PCA Property Care ASSOCIATION

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Best Practice Guidance

Buried Roofs Below Ground Level

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Contents

Sources of information and guidance

BS 8102:2022 Protection of below ground structures against water ingress – Code of practice
BS 6229:2018 - Flat roofs with continuously supported coverings. Code of Practice
BS EN 12056-3:2000 - Gravity drainage systems inside buildings. Roof drainage, layout and calculation.

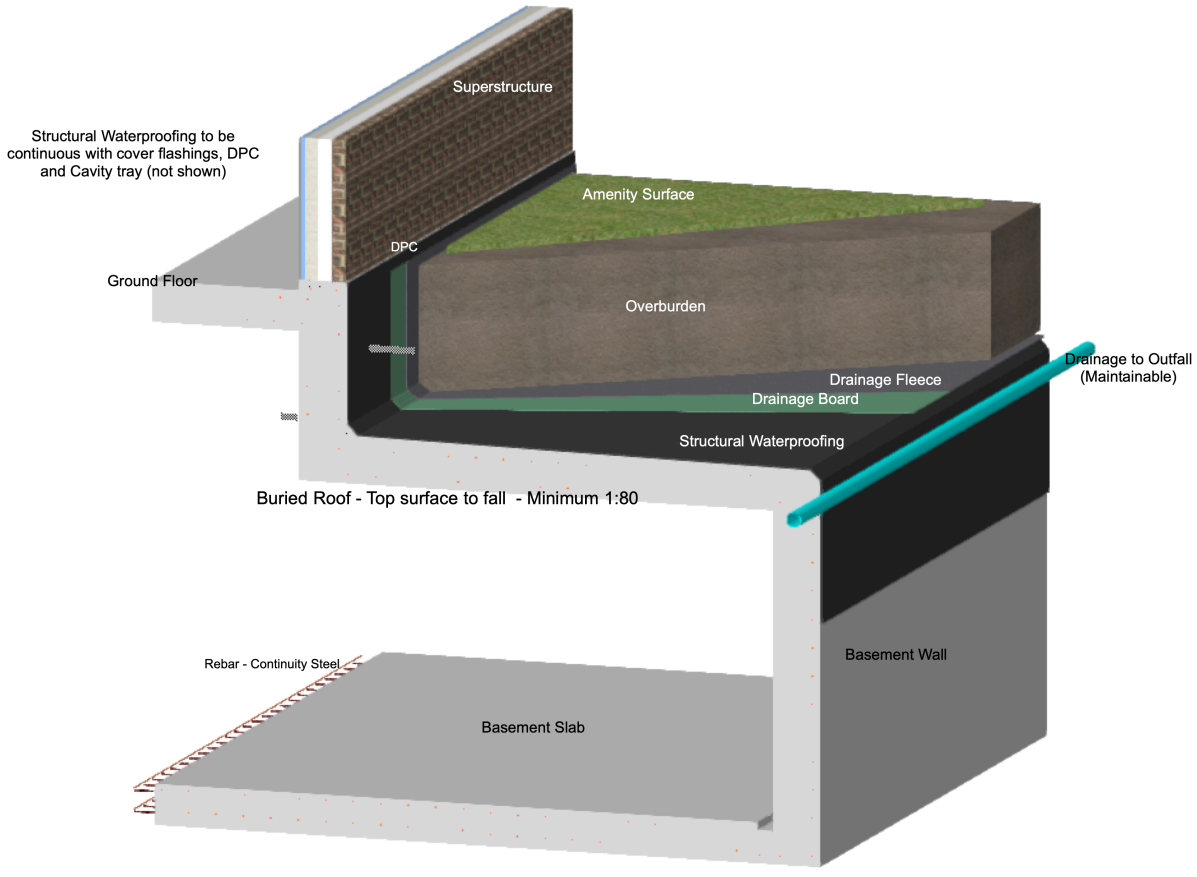
This is a guidance note. Where recommendations are made for specific tasks, these are intended to represent industry 'best practice', and in the opinion of the PCA they meet an acceptable level of competence. Although members are not required to follow the recommendations contained in the note, they should consider the content.

1. Introduction

A buried roof is where the ceiling of a below ground sub-structure extends beyond the superstructure footprint, on plan, and becomes a platform for an external amenity space within the curtilage of a property.

This guidance differentiates between a buried roof beneath the external ground level and a podium deck at ground level to support the design and installation of an effective waterproofing system to these structures. Like all other below ground failures of a waterproofing design, leaking waterproofing protection of a buried roof, is costly to remediate. This is a especially true when water protection systems are located below the ground level and hidden below an extensive build up of moisture retaining layers and growing mediums.

