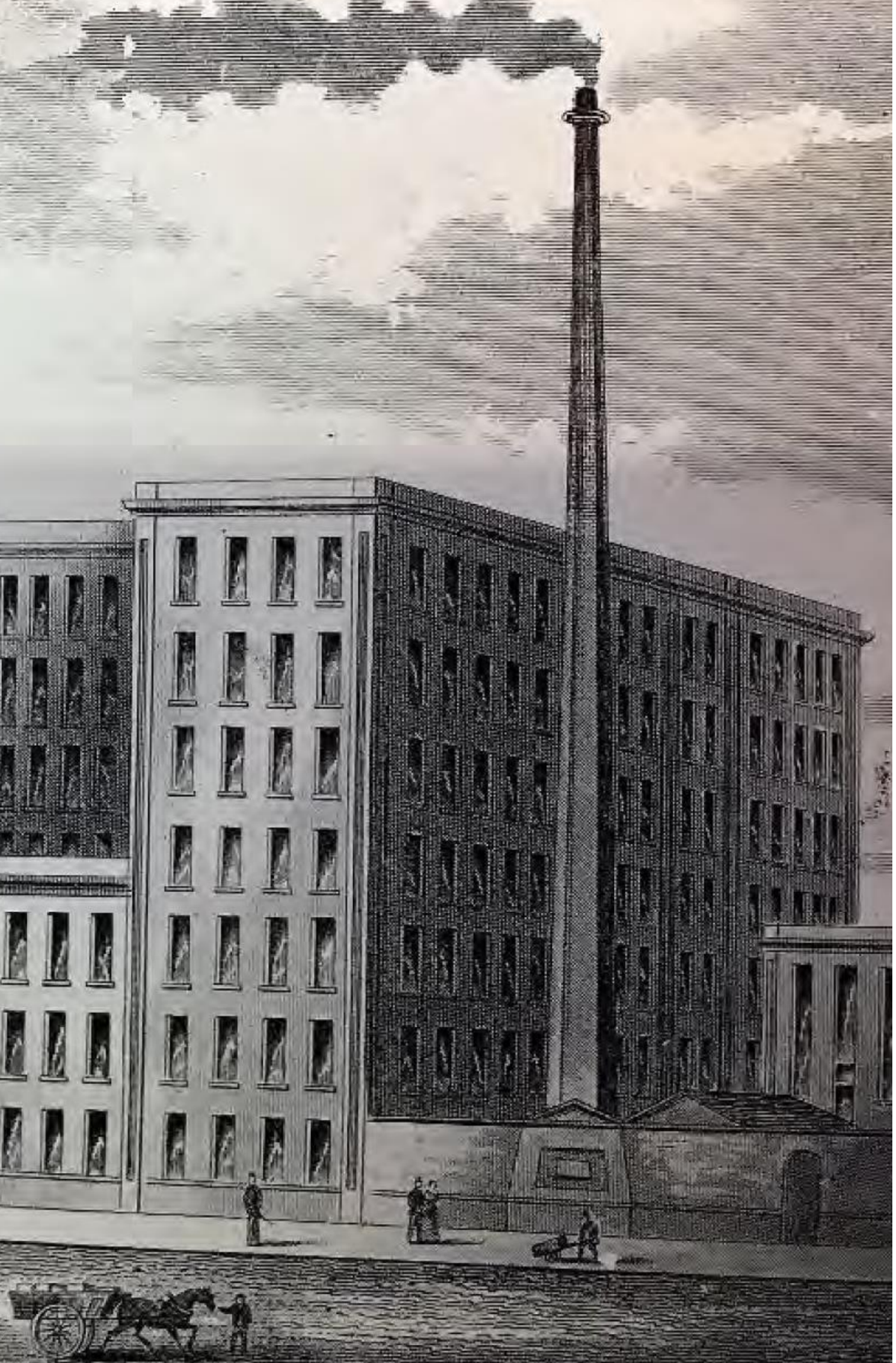

Civic Engineers

Job Title
Brunswick Place

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Contents

Structural Appraisal

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Reviewed by	Dan Podesta
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Revised	

1. Executive Summary

Civic Engineers has been appointed by Maryland Securities to carry out a Structural Appraisal Report to support listed building application to Manchester City Council for the redevelopment of Brunswick Mill.

The site, Brunswick Mill, is situated on Bradford Road, Manchester, M40 7EZ. The proposed development works involve the conversion of the mill to form a residential scheme of apartments and ground floor commercial units. There are various other works associated with the site however, this report relates specifically to the works associated with the existing Brunswick Mill only.

This report provides a description to the structural form and condition of the existing Brunswick Mill.

A visual non-intrusive assessment was conducted at Brunswick Mill on Wednesday 17th February 2021 by Civic Engineers.

This report should be read in conjunction with "Brunswick Mill, Manchester Heritage Statement" by Stephen Levrant Heritage Architecture Ltd which describes the historic development of the site and gives further information on the mill building.

The structural form of the main building of Brunswick Mill is typical and as expected for the construction era of the building. Floor slabs are formed as masonry jack arches spanning between cast iron beams. It would be expected that masonry jack arches are topped with a layer of concrete though this has not yet been confirmed. Cast iron beams span between external masonry piers and internal cast iron columns. Tie bars are evident between cast irons beams to counteract thrust forces induced by arch action of the floors.

Stability of the building is achieved by the two primary stair cores and the large external masonry walls.

