BS 5250:2021

Management of moisture in buildings

A guide to the updated British Standard and the changes to pitched and flat roofing, by BMI.

bmigroup.com/uk

Issued: August 2021

This document seeks to explore the recent update to BS 5250 and the impact on pitched and flat roofing design and specification.

Contents

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What is BS 5250?

BS 5250 examines the causes and effects of surface and interstitial condensation as well as other sources of moisture in buildings and how to manage risk through design, construction and operation. BS 5250:2021 supersedes BS 5250:2011+A1:2016.

This standard is relevant to anyone involved with structural and thermal design, heating equipment, ventilation, mathematical calculations on buildings, condensation, damage prevention, surfaces or the retrofitting of existing buildings; including architects, surveyors, building companies, material manufacturers, housebuilders and roofing contractors.

BS 5250 (2021): Management of moisture in buildings. Code of Practice.

BSI Standards Publication.

PURCHASE HERE

What is this standard for?

BS 5250 is applicable to new build and refurbishment projects. The standard is relevant to buildings of all types, whatever their form, construction or level or type of occupancy, except buildings used for storage at sub-zero temperatures.

BS 5250 is the core code of practice dealing with how moisture is managed in buildings providing guidance for floors, walls and roofs, and as such is one of the most important British Standards for the design of buildings. It is also referenced in the Approved Documents to the Building Regulations in England, and their equivalents in Scotland, Wales and Northern Ireland.

What problem is this updated standard addressing?

Since the Climate Change Act was passed as UK law in 2008 the UK has been working to achieve net zero carbon emissions by 2050. Improved sustainability of the building stock both new build and existing has been driven in significant part by changes to Approved Document L of the England building regulations and their equivalents in Scotland, Wales and Northern Ireland. Approved Document L has progressively increased standards for airtightness of new buildings as well as improving the thermal insulation of the building fabric.

The starting point for the 2021 revision of BS 5250 was a review of condensation risk in those more energy efficient buildings being built in the UK today and whether any changes to the guidance needed to be made.

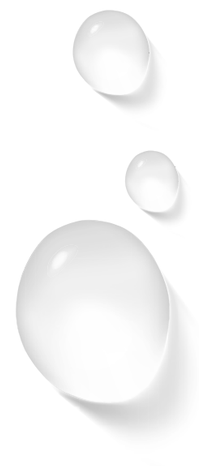
Furthermore, the scope of the BS 5250:2021 guidance has been broadened to cover not only the traditional "As Designed Theoretical (ADT)" approach but also "As Built In Service (ABIS)" and "Connective/Systemic effects " (e.g. at junctions) considerations as well.

A more holistic approach to managing moisture in buildings by not only focusing on condensation but also other sources of moisture such as wind driven rain, rising damp etc. has also been adopted.

Although the standard covers floors, walls and roofs, the focus of this White Paper is roofs.

> "Poorly designed roof build-ups and details for insulation, vapour barriers and other components of the roof system can lead to high levels of moisture in the building and therefore, risk of condensation."

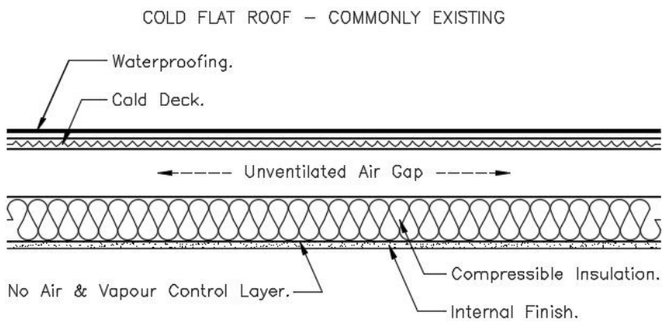
Dr Kevin Ley,
Head of Technical Services,
BMI Group UK



How does this affect roofing?

One of the most significant changes within BS 5250:2021 concerns cold insulated flat roofs. In the UK this type of flat roof has traditionally been used over many extensions to domestic dwellings incorporating timber joists in conjunction with a plywood/OSB deck.

Typical non-compliant, cold insulated flat roof build-up, commonly found on domestic projects.



While not part of the formal recommendations in BS 6229: 2018,(Flat Roofs with continuously supported flexible waterproof coverings - Code of practice) Note 2 of Clause 4.2.3, states "that this type of roof construction is not now recommended". This is because of the difficulty associated with consistently forming and maintaining an effective AVCL (Air and Vapour Control Layer) below the insulation and of providing sufficient cross-ventilation beneath the deck. The latter can be particularly difficult if the flat roof abuts a wall. The absence of either can lead to a high risk of persistent and harmful interstitial condensation occurring on the underside of the deck (eg. plywood or OSB) or upper surface of the insulation.

