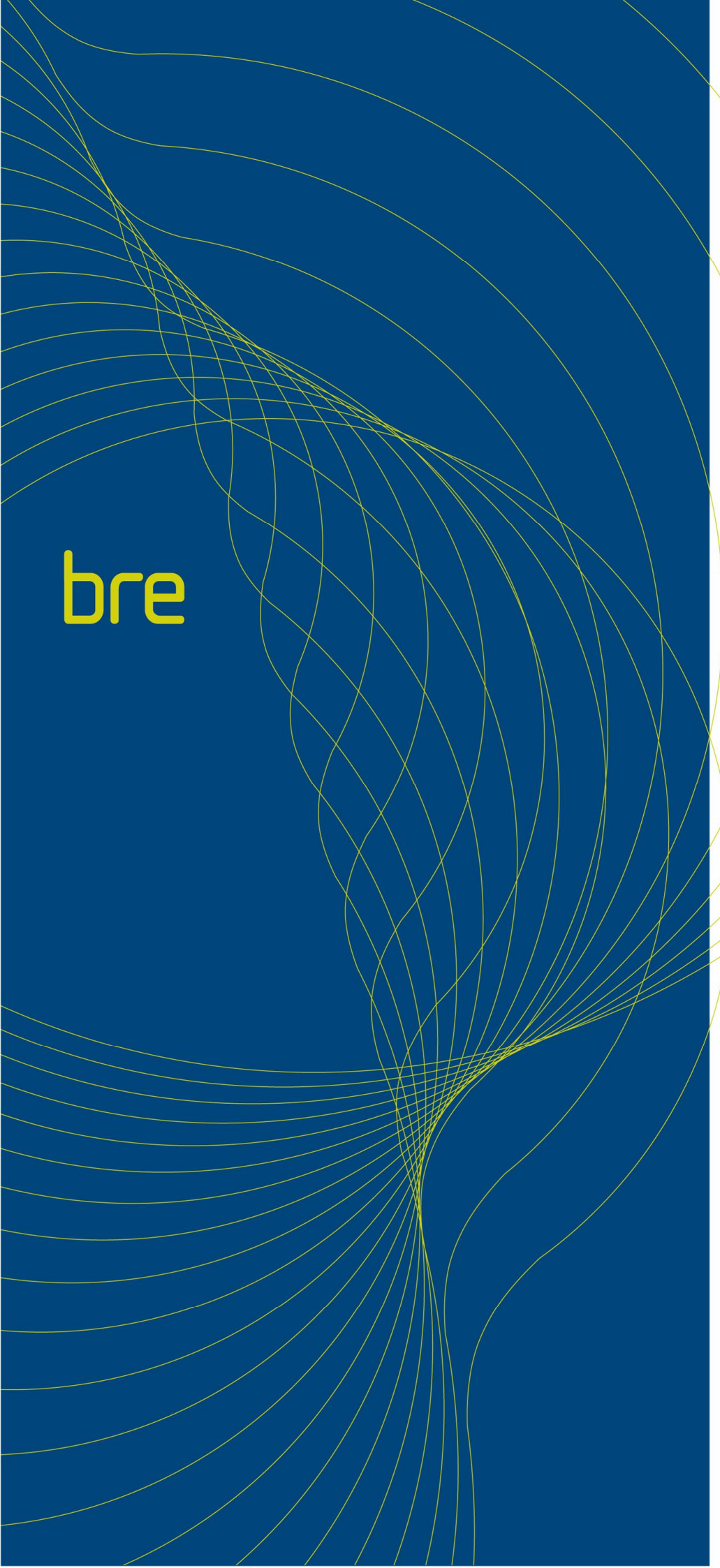

Galley's Bank Estate -

Final Report:

Stages 3 and 4: Option Development and Option Appraisal

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6th July 2010

Client report number 260-844

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Executive Summary

Non-traditional system houses were a feature of the post war UK building boom. The system approach to design meant that, in the 1940s and 1950s, when resources were stretched, houses could be built using generally unskilled labour and few imported materials. As a result some 1½ million non-traditional properties were built throughout the country. One such house type was the Schindler-Gohner system [4]. Some 1,400 dwellings of this type were built by Hawksley Construction in the UK between 1949 and 1954/5.

The Galleys Bank Estate, Kidsgrove, in the Borough of Newcastle-under-Lyme, contains well over 200 of these dwellings, the vast majority of which were constructed as pairs of semi-detached 2-storey houses.

RENEW North Staffordshire has recently purchased the semi-detached 2-storey Hawksley SGS property at 34 Victoria Avenue, Kidsgrove and wishes to develop a cost-effective method of bringing this type of property up to a mortgageable standard. It is looking to do this in two Phases. Phase I consists of baseline research and options appraisal, whereas Phase II involves the implementation and delivery of the selected approach.

Following the submission of proposals by a number of consultants, BRE and Michael Dyson Associates - working in partnership - were commissioned by RENEW North Staffordshire to undertake a programme of work which involves various desk studies and a site-based investigation of 34 Victoria Avenue, Kidsgrove, aimed at developing a cost-effective method of bringing this type of property up to a mortgageable standard.

The aim of the current programme of work is to establish the current condition and future life expectancy of the recently purchased Hawksley SGS property and hence find the most cost-effective method of refurbishing it up to a mortgageable standard, to implement the chosen method on the pilot house and to use the information gleaned from this process to develop the basis of a strategy for the estate.

This part of the commission consists of five stages, and this report contains the results of Stages 3 and 4: options development and appraisal.

Six remedial Options have been developed, covering two Categories:

- Category 1: Solutions where the existing structural frame can be retained
- Category 2: Solutions where the existing structural frame cannot be retained

The basis on which the preferred Options have been selected has depended on a combination of their structural appropriateness, their practicality and their cost.

Our preferred Options for Categories 1 and 2 are:

- Category 1: Option 2: Strengthen the existing frame and overclad with rendered insulation, using the grouting solution
- Category 2: Option 3: Retain first floor and roof construction. Construct new load bearing masonry inner leaf, accessed from outside the building.

Contents

1 Introduction

Non-traditional system houses were a feature of the post war UK building boom. The system approach to design meant that, in the 1940s and 1950s, when resources were stretched, houses could be built using generally unskilled labour and few imported materials. As a result some 1½ million non-traditional properties were built throughout the country. One such house type was the Schindler-Gohner system [4]. Some 1,400 dwellings of this type were built by Hawksley Construction in the UK between 1949 and 1954/5.

The Galleys Bank Estate, Kidsgrove, in the Borough of Newcastle-under-Lyme, contains well over 200 of these dwellings, the vast majority of which were constructed as pairs of semi-detached 2-storey houses.

Some 40% of the dwellings on the estate have undergone remediation but over half have still not been improved and mortgage providers are unwilling to lend money on these properties unless demanding lending criteria are met by potential owner occupiers. As a consequence, private landlords have acquired these properties as cash purchases and rented them on short hold tenancies - this has led to a large transient population on the estate which has had a negative impact on the social and economic status of the area.

The Housing Defects Act 1984 (now incorporated into the Housing Act 1985) was introduced to deal with problems associated with precast reinforced concrete (PRC) properties that had been purchased under the Right to Buy from local authorities and were found to have corrosion or other defects. The Act made provision under an accredited repair scheme (the PRC Homes scheme) and grants were provided to homeowners wishing to bring their properties up to a mortgageable standard. Unfortunately, the government ceased to fund the scheme in the 1990s and it lapsed. The National House Building Council (NHBC) still keeps a list of the firms that will undertake work to the PRC scheme standard and for some people with a PRC constructed property, this is a route to mortgageability.

The Non-Traditional Homes Appraisal Scheme (NTHAS) was developed as an alternative method of achieving mortgageability for designated defective property types and is based upon an engineering assessment of the concrete components rather than an assumption that reinforced concrete is suspect and should be replaced or made redundant.

