Natural Hydraulic Lime
UNILIT

Telling

Contents

Natural Hydraulic Lime - An Explanation

Natural hydraulic lime is produced by burning impure limestone containing clay minerals such as silica, iron and aluminium, at relatively low temperatures, 800 – 900oC compared to 1450oC for Portland cement. The lime is then slaked, sprayed or immersed in water, to produce a mixture of Dicalcium Silicate and Calcium Hydroxide and other compounds, which when mixed with sand and water are used to produce a lime mortar. A Natural Hydraulic Lime mortar therefore contains no cementitious compounds due to the low burning temperature.
The majority of limestone in the UK and the primitive way that it was historically manufactured, produced limes of varying hydraulicity providing sets ranging from feeble to eminent. These allowed the craftsmen to produce mortars that were more suited to withstand inclement/harsh weather conditions with a reduced risk of failure. They also induced a faster hydraulic set when required by added reactive materials such as pozzolan, trass, brick dust, etc., a method dating back to Roman times.

Developments in cement technology for volume construction in the 19th and early 20th century, together with the perceived advantage of increased mechanical strength, served to eliminate the need for the traditional skills of craftsman to create a lime mortar. This has led to a distortion of the concept of mortar to such an extent that today a 'traditional mortar' is defined as a blend of cement/sand/lime whereas it is little more that a modern process adopted to satisfy the demands of mass building. From the beginning of this century until the mid 1970's the benefits of lime in conservation works were widely ignored with the result that many ancient structures were damaged by the application of incompatible mortars of cement and epoxy.

The advantages of lime for conservation projects is becoming more widely acknowledged, but due to its 50 - 60 year absence from UK production for construction use, for many the knowledge regarding performance of Natural Hydraulic Lime is not fully appreciated. Many people considered Hydraulic Lime as being dense, strong and cementious, their source of information generally referring to the later 18th and 19th century Roman Cements used throughout the UK. These claims are generally true of Roman Cements and some artificial or man made hydraulic limes due to the production methods used, where the clay content and burning temperature were increased. Unilit products however, are Natural Hydraulic Lime a mortar wholly distinct in its performance characteristics from cement and Roman Cement.

Unilit Natural Hydraulic Lime Mortars, Grouts and Finishes

Telling are credited with the re-introduction of hydraulic lime to the UK in the early 1990's and lead the field in quality, range and performance in the use of natural hydraulic lime. Our knowledge and experience is also without equal. Our laboratory facilities together with research programmes commissioned with UK and European Universities have enabled us to understand and replicate the chemical and physical performance characteristics of natural hydraulic lime and to convert this in to a leading market technology for conservation and new build projects. We guarantee our products against failure for 10 years and warrant against defect under a professional indemnity insurance.

Using a modern day manufacturing process, which emulates the processes undertaken historically, while ensuring quality control and consistency are maintained, Unilit is produced by the selection of a particular "impure" limestone which when burnt at a specific temperature, produces a lime binder with optimum porosity, an initial set, and slow air carbonation, these being the pre-requisites for a compatible and sympathetic restoration mortar. The Natural Hydraulic lime is then blended with selected aggregates to produce a range of mortars, which replicate the strength, porosity, adhesion and flexibility of historic mortars.

The strength of the mortar is controlled by the grading and sizing of sand and the lime: sand mix ratio and not by its hydraulicity i.e., NHL 2, 3.5 and 5, which indicates the compressive strength of the lime, without sand after 28 days, or feeble, moderate and eminent since these relate more to the timing of the initial chemical set and not as is commonly believed, mortar strength.

The importance of sand grading and binder ratio cannot be over stated in relation to porosity, workability, durability and strength in the production of lime mortars. These characteristics eradicate the risk of failure caused by the incompatibility of the sand, a common cause of shrinkage, de-bonding and cracking.

This is the complete opposite of modern day pure limes since these are the result of selective classification and burning of limestone. This leads to the production of 99.9% pure lime to which pozzolanic material must then be added, sometimes even hydraulic lime to create a set. Where cement is added to a pure lime, even a small proportion will result in a cementitious mortar being produced, and the loss of the desired lime mortar performance. Pure lime is a material intended for chemical and agricultural usage, which was beyond the production capabilities of medieval craftsmen.

