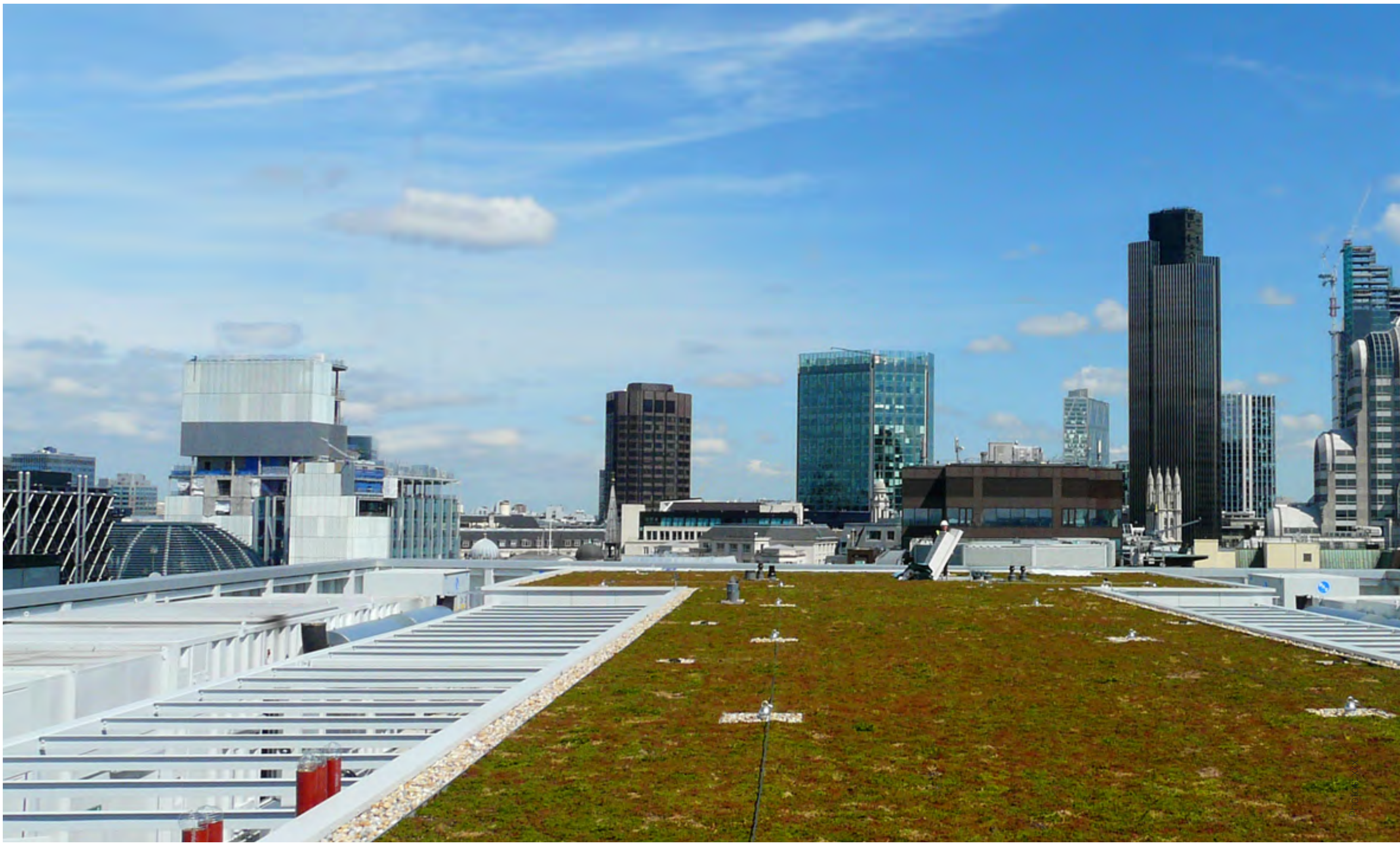


Photo: Courtesy of IKO PLC

# THE GROWTH OF THE GREEN ROOF

## Dusty Gedge explains the benefits of this increasingly popular construction method and the key role of concrete in creating a biodiverse roofscape

Looking over the skyline of London these days, wherever I see a crane I know that a green roof is likely to be installed on top of the building. This wasn't the case 15 years ago. Green roofs have become mainstream in London and are gaining traction outside the capital too. A slow shift in focus to green infrastructure has ensured that soil and vegetation within the urban realm, especially on buildings, has become a popular way to help our cities adapt to climate change.

