

FUNCTIONAL REQUIREMENTS

7.11 ROOF COVERINGS – GREEN ROOFING

Workmanship

- i. All workmanship must be within the tolerances defined in Chapter 1 of this Manual.
- ii. All work is to be carried out by a technically competent person in a workmanlike manner.
- iii. Certification is required for any work completed by an approved installer.

Materials

- i. All materials should be stored correctly in a manner that will not cause damage or deterioration of the product.
- ii. All materials, products and building systems shall be appropriate and suitable for their intended purpose.
- iii. The structure shall, unless specifically agreed otherwise with the Warranty provider, have a life of not less than 60 years. Individual components and assemblies, not integral to the structure, may have a lesser durability, but not in any circumstances less than 15 years.

Design

- i. The design and specifications shall provide a clear indication of the design intent and demonstrate a satisfactory level of performance.
- ii. Roof coverings must prevent any external moisture passing into the internal environment of the dwelling.
- iii. Structural elements outside the parameters of regional Approved Documents must be supported by structural calculations provided by a suitably qualified expert.
- iv. The materials, design and construction must meet the relevant Building Regulations, British Standards, Eurocodes and other statutory requirements.

CHAPTER 7: Superstructure

7.11.1 Scope

This part of the Manual should be read in conjunction with Chapter 7.10 – Roof Coverings. Where appropriate, cross reference will be provided to the relevant section.

This Chapter provides specific advice and requirements in respect of membrane roof systems over which a finish of living vegetation or materials that will support vegetation is to be applied.

The membrane roof systems may comprise one of the following, but the advice of Chapter 7.10 – Roof Coverings applies:

Warm deck, comprising:

- Waterproof membrane
- Principal thermal insulation
- Vapour Control Layer
- Continuously supporting deck (Structural deck)

Inverted warm deck roof systems:

- Ballast
- Water Control Membrane
- Principal thermal insulation
- Waterproof membrane
- Continuously supporting deck

Cold deck roof systems (not recommended):

- Waterproof membrane
- Continuously supporting deck

- Ventilation externally
- Principal thermal insulation
- Vapour Control Layer

7.11.2 Definitions

For the purposes of this standard, the following definitions shall apply:

Biodiverse roof: a roof that is designed to create a desired habitat that will attract a particular flora and fauna, whether replicating the original footprint of the building or enhancing the previous habitat.

Brown roof: a biodiverse roof where the growing medium is purposely selected to allow local plant species to inhabit the roof over time.

Drainage layer/reservoir board: available in a variety of materials, including hard plastic, polystyrene, foam, coarse gravel and crushed recycled brick, depending on the Functional Requirements. This allows excess water to drain away, thereby preventing the waterlogging of the substrate. Some drainage layers also incorporate water storage cells to retain additional water that can be diffused to the plant support layer during prolonged dry periods.

Extensive green roof: a lightweight, low-maintenance roof system, typically with succulents or other hardy plant species (often sedum) planted into a shallow substrate (typically less than 100 mm) that is low in nutrients. Irrigation is not normally required.

Filter fleece/fines layer: geotextile of low resistance to water penetration, which prevents fines and sediments from being washed out of the green roof into the drainage system.

FLL: Forschungsgesellschaft Landschaftsentwicklung Landschaftsbau (German Landscape Research, Development and Construction Society).

Green roof: a roof or deck onto which vegetation is intentionally grown or habitats for wildlife are established, including extensive, intensive and semi-intensive roofs, roof gardens, biodiverse roofs, brown roofs and public and private amenity spaces.

Green roof system: the component layers of a green roof build-up.

Growing medium/substrate: an engineered soil replacement that contains a specified ratio of organic and inorganic material, specifically designed to provide green roof plants with the air, water and nutrient levels they need to survive, whilst facilitating the release of excess water.

GRO: Green Roof Organisation, the industry forum for green roof development and promotion in the UK.

Hydro seeding: spraying a specially designed blend of seeds and growing medium.

Inspection chamber: a chamber situated over an internal rain water outlet designed to constrain the surrounding landscaping but allowing easy

access for maintenance. Allows water entry, but helps prevent unwanted silt, debris or vegetation from entering and obstructing free drainage.

