Belgian Member Society of

Drainage en grondwaterbeheersing met geokunststoffen'

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

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Our vision for 2025

Safety - Reducing personnel onsite activity by

25%

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

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

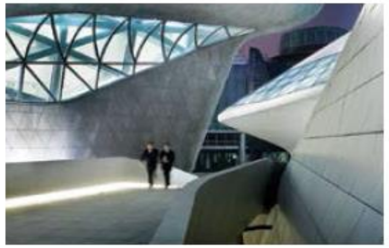
Improvement in exports

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)

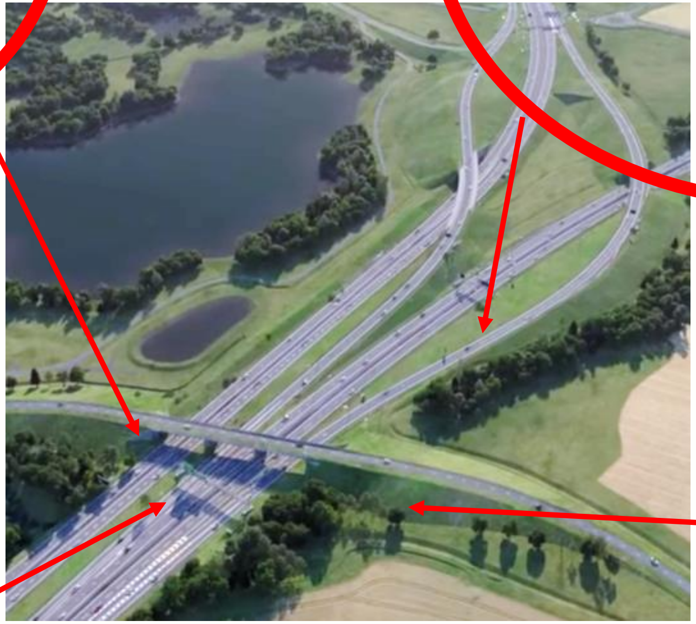
Geosynthetic Drainage Geocomposites in Civil Engineering

Structural Drainage—replace concrete

Starter and Consolidation Layers—replace stone blankets

Geocomposite
- starter layers
- consolidation layers

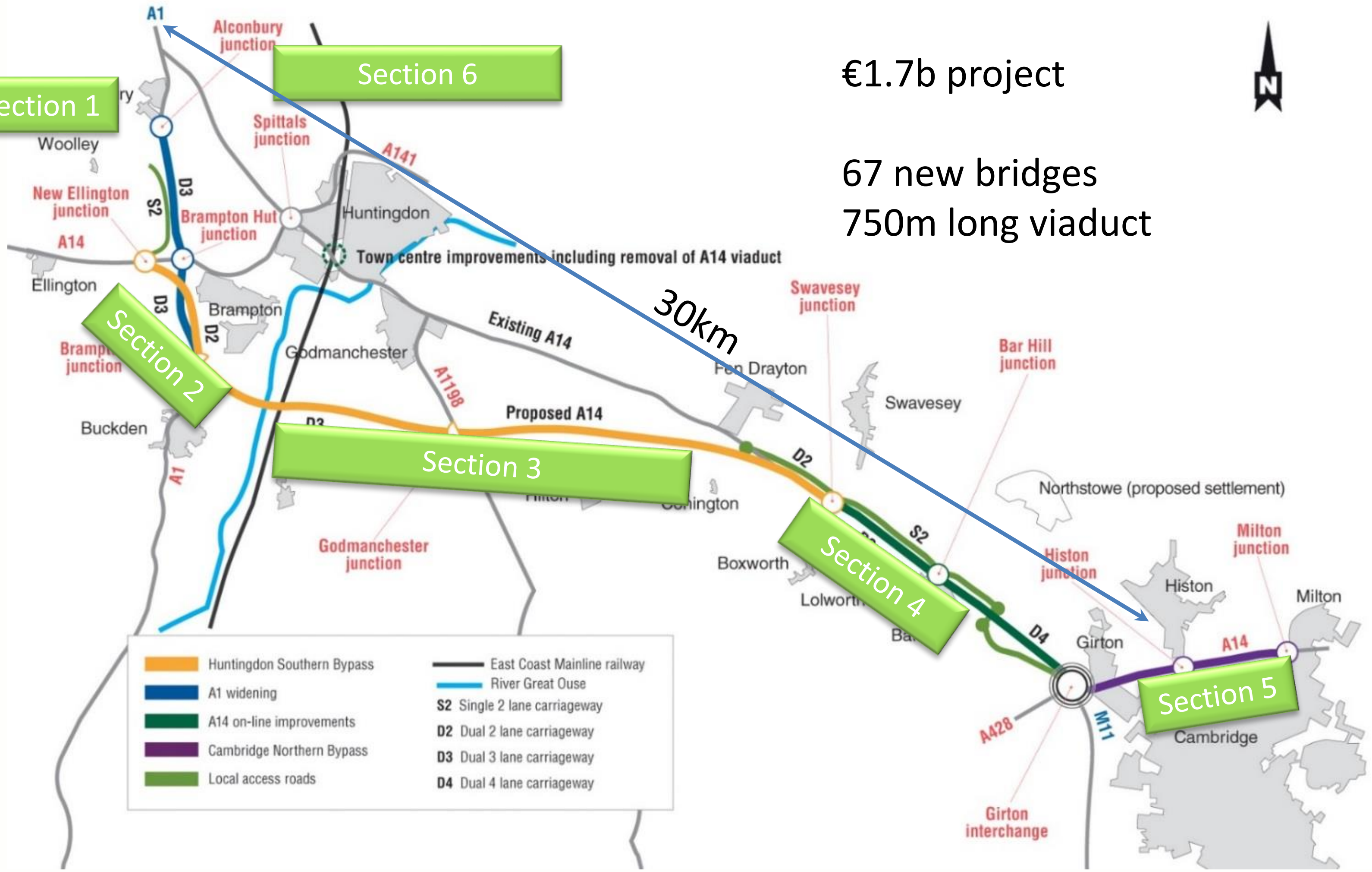
Geocomposite
- back of wall drain



Highway Drainage—replace french stone drains

Counterfort Drainage—replace stone herringbones

CASE STUDY:
A14 Huntingdon to Cambridge



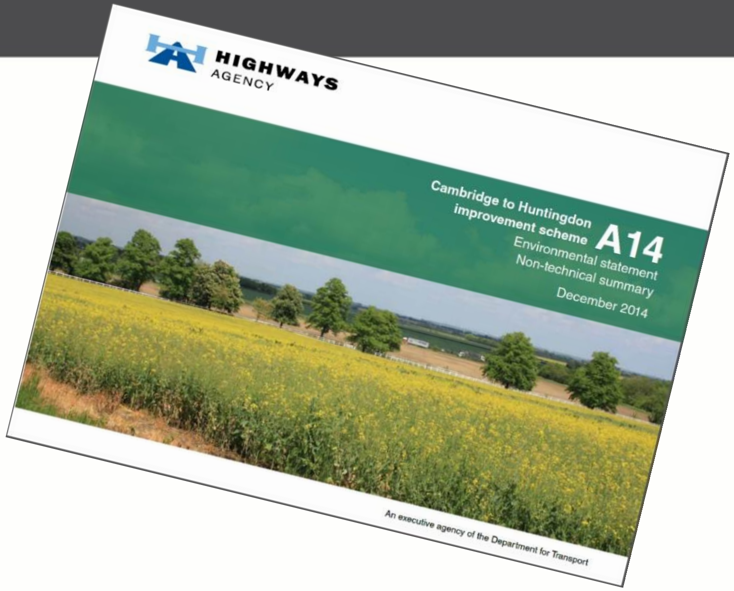
Joint Venture all represented on each section
3 main contractors
2 main consultants

