Building & Urban Infastructure

Geosynthetic systems for sustainable drainage applications

Contents

"The increasing need for SuDS

Stormwater management

In addition to the increasing need to minimise the impact of extreme flooding events, a much more sustainable approach to how we manage surface water is necessary in both urban and rural areas. By embracing the core principles of SuDS, we help to minimise the impact of flooding, whilst also facilitating a more attractive and sustainable landscape in which we work and live.

One of the key strategies to manage our surface water more effectively and minimise the risk of flooding is to install sustainable drainage systems on all new and existing developments.

Historically, new development has involved the construction of large areas of impermeable surfaces, creating heavily polluted stormwater run-off which has been drained into our already overloaded and deteriorating sewerage systems.

This total disregard for source control, and in particular natural infiltration, has significantly contributed to the ongoing problems of extreme flooding, whilst also causing extensive river pollution and limiting groundwater recharge.

A much more creative and sustainable approach is necessary, involving the design of innovative hybrid (both above and below ground) SuDS solutions where our stormwater is effectively managed and when viable utilised as a valuable natural resource.

SuDS source control techniques such as porous paving and green/blue roofs play a significant role in reducing flood risk by managing our stormwater naturally to alleviate the burden on our existing drainage infrastructure.

In addition to incorporating SuDS into all new development, the greatest challenge is the clear need to retrofit SuDS within the existing built environment.

This is essential if we are to achieve our objectives of effective flood risk management and water quality, as well as using water as a resource to improve the environment, promote biodiversity and adapt to ongoing climate change.

The advantages of geosynthetics in SuDS

For more than 60 years, geosynthetics have been used extensively throughout the world to deliver innovative and cost-effective solutions that offer many advantages over 'traditional' construction techniques and help to deliver sustainable solutions.

Geosynthetics are used as the standard method of optimising the structural load carrying capacity of paved areas, leading to improved pavement performance, water treatment, reduced costs and increased longevity.

Both the structural and stormwater treatment benefits of geosynthetics have been recognised and universally adopted in the development of a comprehensive range of SuDS solutions that deliver source control - both above and below ground.

One of the primary benefits of incorporating geosynthetics is that a more sustainable, shallow solution can be achieved which minimises both the risk and cost of construction. This reduced depth of construction also limits the use of natural materials and off-site disposal, which optimises the environmental credentials of a project.

Another prime benefit in the use of geosynthetics is their ability to enhance the water treatment capability of a SuDS system. Source control solutions rely upon a series of treatment stages in order to achieve an acceptable quality of discharge water, and geotextiles and geocomposites in particular have an important role to play in achieving this increasingly onerous requirement.

The role of geosynthetics is fundamental in delivering good urban design which embraces 'garden city' principles to deal with the ever increasing challenges of flooding; through building resilient high quality, well designed places - providing space for sustainable drainage, green infrastructure and enhanced biodiversity without adding additional costs to development.

SUSTAINABLE DRAINAGE

Green, blue roofs & podium decks

Geosynthetics are an integral element of green and blue roof construction, allowing the build to be thinner and lighter, whilst maintaining building performance.

The use of geosynthetics contributes to the drainage and storage capacity whilst having a positive impact on the quality of water discharged from the roof.

Porous paving systems

The benefits of geosynthetics to the construction of porous pavings are well documented, allowing pavements to be constructed using less imported stone, improving water quality by their filtration and allowing pavements to be used for the infiltration/attenuation of collected surface water. Where porous paving is not permitted, drainage geocomposites can provide effective conveyance of collected surface water to other elements of the SuDS system.

ABG blueroof

Traditional roof drainage systems are designed to discharge rainwater from a building as quickly as possible. However, as pressure on water management within new developments becomes more critical and waterproofing systems evolve and improve, this principle is increasingly being challenged.

Blue roofs are intended to temporarily attenuate rainwater during storm events and release the storm water at a controlled rate. Designed and implemented correctly, they can form an integral source control and attenuation element within the Sustainable Drainage Systems (SuDS) requirement on modern developments.

Blue roofs form an important part of meeting SuDS requirements, and are rated as the most sustainable technique in CIRIA's hierarchy. This is based on their contribution to reducing the risk of flooding and pollution and their positive impact on the local landscape and wildlife ecosystems when combined with a green roof finish. Legislation change, advancements in roofing and the need for sustainability in an evolving construction industry, means Blue Roofs are now becoming a first choice solution for new developments.

Implementing SuDS demands that water falling on a development is not simply channelled into storm water drains and discharged into overburdened local sewer and river systems. ABG blueroof is designed to mimic the process found in nature whereby water is attenuated, treated and filtered at a controlled rate using the patented ABG blueroof Restrictor Chamber.

With land at a premium, Blue Roofs allow the developer to maximise usage of any site, especially in city centre developments where underground storage systems are impractical and expensive to excavate.

Blue Roofs are not just limited to the roof areas, they are versatile and can be used on podium decks and amenity areas. ABG's development in product design and improved materials means a multitude of surface finishes can be achieved and a wide range of traffic requests accommodated.

1 Surface Finish
ABG blueroof can be designed to accommodate a variety of surface finishes, including green roofs (intensive and biodiverse) and hard landscaping.

2 ABG Restrictor Chamber
Attenuated water is gradually released through the patented ABG Restrictor Chamber and discharged to the roof outlet at the designed maximum flow rate.

3 ABG Roofdrain Board
Where the roof includes a green roof or soft landscaping areas, the ABG blueroof features an integrated reservoir board to provide water for plants during spells of dry weather.

4 Gravel firebreak

5 Aluminium Upstand

6 Growing Media

7 Attenuation void layer
Water falling on the roof surface percolates through the roof build up to the attenuation void. In normal rainfall events it simply flows through the void to the ABG Restrictor Chamber and into the roof outlet. When rainfall exceeds the maximum permissible discharge, the void is utilised to attenuate the excess water and control the flow rate.

8 Control orifice

9 Rainwater outlet

10 Water flow reduction & geotextile protection layers

11 Insulation

12 Waterproofing

Illustration shows typical inverted roof build up.
Warm and uninsulated roof systems are also available.

