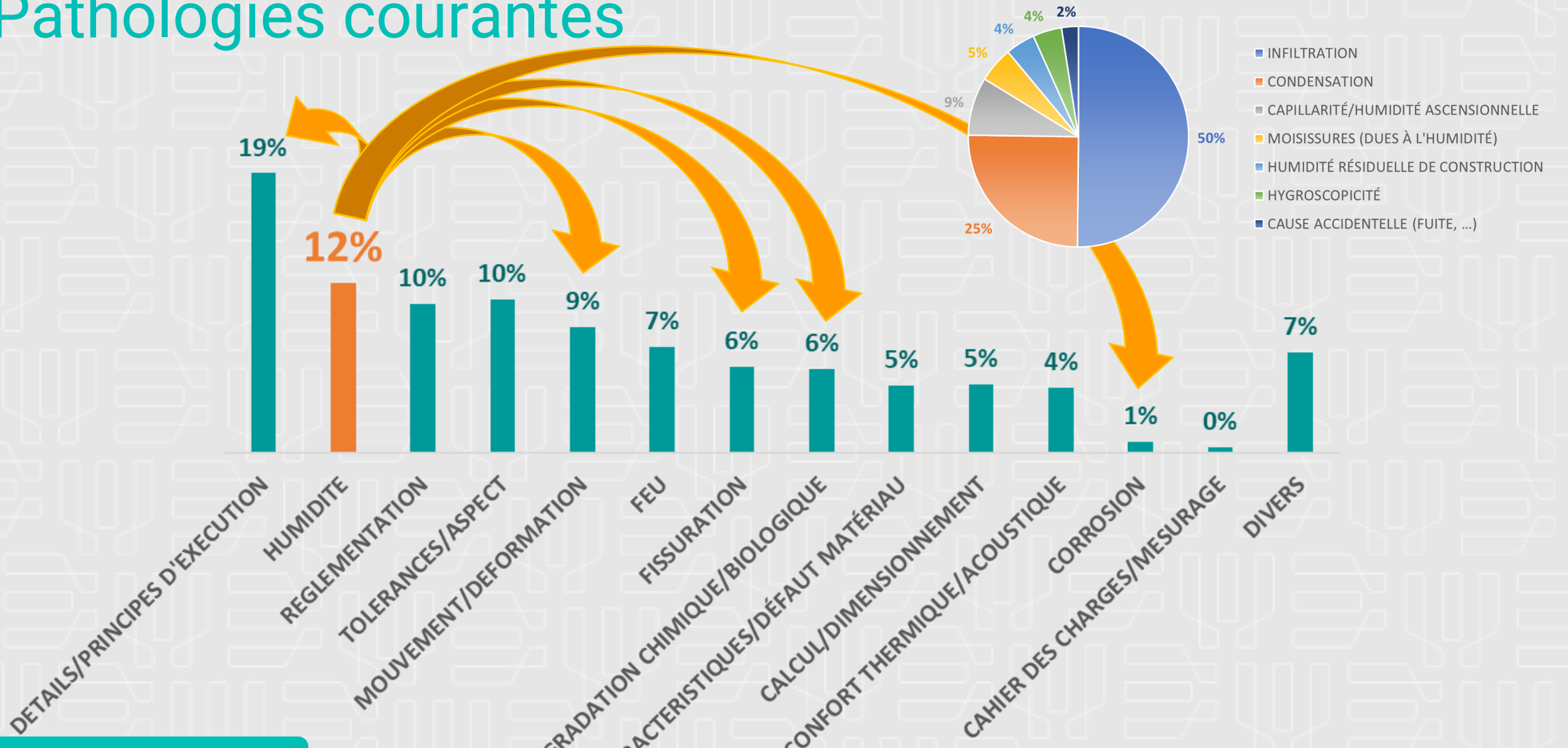


Fig. 84 — Drain placé à une certaine distance des fondations (*).

1. tuyau de drainage
2. graviers
3. écran filtrant
4. dallage, trottoir ou terrasse
5. pente maximale par rapport à la base inférieure de la fondation : 15 % pour les terrains sablonneux fins, 33 % pour les sols argileux

Pathologies courantes



Buildwise

Pathologies courantes

Le remblais doit être composé de **matériau drainant** (pas de gravats)

Les tubes flexibles en fibre de coco sont fabriqués pour l'horticulture

La fibre de coco est une **matière organique qui se décompose avec le temps** et qui perd donc son efficacité après quelques années

- Opter plutôt pour des **tuyaux rigides avec toile filtrante**

Pathologies courantes

- **Absence de filtre** ou filtre inadapté

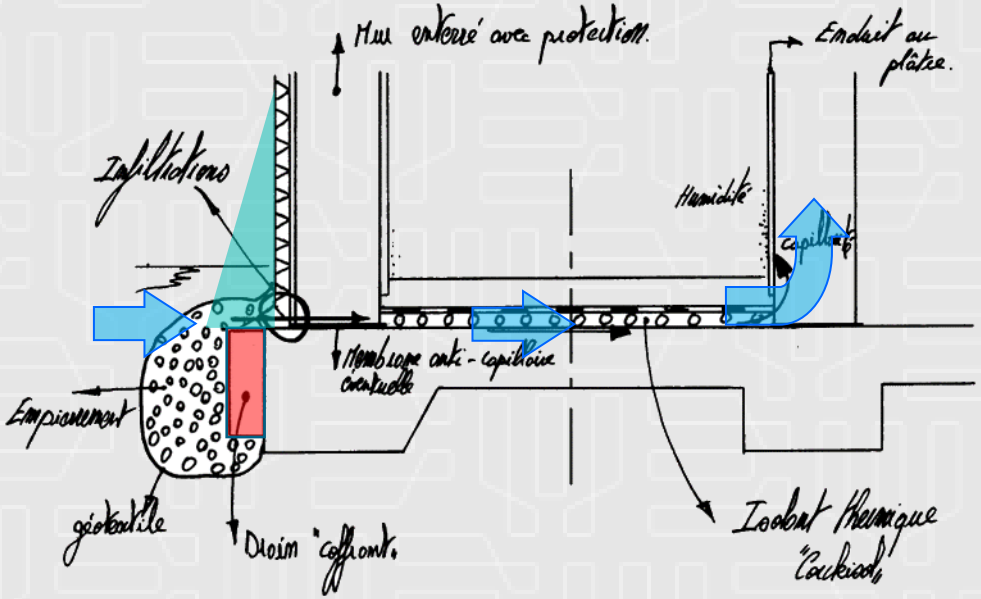
  Un **filtre inadapté**, ou absent, peut laisser passer les particules de sol et, avec le temps, provoquer un affaissement du sol, des chaussées ou une instabilité des structures

Pathologies courantes

Humidité en pied de murs
(int. + ext.)

Drain coffrant

➢ **Obstruction du collecteur**



Buildwise

Que cherchez-vous ?

Compte

Connaissances | Métiers | Thèmes | Innovation | Agenda | Help Center | À propos de nous | FR

- Vue d'ensemble
- Questions les plus fréquentes
- Avis techniques
- Contact

Contacter Buildwise

Demande assistance technique

Vous êtes confronté à des problèmes de construction ?
Appelez-nous au **02 716 42 11** ou demandez un avis technique à nos ingénieurs via le formulaire de demande.

Formulaire de demande

Buildwise

GBMS BGGG Belgian Member Society of SIMSG ISSMGE

BontexGeo Leading in Geosynthetics

abg creative geosynthetic engineering

Drainage en grondwaterbeheersing met geokunststoffen

Case Studies: Structural drainage and Consolidation – Environmental and Cost Savings

Eur Ing **David Shercliff** *BSc CEng MICE CMIWM*

Chief Engineer

ABG Geosynthetics Ltd

david@abgltd.com

Our vision for 2025

Working together, industry and developed a clear and defined se for UK construction.

Safety - Reducing personnel onsite activity by

25%

It begins with a clear vision of where UK construction will be in 2025:

- **PEOPLE** An industry that is known for its talented and diverse workforce
- **SMART** An industry that is efficient and technologically advanced
- **SUSTAINABLE** An industry that leads the world in low-carbon and green construction exports
- **GROWTH** An industry that drives growth across the entire economy
- **LEADERSHIP** An industry with clear leadership from a Construction Leadership Council

This vision will provide the basis for the industry to exploit its strengths in the global market.

Lower costs

33%

reduction in the initial cost of construction and the whole life cost of built assets

Faster delivery

50%

reduction in the overall time, from inception to completion, for newbuild and refurbished assets

Lower emissions

50%

reduction in greenhouse gas emissions in the built environment

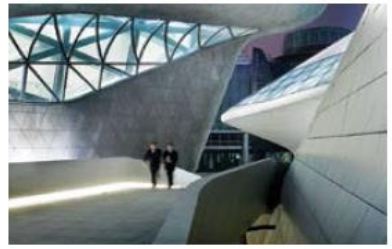
Improvement in exports

50%

reduction in the trade gap between total exports and total imports for construction products and materials

The British-designed Reichstag uses reflected light to significantly cut energy consumption.

Image courtesy of UKTI



The global construction market is forecast to grow by over 70% by 2025.

Global Construction 2025; Global Construction Perspectives and Oxford Economics (July 2013)

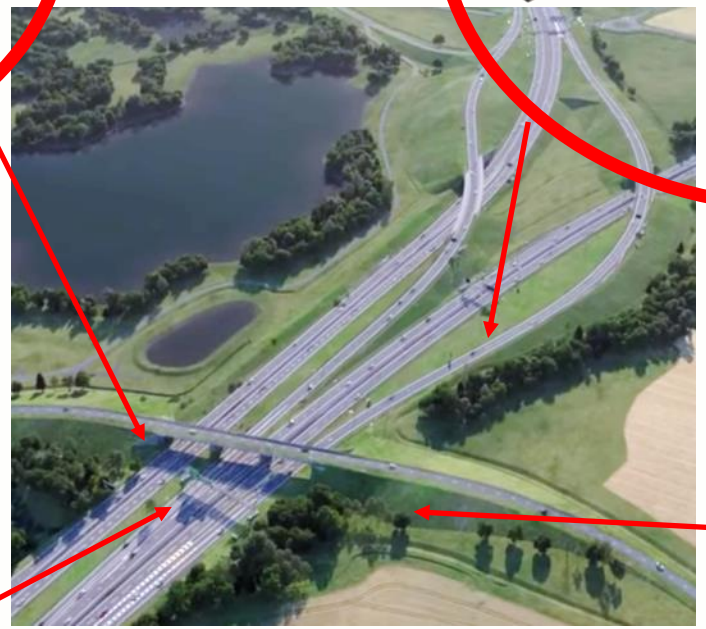
Geosynthetic Drainage Geocomposites in Civil Engineering

Structural Drainage—replace concrete

Geocomposite - back of wall drain

Starter and Consolidation Layers—replace stone blankets

Geocomposite - starter layers - consolidation layers



Highway Drainage—replace french stone drains

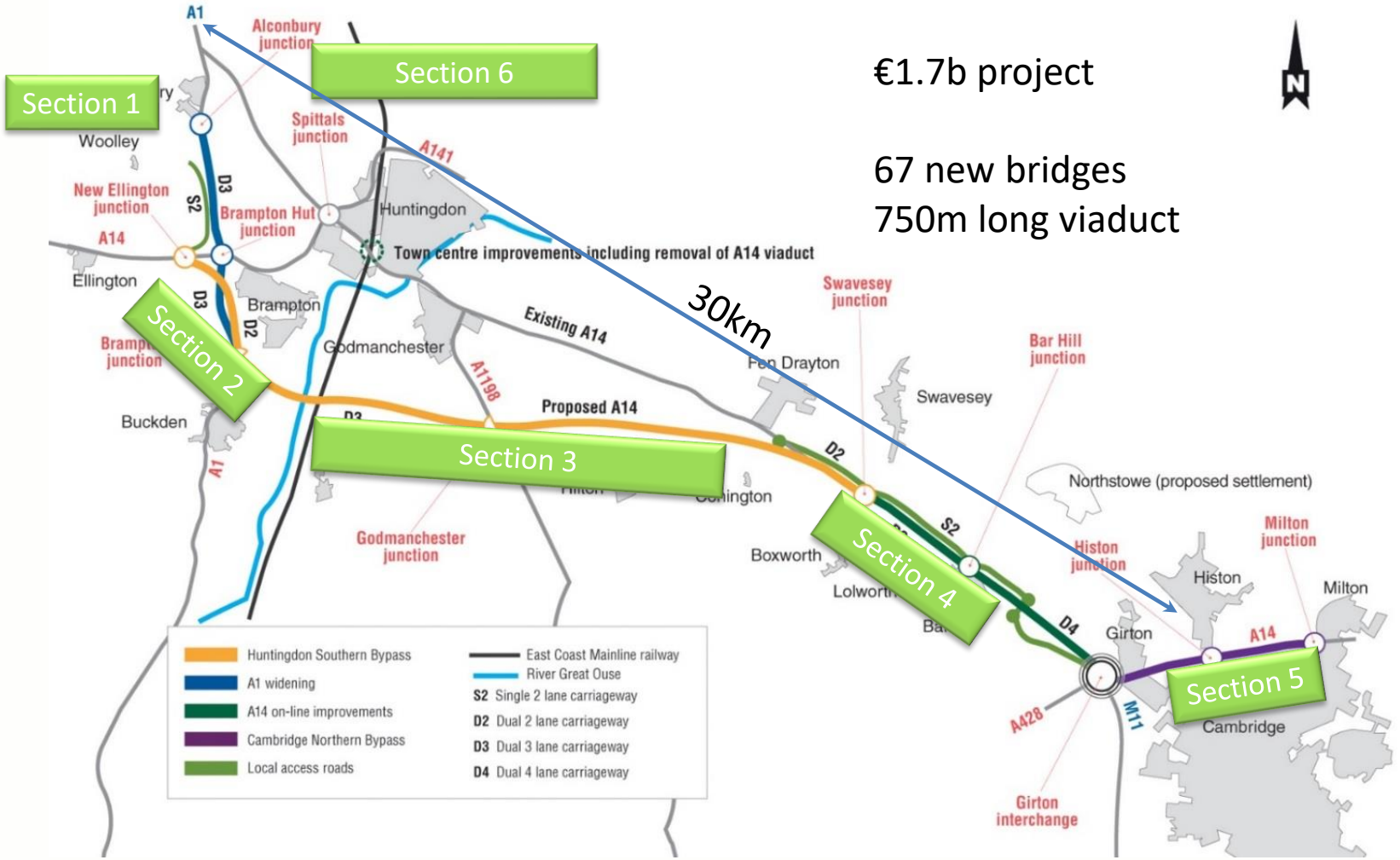
Counterfort Drainage—replace stone herringbones

CASE STUDY:
A14 Huntingdon to Cambridge

Joint Venture all represented on each section
3 main contractors
2 main consultants

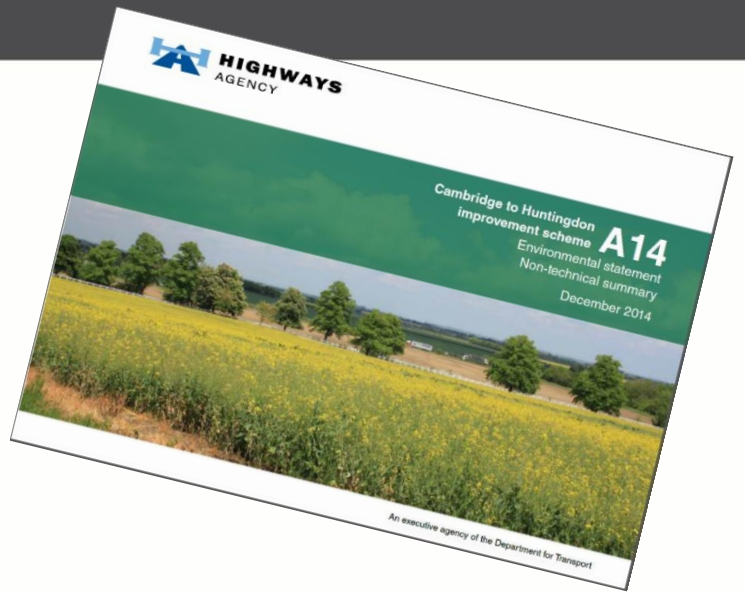
€1.7b project

67 new bridges
750m long viaduct



JV appointed Environment & Sustainability Director

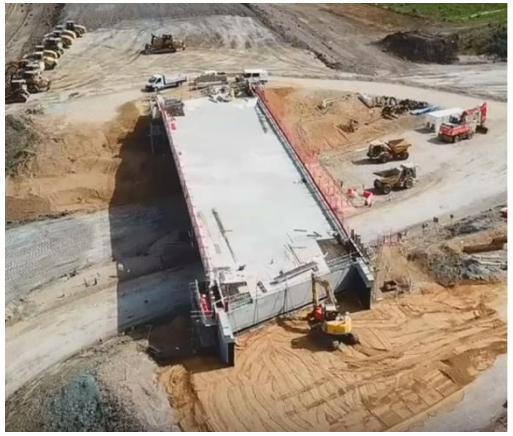
Environmental Impact statement



- Register of environmental actions and commitments
- Code of construction practice – transport impact etc

- Re use of existing soils
- 6 local borrow pits – sand gravel and clay
- Environmental mitigation features including Flood storage areas, earth mounds, Net gain biodiversity
- Environmental re-engineering to <u>save Carbon</u>
  - <u>Site target save 20% carbon every quarter above specification</u>

