Building control guidance document for Upgrading traditional buildings using lime and modern applications

Building Regulations 2010 (including 2015 Amendments) For use in England and Wales

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Introduction

This document has been produced for home owners, occupiers, students, builders, designers and other property professionals who have a basic knowledge of building construction and requires easy to understand guidance on the building regulations for building projects in England. The authors intentions is to ensure the highest standards of conservation practice, to support the effective protection and enhancement of the historic environment and to promote heritage led regeneration of the built heritage for the enjoyment of future generations.

A separate system of building control applies in Scotland, Northern Ireland and Wales.

This document intends to provide education and guidance on how some of the more common technical design and construction requirements of the building regulations can be achieved and met for traditional buildings which have stone built solid wall construction. The author has produced additional guidance which can be obtained from: www.fdean.gov.uk

Typical details, tables, and illustrations have been provided in the guidance documents for the more common construction methods. The diagrams and details produced in these guidance documents are for guidance only and are only interpretation of how the requirements of the building regulations can be met, the actual diagrams and details must be agreed and approved by building control at an early stage and before works commence. You must comply with the requirements of the Building Regulations and you are advised to fully refer to the Approved Documents and contact a suitably qualified and experienced conservation specialist for details and specifications for the most suitable form and method of construction for your project.

Disclaimer

Forest of Dean District Council (the Council) has made every effort to ensure that the information contained in this Building Control Guidance Document is accurate at the time of publication. However, the Guidance is advisory and has been developed by Council officers to assist home owners/occupiers, students, builders, designers England. This Guidance is not a substitute for the advice of a suitably qualified professional. The Council does not guarantee and accepts no legal liability of whatever nature arising from or connected to, the accuracy, reliability, currency or completeness of the content of this Guidance. Users of the Guidance must be aware that alterations after the date of publication may not be incorporated into the content of the Guidance. References to organisations or websites in this Guidance does not constitute an endorsement thereof on the part of the Council.

Building Regulations approval

Building regulations approval may be required for your proposed development and no works should be commenced until approval has been given by building control.

The Building Act 1984 and the Building Regulations 2010

The power to make building regulations are contained within Section 1 of the Building Act 1984 and deals with the powers of the Secretary of State to make building regulations for the following purposes:

- Securing the health, safety, welfare, and convenience of people in or about buildings
- Conservation of fuel and power
- Preventing waste, undue consumption, misuse or contamination of water

(The Building Act 1984 can be viewed at: www.legislation.gov.uk)

The current building regulations are the Building Regulations 2010 and The Building (Approved Inspectors etc.) Regulations 2010 which came into force on October 1st 2010, and applies to England. A separate system of building control applies in Scotland, Northern Ireland and Wales. The 2010 Regulations in both cases consolidate the Building Regulations 2000 and the Building (Approved Inspectors etc.) Regulations 2000. Incorporating amendments since 2000. The Building Regulations are very short, contain no technical details and are expressed as functional requirements and are difficult to interpret or understand. For this reason, the department for Communities and Local Government publishes guidance on meeting the requirements in a series of documents known as ‘Approved Documents’. 
Approved Documents
The Approved Documents are intended to provide guidance on how to achieve the requirements of the building regulations and make reference to other guidance and standards. In themselves the Approved Documents are not mandatory and there is no obligation to adopt any particular solution contained within them if it can be achieved in some other way. In all cases it is the responsibility of the designer, applicant/owner and contractor to ensure the works are carried out in compliance with the building regulations.

The current Approved Documents for England are available to view at: www.labc.co.uk/guidance/technical-guidance

The current Approved Documents for Wales are available to view at: www.labc.co.uk/guidance/technical-guidance-wales

Planning permission and listed building consent
Planning permission, and /or listed building consents may be required for your proposed development and no works should be commenced until approval has been given by the relevant local authority planning department.

If the requirements of the building regulations will unacceptably alter the character or appearance of a historic/listed building/ancient monument or building within a conservation area, then the requirements may be exempt or relaxed to what is reasonably practical or acceptable, ensuring that any exemption or relaxation would not increase the risk of deterioration of the building fabric or fittings in consultation with the local authority's conservation officer (any exemption or relaxation must be approved before works commence). For further information, please see guidance in the relevant Approved Document and contact your local authority Conservation Officer

Professional bodies
Historic England: https://historicengland.org.uk
Cadw Wales: cadw.gov.wales
The Society for the Protection of Ancient Buildings: www.spab.org.uk
The Institute of Historic Building Conservation: www.ihbc.org.uk
Local Authority Conservation Officer for your area
(Work is still in progress on this section)

Technical standards
BS 7913:2013 - Guide to the conservation of historic buildings
BS 5250:2011 Code of practice for control of condensation in buildings
BRE Solid Wall publications
(Work is still in progress on this section)

Conservation specialists
You are advised to employ a suitably qualified and experienced conservation specialist to provide details and specifications for the most suitable form and method of construction for your project. Specialists with the appropriate competence in traditional buildings is very important considering more than 25% of the UK building stock are traditionally built if you take interwar solid wall buildings into account. Competence in traditional buildings for this purpose would include a qualification satisfying National Occupancy Standards ASTOTV1 (recognizing the age, nature, and characteristics of older and traditional buildings including energy efficient measures)
More details are available at: http://www.ukstandards.org.uk
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About the author

Guidance notes copyright

Building control guidance book available

Acknowledgements
Understanding the construction of old buildings
Caring appropriately for old buildings requires an understanding of how they were constructed and how they function, only then is it possible to identify the right materials and repair them. This is particularly important when dealing with heritage or similar existing buildings which requires a sympathetic approach.

*Please note* that if your building is listed or curtilage listed you should check with your Local Authority Conservation Officer before works commence because these works may require listed building consent, or whether the works are repairs for which consent is not needed. This requirement is additional to any requirement under the Building Regulations. Some external works to buildings within Conservation Areas may also require planning permission.

Certain works carried out to existing buildings may be regarded as repairs and will not require building regulations approval, however, other works may be regarded as ‘building work’ and will required building regulations approval. If in doubt, you are advised to contact building control as the proposed works may have to comply with modern standards in compliance with the current building regulations and such works should be specified and carried out by a suitably qualified and experienced conservation specialist.

Traditional 'breathing' construction
Old buildings were traditionally constructed with technologies handed down through generations which allowed the building to breathe naturally. The building fabric was constructed in natural materials, typically with solid walls providing good permeability and flexibility. External surfaces were designed to deflect the rain, penetrating and rising damp was absorbed by the structure that allowed the moisture to evaporate away naturally through the porous surfaces. Natural ventilation was provided through gaps in poorly fitting windows and doors and through chimneys, keeping the building in a state of equilibrium as indicated by the diagram below.

**Guidance Diagram 1:** Typical section through a traditional 'breathing' building (Section detail not to scale)
Inappropriate maintenance of old buildings

When old buildings are maintained and upgraded with inappropriate modern hard impervious materials, membranes and finishes, they can trap moisture and potentially lead to the deterioration of the building fabric and finishes. Additional problems can occur with condensation and mould growth caused by high levels of water vapour produced by the occupants and lack of natural ventilation caused by sealing up of gaps and blocking up of open flues and chimney as indicated by the guidance diagram below.

Guidance Diagram 2: Inappropriate maintenance to old buildings
(Section detail not to scale)
Modern applications to maintain old stone/brick buildings

Old stone/brick buildings can be maintained and upgraded using a mixture of traditional and appropriate new technologies, which allow the building to breathe naturally, typically as detailed in the guidance diagrams below and such works should be specified and carried out by a suitably qualified and experienced conservation specialist.