Generally, the mill structure is in reasonable structural condition. There are various areas which will require further consideration and will need intervention to repair and extend the structures longevity and time to first maintenance. These are reasonable and expected for the age of the structure. These generally include.

- Substantial cracking to lintels on all elevations. Cracks are observed on approximately 20% of all lintels.
- Associated cracking of brickwork with the failure and cracking of lintels.
- General loss of pointing on all elevations.
- Various areas of loose and missing brickwork units
- General overgrowth of vegetation across the parapets on all elevations.
- Internally there are significant amounts of water damage to masonry soffits, walls and structural cast iron beams and columns associated with poor roof drainage, broken and or missing windows, missing masonry units and a general lack of waterproofing and insulation.
- In areas of reinforced concrete construction spalling and associated corrosion of reinforcement is evident.
- There is currently no fire protection to cast iron or steel structure.

The intention to convert the mill to residential apartments will need to be studied in detail with regards to load. Historic Codes of Practice would suggest that the design live load for structures of this nature is typically low and less than contemporary loading residential purposes. However, observing the first-floor rehearsal studios, which could be reasoned to impose similar loads to that of a residential space i.e., a regular grid of partitions with similar floor loading, the proposal for a conversion will most likely be feasible on the existing floor plates. Further detailed consideration will be required to confirm this across the entire structure including foundations. Additional strengthening may still be required.

2. Introduction

Civic Engineers has been appointed by Maryland Securities to carry out a Structural Appraisal Report to support listed building application to Manchester City Council for the redevelopment of Brunswick Mill.

The site, Brunswick Mill, is situated on Bradford Road, Manchester, M40 7EZ. The proposed development works involve the following.

1. The conversion of Brunswick Mill to form a residential scheme of apartments and ground floor commercial units.
2. Construction of a residential scheme comprising of apartments set over a ground floor with commercial units to the corner of Beswick Street and Bradford Road in place of a former white painted brick building.
3. Construction of a residential scheme to Bradford Road comprising of apartments set over a ground floor with commercial units along with a refuse and cycle store.
4. Landscaped route from Bradford Road to the Ashton Canal allowing both pedestrian access to the tow path and vehicular access to the car parking.

This report provides a description to the structural form and condition of the existing Brunswick Mill. Hodder and Partners are the appointed Architects for this scheme along with Stephen Levrant Heritage Architecture Ltd (SLHA) acting as the appointed historic building advisor.

Note that this report relates specifically to the works associated with the existing Brunswick Mill only.

A visual non-intrusive assessment was conducted at Brunswick Mill on Wednesday the 17th of February 2021 by Civic Engineers. The initial condition of the building fabric has been determined through visual assessment. It may be that further intrusive works are required in time to confirm assumptions made within this report as part of further detailed design work.

3. Brunswick Mill

3.1 Brunswick Mill - Historic Development

This section of report provides an outline to the historic development of the site and should be read in conjunction with "Brunswick Mill, Manchester Heritage Statement" by Stephen Levrant Heritage Architecture Ltd.

Brunswick Mill was constructed in 1839 and lies to the north of Manchester City Centre adjacent to The Ashton Canal. In 1994 the site was granted Grade II listed status.

It is understood from historic maps and morphology diagram by SHLA that the site has undergone significant development since construction up to the late 19th century.

The present-day Brunswick Mill is formed as a quadrangle. Three wings of the quadrangle are seven storeys with a four-storey wing fronting onto Bradford Road. A sketch of the present-day layout is presented in figure 1 below.

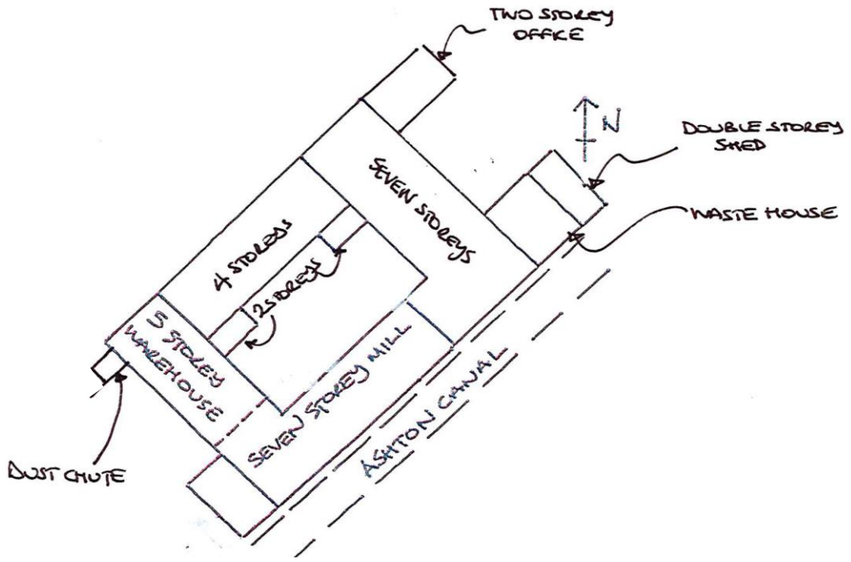

Figure 1: Present day Brunswick Mill Layout

A morphology diagram is shown in figure 2 and 3. This illustrates the various alterations and additions to the site since its original construction. These can be summarised as follows;