Intensive green roof: a version of a green roof often referred to as a roof garden that provides benefits akin to a small urban park or domestic garden. Designed primarily for recreational use, intensive roofs are typically configured with 200mm+ of substrate, and often require regular maintenance and irrigation.

Moisture/protection layer: geotextile blanket, available in varying thicknesses (typically between 2mm–12mm), which performs a dual function. Firstly, protecting the waterproof membrane during the installation of the green roof system, and secondly, increasing the water holding capacity of the green roof system.

Root barrier: a waterproof membrane designed to prevent roots from penetrating the waterproofing layer and building fabric. This function may be incorporated in a single membrane waterproofing product.

Sedum: genus of about 400 species of low-growing, leafy succulents that are wind, frost and drought tolerant and found throughout the northern hemisphere. Not all species are suitable for roofs.

Semi-intensive green roof: intermediate green roof type with characteristics of both extensive and intensive green roofs. Typically with a 100mm–200mm substrate depth, sometimes irrigated, occasionally managed and usually planted with a range of species.

SuDS: Sustainable (Urban) Drainage Systems

Vapour Control Layer (VCL): construction material (usually a membrane) that substantially reduces the transfer of water vapour through the roof.

Wildlife roof: a version of a biodiverse roof designed to provide a specific habitat to attract a wildlife species.

7.11.3 Design and system types

A green roof essentially comprises an organic vegetation layer and those components necessary to support its growth, which is placed over a membrane roof system. For convenience, green roofs are divided into the following types:

- Biodiverse roof
- Brown roof
- Extensive green roof
- Semi-intensive green roof
- Intensive green roof

The roof system may be of warm deck, inverted warm deck or cold deck configuration (see Chapter 7.10 – Continuous Membrane Roofing). Generally, the warm deck configuration is recommended unless there are specific design circumstances for which inverted and cold roofs are better suited. A technical justification for any departure from warm deck will be required.

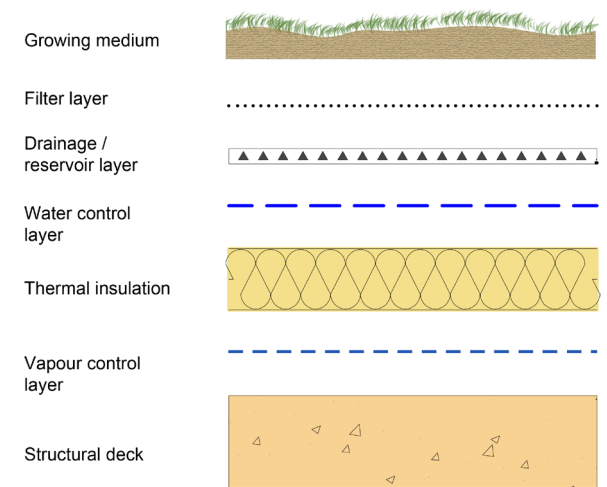


Figure 1: Extensive green roof - warm roof system (section)

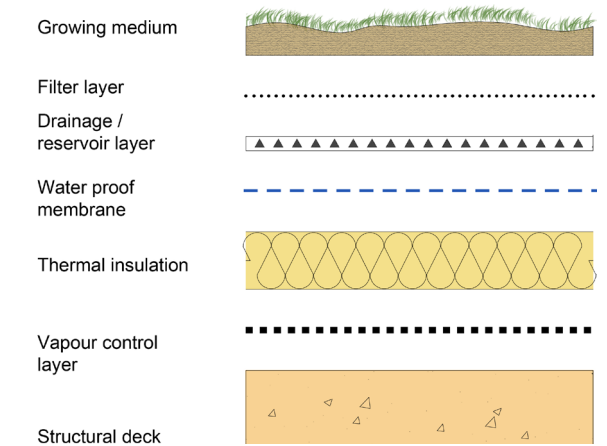


Figure 2: Intensive green roof - inverted warm roof (section)

7.11.4 Loading

7.11.4.1 Statutory requirement

Design for loading should comply with current Building Regulations.

