



Living roofs for life

A guide to designing-in safe access
and maintenance for green roofs



Despite sporadic use over many years, we are only now seeing a rapid growth in the specification and installation of green roofs (also known as ‘living roofs’) in the UK. With pressure from local and national government initiatives, this growth is set to continue. Therefore, it is essential for architects, CDM coordinators, contractors, landscapers, building owners and facilities managers to fully understand their responsibilities and the specific requirements for access and maintenance of green roofs, and incorporate the right safety measures from the start.

As leaders in fall protection systems, Latchways takes an holistic approach to safe access for working at height, looking in detail at developing technologies and the issues affecting particular applications. This ‘White Paper’, prepared by Latchways with contributions from other organisations and experts directly involved with green roofs, provides background information and essential guidance on making green roofs safe.

A background to green roofs

History and development

The principle of using living vegetation and a growing medium or substrate to provide shelter is as old as history itself, and a long tradition of turfed roofs can be found in many cultures and continues today on some pitched roof buildings.



However, it was the European ecological movement of the 1960s that heralded the development of modern green roof technology. Although embraced in some countries like Germany—where around 100,000,000 m² of green roofs are in use today—this technology has been slow to grow in the UK—until now. Although relatively new to the UK, and so requiring familiarisation by the construction and property industries, there are no reasons why they should be considered as any more challenging than most conventional ‘bare’ roofs.

Green roofs offer a range of benefits, outlined opposite, which are recognised as particularly important in addressing pressing environmental issues. Today, they are seen as an effective approach towards ecological urban design. As a result, both local and national government are using the planning system to expand use of green roofs on all kinds of developments.



Biodiversity benefits

Green roofs in general are considered to encourage biodiversity in urban areas, offering potential habitats for a wide range of wildlife and the opportunity for local wild plants to grow, where otherwise they could not. This is seen as of major importance by a growing number of planning authorities in cities around the UK where the most intensive development occurs. Research indicates that biodiversity benefits can be increased with use of local substrates, varying substrate depth, planting local seed mixes and placing locally sourced materials and objects on the roof. This bespoke 'biodiversity roof' approach demands expertise and local knowledge—as well as the early input of fall protection specialists to ensure suitable provision of safe access systems.

Sustainable Drainage Systems (SUDS)

SUDS aim to replicate, as closely as possible, the natural surface water drainage from a site before development. This involves a design methodology combining a range of techniques in a 'management train', such as permeable paving, swales, bioretention areas, wetlands—and green roofs.

The three cornerstones of SUDS are:

- **QUANTITY**—to minimise and slow down the rate of surface water runoff
- **QUALITY**—to remove pollutants such as heavy metals and hydrocarbons from the water
- **AMENITY**—to improve the local environment for both people and wildlife.



Modern green roof in the centre of Edinburgh.
Photo: Icopal

Green roofs play a major role in all three. As the head of the SUDS 'management train', they provide invaluable rainwater source control retaining anything between 40% and 100% of the rainwater, then delaying runoff for the remainder. Water is retained in the substrate and drainage layers with uptake and release by plants through transpiration and photosynthesis or evaporation due to wind and temperature. The plants also absorb airborne pollutants while the supporting substrate acts as a filter retaining and treating pollutants, so improving the water quality.

Unlike the other 'soft' landscaping SUDS techniques, green roofs do not require any additional land-take, making them suitable for high-density, as well as other types of development. Of course, there will be urban situations where a complete SUDS management train is not viable due to space constraints. Here, green roofs can still be used in isolation to reduce, attenuate and improve the quality of water runoff passing into conventional drainage systems. Agreement of the quantitative benefits of green roofs in SUDS should shortly be reached with regulatory authorities such as the Environment Agency, resulting in a further expansion of their use.

Other benefits

Green roofs show reduced emissions of long wave (heating) radiation compared with bare roofs, helping to reduce urban 'heat island' effects in summer. This is one of the key drivers for the new London policy discussed later.

