Drainage with Geocomposites

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MACCAFERRI

Contents

Bologna, Italy
Global Headquarters

About us

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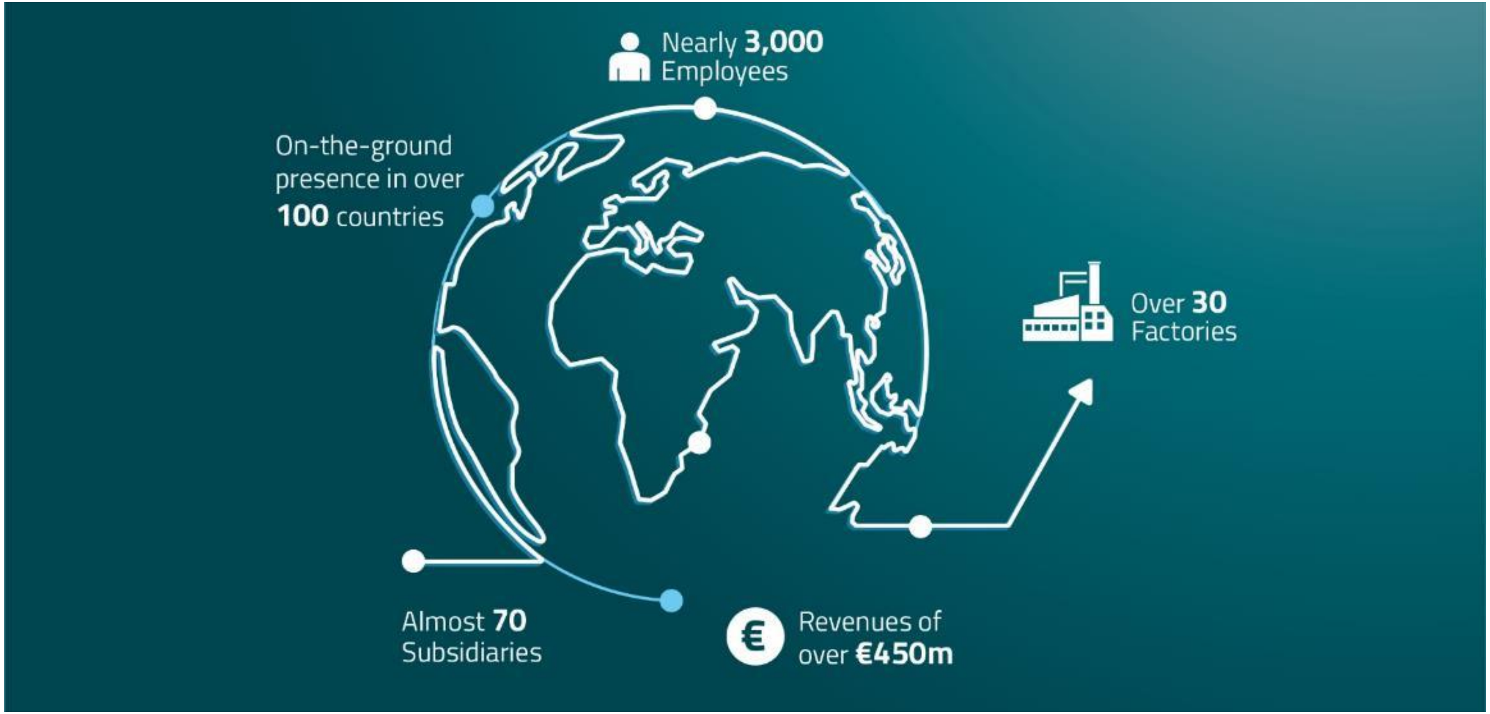
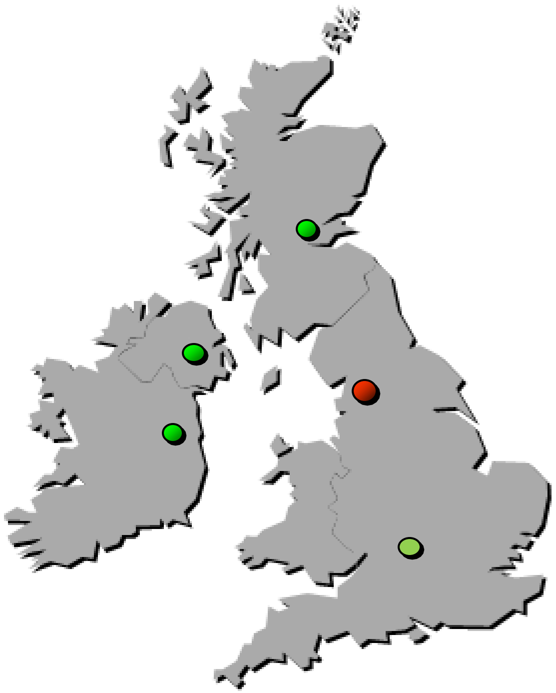
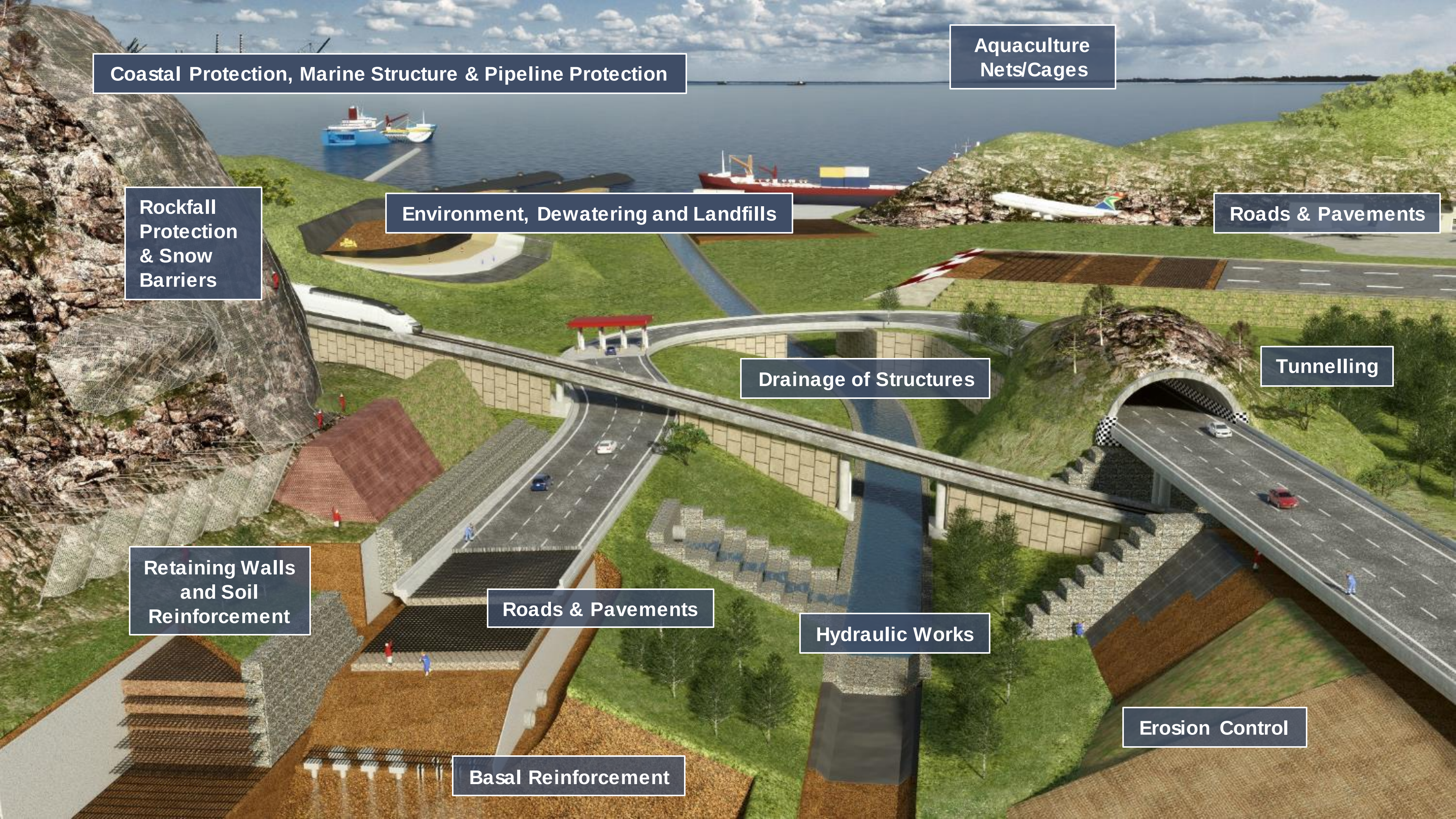


