WARM: Low Energy Building Practice

A site investigation into building airtightness from external wall insulation

3 house types from the Clients stock

for:
The client

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Introduction

This report has been commissioned by The Client, in order to assess the airtightness of 3 existing house construction types both before and after external insulation works are carried out, comprising 3 non-traditional building systems. The three dwellings chosen for testing were:

- House A - BISF
- House B - Laing Easiform
- House C - NoFines

All three dwellings are currently occupied, and have been fitted with uPVC double glazing.

The initial report has been updated to include the results after the insulation was installed. The results of the three tests are listed below, with an illustrated commentary on each house type discussing the main issues. An appendix contains detailed information about each test and documents the individual leakage points.

Air tightness testing was carried out using a fan mounted in a frame in the building entrance door. Air flow rates and pressures are then measured to determine the air change rate in the building at a standard internal pressure of 50 Pa. Tests were carried out in accordance with the general principles of Passivhaus technical standards.

Door fan installation at House A

Results

The following results show the air change rate (ACH) within the buildings as tested. For compassion building regulations require a *maximum* ACH of approximately 10.0 ACH, with most designs achieving around 6 ACH. Passivhaus standards require a maximum of 0.6 ACH, an order of magnitude lower.

Results pre and post External Wall Insulation (EWI):

House	Pre EWI	Post EWI	Change
House A	16.8 ACH	14.0 ACH	-10%
House B	7.7 ACH	11.1 ACH	+45%
House C[1]	26.9 ACH	22.7 ACH	-15%

Note 1: Depressurisation only as too leaky for Pressurisation test to pressurise.

Conclusions

- Clearly the EWI has had only a random effect on the airtightness of the buildings

- The results are all discouraging (apart from the significant appearance improvement)
    - The air changes rates are all massive. Unsurprising therefore that most occupants had sealed up their extract fans in Kitchen and Bathroom – extract fans are really unnecessary as these leakage rates.
    - What is further worrying is that the EWI installation has in fact made airtightness routes inaccessible. How will draught-proofing work be carried out now?
    - The extensive air leakage will of course negate most of the savings from the insulation, as it has been effectively bypassed by the large air leakage

Recommendations

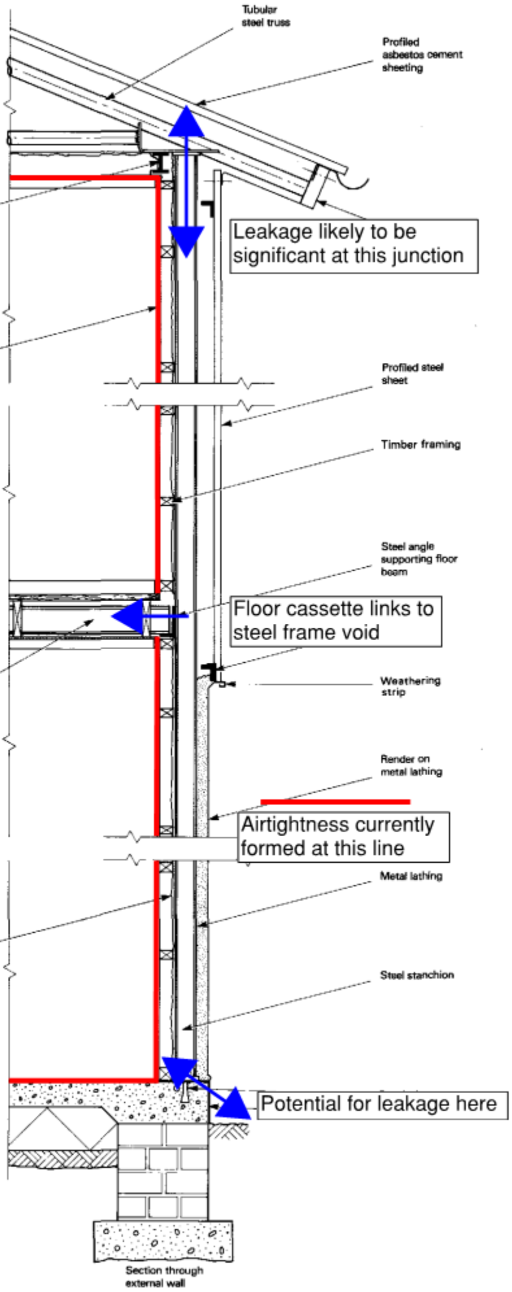
The work leads to a situation where money has been spent on insulation in a way that hampers any further improvement work.