The occurrence of interstitial condensation within an incorrectly constructed and functioning cold insulated flat roof can lead to dampness, thermal insulation performance degradation and premature degradation of both structural elements such as joists or non-structural elements such as plasterboard as well as mould growth which may cause respiratory illness, as a result of poor indoor air quality.

BS 5250: 2021 states via Table 4 and its reference to Clause 4.7.3 in BS 6229: 2018 that all flat roof roof designs should be demonstrated by calculation to avoid the accumulation of condensation year-on-year and that any condensation that does occur should be temporary and dry out during the course of the year. The problem is that as discussed in Clause 13.2 current condensation risk assessment methods in BS 5250: 2021 based upon either BS EN ISO 13788 or BS EN 15026 do not account for moisture movement through constructions via air flows (convection) and hence are not suitable for either cold insulated flat roofs or cold pitched roofs where moisture movement is dominated by airflows. Consequently, for such roofs as stated in Clause 13.2.1.5 in BS 5250: 2021 prescriptive guidance based upon experience has to be followed instead.

For cold insulated flat roofs in addition to cross-ventilation of the cold roof void that means in accordance with Clause 4.7.3 in BS 6229: 2018 that an AVCL should be installed on the warm side of the thermal insulation which is fully sealed at all laps, penetrations and abutments. In practice, it is difficult to achieve continuity of an AVCL in a cold insulated flat roof where you have structural framing and other ceiling penetrations which is one of the main reasons why the construction of cold insulated flat roofs is discouraged by most leading trade associations including Single Ply Roofing Association "SPRA", Liquid Roofing and Waterproofing Association "LRWA" and the National Federation of Roofing Contractors "NFRC".

> **BS 5250: 2021 now clearly states that cold insulated flat roofs where cold roof voids present are greater than 5 m in span should not be used; so if refurbishing an existing roof of this size the existing cold insulated flat roof should be converted into either a warm or inverted flat roof.**

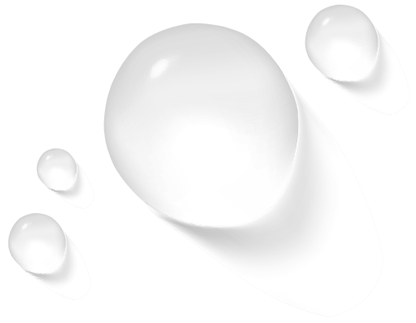
In the Scottish Building Standards Technical Handbook 2019, which is equivalent to the Approved Documents in England, it states "There is evidence to suggest that condensation in cold deck flat roofs can cause problems and this type of roof should be avoided.

BS 5250:2021 What's changed?

It has been ten years since the last major revision of BS 5250 and despite one minor amendment to the wall section of the standard in 2016 the code of practice has had no change in its guidance on roofs. The new 2021 standard has significantly tightened the advice in a few key areas and clarified it in others.

CONDENSATION RISK MANAGEMENT GUIDANCE

A new feature in BS 5250: 2021 for roofs is Table 4: Calculation methods for different roof types, which appears at the start of the Roofs section and provides guidance on when detailed condensation risk analysis should be performed for different roof constructions and when just prescriptive guidance set out in BS 5250: 2021 can be followed (without the need for a condensation risk analysis). This table provides a useful "Table of Contents" for the Roofs section to follow, allowing the specifier to identify the relevant clause number for the roof construction of interest without having to read through the whole section. This is a welcome addition as the reader will notice that BS 5250: 2021 is considerably longer (with a 50% increase in the number of pages) than its predecessor.



MATERIAL PROPERTIES IN CALCULATIONS

A related clarification concerns the properties of materials in terms of their thermal conductivity and vapour resistivity to be used in thermal and condensation risk calculations. BS 5250: 2021 states that independently certified values from manufacturers' literature should always be used when available. In particularly sensitive structures, measured data from the actual materials used if they can be obtained is preferable. However, in the absence of such data, the values given in Table B.1 in BS 5250: 2021 may be used instead although their use should be reported recognising the uncertainty of the results. The values of (water) vapour resistivity given in BS 5250: 2021 are for the material alone; the actual value when installed might be considerably lower as a result of joints, penetrations and workmanship defects.

PITCHED ROOFS

With regards to pitched roofs BS 5250: 2021 has not made any significant changes to how cold pitched, warm pitched or hybrid pitched roofs should be ventilated leaving current guidance essentially unchanged from the BS 5250:2011+A1:2016 standard. Further clarity has been provided on cold pitched roofs utilising a low (water vapour) resistance (LR) underlay with an external roof covering that is classified as air-tight (e.g. fibre cement slates or profiled metal sheet). Whilst previously BS 5250:2011+A1:2016 recommended the specifier either ventilate the batten space or the loft space, the new guidance states that the loft space should be ventilated, as a minimum, and subject to the advice of the manufacturer of the external roof covering, the batten space may also need to be ventilated.