The NTHAS is accepted by a panel of supporting lenders and Michael Dyson Associates, a founding member of the scheme.

RENEW North Staffordshire has recently purchased the semi-detached 2-storey Hawksley SGS property at 34 Victoria Avenue, Kidsgrove and wishes to develop a cost-effective method of bringing this type of property up to a mortgageable standard. It is looking to do this in two Phases. Phase I consists of baseline research and options appraisal, whereas Phase II involves the implementation and delivery of the selected approach.

Following the submission of proposals by a number of consultants, BRE and Michael Dyson Associates - working in partnership - were commissioned by RENEW North Staffordshire to undertake a programme of work which involves various desk studies and a site-based investigation of 34 Victoria Avenue, Kidsgrove,

aimed at developing a cost-effective method of bringing this type of property up to a mortgageable standard.

The aim of the current programme of work is to establish the current condition and future life expectancy of the recently purchased Hawksley SGS property and hence find the most cost-effective method of refurbishing it up to a mortgageable standard, to implement the chosen method on the pilot house and to use the information gleaned from this process to develop the basis of a strategy for the estate.

This part of the commission consists of five stages:

Stage One: Desktop Research

- *A review of relevant documentation, historical records and structural reports in relation to the Schindler properties, original methods of construction and subsequent refurbishment works*
- *Investigation into the key aspects of the construction type and any other factors (e.g. construction method, ground conditions, topography, housing market conditions and other factors that you feel are appropriate) which account for the difficulty in obtaining mortgage finance for the purchase and/or improvement of such properties*

Stage Two: Survey Work

- *Full environmental and ground conditions survey of the pilot property*
- *Full structural survey of the pilot property and any opening up work to determine the construction of building elements*
- *Resolution of all potential issues around the Party Wall etc Act 1996*

(NB Stages One and Two may be undertaken concurrently)

Stage Three: Option Development

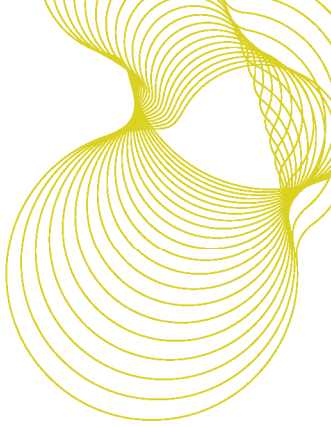
- *Identification of a range of fully costed options for remedial building works that would enable a certifiable and mortgageable standard (i.e. written confirmation/certificate from an a indemnity underwriter provider Avivia/Zurich) and/or a higher standard to be agreed) to be attained for the pilot property and to identify any limits on the implementation and/or applicability of each option to the pilot property and other properties of a similar construction type*

Stage Four: Options Appraisal

- *Using criteria to be agreed, appraisal of the options and identification of the most advantageous option as the basis for the pilot project*
- *Assessment of any additional advantages and challenges for roll-out of the chosen method on the Galleys Bank estate to be tested as part of the implementation of the pilot project*

Stage Five: Specification of Preferred Option

- *Preparation of a detailed construction methodology, specification of works and delivery statement for the preferred option for the pilot study*
- *Obtain planning permission, building regulation approval and Party Wall Act approvals, as necessary. For the latter this will include liaising with the owner of the adjacent property, preparing Notices, appointing party wall surveyor(s) and any other actions to comply with the Act.*



An initial report - BRE Report 260-345 - covering the Stages One and Two of the programme has already been produced.

This report covers both Stages Three and Four of the programme, the development and appraisal of the options.

2 Summary of Stages One and Two: BRE Report 260-345

The initial report - covering Stages One and Two of the programme - included the results of an intensive site investigation, and examined the following:

- a programme of intrusive investigations of the structural frame within 34 Victoria Avenue, Kidsgrove,
- a comprehensive programme of on-site measurements of concrete cover and depth of carbonation and the wet chemical analysis of concrete dust samples taken from selected areas of the structural frame,
- an assessment of the current condition and likely future durability of the in-situ concrete frame and wall ties and hence their potential residual life.
- a desk based review of documentation pertaining to the Hawksley SGS system built house construction.

BRE's preliminary conclusions, following the programme of site-based investigations and materials testing programme, was that, while the structural concrete frame contains significant defects, the apparently satisfactory in-service performance over a period of some 60 years would suggest that there is an adequate level of redundancy with the structural system to accommodate the range and frequency of defects noted during the investigation and the loading history that has occurred over the life of the property.

This opinion was supported by the apparent lack of visible counter-indications within the structural frame itself and/or in the plaster based internal lining to the external walls and internal partitions.

In addition, the level of chlorides found within the concrete in both the columns and the beams forming the structural frame that supports the building were found to be very low - i.e. <0.4% Cl^- by weight of cement in both cases.

Therefore on this basis, and providing there is no subsequent deterioration of the concrete frame due to water ingress or leaks, then we consider that the frame can be retained as part of any future refurbishment works to this property.

It is important to stress that the conclusions drawn from the invasive investigations of 34 Victoria Avenue and the associated programme of material testing are only relevant to this particular property.

We consider that it would be inappropriate and unwise to extrapolate the findings of this single evaluation to other Hawksley SGS houses on the estate.

3 Stage Three: Option Development

Having carried out the onsite investigations, the next stage involves developing a range of upgrading options to ensure that the houses on the estate can have a long remaining life: sixty years is a typical figure for the life expectancy of a new building and there is no reason why the solutions developed here should not be consistent with that. Clearly, the solutions will need to be appropriate to the buildings' needs, be certifiable and of a mortgageable standard.

This report contains an examination of the options for opening up the structure, internally or externally, the level of concrete repairs needed and the reinstatement works.

In addition to the remedial works needed, BRE has examined the relative thermal performance of the various options put forward by calculating U-values for the various wall constructions. This allows a comparison to be made of the thermal performance of the various wall forms, although the requirement of AD L1B is that any wall that is upgraded must have a minimum U value of 0.35 W/m²K.

As part of the remediation process, MDA have advised to ensure that the solutions developed are acceptable to the insurance underwriters and building societies for mortgageability purposes.

3.1 Options

Following both an examination of the results for the building and discussions with MDA, we have drawn up a number of remedial options for this house type.

These fall into two categories:

- Category 1: solutions where the existing structural frame can be retained.
- Category 2: solutions where the existing structural frame cannot be retained

As discussed at the first project review meeting that took place in the Town Hall, Kidsgrove on the 18th February 2010, all Category 1 solutions will require an associated inspection and testing regime to support them.

Within these Categories, we have devised a number of solutions:

1. **Category 1: Solutions where the existing structural frame can be retained**

- **Option 1: Retain the existing frame and overclad with rendered insulation**

  The existing frame is in a reasonable condition: no signs of either cracking or crushing of the internal finishes at either the top or the bottom of the internal walls; the chloride ion content confirmed by testing to meet with the engineering requirements of NTHAS.

Therefore an option is to leave the existing structural frame and over-clad the existing brickwork with rendered insulation.

– **Option 2: Strengthen the existing frame and overclad with rendered insulation**

The existing frame is in a reasonable condition, but there are some signs of either cracking or crushing of the internal finishes at either the top or the bottom of the internal walls; the chloride ion content confirmed by testing to meet with the engineering requirements of NTHAS.

Strengthen the existing structural frame through the use of stainless steel straps and ties.

Therefore the option is again to leave the existing structural frame and over-clad the existing brickwork with rendered insulation.

2. Category 2: Solutions where the existing structural frame cannot be retained

In all of these options, it is assumed that the frame is inadequate - for whatever reason, including the presence of excessive chlorides and/or the presence of cracking or crushing in the internal finishes - and that the structural loads need to be taken by a new structural framework.

– **Option 3: Retain first floor and roof construction. Construct new load bearing masonry inner leaf, accessed from outside the building.**

This option involves making the frame redundant by adding blockwork between the current columns. In this case, the work is carried out from the outside of the building - by removing the existing brick outer leaf and building the new structural element between the existing structural frame.

