One thing leads to another

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In the first in a series on the causes of damp, Mike Parrett looks at the connections between building design, failure and occupants? lifestyle

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Good design is pivotal to preventing damp. Without it, buildings cannot be maintained, construction elements fail and buildings cannot cope with people living in them.

In 2006, CABE?s publication, The cost of bad design stated:

> 'Too often, the people who design andconstruct buildings and parks don?t worryabout whether they will work properlyor what will they cost to run ... But thepublic has to live with badly built, poorlydesigned buildings and spaces.'

It cites examples such as the Holly Street ?snake blocks? built in the 1970s in Dalston, London. Before their demolition, problems included dark staircases, badly situated lifts and poor estate lighting. But this publication only offers architects? views of poor design and does not comment on the towers? actual functionality, the effect on residents and the many damp problems.

Design and maintenance

William Morris, founder of the Society for the Protection of Ancient Buildings , advocated regular maintenance to stave off decay. Various types of buildings sincedemonstrate that poor access leads to poor maintenance, decay and decline, and often to damp problems.

The Construction (Design and Management) Regulations were introduced in 1994 to improve building design and the safety of those maintaining them. At their launch, aspeaker showed photographs of a building with a ring of lights high above the lobby. Without access for a safe working platform, changing a lightbulb was expensive and risky. Poor design meant they would gradually expire and may not be replaced.

In another example, some wharf buildings on the bank of the Thames were converted into flats. On the street side, scaffolding was needed to maintain the windows and gutters. On the river side, this work needed cantilevered scaffolding over the water. How often do you think windows and gutters were maintained?

Materials also play a major role. The original design of Borough Market required 70 tons of thin code 3 lead to be resin-bonded on to plywood sheets for roof panels, but when the sun warmed the lead it just de-bonded. The architect was trying to reduce the roof weight and expense, but did not consider the environmental issues.

Surveyors should consider the failures associated with different classes of buildings, which often provide clues to the risk of dampness.

- In 1875, the Public Health Act introduced damp-proof courses in walls to address problems caused by unconnected sewerage and drainage. New buildings were also separated by 1m to lower the water table.
- Until the 1920s?1930s, there was generally no undersarking to roofs to prevent water penetration if the tiles became defective. Many old buildings with original roofs are still without undersarking.
- Before the 1950s, roof void insulation was uncommon and unlagged water tanks and pipes were vulnerable to freezing, made worse by wind penetration and heat loss from a lack of undersarking.
- Until recently, most suspended solid floors were laid without vapour barriers, but rising water tables meant moisture transfer through the vapour-permeable concrete; withground-supported solid floors, it was incorrectly believed that compacted reinforced concrete, even 400?500mm thick, was vapour-impermeable.
- During the inter-war years, ground floors could be a mix of clinker ash and bitumen tar with timber-boarded and battened floors laid on to them; these failed because of upwards moisture transfer into timbers via the iron nails. Linoleum, vinyl and rubber-backed carpeting also trapped moisture.
- Until the 1950s, many solid ground-supported floors were laid without damp-proof membranes (DPMs). Some later dwellings relied on overlaying pantiles and wood-block flooring with bitumen-based adhesive serving as DPMs. Replacement floors were oftenlaid without any DPMs.
- Victorian and Edwardian properties with chimneys rarely have damp-proof courses (DPCs) to fender walls, which act as conduits for moisture transfer into the breast and adjoining walls.
- In Victorian properties, potable water mains were often routed under suspended floors towards the rear kitchen; these lead pipes are vulnerable to fracture or perforation resulting in underfloor or underground leaks.
- The well-documented failure to construct modern airtight buildings gives rise to heat loss pathways and routes for moisture to permeate and penetrate.

Improvements to older properties (e.g. adding loft insulation and blocking up old fireplaces) mean inherent defects from different building types may not be identified. Many improve the energy e?fficiency of buildings but also hermetically seal them and retain moisture.

Figure 1: Black mould to external corner of party wall behind bedroom furniture. Mould also found at bottom of external wall. Level 1 or 2 surveys suggested use and occupation and/or penetrating damp (via high abutting external timber decking) was to blame. A Level 4 survey found construction and design issues were the main causes

A serious problem associated with energy-saving solutions is retrofit cavity wall insulation. Some fibre insulation retains moisture penetrating from the outer leaf of the wall. After flooding, wet cavity wall insulation may not dry fully, allowing moisture release through the inner leaf into habitable spaces. This creates the conditions for mould long after the drying-out period.