Assessment of the building should be carried out and any moisture problems should be remedied prior to refurbishing and upgrading the building. Advice about lime, aggregates, breathable insulation and breathable paint products, condensation risk analysis, U-value calculations and product specification advice can be obtained from specialist suppliers such as Ty-Mawr at: www.lime.org.uk

You are advised to contact building control before works commence as the proposed works may require building regulations approval and may have to comply with modern standards in compliance with current building regulations. For example, in conversion of buildings into dwellings you will have to consider how you will prevent the passage of moisture into the building where necessary protection against radon gas (further information is provided in guidance for barn conversions). You are also advised to contact your local authority planning officer and conservation officer before works commence as the proposed works may require planning permission/listed building/conservation area consent.

Guidance Diagram 3: Modern applications to maintain/upgrade old stone/brick buildings (Section detail not to scale)

Notes:
1. The sub soil conditions should be assessed to ensure water table levels will not saturate the building structure and effect the natural evaporation of moisture.
2. Walls insulated internally will require external walls to be protected from driving rain and is not suitable in all situations i.e. impervious conditions such as granite and slate
3. Listed building consent is likely to be required for the works indicated above in listed or curtilage listed buildings and you are advised to check with your Local Authority Conservation Officer before works commence.

Key:
* Breathable natural insulation and building products can be obtained from specialist suppliers such as Ty-Mawr at: www.lime.org.uk
The Building Regulations 2010 (with 2015 Amendments)

FoDDC Guidance for upgrading buildings using lime

Guidance Diagram 4: Upgrading thermal insulation to old stone/brick buildings using breathable insulations and finishes (Section detail not to scale)

Overhaul and repair existing roof as necessary including replacement of defective slates/tiles to match existing and fixed as manufacturers details and suitable for the pitch

25 x 50mm treated battens at a gauge to suit roof coverings as manufacturers details

BBA or other approved vapour permeable roof membrane fixed & ventilated as manufacturers details

25 x 50mm treated counter battens fixed to top of rafters if required

Repair existing rafters (specialist to treat for fungal/insect) as necessary or renew defective rafters (see construction details and table in guidance for sizes of rafters suitable for clear spans)

Rain water gutter & down pipe sizes as guidance

Facia/soffit boards

Roof overhang to protect wall

Repair/rebuild/re-point solid walls in lime mortar as guidance detail

Lime render & lime wash/permeable paint finishes applied where required as guidance details

100mm diameter perforated pipe 1:60 falls in 50mm diam clean stone connected to soakaway 5m from buildings (land drain)

Gravel paths absorb rain (path laid to falls away from the building)

Notes:

1. Natural breathable insulations, wall boards & finishes must be specified by a suitably qualified and experienced conservation specialist and subject to building control approval. Some natural breathable insulations/boards and finishes can also be applied externally. For further information, product advice, specifications, U-value calculations, condensation risk analysis and supply of products can be obtained from specialist suppliers such as Ty-Mawr at: www.lime.org.uk. All details including joints and fixing must prevent cold bridging.

2. Walls insulated internally will require external walls to be protected from driving rain and is not suitable in all situations i.e. impervious conditions such as granite and slate.

3. Materials and workmanship should be in compliance with Approved Document- Regulation 7.

4. Listed building consent is likely to be required for the works indicated above in listed or curtilage listed buildings and you are advised to check with your Local Authority Conservation Officer before works commence.

*Note: for full radon protection a radon gas sump and depressurisation pipe must be installed in accordance with manufacturer’s details & upstand extended above ground level with cap & radon pipe signage ready for connection of future radon gas fans & flue if required

Please note: Guidance Diagram 4 above shows upgrading works to the existing roof and walls and guidance for ‘Renovations of existing thermal elements’ below should be followed for the upgrading works. The replacement of the ground floor shown is new works and the guidance ‘new or replacement thermal elements’ below should be followed for the new works.
Guidance Diagram 4.1: Option 2 for upgrading thermal insulation to suspended timber floors using breathable insulations and finishes (Section detail not to scale)

Please note: Guidance Diagram 4.1 above shows upgrading works to the existing floor and guidance for 'Renovations of existing thermal elements' below should be followed for the upgrading works. If the floor is replaced, it is new works and the guidance for 'new or replacement thermal elements' below should be followed.
Section 2: Re-pointing and repair of existing walls

Masonry walls, cement mortars, renders and gypsum plasters
Are normally used in modern buildings which have cavity or solid walls supported on foundations where strong, rapid sets are required. Cement and gypsum binders have poor permeability and flexibility which is unsuitable for older, traditionally constructed breathable buildings.

Normally pre-1919 buildings are constructed with solid walls and usually without foundations. These buildings require mortars, plasters and renders that are more flexible, and breathable lime binders should be used in mortars and renders/plasters to allow water within the walls, either from penetrating or rising damp to be released by evaporation. This process controls damp and condensation within the building.

A suitable qualified and experienced conservation specialist should be consulted for all aspects of the proposed works, and workmanship should be carried out by a suitably experienced conservation bricklayer/stone mason/plasterer.

Examination of the existing masonry wall/render/plaster finishes
Assessment of the existing wall/finishes should be carried out to determine:
- Nature of masonry units, (stone/brick, soft and porous, or hard and dense)
- Type of mortar/render/plaster (lime, cement, gypsum and type and constituents of aggregates, and reinforcement of render/plaster finishes)
- Construction method, including; type of bond, width and finish of joints.
- Nature of defect (mortar weathered out of joints, cracking, water penetration etc)

Analysis of the mortar/render
Analysis of the mortar for re-pointing, repair and rebuilding of masonry should be carried out by a suitably qualified and experienced conservation specialist to ensure the following:
- The binder and aggregate ratios matches to the existing mortar, including; colour, texture and detailing
- Is softer in compressive strength than the masonry units and should be as porous as the existing mortar

Analysis can be carried out visually or by laboratory examination (dissolution analysis) depending on the level of information required, i.e. a listed building. The exact mix should be selected after the presentation of sample panels by the contractor. This service can be carried out by specialist such as Ty-Mawr at: www.lime.org.uk

Re-pointing of existing stone/brick walls
Re-pointing of walls is required to refill outer parts of the joints where the original pointing has weathered out as indicated on the guidance section detail below.

Rake out and remove existing defective mortar as necessary to a minimum depth equal to twice the joint thickness to form a square backed recess using hand tools i.e. plugging chisels or similar (power tools i.e. disc cutters or similar mechanical devices should not be used if there is any possibility of damage to masonry units). Brush out all joints clean of all dust and loose material using suitable non ferrous bristle brushes and thoroughly flush out with clean water.

Joints should be fully packed with mortar, pointed (slightly proud of the face) as work proceeds using a pointing trowel, and left to carbonate. Apply mortar in layers (up to 10-15mm to allow initial set or it will crack and fail). Deep pack pointing is similar to ordinary rake out and re-pointing, except joints will be up to 200mm deep and may involve the occasional removal and replacement of stones. Large holes should be packed out with small slivers of matching stone (termed galletting) or brick to prevent large joints and shrinkage. Do not overwork lime mortars.

Brush and beat the mortar joint surfaces to consolidate and close up any cracks. This should be done when the mortar can no longer be dented with the thumb, but still can be dented with the
Protect the works as necessary from direct winds, sun, rain and frost using protective coverings, i.e. hessian, bubble wrap, polythene sheet etc. Do not use frozen materials, or lay on frozen surfaces. The set slows down below 10°C and stops at 5°C. If temperature is 5°C or below on a falling thermometer, stop work.

Mortar mixes to be in accordance with the guidance tables below and should be carefully selected to match the existing including binder and aggregate ratios, colour, texture and detailing.

**Guidance Diagram 5: Re-pointing of existing stone/brick walls**
*(Section detail not to scale)*

1. Rake out and remove existing defective mortar as necessary to a **minimum depth equal to twice the joint width**

4. Brush out joints clean off all dust and loose material using suitable non ferrous bristle brushes and thoroughly flush out with clean water avoiding unnecessary saturation.

5. Joints should be fully packed with mortar, pointed slightly proud of the face as work proceeds.

6. After the initial set, brush and beat the mortar back to the weathered stone/brick surface using a natural bristle brush to close the mortar joint against the weathered surface, remove any feather edges/excess, and expose the aggregate.