Engineering a Better Solution

UK Operations

- Established 1956.
- 3 Regional Offices + Dublin
- Circa 45 Staff
- Network of Area Engineers across the UK
- Linear Composites
    - Manufacturing of polymer products for civil engineering, mining, O&G, power gen, agribusiness etc




Coastal Protection, Marine Structure & Pipeline Protection
Aquaculture Nets/Cages
Rockfall Protection & Snow Barriers
Environment, Dewatering and Landfills
Roads & Pavements
Drainage of Structures
Tunnelling
Retaining Walls and Soil Reinforcement
Roads & Pavements
Hydraulic Works
Erosion Control
Basal Reinforcement

What is a Geocomposite Drain?

From "ISO 10318:2005 Geosynthetic Terms and Definitions"

A geocomposite is:

a manufactured, assembled material using at least one geosynthetic product among the components

Drainage is:

collecting and transporting of precipitation, ground water and/or other fluids in the plane of a geotextile or a geotextile-related product

A geocomposite drain comprises a drainage core bonded to another geosynthetic, usually either a non-woven filter geotextile or geomembrane

OUR PRODUCT

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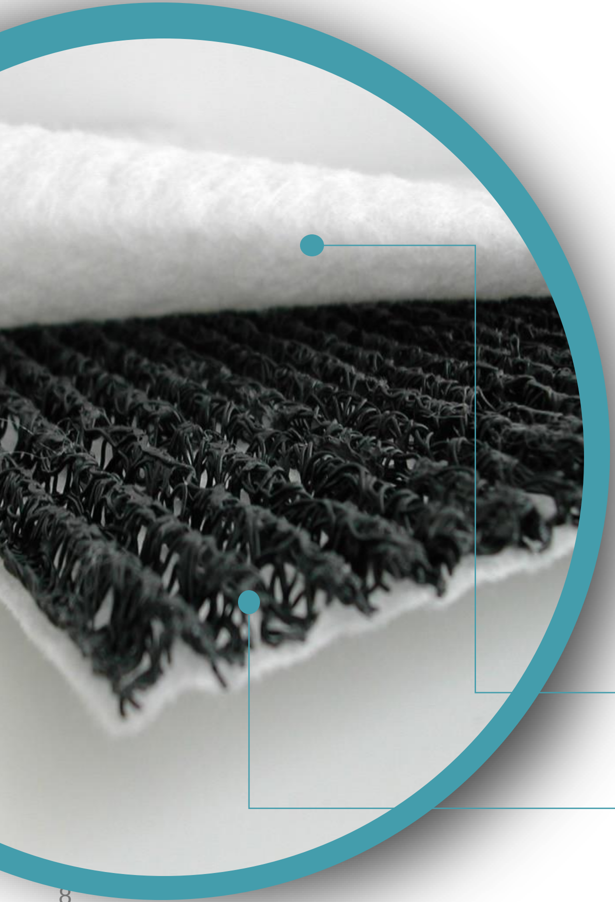


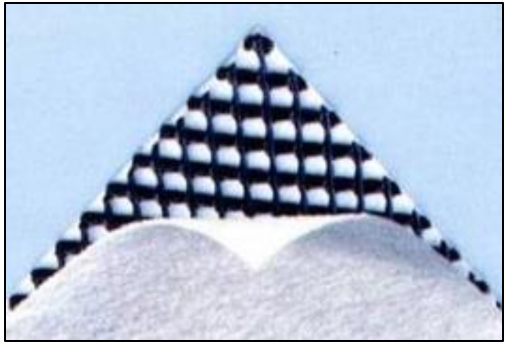
MacDrain

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

DRAINAGE CORE - It drains water and gas

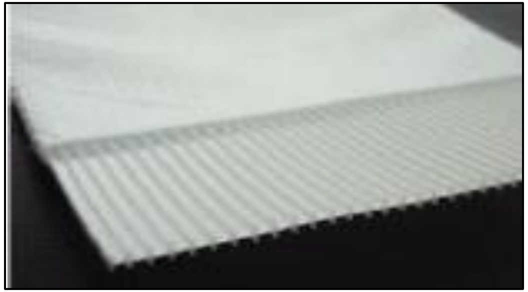
What is a Geocomposite Drain?

Geomat or random fibre



Geonet – bi or tri planar

Geospacer or cuspated



Ribbed or band drain

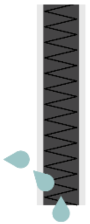
What is a Geocomposite Drain?

Definition & Functions

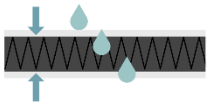
Maccaferri draining geocomposites are called **MacDrain**.

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**:

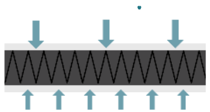
Drainage



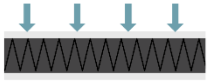
Filtration



Separation



Protection



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

What is a Geocomposite Drain?

MacDrain Range

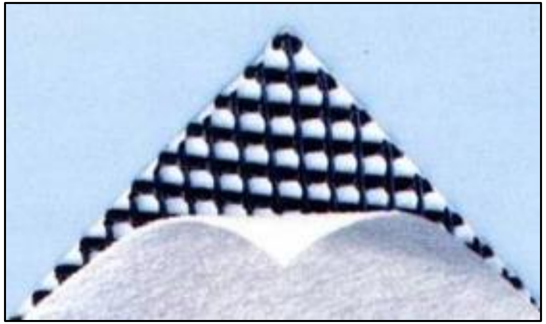
MacDrain M

- 10-22mm flexible core structure
- Very high void ratio
- High flow
- Low-pressure applications

MacDrain W

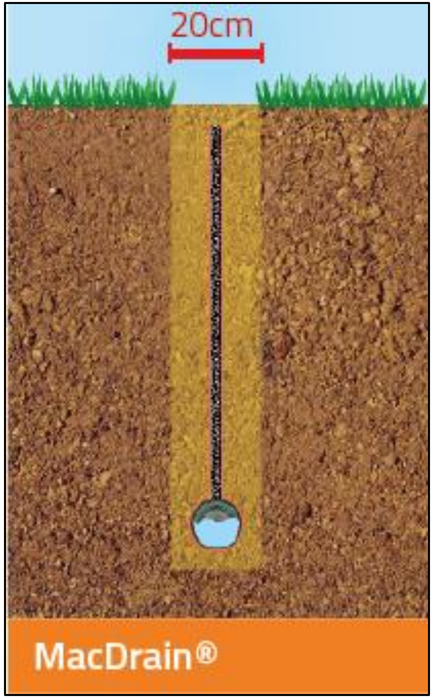
- 4-10mm flexible core structure
- Very high void structure
- High flow
- Medium to high pressure applications

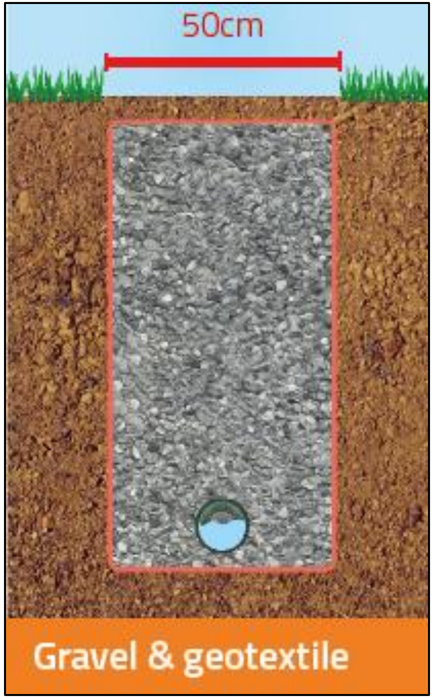
MacDrain N



- 4-10mm flexible core structure
- Very high void structure
- Low flow
- High pressure applications