This new guidance may make it more onerous in practice to ventilate cold pitched roofs with (LR) underlays using air-tight roof coverings since, subject to the manufacturer's guidance, you may need additional ventilation products to simultaneously ventilate both the loft space and batten space. Consequently, it may make more sense when using certain air tight roof coverings on cold pitched roofs to use a high resistance (HR) underlay instead of a low resistance (LR) underlay; that way only the loft space needs to be ventilated.

BS5250 : what does this mean for pitched roofs in practice?

Air open roof coverings such as single lapped interlocking concrete, clay or resin-slate roof tiles only require loft space ventilation when using an (LR) underlay in a traditional cold pitched roof construction - the most common pitched roof construction for houses in the UK. By contrast, air-tight roof coverings such as double lapped fibre cement slates may require both loft space and batten space ventilation when used in the same construction with an (LR) roofing underlay depending on the manufacturer's guidance. Always seek the advice of the manufacturer of the air-tight roof covering to confirm the ventilation specification required.

FLAT ROOFS

For flat roofs, the most significant change concerns cold insulated flat roofs. In Clause 4.2.3, Note 2 of BS 6229: 2018, Flat Roofs with continuously supported flexible waterproof coverings - Code of practice, it states this type of roof construction is not recommended. Where this type of construction cannot be avoided e.g. refurbishment of existing small residential buildings with cold flat roofs, in addition to an AVCL on the warm side of the insulation, BS 6229: 2018 and BS 5250: 2021 recommend that a minimum 50 mm air gap is maintained between the thermal insulation and cold deck and that cross-ventilation is provided to this roof void via ventilation openings equivalent in area to a continuous opening of not less than 25 mm on each side of the roof void. Unlike BS 6229: 2018, however, the guidance in BS 5250: 2021 remains unchanged from BS 5250: 2011 + A1: 2016 in not recommending the use of an air-tight, vapour permeable membrane on the cold side of the thermal insulation.

However, cross-ventilation is now only deemed effective up to a maximum of 5 m spans, where the void can be vented at both ends, and so BS 5250: 2021 states this type of construction should not be used, irrespective of whether in new build or refurbishment of existing, where cold insulated flat roof voids are greater than 5 metre in span, or are less than 5metre in span but can't be ventilated at both ends, or an AVCL can't be installed on the warm side of the insulation. For example, where a side abutment wall occurs, largely because it has been determined that mushroom vents are not sufficiently effective to provide the required level of ventilation of the void.

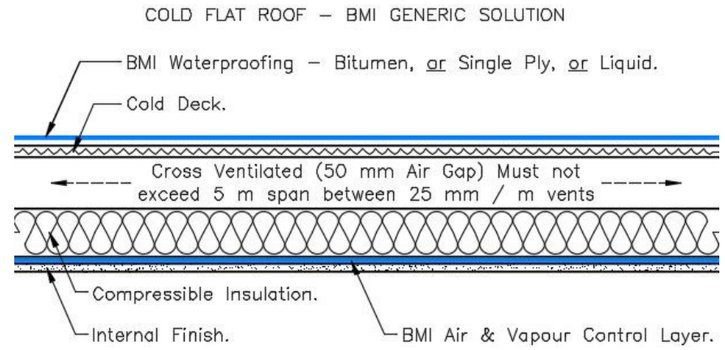
> The Code of Practice recommends that cold insulated roofs refurbishments over 5m span should be considered for conversion to warm or inverted roofs; this also needs to be considered for roofs where the span is less than 5metre and can't be ventilated from both ends, or an AVCL can't be installed on the warm side of the insulation

Matthew Sexton, Technical Standards Director, BMI Group UK

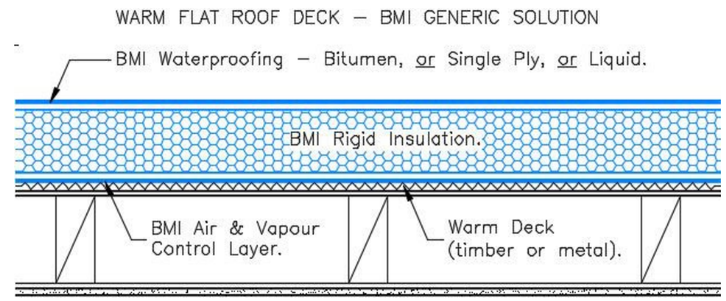
In practice this will have profound impact in the domestic residential flat roof market. In the past specifiers may have considered a simple overlay when refurbishing an existing cold insulated flat roof and introducing ventilation to the cavity between insulation and deck, the new guidance will mean these roofs where they are over 5 metre span will need to be converted into either warm or inverted roofs instead. Similarly for commercial/ industrial cold insulated flat roofs over 5 metre span refurbishments will need to consider conversion to warm or inverted roofs.

