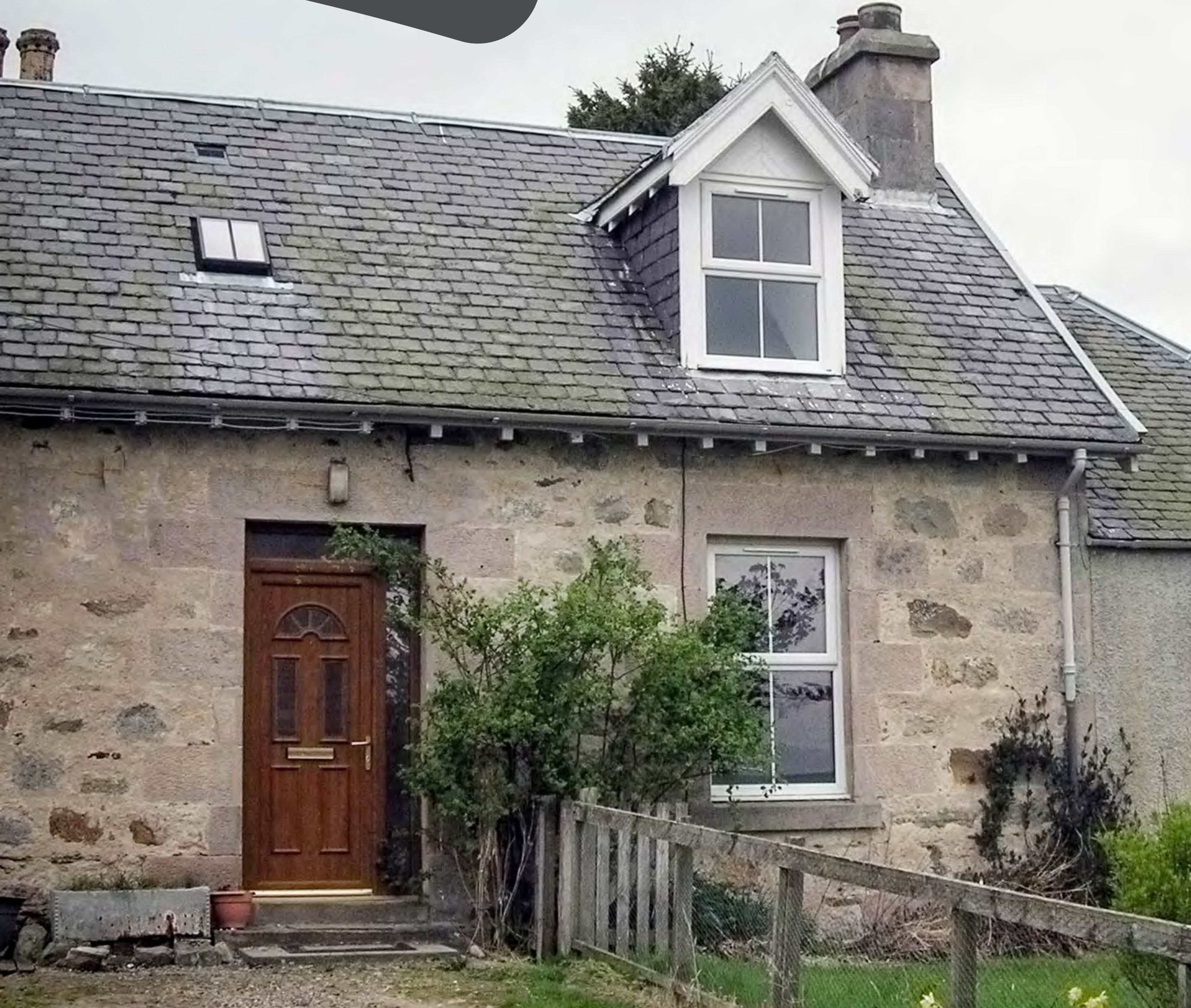
REFURBISHMENT CASE STUDY 27

HOLM FARM COTTAGE GRANTOWN-ON-SPEY

VENTILATION AND INSULATION IMPROVEMENTS

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA



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HISTORIC ENVIRONMENT SCOTLAND REFURBISHMENT CASE STUDY 27

HOLM FARM COTTAGE, GRANTOWN-ON-SPEY

VENTILATION AND INSULATION IMPROVEMENTS

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Acknowledgements:

With thanks to the Reidhaven Estate

REIDHAVEN ESTATE

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1. INTRODUCTION

In response to the drive to reduce CO_2 emissions and make buildings more energy efficient, there is a need to retrofit insulation measures in buildings. Whilst insulation has many benefits, the long term success of retrofitting traditional buildings requires measures that will not negatively impact the building fabric. When any part of a building is insulated this alters how that building behaves, not just in terms of reducing heat loss, but also in how the building handles moisture movement and ventilation. It is important, therefore, to fully understand how a building works and how that will change in response to any alterations, such as improvements to energy efficiency. If these factors are not understood and accounted for when designing an insulation programme, there is potential to create the conditions from which building defects, such as timber decay and mould growth, emerge.

