Historic England

Energy Efficiency and Historic Buildings

Insulating Suspended Timber Floors

This guidance note has been prepared and edited by David Pickles. It forms one of a series of thirteen guidance notes covering the thermal upgrading of building elements such as roofs, walls and floors.

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Our full range of guidance on energy efficiency can be found at:
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Front cover:
Floorboards being re-fixed over an air and vapour control layer laid over insulation within the floor.
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Summary

This guidance note provides advice on the methods, materials and risks involved with insulating suspended timber ground floors. The applications described are also appropriate for timber upper floors where there is an unheated space below, such as above a passageway. Advice is also provided on how suspended floors can be draught-proofed where the installation of insulation may be difficult or potentially damaging to the historic fabric of the building.

Suspended timber ground floors can be a source of considerable heat loss from older buildings, particularly where there are gaps between floorboards that create draughts. Insulating and draught-proofing floors can make an important contribution to improving comfort and reducing fuel bills and carbon emissions.

Timber floors are often a very important and significant part of older buildings. Lifting old floorboards can require the work of a skilled carpenter if damage to the boards is to be avoided. In some cases the potential for damage may be too great, in which case the boards would need to be left in place.

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Introduction

Energy Planning

Before contemplating measures to enhance the thermal performance of a historic building it is important to assess the building and the way it is used in order to understand:

- the heritage values (significance) of the building
- the construction and condition of the building fabric and building services
- the existing hygrothermal behaviour of the building
- the likely effectiveness and value for money of measures to improve energy performance
- the impact of the measures on significance
- the technical risks associated with the measures

This will help to identify the measures best suited to an individual building or household, taking behaviour into consideration as well as the building envelope and services.

Technical Risks

Altering the thermal performance of older buildings is not without risks. The most significant risk is that of creating condensation which can be on the surface of a building component or between layers of the building fabric, which is referred to as 'interstitial condensation'. Condensation can give rise to mould forming and potential health problems for occupants. It can also damage the building fabric through decay. Avoiding the risk of condensation can be complex as a wide range of variables come into play.

Where advice is given in this series of guidance notes on adding insulation into existing permeable construction, we generally consider that insulation which has hygroscopic properties is used as this offers a beneficial 'buffering' effect during fluctuations in temperature and vapour pressure, thus reducing the risk of surface and interstitial condensation occurring. However, high levels of humidity can still pose problems even when the insulation is hygroscopic. Insulation materials with low permeability are not entirely incompatible with older construction but careful thought needs to be given to reducing levels of water vapour moving through such construction either by means of effectively ventilated cavities or through vapour control layers.

The movement of water vapour through parts of the construction is a key issue when considering thermal upgrading, but many other factors need to be considered to arrive at an optimum solution such as heating regimes and the orientation and exposure of the particular building.

More research is needed to help us fully understand the passage of moisture through buildings and how certain forms of construction and materials can mitigate these risks. For older buildings there is no 'one size fits all' solution, each building needs to be considered and an optimum solution devised.

Technical Details

The technical drawings included in this guidance document are diagrammatic only and are used to illustrate general principles. They are not intended to be used as drawings for purposes of construction.

Older buildings need to be evaluated individually to assess the most suitable form of construction based on a wide variety of possible variables.

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1 Suspended Timber Floor Construction

There are several different types of suspended timber ground floor construction. These vary depending upon the age of the building, its structural form, limitations of the timber available and the local traditions.

The ground floors in most medieval domestic buildings were simply compacted earth. By the 17th century, depending on what materials were available locally, clay bricks, floor tiles or stone slabs were being used as a floor finish, normally laid butt-jointed simply on the compacted earth below.

Figure 1
A typical suspended timber floor with ventilated sub floor void.
© Oxley Conservation.

Boarded floors on timber joists resting directly on the ground were introduced into houses at the beginning of the 18th century. As there was no physical separation of the timber from the damp earth, these floors were susceptible to decay, although, if the sub-floor has remained dry, it is possible to find them in surprisingly good condition.

