HISTORIC SCOTLAND
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Wee Causeway, Culross

Insulation to walls & roof

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Historic Scotland Refurbishment Case Study 3

Wee Causeway, Culross

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Moses Jenkins

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a place for everyone

Edinburgh Napier UNIVERSITY

1. Introduction

This report forms part of a series of *Refurbishment Case Studies*, and describes works undertaken to improve the thermal performance of the walls and loft space of a detached cottage in Culross, Fife, owned by the National Trust for Scotland. One of the main objectives of the project was to investigate various fabric interventions which could be used to improve the thermal performance of traditionally constructed buildings in order to inform future work in other properties owned by the Trust. A specific aim was to bring about the greatest improvement in thermal performance by using, where possible, vapour permeable materials to allow the building fabric, whilst retaining as much of the original building fabric as possible.

2. The site

The building used in the upgrade trial described here was a detached cottage known as 'Wee Causeway' (Fig. 1), which dates from the mid 18th century. It is formed of sandstone rubble masonry bound with lime, although has been re-pointed with cement in several areas. It has a pitched pantile roof of a type common in many parts of the east coast of Scotland. The windows are single glazed sash and case and are likely to date to a refurbishment in the 1960's. The walls were lined with lath and plaster in one ground floor room, the others being plastered 'on the hard' (i.e. directly onto the masonry). All rooms had a standard cornice detail in place. During the course of the work described here the tenant vacated the property. Situated in a small village on the Firth of Forth, the property is exposed to only modest wind driven rain.

Fig. 1. The front elevation of Wee Causway, a detached cottage in Fife

3. Pre-intervention thermal performance

The thermal performance of the external walls in both the ground and upper floor rooms and upper floor ceiling was measured prior to work commencing. The work was undertaken by Edinburgh Napier University and the results of this are shown in Table 1. These results are broadly in line with those encountered in other testing work carried out for Historic Scotland, the results of which, along with greater detail of the methodology for obtaining U-values, can be found in Historic Scotland *Technical Paper 10*. Specific results for this project are reported by Edinburgh Napier University in Historic Scotland's *Technical Paper 17*.

Building element	U-value (W/m^{2}K)	Notes
Ground floor wall, west	1.5	Lath and plaster wall lining
First floor wall, north	1.6	Plastered 'on the hard'
First floor ceiling	1.5	-

Table 1. Results of pre-intervention thermal performance monitoring

4. Improvements to external walls

Measure 1 – Aerogel blanket

The insulation used in all external walls in the first floor rooms (excluding the bathroom) was a 10 mm thick aerogel blanket (Fig. 2). Historic Scotland tests have shown aerogel to have a reasonable level of vapour permeability and it was therefore felt appropriate to apply this directly to traditionally constructed mass masonry.

Fig. 2. Aerogel insulation applied as a blanket prior to application of a plaster finish

This was secured to the wall using thermally-decoupled expansion fasteners. Metal mesh was then applied to allow the application of a plaster finish. When applying the plaster, a slim timber bead was fitted below the cornice to ensure a neat junction with the new plasterwork.

Measure 2 – Calcium silicate board

In one room of the ground floor, calcium silicate board insulation was applied directly to the internal face of the masonry. Calcium silicate board is manufactured from sand and lime treated with heated steam to produce an open-pored structure which is permeable to water vapour. The board therefore has a high capillary action and is vapour open, which helps regulate internal humidity. Before application, the existing wallpaper and paint was removed from the wall to give a good base for the adhesive mortar (Fig. 3), which fixes the board to the masonry. Board 15 mm in thickness was used, cut to shape, where required, using a standard hand saw. The adhesive mortar was mixed and applied to the wall using a notched trowel, with a notch size below 12 mm. As each panel was placed on the wall, mortar was applied to the edges of adjacent panels and the new panel slid to sit tightly against it (Fig. 4). The board was finished with two coats of plaster - a rough base coat and a smooth top coat.