Having done this, a new outer leaf would be fitted. In practical terms, the most appropriate would be a cladding system, incorporating insulation, rather than a new brick outer leaf.

– **Option 4: Retain first floor and roof construction. Construct new load bearing masonry inner leaf, accessed from inside the building.**

This option involves making the frame redundant and adding blockwork between the current columns. In this case, the work would be carried out from the inside of the building, by removing the internal finishes - including the plasterboard between the columns - and building the new structural element between the existing structural frame. Having done this, new internal finishes would be fitted.

At the same time, the existing brickwork would be over-clad with rendered insulation.

– **Option 5: Retain first floor and roof construction and outer masonry leaf. Remove structural frame. Construct new load bearing steel framework. Install lining to external wall.**

This option involves removing the structural frame and the whole of the inner leaf and then constructing a new inner leaf using a steel studding system. This work would be carried out internally, as the existing outer leaf would be retained to provide a fixing surface for over-cladding with rendered insulation.

- **Option 6: Retain first floor and roof construction. Remove structural frame. Construct new load bearing external walls: masonry plus cladding system.**

  This option involves removing the external walls in their entirety; constructing a new load bearing inner leaf using blockwork; and then fitting a cladding system, incorporating insulation, to the outside of the building.

4 Additional issues

4.1 Further detailed issues associated with the refurbishment of 34 Victoria Avenue

The following points need to be considered:

1. In all cases, the condition of each house needs to be established prior to the selection of the most appropriate remedial measures. This is to be undertaken following the requirements of a set of preliminary enabling works - a draft set of these are contained in Appendix A. Once the condition of the building has been established, the appropriate Option(s) can be identified.

2. Draft outline remedial works setting out the steps needed for each of the options are contained in Appendix B.

3. For each option that maintains the existing outer leaf, the location of all of the vertical wall ties will need to be identified and these ties removed from the building; new ties will subsequently need to be fitted, as required by the design. Where the option involves removing the outer leaf, the ties will be removed at the same time.

The location of any butterfly wall ties is not important, except where they might affect the installation of the new works: butterfly wall ties are made from relatively thin wire and the bursting forces they create in the outer leaf are generally found to be insufficient to cause cracking of brickwork.

4. The requirements of Approved Document Part L1B - 'Conservation of fuel and power in existing buildings' - would relate to the houses on this estate and there is the requirement that the thermal performance of a wall in an existing building that is replaced be improved to a value of 0.35 W/m²K. Even if no more than 25% of the elements surface treatment (plaster/render) is removed, it is classed as renovation and you are obliged to upgrade to these standards.

5. In general, the amount of insulation that has been incorporated into the various options has been sufficient to provide the required U value of 0.35 W/m²K and it has been assumed that phenolic/polyurethane foam has been used. In one case - covering Options 1 and 2 - the impact on the U value has been calculated for increasing the thickness of the insulation from 50mm to 90mm. The increase in cost associated with this increase in insulation works out at approximately £6/m^2.

6. In all cases where the existing frame is retained, it is a requirement for NTHAS purposes that the solution maintains the frame in a dry condition. For that reason, we have limited the solutions to rendered insulation.

7. Red shale has been found to be present in the area. This is an expansive material which, when found under a concrete slab, damages the floor and requires the slab to be replaced. As a result, tests to check for the presence of red shale should be undertaken on each house assessed on this estate. The current costs associated with the replacement of the ground floor - i.e. digging out; adding: hardcore; insulation; d.p.m.; laying a slab; adding a screed - should be assumed, for budget purposes, to be around £7500, plus VAT.

8) In view of the condition of the house at 34 Victoria Avenue, it should be expected that additional works would be required to bring this property up to habitability at the Decent Homes standard. The costs associated with those works are as follows:

- replacement kitchen £4500
- replacement bathroom £3300
- full rewire £3000
- re-roofing £4400
- full heating system £3500
- re-decorating £1,500

9) Were the demolition of the existing house and its replacement with a new build house to be considered, the various costs associated with this are likely to be as follows:

- Acquisition of a property: £40,000
- Compensation: £4,000
- Professional Fees: £1,500
- Legal Fees: £1,000
- New Build costs for 80sq: £101,000

  Total: £147,500

4.2 Mortgageability

As far as the mortgageability is concerned, the two main elements required by the NTHAS of any remedial solution are that the concrete in the frame has a low chloride content - measured as <0.4% Cl^- by weight of cement - and that the solution guarantees that the frame is kept dry after the remedial works are completed.

The specific requirements are that the external components need to meet a criteria of "fewer than 1 in 20 failures above 0.6 % chloride by weight of cement" for NTHAS 3 to retain the frame. However, in this instance we would argue that, because the outer frame is already protected by an outer brick leaf which will then be overclad with an insulated render, the frame is in effect an "internal" element, in the same way as the party wall and spine walls are considered internal elements - rather than external and exposed to the weather. In this case the frame would only need to pass the "No samples above 1.0% chloride by weight of cement" criteria. Either way, the frame at Nr 34 Victoria avenue passes NTHAS.

As a result, every house that is proposed to have the selected remedial solution fitted will need to be assessed - both visually and invasively - before any work is carried out, with the chloride ion content of the concrete needing to be confirmed through testing at a number of locations within each house to meet with the engineering requirements of NTHAS. A draft set of Preliminary Enabling Works are contained in Appendix A.

4.3 Costings

The costing contained in this document have been drawn up by a chartered QS and are intended to act as a guide to the costs associated with each option. As such, they should be seen as giving a relative price for the various options put forward rather than absolute costs.

The final Stage of this part of the project - Stage 5 - will require more precise costing.

4.4 Space heating and CO_2 issues

In addition to identifying the impact of adding more insulation than is required by the Building Regulations on the U values of the walls, we have also carried out a generic assessment of the differences in both the CO_2 emissions and the energy costs associated with heating a building of the type found at 34 Victoria Avenue.

Earlier, we stated that increasing the thickness of the insulation from 50mm to 90mm reduces the wall's U value from 0.33 to 0.20 W/m²K. Taking a semi- detached house of roughly the same size as the one being assessed, we have used a SAP analysis to calculate the following properties for that house based on three different wall U values: the existing value, of approximately 1.7; the improved value associated with the Building Regulations, of 0.33; and the improved Building Regulations value of 0.20.

The impact these three U values have on both emissions and space heating costs can be seen in the table below:

Wall form	Wall U value (W/m²K)	SAP rating	Space heating	
			CO_2 emissions (kg/year)	Annual costs (£/year)
As is	1.70	F29	6021	£520
Improved, plus 50mm phenolic insulation	0.33	E48	3438	£297
Improved, plus 90mm phenolic insulation	0.20	E50	3194	£275

It can be seen that, simply by upgrading the wall to a U value of 0.33 W/m²K the CO_2 emissions will be reduced by 43%, while the reduction in the annual space heating costs would be expected to reduce by over £220/year.

Note: These figures should be seen as providing an indication of the relative performance of the different wall configurations and not absolute values. For a start, they are based on a SAP model put together for a generically similar property - not the same one - and do not include any changes in the specification of the

house other than the walls. For example, it would be typical to improve the U values of the roof space - and possibly the floor - and replace the existing windows when refurbishing a house; in addition, an efficient boiler would be expected to be fitted. None of these measures have been incorporated in the model which has been used to calculate the table - they rely solely on the walls being improved.

4.5 Estimated remaining life of the property

The expected remaining life of the house at 34 Victoria Avenue, Kidsgrove is difficult to predict as it depends on a large number of factors. A number of these - and the level of intervention that might be expected is one - are critically important.

For a building to "fail", generally one, or more, step changes need to occur to that building that allow water to enter in dramatically increased quantities; this increase in water ingress leads to a sudden increase in the rate of degradation of the building's fabric. This type of step change is provided by failures of such elements as a section of the roof, a window, or the membranes that keep water out of the building.