The development of the suspended timber ground floor began in the 18th century to overcome the difficulty of damp-proofing floors next to the ground. The standard form of construction became the timber floor structure positioned over compacted earth with an air-space in between. This void underneath the suspended floor was ventilated via airbricks or other types of vent in the external walls to ensure a very effective air flow through the under-floor area.

1.1 Ground floor structure

The suspended floors found in most domestic buildings are 'single floors' consisting of one set of timber joists, called common joists or bridging joists. In such buildings the joists span the full distance between the bearing walls with the ends supported by wall plates, either bracketed off the wall or built into the supporting masonry. In floors of a wider span, one or more beams or 'binders' run from wall to wall to carry the joists, with the beam ends supported by the bearing wall. In the largest floors heavy beams or 'girders' run between supports and carry a series of binders which in turn carry the joists.

1.2 Intermediate floors

Timber floors had been used for many centuries to form intermediate floors in buildings before they became common for ground floor construction. There is rarely any need to thermally insulate or draught-proof intermediate floors, where the areas above and below are both heated. However, where there is an unheated space below, the addition of floor insulation may be appropriate.

There is sometimes a need to introduce sound-deadening or fire-proofing into such floors, particularly where the building is divided into flats and needs to be compartmentalised. Such works are beyond the scope of this guidance and will require the use of tested products and building systems. Specialist advice should therefore be sought in these instances.

Figure 2
The character of the floorboards, including their surface finish or patina, their deflection and undulation all contribute to the historic interest of a building.

1.3 Floorboards and coverings

In medieval floor construction, fairly shallow butt-jointed boards were often let into rebates running along the upper edges of large section joists. The continuous floor finish was formed of boards and the exposed parts of the joists and the floor may well have been left open to view from the underside, and decorated in higher status buildings. Wherever such an arrangement is found it is likely that it is a valuable historic survival and should therefore be carefully retained and repaired.

Later floors were simpler, with plain or square edged boards laid over the joists at right angles to provide a continuously boarded upper surface. This is the most common type of suspended floor, found in most buildings of the 18th, 19th and early 20th centuries. Floorboards were generally secured by cut nails called floor brads, usually twice the thickness of the board in length, nailed through, about 25mm from each edge of the boards. For top nailed boards, the most common method was two nails driven through each board over every joist junction, including two nails at the ends.

In higher status buildings more sophisticated techniques were developed for the edge joints of floorboards, generally to improve the visible finish and reduce the appearance of brads. The interlocking between tongued and grooved boards, for instance, both limited draughts through the gaps and allowed the nail heads to be hidden (secret nailing). Before lifting any floorboards of this type it is important to be aware of the method of fixing as special care and techniques will usually be required to avoid significant damage to valuable historic fabric.

The character of the floorboards, including their surface finish or patina, their deflection and undulation with the movement of the structure, and their fixing and jointing pattern, will all contribute to the overall character and historic interest of a building.

In some cases, the floor covering was formed of a layer of lime plaster or gypsum plaster. Surviving examples of these types of coverings are now relatively rare and historically significant. Great care and attention needs to be given to their appropriate repair or reinstatement, and specialist advice should always be sought in such instances.

1.4 Environmental conditions below suspended timber ground floors

The ground below a suspended timber ground floor can often be damp so the timber is protected by being physically separated from the sources of this moisture. In later Victorian and 20th century buildings the ground may have been covered over with a concrete slab or screed. This was usually to control the ingress of pests and vermin and is rarely any impediment to ground moisture.

The timber is further protected from the moisture below by the ventilation of the sub-floor void, normally via airbricks set in the perimeter walls. Cross-ventilation of the space is necessary to prevent any air stagnation. This ventilation keeps the relative humidity here low and the timber structure in sound condition, but it is also a significant source of heat loss from rooms above, particularly if the boarding is butt-jointed with open gaps.

The wall plates onto which the timber joists are set will also need to be protected from rising damp and this is normally achieved with damp proof courses of slate or bitumen. However, in earlier construction these may not be present, in which case the only protection on offer is that of the ventilation keeping the timber as dry as possible by carrying moisture away from permeable construction below.