€1.7b project

67 new bridges
750m long viaduct

JV appointed Environment & Sustainability Director

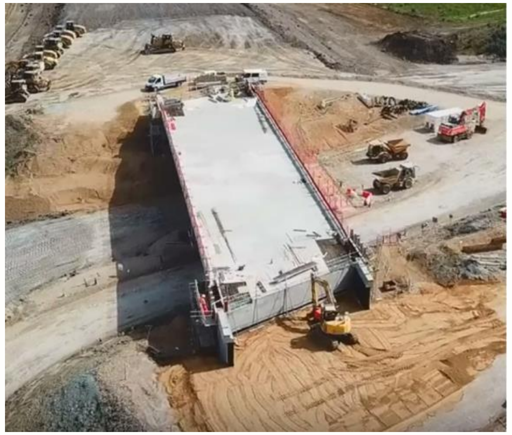
Environmental Impact statement



- 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 save Carbon
  - Site target save 20% carbon every quarter above specification

A14 Structural Drainage to Buried Structures



Wing walls

Abutments

Culverts

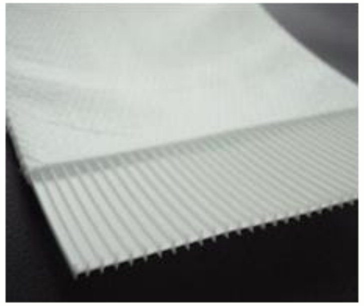
Retaining walls

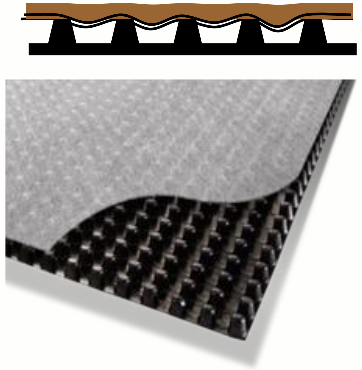
Geocomposite drains


2D geonet

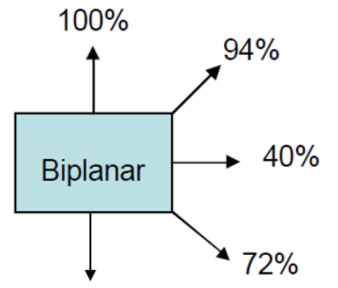

3D geonet

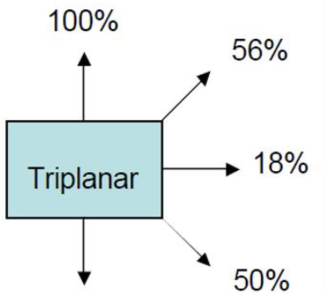

Fibre core

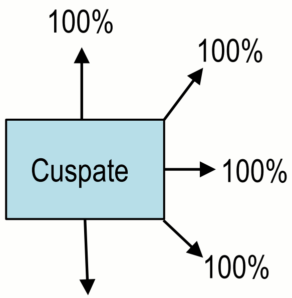

Ribbed core


Cuspated core


“Wallpapering” preparation







Retaining wall

Drainage Options

- speed of flow

Specified alternatives

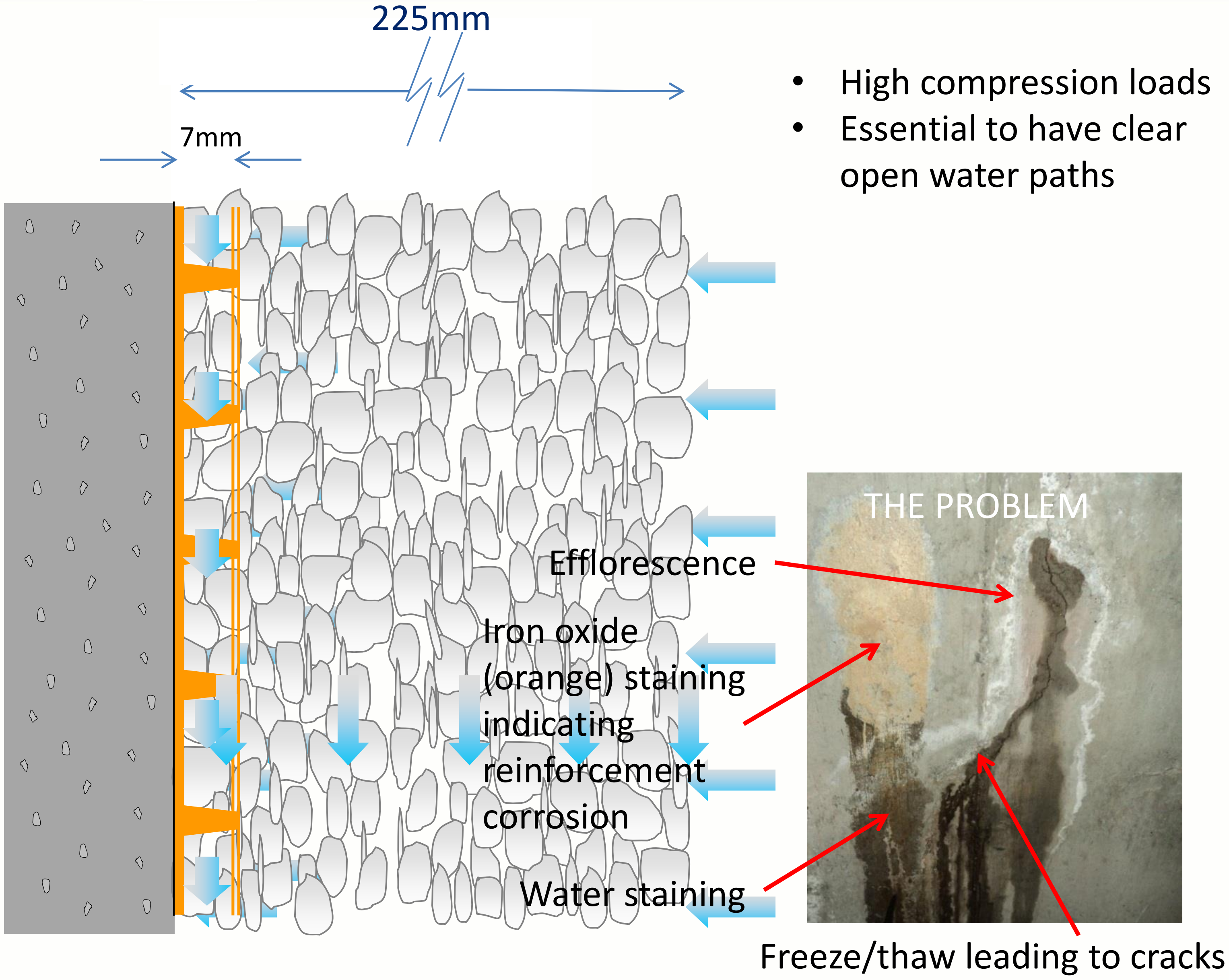
- No fines concrete or concrete block filled with stone (k = 1 x10^{-4} m/s)

