

fabric church



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01 introduction

This Design Statement has been prepared on behalf of Fabric Church in support of Planning and Listed Building applications for works to Ardwick Barracks.

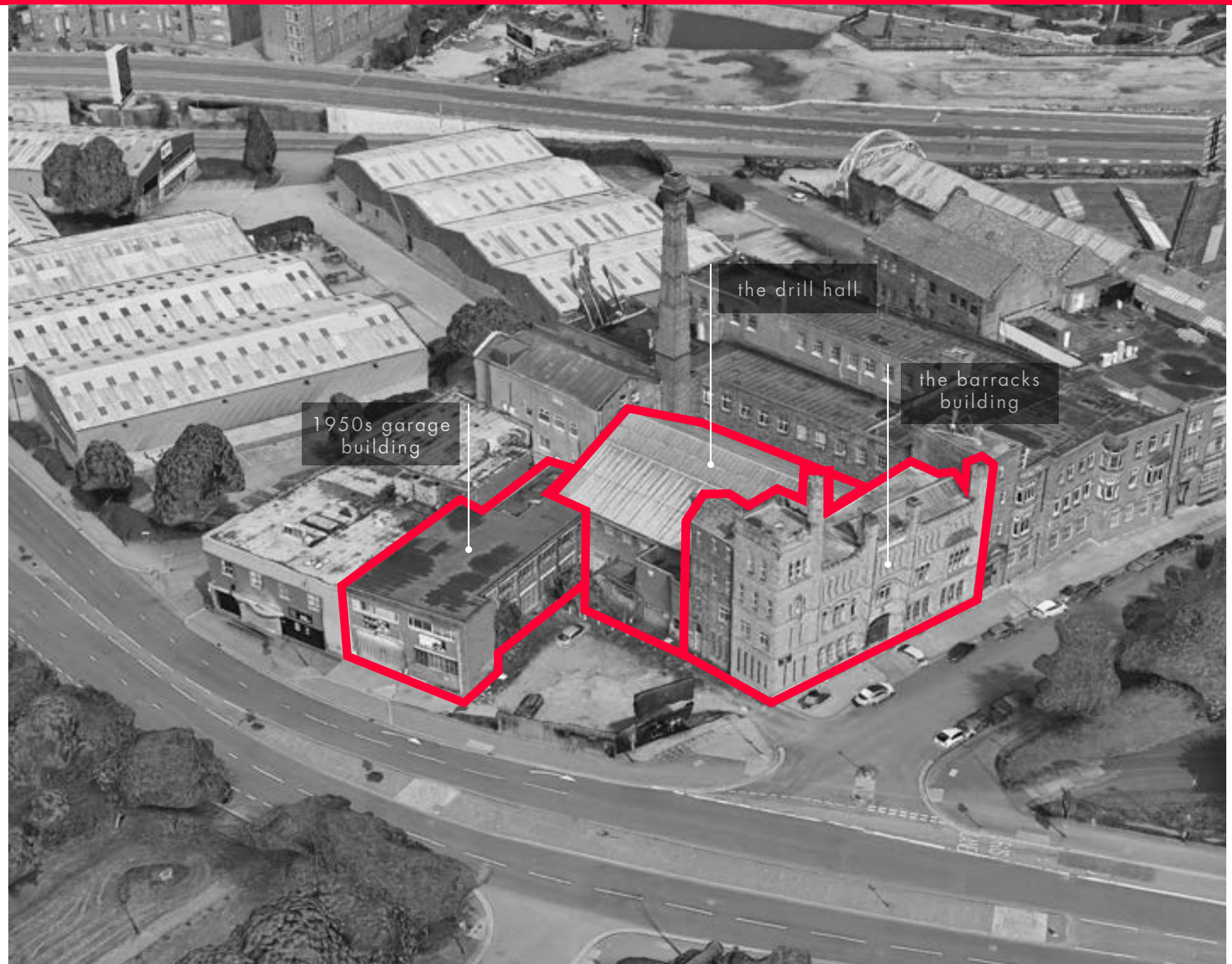
Whilst more extensive plans for the creative re-use of the site are being developed to secure a viable community use and lasting future for the buildings, the initial 'enabling' works for which permission is sought as part of this application is more limited in scope and comprises:

- replacement of the late-20th century Drill Hall roof
- replacement of the late-20th century Drill Hall roof light
- replacement of the late-20th century roof light on the second floor of the barracks building

These works are being prioritised and brought forward as an initial separate planning and listed building application due to the existing roof and roof lights being in a poor state of repair. The intention is to make the buildings weather-tight as soon as possible in order to prevent any lasting damage to the fabric of the buildings.

The Ardwick Barracks site comprises the main barracks building fronting on to Ardwick Green, the Drill Hall immediately behind and a 1950s garage/workshop building. The buildings were listed at Grade II in 1974 - all extensions also form part of this listing. Part of the buildings (predominantly the garage building) is currently in use by Fabric Church, following a successful change of use planning application (application 136050/FO/2023). However, the majority of the buildings are currently unoccupied and have been since the army vacated the property in 2018.

A design team, led by shedkm architects, and supported by Stephen Levrant Heritage Architecture, Hexa structural engineers, Crooks Walker Consulting, Ashton Hale, Design Fire Consultants and PMC2, is working up proposals for the regeneration of the entire site for church, community and outreach activities. These will be brought forward in a separate full planning and listed building application early in 2025, once the plans are fully developed.



01.01 site location



01.02 site history

Refer to Stephen Levrant Heritage Architecture's Heritage Statement for a more detailed analysis of the historical development and significance of the site - this is intended as a brief synopsis only.

01 By the 18th century, the general plan form of Ardwick's townscape had been laid out - the principal routes of which are still evident today. The layout was designed around an open park known as Ardwick Green, complete with a serpentine lake. The 'M. Littlewoods School Buildings' occupied the site at this time. These buildings stepped back from the street and were surrounded by expansive, landscaped grounds and Georgian villas.

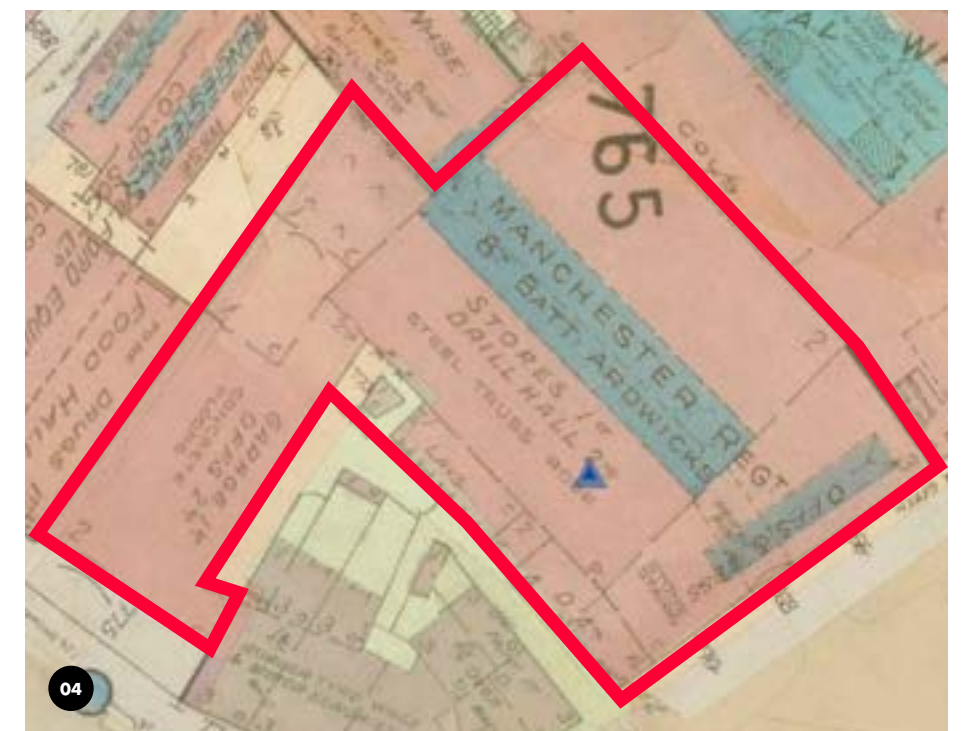
02 The introduction of the railway in the mid-19th century transformed the rural settlement into one of the city's first thriving suburbs. By 1851 Ardwick Green was occupied by terrace-lined streets and industrial premises. Breweries and schools were constructed which encouraged footfall into the area. Around this time the existing school buildings were extended to the rear and records show that the building was used as headquarters for the 33rd Lancashire Volunteer Corps (of Ardwick).

03 By the late 19th century the site was occupied by the Drill Hall that survives to this day. The third image shows the Tudor revival and castellated Gothic design of its entrance building - an architectural style which became the synonymous with drill halls of this period. The Drill Hall would have been accessed through the impressive arched entrance fronting onto Ardwick Green. From here, Ardwick Volunteers would commence the 'ordinary routine of drill' which consisted of marching and rifle drill (cleaning, disassembling and re-assembling their weapons).

