STUDY REPORT

SR234 (2010)

Investigation into the Performance of Brick Veneer Walls Installed with Urea Formaldehyde Foam Insulation

– A Case Study

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Funded by BRANZ
from the Building Research Levy

ISSN: 1179-6197

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1. EXECUTIVE SUMMARY

Work to evaluate the properties of urea formaldehyde foam insulation (UFFI) and the effect UFFI has on the moisture management processes within brick veneer construction has been completed. This work examined the tendency for water running down the inner face of a brick veneer wall to be transported across cavity fill insulation to the position of the wall wrap. The results indicated that the foam fill in the water managed cavity has provided drainage paths to the wall wrap position, and so does not meet New Zealand Building Code criteria in that there should be no systemic water bridging from the back of the cladding to the wall wrap position.

Further work to monitor the humidity and timber moisture content of cavity filled brick veneer walls has also been completed. The results indicate that the drying of the timber framing after UFFI installation is a slow process with timber moisture contents still above the pre-UFFI levels several weeks after installation.

A more detailed assessment of the weathertight characteristics of cavity filled brick veneer walls would be needed to understand the range of application in buildings that would be consistent with clause E2 “External Moisture” of the New Zealand Building Code. This would involve an examination of field evidence and the potential for ventilation drying from the back of the cladding. This is outside the scope of this report.

2. LABORATORY STUDIES

2.1 Effect of Airfoam on Water-Managed Cavity

A sample wall (D4864) was constructed using 2.4m x 2.6m flat panels with 95mm x 45mm H3.1 timber frames clad with red Monier 90 series bricks on a stepped concrete foundation to give a 40mm weathertightness cavity. The wall was constructed with galvanised brick ties and weep holes at appropriate intervals, and had clear Perspex sheets fixed as a building underlay. UF foam was injected into the weathertightness cavity from the outside, using holes drilled through the mortar joints of the brick veneer by an Airfoam applicator on 12 February 2010. The UF foam was installed behind the brick veneer and in front of the clear Perspex sheet.

The measurements described examine the tendency for water running down the inner face of a brick veneer wall to be transported across cavity fill insulation to the position of the wall wrap. Airfoam insulated the water managed cavity of a brick wall 2.4 m wide by 2.7 m high with UF foam in a laboratory at BRANZ (D4864). After a period of two months to dry out the insulation, water (coloured with fluorescein dye) was applied to the back of the brick veneer to test for the transfer of water back to the plane of the wall wrap. The test applied was an adaption of the “Water Management Testing” procedure in verification method E2/VM1[1] for cavity walls. It applied the criteria that there should be no systemic water bridging from the back of the cladding to the wall wrap position.

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During the 1980s work was undertaken[2] at CSIRO by E.R. Ballantyne and D.R. Dubout investigating the suitability of various insulation materials to fill the cavity in double brick cavity construction. The problem with this practice is that introducing any material into a cavity designed for moisture management may increase the tendency for water to bridge the cavity, leading to damp interior linings. The work of Ballantyne proposed two test methods and water flow schedules to determine the likelihood of water transport in a given material. Both methods involve containing the insulation against the face of a brick wall representing the outer leaf of a double brick building. Where the two methods differ is in the means of applying water to the junction between the brick and the insulation. A mode 1 style test involves building the wall into one face of a pressure box and applying water to the face of the wall simulating the outside of the building. An applied pressure difference is used to drive water through the wall into contact with the insulation material, which therefore simulates the water leakage process. Alternatively, in the mode 2 test, water is simply applied to the inner face of the wall and allowed to drain down the interface between the wall and insulation.