  - *(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

Specified - Back-of-wall Drainage

Porous CONCRETE Blocks filled with drainage gravel

Some problems…

- Heavy to transport <u>to</u> site
- Heavy to transport <u>on</u> 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

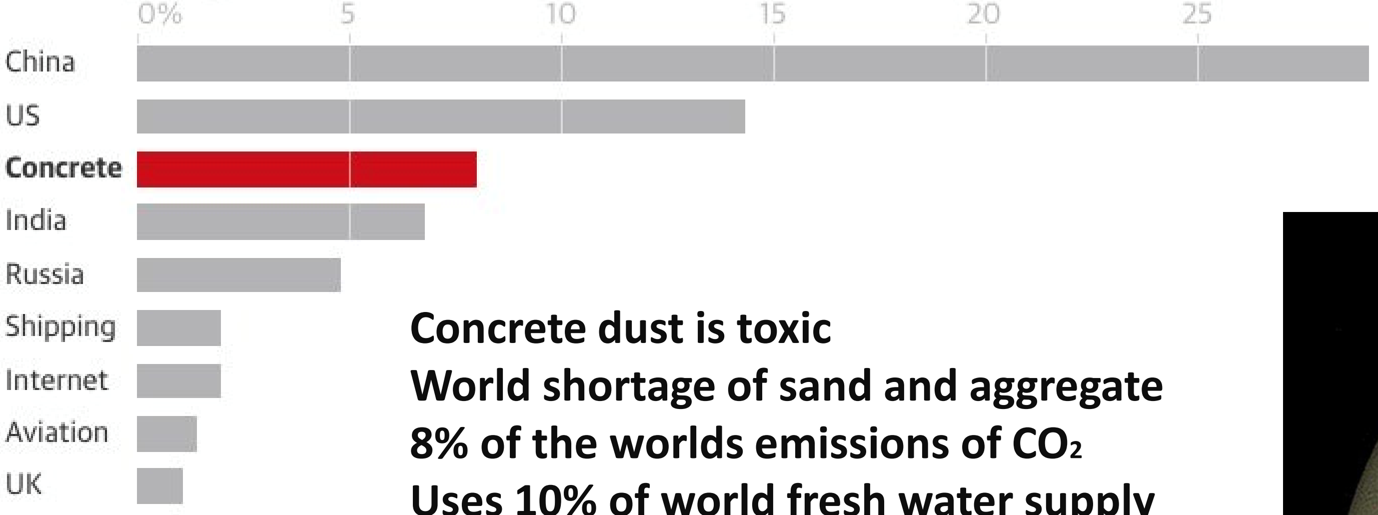
Polluting the air

Concrete

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

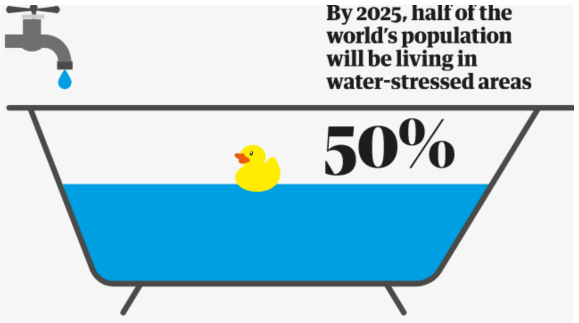
If concrete was a country it would be the third largest carbon emitter in the world

Percentage of global carbon emissions



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

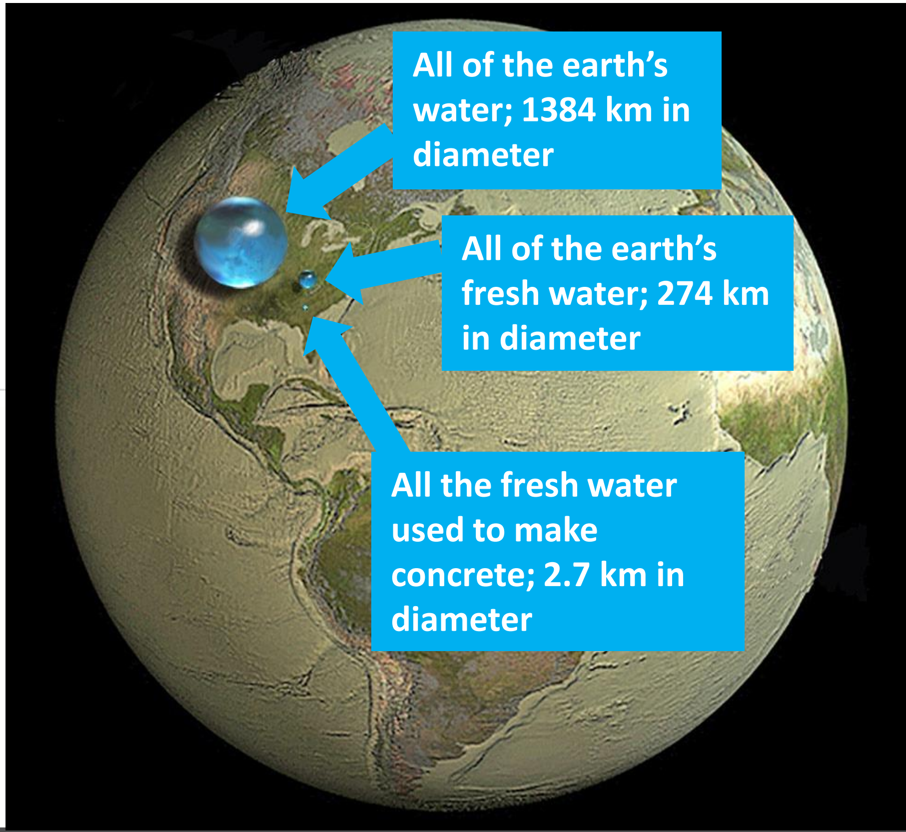
Guardian graphic | Source: UN environment, Chatham House



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.

