Our ref: 2931-d1-240325-Letter Report

25 March 2024
by email ( )

Mr Charlie Brinton
Afriprop Limited
Millhouse
32-38 East Street
Rochford
Essex
SS4 1DB

Dear Mr Brinton,

Stone Ashlar at Bevisfield, Cow Drove, Chilmark, SP3 5AJ: the "Property"

Independent Building Investigation Services Limited (IBIS) has prepared this expert letter report in accordance with instructions received from Mr Charlie Wolseley Brinton of Afriprop Limited ("the Client"), by email dated 07 March 2024, with acceptance of IBIS's estimate of costs via email on 08 March 2024.

I will summarise my understanding of the background to the matter in hand as explained by the Client:

- A construction is being undertaken by the Client for which "Chicksgrove" Stone was described on the "Discharge of Conditions" for the Property as being used for the external rubble walling.

- During construction there was a supply issue, an incorrect stone being supplied, and there was no solution involving the Chicksgrove Stone that would allow the programme to progress in a timely fashion.

- The Client identified that the Chicksgrove Stone had been used in the construction of Salisbury Cathedral and that Clipsham Stone had been accepted as a suitable alternative. After enquiries it was found that Clipsham Stone could be secured more rapidly for the building project to proceed.

The Client believes they undertook reasonable actions to secure suitable replacement materials under the prevailing circumstances. However, they wished to obtain an expert opinion on the matter and approached IBIS for comment on the situation.

The Property is neither located within a conservation area nor close to any listed buildings. The residential properties within Cow Drove are finished in a variety of materials including local stone, render and various reconstituted stones of differing colours. There is no over-riding aesthetic to the external facing materials in this part of the village.

A number of photographs of the Property at various stages of construction, with some of these showing the stone masonry were also provided.

IBIS is fortunate to have an extensive reference collection of natural stone materials including what are known as thin-sections, which are specially prepared ultra-thin slices of rock prepared for viewing with a microscope using a variety of optical techniques that allow a geologist to identify minerals, textures, structures and a variety of other details. It has these for both Chicksgrove and Clipsham Stones, and later uses them to highlight some of the structures and textures, and with them the performance of the stones.

IBIS is also in possession of testing data for many natural stones, having tested many stones in the past but now leaving others to do this. Again, test data for both the Chicksgrove and Clipsham Stones is available and discussed.

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quarry evaluation
condition surveys
roped access
testing including NDT
heritage consultancy
façade investigation
fire & blast damage
petrography
specification advice
endoscopy
XRD and SEM microscopy

Materials
building stone
roofing slate
mortar & concrete
screed, plaster & render
lime & hydraulic lime
cement & pozzolana
high alumina cement
rock & minerals
aggregate & soil
glass & refractories
composites
brick & ceramic terracotta & faience

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Figure 1
Three views of the Chicksgrove Stone in use. The stone can range from near white to grey in colour with creamy or buff tones. Above and to the right are rubble stone uses. Below is a form of ashlar that highlights some of the lightest shades of the stone.
There is a near white grade that may be used instead of the special form of chalk known as "Clunch".

Figure 1 has been provided to demonstrate quite typical appearance of the Chicksgrove Stone originally intended to have been used at the Property. This is very typical appearance of so many Jurassic Period limestones used for rubble stone and ashlar masonry. Whilst IBIS has not researched the full history of the stone it is presumed that it did not become popular due to factors such as low height beds an inconsistency. This may be why only mostly relatively small blocks are produced, making it a reasonable substitute for stones such as Sussex Ragstone.

Before moving on, please note that all photographs of buildings are provided without reference colour correction. They are all taken under unknown lighting conditions in relation to sun intensity, cloud, albedo and other factors. The main thing is that there are clearly variations in the colour of these and all natural stones that must be taken into account.

Overleaf *Figure 2* provides photographs showing the Clipsham Stone, with a couple of these provided by the Client. It is a very similar general picture of a material that has a range in colour from light cream and buff through to grey.



Figure 2
Four views of the Clipsham Stone in use two of them taken from the Property (top-right and bottom-left).
The stone can range from near white to grey in colour with creamy or buff tones.

Across the UK following the band of Jurassic Period rocks, which are dominated by limestones, and more specifically a type of limestone known as Oolitic limestone, the vernacular buildings are found to be, not unsurprisingly, very similar in appearance. The main band of these materials runs from Portland in Dorset, heading very roughly north-eastwards up towards Lincolnshire. We also find that the properties of the many stones extracted for building purposes are mostly very similar, with some weaker, some stronger, but the greater majority of a relatively mediocre quality that is ideal for rubble and ashlar masonry uses.

Table 1 overleaf has been provided as a brief summary of the test results obtained for both the Chicksgrove and Clipsham Stones. The first thing to note about the data for both stones is that it is now very old, but more recent data has not been identified. This is not uncommon for the building stone supply industry although ideally a range of values needs to be declared in order to comply with various British and European Standards. What we do see from the results is that the Chicksgrove has slightly higher strength and slightly lower absorption and porosity, nothing that substantial within the scheme of things. It might be argued that the Chicksgrove Stone is the better material on the basis of engineering properties but natural stone materials do not behave so obviously. This is why petrographic studies are carried out in order to better understand how a stone is put together and likely to perform.

Table 2: Summary of Available Test Results for the Chicksgrove and Clipsham Stones

Stone Property	Chicksgrove	Clipsham
Apparent Density, kg/m^3	2390	2280
Water absorption, % by mass	2.7	6.3
Open Porosity, % by volume	11.3	16.0
Compressive Strength, MPa	96	87 (75)
Flexural Strength, MPa	10.0	4.9 (3.3)
WA by Capillarity, g.m^2.s$^{-0.5}$	11.6	36.0
Design TC, kgm^{-3}	No data	1.8
Year of Test Results	2014	2013

Note: values in parentheses are "lower expected values" for the strength tests.

