UK Centre for Moisture in Buildings

UK Moisture in Buildings Survey

Conditions, Actions and Outcomes

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Author's preface

This study was commissioned to the UK Centre for Moisture in Buildings (UKCMB) and funded by Saint-Gobain.

The survey was designed to:

- Show the multivariate and inter-dependent nature of the matters covered.
- Emphasise system dynamics such as change over time.
- Faithfully report what has been said without imposing undue reporting bias.
- Encourage readers to think for themselves about the matters covered, and perhaps suggest improvements.

For its basis the report draws on a heuristic diagram (Fig 1), which may be found online here. [1] The diagram may also be used as a presentation of the main findings.

The diagram has:

- The conditions, as one respondent put it, which are relevant to thinking about moisture in buildings. These are normally relevant in all situations.
- The actions which are context-dependent and are mainly about how buildings are perceived, occupied, used and maintained.
- The outcomes such as whether needs are met, with occupant health, moisture balance and policy implications being particularly relevant. Outcomes also include a perspective on how systems may improve or degrade over time.
- Each of the categories shown (e.g. Geographical, Era, Construction, Occupant Density, Health) are derived from what respondents have said is important to them in response to what the survey questions have posed.
- The categories are portrayed as nominal (e.g. construction has five discrete types highlighted) or ordinal (e.g. Maintenance, which is a rule-of-thumb scale from 1 to 5, low to high). This is an over-simplification for diagrammatic purposes.
- Each is coloured red, amber, yellow, or green reflecting what respondents have said about them.
- Each part of the diagram is clickable and takes you to a more detailed description of the considerations for each category, and examples of responses.

Adrian Leaman

January 2019

1 This approach is under development and may change after the body of the report is finished. An heuristic is an aid to learning or, in CH Waddington's words, a 'tool for thought.'

Introduction

This is a report of a survey carried out during the summer and autumn of 2018 in order to better understand what its members consider to be the extent and causes of moisture problems in buildings in the UK.

Despite the existing research efforts in the UK and internationally, there are still many unanswered questions and areas of uncertainty. The point of this survey is to help bring new information, experience and opinion to bear on this subject, as well as to help open up new areas of enquiry and research.

It is also a way of testing the level of interest and concern in the sector, which can be important in providing support to research programmes and in informing communications to the wider public, government and industry.

The survey was conducted online. We have asked open questions, preferring them to multiple choice so that respondents are freer to express themselves, allowing plenty of space for evidence and examples. We have tried to ask only about things which we think are important and to which we do not have clear answers. These were drafted by Neil May on the basis of his experience in preparing earlier material.

Thirty-three UKCMB members responded, with one declining for ethical reasons. [2]

The data obtained are fully reported in the appendices.

- Appendix A has frequency histograms of numerical data from three questions.
- Appendix B has the written responses from twenty-one questions, set out alphabetically by question, and mildly edited for spelling, grammar and to help preserve respondents' anonymity.

The subject headings used in the report below are derived in part from a heuristic diagram (Fig 1), which may be accessed here. [3] This serves as an overview of the themes covered and their relative importance from the respondents' point of view.

Tracking the colours in the diagram illustrates what the respondents have been saying, where red describes problematic instances, yellow or amber indicate caution, and green normally good. The conditions (or less colloquially, parameters) at the top of the diagram can loosely be construed as defining the main causal characteristics that are always present. Actions in the centre of the diagram, are user, manager or designer interventions. Outcomes are the results or consequences of the interactions of all the variables described.

Respondents consistently say that:

- Moisture problems are universal, insidious and systemic, made worse by often being invisible to the uninitiated.
- Problems can occur in any building type and in any era if basic requirements like consistent maintenance, adequate resourcing and user awareness are not met.

The majority of respondents (53%) answered from personal experience, 17% on behalf of their organisations and 14% from both (Appendix A1 for details).

[2] At the time of writing we do not have the total number of members polled, so cannot estimate the response rate.
[3] The diagram is a clickable web format exported from a Keynote file which may also be used as a presentation. The Keynote file is available separately,

Just under half of the respondents said that moisture problems had got worse in the UK in the past five years (A3). But 34 per cent said that they did not know.

“Don’t know” was a recurring theme. For example, 36% said they did not know whether moisture problems were worse in different parts of the UK (A2). Three respondents were from outside the UK, which party explains this.

Respondents were a mixture of practitioners, consultants, academics, and PhD students, with a wide range of experience and interest in the field as described fully in Appendix B1.

