HISTORIC SCOTLAND
ALBA AOSMHOR

Newtongrange

Installation of roof and coom insulation and secondary glazing

This case study is published by Historic Scotland, an executive agency of the Scottish Government.

This publication is a web publication and is available for free download from the Historic Scotland website:
www.historic-scotland.gov.uk/refurbcasestudies

This publication should be quoted as:
Historic Scotland Refurbishment Case Study 11

ISBN 978-1-84917-156-4

You can contact us at:

Historic Scotland
Conservation Directorate
Longmore House
Salisbury Place
Edinburgh EH9 1SH

Phone 0131 668 8600
Email hs.conservationgroup@scotland.gsi.gov.uk
Web www.historic-scotland.gov.uk/conservation

Historic Scotland Refurbishment Case Study 11

Newtongrange

Installation of roof and coom insulation and secondary glazing

Jessica Snow

Acknowledgements

Historic Scotland would like to thank all partners participating in this case study:

CASTLE ROCK EDINVAR HOUSING ASSOCIATION

Edinburgh Napier UNIVERSITY

CONTENTS

1. Introduction....2
2. The Site....2
3. Delivery of the Work....3
4. Window Upgrades....3
5. Thermal Performance....4
6. Coom Ceilings....4
7. Roof Space....5
8. Roof Space Ventilation....6
9. Thermal Performance Improvements....7
10. Longer term assessment and defects....7
11. Feedback from the Tenant....8
12. Conclusion....9

1. Introduction

This case study is one in a series of Refurbishment Case Studies and follows the theme of thermal upgrades to traditionally built properties in Scotland. This project focussed primarily on coom ceilings, that is the sloping ceiling in a habitable room that is wholly or partially within a roof-space. These areas have previously been difficult to insulate without stripping out internal linings, often leading to loss of historic fabric, disruptive building work, and the expense of new materials and labour. This project sought to demonstrate that effective thermal upgrades were possible for coom ceilings without excessive cost and disruption for the owner and extensive removal or damage to the fabric. For the project to be successful, it was felt important to use ‘vapour-open’ materials which allow the free transmission of water vapour through the building envelope. This is particularly important for roof spaces or coom ceilings, where there is often considerable water vapour build up combined with changing temperatures, making condensation an important consideration.

2. The Site

The subject of this upgrade trial is a 1½ storey terraced cottage in Newtongrange. It is one of a row of properties dating from 1872, built to accommodate miners at the nearby Lady Victoria Colliery. The property is on the main street of a built up residential area with no unusual exposure issues or vulnerability to extreme weather (Fig.1). The property is constructed from a redbrick with cream bricks for the window surrounds and quoins. The building has wall-head dormers at both the front and back, accommodating bedrooms. The roof is pitched Scots slate on a bituminous underslating felt, laid on 16 mm timber sarking nailed to truss rafters, with sprockets at the eaves forming a bellcast. There are nominal gaps between sarking boards, and no ventilation provision at the eaves or ridge. The internal linings are of plasterboard and the windows are singled glazed timber sash and case.

Fig. 1. Front elevation of Newtongrange Cottage

The accommodation comprises a living room and kitchen on the ground floor, with a staircase leading up to two bedrooms and a bathroom on the upper floor. It is owned and managed by Castle Rock Edinvar Housing Association and let to a family. The upgrades were carried out on the upper floor and roof only. They involved the installation of secondary glazing to the windows, blown polystyrene bead insulation behind the plasterboard linings of the coom, and the replacement of degraded mineral wool with sheep's wool insulation in the loft space. Only the roof and cooms were monitored as similar window improvements have been tested elsewhere. However the design, manufacture and installation of the windows was an important aspect of the upgrade works.

The works are described in terms of the interventions to individual fabric elements. These interventions follow those set out in the Historic Scotland Short Guide *Improving Energy Efficiency in Traditional Buildings*.

3. Delivery of the Work

The work was designed and specified by a local architect under instruction from Historic Scotland, and delivered on site by an insulation installer and joinery contractor. The work was scheduled to be completed within a week, however this did over-run due to delays in delivery of materials, and mechanical problems with plant on site (the pump used to blow in the bonded bead). The work was done entirely with the family in residence. There were no down-takings, apart from the removal of the existing mineral wool insulation from the roof space.

4. Window Upgrades

The architect designed a bespoke timber double glazed secondary glazing unit to suit the existing glazing arrangements. It was fabricated in the contractors workshop using standard joinery equipment and skills. The existing timber beads pinned to the inside facings of the window cases (sides, head, and cill) were removed so that the new units could be fastened directly to the window case without having to disturb the linings. The new units were side hung, with releasable restrictor stays, and included lift-off hinges so that the slender frames could be readily squared-up and fixed to the window case in advance of hanging the sashes. Small timber cover beads were pinned around the perimeter of the units and painted to match (Fig. 2).