Regarding warm flat roofs and flat inverted roofs BS 5250: 2021 has left the existing guidance unchanged. Further guidance can be found in BS 6229: 2018.

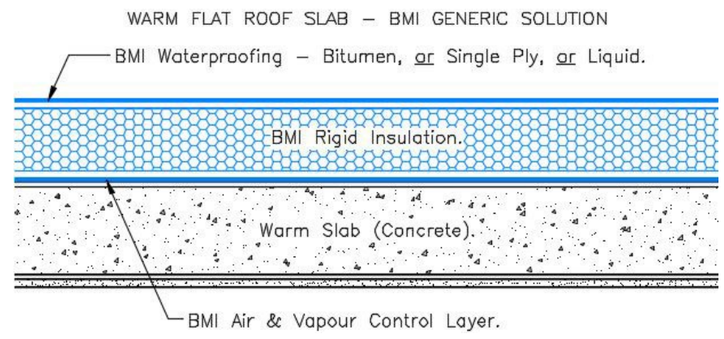
Cold insulated flat roof build up to BS 5250:2021 standard.



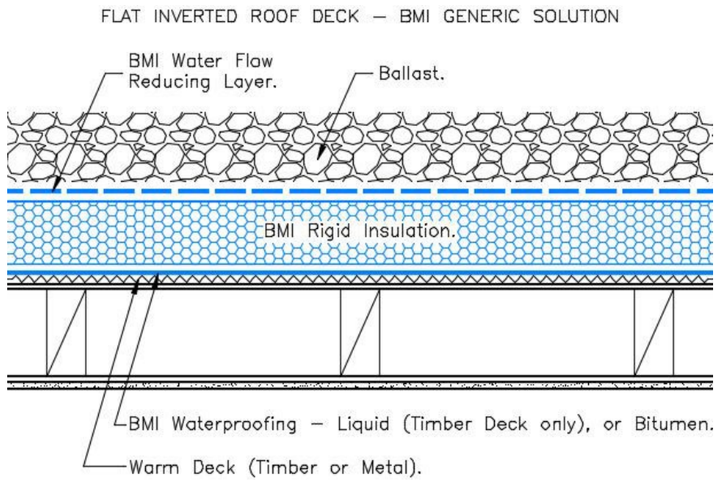
Warm flat roof deck build up to BS 5250:2021 standard.



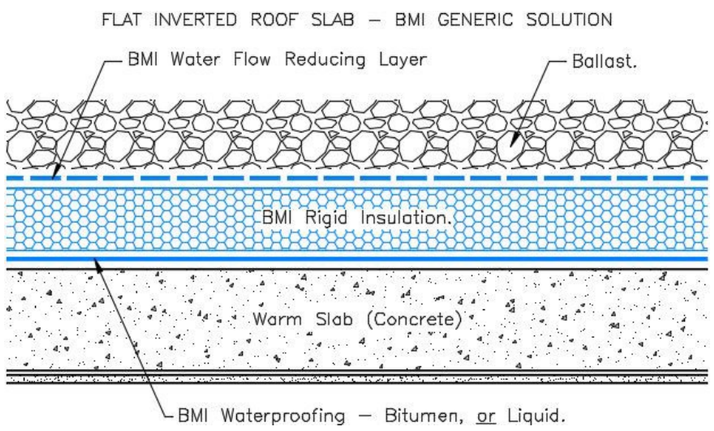
Warm flat roof slab build up to BS 5250:2021 standard.



Inverted flat roof deck build up to BS 5250:2021 standard.



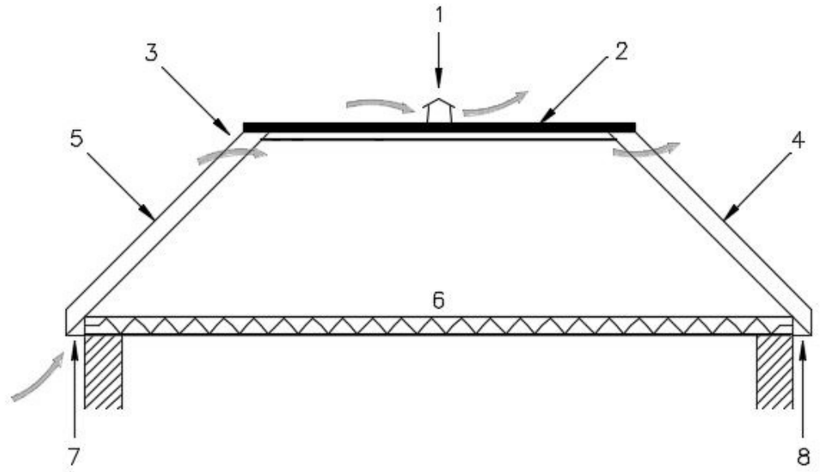
Inverted flat roof slab build up to BS 5250:2021 standard.



