

## BERG COTTAGE: MODERNISED BUT NOT MODERN

### Back to the 1600s, without the shivers

*Richard Oxley*

Berg Cottage, at Barkway, Hertfordshire was given to the National Trust in the 1093s by a former SPAB employee, Miss Madeline Berg. It is a tenanted 17<sup>th</sup> Century Grade II listed timber framed and thatched cottage. Other than some thatching work the cottage had not been subject to any significant repairs since the 1930s.

The building was expensive to heat and the tenant reported that it was extremely cold and draughty. In response to this The Trust installed a highly efficient combination boiler in 1999 to replace inefficient electric night storage heaters that were expensive to run. Nevertheless the tenants still reported high levels of discomfort.



Repair works carried out in 2002-03 to rectify problems caused by well-intentioned but inappropriate and damaging repairs, such as impervious cement render applied in the 1930s, provided the opportunity to improve the energy efficiency of the building and the comfort of tenants. This is a new development in the management of the existing building stock, with little research or proven practical examples to work from.

It is important to realise that making improvements to enhance the energy efficiency of existing buildings, in particular older buildings, can introduce new problems. Changing how traditional buildings perform, as we know from the introduction of impermeable cement-based renders and mortars, can lead to irreparable damage. We must therefore be aware of the dangers of carrying out well-intentioned but ill-considered work to improve energy efficiency, as this will not only prove ineffective but also inevitably lead to the deterioration of historic fabric.

The investigations that contributed to achieving a thorough understanding of Berg Cottage included: a quinquennial condition survey, an energy report; the National Trust's "Vernacular Building Survey" (an archaeological report); and limited opening-up work of the structure.

The work at Berg Cottage underlines the importance of understanding a building well before carrying out alterations and repair work to older structures. An under-used but important diagnostic tool in understanding the performance of a building is a fan pressurisation test. These measure how much air leaks through the fabric. The initial fan pressurisation test at Berg Cottage confirmed the tenants' impressions of draughtiness. It also identified where leakage was happening, and the opportunities for energy saving. This allowed improvements to be targeted on areas most in need of attention, avoiding unnecessary work elsewhere, and so minimising disruption and expense. It also allowed stereotypical presumptions of where problems are perceived to exist to be dispelled. For example, the windows at Berg Cottage were not found to be a significant source of draughts, which is contrary to the popular belief that windows in older buildings are draughty.

Traditional buildings need more background ventilation than newer ones, in order to accommodate evaporation of moisture from the building fabric. Otherwise they can become too damp, putting the health of the building and the occupants at risk leading owing to condensation, mould growth and timber decay. Consequently any

reductions in ventilation (air infiltration) need to be made on an informed and reasoned basis.

Monitoring took place before, during and after the works to ensure that the changes in heating and ventilation had not altered humidity to levels at which active decay was likely to occur. This was done by reviewing records from data loggers left in rooms, including the attic, and externally.

Pressurisation tests carried out in the course of the work is important to determine the success of the ongoing works. At Berg Cottage they first revealed that the infiltration rate had actually increased, because the fabric had been disturbed during the works. To improve the success of the works to reduce draughts the building contractor was left with a fan on site so that the workforce could assess whether the works had been effective in removing the unwanted draughts, which was mainly filling cracks in wall and ceiling junctions with haired lime putty mortar. This was successful because the workforce had a tangible measure as to the effectiveness of their work.

The fan test had shown that the tiled slopes below the dormer windows were a principal source of air leakage. The tiles were lifted, the verges of the thatch pulled back, and woodfibre board laid over the roof timbers and up under the thatch as far as possible, with vapour-permeable roofing felt added above the new board before re-hanging the tiles. The verges of the thatch were then repaired, ensuring a good overlap to the tiles. This work not only decreased the air infiltration, but reduced the U-value of the tiled section itself from an estimated 4.4 W/m<sup>2</sup>K to 0.9 W/m<sup>2</sup>K.