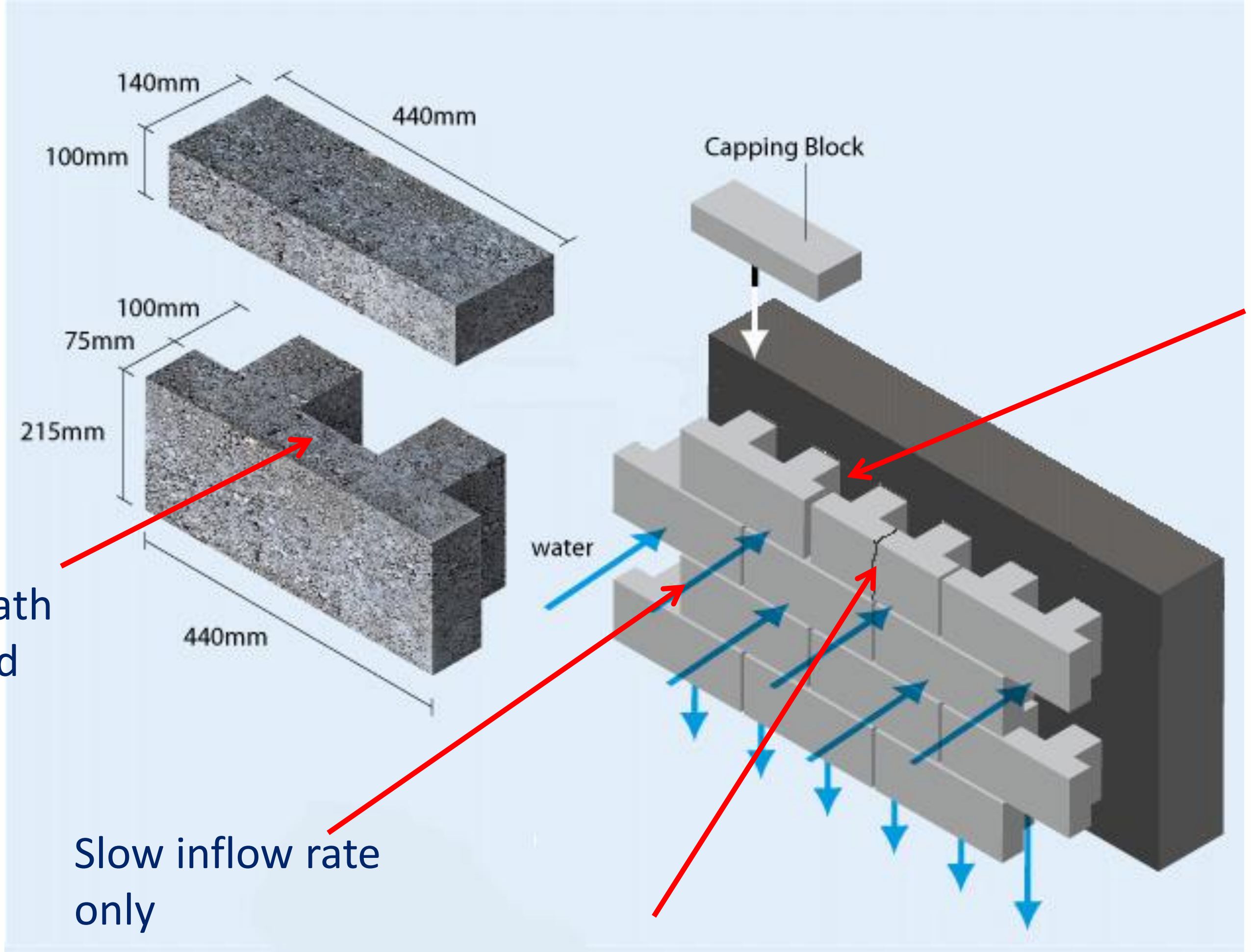
The sand complying with the specification of the project had to be transported from

… Australia!

Although Dubai is essentially covered by sand

– it does not have the correct properties for concrete

Function – hollow concrete blocks



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

Thick filter path easily clogged over time

Slow inflow rate only

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

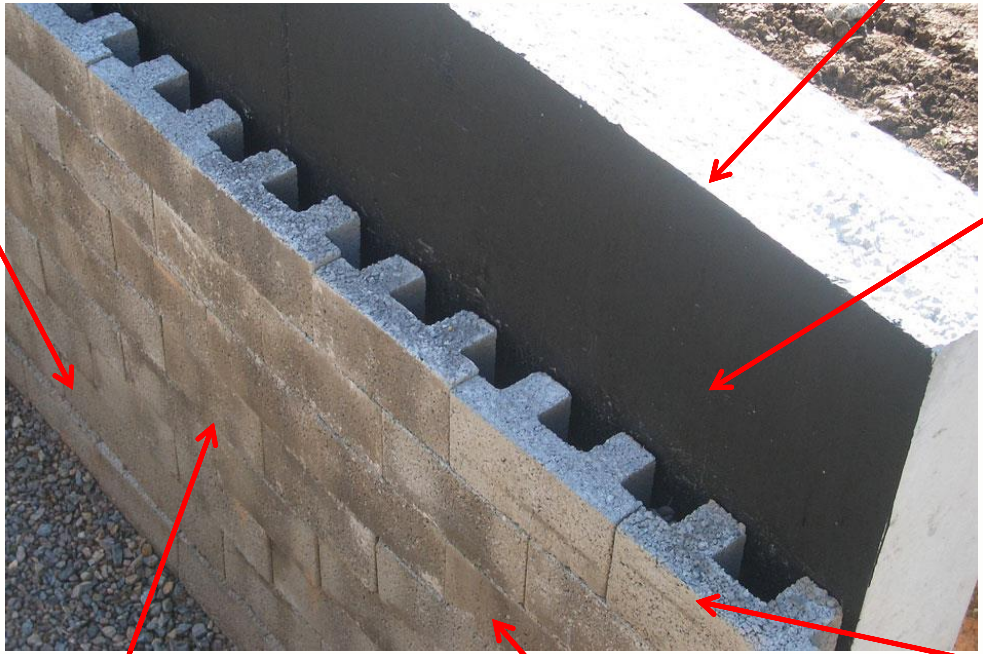
Safety and sustainability in placement

Hard to cut blocks to fit structure finished level

Slowly placed in advance interrupting backfill operation

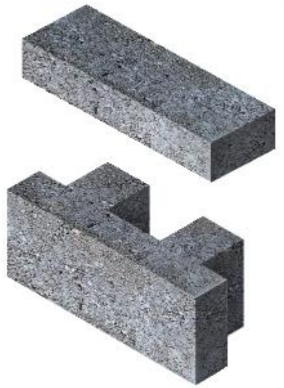
Damages waterproofing during installation and backfill operations

Easily broken during placement and backfill



Fill with selected drainage stone
Secondary operation

Unstable and dangerous above a few blocks high



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.....

= 1 of these

Blocks

Drainage Geocomposite

Infill stone

Installation speed and safe handling - Blocks

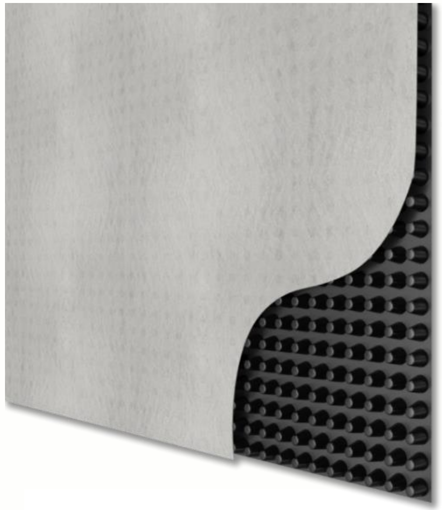
550 of these…..

