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TITLE: Testing of a method for insulation of masonry and lath walls in existing domestic Scottish construction.

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Academic feasibility study:

Testing of a method for insulation of masonry and lath walls in existing Domestic Scottish Construction

Project background

The presence of an existing building stock and its relatively poor energy performance puts great emphasis on the upgrading of existing buildings. The basic fabric of these buildings: walls, roofs, floors and services require upgrading to reach present and future increasing standards of thermal performance.

For the Scottish context this research focuses on existing load-bearing masonry construction with internal plastered lath lining.

Owners are in urgent need to insulate their properties, giving the rising energy prices, but without removing linings which form the historic fabric of the building. Existing technologies have been developed in the context of new-build construction or retro-fit to block or brick masonry cavity walls. There is a lack of suitable skills and appropriate technologies to enable effective insulation of traditional load-bearing masonry while retaining the inner fabric.

Aim and scope

The main aim of this research project is to develop and test the feasibility of a method of insulating an existing house whilst maintaining its original architecture features. The project comprised of the following phases: Phase 1 (Building selection and site surveying); Phase 2 (testing method preparation); Phase 3 (Site preparation); Phase 4 (Application); and Phase 5 (Remedial work).

An overview of the method and product applied

The method involved using water blown foam, developed by Canadian company Icynene Inc. This is the first time such insulation has been used in an historic building in Scotland. The water blown foam was created specifically for injecting into delicate structures. The foam expands slowly putting little pressure on the fragile inner wall and, as it is 100 percent water blown, it contains no harmful blowing agents. Additionally, through its open cell structure, the foam will allow the wall to breathe which will assist in controlling moisture movement. A method was discussed and developed remotely then further on on-site; between all partners; to come up with an appropriate “harm-free” method adapted to this specific building.

It has to be noted that risk assessment was conducted before any work commencing on-site to identify any potential hazards and ensure a safe working environment during the trials. Personal Protective equipment includes: eye and foot protection, breathing apparatus/respirators, in addition to Tyvek suits and gloves to be worn when applying the insulation. The trial was completed successfully without any incidents.

During the trial we gave great attention to monitor the whole process in details that we can report as follow:

Phase 1 (Site surveying):

The project team managed to find a suitable building, after visiting many buildings proposed by local house owners, which met the criteria of a historic building with vulnerable construction details. These specifications required great attention for us as the house of typical type of construction that didn't find an insulation method and was left unaddressed by insulation companies.

The survey addressed the plan layout, the wall construction details with a focus on accessibility to the cavity without damaging it.

Phase 2 (testing method preparation):

Prior to the trial, lot of discussion took place between the researchers, local architects/SME and the company who agreed to supply the insulation material and its implementation using the proposed method agreed by the team. The agreed method was tested in a workshop by KDL on the 19th August before its application on the real wall. This trial involved the construction of a wall representing same characteristics of the real wall in term cavity dimension. The spray foam sealed the area behind where the skirting boards would be fixed, resulting in no loss of pour material. The pour material was capable of being injected down a 2800mm pipe and expanded vertically between and behind the vertical studs, leaving no voids. No deflection in the hardboard was detected. This trial was deemed to be successful, and a decision was made to adopt this method at house at Fettercairn

Trial in the workshop

- Results/Findings: -

Observation of the outcomes

Phase 3 (Site preparation):

- Before the arrival of the team in charge to implement the insulation operation, we made sure to prepare the site. The site preparation involved the installation of boards in the loft; installing some lighting as this was not in place before; the removal of the skirting boards and removing all the dust that might have gathered in the wall cavity in the last 2 centuries.

Floor covering and lighting installed for safety and easy access to the loft

- Other preparations involved the carpet removal in the room that will be insulated, the covering of the floors in the corridors and staircase as lot of walks will happen during the trial that we didn't really know how long it will take.
- Covering all original features such as fire place and windows.

Covering of the floors, features for projection against the foam that might be damaged by accident

- Using industrial vacuum cleaner debris from behind the skirtings were removed to leave the cavity wall as clean as possible to avoid any thermal bridge.