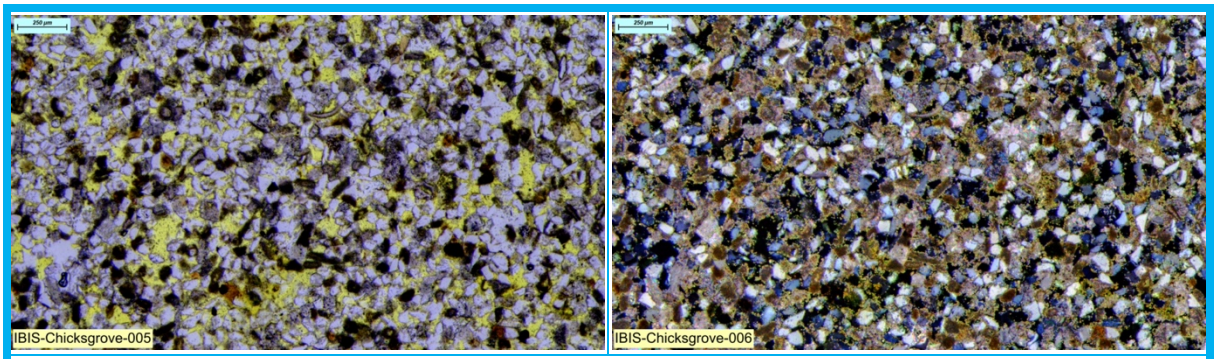

Figure 3a
Above are two microscopic views of the Chicksgrove Stone, the left in plane-polarised and the right in cross-polarised light. The left side shows impregnating yellow resin that demonstrates considerable porosity, which is contrary to the indications of the test results obtained. The grains are a mixture of calcite clasts and quartz.
This might be considered to be a detrital limestone, which is contrary to the more shelly limestone that may occur.

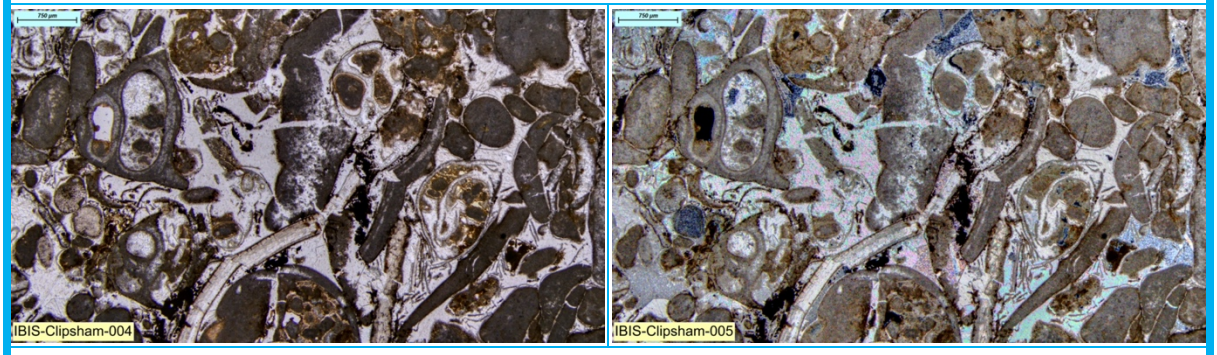

Figure 3b
Above are two microscopic views of the Clipsham Stone, the left in plane-polarised and the right in cross-polarised light. The stone does not exhibit any obvious porosity due to the sparry calcite matrix that is present. There are ooliths, oyster-type shell fragments and other grain types visible, very typical of a Jurassic limestone.
This might be considered to be a type of 'oobiosparite.

Figure 3 above has been provided to demonstrate the microstructure of the two stones. There are very obvious differences in grain size, types and quantities, but both stones are forms of limestone and both exhibit considerable variation. The petrographic findings suggest that the Chicksgrove Stone might be the more susceptible to frost damage due to the very open porous texture of the stone. However, there are always many factors driving stone performance *in situ* within a given design and climate. Ultimately, there is nothing to suggest that either stone is likely to be particularly susceptible to frost damage, salt

attack and other issues unless used incorrectly. Limestones are notoriously poor performers when excess water is allowed to remain within for prolonged periods.

It must be said that the thin-section of the Chicksgrove Stone provides information that is quite contrary to some of the statements of the stone's properties. There is a description of oyster fossils in beds, which is very similar to Portland Stone, and some features grading into materials more like the fossiliferous Purbeck Beds. Suffice to say the main conclusion here is that stone is an intrinsically variable material and sedimentary rocks such as limestones are especially so.

It is iterated that the use of Clipsham Stone as a replacement for Chicksgrove Stone is very telling. The Clipsham Stone was actually employed within the topmost 9 courses of the main spire, which might be argued to be the most exposed location. Clipsham Stone has been used as a replacement material for many other Jurassic limestones where significant decay has been experienced.

Summary of Findings

Clipsham Stone has been used instead of Chicksgrove Stone for rubble masonry walling at the Property. In consideration of both stones' properties, it is very unlikely that there will be any marked difference in performance between the stones.

The aesthetics of stone are always open to considerable interpretation but the main conclusion should be that both stones are extremely similar in appearance in consideration of the type of finish that has been achieved. The two stones are expected to weather in a similar manner.

The greatest differences identified appeared to be microscopical, and favouring the Clipsham Stone, however, these differences were not enough to be concerned. The Clipsham Stone is a very good substitute for the Chicksgrove Stone, which has been borne out by acceptance in conservation practice and observed performance.

Remarks

The observations and comments provided must be regarded as very general given the limitations of the brief. However, it is hoped that the investigation findings provide a sufficiently accurate and usable picture of the conditions presented.

A copy of the career summary of Mr Hunt, Author of this letter report, has been provided in **Annex 1**. In brief summary, Mr Hunt is Chartered as both a Geologist and Surveyor, with over 35 years' experience in the investigation of construction problems, specialising in materials properties. Mr Hunt is a member of the Stone Federation of Great Britain's Technical Committee and has been involved in the production of British and European Standards dealing with natural stone and related materials.

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If you require any further assistance with this or any other matter please do not hesitate to contact IBIS.

Barry J Hunt
BSc MSc MASI MCIOB CGeol EurGeol FGS CSci MRICS FRMS
Director, IBIS Limited

Encl. Annex 1, Career Summary of Barry J Hunt, 11 pages.

Career Summary of Barry J Hunt

BSc MSc MASI MCIOB CGeol EurGeol FGS CSci MRICS FRMS

Including Selected Summaries of Experience and List of Publications

Career Summary

Barry Hunt is chartered as a geologist, surveyor and scientist. He has been awarded the designation of European Geologist and is a Corporate Building, Conservation and Specialist Surveyor. Barry is also a Member of the Chartered Institute of Building and a Fellow of the Royal Microscopical Society.

