Study on hard to fill cavity walls in domestic dwellings in Great Britain

DECC ref: CESA EE0211

Undertaken by Inbuilt Ltd & Davis Langdon

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Prepared by:

Name: Casimir Iwaszkiewicz, James Christofides, Dr William Wright, Robbie Thompson (Inbuilt); John Connaughton, Brian Hayes-Lewin, Richard Newey (Davis Langdon)

Approved on behalf of Inbuilt Ltd:

Name: Casimir Iwaszkiewicz

Position: Associate Director

Signature: Signed on behalf of Inbuilt Ltd

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Inbuilt Ltd
Faraday House
Station Road
Kings Langley
Hertfordshire
WD4 8LH

Tel: 01923 608100

Email: info@inbuilt.co.uk
www.inbuilt.co.uk

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1 Executive Summary

This study was undertaken jointly by Inbuilt with Davis Langdon in fulfilment of DECC project ref CESA EE0211, “Study on hard to fill cavity walls in domestic dwellings in Great Britain”.

1.1 Objectives

The objectives of this study were:

- To stimulate discussion amongst stakeholders on how to address hard to fill cavities for the future in Great Britain
- To engage with stakeholders and identify their issues in hard to fill cavities
- To assess the technical challenges in filling problematic cavities, how these might be overcome and likely costs.
- To assess the risk involved to dwelling owners due to taking on board liabilities directly where not covered by building insurance, warranties and/or guarantees.
- To estimate the carbon dioxide (CO2) savings for Great Britain from filling these problematic cavities
- To identify examples of situations where problematic cavities have already been filled and report on these

1.2 Key findings

Key findings were that:

- Technologies are mature and further innovative technologies are slowly emerging that will be useful to overcome the complex treatment issues hard to fill wall cavities.
- The potential CO2 savings for Great Britain were in the range of 271,000 to 407,000 tonnes CO2 per year assuming a take up of 20%, 1,356,000 to 2,034,000 tonnes CO2 per year for full 100% take-up and 678,000 to 1,017,000 if CERT underperformance and comfort factors are applied and if 100% of potential population of cavities are filled. These predictions based on SAP 2005 exclude the potential effects of underperforming party-wall cavities.

Dwelling Type (Excluding partial fill)	Population	Annual CO2 saving - allowing for 20% application of solutions (Tonnes/annum)	Annual CO2 saving - allowing for 100% application of solutions (Tonnes/annum)	Annual CERT CO2 saving – If CERT underperformance & comfort factors are applied and if 100% of potential is filled. (Tonnes/annum)
Total Number of Hard to Fill Cavities	3.9 million – 5.8 million	271,000 - 407,000	1,356,000 - 2,034,000	**678,000 -1,017,000**
House Type Dwellings	1.9 million – 2.9 million	103,000 - 154,000	515,000 - 772,000	**257,000 - 386,000**
Terrace Type Dwellings	0.9 million - 1.4 million	70,000 - 106,000	352,000 - 528,000	**176,000 - 264,000**
Bungalow Type Dwellings	0.4 million - 0.7 million	22,000 - 32,000	108,000 - 162,000	**54,000 - 81,000**

Low Rise Flat	0.5 million to 0.8 million	55,000 - 83,000	276,000 - 414,000	**138,000 - 207,000**
High Rise Flat	90,000 - 140,000	21,000 - 31,000	105,000 - 157,000	**52,000 - 79,000**

- In addition there is a category of walls that the English House Condition Survey describes as "filled" but that have a remaining cavity. There are in the order of 1.6 to 2.4m such "partially filled" cavities in Great Britain. The potential annual CO2 savings in filling these are in the range of 22,000 to 33,000 tonnes/annum assuming a take up of 20%, 109,000 to 163,000 tonnes/annum for full 100% take up and 54,000 to 81,000 tonnes/annum if CERT underperformance and comfort factors are applied and if 100% of potential population of cavities are filled.

Other Dwellings (Partial fill only)	Population	Annual CO2 saving - allowing for 20% application of solutions (Tonnes/annum)	Annual CO2 saving - allowing for 100% application of solutions (Tonnes/annum)	Annual CERT CO2 saving – If CERT underperformance & comfort factors are applied and if 100% of potential is filled. (Tonnes/annum)
Partial Fill	1.6 million - 2.4 million	22,000 - 33,000	109,000 - 163,000	**54,000 - 82,000**

- There was significant interest in dealing with hard to fill cavities amongst potential stakeholders. Of the forty one organisations contacted, thirty six replied (88%) and engaged actively in the study. A number were also able to provide evidence of work undertaken in filling hard-to-fill cavities. Stakeholders included, Government (DECC), Local Authorities and Arms Length Management Organisations, Academics, CERT managers, Energy Efficiency Partnership for Housing, Energy Action Scotland, Energy Saving Trust, Homes and Communities Agency, SHESP, Manufacturers, British Board of Agrément, Installers, Main Contractor, CIGA and Trade Associations.

- There were significant cost barriers in dealing with hard to fill cavities due to: associated building works, public disinterest/cancellations, variability of costs of non-standard works, lack of funding mechanisms or subsidy for addressing non-standard cavities as hard-to-fill cavities fall outside of the cost effectiveness criteria set by the market for CO2 savings per £ invested.

- The estimated costs of filling both categories of wall cavities (excluding filling of party wall cavities) at current (mid 2010) prices are as follows:

	Dwellings	**20% uptake**	**100% uptake***
	No.	**£m**	**£m**
Hard to Fill	3.9-5.8m	£1,103-1,660	£5,530-8,300
Partial Fill	1.6-2.4m	£450-680	£2,265-3,400

* Full (i.e. 100% take up) is not practically possible – for example, some dwellings are in exposed locations that make them unsuited to retrofitted cavity wall fill; others, because of their built form and construction technology, pose particular access and technical difficulties.

Our estimate is „broad brush' and relies heavily on a range of assumptions covering how the work will be procured, the condition and location of the affected housing stock, the extent of ancillary work required in particular circumstances, and other matters. Further details are provided in section 11 below. A more detailed study has recently been launched by the ETI to predict the distribution of costs associated with undertaking the works to upgrade UK housing stock on different scales across the UK. The context being the achievement of an 80% CO2 saving with wall insulation, new technologies and skills. Results are expected to be available in 2012.

- That the overall outlook was pessimistic in being able to secure funding for such works as well as for funding for conventional cavities in the near future. There was limited reference made by stakeholders to PAYS as a potential funding mechanism.
- A perceived lack of benefit by individual members of the public hampers the uptake of such measures, potentially mitigated through having guaranteed performance benefits.
- Key technical challenges included: overcoming the low quality of preliminary surveys to assess scope for insulation, the lack of standards relating to quality of remedial works to walls in advance of cavity filling, lack of recognised technical guidance in filling hard to fill cavities including guidance on the detailed design to mitigate cold-bridges.
- However, full cavity fill insulation is usually the most cost effective option where the cavity wall is confirmed as being in good overall condition, where the local exposure factors confirm its suitability for use and where external or internal access is not highly costly or otherwise problematic. In instances where the existing wall finish or cladding is life expired or in need of major refurbishment on a highly exposed site where an appearance change can be tolerated, external wall insulation should be considered. In the case of a building where there are complications affecting the condition of the cavity wall on a site too exposed for cavity fill insulation where an appearance change cannot be tolerated, internal insulated dry lining should be considered with the Thermo-Foil type variant minimising the loss of room volume.

1.3 Recommendations

Key recommendations are to:

- Develop a transparent process (e.g. a standard industry approach) to deal with Hard to Fill Cavities through: Survey, Design, Remediation, Installation, Warranty and Pricing.
- Develop a QA scheme to ensure standards are maintained for remedial work to walls that would allow filling and permit warranties to be offered and facilitate subsequent cover by building insurance.

- Explore a means to accelerate take-up and acknowledge innovation
- Identify funding streams specifically for dealing with such hard-to-fill cavities particularly for local authorities
- Address the private householder and low level of uptake by:
    - Raising public awareness and interest, potentially through a national publicity scheme as has proved successful in the past
    - Provision and promotion of quality assured work for Hard to Fill Cavities
    - Provision of quality assured surveys and remedial building works through an independent system of pre-assessments using experienced surveyors and experienced works managers during works phase
    - Reducing financial shock of undertaking remedial building works, which can typically be many times the cost of the insulation works.
    - Encouraging the development or bringing to market of insulation systems suitable for hard-to-fill cavities and independently verified to be “fit for purpose”
    - Identify funding mechanisms for covering the costs

Inbuilt together with Davis Langdon would like to express their thanks to all those stakeholders contacted and also those who were able to engage more actively and in contributing to the workshop and study.

2 Methodology

The study on Hard to Fill Cavity Walls in Domestic Dwellings in Great Britain was undertaken by Inbuilt in conjunction with Davis Langdon in response to DECC project reference CESA EE0211. It was further developed following concatenation of the bids and upon discussion with the advisory group at the outset of the programme. The study was reviewed at stages through the programme with regular meetings. Stakeholder engagement was undertaken in a phased manner culminating in a stakeholder workshop. A significant level of communication was undertaken to address the novel requirements of dealing with Hard to Fill Cavities in Great Britain. The output of the workshop informed the risk and opportunity assessment. The study predicted the potential annual CO2 savings for Great Britain for a range of dwelling constructions e.g. Narrow cavity, random stone, timber frame, system built etc and different dwelling types e.g. terraced dwelling, bungalows, houses, low rise and high rise.

The following stages were adopted for the study:

1. Formalise scope of work
2. Identification and engagement with stakeholders
3. Categorisation of hard to fill cavities and discussion with technical stakeholders
4. Identification of main technical solutions, assessment of likely costs and undertaking an initial risk assessment
5. Confirm filled solutions
6. Identification of previous filling of problem cavities
7. Confirm results/risk assessment
8. Calculate carbon dioxide savings
9. Report

By understanding the types of constructions and associated risks it would be possible to identify the range of solutions and issues associated with filling non traditional cavities.

The proposed technical solutions are indicative and need to be tested for suitability for particular buildings. The calculation of CO2 savings was based on SAP2006. It is envisaged that SAP 2009, when fully available, will be able to account for losses associated with cavity party walls. The populations of dwelling types and corresponding range of constructions have been extrapolated from the English House Condition Survey (2007) and any assumptions made have been stated. The figures for CO2 savings have been presented in the form of ranges to facilitate a discussion about the relative issues between construction types as they relate to particular dwelling types. The CO2 savings refer to the whole of Great Britain extrapolated from the English House Condition Survey. The CO2 potential savings for particular regions or localities would need to be determined from a study of the particular mixes of ages and constructions found there.

The CO2 savings in this report include those based on the CERT savings methodology for conventional cavities, which include an underperformance factor of 35% and a comfort factor of 15%[1]. This is due to the following factors:

- Areas that cannot be filled (e.g. behind conservatories, tile or timber panelling, or cladding.
- Adventitious voids
- Slumping or settling of insulation, leading to voids under eaves & windows
- Variations in the compactness of insulation
- Wetting of insulation.
- Thermal bridging (especially by lintels & jambs)

U values for wall improvements have been calculated per technical solution an average value was agreed[2] to be used for calculating the overall dwelling improvement on the basis that more problematic cavities are inherently likely to perform worse when upgraded than conventional cavities when upgraded.

A variety of sources of information were used including web based sources including government, public and private as well as research publications. The study drew on the experience of Inbuilt as consultants in low and zero carbon building design (New and Refurbishment) including the preparation of EST publications CE97 “Advanced insulation in existing housing” and CE57, “Refurbishing cavity walled dwellings” together with Passivhaus certification and Davis Langdon in Surveying (Quantity and Building) together with its Risk Management Surveying groups and the use of industry standard tools such as “@Risk”.

[1] The estimated savings from insulation, as calculated by BREDEM 12, are subject to two corrections. The first is a correction for underperformance and is -35%. The second is a correction for comfort taking, which is applied after the underperformance correction, and is -23%. The overall correction is therefore (100%-35%)*(100%-23%) = 50%. Note that, if there were no underperformance, the correction factor for comfort taking would be 15% of the estimated BREDEM saving from insulation.

[2] DECC July 2010

3 Stakeholders and discussions

The principal stakeholders for the study were identified as: Trade Organisations, NIA, BRUFMA; InstaFibre Consortium; Warranty providers (CIGA), Insurers British Federation of Insurers); Insulation Installers; Insulation Manufacturers; Insulation Accreditation systems (BBA); Local Authorities; ALMO's; Housing Associations; Academics, Energy Agencies, EST as well as regulators (Ofgem), CERT managers and government represented by DECC.

Approximately 42 different stakeholders were contacted throughout the study. A significant number were responsive and additionally attended the risk workshop that was run as part of the study.

The importance of the householder group became apparent during the course of the study after one organisation InstaFibre consortium (insulation design/installers and scheme managers) undertook an analysis of market take-up in response to this study.

It is hoped that future studies would allow for canvassing comments directly from those householders with an interest in having their cavity walls filled. We would envisage contacting those taking up the recently launched: PAYS scheme; Technology Strategy Board's, Retrofit for the Future project as well as general householders and those with a specific interest in environmental issues such as those belonging to the AECB.

Our study revealed two distinct approaches to cavity wall insulation - the first by private house-owners and the second by public organisations.

3.1 Private householders

Over the last thirty years the private householder interest in cavity wall insulation has been low, averaging three thousand enquiries a month to installation companies. There have been some periods of higher interest, but more recently, due to economic conditions, demand has been dropping.

There are many ways of tapping into the private householder market. Private householders have responded to marketing activities by installation companies, in particular from telephone canvassing associated with funding campaigns. This is a reflection of the fact that cavity wall insulation is a service rather than a product based market. Interest has been increased by governmental campaigns; in particular, the Prime Minister's speech in September 2008 with Local Authority endorsements was particularly successful. The reported level of interest rose three times, from 3,000 to 10,000 enquiries per month for the following 6 months. As an example of the impact of the CERT scheme[3], 1m cavities were installed in 2 years and its predecessor EEC2 insulated 1.76 m in 3 years.

[3] OFGEM report on effectiveness of CERT scheme and previous schemes: http://www.ofgem.gov.uk/Sustainability/Environment/EnergyEff/CU/Documents1/CERT%20Q8%20Update%20FINAL.pdf , http://www.ofgem.gov.uk/Sustainability/Environment/EnergyEff/PrevSchemes/Documents1/Annual%20Report%202008%20Final.pdf

There are a number of ways in which the public seeks such services and they include contacting installers directly, the EST, Local Authorities, utility companies and others. The installers have found direct telephone canvassing effective whilst the benefit of press, leafleting has been low – newspaper advertising has been dropped by most installers and leafleting has only a 1% response. Awareness through shopping channels is low though some DIY chains have had promotions for third party installers - the materials used in cavity fill are only available through specialist channels and not via DIY routes. Cavity installation always requires specialist equipment to apply specific types of insulation that in turn are available from a relatively small number of distributors.

3.2 Local Authorities, ALMOs and Housing Associations

Local Authorities, Housing Associations and ALMO's are not under the same commercial/time pressure to survive as installers and have more time to seek funding and use different options to address fuel poverty, heat loss and carbon reductions for their tenants. They can be considered to be the early adopters in this field[4]. However, there is still the issue of being able to raise the funds in the first place.

As an example, LB Camden has developed techniques to address hard to fill cavities. In addition, it uses an internal technical team rather than being reliant on framework contractual arrangement to develop specifications and tenders and then manage the process. There is a significant variation in the way different LA''s and ALMO's procure their services. As this is a relatively new area of activity, there is a risk that poor practice in procurement at the beginning could potentially jeopardise the success of future CO2 savings.

Amongst the ALMO's contacted[5], some considered the ability to address the remaining stock of housing important as it had not attracted CERT funding to date and would help improve the overall stock SAP profile. This would address Fuel Poverty issues and address the new requirement to make "Warmer Homes Greener Homes" post Decent Homes funding initiatives.[6]

3.3 Issues for stakeholders

Cavity wall installations are carried out for two principal client sectors i.e. Private householders/businesses and Public landlords

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[4] Kirklees BC, Correspondence 28May2010 "looking at new technologies to deal with this"

[5] National Federation of ALMOs

[6] Kensington & Chelsea TMO, Correspondence 25May2010

Installations of conventional cavities are generally funded through grants and obligations including CERT, Warm Front etc. Additionally, funds have been previously been available to public landlords or private householders from discretionary local authority funds. The CERT scheme arises from the obligation that Ofgem, the regulator, imposes on utilities to reach carbon saving targets, which they do at their own cost. Each supplier must reach a carbon saving target, and does so by measures such as insulation or lighting. Ofgem administers the scheme, in the sense that each supplier gives figures for the numbers of measures (insulation / lightbulbs/fridges etc) subsidised, and Ofgem gives a score for each. The scheme has strict criteria on the cost-effectiveness of measures undertaken by those being offered. As a result, this generally precludes addressing more expensive walls such as hard to fill cavities. More recently, insulation works for affordable housing have been funded under the Social Housing Energy Saving Programme (SHESP) running since summer 2009. Further funds are likely to be available to local authorities via the new EU funding stream in compliance with the revised limitation permitted by changes in conditions set by ERDF

In addition public funding has been limited to undertake certain building improvements under obligations set on registered housing landlords (social housing sic.) through the Decent Homes scheme. The opportunity cost of additionally dealing with window and loft insulation upgrades at the same time were borne by local authorities. In addition, local authorities are responsible for ensuring that housing within their local areas conforms to the minimum cost of heating standards set by Affordable Warmth criteria. These criteria apply to both its own and privately owned housing.

Grants are available but do not address Hard to Fill Cavities because they either:

1) Require interventions that are more expensive than standard cavities by dint of being " hard to fill cavities" or are
2) Specifically excluded by the compliance conditions imposed by grant funding streams, originally set up to prioritise "easy hanging fruit" i.e. filling standard cavities.

There is currently no established market for filling hard-to-fill cavities.

The demand for cavity fill is in response to two drivers:

1) Legal duties placed on publicly funded bodies as described above and
2) In response to marketing activities undertaken by private installation companies seeking to promote the uptake of subsidised work. (The installers promote their work to private house owners and alert them to the availability of subsidies that cover part of the cost of installation)

Installers of standard cavity insulation in the "able to pay" private household sector are currently dependent on households paying in the region of a hundred pounds or so with the balance of the costs of £200-300 being paid by subsidy. In the case of "priority groups" full subsidy is available. Where householders have disposable income, the cost of energy alone may not be a sufficient driver to encourage a householder to prioritise an expenditure on cavity insulation, particularly where there are additional remedial works required. The newly introduced PAYS scheme, where loans for energy efficiency improvements are tied to a property, should reduce the impact of capital costs by having the energy savings cover the cost of insulation measures.

However, in response to the dramatic fall-off in demand from private house owners, due to the design of the CERT and Warm Front schemes trade associations are lobbying government for a continuity and enlargement of funds to avoid shrinkage of the market. Trade organisation such as the NIA and others are reporting high rates of disbanding of installer teams. A number of manufacturers were also of the view that the UK cavity wall insulation sector will cease to be a profitable market within five years. This is likely to be as a result of conventional cavities being filled and of the 17-18m cavity dwellings there are estimates[7] that there will be only 5.3m unfilled but fillable cavities left by 2011 with a resultant small market.

To date, installer companies have been geared to addressing the needs of providing lowest tendered cost for insulation fills available. This tendering criterion adopted prevents hard to fill cavities from being addressed in practice. Furthermore, there is evidence of severe competition in this market as a comparison of standard costings based on meterage and typical costs charged show. This may affect the ability and reserves of a company to respond to any changing funding mechanisms or new markets such as Hard to Fill. Installer companies would need to take a commercial view on how they deal with the transition from dealing with standard cavities to those of a future that includes hard to treat cavities.

There is a concern amongst installers also that if the CERT scheme is not extended this summer that there will be little capacity in the installer base. The CERT scheme is perceived by some installers as supporting electrical savings rather than heating bills through the widespread provision of electrically efficient CFL lighting.

A number of organisations would suggest that the terms of CERT be amended to encourage the side walls of a house to be insulated as they currently fall under the compliance criterion set by CERT of being under 75% of the exposed wall and yet are probably the more accessible walls on any given house.

The importance of addressing consumer behaviour was voiced at the risk workshop where Knauf Insulation stated[8] – "Currently the cavity wall insulation industry generally avoids treating anything other than straightforward masonry cavity walls with the exception of the Local Authority and RSL sector where the impact on the properties saleability is not a concern. The issue of saleability is seen as more important to the private market than the potential saving of energy." It remains to be seen how authorities can address the need to encourage private customers to invest in energy efficiency within their home. A system that rewards consumers for energy saving measures may be more effective in creating a culture of energy saving amongst home owners that is more stable in the long term than individual home owners buying energy efficiency measures and then squandering the heat and carbon savings against additional appliances and electrical equipment.

3.4 Discussions with stakeholders – Funding

[7] DECC Correspondence 20Jul2010

[8] Awaiting confirmation

The issue of a lack of funds for such insulation measures is echoed widely by both local authorities and installers[9]. It is highlighted by the significantly different levels of funding available through different channels by government or regulators in the pursuit of carbon reduction. As an example, the funding available via CERT and SHESP are lower than what had been available for standard cavity wall insulation where carbon dioxide is valued at only £17 per tonne[10]. The disparity between funding and actual costs is a significant issue for local authorities including LB Camden, LB Merton, Darwen Borough Council and many others who are active in pursuing hard to fill cavities. This is echoed by insulation companies who are regularly approached by local authorities but are thwarted in the conversion of quotations into purchases through funding constraints.

Where there are experienced internal resources available to the local authority such as with LB Camden, it has been possible to develop innovative solutions that reduce the capital cost. These savings have been estimated as having a direct benefit of £1m in access costs to high-rise dwellings across the borough from the adoption of abseiling teams to install insulation.

The urgency with which reductions in ancillary costs need to be achieved is that a significant number of stock owners i.e. LA's, ALMO's and Housing Associations will have addressed their standard cavities within the next 5 years.

3.5 Discussions with stakeholders – Cancellations

A significant factor emerged following discussions with stakeholders is that whilst technical reasons were recorded as reasons for cancellation; they were outnumbered by a ratio of 4:1 by customer cancellations. Only 1.5% of all cancellations were due to the walls considered as "hard to treat" with 4.3% of cancellations being due to the need for cavity wall remedial work. The most significant technical reason at 12.3 % was that the walls were solid rather than having a cavity (an issue of quality of the initial business lead survey that established the type of wall, rather than of the quality of the detailed inspection required for the work method to be established) whilst overall 47% were due to reduced interest by householders. The remaining cancellations being due to poor management i.e. a social property being mistaken for private; the effect of landlord refusal and the type of insulation needed not attracting funding. The following table analyses the reasons for cancellation and provided by Instafibre in support of the study

[9] Darwen Borough Council, BRUFMA

[10] LB Camden

CWI Cancellation Reason	No of Jobs	% of Jobs
Cavity too narrow	103	1.4%
Cracks in the Render	2	0.0%
Damp problem	93	1.2%
Metal Frame	16	0.2%
No Access	385	5.1%
Property is random stone	27	0.4%
Rubble in Cavity	53	0.7%
Scaffolding Required	50	0.7%
Solid Walls	933	12.3%
Timber Framed	131	1.7%
Ventilation requirements not met: Customer refused to have vent installed	86	1.1%
Total	**1879**	19.8%
% CWI Cancellations	20%	Note 1
Customer Cancellation Reason	**No of Jobs**	
Client – Cost	314	4.1%
Client has missed several appointments	273	3.6%
Client no longer interested	3568	47.0%
No response from client	3436	45.3%
Total	**7591**	80.2%
% Customer Cancellations	**80%**	**Note 2**
Total Cancelled Jobs	**9470**	**Note 3**
Note 1 Originally 9% - Awaiting confirmation		
Note 2- Originally 35% - Awaiting confirmation		
Note 3 - Originally 2192 – Awaiting confirmation		

We would recommend that further work be undertaken to understand these factors better and to determine whether this is representative of other trade organisations across GB.

3.6 Discussion with stakeholders - Technical Issues

The technical issues associated with different cavities are described in brief in the table below:

Type of cavity	Issue
Narrow cavities	Traditional cavity walls typically constructed 1920's to 1950's designed to have free cavities. During injection of insulation the insulation can hang up on points of narrowness in the cavity where mortar had been left protruding internally during brick-laying

Partial filled	Where insulation had previously been installed to a fraction of the cavity width by design or otherwise and may have even sloped away from its intended location on the inner face of the cavity over time. Any newly introduced insulation material would need to be able to fully fill the remaining spaces without unintentionally becoming a cause of unpredictable locations of damp penetration e.g. where condensation builds up after running down the sloping insulation
System build	Prefabricated construction systems with varying material combinations which may have specific aging or deterioration characteristics peculiar to their type. Spanning a wide range of constructions from dense panelised concrete to lightweight timber structures.
Random Stone	Natural stone rectangular blockwork of varying thickness resulting in widely varying internal cavity widths between blocks. The variation in width and potential difficulties in selecting suitable access points for injecting insulation and the possibility of water penetration.
Timber frame	Typically referring to lightweight timber constructions (as distinct from Solid Timber constructions that are typically insulated with external insulation when newly built) that can range from panelled timber frames sheathed in thick plywood on both sides of a cavity through to lighter weight constructions. Typically lacking moisture control barrier layers or having moisture barrier layers located in positions that may precipitate the formation of interstitial condensation when any subsequent insulation is installed leading to premature degradation of the structure.
Exposed locations	Subject to high wind/ driving rain and where the ability to reduce or stop water migration to the inner leaf is an important consideration in the selection of an insulation material or the suitability of the property for insulation.

Very few stakeholders considered technical issues associated with hard to fill cavities as being insurmountable[11]. The general view was that mature technologies were available to successfully fill all but the most problematic cases of hard to treat cavity walls.

In initial discussions with stakeholders, technical issues were generally considered as ones of installation, material selection and access issues alone. In subsequent discussions including those at the Risk Workshop it became apparent that additional technical issues of survey and achieving quality assurance would also be important.

The choice of insulation materials is important to the overall quality of performance in practice and materials, in addition to their standardised performance are additionally assessed and promoted on the basis of their fitness for purpose. There is therefore likely to be some overlap between certified performance of existing insulation materials and particular combinations of wall construction and the tighter requirements set by the hard-to-fill categories identified by this study. It would therefore be necessary to determine what additional tests, if any, would be required to address any new requirements for Hard to Fill

[11] Knauf and additionally Risk Workshop attendees

cavities described in this study. As an example, test equipment may need to be modified. One of the stakeholders of the risk workshop stated that the certification scheme used by one of the industry guarantee schemes (CIGA) had been set up to deal with novel insulation systems[12]. It would be necessary to investigate this aspect further.

In addition to specific technical issues associated with the insulation materials themselves, as part of the technical solution, hard to fill cavity walls do require higher levels of preparatory work. These preparatory works and potentially additional remedial work to the building fabric, incur further plant and access costs. It could be argued that deterioration of the building fabric within which the insulation would be held is the primary issue to address. Consequently a significant proportion of costs of a hard to fill cavity is associated with the repair and remedial works rather than the material costs of the insulation itself.

The attendant problems associated with hard to treat cavity walls naturally inflate the average cost of treatment above a standard cavity wall. The issue is how to control these costs and maintain installer viability.

Interestingly the stakeholders regularly address such technical installation issues but are less familiar with techniques of cold bridge analysis that would need to be undertaken during the design of the specific technical solutions. Such techniques when used before insulation, combined with post construction thermographs could potentially be part of the supporting documentation required by mortgage applications and subsequent applications for building insurance. These would be additional costs.

3.7 Discussion with stakeholders - Costs of ancillary work required

The costs of ancillary works frustrate many installer companies who offer technical solutions but are hampered by the lack of resources available to local authorities and would need to spend a significant time in seeking such funds for such work.

An example was voiced by Dyson Insulations (contractor,) “The biggest problem we have encountered, time and time again, is having to walk away from these non-standard properties on both social housing and private sector schemes, and although various solutions can be offered, the client (local authority/housing association) or domestic homeowner have insufficient monies to pay for these higher cost solutions.

“A small proportion, 9% of InstaFibre’s[13] jobs, are cancelled due to technical reasons – narrow cavities, cracks in render, damp problem, metal frame, no access (20%,) property is random stone, timber frame, rubble in cavity, scaffolding required, property not surveyed properly and discovers solid walls once work crews arrive (50%).” Instafibre

Typical costs incurred:

- Installation of external insulation to avoid treating narrow cavities:

[12] BBA Ltd

[13] A system designer, installer and scheme manager

  - Up to £8,000
- Cleaning dirty cavities:
  - Between £1000 - £3000
- Cost to a high rise tenant excessively high:
  - Between £3000-5000 per dwelling
- Render repair:
  - Between £2000-£5000
- Defective Damp Proof Course (DPC):
  - Between £2000 - £4000
- Removal of existing defective cavity insulation:
  - Between £100 - £1200 per one bedroom flat within a repeating high rise building of minimum 50 flats. Actual cost can be higher.
- Scaffolding to overcome conservatories/single storey drilling/access issues:
  - Between £100 - £1,500.

Costs are generally variable due to:

1) A standardised costing approach that is only geared towards costing of standard cavity filling and not designed to accommodate the very specific remedial work being carried out
2) Lack of „cost norms' for hard to fill cavities
3) Latent defects such as structural damage due to prior ingress of water that preclude low insurance rates

In many cases, the additional costs of dealing with obstructions such as conservatories means that access issues define whether a cavity is hard to fill or not. "In practice, scaffolding is too expensive for the customer or energy supplier to fund"[14]. Furthermore many installers feel that most properties can be filled in accordance with BBA standards and requirements.

3.8 Discussion with stakeholders - Extraction of existing insulation

[14] Mark Group - Installer

In addition, there may be a need to extract existing cavity insulation. CIGA estimates that at best there are probably between 500 and 1,000 extractions per year, of which 10 were to address specific technical issues, often associated with underlying building defects that could not have been identified when the installation took place. It estimates the cost of such extractions in the region of £2000-£3000. This is many times the cost of filling a standard cavity. In some cases the extraction of existing insulation could potentially address issues of deterioration or low quality of existing cavity insulation. LB Camden[15] estimates that 500-1000 properties could be improved upon this way if the costs of extraction were reduced to £1000 or so.

3.9 Discussion with stakeholders - Insurance and Certification

The current method of achieving quality in cavity installations is through works complying with CIGA requirements or the British Urethane Foam Contractors Association (BUFCA) or of an insurance company. The CIGA warranty scheme applies to cavity constructions retrofitted with materials according to the requirements of the BBA accredited insulation systems and fitness for purpose. Whilst there are many established test laboratories certifying insulation materials to technical standards, there are few providers of assessments of fitness for purpose. The scope of a BBA product accreditation is defined by the intended application or ambition of any manufacturer to address the hard to fill market.

Where the CIGA scheme is not used then manufacturers and installers would rely on alternative warranties provided by commercial companies such as Zurich etc. In some cases, insulation manufacturers may offer their own warranties. At the time of the study, the costs of these routes were not available and it had not been possible to identify the scope of such cover.

The BBA is also active in approving the competence of installers and has approved all 260 installers operating in the UK on conventional cavities

The question of insulation durability was one of the issues raised by stakeholders and is currently being addressed in certification circles. However, any changes to international technical standards take a long time (>5 years) and the significance of the current work to establish a methodology for derating initial performance ratings due to deterioration in performance over time would need to be investigated further.

One of the areas not covered by guarantees was of cavities in Timber Frame dwellings as these are not considered a traditional construction, a prerequisite of guarantee schemes as offered by CIGA. In principle, there should be plenty of materials available for timber framed constructions including cellulose based insulation materials[16] from across UK and the Continent. However there are likely to be detailed constructional reasons due to control of vapour diffusion (or lack of) in certain types of construction that make this more problematic and requiring very specific solutions. Examples of such reasons would include „wet

[15] Daniel White, LB Camden

[16] Warmcell, Isofloc etc

situations' as in the cavity behind a masonry outer leaf that would lead to the saturation of the cellulose.

The risks associated with installations are described in more detail in the technical section but in practice, where an application falls outside the criteria of either a technical standard or an accreditation system, the dwelling owner takes on the liabilities directly. As dwelling owners, local authorities have more flexibility in how they address and take on potential risks.

Manufacturers of insulation materials would need to see an increase in demand for dealing with such cavities and a marketing advantage in having their products assessed for such applications. A number have achieved this and include nanogel and bead type materials for narrow cavities. Furthermore, if manufacturers were interested in having products deemed suitable for particular combinations of "hard-to-treat" cavities and dwelling types then any test equipment, comprising test cavities and measuring equipment, used by certifying/assessment companies would need to revised.

Any changes in certification/product assessment/insurance work would need to be accompanied by changes in how such cavities are dealt with on a daily basis. This is likely to include the way in which surveys are undertaken, how materials are selected then installed, then having work warranted and subsequently being eligible for building insurance. One respondent considered that advanced methodologies for surveying and installation that would meet the more demanding requirements of hard to fill applications have not been developed or certified[17].

There are some specific issues relating to constructional warranties provided on new homes constructed in the last 10 years. Any attempt to modify a cavity, say by fully filling a partially filled cavity, would potentially invalidate the 10 year NHBC warranty if applied to new homes in that time frame.

In terms of buildings insurance there are also likely to be interest in how to mitigate the effect of climate change and how insulation materials would perform under adverse conditions during water saturation and during dry-out. There is a limited number of studies available relating to how hard to fill cavity constructions would behave due to the rarity of being filled. A recent study sponsored by the Ecclesiastical Insurance Society[18] predicts the relatively higher susceptibility of cavity constructions compared with solid constructions during accelerated drying conditions. The predictive techniques closely matched the measured performance and may help in the design of suitable test and certification methodologies for hard to fill cavities.

[17] Knauf

[18] Engineering Historic Futures - UCL Centre for Sustainable Heritage

4 Categorisation of Cavities

There are a number of methods of categorising cavities. One such proposed by the BRE for Social Housing Energy Saving Programme was of:

Category 1: Standard fillable

Category 2: Non-standard fillable – less problematic

Category 3: Non-standard fillable – more problematic

Category 4: Unfillable

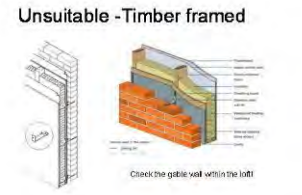
However, it became apparent from discussions with stakeholders including installers, commissioning clients and quantity surveyors that such a categorisation system was not readily transferable to this study. In the light of the tendency of the market to blanket price core work and charge variably for remedial works, that it was important to adopt a different categorisation to be able to assess in detail the risks, costs for specific building types and constructions.