The importance of 'breathing' performance

Most traditional buildings are made of permeable materials and do not incorporate the barriers to external moisture such as cavities, rain-screens, damp-proof courses, vapour barriers and membranes which are standard in modern construction. As a result, the permeable fabric in historic structures tends to absorb more moisture, which is then released by internal and external evaporation. When traditional buildings are working as they were designed to, the evaporation will keep dampness levels in the building fabric below the levels at which decay can start to develop. This is often referred to as a 'breathing' building.

If properly maintained a 'breathing' building has definite advantages over a modern impermeable building. Permeable materials such as lime and/or earth based mortars, renders, plasters and limewash act as a buffer for environmental moisture, absorbing it from the air when humidity is high, and releasing it when the air is dry. Modern construction relies on mechanical extraction to remove water vapour formed by the activities of occupants.

As traditional buildings need to 'breathe', the use of vapour barriers and many materials commonly found in modern buildings must be avoided when making improvements to energy efficiency, as these materials can trap and hold moisture and create problems for the building. The use of any modern materials needs to be based upon an informed analysis where the implications of their inclusion and the risk of problems are fully understood.

It is also important that buildings are well maintained, otherwise improvements made in energy efficiency will be cancelled out by the problems associated with water ingress and/or excessive draughts.

2 Issues to Consider Before Installing Insulation

For the insulation to be as effective as possible and to avoid unnecessary damage to the historic fabric of the building, the installation needs to be carefully considered. It is therefore sensible to plan and consider the following issues:

2.1 Lifting floorboards

Before lifting any floorboards, it is important to establish the structural performance of the floor, the type of floorboards, the number of layers and the method of fixing. All these factors will guide the approach that can be adopted.

As the lifting of floorboards can cause unavoidable damage, especially with secret nailed boards, many higher status floors which are historically significant should be left in place if at all possible. In such cases insulation can only be added from beneath where access is available, such as in cellars or where there are voids and access hatches. If no alternative access is possible it may be preferable to leave these floors un-insulated.

Boards which are unusually wide are often older and historically significant, and may not have been disturbed before. Wide floorboards can be particularly difficult to lever up in one piece without splitting, so lifting them is to be either avoided or carried out with the utmost care. Boards like this should only be lifted by a careful and particularly skilled carpenter or joiner. They should, wherever possible, be subsequently replaced in their original positions.

Additional guidance on methods for lifting floorboards can be found in: *Practical Building Conservation: Timber*.

To reduce avoidable and unnecessary damage:

- Ascertain the historical significance of the floor and the original fixing method
- Identify and label all floorboards individually before any works start
- Draw a plan showing the positions of all the boards
- Lift the floorboards carefully, using an appropriate method for their size, age and fixing method
- Make sure that all lifted boards are stored safely in an area with appropriate environmental conditions

- Provide protection to the exposed areas to prevent people or tools from falling through and causing injury or damaging historic ceilings and finishes

- Provide safe work and storage areas with temporary boarding

2.2 Repairs to floor structure

Use the opportunity offered by the removal of the floorboards to inspect the floor structure and carry out any necessary repairs.

- Retain any significant features, for example early examples of sound insulation or fire protection, but remove any loose debris within the floor structure, particularly if it is flammable

- Where the floor structure has been weakened by the inappropriate cutting of holes and notching for central heating or other service pipes, the floor will require strengthening

- Sloping or springy floors may be due to either the failure of the supporting structure or to movement caused by a defective timber. When considering the type of repair or strengthening required aim for maximum retention of historic fabric with simple carpentry techniques

- Where defects are found in the timber floor joists, beams or wall plates, make sure the cause of the defect is found so the correct remedial repairs are carried out

- Ensure as far as possible that any new timber used for the repair of wall plates or other locations in contact with masonry below or without a damp proof course are separated from sources of moisture with a suitable local barrier, such as building paper

2.3 Sub-floor ventilation

As the health and durability of suspended timber structures often depend on the ventilation to the void below, it is important to ensure that this is effective and unobstructed. Air bricks and other vents are often easily obstructed by raised external ground levels, and these should be carefully reduced to restore full cross flow. The addition of new airbricks or vents may be required if a more serious blockage, such as a house extension, has obstructed the ventilation paths.