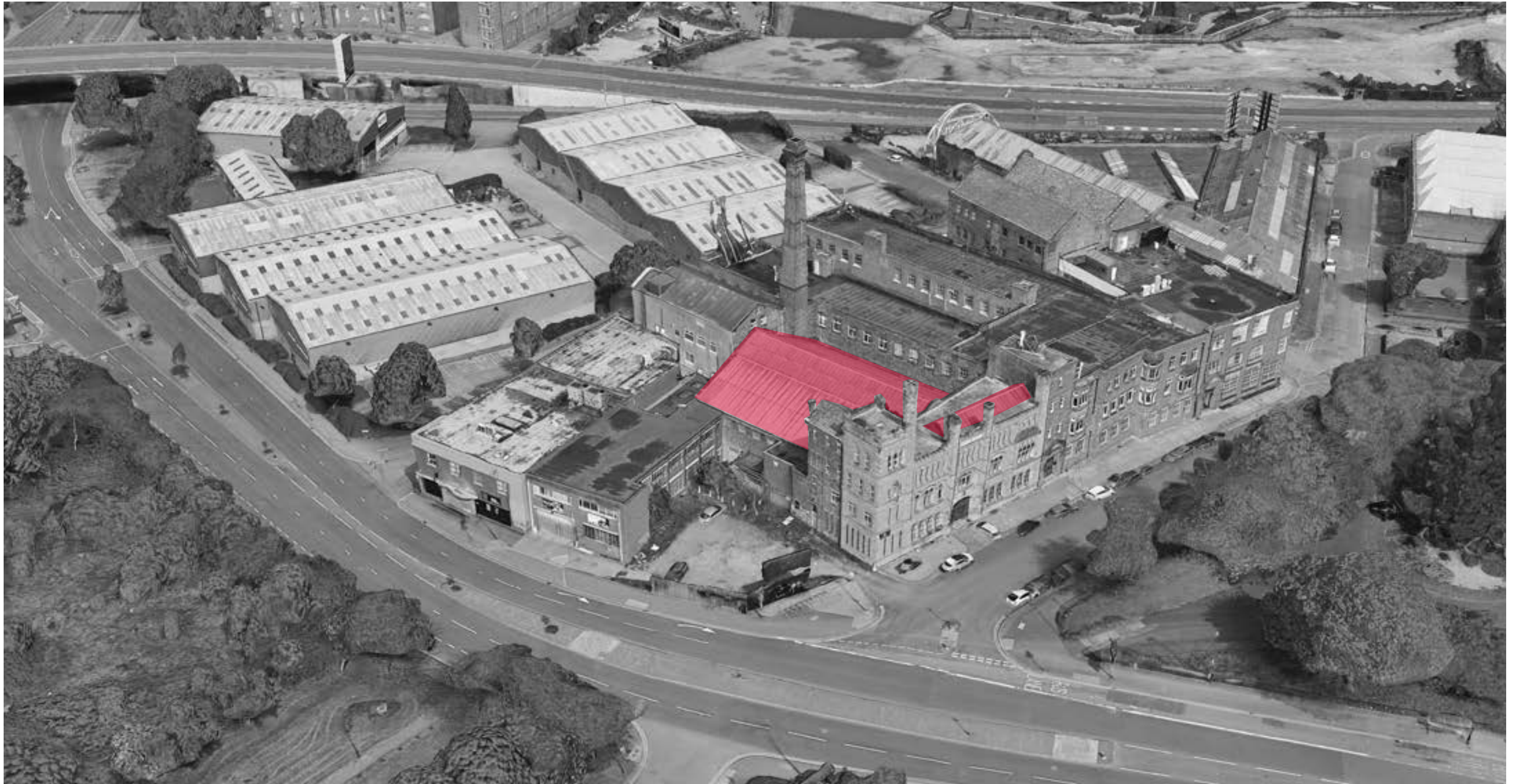
04 At the beginning of the 20th century the site was occupied by the Manchester Regiment 8th Battalion (Ardwick). The plan indicates two roof lights - one of which lit the Drill Hall below and the other lighting the top floor to the main barracks building. The original roof finish is believed to have been slate and was replaced in the late 20th century with a corrugated metal sheet roof.

key

- 01** Site plan showing Ardwick Green, 1794
- 02** Site plan showing Ardwick Grove, 1844-1849
- 03** View from Downing Street towards Ardwick Green Barracks, 1963
- 04** Goad Fire Insurance plan, 1928



02 proposed works



02.01 drill hall roof

The first floor Drill Hall is a large column-free space currently enclosed by a light weight roof supported on delicate wrought iron trusses. During the later period of its use by the army, the roof structure was concealed by a suspended ceiling which covered the entire space.

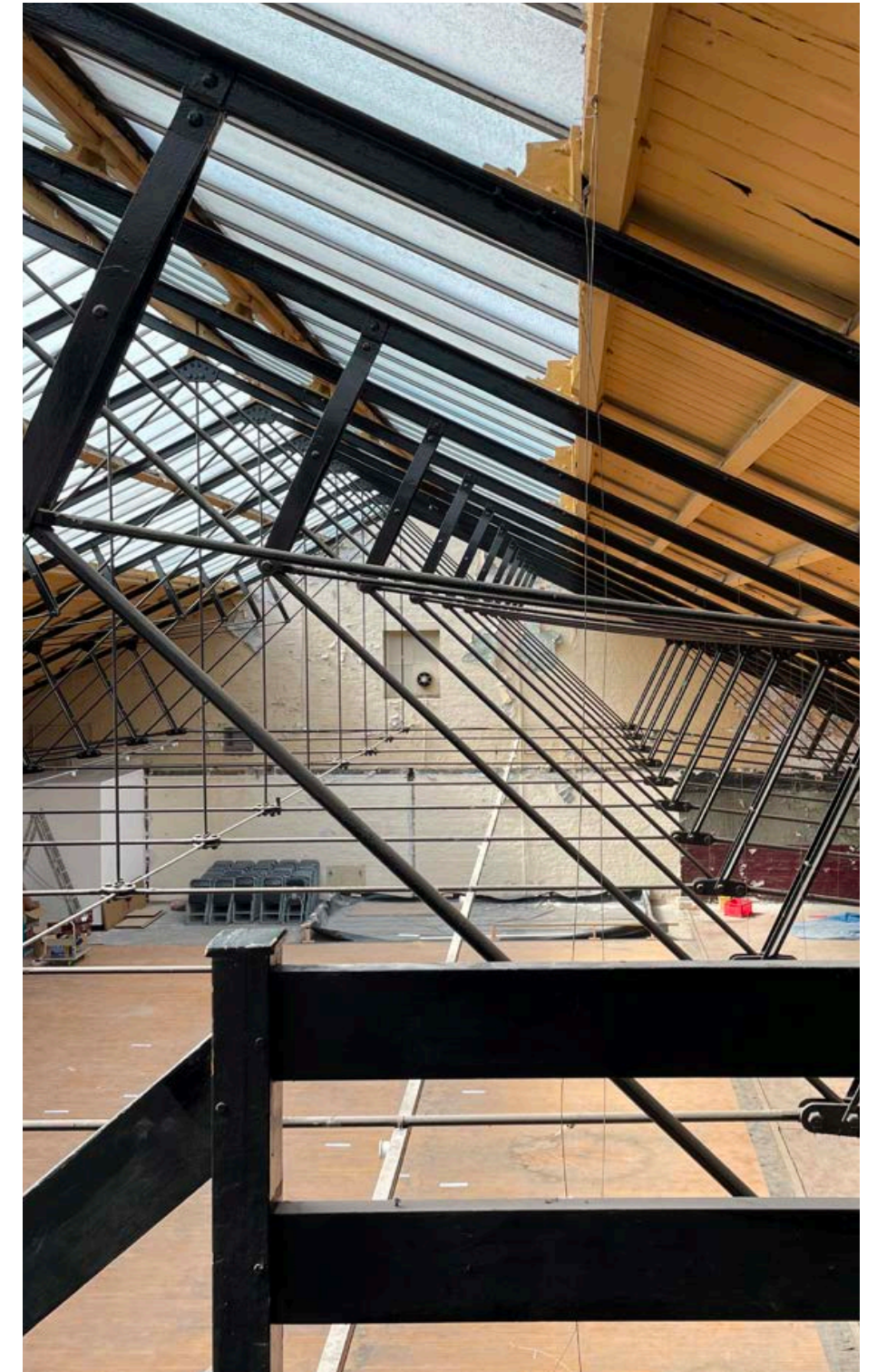
Now visible again (the suspended ceiling was removed before the church bought the building), the trusses are a major factor in the character of the Drill Hall and are deemed to be of high historical significance.

Another key design feature of the space is a large ridge roof light which runs the entire length of the Drill Hall. The roof light is 28.5m long and extends 4m either side of the ridge; this provides the Drill Hall with an excellent quality of light but the space performs poorly for comfort, quickly overheating in summer and getting very cold in winter. In large part this is due to the poor thermal characteristics of the ageing single glazed roof light. The roof light has outlived its design life and is beginning to fail, letting in draughts and water. The current roof light is not original, and therefore whilst the provision of a rooflight in the space is of high significance, the fabric of this particular roof light is of lower significance and replacement with a new and better performing product is proposed.

The remainder of the roof is built up of composite iron and timber purlins spanning lengthways between trusses, timber roof boards spanning along the roof pitch between purlins and an external corrugated metal sheet finish. The metal sheet appears to have once been coated or painted a green colour, although for the most part this has worn away. As with the roof light the roof finish is not original and dates from the latter half of the 20th century.

Overall, the existing Drill Hall roof is in poor condition with evidence of water ingress in multiple locations, some over a sustained period of time. There are particular issues on the eastern eaves gutter which adjoins the neighbouring Tanzaro House, where serious leaks have occurred during heavy rain at both the northern and southern end of the eaves gutter, with significant water ingress potentially damaging the internal fabric. Many of the timber boards are showing signs of decay.

The intention is to replace the existing roof as soon as possible in order to protect the existing fabric from any further water ingress, in preparation for more extensive refurbishment works to follow, securing the future of the whole building.





Our initial analysis of the Drill Hall space identified the delicate wrought iron roof trusses and the quality of light from the extensive linear ridge roof light to be the main contributors to the character of the space. This was backed up by historical assessment which found the roof trusses to be the features of highest significance and greatest originality. Therefore, when exploring options for the re-roofing of the Drill Hall, our focus has been on retaining glazing along the roof ridge and preserving the existing trusses without the need for significant structural strengthening that would be detrimental to the appearance of the trusses. Accordingly, our decision-making process has sought to preserve the trusses with minimal interventions.

