Structural Inspection Report

Flat 3/3, 18 Dunn Street, Paisley

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Ref 14466/FD

Contents

Report By:	Fiona Drew BEng (hons), CEng, MIStructE	Date:	08/02/2026

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1.0 Introduction

Balfour Engineering Consultancy was instructed to undertake a condition survey inspection of the cracking noted within the above property. The inspection was carried out on 28th January 2026, weather conditions were cool and dry, although it had recently been raining.

The non-intrusive and non-disruptive survey was undertaken by Fiona Drew to determine the existing condition of the structure and provide recommendations on any defects noted.

Reference is made in the report to specific areas where alteration works are to be undertaken. Any other elements of note are also included for action/review.

2.0 Observations

The flat is located on the top floor of the building. Dunn Street is to the north-east elevation and Ladyburn Street to the South-east elevation. For the purposes of the report these will be taken as east and south.

The third floor flat is located on the southern side of the property with the majority of the property overlooking Ladyburn Street. There is no known construction date for the property however a review of historical maps indicates that the tenements would have been constructed around the first quarter of the twentieth century, meaning the building is approximately 100 years old.

The property is a traditional tenement with mass masonry external walls finished with blonde sandstone to Ladyburn Street and Dunn Street. The gable end is roughcast with the quoins having been left exposed.
The internal walls are brickwork or timber. The floors are timber joists and the roof is made up of timber roof trusses spanning front to back. The roof is finished externally with concrete roof tiles.

Internally there were a number of horizontal and vertical separation cracks noted at different locations within the property. The worst were within the bathroom and hallway adjacent to the bathroom. Refer to photographs 1-6.

Similar cracking was also noted within the bedroom, photographs 7 & 8.

Diagonal cracking could be seen above the door in the kitchen. Photograph 9.

At the window overlooking the rear courtyard cracking was noted at the side of the window across the full height of this area. Photograph 10.

There is a dip in the floor noted when standing beside the bedroom door going into the bathroom. This was also felt when standing in the bedroom. The dip goes down towards the western gable.

Externally there were signs of cracking and opening up of joints in and around the quoins on both the northern wall and western gable. The joint widths were worst towards the top of the walls. Refer to photographs 11-17.

When viewed from Ladyburn Street there were no obvious signs of defects noted to the walls or roof. Photograph 18.

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Cracking was also noted within the main close, however this does not fall within the prevue of the report and as such no commentary is given herein.

3.0 Discussions & Recommendations

The defects noted within the property are commensurate with the age of the property and style of construction. They are not outwith the range of what would be expected for a tenemental structure, although some of the defects will need repair works carried out sooner rather than later.

Commentary below is given on the potential cause of the defects noted.

No inspection was made of any timber elements within the building, therefore the condition of these cannot be confirmed at this time.

At present there is a degree of movement within the western gable which appears to be the root cause of the defects noted within the flat. There are a number of potential causes for the movement. Some further exploratory works will be required to rule out some of the potential factors prior to undertaking repair works.

- Potential movement due to washout of subsoils below the gable foundations.
    - Two manhole covers were noted close to the base of the gable wall. The covers were not lifted. An inspection should be undertaken within the assumed below ground drainage pipes running parallel to the gable. It should be confirmed whether there are any leaks or other defects within the pipe which may be causing an instability to occur in the wall.

    - Where defects are found then these should be made good prior to any remedial works being undertaken.

    - Remedial works to the foundations would vary dependent upon the extent of washout or damage found. Allowance should be made for locally underpinning at the washed out area, and at the corners of the building.

- Water ingress via the chimney.
    - A close up inspection of the chimney stacks visible on the gable wall should be carried out to ensure that they are in good condition. Over time the heat from the exhaust gases from the fires passing through the chimney will have caused the mortar within the bed and perp end joints within the flues to dry out and fall away over time. This will lead to the internal walls or 'bridges' of the flue to become loose. Weathering from driving rain and wind will further exacerbate deterioration of chimneys. At ground level the chimney on the gable appeared to be in good condition.