A14 Structural Drainage to Buried Structures



Abutments

Wing walls

Culverts

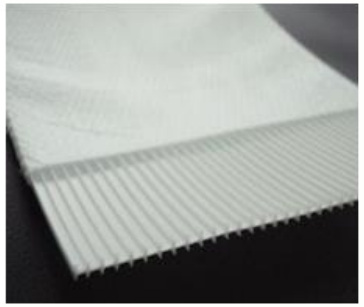
Retaining walls

Geocomposite drains

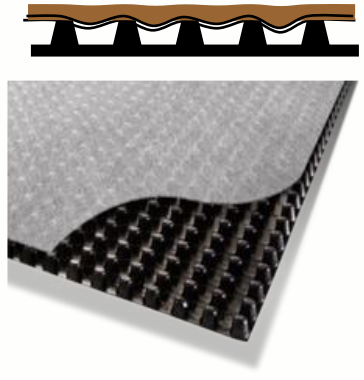
2D geonet

3D geonet

Fibre core

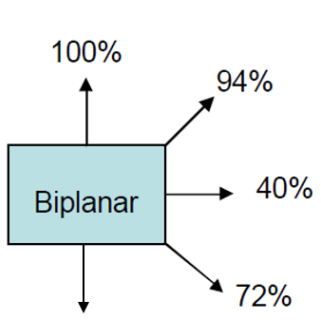


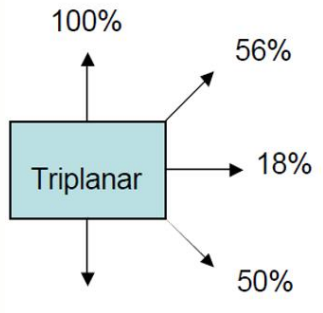
Ribbed core

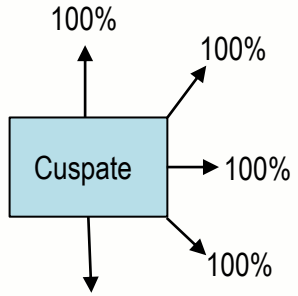


Cuspated core

“Wallpapering” preparation







Retaining wall
Drainage Options
- speed of flow

Specified alternatives

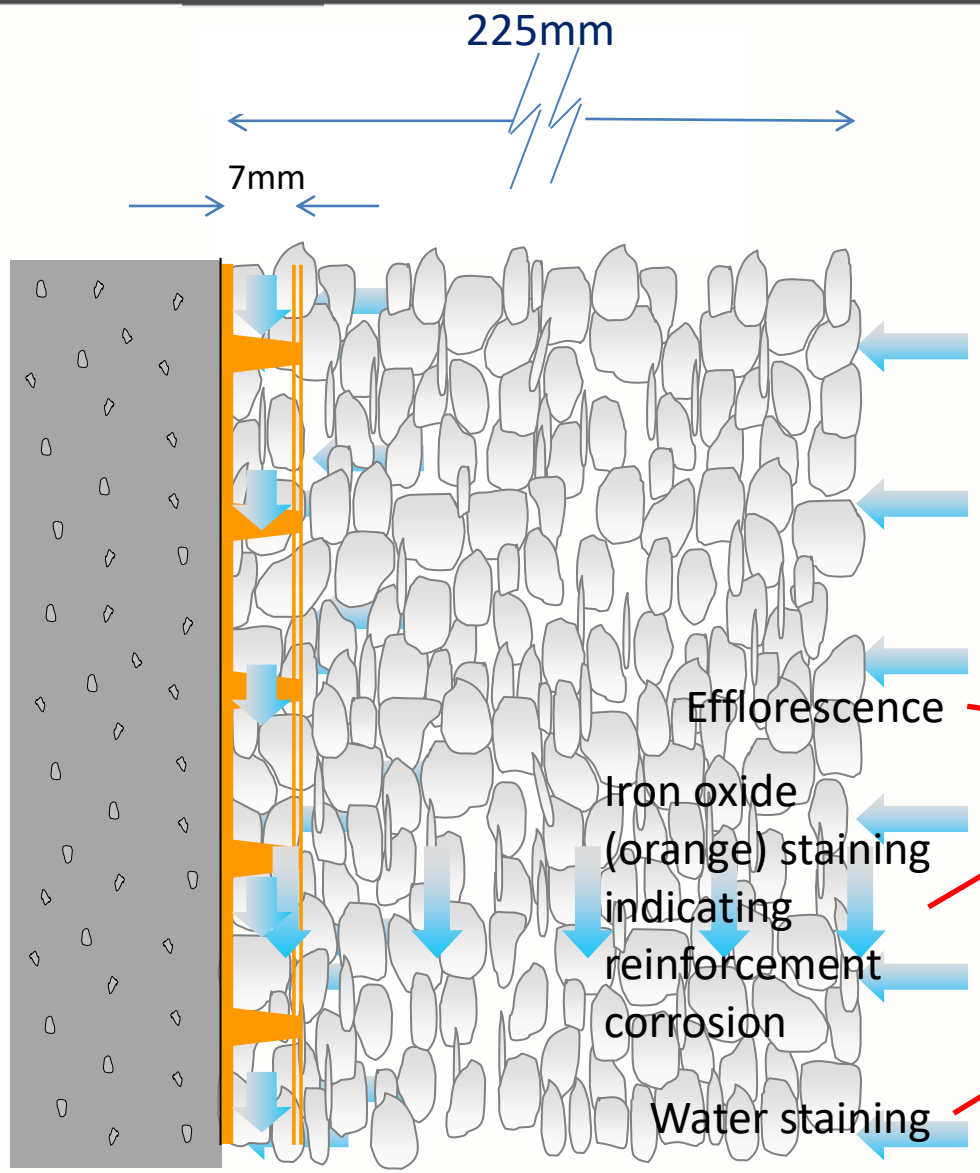
- No fines concrete or concrete block filled with stone (k = 1 x10^{-4} m/s)

  - *(Acts as own filter?)*

Proposed alternative

- Geocomposite (k = 2 x10^{-1}m/s)

  - *(Has integrated filter)*



- High compression loads
- Essential to have clear open water paths

Freeze/thaw leading to cracks

Specified - Back-of-wall Drainage

Porous CONCRETE Blocks filled with drainage gravel

Some problems…

- Heavy to transport to site
- Heavy to transport on site
- Take up space in tight working areas
- Installation inefficient
- Damage to waterproofing layer
- Breakage - waste

Environmental and Public Safety Impact

Quarrying concrete aggregate or drainage stone

Typical concrete block site

Delivering drainage blocks or stone

Disturbing the public

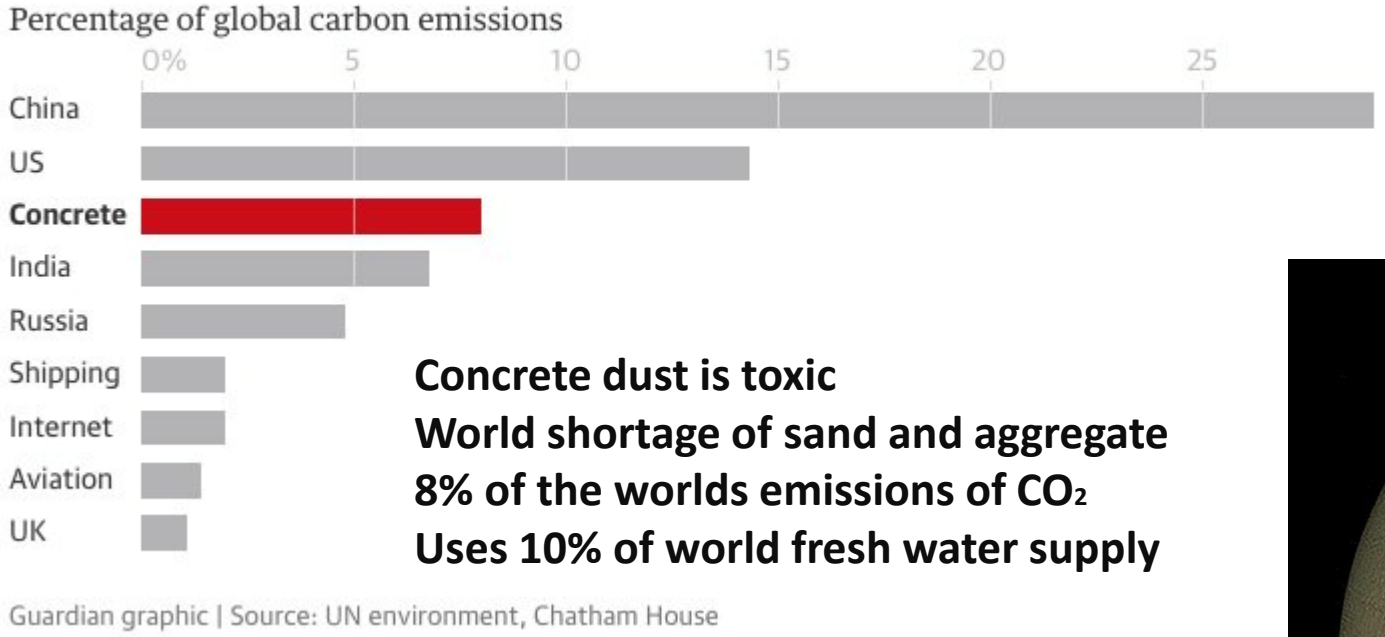
Damaging existing roads

Polluting the air

Concrete

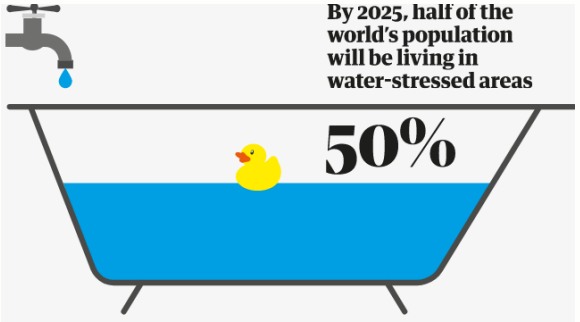
If concrete was a country it would be the third largest carbon emitter in the world

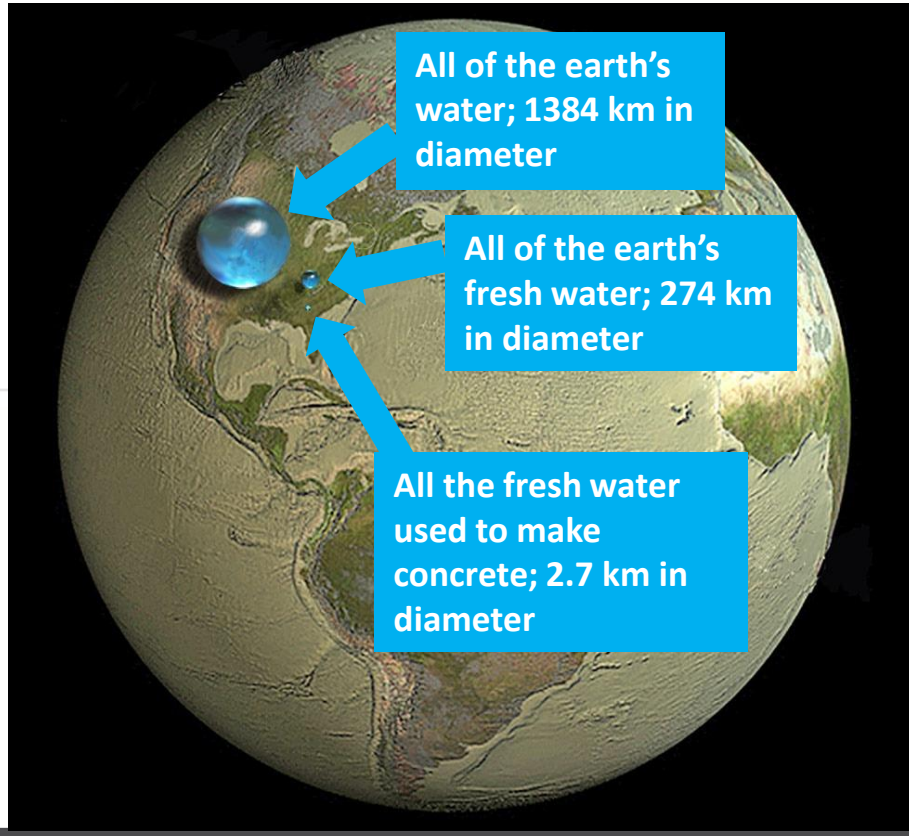
▲ Limestone quarries and cement factories are often sources of air pollution. Photograph: Zoonar GmbH/Alamy



Guardian graphic | Source: UN environment, Chatham House

Concrete dust is toxic
World shortage of sand and aggregate
8% of the worlds emissions of CO_2
Uses 10% of world fresh water supply





Guardian concrete week

Concrete: the most destructive material on Earth

After water, concrete is the most widely used substance on the planet. But its benefits mask enormous dangers to the planet, to human health - and to culture itself

World construction sand and aggregate shortage

110,000 metric tons of concrete.

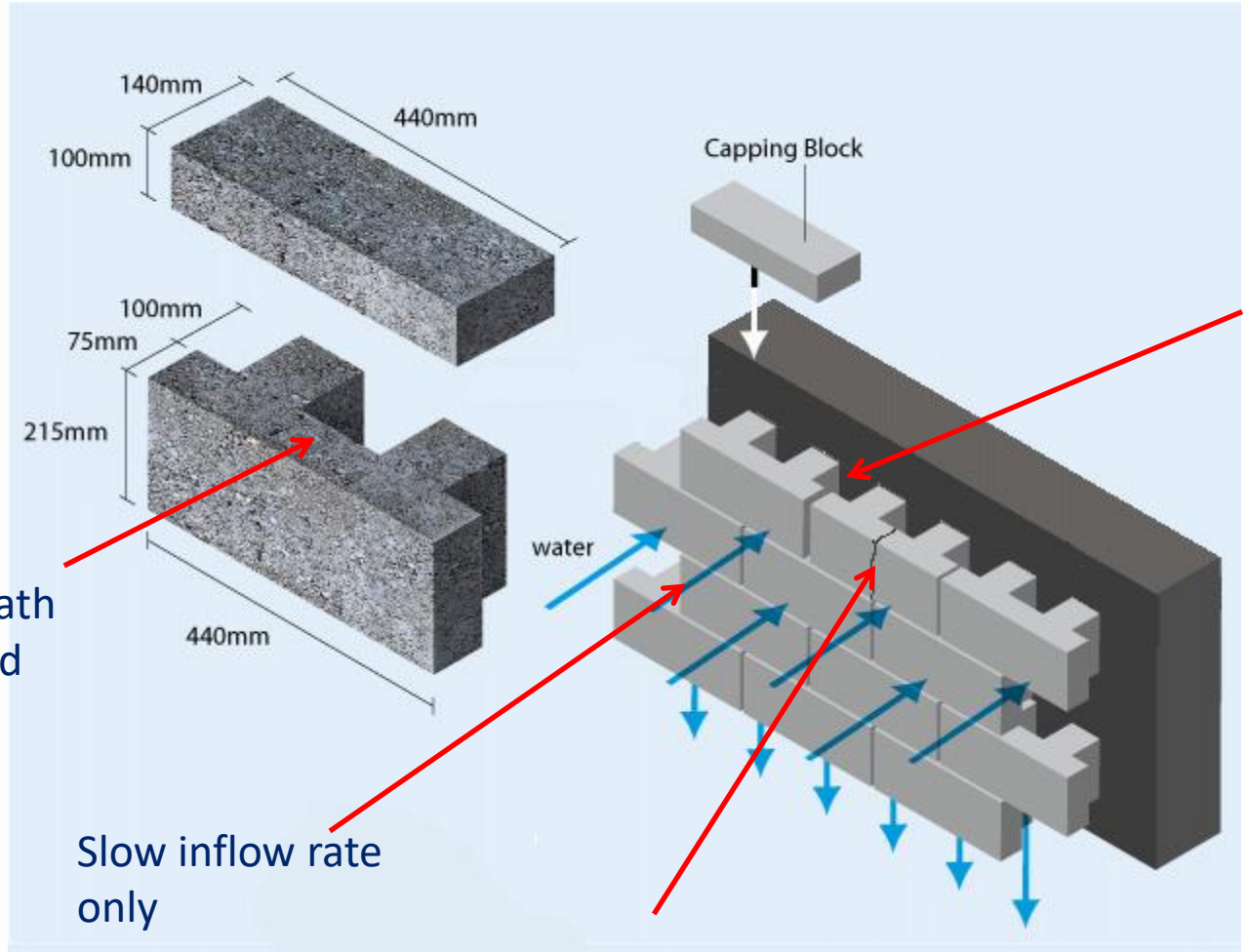
The sand complying with the specification of the project had to be transported from

… Australia!

Although Dubai is essentially covered by sand

– it does not have the correct properties for concrete

Function – hollow concrete blocks



Thick filter path easily clogged over time

Any gaps between blocks or capping act as an open drainage path for piping to occur causing loss of soils into the block cavity and pipe and clogging of drainage

Slow inflow rate only

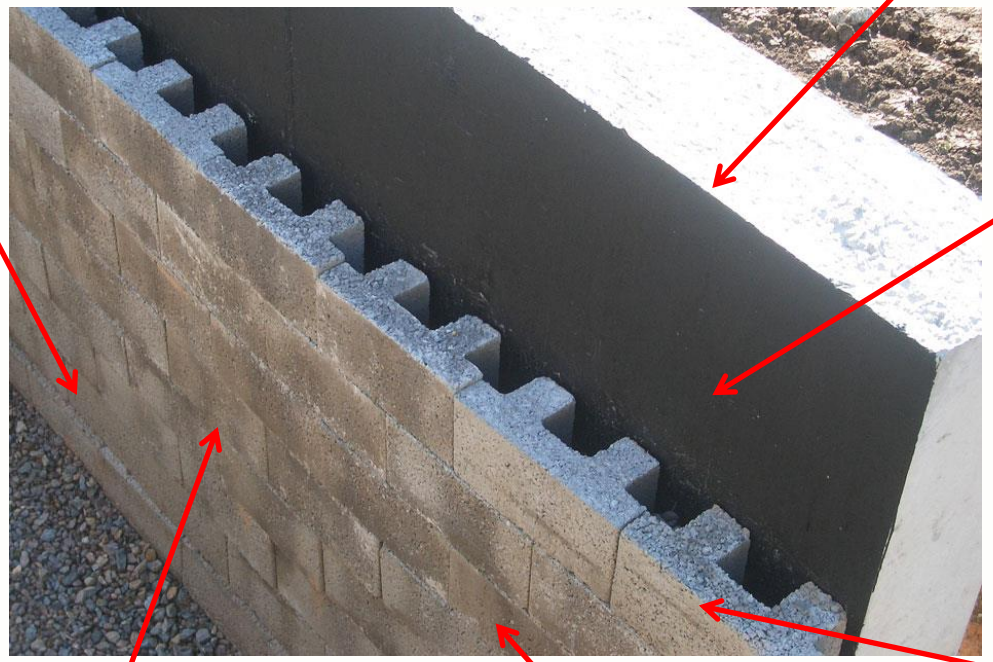
Spanning blocks vulnerable to cracking during backfill operation leading to loss of fines (also typical 5% wastage)

Safety and sustainability in placement

Hard to cut blocks to fit structure finished level

Slowly placed in advance interrupting backfill operation

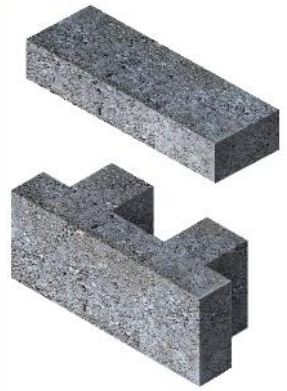
Damages waterproofing during installation and backfill operations



Easily broken during placement and backfill

Unstable and dangerous above a few blocks high

Fill with selected drainage stone Secondary operation



Block and cap

Difficult to shape and fix round abutment contours to maintaining flow path

Hard to work in tight spaces

Concrete **blocks filled with stone**

Factory controlled test
- No soil present
- No cracks in blocks

Can this be achieved on site?

INSTALLATION

- Offload at compound, reload to site transport, offload near structure
- Carry to structure by hand and stack to safe height
- Transport drainage stone to site, load to excavator
- Pour drainage stone into cavities in blocks
- Backfill first lift
- (*Repeat several times to top of wall*)
- Hand split blocks to fit round protrusions etc
- Clean up mess!!

Reduce on road and onsite activity

ARE THERE ANY TRAFFIC JAMS IN BELGIUM?!

60 of these…..

Blocks

Infill stone

= 1 of these

Drainage Geocomposite

BontexGeo
Leading in Geosynthetics

Installation speed and safe handling - Blocks

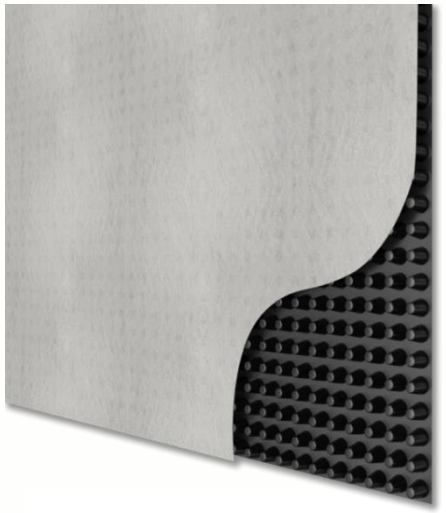
550 of these…..