Key Benefits





REDUCTIONS IN:

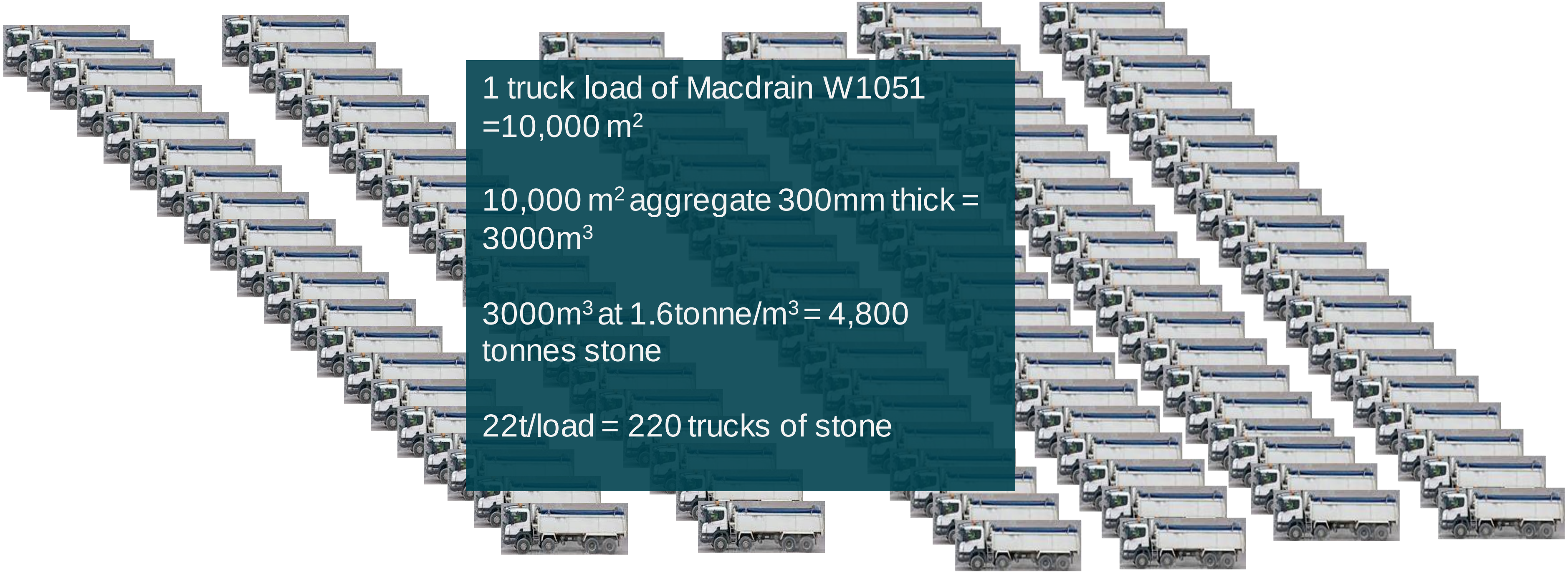
- Material volume
- Carbon footprint
- Vehicle movements
- Time
- Money

INCREASES IN

- Consistency
- Speed of installation
- Safety
- Performance

Key Benefits

Transport Savings



1 truck load of Macdrain W1051 =10,000 m^2

10,000 m^2 aggregate 300mm thick = 3000m^3

3000m^3 at 1.6tonne/m^3 = 4,800 tonnes stone

22t/load = 220 trucks of stone

Key Benefits

Carbon Savings

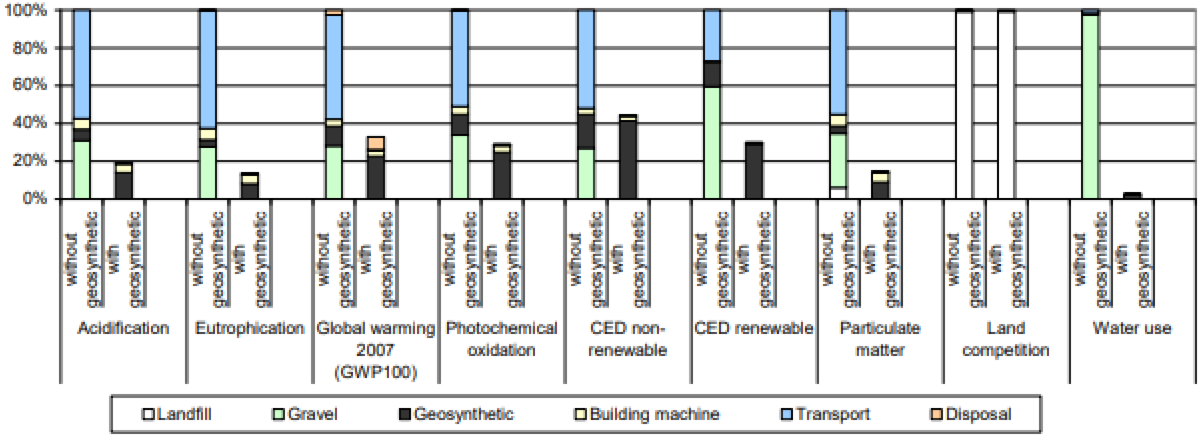


Fig. S. 4: Environmental impacts of the life cycle of 1 m² mineral drainage layer (case 3A) and a geosynthetic drainage layer (case 3B). For each indicator, the case with higher environmental impacts is scaled to 100 %.

Assume 10 miles from quarry to site: 4,800 tonnes of stone = 8.25 tonnes CO_2
Assume 150 miles from factory to site: 6 tonnes MacDrain = 0.01 tonnes CO_2
Even at 1,250 miles from factory to site still only 1.25 tonnes of CO_2

Calculations taken from EA Carbon Calculator tool v3.2

Environmental Benefits

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!

Cost Benefits

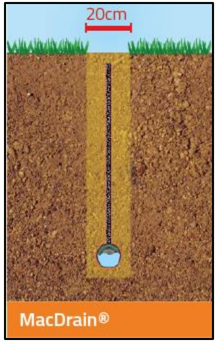
Illustrative costs per m^2

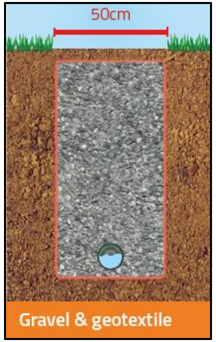
Item	300mm Stone drainage layer	Drainage Geocomposite
m^2 per delivery	30 m^2	10,000m^2
Weight	300kg/m^2	0.6kg/m^2
Material Cost	£10 - £30 m^2	£3 m^2

Assumed stone cost £15 - £45 per tonne

Geocomposite drains installation requires reduced excavation, and allow use of site won backfill