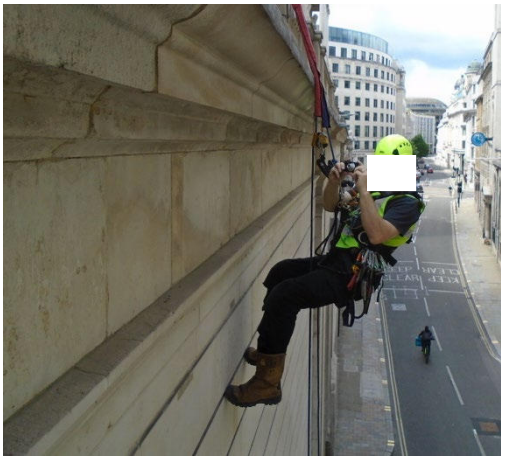
Barry gained 14 years experience working as a consultant for two renowned materials consultancies. During six years with Sandberg, he was responsible for the resolution of a wide range of construction related problems involving site inspection and testing, and laboratory based investigation. During his time at Sandberg, Barry obtained a Masters Degree in construction materials science, sometimes referred to as 'geomaterials'.

When Barry joined STATS in 1994 the company was undertaking limited materials consultancy, much of this being concrete petrography. By marketing services within the fields of expertise developed whilst with Sandberg, Barry helped to build STATS' capabilities in the geomaterials field. He developed a successful materials consultancy service and achieved the position of Associate Director.

In 2001 Barry formed his own company, IBIS, specialising in the investigation of all construction materials. The specialist knowledge obtained and services provided by Barry have allowed him to be instrumental in the resolution of problems ranging from blast damaged claddings in London's West End to advice on the quarrying and extraction of stone from abroad for import to the UK. Other areas of experience include the investigation of all types of building elements and finishes, specialist advice on remedial treatments and the preparation of advice for actual and potential use in litigation or arbitration. Barry has published many papers and articles concerning some of the findings of his numerous investigations.

Having worked for consultancies that both undertook in-house laboratory investigation to UKAS requirements, Barry is also able to conduct or oversee a wide range of on-site and laboratory techniques and ensure that they are carried out to traceable standards. One speciality in all investigations is the hands-on approach adopted. Being trained in industrial roped access (abseiling) allows him to get close to the problems with external building envelopes quickly, efficiently and cost-effectively.

Barry has developed the petrographic capabilities at IBIS and uses three microscopes to assist with materials investigation: Leica DMRXP & MZ16, and Nikon LV100POL. He also has the full PETROG point counting system and employs a Niton GOLDD XRF analyser for elemental analysis. Barry is one of the very few geomaterials experts who routinely undertake their own petrography.



Barry surveying the Bank of England in July 2020

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Materials

building stone
roofing slate
mortar & concrete
screed, plaster & render
lime & hydraulic lime
cement & pozzolana
high alumina cement
rock & minerals
aggregate & soil
glass & refractories
composites
brick & ceramic
terracotta & faience

Selected Experience with Commercial/Public Stone Masonry

Exhibition Road, London	Retained as a consultant to Project Centre to provide advice on all matters related to the selection, quality control and installation of natural stone setts and pavers for a large innovative streetscaping scheme. The shared use scheme, is one of the largest and most prominent of its type in the world.
Hindu Mandir London	Training of client operatives to undertake quality assurance selection of stone at a quarry in Vrabeshnitsa, Bulgaria, for a building designed to last more than 1000 years. The main selection criteria were based on visual characteristics. The Mandir construction has been acclaimed world-wide.
Nostell Priory, Yorkshire	Investigation of stable block to large Georgian manor house and the effects of coal mining subsidence on the stone masonry. Later provision of expert witness services and attendance at arbitration. Considerable disaggregation of the façades had occurred as a consequence of ground movements.
Bank of England	Survey of external stone façades to provide advice on safety to the public in addition to developing a medium to long term maintenance strategy.
Cornmarket Street, Oxford	Expert witness services including representation at Mediation provided for the lead Architect following the failure of a streetscape scheme. Elements of the design, workmanship and site supervision were considered to be at fault. The use of a gun-applied grout into wide joints formed between cropped edges was considered to be the major problem.
National Gallery, London	Assessment of a large statue suspected of movement and thus posing a threat to public safety. The statue and surrounding stone masonry were visually surveyed assisted by roped access and inclinometers were installed to allow monitoring of possible movement.
Den Haag, Holland	Investigation of movement and cracking affecting 16,000m^2 of paving in the centre of Den Haag. Advice provided on the causes along with possible remedial actions. The bedding was considered to have been badly formed whilst there was insufficient restraint to counteract the thermal expansion and contraction effects.
Buckingham Palace, London	Investigation of Nero Marquina limestone panels used for large skirtings in a re-fit of the Queen's Galleries that had suffered various degrees of cracking. Problems identified as moisture sensitive clay minerals within stylolite features.
Bluewater, Dartford, Kent	Assistance with flooring specification and assessment of 11 stones used in the project. The effects on pedestrian slip properties by different floor treatments was investigated, including setting up quality control in the factory in Germany.
Upper Ground Street, London	Investigation of failure of stone setts and pavers whilst construction was on-going. Advice on methods to reduce potential for failure provided in addition to suggested alterations to the design.
High Street, Truro	Investigation of granite sett failure where bedding materials had not been properly hydrated leading to their under-compaction, low strength and ultimate collapse.
New Parliamentary Building, Edinburgh	Investigation of stone to be used for both paving and cladding in and around the building. Visits to quarries and extensive examination and testing regime carried out to ensure and control the quality.
Chiswick Park, London	Investigation of damage occurring to internal atrium flooring of a large office building identified to be from excessive flexure of the floor that had been constructed on top of a pedestal system.
Martineau Square, Birmingham	Investigation of marble cladding warping, one of the few incidences of this phenomenon world-wide. Mostly visual surveying was conducted via roped access and also the measurement of over 5000 panels for degree of flatness. Dye penetration testing carried out on site to assess the presence and nature of cracks induced by the warping.
Broadgate, London	Investigation of bomb blast damaged stone cladding systems as part of a multi-million pound insurance claim. A major part of the months of investigation involved dye testing techniques which were developed for the project. Findings had major consequences concerning the quality of cladding construction.
Green Park, Reading	Investigation of internal flooring that had cracked excessively. Long term monitoring of crack propagation determined that problems related to initial drying shrinkage and underfloor heating system. This also allowed less expensive replacement options to be taken without risk of the effects recurring.
Houses of Parliament, London	Slip resistance testing of road and pedestrian areas for health and safety purposes and advice on specification of new sett materials. Assessment of existing stone paved areas also undertaken following a number of incidents where members had suffered falls.
Hanover Street, London	Investigation of imported glass floor tiling that had stained and was beginning to come loose. The tiles had been etched by cleaning fluids, allowing them to hold dirt. The cleaning water had also attacked the adhesive, which then released salts leading to widespread debonding.