Design Considerations

As part of designing a new blue roof stormwater attenuation system, ABG develops response calculations to model the behaviour of the roof during storm events, with the information required usually contained within the surface water run-off assessment for the specific site.

Rainfall Data
Rainfall depths for the site are calculated according to location, storm duration and return period (the number of times in a set period that a storm of that magnitude is likely to occur (with 1 in 30 year and 1 in 100 year storms usually considered). An allowance is also made for future climatic change.

Waterproofing Design
ABG blueroof is compatible with all modern waterproofing materials, however the selection of the waterproofing type depends on the type of flat roof construction and a BBA certificate for zero falls is recommended. The ABG blueroof is compatible with both warm and inverted roof constructions.

Rainwater Outlets & Restrictor Chambers
The BS EN 12056-2:2000 standard for gravity drainage systems sets out a conservative approach to detailing the number of rainwater outlets required, based on the principle of discharging water from the roof as quickly as possible. This typically results in more outlets being specified than are actually required.

More current CIRIA SuDS best practice guidance sets out to slow the rate of rainwater discharge, and since the ABG blueroof system calculates the exact number of restrictor chambers required to control the flow rate at each outlet, fewer outlets and penetrations are typically required.

Overflow Outlet
As a precautionary measure in the event that the restrictor chamber becomes blocked, or a storm occurs that exceeds the designed capacity; an overflow outlet is positioned level with the top of the restrictor chamber to drain from above the nearest parapet wall. This provides a visual indicator from ground level that a blockage or exceedance has occurred and that maintenance may be required.

Structural and Loading Considerations
The introduction of a blue roof doesn't usually, but may have loading implications for the structure of the building and a structural engineer should be consulted at an early stage, especially when designing for a SuDS solution where water will be temporarily attenuated within the roof structure. This will enable any constraints to be determined, although these are often not as onerous as might be expected. The ABG blueroof attenuates the collected water across the entire area of the roof at a shallow depth, typically less than 100mm and at full capacity this would only exert a maximum additional load of 1.0kN/m2.

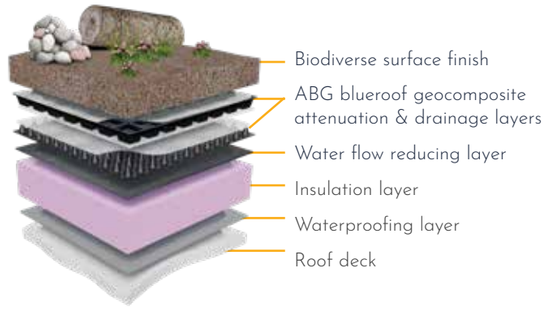
The ABG blueroof components can be designed to take differing loads and to accommodate nearly all eventualities including; landscaped areas, podium decks for emergency fire / HGV vehicle access and large HVAC plant and PV installations.

Water Quality
Installing the ABG blueroof system has a positive impact on the quality of the water discharged. Before the water reaches the roof outlet, it has passed through several filtration layers that remove particulates and pollutants. Even if the surface finish isn't green, the water has passed through at least two layers of filtration.

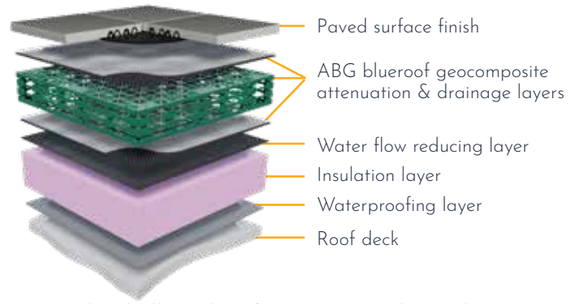
The water is treated to such a degree that it reaches the level required in treatment train stage one of the CIRIA SuDS Manual, allowing the water to be released from the roof directly into the river or sewer systems.

Roof Build-ups & Surfacing

Inverted Roof Examples

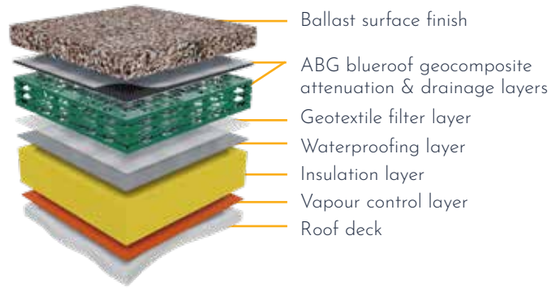


An inverted roof refers specifically to constructions where the waterproofing is below the insulation. The insulation layer helps to protect the waterproof membrane and prolong its life.

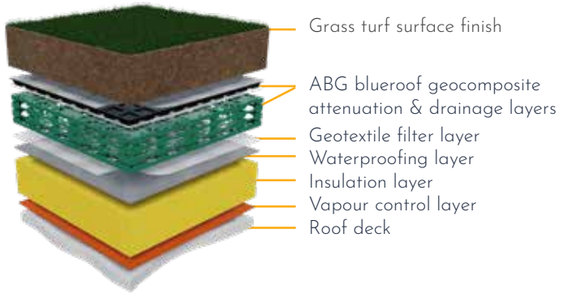


In paved or ballasted roof construction, the voids within the ballast can provide additional attenuation capacity and this can be taken into consideration in the design of the blue roof system to enable a smaller main attenuation void, providing a very cost effective solution.

Warm Roof Examples



In warm roof construction the geocomposites behave in much the same way as within the inverted roof construction whilst providing protection to the waterproofing system laid over the insulation, allowing heat to be retained within a building without the need for a ventilation system.



All green roof types (extensive, intensive and biodiverse) are suitable above an ABG blueroof. For green and biodiverse roofs, ABG has a patented combination of a water retention and water attenuation layer.

Podium Deck Examples

ABG blueroof is suitable for inverted, warm and uninsulated podium deck constructions. The system typically utilises higher strength components within the build-up so that the area can be used for a multitude of applications; ranging from landscaped pedestrian amenity areas to the need to take additional loadings from vehicular traffic (up to and including fire engine access).