- 1839 the mill was constructed as an L-shaped building comprising of a seven-storey mill to the rear (fronting the Ashton Canal) with a five-storey warehouse wing to the south west returning towards Bradford Road. A large chimney existed to the south west of the site also
- 1840-41 the five-storey wing collapsed during an extension to increase to seven storeys. The wing was immediately rebuilt to seven storeys
- 1842 the L-shaped footprint was closed off to form a quadrangle shaped site. A seven-storey wing was constructed along with a three-storey wing fronting Bradford Road
- 1844 a waste house was constructed to the north of the site
- 1880 2No two-storey buildings constructed within the site courtyard
- 1880/1890 a single storey shed constructed to the north of the site along with a dust chute tower between the original chimney and five-storey wing
- 1908 two electrification towers constructed within the courtyard to coincide with the electrification of the mill
- 1920 single storey shed to the north and three-storey wing to Bradford road extended by a single-storey
- 1950 two storey office constructed to the north of the site fronting onto Bradford Road
- Late 19th century electrification towers and original chimney demolished

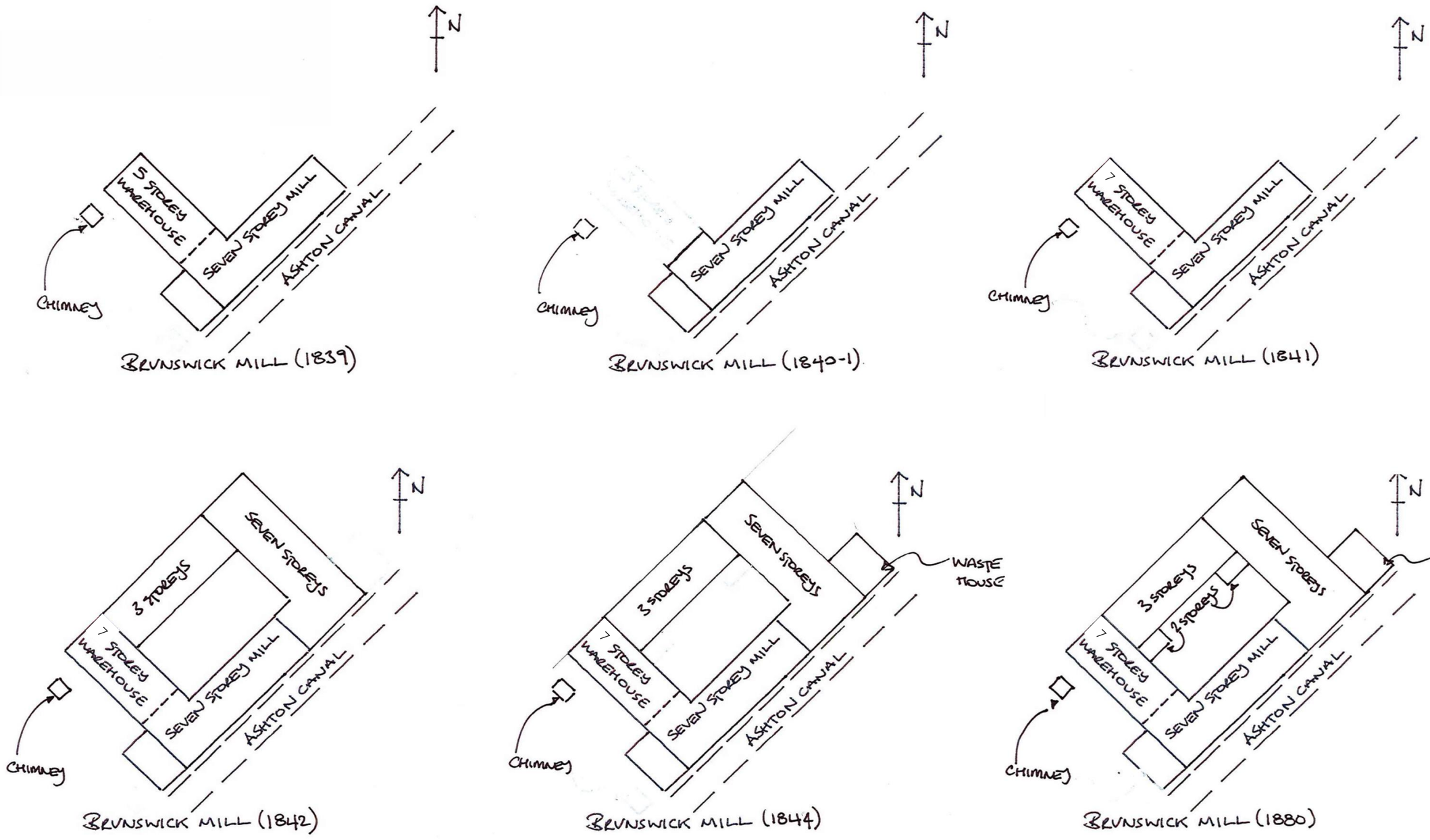

Figure 2: Brunswick Mill Morphology Diagram

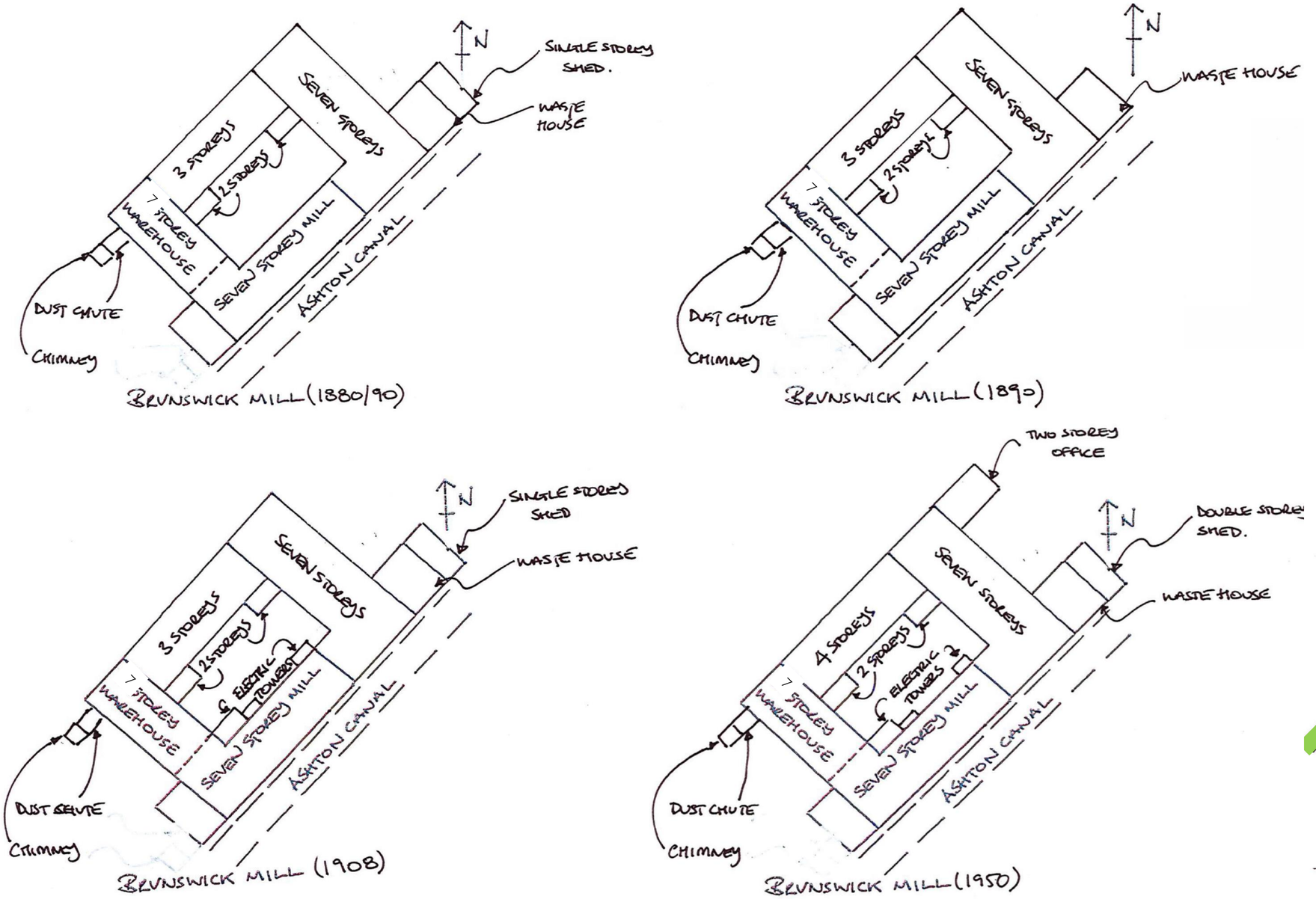

Figure 3: Brunswick Mill Morphology Diagram

3.2 Brunswick Mill – Structural Form

3.2.1 General – Main Wings

Main wings refer to those areas shaded in red within Figure 3.

The structural form of Brunswick Mill is typical and as expected for the construction era of the building.