There can be many reasons for these elemental failures, ranging from the gradual degradation of fixings - for example, the corrosion of the nails holding roof tiles in place leading to roof tiles falling off - to vandalism - such as the breakage of windows or doors. Whatever the cause, if the damage is not put right relatively quickly, degradation of the fabric will occur; if the damage is not put right at all, the fabric will suffer major and ongoing accumulated damage. Ultimately, this will result in the failure of the building.

In this context, failure would be likely to be defined in terms of a serviceability failure of the house - that is, the house wouldn't actually fall down, but the costs associated with making good the degradation that had occurred would be greater than the house itself was worth and would, therefore, not be viable/cost effective.

This is where the difficulty arises in predicting a service life of 34 Victoria Avenue: it will depend on the type of elemental failure and the level - and rate - of the preventative intervention once that occurred.

For that reason, we can only provide scenarios covering a range of possibilities, each of which has an estimate of the likely life.

- **Scenario 1: no intervention post-element failure**

  In this context, the factors that would affect the rate of degradation would be: the severity of the weather; the location of the damage in relation to the direction of the prevalent weather; and the element that failed.

  Expected remaining life: ranging between 3 years to 10 years

- **Scenario 2: intervention limited to stopping access to the building by other parties**

  In this context, the factors that would affect the rate of degradation would be: the severity of the weather; the location of the damage in relation to the direction of the prevalent weather; and the element that failed - if it was a window, it would be repaired relatively quickly; if it was part of the roof, it would not be repaired.

  Expected remaining life: ranging between 3 years to 15 years

- **Scenario 3: full intervention post-element failure**

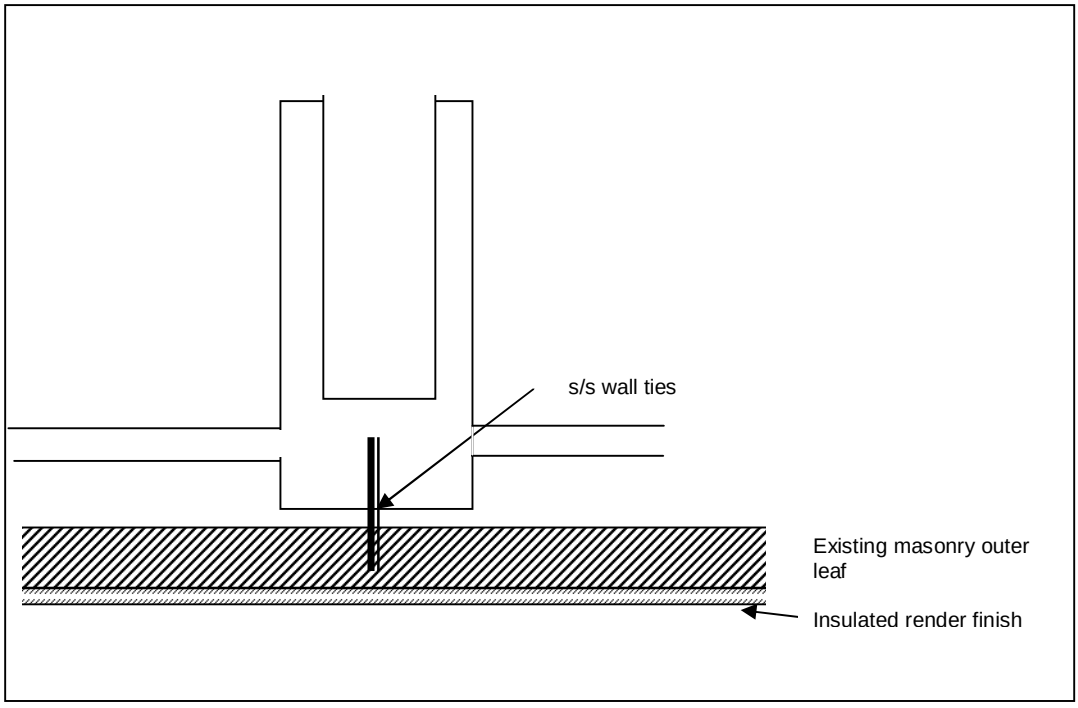
In this context, all the damage would be made good rapidly and the house would be unlikely to degrade.

Expected remaining life: unlimited

5 Option 1: Retain the existing frame and overclad with rendered insulation

This option assumes that the investigation of the building has shown that the existing frame is in a reasonable condition - with no signs of either cracking or crushing of the internal finishes at either the top or the bottom of the internal walls - and that the chloride ion content has been confirmed, by testing, to meet the engineering requirements of NTHAS.

As a result, the existing structural frame can be left in place and the existing brickwork over-clad with rendered insulation to ensure both that the frame remains dry and that the thermal performance of the walls is improved. In this case, it is necessary to apply 50 mm of phenolic or polyurethane insulation to meet the required U value of 0.35 W/m²K.



Costs associated with this option: £14k

The wall makeup is:

- existing wall;
- 50 mm phenolic/polyurethane insulation;
- rendered outer coat

U value for this wall form: 0.33 W/m²K.

If the thickness of insulation is increased from 50mm to 90mm, the U value reduces to 0.20 W/m²K, with a cost increase associated with the insulation of approximately £1k.

6 Option 2: Strengthen the existing frame and overclad with rendered insulation

This option assumes that the investigation of the building has shown that the existing frame is in a reasonable condition and that the chloride ion content has been confirmed, by testing, to meet the engineering requirements of NTHAS. However, there are some signs of either cracking or crushing of the internal finishes at either the top or the bottom of the internal walls.

Under these circumstances, it would be appropriate to apply strengthening to the frame in strategic locations - namely, in those areas that the preliminary enabling works have shown contain voids in the concrete frame. In this case, we propose that the strengthening works involve the addition of either an expanding grout in the areas where voids are present in the frame or the fixing of steel brackets to the top and bottom of the columns.

To do this, the first floor and eaves level perimeter beams, the spine beams and all the corner columns and the columns in the party wall will all need to be examined; the intermediate ones do not have reinforcement and are not critical in this regard.

Grouting solution:

Specifically, having identified those areas where the concrete is missing within the first floor and eaves level perimeter beams, the spine beams and all the corner columns and the columns in the party wall, the following steps need to be taken:

1. Drill the top and cut a slot in the bottom of all the columns;
2. Identify and remove any material that is acting as filler at the base of the columns;
3. Make good access holes; and
4. Pump in expanding grout to fill any voids.

Having installed the strengthening measures, the existing brickwork should then be over-clad with rendered insulation.