Muck away costs = transport plus Landfill tax plus gate fees

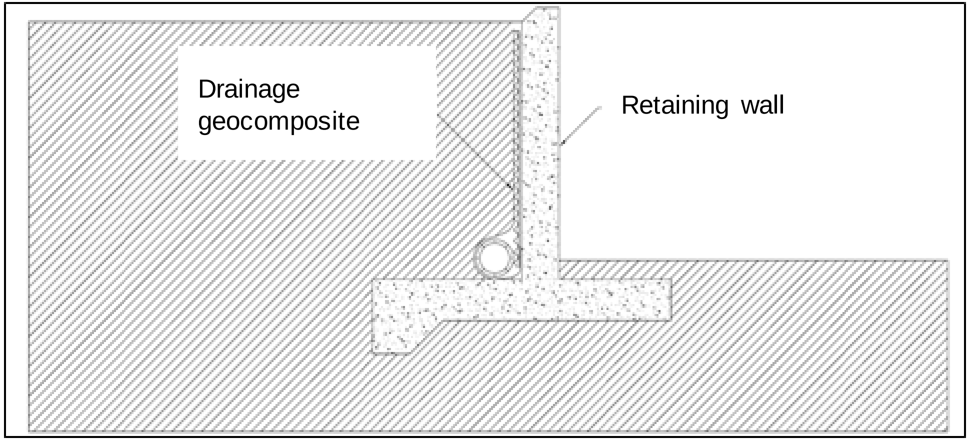


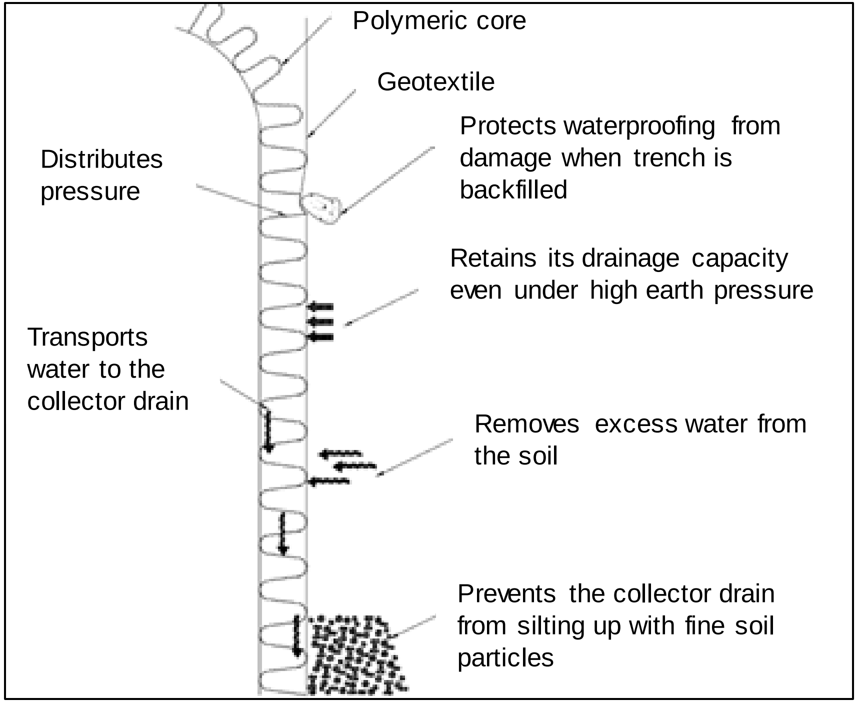


Improved Performance

- Factory produced highly controlled material
- Lightweight - easy handling
- Fast installation
- Consistent performance over whole area
- Multi-functional – drainage, filtration and protection in a single layer
- Use on gradients where aggregates would be unstable

Vertical Applications





Vertical Applications

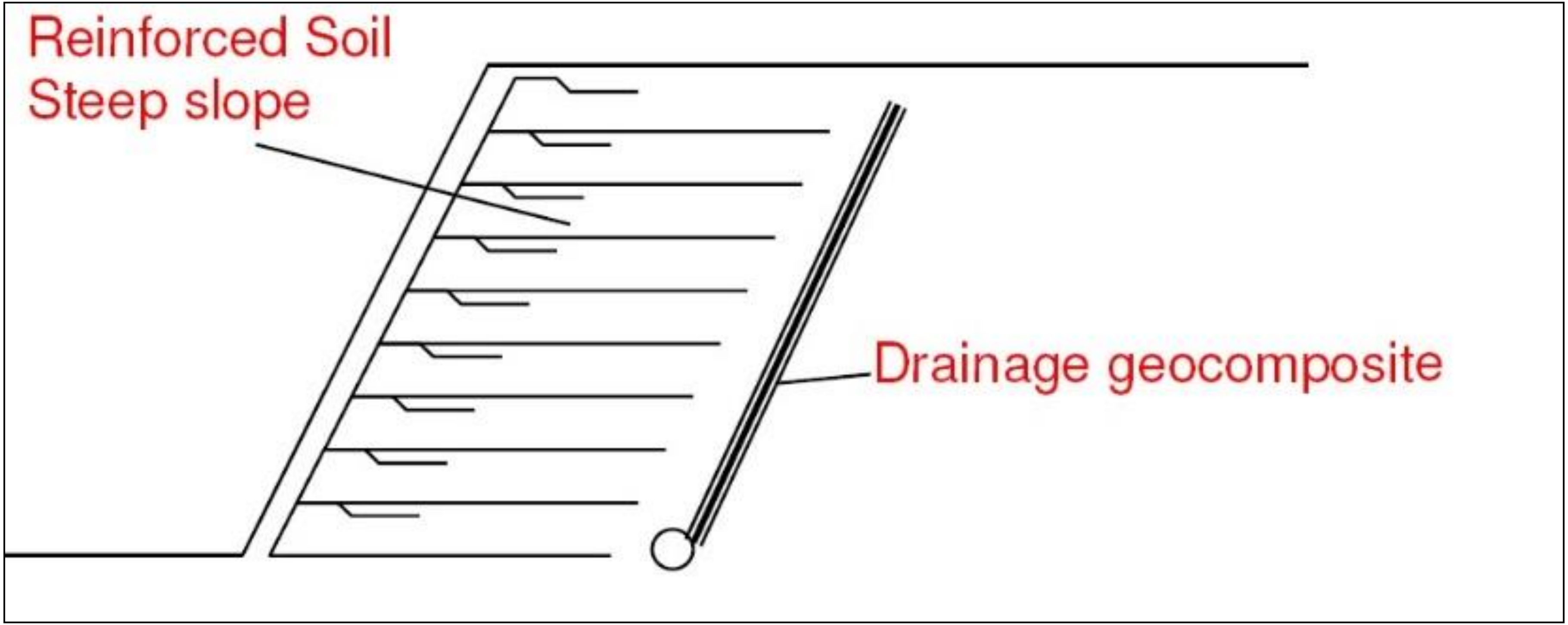
Concrete Structures

Vertical Applications

Cut Slopes

Vertical Applications

Reinforced Earth Structures



Vertical Applications

Reinforced Earth Structures

Slope Applications

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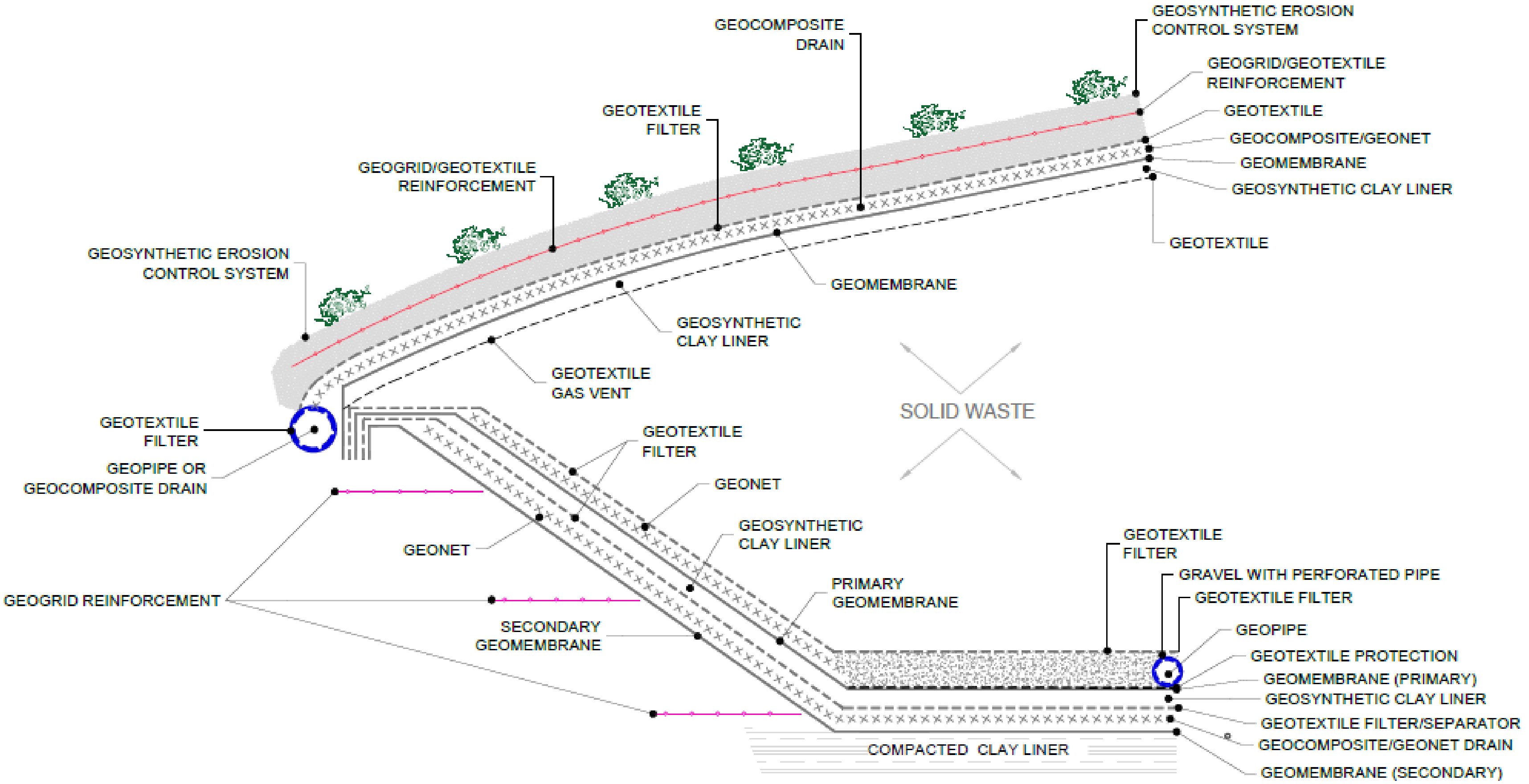