Four of the most significant advantages of natural hydraulic lime over fat/putty lime are:

1. The early initial set, allows the contractor to make unimpeded progress throughout the year, especially during the winter months on the proviso that protection is provided for the first seventy two hours of curing, rather than for several weeks.

2. The quality of manufacture ensures that even as a result of exposure to high levels of moisture extraction in its early set the natural hydraulic lime will not suffer from the unsightly contamination of the face of the mortar by free lime deposits (leeching/lime bloom).

3. Natural hydraulic lime tolerates the transfer of damp and salts without deterioration even if this occurs during the very early days of carbonation.
4. It enables work to be completed quicker, saving time and money.

The perceived difficulty associated with working with lime has been removed by the introduction of Unilit Lime products. These have been developed for the restoration market by the introduction of a modern process to produce traditional restoration products that do not require specialist craftsmen's knowledge for successful application.

Unilit Natural Hydraulic Lime Mortars are highly vapour permeable, to allow the substrate to breathe and stabilise, they are slow in carbonation giving flexibility to tolerate natural movement in the background and variable in strength (by control of sand grading and mix proportion) to ensure compatibility with the background to which they are applied. In addition to traditional lime sand mortars, the Unilit range allows for the selection of natural hydraulic lime products, which maintain the fundamental performance of Natural Hydraulic Lime mortars, while enhancing certain properties such as adhesion, waterproofing or insulation and therefore provide unique solutions to a wide range of problems associated with the repair and restoration of old structures, and ensures the suitability and success of the repair.

Plastering and Rendering

Unilit hydraulic lime mortars are suitable for plastering and rendering internally and externally in both restoration and new building. Our range includes

- traditional lime sand mixes,
- bonding layers for unstable substrates,
- base preparatory coats for thick and thin coat applications,
- salts containment, stabilisation and waterproofing,
- lightweight, insulating and thermal block applications
- natural and pre-coloured finishing coats in a range of textures,
- fine filler and repair plasters

Flg. 1.

Flg. 2.

ABOVE: A comparison of the open structure of hydraulic lime and cement under high magnification, after 6 days. Fig. 1. clearly shows the formation of calcite in the cement which results in strength but low porosity. Fig. 2. indicates the open pore structure of lime.

Unilit allows successful application of lime plaster and render over all mineral substrates, and the range of bonding layers will ensure adhesion to substrates varying from dense concrete to friable masonry. Unilit is noted for its success in traditional lath and plaster applications and can be used with or without hair reinforcement. It is particularly successful where patch repair to old lime plaster is required, and will allow the application of a new finish to both the new and existing plaster. For areas below ground level, up to one metre above ground level and any other excessively damp or salt laden areas we recommend the use of Unilit 30 waterproofing and stabilising mortar which maintains the permeability, prevents water liquid passing through the plaster and ensures damp and salts control.

The majority of our mortars are pre-bagged to ensure the suitability of the mix for the specific substrate.

Condensation and Insulation

The open pore structure of lime mortars provides benefits over dense cementitious materials as they do not transmit heat or cold as readily. The flexibility of the mortar ensures that movement caused by thermal gain is significantly reduced. Expansion joints are not required.

The mortar Unilit 20 is a hydraulic lime blended with perlite to provide a natural insulation mortar that will eradicate problems caused by condensation or thermal shock. In improving the insulation value of the building, Unilit 20 regulates the moisture content in the structure, which can occur due to the introduction of heating into older structures. It is particularly suitable for buildings of architectural or historical importance where skill and care in the selection of the techniques for conservation is critical. Unilit 20 can be applied internally to achieve thermal improvement without adverse affect upon the performance or integrity of the original fabric The product is extremely lightweight (4Kg/cm/m2) making it ideal for application in thicknesses from 15-100mm onto weak substrates.

Insulated render recommendations vary greatly from those above for lime built traditional structures where permeability and vapour control are of paramount importance to those for modern day concrete and cement structures which are covered in the new construction section in the following pages.

Damp Eradication and Control of Hydroscopic Salts

Correct investigation to establish the cause of damp is essential with wall thickness, temperature, ventilation and heat transmission all impacting upon the movement of vapour, as well as the ability of the structure to perform as a dry element. Structural defects, impermeable sealers, decorative coatings and dense cementitious renders can all adversely affect the building performance.