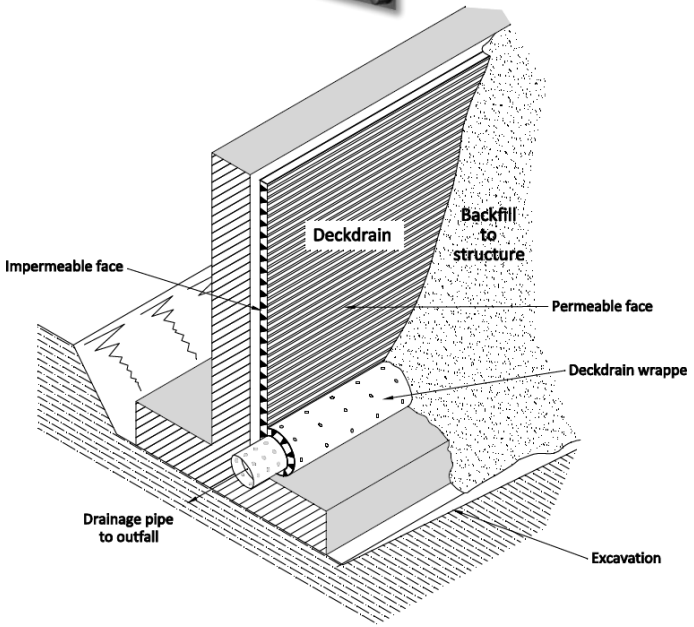
0.44 x 0.23
= 0.1m^2

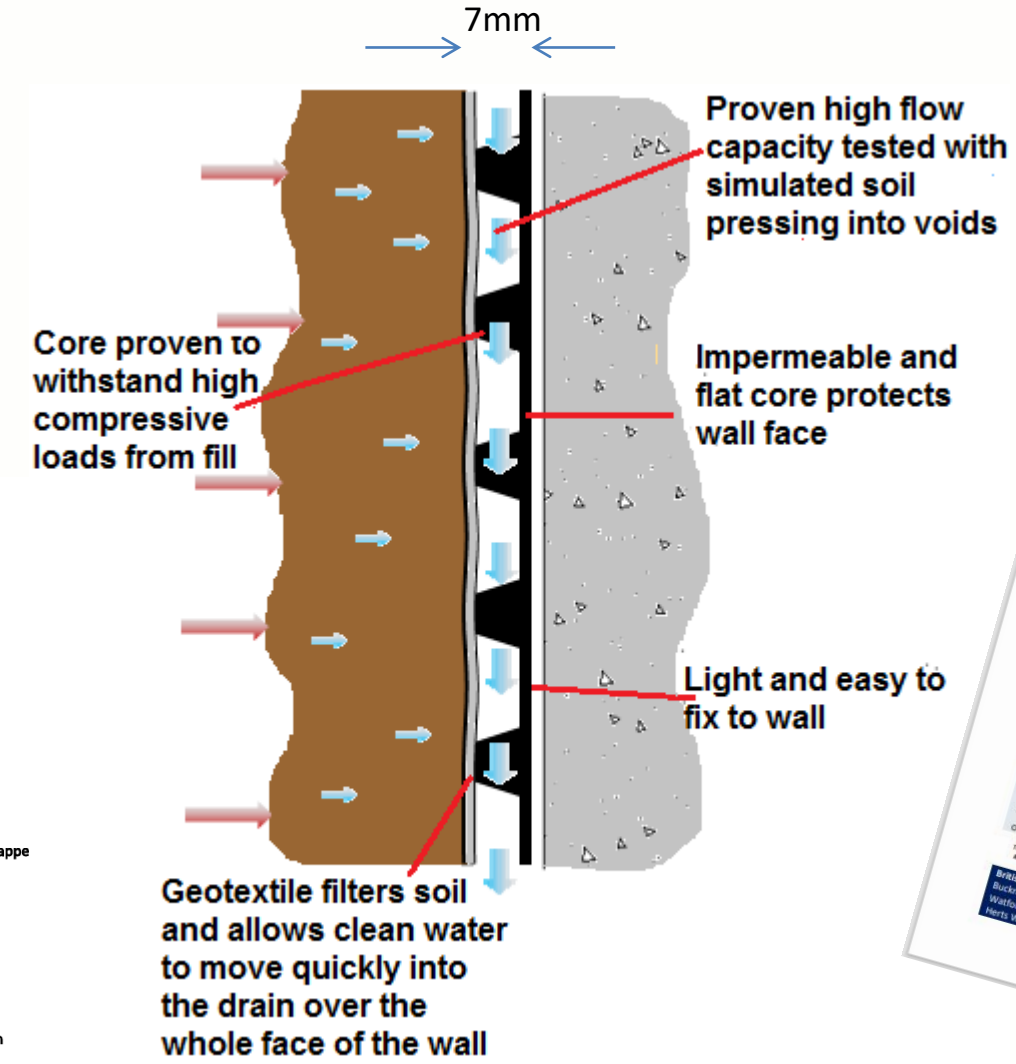
= 1 of these

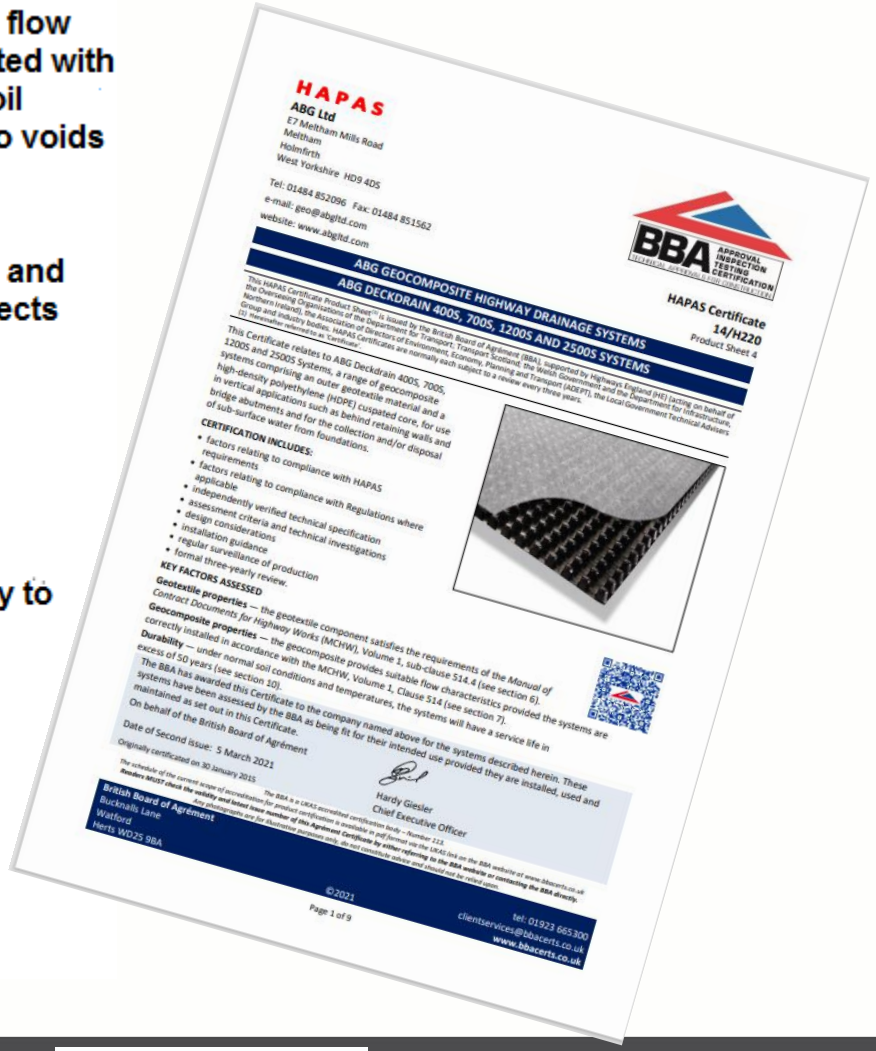
25m x 2.2m
= 55m^2

Function - Geocomposite **PLASTIC** Wall Drains








HAPAS

ABG Ltd
E7 Meltham Mills Road
Meltham
Holmfirth
West Yorkshire HD9 4DS

Tel: 01484 852096 Fax: 01484 851562
e-mail: geo@abgltd.com
website: www.abgltd.com

BBA APPROVAL INSPECTION TESTING CERTIFICATION

HAPAS Certificate 14/H220
Product Sheet 4

ABG GEOCOMPOSITE HIGHWAY DRAINAGE SYSTEMS

ABG DECKDRAIN 400S, 700S, 1200S AND 2500S SYSTEMS

This HAPAS Certificate Product Sheet[1] is issued by the British Board of Agrément (BBA), supported by Highways England (HE) (acting on behalf of the Chartered Organisations of the Department for Transport: Transport Scotland, the Welsh Government and the Department for Infrastructure, Northern Ireland), the Association of Directors of Environment, Economy, Planning and Transport (ADEPT), the Local Government Technical Advisers Group and industry bodies. HAPAS Certificates are normally each subject to a review every three years.
(1) Hereinafter referred to as 'Certificate'.

This Certificate relates to ABG Deckdrain 400S, 700S, 1200S and 2500S Systems, a range of geocomposite systems comprising an outer geotextile material and a high-density polyethylene (HDPE) cuspated core, for use in vertical applications such as behind retaining walls and bridge abutments and for the collection and/or disposal of sub-surface water from foundations.

CERTIFICATION INCLUDES:
- factors relating to compliance with HAPAS requirements
- factors relating to compliance with Regulations where applicable
- independently verified technical specification
- assessment criteria and technical investigations
- design considerations
- installation guidance
- regular surveillance of production
- formal three-yearly review.

KEY FACTORS ASSESSED

Geotextile properties — the geotextile component satisfies the requirements of the *Manual of Contract Documents for Highway Works* (MCHW), Volume 1, sub-clause 514.4 (see section 6).

Geocomposite properties — the geocomposite provides suitable flow characteristics provided the systems are correctly installed in accordance with the MCHW, Volume 1, Clause 514 (see section 7).

Durability — under normal soil conditions and temperatures, the systems will have a service life in excess of 50 years (see section 10).

The BBA has awarded this Certificate to the company named above for the systems described herein. These systems have been assessed by the BBA as being fit for their intended use provided they are installed, used and maintained as set out in this Certificate.

On behalf of the British Board of Agrément

Date of Second Issue: 5 March 2021

Originally certified on 30 January 2015

Hardy Giesler
Chief Executive Officer

The schedule of the current scope of accreditation for product certification is available in pdf format via the UKAS link on the BBA website at www.bbacerts.co.uk

Readers MUST check the validity and latest issue number of this Certificate by reference to the BBA website or contacting the BBA directly.

Any photographs are for illustrative purposes only, do not constitute advice and should not be relied upon.

British Board of Agrément
Bucknalls Lane
Watford
Herts WD25 9BA

©2021

Page 1 of 9

tel: 01923 665300
clientservices@bbacerts.co.uk
www.bbacerts.co.uk

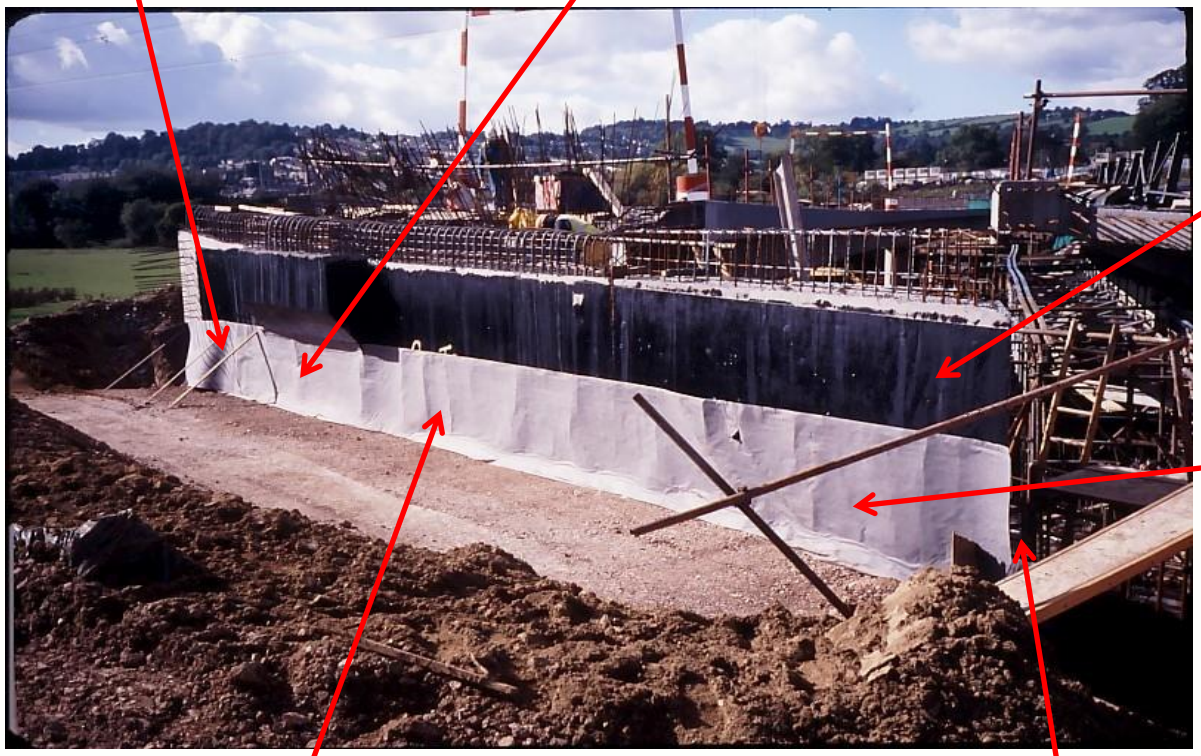
BontexGeo
Leading in Geosynthetics

www.abgltd.com

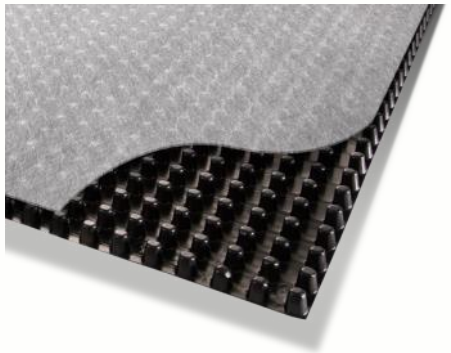
Drainage Geocomposite

Easily fixed to wall

Placed in advance enabling uninterrupted backfill operation



Protects waterproofing

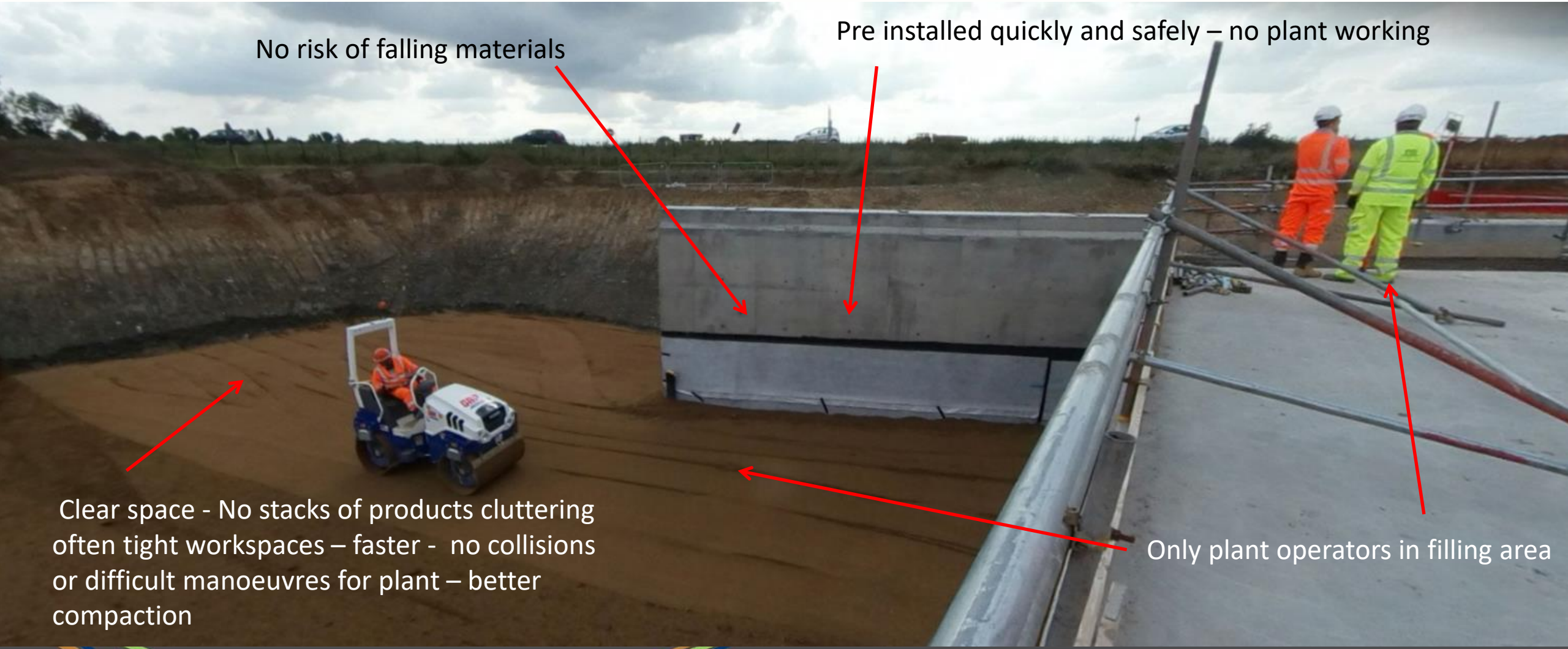


Drainage geocomposite

Easily shaped and jointed round abutment contours but maintaining flow path

Easy to work in tight spaces

Safety & reduced activity



Analysis of the carbon footprint of geosynthetics

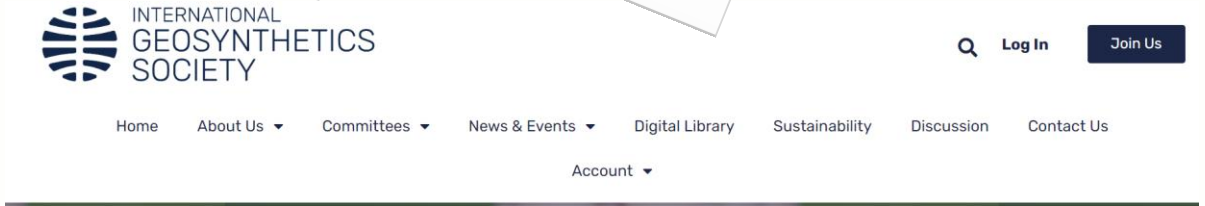
Analysis based on the Embedded Carbon Dioxide cradle to end of construction

B

C

A

D



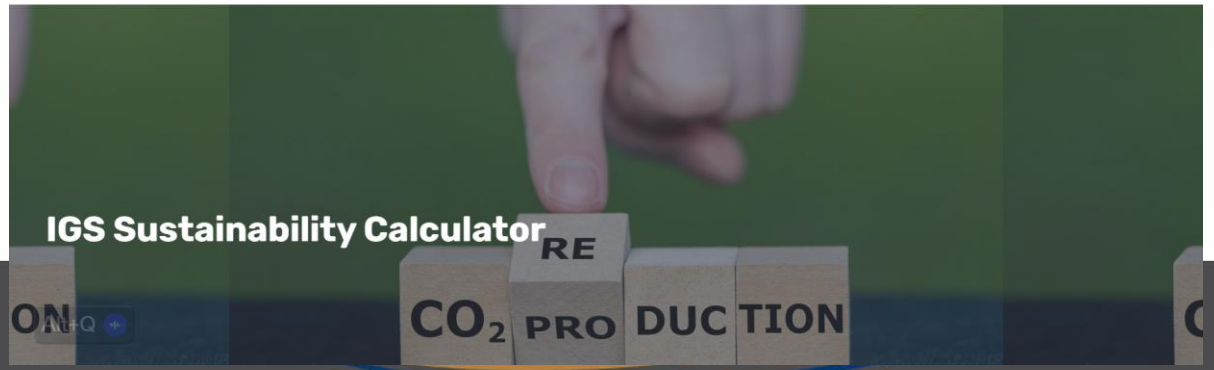


Figure 1. Life cycle boundaries employed in CO_2 analysis of geosynthetics

Output – comparison for one roll of geocomposite - per 55m²

Output		
Construction Stage	**ABG Deckdrain**	**Hollow concrete blocks and gravel**
Part A - Removal of waste material	-	-
Part B - ECO_2e of imported materials	148 kg	1,220 kg
Part C - CO_2e from transporting imported materials to site	2 kg	49 kg
Part D - CO_2e emissions during Construction	-	520 kg
Total CO_2e	**150 kg**	**1,789 kg**
Replacing the Hollow concrete blocks and gravel with an ABG Deckdrain results in CO2e emissions being reduced by:	**94%** ✓	

= 1 of these

550 of these.....