It is recommended that :

- the roll out of EWI across the stock is reviewed and at least some form of air testing/draught proofing work initiated before a building is classed as suitable for EWI.
- a review is made of the standards being used for retrofit: 2.5” of insulation is really wasting the cost of the external render.

Commentary

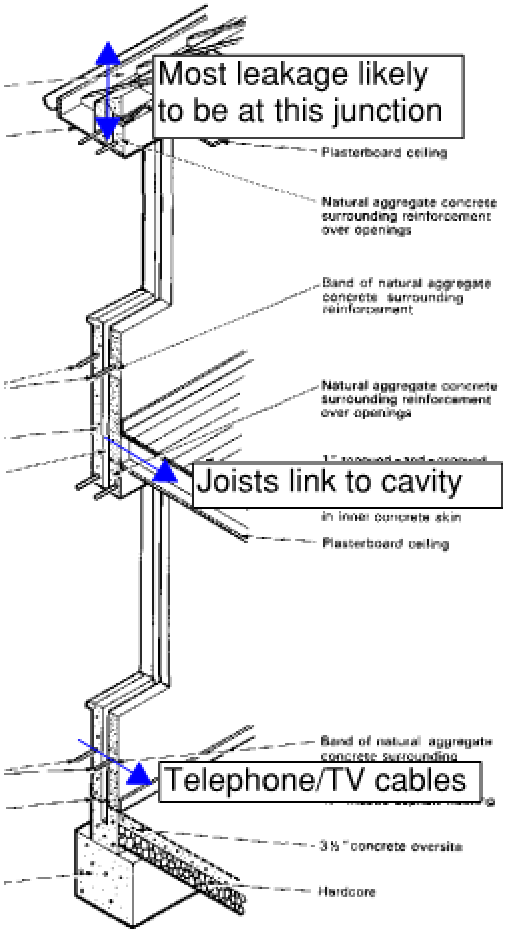
House A



The airtight barrier in this house is currently provided by the plasterboard face to the walls and ceilings.

Air leakage is apparent at the window reveals; at the wall to ground junction; internal wall vents in bedrooms; the stair to wall junction and the wall to roof junction. Including the 'Outhouse' area in the airtightness and insulation strategy is essential, given that the residents use this space as part of their home. The before and after test results show a marginal reduction in air leakage.