7. Joints should be slightly recessed as a key if walls are to be rendered/plastered.

8. The same process is carried out to all wall faces and below external ground level

9. Protect the works against direct wind, sunlight, rain and frost etc.

**Repair/rebuilding of existing stone/brick walls**

Repair and rebuilding of walls is required where the individual stone/brick units have become loose in the wall due to the mortar weathering out or defects in the wall which has made the wall unstable. Remedial works are necessary to stabilise the wall and prevent the passage of moisture into the building.

Carefully cut out individual defective masonry units or take down defective areas of wall using hand tools (not power tools which may damage masonry units) and set aside masonry units for reuse. Masonry must be stored clear of the ground to avoid absorption of water and salts from the ground and be protected from adverse weather.

Replacement stone/brick should follow the original coursing, bonding, wall line, joint profile and be well bonded to the existing material. Second hand materials must be sourced in a sound condition, free from cracks, fissures and defects, and match the existing (including weathering where necessary).

Dampen masonry before and during construction as necessary to control suction. Facing stone/brick to commence not less than 150 mm below finished level of external paving or soil levels. Lay stone/bricks on a full even bed of mortar with all joints filled and between 10 - 18mm...
wide, recessed by double the width of the joint to allow re-pointing of the works when completed to match the existing.

Lay natural stone on their natural bed and evenly distribute different shapes, sizes and colours throughout the face of the wall to give a consistent overall appearance and good bond with no long contiguous vertical joints. Walls which are faced both sides - build in bonding stones of a length two thirds the thickness of the wall, one to every square metre of each side of the wall and staggered. Build up the wall and point up as a separate process to ensure consistency, mortar should be left slightly recessed to allow for re-pointing when building works have completed. Do not overwork the mortar.

Pointing can then be undertaken as previously described. Protect the works as necessary from direct winds, sun, rain and frost using protective coverings, i.e. hessian/polythene. Wetting may also be required to ensure that the joints do not dry out too quickly and cause failures.

Do not use frozen materials, or lay on frozen surfaces. The set slows down below 10°C and stops at 5°C. If temperature is 5°C or below on a falling thermometer, stop work.

Mortar mixes to be in accordance with the guidance tables below and should be carefully selected to match the existing including binder and aggregate ratios, colour, texture and detailing.

**Repair and replacement of external render/internal plaster to walls**

Repair and rendering of existing walls are required where failure of the existing external rendered or internal plastered finishes has occurred possibly due to; water penetration, (penetrating and rising damp), lack of maintenance, inadequate protection, inappropriate repairs, poor or incorrect materials and or workmanship causing shrinkage cracking, loss of adhesion and surface defects etc.

*Please note that wall paintings or other historic schemes of decoration may be lost where historic plaster finishes are removed and stabilisation rather than removal of internal plaster finishes in older buildings should be considered where there is a risk of such evidence being lost.*

Hack off defective finishes at least 300mm beyond last defect or to existing joint lines, remaining sound finishes should be cut back to sound edges, undercut for good key. Remedy any structural deficiencies and re-point/repair existing stone/brick/lath walls as necessary as detailed in guidance, prepare walls and dub out deep hollows in 8mm maximum thick coats (or use hemp plaster for thicker coats where there are significant voids) ready to receive new render/plaster finishes. Do not use beads and stops unless specified, use proprietary manufactured stainless steel beads and stops fixed in accordance with manufacturer's details where specified.

Thoroughly wet the wall to control suction of moisture before application of first render coat, form arisses and ensure correct alignment with all features as necessary. Apply external render/internal plaster coatings in an even, consistent and firm manner, to achieve good adhesion (ensure nibs are created behind timber laths where necessary). Use appropriate tools, finished to a true plane with walls and reveals plumb and square unless otherwise specified. Provide key for next coat by combing render coats and cross scratching plaster coats using appropriate tools, ensuring under coat is not penetrated. Finishes should be appropriate for the building in which they are being applied, e.g. a workers cottage or formal Georgian town house will have dramatically different finishes.

Keep each coat damp with polythene/hessian coverings or spray with water to prevent dry out, curing times to be accordance with manufacturer's details for the type of material used, allow each coat to dry and shrinkage to occur before applying next coat. (Rule of thumb- plaster must be hard enough not to indent with thumb, but soft enough to indent with a nail print).

Render/plaster mixes to match the existing in accordance with the tables below including binder and aggregate ratios, colour, texture and detailing.
Section 3: Lime mortars, renders, plasters and decorative finishes suitable for breathable buildings

Types of lime mortars, lime renders/ plasters and decorative finishes suitable for breathable buildings
There are two main types of lime binder used in mortars, renders and plasters, non hydraulic and hydraulic lime as detailed below:

1. Non- hydraulic lime (known as lime putty or fat lime)
Consists of fairly pure limestone, burnt in a factory process to drive off carbon dioxide, an excess of water is added to slake the resulting quick lime into a lime putty. It hardens by exposure to the air, in the presence of water, in order to carbonate, and over a long period of time it reverts back to a limestone. Commercially produced non hydraulic lime's are available from Ty-Mawr at: www.lime.org.uk.

Non-hydraulic lime mortar mixes
The lime putty to be pre-mixed with aggregates to match the existing mortar in the required ratio depending on the type of stone or brick and degree of exposure in accordance with the guidance table below. Turn, beat and ram the mortar as necessary to make it more plastic without the addition of water in most cases. For walls to be rendered, leave the pointing finished 6mm back from the stone/brick face to provide a key.

Non-hydraulic lime may be more appropriate for use on historic buildings where a slower set and soft mortar is required to maximum permeability and flexibility of the wall structure. Lime mortars can take several months to a year to cure and should be left to weathered naturally without the application of any artificial weathering which may damage the mortar.

Only breathable paints as detailed in this guidance should be applied to breathable walls and breathable buildings.

Pozzolanic materials can be added to the non hydraulic mortar mix to increase initial set times where specified/required, and carried out in strict consultation with an experienced conservation specialist details. Note: Hydrated or bagged lime is normally as a plasticizer and is added to a cement mortar mix, it can be used as a mortar but not always with good results..

Guidance Table 1: Typical non hydraulic lime putty mortar mixes

<table>
<thead>
<tr>
<th>Type of material in wall</th>
<th>Sheltered application</th>
<th>Exposed application</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lime putty: Mortar</td>
<td>Lime putty: Mortar</td>
</tr>
<tr>
<td>Stone/brick - poor durability</td>
<td>1 : 3</td>
<td>1 : 2</td>
</tr>
<tr>
<td>Stone/brick - medium durability</td>
<td>1 : 3 (use hydraulic lime table for sand stone)</td>
<td>Use hydraulic lime table</td>
</tr>
<tr>
<td>Stone/brick - good durability</td>
<td>1 : 3 (use hydraulic lime table for sand stone)</td>
<td>Use hydraulic lime table</td>
</tr>
<tr>
<td>Fine joints (up to 3mm)</td>
<td>1 : 1</td>
<td>1 : 1</td>
</tr>
</tbody>
</table>

Notes: Above mortar mixes are only suggested mixes and the actual mortar mix is to be specified by a suitably qualified and experienced conservation specialist- suitable for the type of wall material and degree of exposure; The exact ratio will depend on the sand/aggregate used; The colour, texture and workability of the mortar is influenced by the sand/aggregate; The softer the stone/brick, the softer the mortar mix required.
2. Hydraulic lime
Consists of limestone containing a natural proportion of clay in addition to calcium and magnesium carbonates, which is burnt in a factory process to produce chemical compounds similar to Portland cement, which are stronger but less workable than non-hydraulic limes. It hardens by chemical reaction with water and by carbonation. The higher the percentage of natural clay and minerals in the lime - the higher the strength and initial set times but the poorer the permeability and flexibility. Commercially produced hydraulic lime is available in varying compressive strengths and setting times for specific projects in strict consultation with an experienced conservation specialist details. Commercially produced hydraulic lime’s are available from specialist lime suppliers such as Ty-Mawr at: www.lime.org.uk.

