Appendix H: WP9 – Site investigations

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Section Contents

1 Site investigations

1.1 Initial proposed scope of site testing

The site investigation work originally proposed for the project was to undertake the following activities:

Site testing on 3 houses, ideally in the same location, with different treatments and conditions for analysis with a variety of simple measurements over a maximum of 16 months. The houses will ideally be from a housing association and through agreement with them, we will test the following:

- A property with no insulation. Waterproofing will be applied
- A property with insulation with known problems with no water proofing. Waterproofing will be applied
- A property which is being insulated anyway. Waterproofing and insulation will be applied

If existing houses where waterproofing applications had already been made were identified during the project these would also be analysed, particularly for possible degradation.

Proposed testing included:

- A survey according to BS 8104 'Assessing exposure of walls to wind driven rain'
- BS 8208 'Assessment of suitability of external cavity walls for filling with thermal insulants'
- Moisture readings taken using calcium carbide testing
- IR Camera surveys with moisture meter
- Internal and external RH and Temperature logging as well as solar radiation and wind
- Physical testing and sample extraction for laboratory analysis

After extensive surveying and assessment of properties put forward for inclusion in the field tests, it has not been possible to find any suitable dwellings in an appropriate condition to accept the application of a waterproofing treatment with any chance of a successful outcome. There are a number of reasons for this, covering the range of previous identified failure mechanisms from WP 2. It has therefore not been possible to implement the site testing originally envisaged.

This report therefore describes the surveying activities carried out and highlights the issues that were identified that prevented site testing. The wider implication for the potential future applicability of waterproofing treatments to exposed cavity walls is also discussed.

1.2 Review of background to cavity walling relevant for site investigation

Cavity walls consist of two masonry leaves tied together but separated by a continuous airspace. The outer leaf acts as a 'protective skin' against the elements, principally driving rain. It works in conjunction with the inner leaf, which serves as a dry construction to carry the interior finishes. The two leaves need to be tied together for structural stability and to help carry the loads imposed on them by upper floors and the roof. The purpose of the cavity is to prevent damp from passing through from the outside to the inside of the wall. It also allows for the evaporation of any condensation or rainwater that penetrates the outer leaf and ensures a more even temperature inside the building.

Although early cavity walls were often tied together with bricks bonded into both leaves of the wall, these are considered more analogous to solid wall construction as moisture is able to transfer across the cavity via these bricks. Such walls would therefore not be considered for site investigation if they were identified. Only walls with metal or plastic ties designed to prevent capillary transfer of moisture across the cavity would be considered. Early metal ties were typically cast or wrought iron either untreated or dipped in tar and sand before being placed in the wall. These were later replaced by galvanised mild steel ties. Early metal ties are liable to corrosion if damp conditions persist, particularly if the ties were embedded in an acidic mortar such as one containing ash, which was particularly prevalent when properties were constructed in the vicinity of industrial activity, such as coal mining, and steel processing work.

In early cavity walls both the masonry leaves and the cavity can vary considerably in width. Cavities can vary in width from 100mm wide to less than 50mm wide. In cheaper buildings, two single skins of brickwork would often be separated by only a 50mm cavity, but it was nevertheless recognised that the thicker the masonry and the wider the gap between the leaves the more effective the protection against driving rain and the warmer the enclosed air space.

Some cavity walls will have been built with a damp-proof course (DPC) above ground level, often with weep-holes to allow water that penetrated the outer skin to drain outwards. DPCs (to prevent rising damp) were in common use by the early 1900s. They could be made from lead, pitch, asphalt and slate. Not until the mid 1920s did vertical DPCs become a standard detail around openings. At openings in early walls, either the window or door itself may be used to 'close' the cavity, but as techniques developed it became more usual for either the outer or inner leaf to be returned to close the cavity more effectively. The use of cavity trays to assist with any failing water in the cavity were not used until relatively recently in cavity wall construction.

In the early days of cavity construction there was much debate about whether or not the cavity should be ventilated. However, by the end of the 19th century a prevailing consensus had developed that there should be a small amount of ventilation, similar to that provided under floors, but that the cavity should be closed effectively at openings and beneath the roof line. This provided a degree of air movement to help any moisture which did penetrate the cavity to evaporate away.

These various features were considered during the site investigations for this study to determine the fundamental quality of the walls and their construction and their subsequent 'natural' resistance to moisture transfer across the cavity.

