

ENVIRONMENTAL MONITORING

Holistic and Sustainable Solutions to Conservation

JAGJIT SINGH

Deterioration of historical building materials is attributed to changes in their environment. The majority of environmental problems are associated with those defects in the fabric that lead to water penetration, condensation and dampness in the building fabric. Severe salt efflorescence, damp staining, blistering of finishes and timber decay in buildings are mainly the result of water penetration.

However the causes of deterioration are also influenced by the building's internal environment. Humidity, temperature and ventilation all contribute to this microclimate, which will vary depending upon the building structure and the envelope of the internal building fabric.

ENVIRONMENTAL MONITORING

There is little point in dealing with decay if the causes of the decay are not dealt with first. Indeed, it is often necessary to treat the cause alone. When dealing with historic building fabric the historic value of the original material often justifies retaining partially decayed material, provided that neither its integrity, nor that of the building of which it is part, is jeopardised in any way.

Where the causes of decay are not obvious it is necessary to carry out a thorough study of the environmental conditions to identify the cause of decay. This is done by employing a range of hand held instrumentation, physical sampling and sensor technology to monitor various parameters within the fabric of the building.

Environmental monitoring may also be justified where the recurrence of a defect is unlikely to be detected before extensive damage has been caused, for example in the roof space above an auditorium. In this case long-term environmental monitoring will be required.

ENVIRONMENTAL MONITORING, METHODOLOGY AND OVERVIEW OF APPROACH

The first step in the investigation of a problem building is to carry out a thorough inspection of the building for defects. Then:

- Establish moisture contents in affected materials, such as timber, plaster, masonry, insulation materials and textiles.
- Establish the humidity, temperature and dew point in the environment, both internally and externally. (The dew point is the point at which air-borne moisture



Monitoring St George A probe installed by English Heritage monitors variations in relative humidity and ambient temperature of a magnificent but highly vulnerable wall painting in the castle chapel at Farleigh Hungerford near Bath.

condenses due to a fall in temperature, for example in a porous masonry wall which is cold on one side and warm on the other.)

- Investigate in greater detail as necessary the moisture profiles in large dimension timbers and across masonry masses.
- This information can be determined by:
- Measuring moisture contents of timber with resistance based moisture meters. Probes can also be used to measure moisture contents at depth in large section timbers and those built into masonry.
 - Surface moisture readings in plaster and masonry using moisture meters. These will indicate if a wall is dry but can give false readings of dampness (see below).
 - Where possible, mortar samples should be taken of the areas affected to determine accurately the moisture and salt content of the masonry. This does, however, have the disadvantage of not being non-destructive.
 - Data loggers used to measure the environmental parameters (temperature,

humidity and dew point in particular) both internally and externally.

- Specialist probes used to measure moisture across masonry walls.

The results of all or some of the above tests will establish the cause and enable a solution to the problem to be put forward.

Mortar sample analysis

Mortar sample analysis is one of the most important tools in establishing accurately the moisture levels in masonry and plasters. Where moisture levels are high it is also possible to determine how long there has been a damp problem from the salt content, a high salt content indicating a long-established problem. Mortar sample analysis can also be useful to determine the type of salt when trying to establish whether there is a genuine problem with rising dampness. However taking samples of mortar or plaster for analysis has the disadvantage of causing some damage, and might not be appropriate where, for example, ornate plasterwork is concerned.

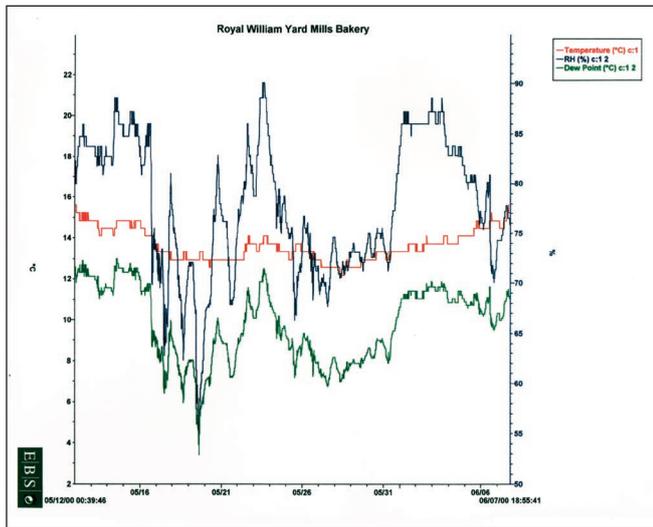
Timber moisture contents

Timber moisture contents above 20 per cent indicate unacceptably high moisture levels in the building. If this is a general

moisture level rather than localised then this is likely to be associated with high humidity in the building. Localised high readings are more likely to be associated with a building defect. For instance, high readings in a built-in end of a timber would indicate that the wall was damp, posing the threat of future timber decay. The options are to isolate the timber from the wall, provide an air gap around the timber to allow the timber to breathe, or to eradicate the source of damp and monitor the timber as the wall dries out. Which option is chosen will be determined according to each situation.