Floor slabs are formed as masonry jack arches spanning between cast iron beams. Cast iron beams span between external masonry piers and internal cast iron columns. In the seven storeys south eastern wing (fronting the Ashton Canal) there are two internal rows of cast iron columns whereas in the remaining three wings there is a single row of internal columns. Thrust tie bars are evident within the depth of the jack-arch floor between cast irons beams to counteract thrust forces induced by arch action of the floors.

Within the south facing short wing, in the outer bays (fronting Bradford Road) of jack arches are reversed perpendicular to avoid thrust forces in masonry walls and piers. In the corner bays floors are cast in a squinch type arrangement. Refer to figure 6.

Floors are topped in what is believed to be terracotta tiles. Owing to the type of floor construction it is likely that these are cast on a concrete topper which is cast directly onto the masonry jack arches below.

External masonry walls and piers are most likely to be solid owing to the era of construction though this should be confirmed via intrusive investigations during detailed design.

A series of isolated investigation works were carried out to understand in further detail the build-up of floor slabs. This involved a series of pilot holes to study the depths of different materials. Pilot holes were drilled at different points along the arch including the springing point, over the anticipated beam flange and the crown of the arch to determine the changing depth of structure.

These investigations were limited to specific areas and do not confirm the same build ups across the entire building. An indicative sketch is shown in Figure 4a taken from the results of investigation.