Selected Experience with Stone Sourcing, Selection and Processing

Vratza limestone, Bulgaria – Hindu Mandir, London	Training of client operatives to undertake quality assurance selection of stone at a quarry in Vrabeshnitsa, Bulgaria, for a building designed to last more than 1000 years. The main selection criteria were based on visual characteristics. The Mandir construction has been acclaimed world-wide.
Portland stone – British Museum, London	Expert witness services provided on behalf of the Evening Standard in their defence of a libel action brought by Sir Norman Foster and Foster and Partners regarding the use of the wrong stone for the South Portico of the Great Court. Visits to the quarries and processing works to determine how the wrong stone was used.
Rhon Dolomit, Germany – Bluewater, Dartford, Kent	Assistance with flooring specification and assessment of 11 stones used in the project. The effects on slip properties by floor treatments was investigated, including setting up quality control in the factory in Germany. Slip testing of stone also undertaken in Germany to demonstrate long term slip resistance of some of the stones to be used.
Ancaster limestone – St Pancras, London	Assessment of Ancaster Hard White limestone used in the original construction of St Pancras station and then inspection of quarries currently producing the same stone to determine the level of matching following a dispute. The quality of the stone and gauged brick masonry mock-ups and initial construction work were also assessed.
Ruschita marble, Romania	Investigation of Ruschita marble quarry which had suffered a dramatic decrease in the volume of finished material from 50% down to less than 5% following modernisation of plant. Problems identified to be caused by stress fracturing affecting the larger blocks being cut. New quarrying practices were advised that significantly increased production levels.
Tunisian limestones, various – for use in the UK	Several visits over a number of years for different clients to seven different quarries producing marbles, limestones and sandstones for export to Europe. Advice provided to both the Tunisian quarries and potential buyers on problems with recovery and ways to minimise costs in production and reduce waste. Selection of over 1000 tonnes of block also carried out for one client.
Achscrabster Caithness stone	Inspection of quarry on two occasions for different reasons. The first to determine the quality of stone to allow its use for paving around the New Parliamentary Building in Edinburgh. The second visit was to assess the waste materials and whether they were liable for the aggregate tax, which had been newly introduced at that time; the material was considered to be exempt given that it could be classified as a type of shale/mudstone.
Vermont slate, USA – Berkeley Square, London	Inspection of Unfading Green and Unfading Purple slate quarries in Vermont, USA, and including sampling and testing of slate both in the quarries and back in the UK. Inspection of processing works undertaken in addition to slate roof constructions in Vermont. Quality control regime set up and regular inspections undertaken.
Iran – various sites	Undertaking reconnaissance of potential Iranian roofing slate resources for a private client. This has included visits to over 30 sites covering 5,000 miles of highly variable terrain. Potential sites identified by reviewing over 400 geology maps and their memoirs following an initial visit to view some of the major geological units within Iran. Liaison and working with experts from Tehran University also undertaken. Work is still on-going.
Independent Whitbed Portland stone	Quarry inspections to determine the extent of a new bed of Portland stone with the aesthetic appeal of Whitbed but the properties of Basebed. Extensive sampling and laboratory investigation undertaken to determine and then compare the properties of the stone with existing materials and also to predict the potential long term durability.
Jura limestone, Germany – The Chimes, Uxbridge	Inspection and assessment of quarry and stone production facilities and then sampling and testing of stone prior to its use in a large shopping centre development. Setting up and testing large mock-ups in addition to an extensive laboratory programme to investigate staining and discoloration potential and durability characteristics.
Creeton limestone, Lincolnshire	Investigation of relatively undeveloped quarry producing aggregate and hoping to produce dimension stone. Extensive sampling and testing undertaken both in the quarry and laboratory with advice provided on the potential uses of the stone and problems within the quarry with continued supply.
Albion Stone, Portland, Dorset	Investigation and advice on the use of lime and pozzolanic additives in the treatment of Portland stone to increase aesthetic appeal and decrease potential weathering problems.
Ruther Quarry, Caithness – Aggregate Tax	Inspection of quarry to assess the waste materials and whether they were liable for the aggregate tax, which had been newly introduced at that time; the material was considered to be exempt given that it was considered to be mostly of shale and/or mudstone.