    - Should defects be found, specifically loss of mortar within the bed joints, the joints should be raked out and infilled with fresh mortar. During these works any defective copes and chimney pots should be removed and/or repaired to ensure the overall longevity of the chimney.

    - Refer to Appendix B for reference document from Historic Scotland which suggests that once buildings reach an age of around 100 years then chimney stacks should be taken down and rebuilt.

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- Water ingress via rainwater goods.
    - On the northern elevation there is a rainwater pipe and soil vent pipe. All of these elements should be inspected to ensure that they are in good condition and that there are no cracks or open joints which would allow water to penetrate into the walling.

    - No damp was noted within the property other than for within the bedroom at the north-western corner. This is close to the open joints and the rainwater goods on the northern elevation.

    - During the inspections it is suggested that the underlying woodwork should be inspected for rot.

- Damage due to roughcasting.
    - At some point in the history of the building the gable end has received a roughcast finish. This has broken away in at least three locations on the gable end at high level. This would suggest that there is water to the rear of the roughcast.

Irrespective of the site findings in the first instance crack stitching must be undertaken to improve the connection between the walls. Reference should be made to initial information given within Appendix C for Helifix crack stitching bars and methodology.

Scope of the Visual Inspection

This report is based on a visual examination of the relevant structural elements of the property, such as internal and external walls. Certain parts of the structure are inaccessible, and these are obviously out-with the scope of a visual examination. Attention may be drawn to non-structural elements, which could lead to deterioration of the fabric. Where an opinion is expressed regarding structural adequacy or settlement it is based on the evidence available.

In all aspects of a purely visual investigation opinion is expressed on the adequacy of the structure and unless specifically requested, no calculation is undertaken to establish the adequacy of individual structural elements. No examination of timber is made for deterioration due to woodworm, or wet or dry rot and a specialist may be required to examine this aspect of the condition of the property.

The visit to the referenced building does not constitute a design and the structural system for the building cannot be warranted. This report is limited to the observed conditions as much as site observations allow.

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Appendix A
Photographs

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Photograph No.1 – Vertical crack between cross walls and along ceiling in bathroom on gable wall.

Photograph No.2 – Horizontal crack extending towards the southwestern corner of the building.

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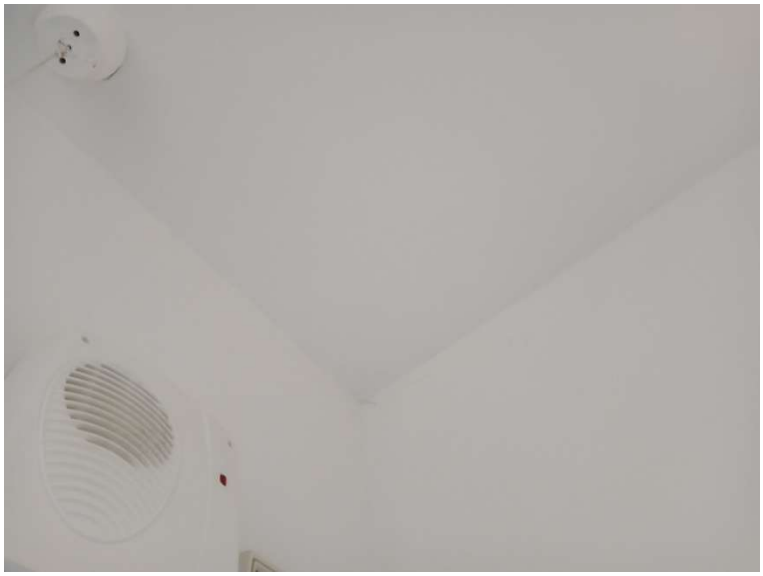

Photograph No.3 – Horizontal crack at ceiling/wall juncture to internal wall within bathroom.

Photograph No.4 – Vertical crack at door junction of architrave and rear external wall from within bathroom.

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Photograph No.5 – Diagonal cracking above door into bedroom from hallway.