The accumulation of excess moisture behind the weathering layers of a mortar, paint or decorative coating and the subsequent evaporation lead to the build up of hygroscopic salts deposits. These cause degradation of decoration and deterioration of the building fabric. To seek a cure by mechanical extraction or synthetic overcoating is to neglect to tackle the cause of initial dampness. Natural hydraulic lime provides a vital link between the needs of a modern day specifier and those of a conservator. It does not deteriorate due to the presence of humidity or moisture in the substrate in fact its performance is enhanced by these to promote the initial set. Due to careful slaking during production Unilit does not suffer from the leeching of free lime caused by early exposure to excess moisture. The product Unilit 30 can be utilised in salts containment applications such as in cellars and against rising damp as well as for the protection of highly exposed surfaces at roof level such as chimneys. The unique formulation of this product ensures optimum stabilisation along with salts control.

Stabilisation and Consolidation Grouts

Unilit Natural Hydraulic lime is ideally formulated for the maintenance of the fabric of the historic infrastructure of the UK's transport system. Consolidation of existing structures is increasingly called for in preserving tunnels, canal locks and bridges. It is also increasingly called for where the fabric of a building has been undermined by flooding. Several European testing authorities have been undertaking studies to increase awareness in this diverse field. Using consolidation to stabilise or rejuvenate weakened structures must take account of the physical and mechanical properties of the original construction. Ease of application and compatible materials of comparable strength are found in the Unilit B Fluid X range of grouts and mortars. Injection grouts enable the equilibrium of the physical properties to be retained without detrimental effect upon the structural components. The success of injection lies in the ability to stabilise the mass without risk of causing structural stress or cracking which can occur by using mediums that are stronger than the elements they are bonding. The characteristics of vapour permeability, mechanical resistance, excellent flow and low salts content of Unilit lime grouts ensure the repairs will maintain the fundamental performance of the structure.

Grades from 0 up top 4mm are supplied in pre-bagged grouts and pointing mortars. UK blended lime mortars, with limestone aggregates are also available. Pressure pointing and grouting has been tested and been most successful with gravity flow also an option.

Brick Mesh

Mesh reinforcement is an option for deteriorated backgrounds. Telling supply 'Brick Mesh', as stainless steel wire coated with nodules of clay to ensure fusion of lime to the natural mineral. Substrates that are cracked or suffering from high levels of movement are suitable for 'Brick Lathe' applications as well as timber backgrounds or as an application over insulation slabs. Moulding or pre-shaping the mesh to match existing profiles before running the plaster to form cornices, bands etc., is a cost effective method of use.

Flooring

It is a commonly held belief that concrete and wearing screeds can only be created with cementitious materials. This is not the case as the selection of binder, aggregate grading and mix ratio enable the creation of 'lime concrete, Unilit floor screeds, stone, tile and flags bedding and pointing and in conjunction with insulation and under floor heating systems.

Natural hydraulic lime allows the application of slabs and floor screeds in large areas without the requirement for expansion or slip joints. These prevent differential movement between the floor screed and the walls of lime built buildings. Application without a DPM will allow the floor to "breathe" with moisture from beneath the screed is evacuated as a vapour preventing the build up of a hydrostatic pressure within the floor with the subsequent diversion of salt laden water into the walls. Where stone, paving or tiles laid over the screed the use of a Unilit bedding mortar will ensure the performance of the screed is maintained and the compatibility of the mortar with the stone.

The application of a hydraulic lime screeds compliments the application of Unilit 30 waterproofing and stabilising plaster to basement walls and up to 1 meter above ground level.

Unilit screeds can be applied over insulation boards and in conjunction with underfloor heating. The enhanced stability, open pore structure and extremely low coefficient of thermal expansion of hydraulic lime mortars prevents the build up of moisture within the floor, removes the risk of thermal movement, and produces an improved storage of heat within the floor when compared to cementitious screeds.

Flooding – Resilience and Repair

There is little solace for the thousands of property owners whose homes or business were devastated by the widescale flooding in the mid summer of 2007. Whether caused by freak conditions relating to climate change, lack of investment in flood prevention measures or antiquated drainage systems ill equipped to handle the scale of homes built, is of scant relevance.

There is a study programme to meet the challenge for resistance and resilience of buildings headed by a CIRIA consortium and advised by steering and advisory groups of funders and other stakeholders. Its aim is to determine how the implications of flooding may be mitigated by best practice in material selection and construction techniques and that by laboratory and field testing their findings should influence building regulations.

