Nothing lasts forever

31 October 2016

Continuing his series on the connections between building design, failure andoccupants? lifestyle, Michael Parrett considers how building defects contributeto damp problems

---

Defects and failures occur through natural deterioration, lack of maintenance, architectural design and poor construction. The difficulty arises when internal dampness and mould develop and investigators often struggle to make the vital connections betweenthe principal factors.

For example, in social housing, emphasis has been placed on problems being caused by occupants? lifestyles. In my opinion, based on thousands of investigations, it would be a mistake for practitioners to make this assumption without eliminating the other elementsaffecting the building; the approach must be holistic.

Figure 1: Roof spread on a typical 1920s cottage where the original slate-tiled roof was

replaced with interlocking concrete tiles with a much higher implied weight loading on to the frame. The timber collars had not been strengthened with additional bolts to the rafters. Warning signs include separation of the soffit boards from the wall face, curvature of the cast iron guttering and outward movement of the top of the brick walls.

Natural deterioration

All materials have a life expectancy. Even something as durable as natural Welsh slate, which took millions of years to form, will eventually delaminate and crack; this is through natural deterioration caused by exposure to water, algae, frost and so on. Hard Portland cements used for wall renders will also deteriorate over time because they are unforgiving when buildings naturally move. Cracks will allow water in, and so starts the degradationcycle of frost action.

Another example is lime used on walls. In Venice, lime is partly used to encourage salt to come out of the brickwork because of the high incidence of rising damp. The salt naturally breaks down the lime and the walls have to be re-limed at least every 15?20 years.

Figure 2: Perforation of steel barrel underground water main supply pipes. Galvanised (zinc-coated) steel pipes laid into soil will eventually corrode and lead to an escape of water. These pipes were excavated from the ground at an 85-year-old property. Zinc is a sacrificial anode and will deteriorate in most soils, especially ones with higher acidity. This results in the steel gradually losing its protection, leading to corrosion and eventual perforation of the buried bare steel pipes.

Underground lead water mains meanwhile have a proven life of around 100 years, after which they become brittle and the slightest movement will cause them to perforate or fracture, particularly if they are laid in acidic or aggressive soils. Natural deterioration also happens with underground steel pipes for gas and water mains. Some are galvanised and use zinc as a sacrificial anode that will deteriorate; a similar process is used on old steel-frame windows. In both cases, the zinc breaks down and exposes the unprotected steel beneath, which then rapidly corrodes.

Other examples of natural forces causing deterioration include:

- ground movements ? both subsidence and heave ? cracking slate damp-proof courses and disturbing gas, water mains and drainage
- sulphates permeating through a rising water table causing solid floors to crack,craze and delaminate, in particular in older buildings
- carbonation of concrete, when carbon dioxide slowly penetrates the surface and mixes with moisture trapped in the pores, reacting with calcium hydroxide to form calcium carbonate that causes the deterioration of the concrete and the steel reinforcements inside
- chloride attack on concrete, for example, caused by salt being spread on road bridges, which leads to severe breakdown of the concrete
- low bitumen content undersarking will erode, especially where it is lapped into the gutter. Water then runs down the back, rotting fascia and soffit boards, and perhaps also runs into the walls or the top of window heads as well, leading to further deterioration.

Case study

A four-storey flat conversion in south London suffered from many of these issues. Poor design and construction, natural and assisted deterioration, and lack of maintenance all combined to create serious problems in the property.

The owners had partially extended the rear ground floor and installed a mono-pitch roof. Unfortunately, this prevented easy access to the eaves gutters of the main roof and impeded routine maintenance, such as painting the cast-iron gutters. The gutters alsofilled with leaf litter and moss balls that had formed on the north-facing main roof. This had been replaced some years earlier but now suffered from erosion of the low-bitumen content undersarking, which further deteriorated in the eaves gutter.

The result was that rainwater spilled over the gutters and penetrated the solid wall where timber-floor joists anchored into the wall between floors. These joists then started to decay. An under-sink pipe also leaked because of poor maintenance and a blocked bathroom extractor fan did not remove the moisture.

These issues together conspired to create a massive outbreak of the dry-rot fungus, Serpula lacrymans. Because this growth had prevailed over time, the fungus produced the?fruiting? body from which extended the mycelium hyphae and its characteristically cobweb-like strands. These eventually weakened the timber joists to the point where their collapse was a possibility.