New Zealand Building Code requirements for controlling external moisture were revised in 2005 in response to a systemic leaking building problem. The new Acceptable Solutions[3] in E2/AS1 stipulated the use of cavities more widely than before, and defined weathertightness performance expectations for cavity walls in Verification Method E2/VM1[2]. The test sequence in E2/VM1 is significantly different to that proposed by Ballantyne. Firstly, it is designed to protect timber framing inside a wall from water, where the Ballantyne test applied to brick/block veneer walls with no timber (or other material likely to be damaged by water). Consequently, the failure criteria in the two test methods are different. In E2/VM1 the failure criteria is water reaching the building wrap where in the Ballantyne method it is water reaching the internal wall lining. The second important difference between the two methods is that the E2/VM1 test sequence calls for a drainage path on the back of the cladding that is independent of the weathertightness characteristics of the cladding. The test actually creates leakage paths through the cladding to ensure that water reaches the drainage path. The test applied in this report followed this approach by simply allowing water to drain down the back of the cladding.

Brick veneer walls are known to be relatively porous and have been designed to include a water managed cavity throughout their history of application in New Zealand. Cladding water leakage studies at BRANZ[4] have measured leakage rates through brick veneer walls of 0.04 l/m^2.min. and this rate has been used to calculate a target water application rate of 0.26 l/min for application at the head of the test wall. The test brick wall measuring 2.4 m wide by 2.7 m high was built in the laboratory and fitted with a porous tube (see Figure 1) to feed water to the back of the cladding. The dosing rate was controlled by a peristaltic pump, which was later measured using a catch and weigh method. The wall wrap was replaced in this test wall with a sheet of transparent Perspex to ensure that any water leakage would be seen. It was noted that water tended to initially to flow down the wall in defined trails (see Figure 1) but that in time, the flow spread out as the full surface of the brick wall became wet.

Figure 1: Water applied through a porous tube (D4864)

The following sequence of events was recorded after dosing was started at 10:37 am on Friday 9th April 2010.

Time	Observation	See Figure
10:37 am	Start of test	
10:39 am	First signs of water at the wall wrap position	Figure 2
10:43 am	Second sign of water at wall wrap position	Figure 3
11:20 am	Significant leakage observed and test terminated	Figure 4

Table 1: Observations during test

The dosing flow rate was measured and found to be 0.174 l/min, somewhat less than the target rate of 0.26 l/min.

Figure 2 to Figure 4 show water reaching the wall wrap position only minutes after the start of water leakage down the back of the cladding. This is evidence that the foam fill in the water managed cavity has provided drainage paths to the wall wrap position.

Figure 2: Leakage observed 2 minutes after start of test (D4864)

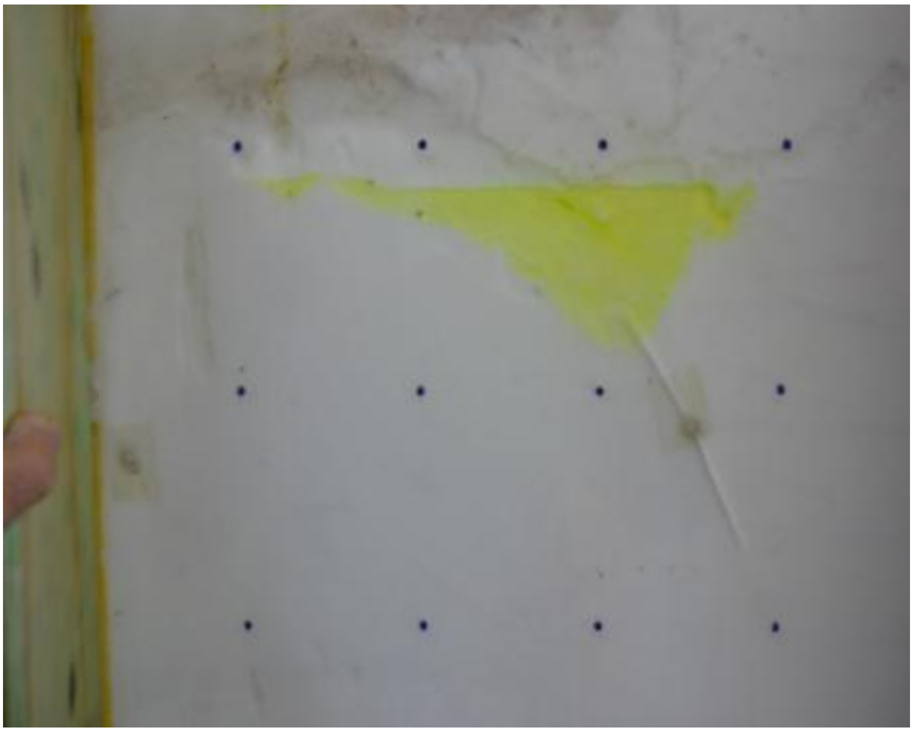

Figure 3: Leakage observed 6 minutes after start of test (D4864)