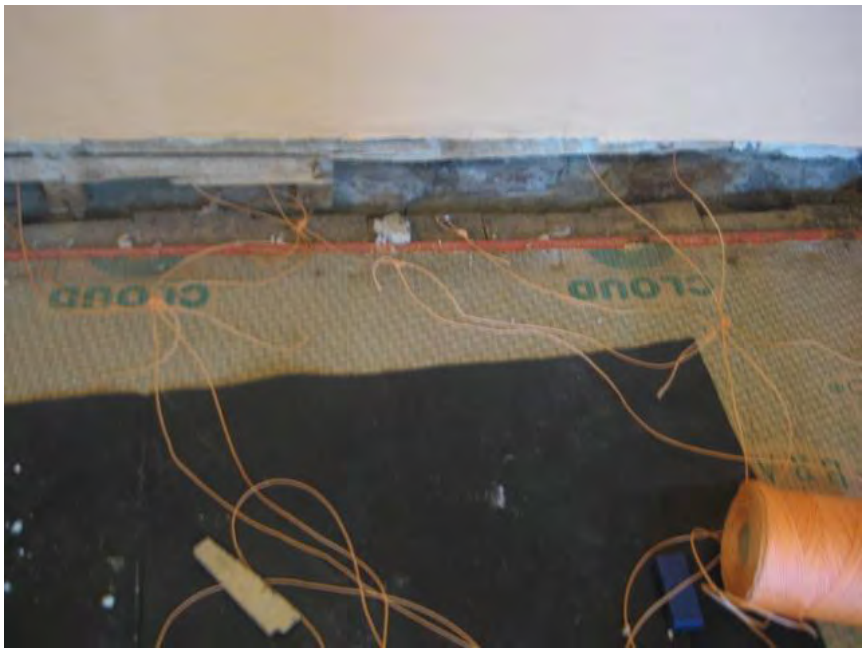
Stairs and corridors where covered to as many people were on site and lot of movement in and out the premises took place.

Phase 4 (Application):

- On arrival at the house at Fettercairn, The team was satisfied with the site preparation, which was a good starting point. The condition of the makeup existing lath and plaster lining was examined; it was found that it was possible to move the wall at the bottom, in and out, by 30mm with very little force used, indicating the

bottom of the wall was no longer fixed, and the studs not fixed (by dooks) to the masonry. A void of approximately 20mm 40mm was found behind the lath and plaster, which was supported on 50mm X 20mm studs/battens. An endoscope was used and the cavity behind the lath and plaster lining appeared to be clear. Upon inspection in the attic area it was found the gable wall was accessible between the ceiling joist and the masonry wall. The front elevation wall had a 450mm comb above, making access to the wall head difficult, and not visible. A meeting was held with the project team and it was decided that the method user in the trial at Kishorn would be appropriate here.

- Using fibreglass probes the draw cords were inserted from the attic area until the emerged at the open void, behind where the skirting boards would be positioned. The involvement of the introduction of cords was abounded latter on, as it shows inappropriate.



Cords put in place

- The draw cords were the attached to the 10mm polyurethane pipes and the pipes pulled down, and then retracted 200mm, then secured. A pipe was inserted between each stud. The site supply of polyurethane pipe ran out and the only available pipe, locally, of the same diameter was a PVC pipe, this was used to 4 bays. This type of pipe appeared latter on to be more difficult the previous one to work with.

Pipes attached to cords

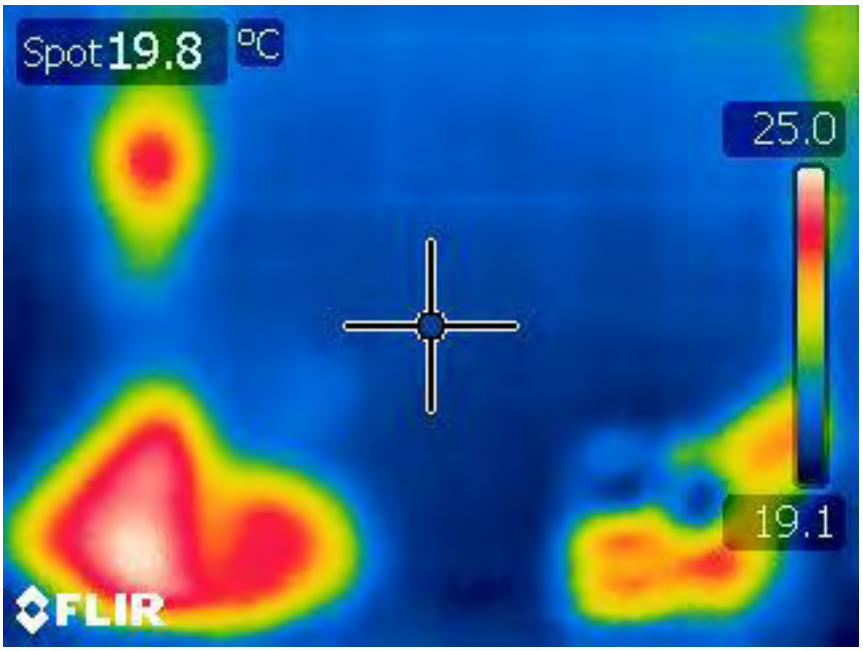
- As the pipes were installed it was noted that debris was falling down when disturbed. To ensure no bridge within the cavity was caused, which could lead to damp problems in the future, it was decided to clean the cavity. This was achieved by moving the fibreglass probes around to dislodge trapped debris, assisted by an airline inserted into the cavity. The result was that approximately a pale full of debris was removed, which consisted of plaster lumps, fine dust and wooden twigs, presumably put there by birds making nests. The void was then cleaned by vacuum and brushing.