Hydraulic lime mortar mixes
The lime used for re pointing and building has to be mixed with aggregates to match the existing mortar in the required ratio depending on the type of stone or brick and degree of exposure in accordance with the guidance table below.

Mortar must not be allowed to dry out too quickly and surrounding masonry must be kept damp. Pointing should be kept moist for 7 days- the carbonation set can only complete in the presence of moisture. Building can be carried out at the same rate as Portland cement, depending on hydraulic lime used and weather conditions.

Hydraulic lime is more appropriate where a strong rapid set is required. Lime mortars can take several months to fully cure and should be left to weathered naturally. The application of artificial weathering finishes may reduce the life of the mortar.

Only breathable paints as detailed in this guidance should be applied to breathable walls and breathable buildings.

<table>
<thead>
<tr>
<th>Type of material in wall</th>
<th>Sheltered application Lime: Mortar</th>
<th>Exposed application Lime: Mortar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stone/brick - poor durability</td>
<td>1(^{\text{NHL2}}) : 3 or softer (use non hydraulic lime table for lime stones)</td>
<td>1(^{\text{NHL2}}) : 3 or softer (use non hydraulic lime table for lime stones)</td>
</tr>
<tr>
<td>Stone/brick - medium durability</td>
<td>1(^{\text{NHL3.5}}) : 3</td>
<td>1(^{\text{NHL3.5}}) : 2.5</td>
</tr>
<tr>
<td>Stone/brick - good durability</td>
<td>1(^{\text{NHL5}}) : 3</td>
<td>1(^{\text{NHL5}}) : 2.5</td>
</tr>
<tr>
<td>Fine joints (up to 3mm)</td>
<td>Use non hydraulic lime table</td>
<td>Use non hydraulic lime table</td>
</tr>
</tbody>
</table>

Key: \(^{\text{NHL2}}\) Natural hydraulic lime containing up to 12% clay (slow set); \(^{\text{NHL3.5}}\) Natural hydraulic lime containing 12-18% clay (moderate set); \(^{\text{NHL5}}\) Natural hydraulic lime containing up to 25% clay( faster set). All are natural hydraulic lime.

Notes: Above mortar mixes are only suggested mixes and the actual mortar mix is to be specified by a suitably qualified and experienced conservation specialist- suitable for the type of wall material and degree of exposure; The exact ratio will depend on the sand/aggregate used; The colour, texture and workability of the mortar is influenced by the sand/aggregate; The softer the stone/brick, the softer the mortar mix required.
Non-hydraulic/hydraulic lime render/plaster mixes.

Type of lime binder and number of coats
Non-hydraulic or hydraulic lime used for external renders and internal plasters should be suitable for the wall type and degree of exposure and mixed with aggregates (to match the existing where necessary) in accordance with the guidance tables below: Lime render/plasters can take several months to fully cure and should be left to weather down naturally without the application any artificial weathering which could damage the render/plaster. Only breathable paints as detailed in this guidance should be used on breathable renders/plasters and should be applied in accordance with the paint manufacturer’s details.

Guidance Table 3: Lime render/plaster mixes (suggested mixes)

<table>
<thead>
<tr>
<th>Wall construction°</th>
<th>Internal plaster or External render</th>
<th>Base/leveling Coat(s)</th>
<th>Number and thickness of base/leveling coat(s)</th>
<th>Top/finishing coat (top/finishing coat should not be harder than the base coat)</th>
<th>Number and thickness of top coat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cob, rammed earth, straw bale* (Haired base coats)</td>
<td>Internal plaster</td>
<td>Fat Lime Base Coat Plaster</td>
<td>2 x 9mm</td>
<td>Fat Lime Top Coat Plaster</td>
<td>1 x 3mm</td>
</tr>
<tr>
<td></td>
<td>External render</td>
<td>Fat Lime Base Coat Plaster or Hydraulic Lime NHL2</td>
<td>2 x 9mm</td>
<td>Fat Lime Top Coat Plaster or Hydraulic Lime NHL2</td>
<td>1 x 6mm</td>
</tr>
<tr>
<td>Reed mat, reed board (Haired base coat)</td>
<td>Internal plaster**</td>
<td>Fat Lime Plaster for Boards</td>
<td>2 x 9mm</td>
<td>Fat Lime Top Coat Plaster</td>
<td>1 x 3mm</td>
</tr>
<tr>
<td></td>
<td>External render</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Celenit Wood Wool boards (Mesh base coat)</td>
<td>Internal** walls and ceilings</td>
<td>Fat Lime Plaster for Boards (un haired) or Hydraulic Lime NHL3.5/ NHL2 (with beach aggregate)</td>
<td>2 x 6mm</td>
<td>Fat Lime Top Coat Plaster or Hydraulic Lime NHL 3.5</td>
<td>1 x 3mm</td>
</tr>
<tr>
<td></td>
<td>External render</td>
<td>Hydraulic Lime NHL3.5 (with beach aggregate)</td>
<td>1 x 9mm</td>
<td>Hydraulic Lime NHL 3.5</td>
<td>1 x 9mm</td>
</tr>
<tr>
<td>Wood fibre boards (Mesh base coat)</td>
<td>Internal plaster**</td>
<td>Fat Lime Plaster for Boards or Hydraulic Lime NHL3.5 (with beach aggregate)</td>
<td>2 x 6mm</td>
<td>Fat Lime Top Coat Plaster or Hydraulic Lime NHL 3.5</td>
<td>1 x 3mm</td>
</tr>
<tr>
<td></td>
<td>External render</td>
<td>Hydraulic Lime NHL3.5 (with beach aggregate)</td>
<td>1 x 9mm</td>
<td>Hydraulic Lime NHL 3.5</td>
<td>1 x 9mm</td>
</tr>
<tr>
<td>Lath (internal only) or soft stone (haired base coats)</td>
<td>Internal plaster</td>
<td>Fat Lime Base Coat Plaster</td>
<td>2 x 9mm</td>
<td>Fat Lime Top Coat Plaster</td>
<td>1 x 3mm</td>
</tr>
<tr>
<td></td>
<td>External render</td>
<td>Hydraulic Lime NHL3.5/ NHL2</td>
<td>2 x 9mm</td>
<td>Fat Lime Top Coat Plaster or Hydraulic Lime NHL3.5/NHL2</td>
<td>1 x 6mm</td>
</tr>
<tr>
<td>Soft brick (haired base coats)</td>
<td>Internal plaster</td>
<td>Fat Lime Base Coat Plaster</td>
<td>2 x 9mm</td>
<td>Fat Lime Top Coat Plaster</td>
<td>1 x 3mm</td>
</tr>
<tr>
<td></td>
<td>External render</td>
<td>Fat Lime Base Coat Plaster or Hydraulic Lime NHL 3.5/ NHL2</td>
<td>2 x 9mm</td>
<td>Fat Lime Top Coat Plaster or Hydraulic Lime NHL 3.5/NHL2</td>
<td>1 x 6mm</td>
</tr>
<tr>
<td>Hard stone (haired base coats)</td>
<td>Internal plaster</td>
<td>Hydraulic Lime NHL 2</td>
<td>2 x 9mm</td>
<td>Fat Lime Top Coat Plaster</td>
<td>1 x 3mm</td>
</tr>
<tr>
<td></td>
<td>External render</td>
<td>Hydraulic Lime NHL 3.5</td>
<td>2 x 9mm</td>
<td>Hydraulic Lime NHL 3.5</td>
<td>1 x 6mm</td>
</tr>
<tr>
<td>Hard engineering brick or dense concrete blocks (10mm mesh or haired base coat)</td>
<td>Internal plaster</td>
<td>Hydraulic Lime NHL 3.5/ NHL2</td>
<td>2 x 9mm</td>
<td>Fat Lime Top Coat Plaster or Hydraulic Lime NHL 3.5/NHL2</td>
<td>1 x 3mm</td>
</tr>
<tr>
<td></td>
<td>External render</td>
<td>Hydraulic Lime NHL 3.5</td>
<td>2 x 9mm</td>
<td>Hydraulic Lime NHL 3.5</td>
<td>1 x 6mm</td>
</tr>
<tr>
<td>Insulation blocks* (10mm mesh or haired base coat)</td>
<td>Internal plaster</td>
<td>Hydraulic Lime NHL 3.5/ NHL2</td>
<td>2 x 9mm</td>
<td>Fat Lime Top Coat Plaster</td>
<td>1 x 3mm</td>
</tr>
<tr>
<td></td>
<td>External render</td>
<td>Hydraulic Lime NHL 3.5</td>
<td>2 x 9mm</td>
<td>Hydraulic Lime NHL 3.5</td>
<td>1 x 6mm</td>
</tr>
</tbody>
</table>