Fig. 2. The timber double-glazed secondary glazing. Testing equipment from Napier University also seen on right.

Fig. 3. Access to original windows for cleaning was maintained

The existing draught-stripping on the original windows, which was in poor condition, was removed in order to increase the passive ventilation and prevent condensation forming on the inside face of the external glazing. The secondary glazed units had integral trickle ventilation. The existing sash and case windows were also fitted with cord clutches and eyelets, removable batten rods and simplex hinges, to allow safe cleaning of the windows on both sides, from the inside (Fig. 3).

5. Thermal Performance

The thermal performance of the unimproved elements in the ceiling were measured prior to the works by Edinburgh Napier University and consisted of *in situ* U-value measurements of the coom and the ceiling using the standard heat flux plate and associated equipment. As glazing of the type found at the cottage had been tested before, the windows were omitted from the testing process. This allowed a baseline pre intervention figure to be calculated, from which could be measured the effectiveness of the upgrade works (Table 1). The relative humidity for the void behind the existing plasterboard was also measured. The techniques for measurement and analysis are described in Historic Scotland Technical Paper 10 and Technical paper 19. The results are similar to other *in situ* measurements that Historic Scotland has monitored in traditional built fabric and as such need no further discussion.

Building element	U-value (W/m^2K)*	Notes
Ceiling	1.6	100mm mineral wool plasterboard ceiling
Coom ceiling	1.9	Slate on sarking, plasterboard

Table 1 – Pre-intervention U-values

*Measurement taken December 2011
Average internal temperature 17°C / average internal RH 58%
Average external temperature 11°C / average external RH 88%

6. Coom Ceilings

The existing insulation was removed from between the truss ties, with a focus on removing any surplus which had been pushed down in between the timbers to the coom ceilings This work was carried out with some care due to the slate nails projecting through the underside of the sarking (Fig. 4).

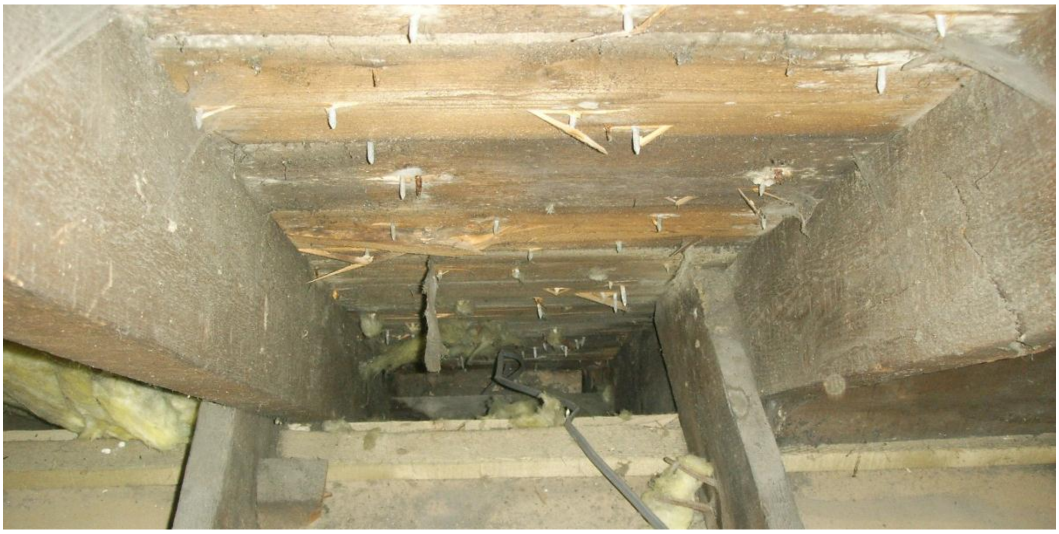

Fig. 4. Access to voids in coom ceiling via attic space

Following the removal of all debris (Fig. 5), bonded polystyrene bead insulation was installed between the rafters of the coom ceilings, via the open voids from within the roof space, so as to avoid any disturbance to the coom linings and decoration of the rooms below (Fig. 6). The insulation was mechanically blown in by the insulation contractor. The blowing equipment is mounted in a small lorry, and as such ensuring parking was available on the street was important.

Fig. 5. Ceiling space prior to insertion of insulation

Fig. 6. The bonded bead insulation installed in the cooms

7. Roof Space

After insertion of the blown bead insulation, 140 mm sheep's wool insulation was laid between the main roof ties and dormer roof ties, with 100 mm insulation above, across the ties (Fig. 7).