Photograph No.6 – Crack extends across bathroom wall from photograph 5.

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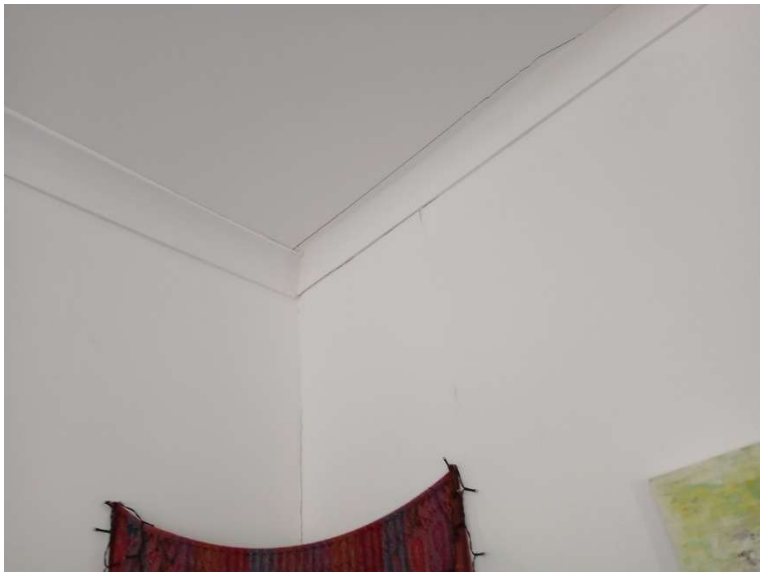

Photograph No.7 – Horizontal cracking at wall/ceiling juncture within bedroom, on opposite side of wall from bathroom.

Photograph No.8 – Cracking extending along gable wall at high level along full length of gable.

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Photograph No.9 – Diagonal crack leading up from kitchen door, within kitchen.

Photograph No.10 – Cracking at window reveal rear wall.

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Photograph No.11 – Step crack/open joints on north elevation wider at top of wall getting narrower towards base.

Photograph No.12 – Continuation from Photograph 11.

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Photograph No.13 – Cracking visible in quoins and between quoins & roughcast on northern side of gable.

Photograph No.14 – Alternate view of cracking visible on both sides of gable.

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Photograph No.15 – Cracking extending to base of wall.

Photograph No.16 – Manhole adjacent to gable.

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Photograph No.17 – Cracking extending to base of wall, north-western corner of gable.

Photograph No.18 – View of property from Ladyburn Street. No visible defects on southern elevation.

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Appendix B
Historic Scotland Document