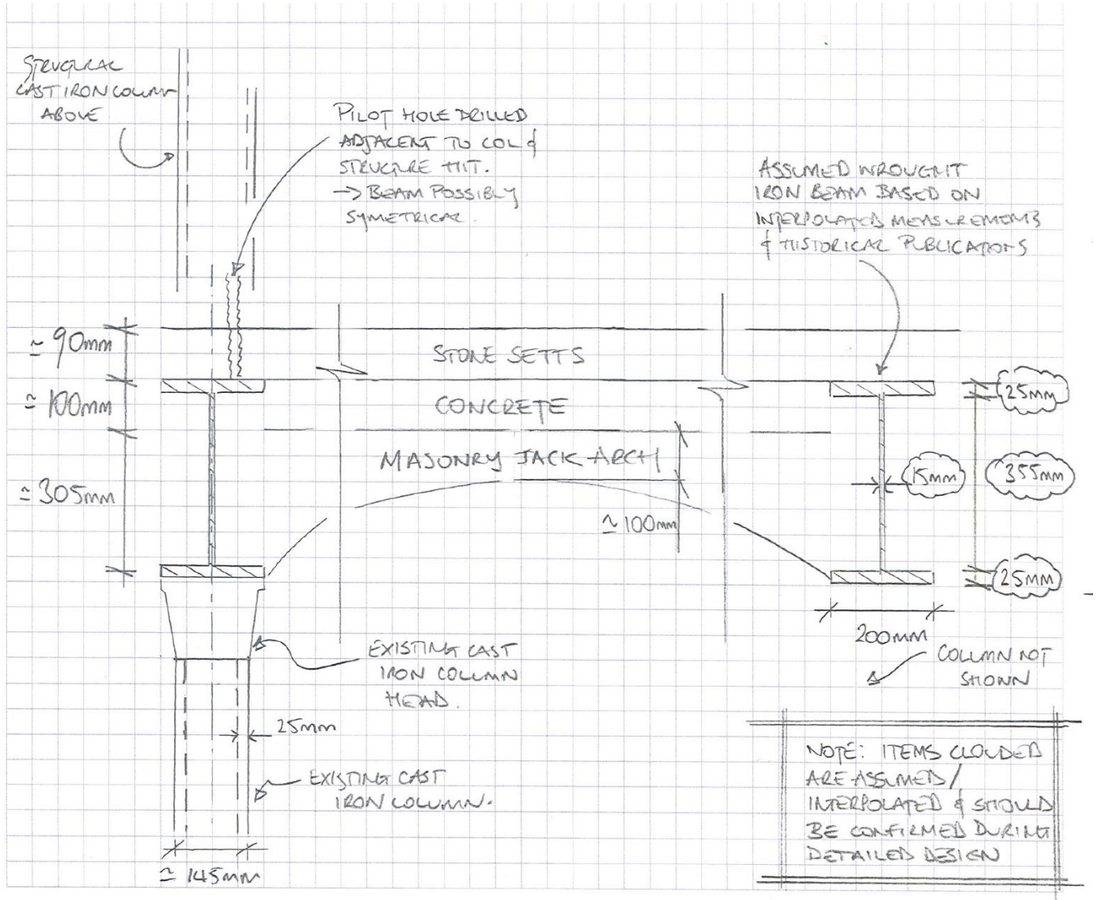

Figure 4a: Masonry Jack Arch Floor Slabs Sketch Section

Figure 5: Masonry Jack Arch Floor Slabs on Cast Iron Frame

Figure 6: Thrust Tie Bars in Masonry Jack Arch

Figure 7: Squinch Corner Slab

Figure 8: External Solid Masonry Walls

There are two primary stair cores, these are located in the south western and north eastern (shorter) wings and are constructed around solid masonry walls. Stair treads and landings are formed using stone slabs which are supported on inner and outer solid masonry walls. The stair treads and landings on the lower floors have been capped with a screed or concrete layer, presumably as a remedial detail following excessive wear of the stone elements. The staircases terminate at the seventh storey with a decorative half domed masonry ceiling/roof slab.

Foundations were not exposed as part of these investigations; however, it is likely that due to the type of construction evident in the storeys above and the era of construction these will be typical masonry corbel footings cast directly on to the subsoil.

In the seven storey south eastern wing the two external bays have been strengthened historically. According to "Brunswick Mill, Manchester Heritage Statement" by Stephen Levrant Heritage Architecture Ltd this was carried out during the 1920's to accommodate new cotton spinning machinery. Note that these strengthening works are limited to structural beams only and no strengthening was carried out to the masonry jack arches or cast-iron columns. These strengthening works were achieved using underslung tie bars (most likely mild steel) to the cast iron beams to create a truss-like action. Ties are restrained and positioned by what is believed to be, owing to the era, mild steel moulded clamps. Strengthening works were limited to levels three, four, six and seven only.

Stability of the building is achieved through several means. It is most likely that the three seven storey wings are stabilised by the two primary stair cores and the large external masonry walls. Masonry panels (inc piers) span vertically between floor plates which act as rigid structural diaphragms to distribute loads via in plane compression and tension to stair cores and external masonry walls. The masonry walls act as large, extremely heavy, cantilevering shear walls which resist load in compression only to transmit load to the underlying foundations. Foundations transmit load to the supporting subsoil via direct bearing.

In the four storey wing fronting Bradford Road there are no stair cores therefore stability is achieved via the large external masonry walls. As above, masonry panels span vertically between floor plates which act as rigid structural diaphragms to distribute loads via in plane compression and tension to external masonry walls. These masonry walls act as large, extremely heavy, cantilevering shear walls which resist load in compression to transmit load to the underlying foundations. Foundations transmit load to the supporting subsoil in direct bearing.

As highlighted above no movement/expansion joints were evident across the building though there are no signs of major structural distress which would suggest movement induced cracking has occurred.