Costs associated with this option: £19k

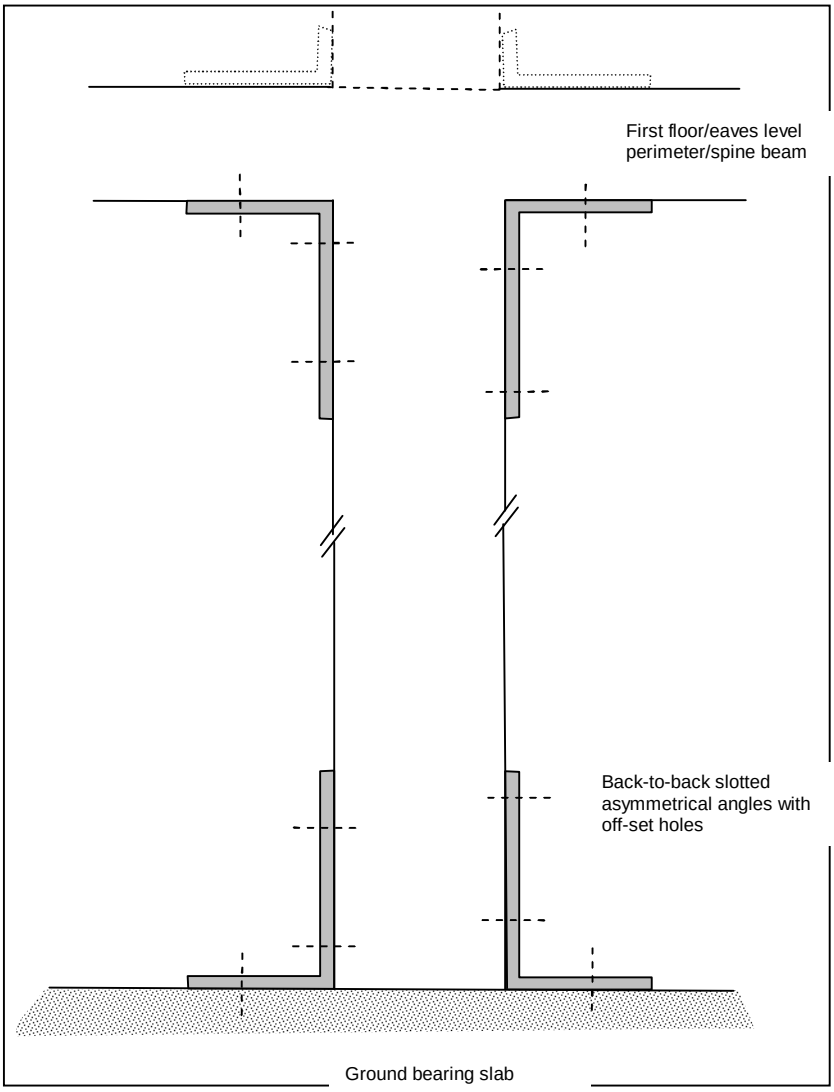
Steel bracket solution:

Alternatively, add steel straps to the outside surfaces of the vertical columns, using staggered resin bonded fixings to fix these into the columns and to the floor slab/beam (see diagram on next page).

Costs associated with this option: £25k

This strengthening work will need to be applied from the outside of the building.

- Having installed the strengthening measures, the existing brickwork should be over-clad with rendered insulation.



Option 2: Schematic Vertical Section at Column / Beam Intersection Showing Position of Strengthening Angles

The wall makeup is:

- existing wall;
- 50mm phenolic/polyurethane insulation;
- rendered outer coat

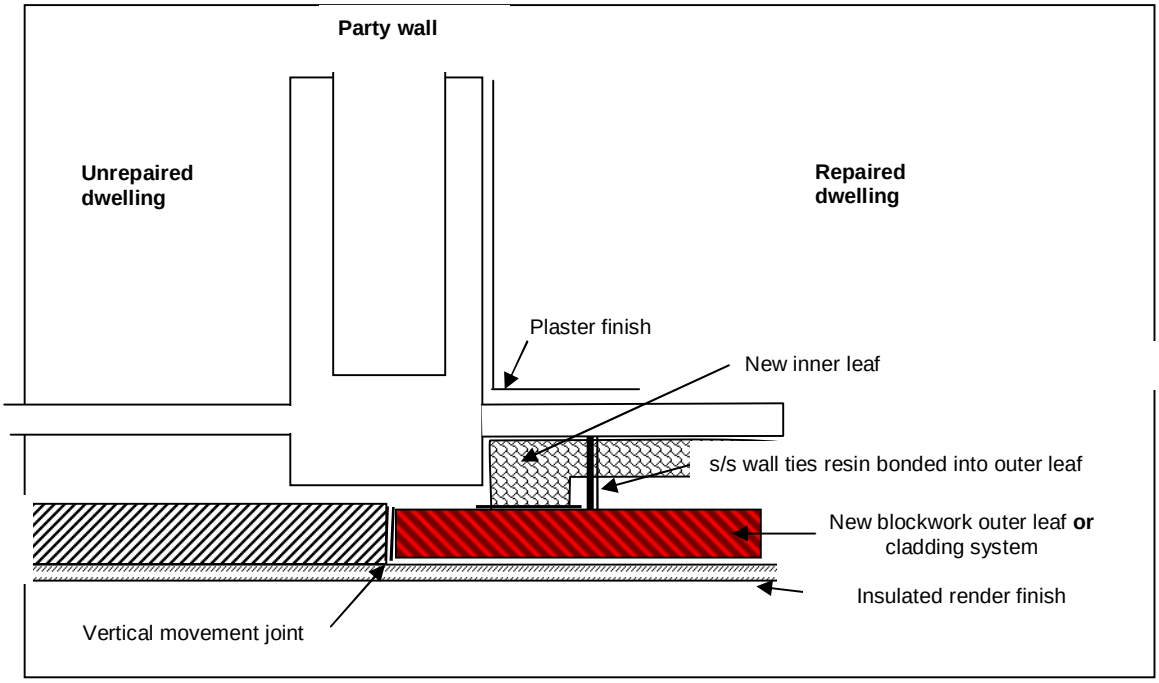
U value for this wall form: 0.33 W/m²K

7 Option 3: Retain first floor and roof construction. Construct new load bearing masonry inner leaf, accessed from outside the building.

This option assumes that the investigation of the building has shown that the existing frame is not capable of supporting the loads applied to the building, either because it is in too poor a condition - resulting in considerable areas of cracking or crushing of the internal finishes at either the top or the bottom of the internal walls - or because the chloride ion content is too high to meet the engineering requirements of NTHAS.

In this case, the frame would be made redundant by adding blockwork between the current columns to provide the structural support for the building. The work would be carried out from the outside of the building - by removing the existing brick outer leaf and building the new masonry structural element between the columns of the existing structural frame.

Having done this, a new outer leaf would be fitted. In practical terms, this could be either a new blockwork outer leaf - with rendered external insulation - or a proprietary cladding system - incorporating the insulation. We believe the costs to be roughly the same for these two cases, so just one cost has been provided.



Option 3: Plan view

Costs associated with this option: £30k

The wall makeup for the blockwork solution is:

- internal plaster finish;
- existing frame construction;
- 100mm aircrete blockwork (450kg/m^3);
- 25mm cavity;
- 100mm aircrete blockwork (600kg/m^3);
- 25mm phenolic/polyurethane insulation;
- rendered outer coat.

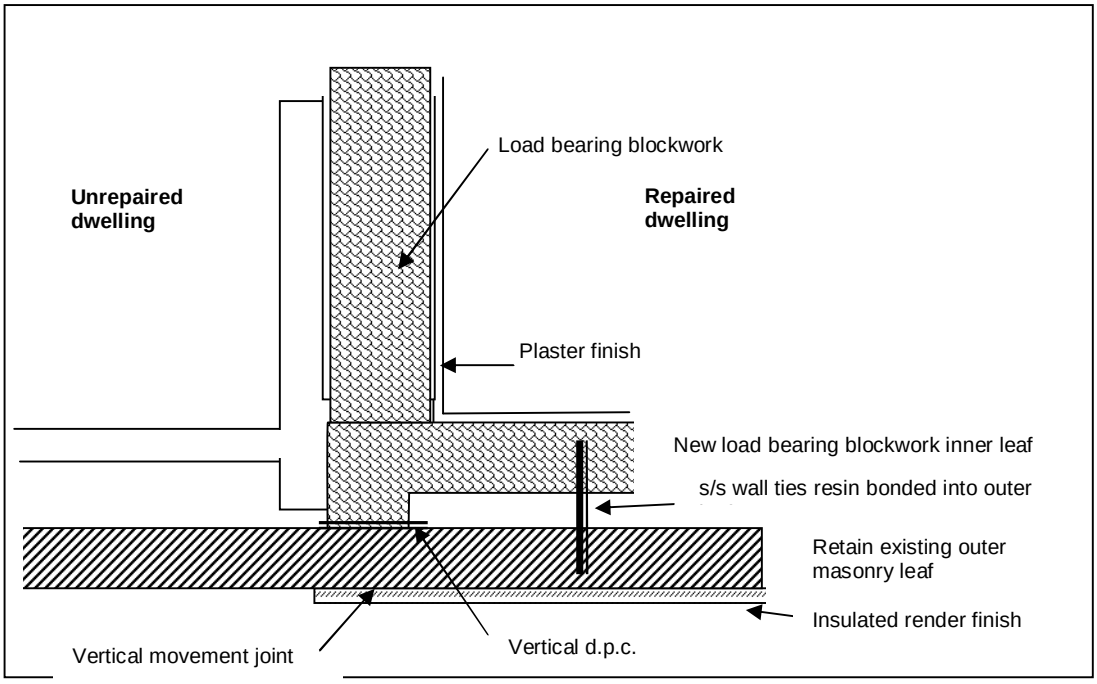
U value for this wall form: 0.33 W/m²K

8 Option 4: Retain first floor and roof construction. Construct new load bearing masonry inner leaf, accessed from inside the building.