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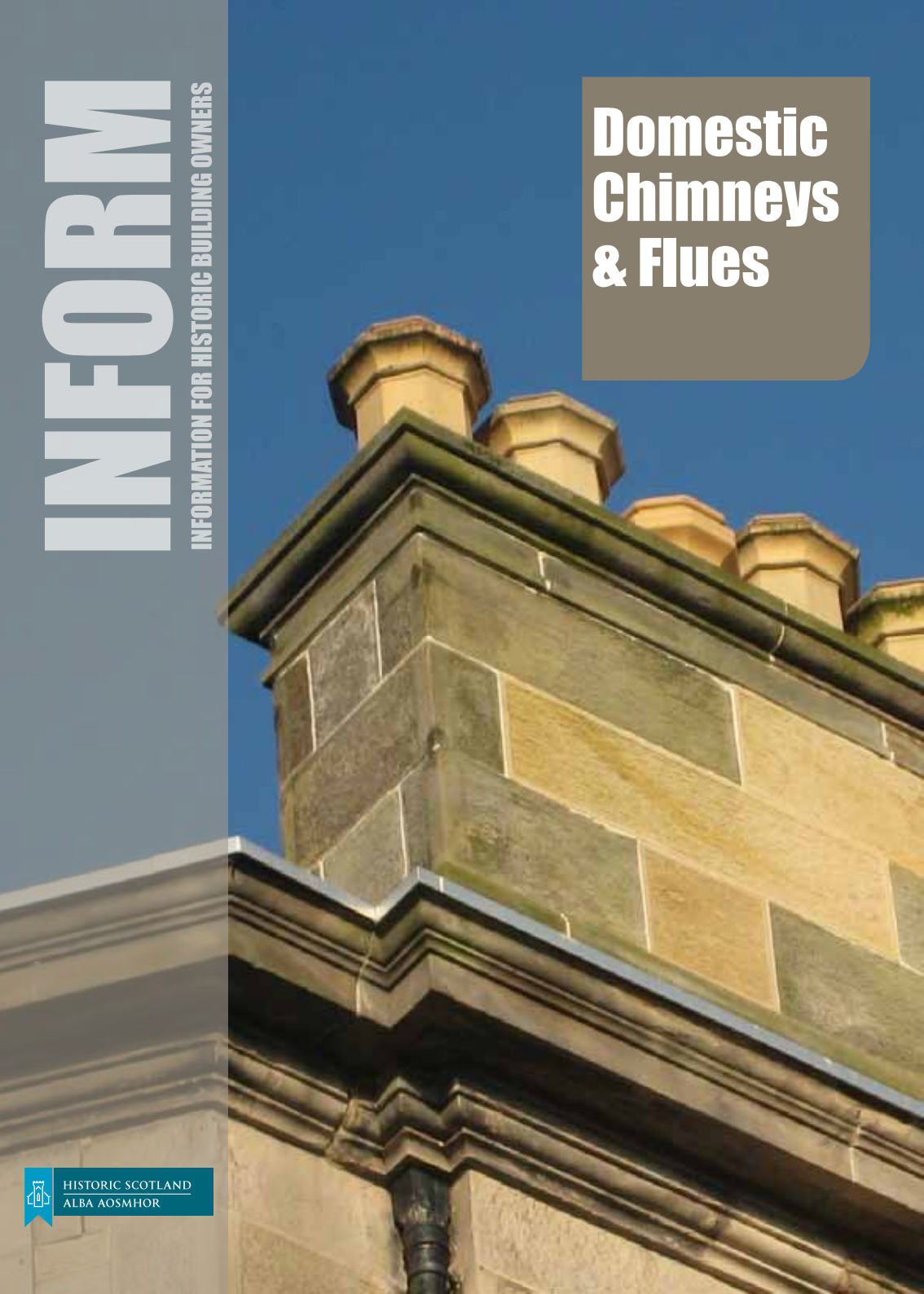
INFORM

INFORMATION FOR HISTORIC BUILDING OWNERS

Domestic Chimneys & Flues



HISTORIC SCOTLAND
ALBA AOSMHOR

Fig. 1 *Chimneys and cans are a dominant and distinctive feature of the urban environment.*

Introduction

This INFORM will outline the basic elements of a flue and chimney system and identify common faults, their diagnosis and the principles of how to deal with them. The chimney and flue system are an integral part of the structure, function and aesthetic composition of a traditional building and often contribute to the character of the streetscape in which the building sits. They are structural elements that require care and maintenance although, due to their often inaccessible location, this is frequently omitted.

History and Development

Chimneys have long been part of domestic construction, and have come to be part of the urban and rural standard (Fig. 1). Originally homes did not have chimneys, and fumes were vented through the roof. Since the early middle ages high status buildings were fitted with effective fireplaces and flues; sometime later domestic dwellings adopted the chimney and flue system, although many Hebridean blackhouses continued without a chimney well into the 20th century. The design of flues and chimneys has in part developed due to the type of fuel burnt in them – generally, lower calorific value fuels such as wood and peat require bigger openings and flues; fuels such as coal and anthracite can burn effectively through narrower bore flues and chimneys - although most types of fuel will work in most hearths.

The shape of the flue is normally a square or a rectangle, early flues from the 16th century tended to be much flatter rectangles, reflected in the shape of the chimney head. The size and openings of hearths varied with use, status and wealth; medieval openings were sometimes semicircular, while most Georgian or Victorian openings were rectangular or trapezoidal.