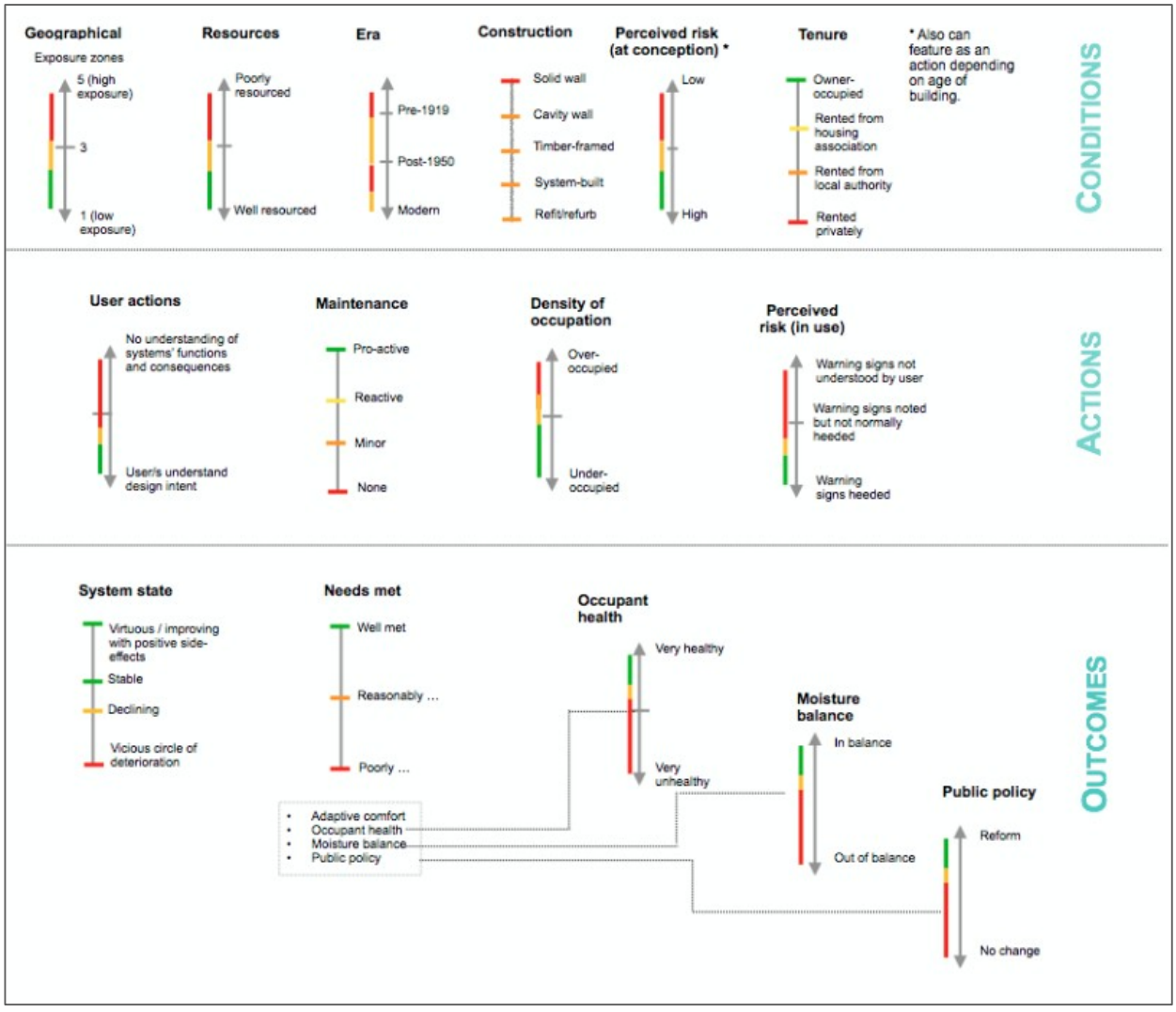

Figure 1. Dynamic Heuristic Diagram: Conditions, Actions and Outcomes. Click here to access the diagram

Overview

The purpose of this work was to poll UKCMB members to elicit more detailed responses on current problems associated with moisture in buildings in the UK. The internet-based survey necessarily has downsides, especially when many of the questions did not have easy or short answers.

These are some of the main points arising.

- Respondents drew widely on their own experience rather than published research, hence frequent acknowledgement by them of 'I don't know' or 'I am guessing'. For instance, a third of respondents did not attempt to say what proportion of UK homes had serious moisture problems.
- Respondents repeatedly stressed the importance of interdependence, which was lacking in both regulations and in design strategy, colloquially put as the 'lack of joined-up thinking'.
- There appears to be widespread ignorance amongst designers, developers, clients, contractors, managers and users about how heating, ventilation and moisture work together.
- Single-issue treatment of carbon reduction and energy efficiency has had noticeably negative effects on moisture balance in buildings especially with respect to air-tightness.
- Many occupants and managers do not understand the importance of ventilation, passively or actively, hence the need for better guidance on use.
- Higher densities of occupation and lower capacities of new buildings to accommodate the moisture generated in them are a cause for concern, especially where house sizes are getting smaller and the activities in them increasing.
- Risks to occupants' health, especially in the context of fuel poverty, where users are frightened to heat their homes because of debt fears, are a growing concern.
- Many moisture problems are down to poor monitoring and maintenance, irrespective of era or construction type.
- Moisture problems have worsened over the past five years in the UK.

Conditions, Actions and Outcomes

Proportion of UK homes with moisture problems

We asked respondents for their estimates of the proportions of UK homes with serious moisture problems (Appendix B2) and any moisture problems (B3). It is clear from the answers that many do not know, and have to guess or caveat their answers. For serious moisture problems, estimates range from "a few percent" (B2/4) to "40-80%. Research needed" (B2/17). For any moisture problems (Appendix B3), of the few answers that were attempted, 50-80% were the most common.

One of the respondents said:

> "I suspect that various combinations of fuel poverty, social housing, ill-health, exposure zones 3-4, poor maintenance regimes, sloppy renovations and inadequate insulation and ventilation greatly affect the likelihood of serious moisture problems." (B2/17, B5/6)

Another gives details:

> "I've carried out approximately 40 whole house assessments or other house visits over the last year, mainly in the North West of England - so my data (are) fairly anecdotal. Out of those 5 had serious problems with moisture. (One a failed cavity wall insulation install in a coastal location, one a very damp cellar/undercroft with rising damp and rotting floor timbers plus problems at the roof with missing leadwork around a chimney, one cause by under-heating over a prolonged period combined with under-ventilation and penetrating damp through damaged pointing in a solid brick wall, two had failed gutter/failed external wall insulation (<<in a town >> - where lots of other houses also affected))" (B2/18)

Geographical extent

One-third of the respondents offered an answer to the geographical distribution of moisture problems, heavily underscored with caution, typically:

> "Areas of high exposure certainly seem to fair considerably worse. This can be due to local differences in micro climate as well as regional differences." (B5/1)

More specifically:

> "I believe that Cornwall has a higher than average prevalence of damp homes, there being a high proportion of solid-walled buildings. Other contributory factors no doubt include the (i) low socio-economic status (SES) of a large number of resident householders and (ii) climate. … Large numbers cannot afford to get on to the property ladder, contributory factors including (a) low levels of industry (which is over-reliant on seasonal tourism), and a shortage of affordable homes; this is partly due to the large numbers of second homes which push prices up. People are forced to rent, with the data from the English Housing Survey showing higher levels of dampness amongst tenants' homes. … Clearly, as the most westerly county in England, levels of driving rain are higher here than elsewhere in the country." (B5/4)

Others think not (B5/7):

> "I would anecdotally say no, anywhere where overcrowding, poor ventilation, low or no maintenance and a fear of bills from running extract or heating."