This Refurbishment Case Study examines a building in which the conditions to support the development of extensive mould growth were created following the introduction of certain energy efficiency measures. These measures included the use of insulation which was impermeable, restricting the ability for moisture to diffuse through the building fabric, and also the introduction of double glazed windows which, when the trickle vents were closed, prevented sufficient ventilation of the building. Thus, attempts to create a more energy efficient building had the unintended effect of creating ideal conditions for mould growth. Occupant behaviour, in regard to the correct use of ventilation and minimising the production of moisture within the internal environment, was also a critical factor in the problems seen at the building. This Refurbishment Case Study looks at the measures undertaken to reverse these harmful effects whilst still making the building more energy efficient.

2. THE BUILDING

Holm Farm Cottage, located in Grantown-on-Spey, is one of a semi-detached pair of mid-19th century estate cottages on the Reidhaven Estate (Figure 1). The original part of the building is built of rubble walled masonry, with a later cement rendered extension. Both parts of the building are roofed with slate laid onto sarking boards. The building was refurbished in the early 2000s and had lost most of its original internal finishes. The windows were removed and replaced with uPVC double glazing as part of this previous refurbishment work.

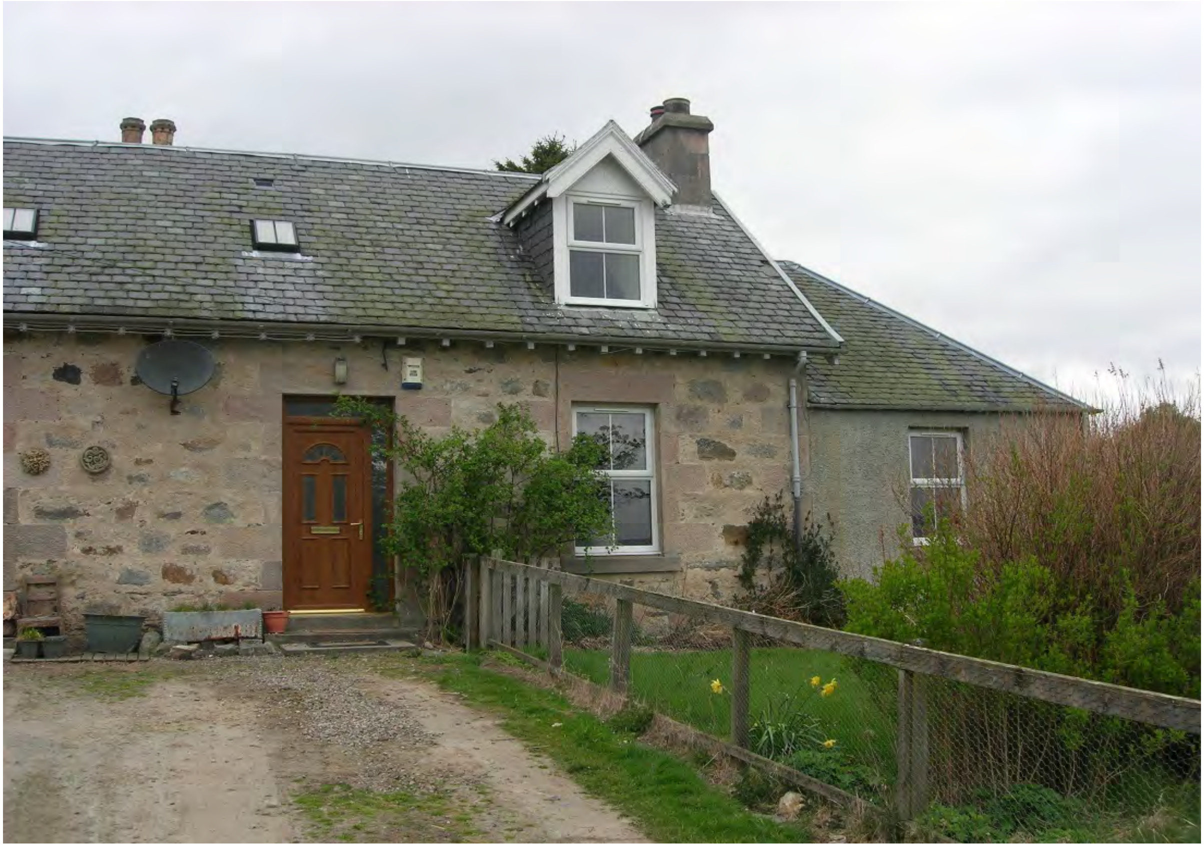
Figure 1. Holm Farm Cottage, showing the original building and the modern bathroom extension on the right.

