

**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**

Introduction

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 require easy to understand guidance on the building regulations for building projects in England. 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 property professional 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 the local authority building regulations department.

Planning Permission, listed building and conservation area consents

Planning permission, listed building/conservation area 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 planning authorities conservation officer (any exemption or relaxation must be approved before works commence). For further information, please contact your local authority planning department.

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Upgrading traditional buildings using lime and modern applications

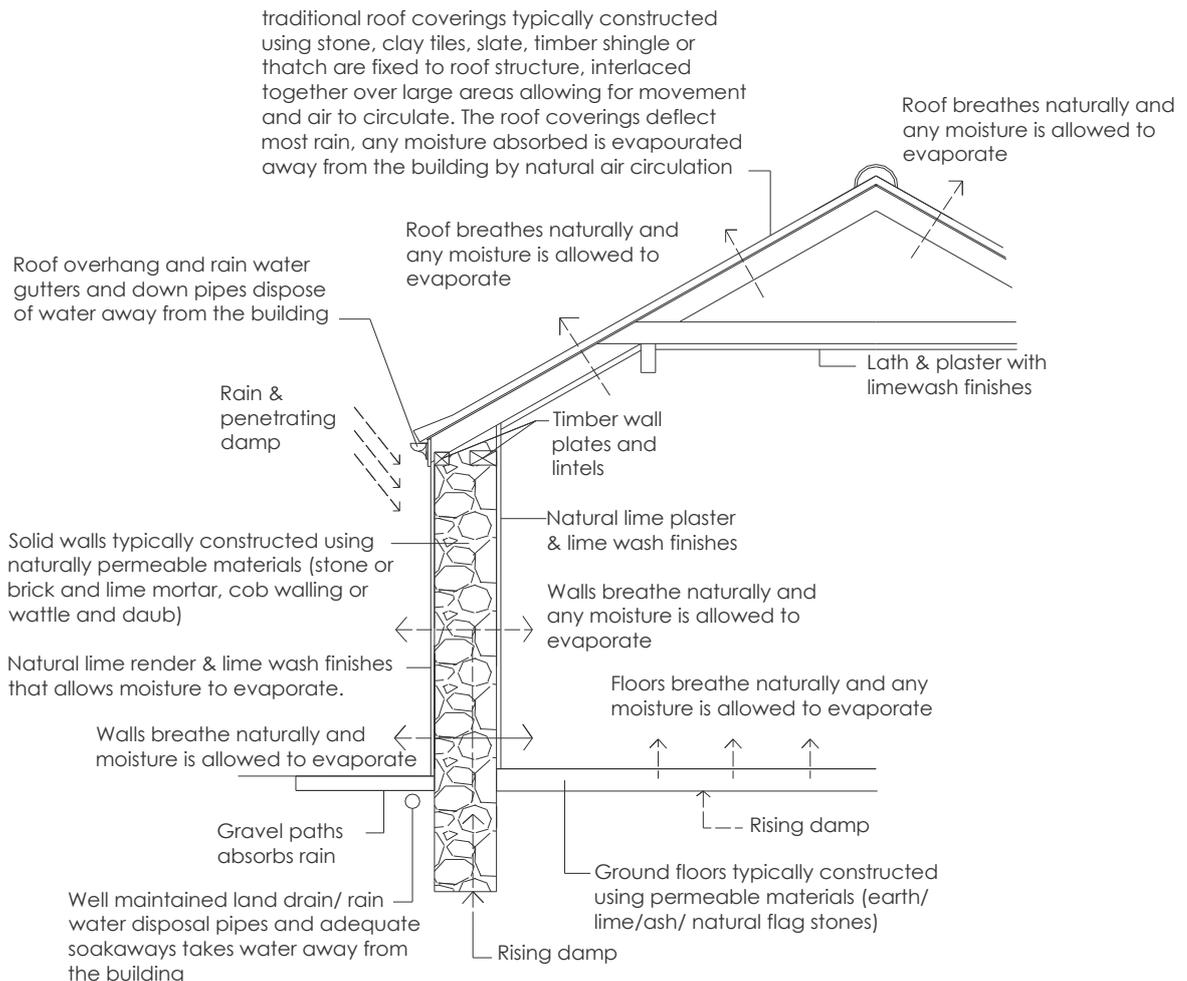
Understanding the construction of old buildings