The ABG blueroof system is suitable for installation beneath landscaped amenity areas incorporating planter wall designs. Where larger walls are detailed, concrete footings can be poured in-situ or pre-cast wall sections can be installed on top of the system.

Stormwater drainage system

St James Quarter is a large new retail shopping centre and residential development in Edinburgh city centre. The £1 bn project creates 850,000 sq. feet of new retail space, with a capacity for 80 stores alongside a Food Hall.

The proposals for drainage and SuDS at the St James Quarter development were mainly focussed on the large 15,000m² catchment area on roof level 5, with 4,734m2 of 80mm deep attenuation void capacity installed by ABG's installation division ABG Installs.

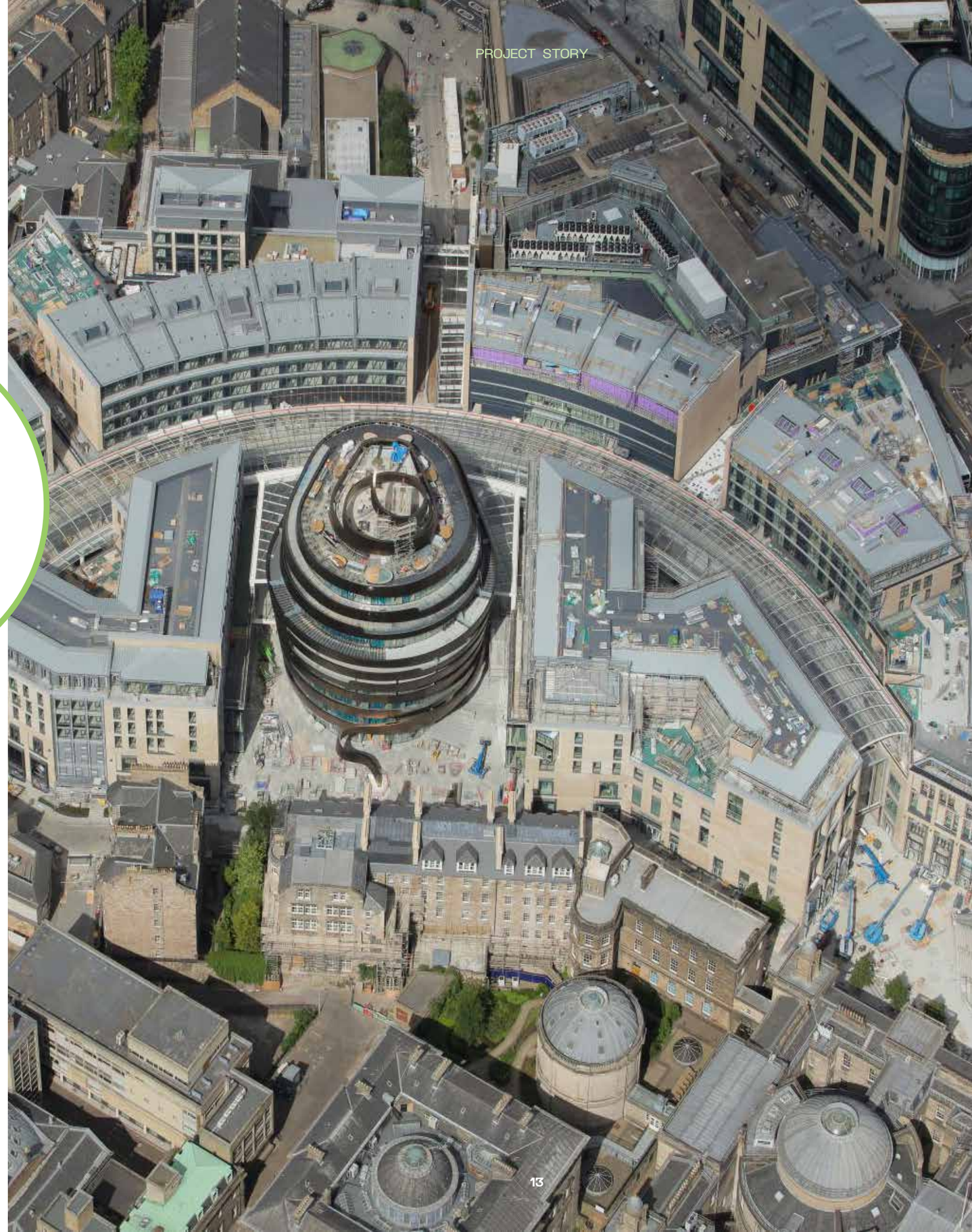
The blueroof system treats and restricts stormwater that deluges onto the roof before it is gradually released over a number of hours via outlet control and filtration chambers into the underground drainage system.