Concrete is an important structural material for the construction of green roofs on modern buildings. A concrete slab is easy to install and will give the required structural loading for any given green roof.

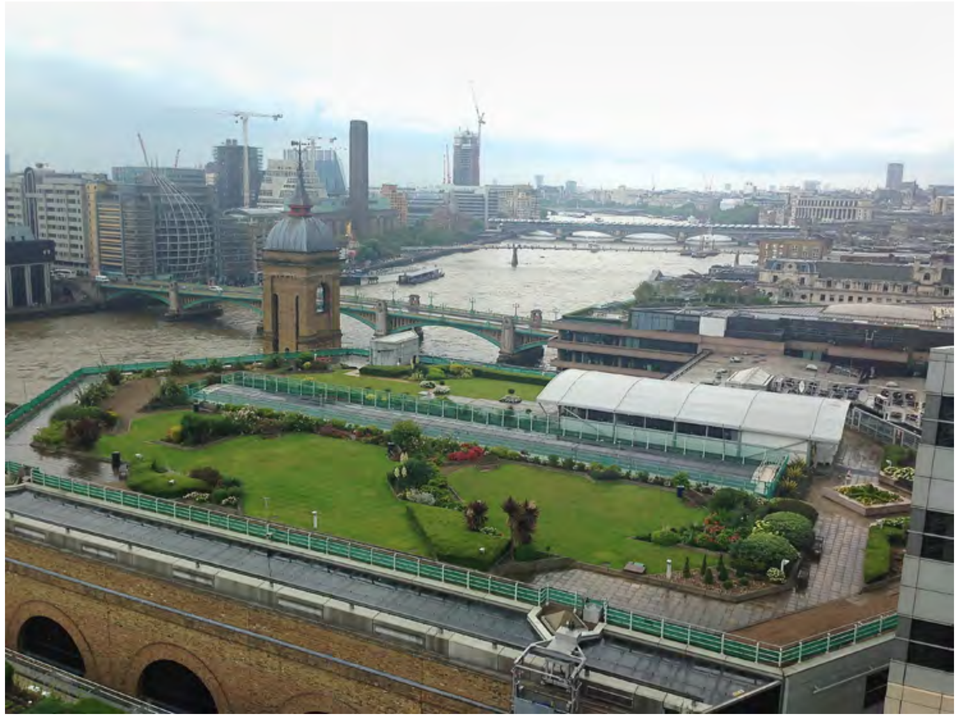
### Benefits of green roofs

Vegetation and soil on roofs can provide a range of benefits. They help to ensure building integrity by protecting waterproofing membranes from deterioration, reducing the impact of UV light and frost/thaw and perhaps extending the membrane life beyond the standard UK guarantee of 20 years.

Environmentally, green roofs have a role to play in helping cities adapt to climate change, through reducing the urban heat island effect during heat waves, and mitigating flash floods during intense summer storms – the deeper the substrate the greater the capacity to store rainwater.

They can also provide biodiversity benefits that may not always be recognised by the construction industry. These include visual amelioration, reduction in noise pollution, and removal of airborne particles. There is perceived to be competition from sustainable technologies such as solar panels for the use of roof space, but with good design, the two technologies can work very well together, leading to improved performance of both, as with recently piloted bio-solar roofs.

Designers sometimes express concern over the potential fire risk associated with dry vegetation, but guidelines published by the Department for Communities and Local Government in 2013 have clarified this issue. The UK's Green Roof Code follows the guidelines of the German Landscape Research, Development and Construction Society (FLL), which has specific requirements regarding fire, including the amount of organic material permitted in substrates, and the need for firebreaks and in some cases irrigation, depending on the type of green roof to be installed.