This option assumes that the investigation of the building has shown that the existing frame is not capable of supporting the loads applied to the building, either because it is in too poor a condition - resulting in considerable areas of cracking or crushing of the internal finishes at either the top or the bottom of the internal walls - or because the chloride ion content is too high to meet the engineering requirements of NTHAS.

This option involves making the frame redundant and adding blockwork between the current columns. In this case, the work is carried out from the inside of the building, by removing the internal finishes - including the plasterboard between the columns - and building the new structural element between the existing structural frame. Having done this, new internal finishes would be fitted.

At the same time, the existing brickwork would be over-clad with rendered insulation.



Option4: horizontal section – outer/party wall

Costs associated with this option: £30k

The wall makeup is:

- internal plaster finish;

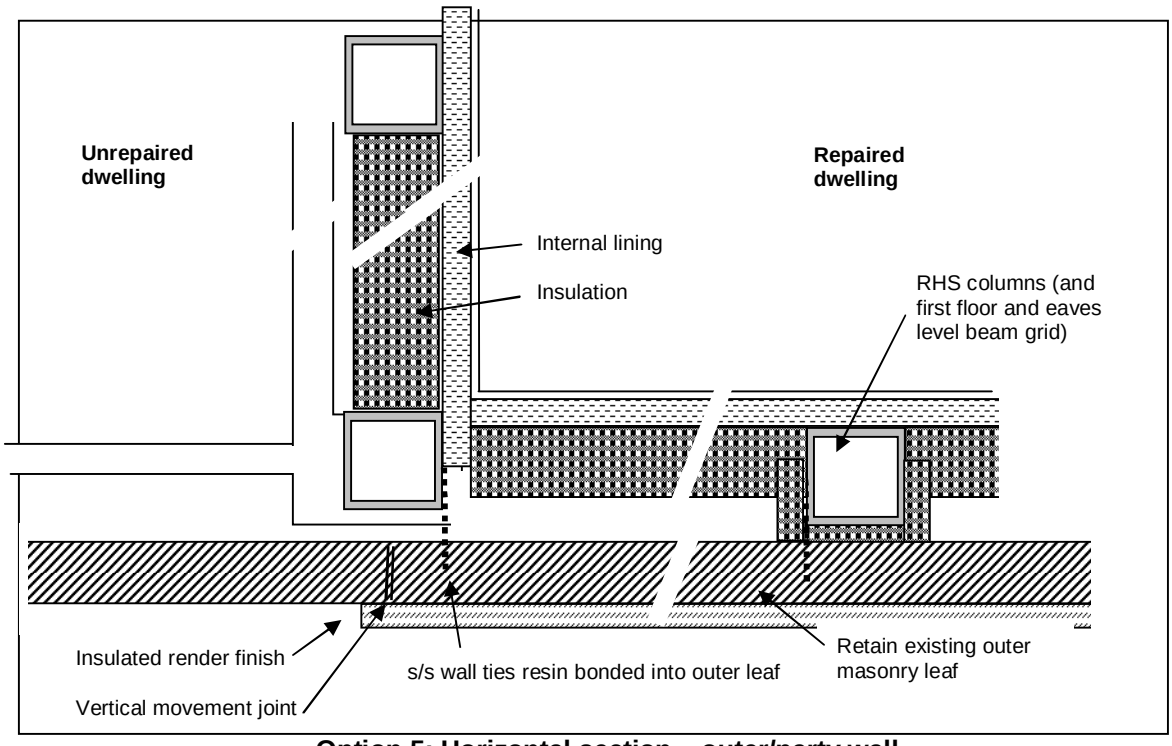
- 100mm aircrete blockwork (450kg/m^3);
- 35mm phenolic/polyurethane insulation;
- 50mm clear cavity;
- existing brickwork outer leaf.

U value for this wall form: 0.34 W/m²K

9 Option 5: Retain first floor and roof construction and outer masonry leaf. Remove structural frame. Construct new load bearing steel framework. Install lining to external wall.

This option assumes that the investigation of the building has shown that the existing frame is not capable of supporting the loads applied to the building, either because it is in too poor a condition - resulting in considerable areas of cracking or crushing of the internal finishes at either the top or the bottom of the internal walls - or because the chloride ion content is too high to meet the engineering requirements of NTHAS.

This option involves removing the structural frame and the whole of the inner leaf and then constructing a new inner leaf using a steel studding system. This work would be carried out internally, as the existing outer leaf would be retained to provide a fixing surface for over-cladding with rendered insulation.



Option 5: Horizontal section – outer/party wall

Costs associated with this option: £50k

The wall makeup is:

- internal plaster finish;
- dry lining

- RHS columns with insulation ;
- 55mm cavity;
- Existing outer leaf
- 30mm phenolic/polyurethane insulation;
- render outer coat.

U value for this wall form: 0.35 W/m²K

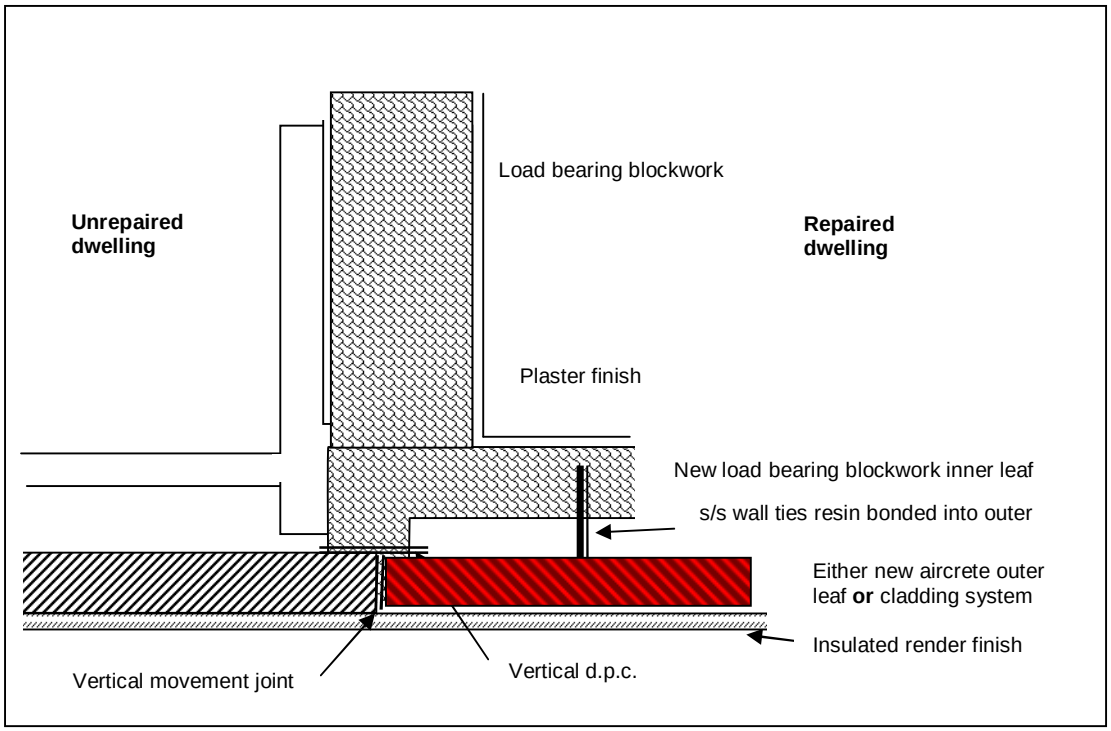
10 Option 6: Retain first floor and roof construction. Remove structural frame. Construct new load bearing external walls: masonry plus cladding system.