The chimney (now demolished) and later added dust chute (still standing) are both formed in solid load bearing masonry.

3.2.2 General – Electrification Towers

The electrification towers refer to the area shaded grey within figure 3.

2no electrification towers were constructed historically which coincided with the adoption of electric power in the early 1900's. One of these towers, to the north, has since been demolished. Shown below in figure 8, the remaining electrification tower consists of a lower ground floor/ semi basement space with a two storey clear internal space above.

Although not accessible due to what was deemed to be unsafe staircase access the roof structure is thought to be formed in traditional timber joists spanning between the existing south east wing and newly built external wall of the electrification tower.

Again, although not accessible due to safety concerns, the ground floor structure, could be seen from above windows and semi basement soffit to be formed in steel filler joist floors with reinforced concrete slabs spanning between. Refer to figure 9.

The semi basement of the building comprises of a ground bearing, unreinforced concrete slab.

Foundations were not exposed as part of these investigations however, corbelling of the masonry walls could be seen within the semi basement therefore it is likely that foundations will be typical masonry corbel footings cast directly on to the subsoil. Refer to figure 10.

Stability is achieved via masonry panels which span vertically between floor plates acting act as rigid structural diaphragms to distribute loads via in plane compression and tension to external masonry walls. These masonry walls act as large, extremely heavy, cantilevering shear walls which resit load in compression to transmit load to the underlying foundations. Foundations transmit load to the supporting subsoil in direct bearing. The building may be relying on the seven storey wing behind also for stability purposes. No movement/expansion joints were observed.

Figure 9: Steel Filler Joist Floor

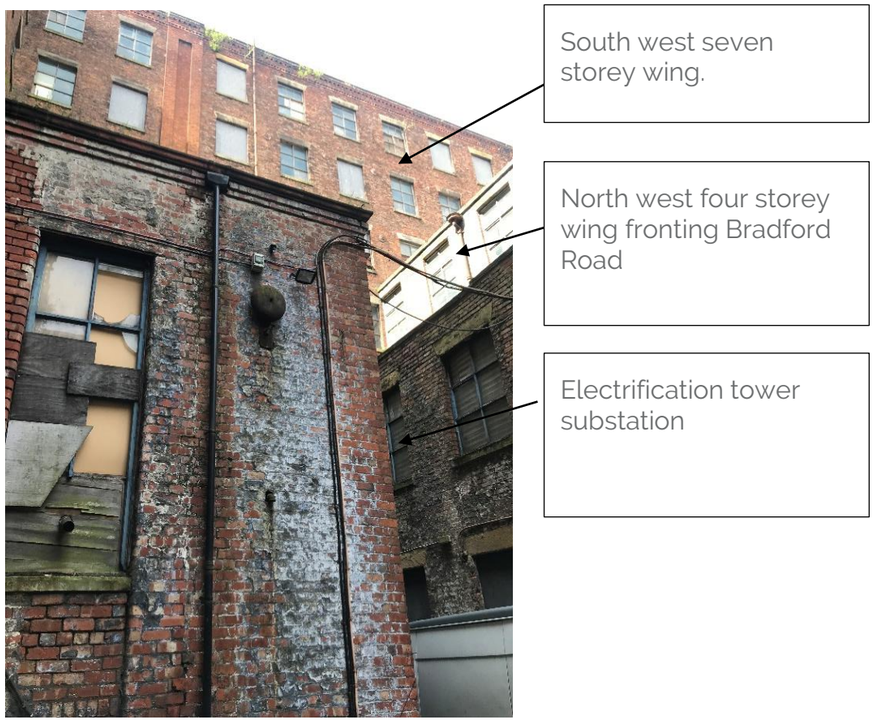

Figure 10: Southern Electrification Tower (looking south)

Figure 11: Corbelled Masonry Footing of Main Wing Viewed from within Electrification Tower

3.2.3 General – Waste House

Waste house refers to the area shaded in dark blue within figure 3.

The waste house to the north east of the site was originally constructed as a three storey building. The waste house was constructed as per the main mill wings using masonry jack arches supported on cast iron beam and column superstructure.

The waste house was historically extended to create a fourth storey (third floor). This was constructed using reinforced concrete slabs supported on steel (most likely) beams spanning between newly extended masonry walls.

Foundations were not exposed as part of the investigation.

Stability is achieved via masonry “panels” which span vertically between floor plates acting act as rigid structural diaphragms to distribute loads via in plane compression and tension to external masonry walls. These masonry walls act as large, extremely heavy, cantilevering shear walls which resit load in compression to transmit load to the underlying foundations. Foundations transmit load to the supporting subsoil in direct bearing.

3.2.4 General – Boiler House

The boiler house refers to the area shaded light blue within figure 3.

The boiler house was not accessible during Civic Engineers site visit. It appears that original access would have been provided via the main wings of the mill however these have since been blocked up. Further access may be available via the cleared India Mills site adjacent to Brunswick Mill though due to hoarding around the site, as well as overgrown vegetation and general waste this was also not accessible.

From further observations, looking down from roof of the mill and towpath behind it can be seen the boiler house has sustained significant fire damage at some point in the past and would therefore not be safe to access. Refer to figures 11 and 12.

Figure 12: Boiler House Roof Looking Down from Mill Roof

Figure 13: Rear Elevation of Boiler House from Towpath

3.3 Brunswick Mill - Structural Appraisal and Condition Summary

3.3.5 Roof Level

The roof was accessed during a site visit of Wednesday 17th February 2021. The structural arrangement is as described in Section 3.2.