3. PREVIOUS INSULATION WORK

As part of the aforementioned refurbishment, the external walls on the ground floor had been insulated using 100mm thick phenolic foam. Along with uPVC double glazed windows, this insulation resulted in an internal environment with little ability to buffer relative humidity within the building fabric, and which relied on the operation of trickle vents and inadequate extractor fans in the bathroom and kitchen for ventilation. These ventilation measures proved insufficient as mould growth began shortly after the refurbishment (Figure 2).

Mould growth was particularly pronounced in the later extension, the bedroom, bathroom, and in the stairwell, even though this area had not been insulated (Figure 3). Following this failure, it was deemed necessary to reverse the retrofit and implement a strategy to both thermally insulate the whole building envelope and tackle the relative humidity which had led to the mould growth. These works principally involved the use of a vapour permeable insulation material to help buffer relative humidity. Mould growth was further arrested by installing a more sophisticated extractor ventilation system to ensure warm moist air, caused by occupancy, could be removed from the building.

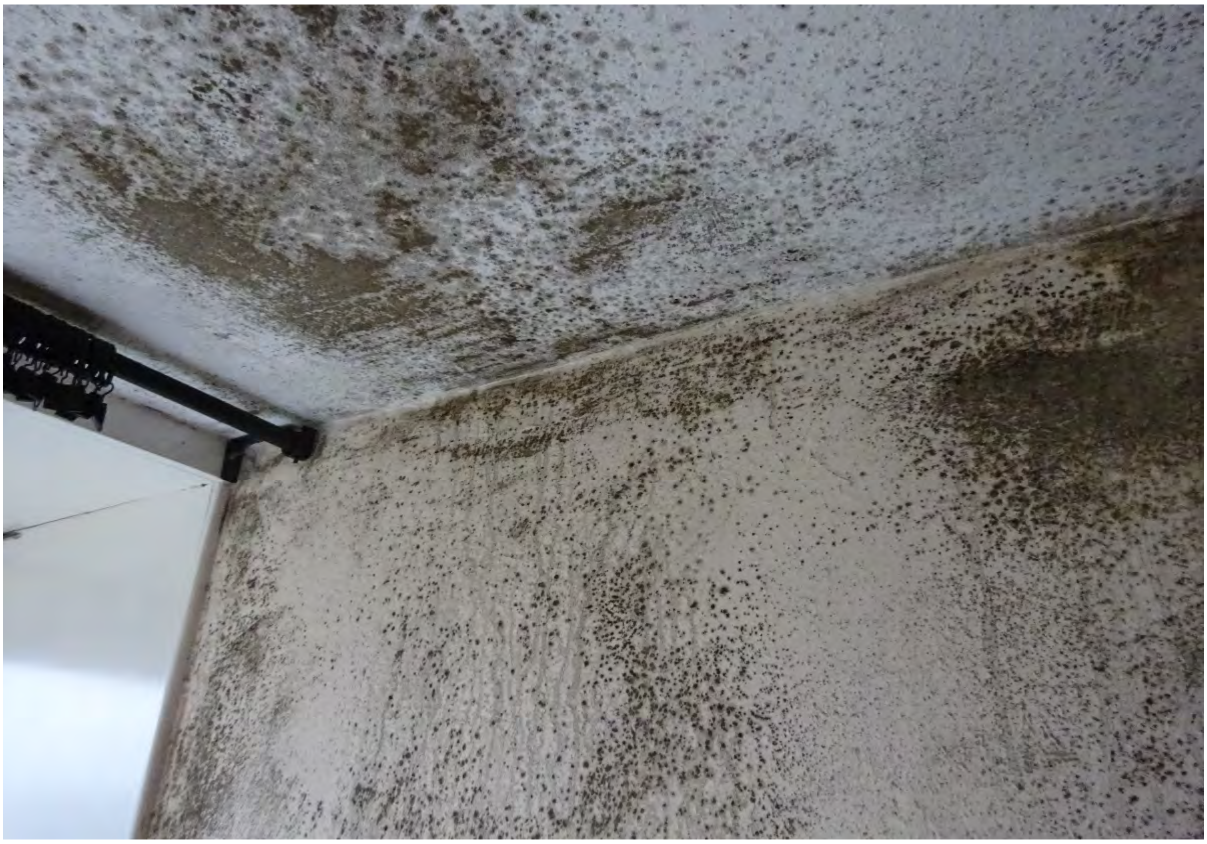
Figure 2. Previous insulation and ventilation schemes had failed, leading to substantial mould growth throughout the building.