Chimneys flues can be a source of massive air infiltration. Dampers reduce draughts when flues are not in use but should not be a tight fit, as some air flow is needed to ventilate the chimney. Berg Cottage has two inglenook fireplaces: the first already had a damper and the second had one added. A cheap and effective temporary alternative is a heavy-duty chimney balloon.

The cement render and the corroding metal lath were removed and any necessary repairs to the timber frame undertaken, taking care to preserve remaining sections of historic chalk-based render. Gaps between the interior and the external finishes were tightly packed with sheep's wool insulation prior to re-rendering with a chalk, sand and lime putty mix based on the surviving historic remnants.

The traditional performance of the building was reinstated. No vapour or secondary barriers were provided between the timber frame and the new render. With appropriate regular maintenance this "breathing"

wall system will absorb moisture into the top layer of lime-based render and let it evaporate when suitable conditions prevail. Naturally hygroscopic materials including the sheep's wool insulation complement this performance. If the wool ever gets damp it will retain much of its insulating properties, and can also 'wick' moisture away from the vulnerable timber frame.

In the 1990s, the tenant removed the boarding and installed glass fibre insulation between the timber framing and put back the boards. These well-intentioned repairs however had little benefit as there were many gaps between the insulation and the vertical studs of the timber frame. The glass fibre was removed and replaced with sheep's wool insulation. Before replacing the weatherboarding the framing was clad with latex impregnated breathable tongued and grooved woodfibre board.

This improved the insulation but was primarily a wind barrier to reduce air infiltration and convection, with an added bonus of a high decrement delay (the time taken for outside peak temperature to match the inside temperature), helping to prevent summer overheating in a building with a relatively low thermal capacity. For further protection against air leakage vapour permeable roofing felt was dressed over the joints and around openings. The U-value of the weatherboarded elevations was reduced from an estimated 2.2 W/m<sup>2</sup>K to 0.3 W/m<sup>2</sup>K - better than the 2006 Part L standard for a replacement wall (0.35 W/m<sup>2</sup>K). All the windows were retained and draught-stripped apart from two where the casements fitted very poorly. Here secondary glazing was installed by a specialist.

Unlike many projects to improve energy efficiency the works at Berg Cottage were measured and monitored. This is in contrast with other projects, where improvements and assessments are made on arbitrary calculations that do not take into account the actual performance in use of the building. Where works are carried out on this basis the improvements in energy efficiency are theoretical, whereas at Berg Cottage we can show actual savings and improvements.

The measured air change rate prior to the works was a very leaky 24.2 air changes per hour (ac/h) at 50 Pascals pressure - equivalent to about 1.3 ac/h under typical wind conditions. The measured air change after the repairs but before the rethatching in 2005 was 16 ac/h @ 50 Pa (against a target of 14 ac/h). The energy assessment provided a SAP rating of 49 after the new heating had been installed. The fabric and ventilation measured increased the rating to 63 (in 2001 77% of houses in England had SAP ratings of 60 or less). Annual CO<sub>2</sub> emissions associated with gas and electricity consumption were reduced by 3 tonnes from 11.1 tonnes

to 8.1 tonnes. Measured annual gas consumption fell by 27% while average internal temperatures increased. The occupants reported improved comfort, in particular fewer draughts, and found the heating much easier to control.

Ongoing monitoring has not revealed any problems within the building fabric. The living room and the bedroom were immediately warmer after the work. The attic temperature fell, indicating less air rising from the house into the attic. The attic winter relative humidity rose but not to the point where it was of concern and still below the summer time peak before the work started.

The sympathetic improvements at Berg Cottage returned a 350 year old building to a condition of good repair, reinstating aspects of its traditional performance whilst also improving comfort, saving energy, and reducing CO2 emissions.

With a regular programme of preventative maintenance the building will survive for many more years, a true measure of sustainability.

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