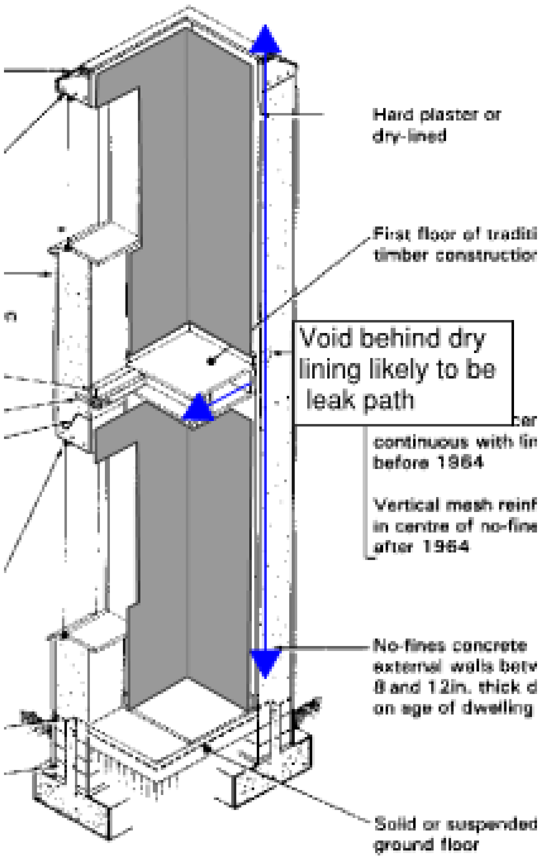
House B



Cast concrete cavity construction is by its nature likely to be the most airtight of the 3 types tested. The most significant leaks were through services penetrations and probably the intermediate floor, likely to be caused at the point where floor joists are cast into the inner leaf of the concrete. However, given that the outhouse area forms a regularly used part of the house, airtightness in this should be addressed of the dwelling. (see photographs in Appendix for further details).

The before and after test results indicate that the air leakage has actually increased since the initial test. It is not clear why this has occurred.

House C



While we could undertake depressurisation tests, it was not possible to pressurise the house to 50Pa with our fan. We abandoned the test at this point as one of the residents was unwell with chest problems, and even with heating on the fan test was cooling the house to an uncomfortable level. While earlier No-fines houses were wet plastered internally, these later ones have an internal lining which appears to be consist of plasterboard on battens. Therefore there is essentially a cavity behind the concrete. Significant leakage through the intermediate floor shows that this cavity is not well sealed from the outside. Without further examination it is not possible to say definitively where these leaks originate from.

Given the airflow felt through a socket on an internal wall it is possible that the wall to roof junctions play an important role. The very high air leakage in this house would certainly limit the effectiveness of any external insulation unless the detailing of the insulation is carefully considered at the window reveals, at the wall to ground junction and the wall to roof junction. However BRE guidance (Williams 1991) suggests that there is an intentional drainage slot at the base of the No-fines wall which needs to be maintained, so the strategy does need some thought.

The before and after test results show a marginal reduction in air leakage.

3 house types from
the Clients stock

Sources of illustrations

Building Research Station (1986) The British Iron & Steel Federation steel framed house Building Research Establishment

Currie RJ (1988) The Structural Condition of Wimpey No-fines low rise dwellings Building Research Establishment

Reeves BR & Martin GR (1989) The Structural Condition of Wimpey No-fines low rise dwellings Building Research Establishment

Williams AW (1991)The Renovation of no-fines housing BRE Press

Appendix

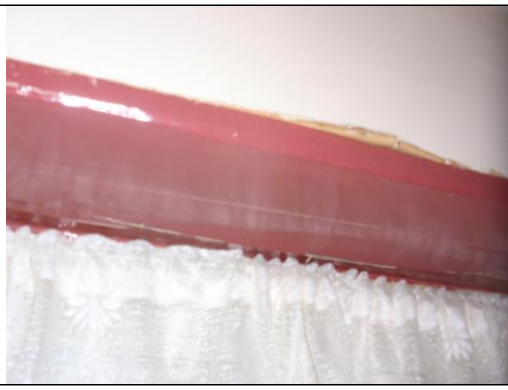
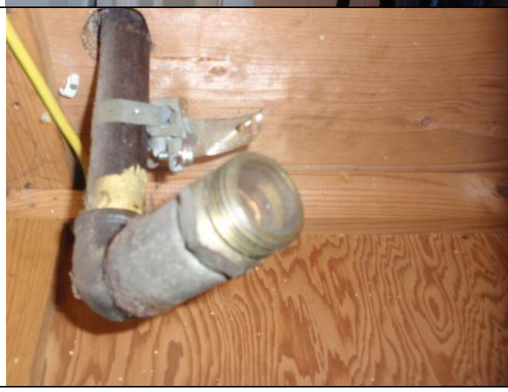
Notes: House A