Sample of debris removed from the wall during this phase of the trial despite the cleaning prior to the start

- Once the cavity was re-inspected with the endoscope, and deemed to be free of loose debris, spray foam was applied to seal the base void. The spray foam added some rigidity, and bonded well to the surrounding areas within the void.

- The equipment was changed over from the spray foam material to the pour foam material, and samples taken to prove the correct rate of expansion.

Quality check of the foam



Alteration between bays

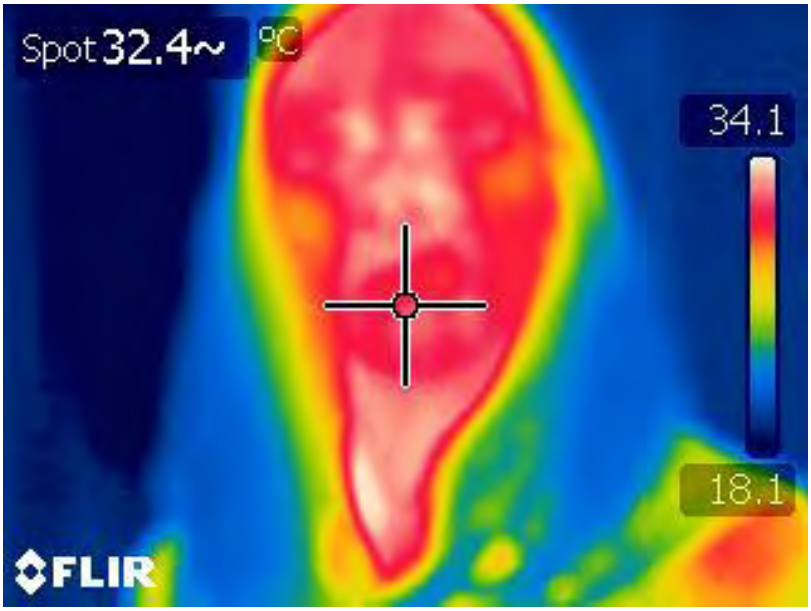
- Pour foam was then injected down the pre installed pipes in durations of 10 seconds, the pipes were withdrawn 500mm after each injection and blown through with the airline. The process of injecting alternate bays was adopted to ensure the least possible outward pressure was applied to the wall. The wall was monitored at all times for movement. It was noted that there were small areas where the pour foam

leaked out while still in liquid form, these areas were plugged using expanded spray foam pieces.

Leak of the foam at the bottom pat of the wall

Alternation of bays and localisation of the foam level on the wall

- An infra red camera available on site gave some indication where the material was injected, but this was not conclusive, and only showed the body of the pour foam in liquid form and not the area as the expansion took place.



Monitoring the foam expansion with infra red camera

- 10 second Injections were then made to the missed bays, and the pipes blown clean.
- When all the heat created during the pour foam expansion, further 10 second injections were made to alternative bays. With the missing bays returned to when the heat had dissipated. It was found that the PVC pipe would not take a second injection without blocking, (which in turn caused a blockage in the gun), requiring four of the bays with polyurethane pipes to have the pipes removed and re-installed in the bays with the PVC pipes.
- This was achieved by taping the pipe to the fibreglass probes and inserting down the cavity while the injection took place. This method was also required in instances when the draw cords became fast within the expanded pour foam.

Pipe blockage

- The process was repeated until the pour foam was visible in the attic space. Once this was achieved the material was changed back to spray foam and in the area of the comb, spray foam was installed to join the existing fibreglass insulation to the newly placed Icynene.