Another important factor which has informed our proposals is the need to upgrade the thermal performance of the roof in order to keep heat loss and energy use to a minimum, both to limit carbon use and manage running costs and therefore secure the building's long term future. The client has set the design team the challenge of meeting the Church of England's Net Zero Carbon target, hence targeting thermal performance in line with Building Regulation Part L as a minimum. Prioritising building fabric performance will be instrumental in the development of a detailed strategy for de-carbonising the energy use of the building which will form part of the wider regeneration plans.

The intention, therefore, is to retain, unaltered, the existing roof trusses, but strip off the existing uninsulated roof coverings and single glazed ridge roof light and replace them with a new insulated roof and double glazed roof lights with enhanced thermal performance.

The insulated roof and double glazed roof lights are both heavier than the existing finishes and therefore great care has been taken to consider the structural loads to avoid impacting on the existing trusses. Halving the size of the roof light was considered to reduce weight, but the team concluded that this would be harmful to the quality of the space. The proposed new roof is a lightweight aluminium standing seam system that helps to keep loads manageable; re-establishing the original slate roof finish was considered, but was a much heavier solution which would have required the strengthening of the trusses with new steel members.

The existing composite timber/iron purlins and timber roof soffit boards, visible internally in the Drill Hall, are unable to perform structurally to modern standards and to support the increased weight of the insulated roof. Both are to be removed, however, the soffit boards are to be retained for re-use elsewhere in the building, subject to condition.





02.01.01 structure

The Drill Hall truss is an original late-19th century feature of the Grade II listed Drill Hall. The truss is composed of wrought iron, a material widely used at the time for structural elements due to its advantageous tensile strength. The durable nature of the material means that the trusses still provide structural integrity to the existing roof today. Their structural integrity combined with their heritage value deems the trusses key elements for retention and subject to minimal intervention.

The delicacy and slenderness of the existing trusses are a key factor in the character of the space and avoiding the need for any cumbersome modern strengthening members was paramount.

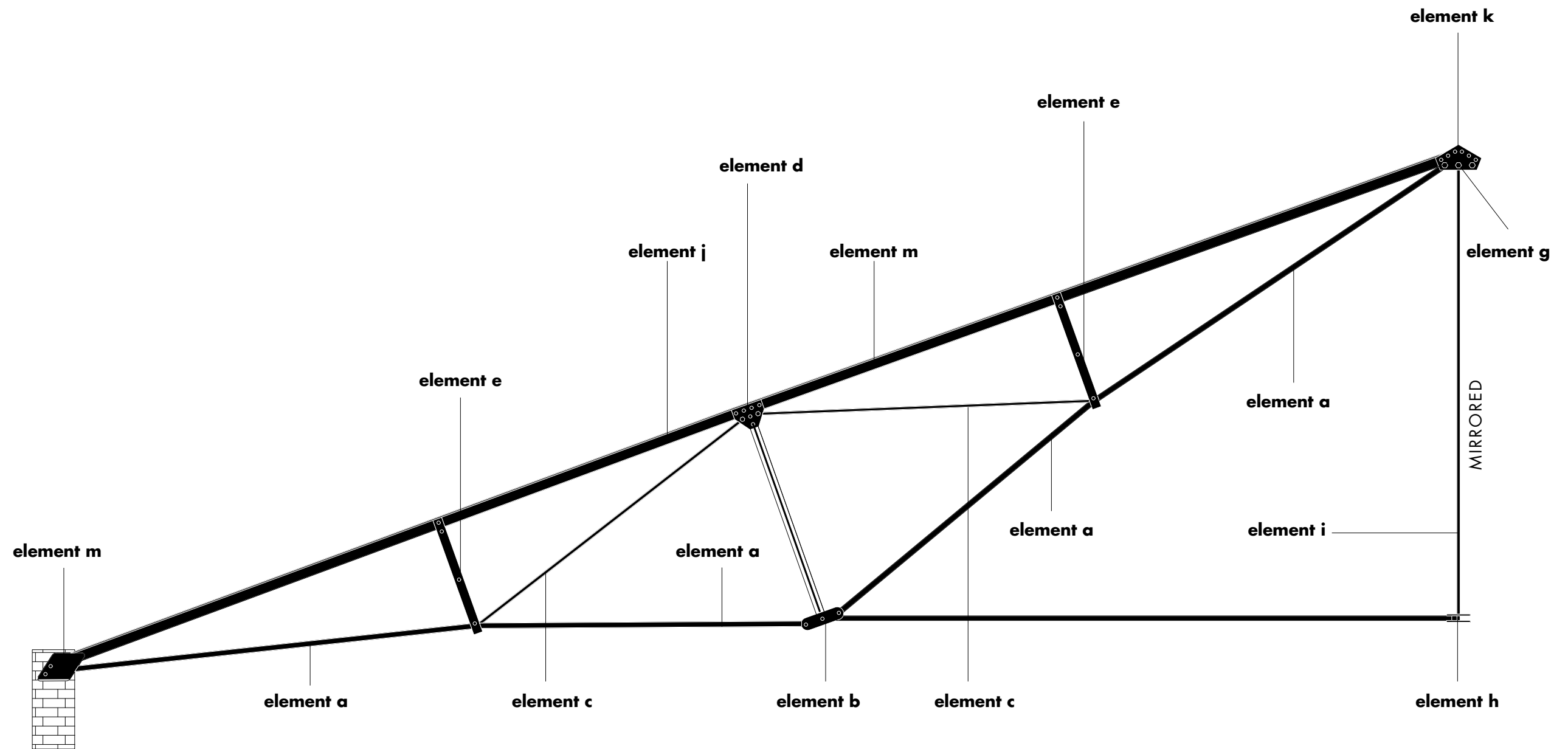
Whilst the proposals retain the existing trusses unaltered, we are proposing to remove the existing composite iron and timber purlins that span between trusses at approximately 600mm centres. These will be replaced with new steel PFC members that are placed at truss node points (approximately 3.2m centres) and thus avoid overloading the top chord of the truss and channel loads more efficiently, avoiding the need for new strengthening members to be added to the existing trusses.

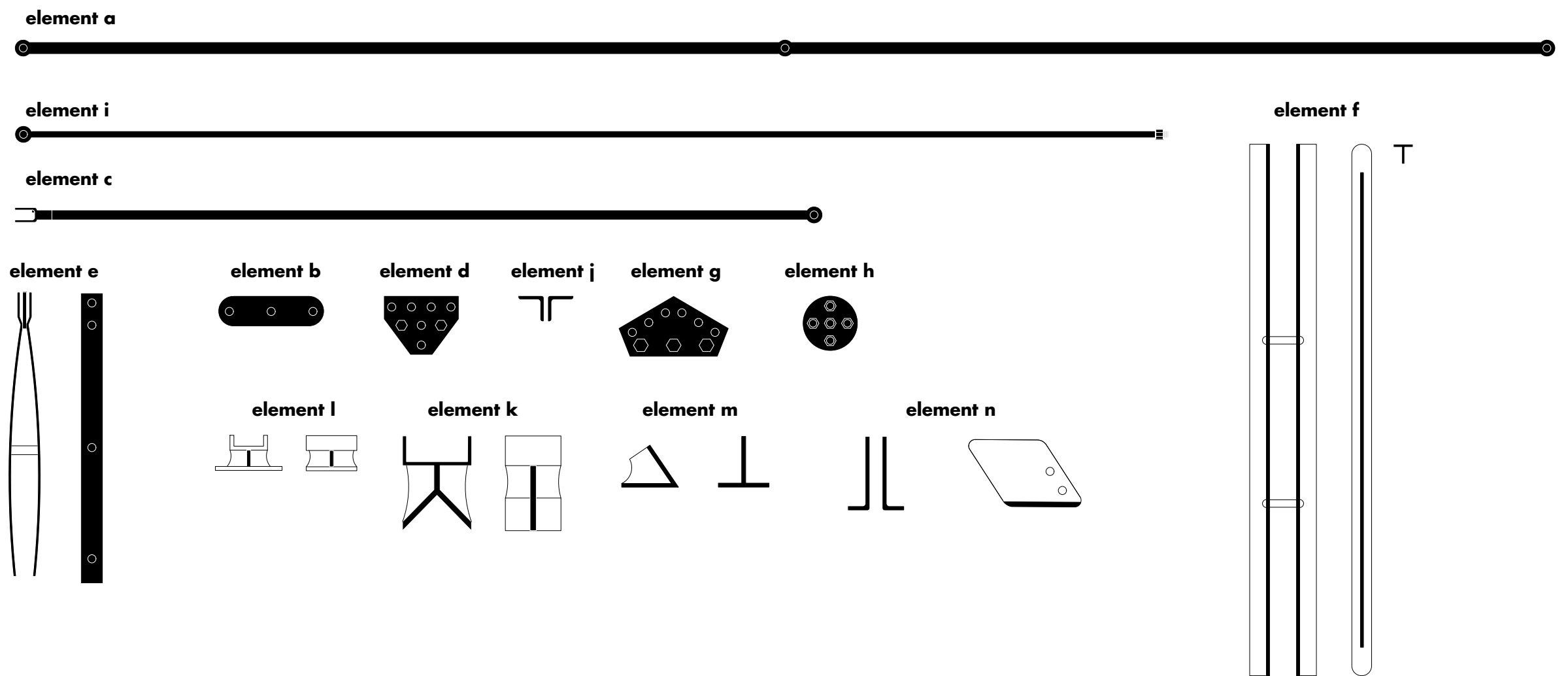
key (ref following pages)

- 01 Element K/G (steel ridge beam shoe atop steel gusset)
- 02 Element D (steel gusset)
- 03 Element E (truss web)
- 04 Element B (bottom chord tie beam)
- 05 Element B (bottom chord tie beam)
- 06 Element H
- 07 Element N (heel)
- 08 Element K (steel ridge beam shoe)
- 09 Element K (steel ridge beam shoe)
- 10 Element M (roof light angle)









02.01.02 external roof finish

Poor condition and significant water ingress through the existing roof has made the need for replacement urgent. Whilst the structural roof trusses are of significant heritage value, the existing corrugated sheet metal external finish was added in the latter half of the 20th century and therefore are deemed less significant. The existing profiled steel sheeting originally featured a green colour coating, although this has mostly now worn away as the material has exceeded its original design life.