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. 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 require 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. You are also advised to contact the Local Authority Conservation officer for your area as consent may be required for any proposed repairs/works to listed buildings and buildings in conservation areas.

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.

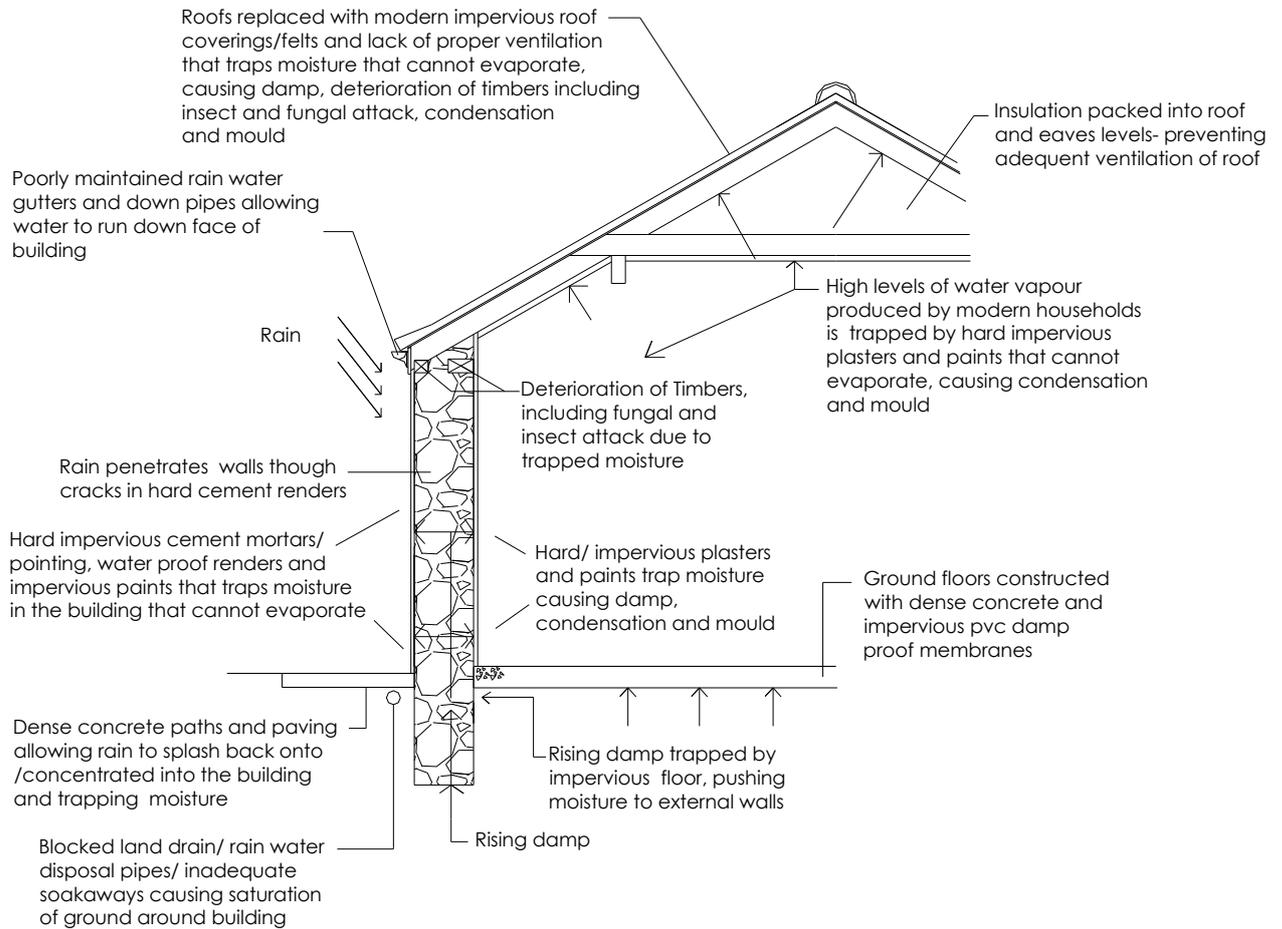
Guidance Diagram 1: Typical section through a traditional 'breathing' building (not to scale)