This best practice guidance document primarily focuses on buried roofs to a conditioned or regulated space below the reinforced concrete slab. The guiding principles however, may also be applied to an exposed podium deck situation located at ground level.



Illustrative view of a buried roof

2. Design and construction build philosophy

All building and structural elements necessitating structural waterproofing must be considered at the construction design stage – RIBA Stage 3 (*Spatial Coordination*).

The following waterproofing design philosophies should also be recognised:

- The necessity of a dimensionally stable durable substrate
- Ensure the provision of adequate gradient or falls to provide effective surface drainage
- Repairability requirements, including the ability to locate defects.

Design and installation of any buried roof should comply with *Regulation 7 of the Building Regulations: Materials and Workmanship*

3. Buried roofs

A buried roof is a structurally flat reinforced concrete slab, with a specific requirement to waterproof the top surface protecting the basement void below from the ingress of water, and allowing for the use of an environmentally exposed external amenity space above.

The failure of a waterproofing system and the subsequent leakage of water into the basement below, often originate at the design stages of construction. Construction professionals often specify inappropriate structural materials to form the buried roof which may include block and beam systems, ribbed decking , hollow rib planks and other composite construction system builds. These all have proven to be problematic in providing a stable substrate on which an effective waterproofing system can be successfully applied.

An early appointment of a competent waterproofing design specialist (WDS) will provide advisory design requirements to architects and engineers on the suitability and appropriate use of structural materials where waterproofing materials are being applied. With knowledge and understanding of waterproofing materials and their effectiveness when applied to various construction materials the WDS can provide an appropriate and effective barrier solution to cater for imposed and cyclic building movement.

The WDS will provide a clear practical design solution and methodology statement for the application of the waterproofing materials specified to the below ground structure. Included within the design specification the WDS will specify location of construction joints, surface waterproofing and drainage systems above the construction to avoid the total saturation of built-up layers above the basement buried roof.

Buried roofs that have been constructed using reinforced concrete designed by an experienced structural engineer have proven to be the most reliable form of construction for the application of an effective waterproofing protection system. It is important that structural elements must be stable. Buried roof deflections must be identified so that adequate falls can be provided to avoid surface ponding. A detailed defection analysis of the structure is considered essential. This will allow the waterproofing designer to specify appropriate materials and necessary detailing to accommodate any anticipated movement of the concrete structure.

The adoption of fully bonded elastomeric or flexible sheet type waterproof products or combinations of these materials to protect the top surface of the slab from the ingress of surface water and to provide a suitable drainage layer to adequately remove surface water from overburden materials laid above.

4. Provision of falls and effective drainage

4.1 Falls

Waterproofing systems applied onto the concrete structure below ground should be capable of directing water to a suitable drainage outlet. The achievement of these falls requires the consideration of numerous factors including; construction tolerances, deflection, the weight of overburden and long term creep. These all typically demand that the concrete substrate be designed with falls not less than 1:80 prior to the application of waterproofing barriers.

Roof falls may be achieved with the application of cementitious screeds over the reinforced structure. However, this additional layer may introduce construction sequence delays due to drying times and also introduce the risk of cracking within the screed especially where the screed is feathered. Lateral movement of water at the concrete and screed interface will make identification of where water ingress occurs substantially more difficult if not fully bonded.

The use of tapered insulation could be used to achieve the desired falls. Where inverted warm roof build-ups are adopted. Similarly the location point where water ingress occurs in a waterproofing system cannot be established due to water tracking under the insulation forms.

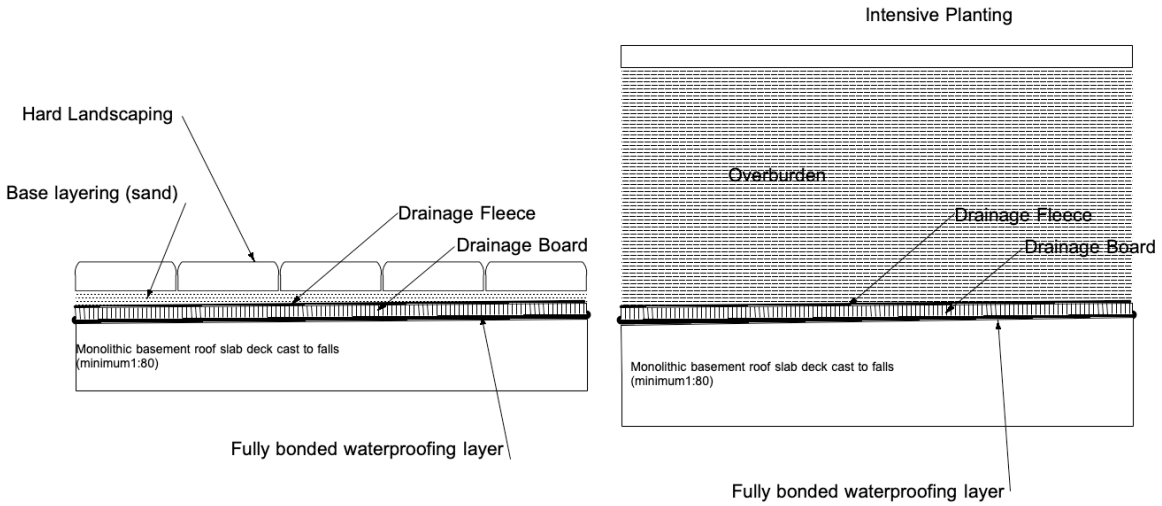
A monolithic basement roof cast to falls is therefore preferable, as this approach will provide not only structural stability, but will afford the ability to precisely locate defects should water ingress occur.