94% CO2e reduction ✓

Geocomposite v hollow concrete blocks

BontexGeo
Leading in Geosynthetics

www.abgltd.com

AWARD Winning

A14 Internal Site Sustainability Award Winner

A14 DECKDRAIN

A14 Deckdrain

ABG Geosynthetics

INNOVATION CASE STUDY

Back of wall drainage

by Stuart Wilson

Traditional back of wall drainage as per SHW clause 513 consists of either hollow concrete blocks filled with single sized stone or no fines concrete built above a perforated pipe. This allows any water that may build up behind a retaining wall or a bridge abutment to escape and release the hydrostatic pressure behind the earth retaining structure.

On the A14 we have looked to incorporate other proven methods that can offer the same performance, at the same time as offering further benefits in comparison to traditional methods. ABG Geosynthetics have worked with the A14 IDT to suggest one of their products that can offer this. Deckdrain is a high performance geocomposite which offers an environmentally friendly alternative to traditional structural drainage techniques that utilise aggregates.

After successful use of this product on previous delivery partner projects I contacted ABG Geosynthetics about using this product on the A14. Through ABG Geosynthetics and A14 IDT we could demonstrate that Deckdrain had suitable properties to be used as a back of wall drainage media.

After being accepted through the MAR process Deckdrain was on BN06 East Coast Mainline bridge. The construction of BN06 is key to allowing the new A14 to cross the East Coast mainline. Deckdrain was one of the design changes which helped reduce installation time which in turn assisted the site team to stick to a tight programme of works whilst installing the lightweight fill against the structure. As the lightweight fill is placed in 1m layers the Deckdrain dimensions of 1.1m (height of roll) added to the ease of installation.

The benefits are not just limited to a reduction in installation time they also include:

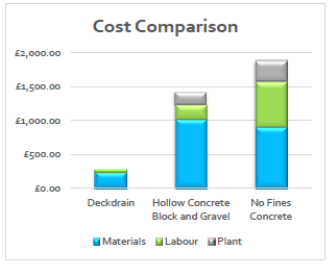
- Reduced material costs
- Reduced labour/plant costs
- More environmentally friendly product
- Lower potential for wastage
- Long life performance
- High flow capacity

The use of this product continues to be utilised more widely across the A14 and offering further savings on the original forecast.

This product keeps offering additional savings across the scheme, with each section collating the overall saving to post the final figure realized.

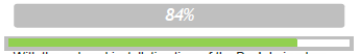
The next page shows the figures behind the benefits this product has had and can continue to bring to the A14 and future highways schemes.

A14 DECKDRAIN 2



Based on 55m² of back of wall drainage media Deckdrain works out to be much cheaper than traditional alternatives. The total cost of installing this amount of Deckdrain amounts to £235.60 as opposed to £1,423.51 for hollow concrete block and gravel, and £1,888.45 for no fines concrete.

Based on these figures, on BN06 where there was 1530m² of back of wall drainage media required, there was a saving of £33023.91 compared to hollow blocks and £45949.23 compared to no fines concrete.

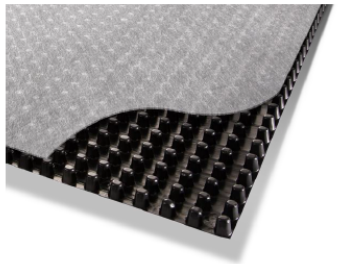


With the reduced installation time of the Deckdrain when compared to hollow block there was an 84% saving in time of installing and there would have been a 92% saving of time in comparison to no fines concrete.

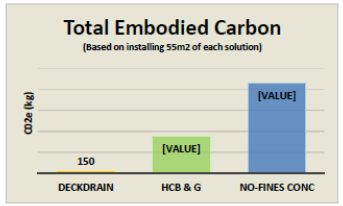
ZERO EMISSIONS

As Deckdrain is a product laid by hand, during the backfilling process, there is a zero requirement for plant during installation. By not involving any plant to install, Deckdrain is a product that can boast zero emissions produced during installation in comparison to traditional back of wall drainage materials.

Over the course of the project, the A14 any reduction we can achieve in lowering plant emissions can help to reduce the projects carbon footprint, whilst also eliminating the risk to the environment from any potential spills.



The exact amounts of embodied carbon for the various solutions are as follows:



Based on these figures there is a huge reduction in embodied carbon across BN06. The embodied carbon (C02e) realised through installing Deckdrain amounted to 4.17T which compares to 49.7T if hollow block had been used and 119.8T if no fines concrete had been used.

In conclusion Deckdrain has proved to be a sustainable solution that offers huge benefits to the traditional methods of back of wall drainage. It is the best choice from a commercial, environmental and health and safety point of view, whilst achieving the same design requirements. Based on this evidence deckdrain is the obvious choice for all back of wall drainage solutions going forward.

During construction phase

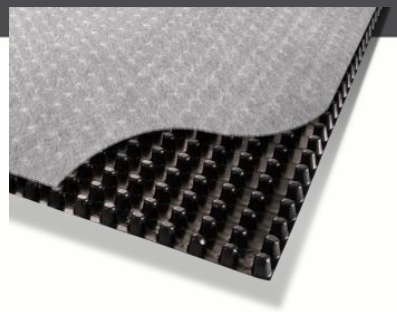
Ground Engineering Sustainability Awards Finalist with A14 team for ABG Deckdrain

GROUND ENGINEERING AWARDS 2019 FINALIST

BontexGeo Leading in Geosynthetics

www.abgltd.com

Geocomposite Summary



- Certified design life (……*blocks????*)
- Rapid installation (1.1 or 2.2m wide rolls) = reduced time and environmental impact
- No need for mechanical handling equipment = fuel savings ("zero emissions" on site)

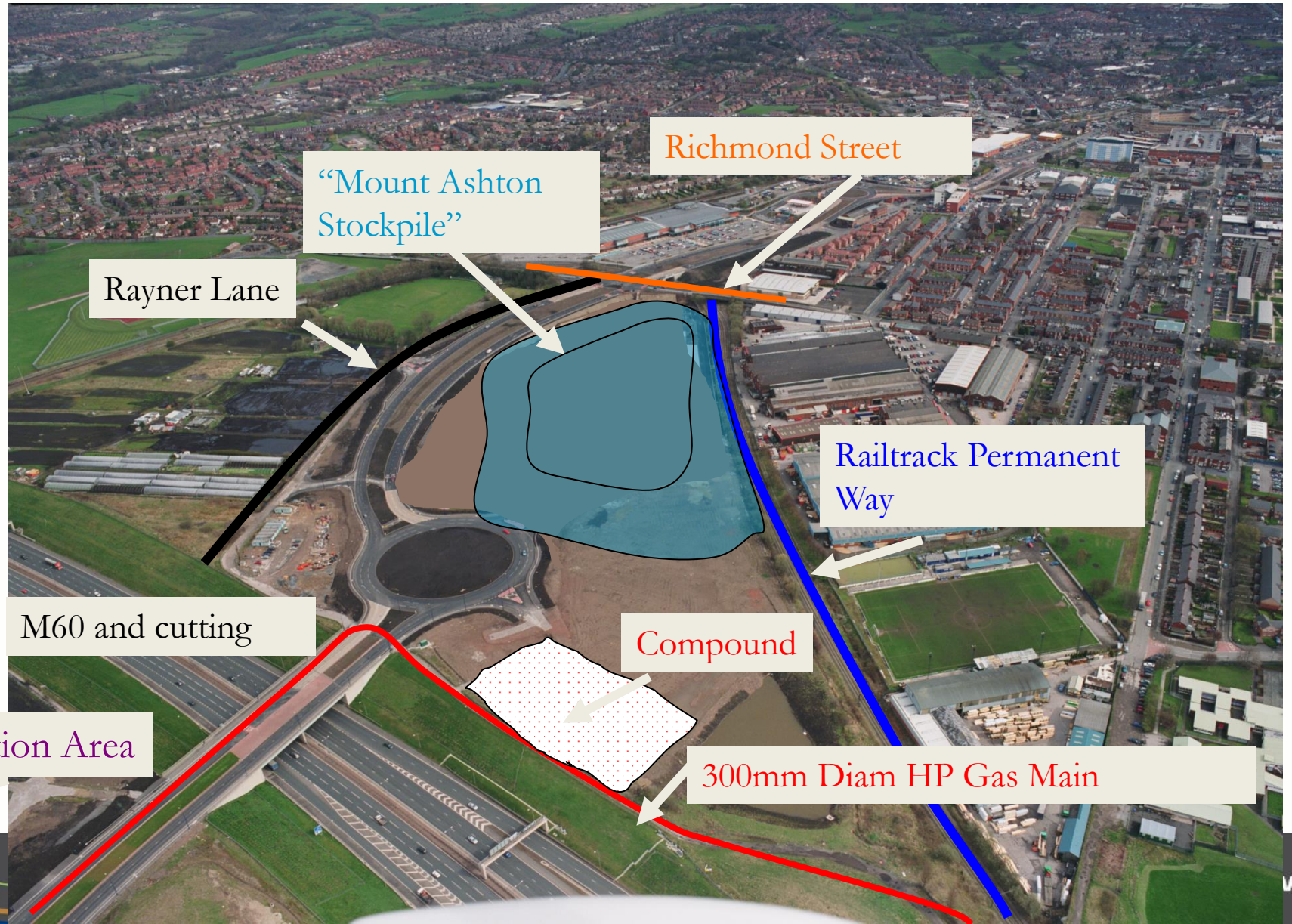
50% cost saving

- Protection to waterproofing = longer life span = lower maintenance
- High crush strength up to 500kPa = less likely to damage = longer lifespan
- No clogging – open hydraulic shapes – self cleansing = longer lifespan = lower maintenance
- Reuse of site fills at back of wall 225mm (blocks) – 7mm (geocomposite) = 0.218 m^3/sqm (typically 50m^3 per structure) = saving removal of spoil from site (*Part A - not accounted for in calculation*)
- Meets and far exceeds UK Government targets against traditional methods ESPECIALLY "Lower emissions" (94% saving!) AND reduced site activity goal

A14 Environmental goals achieved in 2018

- Target of reducing carbon by 20% achieved every quarter
- Achieved reduction imported soils and fills by 50% by using local borrow pits on site
- Interim assessment award 'Excellent' for CEEQUAL/BREEAM (independent environmental assessment)
- Internal sustainability award won by Stuart Wilson for introducing geocomposite to the site – motivational award for young engineer in favour of geosynthetics
- Used 10,560sqm of Geocomposite = 326tonnes CO_{2e} saved against specified concrete blocks
- 80% wall drainage construction time saved reducing disruption time contributing to 10% saved time overall on earthworks programme
- A14 opened December 2019 - 1 year ahead of schedule

CASE STUDY: Ashton Moss Development , Manchester, UK



CONTRACTUAL SITUATION

- Excavate peat and soft materials and replace with fill to provide development platforms and road construction

AND

- Contractor had a previous contract to excavate and fill the site – partially completed!
- Change of ownership led to termination of the previous contract and re-tendering as an ICE D&C with a very different controls
- Contractor did not realise the large jump in requirements of new Contract
- ABG were asked to join at last moment advising contractor in design

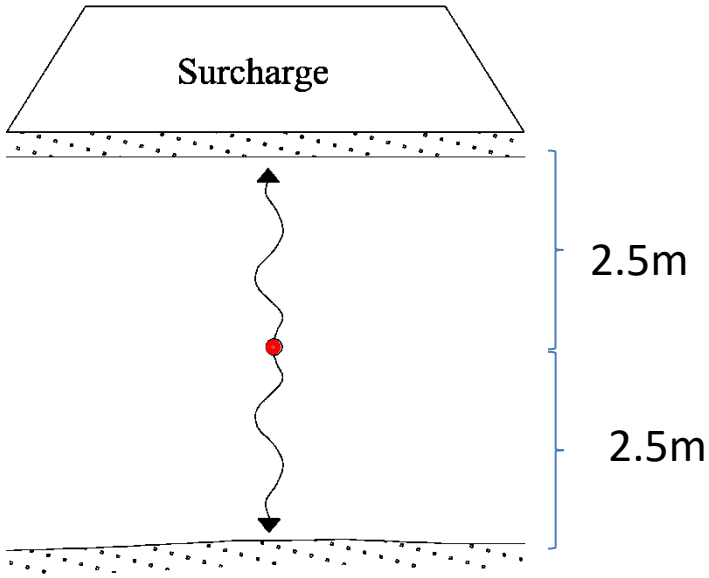
EMPLOYER'S ACCEPTANCE CRITERIA

Design and construct earthworks … so as to provide a finished formation which <u>within six months</u> after completion of filling shall support ground bearing floor slabs with individual gross floor areas of up to 15,000m2 with…

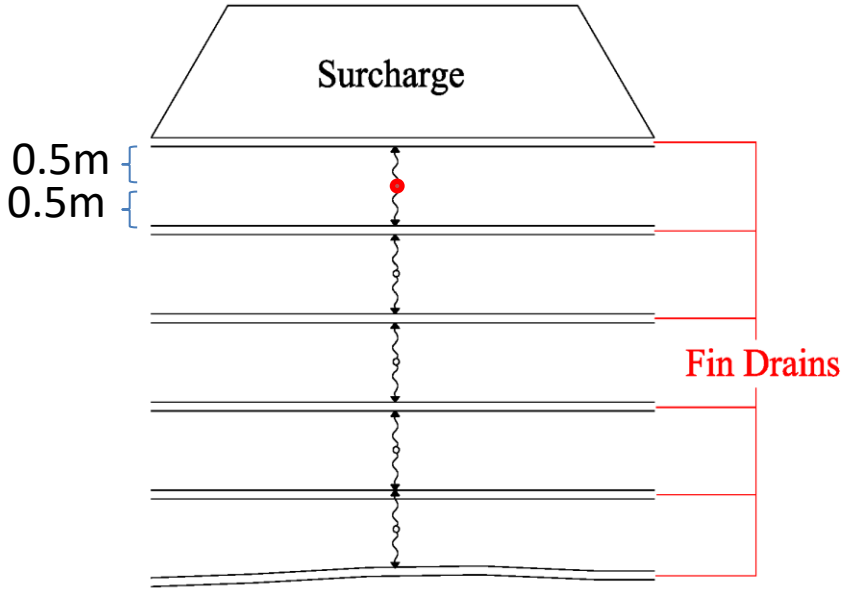
- … a maximum ground loading intensity of **27kPa**,
- … **limit the total settlement of the floor slabs to a max. of 25mm** at end of six months after completion of their construction
- … and shall **limit further settlement to 10mm** after a further six month period.
- Maximum slab differential settlement shall not exceed **1 in 700**.

SHORTENING FLOW PATH/SETTLEMENT PERIOD – THE THEORY

Time (t) for consolidation is related to the square of the length of the drainage path (h)



Say 5m thick layer
– drainage path h = 2.5m
$h^2 = 6.25$



1m thick layers
– drainage path h = 0.5m
$h^2 = 0.25$

Time for consolidation is $1/25^{th}$ of that for the above.

THE WAY FORWARD

Considerations – Chosen method would have to:

- Cope with using wet fill
- Allow construction through all weathers (winter working)
- Minimise the use of surcharge
- Provide confidence of compliance with performance specification
- Meet the deadline!

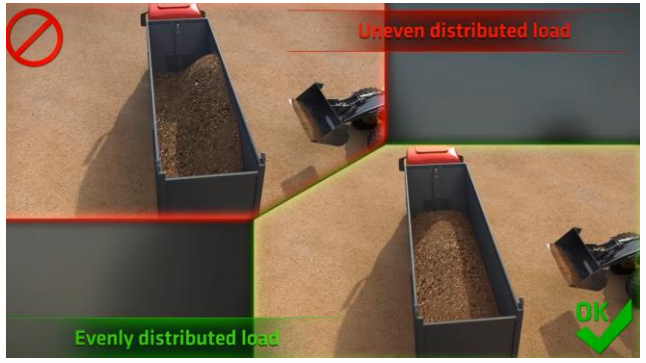
CHOICE OF GEOSYNTHETIC

- Significantly cheaper than two layers of geotextile and 100mm gravel
- Fast to lay – area can be covered in a couple of hours as filling commences – minimum plant , manpower and delay
- ABG Fildrain ideal it provided high flow capacity – FoS >50
- Double sided – water collection from both sides

Cross Section of ABG Fildrain – double cuspated 7mm thick

Safety in delivery of aggregates

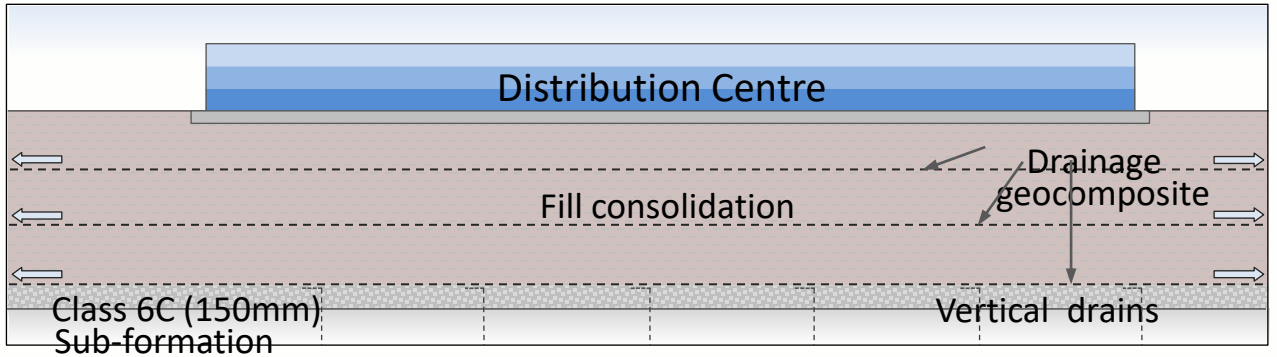
- Road tyre footprint often unsuitable on soft soils
- Some sites implementing a 3degree crossfall limit for tipping
- Limitations on height with overhead power cables or low structures
- Bearing capacity of soil needs to be high for road tippers can vary in poor weather conditions
- Loads can be uneven in truck
- Loads can become wedged in the truck
- Loads can separate and become uneven
- Tracking on poor strength stone can crush it
  - Small quantity of fines can reduce
- Wheel washing before return to highway

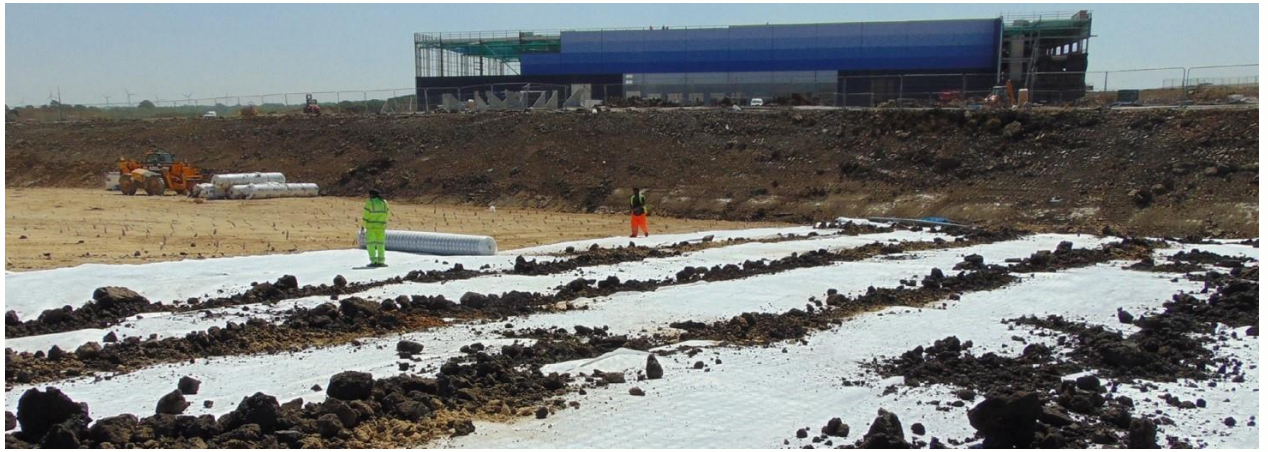


THE FINISHED PROJECT – on time!

