Building Performance Survey 2016 – Summary

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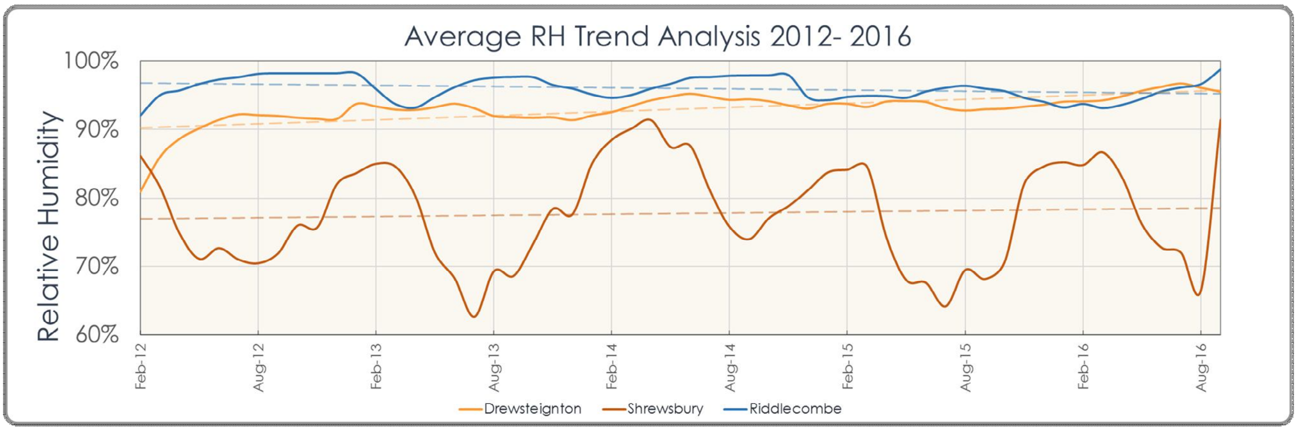

Average Relative Humidity (RH) Trend Analysis, Shrewsbury, Drewsteignton & Riddlecombe, 2012 - 2016. From The SPAB Building Performance Survey 2016 Report, p. 95.

The SPAB Building Performance Survey has been established in order to look at questions of risk in the refurbishment of traditional buildings. Since 2011 temperature and relative humidity profiles have been measured through three insulated solid walls. Joined, in 2014, by measurements of material moisture content. These different measurement techniques aim to provide a detailed insight into the behaviour of moisture and moisture risks in the fabric of the walls. Measurements show us how moisture quantities change and we are able to see to what extent these changes may be due to the weather, the location and orientation of the walls, their general condition and the materials used within them. Over the past six years we have built up a picture of the seasonal behavior of moisture in the walls, as well as longer-term trends, which allows us to see the different and at times competing influences that affect these moisture profiles.

The 345 mm thick brick wall in Shrewsbury is the thinnest of the three walls in the study. It is south-facing, made of low fired porous brick with decayed pointing. The wall is insulated internally with 40 mm of woodfibre board with a lime plaster finish. Of the three walls under study, it has the lowest measurements of vapour (factored either as relative or absolute humidity – RH or AH) and the lowest rates of material moisture content (%MC the measurement of liquid water). A granite wall in Drewsteignton, Devon, has also been internally insulated. This wall is north-west facing, 580 mm thick and has 100 mm of polyisocyanurate (PIR) insulation added to the internal face with a 25 mm air-gap and skimmed plasterboard finish. This granite wall provides higher measurements of vapour and %MC, measurements of RH in this wall exceed 80%, the threshold associated with the risk of mould growth and fungal decay. The third wall in the study is situated in Riddlecombe, also in Devon and is made of cob (unfired earth). This wall is 650 mm thick and has insulation incorporated into it's thick external render. This wall has the highest quantities of vapour and %MC measured through it's section.