Selected Experience with Façade Surveys

Westminster Bridge, London	Investigation of bridge pier construction using borescope and radar techniques to identify the location of metal fascia panels passing into the stonework to allow a finite element analysis. The location and condition of stone fixings and also the stone condition were assessed.
Broadgate, London	Investigation of bomb blast damaged cladding systems as part of a multi-million pound insurance claim. A major part of the months of investigation involved dye testing techniques which were developed for the project. Findings had major consequences concerning the quality of cladding construction. Investigation of Statuario Venato Carrara marble quality issues for internal linings to a lobby areas. Later investigation of Statuario Venato and Bianco Carrara marbles subjected to fire.
Tolworth Tower, London	Inspection of tiled mosaic covering external concrete elements up to 23 storeys high that was suffering varying degrees of debonding and which had suffered a number of low level failures. Delaminated and cracked areas located and plotted showing how a lack of expansion joints was creating issues at higher levels, probably related to building creep over time.
Martineau Square, Birmingham	Investigation of marble cladding warping, one of the few incidences of this phenomenon world-wide. Mostly visual surveying was conducted via roped access and also the measurement of over 5000 panels for degree of flatness. Dye penetration testing carried out on site to assess the presence and nature of cracks induced by the warping.
South Quay Plaza, London	Damage assessments of bomb blast affected claddings. Both visual inspection and dye penetration testing was carried out to determine the presence of cracks and their likely origin. Work was carried out using roped access techniques after safety of cradle system was not able to be guaranteed.
Regent Street, London	Inspection and advice regarding the retention of a stone masonry façade suffering from 'Regent Street disease'. Bressumer beams had sagged causing excessive cracking and a repair strategy was recommended.
Victoria Palace Theatre, London	Inspection of faience façade on Grade II listed building following a fall of masonry on to a glass entrance canopy. Radar techniques were used to determine the location of fixings and metal superstructure. A remedial repair programme was recommended along with a prediction of the future safety of the facades. A survey of a Portland stone façade was also carried out.
Trinity House Lighthouse Service	Inspection of a number of lighthouses around the UK following de-manning and full automation, which had led to a number of unforeseen problems. Lack of heating and day to day maintenance had led to slats ingress problems and related accelerated decay issues. The proficiency of paint and other coating systems was reviewed.
Cavendish Square, London	Investigation of 1960s 23 storey office block clad by exceptionally large stone panels following an internal explosion that had shaken the building, causing considerable damage at lower levels. It was additionally identified that long term building creep and a lack of movement joints had led to panels being forced off their fixings leading to a regime of replacement and monitoring.
Nelson Gate, Southampton	Inspection of 1960s concrete tower suffering reinforcement corrosion resulting in large fins suffering detachment with a potential to fall. A number of fins were removed during the inspection to make the building temporarily safe.
Aquatical House, London	Condition inspection of brick masonry clad building in the heart of the City to provide a reference point prior to adjacent works beginning on the construction of several large skyscrapers. The building will be re-surveyed post construction to determine whether the adjacent construction disturbs the building.
International House, Tower Bridge, London	Inspection of several thousand metres of old mastic filling movement and window joints and categorising condition into ease of removal and replacement to allow potential contractors to price the works with greater precision. This followed abandonment of previous works when the contractor realised the mastic was in a considerably worse condition than anticipated.
Barts and the NHS, London	Full condition survey of nine storey former nursing home including concrete, brick and stone masonry, glazing systems and balcony railings. As a consequence of findings all railings were removed and a £1 million programme of remedial actions instigated. Works regularly overseen and checked.
Bristol City Council – Various tower blocks	Inspection of concrete condition and full sampling, including coring, undertaken using roped access, of several buildings to determine present condition and provide an insight for future maintenance. The effectiveness of previous maintenance procedures and protective systems applied was also assessed.
Irish Castles	Condition assessment of Monkstown, Waterford and Dufftown castles and also Waterford City walls with advice provided on local stones and types of mortar employed. This formed part of major restoration works undertaken to the various properties.

Selected Experience with Roofing Slate

Sydney, Australia	Investigation for the owner of a prestige property concerning the deterioration of Greaves Welsh slate. As a result of the ensuing litigation a new roof was obtained and a judgement given that pyrite must not be considered inert in slate.
Moortown, Leeds	Investigation of newly built slate roof to determine the quality of the roofing slate employed. The slate did not comply with Building Regulations and it was also determined that the roof had been badly constructed.
Cembrit Blunn, London	Testing of the full range of roofing slates offered by Cembrit Blunn to the new British and European Standard. Advice was provided on potential life expectancy of the slates along with prediction of possible problems. The work was used to help formulate a new table for roofing slate service life expectancy.
No. 1, The Aldwych, London	Inspection and testing of Grade I listed building during major refurbishment works and resulting in advice to replace the existing slate, which had reached the end of its useful life. The slate was identified to be Cornish; an unusual occurrence in London.
SIG Roofing, Cambridgeshire	Assessment of over 20 different slates comprising the major proportion of roofing slates marketed and sold by the UK's largest slate supplier. Guidance was provided on the likelihood of problems with the different slates, particularly those containing carbonate minerals with the potential for discoloration and lightening in service. As a consequence several of the slates being marketed were suspended from use pending more in-depth enquiries.
Mill Hill Quarry, Devon	Assessment of quarry for re-opening of slate vein not used for 100 years, to supply a major heritage project. Also the assessment of imported Argentinean slate for use as a cheap substitute to the locally produced slate.
The Tabernacle, London	Investigation of fibre-cement tiles and their possible re-use within part of a large refurbishment project. Tiles were considered to have altered to the shape of the roof and their brittleness made re-use unfeasible.
Eternit UK Ltd, Hertfordshire	Series of seminars undertaken to train all sales staff in the properties of and problems with slates for roofing. Training also carried out at Tegral (Eternit owned) in both Dublin and Belfast. The objective was to provide the sales team with knowledge to allow them to answer technical questions from architects and other interested parties, thus gaining a significant advantage over other sales teams. A manual was produced to complement the series of lectures.
The Glades, Bromley, Kent	Investigation of extensive new slate roofing covering the large shopping centre and car parks. The slate was identified to be of Spanish origin and comprising a mixture of at least five different qualities of material. A major proportion of the slate was already suffering discoloration, and splitting during construction. Welsh slate was used to replace the Spanish material. The Welsh slate was also investigated to ensure that similar problems were not able to recur.
SSQ Group, London	Assessment of an Argentinean slate to American, French and German standards prior to product launch throughout Europe. Included the preparation of a marketing manual covering the geology and history of the slate and expected performance. A marketing manual was also prepared for the Group's existing Del Carmen slate and provision of training sessions to sales personnel.
Springfields Nursing Home, Devon	Investigation of slate roofing problem during the initial scares over the quality of imported Spanish slates during the late 1980s. The slates were found to be a mixture of five different qualities and incorporating materials that were not fit for purpose. Approximately 50% of the slates were discolouring whilst 20% were suffering splitting and other damage. The roof was recommended to be replaced.
Basingstoke, Hampshire	Investigation of fibre-cement slates that were suffering from loss of surface and apparent bowing. Petrographic investigations identified the presence of a curing layer and alteration in the carbonation state of exposed surfaces causing differential shrinkage and other effects.
Braintree, Essex	Investigation of wind uplift affecting hook-fixed slates on a large, low pitch school hall roof. Ripple effects were observed during high winds and calculations were carried out to determine the potential for slates to detach. Problems with wind driven rain were also assessed.
Hove, Sussex	Investigation of roof of Grade II listed building which had been re-slated 15 years previously. The roof was to be redesigned and it was hoped that the existing slates could be salvaged. However, the slates were found to be from Xemil, Spain, where most problem Spanish slates were supplied from and the level of deterioration meant that salvage was not possible.
Newton Ferrers Estate, Devon	Inspection of country estate undergoing major redevelopment with new Spanish slate roof coverings being applied. The slate was identified to be weak and suffering discoloration and splitting prior to placement on the roof. Construction was stopped until a suitable replacement material could be identified.