In order to establish the most appropriate replacement roof finish material and associated roof build-up, a number of loading tests were carried out by the structural engineers (Hexa). These all started from the basis of a new insulated roof to achieve the minimum U-value required under Building Regulations of 0.16W/m2K, which equates to circa 230mm of insulation. Some adjacent walls will need to be extended - with matching brick masonry - to suit the new, deeper roof build-up.

Slate is believed to have been the original roof finish, therefore, a new slate roof finished was considered, however, this proved too heavy for the truss to support safely without significant reinforcement. A composite slate look-a-like product was also tested, but offered an inferior visual appearance whilst still adding weight.

Lightweight metal (steel or aluminium) sheet roof options were then considered. Various systems, profiles, materials and finishes are available, but all are lighter than the slate options, both in finished material weights, but also due to simpler build ups that avoid the need for timber battens and counter battens. This ensures that no strengthening works to the trusses are required. By reducing the number of purlins and placing them only on the truss nodes, the trusses maintain both structural integrity and historical authenticity.

The proposed roof finish is a standing seam aluminium sheet, coated with an anthracite finish, RAL 7016 (image 04). This provides a significant visual improvement over the existing roof and is tonally similar to a slate finish.

key

- 01 Existing roof - steel gutter and corrugated steel sheet roof finish
- 02 Existing roof - corrugated steel sheet roof finish with remains of green colour coating
- 03 Existing roof - corrugated galvanised steel sheet roof finish (coating worn away)
- 04 Proposed roof - aluminium standing seam roof sheet with anthracite coating



02.01.03 internal roof finish

Internally the existing finish to the underside of the Drill Hall roof is the timber roof boards which span up the roof pitch between purlins. This directly support the existing metal sheet external finish. The boards are thought to date from the latter half of the 20th century when the original roof finish was replaced. The timber soffit boards are painted internally.

In a number of places, the timber boards are showing signs of deterioration due to sustained water ingress. In addition to their poor condition, the boards are incapable of carrying the structural loads required by current-day codes and factors of safety, as well as the increased weight of the new roof finishes.

Our proposal is to replace the timber roof boards with a profiled structural metal deck which can carry the necessary loads and span the greater distance between the new steel purlins at truss node points.

Initially the team explored the possibility of salvaging any existing boards in a good enough condition and retaining them (albeit in a non-structural and purely visual capacity) as a cosmetic soffit lining beneath the new metal deck. However, in addition to concerns that only 50% of the timber boards may be reusable, this option was also found to add significant weight to the roof build-up, not just of the boards themselves but also in additional new structural purlins required to hang the boards from. There are also challenges in satisfying current fire regulations when exposing timber boards in an area of public assembly.

It was therefore decided to omit the timber soffit, and leave the metal deck as the visual finish internally. It is still hoped to salvage any timber in good enough condition and reuse it elsewhere in the building as part of the wider refurbishment subject to later application. Exposing the metal deck expresses the new roof as a clearly modern intervention, but the visual appearance of the profile spanning up the roof pitch makes reference to the existing timber boards (images 03 + 04). With the deck exposed, there is an opportunity to specify a perforated deck, enhancing the acoustic performance and avoiding hanging baffles.

key

- 01 Existing soffit - timber roof boards (painted)
- 02 Existing soffit - timber roof boards (painted)
- 03 Proposed soffit - perforated structural metal deck
- 04 Proposed soffit - perforated structural metal deck



02.01.04 roof light

The existing single-glazed roof lights have reached the end of their design life and are in poor condition, as well as performing poorly in terms of thermal and acoustic performance. The existing roof lights date from the latter half of the 20th century, however, the provision of a large ridge roof light running the entire length of the Drill Hall is evident on much earlier plans. Therefore, whilst the fabric of the existing roof light itself is not of great significance, the provision of extensive roof glazing in this location is significant to the original character of the Drill Hall.

The intention is to replace the roof light with a modern aluminium-framed double glazed roof light that can meet the thermal performance requirements of current Building Regulations Part L2 and support the client’s desire to strive to meet the Church of England’s ambitious Net Zero Carbon targets. Opening vents are incorporated to improve ventilation of the Drill Hall space, in preparation for bringing the space back in to use. The roof light system has been chosen to ensure that the opening vents have the same profile and sight lines as the fixed panes.

The new roof light is proposed to follow the same form as the existing roof light in that it runs the entire length of the Drill Hall roof and is subdivided into two rows of glazed panels either side of the ridge; panels are approximately 600mm wide (4 per structural bay) and held in an aluminium frame. The roof light depth is reduced slightly compared with the existing condition (approximately 500mm either side of the ridge). This is driven by the structural solution to avoid placing significant extra structural load on the top chords of the trusses by positioning new steel purlins at the truss node points. This has necessitated the reduction in the depth of the roof light so that the roof light aligns with the truss node points and new purlin locations. The length and subdivision remain unaltered and the reduction in depth is only circa 12%, thus, ensuring that the roof light follows a rhythm largely similar to the existing layout and retains the character of the space. The reduced area of glazing, whilst proportionally small, does have a helpful impact in terms of reducing overheating in the space in summer.

key

- 01 Existing roof light - internal view
- 02 Existing roof light - external view
- 03 Proposed roof light - internal view
- 04 Proposed roof light - external view



Whilst the double glazed roof light adds additional weight to the roof compared to the existing condition, double glazing is preferred for improving both acoustic (rain noise) and thermal performance and reducing winter heat loss and, therefore, running costs for the client.

The team have explored the impact of a single glazed roof light and of 'Histoglass' heritage double glazing. Structurally, Hexa have advised that whilst single glazing will reduce loads locally to the members supporting the roof light (ridge beam and the PFC purlins on either side), the impact would be a reduction in the weight of the steel section rather than a reduction in size, thereby having no visual impact on the proposals.

Furthermore, the reduced weight of a single glazed roof light is not sufficient to allow the reintroduction of slate across the remainder of the roof as this would result in a net increase in overall roof load. The roof lights account for approximately 30% of the roof area, so whilst this would see a reduction in load for that portion, the heavier slate roof across the remaining area would result in an overall increase in load and the purlins supporting the slate roof would need to be upsized to accommodate the additional weight of the slate.

Thermally, a double glazed roof light with low E coating and argon fill will achieve a U-value of circa $1.5\text{W/m}^2\text{K}$ overall. Single glazing or Histoglass is significantly worse at between 5.6 to $4.2\text{W/m}^2\text{K}$ depending on specification. Therefore thermal performance, heat loss, running costs and occupancy comfort will be impacted significantly as the heat loss through 30% of the roof area will be circa 4x higher.

None of the single glazed or Histoglass options meet the minimum U-value required by Building Regulations ($1.6\text{W/m}^2\text{K}$). Whilst Approved Document Part L2 does allow some leeway for listed buildings, we have been informed by Building Control that they do not believe that double glazing would meet the threshold for 'unacceptable impacts on the building's character' required to justify relaxing Part L requirements in this case.

There are numerous examples of Grade II listed buildings locally in Manchester, and further afield, where the replacement of single glazed roof lights with modern double glazed roof lights of a similar specification to that proposed has been deemed acceptable and completed successfully.