Assisted deterioration

Human intervention can exacerbate deterioration and is often linked to poor maintenance routines, for instance, where work is ill-conceived, badly performed ornot carried out at all. Examples include:

- decorating externally during poor weather ? I have witnessed painters sweep snow from window sills before painting them
- wooden windows being painted on an irregular basis

- external spar-dash render only infrequently painted, often just covering cracks in the surface
- cast-iron gutters not being painted on the back, so they then corrode, allowing water to run down the walls
- using the wrong type of primer paint, e.g. a non-aluminium type primer, which is typically used on hardwood timber window sills, used on metal windows will accelerate deterioration
- using non-micro-porous paints on wall renders, particularly lime renders that require lime-wash finish, which trap moisture rather than letting walls breathe
- use of most chemical damp-proof injections, which do not provide a complete barrier to prevent rising damp in masonry and other walls.

The Society for the Protection of Ancient Buildings promotes the annual National Maintenance Week and National Gutters Day to help raise the profile of preventative maintenance.

The building surveying profession needs a Hippocratic oath that recognises thelimitations of most general or structural surveys

Poor construction often exacerbates deterioration and increases the chance of building failures. Take the example of a slate roof that has naturally deteriorated and needs renewing. Slate roofs should normally be replaced with a similar natural or simulated material, but interlocking concrete tiles are often used and these place a much higher loading on to a timber-framed roof, so additional strengthening works are needed.

We have found cases where this has not happened and even instances where some collars, struts and purlins have been removed, or the collars are merely nailed rather than bolted to the rafters. These issues lead to roof spread that pushes out the tops of the externalwalls, distorting soffits and fascia boards and even bending cast-iron gutters. In extreme cases the roof can collapse.

Identifying the cause

The signs of dampness caused by a building defect are similar to other causes. There may be staining on walls, mould, high meter readings and so on. Many defects happen at roof level with water penetrating downwards throughout a building.

Indications of building failures can be obvious, such as cracked or dislodgedroof tiles and leaking pipes. Or they may be more subtle, such as the slight outward movement of walls, distortion of fascias or the curvature of guttering.

Figure 3: Carbonation of reinforced concrete mullions on a 1960s building. Some buildings with reinforced steel concrete can benefit from additional cathodic protection, which can act as a medium to take the corrosive electrical flow away from the embedded steel rebars in damp concrete.

These signs should be easy to see in houses, but may be more difficult to identify on a much taller building where it is harder to check clearly whether guttering is an older cast-iron system or a modern replacement, for example. Good binoculars or a telephoto lens on a camera should help you identify detail.

Defective rainwater goods are the most common failure that cause damp penetration, often leading to a misdiagnosis of rising damp when water from an overspilling gutter strikes the ground and splashes onto the base of the wall.

While it may sound simplistic to talk about issues such as gutters, these problems bedevil everyone from surveyors to social landlords. I have been called to many properties where it has turned out to be routine gutter and rainwater pipe failures that have somehow escaped identification by many other people.

But to properly identify the cause of a building defect problem, it is crucial forsurveyors to have knowledge of the in-built defects caused by design, material selection and construction across different types of buildings (see One thing leads to another).

Besides using your investigative skills, remember to talk to people during site reconnaissance. A seller is unlikely to give information that might prevent a sale. However, in multiple-occupancy buildings other people might give clues to help diagnose potential problems. A chat with someone else ? such as another tenant, neighbour, management committee member or the person in charge of maintenance ? might reveal a lot more about the history of a building and any maintenance issues.

It is easy for a surveyor to miss or misdiagnose a building defect. This is mainly because surveys are usually conducted on a single visit and often do not include any measurement, invasive testing or detailed investigation. In such a short timescale, it can therefore be difficult to correctly determine the cause of an issue, so surveyors invoke *caveat emptor* ('let the buyer beware').

All materials have a life expectancy and even somethingas durable as natural Welsh slate that took millions of years to form will eventuallydelaminate and crack

Some causes and problems are clearly connected, such as a leaking external rainwater pipe and a corresponding internal damp stain. But what happens if the link isn?t clear, or there may be more than one cause? What if the actual cause is a leaking water main, a missing damp-proof membrane or some other problem that is invisible on a brief inspection? A surveyor might use their professional judgement about the likely cause, but this will require further examination and testing to be certain. More in-depth pathology is required, which will usually mean some degree of invasive investigation.

