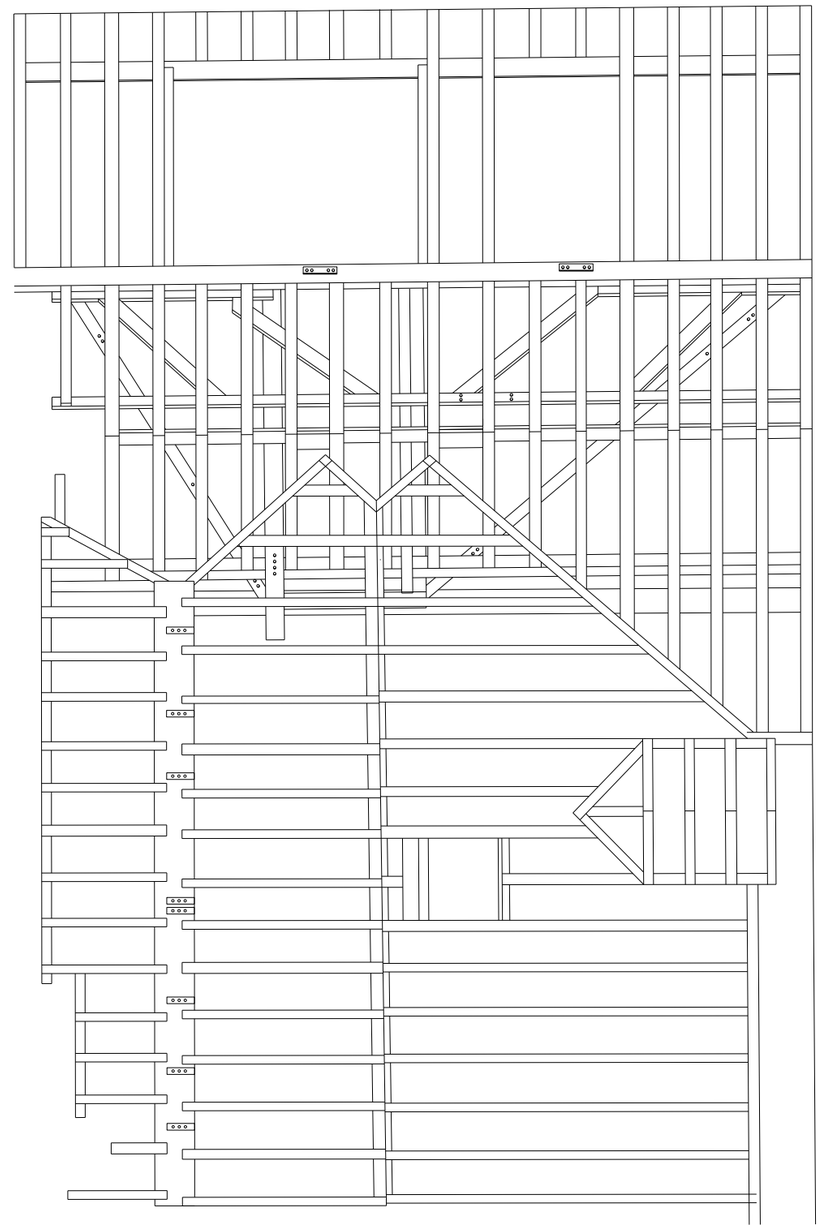
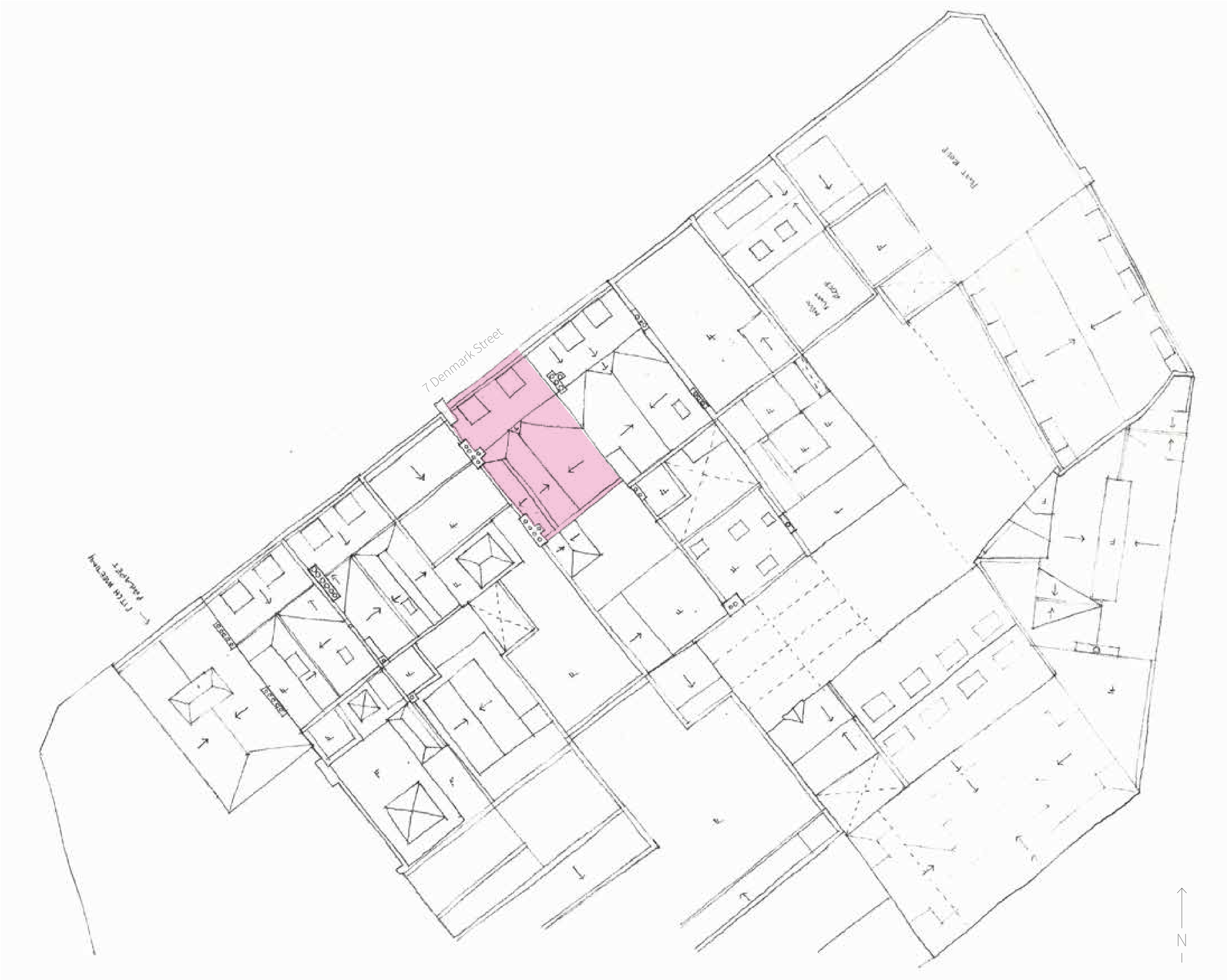


St Giles: 7 Denmark Street

Timber Roof Structure: Condition & Repair

May 2018

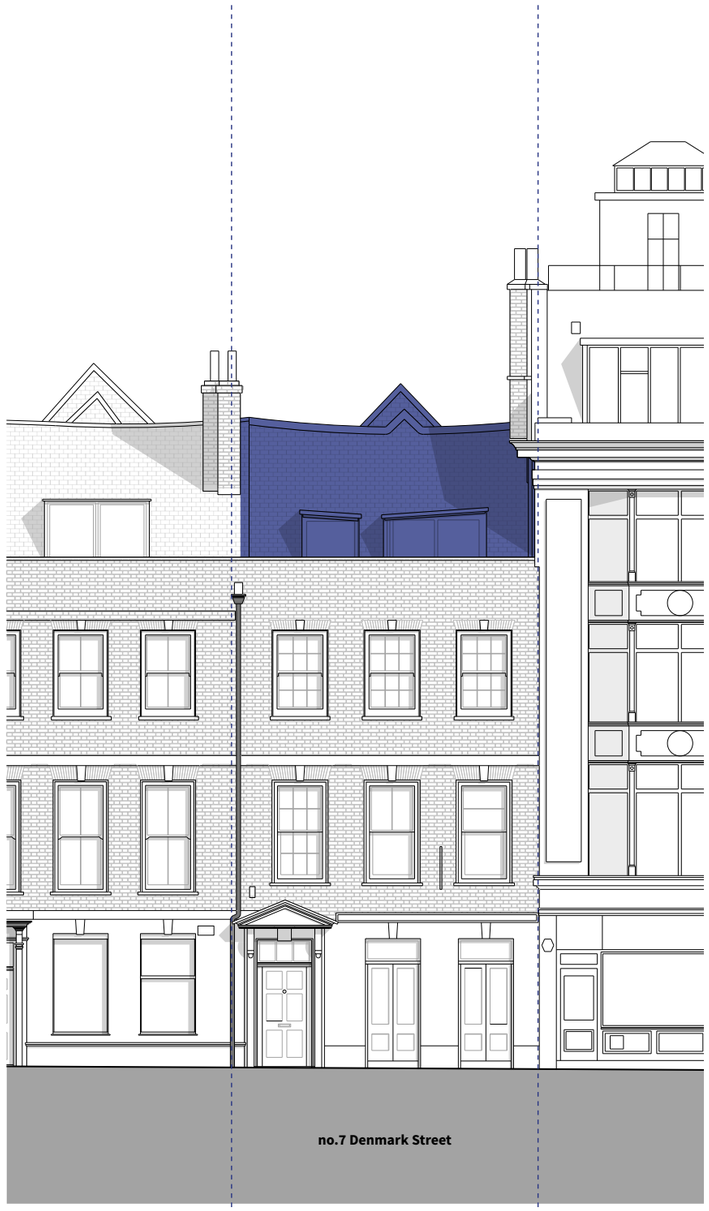

7 Denmark Street
N

Introduction

The overriding objective of the sequence of like-for-like repairs to the roof of No.7 Denmark Street outlined in the following report is to restore the roof to its original form.