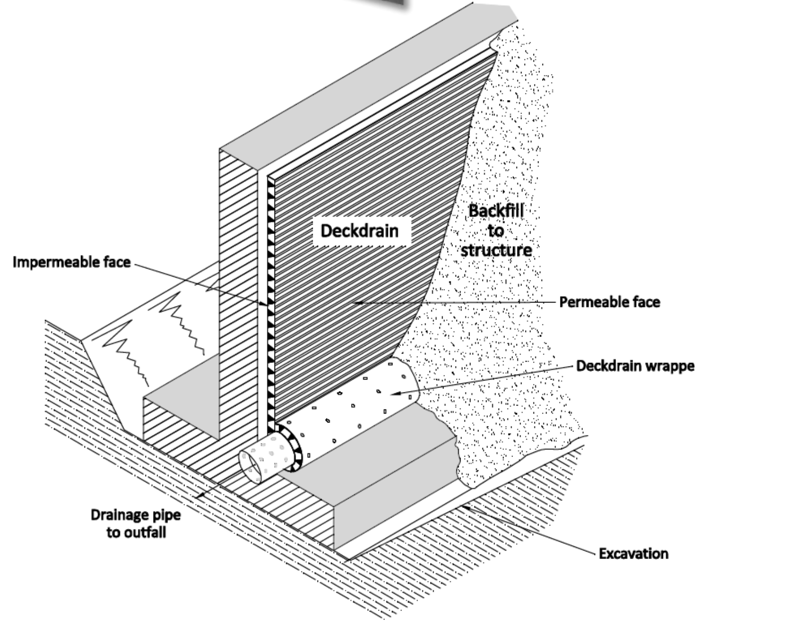
= 1 of these

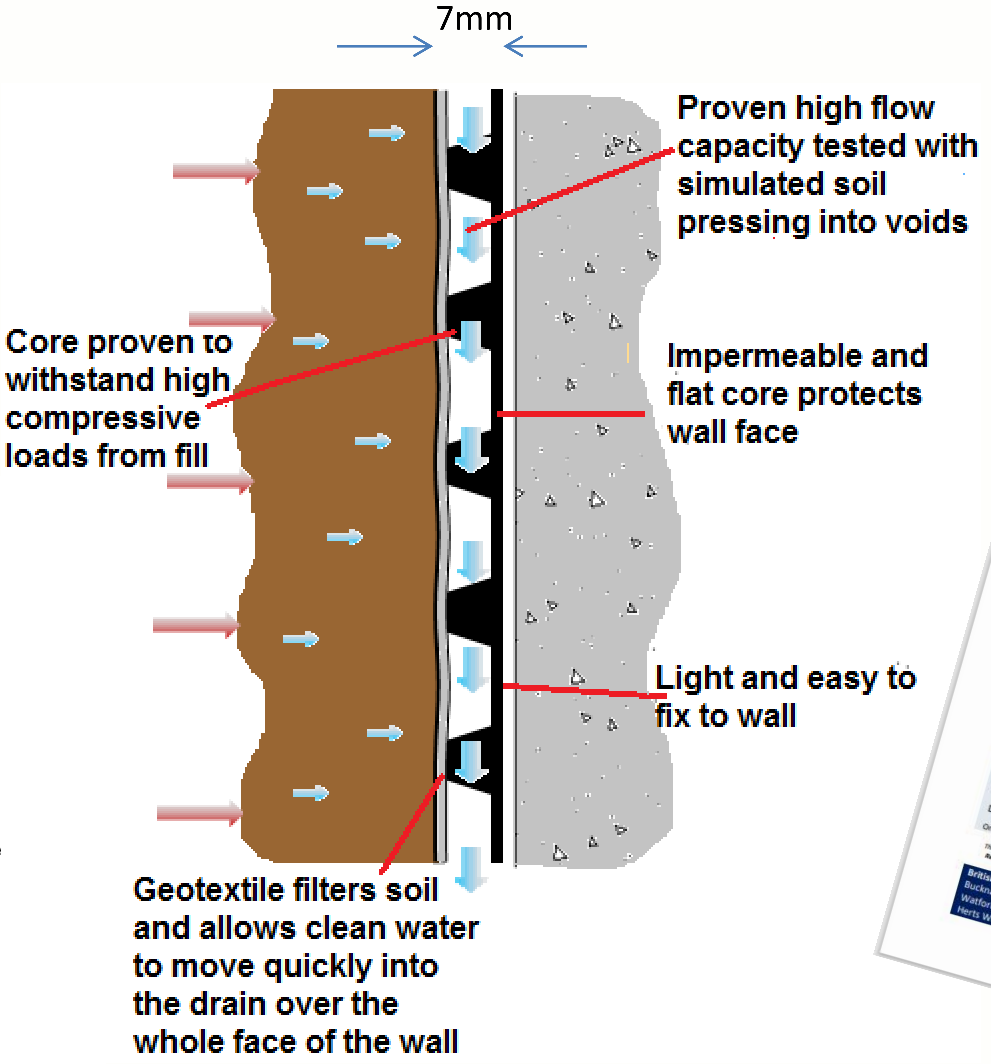
0.44 x 0.23
= $0.1m^2$

25m x 2.2m
= $55m^2$

Function - Geocomposite **PLASTIC** Wall Drains





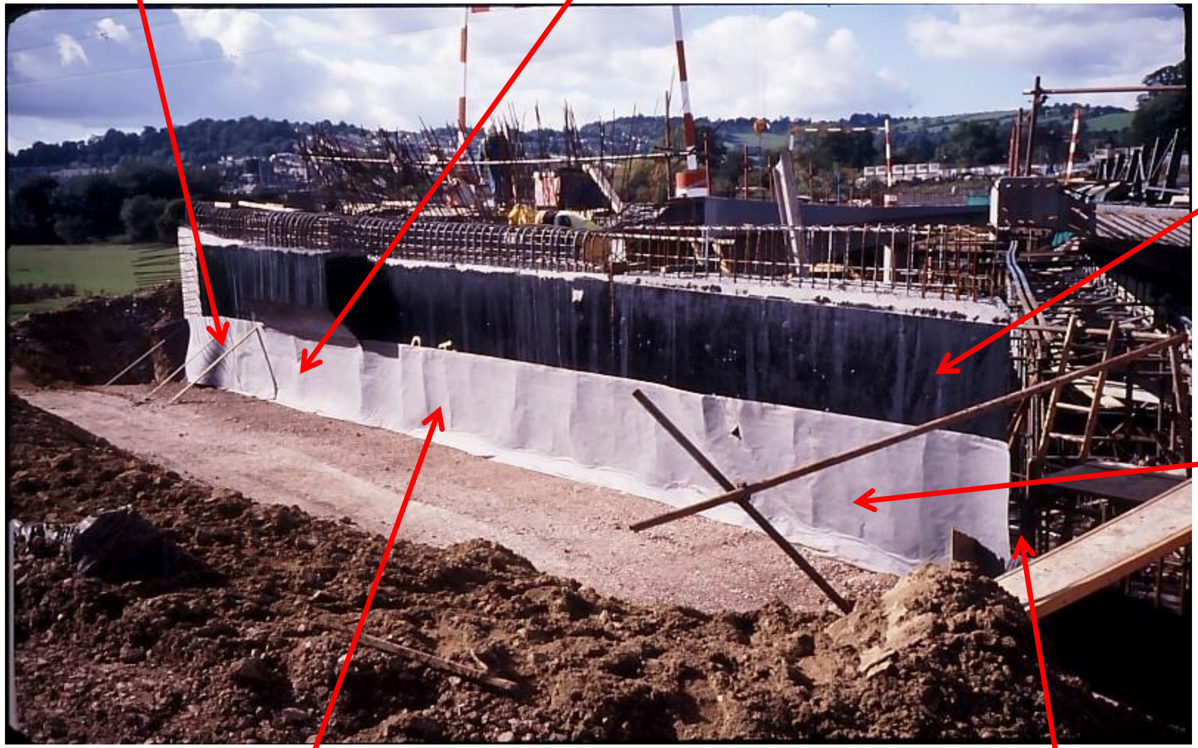


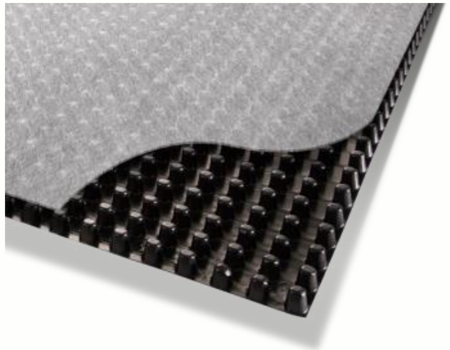
Drainage Geocomposite

Easily fixed to wall

Placed in advance enabling uninterrupted backfill operation

Protects waterproofing



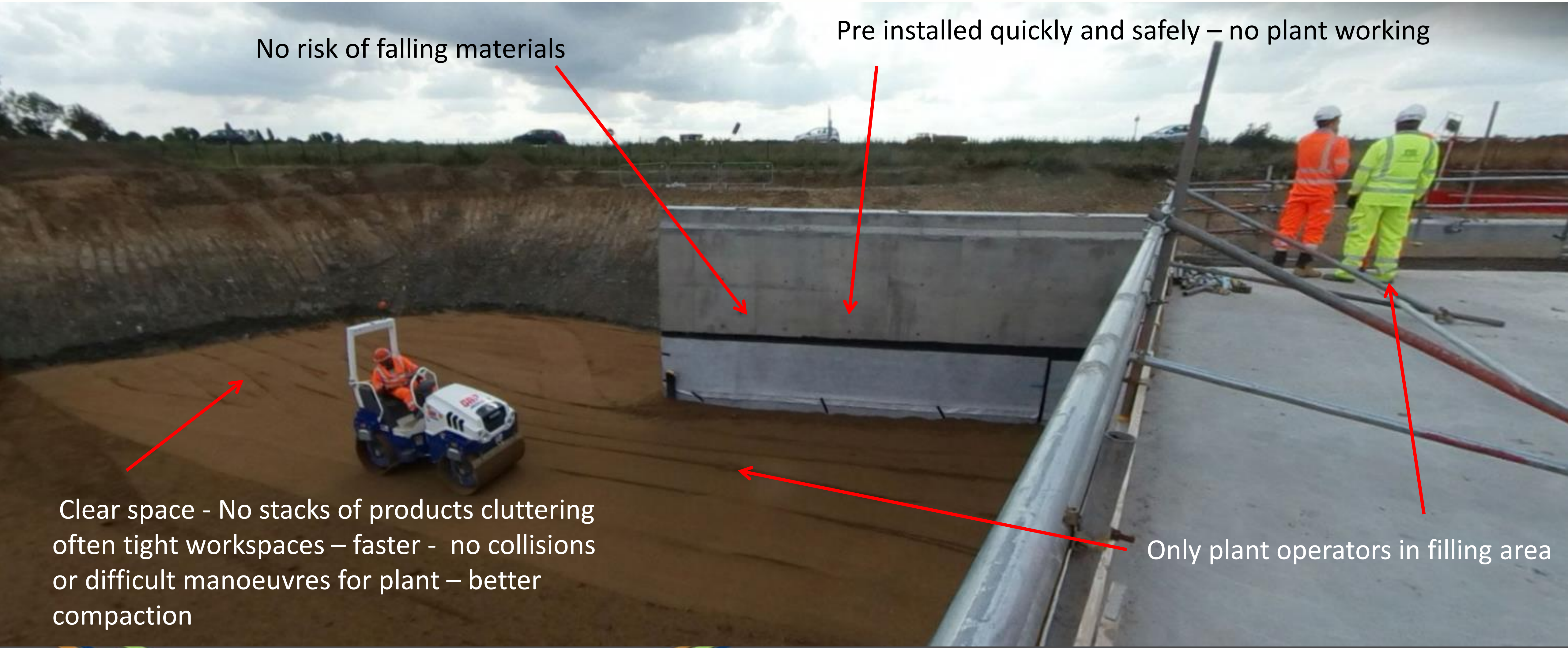


Easily shaped and jointed round abutment contours but maintaining flow path

Easy to work in tight spaces

Drainage geocomposite

Safety & reduced activity

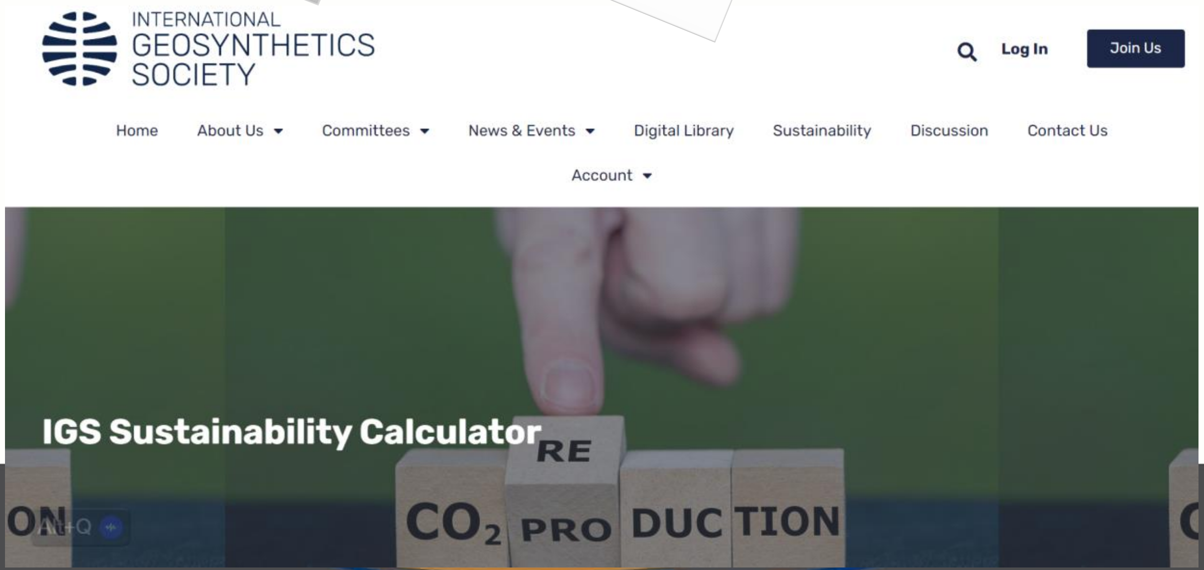


Analysis of the carbon footprint of geosynthetics

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

B

C



A

D

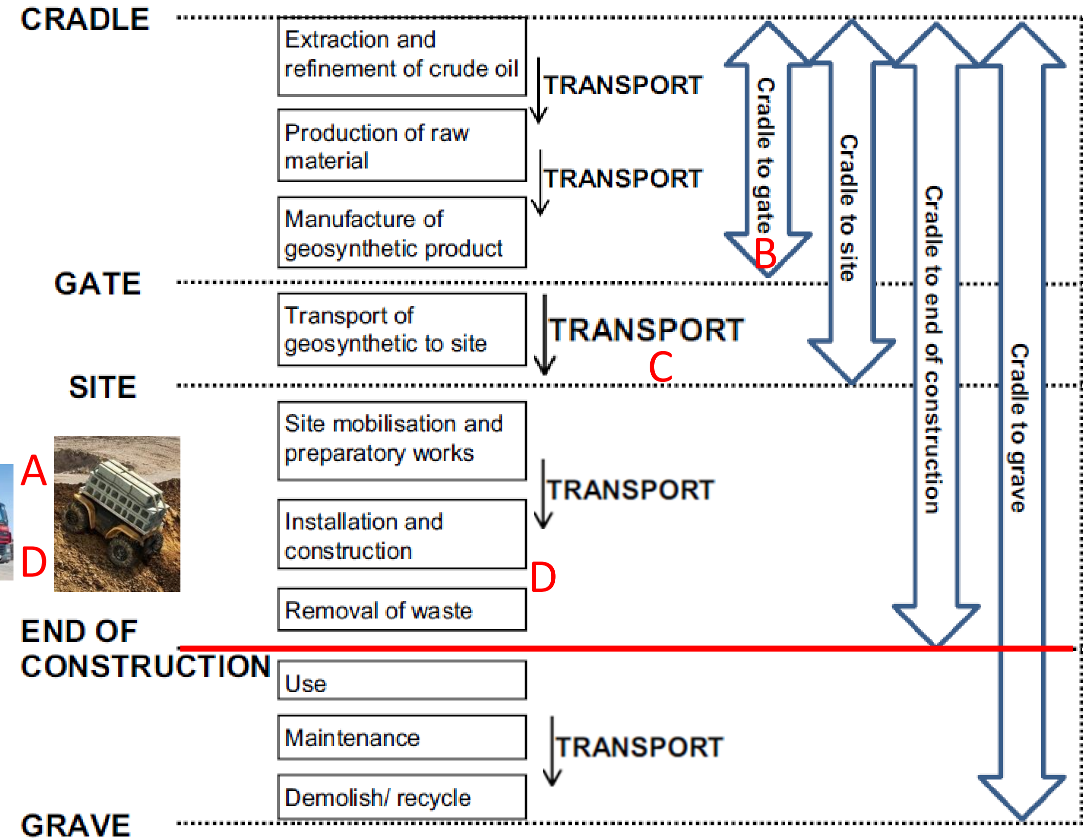