Selected General Experience

Sint Maarten, Dutch Antilles	Investigation of buildings suffering from various forms of concrete decay including assessment of the quarry where the aggregates were obtained from. Guidance was provided concerning continuation of the quarry extraction and, following geological reconnaissance, suggestions made regarding other possible areas to quarry on the island. The quarry was closed and moved to the main alternative location suggested.
Harrods, London	Investigation of existing terracotta materials to determine the original method of manufacture including the mix proportions and firing temperatures. Following this a replacement terracotta was manufactured which proved to be compatible with the old material.
Aga Khan Hospital, Karachi, Pakistan	Assessment of the construction of a hospital complex and possible problems should different levels of earthquake occur. The biggest problem was the debonding of external 'snotted' plaster.
Aylesbury Prison, Buckinghamshire	Investigation of replacement render cracking and advice on remedial actions following a major refurbishment. Later investigation of finish render debonding and cracking also carried out.
Thelwall Viaduct, M6	Investigation of long term performance of large concrete structure including the petrographic examination of over 300 core samples, which were also all subjected to expansion testing and a variety of test procedures. The aggregate combinations were identified to be potentially alkali-reactive and some of the concretes were demonstrated to have a high potential for reaction. A range of recommendations was provided to reduce the potential for future alkali reaction.
SKM House, Hayes, Middlesex	Assessment of fire-damaged concrete structure used as a warehouse for the storage of organic materials, including determining the effects of organic acids released by the fire on the concrete.
Alton College, Hampshire	Investigation and advice on flooring system design for a new sports hall exhibiting problems with recurring damp affecting the newly laid wooden flooring which had warped on three separate occasions.
Mediterranean, Various locations	Assessment of ancient concretes from around the Mediterranean including the determination of the constituents and their likely provenance. Different locations were compared and the use of particular additions from specific regions that had then been exported for use was identified.
Bank of America, Frankfurt and Lahore	Survey of premises for asbestos-containing construction products, as part of a wider survey of over 30 offices around the World. This followed a federal directive to ensure all offices were free of asbestos products.
Houses of Parliament, London	Investigation of floor construction and advice on the presence of deleterious reactions within 19thC Portland cement based concrete. Various sulfate reactions identified related to the presence of clinker and unburnt or partially burnt coal within the aggregate particles.
Maritime Museum, London	Investigation of 300 year old brick masonry to assess the potential for supporting a new construction for the Millennium celebrations.
Wimpey Homes, London	Investigation of concrete block walling following the serious collapse of an apartment building. It was determined that the wrong strength blocks had been used in the internal leaf construction which had to support large concrete beams.
Sussex University, Brighton, Sussex	Assessment of damp penetration across the cavity walls of over 200 newly built student residences. During the investigation sulphate attack of the brickwork mortars was identified and guidance was given concerning remediation including comments concerning potential forms of over-cladding.
Minster Court, London	Investigation of damage to the superstructure caused by a major fire. Over 1000 concrete cores were taken from a grid of locations on different floors of the building and the temperature profiles plotted. This enabled a good understanding of the spread of the fire and the likely damage to all of the concrete elements.
HMP Everthorpe	Investigation of an extensive area of floor tiling that was failing prematurely under the conditions of use within the kitchens and food stores, presenting a very serious problem as tiles could be removed and used as potential weapons. The original specification and tiles employed were both found to be at fault and procedures were recommended to minimise future problems.
Dover and Pevensey Castles, Kent	Investigation of historic concrete used in the construction of the original Roman fortifications. A range of unusual reactions was identified including the dissolution of quartz sand grains. Advice was provided on the likely source of the aggregate materials used for the concrete.

Selected Experience with Domestic Properties

St Johns Wood, London	Investigation of extensive use of Crema Marfil stone for internal flooring, ceramic tiling for both flooring and wall tiling, and glass panels for wall tiling. Comment provided on failure of all materials in relation to both design and workmanship issues.
Wisset – Tiling adhesive failure	External ceramic tiling to a swimming pool surround found to be lifting as a consequence of failure of the adhesive. The adhesive manufacturer claimed inadequate movement joints were to blame but this could not be substantiated. Workmanship was not found to be at fault.
Portman Square, London – Turkish travertine flooring	Investigation of very large format tiles over $1m^2$ in size that were suffering cracking and debonding. Whilst being outside current British Standard guidance the tiles had not been properly bedded and there was insufficient allowance for differential movement.
W1, London – Glazing leakage	Investigation of internal leakage problems caused by faulty installation of large window panels on the corner of the penthouse to a ten storey apartment. Inappropriate use of mastic materials and low quality non-stainless fixings had compromised the seals and directed water inwards. Construction details were found not to reflect the original design brief.
Orpington – Kitchen worktop damage	Inspection of 'black granite' installation where the surface had been scratched by the installers. It was also identified that the installation was incorrect in many ways being improperly restrained with unsupported thin elements and insufficient allowance of movement.
Derby – Equestrian area construction	Investigation of paddock behind a private residence that had been refurbished to provide an equestrian surface for two horses. The construction methods and materials were found not to comply with recommended guidelines and the health of the horses had been put at risk.
Tonbridge – Basaltina worktop	Advice provided on the installation of an exceptionally large 'Basaltina' kitchen work surface that had a flaw that was potentially unavoidable but also had been poorly repaired.
Penn, Bucks. – Refurbishment problems	Full survey of internal and external construction of a large house following a dispute between the main contractor and home owner. Problems included plaster cracking, poor alignment and flatness, trip hazards, incorrect guttering, inappropriate soil drainage, sub-standard masonry, cold-bridging problems, incorrect dpc and inadequate venting.
Emperador marble worktop, Norwich	Inspection of very large limestone slab used for an island work surface that had been subjected to re-finishing to change the finish from polished to honed but which had resulted in an uneven finish. Recommendations were provided to allow the stone to be re-finished more evenly without replacement.
Residence in Hampstead, London	Advice on the installation of internal flooring that had suffered cracking. This was found to have been caused when an adjacent bath was filled and the floor deflected. The situation was exacerbated by improper bedding procedures and the omission of both a decoupling membrane and two cross bonded ply layers to a timber substrate.
Clapham – Isola slate tiling	Investigation of stone tiling to both the floors and walls within bath and shower room areas. Although the design and workmanship were generally considered to be of a reasonable quality the stone itself had a number of flaws that resulted in cracking that then led to problems with the substrate as water accumulated behind the structure.
Kensington – Bateig Blue limestone tiling	Inspection of large format slabs lining a shower installation that wee exhibiting signs of surface decay despite surface sealing. Problems identified with joint construction allowing water and salts to become trapped behind the slabs and then crystallise below the sealed stone surface.
Brookwood – Nero Impala staining	Investigation of staining affecting an advised 'Nero Impala' stone worktop. Worktop considered likely to comprise a Chinese material of similar appearance but different performance as a consequence of reaction to mildly acidic spillage leading to considerable lightening in colour.
Barking – Roofing failure	Inspection of a relatively new roof to a block of flats following incidences of damp ingress to the top flat. The original layer was found not to have been stripped away and detailing around pipes and outlets was incorrect. It was recommended that a new surface be installed.
Holland Park – Portland stone external paving	Investigation of high specification external garden paving that was suffering staining and loss of grout from joints. The staining and damage were caused by inappropriate bedding procedures that were encouraging the concentration of moisture at specific locations. The quality of the stone supplied was also found to be lower than expected, which was admitted by the installer.
Bishops Sutton – Swimming pool tiling	Inspection of completed mosaic tiling that was considered to be or a low standard with uneven surfaces and variable grouting. A lack of allowance for differential movement had resulted in cracking and the installation of movement joints was recommended.