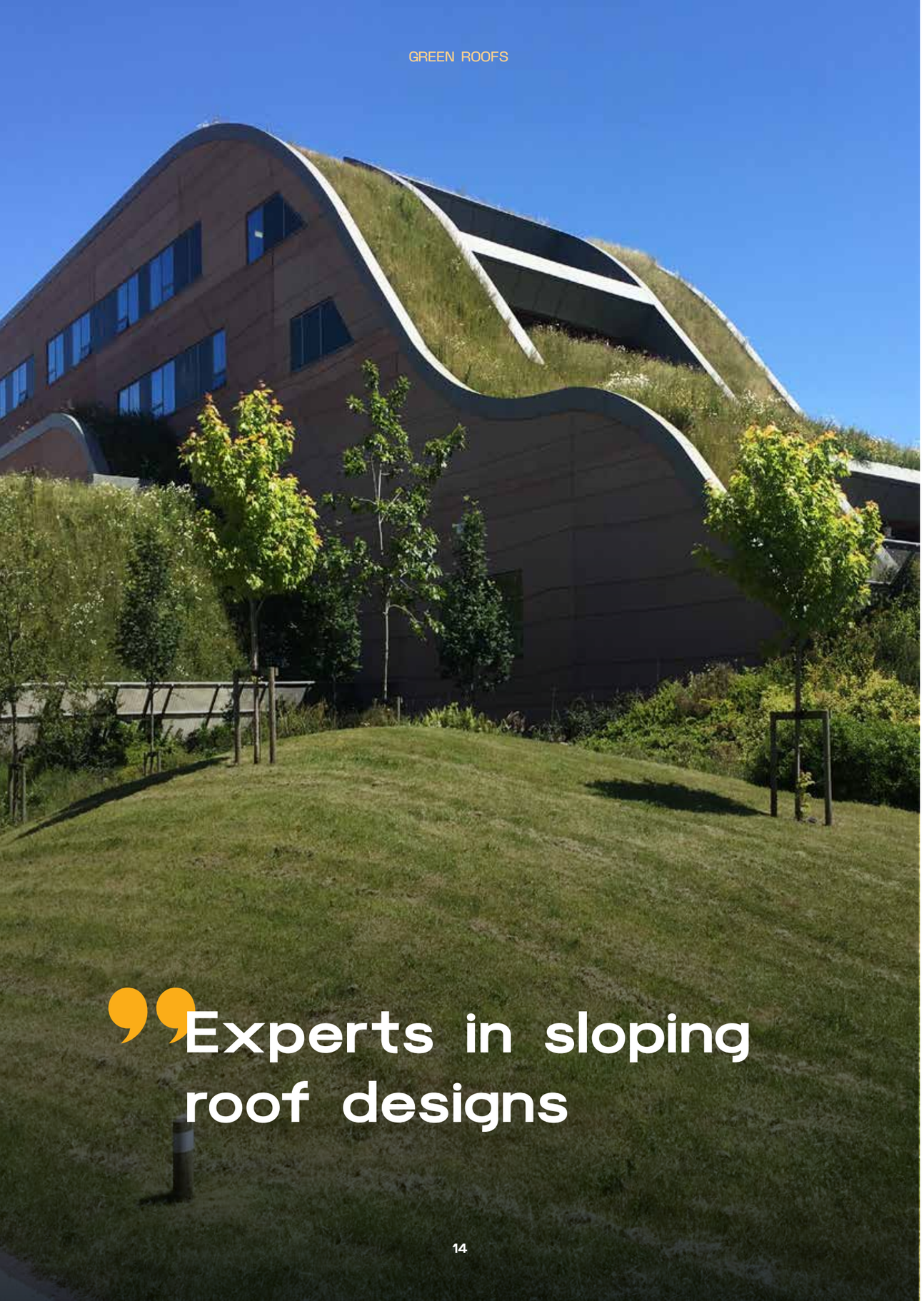
The attenuation and restrictor chambers on level 5 (east and west of the central circular W hotel building) and onto balcony areas 1 and 2 at the front and back of the upper apartment buildings are supplemented with an additional of 2,280m² of ABG Roofdrain geocomposite, installed at the base of rooftop planters to provide a connected drainage and irrigation / reservoir layer as part of the landscaping design.

Product:
ABG blueroof

Project:
St James Quarter, Edinburgh

Quantity:
7,415m²





"Experts in sloping roof designs

Green Roofs

Virtually any type of roof structure can accommodate a Green Roof, including domestic, commercial, new-build and retrofit projects. The benefits are wide ranging; from helping to mitigate the effects of climate change and whole-life cost advantages of the building to simply adding a natural habitat area in an urban setting.

As much as 95% of rainfall on undeveloped land is naturally absorbed into the vegetated surface. By contrast, urbanisation and land development creates hard impervious surfaces that absorb only 5% of rainfall, leaving the remainder to run-off into the local water network that struggles to cope with the volume.

This is becoming more apparent in light of climatic change and the increasing intensity of rainfall and flash flooding events.

Green Roofs can play an important role in mitigating these events, especially when designed as an integral element of a sustainable urban drainage system, also known as SuDs.

Green Roofs are increasingly being adapted to attenuate stormwater, providing an alternative solution to SuDs tanks and helping to reduce flooding in urban environments.

If you are thinking of incorporating a Green Roof system into a new or existing development, please don't hesitate to contact ABG and let us assist you through each stage of the project; from design through to installation.

Green Roof Design

A Green Roof is a complex, multi-component system that requires careful consideration throughout the design process in order for it to function correctly as both a waterproof structure and as a living environment.

Access & maintenance
The British Standards Institute states that all new builds must provide access to the roof area to enable a minimum of two inspections per year, so working at height regulations must be considered. If a building is of a height which can cause an injury from a fall, edge protection is required.

Even though extensive Green Roofs are relatively self-sustaining, they still require some scheduled maintenance. ABG recommends this be dealt with in the form of a maintenance contract. Maintenance for extensive roofs will typically only be required twice per annum, and therefore the overall cost of maintaining a Green Roof can be relatively minimal.

Drainage & water retention
Drainage and water retention are key elements to consider when designing a Green Roof. The type of drainage specified is dependent upon the project's landscaping plans, and ensuring adequate water retention/drainage requirements are provided is paramount to the long-term survival of the vegetation and to prevent pooling forming on the waterproofing layer.