Top of the gable wall, foam seen from the attic

Foam seen at the eave level

- Other area proven to be in need to be insulated was discovered during the trial such as under the window. The team decided to insulate it using the spray method.

Insulating the wall under the window

Lessons learnt

- During the trial it was discovered that the PVC pipe was not capable of more than one injection without blocking, and therefore not suitable for this application.
- The debris behind the lath and plaster should have been cleaned of debris before the draw strings and pipes installed. This would have made installing the pipes much quicker and easier.
- It was determined that in some locations the draw cords for the delivery pipe were not required and the pipe could be inserted, positioned and withdrawn while attached to the fibreglass probes. This would make the process quicker in certain circumstances.
- It was found that the Icynene insulation added rigidity to the wall.

Conclusion

The trials were a success, proving the Icynene insulation can be injected behind existing plaster linings without causing any damage. A high level of skill is required, along with an understanding of the construction of the building to ensure that no damage is caused; trained installers with a joinery background would be suitable. The process needs to be executed unhurriedly and methodically with no time constraints placed on the operatives.

Future research

Monitoring of the insulation performance of the wall is essential in order to ascertain the actual impact of applying the material used in the study in addition to getting a feedback from the end-user. The research team intends to apply for another CIC grant in order to complete this work

The team involved in the trial:

Academics

Dr Amar Bennadji

Dr Mohamed Abdel-Wahab

Local architects

Craigie Levie : Local Architect consultant.

David Chouman : Architect and consultant specialised in historic buildings.

Industrials

KDL team

Mike Tweats, KDL Managing Director. Role – To devise a method and direct the site process, drawing on his knowledge and experience with historic buildings.

Finlay Black, KDL Contracts Director, Role – To manage the onsite works.

Lewis Macdonald, KDL Icynene Insulation Manager, To carry out the onsite works.

Neil Gascoyne, KDL Icynene Installer, Role – To carry out the onsite works.

Assisted by

Rob Gilmore, Icynene Technical Services Manager, to assist with on site works and advise on material and equipment settings.

Jason Prizeman, Icynene Technical Services , To assist with on site works.

Gerry Sheridan, GMS Renewable Products, Icynene Distributer, to assist with on site works.

Simon Faulkner-Lee, Icynene, To assist with on site works.

Jeff Hood, Icynene, To assist with on site works

Outcomes

As a result of this feasibility study project, an innovative method and material successfully used to insulate a historic listed building in Scotland. A press release was co-ordinated and communicated widely to the media and the project funders were cited as well as CIC start. See for example:

www.build.co.uk/construction_news.asp?newsid=133283;

http://readaboutattic.info/innovative-method-successfully-used-to-insulate-historic-house-build-co-uk/; http://atticreference.info/innovative-method-successfully-used-to-insulate-historic-house-build-co-uk/;

http://www.houseparts.com/houseparts/info/buildcouk/construction_news.html

http://kirstonian.posterous.com/innovative-method-successfully-used-for-first

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Dr. Amar Bennadji, Principle Investigator of the project and lecturer in Architectural Technology at Robert Gordon University (RGU) Aberdeen stated that "following the successful trial, the heat loss through the wall was reduced by approximately 50 per cent". He explained that "this project opens the door for historic buildings to finally retain warmth, reduce their energy bills and contribute to efforts to curb global warming by reducing their carbon footprint." He further added that "the project team aims to pursue further work to improve historic building components, such as solid floors and sash windows."

Jeff Hood, Icynene's Vice-President flew in from Canada to Scotland to witness the trials. He said "as a pioneer of the Green Building movement Icynene has developed non-destructive techniques of insulation that have been successfully used in historic buildings in North America for a number of years,". He added that "We were very keen to observe and advise on the first test of this technology in the UK as until now there wasn't a procedure available which could be used to insulate internally-lined solid masonry walls. The performance of the wall will be observed and monitored over the coming months."

The project is multi-disciplinary as it is not only limited to testing an innovative method for cavity wall insulation, but also it captures the implications for skills development and

training. The insulation was installed by Kishorn Developments, an Icynene approved installer, supported by the Irish distributor - GMS Renewable Products.

Dr. Abdel-Wahab said “this multi-disciplinary project presents a unique opportunity for providing actual project-based information on the skills requirements for successful wall insulation in historic buildings”. He explained that “such information is crucial for providing guidance to government skills policy in support of retrofitting historic buildings.”