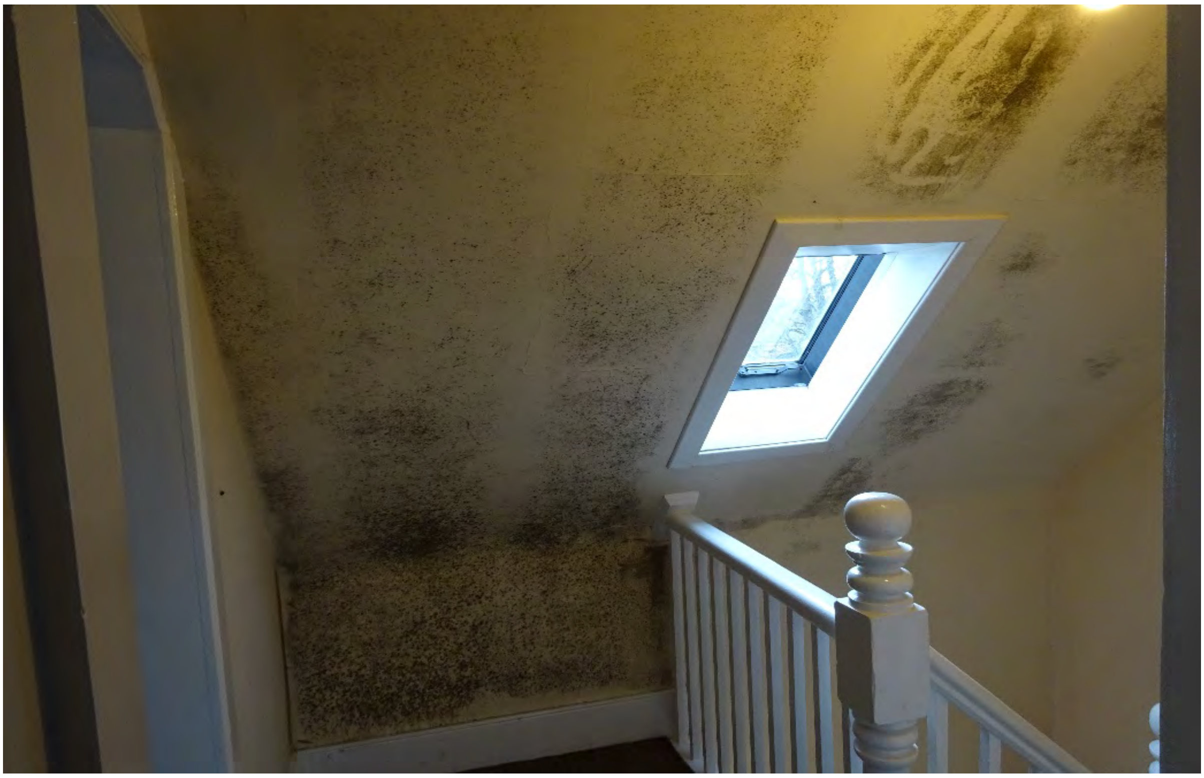
Figure 3. Substantial mould growth on the surface of the uninsulated stairwell roof space.

4. MOULD GROWTH IN BUILDINGS

A basic review of the mechanisms which lead to mould growth in buildings is necessary to understand both the problem and its solutions. Mould growth only occurs when the conditions are right to allow it, as it is a symptom of a wider failure with the way in which a building handles moisture. Only by changing the conditions that have led to the excess moisture can the problem be truly corrected. Mould needs three things to grow: spores from which to germinate, a food source and sufficient levels of moisture. Microscopic mould spores are ubiquitous in the air and their presence cannot be contained, so it is the control of food sources and moisture that determine a mould's ability to grow. In a building, it is the materials of the building (wallpaper, plaster, timber, etc.) that comprise the food for mould but since these cannot be eliminated, moisture levels are the major cause of a mould's ability to establish itself. Other factors such as temperature and exposure to light can also influence the growth of mould.

Most moulds grow when moisture levels are over 70-75% relative humidity, with above 85% required to thrive in most cases. Relative humidity refers to the amount of moisture vapour held in the air relative to the amount of moisture vapour the air can hold at the given temperature, expressed as a percentage. Reducing indoor relative humidity to between 30-60% is therefore likely to inhibit the growth of mould and prevent it re-establishing itself where it has been removed.

The moisture required for mould to grow in a building can come from many sources, including building defects and leaks. Condensation as a result of high internal relative humidity can also create the conditions for mould to grow (Figure 4). The only effective way to control mould and prevent it re-establishing itself is to remove the source of moisture which has led to its growth in the first place. For more information on managing moisture levels in buildings, see Historic Environment Scotland's INFORM guides *Damp: Causes and Solutions* and *Ventilation in Traditional Houses*.