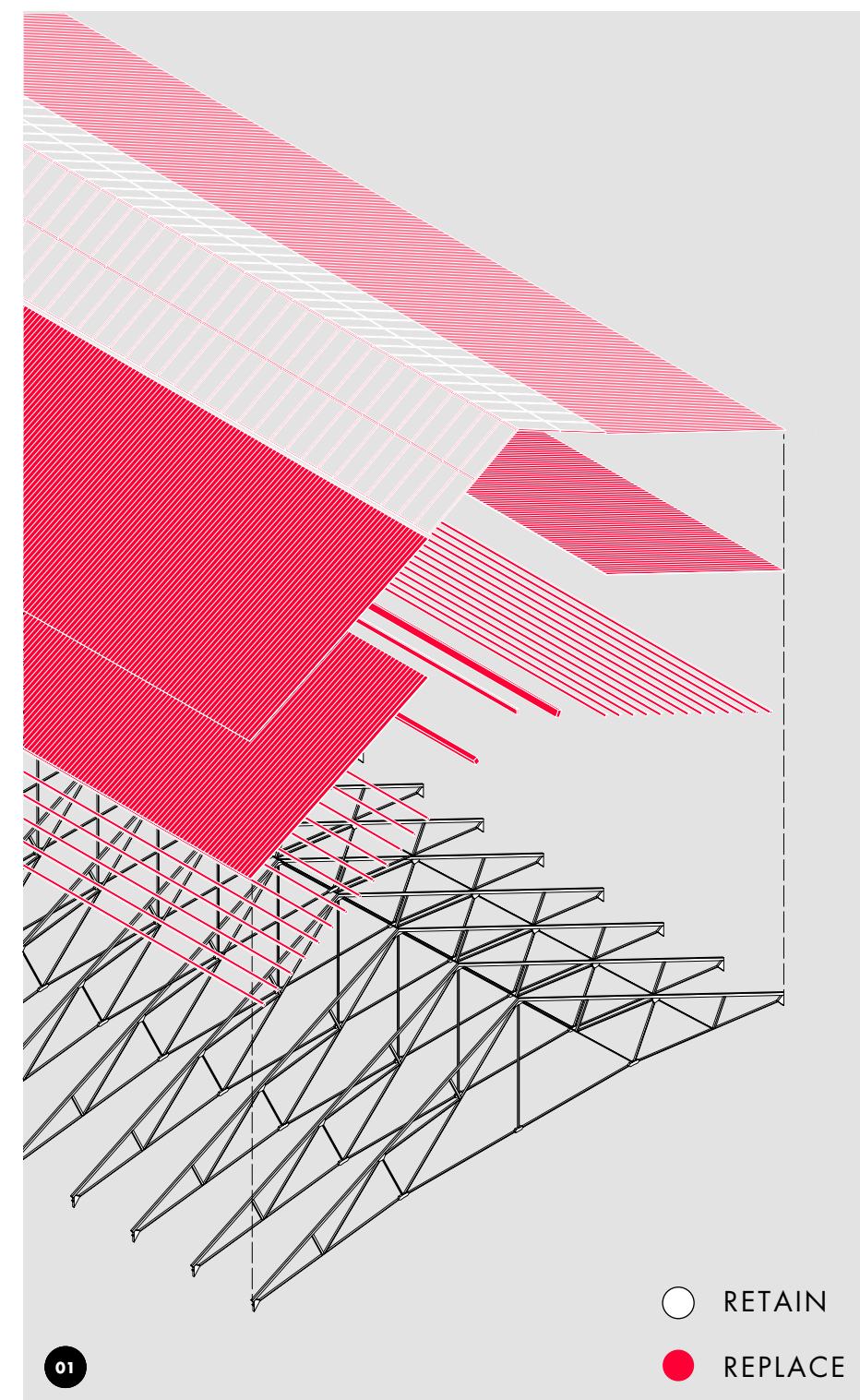
02.01.05 summary of proposed works

The scope of works includes:

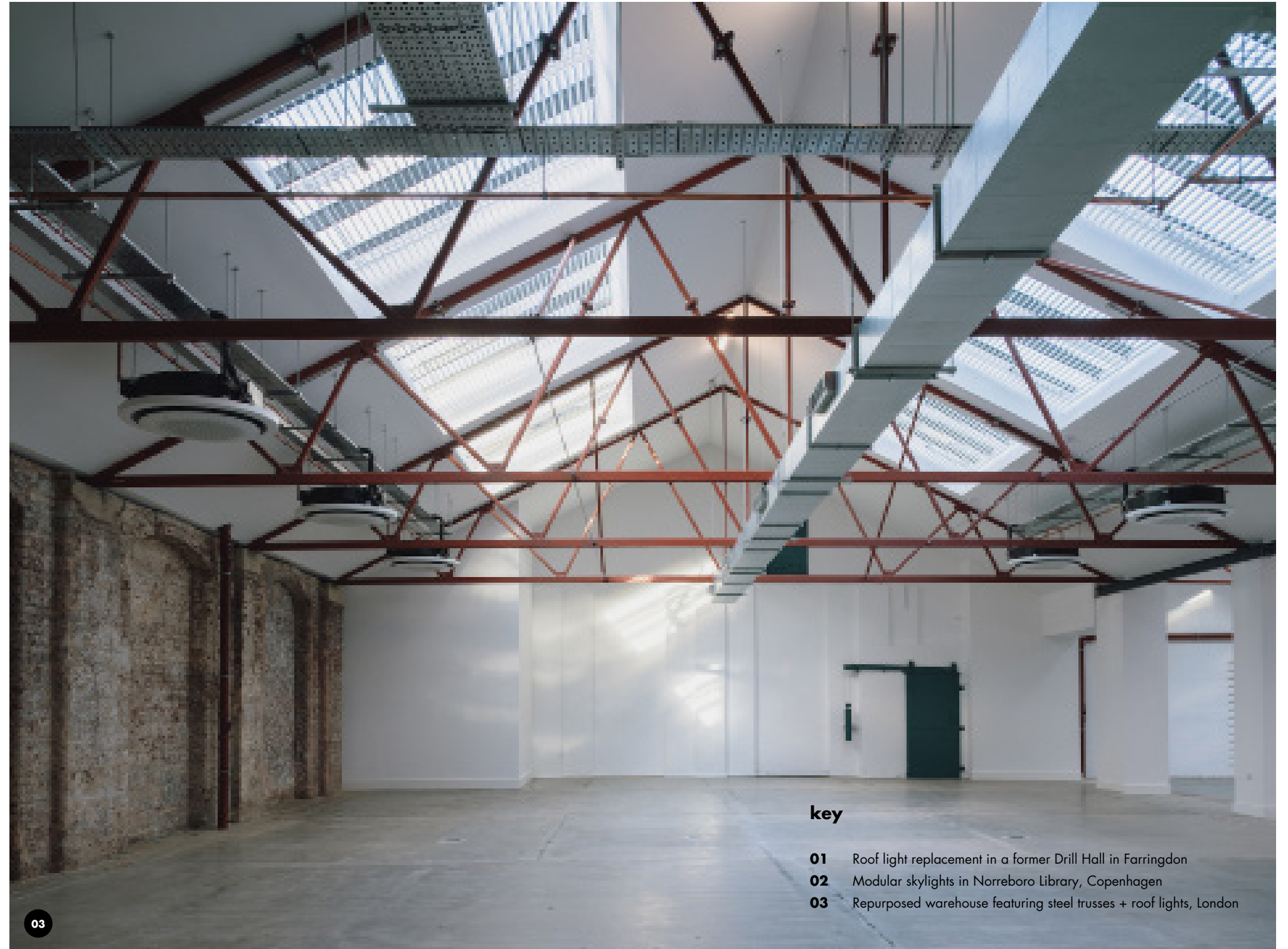
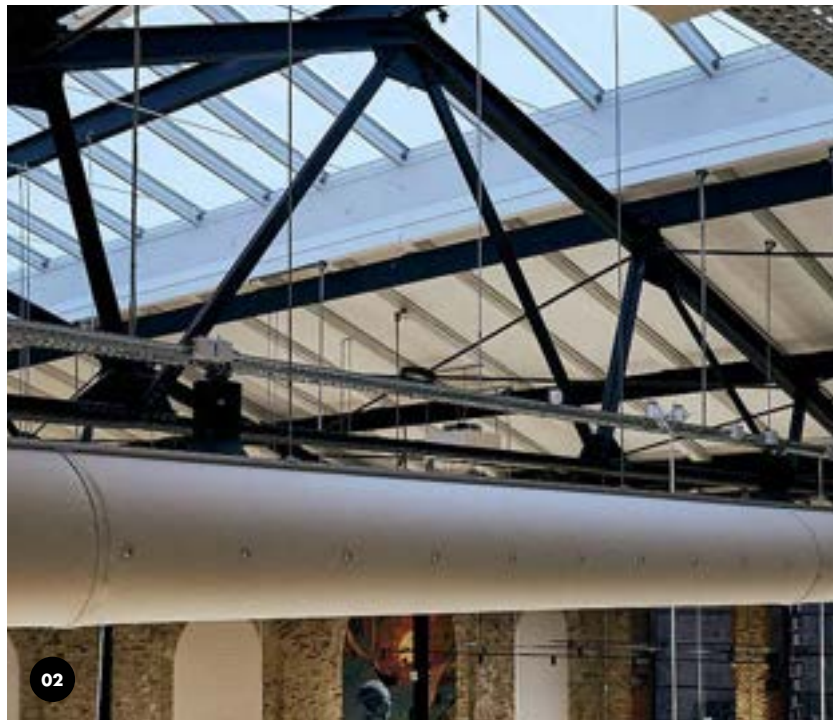
- Retain and clean existing late-19th century wrought iron roof trusses
- Existing wrought iron shoe details at ridge to be retained and cleaned
- Replace existing wrought iron/timber composite purlins at 600mm centres with new larger PFC steel purlins at wider (3.2m) spacings, thus allowing increased roof loads to be transferred through the truss without intrusive strengthening works to the trusses
- Existing timber boards to be carefully removed and sorted. Where condition allows, timber boards are to be saved for cleaning and re-use elsewhere in the building as part of the subsequent wider works
- Lightweight profiled structural metal deck roof installed spanning up the roof pitch between new steel purlins
- New metal deck to be perforated for enhanced acoustic performance and supplied with colour coat finish (colour tbc) designed to be exposed internally as the finished soffit
- New insulation above the structural metal deck to provide enhanced acoustic and thermal performance, thus making the Drill Hall space fit for purpose and securing its long term future as a usable space. The overall roof build-up above the new purlins is 335mm, providing U-values compliant with current Building Regulations Approved Document L2
- Existing profiled steel sheet roof finish replaced with aluminium standing seam roofing system with anthracite colourcoat finish
- Gutter to east side of roof (adjacent to neighbouring building) widened to allow maintenance access
- Maintenance access provided to gutter and eastern roof pitch via existing second floor window. Proprietary access stair provided to this area to facilitate safe access
- Existing late-20th century, single glazed roof light replaced with double glazed aluminium-framed roof light, incorporating opening vents. Maintaining the appearance of the central skylight to Drill Hall (as per late-19th century design)
- Size of roof light reduced by 500mm to align with structural nodes in the trusses, thus reducing bending stresses on existing trusses. This also helps to reduce solar gain and overheating whilst retaining the character of the top-lit space
- Repointing of adjacent brick wall to the main barracks building (south gable of roof) utilising suitable like-for-like mortar
- Small high level second floor window in north wall of barracks building blocked up (due to thicker roof build-up)
- Height of existing brickwork wall to eaves and north gable of roof extended by 450mm to suit increased depth of roof build-up
- Removal of redundant modern access ladders and walkways

key

- 01 Exploded axonometric drawing of the Drill Hall roof structure, highlighting those elements which are to be retained and those which are to be replaced



02.02 precedent images



key

- 01 Roof light replacement in a former Drill Hall in Farringdon
- 02 Modular skylights in Norrebro Library, Copenhagen
- 03 Repurposed warehouse featuring steel trusses + roof lights, London

02.03 barracks building roof light

The existing second floor roof light is in poor condition and is leaking in several locations, with water ingress causing damage to the historic fabric. The intention is to replace the existing single glazed roof light with a new double glazed roof light of the same size but with enhanced thermal performance. Opening vents are to be incorporated to assist with the ventilation strategy. The roof light system has been chosen to ensure that the opening vents have the same profile and sight lines as the fixed panes.