Resources available

The survey did not specifically ask about resources, because this is obviously crucial, but many emphasised it nevertheless, especially in the context of fuel poverty. For example:

> "In my experience, solid wall properties suffer very easily but partly because fuel poverty has a disproportionate impact. Flats in high and mid rise (partly due to nature of ventilation, but also because ducts etc have become blocked over the years)." (B6/12)

Era

Is there a particular era which has more moisture problems? Opinion is divided. For instance, these think not:

> "Not really. The problems are caused by numerous variables. While some concrete houses from the 60s may be prone to condensation issues by virtue of good air tightness and poor u-value, that problem may only be apparent if the occupancy is high. All buildings have their weak areas. These can be made problematic by i under ventilation ii under heating iii over occupancy iv lack of maintenance v lack of occupant understanding vi particular microclimate vii poor quality of original construction." (B6/19)

> "No. it is more to do with how people live in their houses. There is a very high percentage that do not ventilate their homes in any way because they think that to do so will waste heat and the cost of producing it. This extends to disconnecting extractor fans, blocking air bricks, preventing cross flow ventilation in roof spaces, closing up chimney flues and many more examples. (B6/17).

> "I think 'old = hard to heat / problematic' is greatly over-stated. A lot of old buildings have been treated appallingly which has made them respond badly to the modern heat and moisture levels we impose (partial renovations, poor maintenance, walls covered in PVA then acrylic paints applied reducing moisture buffering capacity, pavements raised, etc). (B6/7)

> "Poorly insulated / unable to afford to heat ones; poorly ventilated; poorly maintained; Unprotected (those without sufficient external cladding approaches to reduce the effect of driving rain. This can be the case across a large variety of ages." (B6/22)

> "Our claims span all eras of housing stock. Modern construction has better ventilation, trickle vents on windows, extraction fans in bathrooms & kitchens, etc which day by day appear to better manage moisture levels to a happy equilibrium. This would lead me to consider that older housing stock may suffer more with moisture problems where ventilation is not designed into the structure. " (B6/21)

On the other hand:

> "Certain types of dampness are more likely to affect houses of certain eras. Solid-walled properties typically built >100 years ago are more likely to suffer from structural forms of dampness such as rising damp or penetrating damp. They were commonly built without a damp-proof course. Porous lime mortars and under-fired bricks were often used… In more modern housing stock, condensation tends to be the dominant form of dampness." (B6/3)

> "1960s - 1980s seem worst for internally generated moisture loads, traditional buildings badly maintained are worst for moisture ingress from outside and occasional rising damp (due to incorrect ground levels and saturation due to faulty rainwater goods or abutting walls etc)." (B6/1)

> "Pre-1919 because of construction defects and leaks. 1960s-1970s system built because of poor insulation and thermal bridging." (B6/1)

Construction

Are there particular types of houses that suffer more? The greatest emphasis is on 'coincidences of variables'. Thus:

> "…there may be coincidences of variables that produce especially risky conditions. So a super low energy target combined with vapour tight construction that has only one membrane on the outside and a poorly installed vapour control layer (VCL) on the inside around a complicated geometry… Such conditions would increase the risk of failure and probably catastrophic failure. The archetypal flat roof extension is often subject to many of the above." (B7/2)

> "… The key issue is about condition and actions, not typologies. Solid wall (including modern hollow and solid concrete blocks) may be most likely to have low surface temperatures. Cavity wall may be structurally vulnerable if poorly built. Timber frame may be most hygrothermally vulnerable is built or renovated poorly. Low energy housing can be most vulnerable to poor indoor air quality (IAQ)." (B7/9)

> "Serious problems stem from a host of issues including their use as well as structural elements therefore, it is my opinion that all properties have the potential to suffer the same problems." (B7/16)

Solid and rubble walls, cavity walls and timber frame are most frequently mentioned, as in:

> "Solid wall (more specifically rubble walls), brick and block with fibrous insulation in the cavity. Loft spaces where the householder has blocked off the eaves ventilation or boarded over the loft ." (B7/17)

> "Solid wall concrete panel (ranges from high rise to Tarrans bungalows)" (B7/18)

> "Solid wall houses are more at risk of moisture problems due to their cold surfaces and possible moisture penetration from rain. " (B7/21)

> "Traditional solid wall houses where there is external vapour impervious render and/or paint coatings and to some extent hard cement and not lime pointing to masonry joints suffer particularly from interstitial condensation. This is due to the inability of the fabric to allow vapour to escape to the external air. " (B7/25)

> "Cavity wall after having the cavity filled." (B7/5)

> "Cavity wall, timber frame and 'low energy' housing." (B7/6)

> "Timber frames have an elevated risk due to the damage moisture may cause for mould growth, degradation, and wood warping. Damp risks will exist in all dwellings that do not have a design appropriate for the surrounding conditions. " (B7/24)

Poor maintenance also features, as in:

> “Poorly maintained homes are probably the worse, but with types I would think that cavity and solid walls are the worse.” (B7/15)

The main causes of serious moisture problems in existing homes are portrayed as systemic, with knock-on effects that are rarely envisaged or understood, an over-exaggerated faith in technology, while under-estimating the efficacy of basic ventilation and heating.