This might feel like a step into the unknown on a residential survey, and goes against general guidance that promotes non-intrusive, non-destructive approaches. I have often found that the best way to determine the cause and source of a problem is throughsome kind of invasive testing, such as an optical endoscope. In many cases, further and better pathology should be suggested to the client to make them aware of what is required, rather than a referral to damp ?specialists? offering long-term guarantees.

Construction supervision

Insufficient supervision of construction contributes to building defects; it can beeasy for the quality on projects to slip and this increases the risk of failures. My previous article (see Property Journal May/June 2016, p.36) discussed an example in which poor design led to many failures, including damp caused by leaking soil vent pipes and buildings that did not comply with fire regulations. These issues had not been identifiedduring building control visits.

Another example of poor building control processes relates to airtightness. A building was nearing completion and a standard air pressurisation test was conducted. It found that the building leaked like a colander. When the head of building control was asked about inspections, he said his department had never been invited to visit the site.

In my opinion, the building control service needs to be strengthened to meet the challenge of an increased number of construction projects during stronger economic cycles. This can only be done by engaging more trained inspectors to cope with the demands and complexities of making buildings sustainable, airtight and energy efficient.

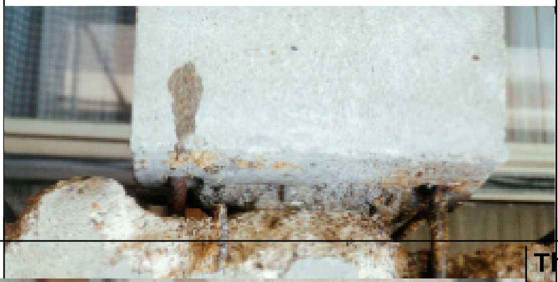

Figure 4: Carbonation of concrete, as seen in both images, occurs when reinforced concrete absorbs moisture and carbon dioxide from the air. This reacts with the Portland cement, which contains calcium hydroxide, and begins to lower the alkalinity of the concrete from the normal level of around pH 12.

The acidity then increases andbegins to corrode the steel reinforcements at pH 7 or below. The deterioration weakens the structure, eventually requiring specialist repair. The carbonation process is only harmful in reinforced concrete and will not occur in very dry environments (below 40%relative humidity).

Maintenance data

When budgets are tight, maintenance cycles are often stretched and cause building elements to fail, when more regular intervention would have prevented damage. It is important that those responsible for maintaining property portfolios, such as social landlords, build accurate databases recording when different solutions were applied to various elements of buildings. The system should include reminders of when a previous repair or renewal solution is approaching its anniversary, so its condition can be reassessed and a decision made about whether a renewal is required. It should also drive and record the mid-life maintenance regimes of solutions, as these will help prolong their working life.

For example, flat roofs with elastomeric mineral felt systems only have an insured life of 20?25 years, but many may not last that long. A protected underground steel water main may last 50?80 years, but an unprotected one may perforate in eight to 10 years. It is important that somebody understands this lifecycle information as it allows them to make proactive and informed decisions about maintenance work.

Lifecycle work

While ensuring high-quality construction for a building is crucial to its future performance, preventative maintenance is probably the most important way to avert ongoing building failure. So when you next perform a survey, what questions are you going to ask about work that has or should have been done?

The building surveying profession needs an equivalent of doctors? Hippocratic oath, one that recognises the limitations of most general or home surveys. It needs to develop a new generation of forensic building pathologists who can independently determine the source and cause of a building defect, especially relating to dampness. These pathologists will be able to write a specification of remedial works, or at least be moreprescriptive about the exact remediation, further investigation or monitoring that may be required.

Michael Parrett is a building pathologist, chartered building surveyor and founder of [Michael Parrett Associates]

Further information

- Images ? Michael Parrett

- For the first in the series, see One thing leads to another
- For the next in the series, see The golden rule of surveying .
- Related competencies include Inspection , Building pathology , Housing maintenance, repair and improvements , Design and specification
- This feature was taken from the RICS *Property journal* (July/August 2016)