Suspended ground floors were occasionally constructed without ventilation paths below. If the timbers and support walls are relatively dry then this will indicate that conditions are stable and careful thought must be given to what effect adding insulation will have. In some cases stable conditions have been helped by ventilation through board gaps to the room above. Under these circumstances the addition of insulation may significantly obstruct this ventilation, and the addition of new ventilation paths below the floor may therefore be necessary.

2.4 Plan for access and maintenance

To minimise future disruption and consequent damage, it is good practice when relaying the floorboards to provide access covers into the under-floor void for inspection, maintenance and upgrading. These access covers should be screw fixed or latched for ease of access, and in insulated floors should also be insulated and draught-sealed to prevent a thermal bridge and draughts.

Services

Many floor voids are used for the routing of services, water and heating pipes and electrical cables, which lie in notches in the floor joists or are clipped to the joists. These may have to be relocated in order to provide suitable space for added insulation. It is not advisable to run services in floor voids unless there is access to the void to inspect them.

The following issues need to be considered:

- Water pipes at ground level below floor insulation can easily be damaged by frost. Lag any cold water supply pipes passing through a ventilated sub-floor whatever the distance from the external wall. The recommended insulation thickness, using an insulant with a thermal conductivity of 0.035 W/mK, is 25mm thickness for 15 mm diameter pipes and 19mm thickness for 22 to 28 mm pipes

- Lag any central heating pipes within the floor structure to prevent wastage of heat.

- Electricity cables give off heat when in use and may overheat where they are covered by thermal insulation, increasing the risk of short circuit and fire. This risk is further increased by the presence of combustible loose fill and/or plastic insulation. To reduce the possibility of the electricity cables overheating, before installing insulation to any suspended floor consider re-wiring to move the. If cables must be run within insulation they can be replaced with higher capacity cables which will generate less heat from the same current

- When cables pass through thermal insulation, they should be routed at right angles so that the cables are in contact with the smallest possible amount of thermal insulation to minimise the heating effect of the thermal insulation on the cable

- Whenever cables or pipes pass through the air-tightness barrier (see below) the hole created should be sealed carefully around the cable or pipe

2.5 Relaying old boards

Best practice in historic buildings is to conserve the old floor boards and patch repair them locally as necessary. Floorboards should only be replaced where repair is impossible. Replacement timber should match the existing timber both in species and in manner of conversion, which will allow the quality and grain also to match.

Considerable care may need to be taken when relaying old floorboards. Boards should generally be re-fixed in their original positions with nails, taking great care not to puncture underlying cables or pipe-work. However, in certain situations such as over a decorative plaster ceiling, a valuable ceiling painting, or a lath and plaster ceiling where the plaster key is suspect and might be disturbed by the vibration from nailing above, it is advisable to use screws instead. Brass screws are often preferred, and can be lightly greased before fitting to aid later removal for maintenance. Where a board is likely to be frequently lifted and re-laid, use brass cups to protect the board from damage caused by the screw head.

3 Installing Insulation and Draughtproofing

3.1 Options

The thermal performance of suspended floors can be very significantly upgraded by insulating and/or by draught-proofing. Installation of insulation reduces the heat loss through the floor and eliminates draughts from the unheated and ventilated void below.

The choice of insulation and/or draught-proofing measures will be determined by whether the floorboards can be lifted without damage, whether access is available to the void beneath the floor, and whether other works are being undertaken at the same time. The insulation of suspended floors in a building can usually be installed on a room by room basis whenever the opportunity arises.

Draughts in buildings are particularly wasteful of energy because they not only allow heated air to escape, but also make the occupants of the building feel cold. Occupants of draughty buildings often turn up thermostats to compensate for this discomfort, which wastes even more energy, and the problem can grow into a vicious circle.