Thus:

> “Poor ventilation caused by blocked trickle vents, windows that do not stay open easily for ventilation, recirculating kitchen extractors (that people think are extracting!), occupants not aware of need to ventilate, thermal bridges in construction, heating systems with no or poor controls, poor maintenance (in particular related to rainwater management), fuel poverty creating extreme cold spots behind curtains/furniture.” (B11/23)

> “Replacement windows with no consideration of ventilation strategy. Shower rooms with poor ventilation and lots of cold surfaces. Existing windows with very poor thermal performance and chronic condensation coupled with no maintenance. Poorly weathered door thresholds. Impermeable external landscaping dressed up to the building plus building levels. “ (B11/26)

> “I believe that a combination of inadequate heating and poor ventilation in alliance with the householder's failure to understand their importance. I consider the interaction of these three to be most important. The problem is made all the worse because the householders do not think that such simple things as opening the windows and heating the house can really make a big difference. In another timber-framed house rented out, recent tenants also started to experience dampness where the house had been dry for years before. We believe that this resulted from the fact the occupants did not ever leave the relatively newly-installed windows (lacking window vents) open on the secondary latch, for fear of "throwing heat out of the window". People want high tech solutions, the letting agent wanted to have mechanical ventilation installed! Another tenant sealed the kitchen fan vent to prevent heat losses. Tenants, often on low incomes, try to save on heating, but in so doing create problems of dampness.” (B11/7)

> “It is more to do with how people live in their houses. There is a very high percentage that do not ventilate their homes in any way because they think that to do so will waste heat and the cost of producing it. This extends to disconnecting extractor fans, blocking air bricks, preventing cross-flow ventilation in roof spaces, closing up chimney flues and many more examples.” (B11/9)

Lack of maintenance again features, for instance:

> “Poor maintenance - seals around windows, flashings around chimneys, incorrect ground levels internal poor occupant behaviour (though not poor but logical if you have no other way to dry clothes), inadequate ventilation in postwar homes” (B11/17)

> “Poor maintenance, guttering and penetrating damp associated with inappropriate material selection e.g. renders etc”. (B11/19)”

> “Poor maintenance, inadequate ventilation, poor construction where old meets new and poor occupant knowledge” (B11/20)

For new homes air tightness, lack of air movement, poor detailing and poor construction standards are prominent in the comments. The trend towards smaller floorplates increase occupant densities. A sellers' market with poor technical competence among corporate clients means that risks are not properly mitigated and buyers are forced into poorer quality, smaller homes. (B11/22) Individual factors are seen as prey to the culture of a compliance-driven industry.

> "Poor detailing and workmanship regarding the design and installation of cavity trays and DPC's at roof abutments and around window openings. Turning off MVHR ventilations system and then having no alternative ventilation method other than opening windows. Providing vapour control layers (VCLs) in all external walls, ground floors and ceilings under roofs, this forms a plastic bag type environment, coupled with not providing a suitable ventilation system to remove harmful water vapour created by the occupants and their activities." (B12/13)

> "Poor detailing by designers, very poor construction standards and the lack of ventilation provision due to the need to make houses as air tight as possible. That is exacerbated by the lack of guidance / instruction given to new and successive occupants on how to live in their houses and how to operate them. The average person will assume that they will live in a new house in exactly the same manner as an older house." (B12/14)

> "Poorly designed ventilation systems. Sometimes no design and heavy reliance on intermittent bathroom extract fans installed for 'compliance'. Trickle vents not sized or not achieving free area claimed. Flow rates not checked on site, flow rates affected by installation (e.g. flexible ductwork and back pressure). Where full mechanical systems are specified residential buildings suffer from very poor mechanical design, there is a clear split in quality between res/non-res. Design flow rates are sometimes not possible to achieve with the fan and duct sizes specified. Installation is similarly poor. There is often no commissioning or ineffectual commissioning at 'boost' rate. Chronic thermal bridging, usually from steelwork e.g window lintels for large openings. Rooflight installation details." (B12/17)

> "So it isn't about the individual measures/factors that cause moisture, it's about retail buyers who are obliged to buy poor quality homes from a compliance-driven construction industry, and corporate clients (again social landlords, local authorities, with few exceptions) that are not technically competent enough to recognise and mitigate risk - primarily performance, overheating, ventilation and moisture - in the homes they commission. " (B12/22)

We asked whether there are parts of buildings with moisture problems that have not been fully recognised in the regulations. Abstracting from the full list in Appendix B8 these are some of the points raised.

- Blocked vents under suspended ground floors.
- Building Regulations set out systems that are acceptable for new build or refurbishment but it is left to the designer to make the selection. There should be more information on when it is considered necessary to have continuous ventilation in preference to intermittent.
- Cavity wall insulation (injection type)
- Cavity walls with faults in external skin.
- Complex junctions
- Conditions in super-insulated attics
- Degradation of integrity of EWI - lack of client awareness and skill in recognising this risk
- Degradation of MVHR
- Eaves box areas

- Flashings around chimneys
- Incorrect ground levels.
- Insufficient advice on ventilation.
- Interaction between solid walls and modern solid floors with damp-proof membranes
- Interstitial condensation within the fabric
- Laminate floors removing floors breathing
- Mineral fibre in brick and block cavities.
- Modern materials are not always appropriate to be used on traditional buildings and fabric.
- Moisture conditions within internal and external walls of fully tiled wet rooms.
- No requirement for ongoing maintenance, monitoring etc.
- Overheating of roof spaces
- Rain penetration in general is poorly covered by regulations.
- Relative to other countries, there is very little attention paid to the need for maintenance in the UK - i.e. clearing gutters and drains.
- Site moisture during the building phase when buildings are exposed and when wet trades are adding water to the fabric.
- Soakaway drains
- Thermal bridges
- Ventilation below suspended timber floors
- Verge trims

Are problems different in non-domestic buildings?