COLD PITCHED ROOFS WITH COLD FLAT ROOF APEXES

A roof construction that has been given new attention in BS 5250: 2021 is where a cold pitched roof possesses a cold flat roof apex. In this construction regardless of the span of the flat roof apex, where an LR underlay is used on the pitched roof, ventilation should be introduced to the flat roof apex where it meets the pitched roof on all sides to a minimum free area of 5,000 mm2/m. If the span of the flat roof apex is more than 5 m then additional ventilation to the cold roof space to a minimum free area of 5,000 mm2/m should be introduced, as close as practicable across the midpoint of the flat roof apex. If a HR underlay is used on the pitched roof then a minimum free area of 10,000 mm2/m ventilation should be provided at low level to the pitched roof in addition to the 5,000 mm2/m ventilation provided at high level.

Ventilation guidance to BS 5250: 2021 for cold pitched roof with cold flat roof apex.

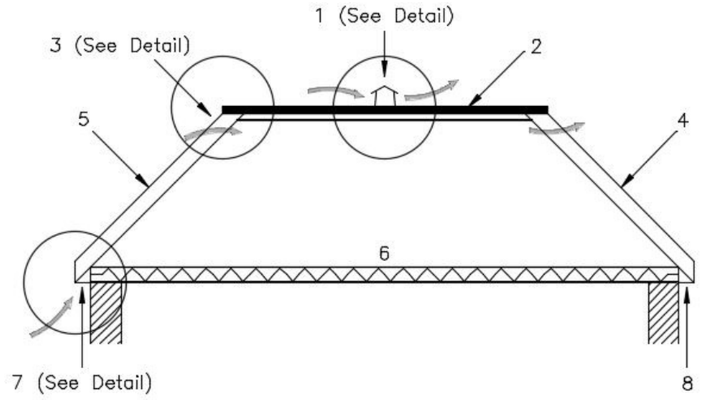


Key
1 Additional mid–span ventilation for large roof areas.
2 Impervious flat roof covering.
3 Ventilation equivalent to a continuous opening of 5 mm on both sides of flat roof area where LR or HR underlay is used.
4 Cold pitched roof construction with LR underlay.
5 Cold pitched roof construction with HR underlay.
6 Cold roof void.
7 10 mm opening where type HR underlay is used on pitched roof section, in addition to high level ventilation.
8 No eaves ventilation where type LR underlay is used on pitched roof sections.

Source:
Figure 54
BS 5250:2021

EXAMPLES: COLD PITCHED ROOFS WITH COLD FLAT ROOF APEXES

Cold pitched roof with cold flat roof apex build up to BS 5250:2021 standard.



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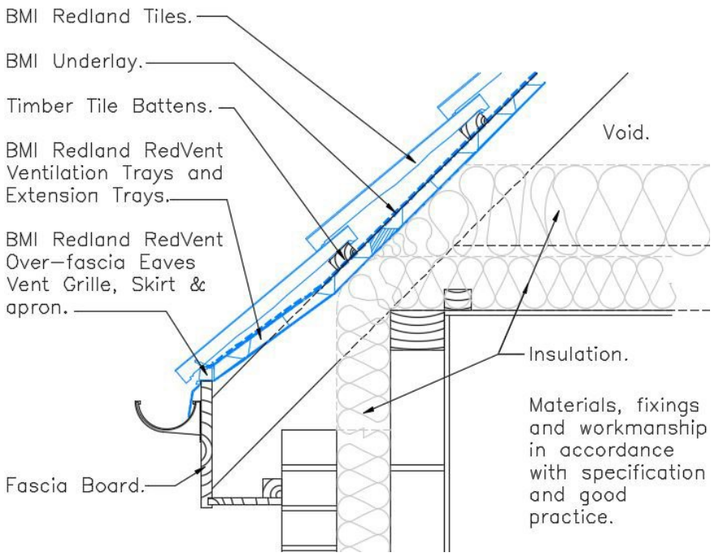
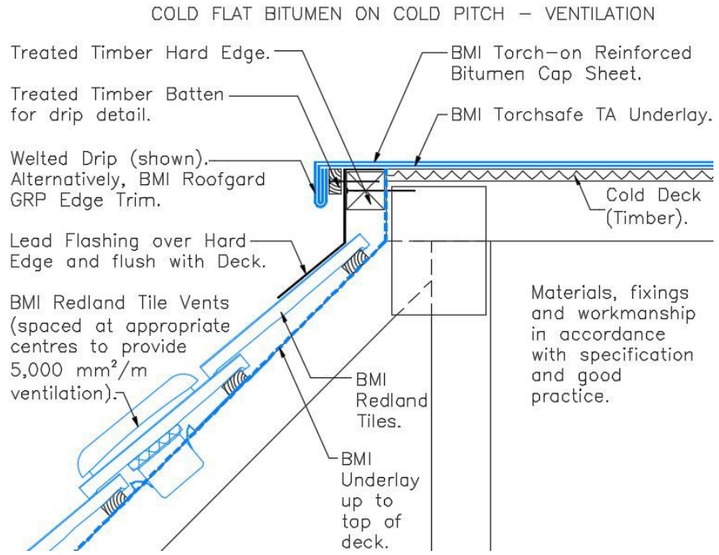
8 No eaves ventilation where type LR underlay is used on pitched roof sections.