Amongst the many practical and innovative inventions that are available to achieve this goal, one contributory solution identified by the programme is hydraulic lime. Before the technology for kilns was available to fire limestone/clay to temperatures >1450°C to create modern day cement, lime was the binder relied upon in the construction of our heritage.

For property owners and for the institutions responsible for aiding them in their recovery from the effects of the flooding, hydraulic lime represents a repair and a cure. Hydraulic lime mortars will assist in stabilising a saturated existing structure. They will allow the moisture to escape as a vapour over the years that it will take for its extraction from solid masonry walls. Formulated self flowing grouts for rubble walls undermined by flowing water and salt resistant mortars can ensure that water will not enter the walls again. If flooding should re-occur the mortars will not deteriorate and will dry out without detrimental effect other than to decoration. A far more tolerable effect than structural remediation.

Unilit natural hydraulic lime has been successfully used in the remedial process and benefit has been gained by the increased awareness of a natural process for repair that will offer resilience should events repeat and offer best economical value.

For modern modern methods of construction a combination of Foamglas™ recycled cellular glass insulation and hydraulic lime have been tested at the Taylor Woodrow Laboratories as an insulated cladding developed under a collaborative agreement with Pittsburgh Corning (PC UK) to provide a render system with unique characteristics.

Sustainability of source, maximised use of recycled materials, resilience to flooding, non combustibility, strength, water resistance, durability and ease of installation in an on or off-site condition are priorities applied to these tests.

In addition to gaining CWCT certification the system was subjected to a unique evaluation to establish the resilience of the system to flooding when applied upon a panel of lightweight steel walling immersed under a one metre head of water for a 72 hour period.

The re-emergence of natural hydraulic lime as a traditional mortar capable of meeting the challenges of new construction is gaining strength.

Natural Hydraulic Lime in New Construction

There is an increasing interest from specifiers in the reintroduction of lime as a mortar for new construction projects. For masonry, particularly where porous stone or brick is selected, the lime is a suitable material whether working in thick joints or thin. The extraction of any moisture that penetrates into the façade is assured as soon as it comes into contact with the mortar joint ensuring that damage from salts and staining cannot occur. Fine stonework and brick suffer no contamination, staining or bleaching from Unilit Natural Hydraulic Lime mortar.

Natural Hydraulic lime is particularly suited to building without expansion and movement joints which are prevalent in modern day construction. Leading research has been undertaken in to the performance of hydraulic lime mortars in compression and axial loading. The open pore structure of the mortar promotes the ability of each individual unit of the masonry to move as an independent element, rather than as a mass as occurs with cement and concrete. This tolerance of movement allows construction without unsightly movement joints to mirror the style and continuity of our historic buildings.

Harmful CO2 emissions acknowledged as being a major cause of the greenhouse effect occur during the production of both cement and lime. However with lime burnt at temperatures of circa 900°C and cement exceeding >1450°C, more energy is required for the production of cement. Additionally, a study of the lime cycle indicates that an equal amount of CO2 is retained during the carbonation/setting process as is released by the limestone during burning. As a consequence lime mortar is by far the more ecologically preferable product.

Base mortars are supplied pre-bagged, in hydrate form for site mixing or in a pre-blend manufactured in the UK with limestone sand of an appropriate grade. Natural earth ochre mortars are pre-mixed to produce coloured finishes that weather and performs similarly to natural stone. The assured bond of lime to lime enables thickness to be built up without risk of delamination between the layers. Feature rendering in ashlar, cornices and raised bands is particularly suited to Unilit. The low salt content and control of free lime in the mortars ensures the façade is resistant to lime bloom.

Masons and bricklayers view natural hydraulic lime favourably due to the excellent workability achieved without the addition of synthetic plasticisers, together with its ease of application and mixing.

Insulated Render - 'Together We Are Stronger'

Telling Lime Products have entered in to a collaborative agreement with Pittsburgh Corning (PC UK) to develop an insulated render system that has remarkable performance characteristics that surpass those of the currently available systems.

Sustainability

- The FOAMGLAS® insulant is a dense cellular glass slab, manufactured from 66% recycled glass.
- The render systems are manufactured from natural hydraulic lime produced from naturally occurring limestone
- Colours are derived from natural earth ochres created from iron oxides and mineral pigments.