Occupants? lifestyle

Without large-scale monitoring of environmental conditions inside properties, it is impossible to fully establish the effect of use and occupation on dwellings. However, I have seen many examples of people unwittingly contributing to damp issues.

Someone on a budget may buy a second-hand tumble dryer with a missing hose, for example, but an unvented dryer can pump around 7.5 litres of moisture into the atmosphere in 24 hours. Occupants in social housing or fuel poverty often underheat homes; insome, I have struggled to record internal temperatures above 12?C (below 15?C damages the health of children and the elderly). These homes are often thermally ine?fficient, with large external solid wall areas, single-glazed windows and no loft insulation. Poor heating and heat loss increase the risk of condensation and damp, especially when combined with building defects.

Even an overcrowded PassivHaus would have problems because of the extra moisture in the internal air

Societal and cultural problems may contribute to dampness. Some people living on ground floors may choose never to open their windows or curtains because their rooms are visible from outside. Installing tinted, one-way glass may encourage them to do so andimprove ventilation.

Accommodating different cultures is very important. Some bathe by pouring water over themselves; if this splashes over the floor it could penetrate into a property below and/or cause the rotting of nearby timbers. If bathrooms were converted into wet rooms, people could bathe however they wanted.

Another occupant-related issue is overcrowding. Even an overcrowded PassivHaus would have problems because of the extra moisture in the internal air.

Identifying problems

It can be di?cult to identify the true cause of damp. For example, crescent-shaped mould can indicate internal atmospheric moisture, but from use and occupation, building defects, such as dampness coming through the solid floor or walls, or both?

We should consider some definitions:

- penetrating damp is moisture that has moved from one side of a wall to the other
- rising damp is moisture that has moved vertically by capillary action or suction where the moisture source is from the ground below the building.

These definitions are important because:

- rising, penetrating and condensation damp are not causes of damp: they aremechanisms
- all the causes of rising and penetrating damp create condensation
- condensation caused by use or occupation rarely creates penetrating or rising damp.

It is easy for surveyors to assume that mouldy walls are due to occupants? lifestyles. In a HomeBuyer Report, surveyors can cover themselves by stating it could be caused by the three principal mechanisms of rising damp, penetrating damp or condensation.

But there is no specific diagnosis. This inexorably leads to the recommendationthat the homeowner or purchaser seeks ?commercial? help ? from those benefiting financially from their own diagnosis. This is like a doctor passing their patient onto a drug company. I have rarely known a surveyor recommend damp-related pathology tests.

Conjecture is risky for surveyors but they should assume nothing. Understanding the different contributing factors causing damp in buildings is pivotal and not assessing all possible causes, or recommending the required tests for a Level 4 survey, is a mistake.

Figure 2: Opening a suspended (block and beam) solid floor revealed high rubble and arisings from original construction, in some areas in contact with the floor?s underside.

No DPM to the oversite or vapour barrier to the floor (not a requirement in late 1970s/early 1980s properties on level sites)

Surveyors might make an intelligent assumption from tangible findings, e.g. high readings from timber skirtings, but in my experience, the three main assumptions about damp in walls is that it is caused by failure of:

- the DPC;
- no DPC; or
- bridging of the DPC.

I can confidently say that if a surveyor finds a high moisture reading in a wall it would be a huge error to assume a problem with the damp-proof course. It is likely to be, for example, a solid floor without a DPM, or even the resistance or capacitance meter coming into contact with conductive material.

A suggested approach

The first action should be to ask the occupier about the damp problem. Has it always been present or has it started suddenly? Does it happen when it rains or during cold weather? Is there a problem next door? In social housing, the repair history of a portfolio can allow a surveyor to identify common problems.

Figure 3: With evidence of distressed wood laminate flooring, a mechanical hair floor hygrometer was sealed to the exposed floor trapping a pocket of air, which stabilised at 90% relative humidity. As per BS 8203:2009, the solid floorwas damp above the tolerable level (75%) for overlaying with floor coverings. Further investigation was

required (see figure 4)

The next step is to produce a floor-plan drawing, particularly if damp is at ground level. This is a pathological storyboard showing your measurements, indicating, for instance, where they were taken and the equipment used. You should photograph your instruments to record evidence of your readings.