This means that where possible, deflected members shall be strengthened and if structurally necessary, straightened; decaying pieces of timber shall be repaired on an individual basis; the structural integrity of the whole shall be increased; and any current or potential causes of failure will be addressed.

Over its life time, the roof has clearly been the subject of many attempts at repair, indicating that the roof has been failing for some decades. The uncovering and inspection of the roof, along with structural analysis conducted by Engenuiti, show where repairs are most urgent. The required repairs are focussed around the street-facing roof slope, but are necessary throughout. Extraneous modifications that have appeared over the last century or so can be removed when the purlins and principal rafters are repaired and strengthened, helping the roof take steps towards returning to its original form.



Decay and Deflection

Comparing no.7 Denmark Street (righthand side of the adjacent image) and no.6 Denmark Street (lefthand side) highlights the amount of repair required to no.7.

The purlin, rafters and joists towards the front of the roof are all suffering from rot and severe deflection. Having examined the structure and historic fabric, and building upon the principles developed in the repairs of no.6. the following document outlines the intentions for the like-for-like repair of the original roof structure.

Scarfing of the exposed timber frame allows the repair for each individual rafter to be carefully thought through to ensure the signs of centuries of deflection and movement are mitigated.

References:

Historic England
'Practical Building Conservation: Timber'
David Yeomans '
The Repair of Historic Timber Structures'
S.P.A.B, Old House Handbook
'Traditional Carpentry Repairs'
S.P.A.B, Repair of Ancient Buildings
'The Repair of Ancient Timber Roofs and Other Works of Fine Carpentry'

6 Denmark Street: Tiled Roof
7 Denmark Street: Exposed Structure

Following the repair of the roof structure of no.6, red tiles have been laid to restore the roof to its original appearance. No.7 would receive the same repair and finishes

6 Denmark Street

7 Denmark Street

Necessity for Immediate Repair

Comparing no.6 & no.7 even more closely, where they meet at the party wall, reveals how urgent the need for repair on the roof of no.7 is.

The level of deflection is so great that the purlin is being pulled from the party wall and distorting the rafters as it moves. Splits have occurred across a number of the timber members, decreasing the structural integrity of the roof. Later bracing, strapping and repairs are not solving the problem. Like-for-like repairs are required.

While the need for repair may be urgent, they shall not be rushed. Taking precedent from the repair of No.6 Denmark Street and taking guidance from heritage consultants, structural engineers and a series of heritage and conservation books we devised a repair strategy that informed the considered approach taken since.

With reference to Historic England guidance, an outline of the strategy went as follows:

Diagnose deterioration and its causes
Define the objects of treatment and repair
Determine how urgent the need for work is
Establish the likely extent of the works
Assess the available resources
Identify options that meet objects for repair
Assess the 'buildability' and practicalities
Assess the impact on the heritage values
Select options that minimise harm
Determine priorities for implementation

Throughout, we've ensured that:

Only appropriate materials were considered
Only appropriate techniques were used
Interventions maximise life expectancy
Interventions are reversible
All works are adequately recorded
Interventions contribute to sustainability