Fig. 7. Insulation between and over joists

Fig. 8. Sheep's Wool Insulation

Whilst the building had some degraded mineral wool insulation *in situ*, the replacement with sheep's wool was considered an improvement. As well as increasing the depth of insulation, the more 'breathable' characteristics of the sheep's wool were considered to be desirable as a humidity buffer. In addition, it is more pleasant to handle than synthetic alternatives and is a more sustainable material overall. Fig. 8 shows the insulation post-installation.

The cold water tanks, copper pipework, and ceiling hatch were all also insulated using proprietary materials and installation methods (Fig. 9). This is to prevent the water in the tank and pipes freezing during cold spells, which is a risk when loft insulation is increased.

Fig. 9. The water tank and pipes were insulate top prevent freezing.

8. Roof Space Ventilation

Any insulation work to a ceiling, that creates a “cold roof” will require additional roof space ventilation in order to ensure water vapour from habitation below is dispersed. In an original traditional roof, where there is no layer between the slates and the sarking, the roof spaces are generally well ventilated, and only modest additional ventilation is required. In the case of roofs that have been re-done since 1945 using an under slate bitumous felt, there is much less ventilation into the attic, and more formal arrangements are required, such as the addition of slate vents on the roof slopes. Within this case study, the decision was made to assess if the blown bead in the cooms allowed enough ventilation to not require additional ventilation. To ensure this an open cell material was selected, to allow the modest passage of air through the cooms. Bonded polystyrene bead insulation consists of small beads of polystyrene held loosely together with PVA glue. This creates an ‘open celled’ material which allows air to move through it.

The assumption was made in this study that small amounts of liquid water, either penetrating or forming from condensation can be dissipated through the insulation and building fabric by existing ventilation mechanisms before it causes levels of relative humidity above normal limits. In addition to the under slate felt of the roof, the coom linings in the bedroom below were plasterboard with several layers of emulsion paint, so water vapour dispersal to the interior would be minimal. As such, the roof space at Newtongrange offered a chance to test new techniques within fairly narrow parameters, and establish the effects of blown insulation in typical cooms.

9. U-value measurements

Following the works measurements were taken to assess the thermal improvements made by the interventions (see Table 2). The improvements to the coom and ceiling were good and compare reasonably well to the Scottish Building Standard U-value of 0.35 W/m^{2}K for the roof as an individual element.

Building element	Pre intervention U-value (W/m^{2}K)	Post intervention U-value (W/m^{2}K)*	Notes
Ceiling	1.6	0.4	240mm sheeps's wool
Coom	1.9	0.3	100mm blown polystyrene bead behind plasterboard

Table 2 Thermal monitoring results

*Measurement taken March 2012
Average internal temperature 21°C / average external temp 11°C

The full results and analysis of the U-value and humidity monitoring at Newtongrange can be found in Historic Scotland *Technical Paper 19: Assessing Insulation Retrofit in Traditional Buildings.*

10. Longer term assessment and defects

The works were completed in the Autumn of 2011, and the tenant reported an improvement in temperatures in the upstairs bedrooms. However, in December 2012, the tenant noticed white mould on the underside of the sarking board at all levels of the roof. Investigations by the Architect and Historic Scotland confirmed that this was white mould, growing due to high relative humidity levels in the roof space (Fig. 10). It was immediately apparent that the roof space ventilation was insufficient, resulting in high relative humidity levels; the condensation resulting from the changes in dew point (as a consequence of the reduced attic temperatures) were giving suitable conditions for mould growth. During the inspection it was also noticed that there were droplets of water on the end of the nail heads protruding from the sarking, also an indicator of excessive relative humidity. The sheep's wool insulation on the ceiling joists was not affected.

Fig. 10. White mould on the roof slope, caused by insufficient ventilation

It was obvious that remedial work was required. To check for further hidden defects the blown bead insulation was removed from the cooms and the air path down the coom was checked. On closer inspection it transpired that while the mineral wool from previous interventions had been largely removed, a tight plug of material remained at the base of the coom, and there was no ventilated pathway to the eaves. The junction between the wall head and the roof slope had not allowed the anticipated ventilation levels. After removal of the blown bead insulation in February 2013, additional monitors were installed by Napier University, to assess the situation over several months. According to BS EN 13788 (2012)[1], BS 5250 (2011)[2] and CIBSE Guide A (2006)[3] internal relative humidity levels of >80% provide a condition conducive for mould growth in building timbers. Mould can continue to grow in relative humidity levels >70% if such humidity spikes occur over prolonged periods of time. Fig. 11 shows the relative humidity levels taken in the roof during 2013. While at times the levels reached over 70% and even 80% it was never for a prolonged period of time after February 2013.