Slope Applications

Slope Applications

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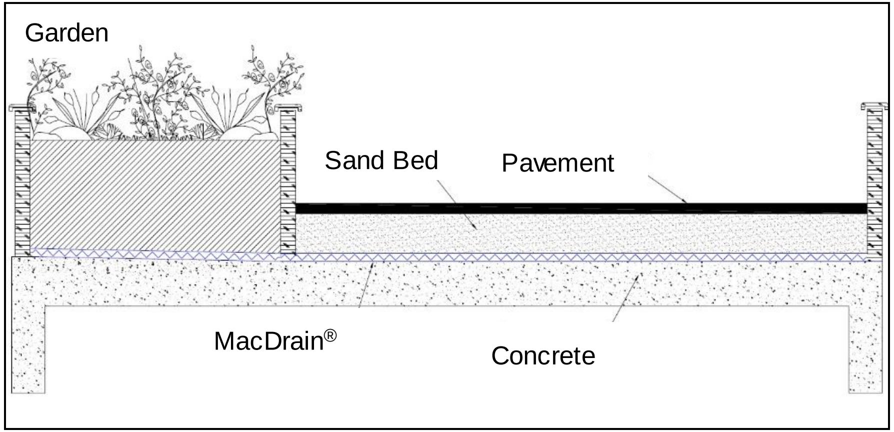
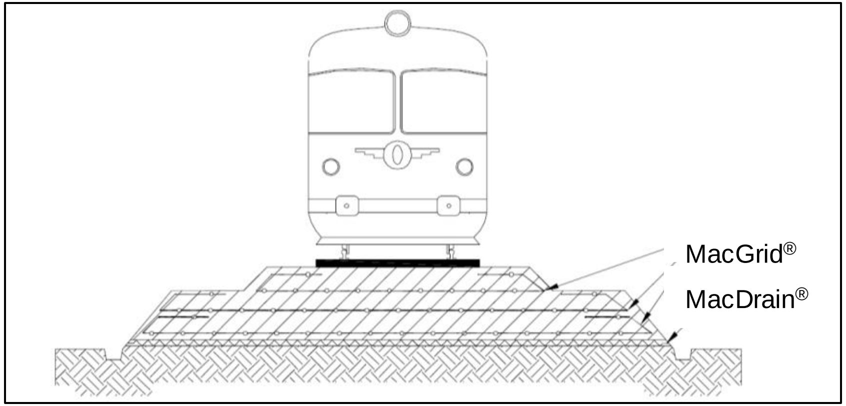
Horizontal Applications





Horizontal Applications

Horizontal Applications

MAIN APPLICATION OF MACDRAIN W

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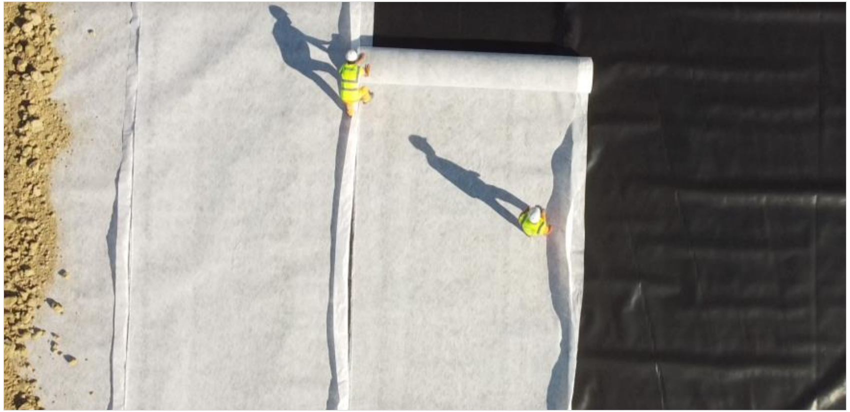
- Retaining wall drainage
- Horizontal drainage for transportation sector
- Anti capillary layer
- Against frost heave
- Draining trenches
- Sport fields
- Leachate collection and gas ventilation in landfills
- Tunnel applications
- Roofing / Noise barrier / Foundation
- Vertical walls



Performance Specification

Key Parameters

Understanding the application is critical to building the performance specification

- Expected volume of water/gas
- Underlying layers
- Overlying layers
- Presence of contaminants
- Expected loading
- Will it be trafficked?
- Design life
- Gradient – slope stability
- Outlet detailing
- Shear interfaces

Performance Specification

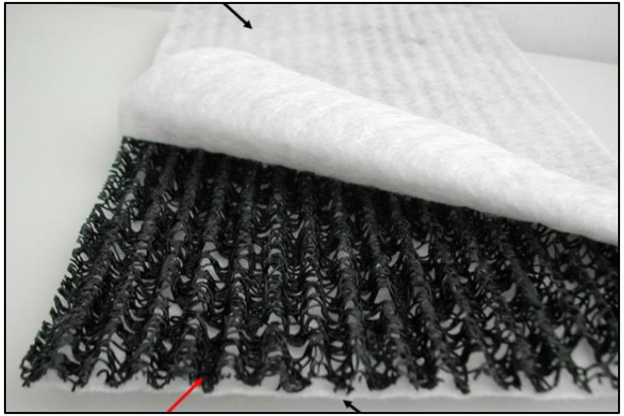
Key Parameters

Permeability and Filtration are functions of the filter geotextile

- Permeability
  - The speed at which liquids and gases can pass through the filter
  - Needs to be greater than that of the adjacent soil
  - Measured under EN ISO 11058 reported as l/m^2.s
  - MacDrain standard geotextile allows 100 l/m^2.s

- Filtration
  - Defines size of particle that can pass through the filter geotextile
  - Creates Terzaghi filter in the adjacent soil
  - Measured under EN ISO 12956 reported as Characteristic opening size (O_{90})
  - MacDrain standard geotextile is 110 micron – suited to most UK soils

Geotextile filter



Drainage core

Geotextile filter

Filter geotextiles can be matched where necessary to allow use of more specialised materials such as PFA.