The structural condition of the roof is generally of fine condition with no major signs of structural distress.

The following items were noted to be areas of consideration as part of the proposed works. This should be read in accordance with Civic Engineers sketches appended with Appendix A – Structural Investigation Notes.

Waterproofing of the roof appears to have been addressed multiple times and is generally ad-hoc with no particular falls. The level of the roof undulates due to various patch repairing of the waterproofing and finishing system. Refer to figure 13.

Figure 14: General Roof Observation

The southern parapet at roof level appears to bow outwards significantly between towpath flank wall and original dust chute, refer to figure 14.

The interface between southern parapet and original dust chute appears to be leaning outwards towards Bradford Road. Cracking of mortar joints is concurrent with apparent leaning. Refer to figure 15.

There are general areas of loose masonry and loss of pointing. Refer to figure 16.

Figure 15: Significant Bowing of Southern Parapet

Figure 16: Leaning Dust Chute

Figure 17: Cracking and Loss of Pointing Generally

Areas of historic brickwork repair are noted on the elevation adjacent to the courtyard area. In these areas brickwork panels have been infilled. This appears to coincide with the former hoist location.

3.3.6 Sixth Floor

The sixth floor was accessed during a site visit of Wednesday 17th February 2021. The area is currently vacant and appears to have been for some time. The structural arrangement is as described in Section 3.2.

The below figures show the general layout of the sixth floor along with the structural form as previously described.

The structural condition of the sixth floor is generally in average condition with some signs of structural distress.

Significant water ingress was evident throughout the jack arches and supporting structure. Civic Engineers are aware of historic roof leaks which is concurrent with the previously described roof waterproofing repairs but also the strategic placement of buckets across the sixth floor. Roof leakage over time has resulted in delamination of the cast iron structure in

Figure 18: Plastic Buckets to Catch Water from Leaking Roof.

There are further areas which present distress due to water ingress. Generally, there is a significant loss of plaster to the soffit of jack arches as well as loss of masonry units and pointing. Walls also appear damp, and paint has blistered and come away from brickwork Refer to figure 19.

See attached sketch mark-ups for specific locations of the damages in Appendix A.

Figure 19: Lamination of Cast Iron Structure Resulting from Water Ingress

Figure 20: Significant Loss of Plaster, Masonry Units and Pointing to Jack Arches

In approximately the second quarter of the elevation fronting the Ashton Canal, the masonry wall appears to have settled. This occurs across 4No bays and is evident through visual signs of distress in the structure. There is an obvious drop in cill level across the four bays with associated cracking to adjacent spandrel panels and masonry panels beneath cills. With this there is also an obvious drop and undulation of the floor level. Refer to figure 20.

Figure 21: Drop in Cill Level and Associated Cracking to Masonry

To the elevation fronting Bradford Road within the south western wing lintels have been propped presumably to address failure of these units. Refer to figure 21 and also sections discussing observations of elevations.

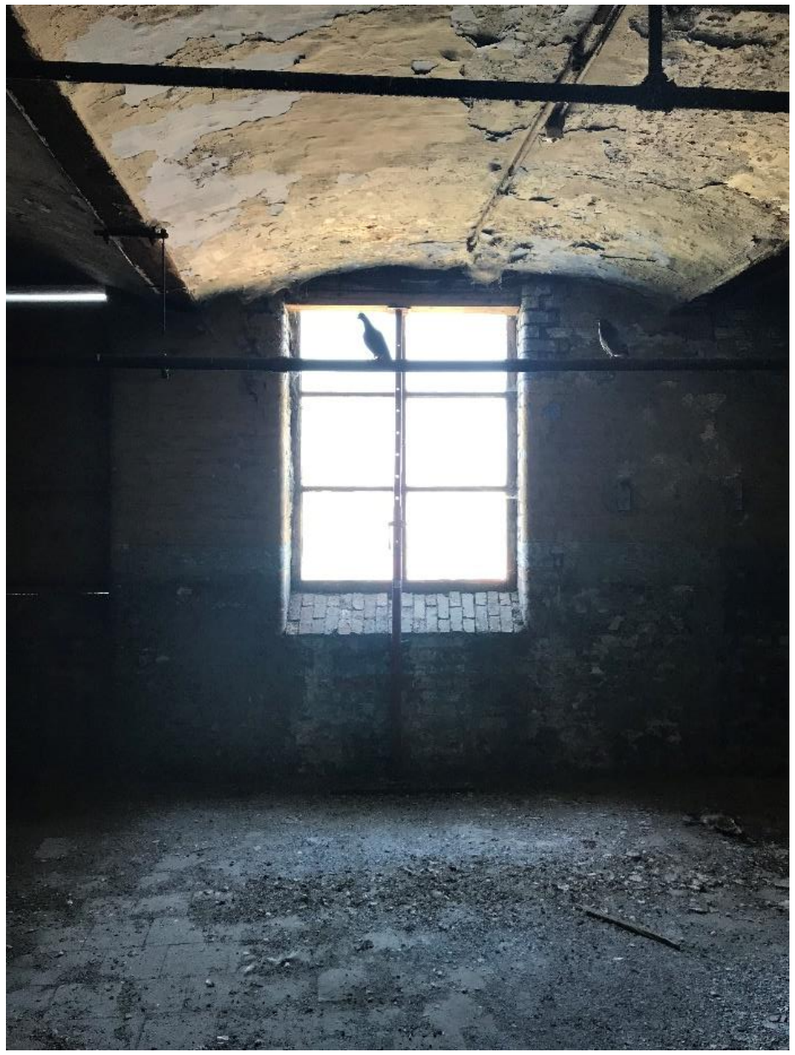

Figure 22: Propped Lintels

3.3.7 Fifth Floor

The fifth floor was accessed during a site visit of Wednesday 17th February 2021. The area is currently vacant and appears to have been for some time. The structural arrangement is as described in Section 3.2.