4.2 Effective drainage

Immediately above the waterproofing system applied a drainage layer should be provided to ensure that water can be shed from the buried roof. Paviours on pedestals are considered to be the most effective for hard landscaped spaces. For extensive or intensive green spaces, a cuspated membrane incorporating filtered layers should be used to provide a drainage void to the drainage outlet.

Drainage outlets on or off the buried roof should always be accessible for maintenance ensuring the long term success of the drainage system. Therefore a scheduled maintenance provision should be included as a part of the overall basement waterproofing design.

When the basement wall construction is positioned on site boundaries, party walls or garden boundary walls there is no adequate access to the buried roof and the head of the basement wall. Therefore boundary line drainage should be designed by adopting a perimeter drainage approach into a rebated joint within the structure. Appropriate detailing will provide a positive discharge of surface water from the buried roof.



Example sections buried roof with deck cast to falls

5. Repairability

With all waterproofing designs of below ground structures, reparability must be considered throughout the life of the building. Where appropriate this should include consideration for locating defects to undertake any necessary repair. For buried roofs accessibility to the waterproofing layer may not be possible, and therefore fully bonded waterproofing layering systems onto the reinforced concrete deck are the only system available. If leakage should occur through the waterproofing system then resin injection at the point of ingress will be the most effective remedial strategy.

Where the waterproofing layer is not fully bonded to the buried roof, permanent leak detection systems may be considered. However these systems offer limited identification of leakage and accessibility will remain a major difficulty.

6. Buried roof construction considerations

6.1 Choice of waterproofing system

There are many different types of materials that can be used to waterproof a buried roof. However any system specified should be preferably bonded to the structural concrete as this will significantly minimise the risk of water ingress. Common systems include:

- Two coat - hot melt waterproofing systems
- Fully bonded membranes
- Polyurea systems (synthetic resin and isocyanate-reactive material)
- Polymethyl Methacrylate (PMMA) Liquid Applied Systems
- Cementitious applications.

Note: Design considerations and limitations must be recognised when using cementitious waterproofing for buried roofs for possible interface debonding and differential shrinkage.

Material choices by the WDS will depend on service life, durability, installation requirements or limitations, new build or refurbishment, final use and application.

Some available waterproofing systems are not generally recommended for buried roofs. Examples include: Epoxy coatings; Glass reinforced Plastic (GRP) and single ply membranes.

6.2 Construction and movement joints

At the design phase the WDS should consider:

- structurally designed movement joints to any element of the basement and avoid if possible.
- where movement joints are positioned on the buried roof, they should be located within raised upstands and identified on the landscaped finish to ensure accessibility and reparability.
- waterproofing continuity at construction joints, requiring specification and appropriately detailed.

6.3 Falls

The WDS should be appointed within RIBA Stage 3, and should proactively coordinate amongst the design team to ensure that sufficient and appropriate falls for the discharge of surface water from the waterproofing layer are provided. This can be particularly relevant where infinity (level) thresholds are evident.

Ideally falls would be cast monolithically in the reinforced concrete, however this cannot always be achieved adequately on site.

It may be necessary for the engineer to complete a detailed deflection analysis combined with level surveys to provide appropriately positioned site drainage outlets at low points to avoid ponding on the surface of the buried roof.

In all cases a minimum finished fall of 1:80 should be achieved. BS 6229:2018 recommends that decks be designed to 1:40 to achieve a minimum of 1:80 on site with falls towards suitable drainage outlets.

6.4 Drainage

There must be adequate drainage designed across a buried roof. The design of the drainage must be completed by the WDS or suitably qualified drainage engineer.