In contrast, stakeholders readily identified a “hard to treat cavity wall” as broadly overlapping the BBA definition:

1. System build properties
2. Partially treated properties (Existing foam or mineral fibre batts)
3. Random stone walls
4. Narrow cavities (less than 50mm)
5. Timber frame
6. Properties in geographic areas subject to very severe exposure to wind-driven rain

These are shown in the table overleaf together with issues associated with survey and mis-identification of wall constructions.

4.1 Examples of Hard to Fill Cavities

				
System built house (dyson insulation)	Partially filled cavities (existing foam or batts) (dyson insulation)	Random stone (Isothane Ltd)	Timber framed (dyson insulation)	Exposed location – Moisture test and inspection of retro insulated steel frame (CIGA)

Examples of Hard to Fill Cavities (cont'd)

				
Additional cost of scaffolding required to overcome access issues	Presence of brick headers (ends of bricks) reveals that this is a solid rather than cavity wall	Early form of cavity construction using brick ties	Brick ties instead of wire ties (rat trap bond)	Steel frame (hidden behind cavity like brick work – horizontal stretcher bond without headers)

4.2 Assumptions

The following assumptions were used in predicting the CO_2 savings in GB and are based on the English House Survey 2007[19] except where stated:

There is limited definitive data on the numbers of hard to fill cavities. These have been variously estimated by, Hard to Treat Homes Sub-Group, EEPH, Centre for Sustainable Energy, National Energy Action and BRUFMA and we estimate that there are currently approximately 3.9 to 5.8 million properties with hard to fill cavities in GB.

These can be broken down by wall types as below:

- Narrow Cavity, a cavity with width less than 50mm
- Random Stone Property, a stone build with a variable width cavity
- Timber Frame, including steel frame
- Concrete Frame, sub divided into insitu and Rainscreen

In addition that there are 1.6 to 2.4 million properties with

- Partial Fill Cavities, as common post 1995

Narrow Cavity – From the early 1920s up to the start of the Second World War the two common types of construction used were solid wall construction and narrow cavity construction (P Dicks/CIGA; Refurbishing cavity-walled dwellings, Energy Efficiency Best Practice in Housing). At the beginning of this period the vast majority of walls were known to be of the solid wall type with the minority being Narrow Cavity. By the end of this period this trend had been reversed with narrow cavity construction being the most common. Using this knowledge, the assumption that the majority of unfilled cavities as reported in EHCS 2007 are narrow cavities and our estimates for the types of building construction during this period. We estimate that the number of narrow cavities in the UK is 2.1 million.

Random Stone Properties: Evidence is very scarce however we based our calculations on current sales data which suggested that 20% of housing for sale in rural locations is of Random Stone construction. We combine this with information regarding the total number of rural dwellings from EHCS 2007 to give an approximate value of 404,000 Random Stone dwellings in the UK. (This would include over 100,000 properties with cavities as identified by three Local Authorities in West Yorkshire in response to this study).

Timber and Concrete Frame: Our main point of reference is BRE Client Report: (216-568 March 2004). This report suggests that there are approximately 700,000 timber frame cavities in the UK, the majority built in the period between 1965 to the present. This report also gives separate values for the number of timber frame houses built in Scotland, England, Wales and Northern Island for a portion of this period. We have assumed that these proportions remain constant where actual data is missing. We combine this with knowledge from EHCS 2007 which gives the number of non-cavity walls; as the number of solid walls

[19] See Appendix for extract of English House Condition Survey 2007

built during this period was minimal we assume that this value gives an indication of the combined number of timber and concrete frame buildings in the current English housing stock.

Data suggests that the number of timber frame buildings and solid wall construction from 1945 - 1965 still in the housing stock is negligible therefore the EHCS 2007 values for non cavity walls give an indication purely for the number of concrete frame structures built in this period. Consequentially, we assume that the number of timber frame buildings in the UK is 0.8 million and the number of concrete frame buildings is 1.2 million. Due to lack of data for further subdivision between insitu and rainscreen type frame we assume an equal split between the two types.

Partial Fill – Wide scale use of partial fill cavities was the result of building regulation changes in 1990 and 1995 which gave requirements for U Values in residential dwellings. Some up take occurred prior to 1995, particularly within social housing, however after 1995 it rapidly became the standard method of building. Using data from EHCS 2007 for the number of buildings built during this period and our estimations for the number alternative forms of frame and cavity used. We have modelled the number of partial fill cavities in the UK to be 2 million.

These estimates for each wall type were further split into the various buildings types. The building types considered were:

- Terrace (End and Mid)
- Bungalow (Semi detached and detached)
- Semi-Detached House
- Detached House
- Low Rise Flats (two/three external walls)
- High Rise Flats (two/three external walls)

Our method for sub-division between the various building types was based upon current sales figures, data from EHCS 2007 and expert advice. The statistical device used was in apportioning the known number each building type built during a specific time period to the known (see above) fraction of each wall type built in the same period. Additional factors were used based on additional assumptions. These additional assumptions are described in more detail below:

- Terrace (End and Mid): Current sales figures suggest there is a national split of approximately 1:3, End-terrace to Mid-terrace. We assume this is representative. We assume that Terraces may be constructed using any wall type but we have included a 50% correction factor against use of concrete construction from expert advice.
- Bungalow (Detached and Semi-Detached): Current sales figures suggest there is a national split of approximately 1:3, detached to semi-detached. We assume this is representative. We assume that any wall type apart from concrete frames may be used for Bungalow construction.
- Semi-Detached House: We assume that any wall type apart from concrete frames may be used for Semi-Detached House construction.
- Detached House: We assume that any wall type apart from Concrete Frame may be used for Detached House construction.

- Low Rise Flats: Due to lack of specific figures, we assume the split between two and three external wall type flats is equal. We assume that any wall type apart from Random Stone may be used for Low Rise Flat construction.
- High Rise Flat: Due to lack of specific figures, we assume the split between two and three external wall type flats is equal. We assume that any wall type apart from Random Stone or Timber Frame may be used for High Rise Flat construction.

In the light of the range of populations of particular building constructions certain assumptions were made to facilitate the prediction of CO2 reductions from addressing hard to fill cavities. Furthermore, as the hard to fill cavities represent only one element amongst a number of interventions that could potentially be adopted (e.g. double glazed windows, loft insulation as well as party-wall insulation, renewable energy, efficient lighting etc.) and in the light of the likely errors in building populations, the potential impact of cold-bridges and the significant impact of variability in take-up rates, that an average U-value figure for an improved wall was adopted.

The following tables summarise how cavity construction and insulation levels have changed over the years. These date and construction ranges have been used to determine the annual CO2 savings associated with different construction systems for different house types.

Timeline of cavity wall constructions

	Private sector stock profile	Solid walls	Cavity wall construction	General cavity width (Scotland greater)	Cavity ground floor solid first floor	Building regs requirement for U value for new construction	Brick & brick	Brick & block	Brick & thermal block	Brick and high thermal block	Partial & full fill during construction	Retrofit CWI insulation (major type)	Alternative CWI	Thermal requirements for new build walls	New build roof	Thickness of glass wool in roof	SAP rating	Notes
1900	25% (4.2 million)	Almost all	Isolated examples											None				
1905		Most												None				
1910														None				
~~1915~~																		
1920	19%	Many	Some		Some		Y							None				
1925							Y	Y						None				
1930		Few	Many		Many		Y	Y						None				
1935		Few	Most		Many		Y	Y						None				
~~1940~~																		
1945	18%	Very few	Most		Some		Y	Y						None				
1950		Almost none	Most	50mm			Y	Y	Y					None				
1955			Most		Almost none		Y	Y	Y					None				
1960			Almost universal				Y	Y	Y					None				
1965	20%		Universal			1.65	Y	Y	Y			UF foam	Mineral wool	1.56	1.47			Local Byelaws replaced by Building Regulations 1965
1970			Universal	65mm			Almost none	Y	Y		Isolated examples	UF foam	Mineral wool					
1975			Universal			1.70	None	Y	Y		Some	UF foam	Mineral wool & eps	1.00	0.60	60 mm		Energy crisis and thermal regulations insulation value of external walls set
1980			Universal					Y	Y		Y	UF foam + Mineral wool	eps	1.00	0.60			
1985	20%		Universal			0.60		Y	Y		Y	Mineral wool	eps	0.60 (1982)	0.35 (1982)	100 mm		
1990			Universal			0.45		Y	Y	Y	Y	Mineral wool	eps	0.45	0.25	150 mm	60 or less	
1995			Universal	75mm				Y	Y	Y	Y	Mineral wool	eps	0.45	0.20	200 mm	60 or over	Proportional method came in where joists and studs had to be taken into consideration
2002			Universal	100mm		.35			Y	Y	Y	Mineral wool	eps	0.35	0.16	250→270 mm		

Notes:
The above relates to the 'average' in GB – however regional practices and needs will vary implementation and decline dates. Building Regulation statements relate to England and Wales – Scotland has different dates and values. Information on Northern Ireland is not available.

P Dicks/CIGA

Split between house types (EHCS 2007)

Dwelling Type	Pre 1919	1919 to 1944*	1945 to 1964	1965 to 1979	1980 to 1990	1990 to 2007
Mid Terrace	1873	765	647	779	228	388
End Terrace	624	255	216	260	76	129
Semi-Detached House	764	1871	1780	1030	243	414
Detached House	586	440	453	922	582	990
Bungalow	48	164	455	542	136	231
Semi- Bungalow	16	55	152	181	45	77
Low Rise	187	235	502	935	310	528
High Rise	22	10	107	151	10	17

Numbers of each wall type built in each time band.

Date	pre-1919	1919 to 1944	1945 to 1964	1965 to 1980	1981 to 1990	1990 to 2007
Narrow Cavity	0	2,145,721	0	0	0	0
Partial	0	0	0	0	0	1,990,310
Timber frame**	0	0	0	290,000	283,000	240,429
Random stone***	0	0	159,377	176,281	68,879	0
Concrete (all types)	0	0	765,638	387,538	15,590	58,140

*A negligible number of buildings were constructed between 1939 and 1944 due to the Second World War

** Timber Frame including Steel Frame

** Random stone cavity constructions shown. Assumes solid before 1945 i.e. late adoption of cavity construction and partial fill construction after 1990

5 Technical solutions

There are a large number of potential technical options available to fill cavities. In order to easily identify risks and opportunities to specific house types, we have adopted a coding methodology to identify particular combinations of construction and dwelling type and potential technical solutions. This methodology also allows costs to be estimated for such elemental interventions. The following chapters will further describe: the key processes currently associated with treating those hard to fill cavities, the typical filling insulation materials used and identify the typical problems arising specifically from treating system built housing.

5.1 Pro-forma for ranking outline technical solutions

The following hard to fill cavity construction types have been identified for Great Britain: Narrow Cavity, Random Stone, Reinforced Concrete In-Situ Frames, Timber Frames, Rainscreen cladding systems and Non-Traditional System constructions as well as Partial Fill Cavities. These constructions have been used to a greater or lesser extent in dwellings in Great Britain. The dwelling types include: Terraced (Mid and End), Bungalows (Semi-detached and Detached), Houses (Semi-detached and Detached), Low rise Flats (2 external Walls and 3 External Walls) and High Rise Flats (2 External Walls and 3 External Walls). In each of the following technical solutions the incidence of occurrence may be limited to a few properties only. In others, the particular combination of technical solution and construction type is unlikely to be applied in practice. In such cases the code is Not Applicable (N/A).

			
Mineral fibre filled cavity[20] (e.g. Rockwool etc).	Blown fibre cavity (e.g. Mineral wool; Rockwool etc, Cellulose fibre; Warmcel, Isofloc etc)	Foam filled cavity (e.g. PUR; isothane etc)	Bead filled cavity (e.g. Polypearl etc)

There are a number of installation methods that differ between materials:

Low pressure/blowing machinery is suited to:

Fibre pellets, EPS (virgin or granulated)

[20] EST GPG 26

Foam injection is suited to:

Polyurethane

Urea formaldehyde

As a result of machinery and access requirements, the installation costs vary:

Approximate costs per method of Cavity Wall Insulation

Low pressure/ blowing machinery

Fibre pellets Average £ 7.00 psm

Polystyrene beads Average £ 7.25 psm

Granular beads – Not currently available in the UK

Foam injection

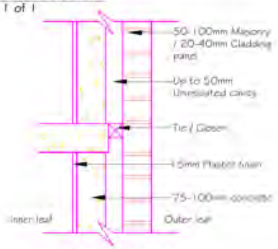
Polyurethane Average £ 33.50 psm (£15-£20[21] psm)

Urea formaldehyde – Currently not widely available in the UK

For detailed estimates of overall costs see Section 10. An example of one particular combination of constructions and potential solutions is shown below. These are described in fuller detail with cross-sectional details and elemental costs in Appendix B

[21] BUFCA average

TYPICAL DETAIL - CAVITY WALL WITH CONTINUAL EXTERNAL CLADDING # INTERNAL CONCRETE FLOOR IN HIGH RISE BUILDINGS
Sheet 1 of 1



Key Requirements of Technical Solution

- Injection holes must be drilled using the set correct procedures to prevent blowing surfaces of the concrete panel.
- Free flowing to accommodate potential wide variations in cavity width.
- Relative low weight to avoid moving floor plate.
- Chemically inert and must not require ventilation.
- Cavity closure required around openings.

Budget Cost Information

- ERCFCW1 -

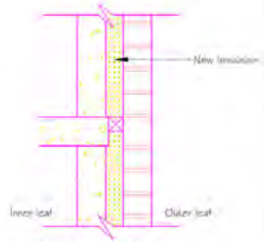
Internally applied: £7.21 /m^2 per installation
Externally applied: £6.61 /m^2 per installation

- ERCFCW2 -

Internally applied: £33.54 /m^2 per installation
Externally applied: £32.94 /m^2 per installation

Please refer to 'Costing' document for other Cost considerations e.g. access.

Technical Solution (IFRCCW) 1 - Pressure Injection Installation e.g. Blown Mineral Wool



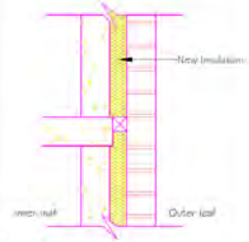
Outline Specification of Works
- Ensure air bricks and flues are fitted with cavity sleeves where necesary.
- Drill injection holes in external walls at predetermined centres.
- Blow mineral wool via a flexible hose fitted with an injection nozzle.
- Make good all injection holes and replace air bricks and flues.
- Carry out check on all air bricks and flues.

Advantages
- Fire resistant # can act as cavity barrier at party wall line.
- Breathable.
- Can be used up to 25m above g.l.
- BBA Certified # can be CIGA guaranteed.

Risks
- High embodied energy content.
- Not resistant to water and unsuitable for areas of high exposure to wind-driven rain.
- Issues with insulation not sitting evenly in cavity and can consolidate over time to produce cold spots.
- Cost and safety implications of drilling holes at high levels

Survey Considerations
- Assess exposure to temperate climate.
- Asbestos Containing Materials around openings.
- Assess position of firebreaks and conditions of existing cavity materials.

Technical Solution (IFRCCW) 2 - Foam Installation e.g. PUR Foam



Outline Specification of Works
- Ensure air bricks and flues are fitted with cavity sleeves where necessary.
- Drill injection holes in external walls in staggered pattern.
- Inject form in specified sequence.
- Make good all injection holes and replace air bricks and flues.
- Carry out check on all air bricks and flues.

Advantages
- Fire, moisture, rot, fungi and vermin resistant # Breathable.
- Suitable for narrow cavities
- Strong bonding properties, self supporting in cavity and overcomes wall tie problems.
- Does not require cavity fire barriers.
- Can be easily removed in localised areas for alterations or repairs and will last the lifespan of the property.
- BBA Certified.

Risks
- The toxic UF product cannot be used in high exposure zones of the UK # not suitable for high rise buildings.
- PUR product not CIGA guaranteed.

Survey Considerations
- Assess exposure to temperate climate.
- Asbestos Containing Materials around openings.
- Assess position of firebreaks and conditions of existing cavity materials.

Note that further consideration should also be given to the combination of construction methods that may be present on any given building that may require a combination of insulation installation solutions. In some cases requiring localised mix of internal and/or external insulation to avoid cold bridges.

Categorisation of Constructions against Dwelling Types and Potential Technical Solutions

Cavity category: > **Dwelling type: v**	**Category 2/3** **Narrow Cavity**	**Category 2/3** **Partial Fill/ cavity obstructions**	**Category 3** **RC insitu Frame**	**Category 3** **Timber Frame**	**Category 3** **Rainscreen/ Cladding materials**	**Category 3** **Random Stone**	**Category 3** **Non Traditional / System Built**
Mid-terrace*	NCW 1 – NCW 3 NCW 2	PFCW 1 – PFCW 3 PFCW 2 –	ICCW1 – ICCW2	TFCW1 – TFCW2 -	ERCFCW1 – ERCFCW2 – ERCFCW3 –	RSCW1 – RSCW3 RSCW2 – RSCW4	Covered generally under RC Frame and Timber Frame
End-terrace*	NCW 1 – NCW 3 NCW 2	PFCW 1 – PFCW 3 PFCW 2 –	ICCW1 – ICCW2	TFCW1 – TFCW2 -	ERCFCW1 – ERCFCW2 – ERCFCW3 –	RSCW1 – RSCW3 RSCW2 – RSCW4	Covered generally under RC Frame and Timber Frame
Semi-detached bungalow*	NCW 1 – NCW 2	PFCW 1 – PFCW 2 –	Not Applicable	TFCW1 – TFCW2 -	Not Applicable	RSCW1 – RSCW3 RSCW2 – RSCW4	Covered generally under RC Frame and Timber Frame
Detached bungalow**	NCW 1 – NCW 2	PFCW 1 – PFCW 2 –	Not Applicable	TFCW1 – TFCW2 -	Not Applicable	RSCW1 – RSCW3 RSCW2 – RSCW4	Covered generally under RC Frame and Timber Frame
Semi-detached house*	NCW 1 – NCW 3 NCW 2	PFCW 1 – PFCW 3 PFCW 2 –	ICCWM1 – ICCWM2 ICCWM3 – ICCW1 – ICCW2	TFCW1 – TFCW2 -	Not Applicable	RSCW1 – RSCW3 RSCW2 – RSCW4	Covered generally under RC Frame and Timber Frame
Detached house**	NCW 1 – NCW 3 NCW 2	PFCW 1 – PFCW 3 PFCW 2 –	Not Applicable	TFCW1 – TFCW2 -	Not Applicable	RSCW1 – RSCW3 RSCW2 – RSCW4	Covered generally under RC Frame and Timber Frame
Low Rise Flat with 2 external walls*	NCW 1 – NCW 3 NCW 2	PFCW 1 – PFCW 3 PFCW 2 –	ICCWM1 – ICCWM2 ICCWM3 – ICCW1 – ICCW2	TFCW1 – TFCW2 -	ERCFCW1 – ERCFCW2 – ERCFCW3 –	Not Applicable	Not possible to examine all systems. IFRCCW1-2 See also Rainscreen Cladding (ERCFCW1-3)

Cavity category: > Dwelling type: v	Category 2/3 Narrow Cavity	Category 2/3 Partial Fill/ cavity obstructions	Category 3 RC insitu Frame	Category 3 Timber Frame	Category 3 Rainscreen/ Cladding materials	Category 3 Random Stone	Category 3 Non Traditional / System Built
Low Rise Flat with 3 external walls*	NCW 1 – NCW 3 NCW 2	PFCW 1 – PFCW 3 PFCW 2 –	ICCWM1 – ICCWM2 ICCWM3 – ICCW1 – ICCW2	TFCW1 – TFCW2 -	ERCFCW1 – ERCFCW2 – ERCFCW3 –	Not Applicable	Not possible to examine all systems. IFRCCW1-2 See also Rainscreen Cladding (ERCFCW1-3)
High Rise Flat with 2 external walls*	NCW 1 – NCW 3 NCW 2	PFCW 1 – PFCW 3 PFCW 2 –	ICCWM1 – ICCWM2 ICCWM3 – ICCW1 – ICCW2	Not Applicable	ERCFCW1 – ERCFCW2 – ERCFCW3 –	Not Applicable	Not possible to examine all systems. IFRCCW1-2 See also Rainscreen Cladding (ERCFCW1-3)
High Rise Flat with 3 external walls*	NCW 1 – NCW 3 NCW 2	PFCW 1 – PFCW 3 PFCW 2 –	ICCWM1 – ICCWM2 ICCWM3 – ICCW1 – ICCW2	Not Applicable	ERCFCW1 – ERCFCW2 – ERCFCW3 –	Not Applicable	Not possible to examine all systems. IFRCCW1-2 See also Rainscreen Cladding (ERCFCW1-3)

* Overall variables – site topography / exposure zone, potential climate change, condition of cavity wall and party wall issues
** Overall variables – site topography / exposure zone, potential climate change and condition of cavity wall

Category 1 – standard fillable   Category 2 – Non-standard fillable (less problematic)   Category 3 - Non-standard fillable (more problematic) –

Category 4 – Unfillable   (Category references taken from BRE guide prepared for Homes and Communities Agency)

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6 Key issues in filling wall cavities in existing dwellings

The following sections identify and describe the issues associated with Survey and Installation of insulation in Hard to Fill Cavities.

6.1 Survey

The level of detail that a full survey would need to include to establish beyond reasonable doubt the issues that would need to be addressed in taking up hard to fill cavities. It is clear from inspection, that this would be a significant additional cost compared with current practice, requiring a significantly greater precision than currently seen, where over 50% of cancellations on technical grounds alone (933 out of the 1879[22]) were due to misidentification of solid walls as cavity constructions. Part of this may be due to the first stage, “the assessment” being undertaken as part of a general “energy efficiency” inspection as compared with the second stage “the technical assessment” being undertaken in more detail.

A cavity wall survey by boroscope and a roof void inspection (if relevant) should be carried out to determine:

a. Type(s) and extent of wall construction

b. Storey heights where insulation is contemplated and ease of access to the elevations

c. Type, condition and effectiveness of external protection or cladding (render, tile hanging, decorative/protective coating, rainscreen cladding etc.

d. Type and condition of the wall finishes and decorative finishes on the inside faces of the external cavity walls together with the degree of obstruction by fixtures and fittings

e. Width of cavity

f. Presence, type frequency and condition of cavity wall ties

g. Condition of mortar joints

h. Presence of weep holes, frequency and degree of obstruction

i. DPC’s and cavity trays are fitted and stop-ends present

j. Presence or not of debris in the cavity

k. Whether all ducts or pipes have sleeves or collars

l. The wind driven rain exposure zone (1-4) for the subject property(s) though in practice most insulation products are certified for use in all four zones

m. The location of the wall and its exposure to wind driven rain based on orientation, height above ground level and local site topography

n. The presence or otherwise of overhangs, parapets or other construction detailing that influences the protection or exposure of the wall

[22] Assuming InstaFibre survey can be extrapolated – see Appendix for analysis

o. Cavity barriers are in position and there is sufficient masonry thickness between chimney (where present) and insulation

6.1.1 Essential requirements

Only when this information has been verified, can a well informed decision be made on the most cost effective strategy to be employed to insulate the walls defined as "Hard to Treat" Cavities.

If structural problems are identified by the cavity wall survey e.g. absent or defective cavity wall ties, cavity blockages or unsound masonry construction, these matters should be the subject of suitable remedial works before insulation whichever type of insulation strategy is adopted.

6.2 Insulation options

Broadly, with retro-fit insulation to external cavity walls, the following options should be considered:

a. Full fill cavity wall insulation injected from the outside

b. Full fill cavity wall insulation injected from the inside

c. External wall insulation system

d. Internal dry-lining incorporating timber battens, Thermo-Foil or similar and plasterboard

e. Internal dry-lining using an insulated plasterboard system

These will be discussed in turn.

6.3 Full fill cavity wall insulation injected from the outside

6.3.1 Advantages

a. No or minimal disruption to the interior of the property or occupants

b. Fast to install

c. Minimal impact on the external appearance of the building

6.3.2 Disadvantages

a. Relies on cavity being clear of debris and requires detailed checks to be carried out on other aspects of cavity wall condition/construction and remedied if necessary prior to installation

b. Access costs can become very high where works above four storeys are to carried out or where lean-to buildings or other obstructions affect lower levels

c. Leaves a pattern of made good drill holes in the façade of the building, lowest cost when in facing brickwork, higher costs when in masonry painted render and the like.

d. External making good may be impossible to conceal sufficiently on listed or other sensitive buildings

e. Very careful consideration needs to be taken of maximum recommended exposure zones and areas at risk of flooding for insulated masonry walls of this type.

f. Increased risk of frost damage to the outer leaf/finish of the wall. Note that most damage to existing brickwork is by sulphates.

g. Increased risk of creating localised cold bridge condensation.

h. Risk that climate change will increase the exposure zone value of the site over time, potentially leading to water penetration where none previously occurred

6.4 Full fill cavity wall insulation injected from the inside

6.4.1 Advantages

a. Often avoids the need for an external scaffold with arising cost savings

b. No external drill holes to be made good

c. Fast to install

6.4.2 Disadvantages

a. Disruption to the internal finishes and decorations inside the building which would require making good

b. Disruption to building occupants

c. Increased risk of frost damage to the outer leaf/finish of the wall. Note that most damage to existing brickwork is by sulphates.

d. Increased risk of creating localised cold bridge condensation

e. Risk that climate change will increase the exposure zone value of the site over time, potentially leading to water penetration where none previously occurred.

6.5 Comparison with internal or external insulation

In order to make a comparison with the alternatives to filling hard to fill cavities the following notes are included to identify the pros and cons of applying either internal or external retro insulation.

6.6 Externally applied wall insulation system

6.6.1 Advantages

a. No need to address issues of cavity debris, sleeves, cavity tray DPC's etc but wall would need to be structurally sound.

b. The wall finish is replaced at the same time as the wall is insulated – an advantage when the original wall finish is in very poor condition

c. Virtual elimination of the possibility of cold bridge condensation

d. Suitable for use on high exposure sites where the use of full fill cavity insulation is not recommended – assuming the external finish is water resistant

e. Minimal disruption to the interior or occupiers

f. No loss of internal room volume

6.6.2 Disadvantages

a. High unit cost

b. Requires access scaffold

c. Often entraps window and door frames

d. Modifications usually required to window cills, external soffits, rainwater goods, soil, waste and service pipes

e. Results in a substantial change in the appearance of the building which may or may not be desirable

6.7 Internally applied dry lining incorporating timber battens, Thermo-Foil or similar and plasterboard

6.7.1 Advantages

a. No need to address issues of cavity debris, sleeves, cavity tray DPC's etc but wall would need to be structurally sound.

b. Suitable for use on high exposure sites where the use of full fill cavity insulation is not recommended

c. Does not change the external appearance of the building

6.7.2 Disadvantages

a. High unit cost

b. Replacement cost of the internal wall finishes and decoration together with associated electrical work and second fix joinery.

c. Disruption to the occupiers

d. Small loss of room volume

e. Criticality of vapour barrier in minimising the risk of interstitial condensation

f. Risk of localised cold bridging and condensation at junctions with internal walls, around window openings etc.

6.8 Internally applied dry lining using an insulated plasterboard system

6.8.1 Advantages

a. No need to address issues of cavity debris, sleeves, cavity tray DPC's etc but wall would need to be structurally sound.

b. Suitable for use on high exposure sites where the use of full fill cavity insulation is not recommended

c. Does not change the external appearance of the building

6.8.2 Disadvantages

a. High unit cost

b. Replacement cost of the internal wall finishes and decoration together with associated electrical work, second fix joinery and re-plumbing of central heating radiators.

c. Disruption to the occupiers

d. Noticeable loss of room volume

e. Criticality of vapour barrier in minimising the risk of interstitial condensation

f. Risk of localised cold bridging and condensation at junctions with internal walls, around window openings etc.

6.9 Summary

In summary, full cavity fill insulation is usually the most cost effective option where the cavity wall is confirmed as being in good overall condition, where the local exposure factors confirm its suitability for use and where external or internal access is not highly costly or otherwise problematic. In instances where the existing wall finish or cladding is life expired or in need of major refurbishment on a highly exposed site where an appearance change can be tolerated, external wall insulation should be considered. In the case of a building where there are complications affecting the condition of the cavity wall on a site too exposed for cavity fill insulation where an appearance change cannot be tolerated, internal insulated dry lining should be considered with the Thermo-Foil type variant minimising the loss of room volume.

6.10 “Unfillable” Cavities

6.10.1 Preliminary Survey

A site survey using a boroscope, localised exposure or opening up of the wall structure should be carried out to confirm that there are either insufficient or no mortar joints that can be drilled to enable the insertion of the injector nozzle for the cavity fill insulation. Matters to be determined are:

a. Whether one or both leafs of the cavity wall contains sufficient mortar joints to enable cavity fill insulation to be injected

b. The ability or otherwise of both leafs to effectively contain the cavity fill insulation

6.10.2 Further inspection

If this preliminary inspection indicates that the building has a potentially fillable cavity, contrary to initial opinion, the following further checks should be carried out to determine:

a. Storey heights where insulation is contemplated and ease of access to the elevations

b. Type, condition and effectiveness of external protection or cladding (render, tile hanging, decorative/protective coating, rainscreen cladding etc.

c. Type and condition of the wall finishes and decorative finishes on the inside faces of the external cavity walls together with the degree of obstruction by fixtures and fittings

d. Width of cavity

e. Presence, type frequency and condition of cavity wall ties

f. Condition of mortar joints

g. Presence of weep holes, frequency and degree of obstruction

h. DPC’s and cavity trays are fitted and stop-ends present

i. Presence or not of debris in the cavity

j. Whether all ducts or pipes have sleeves or collars

k. The wind driven rain exposure zone (1-4) for the subject property(s)

l. The location of the wall and its exposure to wind driven rain based on orientation, height above ground level and local site topography

m. The presence or otherwise of overhangs, parapets or other construction detailing that influences the protection or exposure of the wall

n. Cavity barriers are in position and there is sufficient masonry thickness between chimney (where present) and insulation

When this survey has been completed, the same process of consideration should be applied as set out in paragraphs 6.1.1 inclusive.

In the event of this investigation confirming either that no or insufficient mortar joints are present or that the wall is of steel or timber framed construction, the insulation options set out under paragraphs 6.6, 6.7 and 6.8 should be considered.

6.10.3 Party Walls

3.1.1 The party wall should be surveyed involving the use of a boroscope and may also require localised exposure of masonry or opening up. A roof void inspection should be undertaken where relevant. This inspection should determine:

a. Type(s) and extent of wall construction

b. Type and condition of the wall finishes and decorative finishes on the inside faces of the party wall together with the degree of obstruction by fixtures and fittings to assist installation, and making good.

c. Width of cavity

d. Presence, type frequency and condition of cavity wall ties

e. Condition of mortar joints

f. Presence of DPC. The cavity condition will change as a result of insulation application and lack of DPC may therefore attract moisture through the structure, particularly adjacent to chimney breasts.

g. Presence or not of debris in the cavity to identify issues of fillability. Cavity may still be subject to moisture ingress which enable debris to transfer moisture (see (i) below).

h. Whether any ducts or pipes are present and that they have sleeves or collars

i. The wind driven rain exposure zone (1-4) for the subject property(s) if any significant section of the party wall is external – e.g. steps and staggers in terraces.

j. The location of the wall and its exposure to wind driven rain based on orientation, height above ground level and local site topography if any section of the party wall is external

k. The presence or otherwise of overhangs, parapets or other construction detailing that influences the protection or exposure of the wall if any significant section of the wall is external

l. Cavity barriers are in position and there is sufficient masonry thickness between chimney flue (where present) and insulation

m. The presence and integrity of a firebreak wall in any roof void

n. Points at which the cavity fill insulation requires containment to prevent „overspill'

o. The level of acoustic isolation - this may have relevance where apartments in multi occupancy dwellings are to be acoustically treated in order to establish best value solution where a choice of insulation materials fulfil a number of performance criteria.

If no part of the party wall is external, exposure zone values are not relevant and can be disregarded. Consideration should be made of noise transmission to achieve the required level of acoustic isolation and fire spread properties of any insulation selected for use, together with the method that would keep disruption of the internal finishes and decoration and building occupants to a minimum.

6.10.4 Narrow Cavities

The narrower a cavity becomes, the lower the maximum recommended exposure zone value becomes for full fill cavity insulation in any given location. For example, a 50mm wide cavity filled injected with non UF foam insulation into facing brickwork with tooled flush joints has a maximum recommended exposure zone of 2, whereas the same insulation material would have a recommended exposure zone of 3 in the same wall construction but with a 75mm cavity. Clearly, full fill cavity insulation cannot be used as widely in walls with narrow cavities as in walls with wider cavities and for sites with above average exposure, external or internal insulation options should be considered. The width of the cavity in every building considered for full fill cavity insulation should be determined by measurement or localised opening up. If a narrow cavity is only encountered to a small proportion of the total wall area, this does not necessarily preclude the use of full fill cavity insulation and consideration should be given to a localised solution to narrow cavity width.

7 Summary of Cavity Wall Insulation (CWI) materials in the UK/GB

There is a wide range of materials available in the UK to undertake cavity wall insulation. In determining their suitability for particular situations, the methods of application have to be taken into account as they have different limitations imposed by the method of application and have some differences in thermal characteristic that may or may not be significant in the context of a whole building energy calculation. The technical characteristics are summarised below. Note that where there is reference to BBA certification of a product this refers to a product carrying a BBA mark. The suitability of a particular product for a particular building needs to be checked to ensure that the product is being used within its defined parameters e.g. in buildings below 25m. Use of materials outside of such parameters may require that superior assessment may be required and/or alternative assurances are sought. This may include any mix of the following to suit any legal obligations carried by the building owner and to suit the level of risk that the building owner is prepared to carry. Mitigation measures may include assessment certificates for a complete building (BBA etc), installer warranties, professional warranties, or others to suit. Further information on materials is available in the Appendix B.