Basic structure of flues

During construction of a building the masons would create an opening for the fire, and build the flue up within the wall. Single or multiple flues were normally built into the thickness of an external masonry wall, frequently on the gable ends. Larger properties with internal masonry walls could accommodate additional flues within these. Buildings which experienced problems with the flue's function, or where an additional hearth was added, could have extra flues constructed in external or internal walls or against a gable. Internally the flues were lined with smooth plastered masonry (a layer of lime mortar sometimes called pargetting).

Fig. 2 *Diagonal bridges made from stone slabs, visible on the gable end of this tenement in Edinburgh, indicate the presence of flues within the wall.*

As fuels became more energy intensive, flues tended to become smaller and more effectively lined. Where the builders had to fit a large number of flues within a gable, such as a tenement, stone slabs were used to separate flues. The pattern of these slabs can sometimes be seen on gable ends of tenements (Fig. 2).

In small 18th century rural properties flues were often built against a masonry wall in timber and clay, sometimes called a "hanging lum". The clay coating and the relatively low temperature of the smoke ensured that these could be safely employed as a flue. Such survivals are rare and historically valuable and if encountered, should be retained.

From the 19th century, ceramic flue liners were used. As well as being quicker to fit and build, they also proved more durable, as they seem better able to resist corrosive flue deposits.

Basic structure of chimney heads

The chimney flue terminates at the chimney head - sometimes called a stack - which is the element visible above the roofline. The chimney could be built of rubble or ashlar, with multiple flues separated by a stone slab or 'bridge'. The design and location of chimneys on a dwelling are much more than purely functional routes out for smoke - they were used to deliberately convey messages of status; historically builders and architects took full advantage of this.

Fig. 3 *Victorian trade catalogue showing the wide variety of styles available.*

Fig. 4 *Banding on this late 17th century chimney.*

Until the late 18th century, chimney heads were finished with a cope only, but from the 19th century onwards all but the largest chimneys were finished with additional clay pots or cans. They developed in many styles, with some 19th century ones being very decorative indeed (Fig. 3). The pot is sometimes set into a slight recess in the cope, and mortared in or "haunched" with mortar.

Styles of finishing chimney heads have changed over the years, and can provide an indication of the building's age. Capping the chimney is the cope; a single stone, or several dressed stones providing the level top. Patterns have varied over time, from sloped copes with rolled edges of the 16th century, to very square tabulated cornicing and drip details on some 19th century chimney heads. Banding (raised margins) on the chimney quoins can give clues as to the original surface finish of the chimney and any elevation in height (Fig. 4). Sometimes the cope stones are held together with iron or bronze cramps which are secured with hot poured lead.

Fig. 5 *Chimney balloon used to close a flue.*

Fig. 6 *A mid 19th century chimney and cans showing dislodged cans and other problems.*

Ventilation

Even when no fire is lit, ventilation is an important function of the chimney system in a traditional structure. The rising air in the chimney draws new air into the room from under the floor and behind plastered surfaces, keeping void spaces and hidden areas dry. Flues should not be closed off. To reduce draughts from unused flues they should be temporarily closed off with a chimney balloon (Fig. 5).

Issues with smoking

A smoking chimney can be caused by many things, including physical blockage from masonry collapse above. There is a strict relationship between the size of the opening in the room, and the size of the opening at the chimney head. Normally the proportion is 10:1, but historically much consideration was given to the optimal shape and design of an opening. For example, if the flue has been relined for a stove yet an open fire is favoured, the chimney is unlikely to draw well.

There are many thoughts on how to improve draw, ranging from the shape of the hearth to types of cowl on the pot. Other factors come into play, including surrounding landscape and type of fuel being burnt, but generally speaking most unaltered flues should work well.