> "High moisture load buildings are highest risk, such as high activity buildings, swimming pools and offices with high occupancy like call centres." (B10/7)
>
> "Period properties suffer the most … as they tend to exhibit long term damp related issues. Whilst this is not uncommon in these types of buildings, understanding its age, construction and ability to deal with expected damp is paramount." (B10/14)
>
> "Older converted leased properties generally occupied by SMEs where maintenance and upkeep of a leased property is down to an unconcerned landlord." (B10/11)
>
> "Most are structural ingress issues either by breakdown of original as-built criteria or the implementation of latter day damp remediation techniques that may not have been suitable or indeed, installed correctly." (B13/10)

Other building types at risk include:

- Basements
- Churches
- Hotels (especially 19th century)
- Ice rinks
- Kitchens
- Older public buildings with multiple occupancy e.g. schools
- Poorly maintained traditional buildings without experienced or skilled managers
- Saunas

Factors to consider include:

- Cold bridges

- Commercial properties converted from domestic, with the conversion hiding older problems.
- Over-occupancy
- Leaks
- Flood risk
- Poor maintenance

In new non-domestic builds:

> “Poor detailing by designers, very poor construction standards and the lack of ventilation provision due to the need to make houses as air tight as possible. That is exacerbated by the lack of guidance / instruction given to new and successive occupants on how to occupy in their buildings and how to operate them. The average occupant will assume that they will use (the) new building in exactly the same manner as an older one.” (B14/10)

Renovation

Feedback on the consequences of renovation and retrofit (Appendices B15 to B18), mirror earlier observations but also add these insights.

> “Lack of attention to existing leaks and failures throughout process and the desire to cover up existing problems. Addition of non moisture open layers, including plastic paints. Addition of complex heating and domestic hot and cold water systems with no consideration of where water will go of a pipe is damaged. The covering up of all pipework behind layers that cannot be removed. Poorly executed or inappropriate insulation.“ (B15/12)

> “Lack of proper surveys, introducing systemic cold bridging, poor material selection not considering hygrothermal performance of the original structure” (B15/13)

> “Materials degrade, become porous over time, things that were designed into allow air movement have become blocked, covered up, or sealed, (fireplaces, Int floor vents, wall vents, weep holes). Stock is not maintained, often a moisture problem can be ignored, go unnoticed for months and when fixed, it is fixed locally to the source, by then moisture has affected much more of the surrounding area and the rot continues. The source, reason for the failure rarely explored, people go straight to "the cure”. (B15/15)

> “Poor understanding of how older buildings were constructed and the type and behaviour of the materials that were used in them. There is an assumption that older buildings are inherently damp, which they are not. The problems arise when the natural vapour permeable nature of the structure is disrupted by poor design and detailing, very poor construction standards and the lack of ventilation provision due to the need to make houses as air tight as possible.” (B15/21)

> “Providing insulation to inside of solid non-insulated external walls which changes the dynamics of the wall, i.e. making it colder and increasing the risks of surface and interstitial condensation in the wall and also reducing its ability to use the heat from the room to keep it dried out. Likewise, increasing insulation to a cold roof void without checking the need for extra cross ventilation to compensate for the reduced air temperature of the roof void leading to a higher risk of surface condensation on underlays and exposed structural members. “ (B15/25)

Are there types of properties more prone to problems after renovation?

“Older properties tended to have natural airflow through them due tot heir construction whereas latter day properties have insulation elements added as standard. The addition of these elements to older properties has also served to encourage problems that previously didn't exist. “ (B16/12)

“Not really. The problems are caused by numerous variables. While some concrete houses from the 1960s may be prone to condensation issues by virtue of good air tightness and poor u-value, that problem may only be apparent if the occupancy is high. All buildings have their weak areas. These can be made problematic by under ventilation, under heating , over occupancy , lack of maintenance , lack of occupant understanding , particular microclimate , and poor quality of original construction. “ (B16/13)

As for ‘deep’ retrofit:

“All elements (walls floor and roofs) have their challenges and solutions. The myriad of interfaces between the elements is the hardest issue to resolve. This takes time and experience and costs money. The occupant needs to appreciate that the home may not need heating as hard as before and that there may be a mechanical system regulating the ventilation. They need to understand that if the ventilation system fails or is switched off that may adversely affect the air quality and humidity levels inside. They should also be aware that if they see a damp patch it may be more important to get it fixed than in a non retrofit.” (B17/2)

“Detailing around other building elements - creates cold bridges and gaps through which moisture can penetrate. On the better projects these are dealt with well. Problems more likely to occur on projects that are rushed to take advantage of government funding and not overseen by eco architect or specialist deep retrofit company.” (B17/3)

“Embedded timbers (from suspended ground floor joists to upper floor and ceiling joists, wallplates and window lintels) in exposed solid masonry facing south-west. Interstitial condensation between original windows and secondary glazing above the plane of neutral pressure at the tops of houses on the leeward side of prevailing wind. Roof timbers above areas of leakage (e.g. around loft hatches) into cold loft spaces. In parts of the building where leakage from poorly maintained rainwater goods haven't been prepared. “ (B17/4)

“Internal insulation of solid walls making the walls colder, slower to dry out and risk of any water penetration building up and becoming harmful. Risk of surface condensation on the inner surface of the solid wall between the insulation and wall where no VCL, or only partial VCL, is provided on the warm side of the insulation and difficulty in continuing the VCL around openings and junctions with intermediate floors.” (B17/10)

“IWI, much research now being done on the need to look at the outside and the inside for treatment. Even then, is a breathable system or a vapour closed system employed?. How do you maintain a true VCL?, what happens with radiator pipes, sockets, hanging shelves? How far into the room do you stop it if EWI is used on the back to be safe? What about the intermediate floor, what about the fact the wall is now cold and wet and will remain so because most of the heat that went through the wall has now been stopped?, does the external wall degrade faster?.“ (B17/11)

“Junctions between thermal elements. These are hard to treat, they span different retrofit trades (ergo contracts), each building is different, so standardisation of robust details is hard to achieve. Roof structures are complex, and many buildings have

subsequent additions of many different periods (hence varying thermal performance). “ (B17/12)

“Obsession with energy saving rather than whole house thinking, reliance on chemical fixes, membrane use.” (B17/13)

“Solid floors. We have experienced this in the past. The best solution, digging up the floor and installing insulation is costly and disruptive. The secondary inferior solution of installing thin insulating materials and/or carpeting can result in different floor levels (a tripping hazard) as well as look aesthetically unpleasing. This secondary remedy may only be partially effective, and the carpeting may act to promote the proliferation of house dust mites.” (B17/19)

Following retrofit are lifestyle or maintenance changes desirable?