7.1 Materials

Materials include:

Blown mineral wool - glass wool/rockwool granulates

Expanded Polystyrene (EPS Beads)

Granular Vermiculite/ Perlite Beads (plus variations)

Polyurethane (PUR) Foam

Cellulose Loose Fill

Urea Formaldehyde (UF) Foam

7.2 Installation Methods

There are two main methods of installation:

Blown in an air stream

Injection

7.3 Blown Mineral Wool – Glass wool

Thermal Conductivity (λ value) = 0.040 $Wm^{-1}K^{-1}$

7.3.1 Pros

a. Fire resistant

b. Vapour permeable

c. BBA Certified

d. Can be CIGA guaranteed

7.3.2 Cons

a. 12m maximum recommended height of installation above ground level but can apply for a relaxation up to 25m

b. Installed to manufacturers guidance the insulation should perform as intended. However, where defects in the cavity have not been fully investigated, the defect may influence insulation performance.

c. Potential to retain water and wick water across cavities.

d. Mineral wool manufacturers advise against installation of this product above 12m.

7.4 Blown Mineral Wool - Rockwool

Thermal Conductivity (λ value) = 0.039 $Wm^{-1}K^{-1}$

7.4.1 Pros

a. Fire resistant – can act as a cavity barrier between adjoining buildings at party wall line

b. Vapour permeable

c. Can be used up to 25m above ground level subject to survey

d. BBA Certified

e. Can be CIGA guaranteed

7.4.2 Cons

a. Installed to manufacturers guidance the insulation should perform as intended. However, where defects in the cavity have not been fully investigated, the defect may influence insulation performance.

b. Potential to retain water and wick water across cavities.

c. Mineral wool manufacturers advise against installation of this product above 12m.

7.5 Blown Mineral Wool

7.5.1 Survey Considerations

a. The installation must be carried out in accordance with a current BBA Certificate.

b. Carry out a pre-installation survey to assess the suitability of the property and its exposure consideration to the temperate climate - A boroscope survey should also be carried out in high and low rise premises to assess the position of firebreaks etc. located within the cavity and to assess the condition of materials used to form the cavity.

7.5.2 Scope of Works - External Installation

a. Check all ventilation openings and flues within the cavity wall and ensure adequate sleeves or cavity closures are in place to prevent migration of insulation, prior to any installation of insulant.

b. For semi – detached and terraced properties, it is necessary to insert a nylon brush into the cavity at the party wall line in order to contain the insulation and prevent it spreading to the adjacent property. The brush is to be inserted at the top of the wall and dropped down and is to remain in place permanently.

c. Drill injection holes of 22mm or 25mm diameter into outer leaf at predetermined centres (centres depend on individual BBA certificate).

d. Blow mineral wool into the cavity via a flexible hose fitted with an injection nozzle, using an approved blowing machine.

e. Make good to all injection holes.

f. Carry out checks on all air vents, flues and appliances to ensure they are not compromised by the insulation.

7.6 Internal Installation – Rock Wool (low pressure blown installation)

7.6.1 Survey Considerations

a. The installation must be carried out in accordance with a current BBA Certificate.

b. Carry out a pre-installation survey to assess the suitability of the property and its exposure consideration to the temperate climate - A boroscope survey should also be carried out in high and low rise premises to assess the position of firebreaks etc. located within the cavity and to assess conditions of materials used to form the cavity.

7.6.2 Scope of Works

a. All walls should be inspected prior to installation works taking place to assess their suitability. All defects and dampness penetration problems must be addressed before starting the work.

b. Check all ventilation openings and flues within the cavity wall and ensure adequate sleeves or cavity closures are in place to prevent blockage from the insulation, prior to any installation works taking place.

c. Include for removal where necessary of all floor and wall coverings including desks, chairs, other furniture, shelving, book racks, pinboards etc. Ensure that removed items are protected from damage, dirt & debris.

d. Include for disconnection and temporary removal of all kitchen and bathroom units and sanitary ware where required.

e. Adequately protect any floors, walls, ceilings and items that fall within or adjacent to the working area and are not to be removed or modified for the duration of the works.

f. Drill injection holes into inner leaf at predetermined centres (hole dimensions and centres depend on individual BBA certificate).

g. Blow mineral wool into the cavity via a flexible hose fitted with an injection nozzle, using an approved blowing machine.

h. Make good to all injection holes in plaster and allow for redecoration/repapering/retiling where required.

i. Allow for repositioning/replacing all previously removed carpets, furniture, shelving etc.

j. Carry out checks on all air vents and flues to ensure they are not obstructed by the insulation.

7.7 Cellulose Loose Fill (e.g. „Warmcel')

Thermal Conductivity (λ value) = 0.40 $Wm^{-1}K^{-1}$

7.7.1 Pros

a. High recycled content

b. Low embodied energy

c. Safe to handle and install

d. Can be manufactured to be fire and moisture resistant

e. Vapour permeable

f. Non-toxic, non-irritant

g. Recyclable if kept dry

h. Biodegradable

i. Durable so long as kept away from moisture and water

j. Resistant to biological and fungal attack

7.7.2 Cons

a. May contain very low levels of formaldehyde from ink residues. Government should seek confirmation from HSE that there is not a health risk before encouraging widespread use.

b. Can wick moisture across cavity materials

c. Can still be susceptible to mould and fungal attack if untreated

d. Strength and resistance to compression is very low

e. Cavity barrier required between adjoining buildings at party wall line

f. Not currently covered by CIGA Guarantee

g. BBA certified for timber framed buildings only

7.7.3 Scope of Works - Internal Installation

a. All stud/ nogging locations are identified by drawings or stud locators and holes marked out in either the sheathing board or plasterboard lining to ensure all cavities are filled.

b. Injection is made through a 25 mm diameter hole made using a hole-cutter and the core is retained for making the hole good, using silicone sealant or gypsum-based adhesive as appropriate. For a normal 2.4 m high wall with studs at 0.6 m centres, three holes are required at heights of 0.2 m, 1.2 m and 2.2 m from the floor.

c. The upper holes are temporarily blocked to prevent fibre escape, the nozzle inserted into the lower hole and insulation blown until the machine stalls.

d. When accessing cavities lined with a gypsum fibreboard, a single circular piece is cut near the top of the cavity large enough to accept the 50 mm diameter hose and 106 mm diameter Turbofill gun and cut at 45 degrees with a jigsaw to facilitate its reinstatement with a suitable gypsum-based adhesive. The hose is inserted into the cavity to within 200 mm of the bottom and filling proceeds until the fibre flow rate slows. The hose is withdrawn about 200 mm until the flow rate slows again; the process continues until the cavity is full.

e. Any damage to a breather or control layer must be made good.

7.8 Expanded Polystyrene (EPS) Beads (high and low pressure installations)

Thermal Conductivity (λ value) = 0.033 to 0.040 $Wm^{-1}K^{-1}$

7.8.1 Pros

a. Safe to handle and install

b. Moisture resistant

c. Closed cell product

d. Vapour permeable

e. Typically, injection holes to upper part of wall only and below windows and lintels

f. BBA Certified

g. Can be CIGA guaranteed

h. Recoverable

7.8.2 Cons

a. Cavity barrier required between adjoining buildings at party wall line

b. If not installed in line with manufacturer guidance „static cling' could lead to uninsulated pockets within cavity.

c. Made from fossil fuels

d. Top of cavity must be capped

e. Excess material in roof space must be removed (if fire risk)

f. 12m maximum recommended height of installation above ground level unless specific relaxation obtained from BBA.

g. If not installed with manufacturers guidance and bonding agent omitted discharge can occur when holes are made in the cavity – e.g. installing new openings or vents

7.8.3 Survey Considerations-external installation

- Carry out a pre-installation survey to assess the suitability of the property and its exposure
- A boroscope survey should also be carried out in high and low rise premises to assess the position of firebreaks etc. located within the cavity and to assess conditions of materials used to form the cavity.

- Survey required to determine whether walls are „closed' around openings to allow future replacement of windows and doors.

7.8.4 Scope of Works-external installation

a. The installation must be carried out in accordance with the relevant BBA Certificate, their surveillance scheme, the System Suppliers installation Manual and all CIGA guides to best practice.

b. Where a semi-detached or terraced property is to be treated, the insulant is contained within cavity by a cavity barrier. This is positioned at the party wall line dividing the properties and consists of a synthetic brush which remains in place when the installation is completed.

c. Internal and external checks are carried out by the Technician prior to installation. Injection holes (ca 22mm diameter) are drilled in the external wall of the cavity as specified by the relevant BBA Certificate and System Suppliers manual e.g. around the upper part of the building only and below windows and lintels or as specified.

d. The polystyrene beads are then injected into the cavity via an injection gun together with an adhesive in a specified sequence to ensure a complete fill of the cavity.

e. Make good to all injection holes.

f. Carry out post installation checks on all fuel-burning appliances, their flues and source of air supply to confirm their effectiveness.

7.8.5 Survey Considerations-internal installation

a. Carry out a pre-installation survey to assess the suitability of the property and its exposure consideration to the temperate climate

b. A boroscope survey should also be carried out in high and low rise premises to assess the position of firebreaks etc. located within the cavity and to assess conditions of materials used to form the cavity.

c. Survey required to determine whether walls are „closed' around openings to allow furure replacement of windows and doors.

7.8.6 Scope of Works-internal installation

a. The installation must be carried out in accordance with the relevant BBA Certificate, their surveillance scheme, the System Suppliers installation Manual and all CIGA guides to best practice.

b. Where a semi-detached or terraced property is to be treated, the insulation is contained within the cavity with a cavity barrier. This is positioned at the party wall line dividing the properties and consists of a synthetic brush which remains in place when the installation is completed.

c. Ensure prior removal where necessary of all desks, chairs, other furniture, shelving, book racks, pinboards etc. Ensure that removed items are protected from damage, dirt & debris.

d. Include for disconnection and temporary removal of all kitchen and bathroom units and sanitary ware where required to gain access for the installation.

e. Adequately protect any floors, walls, ceilings and items that fall within or adjacent to the working area and are not to be removed or modified for the duration of the works.

f. Internal and external checks are carried out by the Technician prior to installation. Injection holes of 22mm diameter are drilled in the internal wall of the cavity as specified by the relevant BBA Certificate and System Suppliers manual. Typically holes are drilled around the upper sections of walls only and below windows and lintels.

g. The polystyrene beads are then injected into the cavity via an injection gun together with an adhesive in a specified sequence to ensure a complete fill of the cavity.

h. Make good to all injection holes in plaster and allow for decoration / repapering / retiling where required.

i. Allow for repositioning/replacing all previously removed carpets, furniture, shelving etc.

j. Carry out post installation checks on all fuel-burning appliances and their flues or source of air supply to confirm their effectiveness.

7.9 Perlite Beads

Thermal Conductivity (λ value) = 0.045 $Wm^{-1}K^{-1}$

7.9.1 Pros

a. Reclaimable

b. Relatively high natural content

c. Safe to handle and install

d. Fire and moisture resistant

e. Free flowing - good void filler

f. Inorganic, rot, vermin and insect resistant

g. Non settling and supports its own weight

h. Covered by BSEN standard

7.9.2 Cons

a. Rarely used in retrofit applications in UK

b. Made from fossil fuels

c. Raw materials obtained through mining

d. Must be installed in sealed spaces

e. Not BBA Certified

f. Not currently covered by CIGA Guarantee

g. Use above 9m above ground level uncommon in UK

7.9.3 Scope of Works- External Installation

- The insulation material must be a product of a member of the Perlite Institute, Inc

- All holes and openings in the wall through which insulation can escape shall be permanently sealed or caulked prior to installation of the insulation. Copper, galvanized steel, or fibre glass screening should be used in all weep holes.

- The insulation should be poured via a hopper in the top of the wall at any convenient interval (not in excess of 20 ft [6 m]) and underneath window openings, allow for removal of individual bricks to facilitate pouring of the Perlite and for reinstatement afterwards.

7.10 Exfoliated Vermiculite Pellets

Thermal Conductivity (λ value) = 0.045 $Wm^{-1}K^{-1}$

7.10.1 Pros

a. Reclaimable

b. Relatively high natural content

c. Safe to handle and install

d. Fire and moisture resistant

7.10.2 Cons

a. Rarely used for retrofit

b. Made from fossil fuels

c. Raw materials obtained through mining

d. Must only be installed in sealed spaces

e. Not BBA Certified

f. Not currently covered by CIGA Guarantee

g. Not recommended for use in EXTERNAL wall cavities (indicating internal party wall use only)

h. Source may contain asbestos depending on country of origin

7.10.3 Scope of Works

See perlite beads for methodology

7.11 Polyurethane (PUR) Foam

Thermal Conductivity (λ value) = 0.022 – 0.028 $Wm^{-1}K^{-1}$

7.11.1 Pros

a. Moisture resistant

b. Vapour permeable

c. Strong bonding properties – strengthens structure

d. Suitable for use on high rise buildings

e. Suitable for use in narrow cavities

f. Self supporting within the cavity

g. Resistant to attack by rot, fungi and vermin

h. Inert and non hazardous once installed

i. Only requires 12mm diameter drill holes

j. Can be easily removed in localised areas for alterations or repairs e.g. creating new openings

k. BBA Certified

l. Covered by BUFCA Guarantee

m. Suitable for use in non-traditional construction

n. Good thermal performance - low thermal conductivity of 0.022 – 0.028 $Wm^{-1}K^{-1}$

o. Continuous layer of insulation minimises thermal bridging and reduces heat losses associated through air leakage by increasing air tightness

p. Suitable for random stone wall construction

q. Recyclable through grinding down and adding to new sheeting.

r. Can be used in situations where the wall ties have begun to corrode to bond the two leaves of the cavity together. This may reduce the need for replacement of wall ties

7.11.2 Cons

a. Made from fossil fuels

b. Cost per installation medium-high

c. Careful selection of grade of insulation required to ensure its dimensional characteristics are compatible with the structural strength of the cavity forming materials

d. Extraction probably not possible without dissembling part of wall.

7.11.3 Survey Considerations- External installation, (Pressure injection installation)

a. Install in accordance with the BBA surveillance scheme

b. Carry out a pre-installation survey to assess the suitability of the property and its exposure

c. A boroscope survey should also be carried out in high and low rise premises to assess the position of firebreaks etc. located within the cavity and to assess conditions of materials used to form the cavity.

7.11.4 Scope of Works- External Installation

a. Check all ventilation openings and flues within the cavity wall and ensure adequate sleeves or cavity closures are in place to prevent blockage from the insulation, prior to any installation works taking place. Ensure all gaps and cracks in the inner and outer leaf and tops of uncapped cavities are sealed where possible to limit the escape of any material.

b. Drill injection holes of 12mm diameter into outer leaf at the intersections of mortar joints. A staggered pattern should be used with holes approximately 0.65m apart horizontally and 0.45m apart vertically. By drilling a series of vertical sight holes, the flow of foam may be permitted to set in a vertical line at any party wall line.

c. Remove and replace air bricks with cavity sleeves where necessary.

d. The foam is injected through the holes in a specified sequence, in order to ensure a complete fill of the cavity. Where the property has a party wall, these holes are injected first.

e. Make good to all injection holes.

f. Carry out checks on all air bricks and flues etc. to ensure they are not obstructed by the insulation. The interior of the building should also be checked for the presence of surplus material. If this has occurred in inhabited parts of the building, it must be removed.

7.11.5 Survey Considerations – Internal installation (Pressure Injection Installation)

a. Install in accordance with the BBA surveillance scheme

b. Carry out a pre-installation survey to assess the suitability of the property and consideration to its exposure in different parts of the country.

c. A boroscope survey should also be carried out in high and low rise premises to assess the position of firebreaks etc. located within the cavity and to assess conditions of materials used to form the cavity.

7.11.6 Scope of Works – Internal installation (Pressure Injection Installation)

a. Check all ventilation openings and flues within the cavity wall and ensure adequate sleeves or cavity closures are in place to prevent blockage from the insulation, prior to any installation works taking place. Ensure all gaps and cracks in the inner and outer leaf and tops of uncapped cavities are sealed where possible to limit the escape of any material.

b. Include for removal where necessary of all desks, chairs, other furniture, shelving, book racks, pinboards etc. Ensure that removed items are protected from damage, dirt & debris.

c. Include for disconnection and temporary removal of all kitchen and bathroom units and sanitary ware where required.

d. Adequately protect any floors, walls, ceilings and items that fall within or adjacent to the working area and are not to be removed or modified for the duration of the works.

e. Drill injection holes of 12mm diameter into outer leaf at the intersections of mortar joints. A staggered pattern should be used with holes approximately 0.65m apart horizontally and 0.45m apart vertically. By drilling a series of sight holes, the flow of foam may be stopped to set in a vertical line at any party wall.

f. Remove and replace air bricks with cavity sleeves where necessary.

g. The chemicals that generate the foam are injected through the holes in a specified sequence, in order to ensure a complete fill of the cavity. Where the property has a party wall, these holes are injected first.

h. Make good to all injection holes in plaster and allow for decoration / repapering / retiling where required.

i. Allow for repositioning/replacing all previously removed carpets, furniture, shelving etc.

j. Carry out checks on all air bricks and flues etc. to ensure they are not obstructed by the insulation. The interior of the building should also be checked for the presence of surplus material. If this has occurred in inhabited parts of the building, it must be removed.

7.12 Urea-Formaldehyde (UF) Foam

Thermal Conductivity (λ value) = 0.40 $Wm^{-1}K^{-1}$

7.12.1 Pros

a. Fire and moisture resistant

b. Self supporting in the cavity

c. Resistant to attack by rot, fungi and vermin

d. Vapour permeable

e. Can be easily removed in localised areas for alterations or repairs

f. Can be CIGA guaranteed

7.12.2 Cons

a. Potentially hazardous material whose manufacture and installation[23] are controlled by Part D of the Building Regulations and three British Standards.

b. Inner leaf of cavity wall must be masonry (bricks or blocks)

c. Cannot be used in high exposure zones of the UK

d. Some evidence that UF foam may accelerate corrosion in galvanized steel wall ties, in particular the thin galvanized "butterfly" ties.

e. Not suitable for high rise, unless the wall is protected by over-cladding

f. The Health & Safety Executive advises against the use of Urea Formaldehyde Foam Insulation where the internal leaf of the wall is of porous material or where there are unsealed construction holes or gaps in the structure. It also warns against its use with concrete or steel constructions with vapour permeable plasterboard or insulation board as the decorative internal surface.

7.12.3 Survey Considerations

- - Carry out a pre-installation survey to assess the suitability of the property and its exposure consideration to the temperate climate - A boroscope survey should also be carried out in high and low rise premises to assess the position of firebreaks etc. located within the cavity and to assess conditions of materials used to form the cavity.

7.12.4 Scope of Works - External Installation

a. Install in accordance with BS 5618 (1978). Installer must hold or operate under a current BSI Certificate of Registration of Assessed Capability

b. Check all ventilation openings and flues within the cavity wall and ensure adequate sleeves or cavity closures are in place to prevent blockage of any required ventilation paths from the insulation product, prior to any installation works taking place.

c. Drill injection holes of 19mm diameter into outer leaf at no more than 1m centres. By drilling a series of vertical sight holes, the flow of foam may be permitted to set in a vertical line at any party wall line.

d. The foam is injected through the holes in a specified sequence, in order to ensure a complete fill of the cavity.

e. Make good to all injection holes.

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f. Carry out checks on all air bricks and flues etc. to ensure they are not obstructed by the insulation. The interior of the building should also be checked for the presence of surplus material. If this has occurred in inhabited parts of the building, it must be removed.

7.13 Nanogel (Silica product)

Thermal Conductivity (λ value) = 0.15 $Wm^{-1}K^{-1}$

7.13.1 Pros

a. Ultra low thermal conductivity as low as 0.015 $Wm^{-1}K^{-1}$ gives thermal efficiency that is 2 to 4 times greater than traditional materials such as polystyrene, mineral wool, and cellulose

b. Hydrophobicity - repels water

c. Non-combustible

d. Resists settling

e. Can be easily removed in localised areas for alterations or repairs

f. Superior acoustic insulation

g. Long life span

h. Suitable for narrow cavity installation

i. Non toxic source

7.13.2 Cons

a. Not recognised by the BRE/BBA

b. Expensive

c. Relatively untested in the UK construction industry

7.13.3 Survey Considerations

a. Carry out a pre-installation survey to assess the suitability of the property and its exposure consideration to the temperate climate - A boroscope survey should also be carried out in high and low rise premises to assess the position of firebreaks etc. located within the cavity and to assess conditions of materials used to form the cavity.

b. Survey required to obtain window positions within the cavity (may prevent future installation of new windows)

7.13.4 Scope of Works

a. The installation must be carried out in accordance with the relevant manufacturer product warranty, their surveillance scheme, the System Suppliers installation Manual and all guides to best practice.

b. Where a semi-detached or terraced property is to be treated, the insulant is contained within a sealed cavity with a suitable cavity barrier. This is positioned at the party wall line dividing the properties.

c. Internal and external checks are carried out by the Technician prior to installation. Injection holes of 22mm diameter are drilled in the external wall of the cavity as specified by the relevant System Suppliers manual. Typically holes are drilled around the upper part of the building only and below windows and lintels.

d. The beads are then poured through a hopper or injected into the cavity via an injection gun under low or high pressure in a specified sequence to ensure a complete fill of the cavity.

e. Make good to all injection holes.

f. Carry out post installation checks on all fuel-burning appliances and their flues or source of air supply to confirm their effectiveness.

8 Risk and Opportunities Assessment

The risk workshop held by Davis Langdon with Inbuilt and DECC engaged stakeholders in identifying more precisely the issues that needed to be addressed in hard to fill cavities. Stakeholders were keen to identify the specific opportunities of how hard to fill cavities could be overcome and to identify the interrelationships.

The resulting table identifies that the issues are generally high risk in the case of: Dependency on Grants including certification requirements, Low innovation, Insufficient interest by publicly funded landlords, Condition of buildings, Difficulties in access, Exposure of buildings, Health risks to installers, Damage to interior, Poor performance (CO_2 savings) in practice, Deterioration of insulation materials with time (currently the subject of new international standards work) and escape of insulation from cavities. The risk was identified as medium for a single category: that the cost of insulation material would be significant due to high embodied energy of manufacture.

Risk and Opportunity Register

V0.5

Risk Identification				Risk Analysis				Risk Management		
1	4	5	6	8		14	15	18	19	20
No	Risk Title/ Category	Risk Description	Consequence	Likelihood	Max Impact	Rating	Risk Status	Response Actions Planned	Action Owner	Date By
1	**Procedural/ Market**	Grant application failure Causes 1. Cavity Wall Insulation system not approved/ certified 2. Number of different grant systems is confusing 3. Products do not meet CIGA or alternative body criteria 4. No financial incentive to innovate 5. Accessory costs 6. BBA cost barrier to achieve certification	1. No take up of scheme (No CO2 reduction)	H	VH	12000	RED	1. Ensure policing of the BBA approval process 2. Certification criteria is to be enhanced to cover hard to fill cavities 3. Training and awareness 4. Consider a hard to fill cavity survey fee		
2		Lack of product innovation/ choice Causes 1. Highly price sensitive market with no incentive for innovation 2. Difficult scenarios not addressed 3. Standards are variable across the UK and Europe 4. Methodology for thermal testing to ensure the performance of products is not standardised 5. Bespoke solutions are often required 6. Limited transfer of knowledge	Shrinkage of the market	H	VH	12000	RED	1. Develop standardised test methodology 2. Realism required in terms of prices and the market size		
3		Insufficient client (Commercial, Private, Local Authority and Housing Association) interest Causes 1. Lack of awareness of technical solutions 2. Perceived as costly 3. Additional construction cost risk borne by the client 4. Perception of the market 5. Clients are unable to afford to proceed 6. Some Local Authorities are resistant to cavity fill in exposed areas	No take up of scheme (No CO2 reduction)	H	VH	12000	RED	1. Remove barriers to provide more funding 2. Positive publicity 3. Change perceived view of grant funding i.e. that cavity fill should be free 4. Improved information available to enable a more informed choice		

Risk Identification				Risk Analysis				Risk Management		
1	4	5	6	8		14	15	18	19	20
No	**Risk Title/ Category**	**Risk Description**	**Consequence**	**Likelihood**	**Max Impact**	**Rating**	**Risk Status**	**Response Actions Planned**	**Action Owner**	**Date By**
4	**Product / Installation**	Physical constraints of construction type limits installation methods Causes 1. Poor quality of workmanship and product 2. Condition and type of construction 3. Some building systems unable to achieve BBA certification	No / low take up of scheme (No / low CO2 reduction)	H	H	6000	RED	1. Innovation incentives are required to be identified 2. Produce technical guidance to improve choice of material 3. Tighter control over survey data		
5		Physical constraints of building / dwelling type limits installation Causes 1. Building shape 2. Degree of modification required 3. Partial installation in difficult to fill situations 4. New Part L works will focus on cold bridging	No / low take up of scheme (No / low CO2 reduction)	H	H	6000	RED	1. Collaborative approach to develop installation solution (more difficult to achieve in the private sector) 2. Centres of excellence 3. Develop solutions with larger public landlords/ clients and share knowledge within the industry		
6		Location / climate (exposure and flooding) conditions limit installation Causes 1. Location and specific exposure rating 2. Products may not be suitable in certain areas 3. Incorrect specifications being used 4. Variance by Local Authorities in terms of requirements	No / low take up Poor performance in use	H	H	6000	RED	1. Product suitability and recoverability 2. Education of mortgage lenders 3. Produce technical guidance		
7		Health risks to occupants resulting from hazardous materials Causes Product manufacture, compliance with accepted standards	Expensive installation costs Residual hazard performance in use	H	H	6000	RED	1. BBA are to ensure hazardous material are not used 2. Share knowledge within the Industry to produce technical guidance		
8		Product is costly resulting from high embodied energy together with high CO2 of product Causes Manufacturing process	Reduced (net) CO2 performance	M	H	4000	ORANGE	1. Measure Primary not Embodied Co2 2. Production of technical guidance to ensure choice of suitable material 3. Promote other benefits linked to cavity forming materials		
9		Damage to building fabric / interior Causes 1. Poor workmanship 2. Condition of cavity. 3. Inadequate survey data	1. No / low take up 2. Cost of mitigation 3. Risk of remedial in high risk situations may not be covered under Insurance warranty	H	H	6000	RED	1. Innovate installation approach 2. Accuracy/ rigour of survey procedure		

2

Risk Identification				Risk Analysis				Risk Management		
1	4	5	6	8		14	15	18	19	20
No	Risk Title/ Category	Risk Description	Consequence	Likelihood	Max Impact	Rating	Risk Status	Response Actions Planned	Action Owner	Date By
10	Performance In Use	Poor thermal performance (inadequate heat retention) Causes 1. Inappropriate product for construction type 2. Poor condition of cavity 3. Inadequate survey, etc. 4. Adequacy of fill 5. Type of dwelling construction 6. Performance of the product	Reduction in energy savings Energy cost and expected CO2 reduction	H	H	6000	RED	1. Develop standardised test methodology 2. Realism required in terms of prices and the market size 3. Improved training and marketing of products to ensure suitable solutions are chosen		
11		Deterioration in cavity forming materials Causes 1. Rain penetration / wick across cavity 2. Change in dew point position within cavity 3. Seasonal affect of cavity once filled 4. Wall tie issues 5. Pointing type	1. Damp penetration problems 2. Corrosion/ failure of structural elements from interstitial condensation	H	H	6000	RED	1. Undertake a durability assessment 2. More rigour within the survey process 3. Improved training and marketing of products to ensure suitable solutions are chosen		
12		Escape of insulant from cavity Causes Unauthorised modifications to fabric (e.g. new windows)	Reduction in energy savings, etc. Cold bridging	H	H	6000	RED	1. Undertake a durability assessment 2. More rigour within the survey process 3. Make warranty information available to future contractors		

9 CO2 Potential Savings

The potential annual savings for retrofitting hard to fill cavities in GB are estimated to be in the order of 286,000-429,000 and 1,437,000-2,156,000 tonnes CO2/year depending on the assumptions for take up rates. These take-up rates are estimated to lie between 20% and 100%. In addition, the efficacy of the fill is likely to be less than 100% and occupants are also likely to take some additional benefit through a higher temperature setting than assumed in SAP 2005. One way of accounting for this combined effect on CO2 savings in practice is through the application of CERT's derating factor as used for conventional cavities. A CERT factor of 0.50[24] was used and the annual savings estimated in the order of 719,000 and 1,078,000 tonnes CO2/year.

The savings were calculated for a range of housing types and technical options for insulation. Hard to fill cavities include: narrow, system framed, timber framed, random stone as well as rainscreen clad dwellings. In addition partial fill cavities, ones which were considered by the English House Condition Survey as having insulation but with a remaining cavity were also assessed.

In presenting the figures it is important to be aware of the limitations in precision due to the certain assumptions that have to be made and in the limitations of the assessment methodology used i.e. SAP 2005 to permit comparison with previous statistics. It is envisaged that SAP 2009, when available for regular use, will identify additional energy losses through cavity party walls, currently not assessed by SAP 2005. The potential benefit of applying party wall insulation to existing dwellings could then be quantified.

The savings are based on improving external wall U-values due to the adoption of different technical options for different types of dwellings that include: terraced, bungalow, houses, low and high rise blocks.

Determining the likely annual CO2 savings is dependent on a range of factors that include both technical and non-technical ones.

Technical factors include:

- The precision with which the population of different house types can be established
- The range of U-value improvements due to the properties of different insulation materials
- The effect of reduced impact of insulation when insulating narrower than normal cavities
- The impact of existing cold bridges
- The effect of other energy efficiency improvements already made

[24] Effectiveness of CO2 measures was calculated as = (1-0.35)*(1-0.23) = 0.65*0.77 = 0.50 per DECC Jul 2010: For the purposes of CERT, the underperformance factor is 35%, and the comfort factor, which is applied after the underperformance, is 23%; this is equivalent to a comfort factor of 15% of an uninsulated cavity wall.

Non-technical factors include:

- The level of interest of landlords/occupants to having insulation installed
- The willingness to pay the additional costs associated with access, remediation of walls for structural, water penetration or thermal reasons
- The level of applicability in practice.

The effect of these two non-technical issues is represented in the tables as derating factors of 20% and 100% to indicate the width of the spread of likely annual CO2 savings in practice.

The derating factor of 20% was based on the current low level of take-up by homeowners as experienced by the Instafibre group. This group represents the largest number of installers in the UK who carry out mineral wool installations. The data is based upon a recent analysis of its market data provided by the Instafibre group in response to our enquiries as part of the study. The analysis is described in the Appendix I.

This derating factor has been used as a proxy to estimate the likely take-up of hard to fill cavities, if they were targeted by government and associated agencies. It has been assumed that without a change in occupant behaviour that this low level will continue to apply regardless of the technical challenges or opportunities presented by different insulation systems and developments in insulation systems.

The upper figure of 100% would be dependent on the suitability of the technical solutions proposed for particular combinations of dwelling and construction types. The risks and opportunities in achieving this higher set of figures is described in detail in the risk and opportunities register that was developed at a later stage in the study with the aid of interactive workshop attended by stakeholders. From separate work carried out by Inbuilt staff, it will also be important to assess the impact on numbers that could be addressed due to risks including cold-bridges arising from any non-homogeneity of insulated cavities. These would need to be assessed on a case-by-case basis. Whilst the impact on overall energy and hence carbon savings may not necessarily be high (in the context of the medium levels of energy efficiency improvement envisioned through filling cavities and in the simplifying assumptions inherent in the SAP calculator) they may be potential sources of condensation risk to either structure or to occupants. In the former case the risk would materialise as deterioration in the structure (e.g. wood rot) or as a health risk through mould growth on internal wall surfaces. The level of additional performance required of products, professional and practical skills is described in more detail elsewhere in the study.

For the purpose of predicting the potential CO2 savings, it was necessary to establish the numbers of dwellings in Great Britain for the different building types and construction systems. Whilst data sources such as the English House Survey could potentially be extrapolated to provide figures for the whole of Great Britain, they do not have sufficiently granularity to permit the calculation of costs of additional measures over and above those expected for “standard cavities”. The additional costs would be associated with the additional works of access and other remedial works and would need to based on a meterage quantum rather than on a building unit basis as there have been relatively few “hard to fill cavity” programmes undertaken to date and therefore "average" costs mask the wide range of costs that can be expected.

To permit transfer of data between the cost study and the SAP calculations it was important to identify the dimensions of the different dwelling types. As these are not readily available, they were based on typical real dwellings from the library of surveys undertaken by Davis Langdon. Inbuilt processed these so that they were compatible with SAP data entry requirements. These "real dwellings" allowed standardised costings and CO2 emissions to be developed in a systematic manner. (For details of the dimensions used for QS purposes and SAP input data refer to Appendix D). This level of detail allowed a judgement to be made on the level of impact from the selection of different materials on the overall dwelling performance as distinct from its impact on a specific wall in isolation.

By differentiating between different configurations of dwellings (i.e. end of terrace, 2 exposed walls, 3 exposed walls) it was possible to identify the range of overall costs due to installation methods as well as due to materials. An initial analysis of the CO2 savings in GB revealed that the greatest uncertainty was due to the imprecision in numbers of dwellings constructed. Where there was confidence in the numbers e.g. system built houses (but without an allowance for demolition[25] these were factored upwards to represent the whole of Great Britain.

The baseline performance of the wall constructions being considered in this study are shown below and their U-value ranges from 0.464W/m2K to 2.457W/m2K. The value of 0.464W/m2K for partial fill assumes that it has been installed ideally i.e. retained permanently against the inner leaf of a cavity and in a continuous manner with no gaps in insulation. If the installation were poorer in practice then the predicted savings shown for retro-fitting partial fill cavities would be higher than described below.

Baseline Wall (uninsulated)	Description	U-value (calculated) W/m2K
ERCFCW0	Exposed reinforced concrete floor cavity wall	1.427
ICCW0	Internal concrete floor cavity wall	2.457
NCW0	Narrow Cavity Wall	1.037
PFCW0	Partial Fill Cavity Wall	0.464
RSCW0	Random Stone Cavity Wall	1.083
TFCW0	Timber Frame Cavity	1.129

Figure: Baseline U-values of uninsulated walls

[25] BRE Non Traditional Housing 1919-1975

The tables that follow summarise the potential savings for each of these dwelling types that are likely to have “Hard to Fill Cavities”.