Case Study : Consolidation (2)– Carbon saving

- Geocomposite replaced 150 mm stone drainage layers
- 31 deliveries of geosynthetic
- Replaced 8,000 aggregate deliveries
- Total savings: 2,998 tonnes of embedded carbon – cradle to end of construction





86% CO_2e reduction
Geocomposite v drainage aggregate

CONCLUSIONS – ABG Fildrain for consolidation

- ABG Fildrain maximises the use of unsuitable material especially in wet weather.
- ABG Fildrain for horizontal drainage is very effective – reduced time taken by 70%
- ABG Fildrain is fast to deploy with minimal manpower and delay to other operations (60% faster)
- Avoids unsafe and damaging aggregate trucks on site
- Saves 70-90% saving in carbon usage

60% cost saving

- **Avoid using CONCRETE, STONE, SAND AND WATER wherever possible!!!**

- **GEOSYNTHETICS use in average 50% less carbon at 50% of the cost**

abg | creative geosynthetic engineering

Thank you for listening!!

Contact

David Shercliff BSc CEng MICE CMIWM

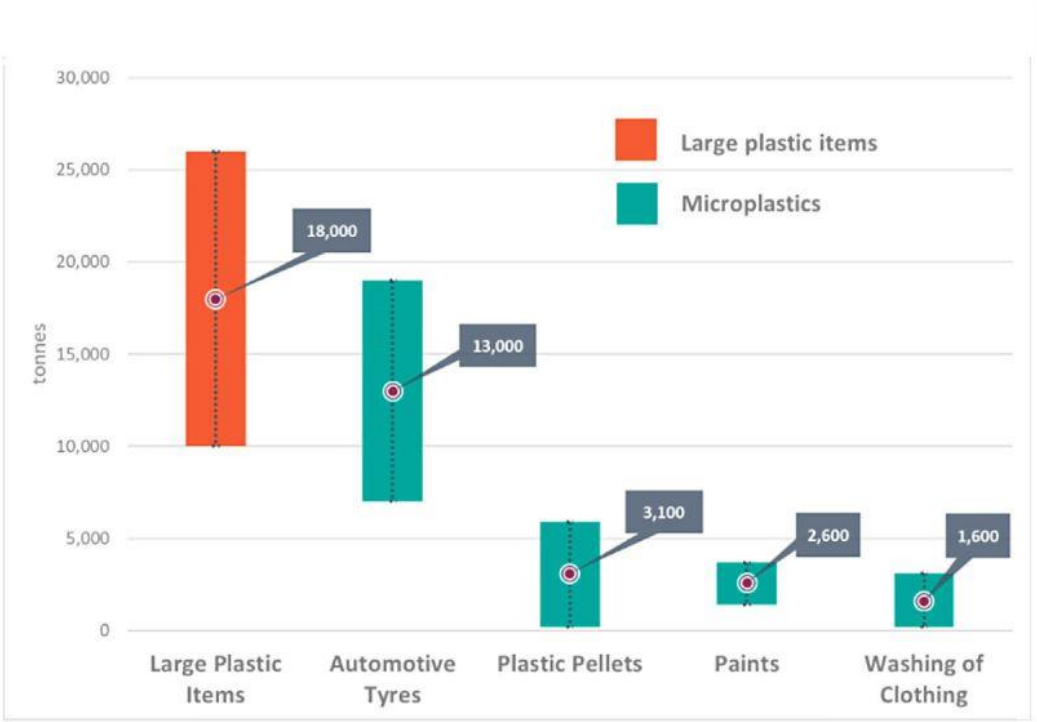
Chief Engineer

david@abgltd.com

01484 354811

Annual amount of UK microplastics entering surface water after wear or accidental loss

- 500,000tonnes/yr tyre wear fragments – Europe
- 68,000tonnes/yr – UK
- 19,000tonnes/yr – UK – entering waterways
- Carbon black – carcinogen - non biodegradable
- Tyres – only 20% rubber rest synthetics of different types



How government can cut tyre pollution

Test and label tyres; Introduce a tyre levy; Capture tyre pollution from roads; Increase road cleaning;

encourage less driving! – (*use geosynthetics!!!)*

Friends of the Earth

DRAINAGE GEOCOMPOSITES:

APPLICATION DESIGN AND ENVIRONMENTAL ASPECTS

Date November 21, 2023

Speaker: Francesco Masola

MACCAFERRI

Texion

MACCAFERRI

My name is Francesco Masola,
I come from Italy and
I have worked in MACCAFERRI since 2015.
I am based in Berlin (Germany) as
Technical Manager for Scandinavia, BeNeLux,
Germany, and Austria

E-mail: **f.masola@maccaferri.com**

Texion


MACCAFERRI
Water management is crucial for the **long-term performance** of structures.
Texion

MACCAFERRI

Sand and gravel have been utilized as **drainage solutions** throughout History.

Texion


MACCAFERRI
How can **designers** achieve **efficiency without compromising affordability, sustainability**, and other critical factors?
Texion

Maccaferri has the **solution**

MACCAFERRI

Texion®

MacDrain™

EFFECTIVE WATER MANAGEMENT

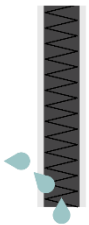
DRAINAGE GEOCOMPOSITE

Definition & Functions

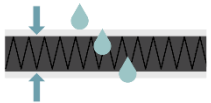
Maccaferri draining geocomposites are called **MacDrain**.

MacDrain geocomposites are made from a polymeric drainage core thermally bonded to a geotextile on one or both sides or to a waterproofing layer on one side. They provide several **main functions**:

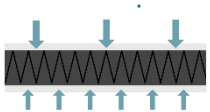
Drainage



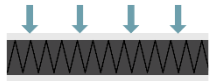
Filtration



Separation



Protection



MacDrain geocomposites can fulfill additional functions based on project requirements and specific site conditions.

FOCUS ON MACDRAIN W

MacDrain W

The core structure is flexible, with thickness ranging from 4 to 10 mm, a very high void ratio, and medium-high compressive resistance; due to the channel pattern, the flow capacity is much higher in the longitudinal direction than in the transversal direction.

NON-WOVEN GEOTEXTILE FILTER

GEOMAT WITH W-SHAPED

OUR PRODUCT

MACCAFERRI

MacDrain

FILTER - Water and gas can pass through it - Soil is retained

DRAINAGE CORE - It drains water and gas

Texion

ADVANTAGES

- QUALITY ASSURED
- QUICK AND FAST INSTALLATION
- LONG TERM COMPRESSIVE CREEP
- COST SAVING
- ENVIRONMENTAL FRIENDLY

MacDrain

ADVANTAGES

Quality assured

QUALITY ASSURED

MacDrain W is designed to be highly durable, with a range of chemical and UV-resistant materials that ensure long-term performance and protection. The product is subject to continuous quality control and testing.

MacDrain

ADVANTAGES

Quality Assured

ASTM D4716/D4716M-22

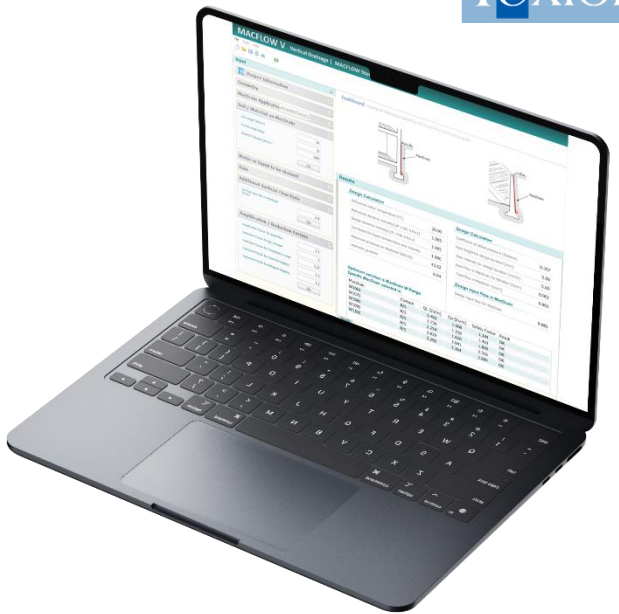
Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head

ASTM D7931/D7931M-21a

Standard Guide for Specifying Drainage Geocomposites

ISO/TR 18228-4

Design using geosynthetics - Part 4: Drainage



ADVANTAGES

Quality Assured

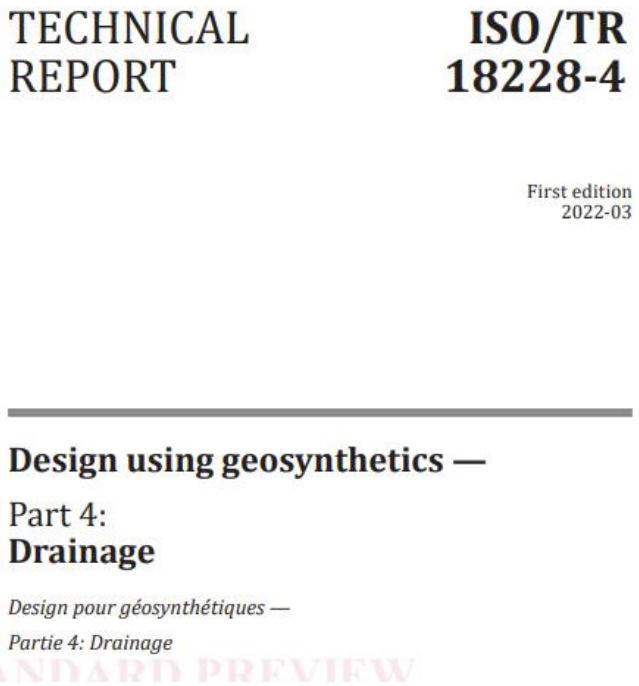
ISO/TR 18228-4 –
Published in March 2022

Main points about the new ISO/TR 18228-4:

- Calculation of the input flow rate

- Design procedure for drainage geocomposites considering the long-term conditions (e.g. applications of reduction factors)

- Equivalence with a granular drainage layer


TECHNICAL REPORT

ISO/TR 18228-4

First edition
2022-03

Design using geosynthetics —

Part 4:
Drainage

Design pour géosynthétiques —

Partie 4: Drainage

ADVANTAGES

Quality Assured

ISO/TR 18228-4 – Published in March 2022

For all applications, the available flow rate of the geocomposites shall be obtained by applying a set of Reduction Factors (Cancelli & Rimoldi, 1989; Koerner, 1994) which take into account all the phenomena that may decrease the flow rate over the entire design life compared to the short term flow rate measured in the tests according to EN ISO 12958:2010 or ASTM D4716 - 08(2013) standard:

$$Q_a = \frac{Q_L}{RF_{in} \cdot RF_{cr} \cdot Rf_{cc} \cdot RF_{bc}}$$

where:

Qa = available long term flow rate for the geocomposite;
QL = short term flow rate obtained from laboratory tests;
RFin = Reduction Factor for the intrusion of filter geotextiles into the draining core;
RFcr = Reduction Factor for the compressive creep of the geocomposite;
RFcc = Reduction Factor for chemical clogging of the draining core
RFbc = Reduction Factor for biological clogging of the draining core

Once the design input flow Q_D has been calculated, the available input flow Q_a shall be calculated for one or more geocomposites. The final Factor of Safety FS_G afforded by the design with each geocomposite is given by:

$$\mathbf{FS_G = Q_a / Q_D}$$

Only those geocomposites for which $FS_G \geq 1.00$ are suitable for the project.

ADVANTAGES

Quality Assured

ISO/TR 18228-4 –
Published in March 2022

The Reduction Factors shall be set considering the specific conditions of each project, taking into consideration the experience and/or research on similar conditions of use.

Table 15 - Suggested range of values for the different RFs

Term	Description	Suggested range for MacDrain® geocomposites
RF_{in}	Reduction Factor for intrusion of the filter geotextiles into the draining core	1.0 – 1.5
RF_{cr}	Reduction Factor for thickness change due to compressive creep of the core	1.2 – 1.5
RF_{cc}	Reduction Factor for pore/volume reduction due to chemical clogging **	1.0 – 1.3
RF_{bc}	Reduction Factor for pore/volume reduction due to biological clogging**	1.0 – 1.3
Π RF	**Product of all Reduction Factors for the site-specific conditions**	**1.20 – 4.0**

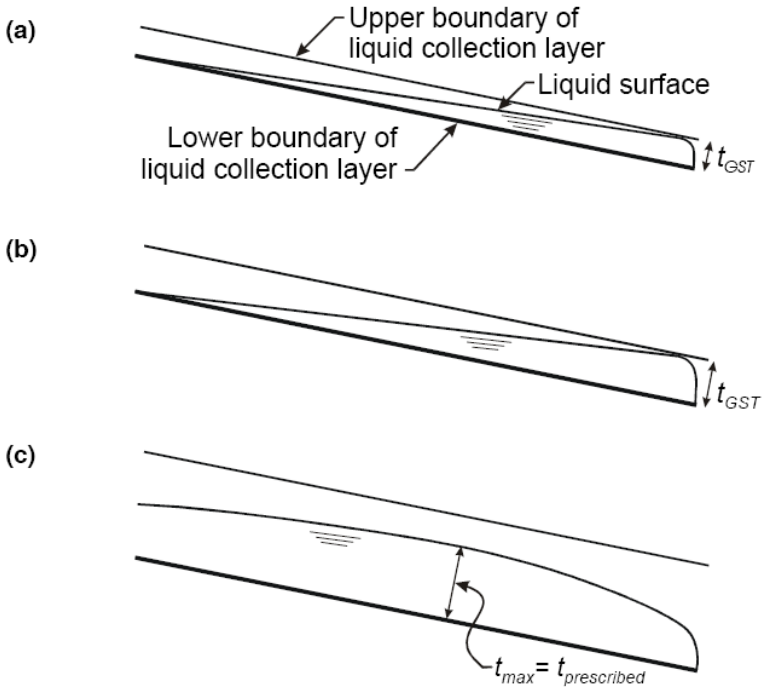
* values can change according to the type of the core and also according to the type of filtering geotextile used

** values are related to the type of liquid / fluid to be drained and to its nature (clean water, polluted water, leachate, etc)

ADVANTAGES

Quality Assured

ISO/TR 18228-4 – Published in March 2022



Schematic representation of the shape of the liquid surface in liquid collection layers:

(a) case of a geosynthetic liquid collection layer at full capacity with unconfined flow;

(b) case of a thicker geosynthetic liquid collection layer, also at full capacity with unconfined flow;

(c) case of a granular liquid collection layer with the maximum liquid thickness equal to the prescribed liquid thickness.

ADVANTAGES

Quality Assured

ISO/TR 18228-4 –
Published in March 2022

Chapter: 12.5.2 Equivalence for water flow on slopes

It is important to consider that, when comparing the drainage capacity of geosynthetic drains with those of granular drainage materials, ***the comparison should be made on the same base: since the flow rate of geocomposites is evaluated at the end of their design life, even the permeability of the drainage aggregate should be evaluated in situ at the end of its design life***, not as a laboratory value on fresh, clean material placed under ideal conditions.

As shown by Giroud et al (2000), based on preceding work by Giroud et al. (1992) and Giroud and Houlihan (1995), in unconfined flow conditions, the maximum thickness of liquid in a granular soil layer, hmax (m), is given by the following formula:

$$h_{max} = j \frac{\sqrt{\tan^2 \beta + 4 q_h / K_{lt}} - \tan \beta}{2 \cos \beta} L_h$$

ADVANTAGES

MACCAFERRI

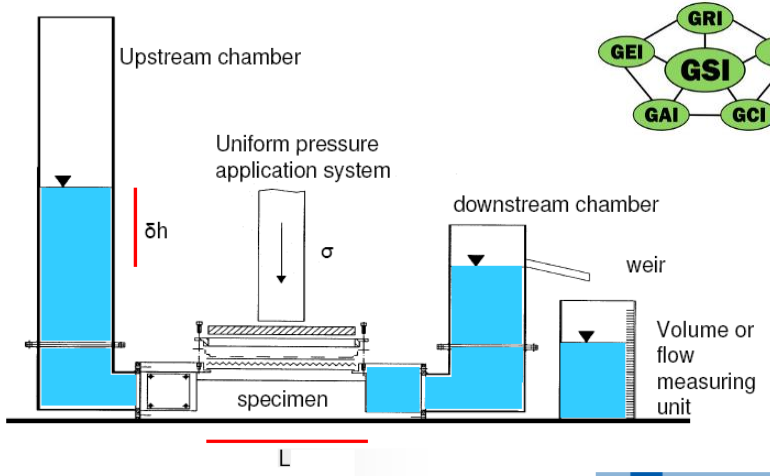
Quality Assured - ASTM D4716

ASTM INTERNATIONAL

Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head

SCOPE

Determine the **flow rate per unit width** within the manufactured plane of geosynthetics under **varying perpendicular compressive stresses and a constant head.**



Texion

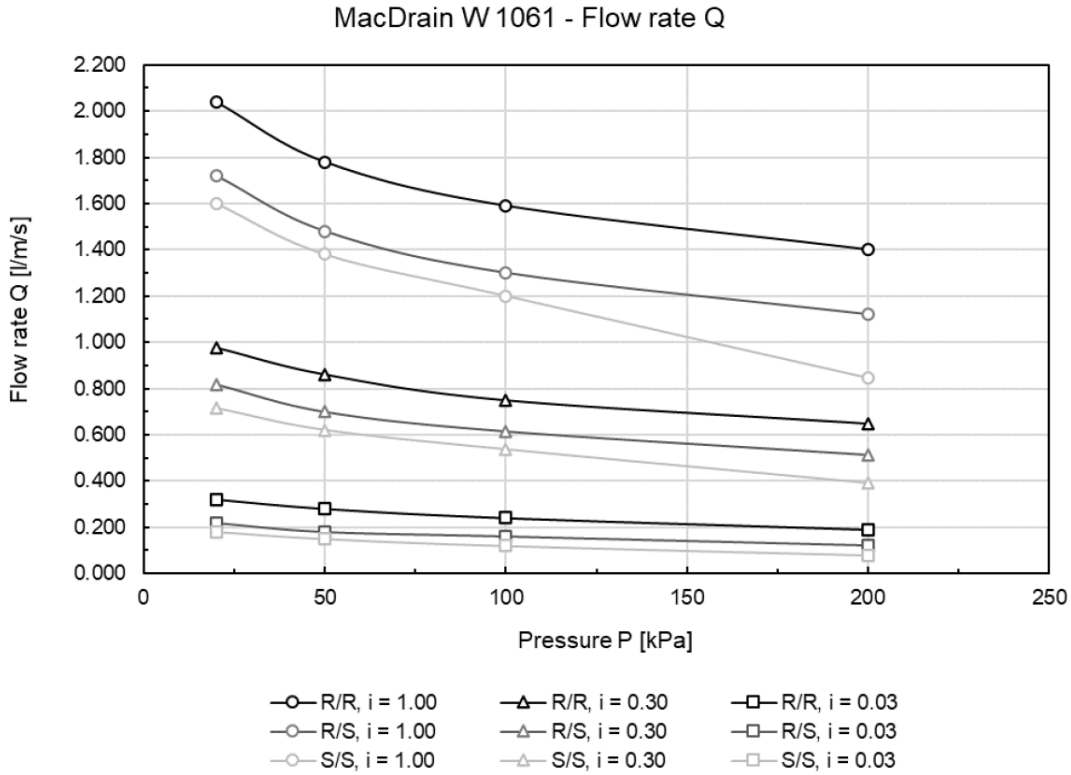
ADVANTAGES

MACCAFERRI

Quality Assured

ASTM D4716/D4716M-22

Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head



Texion

ADVANTAGES

Quick and fast installation

QUICK AND FAST INSTALLATION

The product is also quick and easy to install, with a range of connection and anchoring systems that enable quick and efficient implementation, ensuring that it meets or exceeds the required performance.