Key: Fat Lime = non hydraulic lime; NHL 1 or 2: Natural hydraulic lime containing up to 12% clay (slow set); NHL 3.5: Natural hydraulic lime containing 12-18% clay (moderate set); NHL 5: Natural hydraulic lime containing up to 25% clay (fast set).

°Dub out uneven surfaces prior to applying first coat. *May require more coats due to waviness of bales

* Insulation blocks have very high suction, be careful to maintain moisture content in render/plaster mixes in accordance with manufacturer’s details. **Lime Hemp plaster is preferred in these situations applied in accordance with lime specialists details (available from Ty-Mawr at: www.lime.org.uk).

Notes: Above table contains suggested mortar mixes only and the actual mortar mix, build up ant thickness of coats is to be specified by a suitably qualified and experienced conservation specialist- suitable for the type of wall material and degree of exposure. Exposed elevations may require additional coats.
Guidance Table 4: Mix ratio for lime render/plaster coats

<table>
<thead>
<tr>
<th>Application</th>
<th>Type of lime</th>
<th>Lime : aggregate mix ratio by volume</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal plaster</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base/levelling coats</td>
<td>As above table</td>
<td>1 : 2.5 or 1 : 3 sand/aggregate</td>
<td>Add hair/fibre at 1.5kg per tonne to provide tensile strength (unless using polypropylene render mesh, and that it is towelled into the first coat.)</td>
</tr>
<tr>
<td>Top/finishing coat</td>
<td>As above table</td>
<td>1 : 2.5 or 1 : 3 fine sand</td>
<td>Use finer sand</td>
</tr>
<tr>
<td>External render</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Base/levelling coats</td>
<td>As above table</td>
<td>1 : 2.5 or 1 : 3 sand/aggregate</td>
<td></td>
</tr>
<tr>
<td>Top/finishing coat</td>
<td>As above table</td>
<td>1 : 2.5 or 1 : 3 fine sand</td>
<td>Use finer sand</td>
</tr>
<tr>
<td>Harling/roughcast finish coat</td>
<td>As above table</td>
<td>1 : 2.5 or 1 : 3 course sand</td>
<td>Apply to external render with Harling trowel or Tyrolene machine</td>
</tr>
</tbody>
</table>

Notes: Above are suggested render/plaster mixes only and the actual mix is to be specified by a suitably qualified and experienced conservation specialist- suitable for the type of wall material and degree of exposure.

Guidance Table 5: Compressive strengths for lime

<table>
<thead>
<tr>
<th>Type of lime</th>
<th>Typical compressive strength (N/mm²)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional Fat Lime (non hydraulic)*</td>
<td>0.3 - 0.5</td>
<td></td>
</tr>
<tr>
<td>Hydraulic lime*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NHL 2</td>
<td>1.3 - 2.0</td>
<td></td>
</tr>
<tr>
<td>NHL 3.5</td>
<td>2.0 - 4.5</td>
<td></td>
</tr>
<tr>
<td>NHL 5</td>
<td>5.0 - 10.0</td>
<td></td>
</tr>
<tr>
<td>Limecrete floors (produced by Ty-Mawr with LABC Type Approval)</td>
<td>4.0 (increases to 6.5 at 56 days and 8.3 at 90 days)</td>
<td>* Increased strength reduces permeability and flexibility.</td>
</tr>
</tbody>
</table>

Notes: * Increased strength reduces permeability and flexibility.

Haired lime plaster
Incorporate hair/fibre (typically goats/horse hair or synthetic hair or other approved at 1.5kg per tonne) to provide tensile strength where necessary, cut into 50mm lengths and added (teased) into the mix to the proportion/ratio as specified by a suitably qualified and experienced conservation specialist. Note: Synthetic hair is often used in premixed plasters as natural hair will degrade in un-carbonated lime after a few weeks.

Pozzolanic materials for lime plaster
Pozzolanic materials containing silica and alumina such as brick dust, pulverized fuel ash (PFA) and calcined clay can be added to non hydraulic lime putty (also known as fat lime) where necessary to increase the setting time similar to that of hydraulic lime. The type and ratio of pozzolanic material is to be specified by a suitably qualified and experienced conservation specialist.
Breathable paints
All solid stone/brick walls with lime render/plaster finishes should be decorated with a breathable finish as follows:

Limewash (and shelter coat)
Limewash is suitable for internal and external surfaces. It is made using a high calcium (fat) lime putty and is commercially available pre mixed from specialist manufacturer's/suppliers. Limewash is naturally white or off white and has a matt finish. It can be coloured using the addition of pigments which can cause slight colour variation across the surface and a slightly blotchy appearance which is normal. Limewash adheres by suction to lime renders and plasters, stone, brick, and similar materials, but not to modern materials. It sets when exposed to carbon dioxide in the air.

Where necessary, a shelter coat consisting of lime putty and fine aggregate can be applied with a soft bristle brush over bare stone to provide a key on hard non porous surfaces and allows the limewash to stick and remain on the surface.

Limewash is to be applied and protected in accordance with limewash manufacturer's details or as specified by a suitably qualified and experienced conservation specialist. Limewash is normally applied vigorously and pushed into the surface/cracks with a stiff brush in thin layers (to the consistency of single cream -otherwise if too thick it will crack and crumble), applied in three coats minimum, allowing at least 12 hours between each coat for carbonation to take place before the next coat is applied. Gently water mist surfaces between coats. Protect the works as necessary from direct winds, sun, rain and frost using protective coverings, i.e. hessian and polythene. Lime wash normally requires reapplication every 4-5 years depending on exposure and application.

Clay paint
Clay paint is suitable for most internal wall surfaces. It is a solvent free, breathable paint and helps to balance the indoor humidity of the room and is available in a range of soft and rich colours. Clay paint is to be applied and protected in accordance with the paint manufacturer's details or as specified by a suitably qualified and experienced conservation specialist.

Plant based/natural emulsion wall paints
Natural emulsion/resin wall paints are plant based, vapour permeable and aesthetically soft but durable and suitable for most backgrounds. These paints are to be applied and protected in accordance with the paint manufacturer's details or as specified by a suitably qualified and experienced conservation specialist.

Mineral based wall paints
Silicate paint is a vapour permeable and durable paint with a lustre similar to limewash, and can be applied over existing internal coatings with the correct preparation/primer/bonding coats as specified by the paint manufacturer.

Silicate masonry paint (not silicone paint), is an exterior paint, free of resins, solvents and biocides. It is vapour permeable (and can be used as an alternative to limewash), is water repellent, non-flammable, non-toxic, light fast and mould resistant. It has a serviceable life of 25 years when used in conjunction with a clear hydro phobing agent. Note: this paint bonds to the wall surface and should only be applied in consultation with the Local Authority Conservation Officer if it is applied directly to stone/brick on a listed building. Mineral paints are to be applied and protected in accordance with the paint manufacturer's details or as specified by a suitably qualified and experienced conservation specialist.
Clear protective coatings
Proprietary clear protective coatings consisting of highly alkali-resistant hydro phobing agents (silane-siloxane based organosilicon substances) and can be applied to absorbent, porous stone/brick surfaces to provide a clear long term protection from penetrating humidity, pollution and infiltration through noxious substances in porous mineral building materials while maintaining vapour permeability. They maintain the aesthetic appearance of the stone/brick but provides extra protection from rain where required.