At the cottage the main problem which led to an excess of moisture internally was a lack of ventilation, exacerbated by high internal relative humidity created by occupant behaviour. Examples of occupant behaviour which produce moisture internally include cooking, drying clothes indoors, showers and bathing. Whilst these are all part of everyday life, if vents are not kept open, including trickle vents where appropriate, and extractor ventilation not used correctly, high levels of internal relative humidity can be created (Figure 5). The measures described below were all designed to reduce internal moisture levels to ensure the mould did not re-establish itself.

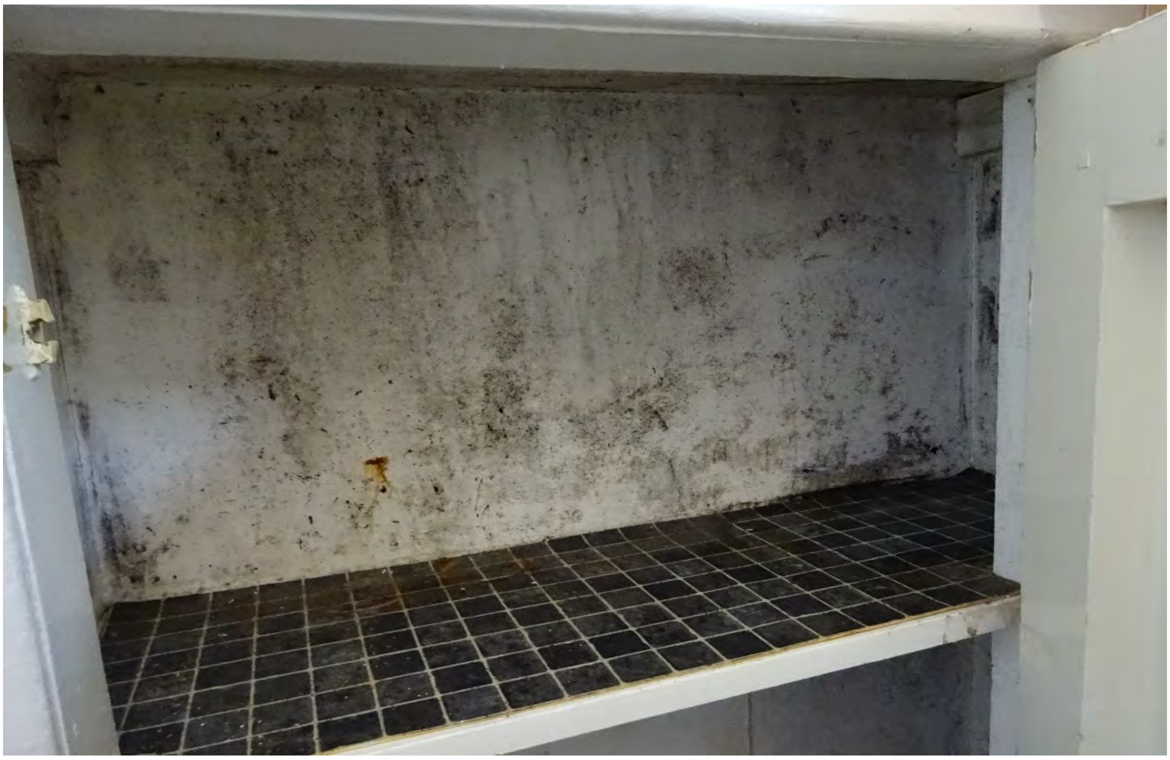

Figure 4. Mould growth in a press cupboard built into the masonry wall. As the wall is thinner at this point and therefore colder, it is a vulnerable point for condensation and associated mould growth.