“All energy saving measures bring a need to change lifestyle. Boiler and effective heating systems should be balanced, with TVRs set for optimum settings and these should be registered (never happens), control of the thermostat takes getting used to as people perceive it costs a lot more than intermittent on off heating. Loft requires eaves remain clear, Cavity requires good roof, gutter and pointing maintained and solid wall requires control of impact, raising of paths and fixing things into it. All retrofits should come with a section for the home owner, how to use, do, do not, then there should be a section for any contractors who come in to do any work that would interface with the retrofit undertaken with a list of do, do not etc.” (B18/1)

“Focus on occupant induction because like 99% of the population, they will be used to operating a building in a traditional way. Follow up is likely to be needed. Would be wise to fit a Switchee or similar device instead of a traditional thermostat, as this type of device can send alerts when temp and RH go outside certain parameters. You can add a CO2 sensor to the system, it will feed to the Switchee which will then transmit CO2 data. So extra expense for the Switchee hub, CO2 sensor and data charges, but much more risk managed and gives you an understanding of what may need to be improved when reiterating the design, i.e. provides a learning loop for the next project. “ (B18/4)

“Knowledge that as the house has far less uncontrolled air leakage (i.e. is airtight) the ventilation system needs to be functioning correctly, maintained (or filters changed) and serviced. That maintenance of roofs, rainwater goods, window sills, brickwork etc, is even more important to prevent the build up of moisture in spaces that can't be seen such as between brick and internal wall insulation interface. “ (B17/7)

“People need to be re-acquainted with their building and made to understand how new or adjusted behaviours are advisable. Leaky buildings and buildings with low levels of moisture generation are forgiving! A bit like climate change people expect they can judge the future from what happened in the past but a higher level of airtightness with higher levels of moisture generation may have the same address but is effectively a different building.” (B17/13)

“This is a real problem. How do you get a householder to open the windows and heat the home, when the resulting dampness problem is at a remove, intangible? By nature, human beings on the whole tend to respond to authority. They are more likely to act upon an authoritative, simple-to-watch, 3-minute video explaining why it is so important to do this, rather than heed the advice of a landlord or make the additional effort of reading a leaflet. Is this something UKCMB could promote? To make such a video and ensure that all window fitters supply customers with one?” (B17/17)

Are there special lifestyle or maintenance adjustments that need to be made after a retrofit project in addition to those that might be expected in non-retrofit? The implications of greater air-tightness for maintenance and users' understanding of ventilation systems and vapour control layers, as in:

> "Knowledge that as the house has far less uncontrolled air leakage (i.e. is airtight) the ventilation system needs to be functioning correctly, maintained (or filters changed) and serviced. That maintenance of roofs, rainwater goods, window sills, brickwork etc, is even more important to prevent the build up of moisture in spaces that can't be seen such as between brick and internal wall insulation interface." (B18/7)

> "Ensuring the condition of any solid internally insulated external walls is kept in good repair to reduce or prevent rainwater penetration which could persist within the wall for longer due to the lack of heat from inside the building reaching the wall through the insulation. Maintenance and correct operation of any heating or ventilation system provided as part of the retrofit to keep internal humidity and temperature at acceptable levels. " (B18/3)

> "Not in addition to - with possible exception of … taking care to maintain vapour control layer on IWI, roof/loft and floor insulation (though this also true of a lot of new build, and VCL should be designed to take people's habits into account and so is robust). " (B18/12)

But people should live as they think fit.

> "There should be only improvements to lifestyle, people must be able to live in their homes how they see fit. There are likely to be increased maintenance requirements as it seems mechanical fans and associated filters are valuable enough in moisture, energy/cost, and air quality terms. Can this be balanced by reduction in heating maintenance requirements?"

Perceived risk at conception

As might be expected, several say that appropriateness of design and client competencies are contributory factors, as in:

> "Damp risks will exist in all dwellings that do not have a design appropriate for the surrounding conditions." (B7/24)

> "Poor design, lack of access to appropriate materials and skills, lack of knowledge re-traditional buildings, poor specification, lack of detailing, timescales for work, cost constraints, grant programme timings, EPC driven decisions, short term fixes and no long term assessment of solutions …"

> "Poorly thought through design and (connected with this) poor client competence. There is simply too little awareness in large client groups of the risks of deep retrofit, and investing in training (eg retrofit co-ordinators) is seen as an expense rather than an investment in managing risk. The costs of poor retrofit are absorbed in day to day revenue expenditure, with no-one linking back effect to design, construction and site supervision, so the costs are hidden, unlike capital costs which are driven down. Minimum regulatory standards are used almost exclusively as the driver for practice and outcome. So poor clienting is the main cause, with the list you have given being the outcomes from this." (B11/25)

Tenure

Tenure, specifically differences between owner occupation and rental, features as significant for both domestic and non-domestic buildings, especially where it impacts on monitoring and maintenance, as here:

> "There is not much difference between types of non domestic buildings in respect of damp. It all comes down to how they were built in the first place and how they are maintained. The main difference is between those that are owner occupied and those that are rented where the latter are usually worse maintained and therefore prone to damp than owner occupied who have the vested interest of maintaining capital values rather than gross rental income." (B10/20)

User actions and lifestyles

Moving on to aspects of users and managers' behaviours, we asked whether there are aspects of lifestyles which have not been fully recognised. This prompted:

> Real-world behaviours "Most regulations do not take any account of how people really live their lives in their homes. There seems to be an idealised image as to how people live or that they have read some sort of manual as to how to do so. A far more realistic approach should be taken when developing any new regulations or reviewing existing ones and that should be based on a detailed study of how people actually live and behave." (B8/9)
>
> Design for the most challenging lifestyles "Lifestyles are so very different that it is difficult to design for. But having worked for 13 years with one of the larger housing associations one learnt to design for the most challenging lifestyle. These were where occupants would not operate complex controls for heating and ventilation, would not open windows, would seal over trickle vents and turn off electrically operated ventilation systems in the mistaken belief that they were using electric so were expensive to run. The consequences of such actions meant that internal environments could quickly become unhealthy. I have heard that some housing associations who fitted MVHR systems, for energy efficiency, have experienced very bad condensation problems due to occupants turning off the systems and then having no ventilation, including no background ventilation. Is this the fault of the occupants or the designer for not anticipating the occupant's behaviour?" (B8/14)
>
> Awareness "There is a lack of awareness about how much moisture people and activities produce, but the challenge is getting people to believe you. In many cases they are looking for a physical cause - eg leaks, poor quality work - when in reality it is often poor design interacting with occupant behaviour. But occupants rarely want to listen to how they can be part of the solution. I have tried to convince tenants with uncovered fish tanks that the water evaporating daily from the tank is a considerable part of the condensation issue they were having, to no avail." (B9/21)
>
> "Regulation places responsibility on landlords to ensure properties are safe, where lifestyle is the issue however, there is little that can be enforced on tenants who fail to understand or cooperate" (B9/19)

Examples include:

- Clothes drying habits
- Cooker extracts not venting to outside
- Cooking without lids on pans

- Education of occupants
- High occupant densities
- Houses in multiple occupation
- Lack of sufficient extract in bathrooms
- Loft insulation blocked off
- New babies
- Pets
- Under-heating
- Washing
- Washing drying on radiators

Impacts

We wanted to know what regulatory, demographic, construction practice or lifestyle changes are having the greatest impact, positive or negative. This is challenging, but almost all respondents offered a view:

> Client competence "Crikey. For retail clients, they should be able to trust that they have procured a building where the work is sound, well designed and risk managed - I think this is a regulatory issue, unlike corporate clienting (build to rent sector to some extent but mainly social landlords, Local Authorities) where clients just need to undertake the long, hard slog of cultural change. They don't need the government to mandate them to do it, or be given money, they need to be much more effectively challenged by their own regulator in terms of outcomes and value for money. They are spending the money at the moment on poor quality outcomes, so this needs to be diverted into clienting practice. Dealing with this by regulation/grant will not embed client change." B20/8"
>
> Cost of maintenance "Cost of carrying our repairs and maintenance is too high for most people - due to a number of issues such as - VAT is chargeable on building repairs. Building repairs tend to be labour intensive and difficult to automate due to variability of the housing stock - Certain regulations - e.g. working at heights - makes minor maintenance such as gutter clearance prohibitively expensive for many - Lack of skilled tradespeople able to carry out this type of work (apprenticeship and training schemes tend to focus on new build)" (B20/7)
>
> Increased demand for services and variable demand "Demands for more domestic hot and cold water services and the desire that these are hidden. The increase of all manner of extensions that have intrinsically challenging interfaces while being built by those with the lowest standards. Variable occupancy (from overcrowding to more temporary occupancy in holiday homes for instance)" (B20/9)
>
> Carbon wagging the dog "Eco schemes where cost per unit of carbon is everything. Situation where will acknowledge that up to a third may have terrible moisture issues identified in their survey but if having any other measure than insolation, nothing will be done about it. Government needs to get out of its silo mentality, where each dept. has a budget and look at policy effects across the piece. Providing decent retrofit, including robust moisture management strategy alongside energy efficiency will not only help the environment dep't meet its goals, it will reduce health service costs, improve tax revenue and create jobs, but any "funding" is seen as a cost and it all comes from the one area. " (B20/11)
>
> Moisture control and energy efficiency "This seems to want the answer to be 'energy efficiency' but I believe energy efficiency is very important to user comfort and user

prosperity so UKCMB should highlight the ways in which moisture control and energy efficiency can work together for positive benefit." (B20/24)

Flood Re insurance "Flood Re is helping consumers obtain insurance at a reasonable cost in known flood risk areas. Planning and building control are trying to improve flood resilience in modern construction design. I have just finished a new build on the Thames where the property has had to be elevated in its build to rise above flood waters and have utility connections that can with-stand flood conditions." (B20/13)

Joined-up thinking "Negative, lack of joined up thinking and regulations including testing of materials. Beneficial, people slowly starting to understand breathability and the need for whole house esp with PAS 2035 and the potential knock-on effects of this" (B20/20)

People not at home "People are less likely to leave windows open when not in. More people work than ever before so properties don't have people coming & going and again locked up." (B20/21) and " There seem to be a host of approaches by installers, new build developers, surveyors and construction companies alike but it is my opinion i am not sure if there is uniformity through all sectors and demographics. " (B20/23)

Construction moisture "Procurement often forces work to be carried out at the wrong time of year - so forcing construction during wet weather and increasing construction moisture." (B20/22)

As for wider consequences of moisture problems for the UK deterioration of building fabric leading to earlier failure, cost of remedial work, and occupant health featured widely as in:

"New generation' of moisture problems caused by rush to retrofit without thinking it through, and changes in new build construction (e.g. airtight buildings). At the same time, there is a culture of not bothering to maintain existing housing stock and waiting until issues become critical before dealing with them." (B19/22)

"Rot in houses, structural failure and poorer health associated with breathing issues." (B19/26)

"Serious, high-profile failures undermining confidence of government and the consumer in the industry, with consequential failure to retrofit the building stock." (B19/27)