MacDrain

ADVANTAGES

Quick and fast installation

Quick and **easy** unrolling system

ADVANTAGES

Quick and fast installation

For a number of **different applications**

ADVANTAGES

Long term compressive creep

LONG TERM COMPRESSIVE CREEP

One of the main advantages of MacDrain W is its compressive strength. It provides significant drainage characteristics with high resistance to compressive loads, minimizing compressive creep.

MacDrain

ADVANTAGES

Long term compressive creep

ASTM D7406-20

Standard Test Method for Time Dependent (Creep) Deformation Under constant Pressure for Geosynthetics Drainage Products.

ASTM D 7361-07

Standard Test Method for Accelerated Compressive Creep of Geosynthetic Materials Based on Time-Temperature Superposition Using the Stepped Isothermal Method

ISO 25619-1

Geosynthetics — Determination of compression behaviour — Part 1: Compressive creep properties

LONG TERM TESTED COMPRESSIVE CREEP

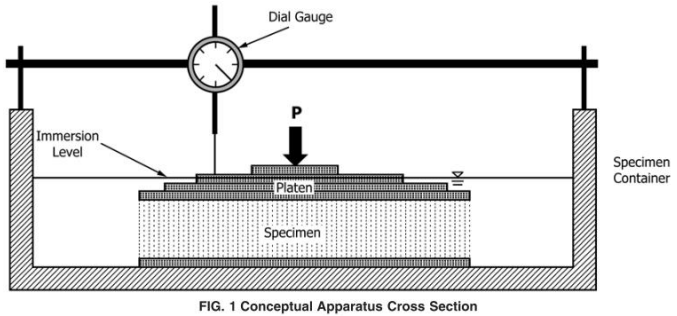


FIG. 1 Conceptual Apparatus Cross Section

ADVANTAGES

Cost saving

COST SAVING

The use of MacDrain instead of a traditional solution with mineral fills (gravels, sand) results in significant cost reductions, such as material cost, transportation, and overall efficiency.

MacDrain

ADVANTAGES

Cost saving

MACCAFERRI

MACDRAIN W

VS

MINERAL SOLUTION

Texion

ADVANTAGES

Cost saving

ADVANTAGES

Environmental friendly

MacDrain W is designed to be highly durable, with a range of chemical and UV-resistant materials that ensure long-term performance and protection. The system is subject to ongoing quality control and testing, ensuring that it meets or exceeds the required performance.

ENVIRONMENTAL FRIENDLY

MacDrain

ADVANTAGES

Environmental friendly

MACCAFERRI

Texion®

MACDRAIN W

MINERAL SOLUTION

GWP GLOBAL WARMING POTENTIAL

2.33 kg/CO_2 **2.67 kg/CO_2**

TRASPORATION

1 Truck of MacDrain W equals approximately 150 Trucks of Sand/Gravel

QUARRYING

0.5 m^3

of aggregates saved
per linear meter

NOTES: 1) GWP of gravel is taken from epditaly.it; 2) estimation based on the assumption that a truck (30 t capacity) can carry 5,500 sqm of MacDrain while it can carry 18-20 m3 of aggregates 3) the thinkness of the aggregate layer is 50 cm

ADVANTAGES

Environmental friendly - MacDrain W vs Mineral Solutions

MACDRAIN W

MINERAL SOLUTION

GWP GLOBAL WARMING POTENTIAL

2.33 kg/CO_2 **2.67 kg/CO_2**

TRASPORATION

1 Truck of MacDrain W equals approximately 150 Trucks of Sand/Gravel

QUARRYING

0.5 m^3

of aggregates saved
per linear meter

NOTES: 1) GWP of gravel is taken from epditaly.it; 2) estimation based on the assumption that a truck (30 t capacity) can carry 5,500 sqm of MacDrain while it can carry 18-20 m3 of aggregates 3) the thinkness of the aggregate layer is 50 cm

ADVANTAGES

MACCAFERRI

Environmental friendly

Life Cycle Assessment studies aim at weighing emissions and impacts of a solution, starting from the raw materials to the construction and delivery of the finished system.

We conducted a detailed LCA study on our MacDrain Series to provide reliable and comparable information on the environmental impacts of our solutions, reducing energy and material consumption.

EPD®

THE INTERNATIONAL EPD® SYSTEM

Certification number S-P-01470

Click on the link to find more information

EPD MACDRAIN

or use the QR code!

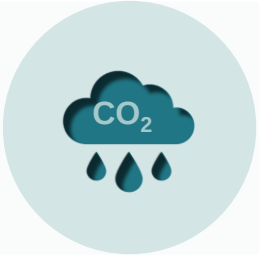
Texion®

ADVANTAGES

Environmental friendly

The **environmental performance** is assessed with the following impact category indicators:

Global warming potential (GWP) measures how much heat a greenhouse gas traps in the atmosphere up to a specific time horizon relative to carbon dioxide.



Acidification Potential provides a measure of the decrease in the pH value of rainwater and fog, which has the effect of ecosystem damage.

Eutrophication Potential provides a measure of nutrient enrichment in aquatic or terrestrial environments, which leads to ecosystem damage.

Particulate Matter is defined as a mixture of solid and liquid particles of organic and inorganic substances resulting from human activities and suspended in the atmosphere.

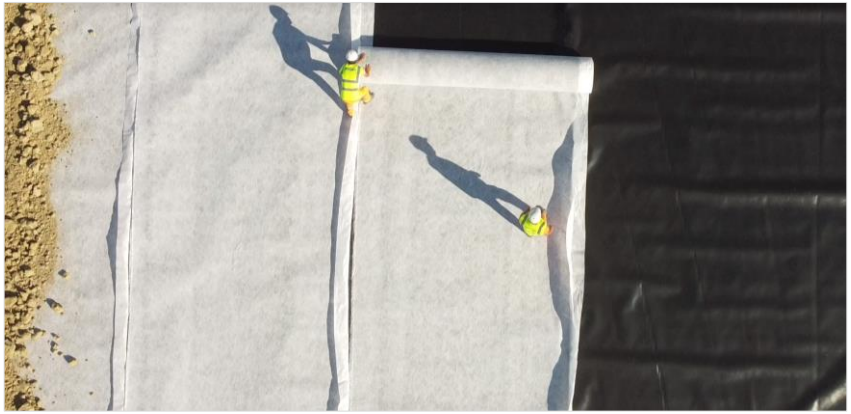
Click on the link to find more information

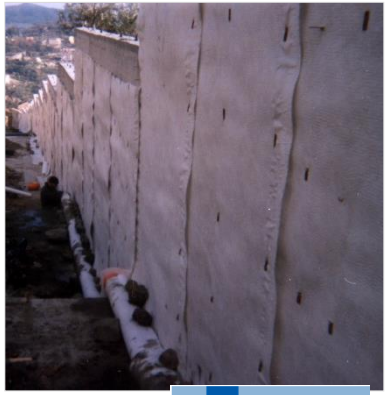
EPD MACDRAIN

or use the QR code!

MAIN APPLICATION OF MACDRAIN W

- Retaining wall drainage
- Horizontal drainage for transportation sector
- Anti capillary layer
- Against frost heave
- Draining trenches
- Sport fields
- Leachate collection and gas ventilation in landfills
- Tunnel applications
- Roofing / Noise barrier / Foundation
- Vertical walls





REUSE OF WASTE AND SITE WON MATERIALS

THE NEGATIVE IMPACT OF IMPORTED FILLS

MACCAFERRI

IMPORTED FILLS

- Expensive to quarry and becoming more so as tax penalties increase
- Environmentally unacceptable as quarrying damages the countryside
- Costly and environmentally unacceptable to transport
- Not necessary since marginal fills can be used

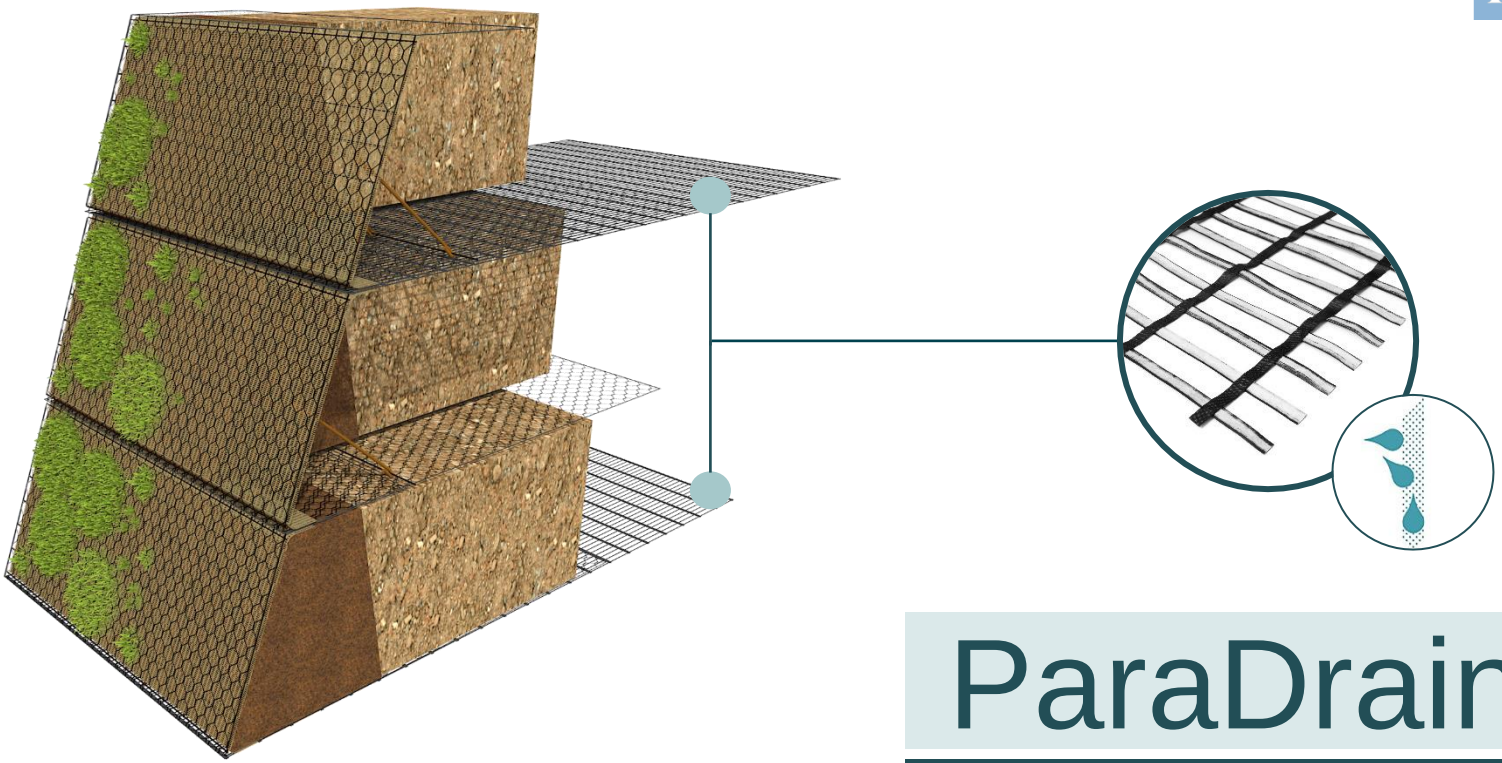
Texion

THE BENEFITS OF REUSING IN SITU SOIL

REUSE OF IN SITU SOIL

- They are cheap. They can even be a positive source of income in some situations;
- They are usually readily available;
- Their use results in reduced haulage and the consequent environmental impact of this;
- Their use results in reduced quarrying which helps to preserve the environment.

THE SOLUTION: PARADRAIN™

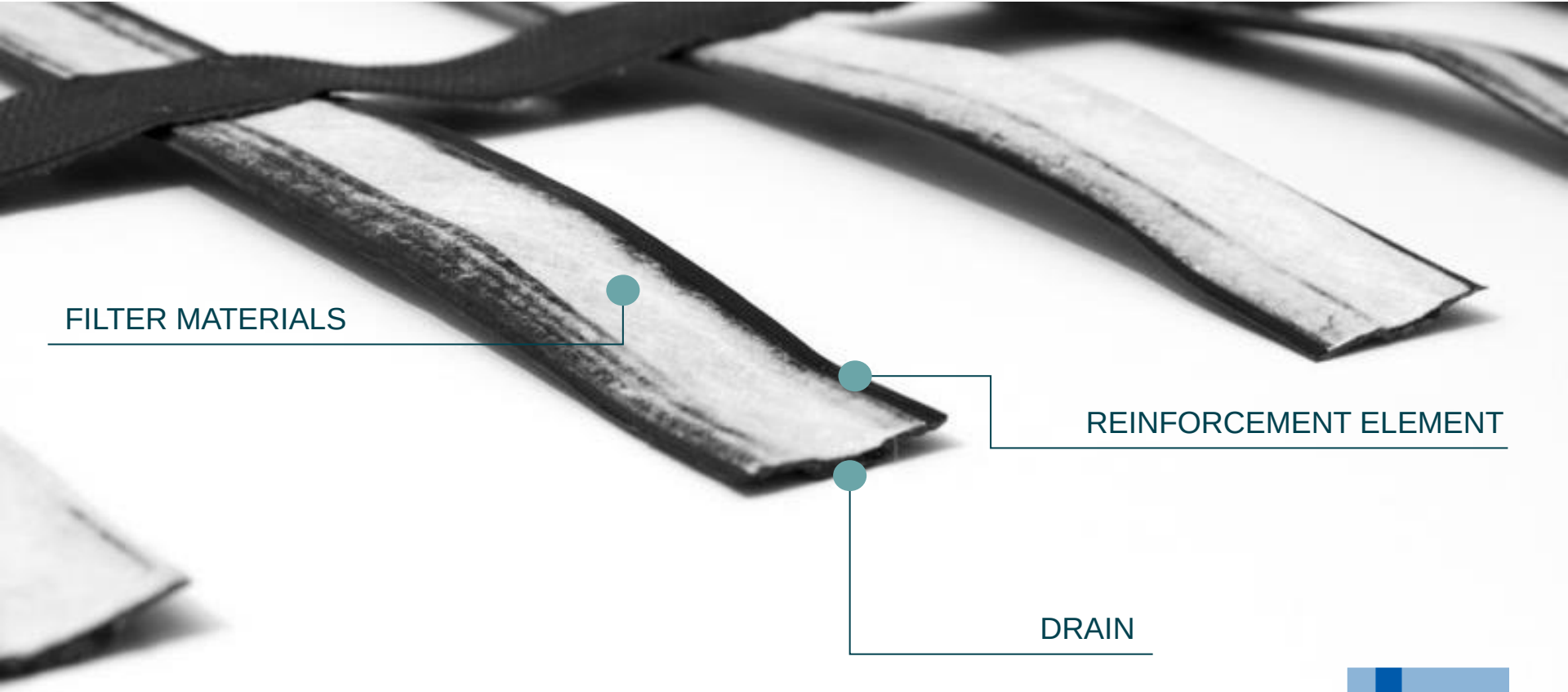


ParaDrain™

The geogrid that drains while reinforcing

THE SOLUTION: PARADRAIN™

THE SOLUTION: PARADRAIN™



A SELF WATERING VEGETATED SLOPE USING PARADRAIN™

MACCAFERRI

Burlington, Ontario
Canada

A natural-looking solution was constructed within a forested area to stabilize a failing slope.

ParaDrain™ in combination with TerraMesh™ Green, acting both as a geogrid reinforcement and as a drainage channel.

Texion

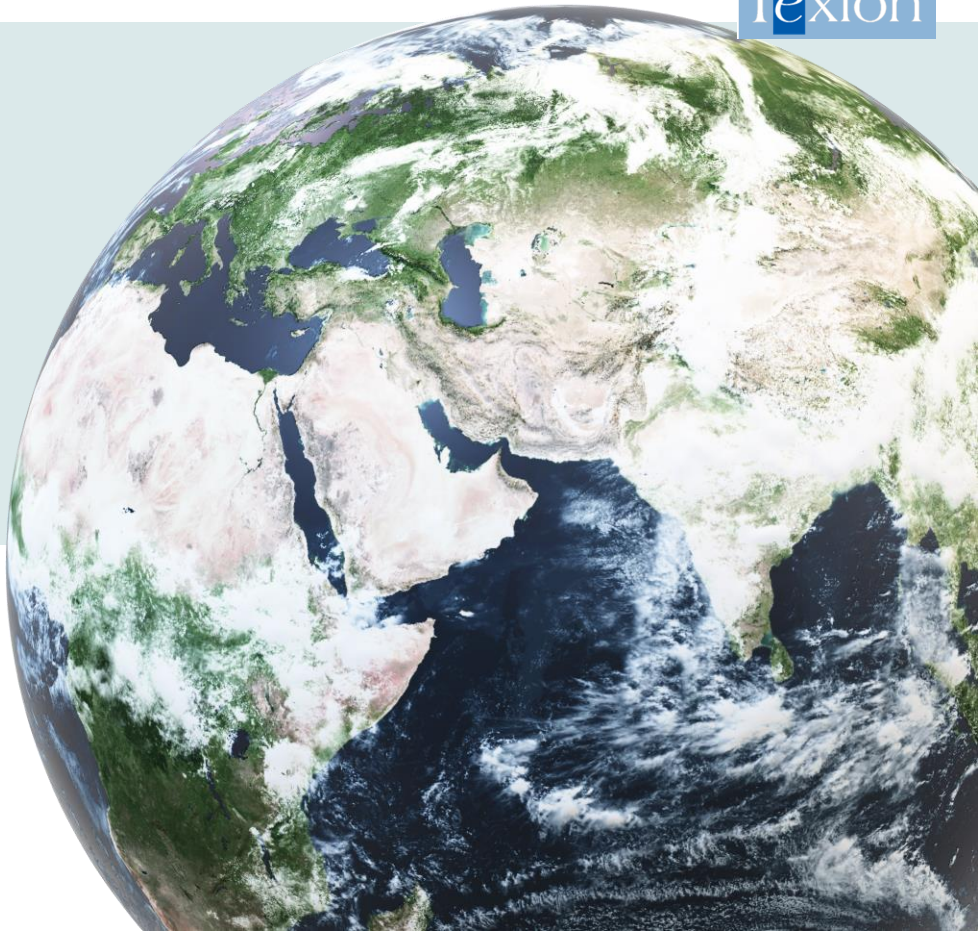
THE SOLUTION: PARADRAIN

OUR BEST PROJECT AROUND THE WORLD

In its

140 years of experience

Maccaferri has carried out thousands of projects around the world.