Figure 4: Leakage well established 43 minutes after start of test (D4864)

Masonry veneer walls have a record of satisfactory weathertight performance in New Zealand. They provide acceptable cladding solutions for high risk buildings (up to risk score 20) that could include a number of design features associated with rain water leaks. Filling the water managed cavity with insulation products potentially reduces the acceptable risk score to somewhere in the range 0 – 6, in line with many other direct fixed claddings. At this time, brick veneer without the traditional drained and ventilated cavity is not listed as an acceptable solution in E2/AS1[3]. It falls into the category of “specific design” until further testing and an examination of field performance records can be used to recommend a risk score.

The Airfoam insulation cavity fill was observed to have shrunk away from the brick veneer cladding, creating a potential drainage and ventilation passage down the back of the brick veneer. Because the cavity formed was rather less than the minimum 18 mm required for a full test to E2/VM1,[1] some adaption of the test sequence was needed to test for water bridging paths between the back of the cladding and the wall wrap.

The measurements described in this report show that the small cavity formed between the brick veneer and insulation by shrinkage was insufficiently continuous to prevent water bridging across to the insulation where it was transported to the building wrap position. The drainage cavity in the test wall did not provide a reliable drainage path for water leakage on the back of the brick veneer cladding.

2.2 Effect of Airfoam on Humidity and Timber Moisture Content

Two brick veneer walls were installed on both the north and south elevations of the weathertightness test building at BRANZ in 2003-2004 and used for moisture studies within various research programmes. The walls are fully instrumented and actively logged for temperature, humidity and timber moisture content. From December 2009 the two brick veneer walls have been used to investigate the effects of introducing UFF insulation into the stud cavities and the effect on timber moisture content levels within the wall. The brick veneer test walls in the weathertightness test building at BRANZ were also installed with Airfoam during an initial visit in December 2009.

Figure 5: Brick veneer cladding on BRANZ test building

Figure 6: Thermal image of brick veneer test sample during drying stage after Airfoam installation

The framing and instrumentation layout is shown in Figure 7. For the purposes of the current study the moisture content pins were all moved to the middle of their respective framing member, as shown in Figure 7. This was done in an attempt to look at the moisture distribution across the frame from the internal lining to the building wrap. The exposed ends of the moisture pins were coated with an adhesive in an attempt to eliminate shorting of the pins through the wet foam. The humidity sensors were located in the stud space and were protected from liquid water by placing masking tape over the ends of their sheathing.

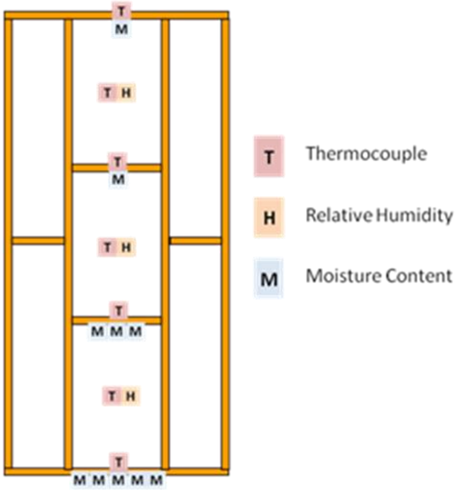

Figure 7: Framing and instrumentation layout for test building sample

Holes were drilled through the internal lining and the foam was pumped into each of the cavities formed by the framing. The holes were then left open to the indoor environment. The logging system recorded information from all of the channels every 15 minutes recording the moisture content and the humidity in the insulated cavity.