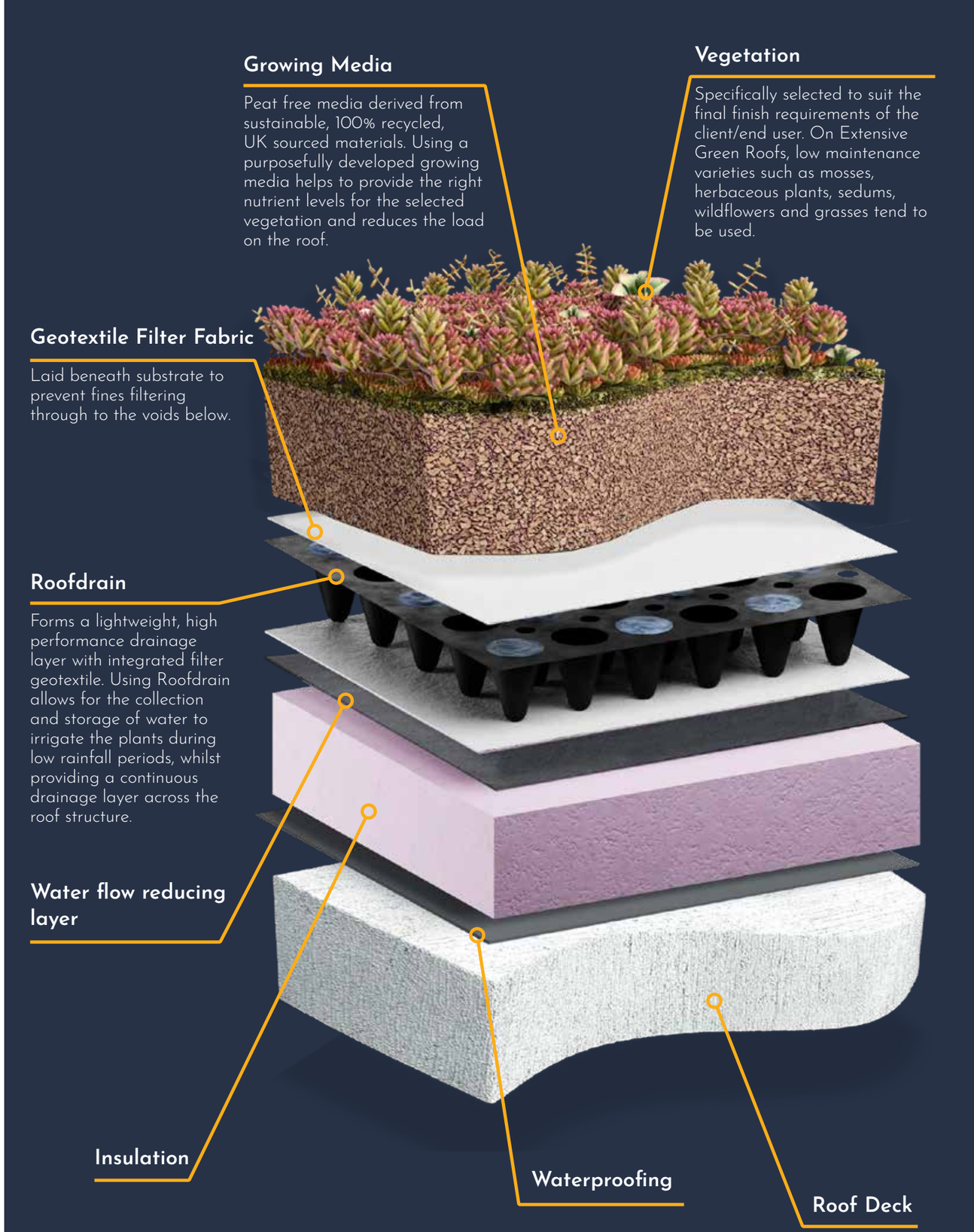
Geographical location
Geographical location and orientation are also an important part of designing the roof. Which part of the country, the direction the roof faces, the amount of average rainfall and sunlight in that area and the prevalent wind direction all influence the types of vegetation required for a successful roof.

The biodiversity and drainage elements are then derived following consideration of the local conditions. It is worth noting that Green Roofs in coastal locations require careful consideration in order to ensure that the vegetation specified is hardy enough to withstand the elements.

Structural loadings
The introduction of a Green Roof will have loading implications for the building. It is vital to consult a structural engineer at an early stage, especially when designing for a SuDS solution where water may be attenuated within the roof structure. This will enable any constraints to be determined and in turn inform which type of Green Roof system it is most suitable to implement.

Compressive strength
A design consideration that is typically most relevant for podium deck applications is the compressive strength of the drainage layer. The structural requirements of these systems are commonly misinterpreted, with erroneous descriptions such as 1,000kPa sometimes referenced. This is significantly greater than the overall loading requirements of the roof, and in reality, most drainage layers do not need a compressive strength above 150kPa.

Roof pitch
Contrary to popular belief, Green Roofs can be constructed on sloping roofs. However, it is worth noting that once the slope angle is above twenty degrees, both installation and maintenance may start to become increasingly complex.



Extensive Green Roof

A 'new concept' building design was employed by Extra MSA Group for the Leeds site at Junction 45 on the M1, focusing on providing a wide choice of food outlets and business, leisure and community facilities within attractive and relaxing surroundings.

To minimise the visual impact of the development on the natural landscape and local wildlife, the main 5,277m^2 amenity building features an over sailing, undulating green roof. The roof is configured in a unique 'ribbon' pattern in eleven separate sections, adjoining a new 100 room Ramada hotel building.