Publications – Sole Author

Buried treasure. Preserving stonework. Natural Stone Specialist, Vol. 55, No. 6, pp 28-31, July/August 2020.

Totternhoe Clunch. The white choice of stone for Woburn Abbey. Natural Stone Specialist, Vol. 50, No. 6, pp 34-38, July/August 2015.

Clipsham. The stone that has rescued the Houses of Parliament. Natural Stone Specialist, Vol. 50, No. 4, pp 26-30, May 2015.

The choice is undoubtedly yours but let me make a suggestion. Science meets art, Understanding stone. Natural Stone Specialist, Vol. 50, No. 3, pp 10-14, April 2015.

Ffestiniog slate. Ffestiniog shades of grey. Natural Stone Specialist, Vol. 50, No. 2, pp 34-40, March 2015.

Bath stone. A construction stone to challenge the rules. Natural Stone Specialist, Vol. 50, No. 1, pp 30-33, January/February 2015.

Caithness stone. A quintessential stone for construction. Natural Stone Specialist, Vol. 49, No. 9, pp 30-33, November 2014.

DeLank granite. A stone that is virtually indestructable. Natural Stone Specialist, Vol. 49, No. 8, pp 32-35, October 2014.

Cumbrian slate. A slate like no other. Natural Stone Specialist, Vol. 49, No. 7, pp 32-34, September 2014.

York stone. So famous, yet so elusive. Natural Stone Specialist, Vol. 49, No. 6, pp 38-42, July/August 2014.

The stone beneath our feet. A heritage that continues to be set in stone. Natural Stone Specialist, Vol. 49, No. 5, pp 34-38, June 2014.

Portland limestone. The greatest of all British stones… probably. Natural Stone Specialist, Vol. 49, No. 4, pp 34-38, May 2014.

Verde. Green… but maybe not so environmentally friendly. Natural Stone Specialist, Vol. 49, No. 3, pp 36-38, April 2014.

Black granite. Any colour as long as it's black. Natural Stone Specialist, Vol. 49, No. 2, pp 35-38, March 2014.

Travertine. Marble's young pretender. Natural Stone Specialist, Vol. 49, No. 1, pp 35-38, January/February 2014.

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Slate (Part 1). The Earth's greatest gift. Natural Stone Specialist, Vol. 48, No. 11, pp 30-34, November 2013.

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Marble. The most regal of stones. Natural Stone Specialist, Vol. 48, No. 8, pp 25-28, August 2013.

Sandstone (Part 2). Simple… but misunderstood. Natural Stone Specialist, Vol. 48, No. 7, pp 30-33, July 2013.

Sandstone (Part 1). Simple… but misunderstood. Natural Stone Specialist, Vol. 48, No. 6, pp 30-33, June 2013.

Limestone. The original building stone. Natural Stone Specialist, Vol. 48, No. 5, pp 28-31, May 2013.

The geological comfort factor. Natural Stone Specialist, Vol. 48, No. 4, pp 60-63, April 2013.

What's in a name? A technical review. Natural Stone Specialist, Vol. 47, No. 2, pp. 37-38, February 2012.

Building Stones Explained 5: Sandstone. Geology Today. Vol. 24, No. 1, pp. 33-38, January/ February 2008.

Building Stones Explained 4: Slate. Geology Today. Vol. 22, No. 1, pp. 37-44, January/ February 2006.

A not so clean slate. Structural Survey. Vol. 23, No.5, pp. 334-345, 2005.

Setting new slate standards. Roofing Cladding & Insulation. Pp. 60-62, September 2005.

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Selecting the Correct Stone. Published by Stone Federation Great Britain, April 2010. (Member of Technical Committee and contributing author.)

England's Heritage in Stone. Proceedings of a Conference. Tempest Anderson Hall, York, 15-17 March 2005. Edited by P Doyle. Published by the English Stone Forum, 2008

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Natural Stone Kitchen Worktops. Code of practice for the design, manufacture, installation and maintenance of natural stone kitchen worktops – including reception desks, counter tops and other similar horizontal and associated vertical surfaces for use in domestic and commercial situations. Published by the Stone Federation Great Britain, February 2005. (Member of Technical Committee and contributing author.)

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Publications – Ask the Expert*

* A Q&A column in the Natural Stone Specialist.