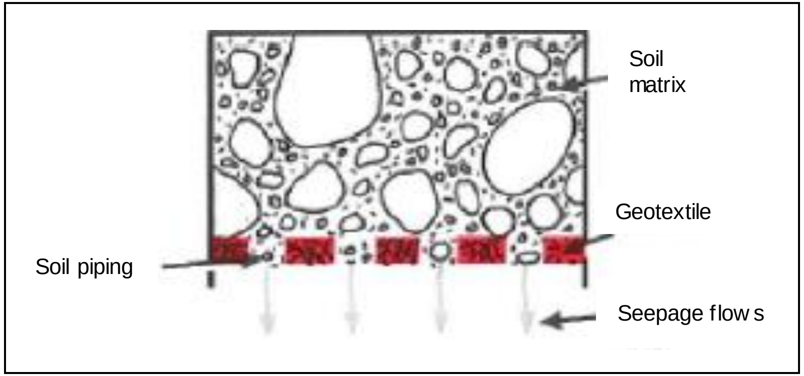
Performance Specification

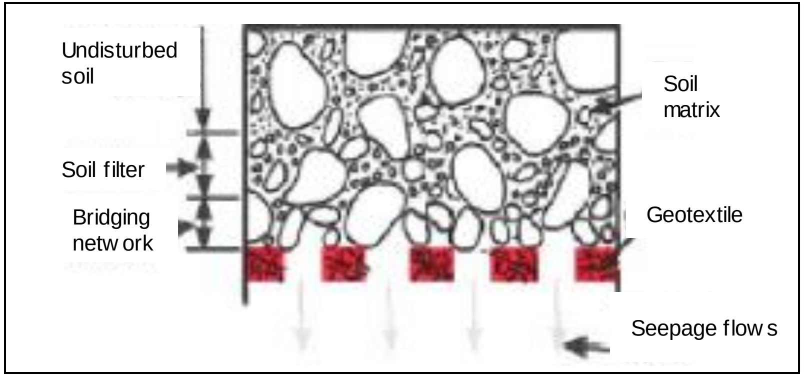
Geotextile Filter

Soil Filter Principle – Terzaghi Filter

Stratification creates 3 zones in the soil:

1. Undisturbed soil
2. Soil Filter
   - Particles get progressively larger as the distance from the geotextile increases
3. Bridging layer
   - Porous, open structure





Once formed it is this soil filter layer which actively filters the water.

Performance Specification

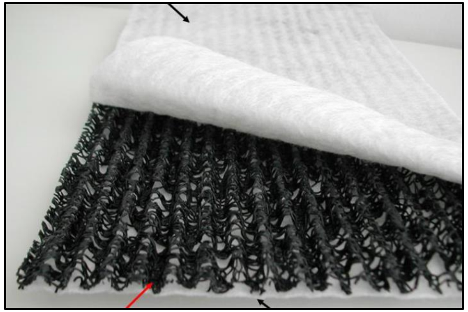
Key Parameters

In plane flow or Transmissivity.

This is the key parameter as it describes the level of drainage provided

- Function of the drainage core
- Measured under EN ISO 12958 reported as l/(m.s)
- Affected by pressure and hydraulic gradient

Geotextile filter



Drainage core

Geotextile filter

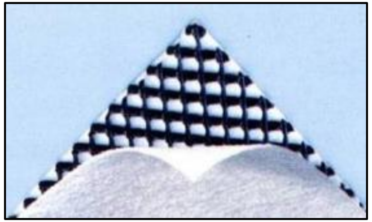
MacDrain M

- 10-22mm flexible core structure
- Very high void ratio
- High flow
- Low pressure applications

MacDrain W

- 4-10mm flexible core structure
- Very high void structure
- High flow
- Medium to high pressure applications

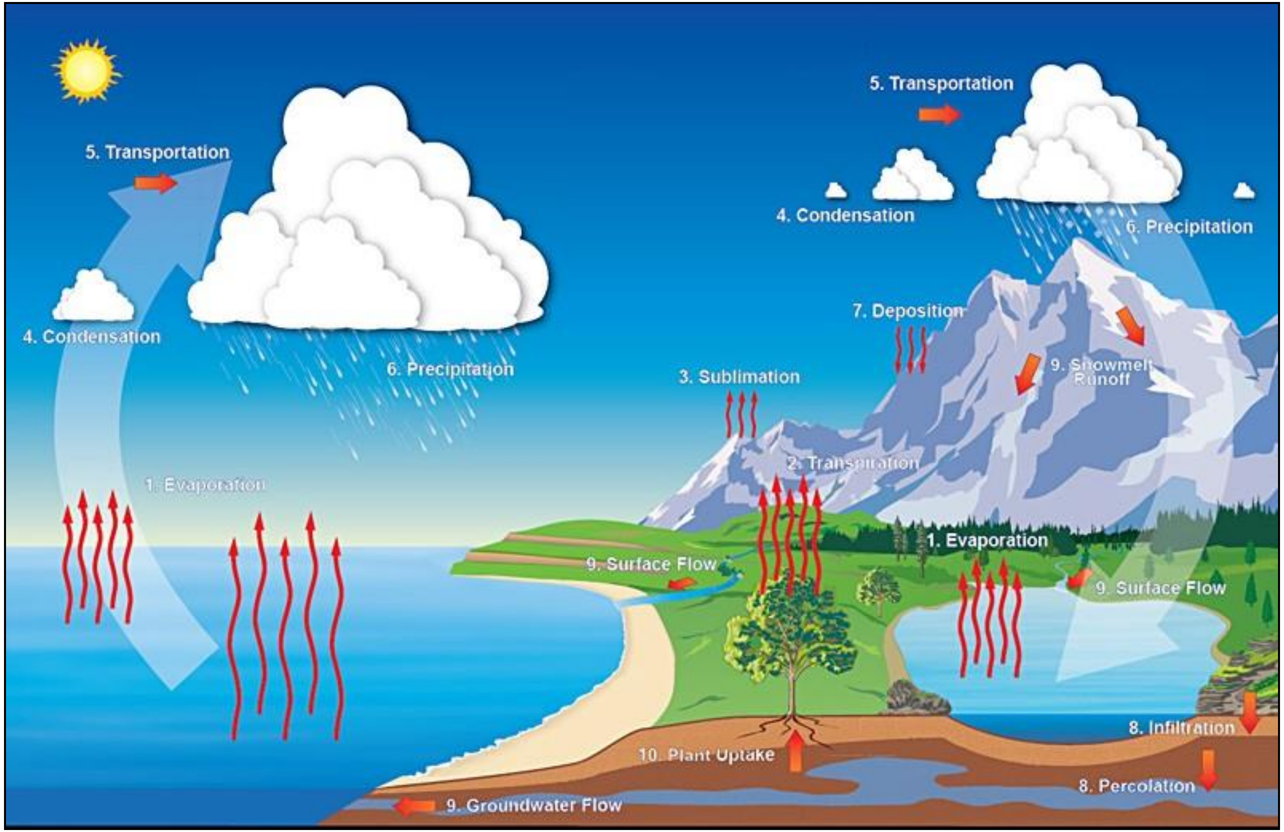
MacDrain N



- 4-10mm flexible core structure
- Very high void structure
- Low flow
- High pressure applications

Performance Specification

The Water Cycle



Performance Specification

Darcy's Law

The movement of water through soil is represented by Darcy's Law

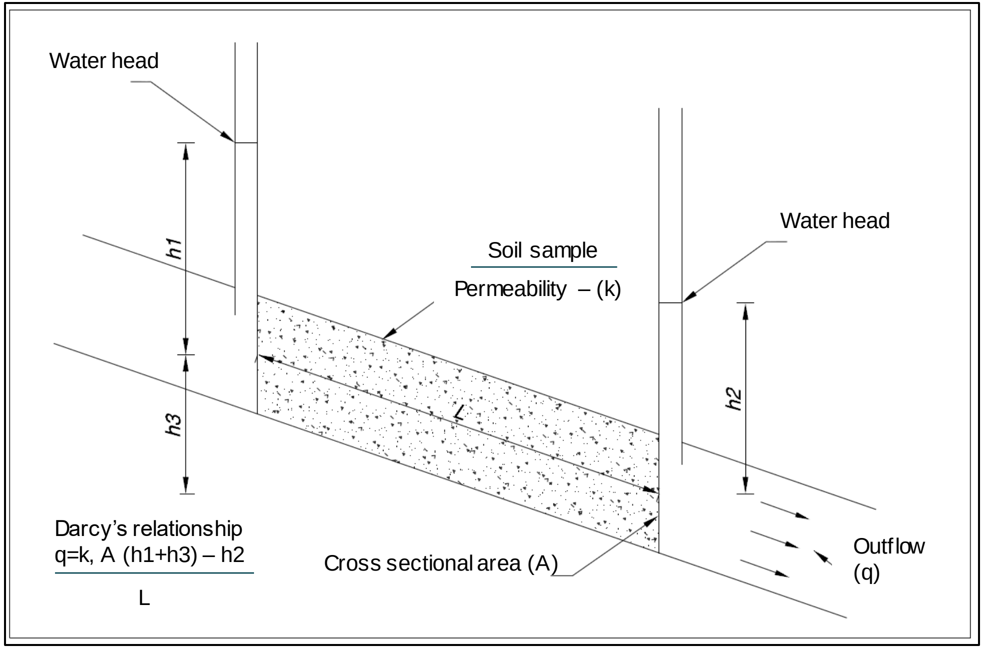
$$\frac{\partial Q}{\partial t} = K \cdot A \cdot \frac{\partial h}{\partial l}$$

Where:
∂Q/∂t = volumetric flow rate of water through the soil
A = bulk cross-sectional area through which the flow occurs
h = hydraulic head
l = distance travelled by the bulk water flow
∂h/∂l = hydraulic gradient
K = hydraulic conductivity or coefficient of permeability of the soil.

