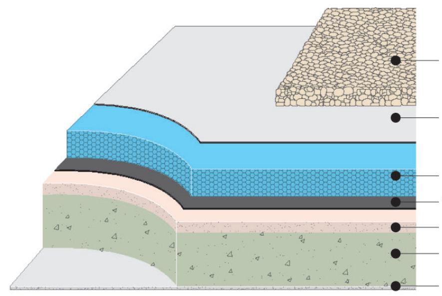
Inverted roofs – Drainage and U value corrections



An inverted roof is quite simply where the waterproofing layer is installed below the insulation. Specifications for inverted roofs currently focus on several issues; in particular correct drainage and the corrections to calculated U values that result from cold rainwater seeping under the insulation, which carries heat away, and the effect of moisture on the insulation's conductivity.

The following are technical specifications to clarify details of the essential elements that need to be considered when ensuring effective inverted roof insulation measures.

Drainage

It is essential that roof falls and drainage paths are correctly designed to avoid ponding and subsequent risk of silt build up, causing stresses in freezing conditions, and to reduce water entry in the event of a waterproof layer failure.

Drainage points need to be located at the lowest point of the roof, to facilitate effective removal of rainwater. Care is needed to identify the locations of these. For example, since roofing decks will deflect between spans, mid-span may be the lowest point of the roof, rather than the edges or column supports.

Where a water flow reducing layer is used, drainage must be provided at the two levels: at the water flow reducing layer level and at the roof deck waterproofing level.

Zero falls roofs

Zero fall roofs have a slope between 0 degrees and 1 in 80 degrees. On these roofs it is particularly important to identify the correct drainage points, to ensure that the drainage provided is sufficient and effective. It is suggested that falls are designed to 1 in 80 to achieve a minimum finished fall of 0.

The effectiveness of water flow reducing layers in limiting cold rainfall reaching the roof deck must be robustly established by assessment and physical testing of the zero pitch roof assembly (see note 1).

Where areas are found to have negative falls, i.e. will hold water, remedial action must be taken, e.g. localised screed or additional rainwater outlet.

U value corrections

Cold rainwater reaching the roof waterproof layer will temporarily affect the rate of heat loss from the roof and should be accounted for by adding a correction (ΔU_r) to the calculated roof U value in accordance with Section 7 and Annex F.4 of BS EN ISO 6946 : 2017, as follows:

$$\Delta U_r = p \cdot f \cdot x \, (R_1/R_{tot})^2 \text{ where:}$$

ΔU_r	correction to the calculated thermal transmittance of the roof element ($W{\cdot}m^{-2}{\cdot}K^{-1}$)
p	average rate of precipitation during the heating season (October – May) $mm{\cdot}day^{-1}$ (see note 2)
f	drainage factor giving the fraction of p reaching the waterproof layer
x	factor for increased heat loss caused by rainwater flowing on the waterproof layer ($0.04\ W{\cdot}day{\cdot}m^{-2}{\cdot}K^{-1}{\cdot}mm^{-1}$)
R_1	thermal resistance of the layer of thermal insulation above the waterproof layer ($m^2{\cdot}K{\cdot}W^{-1}$) using design conductivity λ_u
R_{tot}	total thermal resistance of the construction before application of the correction ($m^2{\cdot}K{\cdot}W^{-1}$)

The test must be on the thinnest board and thinnest most liquid permeable ballast layer at the lowest deck slope. Where a zero fall roof construction is proposed, the tested assembly must also be flat, i.e. without falls.

In the event that a test yields an '*f*' factor of zero, designers should not assume that the water flow reducing layer is therefore a waterproof layer. Taking into account slope and issues a minimum '*f*' factor of 2.5% is recommended, ie fx = 0.001 in such circumstances. For a higher level of security, this figure can be increased to allow for average workmanship, detailing and site damage.

The following values of *f* may be used without the need for testing (these may be conservative and in many cases suppliers may choose to seek improved values by carrying out a test on a specific construction):

- 0.5 for roof gardens, green roofs and parking decks with cast concrete finish
- 0.75 for insulation with rebated joints and an open covering
- 1.0 for insulation with butt edged joints and an open covering

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Design conductivity (λ_u) should be to the relevant product standard, and include a moisture correction to BS EN ISO 10456 : 2007 (or ETAG 031) using the average tested value for water absorption by diffusion (EN 12088) and freeze thaw (EN 12091) established by initial type testing (ITT) or product type determination (PTD).

The U value calculation should not include any value for the ballast layer and the correction may be ignored if the total correction ΔU_r is less than 3% of the uncorrected U value.

Any water flow reducing layer should be permeable to water vapour but impermeable to liquid water. The effectiveness of detailing and the effects of the following shall be considered and its effectiveness confirmed by the manufacturer:

- lime water, sodium chloride solutions and sulfurous acid (EN 1847 : 2009)
- Ultraviolet, water and heat (EN 13859-1 : 2005 modified by ETAG 031)
- puncturing to EN 12730 : 2001, Method A.

The above corrections are applicable to both XPS and EPS and for zero fall roofs that are designed and built to avoid ponding.

When designing inverted, intensive green roofs, an additional allowance should be made for root damage to the insulation if a root layer is not installed above the insulation.

Notes:

(1) *f* is established by test to ETAG 031 Guideline for European Technical Approval of Inverted Roof Insulation Kits Part 1: General. See **http://www.eota.be**

(2) Seasonal average rainfall can be found at **http://www.metoffice.gov.uk/public/weather/climate/** by selecting; Averages map, Climate variable – Rainfall and the higher of the rainfalls for Autumn or Winter season. Alternatively, enter Town, City or postcode to find the nearest of around 300 UK weather stations, select Average tables and sum the monthly rainfalls for October to May and divide by 243 to get *p* in mm·day^{-1}. The typical range is 1mm to 8mm average over an 8 month period.

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