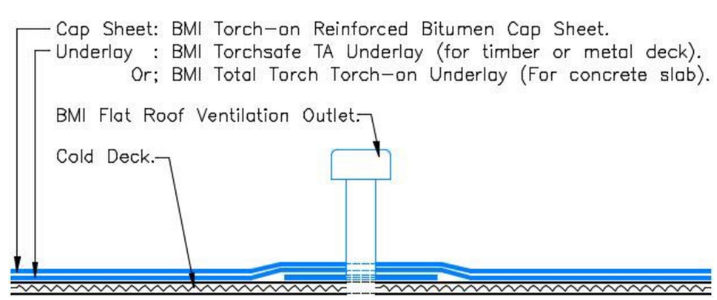
Eaves ventilation to cold pitched roof with cold flat roof apex, to BS 5250:2021 standard.



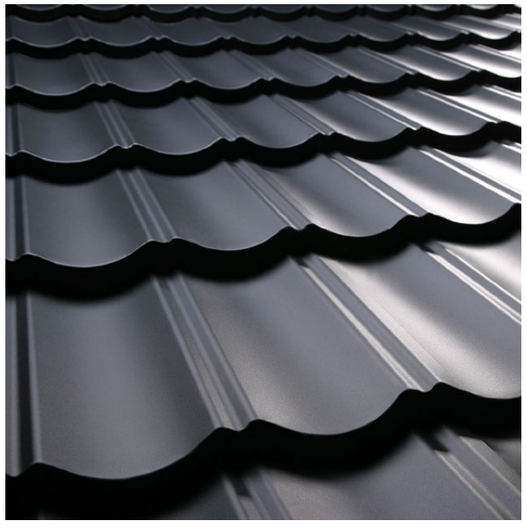
High level ventilation to cold pitched roof with cold flat roof apex, to BS 5250:2021 standard..



Additional mid-span ventilation to cold flat roof apex, for roofs with a span greater than 5 metres, to BS 5250:2021 standard.



LOW PITCH METAL ROOFS



For low pitch (10 degrees or less) metal roofs BS 5250: 2021 provides guidance on both self-supported sheet metal roofs and fully supported metal roofs.

The standard states; self-supporting sheet metal roofs can either be site-assembled or pre-formed in the factory as part of a composite insulated panel. To avoid condensation occurring, all site-assembled sheet metal roofs should incorporate an AVCL on the warm side of the thermal insulation. An independent AVCL can be used or alternatively the internal metal liner tray might constitute an AVCL, provided all joints between trays and all penetrations are fully sealed. In addition, all voids formed by the profile of the outer sheet metal roof covering should be ventilated by leaving open the profile at both ends of the sheeting above the insulation and, if fitted, any breather membrane. If profile fillers (normally foam) are fitted, they should leave a free area of not less than 5% of the cross-sectional area of the void.

For composite insulated panels to avoid condensation, all composite panels should incorporate a factory-fitted AVCL in the panel side lap joints. At the panel end laps, a butt joint occurs in the insulation; this requires a site- or factory-installed AVCL on the warm face of the panel joint.

For fully supported metal roofs the risk of surface condensation on the underside of fully supported metal conforming to BS EN 14783 depends on the performance of the AVCL below the insulation and the risk of moisture vapour ingress through unsealed joints in the roof covering.

Aluminium, lead and zinc roof coverings are subject to aggressive corrosion from the underside in the presence of moisture, if the metal passivating layer does not form due to inadequate ventilation. Guidance for use and ventilation of fully supported metal roofing is available in the Federation of Traditional Metal Roofing Contractors (FTMRC) UK guide to good practice. Fully supported metal roofs should include a separating layer between the metal and structural support (e.g. plywood).