02.03.01 summary of proposed works

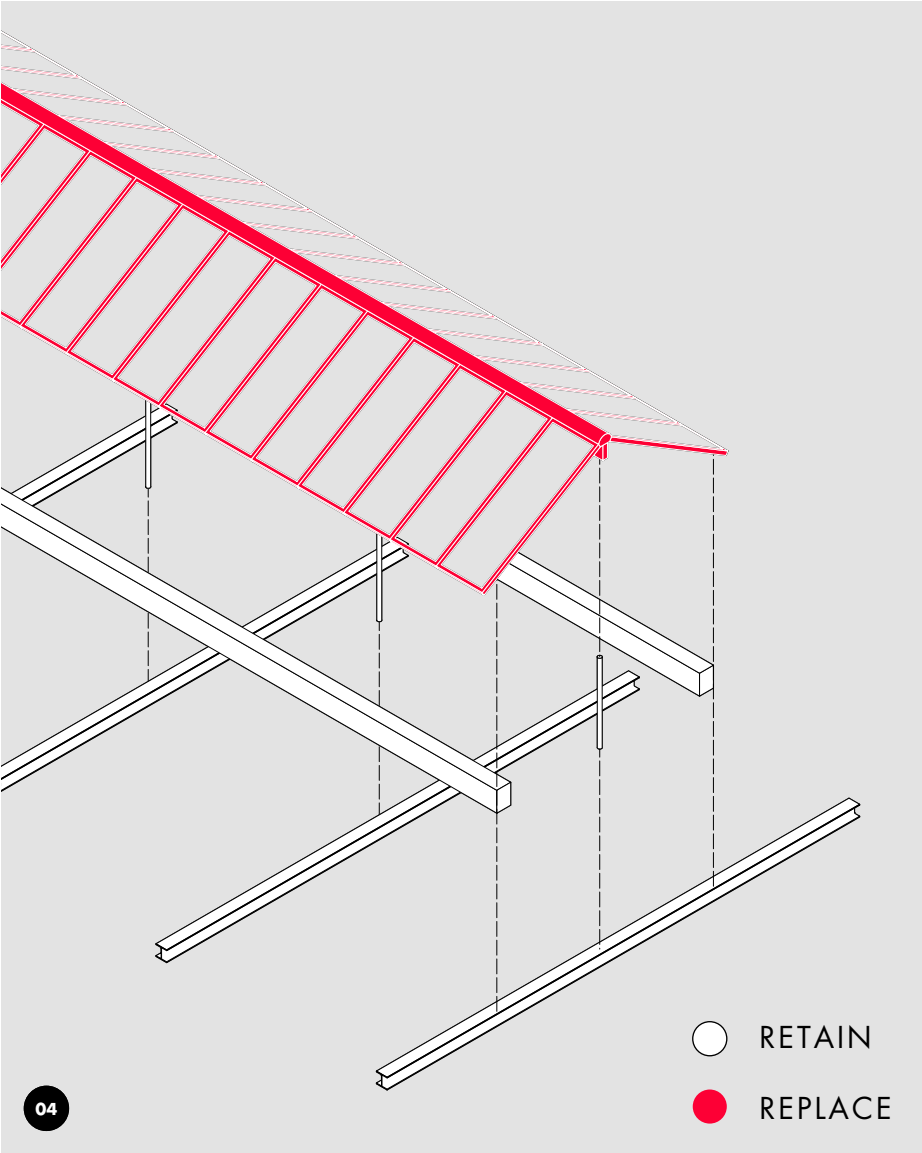
The scope of works includes:

- Existing late-20th century internal partitions subdividing the second floor function room to be removed, restoring the room to its original extent
- Existing late-20th century internal suspended ceiling to second floor function room to be removed, providing access to roof light
- Existing single glazed roof light replaced with double glazed aluminium framed roof light, incorporating opening vents
- Existing roof light upstand to be retained, but condition to be inspected once finishes removed and remedial works to be undertaken if required
- Existing steel tie rods to be retained and cleaned
- Existing steel beams running beneath the roof light to be retained and cleaned
- Existing timber ridge beam to be replaced with new timber beam
- New roof light installed on to existing upstands, made good where required
- New flashings and trims as required
- Existing brick gable walls to be repointed in suitable like-for-like mortar



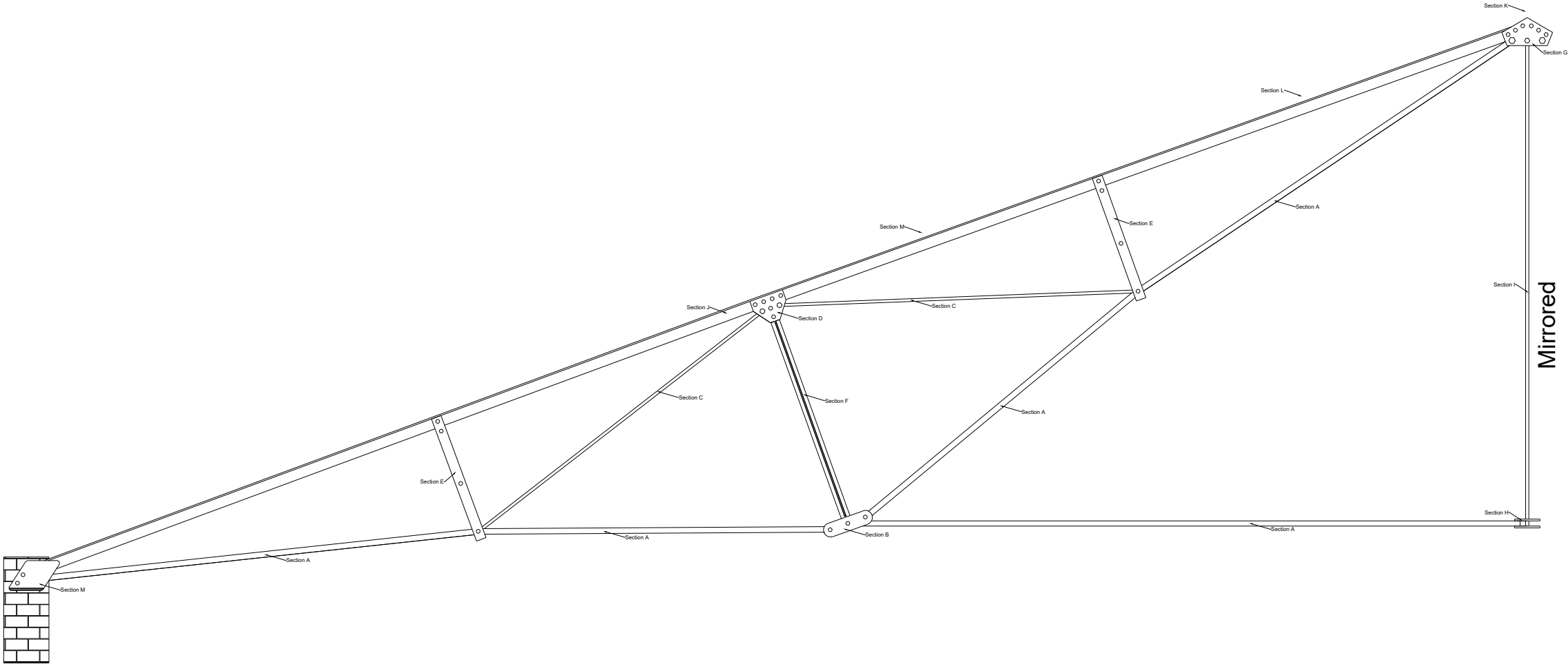
key

- 01 Exterior of the Barracks building roof light, looking towards adjacent property
- 02 Exterior of the Barracks building roof light, looking towards the caretaker's apartment
- 03 Underside of the roof light is hidden by a 20th-century suspended ceiling featuring secondary skylights
- 04 Exploded axonometric drawing of the Barracks building roof light structure, highlighting those elements which are to be retained and those which are to be replaced
- 05 Photograph of the existing condition