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9.1.1 CO2 Savings – Terrace Dwellings

Inbuilt Ltd

Terraced Type Dwellings

Dwelling type	Category	Technical Option	Average Treated U-value (W/m²K) after insulation	kg CO_2 Saving/Year per dwelling treated	No. in the UK	Factor F1 (to allow for 20% application of technical options)	Σ CO_2 GB total (Tonnes/Year) 20% takeup Factor	Factor F2 (to allow for 100% application of technical options)	Σ CO_2 GB total (Tonnes/Year) 100% takeup Factor	Factor F3 CERT Factor	Σ CO2 GB total (Tonnes/Year) CERT-Std Cavity
Mid-terrace	Category 2/3 Narrow Cavity	NCW1	0.475	289	98400 - 147600	0.2	5700 - 8500	1	28400 - 42700	0.5	14200 - 21300
		NCW2	0.579	236	98400 - 147600	0.2	4600 - 7000	1	23200 - 34800	0.5	11600 - 17400
		NCW3	0.579	236	98400 - 147600	0.2	4600 - 7000	1	23200 - 34800	0.5	11600 - 17400
	Category 3 RC insituFrame	ICCW1	0.698	879	52800 - 79200	0.2	9300 - 13900	1	46400 - 69600	0.5	23200 - 34800
		ICCW2	0.536	963	52800 - 79200	0.2	10200 - 15300	1	50800 - 76300	0.5	25400 - 38100
	Category 3 TimberFrame	TFCW1	0.383	383	41600 - 62400	0.2	3200 - 4800	1	15900 - 23900	0.5	8000 - 11900
		TFCW2	0.383	383	41600 - 62400	0.2	3200 - 4800	1	15900 - 23900	0.5	8000 - 11900
	Category 3 Rainscreen/Cladding materials	ERCFCW1	0.418	516	39200 - 58800	0.2	4000 - 6100	1	20200 - 30300	0.5	10100 - 15200
		ERCFCW2	0.639	403	39200 - 58800	0.2	3200 - 4700	1	15800 - 23700	0.5	7900 - 11800
		ERCFCW3	0.596	425	39200 - 58800	0.2	3300 - 5000	1	16700 - 25000	0.5	8300 - 12500
	Category 3 Random Stone	RSCW1	0.739	176	40000 - 60000	0.2	1400 - 2100	1	7000 - 10600	0.5	3500 - 5300
		RSCW2	0.855	117	40000 - 60000	0.2	900 - 1400	1	4700 - 7000	0.5	2300 - 3500
		RSCW3	0.855	117	40000 - 60000	0.2	900 - 1400	1	4700 - 7000	0.5	2300 - 3500
		RSCW4	0.839	125	40000 - 60000	0.2	1000 - 1500	1	5000 - 7500	0.5	2500 - 3800
End-terrace	Category 2/3 NarrowCavity	NCW1	0.475	230	32800 - 49200	0.2	1500 - 2300	1	7500 - 11300	0.5	3800 - 5700
		NCW2	0.579	188	32800 - 49200	0.2	1200 - 1800	1	6200 - 9200	0.5	3100 - 4600
		NCW3	0.579	188	32800 - 49200	0.2	1200 - 1800	1	6200 - 9200	0.5	3100 - 4600
	Category 3 RC insituFrame	ICCW1	0.698	714	17600 - 26400	0.2	2500 - 3800	1	12600 - 18800	0.5	6300 - 9400
		ICCW2	0.536	781	17600 - 26400	0.2	2700 - 4100	1	13700 - 20600	0.5	6900 - 10300
	Category 3 TimberFrame	TFCW1	0.383	305	13600 - 20400	0.2	800 - 1200	1	4100 - 6200	0.5	2100 - 3100
		TFCW2	0.383	305	13600 - 20400	0.2	800 - 1200	1	4100 - 6200	0.5	2100 - 3100
	Category 3 Rainscreen/Cladding materials	ERCFCW1	0.418	413	12800 - 19200	0.2	1100 - 1600	1	5300 - 7900	0.5	2600 - 4000
		ERCFCW2	0.639	323	12800 - 19200	0.2	800 - 1200	1	4100 - 6200	0.5	2100 - 3100
		ERCFCW3	0.596	341	12800 - 19200	0.2	900 - 1300	1	4400 - 6500	0.5	2200 - 3300
	Category 3 Random Stone	RSCW1	0.739	141	13600 - 20400	0.2	400 - 600	1	1900 - 2900	0.5	1000 - 1400
		RSCW2	0.855	94	13600 - 20400	0.2	300 - 400	1	1300 - 1900	0.5	600 - 1000
		RSCW3	0.855	94	13600 - 20400	0.2	300 - 400	1	1300 - 1900	0.5	600 - 1000
		RSCW4	0.839	100	13600 - 20400	0.2	300 - 400	1	1400 - 2000	0.5	700 - 1000

Sub-total number of applicable terraced dwellings in GB (1000s)	900 - 1400	Total GB emissions saved due to insulating Hard to Fill cavity walls (tonnes):	70000 - 106000	Total GB emissions saved due to insulating Hard to Fill cavity walls (tonnes):	352000 - 528000	Total GB emissions saved due to insulating Hard to Fill cavity walls (tonnes):	176000 - 264000
Total number of suitable dwellings in GB (000s)	3,900 - 5,800	Total GB emissions saved due to insulating hard to fill cavity walls (tonnes):	339,000 - 509,000	Total GB emissions saved due to insulating hard to fill cavity walls (tonnes):	1,356,000 - 2,034,000	Total GB emissions saved due to insulating hard to fill cavity walls (tonnes):	678,000 - 1,017,000

Note ref Right Hand Column: "∑CO2 GB Total CERT Cavity"

These are the savings if CERT underperformance & comfort factors are applied and if 100% of potential is filled.

(100%-underperformance)*(100%-comfort) where underperformance =35% and where comfort =23% (where comfort of an insulated wall is 15%). "CERT factor" = (100%-35%)*(100%-23%) = (0.65)*(0.77) = 0.50

9.1.2 CO2 Savings – House Dwellings

Inbuilt Ltd

House Type Dwellings

Dwelling type	Category	Technical Option	Average Treated U-value (W/m²K) after insulation	kg CO_2 Saving/Year per dwelling treated	No. in the UK	Factor F1 (to allow for 20% application of technical options)	Σ CO_2 GB total (Tonnes/Year) 20% takeup Factor	Factor F2 (to allow for 100% application of technical options)	Σ CO_2 GB total (Tonnes/Year) 100% takeup Factor	Factor F3 CERT Factor	Σ CO2 GB total (Tonnes/Year) CERT-Std Cavity
Semi-detached house	Category 2/3 NarrowCavity	NCW1	0.475	230	332800 - 499200	0.2	15300 - 23000	1	76500 - 114800	0.5	38300 - 57400
		NCW2	0.579	186	332800 - 499200	0.2	12400 - 18600	1	61900 - 92900	0.5	31000 - 46400
		NCW3	0.579	186	332800 - 499200	0.2	12400 - 18600	1	61900 - 92900	0.5	31000 - 46400
	Category 3 RC insituFrame	ICCW1	0.698	N/A							
		ICCW2	0.536	N/A							
	Category 3 TimberFrame	TFCW1	0.383	306	67200 - 100800	0.2	4100 - 6200	1	20600 - 30800	0.5	10300 - 15400
		TFCW2	0.383	306	67200 - 100800	0.2	4100 - 6200	1	20600 - 30800	0.5	10300 - 15400
	Category 3 Rainscreen/Cladding materials	ERCFCW1	0.418	N/A							
		ERCFCW2	0.639	N/A							
		ERCFCW3	0.596	N/A							
	Category 3 Random Stone	RSCW1	0.739	139	69600 - 104400	0.2	1900 - 2900	1	9700 - 14500	0.5	4800 - 7300
		RSCW2	0.855	92	69600 - 104400	0.2	1300 - 1900	1	6400 - 9600	0.5	3200 - 4800
		RSCW3	0.855	92	69600 - 104400	0.2	1300 - 1900	1	6400 - 9600	0.5	3200 - 4800
		RSCW4	0.839	98	69600 - 104400	0.2	1400 - 2000	1	6800 - 10200	0.5	3400 - 5100
Detached house	Category 2/3 NarrowCavity	NCW1	0.475	453	70400 - 105600	0.2	6400 - 9600	1	31900 - 47800	0.5	15900 - 23900
		NCW2	0.579	370	70400 - 105600	0.2	5200 - 7800	1	26000 - 39100	0.5	13000 - 19500
		NCW3	0.579	370	70400 - 105600	0.2	5200 - 7800	1	26000 - 39100	0.5	13000 - 19500
	Category 3 RC insituFrame	ICCW1	0.698	N/A							
		ICCW2	0.536	N/A							
	Category 3 TimberFrame	TFCW1	0.383	600	104800 - 157200	0.2	12600 - 18900	1	62900 - 94300	0.5	31400 - 47200
		TFCW2	0.383	600	104800 - 157200	0.2	12600 - 18900	1	62900 - 94300	0.5	31400 - 47200
	Category 3 Rainscreen/Cladding materials	ERCFCW1	0.418	N/A							
		ERCFCW2	0.639	N/A							
		ERCFCW3	0.596	N/A							
	Category 3 Random Stone	RSCW1	0.739	278	40800 - 61200	0.2	2300 - 3400	1	11300 - 17000	0.5	5700 - 8500
		RSCW2	0.855	184	40800 - 61200	0.2	1500 - 2300	1	7500 - 11300	0.5	3800 - 5600
		RSCW3	0.855	184	40800 - 61200	0.2	1500 - 2300	1	7500 - 11300	0.5	3800 - 5600
		RSCW4	0.839	197	40800 - 61200	0.2	1600 - 2400	1	8000 - 12100	0.5	4000 - 6000

Sub-total number of applicable house type dwellings in GB (1000s)	1900 - 2900	Total GB emissions saved due to insulating Hard to Fill cavity walls (tonnes):	103000 - 154000	Total GB emissions saved due to insulating Hard to Fill cavity walls (tonnes):	515000 - 772000	Total GB emissions saved due to insulating Hard to Fill cavity walls (tonnes):	257000 - 386000
Total number of suitable dwellings in GB (000s)	3,900 - 5,800	Total GB emissions saved due to insulating hard to fill cavity walls (tonnes):	339,000 - 509,000	Total GB emissions saved due to insulating hard to fill cavity walls (tonnes):	1,356,000 - 2,034,000	Total GB emissions saved due to insulating hard to fill cavity walls (tonnes):	678,000 - 1,017,000

Note ref Right Hand Column: "∑CO2 GB Total CERT Cavity"

These are the savings if CERT underperformance & comfort factors are applied and if 100% of potential is filled.

(100%-underperformance)*(100%-comfort) where underperformance =35% and where comfort =23% (where comfort of an insulated wall is 15%). "CERT factor" = (100%-35%)*(100%-23%) = (0.65)*(0.77) = 0.50

9.1.3 CO2 Savings – Bungalow Dwellings

Inbuilt Ltd

Bungalow Type Dwellings

Dwelling type	Category	Technical Option	Average Treated U-value (W/m²K) after insulation	kg CO_2 Saving/Year per dwelling treated	No. in the UK	Factor F1 (to allow for 20% application of technical options)	Σ CO_2 GB total (Tonnes/Year) 20% takeup Factor	Factor F2 (to allow for 100% application of technical options)	Σ CO_2 GB total (Tonnes/Year) 100% takeup Factor	Factor F3 CERT Factor	Σ CO2 GB total (Tonnes/Year) CERT-Std Cavity
Semi-detached bungalow	Category 2/3 NarrowCavity	NCW1	0.475	230	10400 - 15600	0.2	500 - 700	1	2400 - 3600	0.5	1200 - 1800
		NCW2	0.579	186	10400 - 15600	0.2	400 - 600	1	1900 - 2900	0.5	1000 - 1500
		NCW3	0.579	186	10400 - 15600	0.2	400 - 600	1	1900 - 2900	0.5	1000 - 1500
	Category 3 RC insituFrame	ICCW1	0.698	N/A							
		ICCW2	0.536	N/A							
	Category 3 TimberFrame	TFCW1	0.383	383	13600 - 20400	0.2	1000 - 1600	1	5200 - 7800	0.5	2600 - 3900
		TFCW2	0.383	383	13600 - 20400	0.2	1000 - 1600	1	5200 - 7800	0.5	2600 - 3900
	Category 3 Rainscreen/Cladding materials	ERCFCW1	0.418	N/A							
		ERCFCW2	0.639	N/A							
		ERCFCW3	0.596	N/A							
	Category 3 Random Stone	RSCW1	0.739	176	6400 - 9600	0.2	200 - 300	1	1100 - 1700	0.5	600 - 800
		RSCW2	0.855	117	6400 - 9600	0.2	100 - 200	1	700 - 1100	0.5	400 - 600
		RSCW3	0.855	117	6400 - 9600	0.2	100 - 200	1	700 - 1100	0.5	400 - 600
		RSCW4	0.839	125	6400 - 9600	0.2	200 - 200	1	800 - 1200	0.5	400 - 600
Detached bungalow	Category 2/3 NarrowCavity	NCW1	0.475	257	48000 - 72000	0.2	2500 - 3700	1	12300 - 18500	0.5	6200 - 9300
		NCW2	0.579	209	48000 - 72000	0.2	2000 - 3000	1	10000 - 15000	0.5	5000 - 7500
		NCW3	0.579	209	48000 - 72000	0.2	2000 - 3000	1	10000 - 15000	0.5	5000 - 7500
	Category 3 RC insituFrame	ICCW1	0.698	N/A							
		ICCW2	0.536	N/A							
	Category 3 TimberFrame	TFCW1	0.383	341	60800 - 91200	0.2	4100 - 6200	1	20700 - 31100	0.5	10400 - 15500
		TFCW2	0.383	341	60800 - 91200	0.2	4100 - 6200	1	20700 - 31100	0.5	10400 - 15500
	Category 3 Rainscreen/Cladding materials	ERCFCW1	0.418	N/A	0 - 0						
		ERCFCW2	0.639	N/A	0 - 0						
		ERCFCW3	0.596	N/A	0 - 0						
	Category 3 Random Stone	RSCW1	0.739	156	29600 - 44400	0.2	900 - 1400	1	4600 - 6900	0.5	2300 - 3500
		RSCW2	0.855	103	29600 - 44400	0.2	600 - 900	1	3000 - 4600	0.5	1500 - 2300
		RSCW3	0.855	103	29600 - 44400	0.2	600 - 900	1	3000 - 4600	0.5	1500 - 2300
		RSCW4	0.839	111	29600 - 44400	0.2	700 - 1000	1	3300 - 4900	0.5	1600 - 2500

Sub-total number of applicable bungalow type dwellings in GB (1000s)	400 - 700	Total GB emissions saved due to insulating Hard to Fill cavity walls (tonnes):	22000 - 32000	Total GB emissions saved due to insulating Hard to Fill cavity walls (tonnes):	108000 - 162000	Total GB emissions saved due to insulating Hard to Fill cavity walls (tonnes):	54000 - 81000
Total number of suitable dwellings in GB (000s)	3,900 - 5,800	Total GB emissions saved due to insulating hard to fill cavity walls (tonnes):	339,000 - 509,000	Total GB emissions saved due to insulating hard to fill cavity walls (tonnes):	1,356,000 - 2,034,000	Total GB emissions saved due to insulating hard to fill cavity walls (tonnes):	678,000 - 1,017,000

Note ref Right Hand Column: "∑CO2 GB Total CERT Cavity"

These are the savings if CERT underperformance & comfort factors are applied and if 100% of potential is filled.

(100%-underperformance)*(100%-comfort) where underperformance =35% and where comfort =23% (where comfort of an insulated wall is 15%). "CERT factor" = (100%-35%)*(100%-23%) = (0.65)*(0.77) = 0.50

9.1.4 CO2 Savings – Low Rise- Flat Dwellings

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Low Rise Type Dwellings

Dwelling type	Category	Technical Option	Average Treated U-value (W/m²K) after insulation	kg CO_2 Saving/Year per dwelling treated	No. in the UK	Factor F1 (to allow for 20% application of technical options)	Σ CO_2 GB total (Tonnes/Year) 20% takeup Factor	Factor F2 (to allow for 100% application of technical options)	Σ CO_2 GB total (Tonnes/Year) 100% takeup Factor	Factor F3 CERT Factor	Σ CO2 GB total (Tonnes/Year) CERT-Std Cavity
Low Rise Flat with 2 external walls	Category 2/3 NarrowCavity	NCW1	0.475	285	12800 - 19200	0.2	700 - 1100	1	3600 - 5500	0.5	1800 - 2700
		NCW2	0.579	230	12800 - 19200	0.2	600 - 900	1	2900 - 4400	0.5	1500 - 2200
		NCW3	0.579	230	12800 - 19200	0.2	600 - 900	1	2900 - 4400	0.5	1500 - 2200
	Category 3 RC insituFrame	ICCW1	0.698	844	42400 - 63600	0.2	7200 - 10700	1	35800 - 53700	0.5	17900 - 26800
		ICCW2	0.536	927	42400 - 63600	0.2	7900 - 11800	1	39300 - 59000	0.5	19700 - 29500
	Category 3 TimberFrame	TFCW1	0.383	379	23200 - 34800	0.2	1800 - 2600	1	8800 - 13200	0.5	4400 - 6600
		TFCW2	0.383	379	23200 - 34800	0.2	1800 - 2600	1	8800 - 13200	0.5	4400 - 6600
	Category 3 Rainscreen/Cladding materials	ERCFCW1	0.418	503	31200 - 46800	0.2	3100 - 4700	1	15700 - 23500	0.5	7800 - 11800
		ERCFCW2	0.639	391	31200 - 46800	0.2	2400 - 3700	1	12200 - 18300	0.5	6100 - 9100
		ERCFCW3	0.596	414	31200 - 46800	0.2	2600 - 3900	1	12900 - 19400	0.5	6500 - 9700
	Category 3 Random Stone	RSCW1	0.739	N/A							
		RSCW2	0.855	N/A							
		RSCW3	0.855	N/A							
		RSCW4	0.839	N/A							
Low Rise Flat with 3 external walls	Category 2/3 NarrowCavity	NCW1	0.475	268	12800 - 19200	0.2	700 - 1000	1	3400 - 5100	0.5	1700 - 2600
		NCW2	0.579	217	12800 - 19200	0.2	600 - 800	1	2800 - 4200	0.5	1400 - 2100
		NCW3	0.579	217	12800 - 19200	0.2	600 - 800	1	2800 - 4200	0.5	1400 - 2100
	Category 3 RC insituFrame	ICCW1	0.698	779	42400 - 63600	0.2	6600 - 9900	1	33000 - 49500	0.5	16500 - 24800
		ICCW2	0.536	857	42400 - 63600	0.2	7300 - 10900	1	36300 - 54500	0.5	18200 - 27300
	Category 3 TimberFrame	TFCW1	0.383	356	23200 - 34800	0.2	1700 - 2500	1	8300 - 12400	0.5	4100 - 6200
		TFCW2	0.383	356	23200 - 34800	0.2	1700 - 2500	1	8300 - 12400	0.5	4100 - 6200
	Category 3 Rainscreen/Cladding materials	ERCFCW1	0.418	474	31200 - 46800	0.2	3000 - 4400	1	14800 - 22200	0.5	7400 - 11100
		ERCFCW2	0.639	367	31200 - 46800	0.2	2300 - 3400	1	11500 - 17200	0.5	5700 - 8600
		ERCFCW3	0.596	387	31200 - 46800	0.2	2400 - 3600	1	12100 - 18100	0.5	6000 - 9100
	Category 3 Random Stone	RSCW1	0.739	N/A							
		RSCW2	0.855	N/A							
		RSCW3	0.855	N/A							
		RSCW4	0.839	N/A							

Sub-total number of applicable low rise dwellings in GB (1000s)	500 - 800	Total GB emissions saved due to insulating Hard to Fill cavity walls (tonnes):	55000 - 83000	Total GB emissions saved due to insulating Hard to Fill cavity walls (tonnes):	276000 - 414000	Total GB emissions saved due to insulating Hard to Fill cavity walls (tonnes):	138000 - 207000
Total number of suitable dwellings in GB (000s)	3,900 - 5,800	Total GB emissions saved due to insulating hard to fill cavity walls (tonnes):	339,000 - 509,000	Total GB emissions saved due to insulating hard to fill cavity walls (tonnes):	1,356,000 - 2,034,000	Total GB emissions saved due to insulating hard to fill cavity walls (tonnes):	678,000 - 1,017,000

Note ref Right Hand Column: "∑CO2 GB Total CERT Cavity"

These are the savings if CERT underperformance & comfort factors are applied and if 100% of potential is filled.

(100%-underperformance)*(100%-comfort) where underperformance =35% and where comfort =23% (where comfort of an insulated wall is 15%). "CERT factor" = (100%-35%)*(100%-23%) = (0.65)*(0.77) = 0.50

9.1.5 CO2 Savings – High Rise Dwellings

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High Rise Dwellings

Dwelling type	Category	Technical Option	Average Treated U-value (W/m²K) after insulation	kg CO_2 Saving/Year per dwelling treated	No. in the UK	Factor F1 (to allow for 20% application of technical options)	Σ CO_2 GB total (Tonnes/Year) 20% takeup Factor	Factor F2 (to allow for 100% application of technical options)	Σ CO_2 GB total (Tonnes/Year) 100% takeup Factor	Factor F3 CERT Factor	Σ CO2 GB total (Tonnes/Year) CERT-Std Cavity
High Rise Flat with 2 external walls	Category 2/3 NarrowCavity	NCW1	0.475	492	0 - 0	0.2	0 - 0	1	0 - 0	0.5	0 - 0
		NCW2	0.579	399	0 - 0	0.2	0 - 0	1	0 - 0	0.5	0 - 0
		NCW3	0.579	399	0 - 0	0.2	0 - 0	1	0 - 0	0.5	0 - 0
	Category 3 RC insituFrame	ICCW1	0.698	1390	11200 - 16800	0.2	3100 - 4700	1	15600 - 23400	0.5	7800 - 11700
		ICCW2	0.536	1534	11200 - 16800	0.2	3400 - 5200	1	17200 - 25800	0.5	8600 - 12900
	Category 3 TimberFrame	TFCW1	0.383	N/A							
		TFCW2	0.383	N/A							
	Category 3 Rainscreen/Cladding materials	ERCFCW1	0.418	866	8000 - 12000	0.2	1400 - 2100	1	6900 - 10400	0.5	3500 - 5200
		ERCFCW2	0.639	667	8000 - 12000	0.2	1100 - 1600	1	5300 - 8000	0.5	2700 - 4000
		ERCFCW3	0.596	706	8000 - 12000	0.2	1100 - 1700	1	5600 - 8500	0.5	2800 - 4200
	Category 3 Random Stone	RSCW1	0.739	N/A							
		RSCW2	0.855	N/A							
		RSCW3	0.855	N/A							
		RSCW4	0.839	N/A							
High Rise Flat with 3 external walls	Category 2/3 NarrowCavity	NCW1	0.475	491	0 - 0	0.2	0 - 0	1	0 - 0	0.5	0 - 0
		NCW2	0.579	400	0 - 0	0.2	0 - 0	1	0 - 0	0.5	0 - 0
		NCW3	0.579	400	0 - 0	0.2	0 - 0	1	0 - 0	0.5	0 - 0
	Category 3 RC insituFrame	ICCW1	0.698	1533	11200 - 16800	0.2	3400 - 5200	1	17200 - 25800	0.5	8600 - 12900
		ICCW2	0.536	1676	11200 - 16800	0.2	3800 - 5600	1	18800 - 28200	0.5	9400 - 14100
	Category 3 TimberFrame	TFCW1	0.383	N/A							
		TFCW2	0.383	N/A							
	Category 3 Rainscreen/Cladding materials	ERCFCW1	0.418	881	8000 - 12000	0.2	1400 - 2100	1	7000 - 10600	0.5	3500 - 5300
		ERCFCW2	0.639	687	8000 - 12000	0.2	1100 - 1600	1	5500 - 8200	0.5	2700 - 4100
		ERCFCW3	0.596	725	8000 - 12000	0.2	1200 - 1700	1	5800 - 8700	0.5	2900 - 4400
	Category 3 Random Stone	RSCW1	0.739	N/A							
		RSCW2	0.855	N/A							
		RSCW3	0.855	N/A							
		RSCW4	0.839	N/A							

Sub-total number of applicable high rise dwellings in GB (1000s)	90 - 140	Total GB emissions saved due to insulating Hard to Fill cavity walls (tonnes):	21000 - 31000	Total GB emissions saved due to insulating Hard to Fill cavity walls (tonnes):	105000 - 157000	Total GB emissions saved due to insulating Hard to Fill cavity walls (tonnes):	52000 - 79000
Total number of suitable dwellings in GB (000s)	3,900 - 5,800	Total GB emissions saved due to insulating hard to fill cavity walls (tonnes):	339,000 - 509,000	Total GB emissions saved due to insulating hard to fill cavity walls (tonnes):	1,356,000 - 2,034,000	Total GB emissions saved due to insulating hard to fill cavity walls (tonnes):	678,000 - 1,017,000

Note ref Right Hand Column: "∑CO2 GB Total CERT Cavity"

These are the savings if CERT underperformance & comfort factors are applied and if 100% of potential is filled.

(100%-underperformance)*(100%-comfort) where underperformance =35% and where comfort =23% (where comfort of an insulated wall is 15%). "CERT factor" = (100%-35%)*(100%-23%) = (0.65)*(0.77) = 0.50

9.1.6 CO2 Savings – Partial Fill Walls

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Partial Fill Cavity Dwellings

Dwelling type	Category	Technical Option	Average Treated U-value (W/m²K) after insulation	kg CO_2 Saving/Year per dwelling treated	No. in the UK	Factor F1 (to allow for 20% application of technical options)	Σ CO_2 GB total (Tonnes/Year) 20% takeup Factor	Factor F2 (to allow for 100% application of technical options)	Σ CO_2 GB total (Tonnes/Year) 100% takeup Factor	Factor F3 CERT Factor	Σ CO2 GB total (Tonnes/Year) CERT-Std Cavity
Mid Terrace	Category 1/2 Partial Fill/cavity obstructions	PFCW1	0.373	47	67200 - 100800	0.2	600 - 900	1	3200 - 4700	0.5	1600 - 2400
		PFCW2	0.318	75	67200 - 100800	0.2	1000 - 1500	1	5000 - 7600	0.5	2500 - 3800
		PFCW3	0.36	53	67200 - 100800	0.2	700 - 1100	1	3600 - 5300	0.5	1800 - 2700
End Terrace	Category 1/2 Partial Fill/cavity obstructions	PFCW1	0.373	36	22400 - 33600	0.2	200 - 200	1	800 - 1200	0.5	400 - 600
		PFCW2	0.318	58	22400 - 33600	0.2	300 - 400	1	1300 - 1900	0.5	600 - 1000
		PFCW3	0.36	42	22400 - 33600	0.2	200 - 300	1	900 - 1400	0.5	500 - 700
Semi-Detached Bungalow	Category 1/2 Partial Fill/cavity obstructions	PFCW1	0.373	39	19200 - 28800	0.2	100 - 200	1	700 - 1100	0.5	400 - 600
		PFCW2	0.318	62	19200 - 28800	0.2	200 - 400	1	1200 - 1800	0.5	600 - 900
		PFCW3	0.318	62	19200 - 28800	0.2	200 - 400	1	1200 - 1800	0.5	600 - 900
Detached Bungalow	Category 1/2 Partial Fill/cavity obstructions	PFCW1	0.373	39	29600 - 44400	0.2	200 - 300	1	1200 - 1700	0.5	600 - 900
		PFCW2	0.318	62	29600 - 44400	0.2	400 - 600	1	1800 - 2800	0.5	900 - 1400
		PFCW3	0.318	62	29600 - 44400	0.2	400 - 600	1	1800 - 2800	0.5	900 - 1400
Semi-Detached House	Category 1/2 Partial Fill/cavity obstructions	PFCW1	0.373	39	99200 - 148800	0.2	800 - 1200	1	3900 - 5800	0.5	1900 - 2900
		PFCW2	0.318	62	99200 - 148800	0.2	1200 - 1800	1	6200 - 9200	0.5	3100 - 4600
		PFCW3	0.36	44	99200 - 148800	0.2	900 - 1300	1	4400 - 6500	0.5	2200 - 3300
Detached House	Category 1/2 Partial Fill/cavity obstructions	PFCW1	0.373	72	213600 - 320400	0.2	3100 - 4600	1	15400 - 23100	0.5	7700 - 11500
		PFCW2	0.318	116	213600 - 320400	0.2	5000 - 7400	1	24800 - 37200	0.5	12400 - 18600
		PFCW3	0.36	83	213600 - 320400	0.2	3500 - 5300	1	17700 - 26600	0.5	8900 - 13300
Low Rise Flat with 2 external walls	Category 1/2 Partial Fill/cavity obstructions	PFCW1	0.373	48	38400 - 57600	0.2	400 - 600	1	1800 - 2800	0.5	900 - 1400
		PFCW3	0.36	55	38400 - 57600	0.2	400 - 600	1	2100 - 3200	0.5	1100 - 1600
		PFCW2	0.318	77	38400 - 57600	0.2	600 - 900	1	3000 - 4400	0.5	1500 - 2200
Low Rise Flat with 3 external walls	Category 1/2 Partial Fill/cavity obstructions	PFCW1	0.373	44	38400 - 57600	0.2	300 - 500	1	1700 - 2500	0.5	800 - 1300
		PFCW3	0.36	51	38400 - 57600	0.2	400 - 600	1	2000 - 2900	0.5	1000 - 1500
		PFCW2	0.318	71	38400 - 57600	0.2	500 - 800	1	2700 - 4100	0.5	1400 - 2000
High Rise Flat with 2 external walls	Category 1/2 Partial Fill/cavity obstructions	PFCW1	0.373	83	800 - 1200	0.2	10 - 20	1	70 - 100	0.5	30 - 50
		PFCW3	0.36	95	800 - 1200	0.2	20 - 20	1	80 - 110	0.5	40 - 60
		PFCW2	0.318	134	800 - 1200	0.2	20 - 30	1	110 - 160	0.5	50 - 80
High Rise Flat with 3 external walls	Category 1/2 Partial Fill/cavity obstructions	PFCW1	0.373	79	800 - 1200	0.2	10 - 20	1	60 - 90	0.5	30 - 50
		PFCW3	0.36	91	800 - 1200	0.2	10 - 20	1	70 - 110	0.5	40 - 50
		PFCW2	0.318	128	800 - 1200	0.2	20 - 30	1	100 - 150	0.5	50 - 80

Sub-total number of partial cavity type dwellings in GB (1000s)	1600 - 2400	Total GB emissions saved due to insulating hard to fill cavity walls (tonnes):	22000 - 33000	Total GB emissions saved due to insulating hard to fill cavity walls (tonnes):	109000 - 163000	Total GB emissions saved due to insulating hard to fill cavity walls (tonnes):	54000 - 82000
Total number of suitable dwellings in GB (000s)	1.6 - 2.4	Total GB emissions saved due to insulating hard to fill cavity walls (tonnes):	22,000 - 33,000	Total GB emissions saved due to insulating hard to fill cavity walls (tonnes):	109,000 - 163,000	Total GB emissions saved due to insulating hard to fill cavity walls (tonnes):	54,000 - 82,000

Note ref Right Hand Column: "∑CO2 GB Total CERT Cavity"

These are the savings if CERT underperformance & comfort factors are applied and if 100% of potential is filled.

(100%-underperformance)*(100%-comfort) where underperformance =35% and where comfort =23% (where comfort of an insulated wall is 15%). "CERT factor" = (100%-35%)*(100%-23%) = (0.65)*(0.77) = 0.50

10 Indicative Costs of Hard to Fill Cavities

10.1 Cavity wall insulation costs for key dwelling types

The currently available cavity wall insulation (CWI) methods are reviewed in detail in section 7 of the report. These details, together with indicative costs (per square metre of cavity wall area) are summarised in section 12 (Appendix B – Technical Solutions), together with illustrations of typical installations.

Cost models have been developed for the main dwelling types covered in this study. These are based on the quantity data for each dwelling type in section 13 (Appendix C). Costs are estimated using indicative rates (per square metre of cavity wall area) for different CWI methods obtained from market testing undertaken with a sample of typical CWI companies in England during the early summer of 2010. Allowances are included for normal work associated with clearing the existing cavity of debris and for normal „making good' of the external or internal leaf, depending on the method of installation. Costs are therefore specific to the dwelling characteristics identified as typical for dwellings in each category.

The table below summarises indicative costs for the main dwelling types as follows:

Dwelling type	**Sub-type** (see section 13 – Appendix C)	**Typical CWI cost** **£ per dwelling**
Houses (semi and detached)	Semi: 2 storeys	£600-690
	Semi: 2 storeys (random stone)	£1130-5000*
	Detached: 2 storeys	£1340-1520
Houses (Terraced)	Mid terrace: 2 storeys	£1130-1230
	End terrace: 2 storeys	£1110-1200
Bungalows	Semi: 1 storey	£460-490
	Detached: 1 storey (+ side garage)	£670-725
Low rise flats	With 2 external walls	£490-530
	With 3 external walls	£630-720
High rise flats	With 1external wall	£250-1220*
	With 3 external walls	£260-1260

* High maxima are due to the expected use of relatively more expensive materials in these installations

The range of typical CWI costs is relatively narrow and covers three main insulation types: gravity fed beads, blown mineral wool and injected beads (see section 7). Costs per square metre of wall area for these three types generally vary by no more than +/- 10%. The exception is PUR Foam which costs more per square metre of wall area – we have included PUR costs in the random stone and high rise flat dwellings to indicate the potentially relatively high costs of filling cavities in these dwelling types.

The above costs exclude extraordinary items such as difficult access and other abnormal items (see further below), as well as any grant provision and VAT charges.

10.2 Indicative costs of filling Hard to Fill cavities in Great Britain

Data currently available on the stock of dwellings in Great Britain suggest that between 3.9 million and 5.8 million are constructed with „hard to fill' external wall cavities. A further 1.6 million to 2.4 million dwellings are constructed with cavity walls that have been partially filled – these latter dwellings tend to be included as having filled wall cavities in the English House Survey.