The separating layer (structural membrane) is intended to provide for moisture diffusion into the cross-ventilated space and air circulation. For large span (from 5 m to 10 m), fully supported flat sheet metal roofs, a verge to verge cross ventilated void with minimum 100 mm depth should be provided together with an edge ventilation gap of not less than 60 mm on each side of the void. For fully supported lead roofs they should be installed in accordance with BS 6915.

STRUCTURAL INSULATED PANEL SYSTEMS (SIPS)

Clear guidance is provided for Structural Insulated Panel Systems (SIPS) used to construct either flat roofs or pitched roofs. SIPS consist of inner and outer surface layers bonded to a thermal insulant. The insulant can be auto-adhesively bonded to the surface layers or pre-formed and bonded with adhesive to the surface layers. While it is generally recommended to provide an AVCL, or subject to a condensation risk analysis an additional layer of insulation of high (water) vapour resistance, to the warm side of the SIP in BS 5250: 2021 it is also stated that the performance of the AVCL alone should not be relied upon to prevent condensation.

Consequently, additional ventilation (normally required above the SIPS) should be provided using timber battens. For SIPS used to form flat roofs the specifier is referred to the guidance for ventilating cold flat roofs in BS 5250: 2021 for the correct ventilation advice. For SIPS used to form pitched roofs, the specifier is referred to the guidance for warm pitched roofs.

Description of when and how the roof build ups should be cross ventilated and what generic product descriptions should be used to describe the buildups/section drawings.

- Specific guidance on what should and should notbedone in relation to these scenarios.
- RMI & New examples of Warm roof (bituminous, synthetic & liquid)& Inverted flat roof (Liquid & hot melt) section drawing in the same context as the BS section drawings and sections described above.

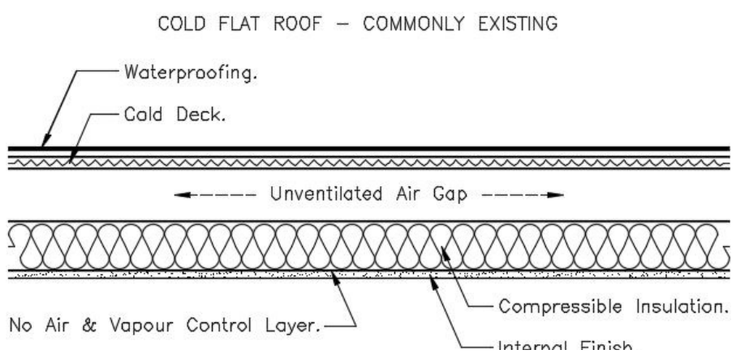
Why have these changes been made?

- The new guidance for cold insulated flat roofs which effectively bans the use of such constructions where the cold void is greater than 5 m in span is based upon evidence that cross-ventilation of such roof voids in cold flat roofs is ineffective as a means of controlling the risk of interstitial condensation with mushroom vents not providing a robust solution.
- The new guidance for where a cold pitched roof has a cold flat roof apex is introduced in response to increased evidence of condensation complaints arising from condensation forming on the underside of the cold decking (often timber) in such constructions especially with larger roof spans.

Who does this affect?

SPECIFIC PROJECT TYPES

Typical non-compliant, cold insulated flat roof build-up, commonly found on domestic projects.



RESIDENTIAL FLAT ROOF EXTENSIONS

Cold insulated flat roof designs are a popular method of construction for domestic extensions, garages, outbuildings etc. The new advice provided in BS 5250: 2021 states that cold insulated flat roofs designed with a span greater than 5 metres should no longer be used, and should be converted to a warm or inverted roof design. Consequently, the following checks are recommended:

- Is the proposed flat roof waterproofing membrane suitable for warm or inverted roof applications?
- Is there sufficient height at junctions with walls to tolerate the greater roof build up (to achieve target or project specific U-Values)?
- Is there sufficient height at the junctions with walls to allow the effective forming of the required junction and upstand details including thermal breaks?
- Can the roof structure accept additional loadings associated with warm or inverted roof designs?

NEW BUILD:

In theory, cold insulated flat roofs with a span less than 5 metres can still be constructed so long as the recommended level of eaves cross ventilation to a 50 mm air gap via minimum 25 mm openings is achieved as well as an AVCL is installed. However, our recommendation is to avoid this type of roof build-up wherever possible due to the practical complexity to achieve this build-up.

REFURBISHMENT:

Existing cold insulated flat roofs up to 5 metres span can be overlaid but you need to provide cross ventilation as well as an AVCL, or alternatively they can be converted to warm or inverted roof formats.

COMMERCIAL AND INDUSTRIAL COLD ROOFS

Commercial / Industrial roofs incorporating an insulated cold flat roof design greater than 5 metre in span are equally in contravention of the advice given in BS 5250: 2021. In such instances the designer should convert the existing to a warm or inverted roof.