03 appendices

03.01 appendix 01

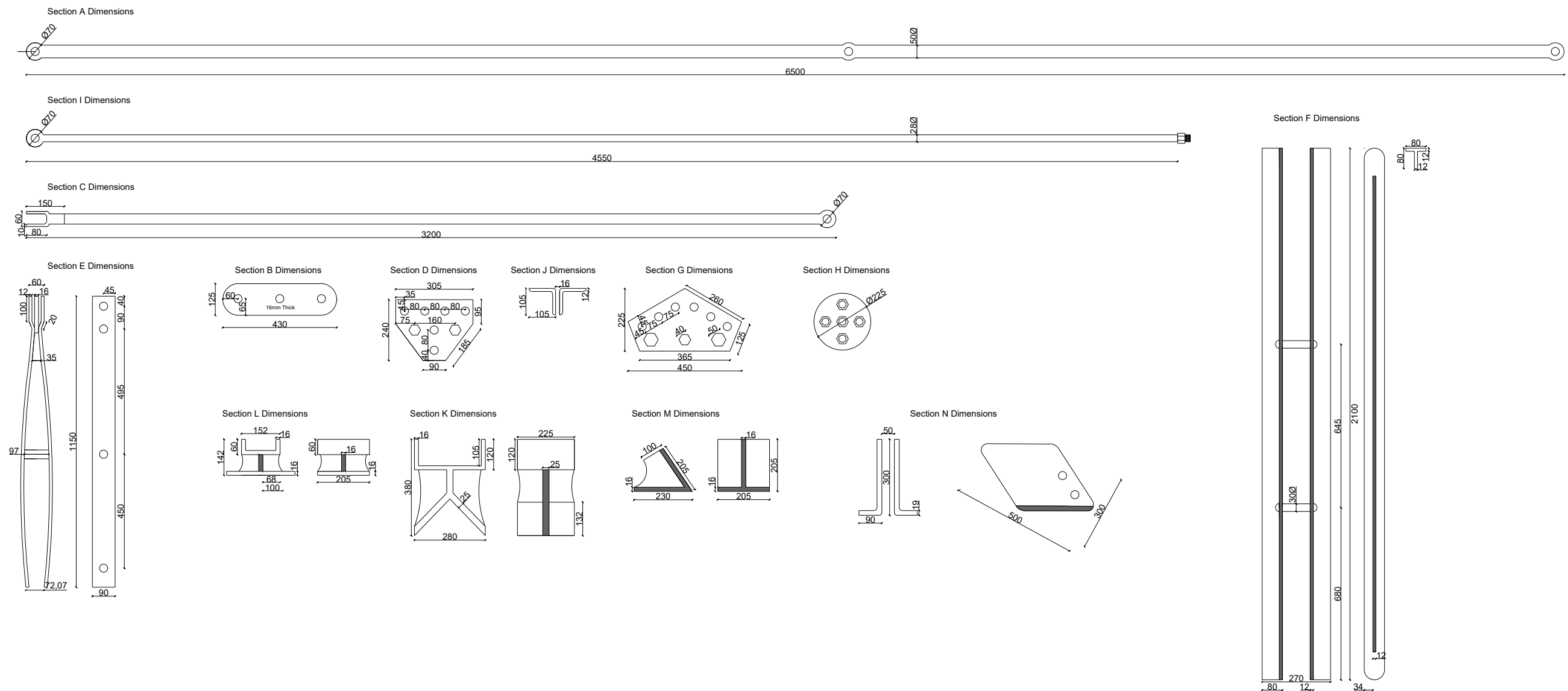


Project Name: Fabric Church, Manchester			
Drawing Title: Second Floor Roof Truss - General Arrangement			
Drawn By: B.Dimbleby	Checked By: S.Grayson	Approved By: -	Date: 30/07/2024

Client Name & Address:

Contractor: Structural Investigation Services 23 Birkdale Close Manners Industrial Estate Ilkeston DE7 8YA CONTACT NO- 01332 916137 E-MAIL : Fabrics@sisgroupuk.com
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Project No: P1537	Scale: NTS	Size: A3
Drawing No:	Drawing No:	
Revision: 01		
Unit: mm		



Project Name:			
Fabric Church, Manchester			
Drawing Title:			
Second Floor Roof Truss - Section Sizes			
Drawn By:	Checked By:	Approved By:	Date:
B.Dimbleby	S.Grayson	-	30/07/2024

Client Name & Address:

Contractor:

Structural Investigation Services
23 Birkdale Close
Manners Industrial Estate
Ilkeston
DE7 8YA

CONTACT NO- 01332 916137
E-MAIL : Fabrics@sisgroupuk.com

Project No: P1537	Scale: NTS	Size: A3
Drawing No:	Drawing No:	
Revision: 01		
Unit: mm		

03.02 appendix 02

03.02.01 structural analysis

The Ardwick Barracks is listed at Grade II and was constructed in the late-19th century. The Drill Hall component of the building features a wrought iron truss roof structure with a central glazed roof light and corrugated metal roof (glazing and roofing material are late-20th century). Given the heritage value of the trusses, a key objective in planning the roof replacement was to select a solution that would avoid any alterations or strengthening works to the original truss, thereby preserving its authentic structure.

Three roofing materials were evaluated, each with a different impact on the truss. First, a traditional slate option was considered, which, although historically accurate, proved too heavy for the truss to support safely without major reinforcement. This material would introduce excessive stress, necessitating extensive structural modifications to both the top and bottom truss members to achieve required current safety standards. These alterations would permanently change the original truss, with significant new steel members fixed to the existing truss making this option unsuitable from a heritage-sensitivity perspective.

The second option, a composite slate “look-a-like” material, was a lighter alternative but still produced bending stresses that would require reinforcement of the top members of the trusses. While this option involved less modification than natural slate, it still demanded changes to the truss that would compromise its historical integrity.

The third option, a lightweight metal roof, emerged as the most suitable choice, primarily because its lighter weight significantly reduces the stress on the truss and would be a visual improvement to the existing roof material. This material allows for purlins to be strategically positioned at the node points of the truss, reducing bending forces. By removing the need for any reinforcement to the truss itself, this solution preserves the truss in its original form, maintaining both the structural and historical authenticity of the Drill Hall.

In conclusion, the metal composite roof was put forward because it meets all necessary safety standards while fully respecting the original truss design and structural integrity. This option allows the Drill Hall to retain its historical character without any structural modifications to the truss.

1.0 Overview

The Drill Hall Truss is believed to have been constructed in 1887, during the late 19th century. The truss is composed of wrought iron, a material widely used at the time for structural elements due to its advantageous tensile strength and durability.

During this period, structural design was based on the permissible stress method. This method incorporated a factor of safety applied to the material's ultimate strength to ensure structural reliability while accounting for uncertainties in loading conditions, material properties, and construction practices.

In line with historical design principles, our assessment has maintained a factor of safety of 4 in the analysis to ensure the truss's continued integrity. Figure 1.0 (below) outlines the recommended strength values for wrought iron, which are consistent with the results obtained from laboratory testing undertaken by SIS on behalf of Hexa Consulting. These values have been adopted for the purposes of the assessment.

In 1879 the following values were recommended as average for the strength of wrought iron:				
tension	21	tons/in ²	324.3	N/mm ²
compression	16	tons/in ²	247.1	N/mm ²
shear	20	tons/in ²	308.9	N/mm ²

Figure 1 Extract from 'Historical Structural Iron & Steel Sections (Section 2.3)'

2.0 Loading

The truss was assessed under three different roof build-up scenarios: a traditional slate option, a lightweight slate-look alternative, and a lighter roof system utilising an aluminium structural deck. Each of these roof configurations was evaluated in combination with imposed loads, wind loads, and snow loads to determine the overall impact on the structural integrity of the truss. The analysis was conducted to ensure that the truss could safely support the various load conditions associated with each roof type.

The Roof build ups for each of the options are outlined in the Tables 1,2 & 3 below.

Slate Option		
Double Glazing	0.55	kN/m ²
Services	0.15	kN/m ²
Slates, timber battens & felt	0.55	kN/m ²
Rafters Insulation	0.2	kN/m ²
18mm Ply	0.13	kN/m ²
Total Exc. Double Glazing	1.03	kN/m ²

Table 1.0 Slate Option Loading

Slate (Look a like) Option		
Double Glazing	0.55	kN/m ²
Services	0.15	kN/m ²
Slate (Look a like)	0.2	kN/m ²
Timber battens and felt	0.2	kN/m ²
Rafters Insulation	0.2	kN/m ²
18mm Ply	0.13	kN/m ²
Total Exc. Double Glazing	0.88	kN/m ²

Table 2.0 Slate Look alike Option Loading

Structural Deck Option		
Double Glazing	0.55	kN/m ²
Services	0.15	kN/m ²
Outerlining, Insulation, Deck	0.4	kN/m ²
Purlins	0.15	kN/m ²
Total Exc. Double Glazing	0.7	kN/m ²

Table 3.0 Structural Deck Option Loading

3.0 Truss Analysis

The truss was analysed using TEDDS software and assessed under two distinct load combinations. The first combination, representing the general load case, including imposed load, dead load, and wind load. This combination is required to achieve the recommended safety factor of 4. The second combination, classified as an accidental load case, accounted for dead load, snow drift, and wind load. Given the likelihood and duration of snow drift loading, a reduced safety factor of 3 was deemed acceptable for this case.

3.1 Slate Option

The following load was applied as a permanent dead load to the truss model, in addition to the roof light loading. The roof light loading has been omitted from the diagram as it remains consistent across all options.