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 chimneys as indicated by the guidance diagram below.

Guidance Diagram 2: Inappropriate maintenance to old buildings (section detail not to scale)



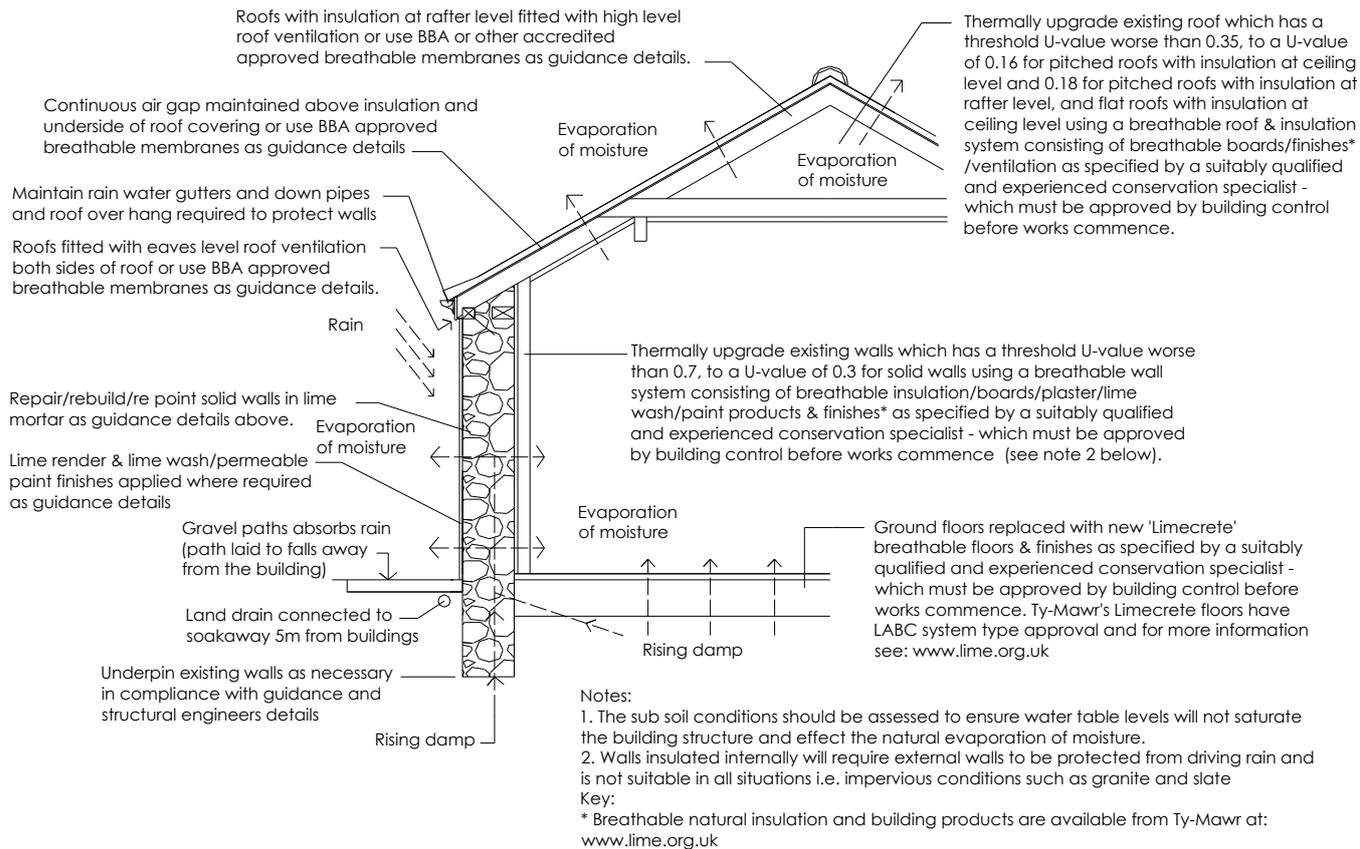
Modern applications to maintain old stone/brick buildings