1.3 Approach to site investigations

BRE undertook extensive searches to try to identify properties that are constructed of facing brickwork, that are located in exposed locations according to BS 8104, and in a condition that would be suitable for the application of water proofing treatments. The following organisations were approached to assess their housing stock for suitability:

- Merthyr Valley Homes – Heads of the Valley in South Wales
- Merthyr Tydfil Housing Association - Merthyr Tydfil
- Bron Afon Housing Association – Newport, Cwmbran and Pontypool in Gwent
- Valleys to Coast Housing Association – Bridgend
- Gwalia Housing Association – Swansea
- Liverpool Housing Trust – Bootle, Kirby and Birkenhead

Surveys were undertaken by Colin King of BRE using a number of techniques:

- Assessment of exposure to wind driven rain according to BS 8104 'Assessing exposure of walls to wind driven rain' (to determine if located in zone 3 or 4 according to BR 262 and Part C of the Building Regulations)
- External surveys of the properties to determine the condition and external wall finish (i.e. facing brick or render)

* Internal surveys of the cavity to identify the presence of defects or design issues that could lead to water ingress not directly attributable to the failure or otherwise of water proofing treatment that may be applied. The cavity was surveyed according to BS 8208 'Assessment of suitability of external cavity walls for filling with thermal insulants'

100 properties underwent the external inspection, with 50 also undergoing internal inspection.

1.3.1 Selection criteria for potential properties for site investigation

Since the aim of the project was to assess the suitability and effectiveness of any water proofing treatments readily available on the market for fair faced brickwork in high exposure conditions, it was essential that properties located in Zones 3 or 4 were identified that were constructed of facing brickwork, either fully or substantially. Investigated properties were allocated to the following classifications. Only properties with substantial facing brickwork in good condition (highlighted in bold) would be selected for an internal inspection of the cavity to then, if suitable, be considered for the wall water proofing treatment stage. Detailed assessments on actual properties would be undertaken once suitability of the façade finish was ascertained.

* Fully rendered, good condition, no cracking in excess of 0.5mm
* Fully rendered, poor condition, cracking in excess of 0.5mm multiple areas
* **Full facing brickwork, good condition, no obvious defects, delamination of face, missing or eroded mortar or structural issues**
* Full facing brickwork poor condition, delamination of facing brick work, missing mortar joints, cracking and or structural issues
* **Half rendered / half facing brickwork good condition, no obvious defects, delamination of face, missing or eroded mortar or structural issues**
* Half rendered / half facing brickwork poor condition, obvious defects, delamination of face, missing or eroded mortar or structural issues
* Incorrect pointing finish of brickwork in exposed location
* Insufficient overhang on sills and verge leading to run off strike

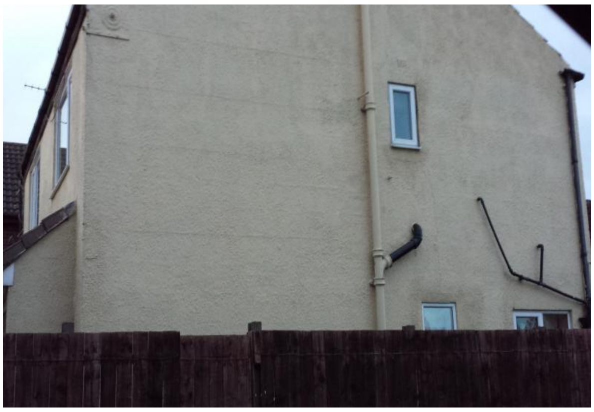
1.4 Observations from site investigations

The first main observation of note when surveying the locations was that fully facing brickwork in exposed locations was not typical, or in significant numbers. In the main, the properties were fully rendered or partially rendered. The following images show the external finish of a sample of the typical properties surveyed.