Drainage elements must be both accessible and serviceable to prolong their useful service lives. Reference to this should be made clear by the waterproofing designer from the design inception stage, for any drainage consultant to include within their overall surface water strategies.

6.5 Terminations, flashings, and interfaces

Penetrations and service entry points should be avoided where possible. Where unavoidable such penetrations should be sited within upstands raised out of the wet zone.

Continuity of waterproofing systems must be carefully considered at all terminations penetrations and interfaces. Appropriate jointing requires specific and careful detailing to prevent water ingress, as hydrostatic pressure may be present. Suitably specified waterproofing materials are required to avoid the potential of capillary movement of water at the interface.

6.6 Installation

Preparation of concrete substrates on which waterproofing materials are applied and the application methodology, must be undertaken in accordance with the product manufacturers recommendations. Only fully trained and competent work force should install waterproofing products.

6.7 Site inspection checks- visual

- design compliance
- concrete surface condition
- contaminates
- structural movement
- drainage arrangements
- the surface preparation including prior treatments, coatings, laitance

Other areas to consider when undertaking site inspections of works completed include:

- cleanliness of surfaces
- application of lime inhibitors
- minimum areas
- site personnel control and management
- protection from follow-on trades
- weather protection.

6.8 Installation cracking

Static cracks should be repaired, with live cracks opened and sealed using suitable means. Non-static cracks can be repaired with elastomeric types of waterproofing products.

Repairs to defects should be carried out in accordance with the product or systems manufacturer specification, as these will vary between types and forms of construction materials.

A maintenance schedule should always be provided by the installing contractor for all maintainable waterproofing systems and be included in the building Operation and Maintenance manual.

6.9 Fire Considerations

Fire safety needs to be considered at all stages to ensure safety of the occupants and suitability of products for the relevant application. Basements must fully comply with the relevant guidance set out in Building Regulations Approved Document B – Fire safety, Volumes 1 & 2 and any other associated standards or guidance documents. Where there is uncertainty expert fire guidance should be sought.

7. Definitions

Buried Roof	A reinforced concrete flat roof over a regulated or unregulated space positioned beneath the external ground level
Deck (Structural)	A deck may be referred to as a Flat Deck or Roof Deck and is defined as a horizontal structure above a regulated space. Decks have a defined build up according to usage. All external decks must provide a minimum fall of 1:80 to enable dispersion of water from the upper surface.
Cold Deck	Thermal insulation is positioned on the warm side of the structural deck or roof requiring cross ventilation or free flow of air above to avoid condensation occurring above the insulated layer. Where no insulation is present this may also be classified as a cold deck. Not recommended for a regulated space below a buried roof.
Warm Deck	Thermal insulation is positioned above the buried roof deck but placed below the waterproofing layer, separated from the structural deck with an air and vapour control layer (AVCL).
Inverted Warm Deck	Thermal insulation is positioned above a bonded waterproofing layer applied to the structural deck. Insulation is secured in position by ballast placed on top and separated by a water control membrane (WCM).
Podium Deck	An external flat weathered amenity platform over an unregulated space below. The flat deck is principally located at ground level but may be positioned at an elevated level above the ground. A podium deck is not a roof which has a regulated space below.
Hybrid Deck (Duo Deck)	The waterproofing layer may be located between insulation layers. Decks of high thermal resistance combined with additional insulation or added insulation to a an existing deck are considered to be a hybrid deck. There is an increased risk of interstitial condensation occurring and therefore a condensation risk analysis must be undertaken.
Transfer Deck	A uniquely loaded buried roof or podium deck supporting vertical loading from construction above. These loads transfer the loading along a horizontal pathway to alternative not in line supports.
Waterproofing Design Specialist (WDS)	A competent construction professional who has specific training, knowledge, experience and behavior in the design, specification and installation of all system waterproofing to structures above and below the ground.

Ponding	An accumulation of water that is unable to be dispersed from a structural deck due to an insufficient falls, a back fall or deflection between supports.
Resin Injection	Product materials and installation methodology for the repair of cracking in structural concrete and stopping water leaks in concrete construction.

8. Acknowledgements

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9. Version history

Date Effective	Description of amendment	Author
March 2017	• Initial document- Podium Decks and Buried Roofs	
May 2022	• Amended to Buried Decks • Incorporating amendments to BS 8102 : 2022 Protection of below ground structures against water ingress • Updated References • Minor Formatting	James Berry / Ben Hickman
Dec 2024	• Title change • Update requirements to BS 8102;2022 • Podium deck references removed • Definition and references amendments • Text , ordering and format amended	Andrew Devitt James Berry Ben Hickman

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