Stability

- FOAMGLAS® can be demonstrated to have a life expectancy of 50 years with surety that the thermal value of the slab will not diminish over time. The material is inert and unaffected by moisture.

Fire

- FOAMGLAS® is classified as non combustible to Euro Class A1 – no contribution to fire, as are the mineral hydraulic lime renders.

Impact Resistance

When rendered with the natural hydraulic lime and bonded to a stable substrate the FOAMGLAS® will provide the characteristics of a thermal masonry unit in terms of impact resistance and sound resonance.

FOAMGLAS® has a global warming potential of less than 5.

Appearance

Unilit Natural hydraulic lime enables the render to be applied to create traditional Stucco/ without synthetic textured effect or colouring. Traditional render features of ashlar grooves and struck joints can be formed.

Lime Paints and Finishes

A comprehensive range of lime finishes and paints are available in a range of textures and colours to maintain the compatibility and porosity of the background. These comprise the Corical Range along with Venetian polished plasters, simulated marble coatings, fine, medium and coarse granular aggregate finishes, and roughcast renders.
Compatibility throughout the decoration and plaster systems ensures many years of resistance to deterioration due to flaking, cracking or peeling. The products are suitable for internal and external use.

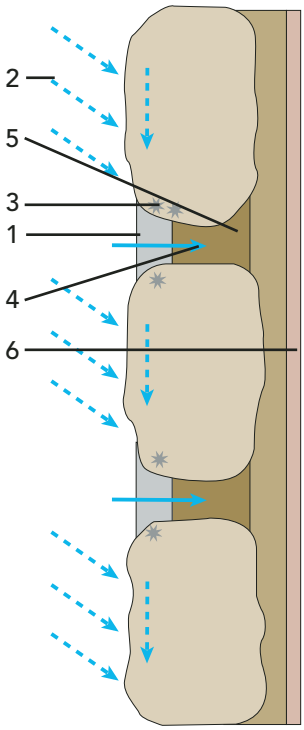
Façade Refurbishment

Old structures rendered with Roman Cement and lime mortars need not necessarily be hacked back to the substrate. The range of bonding mediums available in the Unilit range ensure perfect adhesion and compatibility as a competitive option for façade upgrading. Unilit 10 and Unilit 15 (P1 and P2) in the product guide refer.

Pointing Mortars

The importance of the binding material and its function in the joint of masonry is often overlooked. The bedding joint is the means by which the structure stands up (in all but dry stone walling) but in lime built structures it is also the conduit, which allows the structure to breathe and allow vapours that occur inside the building to migrate outwards. It is also the drainage mechanism that allows any wind driven rain to penetrates in to the external fabric via fissures in the stone or brick. A hydraulic lime mortar in a pointing joint will naturally draw any moisture from the less porous stone and brick and extract it in to the atmosphere to dissipate as a vapour. A cement or synthetic pointing mortar that is less permeable than the masonry will cause moisture to build up at the joint as outlined in the diagrams below.

Unilit Natural Hydraulic Limes contain no resins or synthetic additives that can cause staining to the stone that it is in contact with, it will always remain softer than the medium whose joint it is protecting and allow each element to naturally move without debonding. If cracking of the substrate does occur as a result of building stresses or movement, there is less concern than with synthetic materials as any moisture that penetrates will eventually be extracted by the lime mortars in the surrounding sound areas.

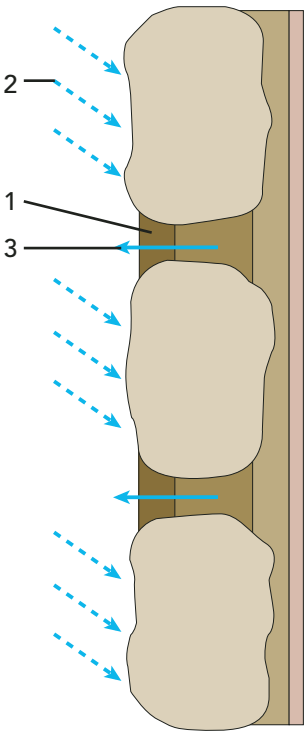


Flg. 1.