The reason for the differences between the moisture responses in the three walls lie with the differences between the circumstances of the walls themselves and their individual treatments. The thinner, south-facing wall at Shrewsbury is quite exposed to rain, including rain driven by southerly winds. The porous nature of the brickwork and washed-out pointing ensures that moisture can penetrate quite deeply into the wall structure. However, due to its southerly aspect, the wall also receives plentiful heat from direct sunshine as well as air movement through its relatively open structure. Due to the nature and orientation of the construction, vapour responses in this wall are very dynamic and at times quite extreme. The external side of the wall quickly becomes wet and during periods of driving rain this moisture can penetrate towards the centre of the wall. However, the wall also dries out rapidly due to heat and abundant air exchange through the substrate. It is noticeable that despite this volatility, parts of this wall, in particular the interface between the woodfibre insulation and masonry, maintain a relatively stable RH profile, below that of the 80% risk threshold. It is possible that the moisture buffering qualities of the woodfibre insulation make a positive contribution to this vapour profile, flattening out RH responses at this location. Over the past six years we have seen that this wall responds very quickly to it's immediate environment and despite some years of record breaking wet weather the wall is able to dry out sufficiently over an annual cycle to maintain RH quantities below the risk threshold. The long-term vapour trends in the wall are strongly influenced by annual weather patterns.

The wall at Drewsteignton is different. It is thick and constructed from granite, a stone of limited porosity. Its north-west facing aspect means that the external wall face receives little sun and the building is located in a Devon valley bottom which has roughly double the rainfall than that of Shrewsbury. It is therefore, perhaps, not surprising that this wall has a higher vapour and material moisture profile than that of the brick wall. However, it is the long term RH trends which are of interest at Drewsteignton. These are high (90%+) and have continued to increase year on year since the wall was insulated. Thus, regardless of the weather patterns of individual years, the moisture profile of the wall is increasing, which suggests that moisture is in someway accumulating within the fabric. We suspect that this is, in part, the result of the application of a relatively large quantity of a vapour closed insulation material. The foil-faced insulation prevents the movement of moisture, either as a vapour or a liquid, to the internal wall surface from where it might evaporate. The insulation has also significantly reduced the amount of heat that passes through the wall from the interior which, particularly in winter, results in a lower dewpoint temperature through the masonry section increasing the possibilities of moisture accumulation. It appears, given the construction and location of this solid wall, the addition of a material which compromises its ability to move moisture and significantly alters its dewpoint has increased the risks associated with high RH within the fabric of this wall.

The cob wall is different again and is found to have the highest records of both vapour and %MC. This wall is externally insulated and south-facing. It is very thick and made of a porous, highly permeable material (unfired earth) which is also able to absorb and hold large quantities of water. As part of the refurbishment process a cement render was removed and the cob damped down with significant amounts of water to aid the adherence of the new render. Since measurements began in 2011 we have recorded very high RH in this wall and dewpoint conditions (100% RH) almost permanently toward the external side of the rendered wall surface. We found that, contrary to other walls, RH records peaked in high summer and concluded that this was due to the vaporisation of moisture from the wet cob substrate in the south-facing wall. Over the years, whilst RH is still high, in the centre of the wall we have seen these quantities slowly decline as the wall gradually loses the excess water held within its fabric. Long-term, this downward trajectory means that over the past year average RH quantities measured from the wall at Riddlecombe are, for the first time, lower than those of Drewsteignton. Therefore, whilst vapour quantities may still be high we see a picture of slow improvement. Cob is a vapour open material which allows for the free movement of vapour, however, it is possible that the thickness of the new render and its relative permeability is acting as a significant impediment and slowing drying down in this wall.

In conclusion, we find that as well as the influences of external and internal climate the performance of these walls is conditioned by their individual material components and context. The wall at Shrewsbury might be seen as an example of an intervention to improve energy efficiency which has not compromised the wall's ability to moderate its moisture over the long term. However, the same may not be the case for the wall at Drewsteignton, where a trend of rising RH suggests an accumulation of moisture within the wall fabric over the years following refurbishment. Riddlecombe tells a different story, of how high quantities of moisture can be bound within materials and the significant time it may take for this moisture to dissipate depending on the qualities of those materials and their ability to move and dry out excess moisture. The long-term measurement of these walls allows a detailed view of what determines moisture behaviour in solid walls. Through careful analysis we can be more confident in identifying risks for particular structures and what may, or may not, constitute an effective treatment with regard to energy efficiency interventions.

For more detailed information please refer to *The SPAB Building Performance Survey 2016 Report.*