6 Denmark Street

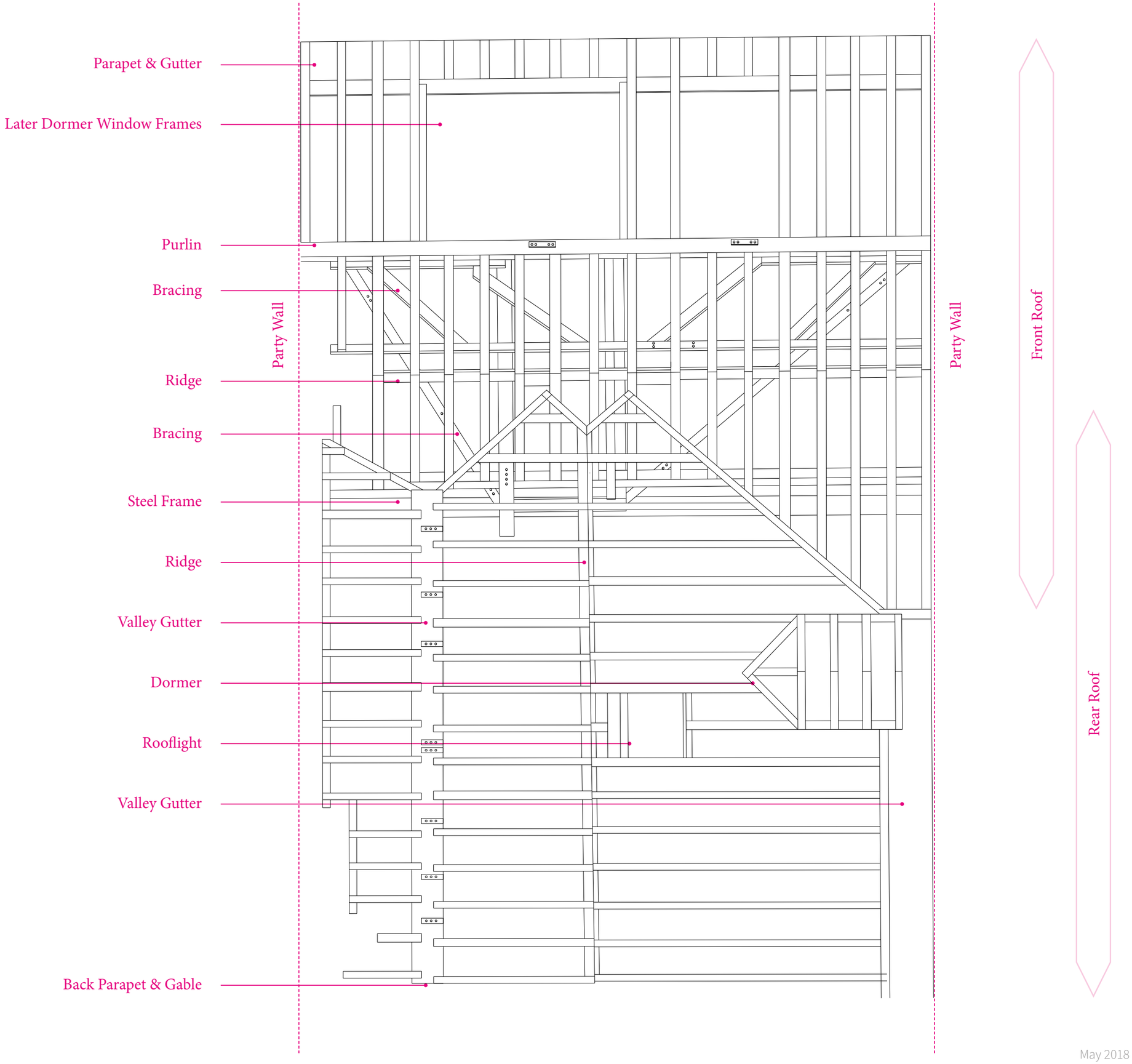
7 Denmark Street

Plan of Present Roof Structure

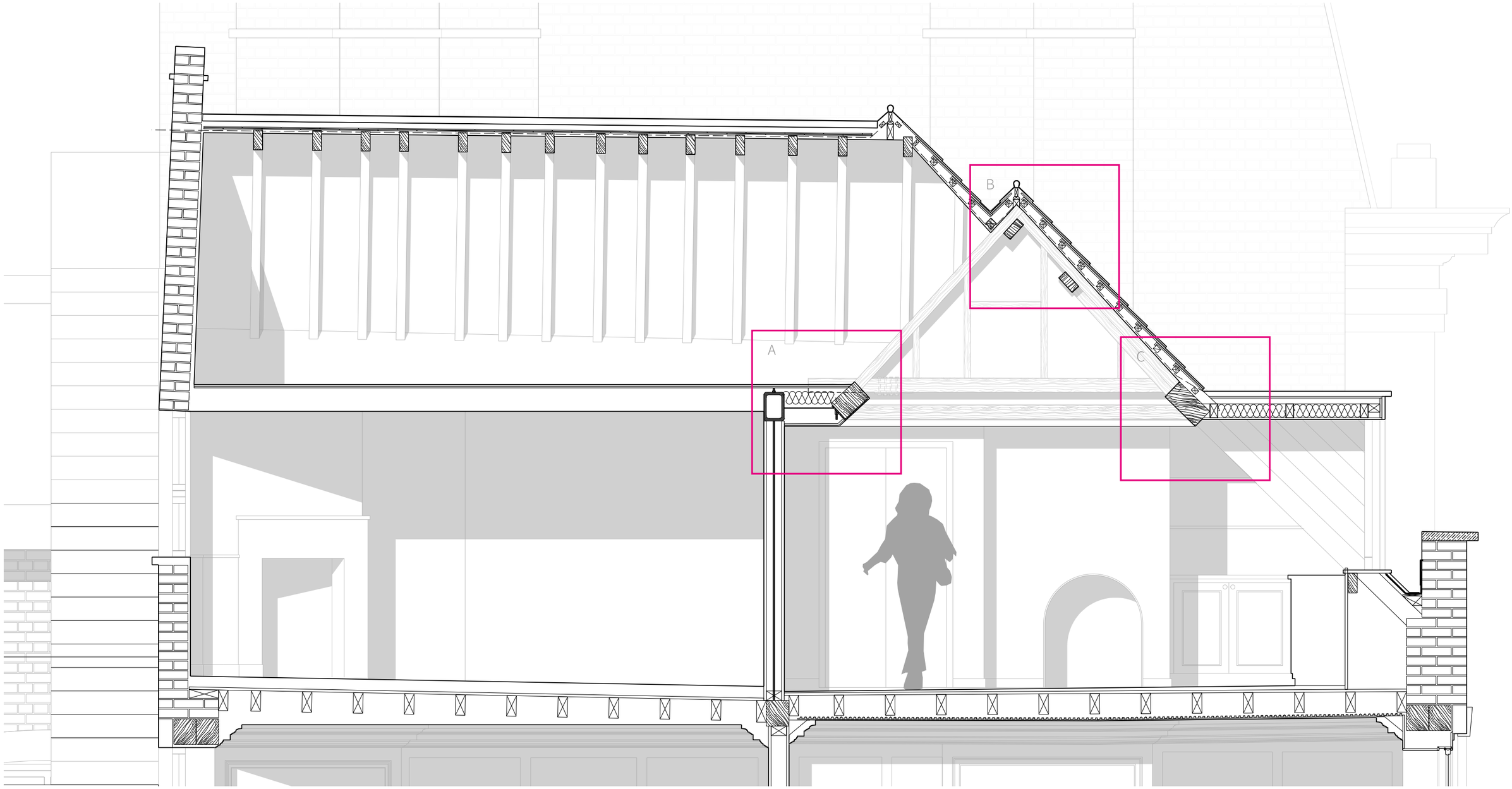
Repairs to the roof generally exist in the void of the front roof pitch, providing the structure with greater lateral stability.

In places throughout the roof, strengthening works undertaken in the 19th and 20th centuries comprising steel cradles, plates and bolts stiffen the failing timber structure.

By replacing the front purlin, which is affecting the integrity of the entire structure, we could remove some of the redundant modifications to the roof while ensuring it doesn't continue to deflect further.

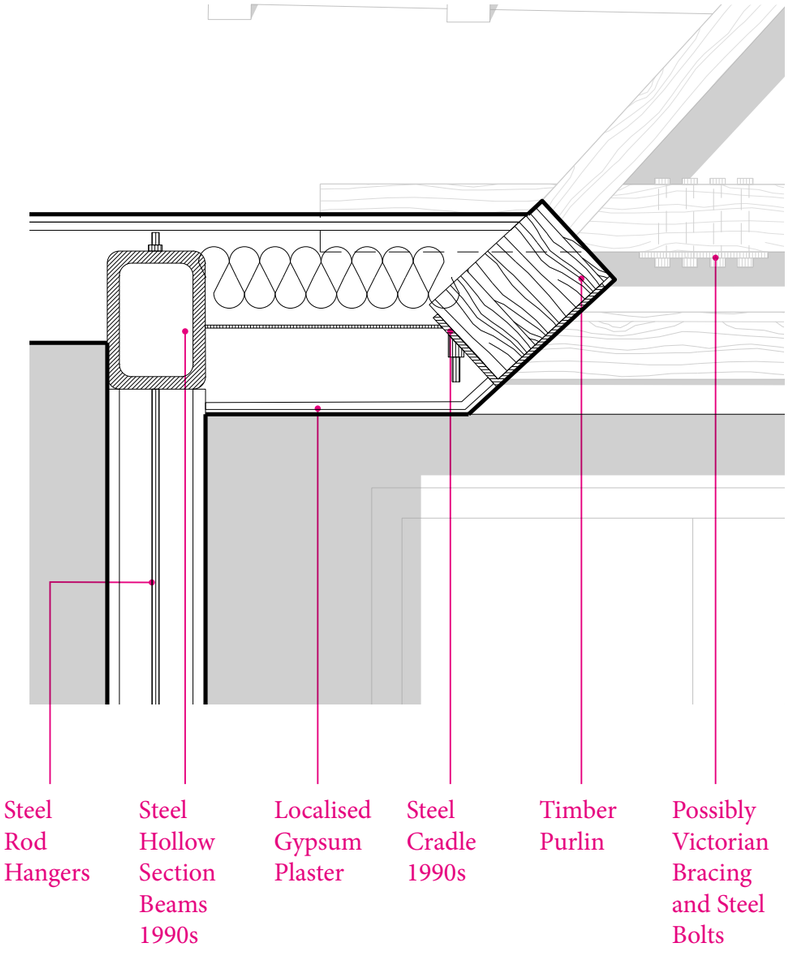


Existing Section



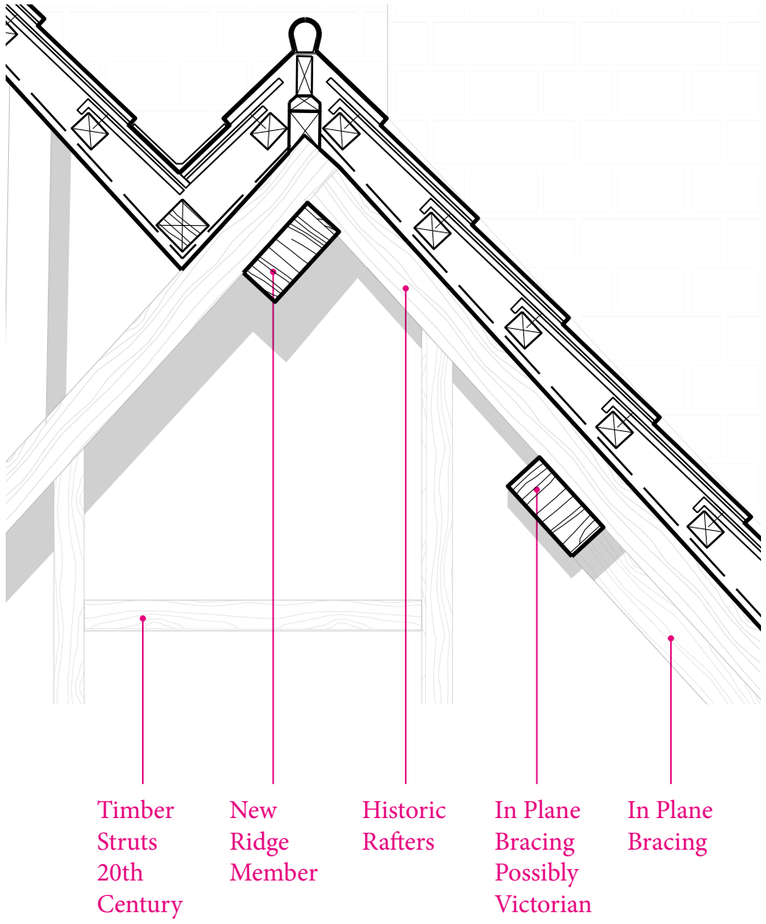
Existing Detail A

Steel supports improve the integrity of the original structure and are to be retained



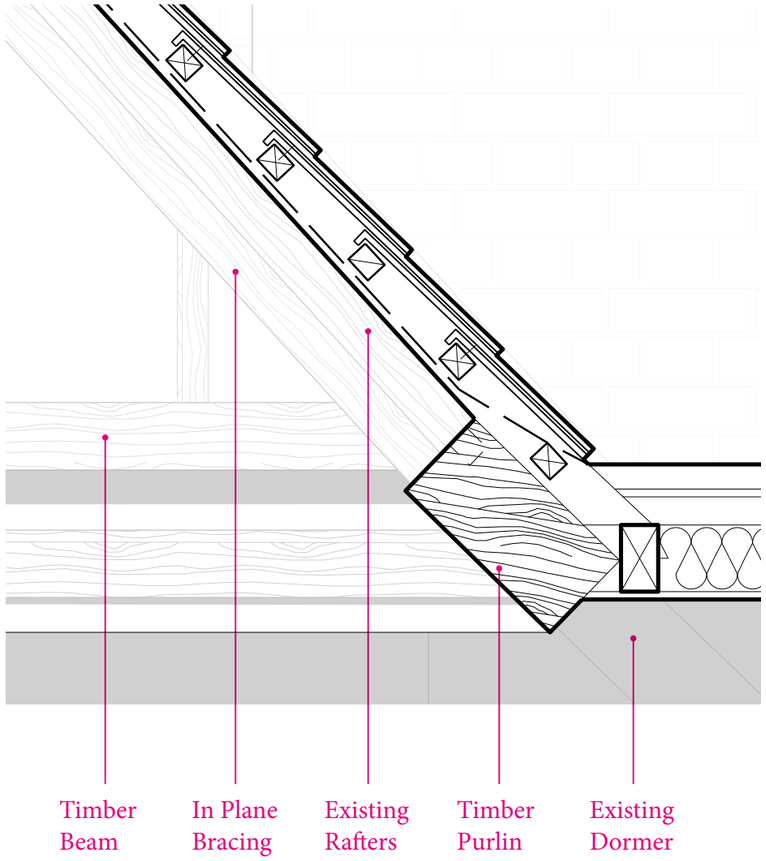
Existing Detail B

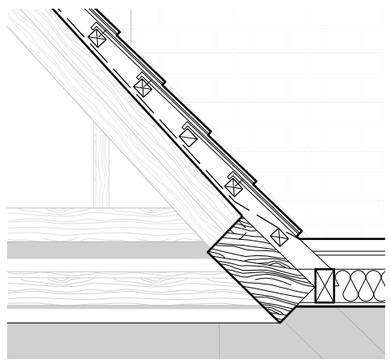
New timber bracing within the void of the front roof improves the stability of the structure. However, the current struts will no longer be needed once the replacement purlin is in place and existing rafters repaired