Proprietary clear coatings are to be used only where specified by a suitably qualified and experienced conservation specialist and must be applied and protected in accordance with the protective coating manufacturer's details. **Note:** Clear protective coatings should only be applied in consultation with the Local Authority Conservation officer if it is applied directly to stone/brick on a listed building. Further information and protective coatings can be obtained from specialist suppliers such as Ty-Mawr at: www.lime.org.uk

**Application of coatings/paints/systems, protection, storage and after care.**
To be in accordance with the manufacturer’s details as specified by a suitably qualified and experienced conservation specialist. Provide all personal protective equipment (PPE) in accordance with current health and safety legislation and temporary protection to the works as necessary, and in accordance with manufacturer’s details.
Section 5: Upgrading (renovating) existing thermal elements

Building regulation requirements- upgrading existing thermal elements
Please refer fully to Approved Document L1B (ADL1B for England and Wales)
Work on existing thermal elements must comply with ADL1B

Where a thermal element is subject to a renovation the performance of the whole of the thermal element should be improved provided the area to be renovated is greater than 50% of the surface of the individual thermal element or constitutes a major renovation where more than 25% of the surface area of the building envelope undergoes renovation.

When a building undergoes a major renovation this may represent an opportunity to consider and take into account the technical, environmental and economic feasibility of installing high-efficiency alternative systems

Thermal element is used in the Building Regulations to describe a wall, floor or roof, which separates a heated space from the external environment, the ground, and any parts of the building which are not heated or, where another part of the building which is not a dwelling, is heated to a different temperature.

The provision of a new layer means cladding or rendering the external surface or dry lining the internal surface. The replacement of an existing layer means either stripping down the element to its basic structural components (masonry, timber frame, steel frame, etc.) and then rebuilding or replacing the waterproof membrane of a flat roof.

When assessing the proportion of the area to be renovated in the paragraph above, the area of the element to be renovated should be taken as that of the individual element, not all the elements of that type in the building. For example, if stripping down the roof of an extension the area of the element is the area of the extension roof, not the total roof area of the dwelling. The area of the element also differs whether the element is being renovated from the inside or the outside. For example, if removing all the plaster finish from the inside of a wall, the area of the element is the area of the wall in the room, however, if removing the external render, it is the area of the elevation in which that wall sits.

Alternative optional approaches to the guidance below, that offer more design flexibility by allowing some elements of the design to be relaxed if compensated for elsewhere.

Building Fabric
Where a thermal element is renovated the performance of the whole element should be improved to achieve or better the U-values set out in column (a) of Guidance Table 6.

Where the U-value set out in column (a) of Guidance Table 6 is not economically, functionally or technically feasible, then the thermal element should be upgraded to the best standard that is economically, functionally and technically feasible. Guidance on this approach is given in ADL1B – Cost-effective insulation improvements. Generally, the U-value of the thermal element should not be worse than the limiting U-values set out in column (b) of Guidance Table 6 to minimise the risk of surface condensation and mould growth

The test of the economic feasibility of an energy efficiency measure is to calculate if the measure achieves a payback of the initial cost within 15 years through energy savings. This is calculated by dividing the cost of implementing the measure (not the whole cost of the project) by the annual energy saving achieved by that measure, estimated using the latest version of SAP, taking account of VAT in both the cost and the saving.
Guidance Table 6: U-values for upgrading (renovating) existing thermal elements (W/m².K)
Please refer fully to Approved Document L1B (ADL1B for England and Wales)

<table>
<thead>
<tr>
<th>Elements</th>
<th>(a) Maximum U-values** for renovated fabric</th>
<th>(b) Limiting U-values** for renovated fabric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walls – cavity insulation³</td>
<td>0.55</td>
<td>0.70</td>
</tr>
<tr>
<td>Walls – external or internal insulation</td>
<td>0.30</td>
<td>0.70</td>
</tr>
<tr>
<td>Floors⁴</td>
<td>0.25</td>
<td>0.70</td>
</tr>
<tr>
<td>Pitched roofs – insulation at ceiling level</td>
<td>0.16</td>
<td>0.35</td>
</tr>
<tr>
<td>Pitched roofs – insulation between the rafters</td>
<td>0.18</td>
<td>0.35</td>
</tr>
<tr>
<td>Flat roofs or roofs with integral insulation</td>
<td>0.18</td>
<td>0.35</td>
</tr>
</tbody>
</table>

**Notes:**
1. ‘Roofs’ include the roofs of dormer windows and ‘walls’ include the walls or cheeks of dormer windows
2. U-values should be calculated as given in ADL1B.
3. If a wall has a cavity but it is not suitable for filling with cavity insulation, it should be treated as ‘wall – external or internal insulation’.
4. The U-value of the floor of an extension can be calculated using the exposed perimeter and floor area of the whole enlarged dwelling.

Guidance Table 7: U-values (W/m².K) for new and replacement windows and doors including roof windows and roof lights
Please refer fully to Approved Document L1B (ADL1B for England and Wales)

<table>
<thead>
<tr>
<th>Controlled fitting</th>
<th>(a) Maximum U-values¹ for new and replacement windows and doors</th>
<th>(b) Alternative Maximum U-values¹ for replacement windows and doors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windows, roof windows/ roof lights</td>
<td>1.6 WER (window energy rating) as Band C²</td>
<td>1.2 centre pane or low-e secondary glazing</td>
</tr>
<tr>
<td>Doors</td>
<td>1.6 or DSER Band E⁺ (Wales only)</td>
<td>1.2 centre pane</td>
</tr>
<tr>
<td></td>
<td>1.8 (England only)</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
1. U-values should be calculated as given in Appendix B of ADL1B: Calculating U-values
Upgrading existing roof coverings

Existing pitched roof coverings
Over haul existing roof as necessary, replace matching slates/tiles etc as required. Repair existing roof timbers as necessary. Existing timbers to be treated by specialist against insect & fungal attack as required

Replacement of pitched roof coverings
Roof coverings consist of slates/tiles and associated ridge, verge, eaves, hip, valley, abutment and ventilation systems etc fitted in accordance with the tile manufacturer’s details, suitable for the minimum recommended roof pitches and exposure.

Roof tiles/cladding to be fixed in accordance with manufacturer's details to 25 x 50mm treated timber battens (battens to be at least 1.2m long, nailed to each rafter and fixed over at least three rafters and spaced in accordance with tile manufacturer's details), rafters to be overlaid with un-tearable underlay's using either a non breathable/high water vapour resistance underlay to BS EN 13707: 2004 (requires ventilation on opposing sides as detailed in guidance) or a British Board of Agreement (BBA or other third party accredited) vapour permeable breathable/low water resistance type underlay, both types to be fixed, ventilated, lapped and fitted with eaves carriers in accordance with manufacturer's details.

Where roof coverings cannot be fixed to the tile/slate manufacturer's required pitch, roof coverings can be fixed below manufacturer's minimum recommended roof pitch by using a proprietary British Board of Agreement (BBA or other third party accredited) corrugated roof sheet system below roof coverings to create an independent secondary weatherproof roof, which must be installed to minimum roof pitches and ventilated in accordance with manufacturer's details. e.g. 'Ondutile' under tile and slate under-sheeting system manufactured by Onduline Building Products Ltd: www.onduline.net. (Typical minimum roof pitches: 12.5° for concrete interlocking tiles; 17.5° for clay pan tiles/ natural and fibre cement slates; 22.5° for plain double lap tiles- contact manufacturer for minimum roof pitches achievable)

Pitched roof ventilation requirements when using a non breathable roof membrane

(i) Duo pitched roof with horizontal ceilings and insulation at ceiling level
Roof insulation to be continuous with the wall insulation but stopped back at eaves or at junctions with rafters to allow a 50mm minimum air gap. Cross ventilation is to be provided by either proprietary facia ventilation strips or soffit vents to opposing sides of roof at eaves level and fitted with an insect grill with a ventilation area equivalent to a 25mm continuous gap for roof pitches below 15° or a 10mm gap for roof pitches above 15°.