- *BS EN 1342 – Setts of natural stone for external paving.* Vol. 48, No. 3, p6, March 2013.
- *BS ENs 12057 & 12058, Tiles and slabs for flooring and paving.* Vol. 48, No. 2, p6, February 2013.
- *BS 1469, Slabs for Cladding,* Vol. 48, No. 1, p6, January 2013
- *BS 6542, Sills and Copings.* Vol. 47, No. 12, p6, December 2012.
- *BS EN 1341, External Paving.* Vol. 47, No. 11, p6, November 2012.
- *BS 5385, Wall and Floor tiling.* Vol. 47, No. 10, p6, October 2012.
- *BS 8415, Specification for Memorials.* Vol. 47, No. 9, p6, September 2012.
- *BS 8298, Cladding and Lining*. Vol. 47, No. 7, p6, July 2012.
- *BS EN 1467, Rough Blocks*. Vol. 47, No. 6, p6, June 2012.
- *The website of the British Standards Institution.* Vol. 47, No. 5, p6, May 2012.
- *Sampling stone for testing*. Vol. 47, No. 4, p6, April 2012.
- *Scanning electron microscopy and X-ray diffraction.* Vol. 47, No. 3, p6, March 2012.
- *Petrography review, Part 2.* Vol. 47, No. 2, p6, February 2012.
- *Petrography review, Part 1.* Vol. 47, No. 1, p6, January 2012.
- *In-service slip resistance prediction*. Vol. 46, No. 12, p6, December 2011.
- *Salt crystallisation testing.* Vol. 46, No. 11, p6, November 2011.
- *Frost resistance testing.* Vol. 46, No. 10, p6, October 2011.
- *Abrasion resistance testing.* Vol. 46, No. 9, p6, September 2011.
- *Density testing.* Vol. 46, No. 8, p6, August 2011.
- *Flexural strength testing.* Vol. 46, No. 7, p6, July 2011.
- *Slip resistance testing.* Vol. 46, No. 6, p6, June 2011.
- *Water absorption testing.* Vol. 46, No. 5, p6, May 2011.
- *Compressive strength testing.* Vol. 46, No. 4, p6, April 2011.
- *What is the most useful stone test and why?* Vol. 46, No. 3, p6, March 2011.
- *What treatments would you recommend for external paving?* Vol. 46, No. 1, p6, January 2011.
- *Large blocks of a well known stone with many veins that have never caused a problem before have recently started splitting. Can you help?* Vol. 45, No. 12, p6, December 2010.
- *Is there something I can treat stone patios with to stop leaf litter from staining them?* Vol. 45, No. 11, p6, November 2010.
- *I am having an extension built on to my 19th century limestone house and the currently quarried stone has a different appearance to the original material, which is apparently the same stone. I am thinking of getting a different stone that is a closer match in appearance. Do you foresee and problems?* Vol. 45, No. 10, p6, October 2010.
- *Stone-topped kitchen islands stand alone, so why do I need rear-edge battening for units installed against walls?* Vol. 45, No. 9, p6, September 2010.
- *More resins seem to be used in association with stone finishing all the time. What do you think of resins and their use with stone?* Vol. 45, No. 8, p6, August 2010.
- *We wish to erect a single block of limestone to commemorate an event and have it last several hundred years. What characteristics should we be looking for when identifying suitable limestone?* Vol. 45, No. 7, p6, July 2010.

- *I have a customer who wants a stone floor in his surgery but is worried about possible blood spillage. Can you get blood out of a stone?* Vol. 45, No. 5, p6, May 2010.
- *During the past cold winter a stone patio I laid using 20mm thick slabs cracked and the pavers lifted, even though I built it to the British Standard.* Can you explain? Vol. 45, No. 4, p6, April 2010.
- *I have been told granite worktops can give off radon gas. Is this true? And if it is, is it a problem? Part 2.* Vol. 45, No. 3, p6, March 2010.
- *I have been told granite worktops can give off radon gas. Is this true? And if it is, is it a problem? Part 1.* Vol. 45, No. 2, p6, February 2010.
- *A limestone shower tray has become slippery, what can I do to make it safe again?* Vol. 45, No. 1, p6, January 2010.
- *We have 90m² of Pakistani white onyx to install in a kitchen / utility / toilet and conservatory area. Are there any special requirements for fixing, sealing and maintaining onyx tiles? How does onyx differ from marble?* Vol. 44, No. 12, p6, December 2009.
- *I believe the granite I supply to be frost resistant, and certainly have never had any problems. Do I really need to have it tested?* Vol. 44, No. 11, p6, November 2009.
- *I am installing stone around a bath. Are there any problems I should be particularly aware of?* Vol. 44, No. 10, p6, October 2009.
- *Architects are always asking me if there is any way of avoiding movement joints. Is there?* Vol. 44, No. 9, p6, September 2009.
- *My granite worktop has slowly developed cracking but the support appears to be sound. What could have caused this?* Vol. 44, No. 8, p6, August 2009.
- *A lacquer I applied to my woodwork has turned the adjacent limestone a vivid blue colour. Can I get rid of this?* Vol. 44, No. 7, p6, July 2009.
- *I have been told not to use building sand to bed and joint setts. Is this correct?* Vol. 44, No. 6, p6., June 2009.
- *I want to use limestone in a toilet, am I asking for trouble?* Vol. 44, No. 5, p6, May 2009.
- *A customer wants a marble worktop rather than granite or engineered quartz. What do you think I should do?* Vol. 44, No. 4, p6, April 2009.
- *I am struggling with my levels on a job. What are the thinnest natural stone flooring tiles I can safely use?* Vol. 44, No. 3, p6, March 2009.
- *Is there a safe way to speed up screed drying when I'm laying floors?* Vol. 44, No. 2, p6, February 2009.
- *I am building a driveway using granite setts. Should I bed them in sand or fix them with mortar?* Vol. 44, No. 1, p6, January 2009.
- *Can I use limestone for lining a swimming pool?* Vol. 43, No. 12, p6, December 2008.
- *I am cleaning some marble sculptures, what can I use to help protect them in the future?* Vol. 43, No. 11, p6, November 2008.
- *I am installing disabled ramp access, what should the slip resistance of the stone finish be?* Vol. 43, No. 10, p6, October 2008.
- *What is the best way to get rid of chewing gum from stone surfaces?* Vol. 43, No. 9, p6, September 2008.
- *What amount of repair or fill to a stone is acceptable?* Vol. 43, No. 8, p6, August 2008.
- *Sandstone patios we have laid often need to be jet-washed every six months or so as they have become green and slippery. Is this a particular problem with sandstone and is there any way to prevent it?* Vol. 43, No. 7, p5, July 2008.
- *What is the best form of underfloor heating to use with stone?* Vol. 43, No. 6, p6, June 2008.
- *Was someone joking when they said you must be wary of mushrooms growing near paving stones?* Vol. 43, No. 5, p6, May 2008.
- *What are stone veins and are they really a problem?* Vol. 43, No. 4, p8, April 2008.
- *Limestone tiling in a shower enclosure.* Vol. 43, No. 3, p6, March 2008.
- *Using the term 'granite' when selling stone.* Vol. 43, No. 2, p89. February 2008.
- *Turmeric staining of kitchen worktop.* Vol. 43, No. 1, p6. January 2008.

Television Appearances

- *The Legalizer, BBC 1, first aired 27.11.2013.*
- *Horizon, BBC 2, The Great Court of the British Museum, first aired 2000.*