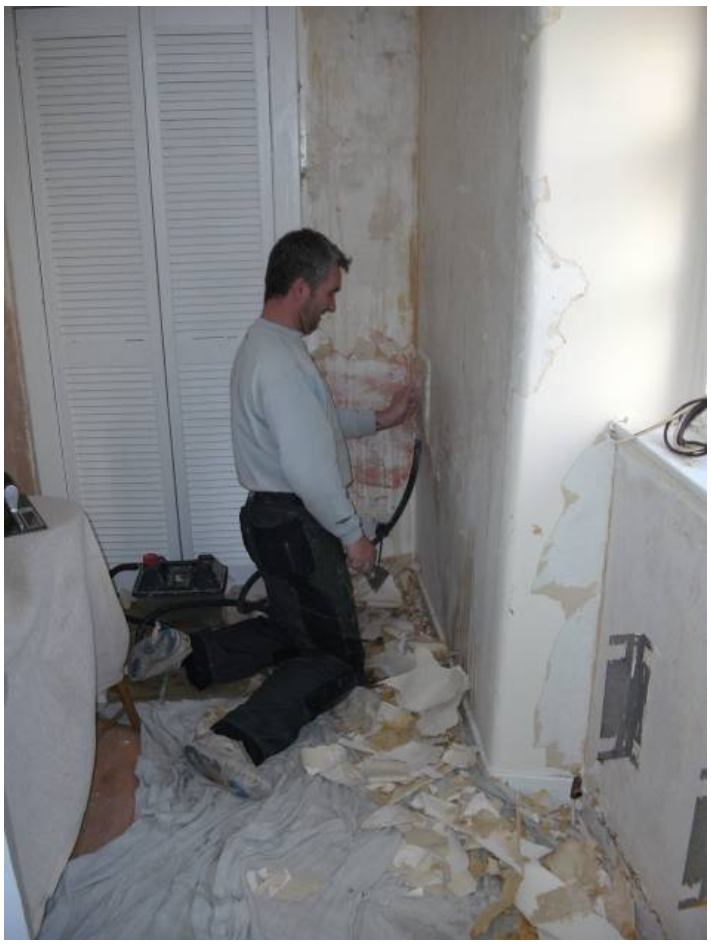

Fig. 3. Stripping of wallpaper and paint prior to application of calcium silicate board

Fig. 4. Calcium silicate board being applied to a masonry wall at Wee Causeway

Measure 3 – Blown polystyrene bead

In the other main room on the ground floor, bonded polystyrene bead was blown into the void behind the existing plasterboard wall lining. The first stage in this process was to remove skirting boards and make sure all voids at floor level were filled to ensure the insulation material did not disperse to other areas of the building. Before the insulation was installed it was necessary to carry out re-lining of electrical cables, as it was understood these might become brittle if they came into contact with the polystyrene bead. Holes 26 mm in diameter were cored approximately every 200 mm from the ceiling and centred between existing timber straps. The bead was then blown into the cavity between the plasterboard and the masonry. As the bead passed through the nozzle it was coated in a water-based adhesive to ensure the beads formed a cogent mass. The holes were then filled and a skim coat of plaster applied.

5. Improvements to roof space

The second element of the building fabric to receive upgrade work was the roof space (Fig. 5). This took the form of 250 mm thick hemp wool insulation laid in the loft, achieved by laying two layers of 100 mm and one of 50 mm. Following previous trials using sheep's wool, it was felt that a different material should be tested. Hemp wool was selected because of its ability to absorb and release moisture and its ability to be installed relatively simply and quickly. Prior to the work commencing, the roof space was cleared of debris and previous insulation.

Fig. 5. The roof space prior to the work

6. Post-intervention thermal performance

The results of the thermal improvement, made by the measures described above, are contained in Table 2 and the full report from Edinburgh Napier University forms part of Historic Scotland's *Technical Paper 17*. The improvement given by blowing the polystyrene bead behind the existing wall lining was considered to be a good result, particularly as this allowed the retention of the existing fabric. The improvement achieved by the use of aerogel blanket was less, but this is balanced by the thinness of the material and the fact that it allowed the cornice to remain in situ with little visual impact. Unfortunately, due to a fault in testing equipment, it was not possible to obtain a result for the level of improvement made by the calcium silicate board. However, based on experience at other sites it is estimated that this would improve the U-value of the wall from 1.5 to 0.7. The improvement made by the hemp insulation to the performance of the loft was considerable.

Building element	**Pre-intervention U-value (W/m^2K)**	**Post-intervention U-value (W/m^2K)**	**Measure undertaken**
Ground floor wall, west	1.5	0.5	Polystyrene bead behind plasterboard wall lining
First floor wall, north	1.6	0.9	10 mm aerogel blanket applied directly to masonry
First floor ceiling	1.5	0.2	275 mm hemp wool insulation

Table 2. Results of post-intervention thermal performance monitoring

7. Conclusion

The site trials at Wee Causeway have provided valuable insights into several methods of insulating mass masonry walls. Two options which can be applied directly to masonry, but which retain the vapour permeability inherent within traditionally constructed mass masonry, were trialled with good results in terms of ease of application and retention of original fabric. Modest work to insulate the loft gave a significant improvement, indicating that the insulating of a roof space, where this can be easily achieved, is a good place to start when looking to improve the thermal performance of traditionally constructed buildings.

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1 Five Tenement Flats, Edinburgh
Wall and window upgrades

2 Wells o' Wearie, Edinburgh
Upgrades to walls, roof, floors and glazing

3 Wee Causeway, Culross
Insulation to walls and roof

4 Sword Street, Glasgow
Internal wall insulation to six tenement flats

5 The Pleasance, Edinburgh
Insulation of coom ceiling, attic space and lightwell

6 Kildonan, South Uist
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