Fig. 1 - Cement Pointing - Porous Stonework

1. Cementitious pointing medium in joints of porous stone.
2. Arrows indicate external rainfall and passage of moisture into and down through fissures in the stone toward the pointing joint.
3. Indicates build up of moisture and crystallisation of salts at the position where moisture penetrates to the cement joint.
4. Arrow indicates direction of moisture toward lime masonry bedding joint.
5. Due to entrapment by cement. This will lead to salts and dampness on the internal plaster face (6).

Eventual detachment of cement joint due to weakening of the stone by salts. Damage is likely as cement breaks away due to the freeze/thaw action taking segments of existing stone with it, particularly if the cement matter was originally harder than the stone.



Flg. 2.

Fig. 2 - Hydraulic Lime Pointing - Porous Stonework

1. Hydraulic Lime Mortar joint.
2. Arrows as previous.
3. Arrows indicated movement of vapour into and out of the hydraulic lime joint ensuring stabilisation, drying out and no salts to build up. Saturation of existing lime joint does not occur. Hydraulic lime never becomes harder than the stone. Mineral bond between the hydraulic lime and the stone and the hydraulic lime and original masonry bed is assured.

Unilit Reference	10	15 P2	15 P1 *4	20	25	30	35	35M	40	45	65F Fine
Plaster/Render											
Internal	●	●	●	●	●	●	●	●		●	●
External	●	●	●	●	●	●	●	●	●		●
Bonding Layer	●	●	●								
Base Coat				●	●	●	●	●			
Internal Finish			●							●	●
External Finish		●	●			●			●		●
Damp Eradication						●					
Waterproofing		●	●			●					
Insulation				●							
Flooring											
Lime Concrete											
Screeds	●	●	●			●	●	●			
Underfloor Heating							●	●			
Wearing Screed Finish		●	●								●
Bedding Slabs/Tiles		●	●			●	●	●			●
Pointing		●	●				●	●	●		●
Waterproofing						●					
Insulation											
Plaster/Render				●							
Foamglas System		●									
Injection Grouts											
0-4mm											
Mortars											
Masonry							●	●		●	
Pointing						●	●	●	●	●	●
Natural Finishes						●	●	●	●	●	●
Stabilisation						●	●	●			
Adhesive		●	●								●
Rising Damp						●					
Salts Containment						●					
Stone Repair		●	●								●
Decorative Coatings											
Pre Coloured Plaster											●
Polished Finishes											
Paint Stripper											
Primer for Paint			●								
Paints											
Slurry Coat			●								●

65M Medium	65N Coarse	400 Fine	300 Medium	200 Coarse	13/20	FEN X Preblend *3	FEN XA *1	FEN XC *2	B Fluid Grouts	Coridecor Marble Finishes	Coridecor Sealer	Corical Paint	Corisilk Paint
●	●	●	●	●		●	●	●		●	●	●	●
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*1 Site blend with selected sand - NHL-5

*2 Site blend with selected sand - NHL-2 & NHL-3.5

*3 Standard 0-4mm or fine 0-2mm

*4 Bonding layer for finishes

(POCKET)

Previous Clients

Restoration Projects

Dover Castle, Dover, Kent
Osborne House, Isle of Wight
Bath Spa, Bath
Map-a-Mundi, Hereford Cathedral
Noah's Ark, London
Bishops Palace, Lincoln
St. Nicholas Church, Plymouth
Silchester Roman Church, Hampshire
Chichester Cathedral
St Paul's Cathedral
Houses Of Parliament, London
Somerset House, London
Royal Courts Of Justice, London
Buckingham Palace, London
Alexandra Palace, London
Wandsworth Prison, London
Victoria & Albert Museum, London
St. Pancras Station, London
Kings Cross Station, London
Garrick Club, London
St Georges Church, Bloomsbury
Waddesdon Manor, Bucks
Stowe Gardens
Nymans House, Crawley
Fort George, Inverness
Downpatrick Courthouse
Dublin City Hall
Hadrian's Wall
Middleton Hall, Royal Botanical Gardens Wales
Aberystwyth Arts Centre
Ville au Veslet, Jersey
St Barnabus Archive Centre, Guernsey

New Build Projects

Magdalen College, Oxford
New Bond Street, London
Charing Cross Police Station
Preacher's Court, London
Old Palace School, Croydon
Wyvern Sixth Form College Weston Super Mare
Urquhart Castle, Inverness
Loch Lomond Visitor Centre
Windsor Castle Visitor Centre
Lower Leas Coastal Park, Folkestone
Royal Hospital, Chelsea

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