Sweeping

Where original fireplaces are still in active use flues should be swept annually to remove soot deposits from the inside of the chimney. Failure to do this will result in a build up of soot, and in the case of a wood fire, tar deposits. These deposits are potentially flammable and should be cleared to avoid the possibility of a chimney fire. Some domestic insurance policies require an annual chimney sweep to be conducted and a certificate issued.

Problems and issues

Flues and chimneys commonly suffer wear from the heat of the flue gasses, their composition, and the elements due to the exposed nature of the chimney. Common problems and indicative solutions are:

Chimney Cans:

Over time, as the haunching washes out or becomes cracked, the chimney cans (or pots) can become loose (Fig. 6). In this instance re-bedding in fresh mortar will be required. Occasionally the can itself becomes cracked and broken and should be replaced. Invariably replacement styles are limited, but cans should be matched where possible - in height and colour as a minimum. If the flue is not used the can should be covered, preferably with a conical galvanised cover fitted with bird netting, allowing adequate ventilation (Fig. 7). Ceramic or conical covers are available (sometimes called 'elephants feet'), but these do limit ventilation somewhat; where there is evidence of damp in the chimney they should not be used.

Fig. 7 *Conical cover for a chimney can.*

Fig. 8 *Collapse of parts of a gable due to washed out mortar.*

Washed out joints:

Fine ashlar joints and thicker joints in rubble chimneys become washed out over time, leading to water ingress and progressive loss of structural stability. In extreme cases this can lead to the collapse of the chimney (Fig. 8). Repointing and sometimes re-rendering is necessary, as well as checking the condition of the cope stones.

Often chimneys acquire fittings and fixtures from previous services and installations, for example TV aerials which, when no longer in use, should be removed as once loose they start to rub and damage the stonework. Corroding ironwork can also damage masonry and lift blocks off their beds.

Degradation of stone:

Due to exposure and corrosive flue gasses, stones of most types tend to suffer increased erosion and damage when part of a chimney. Investigation may show that what appears to be sound external masonry is quite friable and in need of replacement, especially on the hidden interior face.

Plant growth can become a problem, and can greatly accelerate the decay of a chimney head and stack. Generally, if a plant or small tree has become established, it should be taken that the roots are some way into a loose and degraded core, and may indicate that some rebuilding is required. At the very least, vegetation and stem material should be removed and the stump poisoned.

Repairs to chimneys:

For these reasons it is likely that a chimney will need rebuilding every 100 years or so. Points to consider are as follows:

- Close inspection by a building conservation professional is advised before remedial action is taken and listed building consent may be required. Discuss plans with the local authority before proceeding with any work.
- When carrying out work on a chimney, ensure that any replacement work matches the original, in colour, texture and compressive strength. If the cope is being replaced it should be done in stone, with the correct drip detailing on the underside to ensure water is shed clear. Many traditional buildings have a string course or band of projecting masonry that throws water clear of the gable.
- If chimneys have been removed re-instatement is favoured although this may require consent. Any replacement needs to copy the original in style, detail and material for example others in the same building or terrace. The replacement of a masonry chimney stack with a rendered brick alternative is not advised, although it has been common practice.

Flues:

Due to the hidden nature of its construction the flue can be the more difficult element of the chimney to address. Indications of flue problems are smoke ingress in an upstairs or neighbouring property, fragments of stone or mortar coming down the chimney, or problems with the fire smoking or not drawing properly. In more extreme cases render may be cracked

and bulging, with visible staining on interior and exterior surfaces. Excessive loss of pargetting and internal masonry can make using the chimney hazardous; internal timber elements can become exposed, and combustion gasses can escape from the flue into other rooms or properties. Frequently, water in the flue is the driver of such symptoms, entering through a poorly maintained chimney or defective gable render. The soot and other deposits that form in a flue tend to be water absorbing or hydroscopic, and can hold moisture if inappropriate renders or mortars are used. Such moisture leads to slight movement of the masonry in frost, potentially admitting further water. On rubble elevations there may even be holes in the wall leading into the flue itself.