When the roof span is more than 10 metres or when the pitch is more than 35°, provide additional high level ventilated openings equivalent to a continuous 5mm air gap at ridge level to cross ventilate roofs using proprietary dry ridge systems or vent tiles spaced and fixed in accordance with tile manufacturer's details.

(ii) Mono pitched roofs with horizontal ceilings and insulation at ceiling level
Roof insulation to be continuous with the wall insulation but stopped back at eaves or at junctions with rafters to allow a 50mm minimum air gap. Cross ventilation is to be provided by either proprietary facia ventilation strips or soffit vents at eaves level and fitted with an insect grill with a ventilation area equivalent to a 25mm continuous gap for roof pitches below 15° or a 10mm gap for roof pitches above 15°.

Provide high level ventilated openings fitted with an insect grill equivalent to a continuous 5mm air gap to cross ventilate roofs using proprietary ventilation systems or vent tiles spaced and fixed in accordance with tile manufacturer’s details.
(iii) Duo pitched roof with insulation following slope of rafters (rooms in the roof)

Roof insulation to be continuous with the wall insulation but stopped back at eaves or at junctions with rafters to allow a continuous 50mm air gap between the top of the insulation and underside of the roof membrane. Cross ventilation to be provided by a proprietary eaves ventilation strips equivalent to a 25mm continuous air gap to opposing sides of roof at eaves level, fitted with insect grill and at ridge/high level to provide ventilation equivalent to a 5mm air gap in the form of proprietary dry ridge system or vent tiles spaced and fixed in accordance with tile manufacturer’s details.

**Proprietary vapour permeable roof membrane**

Ventilation to the roof space may be omitted, only if a proprietary British Board of Agreement (BBA or other third party accredited) vapour permeable breathable roof membrane is used. Vapour permeable breathable roof membranes must always be installed in strict accordance with manufacturer's details (note. some breathable membranes may also require additional roof ventilation in accordance with manufacturer's details).

**Valleys and lead work**

Lead work, flashing, soakers, valleys and gutters, etc, to be formed from Code 5 lead sheet and fully supported on treated valley boards, etc, and to have a minimum 150mm lap joints, dressed 200mm under tiles, etc, and not to be fixed in lengths exceeding 1.5m and to be fixed in accordance with the roof cladding manufacturer's and the Lead Sheet Association recommendations.

**Pitched roof structure**

Repair/replace existing defective roof timbers as necessary. Existing timbers should be inspected and treated by specialist against insect & fungal attack if required. Replacement of the roof structure is not covered by this document and the author has written building control guidance for Domestic Extensions in England and Wales which includes new roof structures and can be obtained at: [www.fdean.gov.uk](http://www.fdean.gov.uk)
Upgrading existing roof insulation

Upgrading works should be carried out by a suitably qualified and experienced conservation specialist who can provide details and specifications for the most suitable form and method of construction for your project.

Guidance Diagram 6: Typical section through a roof with insulation laid horizontally between and over ceiling joists (Vented cold roof achieving a U-value no worse than 0.16 W/m².k) (Section detail not to scale)

Guidance Table 8: Examples of roof insulation laid horizontally between and over ceiling joists (Vented cold roof achieving a U-value no worse than 0.16 W/m².k)

<table>
<thead>
<tr>
<th>Product</th>
<th>K -Value</th>
<th>Position in roof</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web Dynamics TLX Gold multi foil (new build system) and Insulation with a k value of 0.020 or better</td>
<td>R-value (TBA)</td>
<td>One layer of TLX Gold insulating membrane fixed over rafters with unventilated air layer and</td>
</tr>
</tbody>
</table>

Key: *All unvented roofs using vapour permeable underlay.

Notes: 1. insulation fixed over the roof should be carried out in accordance with insulation manufacturer's details which may require specialist fixings for the build-up of insulation, battens/counter battens and breathable membrane positions required. All specifications assume a vapour check fixed below rafters/counter battens - in accordance with manufacturer's details. (Manufacturer's product details are appended to this guidance). Important note: Actual insulation requirements and condensation risk analysis to be calculated for a specific project by the insulation manufacturer. Source: Calculated by individual insulation manufacturer.
Guidance Diagram 7: Typical section through a roof with insulation fixed between/under rafters (Vented cold roof achieving a U-value no worse than 0.18 W/m².k)
(Section detail not to scale)

Guidance Table 9: Examples of roof insulation fixed between/under rafters
(Vented cold roof achieving a U-value no worse than 0.18 W/m².k)

<table>
<thead>
<tr>
<th>Product</th>
<th>K-Value</th>
<th>Position in roof</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web Dynamics TLX Gold multi foil (new build system) and Insulation with a k value of 0.020 or better</td>
<td>R-value (TBA)</td>
<td>One layer of TLX Gold insulating membrane fixed over rafters with unventilated air layer and</td>
</tr>
</tbody>
</table>

Key: *All unvented roofs using vapour permeable underlay.

Notes: 1. insulation fixed over the roof should be carried out in accordance with insulation manufacturer's details which may require specialist fixings for the build-up of insulation, battens/counter battens and breathable membrane positions required. All specifications assume a vapour check fixed below rafters/counter battens - in accordance with manufacturer's details. (Manufacturer's product details are appended to this guidance). Important note: Actual insulation requirements and condensation risk analysis to be calculated for a specific project by the insulation manufacturer. Source: Calculated by individual insulation manufacturer.
Guidance Diagram 8: Typical section through a roof with insulation fixed over/between rafters (Warm roof achieving a U-value no worse than 0.18 W/m².k) (Section detail not to scale)

Guidance Table 10: Examples of roof insulation fixed over/between rafters (Warm roof achieving a U-value no worse than 0.18 W/m².k)

<table>
<thead>
<tr>
<th>Insulation product</th>
<th>K -Value</th>
<th>Position in roof</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web Dynamics TLX Gold multi foil (new build system) and Insulation with a k value of 0.020 or better</td>
<td>R-value (TBA)</td>
<td>One layer of TLX Gold insulating membrane fixed over rafters with unventilated air layer and</td>
</tr>
</tbody>
</table>

Key: *All unvented roofs using vapour permeable underlay.

Notes: 1. insulation fixed over the roof should be carried out in accordance with insulation manufacturer's details which may require specialist fixings for the build-up of insulation, battens/counter battens and breathable membrane positions required. All specifications assume a vapour check fixed below rafters/counter battens - in accordance with manufacturer's details. (Manufacturer's product details are appended to this guidance). Important note: Actual insulation requirements and condensation risk analysis to be calculated for a specific project by the insulation manufacturer. Source: Calculated by individual insulation manufacturer.

Upgrading existing external walls
Upgrading works should be carried out by a suitably qualified and experienced conservation specialist who can provide details and specifications for the most suitable form and method of construction for your project.

Guidance Table 11: Examples of wall insulation fixed internally
U-value no worse than 0.3 W/m²k

<table>
<thead>
<tr>
<th>External wall construction</th>
<th>Insulation product</th>
<th>Internal wall finish</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brick</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stone</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes. 1. Insulation to be installed in accordance with manufacturer's details subject to the suitability of the wall construction and UK zones for exposure to wind-driven rain in accordance with Diagram 12 and Table 4 of ADC. Important note: Actual insulation requirements and condensation risk analysis to be calculated for a specific project by the insulation manufacturer. Source: Calculated by individual insulation manufacturer.
Upgrading existing suspended ground floors

Upgrading works should be carried out by a suitably qualified and experienced conservation specialist who can provide details and specifications for the most suitable form and method of construction for your project.