7.11.4.2 Resistance to wind load

In all situations, including ballasted and inverted roofs, a calculation of wind load to BS EN 1991-1-4 should be undertaken by a suitably competent person. Wind load acting on a green roof will be affected significantly by the design of the perimeter and by the geometry and finishes on the elevations of the building. Any changes to these elements will necessitate a review of the calculation output.

In biodiverse, brown and extensive green roof systems, the dead load contribution from the growing medium should be calculated on an assumption of dry substrate conditions. Such loadings may be insufficient to restrain the green roof and certain types of waterproof membrane and insulation, necessitating the provision of supplementary ballast or netting restraint. Information on loading is available from horticultural suppliers.

7.11.4.3 Resistance to imposed loads

At the earliest possible stage, the employer should define the range of potential imposed loads for which the green roof is to be designed, such as seats, stand-alone planters, storage and public access. In the absence of such a performance

requirement, the loading limits of the roof should be defined.

7.11.5 Falls and drainage

7.11.5.1 Statutory requirement

Design for drainage should comply with current Building Regulations.

7.11.5.2 British and industry standards

The relevant requirements of BS 6229 should prevail in respect of green roofs, irrespective of the type of vegetative covering.

Falls are required for green roofs because:

- Standing water will inevitably result from design without falls, due to tolerances and deflection. Standing water, which may become stagnant, is not conducive to plant growth and should not be confused with the temporary retention of water in drainage/reservoir layers.
- Absence of falls will result in ponding, a potential slip hazard and the retention of mineral fines in vegetation-free zones, which in turn may encourage the growth of weeds.

7.11.5.3 Creation of falls

Roof falls may either be created during the construction of the deck or alternatively by using tapered insulation systems (warm deck roof systems only).

Where the roof finish is to include paving with or without paving supports, consideration should be given to the height difference created by the falls and spacing of rain water outlets in order that the maximum height of paving supports is not exceeded, the minimum height of upstands is not affected or trip hazards created.

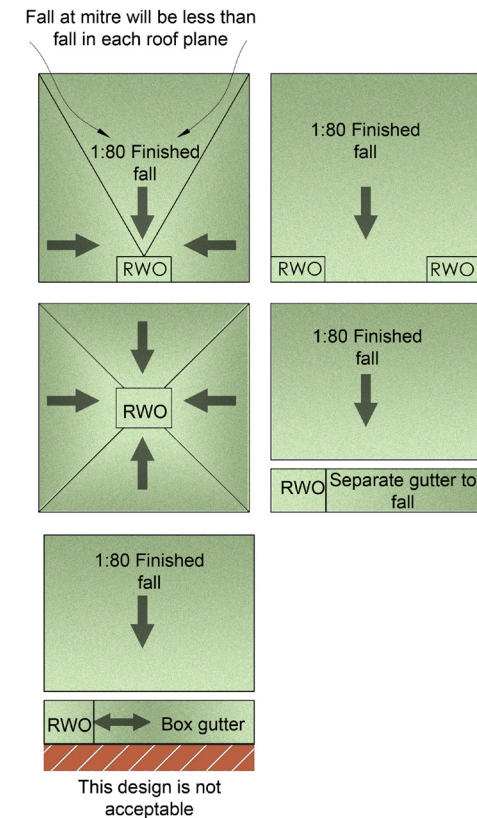


Figure 3: Drainage layout options

7.11.6 Drainage

Drainage design should be based upon calculations to BS EN 12056 given a design head of water (typically 30mm). Rain water outlet capacity should be taken from properly certificated information provided by manufacturers, and the resulting number and layout of outlets should allow for obstruction and drag due to any additional surface finishes, such as walkways.