Before embarking on the insulation of suspended floors it may well be worth carrying out a fan pressurisation test. With the floorboards in place and temporary taping of the windows, a test of the room will help identify the amount of air infiltration through the existing floor structure. This will show how much of the total air infiltration is through the floor, enabling the most effective measures to be devised to suit the individual building.

The floor finish is another element to be taken into consideration when thinking about improving a floor's thermal performance. Fitted carpet laid over floorboards has the advantage of reducing draughts and so improving comfort, but can also significantly reduce the permeability of the floor for moisture movement, particularly if the carpet is made of synthetic fibre and fitted with a rubberised or foam backing.

3.2 Access to top surface only-draughtproofing

If the floorboards are particularly delicate or valuable and cannot be lifted, and there is no separate access to the void beneath the floor, then the only option is simple draught-proofing of the gaps between boards. This will not reduce heat loss by conduction, but can considerably assist comfort by reducing the in-flow of cold air.

To reduce the rate of air infiltration through the floor, the options are:

- Draught-proof and seal the edges of the floor
- Seal gaps below skirting boards with compressed draught seal
- Sealing gaps in floorboards. Various materials can be used for this including papier-mâché or tapered slivers or fillets of well-seasoned and dried timber. However, a better solution is the introduction of proprietary compressible foam rods or beads. These are supplied in a range of diameters to suit the width of the gap and are pressed into the gaps to the required depth. The rods remain flexible and therefore able to accommodate any seasonal movements in the floorboards
- Fit natural fibre floor coverings as synthetic fibres, sheet plastics and foam-backed coverings may interfere with the moisture balance within the floor, increasing the risk of condensation

Figure 3
Plugging gaps between floorboards can be done in a number of ways and will considerably increase comfort by reducing the inflow of cold air.

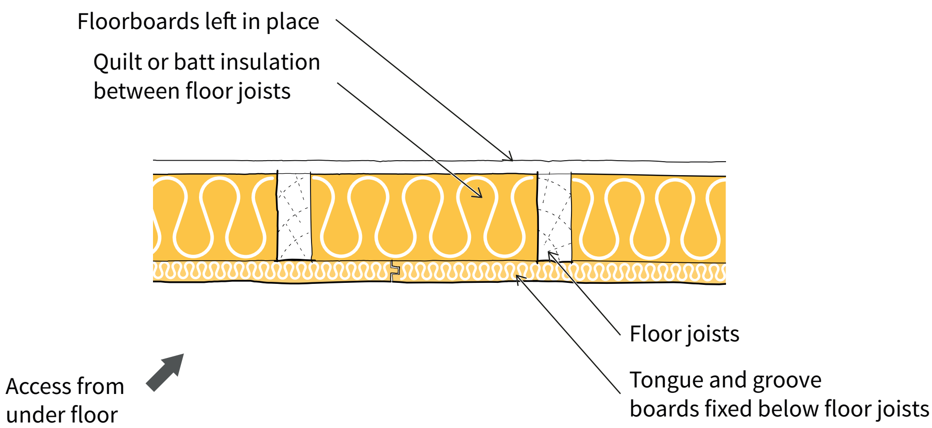
3.3 Fitting insulation from below floorboards

In buildings where there is a cellar or basement, and access is therefore available from below, insulation in the form of batts or boards can be added between the joists.

The insulation should be cut carefully to fully fit the space between the joists to form a tight fit. Any gaps between the joists and the insulation should be kept to a minimum as breaks in the insulation layer will allow air movement, heat loss, and will encourage local condensation.

Most suitable types of insulation can be installed by pushing semi-rigid, compressible batts up between the joists, allowing their natural resilience to hold them in place. Care needs to be taken not to compress the insulation too tightly, as the air between the fibres is important to provide the actual insulating properties. Where there are damp walls immediately adjacent, the insulation should be separated from them with building paper.