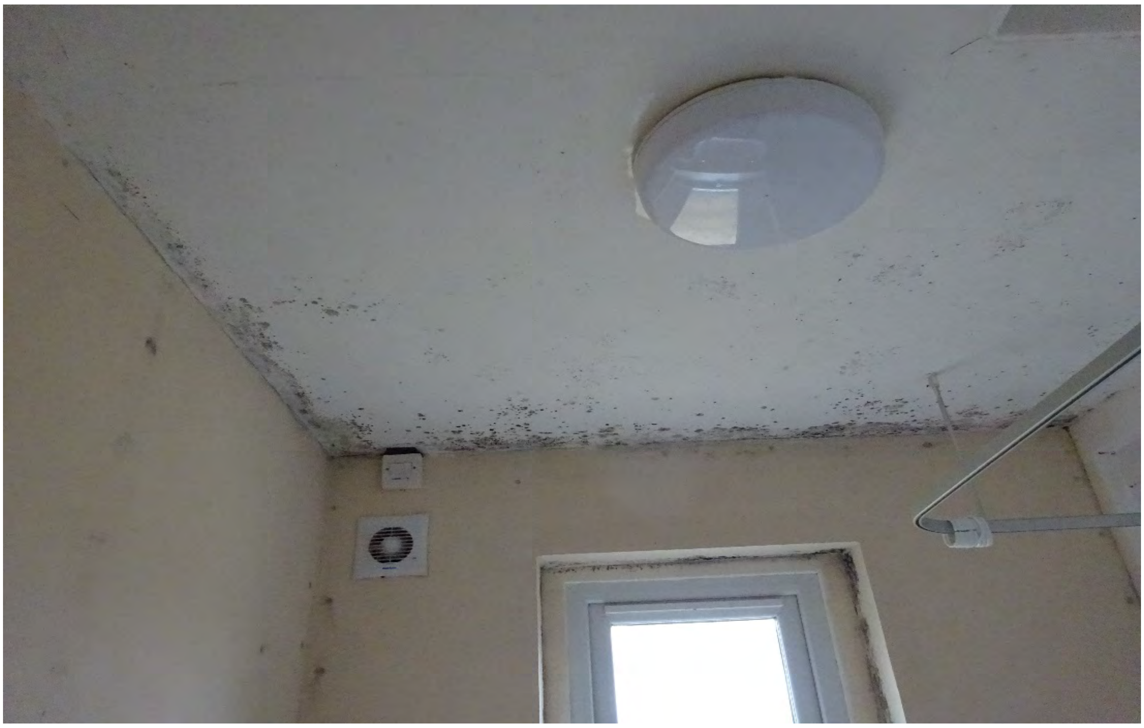

Figure 5. Mould growth in the bathroom, note the inadequate extractor ventilation system in the top left of the wall.

5. REPLACING THE INSULATION

In order to create a more vapour open internal environment, the existing insulation was removed and replaced. As mentioned above, the cottage had been largely refurbished in 2000, so disruption of historical interiors was not a factor here, although it may need to be considered in other cases. In general, traditional plaster finishes, normally lath and plaster, have good vapour buffering properties. However, later work, including the use of gloss paint and vinyl wallpapers can compromise this ability to buffer vapour.

Following removal of the failing internal wall linings and insulation, the walls on the ground floor were framed out and 100mm wood fibreboard insulation fitted. This was finished with plasterboard (not foil backed), ready for a vapour open paint coat to be applied. Issues of access made insulation of the stairwell a difficult operation, but this was overcome and both the pitched roof section and the wall on the ground floor were insulated (Figure 6). The wall on the ground floor was framed out and 100mm wood fibreboard insulation fitted into the frame. Space was more limited in the roof space and here only 40mm thick wood fibreboard insulation was installed. This was fitted in place between existing rafters, a 50mm gap being left between the insulation and the sarking boards of the roof to ensure ventilation was maintained. The roof space insulation was likewise finished with plasterboard. A similar 40mm thick wood fibreboard was used to insulate the dormer cheeks (Figure 7) and roof in the upper floor bedrooms. Lastly, the external gable wall was insulated with 100mm wood fibreboard (Figure 8). Using an insulation material which was permeable to water vapour moisture will help regulate internal relative humidity, allowing moisture to diffuse out of the building through the insulation.

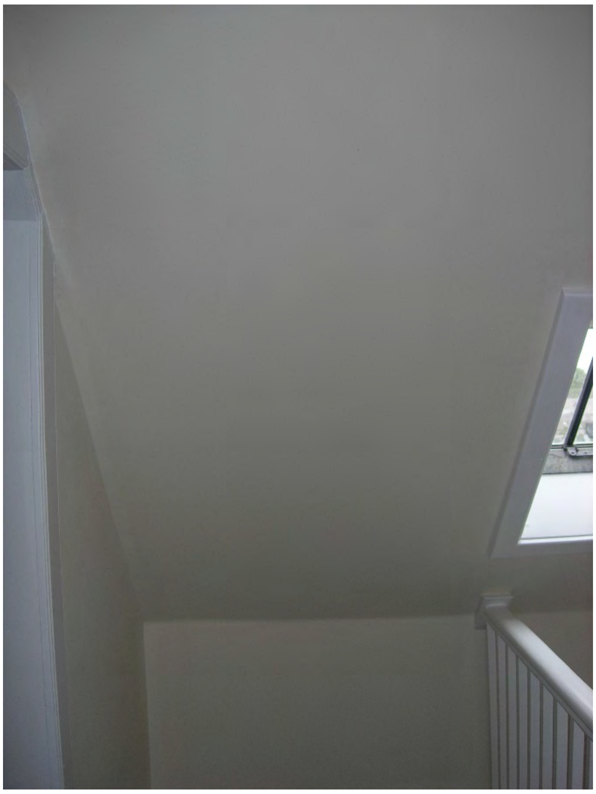

Figure 6. The new insulation was finished with plasterboard. This is the same area of stairwell shown in Figure 2, but following the works.

Figure 7. One of the dormer cheeks ready for insulating with wood fibreboard.