Green roofs are proven to reduce the volume and rate of transfer of rain water-to-rain water goods. This effect is clearly dependent upon many factors, including depth and type of growing medium, type of drainage/reservoir layer, weather conditions prevailing prior to the rainfall event and fall in the waterproof membrane. Due to these variables, it is recommended that the design for rain water drainage in accordance with BS EN 12056 is as follows:

- Brown, biodiverse and extensive green roof systems: no allowance for rain water attenuation
- Intensive green roof systems: attenuation as advised by the horticultural supplier. If no data is supplied, no allowance should be made

The UK's National Annex to BS EN 12056 does permit the use of a coefficient to factor down the drainage infrastructure to account for factors such as the additional retention performance of green roofs. However, the coefficient that is used to reflect this reduction would be based on average annual retention, and not on responses to dynamic storm events.

Any drainage infrastructure designed to accommodate this reduced flow rate may not accurately account for seasonal differences or individual storm events. Any reductions in drainage capacity would therefore need to be countered by alternative measures, e.g. appropriate detailing to ensure that any attenuation of water at the roof level will not be detrimental to the building structure or fabric.

Rain water outlets should be readily accessible without disruption to the green roof or pedestrian finish. On finishes raised above the waterproof membrane (warm deck roofs) or Water Control Membrane (inverted roofs), this may be achieved by a suitably marked paving slab or demountable section of decking. Within the area of the green roof, a specific vegetation-free inspection chamber and cover should be provided in order to avoid plant growth obstructing the outlet. Purpose-made products are available from suppliers of green roof components and waterproof membranes, and it is recommended that they be used wherever possible.

Rain water goods from higher roof areas or adjacent roof areas should not be designed to discharge onto the green roof. The downpipe should be connected directly to the downpipe serving the green roof.

Green roofs are compatible with siphonic roof drainage systems. In the right circumstances, these can offer the advantages of:

- Very high capacity, enabling fewer outlets and therefore less detailing work on site.

- Smaller bore horizontal collector pipework, enabling reduced roof void depth.
- Self-cleaning in many situations.

However, siphonic drainage should be designed specifically for the green roof system because it must operate siphonically with sufficient regularity to avoid silting-up small-bore pipework.

For further information, see www.siphonic-roof-drainage.co.uk.

7.11.7 Design for irrigation

Rainfall is the typical source of water. However, complementary irrigation options may be required for semi-intensive and intensive systems or those where, for example, the appearance of a grass finish may be important.

Provision may include hoses, sprinklers, overhead irrigation and automated systems that pump from some reservoir storage. The establishment of a need for an irrigation system, and the design of an irrigation scheme, should be in accordance with the principles of BS 7562-3. Where irrigation is required, a frost-protected water supply, rain water or grey water storage facility should be provided at roof level.

7.11.8 Thermal performance

7.11.8.1 Statutory requirement

Design for thermal performance must comply with current Building Regulations, as appropriate.

7.11.9 External fire performance

7.11.9.1 Statutory requirement

Design for external fire performance must comply with current Building Regulations.

7.11.9.2 Design for resistance to external fire

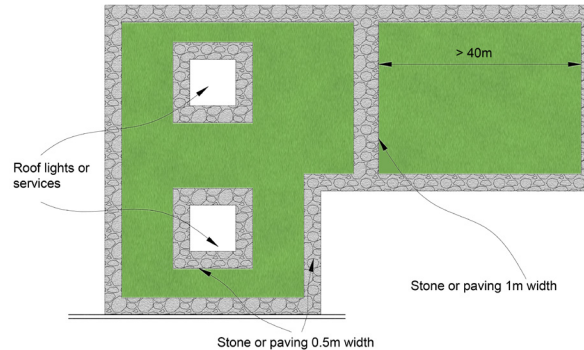
The design of green roof systems can influence the fire performance of the overall roof system. The rate of growth and moisture content of natural vegetation is unpredictable and determined by irregular weather conditions. The substitution of planted species with others is also unpredictable. Design to minimise fire risk cannot be based on an assumption of regular maintenance or of irrigation during drought. The latter is not relevant with sedum species, which die back, but is important for intensive roof gardens or extensive systems planted with grasses.

The design should not allow the vegetation to grow or propagate towards adjoining elements, such as abutments, eaves or pitched roofs. It should also be kept away from openings, such as roof lights and smoke vents.