For their buildings, green roofs provide effective thermal insulation, as well as thermal mass for temperature regulation, so reducing heating and cooling energy demands to maintain the environment within the building, and therefore carbon emissions. They also improve air quality with conversion of CO₂ to oxygen and removal of airborne pollutants. Noise transmission through the roof structure is cut by the planting and substrate. They also protect the structural and waterproofing system below from ultra-violet, frost and erosion—so providing extended lifespan and potentially whole life costs, compared with bare roofing systems.

Green roofs themselves will develop and adapt to suit specific local conditions and are self-regenerating once established. More subjective benefits include the impact of visible green spaces and related wildlife on the health and well-being of those living and working in cities, as well as influencing the aesthetics of modern buildings.



Photo: Sarnafil

Green roofs today

Despite the tangible benefits of green roofs they have not been widely used in the UK—until now. Current local and national government activity is a major driver in the expected growth of green roofs in future.

Firstly, many of our major cities are encouraging—and will be demanding—green roofs on new developments. The strongest example so far is the 2008 *London Plan* which includes the first firm policy on living (green) roofs in the UK, stating that:

‘The Mayor will and boroughs should expect major developments to incorporate living roofs and walls where feasible and reflect this principle in LDF policies. It is expected that this will include roof and wall planting that delivers as many of these objectives as possible:

- accessible roof space
- adapting to and mitigating climate change
- sustainable urban drainage
- enhancing biodiversity
- improved appearance.

Boroughs should also encourage the use of living roofs in smaller developments and extensions where the opportunity arises.’

This requirement is fleshed out with the draft Mayor’s ‘Preferred Standard’ which proposes that:

‘A minimum of 70% of the roof space should be vegetated to provide maximum benefit for SUDS, building energy performance and biodiversity.

At least 25% of the total roof space in any one development should be accessible to residents and/or workers.

A roof with an average depth of 100 mm substrate with 80% of the substrate having an average holding capacity of approximate 2 litres/10 mm/m² equivalent providing a potential minimum capacity of 20 litres/m².’



At the national level, wider measures are in place with SUDS, of which green roofs form a part. In order to meet the requirements of the European Water Framework Directive and to address the growing problem of flooding, governmental planning policy guidance throughout the UK—for example *PPS25: Development and Flood Risk* and *PPS 23: Planning and Pollution Control*—is now united in requiring use of SUDS on all developments wherever possible. It also encourages planners to take a central role in coordinating their acceptance by all stakeholders.

The government’s *Code for Sustainable Homes* includes a mandatory requirement to ensure that peak run-off rates and annual volumes of run-off post development will be no greater than the previous conditions for the site, effectively requiring SUDS solutions such as green roofs. SUDS are also recognised with ‘credits’ in the 2008 BREEAM (Building Research Establishment Environmental Assessment Method) environmental programme. But BREEAM also offers ‘credits’ for developments having minimal or no impact on existing site ecology and, additionally, for enhancing it, as well as for minimising long-term impact on the site’s and surrounding area’s biodiversity. Green roofs offer perhaps the only opportunity to achieve these goals in high-density urban situations.

As a result of all these pressures, the green roof industry faces a period of unprecedented growth. Now is the time to address the issue of safe maintenance.



An intensive roof giving users access to green spaces in the city.
Photo: Livingroofs.org

Green roofs in practice

Intensive green roofs

Intensive green roofs are effectively roof gardens, with a diversity of planting and perhaps lawn grass, requiring regular maintenance and probably access by building occupants or the public for their enjoyment. In terms of safe access, they will require parapets or balustrades forming an integral part of the architectural design and complying with Building Regulations (e.g: Part K for England and Wales). Alternatively, dedicated guardrail systems can be used for 'full containment' maintenance-only access.

Extensive green roofs

Extensive green roofs come in various categories and are characterised by a lightweight growing medium with self-sustaining planting in the form of vegetation mats, plugs or wild flowers. They are also sometimes described as biodiversity, eco-roofs or vegetated roof coverings. There should be no access to occupants or the public. The following guidance in this document concentrates on extensive roofs.

It is considered difficult—and unhelpful—to rigidly categorise extensive green roofs. Although generally used in the context of

flat areas (with a minimum fall of 1:80), green roofs can be used for falls up to 1:3, and a system is always needed for collection and discharge of excess water.