Repairs to flues:

In multiple occupancy buildings, such as tenements, the flue arrangements can be complex, and the structure of the chimneys becomes an important safety issue, especially if the gable is freestanding. Relining or rebuilding of flues is the only viable solution and can be undertaken in one of the following ways:

- Inserting a flexible metal liner. This method is usually used for a boiler or wood burning stove and is the least disruptive to the household. It requires correct termination at the top and bottom and it is advisable to ensure the remaining void within the chimney is ventilated. A significant benefit of this is that it is reversible, but is not suitable for an open hearth.
- Fitting of ceramic flue liners. This is arguably the better long term solution, as it addresses the internal structure of the flue. It can however, reduce the bore of the flue and so the size of liner must be compatible with the type of fire or appliance to be used. Holes are made in the wall every 1.5 metres or so, and the ceramic liner is inserted and bedded in a weak lime mortar.

  This process is continued up the wall until the chimney is reached. If the flue can be accessed from the outside the level of disruption is reduced, but will require a scaffold (Fig. 9). It is also possible to rebuild the flue in the original manner, with stone bridges and slab lining, although this is more time consuming and expensive.

Fig. 9 *A flue relined from the outside.*

Fig. 10 *A new flue built onto the exterior face of a gable.*

- Poured cement based re-lining. There are many contractors offering this option, it should however be noted that the process is irreversible. It involves the creation of a cement lining, temporarily held within a removable rubber former. Care needs to be exercised as the poured lining fills all voids within the flue, including holes into rooms. This method also reduces the bore of the flue and due to the impervious nature of the cementitious material, does not allow proper movement of water vapour within the wall. If the wall and flue are dry or internal, it can be effective, but caution should be exercised when considering this method for external gables or exposed chimneys.
- In some cases an additional flue and stack may be built adjacent to the existing gable. Whilst presenting a solution of sorts, it is likely to be visually intrusive (Fig. 10).

Conclusion

Chimneys and flues are crucial to the correct functioning of a hearth or stove and play an important part in the aesthetic of the building and street to which they belong. They require regular maintenance and even when not in use they provide ventilation vital to the function of the building's fabric and occupation. Blocking or closure should only be a temporary measure.

Further information and reading:

www.historic-scotland.gov.uk/conservation

Society for the Protection of Ancient Buildings
www.spab.org.uk

A. Jackson and D. Day, Period House, ISBN 000-7192754

K. Wedd, The Victorian Society Book of the Victorian House, ISBN 978-1845132941

J. Gilbert and A. Flint, The Tenement Handbook, ISBN 978-1873190142

The Care and conservation of Georgian Houses, 4th Edition, Butterworth 1995

HISTORIC SCOTLAND
ALBA AOSMHOR

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Appendix C
Helifix Data

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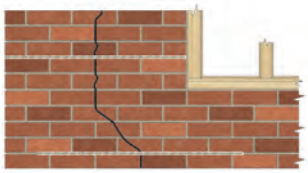
HeliBar

Helical stainless steel reinforcing bar for masonry repair and strengthening in both remedial and new build situations

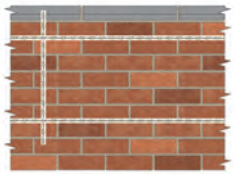
APPLICATIONS

- Crack stitching
- Lintel repair and creation
- Forming deep masonry beams
- Horizontal structural restraint (when used with BowTie systems)
- Reconnecting separated walls
- Securing parapet walls
- Support existing masonry when creating new openings
- Creating movement joints
- Reinforcing new build masonry
- Seismic upgrades for existing masonry
- Repairing bridges, tunnels and arches

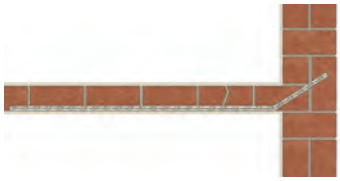


Crack stitching

Lintel reinstatement



Securing parapet walls



Reconnecting separated walls

Over 100 standard repair specifications are available online, covering all common structural faults.