Existing Detail C

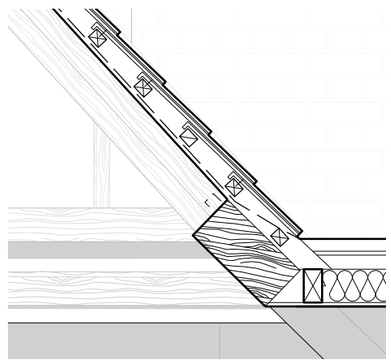
As the image adjacent demonstrates clearly, the front purlin is patently beyond repair and will be replaced with a ‘seasoned’ timber purlin as a like-for-like swap





Current Purlin Location

As the photo above demonstrates, the severely deflected purlin now falls below the ceiling line. The movement of this member has also affected the rafters adjoining it



Proposed Purlin Location

The repairs seek to replace the failed purlin with a new member from which the repaired rafters shall spring. In replacing the purlin, its original height and location shall be reinstated

Methods of Repair - Purlin

Having stripped back and investigated the structure, we then explored a series of different methods of like-for-like repair that would allow work to be done with the roof in-place and thereby reducing an unnecessary potential for further damage.

Options explored:

Retention & Insert Steel Cradle

Localised Repair of Rot

Like-for-Like Replacement

It was agreed that a like-for-like replacement of the purlin was the best solution, ensuring the integrity of the structure into the future and aiding the repairs undertaken to any adjoining elements of the roof structure. The replacement is to be a custom-sized green oak structural beam, sourced from the sustainable supplier, UK Timber.

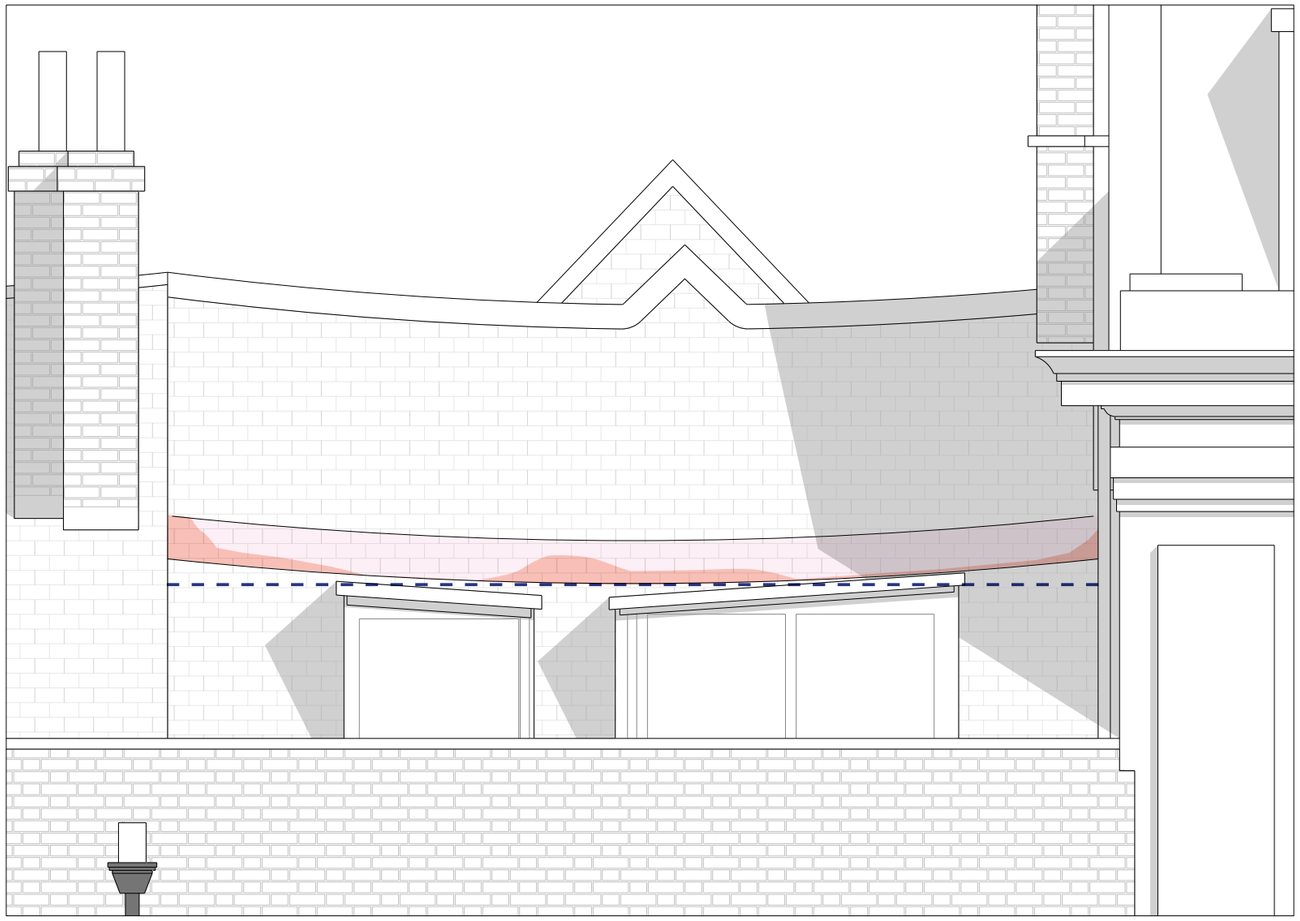
References:

Historic England
'Practical Building Conservation: Timber'

David Yeomans
'The Repair of Historic Timber Structures'

S.P.A.B, Old House Handbook
'Traditional Carpentry Repairs'

S.P.A.B, Repair of Ancient Buildings
'The Repair of Ancient Timber Roofs and Other Works of Fine Carpentry'



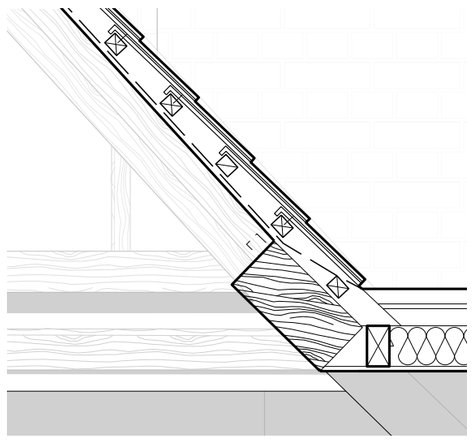
Rotted Areas of Purlin

Potential Steel Cradle Location

No.6 Denmark Street Front Elevation - Steel Cradle

This option sought to support the purlin at its lowest point with a steel cradle, freezing it in position. However, Given the level of deflection, only a small amount of the beam would meet the cradle, and the piece that did would be the section suffering most severely from rot.

And, referring to the Society for the Protection of Ancient Buildings guidance, "iron and steel, although useful sometimes, should be avoided in the repair of ancient timber framed constructions where new oak will serve the purpose"



Proposed Purlin Location - Replacement

Replacing the purlin with a new timber will address not only the issues with the purlin itself, but the knock on effects it had been having on the dormers, rafters and surrounding structure. Following advice from the Old House Handbook, using "green oak is suitable where large areas of the frame are being replaced".