"The most serious problems across all building types relate to deteriorating indoor air quality and its affects on human health. For historic buildings specifically, fabric decay leading to the loss of heritage assets is also a serious risk." (B19/31)

"Failure of UK buildings earlier than needed. Effects to health for occupants, a tacit acceptance that you can do nothing about it. A lack of confidence in solutions when clearly a high percentage mistreat/misdiagnose damp now and will do in the future unless some regulation / training is made mandatory." (B19/6)

Implications for policy and regulation changes

Themes developed above - more systemic thinking, better basic maintenance routines, more emphasis on ensuring a healthy environment, better methods for prediction, better training across the industry, better mitigation strategies when things fail especially when capacity threshold are exceeded - feature in the suggestions. As in:

“We should treat the problem proportionally, and ensure that it complements the other required changes to our society and housing stock needed to respond to the challenges of climate change. The smaller home renovation and cyclic maintenance interventions must be captured, not just projects with professional design teams. Obligations on products and suppliers to ensure they are assisting construction achieve the requirements.” (B21/26)

“Regulation to require effective moisture management is incorporate into the design and construction of new buildings and refurbs. Back up with better design of inspection of buildings as they are being built. Education of construction sector. Encourage better insulation through government programme - windows etc. Encourage the use of triple glazing and heat recovery systems in new build, eliminate trickle vents. Require better forced ventilation.“ (B21/19)

“Everything is done in isolation, it needs a whole property solution that is adaptable depending on the build type, construction method, existing adaptations and proposed.” (B21/11)

“Designers and builders need to consider how insulation, ventilation and moisture work together. They need to design in capacity. The design of water services within buildings needs to be regulated with mitigation strategies for when things fail. This is again about capacity. Constructions such as screed over insulation need to be regulated somehow with a BS for how they should be designed to avoid trapping moisture.”

“Buildings could be inspected on a regular basis and basic repairs and maintenance carried out (e.g. gutter clearing, replacement of perished window seals, crack repairs etc...) much in the same way that one would expect to have to service a car on a regular basis. Certain elements of part C of the Building Regulations could be applied to existing buildings as a level of performance to aspire to - e..g. protecting moisture - vulnerable building elements from moisture from the ground, rain penetration, condensation etc…”

“Building regulations for retrofit need to follow on from the good work done for the new PAS 2035 [4]. The government needs to stop funding poor piecemeal retrofit and instead let the owner of the property decide what it is best to do. More training is required in the industry for contractors, developers, building owners to understand the health implications of moisture in buildings, and their responsibilities under the health and safety act for homes. “ (B21/8)

“Any further increases in thermal insulation values should take into consideration the risk of overheating. Perhaps a method should be investigated for estimating the balancing point between providing enough insulation to gain maximum thermal efficiency before having to provide a cooling system. Ventilation levels should be assessed on the basis of what is needed to provide a healthy environment for air quality in preference to reducing ventilation to save energy. This could help illustrate the need for higher ventilation rates for impervious structures and a lower ventilation rate for breathable structures which allow some of the water vapour to disperse through the structure. This could also establish whether certain types of structure would require continuous ventilation or whether intermittent ventilation systems would be sufficient.” (B21/3)

[4] PAS 2035 PAS 2035:2018 Specification for the energy retrofit of domestic buildings

Summary

The purpose of this work was to poll UKCMB members to elicit more detailed responses on current problems associated with moisture in buildings in the UK. The internet-based survey necessarily has downsides, especially when many of the questions did not have easy or short answers.

These are some of the main points arising.

- Respondents drew widely on their own experience rather than published research, hence frequent acknowledgement by them of 'I don't know' or 'I am guessing'. For instance, a third of respondents did not attempt to say what proportion of UK homes had serious moisture problems.
- Respondents repeatedly stressed the importance of interdependence, which was lacking in both regulations and in design strategy, colloquially put as the 'lack of joined-up thinking'.
- There appears to be widespread ignorance amongst designers, developers, clients, contractors, managers and users about how heating, ventilation and moisture work together.
- Single-issue treatment of carbon reduction and energy efficiency has had noticeably negative effects on moisture balance in buildings especially with respect to air-tightness.
- Many occupants and managers do not understand the importance of ventilation, passively or actively, hence the need for better guidance on use.
- Higher densities of occupation and lower capacities of new buildings to accommodate the moisture generated in them are a cause for concern, especially where house sizes are getting smaller and the activities in them increasing.
- Risks to occupants' health, especially in the context of fuel poverty, where users are frightened to heat their homes because of debt fears, are a growing concern.
- Many moisture problems are down to poor monitoring and maintenance, irrespective of era or construction type.
- Moisture problems have worsened over the past five years in the UK.

The responses have been reported in three broad categories - Conditions, Actions, and Outcomes. These are derived from what the survey questions asked for, and the answers given by the respondents:

- Conditions are the main variables seen to affect moisture conditions:
  - Geographical location
  - Resources available
  - Era of building
  - Construction type
  - Perceived risk (at conception)
  - Tenure type
- Actions are the main variables resulting from user, owner, management and designers interventions:
  - User actions
  - Maintenance
  - Density of occupation

        - Perceived risk (in use)

- Outcomes are the resulting effects of Conditions and Actions operating in given contexts:
    - System state dynamics (how buildings improve or decline over time)
        - e.g. Moisture balance
    - Needs met (the effects on occupants, and wider social implications)
        - e.g. Occupant health
        - e,g. Public policy

We have interpreted what the respondents have said from their comments and ratings by colour codes, where red illustrates the highest risk or most damaging causes and effects. Circumstances described by amber and green colours in combination are reported to produce good outcomes. For example, a well-maintained building in a low exposure area with a timber-frame built post 1960, with knowledgeable occupants who understood moisture-problem symptoms, would normally be expected to have a relatively healthy environment with a stable moisture balance. All the comment data are available in the Appendices, so that readers can check our inferences, should they so wish.