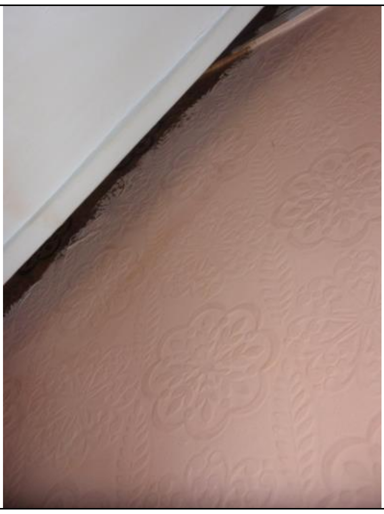
BISF steel frame house, replacement windows, and original render/cladding. ‘Outhouse’ used as part of dwelling. No complaints of mould growth, occasional condensation in kitchen, but only when cooking very large meals. Occupiers like fresh air so door often open. Most trickle vents open on arrival.

Currently the only airtightness line in the walls and roof seems to be the plasterboard. Services etc go through it. If the top and base of walls remain unsealed after insulation the entire house will still leak.

Ground floor

Sockets/switches Leakage was noted from all the sockets and switches in the house	
Plumbing behind kitchen sink A draught could be felt coming from the kitchen sink cupboard. This is likely to be from the plumbing penetrations	
Gas pipe vent in kitchen This gas pipe venting was installed during the refit of the kitchen	
Window reveal in lounge Air appeared to be coming in through the	

damaged reveal, which may be due to corrosion in the steelwork.	
Switches and trunking by front door Despite being surface mounted, air could be felt both from in and around the switches and the trunking	
Disused gas pipework The disconnected pipe appears to run to the outside of the building, where it must also be disconnected, and does not appear to be capped off	
Within electricity cupboard There was significant airflow within the cupboard. This appears to be related to the electric cable entry	

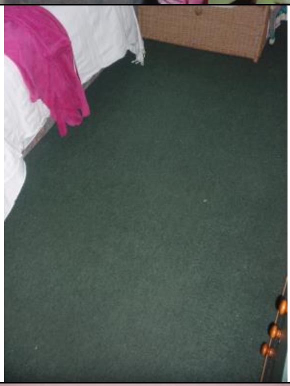
Behind stairs The plasterboard appears to stop somewhere behind the steel stair construction, allowing significant airflow at this point. Access very difficult.	

Outhouse

Wall vents 2 vents within the main wall of the house which are open to the outhouse area but do not appear to connect to the interior	
Doorframe Around the top of the steel doorframe within the outhouse area	

First Floor

Bath panel/plumbing Leakage was noted at the plumbing penetrations and from behind the bath panel	

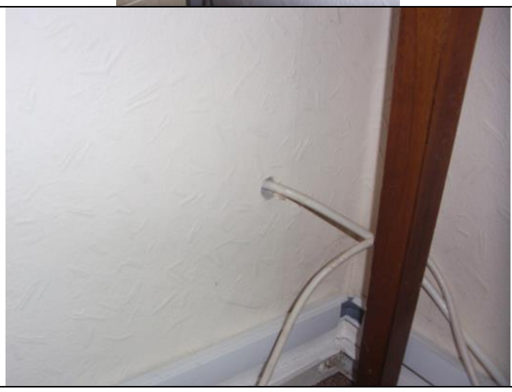
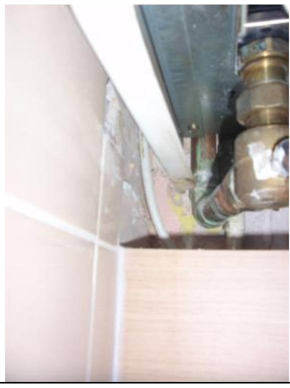
Plasterboard damage A gap in the plasterboard leaked significantly	
Intermediate floor Lightweight carpet upstairs lifted during the depressurisation test, showing a significant leakage path through the wall construction into the floor cassette	
Wall Vents Uncontrolled vents in bedrooms into the wall cavity. There is significant air flow through these. They were temporarily sealed during the tests.	

Notes: House B

Laing Easiform house, with uPVC replacement windows and doors. ‘Outhouse’ used as part of dwelling. Bathroom extract fan and front bedroom ventilator both taped over by tenant to avoid draughts.