This is commonly simplified to

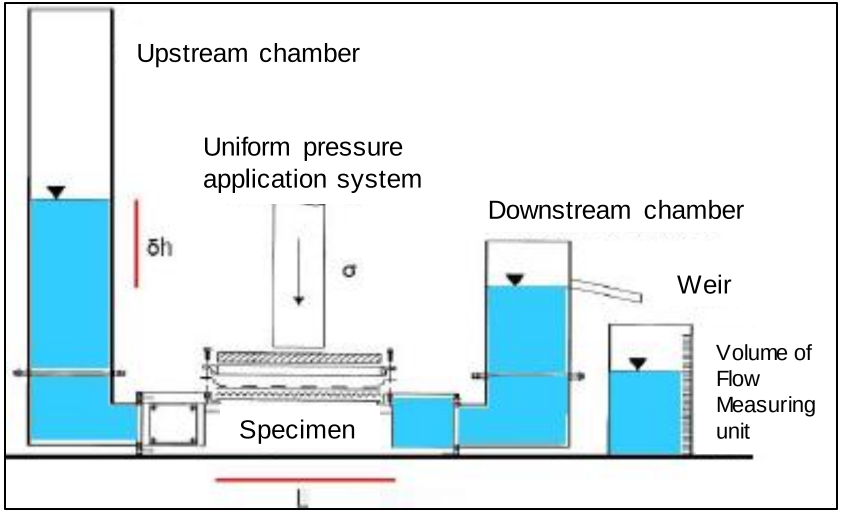
q = K A i

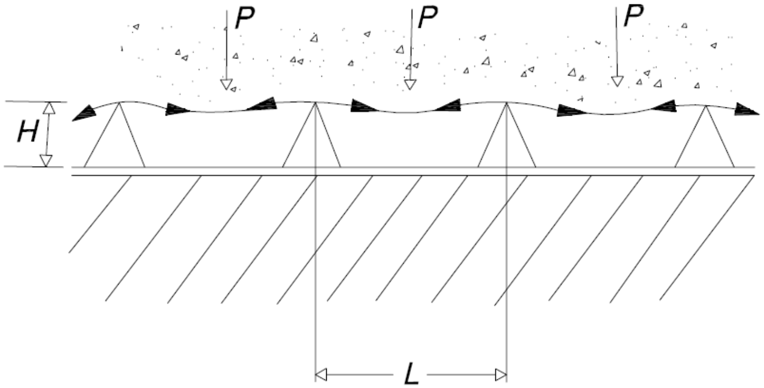
Where:
q = (∂Q/∂t) in Equation 1 = volumetric flow rate
i = (∂h/∂l) in Equation 1 = hydraulic gradient.



Performance Specification

In Plane Flow Testing – EN ISO 12958





- Thickness of the geocomposite (H)
- Distance (L) between the support points of the geotextile filter
- Pressure (P) on the filter
- Strength, modulus and tensile creep of the geotextile filter
- Deformability of the material in contact with the geocomposite

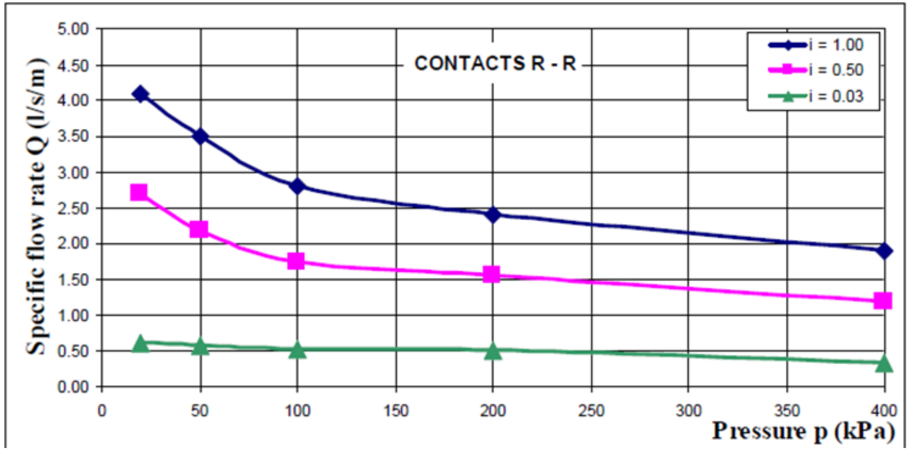
Performance Specification

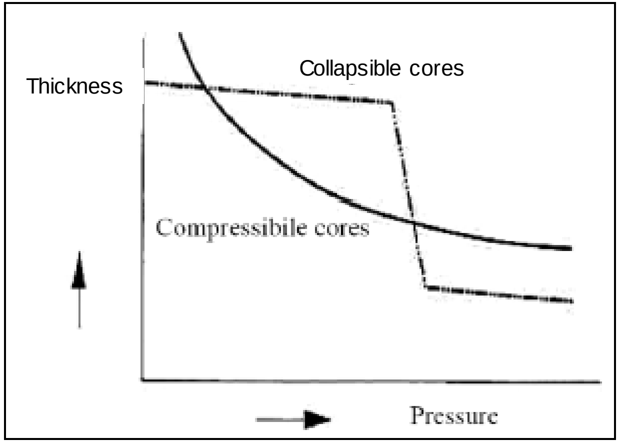
Hard or Soft?

Drainage Flow Capacity (l/s/m) measured with ISO 12958 test *(Test run in SKZ Laboratory)*									
Configuration	120 g/m² gtx + HDPE geonet + 120 g/m², Thickness at 2 kPa = 5,45 mm								
Contact	hard/hard			hard/soft			soft/soft		
Gradient	0.1	0.3	1	0.1	0.3	1	0.1	0.3	1
σ = 20 kPa capping	**0.241**	**0.520**	**1.026**	**0.116 RF=2.1**	**0.287 RF=1.8**	**0.653 RF=1.6**	**-**	**-**	**0.505 RF=2**
σ = 100 kPa Slope in New Landfill Hr = 20 m ; φ'r = 25º ; dr =12 kN/m³	0.221	0.462	0.909	0.086 RF=2,6	0.204 RF=2,3	0.453 RF=2,0	-	-	-
σ = 200 kPa Slope in New Landfill Hr = 40 m ; φ'r = 25º ; dr =12 kN/m³	0.198	0.400	0.839	0.045 RF=4,4	0.094 RF=4,3	0.259 RF=3,2	-	-	-

Performance Specification

Effects of Time and Pressure





Capacity decreases as the confining pressure increases

Flow tests show short term performance. Compressive creep reduces capacity in the long term

Not all drains are equal!