The estimated costs of filling both categories of wall cavities at current (mid 2010) prices are as follows:

	Dwellings	**20% uptake**	**100% uptake***
	No.	**£m**	**£m**
Hard to Fill	**3.9-5.8m**	**£1,103-1,660**	**£5,530-8,300**
Of which:			
Houses (semi and detached)	1.9-2.9m	£550-830	£2,760-4,145
Houses (Terraced)	0.9-1.4m	£305-455	£1,520-2,280
Bungalows	0.4-0.7m	£105-145	£515-725
Low rise flats	0.5-0.8	£125-200	£620-985
High rise flats	0.09-0.14m	£25-35	£110-175
Partial Fill	**1.6-2.4m**	**£450-680**	**£2,265-3,400**

All totals do not sum precisely due to rounding

* Full (i.e. 100% take up) is not practically possible – for example, some dwellings are in exposed locations that make them unsuited to retrofitted cavity wall fill; others, because of their built form and construction technology, pose particular access and technical difficulties.

These costs are based on average CWI costs per dwelling type (see above) and are „broad brush', relying heavily on a range of assumptions covering how the work will be procured, the condition and location of the affected housing stock, the extent of ancillary work required in particular circumstances, and other matters. The following paragraphs summarise the key elements of our costing approach.

A simplified cost model has been constructed for this analysis, based on a series of cost models for each dwelling type as well as the analysis of market size in sections 4 and 9 of the report. The essentials of the costing approach are to „factor' cavity wall installation costs (per dwelling) by the number of affected dwellings in each category. Where alternative installation methods are available for a given dwelling type, we have assumed the lowest cost method would be used. However, as noted, the cost differential between the main methods (with the exception of PUR Foam) is not great. We have made allowances, based on experience, for some of the complexities that might be encountered during installation, in particular:

- Access difficulties – mainly involving Abseil Access, Gondola or other provision for access to high rise properties, and scaffolding for low rise up to 5 storeys (see Section 17)
- Building condition, in particular, the condition of the cavity, whether excessive debris removal is required, together with the removal of existing (partial fill) insulation if considered defective; whether the damp proof course (dpc) requires repair or reinstatement, etc
- Work to „make good' building elements affected by the installation, in particular whether re-render of the external leaf is required; whether internal redecoration and other work (for example, removal and reinstatement of kitchen units, central heating installations, etc)

Of course, our assumptions regarding these complexities are subject to considerable uncertainty. In particular, the model is highly sensitive to assumptions about access difficulties and associated costs as well as the condition of the existing cavities and buildings. While the costs derived from the model are broadly indicative at the national (GB) level, they cannot be expected to apply at the local authority or estate level where more specific considerations will tend to predominate. The greatest uncertainties are around the extent and condition of the stock of different types of dwellings with hard to fill cavities. A more thorough study – involving the development of a detailed stock model, which is outside the scope of the present study – would be required to test and refine the assumptions in the model and to develop a more accurate basis for assessing related costs. We understand that a more detailed study has recently been launched by the Energy Technology Institute to predict the distribution of costs associated with undertaking the works to upgrade UK housing stock on different scales across the UK. The context being the achievement of an 80% CO_2 saving with wall insulation, new technologies and skills. Results are expected to be available in 2012."

As noted, costs per dwelling are based on typical installer's charges to householders. Simply aggregating these across the stock does not provide a very reliable estimate, mainly because work to those properties under landlord control (either public or private) would be procured in greater bulk with the unit cost falling in line with procurement volume. However, as contracts for greater numbers of dwelling units increase in size, additional management and other costs tend to reduce anticipated economies of scale – these are difficult to assess without some prior knowledge of contract size (including details of the dwelling types included), timing, etc. We have made some initial assessments of likely volume adjustments, though again these are subject to significant uncertainties.

Finally, we have made no allowance in our cost estimates for inflation over the period of a national insulation programme. Generally, the cavity wall insulation industry is characterised by SMEs geared primarily to undertake small to medium scale contracts directly for a building owner. Clearly the industry structure would need to change to deliver a programme of several million installations, even over the short to medium term. But of course it is not at all clear how such a programme might be taken to market (if at all in any nationally co-ordinated manner). Nonetheless, at anything like current rates of cavity filling (section 3.1) it will take several years to complete a national programme on a stock of some 4-6 million dwellings.

Allowances for VAT and any grants/subsidies are also excluded from our estimates.

11 Summary

There is potentially in the region of 359,000 to 1,078,000[26] tonnes of CO_2 annual savings available in addressing the hard to fill cavities in Great Britain. There is an untapped market ready to be addressed but with attendant risks. Risks to the dwelling owner include taking on board liabilities directly where these are not covered by buildings insurance or warranties etc

Between 3.9m and 5.8m existing houses could potentially benefit from having the hard to fill cavities, filled. The majority of houses can potentially be filled using techniques that exist or that are currently considered to be innovative. It is believed a minority of those conventional cavities, currently left uninsulated, could be insulated conventionally if existing CERT funding criteria were widened to permit the side walls of houses (that fall under the 75% accessible criterion) to be eligible.

In addition, there are 1.6m to 2.4m cavities that are considered by the English Housing Survey as being filled but that have a remaining cavity that could potentially be filled. Filling such “partial cavities” could provide potential savings in the range of 22,000 to 82,000[27] tonnes of CO_2 annual savings. The potential savings may be greater if, as reported anecdotally, the insulation batts were held poorly against the inner leaf of the wall, so permitting heat losses through air currents between the batts and the inner leaf.

A perceived lack of benefit by individual members of the public hampers the uptake of such measures, potentially mitigated through having guaranteed performance benefits.

Technologies are mature and further innovative technologies are slowly emerging that will be useful to overcome the complex treatment issues hard to fill wall cavities.

The processes of surveying, design, remediation, installation need to be formalised and quality assured to ensure good practice. The technical design to potentially include cold bridge analysis, thermo graphic inspections post construction and modelling the risk of condensation due to different occupancy patterns and different lifestyles e.g. low, medium and high water vapour generation levels.

To date, opportunities have been missed because they are more expensive than the cost of dealing with standard cavities and through a lack of financial support e.g. windows replaced with double glazing and requiring scaffolding but walls left un-insulated.

There are an unknown number of cavities in commercial buildings that represents an additional, potentially sizeable, hard-to-fill cavity wall market.

In summary, full cavity fill insulation is usually the most cost effective option where the cavity wall is confirmed as being in good overall condition, where the local exposure factors confirm its suitability for use and where external or internal access is not highly costly or otherwise problematic. In instances where the existing wall finish or cladding is life expired or in need of major refurbishment on a highly exposed site where an appearance change can be

[26] CERT underperformance and comfort factors applied and 100% of potential population is filled

[27] CERT underperformance and comfort factors applied and 100% of potential population is filled

tolerated, external wall insulation should be considered. In the case of a building where there are complications affecting the condition of the cavity wall on a site too exposed for cavity fill insulation where an appearance change cannot be tolerated, internal insulated dry lining should be considered with the Thermo-Foil type variant minimising the loss of room volume.

12 Appendix A: Case Studies of Hard to Fill Cavity Wall Types

12.1 Case Study – Low Rise, Variable Cavity

12.1.1 City of Edinburgh District Council – Non traditional 3-storey housing

Construction: Non- traditional housing built in 1940's and 1950's with cavity widths varying by up to 171mm comprising houses and three-storey blocks

Issues: Poor insulation, some condensation problems and potential structural problems caused by water ingress resulting in carbonation and corrosion of reinforcement.

Technology/Innovation: Polyurethane foam insulation was installed in the cavities to improve energy efficiency. The condensation caused by the cold walls was eliminated and as moisture penetration was prevented, the structure was stabilised from further deterioration.

Insurance: Unknown at this time

12.2 Case Study - High Rise Dwellings

12.2.1 City of Edinburgh District Council – Kirkgate House, Leith

Construction: Concrete formwork with brick outer skin in a high rise block.

Issues: Problems of wall tie deterioration & water penetration.

Requirement: Tenants to remain in residence. To avoid the cost of overcladding.

Technology/Innovation: A polyurethane insulation and stabilisation foam was installed (Isothane) bonding the inner and outer leaves together. Constructional air leakage was improved.

Insurance: Unknown at this time

12.2.2 LB Camden – Laystall Court, London

Construction: Concrete formwork with brick outer leaf.

Issue: Costs of access to 10 storey block of flats and consistency of fill

Requirement: Cavity fill in preference to overcladding

Technology/Innovation: A novel access solution was developed by LB Camden utilising an abseiling company instead of conventional scaffolding provide an estimated saving in costs of 40%. Additional savings are likely both in time and costs due to the avoidance of the need for “s20” consultation with tenants. Bead insulation (Polybead) was blown in. Thermal analysis was undertaken.

Insurance: Unknown at this time

12.3 Case Study – Steel Framed House, System build, Exposed Site

12.3.1 Semi-detached house, Tarrant Way, Moulton, Northampton

Construction: System Built Steel Frame Cavities

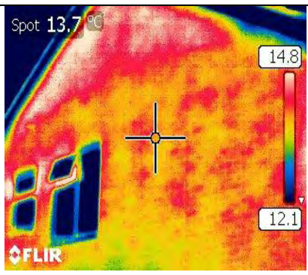
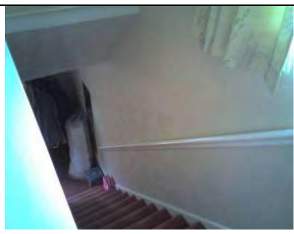
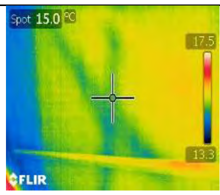
Issue: Saleability of house insulated in 1980's – close to end of 30 year guarantee and originally a "Hard to Fill" type cavity. North-easterly facing wall subject to driving rain/wind

Requirement: Survey confirming that there was no deterioration of steel frame structure or in the insulation -

Technology/Innovation: A thermal camera inspection with boroscope inspection revealed that the walls were fully insulated with the exception of an area identified by thermograph. The Rockwool had caught on a horizontal steel section that resulted in part fill below. Inadvertent sealing of wall vents during original construction may have contributed to a reduction in uncontrolled ventilation in the cavity (located in an exposed location – wind and driving rain) potentially contributing to its longevity with a lack of dampness measured on internal walls and within insulation, otherwise expected from analysis of thermograph.

Insurance: Unknown at this time

The following Thermo grams and photographs show the property to be fully insulated with the exception of one area highlighted below.

			
Steel frame construction of the side elevation wall evident by inspection from inside roof	Thermograph showing heat loss (red) through single brick wall	View down the staircase clearly shows the vertical and horizontal steel frame. Internal surfaces measured dry. Insulation also dry.	Cold steel can be identified clearly (green) with the thermal camera. I metre horizontal spacing

.

12.4 Case Study - Concrete Cavity

12.4.1 Rochdale Borough Council – 3 blocks of Hi-Rise Flats at College Bank Flats, Rochdale

Construction: Reinforced concrete[28], external brick leaf.

Issue: Narrow cavities

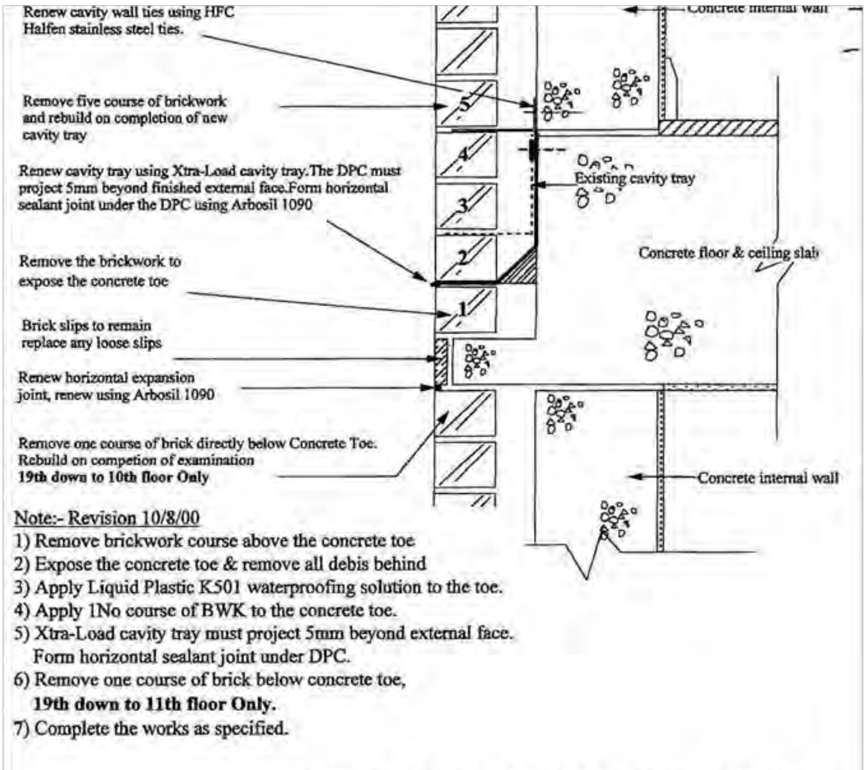
Requirement: To ensure continuity of insulation during works by piloting an insulation system on 3 tower blocks in a planned upgrade of 7 no tower blocks

Technology/Innovation: Thermographic survey before and after works. Injection with polyurethane PUR rigid foam.

Insurance: Unknown at this time

The following are extracts from the thermographic survey undertaken by IRT Surveys:

“IRT Surveys conducted a thermographic survey of 3 blocks at the College Bank flats, Rochdale. The survey was carried out on 9th April 2010. The purpose of the survey was to assess the blocks with regards to continuity of insulation and heat loss. Two Blocks had a Technitherm® injected polyurethane PUR rigid foam cavity wall thermal insulation and stabilisation system, one block remained as built. The internal wall is cast concrete with external leaf in brickwork, seen diagram below:



SECTION THROUGH EXTERNAL WALL

[28] Wendy Stewart, 26/05/10 Rochdale Boroughwide Housing

At the time of the survey the weather conditions were clear. The thermographic survey commenced at 6:00a.m. Average ambient outside temperature was 5˚C. The building was warm with internal temperatures of approximately 21˚C, giving a differential of 16˚C. Temperatures have been assumed to be constant throughout the survey.

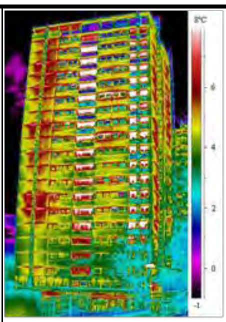
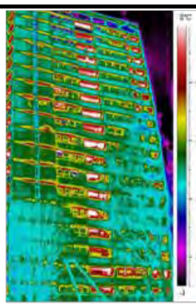
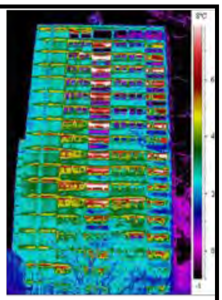
The following report contains several colour infrared images which can be difficult to understand. The equipment we use sees heat instead of light and automatically allocates various colours to different temperatures. For example red is hot and blue is cold. The hottest colour being white the coldest being black. There are several factors that can lead to miss-interpretation of a thermal image. Different materials reflect energy in different ways, such as glass or highly polished metals. Where there are materials like glass, the information recorded must be ignored, as it is not an accurate temperature. A well insulated roof or building in good condition should show consistent temperatures and colours across its surface.

Terms of Reference

This investigation involved the use of non-destructive methods and therefore the majority of the findings presented within this report are the result of the measurement and interpretation of electromagnetic signals. This report represents the best professional opinion of the authors. Every effort has been made .... Factors such as heat sources, surface staining and reflections will have been considered during analysis and although they may not be listed there is always a possibility that these factors have influenced the results.

Summary

Thermal analysis of the uninsulated block 1, Town Mill Brow, revealed inconsistent warmer red and yellow colours across the elevations, indicating areas of heat loss from the building. The Insulated blocks 2 & 3, Tentercroft and Dunkirk Rise, showed a better thermal performance, with cooler blue and green colours across the elevations, indicating lower levels of heat loss. The average temperature of block 1 is 5°C the average of blocks 2 & 3 is 2.6°C. This is a significant difference. Close up images were also taken of the 4th floor flats on the blocks Town Mill Brow and Tentercroft. .... it can be seen that increased temperatures are seen across Town Mill Brow in comparison to Tentercroft. Warmer red colours can be seen extending across the elevations on all 3 blocks at floor levels. This is due to thermal bridging and can be ignored.”

					
Uninsulated: Town Mill Brow	Uninsulated: Town Mill Brow Thermograph	Insulated (1) Tentercroft,	Insulated (1) Tentercroft, Thermograph	Insulated (2) Dunkirk Rise	Insulated (2) Dunkirk Rise, Thermograph

12.5 Case Study -Timber Frame Cavity

Note: No case studies could be identified at the time of the study and the EST Guide to Refurbishment illustrates this pictorially but without constructed images[29]. References to constructions quoted in publications as being timber frame were subsequently found upon investigation to have been of concrete. Trade contacts were unable to locate example of filled hard to fill cavities. Other contacts were aware of such cavities filled inadvertently.[30]

[29] EST 8 June 2010 – See also

http://server-uk.imrworldwide.com/cgi-bin/b?cg=uk_energyst_bestpracticedocs&ci=energyst&tu=http://www.energysavingtrust.org.uk/business/content/download/1033344/3426710/version/1/file/refurb_final_web.pdf

[30] AECB 26 April 2010

13 Appendix B: Technical Solutions

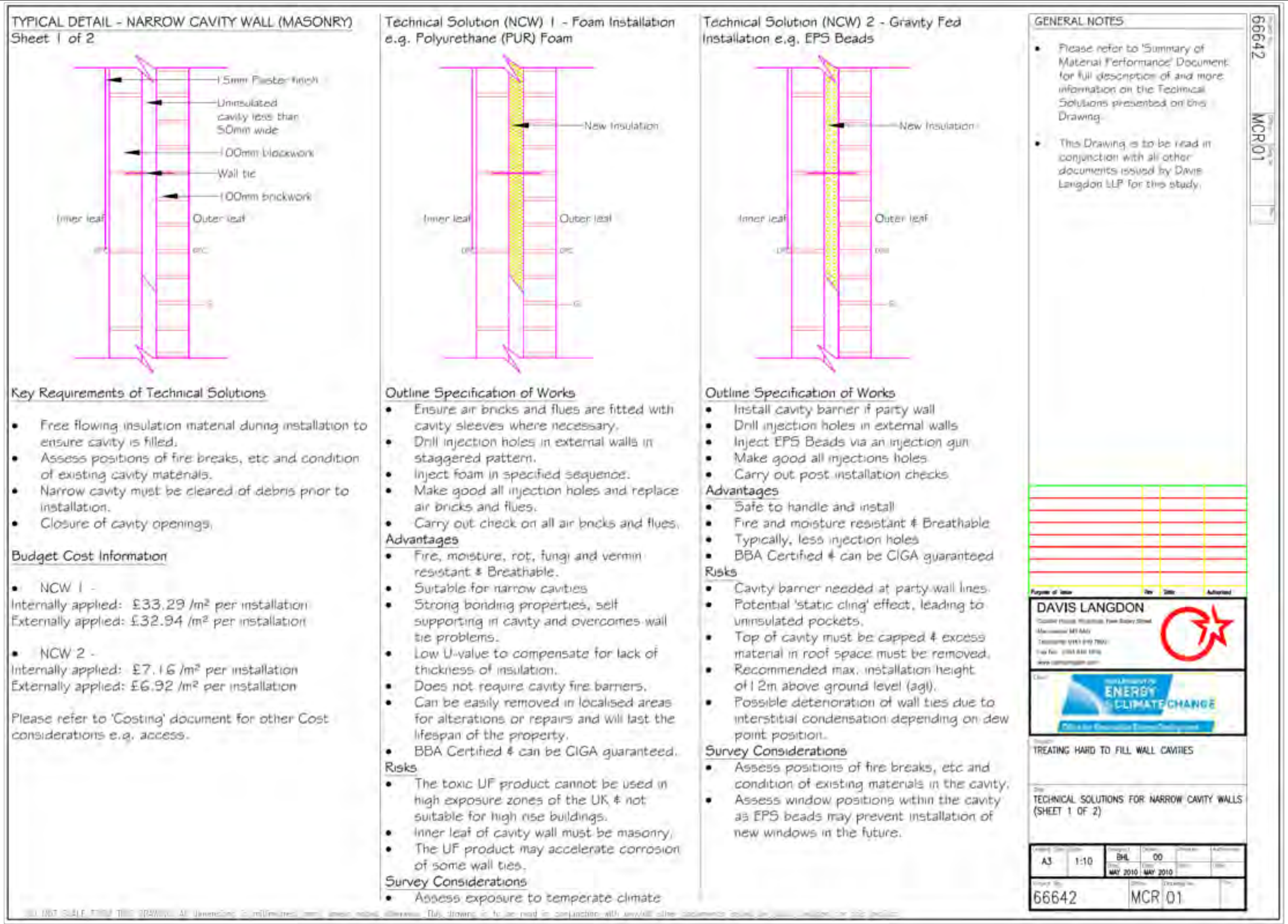
13.1 Narrow Cavity Wall (Masonry) 1/2

13.1.1 NCW-1

Foam Insulation e.g. Polyurethane (PUR) Foam

13.1.2 NCW-2

Gravity Fed Installation e.g. Beads



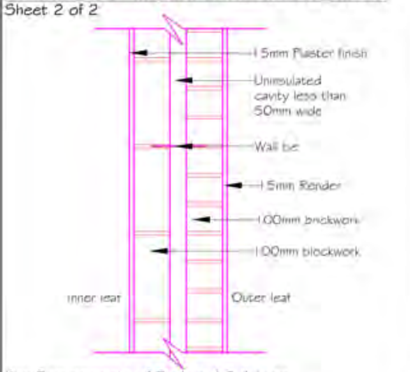
Note that currently PUR foam falls outside of the CIGA warranty scheme but is covered by BUFCA guarantee..

13.2 Narrow Cavity Wall (Masonry) 2/2

13.2.1 NCW-3

Pressure Injection Installation e.g. Blown Mineral Wool

TYPICAL DETAIL - NARROW CAVITY WALL (MASONRY)
Sheet 2 of 2



Key Requirements of Technical Solutions

- Free flowing insulation material during installation to ensure cavity is filled.
- Assess positions of fire breaks, etc and condition of existing cavity materials.
- Narrow cavity must be cleared of debris prior to installation.
- Closure of cavity openings.

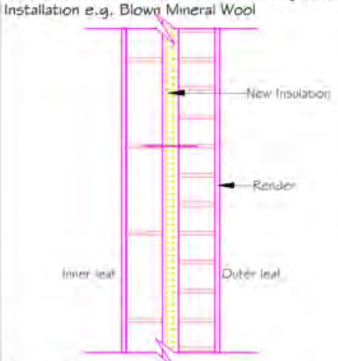
Budget Cost Information

- NCW 3 -

Internally applied: £6.96 /m² per installation
Externally applied: £6.61 /m² per installation

Please refer to 'Costing' document for other Cost considerations e.g. access.

Technical Solution (NCW) 3 - Pressure Injection Installation e.g. Blown Mineral Wool



Outline Specification of Works

- Ensure air bricks and flues are fitted with cavity sleeves where necessary.
- Install cavity barrier if cavity wall.
- Drill injection holes in walls at predetermined centres.
- Blow mineral wool via a flexible hose fitted with an injection nozzle.
- Make good all injection holes.
- Carry out check on all air bricks and flues.

Advantages

- Fire resistant & can act as cavity barrier at party wall line.
- Breathable.
- Can be used up to 25m above g.l.
- BBA Certified & can be CIGA guaranteed.

Risks

- Not suitable for high/exposed storeys unless rendered.
- Issues with insulation not sitting evenly in cavity and can consolidate over time to produce cold spots.
- Cost and safety implications of drilling holes at high levels.
- Product may wick moisture through leaves

Survey Considerations

- Assess exposure to temperate climate.
- Assess position of firebreaks and conditions of existing cavity materials.

GENERAL NOTES

- Please refer to 'Summary of Material Performance' Document for full description of and more information on the Technical Solutions presented on this Drawing.
- This Drawing is to be read in conjunction with all other documents issued by Davis Langdon LLP for this study.

DAVIS LANGDON

ENERGY CLIMATE CHANGE

TREATING HARD TO FILL WALL CAVITIES

TECHNICAL SOLUTIONS FOR NARROW CAVITY WALLS (SHEET 2 OF 2)

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13.3 Partial Fill Cavity Wall (Masonry) 1/2

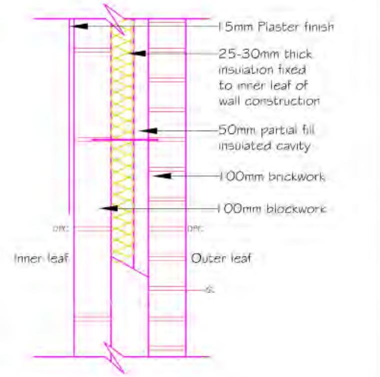
13.3.1 PFCW-1

Gravity Fed Installation e.g. Perlite Beads

13.3.2 PFCW-2

Foam Installation e.g. PUR or UF Foam

TYPICAL DETAIL - PARTIAL FILL CAVITY WALL (MASONRY)
Sheet 1 of 2



Key Requirements of Technical Solution

- Narrow cavity must be cleared of debris prior to installation.
- Free flowing insulation material during installation to ensure cavity is filled.
- New insulation able to push existing insulation back onto inner leaf if parting.
- Cavity must be closed along party wall.

Budget Cost Information

- PFCW 1 -

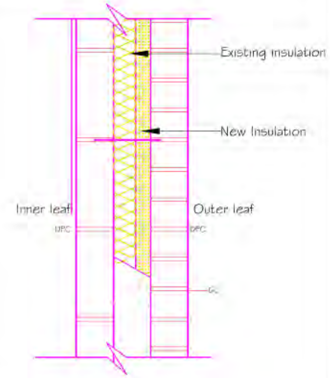
Internally applied: £7.66 /m² per installation
Externally applied: £7.37 /m² per installation

- PFCW 2 -

Internally applied: £35.11 /m² per installation
Externally applied: £34.67 /m² per installation

Please refer to 'Costing' document for other Cost considerations e.g. access.

Technical Solution (PFCW) 1 - Gravity Fed Installation e.g. Perlite Beads



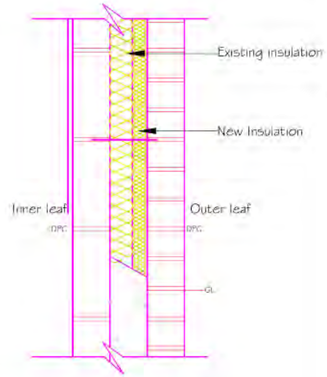
Outline Specification of Works
- Install cavity barrier if party wall
- Drill injection holes in external walls
- Inject Perlite Beads via an injection gun or hopper
- Make good all injection holes
- Carry out post installation checks

Advantages
- Safe to handle and install
- Fire, moisture, inorganic, rot, vermin and insect resistant
- Reclaimable & relatively high natural content
- Free flowing, good void filler, non settling and supports own weight
- Covered by BSEN standard

Risks
- Must be installed in sealed spaces
- Not BBA Certified or CIGA guaranteed
- Raw materials obtained through mining
- Relatively high embodied energy (due to treatments)
- Not commonly used above 9m in the UK

Survey Considerations
- Assess positions of fire breaks, etc and condition of existing materials in the cavity.
- Assess window positions within the cavity as works may prevent installation of new windows in the future.

Technical Solution (PFCW) 2 - Foam Installation e.g. PUR or UF Foam



Outline Specification of Works
- Ensure air bricks and flues are fitted with cavity sleeves where necessary.
- Drill injection holes in external walls in staggered pattern.
- Inject foam in specified sequence.
- Make good all injection holes and replace air bricks and flues.
- Carry out check on all air bricks and flues.

Advantages
- Fire, moisture, rot, fungi and vermin resistant & Breathable.
- Suitable for narrow cavities
- Strong bonding properties, self supporting in cavity and overcomes wall tie problems.
- Does not require cavity fire barriers.
- Can be easily removed in localised areas for alterations or repairs and will last the lifespan of the property.
- BBA Certified & can be CIGA guaranteed.

Risks
- The toxic UF product cannot be used in high exposure zones of the UK & not suitable for high rise buildings.
- Inner leaf of cavity wall must be masonry.
- The UF product may accelerate corrosion of some wall ties.

Survey Considerations
- Assess exposure re. temperate climate

GENERAL NOTES

- Please refer to 'Summary of Material Performance' Document for full description of and more information on the Technical Solutions presented on this Drawing.
- This Drawing is to be read in conjunction with all other documents issued by Davis Langdon LLP for this study.

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ENERGY & CLIMATE CHANGE

TREATING HARD TO FILL WALL CAVITIES

TECHNICAL SOLUTIONS FOR EXISTING PARTIALLY FILLED CAVITY WALLS (SHEET 1 OF 2)

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DO NOT SCALE FROM THIS DRAWING. All dimensions in millimetres (mm) unless noted otherwise. This drawing is to be read in conjunction with any/all other documents issued by Davis Langdon for this project.

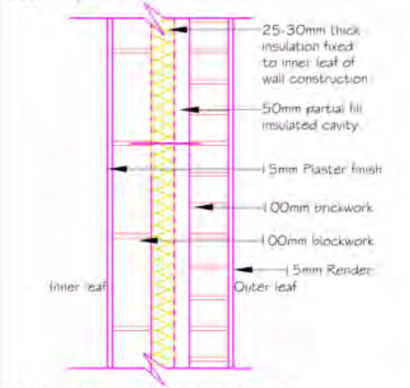
Note that currently PUR foam falls outside of the CIGA warranty scheme but is covered by BUFCA guarantee..

13.4 Partial Fill Cavity Wall (Masonry) 2/2

13.4.1 PFCW-3

Pressure Injection Installation e.g. Blown Mineral Wool

TYPICAL DETAIL - PARTIAL FILL CAVITY WALL (MASONRY)
Sheet 2 of 2



Key Requirements of Technical Solution

- Narrow cavity must be cleared of debris prior to installation.
- Free flowing insulation material during installation to ensure cavity is filled.
- New insulation able to push existing insulation back unto inner leaf if parting.

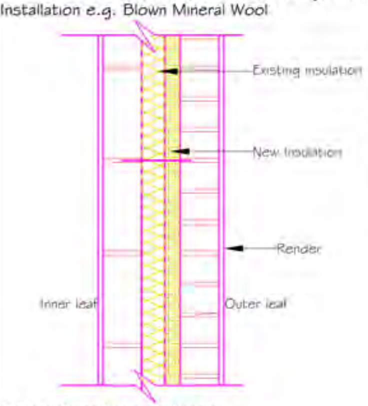
Budget Cost Information

- PFCW 3 -

Internally applied: £7.47 /m² per installation
Externally applied: £7.02 /m² per installation

Please refer to 'Costing' document for other Cost considerations e.g. access.

Technical Solution (PFCW) 3 - Pressure Injection Installation e.g. Blown Mineral Wool



Outline Specification of Works

- Ensure air bricks and flues are fitted with cavity sleeves where necessary.
- Drill injection holes in external walls at predetermined centres.
- Blow mineral wool via a flexible hose fitted with an injection nozzle.
- Make good all injection holes and replace air bricks and flues.
- Carry out check on all air bricks and flues.

Advantages

- Fire resistant & can act as cavity barrier at party wall line.
- Breathable.
- Can be used up to 25m above g.l.
- BBA Certified & can be CIGA guaranteed.

Risks

- High embodied energy content.
- Issues with insulation not sitting evenly in cavity and can consolidate over time to produce cold spots.
- Not suitable for high or exposed levels unless rendered.
- Can wick moisture across leaves.
- Cost and safety implications of drilling holes at high levels

Survey Considerations

- Assess exposure to temperate climate.
- Assess position of firebreaks and conditions of existing cavity materials.

GENERAL NOTES

- Please refer to 'Summary of Material Performance' Document for full description of and more information on the Technical Solutions presented on this Drawing.
- This Drawing is to be read in conjunction with all other documents issued by Davis Langdon LLP for this study.

DAVIS LANGDON

Department of Energy & Climate Change

TREATING HARD TO FILL WALL CAVITIES

TECHNICAL SOLUTIONS FOR EXISTING PARTIALLY FILLED CAVITY WALLS (SHEET 2 OF 2)

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13.5 Random Stone Cavity Wall 1/2

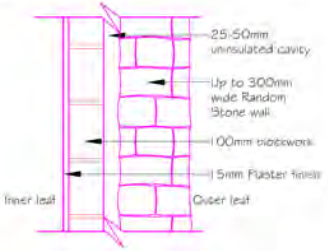
13.5.1 RSCW – 1

Foam Installation e.g. PUR or UF Foam

13.5.2 RSCW – 2

Gravity Fed Installation e.g. EPS Beads

TYPICAL DETAIL - RANDOM STONE CAVITY WALL
Sheet 1 of 2



Key Requirements of Technical Solution

- Free flowing to accommodate potential wide variations in cavity width
- High adhesion to improve bond between random stone and adjacent masonry.
- Inner leaf of cavity must be masonry.
- Top of cavity must be capped and excess material in roof space must be removed.

Budget Cost Information

- RSCW 1 -

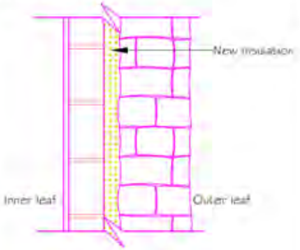
Internally applied: £33.08 /m² per installation
Externally applied: £32.93 /m² per installation

- RSCW 2 -

Internally applied: £6.94 /m² per installation
Externally applied: £6.84 /m² per installation

Please refer to 'Costing' document for other Cost considerations e.g. access.

Technical Solution (RSCW) 1 – Foam Installation e.g. PUR or UF Foam



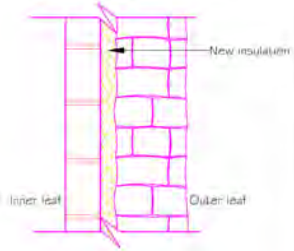
Outline Specification of Works
- Ensure air bricks and flues are fitted with cavity sleeves where necessary.
- Drill injection holes in either internal or external walls in staggered pattern.
- Inject form in specified sequence.
- Make good all injection holes and replace air bricks and flues.
- Carry out check on all air bricks and flues.

Advantages
- Fire, moisture, rot, fungi and vermin resistant & Breathable.
- Suitable for narrow cavities
- Strong bonding properties, self supporting in cavity and overcomes wall tie problems.
- Inert and non hazardous once installed.
- Does not require cavity fire barriers.
- Can be easily removed in localised areas for alterations or repairs and will last the lifespan of the property.
- BBA Certified & can be CIGA guaranteed.