No.6 Denmark Street Purlin Decay - Scarfing

The extent of the rot and splitting across the purlin is apparent in the adjacent photos. Localised repair with scarf joints was considered but given the scale of the works needed, little of the original purlin would remain. This issue would be compounded by the fact that the tenons at each end have suffered extensive decay, as have the joints between the purlin and the rafters

Methods of Repair - Rafters

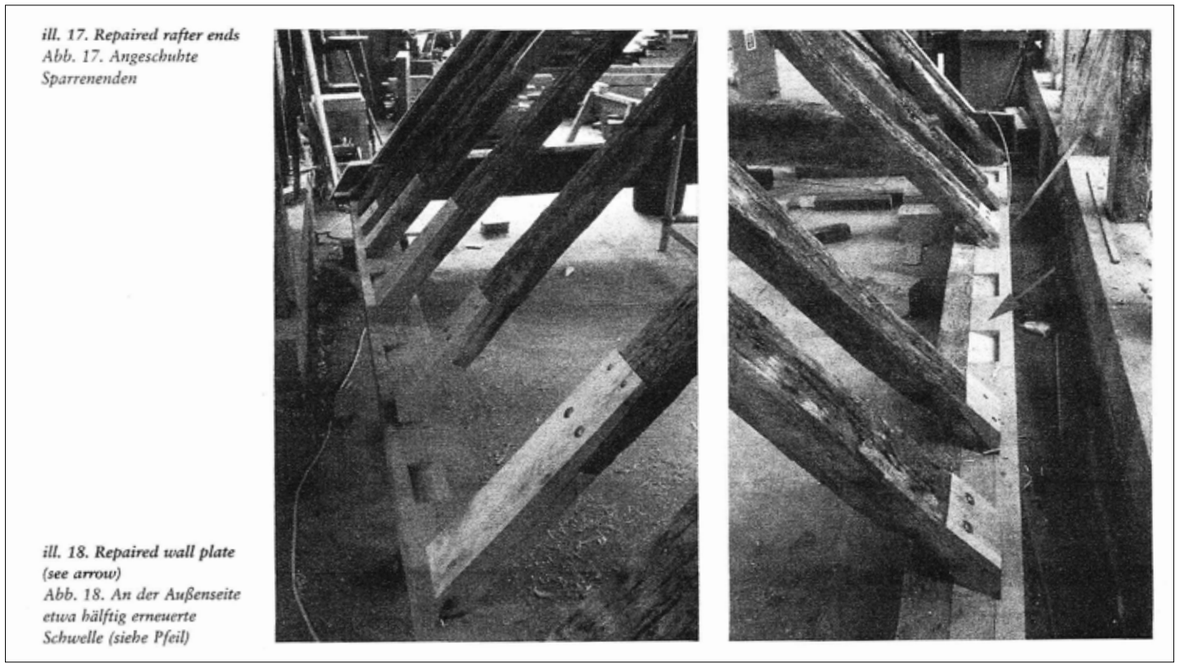
Rotting rafters will be repaired on a case-by-case basis. Only replacing rotting sections of timber with a scarf jointed piece of newer timber when necessary, rather than wholesale replacing entire rafters.

When the apex where two rafters meet is suffering from decay, we shall be follow guidance from S.P.A.B's Repair of Ancient Buildings, as has already been done in no.6 Denmark Street:

"In coupled-rafter roofs where the tops of the rafters are becoming defective it may be convenient in the interests of economy to strengthen the junction of rafterand rafter without adding new tops. This has been done by spiking pieces of one inch thick and nine inch wide planking on each side a little below the ridge."

References:

Historic England
'Practical Building Conservation: Timber'
David Yeomans
'The Repair of Historic Timber Structures'
S.P.A.B, Old House Handbook
'Traditional Carpentry Repairs'
S.P.A.B, Repair of Ancient Buildings
'The Repair of Ancient Timber Roofs and Other Works of Fine Carpentry'



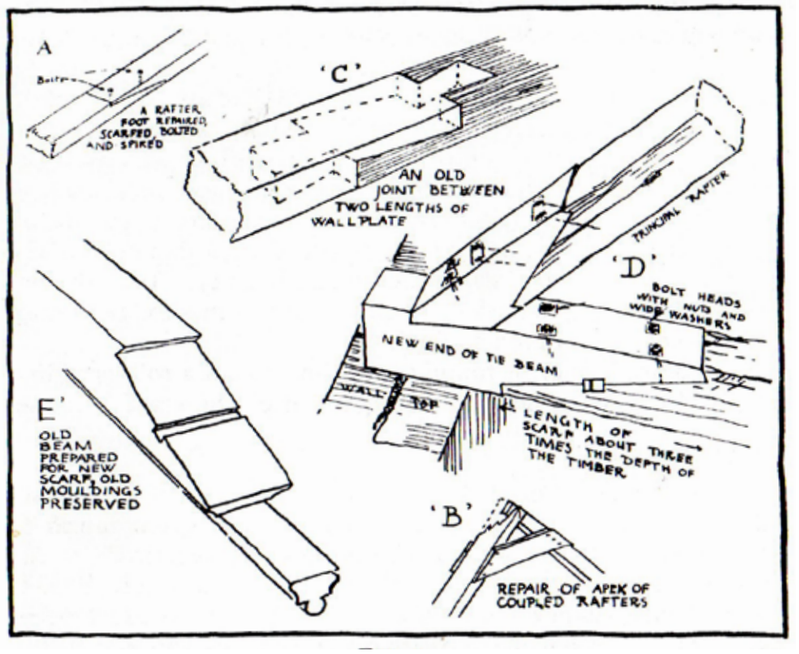
ill. 17. Repaired rafter ends
Abb. 17. Angeschuhte Sparrenenden

ill. 18. Repaired wall plate (see arrow)
Abb. 18. An der Außenseite etwa hälftig erneuerte Schwelle (siehe Pfeil)

Reference:
David Yeomans, *'The Repair of Historic Timber Structures'*

No.6 Denmark Street Rafter Apex

No.6 Denmark Street coupled rafter repair as *Diagram B* of adjacent S.P.A.B reference. No.7 to receive the same repairs at the apex of coupled rafters



Reference:
S.P.A.B, *'Repair of Ancient Buildings'*

Scarfing of Rafters

The adjacent images show the process being undertaken on the repair of the no.6 Denmark Street roof.

Each individual rafter is assessed to ascertain the extent of the damage and how much of the original element can be retained. Following this, rotting and split sections of timber are replaced using a scarf joint.

For no.7 Denmark Street, this method of like-for-like repair shall be used to address the issues of deflection and decay occurring throughout of the roof

Rafters

The original rafters are supported throughout by a mix of bracing from different periods. We intend on repairing and strengthening the original structure before removing any extraneous 20th century bracing.

The following pages provide an overview of our investigations into the structure and our intentions for each component.

7 Denmark Street: Front Roof Pitch

Struts

Retain & Repair **Remove**

Once the replacement purlin is in place, the struts in the front roof void can be removed as they will no longer serve any structural purpose

7 Denmark Street: 20th Century Timber Struts in Roof Void

Later Steels

Retain & Repair **Remove**

The 1990s steels that sit between the rear and front rooms shall be retained as they are in order to continue to support the damaged rear purlin. The beam will sit within the new partition wall while the cradle will be hidden above the repaired ceiling

7 Denmark Street: Steel Supports

In-Plane Bracing

Retain & Repair **Remove**

Later (possibly Victorian) bracing to be retained and help support the repaired rafters that shall sit on top of the bracing.

7 Denmark Street: Bracing in Front Roof Void

Horizontal Bracing

Retain & Repair **Remove**

Later (possibly Victorian) bracing to be retained to control and prevent lateral deflections on the roof, particularly around the ceiling void

7 Denmark Street: Bracing Around Ceiling Opening

Lath and Plaster

Retain & Repair **Remove**

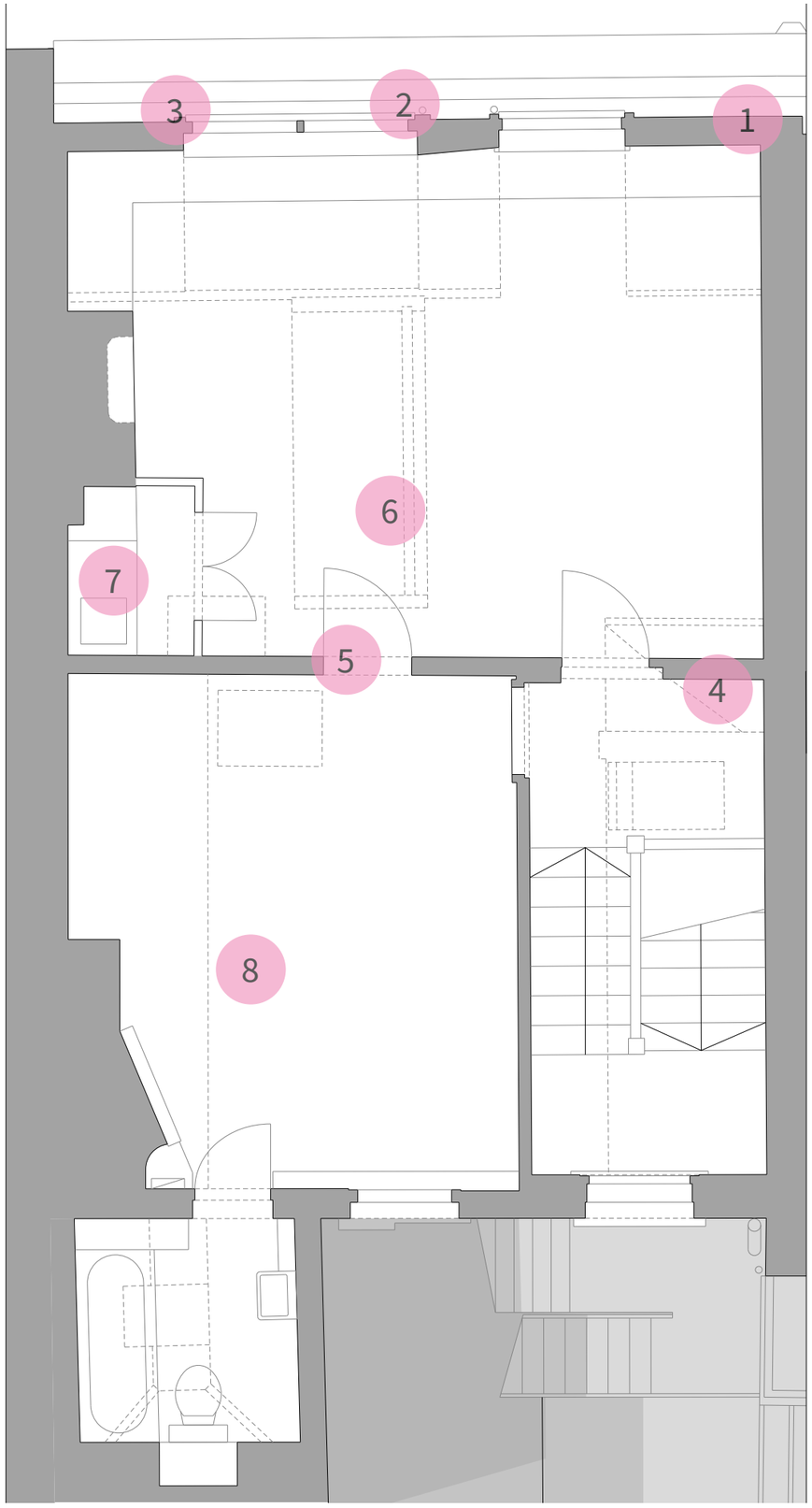
Given the extent of potential repair to the roof, the planned retention of the historic ceilings could be compromised. In addition, when installing a new, straighter purlin, the ceiling would be lower than the structure, making retention more difficult.