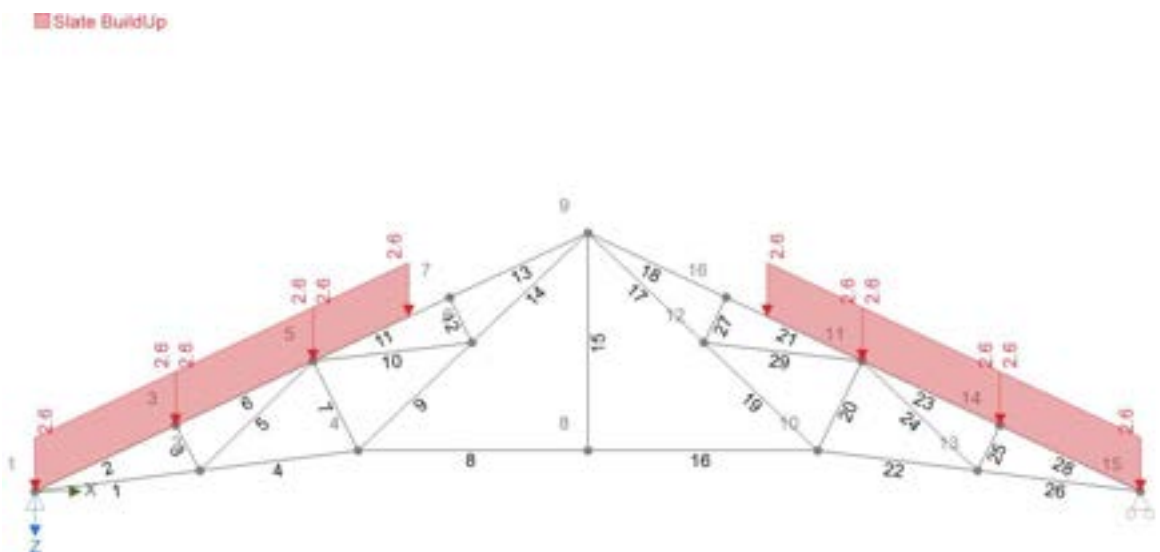
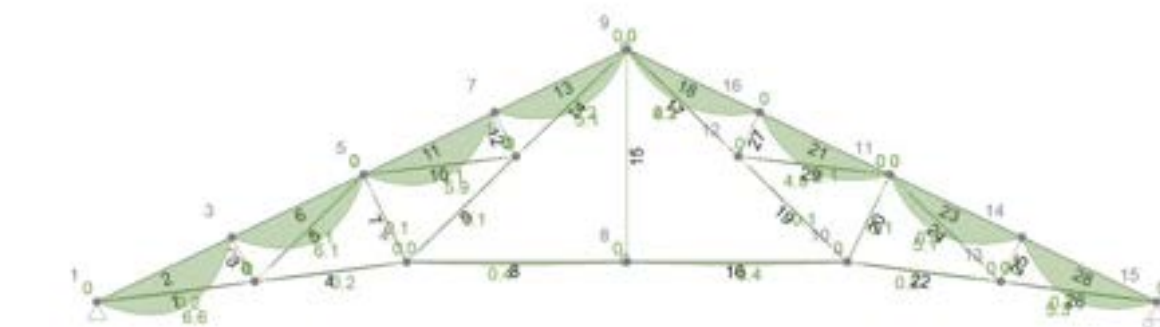


Figure 2 Slate Roof Build Up Applied Line Load

During the assessment of the line load on the top members, significant bending was observed, as illustrated in Figure 3.0. This bending moment substantially reduces the load-bearing capacity of the top members, resulting in a safety factor of 1.6, which is significantly below the recommended factor of 4.



3.2 Slate Look Alike Option

The following load was applied as a permanent dead load to the truss model, in addition to the roof light loading. The roof light loading has been omitted from the diagram as it remains consistent across all options.

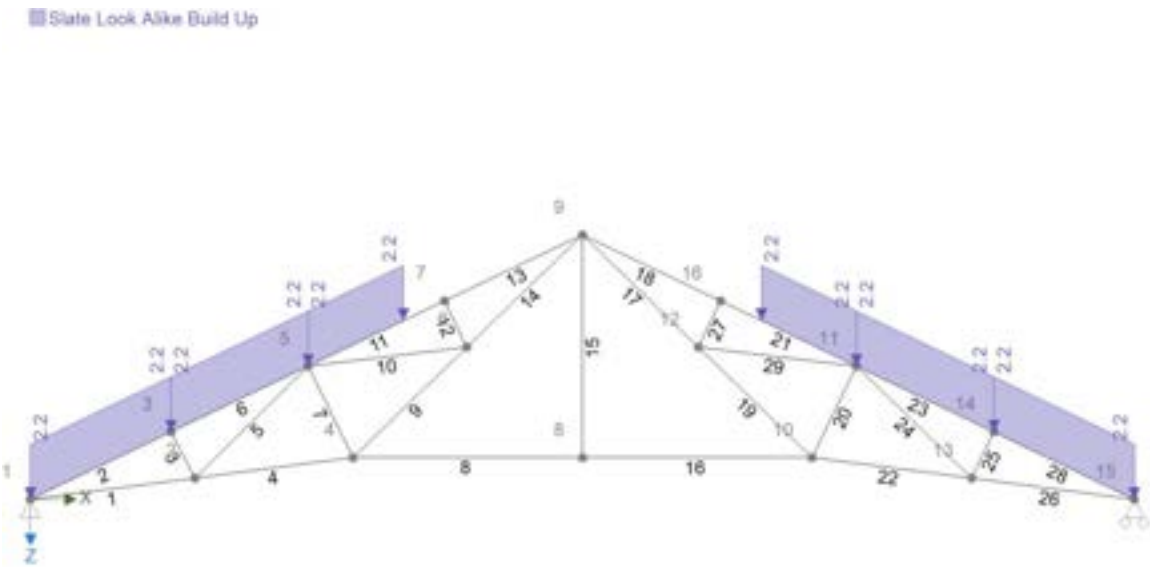


Figure 6 Slate Look Alike Roof Build Up Applied Load

Like the slate option, excessive bending was observed in the top members, resulting in a safety factor of 1.75, which is again significantly below the required safety factor of 4. To achieve the necessary safety factor of 4, strengthening works would be required. As with the full slate option, this would involve welding a reinforcing plate to the existing top members of the truss refer back to Figure 4. However, no strengthening works would be necessary for the bottom members.

3.3 Structural Deck Option

To address the excessive bending in the top members, the use of structural deck capable of spanning greater distances was proposed. This would reduce the number of purlins required, allowing them to be positioned at the node points of the truss. By applying point loads at these node locations, as shown in Figure 7.0 below, the bending within the top members is drastically reduced, enabling the truss to perform more efficiently under load. In practical terms, this solution requires purlins to be located at the junction points of the truss members, as illustrated in Image 6.0. This solution involves incorporating new purlins as part of the roof system but requires no strengthening to any of the existing truss members.

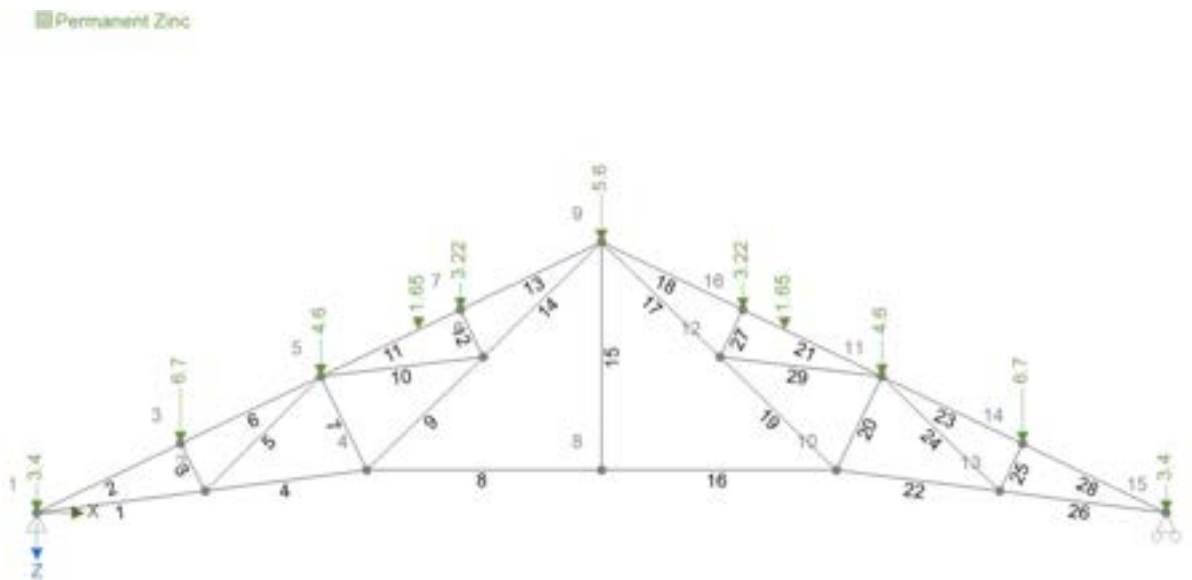


Figure 7 Structural Deck Option Roof Build Up Applied Loading

The existing timber boarding will need to be removed to facilitate the installation of the proposed roof. Once removed, the condition of the boards can be assessed, with the best-preserved boards possibly being reclaimed to be used elsewhere within the building.



Figure 8 Image/Mark Up indicating proposed purlin locations and roof span direction.

4.0 Recommendations

The outcome of the analysis shows that the current truss does not have the capacity to meet the recommended safety factors for both the full slate option and the look-alike slate option, necessitating strengthening works in both scenarios. However, by utilizing a structural deck option that can span greater distances, the number of purlins can be reduced, allowing them to be positioned at the truss nodes, which enables the structure to work more efficiently.

The structural roof deck option meets all the necessary safety factors, including a factor of safety of 4 for general load combinations and 3 for the accidental snow drift load case. It allows the roof light extents to remain unchanged and crucially requires no strengthening works to the truss members, preserving the heritage of the structure. By eliminating excessive bending in the top members and avoiding alterations to the truss, this solution maintains both structural integrity and historical authenticity. For these reasons, the Aluminium structural deck option is the recommended solution.

Table 4.0 below summarises the safety factors achieved by the truss under the different buildups under it existing state.

Utilisation Options		
	FOS Combination 1	FOS Combination 2
Full Slate Option	1.62	1.31
Look aLike Slate Option	1.75	1.38
Structural Deck Option	4.2	3.12
Note: Combination 1 is (General Combination) to achieve a Facor of safety of 4 Combination 2 is (Accidental Combination) to achieve a Facor of safety of 3		

Table 4.0 Utilisation ratios for each option

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