Relevant Repair Details: BW01 & BW02; CS01 to CS14 (except 4, 7, 9, 11 & 12); LB01 to LB05; LR01 to LR11; MA03 to MA05; MJ01 to MJ03; PW01 to PW03; RB06; RF07 & RF09; RW01, 3 & 6;

FEATURES

- Austenitic stainless steel helical bars
- Combines great axial strength with flexibility
- Accommodates differential building movement
- No additional stresses introduced into structure
- Generates high tensile strength with mortar (new build only) or HeliBond grout
- Extremely economical compared with alternative methods
- May remove or reduce the need for mass underpinning
- Fully concealed once installed
- Avoids expensive taking down and rebuilding
- Minimal disruption to building's fabric or occupants
- Spreads structural loads to avoid secondary cracking
- Reduces the potential for cracking in shrinkable materials

TECHNICAL SPECIFICATIONS

SLOTH DEPTH AND SPACING				
	Single skin/ Cavity wall	Solid Masonry		
		Up to 102.5mm	102.5mm to 225mm	Over 225mm
Depth of slot	25 – 35mm		25 – 40 mm	25 – 40mm on both sides
Vertical spacing	Every 4 – 6 courses, 300 – 450mm			

HELIBAR	
Material	Austenitic stainless steel Grade 304 (1.4301) or 316 (1.4401)
Diameter	4.5mm, 6mm, 8mm and 10mm
Tensile strength (6mm HeliBar)	10kN
0.2% Proof stress (6mm HeliBar)	900 N/mm2 (304 / 1.4301) 840 N/mm2 (316 / 1.4401)
Standard lengths	1m, 1.5m & 2m – in packs of 10
Width of slot	Full height of bed joint (10mm in render/plaster)
Bonding agent	HeliBond cementitious grout. 1 x 3ltr HeliBond = 10 linear metres of crack stitching

RECOMMENDED TOOLING	
For cutting slot up to 40mm deep	Twin-bladed cutter with vacuum attachment or angle grinder or hammer and mortar chisel
For mixing HeliBond grout	3-jaw-chuck drill with mixing paddle
For injection of HeliBond into slots	Helifix Pointing Gun CS with mortar nozzle
For smoothing pointing	Standard finger trowel
For inserting HeliBar	HeliBar Insertion Tool

INSTALLATION PROCEDURES

1. HeliBar to be long enough to extend a minimum of 500mm either side of the crack or 500mm beyond the outer cracks if two or more adjacent cracks are being stitched using one rod.
2. Where a crack is less than 500mm from the end of a wall or an opening, the HeliBar is to be continued for at least 200mm around the corner and bonded into the adjoining wall or bent back and fixed into the reveal, avoiding any DPC.
3. For solid masonry in excess of 225mm thick and in a cavity wall where both leaves are cracked, the wall must be crack stitched on both sides.
4. If there is render/plaster, this thickness must be added to the depth of slot. Crack stitching must be installed in the masonry and never in the render.
5. Ensure the masonry is well wetted or primed to prevent premature drying of the HeliBond due to rapid de-watering, especially in hot conditions. Ideally additional wetting of the slot should be carried out 1 to 2 minutes prior to injecting the HeliBond grout.
6. Do not use HeliBond when the air temperature is +4°C and falling or apply over ice. In all instances the slot must be thoroughly damp or primed prior to injection of the HeliBond grout.

1. Rake out or cut slots into the horizontal mortar beds, a minimum of 500mm either side of the crack.

2. Clean out slots and flush with clean water and thoroughly soak the substrate within the slot.

3. Using the Helifix Pointing Gun, inject a bead of HeliBond along the back of the slot.

4. Using the HeliBar Insertion Tool push one HeliBar into the grout to obtain good coverage.

5. Insert a further bead of HeliBond over the exposed HeliBar, finishing 12mm from face and 'iron' firmly into the slot using the HeliBar Insertion Tool.

6. Inject CrackBond TE3 into the crack leaving enough space for making it good. Re-point the bed joints with matching mortar and make good the crack.