BS 5250:2021
We're here to help

PITCHED AND FLAT ROOFING SUPPORT

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Meet our experts

Meet the BMI experts who have authored this guidance on BS 5250:2021 for BMI and our customers.

Dr. Kevin Ley

Head of Technical Services & Residential Standards

BMI Group UK

Having worked for the BMI Redland business for over 20 years, Kevin has held a number of technical pitched roofing positions within the organisation and is currently the Head of Technical Services and Residential Technical Standards.

Chairman of the Roof Tile Association (RTA) Technical Committee, Kevin's focus is to "establish a central viewpoint for clay and concrete roof tile manufacturers". Kevin is part of the committee that has influenced and supported the update to BS 5250:2021.

Matthew Sexton AIoR TIFireE

Market Development & Technical Standards Director

BMI Group UK

With over 30 years of experience in the construction industry, and a demonstrated specific interest in standards and passive fire protection, Matthew is an active member of the Construction products association (CPA) Technical Committee, a member of The Institute of Roofing and The Institute of Fire Engineers and board member of the Single Ply Roofing Association. Matthew also chairs the insulation sub committee for the Liquid Roofing and Waterproofing Association (LRWA) - and represents the LRWA on the BSI Committee for flat

Glossary

Condensation
Process whereby liquid water is deposited from air containing water vapour when its temperature drops to or below the dew point (or the vapour pressure rises above the saturated vapour pressure at a given temperature).

Interstitial condensation
Condensation occurring within or between layers of construction elements that are part of the building envelope.

Membrane
A pliable sheet of material which forms a barrier, covering or lining.

Surface condensation
Condensation occurring on interior surfaces of a building.

Thermal
Where heat is transferred via conduction, convection or radiation in a building.

U-value
A measure of thermal transmittance, which describes how effective an element of building fabric is as a heat insulator. The lower the U-value, the better the construction is as an insulator. U-values are measured in watts per square metre of surface element per degree Kelvin (W/m^2K).

AVCL, Air & Vapour Control Layer
A continuous layer of material with high water vapour resistance (there are varying definitions of this) that reduces/prevents water vapour transmission either via diffusion or air movement through a building element.

Warm roof
A warm roof is a roof build-up where the thermal insulation is present immediately below the flat roof waterproofing system or pitched roof covering, allowing heat to be conserved inside the roof.

Cold roof
A cold roof is a roof build-up where the thermal insulation is present immediately above or between the ceiling joists, meaning that everything above the insulation, such as the roof finish, rafters, and any roof space, will be colder than the space below it.

Inverted roof
An inverted roof, sometimes known as an 'upside down' roof, is a flat roof build-up where the waterproofing layer is beneath the thermal insulation rather than above it. The build-up has a ballasted finish, often with stone or a green roof.

Pitched roof
A pitched roof is a roof that has slopes that angle downwards from an apex in one, two or more sections. Typically the rafter pitch of the slopes is greater than 10° but less than 75°.

Low-pitch roof
A pitched roof with a slope of 10° or less.

Hot-melt waterproofing
A waterproofing system built up from a reinforcement fabric impregnated with a blend of bitumen, synthetic rubbers, polymers and other additives applied as a hot liquid, topped off with an elastomeric membrane.

Bituminous waterproofing
A two or three layer waterproofing roofing system composed of reinforced bitumen membranes.

Cold-applied waterproofing
A waterproofing layer built up from a reinforcement fabric impregnated with a liquid waterproofing system applied at ambient temperature.

Pitched mansard
A pitched roof containing a lower steep pitched section interfaced with an upper lower pitched section.

Synthetic waterproofing
Commonly known as single ply waterproofing composed from polymeric membranes synthesised from PVC, FPO, TPO etc.

Appendix

BS 5250 (2011)+A1: 2016: Code of practice for control of condensation in buildings.
BSI Standards Publication.

BS 5250 (2021): Management of moisture in buildings code of practice.
BSI Standards Publication.

Climate Change Act 2008.
See www.legislation.gov.uk

Conservation of fuel and power: Approved Document L .
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BS 6229 (2018): Flat roofs with continuously supported flexible waterproof coverings – Code of practice

Research into resistance to moisture in buildings, 2019: PRP Architects Ltd,
Ministry of Housing, Communities and Local Government.

BS EN ISO 13788: Hygrothermal performance of building components and building elements.
Internal surface temperature to avoid critical surface humidity and interstitial condensation.
Calculation methods

BS EN ISO 15026: Hygrothermal performance of building components and building elements.
Assessment of moisture transfer by numerical simulation

Federation of Traditional Metal Roofing Contractors (FTMRC) UK guide to good practice, 3rd Edition, 2018.

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