Risks
- UF product toxic during manufacture and installation and controlled by Legislative documents.
- UF product cannot be used in high exposure zones of the UK.
- UF product may accelerate corrosion of some wall ties.

Survey Considerations
- Assess exposure to temperate climate

Technical Solution (RSCW) 2 - Gravity Fed Installation e.g. EPS Beads



Outline Specification of Works
- Install cavity barrier if party wall
- Drill injection holes in either internal or external walls
- Inject EPS Beads via an injection gun/hopper.
- Make good all injection holes
- Carry out post installation checks

Advantages
- Safe to handle and install
- Fire and moisture resistant & Breathable
- Typically, less injection holes
- BBA Certified & can be CIGA guaranteed

Risks
- Cavity barrier needed at party wall lines
- Potential 'static cling' effect, leading to uninsulated pockets.
- Recommended max. installation height of 12m above g.l.
- Possible deterioration of wall ties due to interstitial condensation depending on dew point position.

Survey Considerations
- Assess positions of fire breaks, etc and condition of existing materials in the cavity.
- Assess window positions within the cavity as works may prevent installation of new windows in the future.

GENERAL NOTES
- Please refer to 'Summary of Material Performance' Document for full description of and more information on the Technical Solutions presented on this Drawing.
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TREATING HARD TO FILL WALL CAVITIES

TECHNICAL SOLUTIONS FOR EXISTING RANDOM STONE CAVITY WALL (SHEET 1 OF 2)

A3 1:10 BHL OO MAY 2010 MAY 2010

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Note that currently PUR foam falls outside of the CIGA warranty scheme but is covered by BUFCA guarantee.

13.6 Random Stone Cavity Wall 2/2

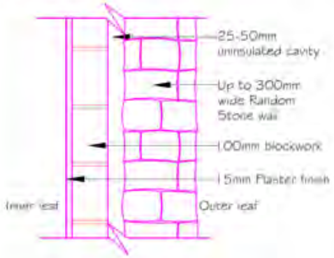
13.6.1 RSCW – 3

Pressure Injection e.g. Blown Mineral Wool

13.6.2 RSCW – 4

Gravity Fed Installation e.g. Perlite Beads

TYPICAL DETAIL - RANDOM STONE CAVITY WALL
Sheet 2 of 2



Key Requirements of Technical Solution

- Free flowing to accommodate potential wide variations in cavity width
- High adhesion to improve bond between random stone and adjacent masonry.
- Inner leaf of cavity must be masonry.
- Top of cavity must be capped and excess material in roof space must be removed.

Budget Cost Information

- RSCW 3 -

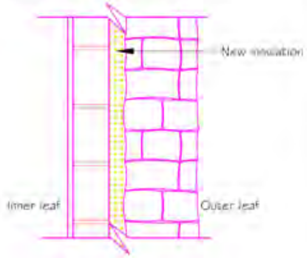
Internally applied: £6.74 /m² per installation
Externally applied: £6.59 /m² per installation

- RSCW 4 -

Internally applied: £TBC /m² per installation
Externally applied: £TBC /m² per installation

Please refer to 'Costing' document for other Cost considerations e.g. access.

Technical Solution (RSCW) 3 - Pressure Injection Installation e.g. Blown Mineral Wool



Outline Specification of Works

- Ensure air bricks and flues are fitted with cavity sleeves where necessary.
- Drill injection holes in either external or internal walls at predetermined centres.
- Blow mineral wool via a flexible hose fitted with an injection nozzle.
- Make good all injection holes and replace air bricks and flues.
- Carry out check on all air bricks and flues.

Advantages

- Fire resistant & can act as cavity barrier at party wall line.
- Breathable.
- Can be used up to 25m above g.l.
- BBA Certified & can be CIGA guaranteed.

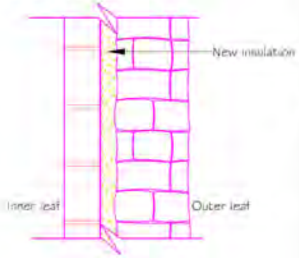
Risks

- High embodied energy content.
- Issues with insulation not sitting evenly in cavity and can consolidate over time to produce cold spots.
- Cost and safety implications of drilling holes at high levels.
- Can wick moisture across leaves.

Survey Considerations

- Assess exposure to temperate climate.
- Assess position of firebreaks and conditions of existing cavity materials.

Technical Solution (RSCW) 4 - Gravity Fed Installation e.g. Perlite Beads



Outline Specification of Works

- Install cavity barrier if party wall
- Drill injection holes in either external or internal walls
- Inject beads via an injection gun
- Make good all injection holes
- Carry out post installation checks

Advantages

- Safe to handle and install
- Fire, moisture, inorganic, rot, vermin and insect resistant
- Reclaimable & relatively high natural content
- Free flowing, good void filler, non setting and supports own weight
- Covered by BSEN standard

Risks

- Must be installed in sealed spaces
- Not BBA Certified or CIGA guaranteed
- Raw materials obtained through mining
- Relatively high embodied energy (due to treatment)
- Not commonly used above 9m in the UK

Survey Considerations

- Assess positions of fire breaks, etc and condition of existing materials in the cavity.
- Assess window positions within the cavity as works may prevent installation of new windows in the future.

GENERAL NOTES

- Please refer to 'Summary of Material Performance' Document for full description of and more information on the Technical Solutions presented on this Drawing.
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ENERGY CLIMATE CHANGE

TREATING HARD TO FILL WALL CAVITIES

TECHNICAL SOLUTIONS FOR EXISTING RANDOM STONE CAVITY WALL (SHEET 2 OF 2)

A3 1:10 BHL 00 MAY 2010 MAY 2010

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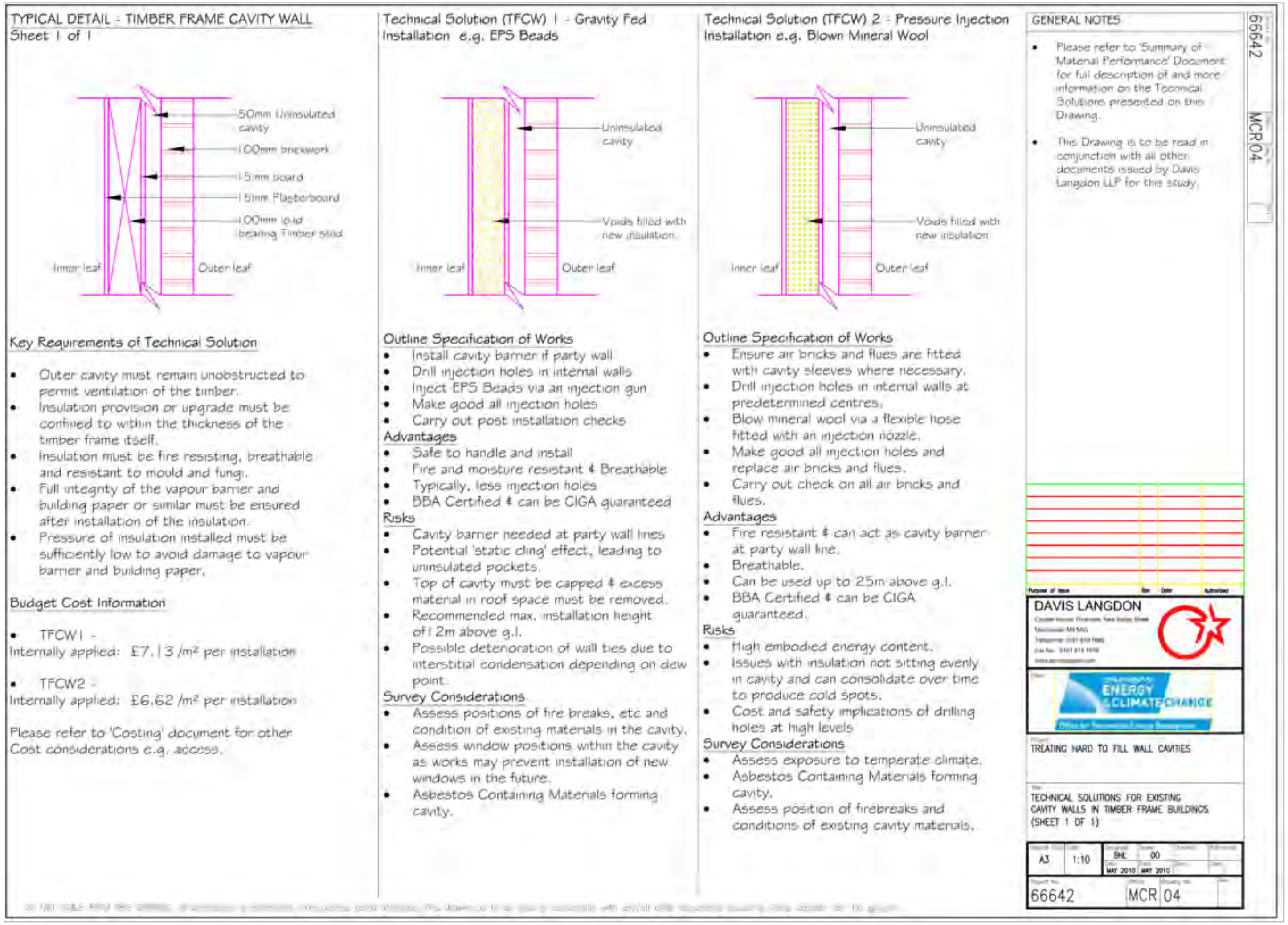
13.7 Timber Frame Cavity Wall

13.7.1 TFCW-1

Gravity Fed Solution e.g. EPS Beads

13.7.2 TFCW-2

Pressure Injection Installation e.g. Blown Mineral Wool



Note: Mineral wool not currently guaranteed

13.8 In Situ Concrete Cavity Wall 1/1

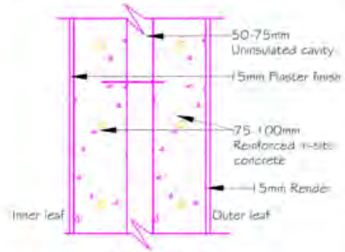
13.8.1 ICCW-1

Gravity Fed Insulation e.g. EP5 Beads

13.8.2 ICCW-2

Foam Insulation e.g. PUR Foam

TYPICAL DETAIL - IN-SITU CONCRETE CAVITY WALL
Sheet 1 of 2



Key Requirements of Technical Solution

- External solution only unless no insulation exists.
- Narrow cavity must be cleared of debris prior to installation.
- Free flowing insulation material during installation to ensure cavity is filled.
- Carry out survey to determine type of concrete mix and to locate positions of reinforcement.
- No fines concrete may blow internal face when drilling (no repair method available)

Budget Cost Information

- ICCW 1 -

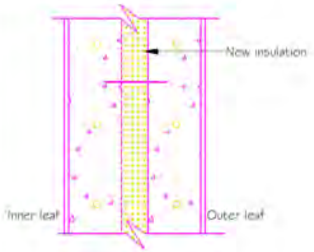
Internally applied: £7.50 /m² per installation
Externally applied: £7.18/m² per installation

- ICCW 2 -

Internally applied: £33.80 /m² per installation
Externally applied: £33.32 /m² per installation

Please refer to 'Costing' document for other Cost considerations e.g. access.

Technical Solution (ICCW) 1 - Gravity Fed Installation e.g. EPS Beads



Outline Specification of Works

- Install cavity barrier if party wall
- Drill injection holes in external walls
- Inject EPS Beads via an injection gun
- Make good all injection holes
- Carry out post installation checks

Advantages

- Safe to handle and install
- Fire and moisture resistant & Breathable
- Typically, less injection holes
- BBA Certified & can be CIGA guaranteed

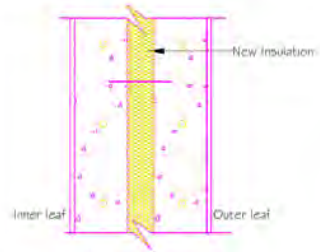
Risks

- Cavity barrier needed at party wall lines
- Potential 'static cling' effect, leading to uninsulated pockets.
- Top of cavity must be capped & excess material in roof space must be removed.
- Recommended max. installation height of 12m agl.
- Possible deterioration of wall ties if present due to interstitial condensation depending on dew point.

Survey Considerations

- Assess exposure to temperate climate.
- Assess positions of fire breaks, etc and condition of existing materials in the cavity.
- Assess window positions within the cavity as works may prevent installation of new windows in the future.

Technical Solution (ICCW) 2 - Foam Installation e.g. PUR Foam



Outline Specification of Works

- Ensure air bricks and flues are fitted with cavity sleeves where necessary.
- Drill injection holes in external walls in staggered pattern.
- Inject form in specified sequence.
- Make good all injection holes, replace air bricks and flues, and carry out checks.

Advantages

- Fire, moisture, rot, fungi and vermin resistant & Breathable.
- Suitable for narrow cavities
- Strong bonding properties, self supporting in cavity and overcomes wall tie problems.
- Does not require cavity fire barriers.
- Can be easily removed in localised areas for alterations or repairs and will last the lifespan of the property.
- BBA Certified.

Risks

- The toxic UF product cannot be used in high exposure zones of the UK & not suitable for high rise buildings.
- Inner leaf of cavity wall must be masonry to use the UF product.
- UF product may accelerate corrosion of wall ties.
- PUR product not CIGA guaranteed.

Survey Considerations

- Assess exposure to temperate climate.
- Assess positions of fire breaks, etc and condition of existing materials in the cavity.
- Assess window positions within the cavity as works may prevent installation of new windows in the future.

GENERAL NOTES

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TREATING HARD TO FILL WALL CAVITIES

TECHNICAL SOLUTIONS FOR EXISTING IN-SITU CONCRETE CAVITY WALL (SHEET 1 OF 1)

A3 1:10 BHL 00 MAY 2010 MAY 2010

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13.9 Cavity Wall with Exposed Re-inforced Concrete Floor Structure in High Rise Building 1/2

13.9.1 ERCFCW-1

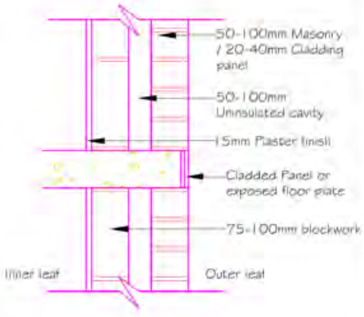
Foam Insulation e.g PUR Foam

13.9.2 ERCFCW-2

Gravity Fed Insulation e.g. Perlite Beads

TYPICAL DETAIL - CAVITY WALL WITH EXPOSED RE-INFORCED CONCRETE FLOOR STRUCTURE IN HIGH RISE BUILDINGS

Sheet 1 of 2



Key Requirements of Technical Solution

- Injection holes must be drilled using the set correct procedures to prevent blowing surfaces of the concrete panel.
- Free flowing to accommodate potential wide variations in cavity width.
- Chemically inert and must not require ventilation.
- Carry out survey to determine type of concrete mix and to locate positions of reinforcement.
- Cavity closures required around openings.

Budget Cost Information

- ERCFCW 1 -

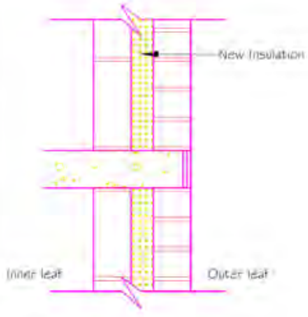
Internally applied: £33.29 /m² per installation
Externally applied: £33.22 /m² per installation

- ERCFCW 2 -

Internally applied: £TBC /m² per installation
Externally applied: £TBC /m² per installation

Please refer to 'Costing' document for other Cost considerations e.g. access.

Technical Solution (ERCFCW) 1 - Foam Installation e.g. PUR Foam



Outline Specification of Works

- Ensure air bricks and flues are fitted with cavity sleeves where necessary.
- Drill injection holes in external walls in staggered pattern.
- Inject foam in specified sequence.
- Make good all injection holes and replace air bricks and flues.
- Carry out check on all air bricks and flues.

Advantages

- Fire, moisture, rot, fungi and vermin resistant & Breathable.
- Suitable for narrow cavities
- Strong bonding properties, self supporting in cavity and overcomes wall tie problems.
- Does not require cavity fire barriers.
- Can be easily removed in localised areas for alterations or repairs and will last the lifespan of the property.
- BBA Certified.

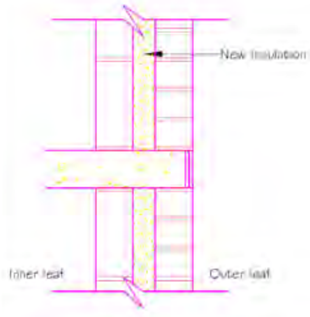
Risks

- The toxic UF product cannot be used in high exposure zones of the UK & not suitable for high rise buildings.
- PUR product not CIGA guaranteed.

Survey Considerations

- Assess exposure to temperate climate.
- Asbestos Containing Materials especially around openings.

Technical Solution (ERCFCW) 2 - Gravity Fed Installation e.g. Perlite Beads



Outline Specification of Works

- Install cavity barrier if party wall
- Drill injection holes in either external or internal walls
- Inject beads via an injection gun or hopper.
- Make good all injection holes
- Carry out post installation checks

Advantages

- Safe to handle and install
- Fire, moisture, inorganic, rot, vermin and insect resistant
- Reclaimable & relatively high natural content
- Free flowing, good void filler, non settling and supports own weight
- Covered by BSEN standard

Risks

- Must be installed in sealed spaces
- Not BBA Certified or CIGA guaranteed
- Raw materials obtained through mining
- Relatively high embodied energy
- Not commonly used above 9m in the UK

Survey Considerations

- Assess positions of fire breaks, etc and condition of existing materials in the cavity.
- Assess window positions within the cavity as works may prevent installation of new windows in the future.
- Asbestos Containing Materials especially around openings.

GENERAL NOTES

- Please refer to 'Summary of Material Performance' Document for full description of and more information on the Technical Solutions presented on this Drawing.
- This Drawing is to be read in conjunction with all other documents issued by Davis Langdon LLP for the study.

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TREATING HARD TO FILL WALL CAVITIES

TECHNICAL SOLUTIONS FOR EXISTING CAVITY WALL IN HIGH RISE BUILDINGS WITH EXPOSED RE-INFORCED CONCRETE FLOOR (SHEET 1 OF 2)

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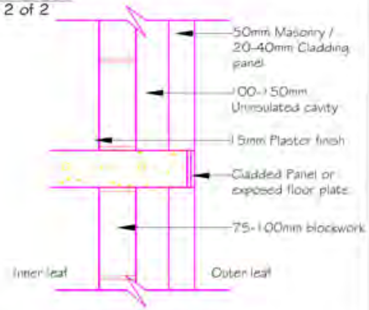
13.10 Cavity Wall with Exposed Re-inforced Concrete Floor Structure in High Rise Building 2/2

13.10.1 ERCFCW-3

Gravity Fed Insulation e.g. EP5 Beads

TYPICAL DETAIL - CAVITY WALL WITH EXPOSED RE-INFORCED CONCRETE FLOOR STRUCTURE IN HIGH RISE BUILDINGS

Sheet 2 of 2



Key Requirements of Technical Solution

- Injection holes must be drilled using the set correct procedures to prevent blowing surfaces of the concrete panel.
- Free flowing to accommodate potential wide variations in cavity width.
- Chemically inert and must not require ventilation.
- Carry out survey to determine type of concrete mix and to locate positions of reinforcement.
- Cavity closure required around openings.

Budget Cost Information

- ERCFCW 3 -

Internally applied: £7.16 /m² per installation
Externally applied: £7.11 /m² per installation

Please refer to 'Costing' document for other Cost considerations e.g. access.

Technical Solution (ERCFCW) 3 - Gravity Fed Installation e.g. EPS Beads

Outline Specification of Works

- Install cavity barrier if party wall
- Drill injection holes in either internal or external walls
- Inject EPS Beads via an injection gun
- Make good all injection holes
- Carry out post installation checks

Advantages

- Safe to handle and install
- Fire and moisture resistant & Breathable
- Typically, less injection holes
- BBA Certified & can be CIGA guaranteed

Risks

- Potential 'static cling' effect, leading to uninsulated pockets.
- Top of cavity must be capped & excess material in roof space must be removed.
- Recommended max. installation height of 12m agl.
- Possible deterioration of wall ties due to interstitial condensation depending on dew point.

Survey Considerations

- Assess positions of fire breaks, etc and condition of existing materials in the cavity.
- Assess window positions within the cavity as works may prevent installation of new windows in the future.
- Asbestos Containing Materials especially around openings.

GENERAL NOTES

- Please refer to 'Summary of Material Performance' Document for full description of and more information on the Technical Solutions presented on this Drawing.
- This Drawing is to be read in conjunction with all other documents issued by Davis Langdon LLP for this study.

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TREATING HARD TO FILL WALL CAVITIES

TECHNICAL SOLUTIONS FOR EXISTING CAVITY WALL IN HIGH RISE BUILDINGS WITH EXPOSED RE-INFORCED CONCRETE FLOOR (SHEET 2 OF 2)

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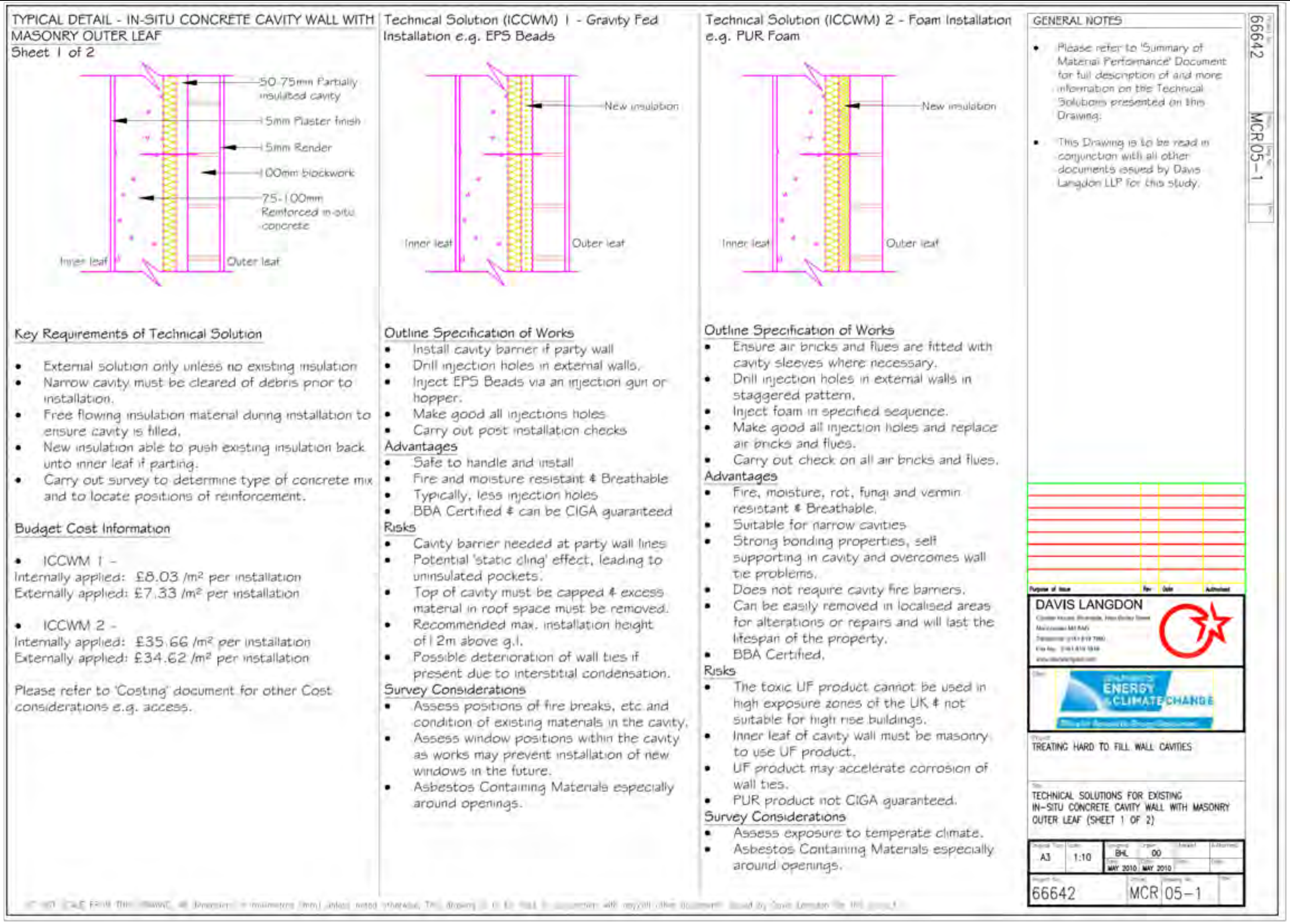
13.11 In-situ Concrete Cavity Wall with Masonry Outer Leaf 1/2

13.11.1 ICC WM-1

Gravity Feed Installation e.g. EPS Beads

13.11.2 ICC WM-2

Foam Installation e.g. PUR Foam

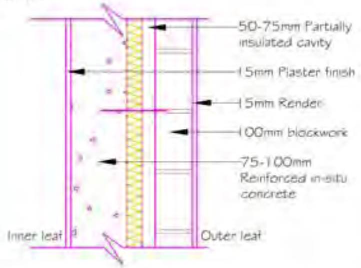


13.12 In-situ Concrete Cavity Wall with Masonry Outer Leaf 2/2

13.12.1 ICCWM-3

Pressure Injection Insulation e.g. Blown Mineral Wool

TYPICAL DETAIL - IN-SITU CONCRETE CAVITY WALL WITH MASONRY OUTER LEAF
Sheet 2 of 2



Key Requirements of Technical Solution

- External solution only unless no existing insulation
- Narrow cavity must be cleared of debris prior to installation.
- Free flowing insulation material during installation to ensure cavity is filled.
- New insulation able to push existing insulation back onto inner leaf if parting.
- Carry out survey to determine type of concrete mix and to locate positions of reinforcement.

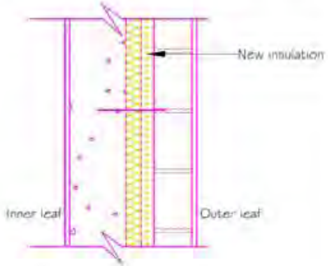
Budget Cost Information

- ICCWM 3 -

Internally applied: £8.01 /m² per installation
Externally applied: £6.97/m² per installation

Please refer to 'Costing' document for other Cost considerations e.g. access.

Technical Solution (ICCWM) 3 - Pressure Injection Installation e.g. Blown Mineral Wool



Outline Specification of Works

- Ensure air bricks and flues are fitted with cavity sleeves where necessary.
- Drill injection holes in external walls at predetermined centres.
- Blow mineral wool via a flexible hose fitted with an injection nozzle.
- Make good all injection holes and replace air bricks and flues.
- Carry out check on all air bricks and flues.

Advantages

- Fire resistant & can act as cavity barrier at party wall line.
- Breathable.
- Can be used up to 25m agl
- BBA Certified & can be CIGA guaranteed.

Risks

- High embodied energy content.
- Issues with insulation not sitting evenly in cavity and can consolidate over time to produce cold spots.
- Not suitable for high or exposed levels unless rendered.
- Can wick moisture across leaves.
- Cost and safety implications of drilling holes at high levels

Survey Considerations

- Assess exposure to temperate climate.
- Asbestos Containing Materials especially to any cladding options around openings.
- Assess position of firebreaks and conditions of existing cavity materials.

GENERAL NOTES

- Please refer to 'Summary of Material Performance' Document for full description of and more information on the Technical Solutions presented on this Drawing.
- This Drawing is to be read in conjunction with all other documents issued by Davis Langdon LLP for this study.

Purpose of Issue | Rev | Date | Authorised

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TREATING HARD TO FILL WALL CAVITIES

TECHNICAL SOLUTIONS FOR EXISTING IN-SITU CONCRETE CAVITY WALL WITH MASONRY OUTER LEAF (SHEET 2 OF 2)

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13.13 Cavity Wall with Continual External Cladding & Internal Concrete Floor in High Rise Building 1/1

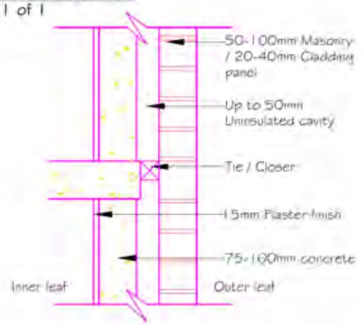
13.13.1 IFRC CW-1

Pressure Injection Insulation e.g. Blown Mineral Wool

13.13.2 IFRC CW-2

Foam Insulation e.g. PUR Foam

TYPICAL DETAIL - CAVITY WALL WITH CONTINUAL EXTERNAL CLADDING & INTERNAL CONCRETE FLOOR IN HIGH RISE BUILDINGS
Sheet 1 of 1



Key Requirements of Technical Solution

- Injection holes must be drilled using the set correct procedures to prevent blowing surfaces of the concrete panel.
- Free flowing to accommodate potential wide variations in cavity width.
- Relative low weight to avoid moving floor plate.
- Chemically inert and must not require ventilation.
- Cavity closure required around openings.

Budget Cost Information

- ERCFCW1 -

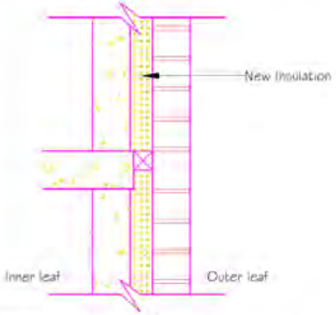
Internally applied: £7.21 /m² per installation
Externally applied: £6.61 /m² per installation

- ERCFCW2 -

Internally applied: £33.54 /m² per installation
Externally applied: £32.94 /m² per installation

Please refer to 'Costing' document for other Cost considerations e.g. access.

Technical Solution (IFRCCW) 1 - Pressure Injection Installation e.g. Blown Mineral Wool



Outline Specification of Works

- Ensure air bricks and flues are fitted with cavity sleeves where necessary.
- Drill injection holes in external walls at predetermined centres.
- Blow mineral wool via a flexible hose fitted with an injection nozzle.
- Make good all injection holes and replace air bricks and flues.
- Carry out check on all air bricks and flues.

Advantages

- Fire resistant & can act as cavity barrier at party wall line.
- Breathable.
- Can be used up to 25m above g.l.
- BBA Certified & can be CIGA guaranteed.

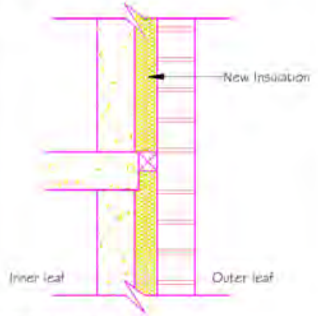
Risks

- High embodied energy content.
- Not resistant to water and unsuitable for areas of high exposure to wind-driven rain.
- Issues with insulation not sitting evenly in cavity and can consolidate over time to produce cold spots.
- Cost and safety implications of drilling holes at high levels

Survey Considerations

- Assess exposure to temperate climate.
- Asbestos Containing Materials around openings.
- Assess position of firebreaks and conditions of existing cavity materials.

Technical Solution (IFRCCW) 2 - Foam Installation e.g. PUR Foam



Outline Specification of Works

- Ensure air bricks and flues are fitted with cavity sleeves where necessary.
- Drill injection holes in external walls in staggered pattern.
- Inject form in specified sequence.
- Make good all injection holes and replace air bricks and flues.
- Carry out check on all air bricks and flues.

Advantages

- Fire, moisture, rot, fungi and vermin resistant & Breathable.
- Suitable for narrow cavities
- Strong bonding properties, self supporting in cavity and overcomes wall tie problems.
- Does not require cavity fire barriers.
- Can be easily removed in localised areas for alterations or repairs and will last the lifespan of the property.
- BBA Certified.

Risks

- The toxic UF product cannot be used in high exposure zones of the UK & not suitable for high rise buildings.
- PUR product not CIGA guaranteed.

Survey Considerations

- Assess exposure to temperate climate.
- Asbestos Containing Materials around openings.
- Assess position of firebreaks and conditions of existing cavity materials.