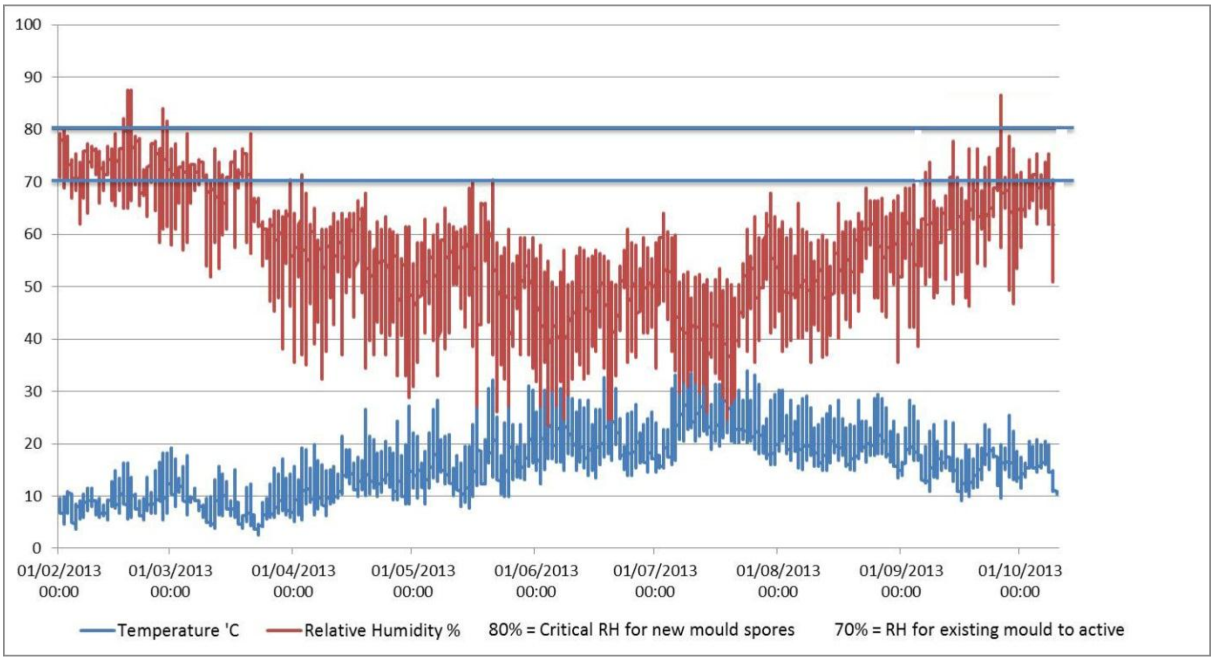

Fig. 11. Temperature and Relative humidity recorded in the attic space of 41 Main Street from February to October 2013. Showing the occurrences when the RH levels in the attic space reached above 70 and 80% during 8 months of 2013.

By December 2013 sufficient data had been collected to determine that the relative humidity readings were at acceptable levels within the attic. No further mould growth or condensation activity was noted, and the tenant did not experience any further disruption. At present the roof coom is without insulation. In Spring 2014 wood fibre board insulation will be installed, with a 30mm space below the sarking, running all the way down to the junction of the coom and the wall. The improvements to the windows did not present any issues.

11. Feedback from the Tenant

Notwithstanding the required re-working, the tenant has experienced improved thermal comfort. Energy bills have reduced as well as a reduction in street noise, due to the secondary glazing improving the acoustic performance.

[1] BS EN 13788:2012 'Hygrothermal performance of building components and building elements. Internal surface temperature to avoid critical surface humidity and interstitial condensation. Calculation methods.' BSI Group.
[2] BS 5250:2011 'Code of practice for control of condensation in buildings' BSI Group.
[3] CIBSE Guide A: 'Environmental Design', 2006. Chartered Institution of Building Services Engineers.

12. Conclusion

This case study showed when considering interventions a full understanding of the existing arrangements is necessary, to ensure the correct approach is taken. Monitoring of the completed works is also important, to check that any unplanned effects are identified early. If this is done, then remedial action can be taken. Notwithstanding the issues with the roof space ventilation, the sheep's wool and the secondary glazing interventions have proved successful, and have improved both the thermal and acoustic comfort in this traditional brick building. It was also important to note that the tenants remained in residence throughout the work, proving that effective upgrades can be achieved with minimal disruption to the occupants.

Historic Scotland Refurbishment Case Studies

Available at **www.historic-scotland.gov.uk/refurbcasestudies**

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
Insulation to walls, roof and windows

7 Scotstarvit Tower Cottage, Cupar
Thermal upgrades and installation of radiant heating

8 Garden Bothy, Cumnock
Upgrades to walls, floors, windows & door

9 Leighton Library
Installation of loft insulation

10 Rothesay
Installation of insulation and secondary glazing

11 Newtongrange
Installation of roof and coom insulation and secondary glazing

12 Kincardine Castle
Installation of biomass system