The most widely installed green roofs use Sedum—moisture retaining succulent plants which are wind, frost and drought tolerant. Sedum roofs offer the benefit of providing immediate coverage. They are usually supplied as mixed plant species, in the form of:

Mats—where the Sedum has been grown into a substrate that usually consists of a thin layer of growing medium over a non-woven synthetic or biodegradable textile layer. On site, mats are rolled out onto a growing medium or directly onto a moisture retention blanket for thin construction.

Plugs—planted directly into a deeper substrate.

Hydro-planting—a cost-effective alternative to blankets where a special coagulate mixture containing seeds, plant cuttings, mulch and fertiliser is sprayed onto a lightweight growing medium.

Other forms of planting and propagation can also be used with deeper growing mediums, generally requiring between 12 – 18 months to establish. They include 'biodiversity roofs' (or 'brown roofs') designed to meet specific ecological needs, an approach taken in many Swiss cities—such as Basel, where it is a legal requirement. Biodiversity roofs are generally seeded with an appropriate wild flower seed mix and encourage natural colonisation. In some examples, various aggregates, other materials and planting found on site are placed on the roof to replicate natural conditions and habitats.

Both construction and thickness of a green roof are generally determined by its intended purpose and vegetation type. Current guidelines indicate thicknesses ranging from as little as 20 mm up to 200 mm.



A biodiversity roof in Switzerland.
Photo: Livingroofs.org



Maintenance requirements

There is a common misconception that extensive green roofs do not require maintenance—this is not the case, even though they are self-sustaining. Having said that, maintenance is no more onerous than for most bare roof types, although involving different trades. A review of various guidelines reveals consensus that all types require full access for a range of tasks at least twice a year, ideally in spring and autumn. Depending on the type of roof, the following maintenance may be needed:

Mostly during the first 2 – 3 years as necessary:

- Irrigation during establishment and application of nutrients
- Removal of dead flower heads and unwanted plants
- Replacement of dead plants.

Generally in Spring and Autumn:

- Check drain outlets and fire breaks
- Inspect all components including flashings, mastic pointing and roofing membrane
- Address drainage erosion channels or substrate settlement
- Remove litter and debris (including dead leaves from adjacent trees)
- Remove any planting encroaching into drainage or pebble barrier areas (for example around safety systems)
- Inspect planting for healthy growth and repair bare patches from abundant growth areas
- Remove colonising planting that could damage the roof such as saplings, and weeds or grasses where desired.

The above maintenance work will largely be carried out by the green roof landscaper/installer. Other maintenance of building

elements may also be carried out by different contractors—such as cleaning rooflights or working on service installations. Similarly, maintenance of renewable energy source equipment, such as photovoltaics or wind turbines—often installed on green roofs—will require third-party maintenance. It is essential that appropriate safety systems are designed and installed, and the relevant training provided, for all these activities.

All types and variants of extensive green roofs require full access for maintenance at least twice a year. Safety systems to enable maintenance of the full planted area, as well as other building maintenance, should form an integral part of the building design.



Photo: Icopal



Making maintenance safe

Legal background

Based on European Council Directive 92/57/EEC, the latest Construction (Design and Management) Regulations—CDM 2007—cover all construction work including maintenance of buildings, placing direct responsibility on building owners. In addition, designers have a responsibility to ‘avoid foreseeable risks ... to those ... using a structure as a workplace, cleaning and maintaining generally.’ This requirement links to important legislation applying to both new and old buildings: the 2005 Work at Height Regulations (WAHR).

Defining responsibilities

WAHR places a duty on employers, the self-employed and anyone who controls the work of others at height—including contractors and building owners—and takes a hierarchical approach. If work at height cannot be avoided, measures should be employed to prevent falls. Then, if the risk of falling cannot be eliminated, measures to minimise the distance and consequence of any fall should be employed.

Bearing in mind CDM 2007, it is for architects to consider these requirements early, as an integral part of their building design. However, the detailed design of a safety system is invariably carried out by the specialist installer or manufacturer. Under CDM 2007, they are also considered as ‘designers’—and their particular competency in the field must be established by the client.

Architects and their clients have a clear legal responsibility to make sure that safety systems are available for all those maintaining their buildings, and to verify the competency of system designers.