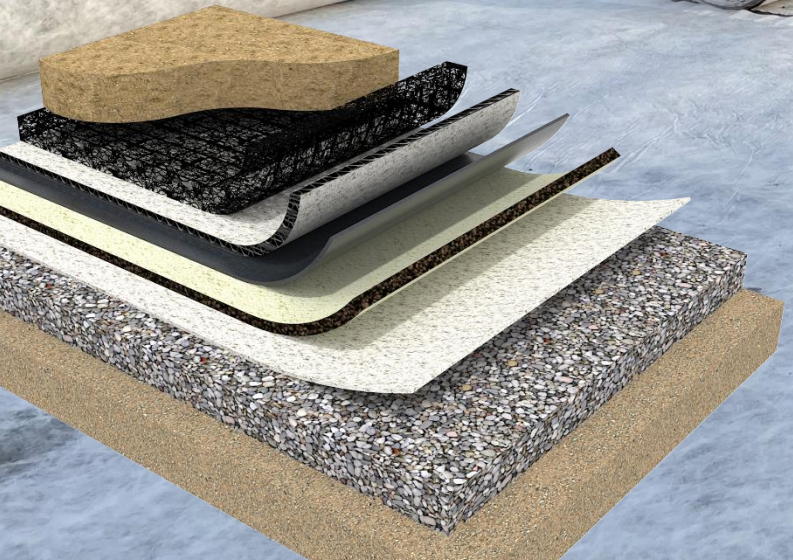


Reclamation intervention of the sin national interest area of Micorosa *(Brindisi, Italy)*

Reclamation intervention of the sin national interest area of Micorosa *(Brindisi, Italy)*

Application: Drainage for garage building – Charleroi Hospital - Grand Hôpital de Charleroi

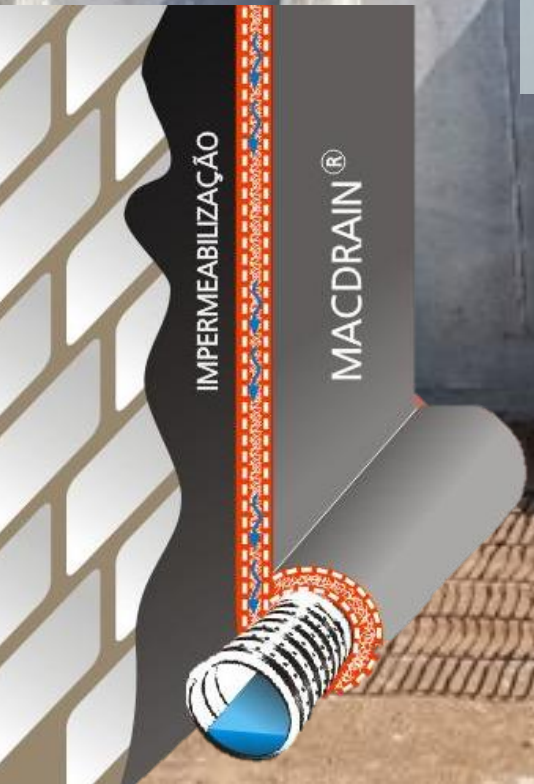
Application: Drainage for garage building – Charleroi Hospital - Grand Hôpital de Charleroi



Danxia smelting plant project

(Danxia, China)

Application: Vertical Walls



Securing The Planas Dam

(Pujaut, France)

Application:
Anti capillary layer in embankments

Slope Management project of Shaanxi Danfeng Senior Middle School

(Shaanxi, China)

Application:
Retaining walls drainage

MACDRAIN™ W FOR THE SDGs

Environmental Sustainability

MACCAFERRI

MATERIAL SAVINGS

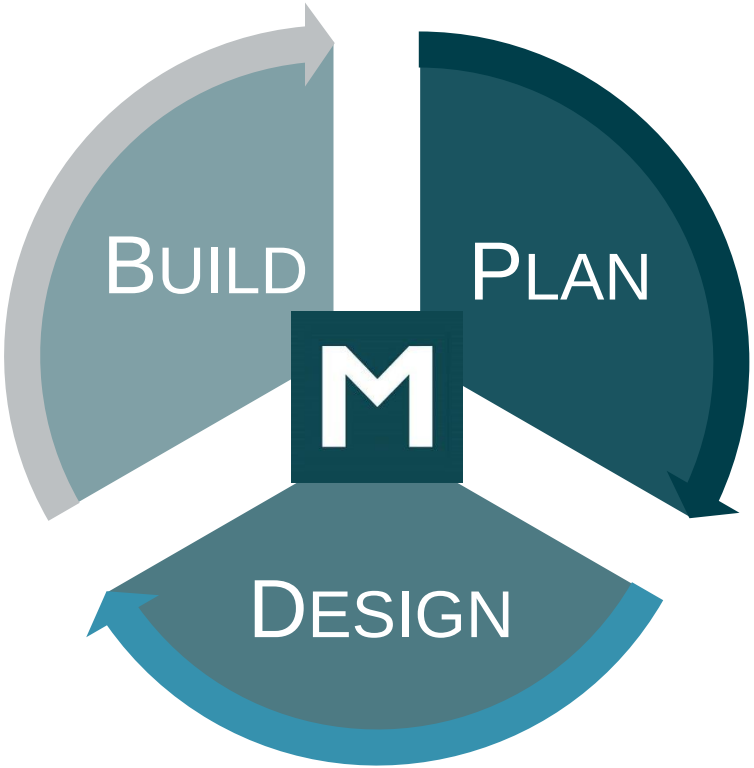
OUTSTANDING PERFORMANCE

FASTER INSTALLATION

Texion

360° SUPPORT FOR YOUR PROJECT

Maccaferri is always side by side with engineers, architects and builders



Our **geotechnical, hydraulic & environmental engineering experts** can support you through all the project phases.

To Bring Home:

- Technical Support
- Innovative and Sustainable Solutions
- Construction Skills
- Team Working
- Wide portfolio of solutions

BELGIAN GEOSYNTHETICS SOCIETY

THANK YOU

For any further info please contact the Maccaferri office which is closer to you or visit Maccaferri website on maccaferri.com and our partner´s website https://www.texion.be/

MACCAFERRI

Texion

DUURZAAM REGENWATERBEHEER MET PLUVIO INFILTRATIETUNNELS

Toenemende verstedelijking leidt tot problemen zoals overbelasting van rioleringssystemen en overstromingen.

Overstromingen in Vlaanderen

- Toenemende verharding
  - In 2021 **15,3%** van de totale oppervlakte verhard of afgedekt
- Toenemende stortbuien
  - Riolen overbelast = **overstromingen**

Droogte in België

- Langere droogteperiodes
- Droge grond laat amper water door
  - Sijpelt niet in de bodem

GEEN KANS OM TE INFILTREREN

Gevolg

- Lage grondwaterstanden
- Lage rivierpeilen tijdens droge zomers
- Overstromingen bij intense regenbuien
- Regenwater gaat via de riolering verloren in de zee

ONZE OPLOSSING

PROJECTEN

WERKING SYSTEEM

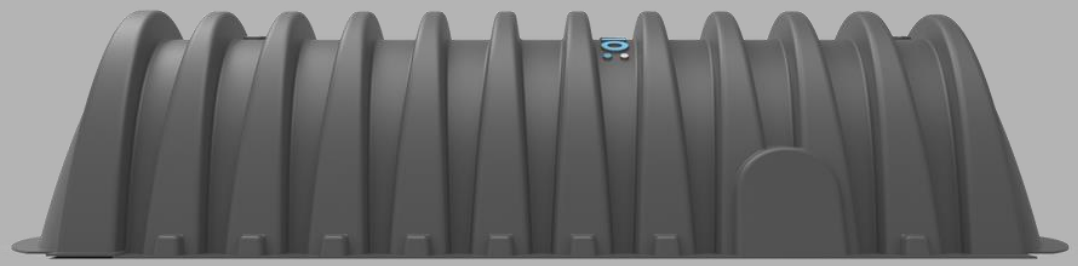
WERKING SYSTEEM

WERKING SYSTEEM

WERKING SYSTEEM

EIGENSCHAPPEN

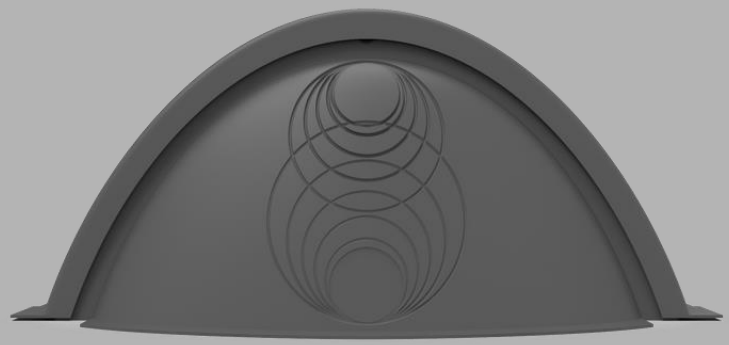
- **Geïnstalleerd Infiltratie Volume**
  - 2.120 liter **(2,12m³)**



- **Boogontwerp**
  - Stapelbaar - compact voor transport & stockage
  - Zeer hoge belasting mogelijk
  - Altijd inspecteerbaar & reinigbaar

EIGENSCHAPPEN

- **Snel & eenvoudig te installeren**
  - Lichtgewicht (19,50kg)
  - Klik- en schuifsysteem
  - Onbeperkt koppelbaar



- **Gemaakt uit 100% gerecycleerd ABS**

DE INSTALLATIE

STAP 1

- Graaf de **put.**
- Plaats **geotextiel** in de bouwput tot ruim over de rand. Dit **voorkomt indringen van slib**.
- Breng **steenfundering** aan van **15mm**.

STAP 2

- Leg de **eerste tunnel op zijn plaats.** Neem een **tweede tunnel** en **schuif deze in elkaar**.
- Doorgaan tot er voldoende tunnels zijn geplaatst in functie van de **nodige infiltratiecapaciteit**.
- Bevestig de **begin- en eindkappen**.
- Sluit de **aan/afvoerbuis** aan.

STAP 3

- **Vul de ruimte tussen de tunnels** aan
  Minimum **150mm** boven de tunnels.
  Links, rechts gelijkmatig aanvullen.

STAP 4

- Plaats de **geotextiel** boven het min. **150mm** steenpuin.

- **Werk de bodem af** voor de beoogde toepassing van het terrein

TOEPASSINGEN

- Parkeerterreinen
- Bedrijfsites
- Scholen
- Shopping centra
- Privé woning

VERGELIJKBARE SYSTEMEN

Wadi’s

Kratten

VOORDELEN PLUVIO

- Groot volume op klein oppervlak
- Terrein optimaal benutten
- Makkelijk te onderhouden
- Efficiënte installatie
- Kostefficiënt

ONZE PARTNERS

Vlaanderen

- Deschacht

Wallonië

- MatGeco (Insulco group)

ONLINE TOOL

- Berekening a.d.h.v. te infiltreren volume

  - het aantal tunnels
  - eindkappen
  - steenslag
  - geotextiel

- Na berekening prijsvoorstel op maat

CONTACTEER ONS

- Pluvio

  Jasmine Thienpont

  jasmine@pluvio.be

- Matgeco

  Vadim Faucon

  vfa@matgeco.be

BELGIAN GEOSYNTHETICS SOCIETY

grondwaterindebouw.be

Genap

Toepassingen en uitvoering van folieconstructies in verdiepte Infrastructuur

- Carlo Scheerder (R&D/Engineering)
- Genap opgericht 7 oktober 1951 (72 jaar!)
- Verwerken van kunststoffolie
- Marktgebieden: Tuinbouw / Landbouw / GWW
- → opslag / scheiden / isoleren of keren van vloeistoffen (water)
- Aanleg eerste folieconstructies in Nederland: 1958 / 1969 (Breda)

Doel van vandaag:

tonen van toepassingen en uitvoeringen van folieconstructies in de GWW

Waarom toepassing folie (geomembranen)?:

Voordelen

- licht en flexibel materiaal die vervorming kan ondergaan
- relatief goedkoop constructie materiaal; beperking bouwkosten (ivt. beton)
- eenvoudig te verwerken en te verbinden door lassen
- duurzaam (> 50-100 jaar)

Nadelen

- Groter ruimtebeslag bij vrije ontgraving
- kwetsbaar tijdens uitvoering en gebruiksfase
- invloed weersomstandigheden op kwaliteit/planning
- aanpassingen en reparaties achteraf complex

Folieconstructies in verdiepte infrastructuur:

- economisch gunstiger dan damwand / betonconstructie (onderwater beton)
- visueel minder impact op directe omgeving (‘groene taluds’ bij toeritten)

- Folies in den droge
- Folies in den natte

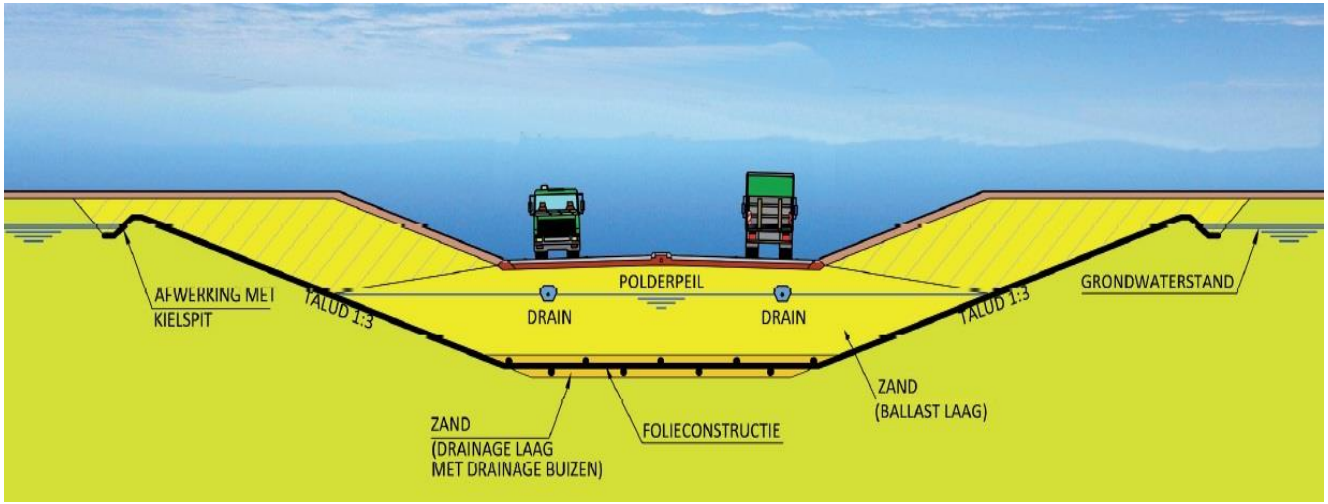
Wanneer in den droge:

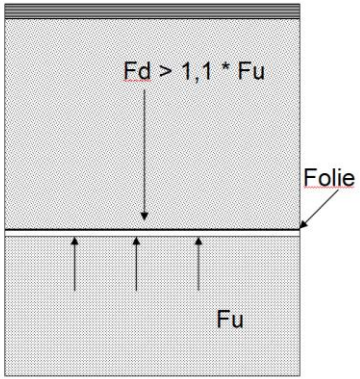
- bemaling mogelijk
- bestek voorschrift
- economisch gunstiger

Wanneer in den natte:

- bemaling niet toegestaan
- bestek voorschrift

Principe:





Verticaal Evenwicht vereist

- creëren van droge bouwkuip
- waarborgen verticaal evenwicht!
- geen bronbemaling nodig in den natte

Folies in “den droge”

- toeritten naar tunnels & aquaducten
- verdiepte liggingen
- referentieproject “De Centrale As”

Uitvoering in “den droge”:

- eventueel damwanden plaatsen
- bemalen (grondwaterniveau verlagen)
- ontgraven
- ontgraving bekleden met folie/geotextiel
- ballastlaag aanbrengen

● *Jeltesloot (LLDPE)*

“De Centrale As” N356 (2010-2016)

- in den droge uitgevoerd
- 16 verdiepte liggingen/onderdoor-gangen
- LLDPE folie 1.5 mm. > 200.000 m^2
- geotextiel 500 gr./m2 > 400.000 m^2
- opbouw afdichting: geotextiel / folie / geotextiel

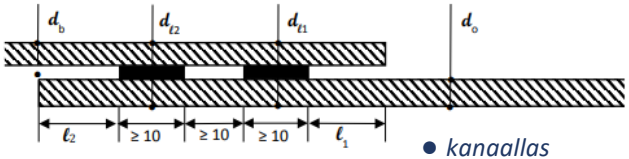
● *Verdiepte ligging op de N356*

● *Onderafdichting*

● *Aanbrengen ballastlaag*

“De Centrale As” N356

- *Onderafdichting*



- *kanaallas*

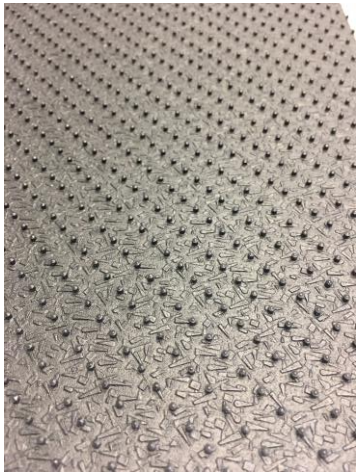
- *Aansluiting damwand*

“De Centrale As” N356 / Doniawei

Materialen:

- kunststoffolie LLDPE 1.5 mm. MSB/MST
  - Gecertificeerde folie conform KIWA BRL-K 546
  - 100 jaar levensduuronderzoek (materiaal/lassen) (versnelde verouderingstest in lab)

- geotextiel 500 gr./m^2, non-woven (onder en boven op de folie)