This option assumes that the investigation of the building has shown that the existing frame is not capable of supporting the loads applied to the building, either because it is in too poor a condition - resulting in considerable areas of cracking or crushing of the internal finishes at either the top or the bottom of the internal walls - or because the chloride ion content is too high to meet the engineering requirements of NTHAS.

It involves supporting the roof and first floor; removing the external walls in their entirety; constructing a new load bearing inner leaf using blockwork; and then fitting one of the following:

- Option 6A: a cladding system, incorporating insulation, to the outside of the building;
- Option 6B: a blockwork outer leaf with rendered insulation on its exterior surface.
- Option 6C: a fair-faced brickwork outer leaf

Again, the costs are roughly comparable for the three systems.



Option 6: Plan view

Costs associated with this option: £50k

The wall makeup for Option 6B is as follows:

- internal plaster finish;
- 100mm aircrete blockwork (450kg/m^3);
- 50mm cavity;
- 100mm aircrete blockwork (600kg/m^3);
- 30mm phenolic/polyurethane insulation;
- render outer coat.

U value for this wall form: 0.34 W/m²K

11 Stage Four: Option Appraisal

As part of the options appraisal process, we have been asked to provide a preferred Option for each of the two Categories:

- Category 1: Solutions where the existing structural frame can be retained
- Category 2: Solutions where the existing structural frame cannot be retained

The basis on which these have been selected has depended on a combination of their structural appropriateness, their practicality and their cost.

Note: In view of the nature of the Hawksley SGS properties on the Galley's Bank estate, if both the Category 1 and the Category 2 solutions were to be considered for each house and the decision on which was the more appropriate were to be made on the basis of the condition of the house - then an inspection and testing regime would need to be carried out on it to establish the viability of its structural frame before the start of that decision making process.

11.1 Category 1: Solutions where the existing structural frame can be retained

11.1.1 Options

There are two Options under Category 1:

- Option 1: Retain the existing frame and overclad with rendered insulation
- Option 2: Strengthen the existing frame and overclad with rendered insulation

Each of these solutions requires an inspection and testing regime to support it. However, while Option 1 involves checking the condition of the key intersections within the structural frame that supports the building, Option 2 also involves carrying out strengthening works in the locations where voids - or a lack of solid concrete - are found. As far as Option 2 is concerned, there are two options: the first involves adding grout to strengthen the frame; the second involves adding steel brackets to the outside of the frame.

11.1.2 Costs

The costs associated with the two Options are similar:

Option ID	Cost
Option 1	£14k
Option 2 - grouted	£19k
Option 2 - steel brackets	£25k

11.1.3 Selection of preferred Option

Comparing the two Option 2s in the first place, both provide the same solution, in slightly different ways: the steel bracket solution is both more expensive and considerably more invasive - in that sections of the outer leaf need to be removed to allow access for the steel brackets to be fitted - while the grouted solution is considerably less invasive - it would be carried out from within the house. As a result, it would seem more appropriate to select the grouted solution as the "preferred" Option 2 solution.

On a technical level, the difference between Options 1 and 2 is that Option 2 provides certainty that the structural framework supporting the house is in a good condition; Option 1 is predicated on a combination of a visual indication and an intrusive survey to show that this is the case. The extra cost of £5k needed to provide certainty would seem also to offer better value and for this reason we would select Option 2 as our preferred Category 1 solution.

11.1.4 Health and Safety issues

While planning the works for Option 2, due consideration should be given to the generation of dust during the various procedures; the work will be intrusive and will need to be undertaken form the inside of the building; this may have implications for the phasing of the work. In view of the expressed desire not to decant the householders during the works, it may be most appropriate to carry out the works in a sequential manner on a room-by-room basis, allowing any dust generated during the procedures to be contained within each of the rooms and be removed from there before moving on to the next room.

11.2 Category 2: Solutions where the existing structural frame cannot be retained

11.2.1 Options

There are four Options associated with the Category 2 condition:

– Option 3: Retain first floor and roof construction. Construct new load bearing masonry inner leaf, accessed from outside the building.

– Option 4: Retain first floor and roof construction. Construct new load bearing masonry inner leaf, accessed from inside the building.

– Option 5: Retain first floor and roof construction and outer masonry leaf. Remove structural frame. Construct new load bearing steel framework. Install lining to external wall.

– Option 6: Retain first floor and roof construction. Remove structural frame. Construct new load bearing external walls: masonry plus cladding system.

11.2.2 Costs

The costs associated with these four Options are as follows:

Option ID	Cost
Option 3	£30k
Option 4	£30k
Option 5	£50k
Option 6	£50k

11.2.3 Selection of preferred Option

Clearly the degree of invasiveness of the works varies greatly between these Options. For example, those Options that require work to be carried out from within the house - and that applies to all but Option 3 - are highly likely to require the householders to be decanted; it is possible, but unlikely - considering the scale of the works required - that a phased approach, involving carrying out the works in a sequential manner on a room-by-room basis, would be viable under these circumstances.

Looking at the costs, Options 3 and 4 are 40% cheaper than Options 5 and 6.

While there is no difference between Options 3 and 4 in terms of the finances, the degree of invasiveness resulting from the internal working required for Option 4 is considerably greater than Option 3.

As a result, it is our opinion that Option 3 is our preferred Category 2 option.

11.2.4 Health and Safety issues

The work associated with Option 3 is carried out exclusively from the outside the building, so there should be no dust created within the building while this work is underway. However, it should still be borne in mind that dust will be created outside the building and that windows are likely to be removed during the process. As a result, it could well be appropriate to carry out the works in a sequential manner on a room-by-room basis to ensure that the householders are affected as little as possible by the remedial works.

11.3 Summary of preferred Options

Our preferred Options for Categories 1 and 2 are:

- Category 1: Option 2: Strengthen the existing frame and overclad with rendered insulation, using the grouting solution
- Category 2: Option 3: Retain first floor and roof construction. Construct new load bearing masonry inner leaf, accessed from outside the building.

12 Next step

This report contains a number of possible options for providing a mortgageable solution for the Schindler properties on the Galleys Bank Estate, depending on the condition of the building being considered.

The next step in this process is the final report, covering Stage 5: Specification of the Preferred Option.

Appendix A – Preliminary Enabling Works

A.1 Preliminary Enabling Works : Investigation of Element Integrity

Visual inspection of the property

A walk around both the interior and the exterior of the house should be undertaken to look for any signs of distress within the building. Specifically, in the exterior of the building the condition of the brickwork should be examined in detail to see whether there are any signs that the wall ties might be expanding and causing cracking in the brickwork.

An assessment should also be made of the interior of the building, looking for the presence of cracking or crushing in the internal finishes in both top and the bottom of the walls. Note the apparent age of the interior decoration of the house as this might suggest that problematic cracking etc could have been hidden; if possible, seek information on when the house was last decorated from the home owner or tenant, although evidence from this source should be treated with caution.

Intermediate and Party Wall Internal Columns (supporting ground and first floor spine beams)

A 100mm square section of the plaster formwork on one face of the column on the first floor landing and within kitchen should be removed at skirting board level to facilitate an inspection of the respective column base (and to enable a concrete dust sample to be obtained - refer section below). Any plaster debris and other construction material that is found at the base of a column shall be removed through this aperture prior to the commencement of any remedial works.