Photos: Dusty Gedge

**ABOVE**
Riverbank House in the City of London has an extensive green roof planted with sedum

**ABOVE RIGHT**
An intensive green roof – essentially a full-scale garden – over Cannon Street station in central London

**RIGHT**
The rubble roof at the Laban Dance Centre in south-east London, which has attracted over 100 wildflower species

**THE THREE MAIN TYPES OF GREEN ROOF**

| | Extensive | Semi-intensive | Intensive |
|---|---|---|---|
| Use | Ecological landscape | Garden / ecological landscape | Garden / park |
| Type of vegetation | Moss / succulents / herbs / grasses | Herbs / grasses / shrubs | Lawns / herbs / shrubs / trees |
| Benefits | Water / thermal / biodiversity | Water / thermal / biodiversity / amenity | Water / thermal / biodiversity / amenity |
| Depth of substrate | 60-200mm | 150-250mm | 150-1,000mm |
| Weight (saturated) | 60-220kg/m$^2$ | 150-350kg/m$^2$ | Greater than 200kg/m$^2$ |
| Maintenance | Low | Periodic | High |

## Types of green roof

There are a range of green roof types and potential vegetation cover, but these fall into three overall categories:

■ **Intensive** This category refers to full-scale gardens and parks installed on roofs, which require the same high level of maintenance as at ground level (hence the term “intensive”). These have been part of the mainstream for many years – one of the oldest examples in the UK is Kensington Roof Gardens, laid out in 1936-8. There is also a sub-category, referred to as “semi-intensive”, which require slightly less maintenance and structure to

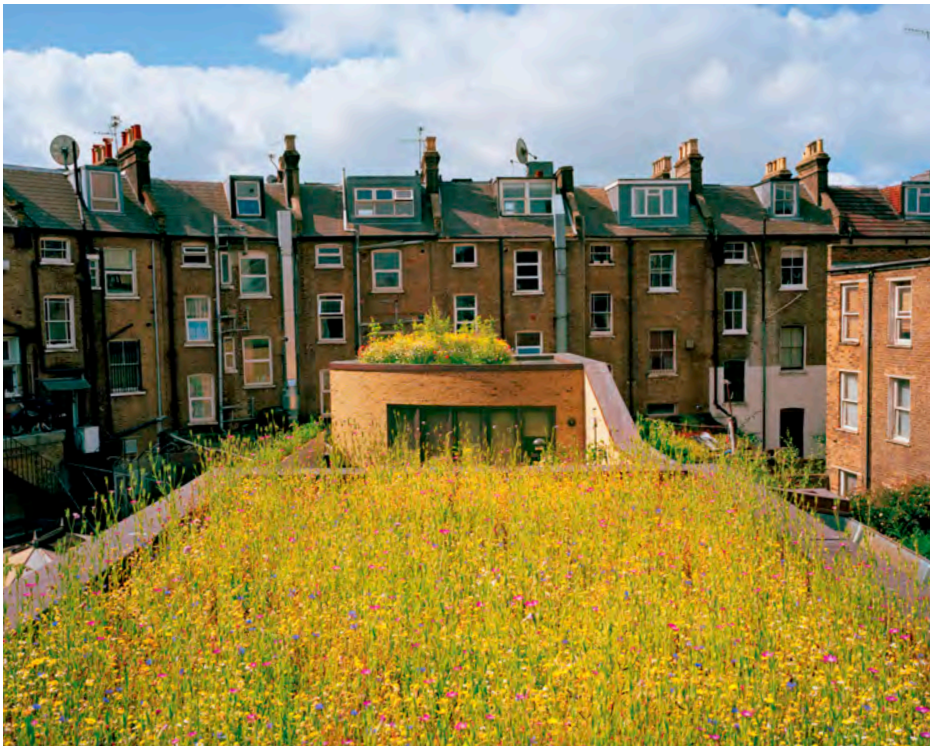


Photo: Diane Cook and Len Jenshel

**ABOVE** The Muse, a family home in Islington, north London has a green roof with varying soil depths for native habitats, including two wildflower meadows, a hazel coppice and a hawthorn thicket

support the soil and vegetation. They tend not to have intensive lawns, trees and shrubs but consist of Mediterranean-style planting needing periodic irrigation and maintenance.