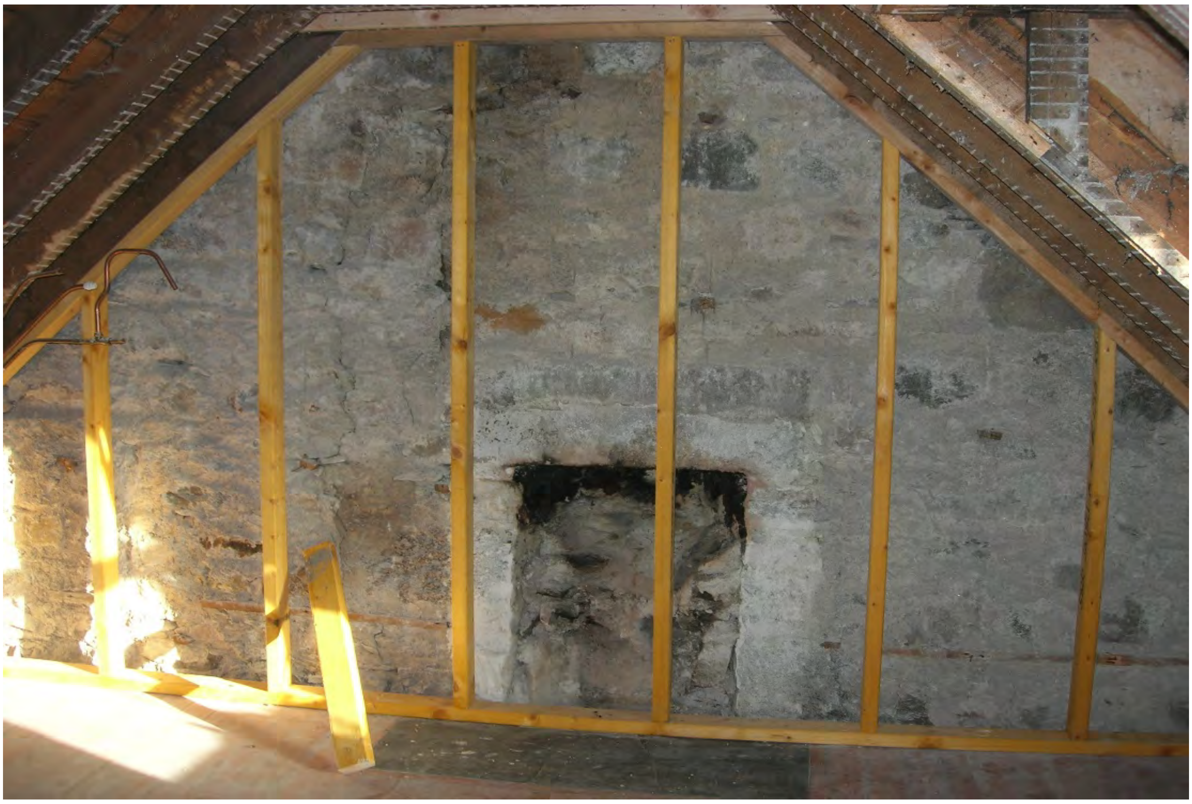
Figure 8. The gable end framed out and ready for insulation, the fireplace was vented to maintain airflow in the flue.

6. VENTILATION IMPROVEMENTS

A significant factor in the growth of mould in the cottage was deficiencies in ventilation following the previous refurbishment; therefore improving the ventilation was integral to the work. The main element of this was the introduction of a humidistat controlled ventilation system at two points in the building: the bathroom downstairs (Figure 9) and on the stairwell ceiling (Figure 10). These points were strategically chosen as both areas had experienced significant mould growth in the past due to high relative humidity levels. The humidity controlled ventilation should reduce these concentrations of moisture and help prevent mould recurring.

The extractor ventilation system installed was of the 'Decentralised Mechanical Extract Ventilation' (DMEV) type. A DMEV fan has two modes of operation, a low level "trickle" speed which operates continuously, and a higher "boost" speed which operates when the humidistat shows high levels of relative humidity, turning back to "trickle" when relative humidity is shown to be sufficiently low. The boost function can also be linked to light switches and turned on and off manually.

Using existing features to maintain the inherent passive ventilation with which traditionally constructed buildings are designed should also be a priority when considering ventilation strategies in refurbishment. However, in some circumstances the use of mechanical ventilation to supplement this will be necessary, especially if high levels of relative humidity are being experienced internally. This can occur as a result of occupant behaviour, inappropriate interventions to a building or, as was the case here, a combination of the two. Where mechanical extract ventilation is being used it is important that this is operated correctly; the use of humidistat controls reduces the likelihood of the system not being used when it is needed.