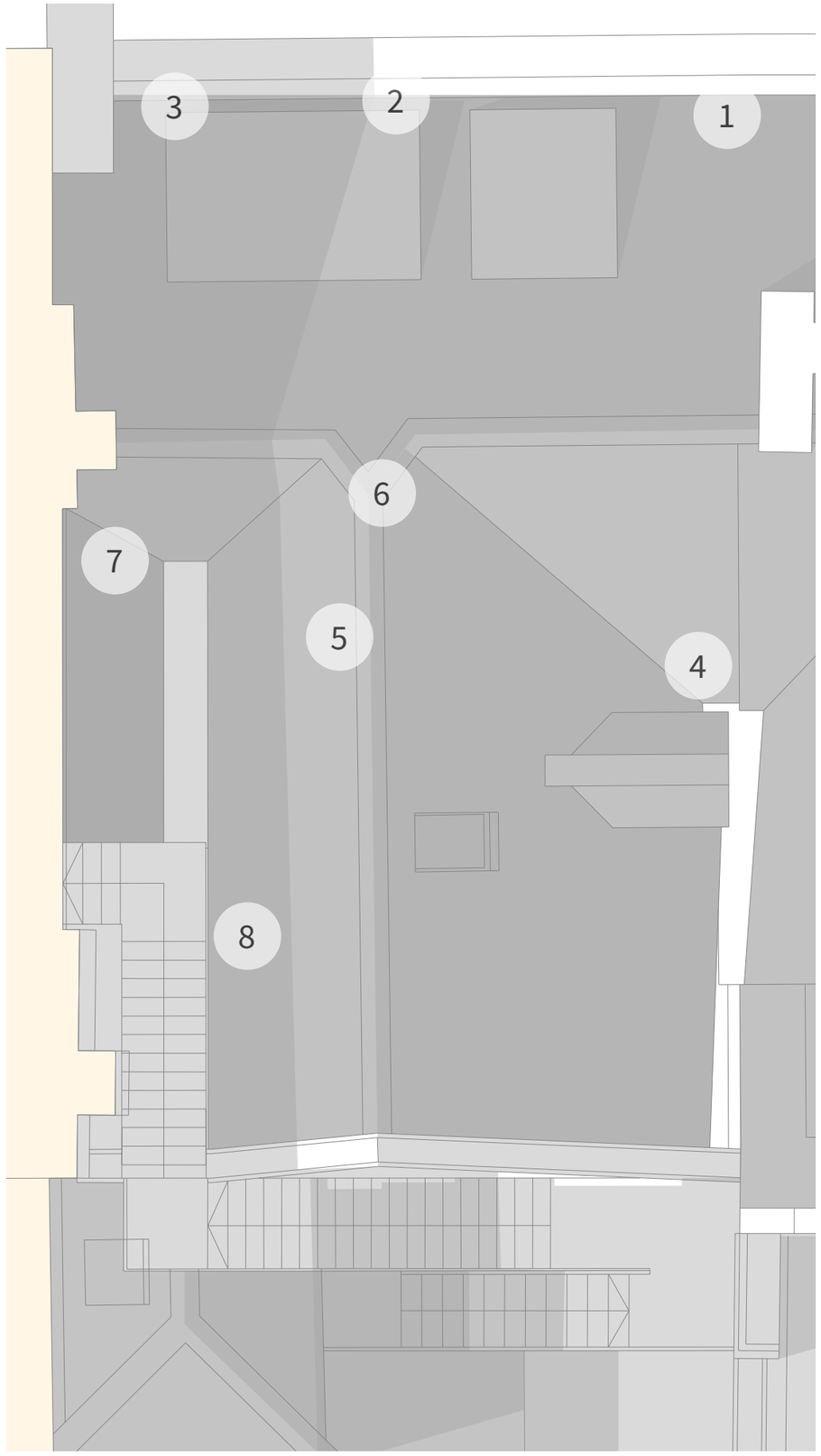
This will be reviewed on an ongoing basis as works commence. All stages will be recorded with photographs.

7 Denmark Street: Existing Ceiling
Remains of existing lath and plaster ceilings

7 Denmark Street: Existing Ceiling
Plasterboard to underside of lath and plaster ceiling

Scope of Repairs





01 Damaged/Rotten/Failing Roof Members

The front purlin that stretches between the party walls shows the greatest level of damage, with rot, splits and deflection all clearly visible

02 Front Roof Slope & Purlin

Rebuild what is necessary in timber, retaining and repairing the existing structure and historic fabric wherever possible. All repair to be like-for-like, yet satisfy today's building codes

03 In-Plane Bracing

Later bracing is provided behind rafters and on top of ceiling joists and is to be retained to control lateral deflections on the roof, particularly around the ceiling void

04 Rear Roof Section

Further assessment of the deflection of the rear purlin will determine the extent of the repair. In theory, the steel cradle supporting the purlin off the steel can be retained to support the purlin

05 Rear Roof Steels

The rear purlin is supported by a 'steel cradle' that transfers load to the new steel. Steels in the rear roof are to be retained to work alongside localised repairs to prevent further deflection

06 Trussing/Struts in Roof-Void

Later trussing struts to be removed as they will not be required in the permanent repair solution

07 Lath and Plaster Ceilings

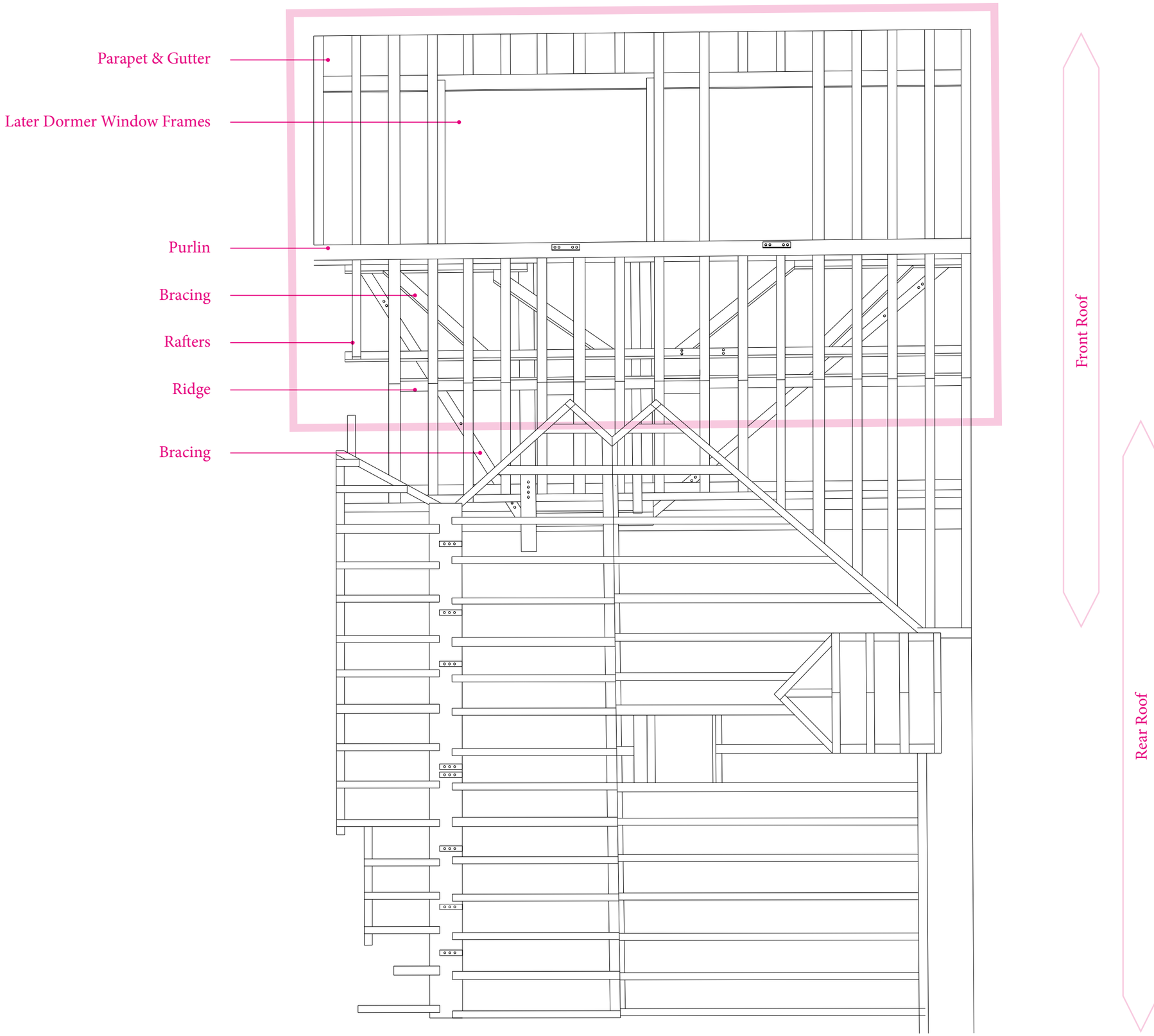
To be retained if possible. Th e proposed new purlin would lift the structure nearer to its existing datum, making the deflected ceiling lower than the structure and making retention very difficult