Safety in practice

Safe access to extensive green roofs

As a general rule for working at height, the first priority is to consider 'collective' measures such as guardrails, particularly where more frequent access is needed by a variety of workers with limited high-level operational experience or training. Latchways' VersiRail is a lightweight, aluminium guardrail system that meets modern architectural requirements without compromising design, or safety demands. Straight, curved or inclined styles are available in either freestanding or fixed forms. A folding upright version, which is concealed from ground level when not in use, minimises visual intrusion. As an alternative to collective protection at the roof edge, VersiRail is also ideal for containing designated access ways for more frequent use, for example to services, photovoltaic zones or wind turbines. For such applications, Latchways' WalkSafe® range of anti-slip roof walkways provides the firm footing that may not be available on the green roof itself.

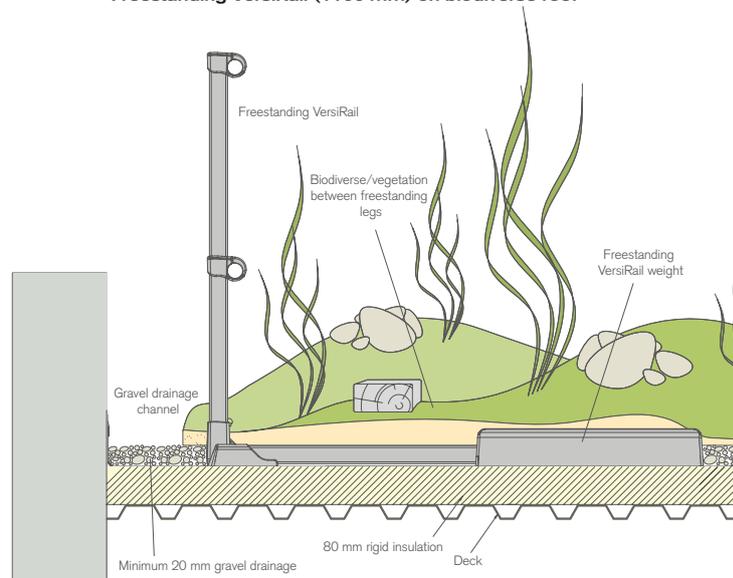
In practice, guardrails are generally limited to flat roofed areas, and there may be situations where collective solutions are not suitable for perimeter protection. Here, cable-based fall restraint or fall arrest systems offer the least invasive solution.

These systems consist of cables secured by fixed anchor points, forming a permanent element of the building. Latchways' patented Constant Force® post offers the most advanced technology in roof safety. The posts contain an energy-absorbing coil that limits load transfer to the roof panel, which is therefore not damaged in the event of a fall. The posts are top-fixed to the roof panel, therefore protecting the integrity of the roof. Critically, Constant Force systems must be specifically designed for, and tested in conjunction with, each particular roofing system, and endorsed by the roofing system manufacturer.



Deployment of Constant Force post in EN 795 test

Freestanding VersiRail (1100 mm) on biodiverse roof



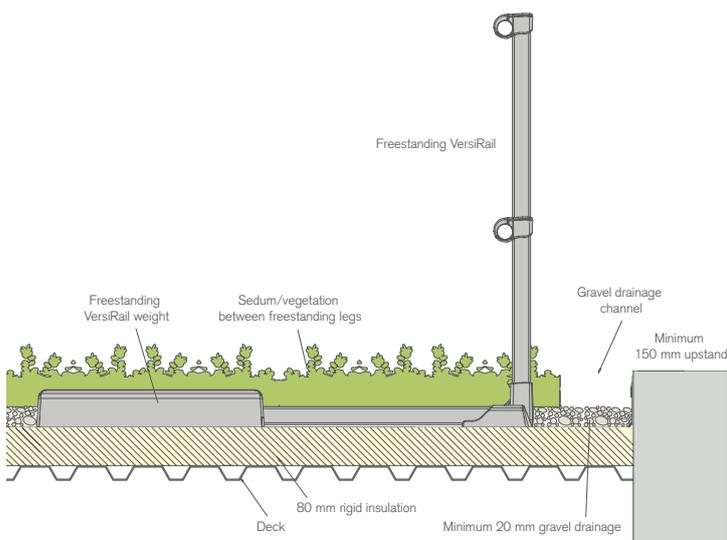
An appropriate Personal Protective Equipment (PPE) body harness can then be attached by a prescribed length lanyard via a Transfastener™ device to the cable at the access point onto the roof. This enables hands-free movement around the roof area as needed without disengaging the lanyard. With Latchways' Constant Force post system, up to three workers can use the system at one time. A prescribed level of training, procedures for rescue and detailed signage are all essential.