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.

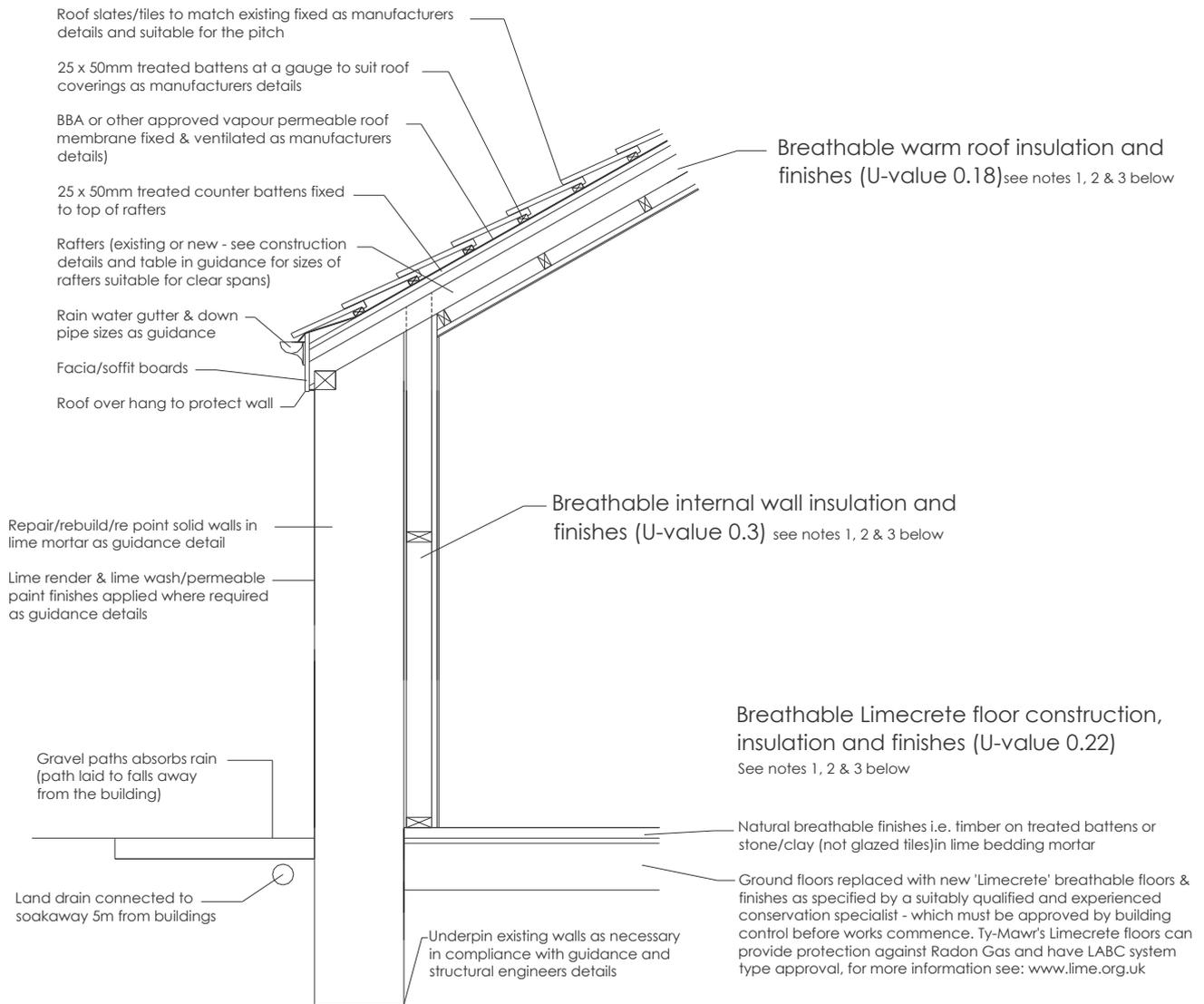
Assessment of the building should be carried out and any moisture problems should be remedied prior to refurbishing and upgrading the building. Advice about lime, aggregates, breathable insulation and breathable paint products, condensation risk analysis, U-value calculations and product specification advice can be obtained from 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 old stone/brick buildings (section detail not to scale)