Measurements using a range of equipment to a Level 4 survey should be considered to find the causes and sources of the dampness, including:

- electrical resistance meters on timber
- electrical capacitance meters to map the wall and/or solid floor surfaces
- invasive tests after high readings, e.g. calcium carbide chemical testing, gravimetric profiling, optical endoscope examinations
- testing for the presence of chloride and/or nitrate ions
- a hygrometer to measure humidity
- testing for sulphates in solid floors
- taking environmental readings, e.g. internal/external air temperatures and moisture content of the internal air
- U-value calculations and heat-loss gradient profiling across wall constructions.

The findings of internal and external reconnaissance should then be compared. For example, if there is dampness in the corner of two external walls, is this from internal condensation or is there a defective rainwater pipe at the corresponding external location?

A surveyor should then form an opinion about the potential causes of damp and indicate any further measurements to pinpoint the source of the problem.

Figure 4: Floor section removed to look for a DPM. We found the solid floor was not ground-supported but suspended block and beam. A hygrometer probe was inserted to measure the moisture content of the sub-floor air, which was found to be 90.7% relative humidity and at equilibrium with moisture transfer through the floor. An optical endoscope examination confirmed significant rubble and arisings in contact withsome sections of the floor

Some tests may be beyond the scope of standard surveys, but by understandingthe symptoms, surveyors can refer clients to further pathology work in a more prescriptive way, similar to a GP referring a patient to an independent medical specialist. The findings will help educate clients in follow-up actions and conversations with experts in damp.

Case study

The leaseholders of a 1970s ground-floor flat complained that the damp and mouldissues in the dwelling were beyond what a couple would create. The freeholderinsisted the problems were entirely due to their use and occupation.

The investigation

The leaseholders said the mould problem had become steadily worse since they moved in four years earlier and suspected it was more severe in winter and when it rained. The local water table was not known to be high.

The dwelling had a solid floor overlaid with wood laminate that had become distressed, indicating the presence of moisture. There were no external low-level through-wall air vents. Capacitance meter readings on the solid floor suggested dampness. A hygrometer wassecured to the floor overnight. The next day, its relative humidity reading had risen from 60% to just over 90%. A solid floor should emit no more than 75% for it to be su?ciently dry to overlay with floor coverings. These measurements indicated a damp solid floor.

A small excavation in the floor to check for a DPM revealed it was actually a suspended solid floor. A hygrometer probe was inserted into the sub-floor void and left for 40 minutes. It also found just over 90% relative humidity, indicating that the dampness emanating from the suspended solid floor was at equilibrium with the sub-floor air.

An endoscope inspection found a deep sub-floor void. It contained builder?s rubble and earth very close to the underside of the floor; this would become increasingly damp during rainfall as the ground became saturated. There were water droplets on the underside of the floor and no vapour barrier. The lack of air vents meant a build-up of water vapour and condensation that permeated into the habitable space.

Remedial actions

The soil and rubble were removed, through-wall air vents installed to the external walls and a DPM installed. Internal mould was removed using a biocide and the flat redecorated and floors recovered. The problem of dampness and mould was resolved tothe satisfaction of the occupiers and an out-of-court settlement reached.

Art and science

Understanding a building?s design, layout and construction materials are vital when determining the risks of moisture intrusion. If there is little or no contribution of dampness from these sources then occupiers? lifestyle must be considered, possibly requiring periodic environmental monitoring to measure their impact on the dwelling.

Without a holistic approach to damp, it can be di?fficult to differentiate between the various causes due to building design, building failure and occupants? lifestyle ? and the connections between these. That is why Professor Malcolm Hollis said: 'Surveying buildings is an art, verifying the cause of failure is a science'.

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Further information

- Level 4 surveys are discussed in Diagnosing damp , Burkinshaw and Parrett, and in Pathology on isurv.
- BRE Digest 297, *Surface condensation and mould growth in traditionally built dwellings*.
- Building pathology film series, Limelite media.
- BS 6576:2005+A1:2012 , *Code of practice for diagnosis of rising damp in walls of buildings and installation of chemical damp-proof courses*.
- BS 5250:2011 , *Code of practice for control of condensation in buildings*.
- BRE Digest 245:2007, *Rising damp in walls ? diagnosis and treatment*.
- Next in the series: Nothing lasts forever
- This feature is taken from RICS *Property* journal (March/April 2016).