Figure 1. Life cycle boundaries employed in CO_2 analysis of geosynthetics

Output – comparison for one roll of geocomposite - per 55m^2

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%** ✓

94% CO2e reduction ✓
Geocomposite v hollow concrete blocks

= 1 of these

550 of these…..

BontexGeo
Leading in Geosynthetics

www.abgltd.com

AWARD Winning

A14 Internal Site Sustainability Award Winner

Ground Engineering Sustainability Awards Finalist with A14 team for ABG Deckdrain

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.

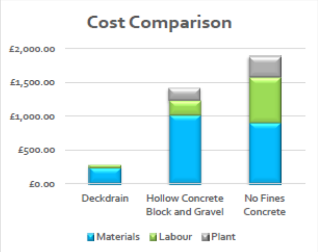
The benefits are not just limited to a reduction in installation time they also include:

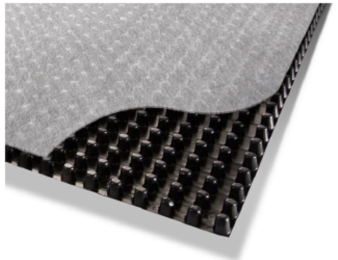
- Reduced material costs
- Reduced labour/plant costs
- More environmentally friendly product
- Lower potential for wastage
- Long life performance
- High flow capacity

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.





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.

84%

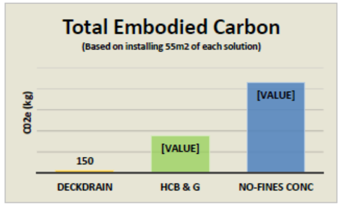
With the reduced installation time of the Deckdrain when compared to hollow block there was an 84% saving in time of installing and there would have been a 92% saving of time in comparison to no fines concrete.

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:

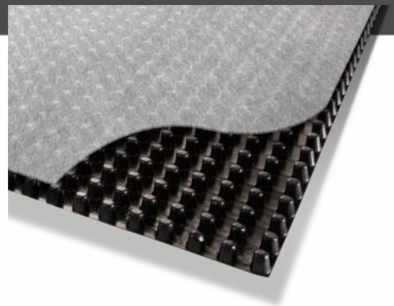


Based on these figures there is a huge reduction in embodied carbon across BN06. The embodied carbon (C02e) realised through installing Deckdrain amounted to 4.17T which compares to 49.7T if hollow block had been used and 119.8T if no fines concrete had been used.