GENERAL NOTES

- Please refer to 'Summary of Material Performance' Document for full description of and more information on the Technical Solutions presented on this Drawing.
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Purpose of Issue	Rev	Date	Authorised

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TREATING HARD TO FILL WALL CAVITIES

TECHNICAL SOLUTIONS FOR EXISTING CAVITY WALL IN HIGH RISE BUILDINGS WITH CONTINUAL EXTERNAL CLADDING AND INTERNAL CONCRETE FLOOR (SHEET 1 OF 1)

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14 Appendix C: House type examples for hard to fill cavity walls

DECC - House type examples for hard to fill cavity walls (Summary details from typical house surveys DL))

Description 1		Semi detached bungalow - single storey	Semi detached house - two storeys	Mid Terrace House - 2 storeys	End Terrace House - 2 storeys	Detached bungalow - 1 storey with garage at side	Detached House - 2 storeys	Random stone semi detached House - 2 storeys	Low rise flat 2 external walls	Low rise flat 3 external walls	High rise flat - 1 external wall	High rise flat - 3 external walls
Description 2		Traditional construction with masonry cavity materials, concrete floor construction (Uninsulated), ceilings timber and plasterboard (insulated above), pitched roof over. Partial fill cavity less than 40mm. Solid party wall	Traditional construction with masonry cavity materials, timber floor construction (Uninsulated), ceilings timber and plasterboard (insulated above), pitched roof over. Solid masonry party wall. Narrow cavity less than 40mm	Traditional construction with masonry cavity materials, concrete floor construction (Uninsulated), uninsulated first floor timber floor and ceilings of timber and plasterboard (insulated above), pitched roof over. Narrow cavity less than 40mm. Party cavity wall (75mm block and plaster)	Traditional construction with masonry cavity materials, timber floor construction (Uninsulated), ceilings timber and plasterboard (insulated above), pitched roof over. Partial fill cavity less than 40mm	Traditional construction with masonry cavity materials, timber floor construction (Uninsulated), ceilings timber and plasterboard (insulated above), pitched roof over. Narrow cavity less than 40mm.	Traditional construction with masonry cavity materials, concrete floor construction (Uninsulated), uninsulated first floor timber floor and ceilings of timber and plasterboard (insulated above), pitched roof over. Partial fill cavity less than 40mm	Random stone construction with masonry cavity materials, concrete floor construction (Uninsulated), ceilings timber and plasterboard (insulated above), pitched roof over. Uneven thickness outer leaf and cavity width varies. Solid party walls	Concrete and brick structure and concrete floor slabs (Uninsulated) with brickwork external leaf panels and masonry materials forming cavities approx 50mm. Flat roof over. Masonry party wall with 50mm cavity	Concrete and brick structure and concrete floor slabs (Uninsulated) with brickwork external leaf panels and masonry materials forming cavities approx 50mm. Flat roof over. Masonry party wall with 50mm cavity	Concrete structure and floor slabs with brickwork external leaf panels and masonry materials forming cavities approx 50mm. Flat roof over. Solid party walls	Concrete structure and floor slabs with brickwork external leaf panels and masonry materials forming cavities approx 50mm. Flat roof over. Solid party walls
Approx date of building		1975	1920	1985	1980	1925	1985	1920	1980	1975	1965	1965
Floor 1 NIA areas	m^2	50.33	29.88	35.80	35.67	84.78	55.45	63.58	42.02	49.17	67.6	47.4
Floor 2 NIA areas	m^2	N\A	28.30	31.64	35.52	N/A	61.92	62.56	N/A	N/A	N/A	N/A
Average storey height	m	2.40	2.495	2.6	2.6	2.80	2.45	2.45	2.40	2.40	2.40	2.40

Net internal floor area (NIFA)	m^2	50.33	58.18	67.44	71.19	84.78	117.37	126.14	42.02	49.17	67.6	47.4
Total external wall area	m^2	61.51	91.47	51.90	105.32	96.79	191.24	154.96	33.41	60.80	36.72	37.44
Total party wall area	m^2	28.15	54.99	101.38	40.34	N/A	N/A	30	33.41	30.56	58.752	31.92
Window/ door area	m^2	12.97	17.24	12.50	14.26	16.78	24.02	30.54	6.41	9.80	12.37	7.63
External footprint area	m^2	54.35	40.80	40.97	43.49	90.25	79.87	85.2	55.48	61.11	72.3	52.5
Total external wall area (less doors and windows)	m^2	48.54	74.22	39.40	91.06	80.01	167.23	124.42	27.00	51.00	24.35	29.81

15 Appendix D: SAP and U value calculations for technical solutions and standard house types

			SAPTotalCO2 (kg/annum)										
Solution	Description	Notes	Detached bungalow - 1 storey with garage at side	Detached House - 2 storeys	End Terrace House - 2 storeys	High rise flat - 1 external wall	High rise flat - 3 external walls	Low rise flat 2 external walls	Low rise flat 3 external walls	Mid Terrace House - 2 storeys	Semi detached bungalow - single storey	Semi detached house - two storeys	Random Stone House
ERCFCW0	Exposed reinforced concrete floor cavity wall	Assumption: standard wall tie spacing (BR443) at 80mm2, 2.5/m2. Mild steel assumed	-	-	-	-	-	-	-	-	-	-	-
ERCFCW1	PUR Foam		N/A	N/A	413	866	881	503	474	516	N/A	545	N/A
ERCFCW2	Perlite Beads		N/A	N/A	323	667	687	391	367	403	N/A	446	N/A
ERCFCW3	EPS Beads		N/A	N/A	341	706	725	414	387	425	N/A	465	N/A
ICCW0	Internal concrete floor cavity wall	Assumption: standard wall tie spacing (BR443) at 80mm2, 2.5/m2. Mild steel assumed	-	-	-	-	-	-	-	-	-	-	-
ICCW1	Blown mineral wool		N/A	N/A	714	1,390	1,533	844	779	879	N/A	745	N/A
ICCW2	PUR Foam		N/A	N/A	781	1,534	1,676	927	857	963	N/A	818	N/A
NCW0	Narrow Cavity Wall	Assumption: standard wall tie spacing (BR443) at 80mm2, 2.5/m2. Mild steel assumed	-	-	-	-	-	-	-	-	-	-	-
NCW1	PUR Foam												N/A

			257	453	230	492	491	285	268	289	230	250	
NCW2	EPS Beads		209	370	188	399	400	230	217	236	186	204	N/A
NCW3	Blown Mineral Wool		209	370	188	399	400	230	217	236	186	204	N/A
PFCW0	Narrow Cavity Wall	Note: have assumed 50mm cavity in addition to 30mm insulation. Wall tie correction applied only once. Assumption: standard wall tie spacing (BR443) at 80mm2, 2.5/m2. Mild steel assumed	-	-	-	-	-	-	-	-	-	-	-
PFCW1	PUR Foam	Note: have assumed 50mm cavity in addition to 30mm insulation. Wall tie correction applied only once.	42	72	36	83	79	48	44	47	39	41	N/A
PFCW2	EPS Beads	Note: have assumed 50mm cavity in addition to 30mm insulation. Wall tie correction applied only once.	68	116	58	134	128	77	71	75	62	66	N/A
PFCW3	Blown Mineral Wool	Note: have assumed 50mm cavity in addition to 30mm insulation. Wall tie correction applied only once.	48	83	42	95	91	55	51	53	44	47	N/A

RSCW0	Random Stone Cavity Wall	Applicable only to random stone house	-	-	-	-	-	-	-	-	-	-	-
RSCW1	PUR Foam		156	278	141	N/A	N/A	N/A	N/A	176	139	152	447
RSCW2	EPS Beads		103	184	94	N/A	N/A	N/A	N/A	117	92	100	295
RSCW3	Blown mineral wool		103	184	94	N/A	N/A	N/A	N/A	117	92	100	295
RSCW4	Perlite Beads		111	197	100	N/A	N/A	N/A	N/A	125	98	108	316
TFCW0	Timber Frame Cavity	Assumption: standard wall tie spacing (BR443) at 80mm2, 2.5/m2. Mild steel assumed	-	-	-	-	-	-	-	-	-	-	-
TFCW1	EPS Beads		341	600	305	N/A	N/A	379	356	383	306	332	N/A
TFCW2	Blown mineral wool		341	600	305	N/A	N/A	379	356	383	306	332	N/A

16 Appendix E: English House Condition Survey (SS6.4)

EHCS 2007: Summary Statistics Table SS6.4: Heating and Insulation - insulation and homes

percentage of grou

	wall type and insulation			loft present and insulation						extent of double glazing				all
	cavity insulated	cavity uninsulated	non-cavity wall[1]	none in loft	less than 50mm	50 to 99mm	100 to 199mm	200mm or more	no loft	none	less than half	more than half	all	dwellings in group
tenure														
owner occupied	33.1	37.9	29.0	3.2	3.0	20.7	49.4	19.0	4.7	8.4	7.1	17.4	67.0	**15,560**
private rented	16.8	36.2	47.0	6.2	2.7	25.4	33.2	11.7	20.8	21.8	10.0	12.6	55.7	**2,738**
local authority	41.8	33.2	25.0	1.9	1.3	9.6	37.2	23.0	27.0	19.6	5.2	5.9	69.2	**1,987**
RSL	43.3	37.6	19.0	1.4	1.0	7.5	39.4	27.3	23.5	12.2	3.4	4.6	79.7	**1,904**
all private	30.7	37.6	31.7	3.7	2.9	21.4	47.0	17.9	7.1	10.4	7.5	16.7	65.3	**18,298**
all social	42.5	35.4	22.1	1.6	1.1	8.6	38.3	25.1	25.3	16.0	4.4	5.3	74.4	**3,891**
vacant														
occupied	33.3	37.2	29.5	3.1	2.6	19.2	45.8	19.5	9.7	11.0	6.8	14.8	67.3	**21,242**
vacant	20.6	38.5	40.9	7.5	2.6	18.8	36.6	12.2	22.3	19.9	10.6	11.7	57.8	**947**
dwelling age														
pre-1919	3.3	12.9	83.8	8.3	2.2	23.7	41.2	14.4	10.3	25.8	15.5	17.9	40.8	**4,766**
1919-44	22.6	35.7	41.8	4.5	3.5	23.5	45.4	18.1	4.9	8.4	7.9	24.8	59.0	**3,864**
1945-64	44.0	43.0	13.0	2.3	3.3	16.5	47.0	22.0	9.0	7.5	4.7	15.9	71.9	**4,345**
1965-80	41.4	51.6	7.0	1.1	3.7	22.0	42.6	16.6	14.1	7.1	4.7	12.4	75.8	**4,806**
1981-90	48.2	48.5	3.3	0.4	0.5	16.7	52.6	15.0	14.8	12.6	3.5	6.4	77.5	**1,878**
post 1990	56.6	39.9	3.5	0.3	0.3	5.1	51.0	33.3	10.1	2.8	0.4	1.8	95.0	**2,531**
dwelling type														
end terrace	30.4	33.2	36.3	3.8	1.9	21.6	50.8	22.0	0.0	11.5	8.2	13.7	66.7	**2,082**
mid terrace	18.5	30.3	51.2	6.2	2.8	23.6	48.5	18.8	0.0	11.7	9.4	16.1	62.8	**4,158**
small terrace	23.3	35.6	41.1	5.5	1.9	22.4	50.6	19.5	0.0	11.2	6.5	12.3	70.0	**2,185**
medium/large terr	22.0	29.0	49.0	5.3	2.8	23.2	48.5	20.1	0.0	11.8	10.3	17.0	60.9	**4,056**
all terrace	22.5	31.3	46.2	5.4	2.5	23.0	49.3	19.9	0.0	11.6	9.0	15.3	64.1	**6,241**
semi detached	34.5	40.8	24.7	3.4	3.7	21.5	50.4	21.1	0.0	6.6	6.8	19.3	67.3	**6,103**
detached	44.2	39.1	16.7	2.1	2.7	19.2	54.1	21.9	0.0	8.0	7.6	15.7	68.7	**3,973**
bungalow	50.6	37.0	12.4	1.7	3.1	17.3	48.5	29.4	0.0	6.1	3.8	13.4	76.6	**2,102**
converted flat	2.7	11.9	85.5	5.0	0.6	20.4	16.2	4.5	53.2	40.5	13.3	11.6	34.6	**757**
pb flat, low rise	32.8	47.6	19.6	1.3	0.7	8.1	22.6	7.8	59.4	20.3	2.8	4.6	72.2	**2,696**
pb flat, high rise	10.4	36.8	52.7	0.0	0.0	2.0	11.3	0.0	86.8	30.8	3.9	4.4	60.9	**318**
all houses	34.4	36.8	28.9	3.6	3.0	21.0	50.6	21.8	0.0	8.6	7.4	16.5	67.6	**18,418**
all flats	24.9	39.5	35.6	1.9	0.6	10.1	20.4	6.5	60.5	25.2	5.0	6.0	63.7	**3,771**
size														
less than 50m^2	31.0	39.9	29.2	1.6	0.8	14.4	28.7	12.7	41.9	21.2	5.0	4.8	68.9	**2,378**
50 to 69m^2	30.6	38.5	30.9	3.3	2.0	16.7	42.6	18.6	16.7	12.5	5.1	11.0	71.3	**5,208**
70 to 89m^2	33.2	37.1	29.8	3.7	3.5	20.6	46.7	21.0	4.4	8.9	5.9	16.6	68.5	**6,440**
90 to 109m^2	35.5	36.2	28.2	3.2	2.9	22.3	51.2	18.3	2.1	7.6	7.9	20.0	64.4	**3,237**
110m^2 or more	33.5	35.5	31.1	3.7	2.6	20.1	51.0	21.2	1.4	11.1	10.6	17.4	60.9	**4,926**
all dwellings	32.7	37.2	30.0	3.3	2.6	19.2	45.4	19.2	10.3	11.4	7.0	14.7	66.9	**22,189**

Base: all dwellings

Notes:

1. Non-cavity walls are predominantly brick and stone solid walls but also include a minority of homes with walls of timber, concrete and metal frames, or are of modular construction

17 Appendix F: Key issues in filling wall cavities in existing dwellings

Davis Langdon Technical Note:

Key issues in filling wall cavities in existing dwellings

1.0 "Hard to Treat" Cavities

1.1 A cavity wall survey by boroscope, localised opening up and a roof void inspection (if relevant) should be carried out to determine:

- Type(s) and extent of wall construction
- Storey heights where insulation is contemplated and ease of access to the elevations
- Type, condition and effectiveness of external protection or cladding (render, tile hanging, decorative/protective coating, rainscreen cladding etc.
- Type and condition of the wall finishes and decorative finishes on the inside faces of the external cavity walls together with the degree of obstruction by fixtures and fittings
- Width of cavity
- Presence, type frequency and condition of cavity wall ties
- Condition of mortar joints
- Presence of weep holes, frequency and degree of obstruction
- DPC's and cavity trays are fitted and stop-ends present
- Presence or not of debris in the cavity
- Whether all ducts or pipes have sleeves or collars
- The wind driven rain exposure zone (1-4) for the subject property(s)
- The location of the wall and its exposure to wind driven rain based on orientation, height above ground level and local site topography
- The presence or otherwise of overhangs, parapets or other construction detailing that influences the protection or exposure of the wall
- Cavity barriers are in position and there is sufficient masonry thickness between chimney (where present) and insulation

1.2 Only when this information has been verified, can a well informed decision be made on the most cost effective strategy to be employed to insulate the walls defined as "Hard to Treat" Cavities.

1.3 If structural problems are identified by the cavity wall survey e.g. absent or defective cavity wall ties, cavity blockages or unsound masonry construction, these matters should be the subject of suitable remedial works whichever type of insulation strategy is adopted.

1.4 Broadly, with retro-fit insulation to external cavity walls, the following options should be considered:

- Full fill cavity wall insulation injected from the outside
- Full fill cavity wall insulation injected from the inside
- External wall insulation system
- Internal drylining incorporating timber battens, Thermo-Foil or similar and plasterboard
- Internal drylining using an insulated plasterboard system

These will be discussed in turn.

1.4.1 Full fill cavity wall insulation injected from the outside

Advantages

- No or minimal disruption to the interior of the property or occupants
- Fast to install
- Minimal impact on the external appearance of the building

Disadvantages

- Relies on cavity being clear of debris and requires detailed checks to be carried out on other aspects of cavity wall condition/construction and remedied if necessary prior to installation
- Access costs can become very high where works above four storeys are to carried out or where lean-to buildings or other obstructions affect lower levels
- Leaves a pattern of made good drill holes in the façade of the building, lowest cost when in facing brickwork, higher costs when in masonry painted render and the like.
- External making good may be impossible to conceal sufficiently on listed or other sensitive buildings
- Very careful consideration needs to be taken of maximum recommended exposure zones for insulated masonry walls of this type.
- Future risk of frost damage to the outer leaf/finish of the wall
- Future risk of creating localised cold bridge condensation
- Risk that climate change will increase the exposure zone value of the site over time, leading to water penetration where none previously occurred

1.4.2 Full fill cavity wall insulation injected from the inside

Advantages

- Often avoids the need for an external scaffold with arising cost savings

- No external drill holes to be made good
- Fast to install

Disadvantages

- Disruption to the internal finishes and decorations inside the building which would require making good
- Disruption to building occupants
- Future risk of frost damage to the outer leaf/finish of the wall
- Future risk of creating localised cold bridge condensation
- Risk that climate change will increase the exposure zone value of the site over time, leading to water penetration where none previously occurred

1.4.3 Externally applied wall insulation system

Advantages

- No need to address issues of cavity debris, sleeves, cavity tray DPC's etc but wall would need to be structurally sound.
- The wall finish is replaced at the same time as the wall is insulated – an advantage when the original wall finish is in very poor condition
- Virtual elimination of the possibility of cold bridge condensation
- Suitable for use on high exposure sites where the use of full fill cavity insulation is not recommended
- Minimal disruption to the interior or occupiers
- No loss of internal room volume

Disadvantages

- High unit cost
- Requires access scaffold
- Often entraps window and door frames
- Modifications usually required to external soffits, rainwater goods, soil, waste and services pipes
- Often results in a substantial change in the appearance of the building which may not always be desirable

1.4.4 Internally applied dry lining incorporating timber battens, Thermo-Foil or similar and plasterboard

Advantages

- No need to address issues of cavity debris, sleeves, cavity tray DPC's etc but wall would need to be structurally sound.
- Suitable for use on high exposure sites where the use of full fill cavity insulation is not recommended
- Does not change the external appearance of the building

Disadvantages

- High unit cost
- Replacement cost of the internal wall finishes and decoration together with associated electrical work and second fix joinery.
- Disruption to the occupiers
- Small loss of room volume
- Criticality of vapour barrier in minimising the risk of interstitial condensation
- Future risk of localised cold bridge condensation

1.4.5 Internally applied dry lining using an insulated plasterboard system

Advantages

- No need to address issues of cavity debris, sleeves, cavity tray DPC's etc but wall would need to be structurally sound.
- Suitable for use on high exposure sites where the use of full fill cavity insulation is not recommended
- Does not change the external appearance of the building

Disadvantages

- High unit cost
- Replacement cost of the internal wall finishes and decoration together with associated electrical work and second fix joinery.
- Disruption to the occupiers
- Noticeable loss of room volume
- Criticality of vapour barrier in minimising the risk of interstitial condensation
- Future risk of localised cold bridge condensation

1.5 In summary, full cavity fill insulation is usually the most cost effective option where the cavity wall is confirmed as being in good overall condition, where the local exposure factors confirm its suitability for use and where external or internal access is not highly costly or otherwise problematic. In instances where the existing wall finish or cladding is life expired or in need of major refurbishment on a highly exposed site where an appearance change can be tolerated, external wall insulation should be considered. In the case of a building where there are complications affecting the condition of the cavity wall on a site too exposed for cavity fill insulation where an appearance change cannot be tolerated, internal insulated dry lining should be considered with the Thermo-Foil type variant minimising the loss of room volume.

2.0 "Unfillable" Cavities

2.1 A site survey using a boroscope, localised exposure or opening up of the wall structure should be carried out to confirm that there are either insufficient or no mortar joints that can be drilled to enable the insertion of the injector nozzle for the cavity fill insulation. Matters to be determined are:

- Whether one or both leafs of the cavity wall contains sufficient mortar joints to enable cavity fill insulation to be injected
- The ability or otherwise of both leafs to effectively contain the cavity fill insulation

2.2 If this preliminary inspection indicates that the building has a potentially fillable cavity, contrary to initial opinion, the following further checks should be carried out to determine:

- Storey heights where insulation is contemplated and ease of access to the elevations
- Type, condition and effectiveness of external protection or cladding (render, tile hanging, decorative/protective coating, rainscreen cladding etc.
- Type and condition of the wall finishes and decorative finishes on the inside faces of the external cavity walls together with the degree of obstruction by fixtures and fittings
- Width of cavity
- Presence, type frequency and condition of cavity wall ties
- Condition of mortar joints
- Presence of weep holes, frequency and degree of obstruction
- DPC's and cavity trays are fitted and stop-ends present
- Presence or not of debris in the cavity
- Whether all ducts or pipes have sleeves or collars
- The wind driven rain exposure zone (1-4) for the subject property(s)
- The location of the wall and its exposure to wind driven rain based on orientation, height above ground level and local site topography
- The presence or otherwise of overhangs, parapets or other construction detailing that influences the protection or exposure of the wall
- Cavity barriers are in position and there is sufficient masonry thickness between chimney (where present) and insulation

2.3 When this survey has been completed, the same process of consideration should be applied as set out in paragraphs 1.2 to 1.5 inclusive.

2.4 In the event of this investigation confirming either that no or insufficient mortar joints are present or that the wall is of steel or timber framed construction, the insulation options set out under paragraphs 1.4.3, 1.4.4 and 1.4.5 should be considered.

3.0 Party Walls and Narrow Cavities

3.1 Party Walls

3.1.1 The party wall should be surveyed involving the use of an boroscope and may also require localised exposure of masonry or opening up. A roof void inspection should be undertaken where relevant. This inspection should determine:

- Type(s) and extent of wall construction
- Type and condition of the wall finishes and decorative finishes on the inside faces of the party wall together with the degree of obstruction by fixtures and fittings
- Width of cavity
- Presence, type frequency and condition of cavity wall ties
- Condition of mortar joints
- DPC is present
- Presence or not of debris in the cavity
- Whether all ducts or pipes have sleeves or collars
- The wind driven rain exposure zone (1-4) for the subject property(s) if any section of the party wall is external
- The location of the wall and its exposure to wind driven rain based on orientation, height above ground level and local site topography if any section of the party wall is external
- The presence or otherwise of overhangs, parapets or other construction detailing that influences the protection or exposure of the wall if any section of the wall is external
- Cavity barriers are in position and there is sufficient masonry thickness between chimney (where present) and insulation
- The presence and integrity of a firebreak wall in any roof void
- Points at which the cavity fill insulation requires containment to prevent „overspill'

3.1.2 If no part of the party wall is external, exposure zone values are not relevant and can be disregarded. Consideration should be made of acoustic and fire spread properties of any insulation selected for use, together with the method that would keep disruption of the internal finishes and decoration and building occupants to a minimum.

3.2 Narrow Cavities

3.2.1 The narrower a cavity becomes, the lower the maximum recommended exposure zone value becomes for full fill cavity insulation in any given location. For example, a 50mm wide cavity filled injected with non UF foam insulation into facing brickwork with tooled flush joints has a maximum recommended exposure zone of 2, whereas the same insulation material would have a recommended exposure zone of 3 in the same wall construction but with a 75mm cavity. Clearly, full fill cavity insulation cannot be used as widely in walls with narrow cavities as in walls with wider cavities and for sites with above average exposure, external or internal insulation options should be considered. The width of the cavity in every building considered for full fill cavity insulation should be determined by boroscope or localised opening up. If a narrow cavity is only encountered to a small proportion of the total wall area, this does not necessarily preclude the use of full fill cavity insulation and consideration should be given to a localised solution to narrow cavity width.

18 Appendix G: Summary of Access Solutions

Davis Langdon Technical Note:

Summary of Access Solutions

The following table summarises the Access and Making Good Costs. These are described in more detail with their underlying assumptions in the following sections.

Item	Description	Access cost (£)	Making Good Cost (£/m2)
Access			
High-Rise	Gondola	£26,000	
High-Rise	Abseil	£19,200	
Low-Rise (<5 storeys)	Scaffold	£4,240	
Low-Rise (<5 storeys)	Mobile elevation works platform	£3,000-£4,000	
Making Good			
	General Redecoration		£6.64
	Kitchen units		£41.35

18.1 High rise solutions

18.1.1 Gondola system electronically operated

Approximately £850 for erection and dismantling.

A weekly hire rate of £150 per week.

£245 for each move (i.e. to another side of the building).

Survey and structural calculations £1,200

Operative (optional depending on training) £5,000

Lifting equipment (Cranage)/ equipment through the building £12,000

The typical load is 173kg per sq ft and that solution will always stay within the typical roof load capacity. Supplier also carry out a survey and undertake calculations prior to installation to prove adequacy of loading. Roof and balcony configuration is important to consider to ensure this method is physically possible.

The guide estimate for the high rise example used elsewhere in this study would be approximately £26,000.

18.1.2 Abseil access

At the time of finalising this report (October 2010) there is only one company in the UK that holds BBA certification for the installation of cavity wall insulation using abseil access.

The company has given a guide estimate of approximately £36,000 to insulate a high rise block comprising 13 floors (64 units) excluding 2 lower floors, using a poly bead graphite product which it installs into high rise buildings. The total cost is broken down into approximately £19,200 for access only and £16,800 for insulation installation. An indicative programme suggests 8 – 10 working days for an abseiling team to complete the works

This estimate is based on the high rise example used elsewhere in this study.

18.2 Low rise up to five storeys

18.2.1 Scaffold over four storeys

Approximately £16 per sqm for erection and dismantling

A weekly hire charge of between £150 and £200 depending on locality

An estimated cost for access scaffold for a four storey block of 8 units could be approximately £3,840 plus hire charges over 2 weeks to give a total of £4,240.

18.2.2 Mobile elevation working platforms

Approximately £550-900 per day variance depending on reach of MEWP.

An estimated cost of a MEWP for a four storey block of 8 units could be approximately between £3,000 and £4,000.

18.3 Assumptions

All prices exclude VAT

Chimney stacks have not been factored in these dwelling types

Party wall cavities have not been factored in the example prices

No cleaning or clearing of occupiers effects are factored in to the example prices

18.4 Internal access solution

Example for high rise block of flats where internal access is accepted by residents as an alternative to external access.

Internal costs per unit area would be similar for treating internal party walls.

Where the configuration of the flats in a block lead to an internal applied cavity wall solution, disruption to internal wall finishes to various rooms can be expected.

18.5 Internal Installation – Costs to Make Good

General Redecoration

Installation of lining paper - £3.12 per m^2

Two coats of emulsion - £3.54 per m^2

Total - £6.66 per m^2

Kitchens

Wall units

Removal of wall units - £12.60 per unit

Refixing of wall units - £18.51 per unit

Total per unit – £31.11 (assuming unit size of 600 x 300 x 720mm)

Base units

Removal of base units - £10.61 per unit

Refixing of base units - £18.51 per unit

Total per unit – £29.12 (assuming unit size of 600 x 600 x 870mm)

Sink units

Removal of sink units - £24.23 per unit (including temporarily capping off)

Refixing of sink units and reconnection - £26.97 per unit

Materials cost (O rings etc. as required) - £2.00 (Included in refit cost)

Total per unit – £51.20

Electric hob

Removal of integrated hob - £21.00 per unit (including temporarily disconnection)

Refixing of integrated hob and reconnection – 25.60

Total per unit - £46.60

Worktops

Fixing of worktop - £5.31 per metre

Jointing strip at corner intersection of worktops (if required) - £10.30

Ceramic Wall tiling

Removing existing tiling - £7.15 per m^2

Installation of new tiling and grout - £34.20 per m^2

Total - £41.35 per m^2 (assuming 152 x 152 x 5.5mm tiles in white)

18.6 Examples

18.6.1 Flat with One External Elevation Wall

By way of example, a two bedroom flat on the tenth floor with 1 external wall with four window openings serving key rooms, Lounge, Bedrooms and Kitchen.

Internal access to each external wall and drilling / installing cavity wall insulation (EPS Bead) requiring the following making good.

Bedroom 1

External wall – redecoration of one wall

Bedroom 2

External wall – redecoration of one wall

Lounge

External wall – redecoration of one wall

Kitchen

External wall – Redecoration of 4 walls

Removal and reinstatement of tiling above worktops

Removal and reinstatement of base kitchen units including sink

Total redecoration and reinstatement of finishes - £717.62

18.6.2 Flat with Two External Elevation Walls

In contrast, a two bedroom flat on the tenth floor with external walls with four window openings serving key rooms, Lounge, Bedrooms and Kitchen.

Internal access to each external wall and drilling / installing cavity wall insulation (EPS Bead) requiring the following making good.

Bedroom 1

External wall – redecoration of all internal walls

Bedroom 2

External wall – redecoration of one wall

Lounge

External wall – redecoration of one wall

Kitchen

External wall – Redecoration of all internal walls

Removal and reinstatement of tiling above worktops

Removal and reinstatement of base and wall kitchen units including sink and hob

Total redecoration and reinstatement of finishes - £877.04

19 Appendix H: Effect of CWI on Non-traditional Construction types

Davis Langdon Technical Note:

Summary of the effect of CWI on Non Traditional Construction Types for Dwellings in the UK

Non Traditional Construction Types in Support of Hard to Fill Cavities Wall Installations

References used for the compilation of this summary are:

- BRE Publications relating to Non Traditional Housing from a Classified List compiled by the BRE for reinforced concrete dwellings, steel framed and steel clad dwellings and timber framed housing between 1920 and 1975
- Specific reference has been made with BRE Publications 275 and 318 for Cast In-Situ Dwellings
- BR74 Preliminary Information for Panel Pre Cast Concrete Systems
- BR107 Prefabricated Reinforced Concrete
- BR113 Inspection and Assessment of Steel Frame and Steel Cladding Housing
- BR282 Timber Frame Housing Inspection and Assessment for Dwellings between 1920 and 1975

19.1 Reinforced Concrete

The BRE have identified three broad approaches to reinforced construction of dwellings, these being cast in-situ dwellings, pre fabricated reinforced concrete dwellings, and large panel system (LPS) dwellings.

Cast in-situ concrete construction methods vary, with the majority of in-situ solutions being of a single skin construction. However there are examples in existence where cavity wall construction has been cast in-situ with formwork retained to form part of the cavity forming construction. There are further examples of in-situ reinforced concrete structure with a variety of external cladding panels, including brickwork, timber and GRP as examples.

In these instances the cavities could be adequate to receive cavity wall insulation. However, with all in-situ concrete structures the condition of the cavity forming materials may present defects to be rectified before considering the retrospective installation of cavity wall insulation. Consideration ought to be given to the possible reduction in life cycle cost of the external leaf and method of fastening of the leaf before retro-fit insulation is installed.

Prefabricated reinforced concrete dwellings typically comprise pre formed pre cast concrete columns with pre cast concrete panels individually tied to supporting structural columns. Large panel construction is similar to the prefabricated reinforced concrete construction as a method and with similar characteristics. Individual precast systems vary considerably and there is a wide range of systems/products available, each designed and constructed by different manufacturers. Depending on the system type, insulation was rarely installed in the wall cavities of these systems.

The deterioration of reinforcement within the concrete as a result of climatic conditions, carbonation, chlorination content and water ingress particularly at joints between panels, is a common cause of failure.

Depending on the external cladding material, non masonry panels may limit the options available to install retrofit cavity wall insulation with appropriate consideration to retaining the current condition of the cavity forming materials and without advancing deterioration of those materials.

19.2 Timber Frame Non Traditional Construction BRE Digest T282

Timber frame construction has been defined by the BRE to evolve over three periods dating back between 1920 and 1944, 1945 to 1965 and 1966 to 1975. The changes in construction detailing for timber frame reflect external wall construction and insulation methods defined through changes in building standards and the building regulations. The three principle forms of timber wall construction identified by the BRE as non traditional form are:

- Directly clad solid timber planking (no cavity)
- Directly clad stud frame external wall (insulation between studs)
- Stud frame wall with separate cladding (insulation between studs only with a separate cavity)

The vast majority of timber frame construction are built using platform construction, i.e. one storey on top of another. In each of the methods cavities are internal and integral to the frame with the exception of the clad solid timber planking. The most common method is the stud frame wall with separate cladding which could be formed from a combination of materials including brickwork external leaf with wall ties tying it back to the structure.

Early timber frame construction tends not to incorporate features to ventilate the wall cavity. Where porous materials form the external leaf, designs have evolved to deal with water penetration and keeping cavities clear between leaves. Specific problems relate to the deterioration of sole plates to the timber structure internal leaf where products have failed or poor workmanship has resulted in moisture penetration to the timber structure from the bottom of the cavity.

The resilience of the cavity forming materials is a key consideration for timber construction where retrofit cavity installation is to be considered. Often the building paper membrane has degraded particularly at low level presenting a pathway for moisture to reach the internal leaf and especially where porous cladding materials form the external leaf. In these instances, a close cell vapour permeable cavity wall insulation option could be considered if appropriate repairs are made to the cavity forming materials and ventilation is introduced to the sealed cavities to enable moisture to wick away from the internal structure and cavity. The condition of the internal leaf should be ascertained and insulated before considering retro fit insulation to the cavity between leaves.

19.3 Steel Frame BR113

There are four broad bands types of steel frame and steel clad construction identified by BR113 and are derived according to their distinguishing features.

- Type 1 framed structure with outer leaf brickwork or other masonry or other cladding with rendered mesh (significant differences in the structural frame and components form a complex overall structure).
- Type 2 framed, concrete panel clad (the various systems under this type have significant differences in the support methods therefore systems should be identified and appropriate system report consulted).
- Type 3 framed steel clad (characteristics include an impervious outer cladding presenting condensation to the back of the outer leaf fixed to the structure)
- Type 4 reinforced load bearing panels (no separate frame composite construction).

Construction types 1 to 3 describe a structural frame located in the cavity forming the support for internal and external cladding materials. The variances of the number of types are such that the composite wall thicknesses varies widely and therefore affects the thermal performance across the composite external wall structures.

Due to the thermal properties of the different materials, the application of specific insulation methods of non traditionally constructed steel frame buildings require specific knowledge and a simulation of characteristics in order to recognise the risks of advanced material deterioration. Inappropriate application of insulation products to the cavities, next to the structure, may vary the performance of the cavity forming materials that may require additional remedies to ensure longevity and structural stability of the dwelling and its cladding components.

19.4 Summary

Cavity wall insulation applications to non traditional forms of housing construction should take into account a number of considerations including climatic factors, component life cycle and compatibility of composite construction methods. Due to the variants between different non traditional construction systems, and to the limited number of properties of each type built, there are instances where the structural type is not readily classified under the investigation by the BRE. As a result of the variances of the structure and the cladding detailing, the thermal performance of composite external wall structures presents conditions that are inherently more complex in treating than traditional construction techniques.

A survey for the building should identify the existing construction and where possible identify the conditions of cavity forming materials. If other defects exist in the construction forms then remedial works should be considered before the installation of cavity wall insulation. Other such problems may be spawling concrete, corroding wall ties, delaminating brickwork, defective construction under workmanship techniques of the composite structure including foundations. Consideration should be given to climatic conditions and behavioural properties of the materials forming the cavities in conjunction with the properties of the cavity wall installation product to ensure that the material compatibility covers a longer term and does not present adverse effects on the cavity materials that will require considerable repair in the medium term.