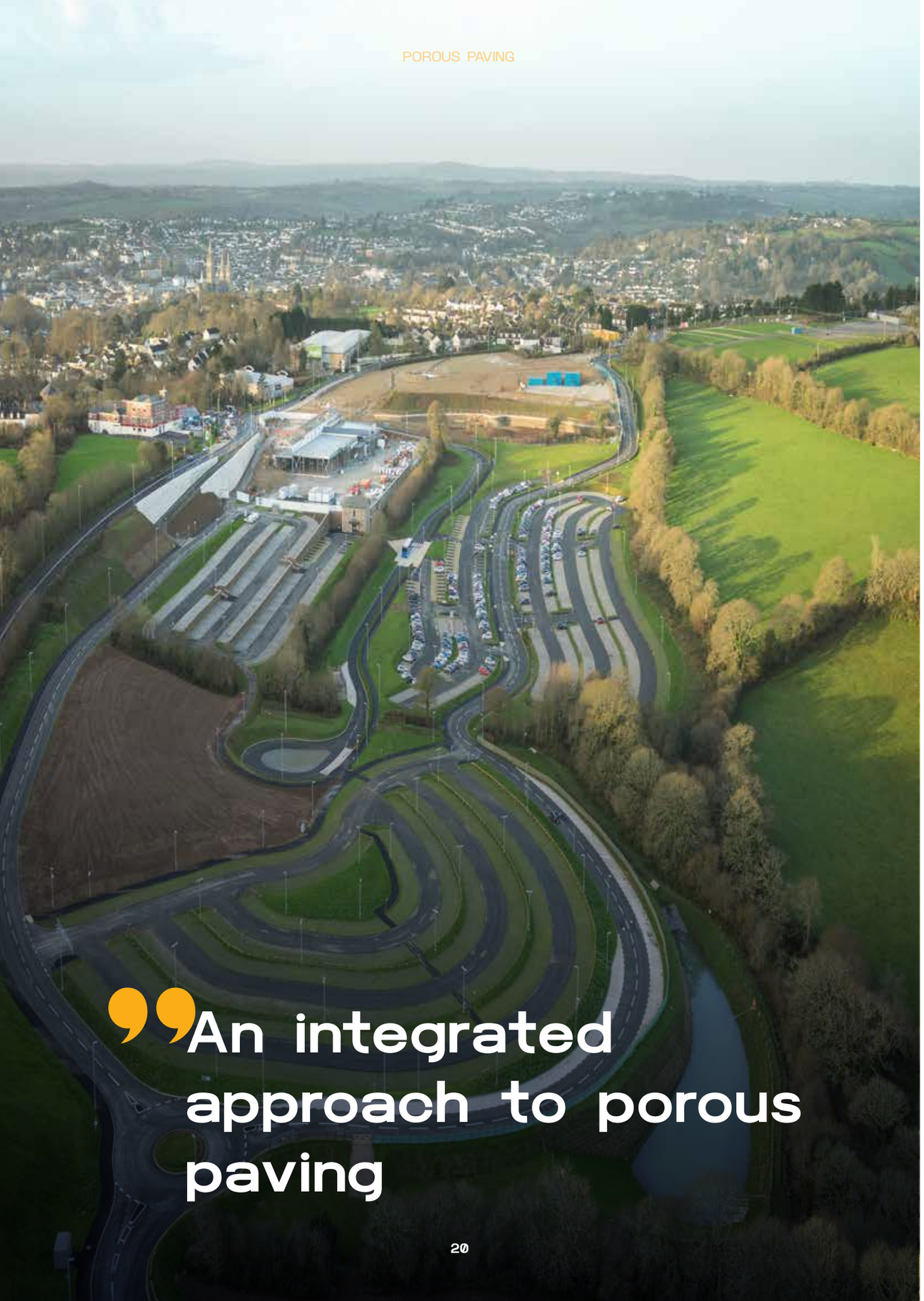
The 'extensive green roof' with wildflower turf and sedum planting adds to the biodiversity of the area, providing a significant expanse of native grassland for invertebrate species.

The green roof also plays an important function as part of the site's overall sustainable drainage strategy, by absorbing rainwater and minimising surface water run-off.

Product:
Extensive Green Roof

Project:
Skelton Lake Motorway Services, Leeds, UK

Quantity:
6,000m^2



> An integrated approach to porous paving

Porous Paving

Porous paving systems have played a key role in managing flood risk for over 30 years and infiltration is now universally recognised as the preferred source control solution within sustainable drainage systems.

In addition to providing an aesthetically pleasing and cost effective solution, porous paving systems also deliver a number of significant environmental benefits; including inherent water treatment, enhanced biodiversity / amenity and recharge of aquifers.

BREEAM credits are awarded where porous paving is used to limit runoff from a development and provide on-site treatment to minimise watercourse pollution.

Further credits can also be gained through the use of porous paving providing beneficial impacts on local ecology. In addition, the use of rainwater harvesting for irrigation is also recognised with a credit.

Porous paving systems can also contribute to wider sustainable water management when they are used as a retrofit solution. The cost benefit of SuDS retrofit in urban areas Science Report – Environment Agency SC060024 estimates that it is possible to retrofit approximately 50% of off-road hardstanding surfaces with porous paving.

This is a conservative judgement and further ongoing research is likely to indicate that this percentage could be increased.

Porous Paving

Permeable paving provides a stabilised pavement where surface water run-off can be reduced, managed, treated or attenuated near the surface to help reduce the risk of floods.

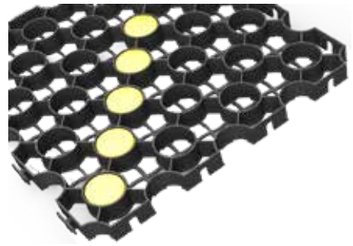
Permeable paving systems are used extensively for car and coach parking, industrial yards, HGV and service access routes for fire / emergency, MEWP and utility vehicles where a sustainable urban drainage solution is required.

ABG Geosynthetics are specialists in the design and supply of permeable paving surface solutions that provide ground reinforcement, stabilisation and permeability.

Our porous paving systems include interlocking plastic pavers and heavy-duty recycled paving grids which form part of a SuDS source control system and an alternative to impermeable hard paved surfaces.

Porous Paving

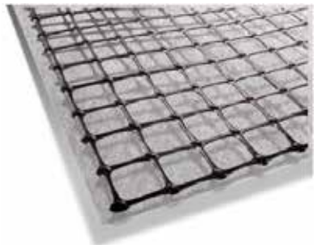
Sudspave porous plastic pavers are ideal for grass or gravel car parking, driveways and paths where a stabilised permeable surface is required. Sudspave retains the grass or gravel within its cells and allows rainwater to permeate into the sub-base beneath. Grass surfacing is suitable for infrequent / overflow usage and gravel fill is recommended for more regular / daily traffic situations.



Truckcell is a heavy-duty cellular porous paving system designed for intensive usage and high-load traffic applications. The permeable paver can be filled with topsoil and seeded, or filled with gravel to provide a structural surface for HGV traffic, trucks and coaches.

Abweb TRP is a no-dig or a reduced-dig, geocellular tree root protection alternative to traditional methods of constructing paths, roads and parking areas in and around trees. It is designed to protect the root structure of the tree from damage caused by the compaction of local soils as a result of vehicular traffic.

Terrex NW geotextile is a range of staple fibre, needle punched and thermally bonded non-woven geotextiles designed specifically to offer optimum filtration and separation performance. The textile is typically combined with the **Abgrid** geogrid for ground stabilisation applications.