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



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 contact: 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

Re-pointing and repair of existing buildings

Cement mortars or 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 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.

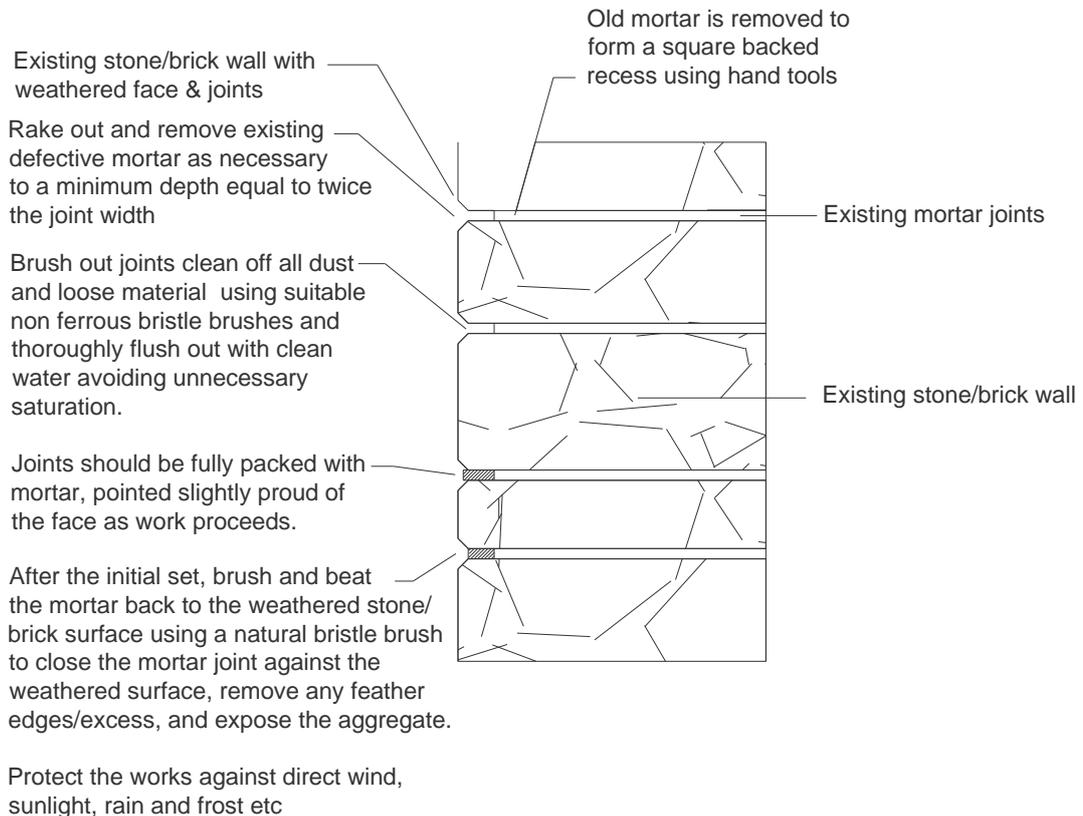
Brush and beat the mortar joint surfaces to consolidate and close up any cracks. This should be done when the mortar can no longer be dented with the thumb, but still can be dented with the