This is achieved in two ways:

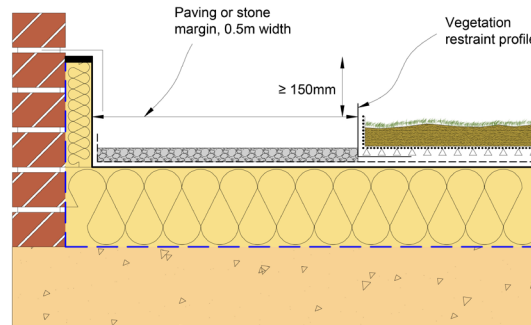
- A vegetation-free zone of minimum 0.5m width at all perimeters, abutments and openings. This zone should be extended to 1m to separate large roof zones in excess of 40m in length

- Design of flexible walkways, hard paving and ballasted areas so as to minimise root and plant spread



- Notes:
1. 0.5 zone around openings, along abutments and at perimeters.
 2. 1.0m zone may be required to separate green roof areas on roof in excess of 40m length.
 3. Vegetation-free zone to comprise non-combustible stone or paving on suitable protection.

Figure 4: Green roofs: vegetation-free zones (plan, zone width: not to scale of building)



- Notes:
1. 0.5m zone around openings, along abutments and at perimeters.
 2. Vegetation restraint profile should be secured with ballast as necessary. Additional restraint will be required on sloping roofs to stop creep of the vegetation zone.
 3. Protection of waterproof membrane should be extended under balast zone.
 4. Paving or stone should not simply be added to the growing medium at the perimeter as this (a) may reduce the available height of upstands and (b) will not stop plant growing in the zone.

Figure 5: Green roofs: vegetation-free zone: warm roof (elevation)

7.11.10 Provision for access

7.11.10.1 Statutory requirement

Design should comply with current Building Regulations.

7.11.10.2 Temporary provision during construction

At the earliest possible stage, the anticipated loading of the roof system (prior to application of the green roof components) should be assessed in terms of:

- Load, e.g. foot traffic, equipment
- Frequency
- Risk of impact

If such usage is intense or long-lasting during the construction phase, consideration should be given to temporary works only, with completion occurring after all non-roofing usage has ceased, as follows:

- Warm deck roof system: installation of temporary Vapour Control Layer, to be overlaid when remainder of system is installed.
- Inverted warm deck roof system: overlay of completed waterproof membrane with geotextile and continuous temporary decking, such as plywood, Oriented Strand Board or compatible recycled thermoplastic board.

7.11.10.3 Permanent pedestrian access finishes

Pedestrian finishes should be designed to suit the purpose and frequency of access in the context of the intended planned maintenance regime. For example, paving on paving supports may be desirable to allow drainage and to level up the finish, but may be unsuitable if plants could spread beneath the paving. Generally, for amenity access, a finish of porous or hard concrete paving laid directly on a suitable protection fleece may be most suitable.

For service and maintenance access only, a flexible walkway tile may be sufficient (depending on the waterproof membrane and roof system type).

7.11.11 Detailing

General principles

At an early stage in the design process, an audit of roof geometry should be carried out to establish what types of details will be required and whether they are to be weather proof (incorporating an upstand/cover flashing arrangement) or waterproof (providing continuous waterproofing across the detail).

The following key principles should be followed in design of all details:

- Upstands to extend 150mm above the finished roof level, i.e. top of growing medium.

- Downstands (of separate metal or other flashings) should lap the upstand by a minimum of 75mm.
- Reliance on sealant as the sole means of protection should be avoided.
- Consideration of the effect of vegetation growth on the integrity of the weather proofing.

The total roof zone depth should be measured from the surface of the growing medium and assessed at critical points, such as the top of drainage slopes, to ensure that there is enough free upstand available to create the minimum required 150mm of waterproofing protection above finished roof level. It is important that this minimum 150mm upstand is maintained at all points around the area of the green roof, except at continuous water checks and at verges.

7.11.12 Design for sustainability

As per Chapter 7.10 - Continuous membrane roofing.

7.11.13 Materials

As per Chapter 7.10 – Continuous Membrane Roofing.

Note: If the waterproof membrane is also intended to provide root resistance, suitable certification of testing in accordance with BS EN 13948 should be available.