Providing full access

After collective protection, the WAHR hierarchy favours 'fall restraint', where the operative's movement is restricted to safer areas, over 'fall arrest', which limits the fall and its consequences where operatives are allowed into areas of fall risk—although both are recognised as valid. While most systems are designed for restraint, there is clearly still a need to access areas on some green roofs where falls might be possible. In addition to keeping operatives away from roof edges, preventing access to rooflights, which can become even more fragile with age, and other hazards within the roof area can also be handled by well-planned cable systems.



Freestanding VersiRail (1100 mm) on sedum roof



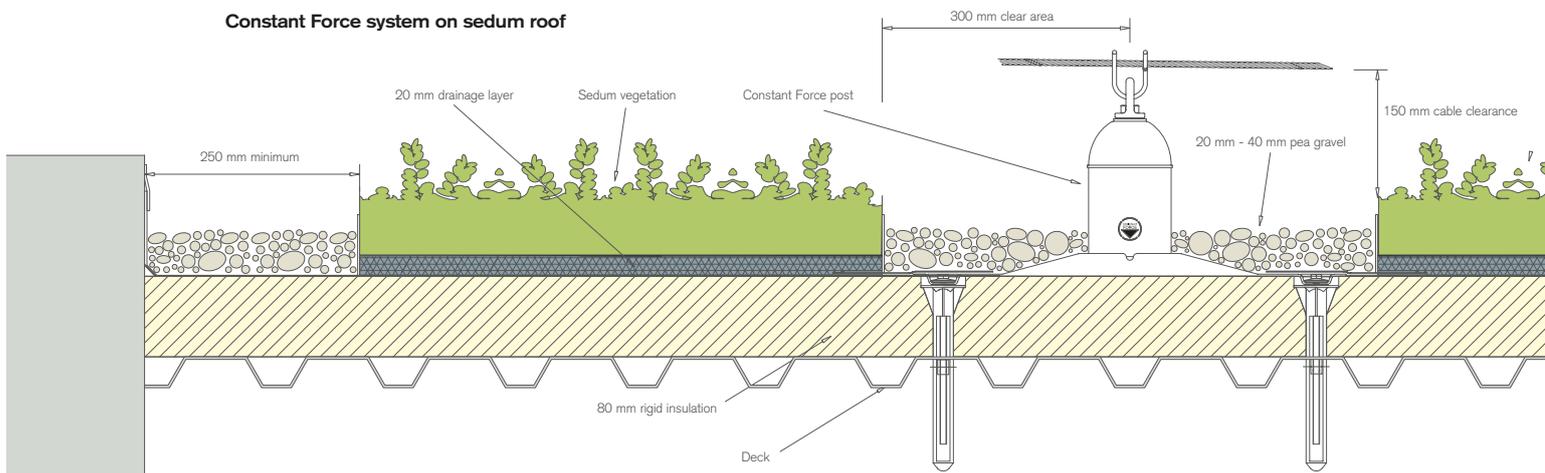
Latchways considers it essential that fall restraint systems meet 'fall arrest' standards in case of misuse such as over-long lanyards. To make them safe in use, both fall restraint and fall arrest systems must be designed by experts and supported by the right training, management and rescue protocols.

Design and detailing

Latchways' specialist designers have the expertise to design safety systems allowing full access for maintenance of extensive green roofs using either guardrails or Constant Force post technology. In addition, provision can be made for other maintenance needs which might involve dedicated walkways, perhaps with guardrail systems, to access service areas. Special requirements may also be needed for pitched or curved green roofs.

The Latchways Constant Force post system has been fully tested in conjunction with each of the leading green roofing systems and specific details developed. In general terms, a small pebbled area clear of vegetation is needed around each post, as shown. Standard details have already been developed for various manufacturers' green roof systems. Details can be adapted easily to suit bespoke green roof and substrate depths described earlier.