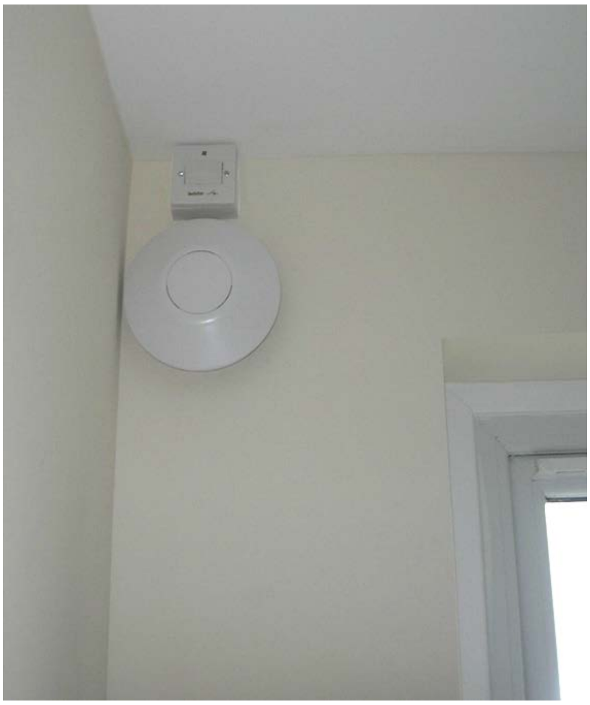

Figure 9. The new humidity controlled extractor ventilation system in the downstairs bathroom.

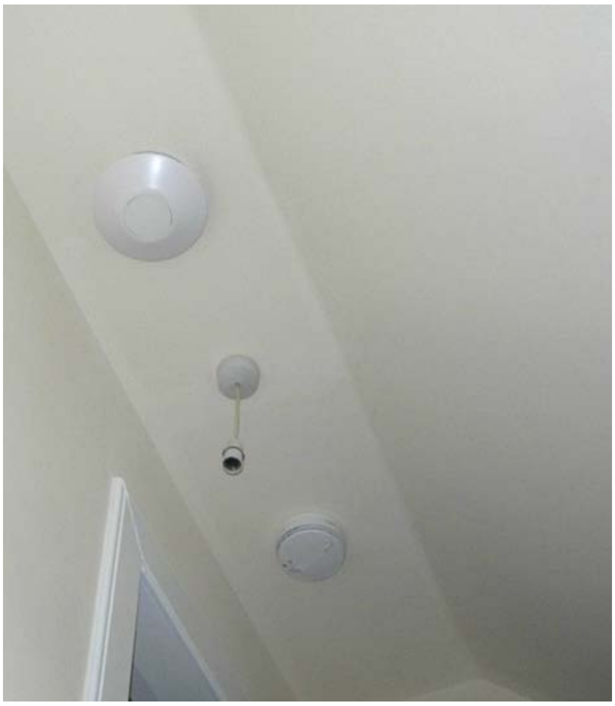

Figure 10. Humidity controlled extractor ventilation system in the stairwell which had previously suffered significant condensation and mould growth.

7. PROJECT COSTS

The total cost of the works at Holm Farm Cottage was £15,090, supported by research funding from Historic Environment Scotland. The new ventilation system was £272, the rest of the cost was fabric and insulation replacement. The cost of the insulation work included removal of the previously failed insulation and all linings which had been damaged by mould. The relatively low cost of the humidity controlled extractor ventilation system, when compared to the much larger sum that went to replacing mould-damaged plasterboard and the ineffective insulation, illustrates that investing in small-scale, well-considered maintenance measures can have an enormous cost-saving benefit to the total health of a building.

8. CONCLUSION

The work which took place at Holm Farm Cottage was designed to alter the conditions which had allowed widespread growth of mould within the building. This had been caused by inadequate ventilation, coupled with occupant behaviour and exacerbated by the use of impermeable insulation materials which trapped moisture internally. As discussed earlier, of the factors necessary for mould to grow within a building, moisture is the only one which is easily controlled. Therefore, it is through the management of internal relative humidity and surface moisture that problems of mould growth are best addressed. By improving ventilation, including passive ventilation and introducing a humidity controlled ventilation system at Holm Farm Cottage, the internal relative humidity should not reach a point at which excess surface moisture will be a problem, thereby arresting mould growth. The use of an insulation material that promotes moisture dissipation should also help with this. The building considered in this case study suffered a significant failure internally which led to costly remedial works. This emphasises the need to consider carefully how moisture within buildings is managed, and exercise care in choosing materials for retrofit, as poor or unconsidered choices can have dramatic and unexpected consequences.

When the building was re-inspected in March 2018, six months after the completion of the work, it was noted that the building was mould free and warmer than before. Therefore, the ventilation and fabric work can be considered to have been successful in tackling the relative humidity and mould growth issues which were evident when the project began.

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