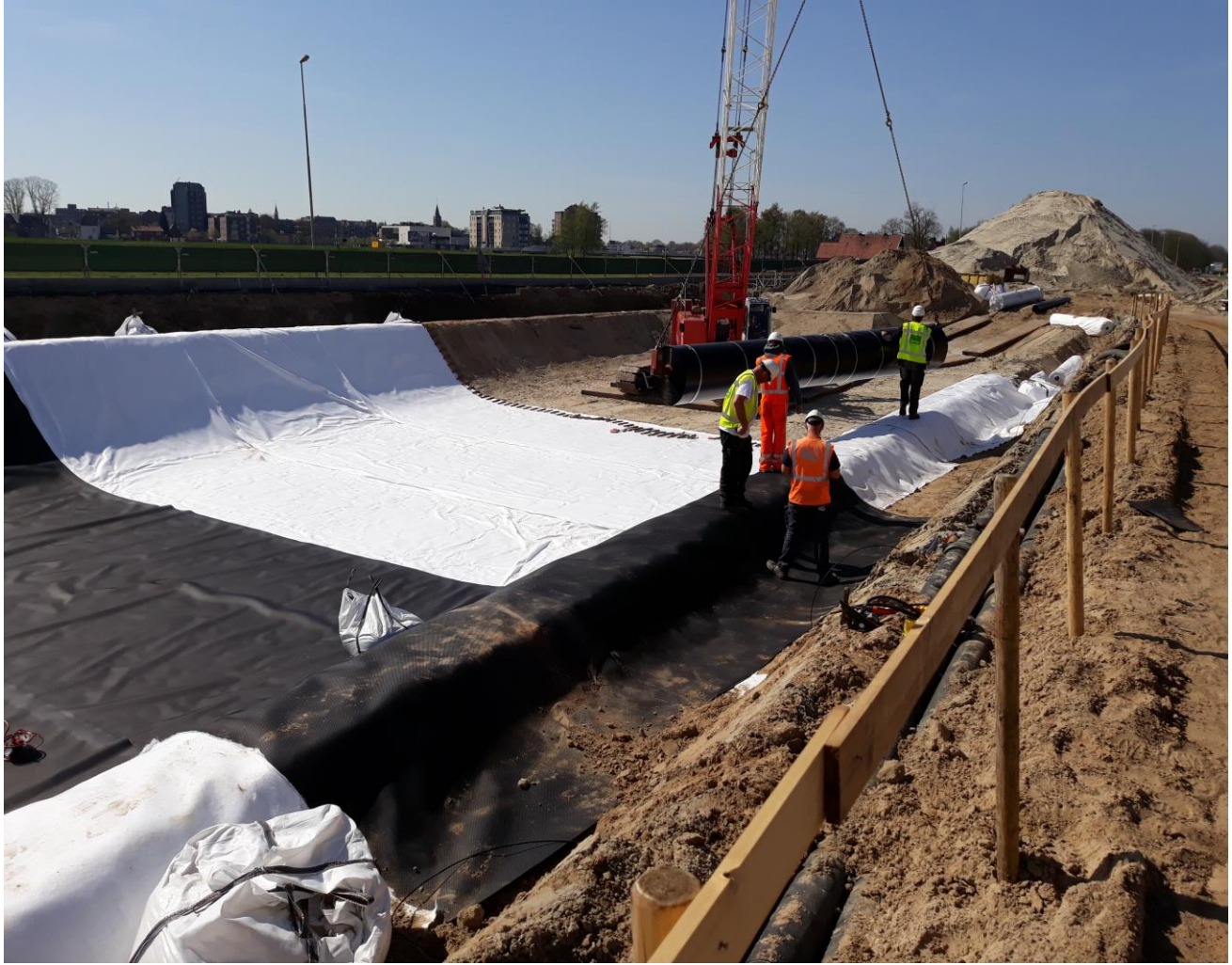
LLDPE 1.5 MST+/MSB

- damwand aansluitingen; MPG 950-20 versterkte PE folie touwzoom

Genap

Project:

- Harlingen N31 toerit Aquaduct
- LLDPE 1.5 mm.
- Geotextiel 500 gr./m^2



Project:

- Hardenberg (N34)
  Kellerlaan
  Verdiepte ligging
- LLDPE 1.5 mm.
- Geotextiel
  500 gr./m^2

Folies in “den natte”

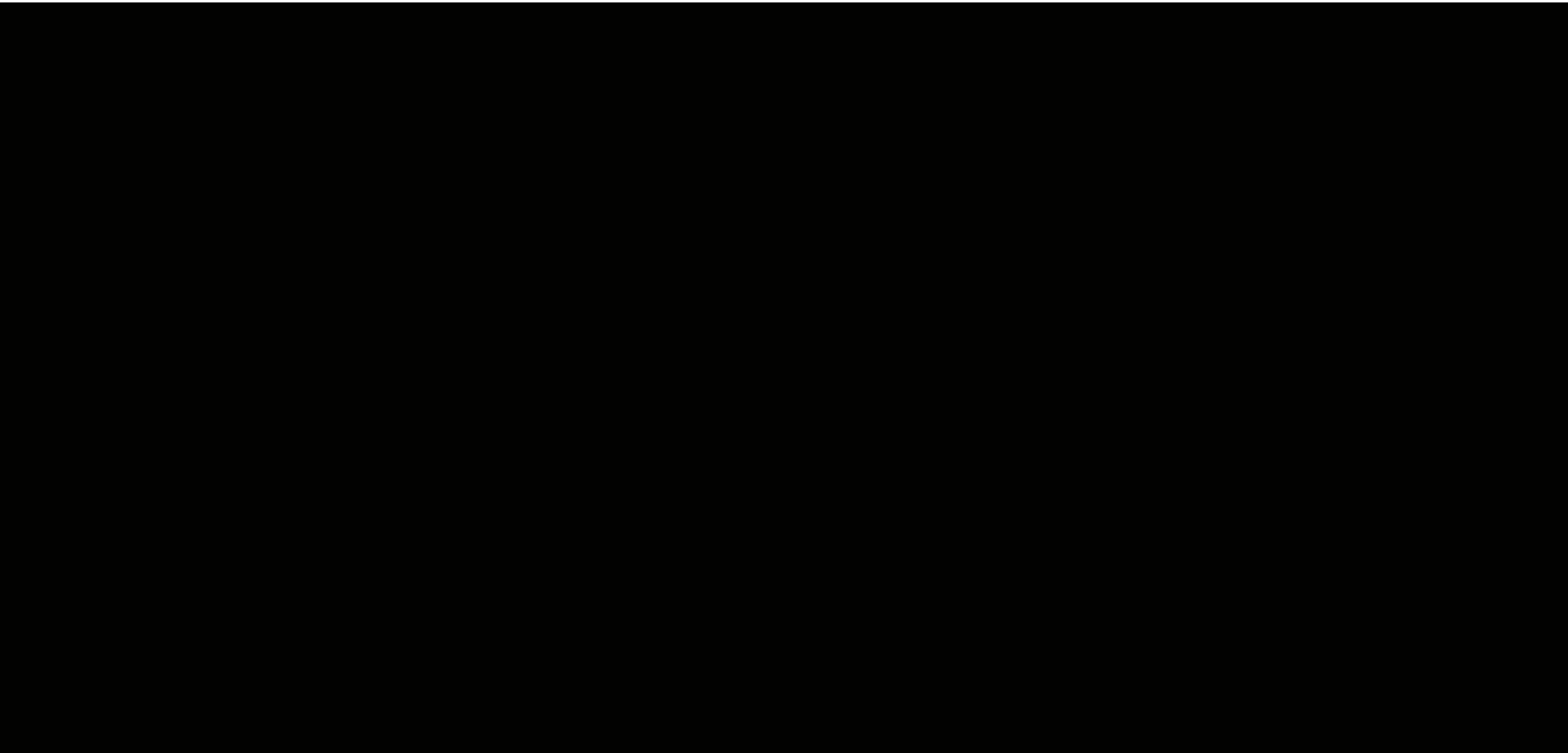
- toeritten naar tunnels & aquaducten
- verdiepte liggingen
- verschillende afzinkmethodes

Uitvoering in “den natte”:

- ontgraven in den natte
- geotextiel afzinken (laag 1)
- folie overtrekken en afzinken (laag 2)
- geotextiel afzinken (laag 3)
- ballastlaag aanbrengen

● *Houten: verdiepte ligging; Achterweg N242*

Animatie afzinken folieconstructie



Materialen:

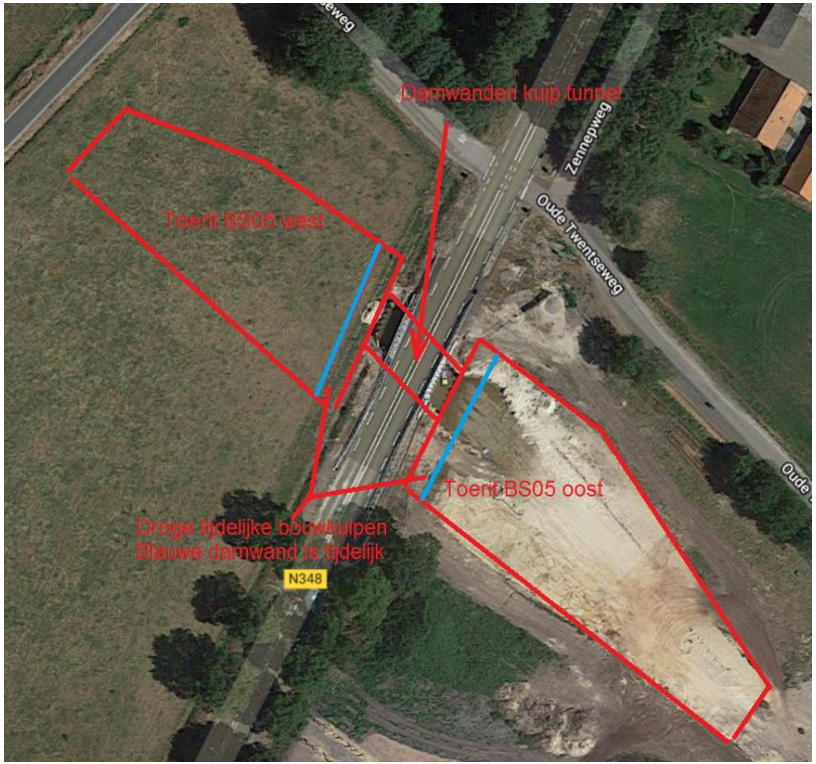
- kunststoffolie; PVC 1.0mm KIWA-HA / Watermark
  - Gecertificeerde folie conform Kiwa BRL-K519
- geotextiel 500 of 1.000 gr./m^2
- aansluiting; versterkt PVC folie; 900 gr./m^2

● *Aansluiting op beton met RVS strip*

Afzinken: 3 methodes

- Vrije ontgraving → indien mogelijk qua ruimte (taluds 1:3,5) bijv. aquaduct Langdeel N31
- Toerit → aansluiting op tunnel (vaak droge aansluiting met tijdelijke bouwkuip) bijv. Onderdoorgangen N348 Raalte-Ommen
- Tussen damwanden → aan twee of meerdere zijden een damwand (bijv. Houten N242)

Project: Onderdoorgangen N348 Raalte-Ommen



Project: Onderdoorgangen N348 Raalte-Ommen

- dec. 2019 – okt. 2020
- 2 locaties BS5 (West)/ BS10 (Oost)
- 4 afzinkwerken
- PES vilt 1000 gr./m2
- PVC-P 1.0 mm.
- ca. 20.000 m2 folie

en 40.000 m2 vilt

- Uniek project:

12x afzinken + combinatie van werkzaamheden in den droge & in den natte

Project: Onderdoorgangen N348 Raalte-Ommen

- Ontgraving (GPS) van de put

Project: Onderdoorgangen N348 Raalte-Ommen

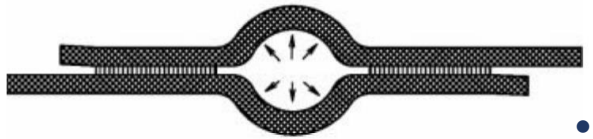
- Stikken van de pre-gefabriceerde non-woven geotextielen op locatie

Project: Onderdoorgangen N348 Raalte-Ommen

- Afzinken van het beschermvilt

Project: Onderdoorgangen N348 Raalte-Ommen

- prefab zeilen samenstellen (lassen)



- Veldwerkzaamheden mbt. verbindingen:
  - Stikken
  - Veldlas
- lassen: kanaallassen
- lassen testen op druk en dichtheid (vacuümklok)
- Afzinken per zeil ca. 3 dagen
- lekdetectie op folie laten uitvoeren (door erkend bedrijf)
- opleverdossier en overdracht aan opdracht-gever

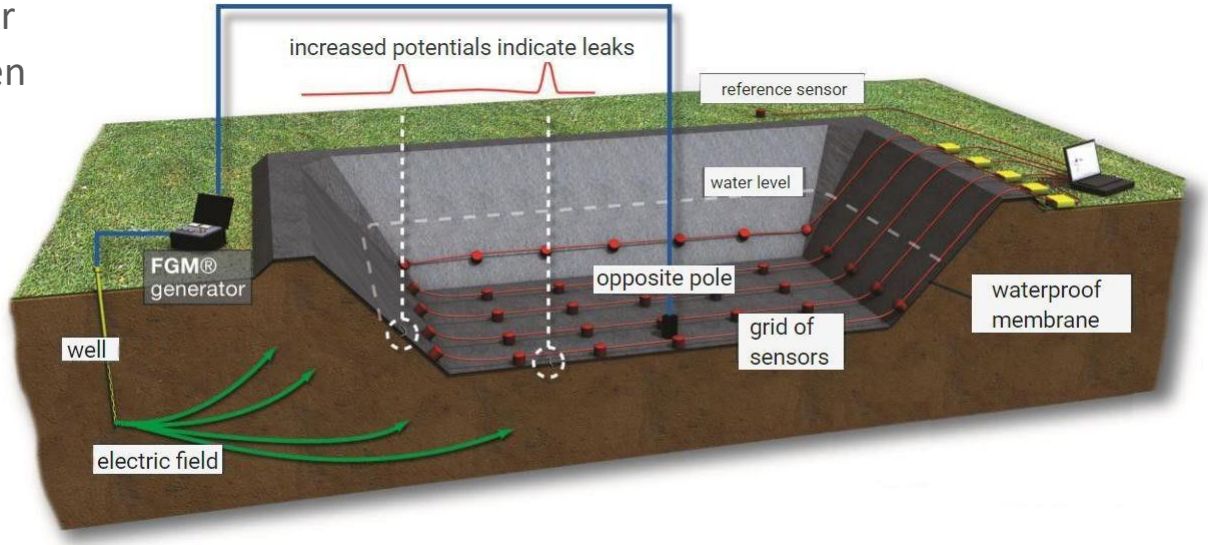
- las testen op druk (pelbelasting)

Project: Onderdoorgangen N348 Raalte-Ommen

- Afzinken PVC-P folie

- Overtrekken zeil mbv. liersysteem

- Uitvoering lekdetectie om lekdichtheid van de folieconstructie na afzinken aan te tonen
  - Geo-electrische methode (Electrical Flux Tracking)
    - Electrische sensors binnen en buiten de folieconstructie
    - Folie (membraan) is een isolator
    - Locatie lekkage opsporen binnen 30 cm. nauwkeurigheid
    - Reparatie door duikers met PVC lijm (PVC-P lijm)



- Prefabricatie
- Gecontroleerde omgeving

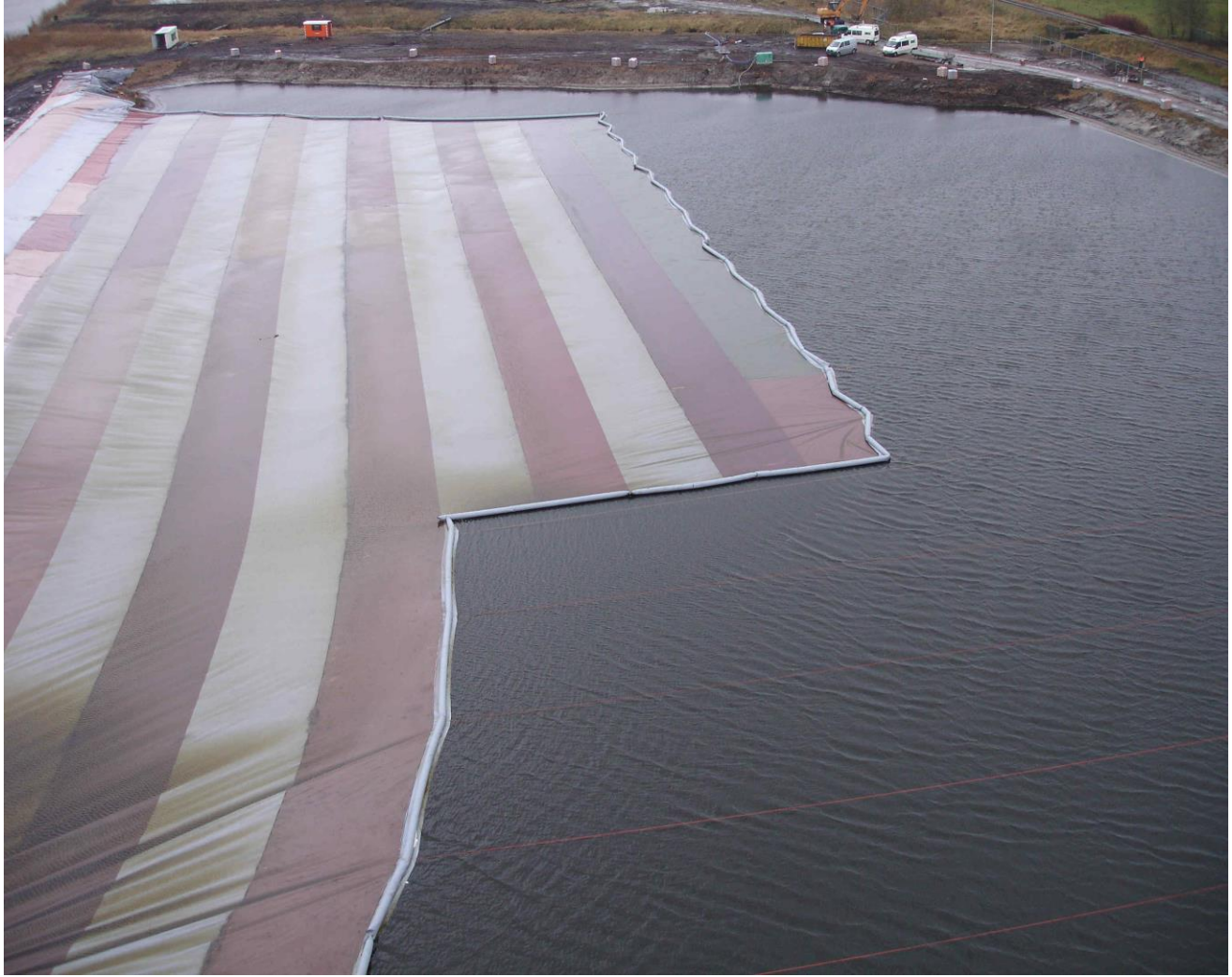
=>

Hoge(re) kwaliteit

& tijdbesparing

- vouwen / oprollen t.b.v. transport

- BS05 Oostzijde



Project:

- Veendam
- PES/PP geotextiel
- scheidingsvlies
- tbv. vervuild slib

Project:

- Doornboslaan
  Breda
- PVC-P 1.3 mm.
- Geotextiel
  1000 gr./m^2

Uitvoering werkzaamheden:

- Conform bestekeisen (leidend)
- NEN protocollen I, II en III (sinds 2018 actueel)
- Toepassing gecertificeerde folies (KIWA BRL-K519/K538/K546)
- Verwerking folie conform KIWA BRL-K537
- Controles conform KIWA BRL-K537 en eventueel onafhankelijk keuringsinstantie

Hoe ontstaan risico's?

- Fouten in ontwerp, uitvoering en/of beheer

→ *Steilheid talud / wijze van bemaling / dwarslassen*

- Overdracht werkzaamheden tussen verschillende disciplines (bv. werkzaamheden hoofd- en onderaannemers)

→ *raakvlakken benoemen, details benoemen en duidelijk maken; bijvoorkeur voor aanbesteding*

- Onbekendheid met folieconstructies

→ *Kwetsbaarheid van folie in aanlegfase wordt vaak onderschat*

- Tijdsdruk versus kwaliteit

→ *stagnatie door weer leidt vaak tot tijdsdruk*

Aandachtspunten

- Ontwerp en uitvoering is erg gespecialiseerd
- Integrale benadering noodzakelijk beheersing risico's (afstemming in de keten)

Tot slot:

- Vragen / opmerkingen?

BELGIAN GEOSYNTHETICS SOCIETY

grondwaterindebouw.be

Genap

Hartelijk dank voor uw aandacht!

Ir. Carlo Scheerder
c.scheerder@genap.nl
www.genap.nl