The installation of a continuous membrane with low vapour resistance below the joists will also help to prevent the insulation batts from slipping



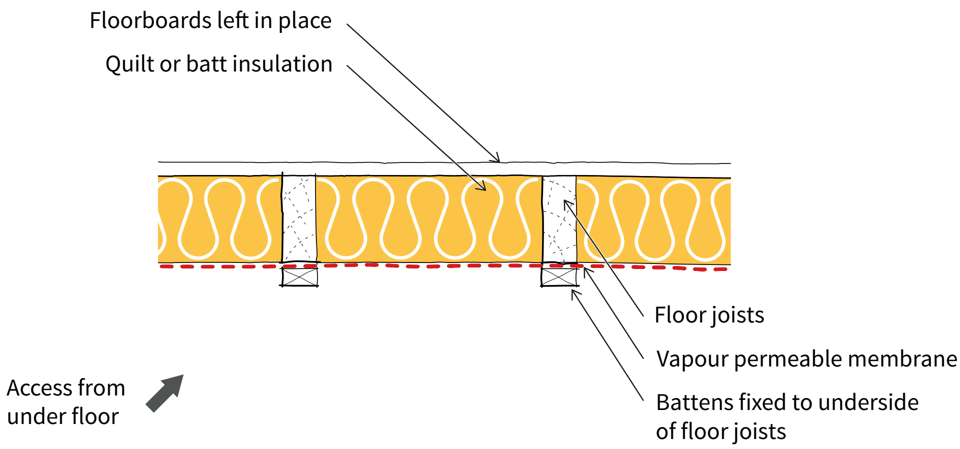


Figure 4 (top): fixing insulation from below floor
If access can be achieved from below the floor then installation can be much easier to achieve in that the floorboards do not need to be removed. Here insulation is held in place with tongue and grooved wood-fibre board which will give a good airtight seal. A variety of insulation materials can be used in this situation. Ideally these should be vapour permeable such as wood-fibre, compressed hemp, sheep's wool.

Figure 5 (above): fixing insulation from below floor
Vapour permeable insulation is shown here held in place with a breather membrane supported by battens fixed to the underside of the floor joists.

out over time, and can usefully enhance the effectiveness of the insulation by reducing air movement through the floor.

If additional thermal insulation is required, wood-fibre or compressed hemp fibre-boards can be added beneath the joists to form a ceiling. If the boards are tongued and grooved and/or have their joints taped, the boards can also provide a vapour permeable ceiling finish to the spaces below. Fitting flat rigid boards can, however, be difficult under irregular joists.

Advantages:

- The floorboards are retained in position
- There is minimal disruption to occupants: even the furniture can be left in place

Disadvantages:

- Confinement of space may make insulation difficult, particularly at the perimeter of the floor
- The irregular space between joists and working overhead makes tight fitting of the insulation detail difficult to achieve
- Full access below the floor is needed