Constant Force system on sedum roof



Construction

Expert guidance on green roofs strongly recommends that the growing medium and planting should only be installed once all other trades no longer require access over the roof. The only exception would be services and similar areas where designated walkways are in place. If this is the case, then the VersiRail or Constant Force post safety system will also be in place and could be used by the green roof installer/landscaper. However, this should only be allowed where evidence of completion and testing of the system is available and correct operative training completed.

Operation

Workers operating in areas contained by VersiRail require minimal training once the system has been installed by qualified operatives. The durable aluminium components are corrosion resistant and require no annual maintenance. The Freestanding Folding option combines safety with architectural aesthetics, is designed to fold flat when not in use and is concealed when viewed from ground level.

Once the Constant Force post system has been commissioned, trained workers attach the appropriate PPE body harness via a prescribed-length lanyard to the cable at the access point onto



the roof. Uniquely with Latchways, up to three people can make use of the system at one time.

Training is a particularly important issue for green roofs, as operatives will generally be from the landscaping industry with no experience of working at height. Latchways is working closely with industry bodies such as BALI (British Association of Landscape Industries) to help resolve this issue. Full details of user requirements for fall restraint/arrest systems should always be included in the green roof Operation and Maintenance manuals.

Irrespective of the form of fall protection provided, the footing provided by green roofs may not be firm and may be variable. To address this, a method statement should be prepared following risk assessment and designated walkways such as Latchways' WalkSafe provided where necessary.

Maintaining the system

Latchways fall protection systems are installed by specialist contractors who also carry out a strict maintenance programme on the system itself throughout its life. This maintenance may involve cutting back vegetation encroaching onto the pebble protection zone around posts or in danger of fouling equipment running along cables between posts. It is helpful if this vegetation control is also included in the green roof maintenance programme carried out by the installer/landscaper and the Operation and Maintenance manuals.

Taking the next steps

In order to meet the requirements of CDM 2007, it is essential for Latchways to liaise with building designers from the earliest stage and establish all accessibility requirements. Latchways is also working closely with the green roofing industry to address any specific issues affecting safe working at height. Latchways' in-house design team offer a unique, free specification service providing comprehensive support and advice to clients, architects, contractors and specifiers.

The landscaping industry view

“The use of green roof technology, whilst increasingly commonplace in Europe, America and the Far East, is only now becoming more widely utilised in the United Kingdom. The challenge of climate change and the resultant move to more sustainable urban planning and construction is undoubtedly fuelling the growing demand for green roofs and living walls.

Professionalism in the implementation of any new technology is naturally acquired over time, with expertise being developed and cascaded to others. However, there can be no such luxury with Health and Safety, where it is vital that sound working practices are implemented from the outset.

This document, instigated by Latchways with comment from relevant industry bodies, represents a valuable contribution to safe working at height on extensive green roofs, and provides informed advice for contractors tasked with their maintenance.”

Sandra Loton-Jones, Chief Executive,
British Association of Landscape Industries (BALI)

Further information

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References and further reading

Mayor of London, Living Roofs and Walls, Technical Report: Supporting London Plan Policy, Greater London Authority 2008

Building Green—available at www.london.gov.uk

Building Greener—published by CIRIA

www.livingroofs.org

www.thegreenroofcentre.co.uk

English Nature Green Roof Report

Green Roofs and Facades—Gary Grant, published by BRE

Work at Height Regulations 2005

CDM Regulations 2007

Research and writing

Chris Hodson—MA, Dip Arch (Cantab), RIBA

Contacts

Sonia Rodrigo—Marketing Manager

Email: sonia.rodrido@latchways.com

Latchways plc, Hopton Park, Devizes, Wiltshire, SN10 2JP, England

Tel: +44 (0)1380 732700 Fax: +44 (0)1380 732701

www.latchways.com



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Latchways plc, Hopton Park, Devizes, Wiltshire, SN10 2JP, England
Tel: +44 (0)1380 732700 Fax: +44 (0)1380 732701
Email: info@latchways.com Website: www.latchways.com

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