Compressible cores as used in MacDrain are not susceptible failure due to collapse

Predictable behaviour allows predictable design

Performance Specification

Reduction Factors

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

Where:

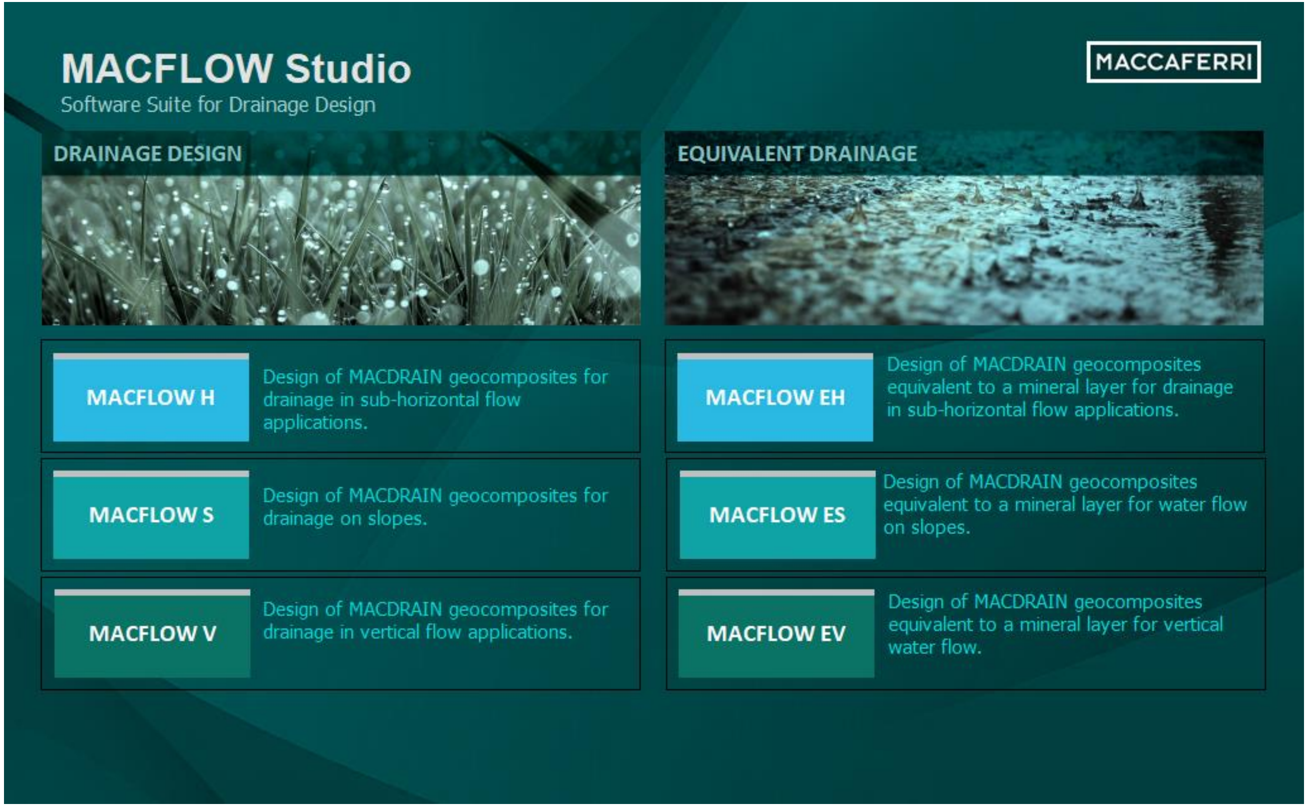
Q_a = available long term flow rate for the geocomposite;

Q_L = short term flow rate obtained from laboratory tests;

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)		

Performance Specification

Design Software



Performance Specification

Design Software

MACFLOW H | MACFLOW Studio
Software Suite for Drainage Design

MACCAFERRI
www.maccaferri.com

Client:

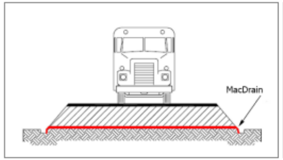
Project Information

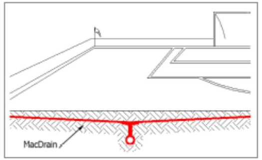
Title:
Number:
Client:
Designer: Jim Herbert

Description:

Horizontal Drainage with MacDrain

MacDrain® drains fluids underground from one place to another. Geotextiles attached to the drainage core on one or both side stop the materials or soils being drained clogging the drainage core or collection pipes. They are designed to replace traditional drainage materials such as gravels and sands. Left in place, water within a structure or the ground can weaken it, affecting the performance of the structure.





Input

Geometry

MacDrain length along slope [m]	18.5
Slope of MacDrain (V / H <= 10%) [%]	10
Coefficient of infiltration	0.05

MacDrain application

Type	**Civil engineering aplications**
Contact type	**S/S (Soft/Soft)**

S/S (Rigid / Rigid):

Both contact surfaces are soft.
Examples:
1. MacDrain inside a trench drain.
2. MacDrain as a draining mattress between two soil layers.

Soil / Material on MacDrain

Saturated unit weight [kN/m3]	10
Thickness [m]	1
Distributed surcharge [kN/m2]	30

Water or liquid to be drained

Water temperature [ºC]	20
Given dynamic viscosity of liquid [cP = 10E-3 Pa.s]	1.8

Rain

Parameter a [mm/hour-n]	150
Exponent	0.62
Duration of critical rain [hours]	1
Given rain height in 1 hour [mm]	0

Additional surficial flow rate

Surficial input flow in MacDrain [l/s/m]	0

Safety Factor

Input flow	1.5
Gtx intrusion	1.3
Compressive creep	1.5
Chemical clogging	1.5
Biological clogging	1.5

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Software Suite for Drainage Design

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Client:

Results

Design Calculation

Reference water temperature [ºC]	20.00
Reference dynamic viscosity [cP = 10-3 Pa-s]	1.01
Design dynamic viscosity [cP = 10-3 Pa-s]	1.80
Correction for liquid temperature and viscosity	0.56
Maximum pressure on MacDrain [kN/m2]	40.00
Hydraulic gradient	0.100

Design Calculation

Rain height for design duration [mm]	150.00
Rain intensity for design duration [mm/h]	150.00
Input flow in MacDrain for filtration [l/s/m]	0.038
Total flow in MacDrain [l/s/m]	0.038

Design Input Flow in MacDrain

Design input flow for MacDrain [l/s/m]	0.058

Optimum solution is MacDrain W Range.
Specific MacDrain selected is:

MacDrain	Contact	QL [l/s/m]	Qa [l/s/m]	Safety Factor	Result
W1091	S/S	0.27	0.06	1.03	OK
W1101	S/S	0.29	0.07	1.21	OK

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360° SUPPORT FOR YOUR PROJECT

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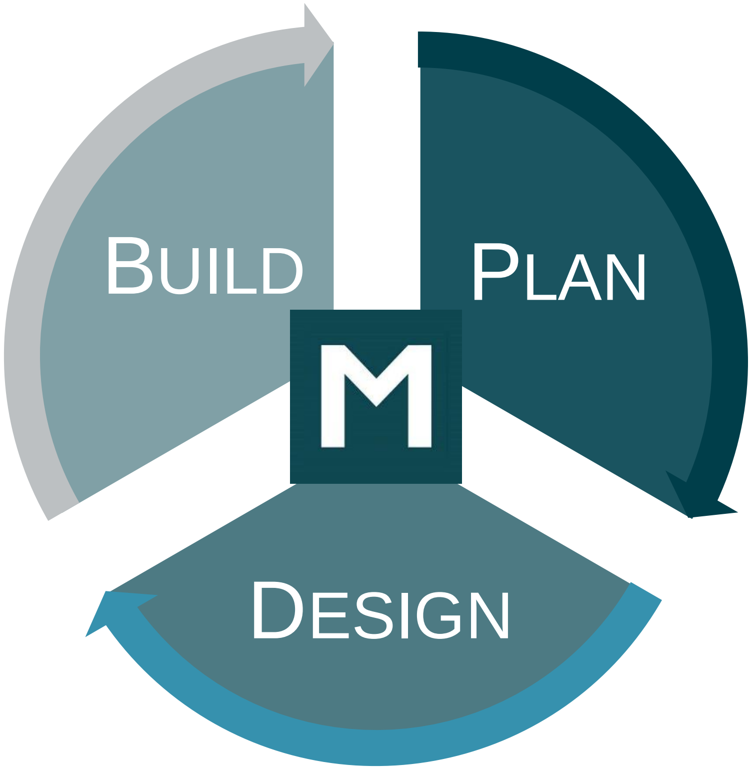
Maccaferri is always side by side with engineers, architects and builders



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

Thank you

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