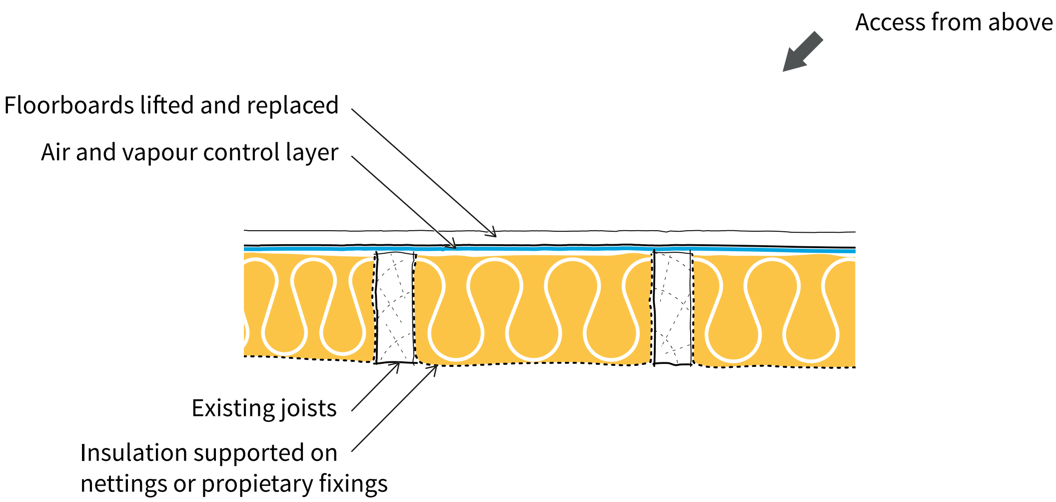


Figure 6: Fixing insulation from above floor
Here insulation is supported between the floor joists and an air and vapour control layer is laid over the insulation below the floorboards. This should be fully supported and therefore used in conjunction with rigid insulation. The insulation can be supported by netting, a breather membrane or proprietary fixings depending on the type of insulation material being used. If there is any sign of dampness in the sub-floor area then it would be advisable to consider a vapour permeable insulation material.

3.4 Fitting insulation by lifting floorboards

This is the situation most frequently found in historic and traditional buildings, particularly where the boards can be lifted without unacceptable levels of damage. If boards are to be lifted for any other reason it would normally be appropriate to take the opportunity to install insulation at the same time. Suitable materials are semi-rigid batts, boards or loose fill cellulose.

Although it is possible to simply install insulation batts between the joists from above by friction fit, the most reliable installations will include some form of restraint to prevent the insulation slipping down over time. In its simplest form this may be achieved by stapling light plastic mesh or netting below or at the bottom of the joists, or even hanging it over the joist tops. If a more expensive breather membrane is used instead this can enhance the performance of the insulation by limiting air movement at its lower face. If sufficient access is available, it may still be possible to install wood or hemp-fibre boards below the joists whilst working from above, but this situation is likely to be rare.

Figure 7 (top left)
Battens have been added to the side of the joists to support boarding to carry compressible sheep's wool insulation.
© Oxley Conservation.

Figure 8 (middle left)
Insulation laid into the space between the floor joists.
© Oxley Conservation.

Figure 9 (bottom left)
Floorboards being re-fixed over an air and vapour control layer laid over insulation within the floor.
© John McKay, Bolsover DC.

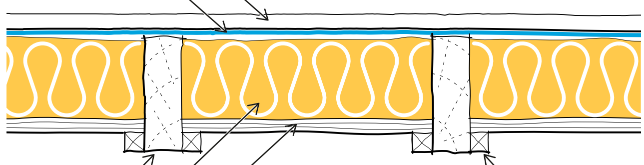


Figure 10: fixing insulation from above floor
Here the insulation is supported by boarding carried off the joists which gives more scope for the type of insulation material that can be used.

3.5 Insulation materials

When selecting the most appropriate insulation material for each building it is important to ensure that the material will continue to perform at a suitable level for many years. If the insulation is likely to suffer physical degradation a more robust material may be appropriate. Similarly, insulation which tolerates vapour movement will be required if high moisture levels are anticipated.

Most types of foamed plastic insulation, such as closed cell polyisocyanurate (PIR), polyurethane or polystyrene are inappropriate for general use in historic and traditional buildings as their inability to absorb and release moisture may increase the risk of condensation. They are often also difficult to form and fit accurately to irregular historic construction. They are therefore not usually appropriate for the insulation of suspended timber floors.

Perhaps the most common materials used for insulating floors in existing buildings are fibreglass and mineral wool, primarily because they are cheap, easy to handle and convenient to install. However, they are not necessarily the best materials for the job, even though they are to a degree air and moisture permeable. As the fibres of the insulation cannot absorb moisture, any condensation forming within the insulation zone will reduce insulation performance, increase the heat loss, and may also promote and sustain mould and rot in adjacent vulnerable fabric. Eventually, with persistent moisture, these materials themselves can start to break down. They also need to be carefully handled by those installing them, and protective clothing and dust masks need to be worn.