Drill (circa 12mm diameter drill) through the plaster formwork on the mid-line of the column and approximately 35mm (exact dimension of outer drilling points to be defined on site) inside of both exposed side faces of the plaster formwork. The aim of this exploratory drilling is to establish whether any significant voids exist at the column heads. The holes so formed will also serve as entry points for injection grout repairs if these are found to be necessary.

External Columns

Remove a single brick at the head of each of the ground and first floor perimeter columns immediately adjacent the soffit of the adjacent perimeter beam. Drill (circa 12mm dia. bit) through the plaster formwork on the mid-line of the column and approximately 35mm (exact dimension of outer drilling points to be defined on site) inside of both exposed side faces of the plaster formwork. The aim of this exploratory drilling is to establish whether any significant voids exist at the column heads. The drill holes will also serve as entry points for injection grout repairs if these are deemed to be necessary.

A.2 Preliminary Enabling Works : Chloride Determinations

The concrete columns at ground and first floor levels within each property shall be sampled and the dust collected tested for chloride ion content. Results should be expressed as % Cl^- by weight of cement (see below)

Three concrete dust samples shall be tested for their cement content. The mean cement content shall be calculated from these data and used to calculate the %Cl^- by weight of cement.

A minimum of 5 no. concrete columns shall be sampled at ground floor level (including both corner columns – assuming property is one of a semi-detached pair) and a similar number at first floor level. The perimeter beam at first floor level shall be sampled at 3no. locations (front, rear and side elevation).

An adequate number of bricks shall be removed from the outer leaf coincident with the selected column/beam positions to facilitate the exposure of the underlying element. The plaster permanent formwork shall be removed to exposed a circa 100mm square section of the underlying concrete. Dust samples shall be collected using a suitable collecting device (i.e. stiff plastic piping or profiled metal collection sluice).

A similar number of concrete dust samples shall be obtained from the eaves level perimeter beam. Due to the position of the eaves beam at the head of the front and rear elevation walls, the former can only realistically be sampled following the removal of one or two roof tiles and a section of the sarking felt. The concrete dust sample from the flank wall eaves level beam can be obtained following the removal of a few bricks from the outer leaf.

A concrete dust sample shall be obtained from each of the first floor and eaves level spine beams, following the localised removal of a 100mm square section of the plaster formwork. A sample of the concrete column supporting the adjacent spine beam at both ground and first floor level should also be taken following the removal of a 100mm square section of the plaster formwork. It is recommended that the concrete dust samples should be obtained from the base of the column.

Appendix B - Draft Outline Remedial Works for the various Options

Option 1: Retain the existing frame and overclad with rendered insulation

1. Install vertical restraint ties between roof wall plates and eaves level beams at a spacing that is in accordance with current Building Regulations.
2. Remove all existing steel fixings/fixtures from outer leaf. Locate all existing wall ties using a wall tie detector in combination with boroscope.
3. Install resin bonded s/s wall ties at each column position at required vertical c/c.
4. Install resin bonded s/s wall ties along the centre line of the first floor perimeter beam at required horizontal c/c.
5. Reinstate brickwork where removed.
6. Implement MD remedial approach of external insulation and render finish.

Option 2: Strengthen the existing frame and overclad with rendered insulation

1. Reinstate formwork to column bases leaving a small diameter hole at the top of the reinstated section to provide entry point for high strength injected grout. Inject high strength expanding grout into each 'defective' column base.
2. Inject high strength expanding grout into all defective column heads where required.
3. Optional : Remove a single brick from the outer leaf at say 750mm c/c to expose the base of the perimeter ring beams at first floor and eaves level. Drill holes through the outward facing plaster formwork where it abuts the soffit formwork. Inject high strength expanding grout into each of the holes allowing grout to migrate into any voids present in the base of the respective beams. Drill holes into the soffit of the plaster formwork to the first floor and eaves level spine beams (include holes at the junction between each column head and adjacent beam section).
4. Open up areas in the outer leaf at the top and bottom of the columns sufficient to allow access with a drill to the sides of the columns and add steel straps to the outside surfaces of the vertical columns, using staggered resin bonded fixings to fix these into the columns and to the floor slab/beam
5. Install vertical restraint ties between roof wall plates and eaves level beams at a spacing that is in accordance with current Building Regulations.
6. Remove all existing steel fixings/fixtures from outer leaf. Locate all existing wall ties using a wall tie detector in combination with boroscope.
7. Install resin bonded s/s wall ties at each column position at required vertical c/c.

8. Install resin bonded s/s wall ties along the centre line of the first floor perimeter beam at required horizontal c/c.
9. Reinstate brickwork where removed.
10. Implement MD remedial approach of external insulation and render finish.

Option 3: Retain first floor and roof construction. Construct new load bearing masonry inner leaf, accessed from outside the building

1. Install temporary support - including internal propping - and remove for storage or discard windows as appropriate.
2. Demolish existing walls - working in sections along the external elevation.
3. Clean up the area on top of floor slab and build new inner and external leaves.; progress around the building.
4. Either refit or replace external windows.
5. Remove the party wall and replace with a timber studding wall.
6. First and second fix.

Option 4: Retain first floor and roof construction. Construct new load bearing masonry inner leaf, accessed from inside the building

1. Install remedial propping to provide support to first floor construction. Install propping at first floor level (to be contiguous with remedial propping on ground floor) to support roof framing
2. Break out first floor level spine beams (2no.) and remove intermediate column.
3. Provide temporary tied lateral bracing to external face of outer leaf. Remove plaster internal wall lining and permanent formwork. Construct new blockwork inner leaf between columns up to underside of first floor perimeter beam. Demolish ground floor structural columns to rear elevation wall first. Tie newly constructed inner leaf to existing outer leaf. Remove first floor columns and eaves level perimeter beam above, then first floor columns and first floor level perimeter beam. Reconstruct first floor level blockwork inner leaf up to existing wall plate level with insulation. Take up floor and roof loads on to new construction.
4. Repeat works on front elevation described under 3 above.
5. Repeat works on flank wall elevation described under 3 above.
6. Repeat works for party wall construction.
7. First and second fix.

Option 5: Retain first floor and roof construction and outer masonry leaf. Remove structural frame. Construct new load bearing steel framework. Install lining to external wall

1. Install remedial propping to provide support to first floor construction. Install propping at first floor level (to be contiguous with remedial propping on ground floor) to support roof framing
2. Break out first floor level spine beams (2no.) and remove intermediate column.
3. Provide temporary tied lateral bracing to external face of outer leaf. Remove plaster internal wall lining and permanent formwork. Remove eaves level perimeter beam and first floor level columns. Remove first floor perimeter beam and ground floor columns. Install ground floor steel columns and supporting steelwork to first floor construction, install first floor columns and supporting steelwork to roof structure. Install insulation within external wall cavity. Install external wall lining. Take up floor and roof loads on to new construction.
4. Repeat works on front elevation described under 3 above.
5. Repeat works on flank wall elevation described under 3 above.
6. Repeat works for party wall construction.
7. First and second fix.

Option 6: Retain first floor and roof construction. Remove structural frame. Construct new load bearing external walls: masonry inner leaf plus either masonry outer leaf or cladding system

1. Install remedial propping to provide support to first floor construction. Install propping at first floor level (to be contiguous with remedial propping on ground floor) to support roof framing.
2. Break out first floor level spine beams (2no.) and remove intermediate column.
3. Break out heads of columns at ends of spine beam. Install new intermediate RHS column (or eliminated if RSJ spine beam can be designed/installed within available space). Install temporary end columns to support new spine beams. Install new RSJ spine beam to be supported by existing chimney breast.
4. Demolish external walls (including structural frame) for full height of building – works to be undertaken in a phase manner.
5. Construct new brick/ insulation/block external cavity ground and first floor walls. Transfer loads from first floor construction and roof into new construction.
6. Construct new leaf to party wall.
7. Install all required vertical/horizontal strapping in accordance with Building regulations.
8. First and second fix.