Masonry moisture monitoring profiles across walls

Measurement of the moisture across the thickness of a wall is a specialised task as there are no instruments available off the shelf for carrying this out. Tailor made probes are used containing hygroscopic materials (materials which absorb moisture). These are placed in the wall at varying depths and sealed off from the outside environment. After some time the probes are removed and their moisture content analysed. This method will give an indication of moisture levels across the thickness of the



An example of a resistograph measurement of moisture content in timber

wall and combined with temperature and humidity readings both internally and externally will give an indication of the moisture source (see below). However, it must be pointed out that the use of hygroscopic material to measure moisture is inaccurate at higher moisture levels.

Environmental data loggers

Data loggers measuring temperature and humidity are useful to determine whether there is, for instance, an abnormally high humidity or whether there is a risk of condensation in a building.

If readings are taken on both the interiors and exteriors of the building, dew points can be calculated within materials such as masonry masses.

STABILISING THE HISTORIC ENVIRONMENT

For the holistic and sustainable conservation and preservation of historic buildings, stable environmental conditions are important.

Once investigations have been completed, a strategy can be devised to stabilise the building's environment. Various building works may be required to prevent further water penetration and to maximise ventilation to damp affected materials. Correction of these building defects, combined with measures to dry out the wet areas and to protect any decorative interior finishes by allowing ventilation of the wet areas, will prevent further deterioration. If thoughtfully and competently carried out, such work may extend the life of the building indefinitely, with dignity.

Until the drying out of the building fabric and its associated timber elements is completed, any other actions to remedy the deterioration problems will be ineffective and a waste of time and resources.

In some situations it may well be necessary to introduce both continuous long-term monitoring and preventative maintenance. Long term monitoring may be necessary for the following reasons

- To provide information on the state of moisture equilibrium and balance (moisture sources, reservoirs and sinks) in the building's environment, its fabric and its structural elements as it dries out.
- To allow co-ordination and scheduling of work stages to prioritise remedial work to achieve acceptable levels of moisture in the masonry and timber and to prevent future deterioration problems.
- To allow a cost-effective, long-term holistic approach to environmental stabilisation of the historic environment.

RECOMMENDED READING

Singh J, *Building Mycology, Management of Health and Decay in Buildings*, Spon, London 1994

Singh J, *Dry rot and other wood-destroying fungi: their occurrence, biology, pathology and control*. Indoor + Built Environment 1999; 8: 3-20

Dr JAGJIT SINGH, Director of Environmental Building Solutions Ltd, is an independent consultant specialising in building health problems, heritage conservation and environmental issues. His current research focuses on interrelationships of building structures and materials with their environments and occupants.

DAMP & TIMBER DECAY

▶ BALMORAL STONE LTD

31 Bankhead Drive, Sighthill, Edinburgh EH11 4DN

Tel 0131 453 4777 Fax 0131 453 6077

WOODWORM AND DRY ROT: *See also: display entry in Stone section, page 106.*

▶ CALDER PRESERVATION SERVICES

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▶ DELTA MEMBRANE SYSTEMS LTD

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▶ DEMAUS BUILDING DIAGNOSTICS LTD

Stagbatch Farm, Leominster, Herefordshire HR6 9DA

Tel 01568 615662 E-mail info@demaus.co.uk Website www.demaus.co.uk

STRUCTURAL TIMBER TESTING AND BUILDING

DIAGNOSTICS: Demaus Building Diagnostics specialises in the detection and assessment of decay, weakness and fire damage in structural timber using non-destructive techniques. *See also: profile entry in Non-destructive Investigations section, page 50.*

▶ HUTTON+ROSTRON ENVIRONMENTAL INVESTIGATIONS LIMITED

Netley House, Gomshall, Surrey GU5 9QA

Tel 01483 203221 Fax 01483 202911

E-mail ei@handr.co.uk Website www.handr.co.uk

Contact **Tim Hutton** MA MSc MRCVS

CONSULTANTS ON TIMBER DECAY, BUILDING FAILURES AND ENVIRONMENTS: Simple solutions to common problems and expertise covering biodeterioration, structural decay, timber strength grading, damp, environmental health, non-destructive surveying and building monitoring systems. H+R carry out independent site and laboratory investigations providing specifications for remedial work or conservation. Expert witness work is also undertaken. They operate the Rothound® dry rot search dogs and install Curator® electronic environmental and structural monitoring systems. Resurgam®, a division of H+R, specialises in building conservation. Clients include The Royal Household, National Trust, English Heritage, national and local government, engineers, surveyors and property owners. *See also: Resurgam profile entry in Heritage Consultants section, page 39.*

▶ MAYSAND PRESERVATION CO LTD

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MASONRY AND TIMBER CONSERVATION CONTRACTORS:

Maysand's preservation team includes highly skilled technical staff to offer solutions required to preserve and conserve the fabric of buildings. These include preventative treatment against dampness, fungal and insect infestations within buildings. Other services include chemical damp-proofing, underground waterproofing tanking systems, timber engineering, specialist timber preserving treatments and building contracting services for historic, ecclesiastical and commercial projects. Members of BWPDC. *See also: display entry in Stone section, page 110.*