HISTORIC SCOTLAND
ALBA AOSMHOR

Leighton Library

Installation of loft insulation

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THE
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TRUST

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1. Introduction

This report describes thermal performance improvements undertaken at The Leighton Library in Dunblane. In keeping with the preceding Refurbishment Case Studies, the aim of this work was to upgrade the property and improve its thermal performance using materials which were appropriate to the fabric of the building. Due to the increasing cost of heating the building there was a desire on the part of the Trustees to improve the energy efficiency of the building. In 2011 Historic Scotland awarded a grant to the Trustees to install insulation in the roof space.

2. The Site

The library building was purpose built in the late 17th century to house a collection of books belonging to Archbishop Leighton, Bishop of Dunkeld. It is Category B Listed. The structure is rectangular in plan with mass masonry lime bonded walls and crowstepped gables. There are chimney stacks on both gables (Fig. 1). The elevations and gables have been harled with a wet dash cement finished with modern masonry paint. While this is not considered ideal in building conservation terms, meaning that the walls are not particularly vapour open, the render is in good condition and does not seem to be causing any problems. Notwithstanding its library function, the scale of the building is domestic and the detailing is standard for Scottish buildings of the period. The accommodation consists of a ground floor, the library floor and an unoccupied roof space above. The upper floor, which houses the books of the library, is accessed by an external staircase. It is thought that the upper floor may originally have been divided into two floors, as the ceiling level was raised during a 19th century refurbishment. The lower floor, or under croft, originally functioned as the living quarters for the librarian but is now used for storage. Internally the walls on the library level are finished with fine joinery, consisting mainly of book cases. Due to this limitation internal wall insulation was not practicable. It was decided that insulating the loft would be the most effective way of improving the energy performance of the building.

Fig. 1. View of the library from the north-east

3. Pre-intervention thermal performance

The thermal performance of the upper floor ceiling was measured prior to work taking place, achieving a U-value of 1.3 W/m^{2}K. This measurement was taken over a 21 day period in January 2012, when the average relative humidity was 69% at 12°C internal temperature, and 95% at 2°C external temperature. The monitoring work was undertaken by Edinburgh Napier University. This U-value is broadly in line with other testing work carried out on ceilings and roofs for Historic Scotland. More detailed results and a description of the methodology for obtaining U-values and relative humidity readings can be found in Historic Scotland Technical Paper 19 available on the Historic Scotland website.

4. Improvement to Roof Space

Fig. 2. Protection measures in the library

Fig. 3. Insulation arrives on site during the improvement works

It was necessary when carrying out this work to take measures to ensure that the contents of the library were protected from damage. Prior to the commencement of the work the bookcases were covered in dust sheets (Fig. 2). To minimise dust the insulation was stored in the ground floor and all cutting took place outside.

In order to ensure that there was a degree of humidity buffering in the roof space, a hygroscopic natural material, wood fibre board, was used. This material, made from a renewable resource, was considered appropriate for a traditionally constructed building such as the library, where the continued use of vapour open materials is considered important. The roof space was insulated using 200 mm of the wood fibre insulation. The insulation came in rigid sheets 100 mm in thickness which were cut using a hand saw. Fig. 3 shows the insulation after arrival on site. It is important for projects such as these, in small towns with narrow streets, to anticipate delivery and storage issues, and plan for them in advance.

The insulation was cut to fit snugly between the existing ceiling joists and laid in two layers, giving a combined thickness of 200 mm (Fig. 4). Extensive use was made of crawl boards to facilitate access during the work. The final level of the insulation was just proud of the ceiling joists (Fig. 5).

Fig 4. The wood fibre board fitted between the ceiling joists

Fig 5. Wood fibre boards fitted with no gaps

The installation of loft insulation at ceiling level creates a 'cold roof' space above, as the roof space now sits out with the insulation. Because of the lowered temperatures, the roof space must be adequately ventilated to mitigate potential condensation, due to the lowered dew point in the now colder space. In a traditional slate roof there is usually no roofing felt or barrier present between the sarking boards and slates and thus a degree of ventilation occurs through the roof fabric; this is often considered adequate ventilation for a 'cold roof' space. However, the Leighton Library underwent a restoration in the mid 1980s and it is understood that a bituminous roofing felt was installed under the slates, thus preventing ventilation through the roof fabric. This is often the case with buildings constructed or restored after 1945. Roofs with bituminous roofing felt in place typically require other methods of ventilation, such as roof vents, or venting at the ridge and eaves.

In the case of the library the previous means of ventilating this roof space was through two large louvered vents on the south-east gable. These had been partially closed off, but were re-opened, ensuring an adequate degree of ventilation into the roof space (Fig. 6).

Fig. 6. Existing vents retained for ventilation

5. Post-intervention monitoring

The monitoring of the U-value of the ceiling showed that the thermal performance was improved from 1.3 W/m^{2}K to 0.2 W/m^{2}K. This is a considerable improvement and will result in significant reductions in heat loss through the roof space of the building.

Ceiling	**Pre-intervention U-value (W/m^{2}K)**	**Post-intervention U-value (W/m^{2}K)**
Ventilated attic with timber ceiling joists, finished internally with softwood v-groove lining (addition of 200 mm wood fibre board – Post Intervention)	1.3	0.2

As part of the long term assessment of the intervention moisture levels at both the interface of the insulation and the ceiling, and within the loft space, are being monitored to establish if the insulation work has resulted in any increases in relative humidity. Post-intervention readings taken in the roof in March 2012 gave an average relative humidity of 57% at an average temperature of 15°C. Externally the average relative humidity level was 69% at an average temperature of 1°C. Additionally, the moisture level within the library itself was measured to ensure that the environment remains within tolerable levels. This is discussed in more depth in Technical Paper 19, available on the Historic Scotland website.

6. Conclusion

The site trial at the Library has shown that considerable improvement can be made to the thermal performance of a traditional roof space using a natural, vapour permeable material. Whilst works to buildings with special contents need careful consideration, the principles and approach for energy efficiency upgrades remain the same. Fig. 7 shows the end gable of library with Dunblane Cathedral in the background.

Fig. 7. South-east gable of library showing the two loft vents at upper level. © Newsquest (Herald & Times). Licensor ***www.scran.ac.uk***

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4 Sword Street, Glasgow
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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