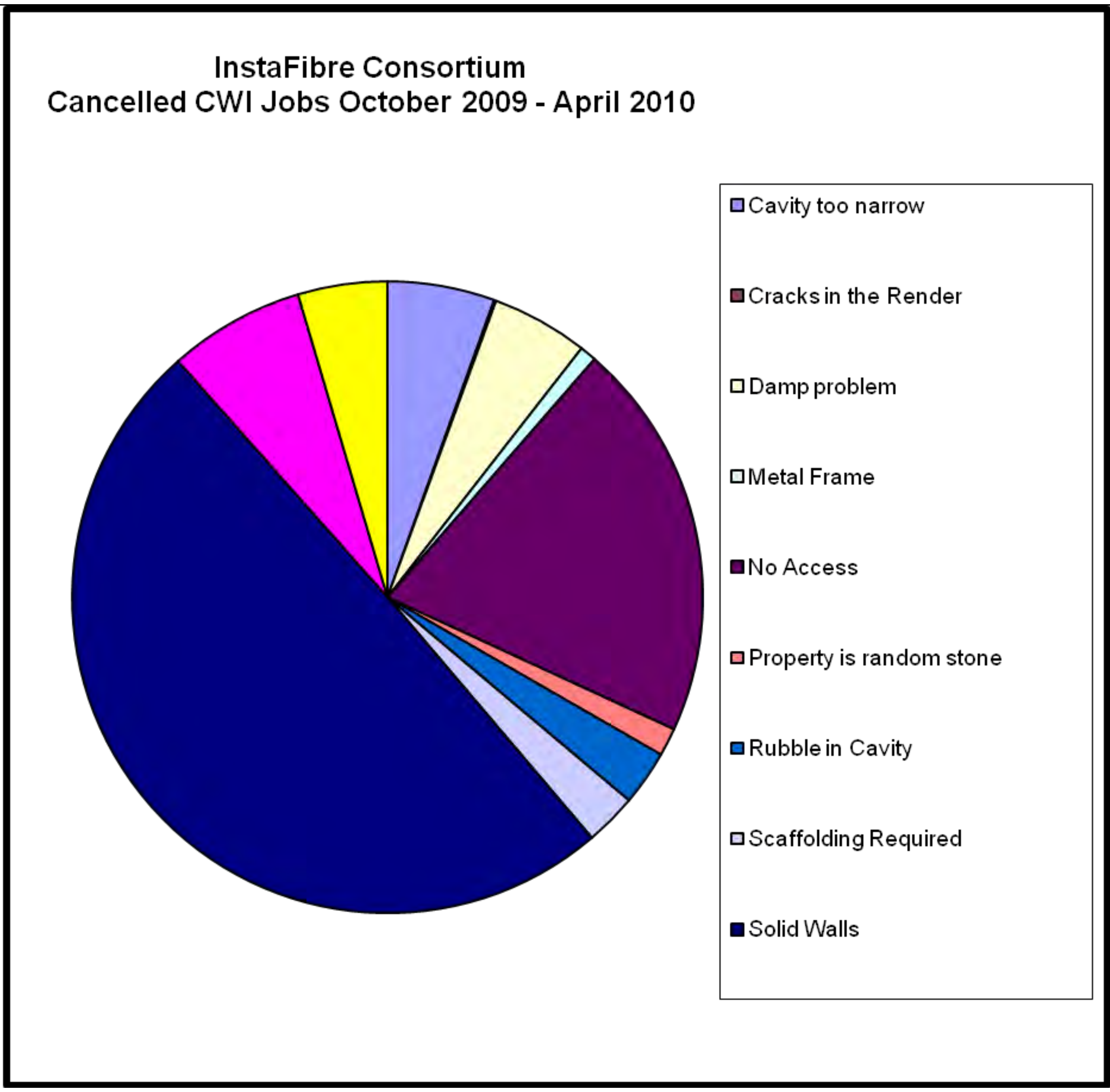
In addition to the relative forms of moisture ingress, the incidence of condensation and cold bridging occurring in existing dwellings dating back to prior 1975 occur more frequently in the non traditional forms of construction particular with concrete and steel. The conditions generated in the cavity as a result installing cavity wall insulation may reduce the life cycle of the structural components.

The choice of retrofit cavity wall installation products is more complex in non traditional housing types, requiring expert knowledge to identify appropriate solutions. In many instances, more appropriate thermal solutions may provide a better thermal performance than other construction and insulation methodologies.

20 Appendix I: Cavity Wall cancellation survey: InstaFibre Consortium

Cavity Wall cancellation survey: InstaFibre Consortium 2009-2010

Technical Factors for Cancellation



Technical and Non-technical reasons for Cancellation

CWI Cancellation Reason	No of Jobs	% of Jobs
Cavity too narrow	103	1.4%
Cracks in the Render	2	0.0%
Damp problem	93	1.2%
Metal Frame	16	0.2%
No Access	385	5.1%
Property is random stone	27	0.4%
Rubble in Cavity	53	0.7%
Scaffolding Required	50	0.7%
Solid Walls	933	12.3%
Timber Framed	131	1.7%
Ventilation requirements not met: Customer refused to have vent installed	86	1.1%
Total	**1879**	19.8%
% CWI Cancellations	20%	Note 1
Customer Cancellation Reason	**No of Jobs**	
Client - Costs	314	4.1%
Client has missed several appointments	273	3.6%
Client no longer interested	3568	47.0%
No response from client	3436	45.3%
Total	**7591**	80.2%
% Customer Cancellations	80%	Note 2
Total Cancelled Jobs	9470	Note 3

Note 1: Originally 9% Awaiting confirmation

Note 2: Originally 35% Awaiting confirmation

Note 3: Originally 21921 Awaiting confirmation

21 Appendix J: Assessment of CWI market: BRUFMA

BRUFMA

Tel/Fax. 01457 865884
E-mail. brufma@brufma.co.uk

British Rigid Urethane Foam Manufacturers Association Limited
12a High Street East, Glossop, Derbyshire SK13 8DA www.brufma.co.uk

28 April 2010

James Christofides
Inbuilt Limited
Enterprise House
Home Park
Kings Langley
Hertfordshire WD4 8LZ

Dear James

NON-STANDARD "HARD TO FILL" CAVITY WALL INSULATION

Thank you for giving us the opportunity to input into this study which we believe will identify a significant opportunity for energy suppliers to continue to achieve CERT targets with a lower investment than with external wall insulation. The market is very difficult to define but occupies a sector within the "Hard to Treat" Homes market. However we would not consider these properties Hard to Treat, but as properties which can't be insulated with standard insulation measures for technical reasons. Information has been brought together from a number of different sources as a starting point. These sources are listed in the References.

Research has been conducted to try to establish the number of properties in the UK with "Hard to Fill" Cavities. These numbers of properties **(1.35 million)** with Hard to Treat Cavities correspond very closely with the numbers identified by NEA in a Technical Paper funded by and submitted to DECC in early 2009 (**1.5 million properties**), which were arrived at using a different set of criteria. This gives an initial confidence that there is some accuracy in these estimates.

Each of the "Hard to Fill" cavity sector sizes is dealt with separately below:-

Market sectors and estimate of numbers of dwellings in each sector

1. Properties with Sub-50mm cavity widths: We estimate that these types of properties are included in the 7 million cavities which have not yet been insulated with standard insulation measures [Ref 1]. Reference 1 does not specify why these cavities have not yet been insulated, but we feel it is a reasonable assumption that technical problems will be one of the factors, and we therefore estimate that dwellings with sub 50mm cavities could number between 5% and 10% of the 7 million.
2. Random Stone Properties: Cavities are of variable width from sub 50mm upwards. We estimate that there are at least 100,000 of these types of properties in 3 Local Authorities in West Yorkshire alone [Ref 2]

Chief Executive: John Roberts Registered in England No. 1369401 Registered Office: 12a High Street East, Glossop, Derbyshire SK13 8DA
A Company Limited by Guarantee VAT Registration No. 305 7710 74

BRUFMA

3. Non-Traditional Housing: We estimate that there are 230,000 of these around the UK [Ref 3], many of which have not been insulated for various reasons. We know there are 1500 un-insulated Wates Houses which belong to Birmingham City Council where PUR has been specified on the first phase [Ref 4]
4. High-Rise dwellings: Many of the 480,000 [Ref 3] in the UK have been built with cavity construction and a large number are not insulated and may have structural and weatherproofing issues [Ref 5]

BRUFMA therefore estimates the total number of properties with "Hard to Fill" Cavities at 1.35 million.

"Hard to Fill" cavities can be insulated with an in-situ injected PUR insulant which offers an excellent insulation value. The insulation is installed by injection from the outside of the property so disruption is minimal, and the installation costs are much lower than external wall insulation.

Some of the benefits of using this type of insulation are:

- Can be used to insulate cavities of sub 50mm width.
- Can be used to insulate cavities of variable width where the narrow parts are below 50 mm, for example in random stone properties.
- Suitable for use in cavities in High Rise Properties.
- Suitable for use in properties of non-traditional construction and other types of Hard to Treat Homes.
- Provides higher insulation value than "standard" insulation measures, with typical thermal conductivities of 0.026 Wm-1K-1.
- Installed under BBA Certification Scheme.
- Listed by OFGEM as qualifying for funding under the CERT scheme.
- Reduces unwanted air leakage as it seals all gaps in the cavity wall.
- Resistant to wind-driven rain and suitable for all UK weather exposure zones.
- Provides a flood resilient insulation barrier as it is completely water resistant.
- Installation costs can vary widely depending on the cavity width and property type but a typical 3 bed semi can be insulated for approx £1500.

Many properties have already been treated successfully with PUR insulation including Multi-Storey High-Rise properties in Edinburgh, Liverpool, Rochdale, etc with variable cavity widths from 80mm to 25mm, Non-Traditional House types (for example, Wates, Orlit, Trustreel, etc), random stones properties, etc. (see attached Case Studies)

2

BRUFMA

I hope the above information is useful for the study. If I can be of any further assistance please do not hesitate to contact me.

Yours sincerely

MELANIE PRICE

References:

1) Report from Hard to treat Homes subgroup of Energy Efficiency Partnership for Homes
2) Meetings with 3 Local Authorities over the last 6 months
3) Centre for Sustainable Energy Report based on the English House Condition Survey
4) Meeting with Birmingham City Council Sept 2009.
5) Meeting with Rochdale Council and phone conversations with Sandwell Council.
6) BS 7456 Code of practice for stabilization and thermal insulation of cavity walls (with masonry or concrete inner and outer leaves) by filling with polyurethane (PUR) foam systems
7) BS 7457 Specification for polyurethane (PUR) foam systems suitable for stabilization and thermal insulation of cavity walls with masonry or concrete inner and outer leaves

3

22 Appendix K: Risk Workshop attendees

Attendees:

Stephen Bundy	Baring Insulation
Chris Hunt	BBA
Melanie Price	BRUFMA
John Connaughton	Davis Langdon LLP
Richard Newey	Davis Langdon LLP
Brian Hayes-Lewin	Davis Langdon LLP
Penny Dunbabin	DECC
Stephen Ryman	DECC
Simon Jones	DECC
Lawrence Connelly	EAGA
James Cristofides	Inbuilt
Casimir Iwaszkiewicz	Inbuilt
Gary Bundy	INCA
Mervyn Kirk	Isothane
Stephen Wise	Knauf Insulation
Daniel White	LB Camden
Ian Tebb	Polypearl
Iain Fitzgibbon	Polypearl
Darren Snaith	Rockwool Ltd

23 Appendix L: Risk Workshop presentations: 4th June 2010

DEPARTMENT OF ENERGY & CLIMATE CHANGE

RESEARCH PROJECT ON "HARD TO TREAT CAVITIES"

Dr Penny Dunbabin
Science & Analysis Team, DECC

4th June 2010

DEPARTMENT OF ENERGY & CLIMATE CHANGE

Demand reduction will help us meet CO_2 targets for 2020

1. Compared with 1990, UK greenhouse gas emissions over the 2018-2022 period must be 34% lower
2. Effort is required from all sectors:

- e.g. For household sector 28% reduction of direct emissions relative to 2008 emissions is needed

3. Strong deal at Copenhagen makes target tougher: 42% reduction relative to 1990 levels for UK

COP15 COPENHAGEN

Cavity insulation

DEPARTMENT OF ENERGY & CLIMATE CHANGE

Cavity insulation is one of the easiest & most cost-effective measures for the householder.

Reduces carbon emissions

CO_2 ↓

Helps reduce fuel poverty.

££ ↑

How many cavities are there left to fill?

DEPARTMENT OF ENERGY & CLIMATE CHANGE

Estimate around 8.4m unfilled cavities in GB in 2008...BUT

The Challenge

BRE classifies cavities into four categories:

1. Standard fillable
2. Less problematic

3. Problematic

> 4 storeys

< 75% masonry pointing

4. Unfillable

Steel or timber frame

No masonry pointing

Categories 3 & 4 account for around 4.5m cavities, and around 1 million cavities have been filled since 2008.

Aim of project

Investigate the technical problems, feasibility, costs and **risks** of insulating:

- High rise buildings
- Party walls
- Narrow cavities
- Cavities in areas affected by driving rain
- Timber framed houses
- Steel framed houses

Hard to fill cavity walls in domestic buildings **What the market is telling us: emerging findings from industry consultation**

Casimir Iwaszkiewicz

Industry Consultation

- Over 40 stakeholders contacted
- Lenders/ insurers/ certifiers/ manufacturers/ installers/ policy makers/ local authorities & academics
- Significant interest

Emerging findings

Current framework

- Industry geared towards standard cavities
- Non standard solutions cost more than the minimum – Who can win with a higher bid? What is an eligible cost?

Subsidy

- Current works are subsidy/CERT funding dependent
- Subsidy for CO_2 or Fuel Poverty?
- If No BBA warranty = No CIGA warranty = No subsidy

Emerging findings (cont'd)

Products

- Limited number of manufacturers offering BBA product warranty for HTFC e.g. "suitable for 40mm cavity" – How to increase market?

Costs

- Out of budget? – wanted a cavity fill (£400), but need building works too (£1,000-13,000)

The importance of the homeowner

- Am I bothered?

Emerging findings (cont'd)

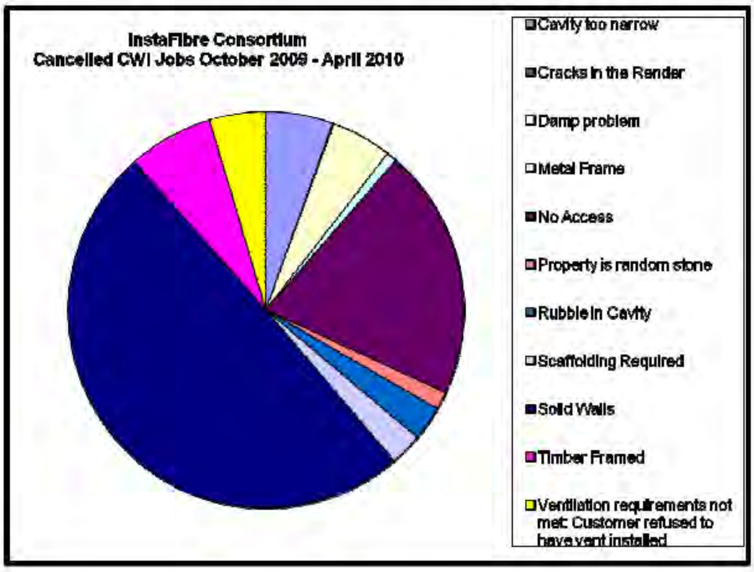
Managing risk

- How would I know which solution to specify?
- Innovation borne only by LA's – warrantied in-house, otherwise risk borne by owner
- Importance of survey and design
- Importance of case studies:

  LB Camden – innovative abseiling installation

  Calderdale C – polybead in random cavity

Cancelations – importance of survey



Cancelations – importance of survey/client interest

CWI Cancellation Reason	No of Jobs
Cavity too narrow	103
Cracks in the Render	2
Damp problem	93
Metal Frame	16
No Access	385
Property is random stone	27
Rubble in Cavity	53
Scaffolding Required	50
Solid Walls	933
Timber Framed	131
Ventilation requirements not met: Customer refused to have vent installed	86
Total	1879
% CWI Cancellations	20%

Customer Cancellation Reason	No of Jobs
Client Canc-Cost	314
Client has missed several appointments	273
Client no longer interested	3568
No response from client	3436
Total	7591
% Customer Cancellations	80%
Total Cancelled Jobs	9470

Potential Carbon Savings for the 6 month period based on the average 3 bed semi house: CO2 Lifetime 240,259.94 tonnes

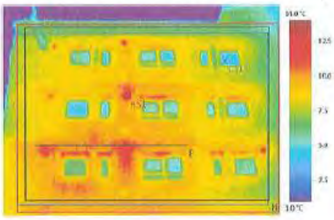
Unexpected Costs

- Cleaning dirty cavities £1000 - £3000
- Cost to a high rise tenant £3000 - £5000
- Render repair £2000 - £5000
- Defective DPC £2000 - £4000
- Removal of defective cavity insulation £100 - £1200/flat (min 50)
- Scaffolding for conservatories/single storey drilling/access issues £100 - £1,500

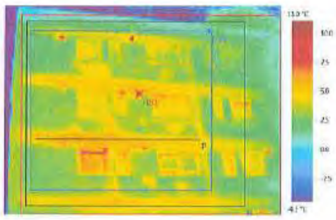
Why?

(Installation of external insulation to avoid treating narrow cavities: < £8,000)

Skills and the role of design and cold-bridge analysis - How will I know the job's been done well?




Before




After

Importance of innovation – Case Study: LB Camden abseiling installation

40% cost saving
LB Camden
Web page 30 May 2010

Improved costs to client through succesful innovation

Casimir Iwaszkiewicz, Associate Director, Inbuilt Ltd
E-mail: casimir.iwaszkiewicz@ymail.com
Tel: 01923 277068

www.inbuilt.co.uk

inbuilt

Hard-to-fill cavity walls in domestic buildings

A study for DECC
by
Inbuilt and Davis Langdon

Workshop programme

09:30	**Workshop start** **Overview of the study** Penny Dunbabin, DECC **Study approach, purpose of the workshop** John Connaughton, Davis Langdon
09:45	**What the market is telling us: emerging findings form industry consultation** Casimir Iwaszkiewicz, Inbuilt Questions and Answers
10:15	**Costs and risks: emerging findings** John Connaughton and Brian Hayes-Lewin, Davis Langdon Questions and answers
10:45	**Break**
11:00	**Focus on risks: how important are they, and how can they be mitigated?** John Connaughton, Richard Newey, Brian Hayes-Lewin and Casimir Iwaszkiewicz
12:30	**Risks and mitigation: sum-up** Report-back from breakout groups
12:40	**Implications for the study: the way ahead** John Connaughton and Casimir Iwaszkiewicz
12:50	**Final points; Any other business**
13:00	**Close, light lunch**

Davis Langdon

Davis Langdon

Hard to fill cavity walls in domestic buildings: Solutions, their likely costs and risks

John Connaughton
Brian Hayes-Lewin

Global construction consultants

Contents

Davis Langdon

Our approach

- Identify the range of cavity wall types, in consultation with CIGA
- Identify the range of dwelling types, in consultation with DECC
- Research the market to identify available technical solutions for each combination of cavity/dwelling type
- Review available best practice for Cavity Wall Insulation (CWI)
- Identify more common technical solutions for each cavity/dwelling type, their advantages and disadvantages, and associated risks
- Assess the likely costs for each solution, in consultation with the market and using standardised cost estimating techniques

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Matrix of cavity/dwelling types (1 of 2)

Cavity category Dwelling type	Category 2/3 Narrow Cavity	Category 1/2 Partial Fill/ cavity obstructions	Category 3 RC insitu Frame	Category 3 Timber Frame	Category 3 Rainscreen/ Cladding materials	Category 3 Random Stone	Category 3 Non traditional / System Built
Mid-terrace*	NCW 1 – NCW 3 NCW 2	PFCW 1 – PFCW 3 PFCW 2 –	ICCW1 – ICCW2 ICCW3	TFCW1 – TFCW2 -	ERCFCW1 – ERCFCW2 – ERCFCW3 – ERCFCW4	RSCW1 – RSCW3 RSCW2 – RSCW4	Variables to be further considered before identifying solution
End-terrace*	NCW 1 – NCW 3 NCW 2	PFCW 1 – PFCW 3 PFCW 2 –	ICCW1 – ICCW2 ICCW3	TFCW1 – TFCW2 -	ERCFCW1 – ERCFCW2 – ERCFCW3 – ERCFCW4	RSCW1 – RSCW3 RSCW2 – RSCW4	Variables to be further considered before identifying solution
Semi-detached bungalow*	NCW 1 – NCW 2	PFCW 1 – PFCW 2 –	Not Applicable	TFCW1 – TFCW2 -	Not Applicable	RSCW1 – RSCW3 RSCW2 – RSCW4	Variables to be further considered before identifying solution
Detached bungalow**	NCW 1 – NCW 2	PFCW 1 – PFCW 2 –	Not Applicable	TFCW1 – TFCW2 -	Not Applicable	RSCW1 – RSCW3 RSCW2 – RSCW4	Variables to be further considered before identifying solution
Semi-detached house*	NCW 1 – NCW 3 NCW 2	PFCW 1 – PFCW 3 PFCW 2 –	ICCWM1 – ICCWM2 ICCWM3 – ICCW1 – ICCW2 ICCW3	TFCW1 – TFCW2 -	ERCFCW1 – ERCFCW2 – ERCFCW3 – ERCFCW4	RSCW1 – RSCW3 RSCW2 – RSCW4	Variables to be further considered before identifying solution
Detached house**	NCW 1 – NCW 3 NCW 2	PFCW 1 – PFCW 3 PFCW 2 –	Not Applicable	TFCW1 – TFCW2 -	Not Applicable	RSCW1 – RSCW3 RSCW2 – RSCW4	Variables to be further considered before identifying solution
Low Rise Flat with 2 external walls*	NCW 1 – NCW 3 NCW 2	PFCW 1 – PFCW 3 PFCW 2 –	ICCWM1 – ICCWM2 ICCWM3 – ICCW1 – ICCW2 ICCW3	TFCW1 – TFCW2 -	ERCFCW1 – ERCFCW2 – ERCFCW3 – ERCFCW4	Not Applicable	Variables to be further considered before identifying solution

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Matrix of cavity/dwelling types (2 of 2)

Cavity category Dwelling type	Category 2/3 Narrow Cavity	Category 1/2 Partial Fill/ cavity obstructions	Category 3 RC insitu Frame	Category 3 Timber Frame	Category 3 Rainscreen/ Cladding materials	Category 3 Random Stone	Category 3 Non Traditional / System Built
Low Rise Flat with 3 external walls*	NCW 1 – NCW 3 NCW 2	PFCW 1 – PFCW 3 PFCW 2 –	ICCWM1 – ICCWM2 ICCWM3 – ICCW1 – ICCW2 ICCW3	TFCW1 – TFCW2 -	ERCFCW1 – ERCFCW2 – ERCFCW3 – ERCFCW4	Not Applicable	Variables to be further considered before identifying solution
High Rise Flat with 2 external walls*	NCW 1 – NCW 3 NCW 2	PFCW 1 – PFCW 3 PFCW 2 –	ICCWM1 – ICCWM2 ICCWM3 – ICCW1 – ICCW2 ICCW3	Not Applicable	ERCFCW1 – ERCFCW2 – ERCFCW3 – ERCFCW4	Not Applicable	Variables to be further considered before identifying solution
High Rise Flat with 3 external walls*	NCW 1 – NCW 3 NCW 2	PFCW 1 – PFCW 3 PFCW 2 –	ICCWM1 – ICCWM2 ICCWM3 – ICCW1 – ICCW2 ICCW3	Not Applicable	ERCFCW1 – ERCFCW2 – ERCFCW3 – ERCFCW4	Not Applicable	Variables to be further considered before identifying solution

* Overall variables – site topography / exposure zone, potential climate change, condition of cavity wall and party wall issues
** Overall variables – site topography / exposure zone, potential climate change and condition of cavity wall

Category 1 – standard fillable Category 2 – Non-standard fillable (less problematic) Category 3 - Non-standard fillable (more problematic) – Category 4 – Unfillable (Category references taken from BRE guide prepared for Homes and Communities Agency)

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7 pages

Main Installation Methods of Cavity Wall Insulation

- Low pressure/ blowing machinery
  - Fibre pellets
- Low pressure injection/ gravity fed
  - Polystyrene beads
  - Granular beads
- Foam injection
  - Polyurethane
  - Urea formaldehyde

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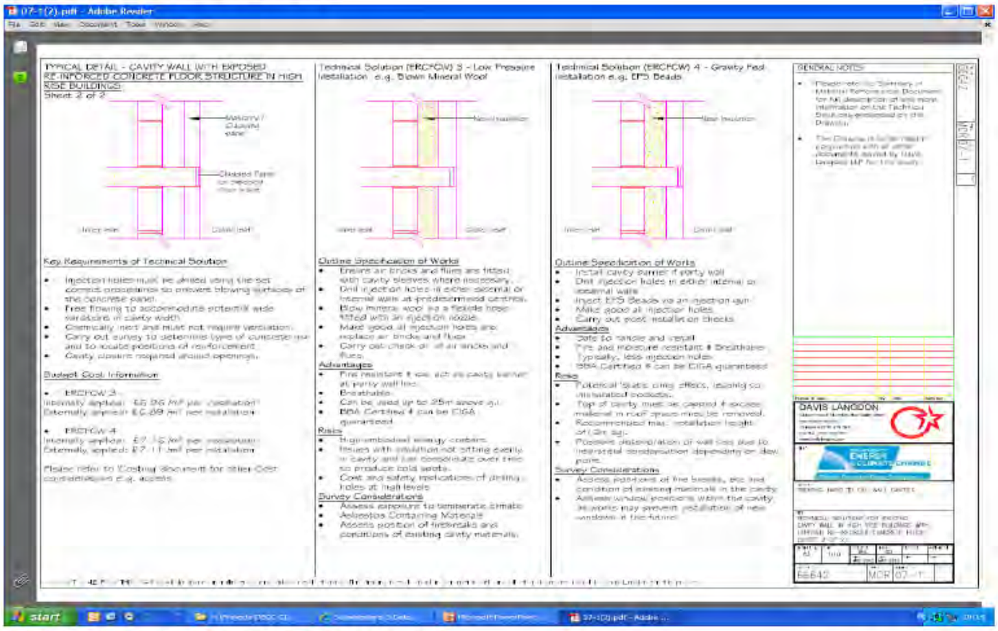
Technical Solutions



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Approximate costs per method of Cavity Wall Insulation Installation

- Low pressure/ blowing machinery
  - Fibre pellets — Average £ 7.00 psm
- Low pressure injection/ gravity fed
  - Polystyrene beads — Average £ 7.25 psm
  - Granular beads — TBC
- Foam injection
  - Polyurethane — Average £ 33.50 psm
  - Urea formaldehyde — Specific consideration only

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Focus on Risks

Risks – key issues

- Three key categories:
  - Procedural/market
  - Product/installation
  - Performance in use
- The following risks are 'generic' – there are more detailed risks associated with each solution/application:
  - Have we identified the key risks?
  - Are there others?
- How do we avoid/reduce these risks? What mitigation would be effective, and who should be responsible?

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Risk Category/Risk	Consequence	Cause, eg
1. Procedural / Market		
a) Grant application fails	No / low take up (no CO_2 reduction)	CWI system not approved / certified
b) Lack of product innovation/choice	Difficult scenarios not addressed	Highly price-sensitive market with no incentive for innovation
c) Insufficient client interest	No / low take up (no CO_2 reduction)	Lack of awareness of technical solutions, costs, risks.
2. Product / Installation		
a) Physical constraints of construction type limits installation	No / low take up	Various: quality, condition and type of construction. Some building systems unable to achieve BBA certification
b) Physical constraints of building/dwelling type limits installation	No / low take up Expensive installation costs (eg difficult access; working at height)	Building shape: height; degree of modification (eg extensions, conservatories, etc)
c) Location/climate conditions limit installation	No / low take up Poor performance in use	Location specific exposure rating
d) Hazardous materials	Expensive installation costs	Product manufacture; compliance with accepted standards
e) High embodied energy / CO_2 of product	Reduced (net) CO_2 performance	Manufacturing process
f) Damage to building fabric / interior	No / low take up Cost of remedial work	Poor installation. Condition of cavity. Inadequate survey
3. Performance in Use		
a) Poor thermal performance (inadequate heat retention)	Reduction in energy savings; energy cost and expected CO_2 reduction	Inappropriate product for construction type; poor condition of cavity; inadequate survey, etc
b) Deterioration in cavity-forming materials	Damp penetration problems; Corrosion/failure of structural elements from interstitial condensation	Rain penetration across cavity; change in dewpoint within cavity, etc
c) Escape of insulant from cavity	Reduction in energy savings, etc Cold bridging.	Unauthorised modifications to fabric (e.g. new windows)

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The way ahead

Next steps

- Consolidate workshop findings:
  - Risks
  - Mitigation actions
  - Key players
- Finalise costing exercise
- Finalise CO_2 assessment
- Report and recommendations

john.connaughton@davislangdon.com
casimir.iwaszkiewicz@inbuilt.co.uk

24 Appendix M: Glossary of terms

Abbreviation	Meaning
BBA	**British Board of Agrément:** An authority offering approval of construction products, systems and installers.
BS EN	**British European Standards Specifications**: A set of standard British technical standards based on a common European wide standard.
CIGA	**Cavity Insulation Guarantee Agency**: An insulation guarantee agency
DPC	**Damp Proof Course**: An impervious membrane laid about two brick courses above ground level to prevent damp from rising.
EHCS	**English House Condition Survey**: A national survey of housing in England, commissioned by Communities and Local Government and updated annually.
HTF	**Hard to Fill**: A form of cavity wall that is considered problematic to fill due to: obstructions in access, an inconsistent internal width of cavity, excessive height of application, exposed location subject to driving wind and rain, non-standard cavity wall construction i.e. differing from a wall comprising an outer brick leaf, a cavity and an inner brick leaf.
NHBC	**National House Building Council**: A standard setting body and warranty provider for new and newly-converted homes.
PAYS	**Pay As You Save**: A government backed scheme to provide financial incentives to home owners who take up energy saving measures
SAP	**Standard Assessment Procedure**: The Government's recommended method for measuring the energy rating of residential dwellings.

Technical Term	Description
Air Brick	Perforated brick used for ventilation, especially to floor voids (beneath timber floors) and roof spaces.
BBA Surveillance Scheme	A scheme to approve installers of BBA products
Boroscope	An optical device that allows a surveyor to look inside a cavity through a small bore opening in the leaf of a wall.
Butter Fly Wall Ties	An alternative form of wall tie holding the inner and outer leaves of a cavity wall together and shaped as a figure of eight.
Carbonation	A chemical reaction that occurs in the outer layer of mortar and concrete increasing its causticity towards metal including wall ties.
Cavity Tray	A plastic insert placed in the cavity wall that courses moisture out of the cavity via weep holes in the outer leaf of a cavity wall.
Dew point position	The position within the wall at which water vapour condenses into water. The dew point position is affected by the amount and location of insulation in the wall.
Exposure Zone	A measure of how prone a building is to wind driven rain.
Outer Leaf	The outer wall bordering the cavity
U-value	A measure of the insulation properties of a material. A wall with a low U-value has a better insulating performance than one with a higher U-value.
Wall Ties	A metal fixing linking inner and outer cavity skins or external cladding to timber framework.
Weep Holes	Holes in the outer skin of the building to allow moisture to escape from the cavity
Cold Bridge	A location within the building fabric where the building's insulation is broken or crossed. A cold bridge is an unwanted location losing heat and a potential cause of condensation build-up leading to mould growth and/or structural decay.

25 Appendix N: Stakeholders

Name	Activity	Organisation
Chris Sanders	Academic	Caledonian University
Prof Malcolm Bell	Academic	Leeds Metropolitan
Steve McBurney	Agency	CERT managers
Mark Brown	Agency	EEPfH - Energy Efficiency Partnership for Housing, Insulation Group/Fuel Poverty Action/Social Housing
Scott Restrick	Agency	Energy Action Scotland
Mat Colmer	Agency	EST – Energy Saving Trust
Ben Castle	Agency	EST Practical Help programme
TBC	Agency	HCA – Homes and Communities Agency
Rob Peck	Agency	PFH/SHESP contact
Ian Bailey	ALMO	Ashfield Homes Limited
John Lythe	ALMO	Berneslai Homes
Suraj Shah	ALMO	Brent Housing Partnership
Chris Williams	ALMO	Cheltenham Borough Homes
Ellen Gava	ALMO	Kensington & Chelsea Tenant Management Organisation
Chris Moorhouse	ALMO	Kirklees Housing
Maya Rehill	ALMO	National Federation of ALMO's
Andy Dewbury	ALMO	Newark and Sherwood Homes
Wendy Stewart	ALMO	Rochdale Boroughwide Housing
James W Henderson	ALMO	St Georges Community Housing Ltd
Lydia Wisby	ALMO	Stevenage Homes
Joe Keating	ALMO	Stockport Homes
Andy Simmonds	Association	AECB - Association of Environmentally Concious Builders
Melanie Price	Association	BRUFMA - British Rigid Urethane Foam Manufacturers' Association
Alan Onslow	Association	BUFCA - British Urethane Foam Contractors Association
Matthew Sharp	Association	EAGA
Gary Bundy	Association	Inca
Neil Marshall	Association	National Insulation Association
Joe Blaisdale	Certification	BBA – British Board of Agrément
Stephen Ryman	Government	DECC

Richard Moores	Installer	Baring Insulation
Tony Hardiman	Installer	Dyson Insulation
Bradley Isaac	Installer	Instafibre
Nina Lajara	Installer	Instafibre
Mr Webb	Installer	Interglow
Paul Mcleish	Installer	Kershaw
Ken Middlemiss	Installer	KNW
Walter French	Installer	Mark Group
Paul O'Driscoll	Installer-Main Contractor	Wates
Peter Dicks	Guarantee	CIGA - The Cavity Insulation Guarantee Agency Ltd
David Malsolm	Local Authority	Calderdale Council
Peter Bridgstock	Local Authority	Hambleton District Council
Daniel White	Local Authority	LB Camden
Ross Mitchell	Local Authority	Merton Council
Lawrence Connelly	Manufacturer	EAGA
Mervyn Kirk	Manufacturer	Isothane
Andy Patel	Manufacturer	Kingspan
Stephen Wise	Manufacturer	Knauf Insulation
Ian Tebb	Manufacturer	Polypearl
Nick Ralph	Manufacturer	Rockwool Ltd
David Burton	Manufacturer	Saint Gobain isover

25.1 Advisory Group

DECC – Dr Penny Dunbabin

CIGA – Gerry Miller

Inbuilt – Casimir Iwaszkiewicz

Davis Langdon – John Connaughton

Contact details

Casimir Iwaszkiewicz, Associate Director
Inbuilt Ltd
Faraday House
Station Road
Kings Langley
Herts
WD4 8LH
UK

T: +44 (0) 1923 608140

E: casimir.iwaszkiewicz@inbuilt.co.uk
W: www.inbuilt.co.uk
www.res-group.com

inbuilt