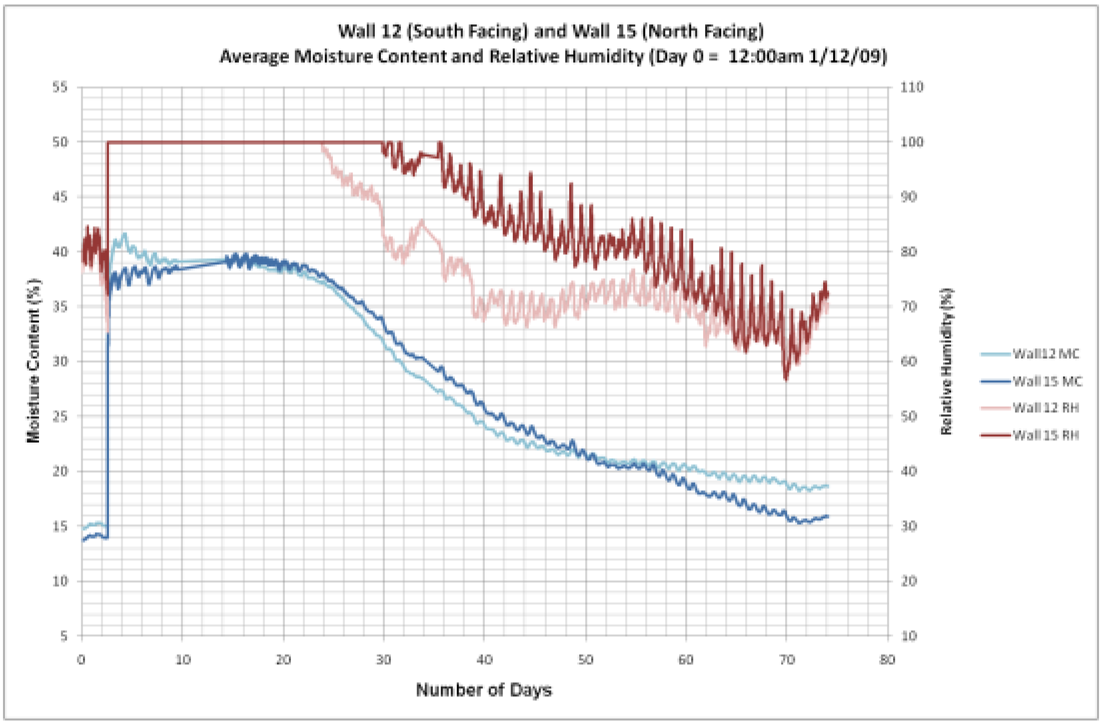

Figure 8: Average Results from Brick Veneer Walls in Test Hut

Figure 8 shows the results from both walls for the period from 1/12/09 to 13/2/10. The installation of the UFF insulation causes a rapid rise in both the relative humidity in the cavity and the moisture content of the framing.

The moisture content of the framing stayed roughly constant for about 2 weeks and then began to slowly dry out. In February 2010, several weeks after installation, the timber was still above the pre-UFFI levels. The results for both walls are similar, but past work indicates that had the UFFI been installed in the winter, the south facing wall would take considerably longer to dry and would be likely to stay wet for the whole of the winter.

The humidity measurements are representative of the moisture in the foam. The results show that the humidity is at 100% (free moisture) for 2-3 weeks before drying out. The foam in the north facing wall dried quicker (about 5 weeks) than its south facing counterpart (about 8 weeks), but in both cases the foam dried at a considerably quicker rate than the framing. Sustained high humidities have the potential to support mould growth and so should be avoided if possible.

3. LIMITATION

The results reported here relate only to the item/s tested.

Higher than expected moisture contents for bottom plates within brick veneer construction several months after UFFI installation have been observed during BRANZ site visits[5,] and DBH investigations[6]. Although these elevated moisture contents (up to 25% in some cases) appear to support the findings of this report, further research would be required to determine whether these elevated moisture contents were due to residual moisture from the installation process, or from external water being transported across the brick veneer.

4. REFERENCES

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