A significant part of the leakage through the outhouse. Note that previously completed insulation works locally do not appear to have addressed this area.

Ground Floor

Phone point The telephone sockets were leaky, suggesting poor sealing of the telephone able entry	
Cable This cable was very poorly sealed. Control over 3rd party works is important in avoiding unwanted leakage	
By boiler This is likely to be from the gas pipe penetration or from another services penetration hidden behind the built-in kitchen units	

Outhouse

Roof to wall junction This junction is not sealed, with gaps between the corrugated asbestos roofing and the rendered blockwork wall	
External view of the same area	
An insulated house nearby The asbestos roofing has been left in situ, and there is a cold bridge where the roofing meets the main house wall. The corrugated roofing junction with the outhouse wall does not appear to have been made airtight, and the insulation stops short of the roof both at the top (main house) and bottom (outhouse)	

First Floor

Intermediate floor Where floor coverings were absent a small amount of leakage could be felt through the gaps between floorboards	

Switch (on internal wall) and ceiling roses The switch was leaky, suggesting that the internal stud wall is open to the loft space Additionally, leakage was noted at ceiling roses, which is to be expected	
Lintel A leak was noted where the lintel surface decoration was damaged, which may suggest that the lintel itself is damaged somehow, or that the internal plaster has come loose and the hole behind communicates with the cavity	
Built in cupboard The corner of this built in cupboard in the front bedroom was leaky	
Windows Some of the windows had slight leaks where either the opening sashes did not seal fully or glazing unit beading was not sealing fully	

Notes: House C

No-fines rendered concrete house, with plasterboard walls internally (presumably with studwork and a void behind), no later than 1970s (dated from Digimap). Occupants note that house is very leaky, including the kitchen, front door and some windows, and that it never feels warm. No access to two cupboards off hall, so unsure if leaks in there.

Unable to pressurise successfully with our fan kit, indicating a very high high leakage rate.

Ground floor

Front door Not tested by us (as the back door was too small for our fan) but with this door closed and at atmospheric pressure significant leakage could be felt on the lock side of the door.	
Behind built in kitchen units Significant airflow could be felt through all the kitchen cupboards and drawers both on the external and party wall, as well as from around the washing machine. Air could also be felt behind the cooker (on the party wall)	
Kitchen Sockets All sockets were leaky, including one on an internal wall	

Under vivarium in dining room Air could be felt coming from under the vivarium. This may have been from a socket on the external wall or from the wall to floor junction	
Internal to external wall junction The junction of the internal wall and external wall was leaky	
Window in dining room This was quite leaky. Other ground floor windows appeared to be ok	

First Floor

Sockets First floor sockets were leaky, indicating that the void behind the dry lining is providing a path for airflow	

Windows Some windows were leaky, particularly the one in the wet room. This room was reported to be particularly draughty by the tenants	
Loft hatch frame The loft hatch was well sealed, but where the frame meets the ceiling there was a leak. There were also leaks at cracks in the plasterboard ceiling	
Boxing in wet room Leaks could be felt at the junction between the wall finish and wet room floor. This room was reported to be particularly draughty by the tenants	
Soil pipe Air leakage was noted at the soil pipe. This runs into the adjacent room (ie the soil pipe runs parallel to the external wall)	

Old overflow Although this was filled with foam externally, leakage was felt through the old disconnected toilet overflow	
Intermediate floor There was a large amount of leakage through the intermediate floor cassette, felt strongly where floorboards were exposed. The lino in the WC lifted during the depressurisation test.	

External Photographs

Ventilators in external wall These ventilators, the purpose of which is unclear, are likely to add significantly to the airflow through the building	
Kitchen extract cowl There are no flaps to this cowl to reduce airflow when the fan is not running	

Render stop line At the back of the render stop line the no-fines concrete could be felt exposed in places, providing a potential leak path due to voids within the no-fines material. However, according to the BRE there is supposed to be drainage at this location	
Eaves vents Eaves ventilation appears to have been fitted. It is likely that this ventilation connects with the void behind the dry lining