**Guidance Diagram 9: Upgrading thermal insulation to existing suspended timber floor using breathable insulations and finishes (Section detail not to scale)**

For the upgrading of breathable internal wall insulation and finishes - see Guidance tables for U-values and options.

- 225 x 75mm grilled air bricks through opposing walls at 2.0m ctrs (falling to outside wall).
- 150mm min above ground level.
- Minimum ventilated void dimension to be 150mm. If the void is liable to flooding, drainage is to be provided.
- Contact specialist if basic/full Radon protection is required.

**Guidance Table 12: Examples of insulation for existing suspended floors- fixed between joists (See Guidance Diagram 4.1- Option 2)**

<table>
<thead>
<tr>
<th>Insulation product</th>
<th>K value</th>
<th>1.0*</th>
<th>0.9</th>
<th>0.8</th>
<th>0.7</th>
<th>0.6</th>
<th>0.5</th>
<th>0.4</th>
<th>0.3</th>
<th>0.2</th>
<th>0.1</th>
</tr>
</thead>
</table>

**NOTE:** Where P/A ratio has not been calculated use insulation thickness stated in 1.0*

**Note 1.** Figures indicated above should be rounded up to the insulation manufacturer’s nearest thickness.

**Note 2.** Where P/A ratio has not been calculated use insulation thickness stated in 1.0* above.

**Note 3.** Insulation to be installed in accordance with manufacturer’s details (Manufacturer’s product details are appended to this guidance). **Important note:** Actual insulation requirements and condensation risk analysis to be calculated for a specific project by the insulation manufacturer. **Source:** Calculated by individual insulation manufacturer.
Section 6: Replacement (renewal) of thermal elements

Replacement of ground bearing floor

Please note; Replacement of the roof and wall structures are not covered by this document and the author has written building control guidance for Domestic Extensions in England and Wales which includes new roof and wall structures and can be obtained at: www.fdean.gov.uk

Guidance Diagram 10: Typical section through a Sublime floor achieving a U-value no worse than 0.22 W/m².k in England and 0.18 W/m².k in Wales) (Section detail not to scale)

Guidance Table 13: Examples of insulation for new ground bearing floor slabs- fixed in accordance with manufacturer's details

<table>
<thead>
<tr>
<th>Insulation product</th>
<th>K value</th>
<th>Calculated Perimeter/Area ratio (P/A)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.0*</td>
<td>0.9</td>
</tr>
<tr>
<td><strong>England: U-value 0.22</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ty-Mawr Sublime (complete floor system)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Wales: U-value 0.18</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ty-Mawr Sublime (complete floor system)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Required thickness of insulation (mm)

Note 1. Figures indicated above should be rounded up to the insulation manufacturer's nearest thickness

Note 2*. Where P/A ratio has not been calculated use insulation thickness stated in 1.0* above

Note 3. Insulation to be installed in accordance with manufacturer's details (Manufacturer's product details are appended to this guidance). **Important note**: Actual insulation requirements and condensation risk analysis to be calculated for a specific project by the insulation manufacturer. **Source**: Calculated by individual insulation manufacturer.
Replacement of external windows and doors

In the case of dwellings of architectural and historic interest where special consideration applies or in other cases where there is a need to maintain the character of a façade, if replacement windows or doors are unable to achieve the U-values set out in column (a) of Guidance Table 7, then they should achieve or better the lesser U-values set out in column (b) of Guidance Table 7.

Where low-e secondary glazing is installed (to supplement single glazing), the draught-proofing should be on the secondary glazing to minimise the risk of condensation forming between the primary and secondary glazing.

Guidance Table 14: Typical U-values (W/m².K) for replacement glazing to windows and doors including roof windows/ roof lights

<table>
<thead>
<tr>
<th>Glass type¹, ⁴ and ⁵</th>
<th>U-value²</th>
<th>Central pane U-value³</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single glazing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Single glazing</td>
<td></td>
<td>5.8</td>
<td>4 to 10mm thick - will not prevent condensation</td>
</tr>
<tr>
<td>Double glazing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pilkington Spacia Cool (6mm total thickness)</td>
<td>0.9</td>
<td>Resembles single glazing. Safety film is required in critical locations as ADK</td>
<td></td>
</tr>
<tr>
<td>Pilkington Spacia (6.5mm total thickness)</td>
<td>1.1</td>
<td>Resembles single glazing. Safety film is required in critical locations as ADK</td>
<td></td>
</tr>
<tr>
<td>Pilkington 4mm Optifloat/16mm air gap argon filled /4mm K Glass (24mm total thickness)</td>
<td>1.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes. 1. Glazing to be installed in accordance with manufacturer’s details
2. U-values are for the complete fitting including frame and glass and are calculated by the manufacturer for the complete fitting or SAP 2009 Table 6a gives values for different window configurations in the absence of test data or calculated values.
3. Central pane U-values are for the glazed unit only and are provided by the glazing manufacturer.
4. Actual U-value requirements for a particular product to be checked for a specific project by the manufacturer. Source: to be calculated by individual insulation manufacturer.
5. If your building is listed or curtilage listed you should check with your Local Authority Conservation Officer before works commence because these works may require listed building consent, or whether the works are repairs for which consent is not needed. Some external works to buildings within Conservation Areas may also require planning permission.
Section 7: Repair and retiling of stone roofs

Guidance Diagram 11: Typical section through a stone tiled roof (Section detail not to scale)

- Matching stone ridge
- Fixings (pegs)
- Torching
- Head lap
- Lathes/battens
- Stone slates (laid in diminishing courses)
- Priniple rafter
- Strut
- Purlins
- Rafters
- Kingpost
- Eaves detail
- External walls (typically 450mm -600mm thick)
- natural stone in lime mortar, lime render externally and lime plaster internally
- Timber wall plate
- Gutter
- Bearing
- Tie beam
- Ground level
- Floor
- Ground level
Guidance Diagram 12: Typical component detail of a stone tiled roof
(Section detail not to scale)
About the author
Anthony Gwynne MRICS; MIFireE, is a Chartered Building Surveyor and Fire Engineer and has 40 years experience in the construction industry. He co-manages a building control section and has been in building control for over 24 years. He has been responsible for overseeing the building control function of major developments including commercial, industrial, healthcare, residential, housing developments, bespoke dwellings, extensions, conversions and works to heritage buildings. He is also a member of the Forest of Dean Buildings Preservation Trust and writes guidance documents for local authority building control.

1986- 1993; was a Building Surveyor with a local authority, dealing with the repair and planned maintenance of buildings including contract procurement and contract administration.

1977- 1986; apprenticed as a banker mason and was responsible for conservation projects with Cadw (Welsh historic monuments and buildings) and following further academic study was later with English Heritage as a professional and technical officer, responsible for historic monuments in the South of England.

1976-1977 Worked in Canada on construction projects

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Building control guidance book available
1. Other guidance documents have been produced by the author and is available to download at: www.fdean.gov.uk

Acknowledgements

<table>
<thead>
<tr>
<th>Name</th>
<th>Contribution</th>
<th>Contact details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ty-Mawr ecological building products Ty-Mawr, Llangasty, Brecon, Powys LD3 7PJ</td>
<td>Breathable building products</td>
<td>Joyce &amp; Nigel Gervis, Sam Hales   <a href="http://www.lime.org.uk">www.lime.org.uk</a> 01874 611350 (Distribution) 01874 658000 (Help &amp; Training)</td>
</tr>
<tr>
<td>David Haigh FoDDC Consultant Conservation Officer</td>
<td>Review of guidance</td>
<td><a href="mailto:david@jmeconservation.co.uk">david@jmeconservation.co.uk</a></td>
</tr>
</tbody>
</table>