## GREEN ROOFS IN LONDON

Under the London Plan, developers in the capital are encouraged to include living roofs and walls where feasible. Individual boroughs such as Islington, as well as local authorities in cities including Sheffield and Brighton also encourage such roofs through the planning process.

An audit of green roofs in London carried by the Green Roof Consultancy for the Greater London Authority in summer 2013 found that there were nearly 700 green roofs in central London alone, covering more than 175,000$m^2$. Black redstarts, the protected bird species that first prompted interest in green roofs in the capital, have been seen on many, in addition to a number of rare bees, butterflies and insect species. Green roofs are here to stay and will be increasingly required as a planning condition of development.

With growing concern regarding climate change, there will no doubt be increasing interest in retrofitting vegetation on to roofs in the near future. The Green Roof Consultancy estimates that over 10 million $m^2$ of green roofs could be installed on existing buildings in the capital.

■ **Extensive** This type of green roof has become mainstream in the construction industry over the last 15 years. It is relatively shallow in depth and planted with a variety of drought-tolerant plants, from succulents such as sedum to wildflowers, and generally inaccessible except to provide the low maintenance required.

■ **Brown roofs** These aim to mitigate the loss of biodiversity on a site by recreating the natural habitats of local species. Although a good idea in principal, there are several issues with simply providing a growing medium and leaving it to be colonised by plants and animals. For example, if invasive species become dominant, it can create serious maintenance problems. Equally, the desired plants may take a long time to establish themselves or fail to make it up to roof level at all.

Locally sourced aggregate from the development site is sometimes used as a growing medium. There are some challenges associated with this approach, particularly as crushed reclaimed concrete retains very little water. However, it has been used with some success. The Laban Dance Centre in south-east London (pictured), built in 2000, was the first brown roof to use recycled crushed concrete from the demolition process, and since then over 100 wildflower species and a number of rare invertebrates have been recorded at the site.

Green roofs can be used to obtain credits in the Land Use & Ecology category of the 2014 version of BREEAM New Construction for enhancing site ecology.'

> WHEN TREES ARE TAKEN INTO CONSIDERATION, LOADS CAN BE UP TO 1,000KG/$M^2$, AND EVEN GREATER DEPENDING ON THE DESIRED PLANTING

## Engineering considerations

From an engineering point of view, an extensive green roof varies in saturated load between 70kg/$m^2$ and 200kg/$m^2$. However a saturated load of above 120kg/$m^2$ is recommended to ensure the widest environmental benefit.

Intensive green roofs are much heavier. These are more likely to be installed on podium deck roofs with the capability to take at least 300kg/$m^2$. When trees are taken into consideration, loads can be up to 1,000kg/$m^2$, and even greater depending on the desired planting.

On modern large-scale developments, concrete is the preferred material for roof decks. Many buildings currently under construction in cities have inverted roofs, where the insulation sits above the waterproofing. This approach is ideal because the green roof can sit above the insulation and replace the ballast (shingle and pavers) that is traditionally used to weigh it down. This can reduce the perceived additional cost of the green roof (see table, previous page). A green roof can be installed on a zero fall if necessary, with drainage layers in the roof build-up to ensure lateral drainage. The steeper the roof, the less consideration of drainage is required in the roof build-up.

There will be need for some maintenance access, even for the shallowest green roof, and this may require a fall arrest system and/or a parapet to ensure compliance with safety regulations.

**Dusty Gedge is a wildlife consultant, specialising in green roofs. He is president of the European Federation of Green Roofs and Walls and the founder of Livingroofs.org and the Green Roof Consultancy: greenroofconsultancy.com**

## KEY REFERENCES

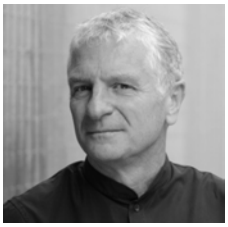
Fire Performance of Green Roofs and Walls, Department for Communities and Local Government, August 2013: bit.ly/1H8iqGb

The GRO Green Roof Code – Green Roof Code of Best Practice for the UK 2014, Green Roof Organisation: bit.ly/1Ek9YDi