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

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

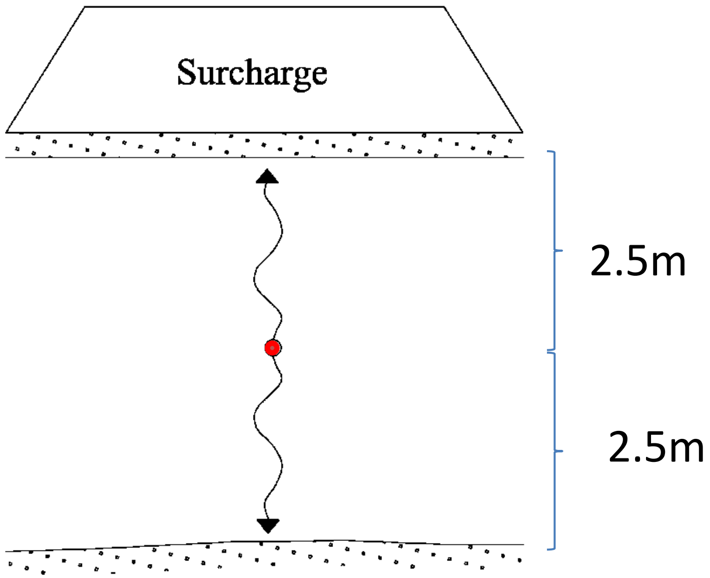
EMPLOYER'S ACCEPTANCE CRITERIA

> ***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…***

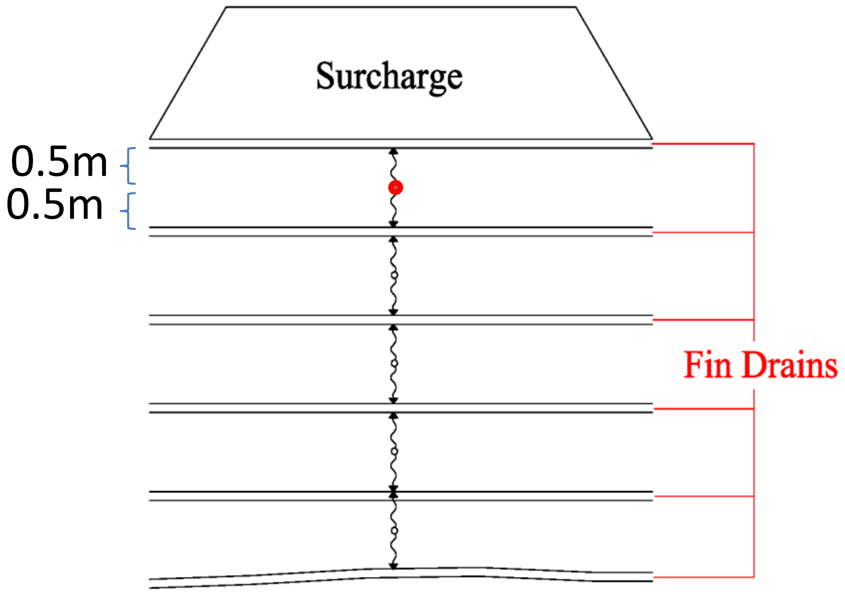
- … a maximum ground loading intensity of **27kPa**,
- … **limit the total settlement of the floor slabs to a max. of 25mm** at end of six months after completion of their construction
- … and shall **limit further settlement to 10mm** after a further six month period.
- Maximum slab differential settlement 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 1/25th 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

Cross Section of ABG Fildrain – double cuspated 7mm thick

- 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

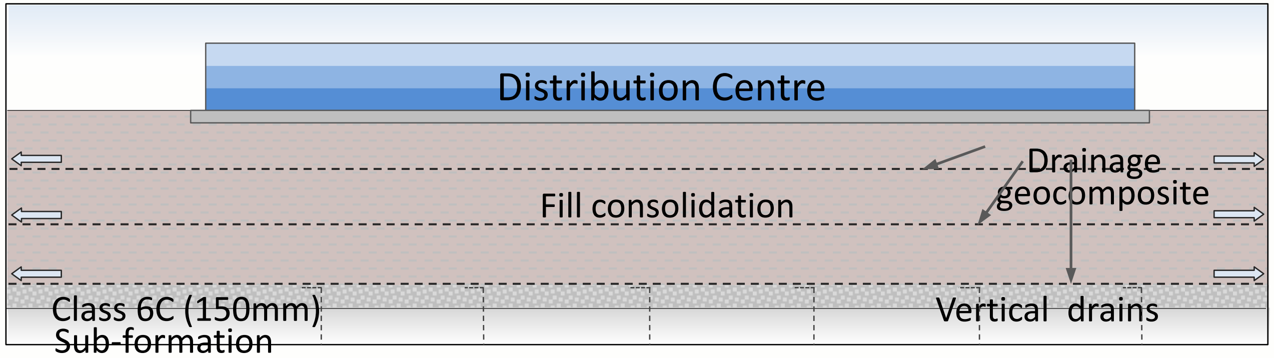
Safety in delivery of aggregates

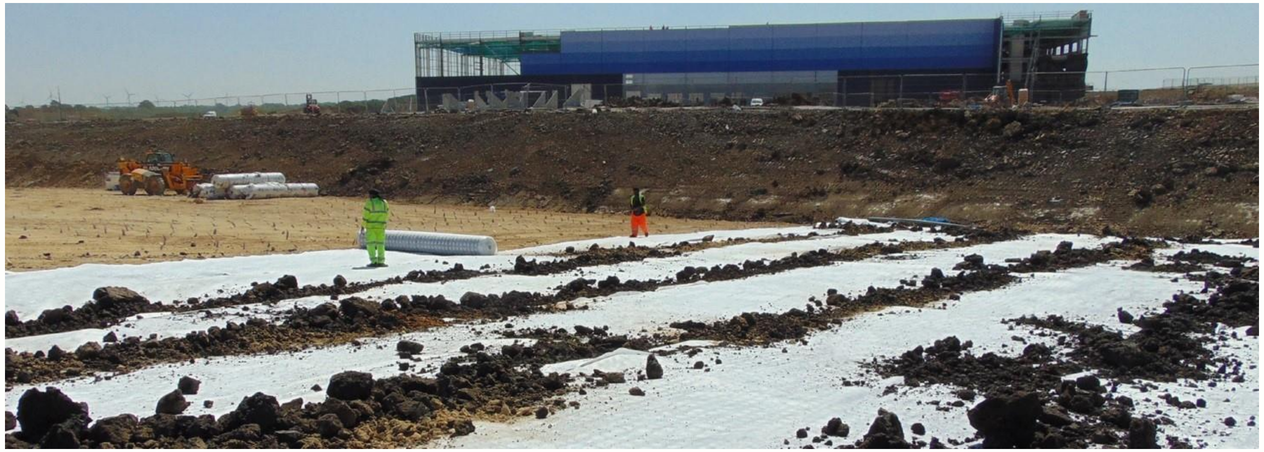
- Road tyre footprint often unsuitable on soft soils
- Some sites implementing a 3degree crossfall limit for tipping
- Limitations on height with overhead power cables or low structures
- Bearing capacity of soil needs to be high for road tippers can vary in poor weather conditions
- Loads can be uneven 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

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Chief Engineer

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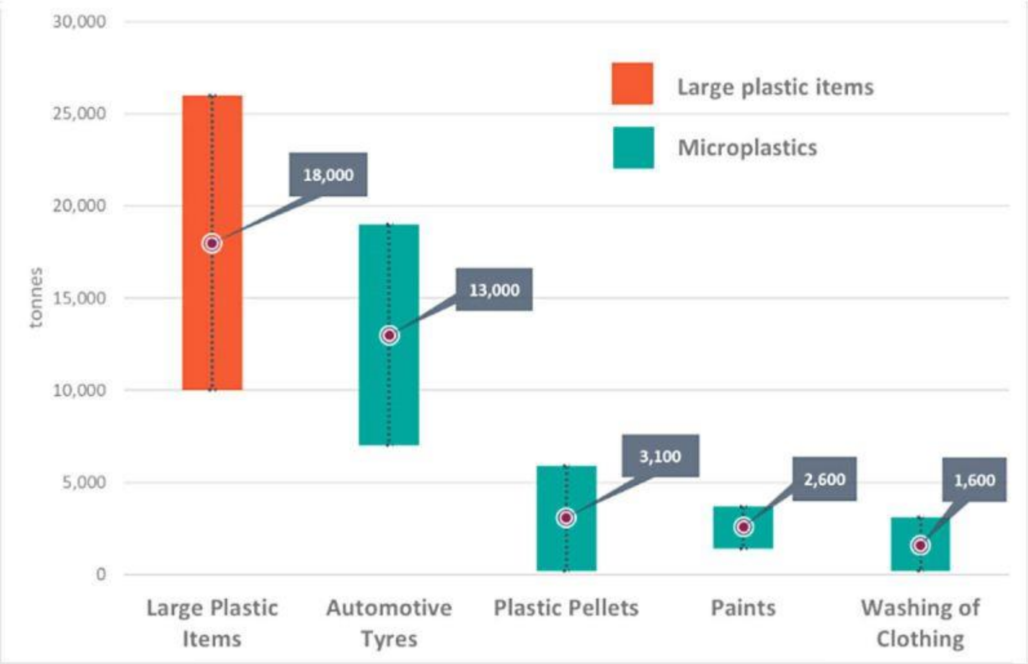
Annual amount of UK microplastics entering surface water after wear or accidental loss

- 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