Swansea

Bridgend

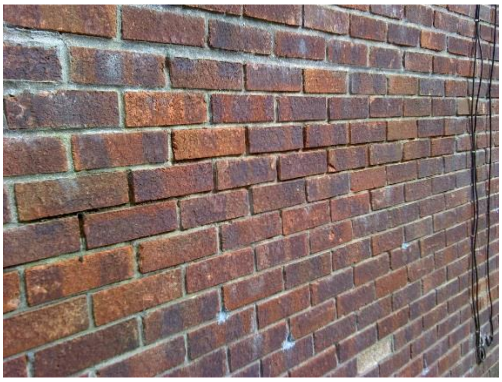

Liverpool **Newport**



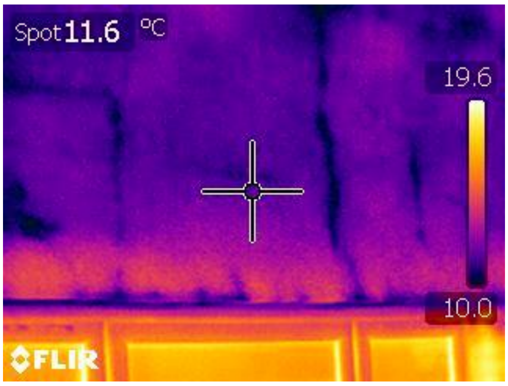

Cwmbran **Kirby**


Merthyr Tydfil **Bootle**

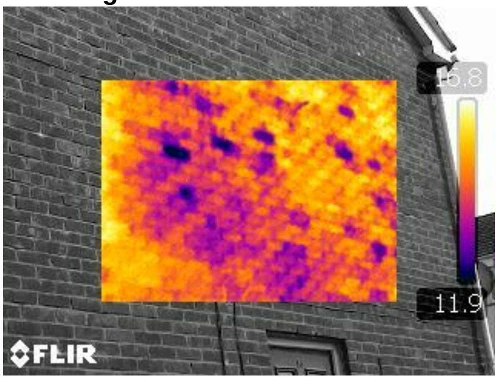
Closer inspection of the condition of the external walls identified high levels of cracking and defects. Some exploratory work was undertaken and the use of an infrared (IR) camera to identify underlying faults or cracks that would preclude their inclusion in the study. Examples of the types of defects observed are shown in the following images.



Eroded mortar



Cracking identified with IR camera



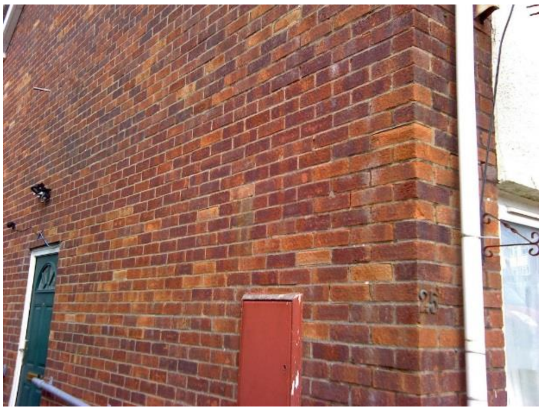
Elevated wetness in bricks caused by erosion or face damage

Incorrect pointing

Severely eroded mortar perp end

Wetness causing mossy growth

Insufficent overhang of sills and verge



Damaged face of bricks **Visibly wet and stained brickwork**

Surveys of the properties identified a number of challenges in terms of their suitability for the application of water proofing treatments and hence their participation in the site investigations:

- Cavities can be blocked at the base with debris and the DPCs are not intact
- The facing brickwork is significantly damaged and the engineered face deteriorated to a large extent exposing the inner layers of the brick. This may be caused by freeze thaw frost damage
- The presence of snots and debris in different locations across the façade that could promote moisture transfer across the cavity
- High frequency of cracks > 0.5mm but < 1.5mm in nearly all circumstances
- Significant cracks (larger than 2mm) in the structure, caused by either localised movement or wall tie failure
- Cavity trays are not in place or damaged
- Seals around windows are either non-existent or in poor condition
- Erosion of the mortar pointing – pointing can be significantly weathered to such an extent that the cavity void can easily be penetrated by rain

1.5 Conclusion from site investigation

For any application of water proofing treatment it is essential that the condition of the external facade is in a sufficiently good condition to allow the treatment to have any chance of reducing the risk of moisture penetration, (as per manufacturers guidance). The site investigation work carried out under WP9 indicates that cavity wall constructions in the UK – particularly those of facing brickwork rather than rendered – are unlikely to be of sufficiently good condition to expect such treatments to offer the intended reduced risk of moisture penetration.

If any of the properties identified during these site investigations were to be tested with water proofing treatments, it would not be possible to determine whether any failure was due to the treatment or a result of potentially multiple other failure routes. The proposed site trials of water proofing treatments were therefore abandoned as they would not offer any additional insights compared to the laboratory testing carried out for the project.

Although laboratory testing may show water proofing treatments to be effective, it would be essential that detailed and rigorous surveys are undertaken on any property where these water proofing treatments are being considered and any defects rectified before application, so they are not undermined by underlying faults within the wall.