thumb nail. 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)



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.

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.

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

Type of material in wall	Non hydraulic lime putty mortar mix (gauged)	
	Sheltered application Lime putty: Mortar	Exposed application Lime putty: Mortar
Stone/brick - poor durability	1 : 3	1 : 2
Stone/brick - medium durability	1 : 3 (use hydraulic lime table for sand stone)	Use hydraulic lime table
Stone/brick - good durability	1 : 3 (use hydraulic lime table for sand stone)	Use hydraulic lime table
Fine joints (up to 3mm)	1 : 1	1 : 1

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 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.

Guidance Table 2: Typical hydraulic lime mortar mixes

Type of material in wall	Hydraulic lime mortar mix (gauged)	
	Sheltered application Lime: Mortar	Exposed application Lime: Mortar
Stone/brick - poor durability	1 ^{NHL2} : 3 or softer (use non hydraulic lime table for lime stones)	1 ^{NHL2} : 3 or softer (use non hydraulic lime table for lime stones)
Stone/brick - medium durability	1 ^{NHL3.5} : 3	1 ^{NHL3.5} : 2.5
Stone/brick - good durability	1 ^{NHL5} : 3	1 ^{NHL5} : 2.5
Fine joints (up to 3mm)	Use non hydraulic lime table	Use non hydraulic lime table

Key: ^{NHL2} Natural hydraulic lime containing up to 12% clay (slow set); ^{NHL3.5} Natural hydraulic lime containing 12-18% clay (moderate set); ^{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)

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

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(faster set).

^oDub out uneven surfaces prior to applying first coat. ¹May 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 and 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

Guidance Table 4: Mix ratio for lime render/plaster coats

Application	Type of lime	Lime : aggregate mix ratio by volume	Comments
Internal plaster			
Base/levelling coats	As above table	1 : 2.5 or 1 : 3 sand/aggregate	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.)
Top/finishing coat	As above table	1 : 2.5 or 1 : 3 fine sand	Use finer sand
External render			
Base/levelling coats	As above table	1 : 2.5 or 1 : 3 sand/aggregate	
Top/finishing coat	As above table	1 : 2.5 or 1 : 3 fine sand	Use finer sand
Harling/roughcast finish coat	As above table	1 : 2.5 or 1 : 3 coarse sand	Apply to external render with Harling trowel or Tyrolene machine

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 88: Compressive strengths for lime

Type of lime	Typical compressive strength (N/mm ²) (tested at 28 days- greater strengths achieved thereafter)
Traditional Fat Lime (non hydraulic)*	0.3 - 0.5
Hydraulic lime*	
NHL 2	1.3 - 2.0
NHL 3.5	2.0 - 4.5
NHL 5	5.0 - 10.0
Limecrete floors (produced by Ty-Mawr with LABC Type Approval)	4.0 (increases to 6.5 at 56 days and 8.3 at 90 days)

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.

3. 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.

Lime wash 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/primers/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 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.

About the author

Anthony Gwynne MRICS; MIFireE, is a Chartered 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.

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*

2. *'Guide to Building Control for Domestic Buildings'* has been produced as a book by the author of this guidance and is published by Wiley- Blackwell. www.wiley.com/go/construction. ISBN 978-0-470-65753-9 and is available to purchase on line at: www.amazon.co.uk.

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