Porous Paving

The Ashford Inland Border Facility in Kent performs the checks required on HGVs crossing the UK Border at the Port of Dover and the Channel Tunnel.

Each location includes parking areas for HGVs with security measures and facilities to check the vehicles and goods entering and exiting the site.

The design of the facility onto 48ha of former agricultural land was developed with a view to maintaining the landscape and biodiversity of the surrounding area and to screen views of the site from the local villages.

Excavated materials were sustainably reused as part of this process in order to create bunds, whilst surface water drainage of the site is directed to local wildlife ponds and wetlands via 30,000 square metres of aggregate filled Truckcell cellular paving.

The site is trafficked by up to 950 HGVs at any one time and provides a free-draining, sustainable and durable SuDS surface to withstand the traffic levels without damage or abrasion.

Product:
Truckcell®

Project:
Ashford Inland Border Facility, UK

Quantity:
30,000m^2

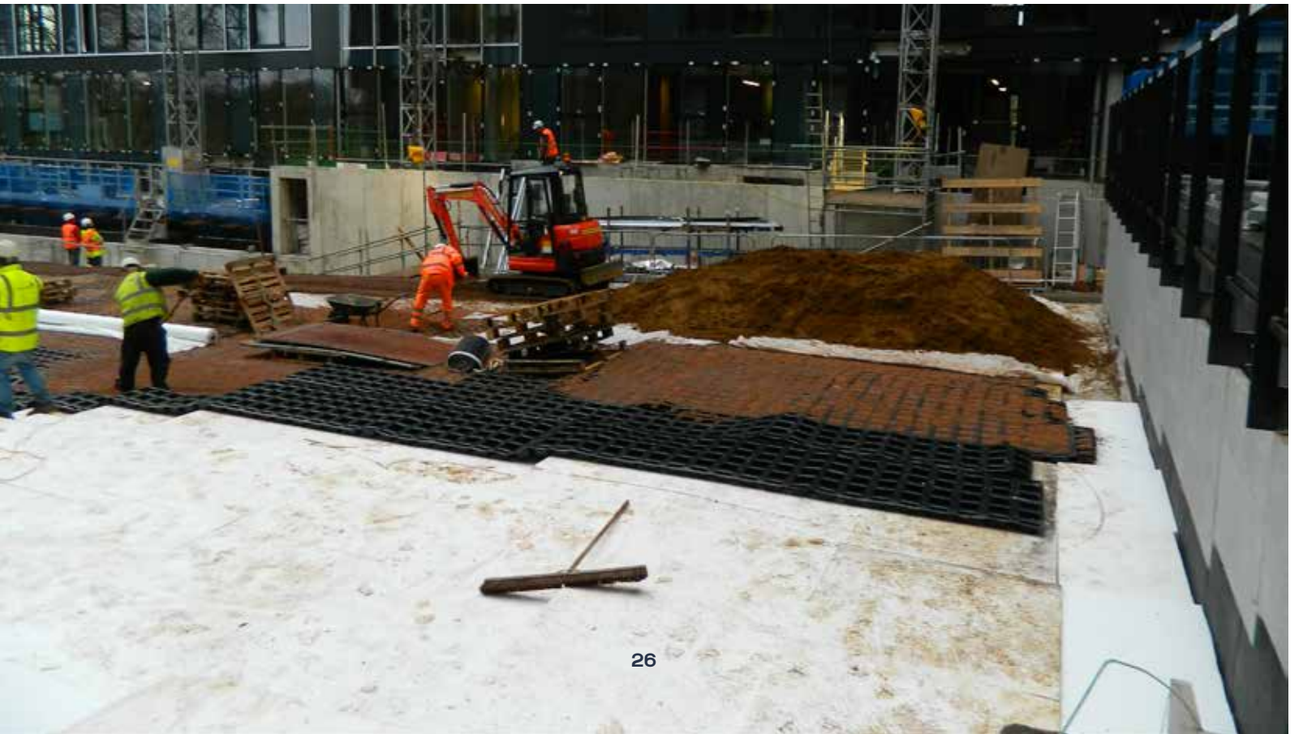
Podium Deck & Basement Drainage

Deckdrain and Roofdrain geocomposites provide a high flow drainage path in a thin and light-weight layer for modern podium deck build-ups and to relieve pore water pressure from the back of buried building structures.

Many new buildings incorporate landscaped amenity areas above basement or car park areas. These podium decks can vary from lawn, planter & paved amenity spaces; to additional areas for access or car parking. These are often large, waterproofed decks with minimal falls which makes drainage a key design parameter. Deckdrain and high-strength Roofdrain options provide sub-surface drainage layers for podium decks of all sizes, whilst also providing additional protection to the waterproofing layer below.

They represent a carbon saving and easier to install alternative to hollow concrete blocks for wall drainage and crushed stone layers beneath paved areas. High CBR puncture resistance also offers additional protection to the waterproofing in both situations.

In addition to drainage of standing water from waterproofed decks, the high CBR puncture resistance protects the waterproofing from backfilling forces and root penetration, thus extending the performance and life of the system.



PODIUM DECK & BASEMENT DRAINAGE

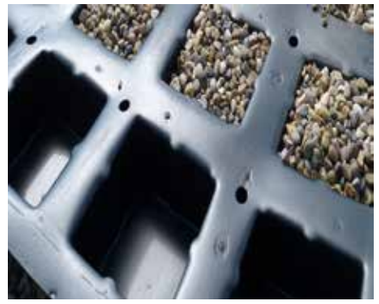
Podium Deck & Basement Drainage

ABG Deckdrain is supplied in rolls, available in standard dimensions of 1.1m wide x 50m long or 2.2m wide x 25m long to enable quick installation and coverage rates. A range of core drainage thicknesses are also available, depending on the in-plane flow performance required and the volume of excess pore water pressure to be drained.

The 4mm or 6mm drainage core size is the most commonly specified for the lining of basement walls in building applications that require a Type C product specification for the waterproofing barrier protection of below ground structures, in accordance with the BS 8102 code of practice.

The aligned flow paths of the cuspated drainage core gives high flow performance in all directions and replaces the need for heavy concrete block drainage.