GLA green roof map, Green Roof Consultancy, 2013: bit.ly/13anRmo

# LASTING IMPRESSION
# RAB BENNETTS

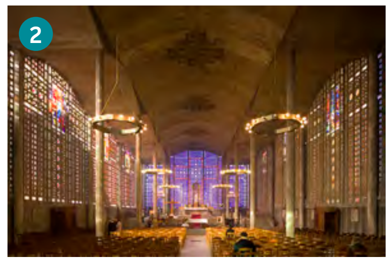
### IN PRAISE OF JUST GETTING ON WITH IT

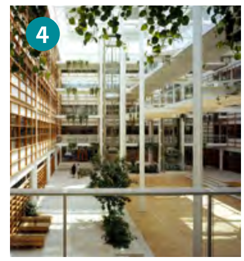


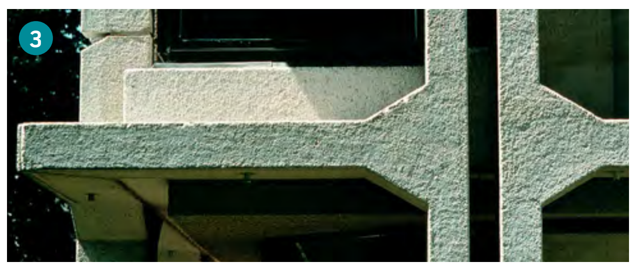
When my wife Denise and I were at college, we were very attracted to the engineers and builders – the rebels – rather than the fine artists. People like Auguste Perret, Owen Williams and Robert Maillart didn't have the social agenda of Le Corbusier or the brutalists, they were just building well. Williams said he didn't have much time for the architectural establishment, he just got on and did buildings and that idea appeals to me a great deal. Most of the avant-garde architects of the day were just doing small residential projects, but Williams was designing enormous buildings, like the Boots manufacturing plant in Nottingham (1) (1932) with its concrete structure and glass curtain-walling. Perret's most extraordinary building is the Church of Notre Dame at Le Raincy, Paris (2) (1923). It's just a concrete structure and glass – there's nothing else to it, and that's what is so beautiful.

I was also intrigued by the way Arup Associates did really good concrete structures, such as the Sir Thomas White Building (3) (1975) at St John's College, Oxford, which takes a kind of romantic approach, or Gateway House for Wiggins Teape [now Mountbatten House and recently listed – see page 2]. I was lucky enough to join Arup, and ended up working on Gateway Two (4) (1982). That was a lightbulb moment, the first time I realised that the exposed concrete structure was helping to keep the building cool. That is fundamental to an awful lot of what we've done as a practice since. It was really inspiring because it meant that the architecture of the interior was inseparable from the exterior, and the whole thing became far more integrated, and visually and architecturally a much richer experience. It's a combination of art and craft and science that is terribly important, coming together in this concrete structure.

**Rab Bennetts is co-founder of Bennetts Associates**







Photos: 1. Boots UK Archive; 2. Barnabas Calder/Twitter: @BrutalConcrete; 3 and 4. Arup Associates

## FROM THE ARCHIVE: WINTER 1961

### THE MUSCLES OF MILAN

"What makes a skyscraper stand up?" It's a question many New Yorkers have been asking as they look up at the wafer-thin 432 Park Avenue (page 8) with its astonishing 14:1 height-to-width ratio. But 54 years ago, CQ was pondering the same thought at Gio Ponti's altogether more substantial Pirelli building in Milan (height-to-length ratio, 2:1), then the tallest reinforced-concrete tower in Europe. The answer it found was "weight".

Behind the 32-storey tower's iconic form, with its distinctive cigar-shaped plan, was "a masterpiece of economic engineering". The structural design, carried out by Pier Luigi Nervi transferred the building's entire 60,000-tonne weight to the ground through four massive concrete piers and two triangular service cores at either end. Large-span concrete floors also played a key role, concentrating loads on these eight elements and ensuring that there was no need for intermediate supports of any kind.

The tower's mighty frame is fully revealed on the top three floors, "a magnificent open space where the rough concrete of the naked piers rises up to the topmost beams, with the floating roof clear above … Here one is fully conscious of the strength of bone and sinew that has gone into this elegant structure".

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