08 Gutter

Valley to be maintained and repaired, with fall towards the rear of the building, rather than the front and through the roof void which has caused long term decay through water ingress

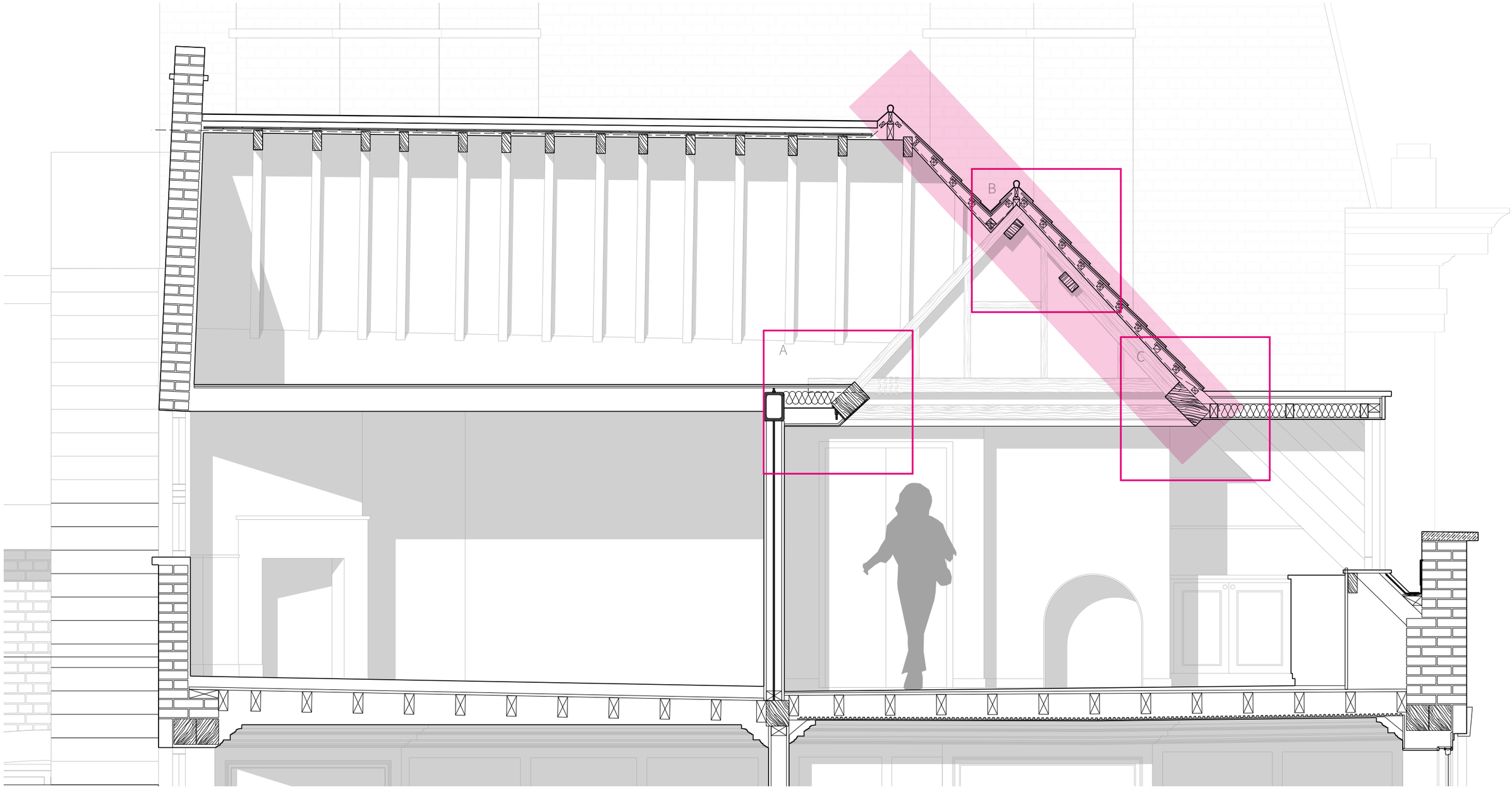
Existing Roof Plan

The main repair works occur to the front roof slope. Following the like-for-like repairs, the level of the original roof line will be retained.



Existing Section

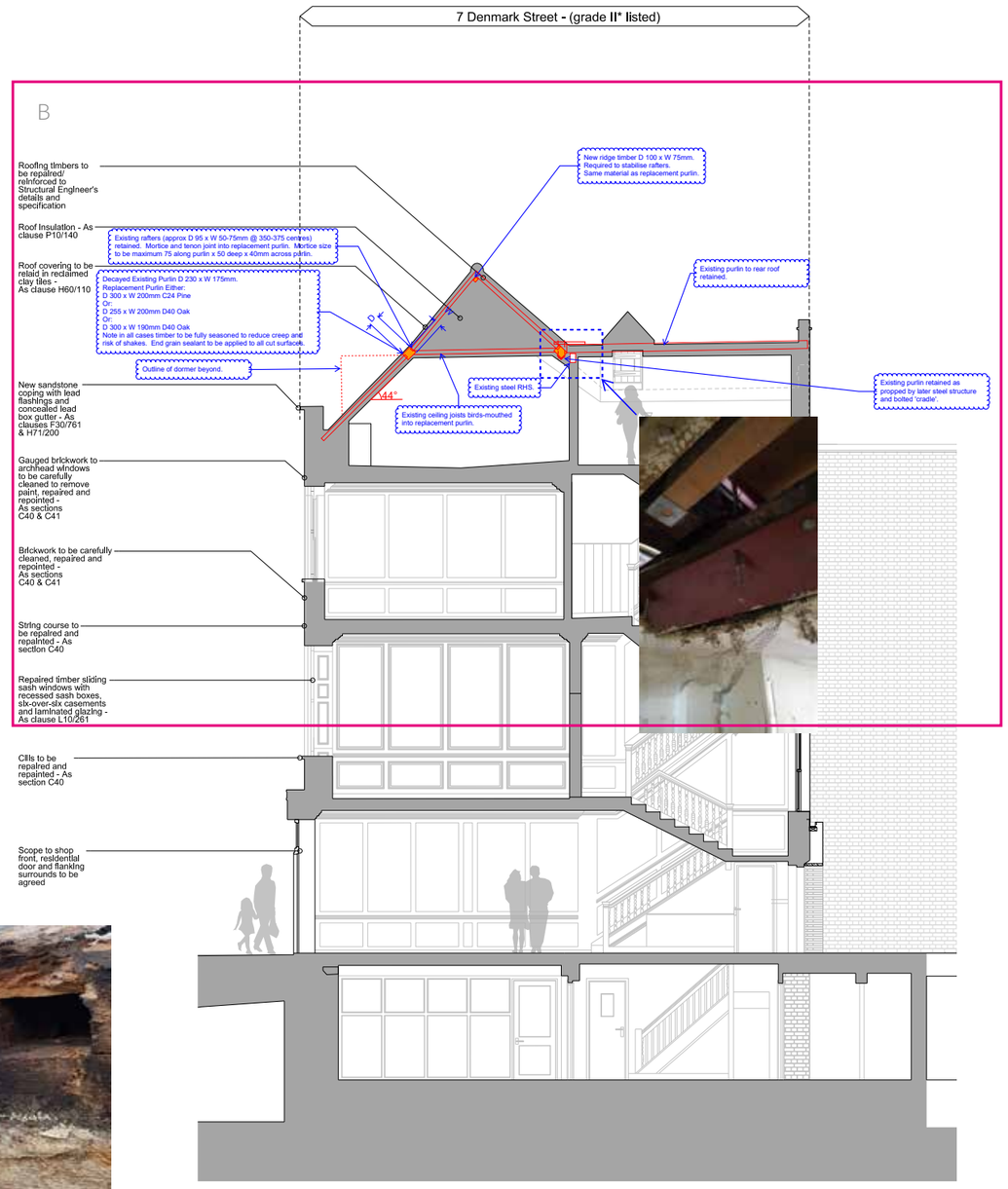
The main repair works occur to the front roof slope. Following the like-for-like repairs, the level of the original roof line will be retained.