The most appropriate materials for older buildings currently available are those based on natural fibres, such as sheep's wool, hemp-fibre, cellulose fibres (derived from recycled newsprint) and wood-fibre board. 'Natural' insulation materials have the ability to 'breathe', allowing both air and moisture vapour to pass through slowly, thus minimising and diffusing the danger of condensation. Unlike artificial fibres, the material itself can also absorb moisture and release it again when the air is drier. This buffering effect can help to reduce the risk of condensation when there are rapid fluctuations in temperature or humidity. However, it should be noted that if exposed to persistently high levels of humidity sufficient moisture may be absorbed to cause decay or damage. An additional benefit of natural insulation materials is their good acoustic performance. They are also non-hazardous and unlikely to be irritants.

Modern insulation systems

It is important to appreciate that modern insulation systems tend to rely on sealants, tapes and foams, particularly at joints between impermeable panels. The performance and durability of these materials is not proven over time and any deterioration in materials used to fill and seal gaps could result in future air infiltration severely compromising the performance of the insulation system.

3.6 Amounts of insulation

The Approved Document that accompanies Part L of the Building Regulations for existing dwellings, ADL1B (2010), calls for insulation of floors to have a U-value of 0.22 W/m²K.

U-Values

U-values measure how quickly energy will pass through one square metre of a barrier when the air temperatures on either side differ by one degree.

U-values are expressed in units of Watts per square metre per degree of temperature difference (W/m²K).

The cost-effectiveness of floor insulation is complicated by the impact of the size and shape of the floor (perimeter/area ratio). Where the existing floor U-value is greater than 0.70W/ m²K, as will normally be the case over an externally-ventilated floor void, the addition of insulation is likely to almost always be both feasible and very cost-effective.

The extent and type of insulation that can be provided between the joists will be dictated by the joist depth, which can vary considerably in older buildings from as little as 75 mm to those that are 225 mm deep, or more. Obviously, the greater the depth of the joists the more opportunity there is to provide insulation.

In many cases it may even be possible to achieve the full target U-value of 0.22W/ m²K, set out in the 2010 Building Regulations, simply by installing insulation between the joists. Individual calculations will need to be carried out for each situation (often provided free of charge by material suppliers) but it is quite possible to meet the required standard for new buildings with as little as 150mm of sheep's wool insulation, assuming air infiltration rates are well controlled by allied methods. Greater depths of insulation can usefully be installed, but very large quantities may not be cost effective.

Where insulation levels approach new building standards, conventional U-value calculations are likely to register the existing floor joists as cold bridges, and to suggest that additional insulation, such as wood-fibre boards, should be installed either above or below. This may be beneficial, but in situations where their installation would be physically difficult, or require unacceptable alterations to historic fabric, they may well be better omitted. In practical terms, as long as good ventilation through the under-floor void is maintained, condensation on the bottom edges of the joists is unlikely to be a problem.

4 Where to Get Advice

This guidance forms part of a series of thirteen documents which are listed below, providing advice on the principles, risks, materials and methods for improving the energy efficiency of various building elements such as roofs, walls and floors in older buildings.

This series forms part of a wider comprehensive suite of guidance providing good practice advice on adaptation to reduce energy use and the application and likely impact of carbon legislation on older buildings.

The complete series of guidance is available to download from the Historic England website: HistoricEngland.org.uk/energyefficiency

Roofs

- *Insulating pitched roofs at rafter level*
- *Insulating pitched roofs at ceiling level*
- *Insulating flat roofs*
- *Insulating thatched roofs*
- *Open fires, chimneys and flues*
- *Insulating dormer windows*

Walls

- *Insulating timber-framed walls*
- *Insulating solid walls*
- *Insulating early cavity walls*

Windows and doors

- *Draught-proofing windows and doors*
- *Secondary glazing for windows*

Floors

- *Insulating suspended timber floors*
- *Insulating solid ground floors*

For information on consents and regulations for energy improvement work see historicengland.org.uk/advice/your-home/saving-energy/consent-regulations/

4.1 Contact Historic England

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