Roofdrain 60 geocomposite offers a high compressive strength and enables a shallower drainage design for podium deck structures. Using a structural geocomposite drainage core in this application means the installation time and amount of drainage stone required can be significantly reduced.



The 60mm HDPE core provides an uninterrupted drainage void, allowing water to flow in all directions across the whole installed area. The cuspates can be interlocked to connect adjoining panels and can be stepped to achieve a tiered installation.

Applications include beneath block and permeable paving, with the 60mm deep Roofdrain core supplied in roll format to enable fast installation over large areas.

Podium Deck & Basement Drainage

The Quartermile development is a cosmopolitan mix of luxury apartments, cafes and businesses in the heart of Edinburgh city centre. The masterplan for the new area is designed by Foster + Partners and enjoys views of some of Edinburgh's greatest landmarks.

The access to the new building (adjacent to the old Edinburgh Royal Infirmary site) is elevated from the North Meadow Walk pedestrian walkway and cycle route. The pathways and landscaped areas in front of the development needed a structural drainage solution and reinforced turf area that would be suitable for trafficking by maintenance and emergency vehicles when required.

ABG's high strength Roofdrain 60S+RX geocomposite was specified to provide sub-surface drainage across the base of the podium deck. The drainage board provides a high flow capacity void to channel water pressure to the surrounding perimeter drains. By utilising a 60mm drainage layer the need for much deeper and harder to install drainage stone layers can be minimised.

Product:
Roofdrain® 60

Project:
Edinburgh Quartermile, UK

Quantity:
1,200m^2

The drainage core features regular perforations to allow surface water to percolate and drain to the underside of the board and adjoining rolls can be easily overlapped with the cups designed to slot into one another.

The Roofdrain was stepped to cascade into lower sections to suit the landscaping layout and was overlaid with a Terrex NW9 geotextile to prevent fines entering the drainage core.

PROJECT STORY

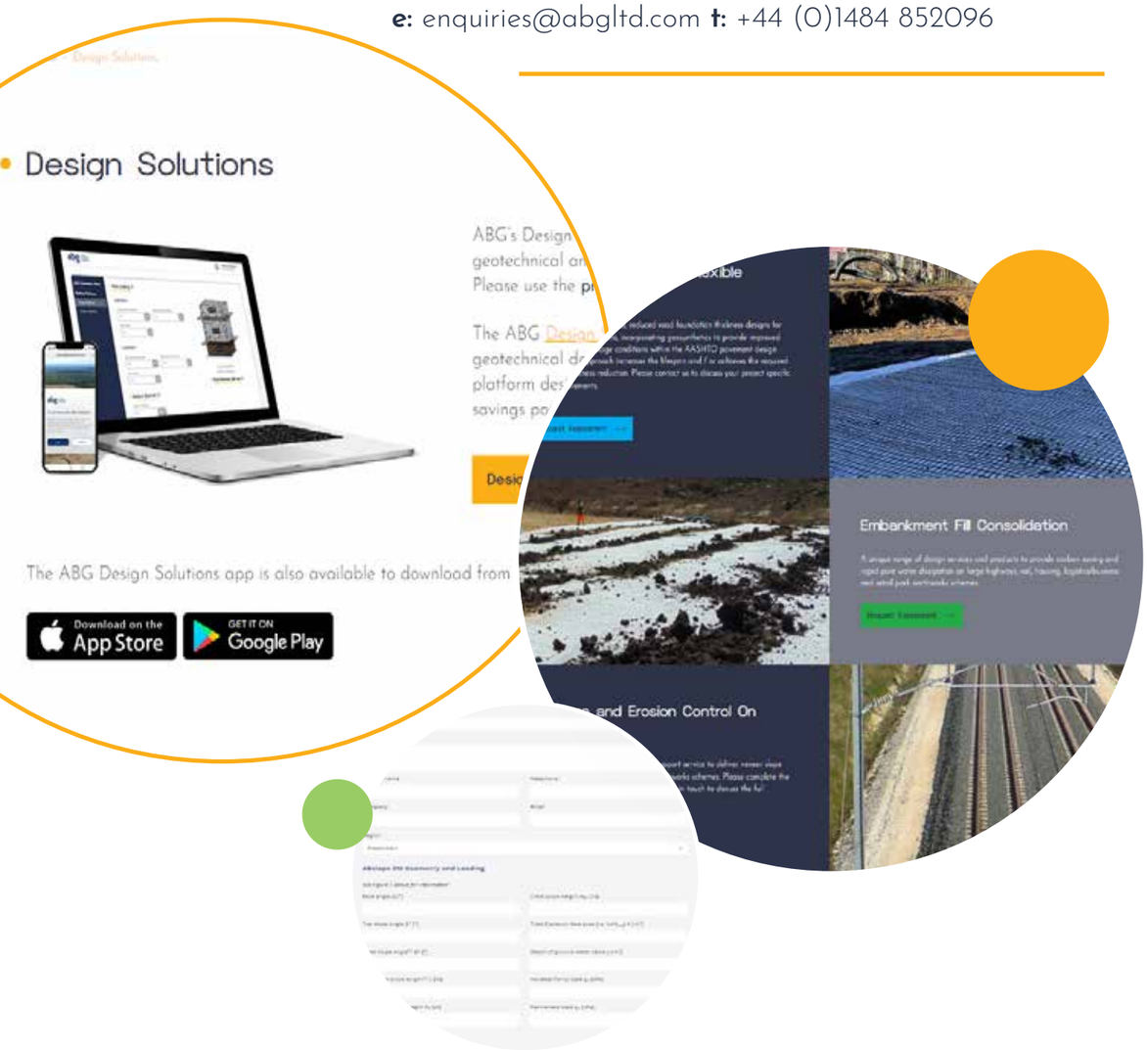
Design Solutions

Our experienced engineering department is on hand to assist with your buildings project requirements.

A range of project assessment forms are now also available on our website to assist with your project design @ www.abg-geosynthetics.com/design-solutions

Contact the ABG engineering team for deisgn and application advice:

e: enquiries@abgltd.com **t:** +44 (0)1484 852096



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