Structural Engineers Design for Timber Repairs

A

B



Example of decay to purlin.

Notes:

Timber:
Areas of existing timber floor rafter are to be replaced or strengthened in a case-by-case basis the existing timbers are visibly damaged or show signs of decay

Steelwork:
Any existing steel work to be retained is to be wire brushed to remove corrosion and re-painted with 2 layers of bituminous paint.

Any new steelwork bearing into masonry to have ends protected with 2 layers of bituminous paint.

Masonry Repair

The following notes provide a general method statement for the level of care and finish needed when repairing the masonry. The existing wall falls within the curtilage of two listed buildings and, as such, particular care must be taken when carrying out repairs. All works are to be carried out by hand only without use of powered, mechanical or percusive tools

Preparation:
Brickwork to be brushed down to remove any loose mortar and surface debris. Mortar joints to full extent of wall to 6&7 Denmark Street to be carefully raked out back to sound mortar bed - minimum of 10mm depth. Dust and debris to all joints be cleared using a dry brush

Cleaning:
Brickwork to be cleaned using suitable water applied method - no high pressure or chemical treatment

Repointing:
Joints to be wetted up thoroughly before commencing repointing. Mortar to be applied to clean, damp joints and brought proud of the brick face. Allow for mortar to go 'green hard' before removing any excess mortar. Joints to be finished flush and hit with a stiff bristle brush to ensure mortar is forced to the back of any joint and close up cracks

Prior to repairing and repointing, trial areas demonstrating the following are required for inspection on site by ICA and Engenuiti:

Raking out and cleaning of joints - horizontal and perpend

Replacement of missing and spalling brickwork with reclaimed bricks - due to the patchwork nature of the wall, there are varying brick types and bricks should be matched in colour and form locally

Strengthening works with the installation of helical bars

Re-pointing, including joint finishing and mortar colour with suitable pigments

Samples panels are needed to ensure that the brickwork repairs retain and enhance the character of the existing wall, whilst providing suitable strengthening to increase its lifespan

Scale 1:50

0 1 2

Revisions

01 *Issued for comment* 13.02.18

Client
Consolidated Ltd.

Project
St. Giles Circus - Zone 3

Drawing Title
7 Denmark Street
Elevation Proposed
Street Frontage

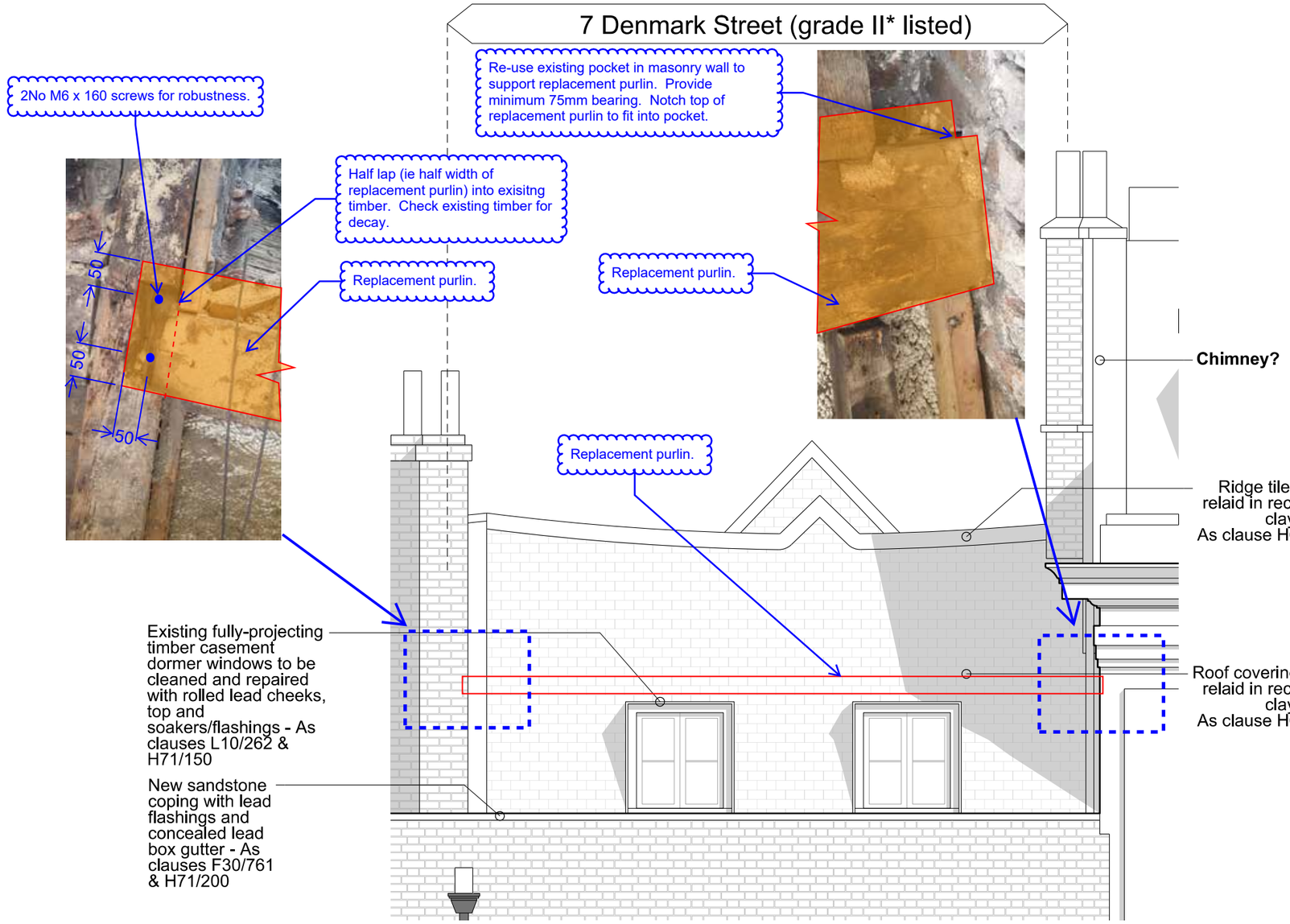
Drawing Number
1401_7D(00)303

Scale	1:50	Status	For Information
Drawn by	NB	Date	05/02/18

ica
70 Cowcross Street
London
EC1M 6EJ
02037807355
07785 973723
ianchalkarchitects.com

engenuiti

project name	7 Denmark Street		
drawing title	Roof Repairs		date 13.05.2018
project no. 879	drawing no. Z3-S-204	rev. 00	by CF


7 Denmark Street (grade II* listed)
2No M6 x 160 screws for robustness.
Re-use existing pocket in masonry wall to support replacement purlin. Provide minimum 75mm bearing. Notch top of replacement purlin to fit into pocket.
Half lap (ie half width of replacement purlin) into exisitng timber. Check existing timber for decay.
Replacement purlin.
Replacement purlin.
Replacement purlin.
50
50
50
Chimney?
Ridge tiles to be relaid in reclaimed clay tiles - As clause H60/110
Existing fully-projecting timber casement dormer windows to be cleaned and repaired with rolled lead cheeks, top and soakers/flashings - As clauses L10/262 & H71/150
New sandstone coping with lead flashings and concealed lead box gutter - As clauses F30/761 & H71/200
Roof covering to be relaid in reclaimed clay tiles - As clause H60/110

Roofing timbers to be repaired/ reinforced to Structural Engineer's details and specification

Roof insulation - As clause P10/140

Roof covering to be relaid in reclaimed clay tiles - As clause H60/110

New sandstone coping with lead flashings and concealed lead box gutter - As clauses F30/761 & H71/200

Gauged brickwork to archhead windows to be carefully cleaned to remove paint, repaired and repointed - As sections C40 & C41

Brickwork to be carefully cleaned, repaired and repointed - As sections C40 & C41

String course to be repaired and repainted - As section C40

Repaired timber sliding sash windows with recessed sash boxes, six-over-six casements

Existing rafters (approx D 95 x W 50-75mm @ 350-375 centres) retained. Mortice and tenon joint into replacement purlin. Mortice size to be maximum 75 along purlin x 50 deep x 40mm across purlin.

Decayed Existing Purlin D 230 x W 175mm.
Replacement Purlin Either:
D 300 x W 200mm C24 Pine
Or:
D 255 x W 200mm D40 Oak
Or:
D 300 x W 190mm D40 Oak
Note in all cases timber to be fully seasoned to reduce creep and risk of shakes. End grain sealant to be applied to all cut surfaces.

Outline of dormer beyond.

New ridge timber D 100 x W 75mm. Required to stabilise rafters. Same material as replacement purlin.

Existing purlin to rear roof retained.

Existing steel RHS.

Existing purlin retained as propped by later steel structure and bolted 'cradle'.

Existing ceiling joists birds-mouthed into replacement purlin.

44°