7.11.14 Installation

7.11.14.1 Protection of the roof

Temporary protection (during construction)

Responsibility for temporary protection and a method statement for its use should be agreed prior to commencement of works. Suitable materials should be selected in consultation with membrane manufacturers as appropriate, for example:

- Linked recycled thermoplastic sheets
- Rolled recycled thermoplastic or elastomeric sheets

Particular consideration should be given to locations of concentrated access, such as step-out areas onto the roof or where wheeled equipment may be used.

Permanent protection (during service)

See Chapter 7.11.14.1.

7.11.14.2 Vapour Control Layer (VCL)

As per Chapter 7.10 - Continuous membrane roofing.

7.11.14.3 Thermal insulation

As per Chapter 7.10 - Continuous membrane roofing.

7.11.14.4 Waterproof membrane

As per Chapter 7.10 - Continuous membrane roofing.

Note: Warm roof systems – restraint against wind load. It is unusual for the installation of ballast and green roof components to follow immediately after installation of the roof system. This may be because the roof system and green roof overlay are to be installed by different contractors, or because of site factors, such as limited storage. Unless it is sequenced to do so, the roof system should be installed with restraint against wind load based on an assumption of an exposed waterproof membrane.

7.11.15 Testing

7.11.15.1 Final inspection

A thorough, recorded, visual inspection of all areas, including details, should be carried out, with representation from the General Contractor and Roofing Contractor in attendance.

7.11.15.2 Procurement of testing services

The waterproof membrane should be tested for integrity before the application of any other components above it. Testing should be undertaken by a third-party that is independent of the roofing contract. The testing service provider should provide evidence of the following:

- Efficacy of the method proposed in the circumstances of the project.

- Experience and training of operator.
- Membership of an appropriate trade association that sets a Code of Conduct for the service.

7.11.15.3 Methods of test

Low voltage earth leakage

Low voltage earth leakage is a safe and effective method for the testing of waterproofing integrity in roofs where the waterproof membrane is an electrical insulator and the deck provides an electrical earth. It is not suitable for testing flat roofs where the waterproof membrane has been overlaid with insulation and ballast (inverted roofs) or ballast only (ballasted warm roofs); therefore, testing should be carried out prior to completion of the roofing system.

High voltage electrical discharge

The high voltage electrical discharge method is best suited to the testing of continuous thin films, such as liquid-applied coatings. Its use is not recommended with polymeric single ply, reinforced bitumen membranes and mastic asphalt.

Vacuum

Vacuum testing of seams of membranes manufactured off-site is an effective means of quality assessment, but is not recommended as a method of demonstrating the integrity of flat roofs.

Flood testing

Flood testing is a suitable method of demonstrating the integrity of small areas of roof to which a green roof system is to be applied. However, consideration should be given to the effect of ingress on programme and the risk of entrapped water in insulation (warm deck roofs) and decks (all types). The area under any one test should not exceed 50m².

7.11.15.4 Testing after installation of green roof system

No reliable method is available for testing the integrity of a green roof following application of the green roof components. With extensive greening on certain warm roof systems, it may be feasible to use low voltage earth leakage, but any defects recorded will in any case involve removal of the green roof components. Therefore, it is strongly recommended to ensure the very highest possible standards of protection of the waterproof membrane during the application of the green roof components.

7.11.16 Provision of information

7.11.16.1 Operation and Maintenance Manual

The following information is required:

- Specification, as-built:
 - Waterproof membrane: generic type, product(s) and (as appropriate) thickness.

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- Thermal insulation: generic type, product(s) and thickness.
 - Acoustic insulation: generic type, product and (as appropriate) thickness.
 - Vapour Control Layer: generic type, product (as appropriate) and thickness (as appropriate).
 - Rain water outlets: type, product, capacity, location and means of access.
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- Procedure for maintenance of waterproof membrane, including (where appropriate) recommended frequency and method of application of solar reflective finish.
 - Procedure for repair of waterproof membrane
 - Instructions for irrigation (method/frequency), weed control and application of fertiliser (type/season/frequency).