The below figures show the general layout of the fifth floor along with the structural form as previously described.

The structural condition of the fifth floor is generally in average condition with some signs of structural distress.

As with the sixth floor, in approximately the second quarter of the elevation fronting the Ashton Canal, the wall appears to have settled. This occurs across 4No bays and is evident through visual signs of distress in the structure. There is an obvious drop in cill level across the four bays with associated cracking to adjacent spandrel panels and masonry panels beneath cills. With this there is also an obvious drop and undulation of the floor level.

Small areas of localised masonry section loss can be seen within the structural masonry piers. Refer to figure 22.

Figure 23: Small Areas of Masonry Loss in Pier

Significant amounts of water staining to the soffits of the south west wing were observed [Figure 23]. Unlike other floors the structure at high level fifth floor the south western wing has been strengthened similarly to the main wing with underslung, assumed, steel tie bars. Refer to figure 23 and 24.

See attached sketch mark-ups for specific locations of the damages in Appendix A.

Figure 24: Significant Water Staining to Soffit. Strengthening Observed to Beams

Figure 25: Water Staining and Damage to Jack Arches at Squinch Corner

3.3.8 Fourth Floor

The fourth floor was accessed during a site visit of Wednesday 17th February 2021. The area is currently used by a textile manufacturer with a series textile machines situated across the floor plate along with significant amounts of storage. The structural arrangement is as described in Section 3.2.

The below figures show the general layout of the fourth floor along with the structural form as previously described.

The structural condition of the fourth floor is generally in average condition with no major signs of structural distress.

Note that access was not available to the south western wing of the fourth floor and therefore has not been covered by this appraisal.

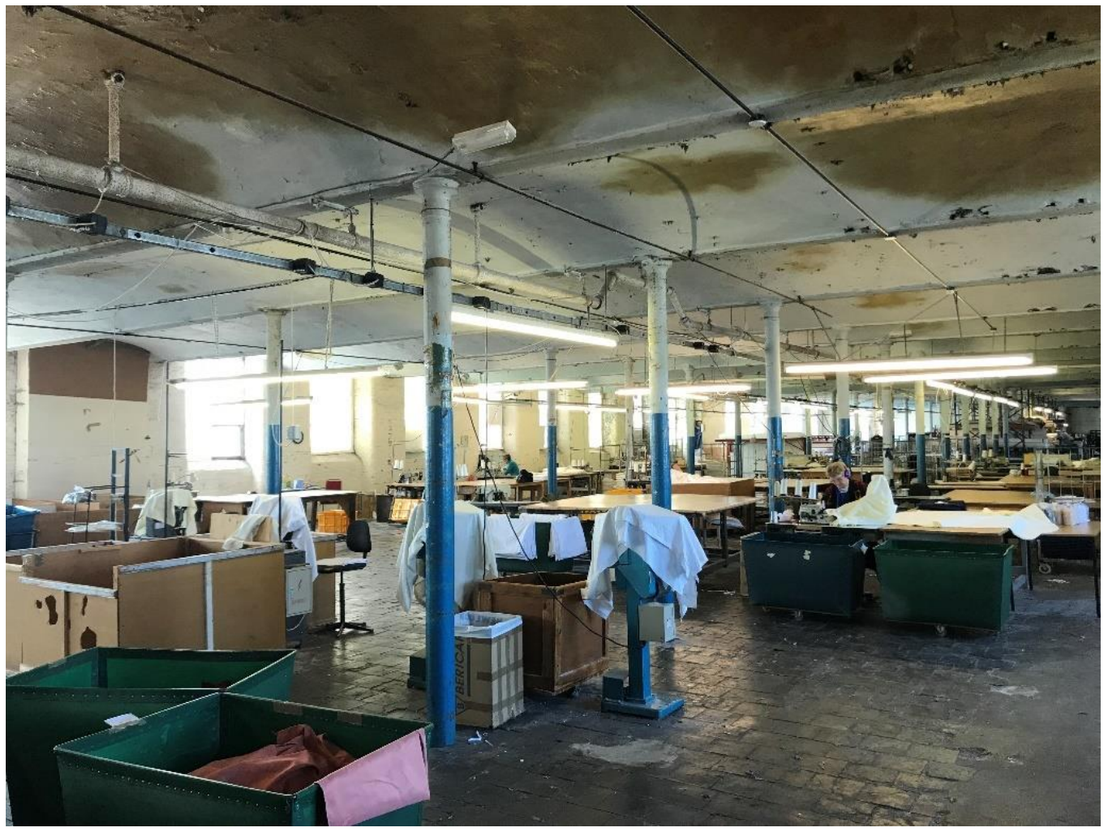

Figure 26: General View of Fourth Floor

There is evidence of significant water ingress and associated damage to masonry jack arches and lamination of cast iron structure. Refer to figure 26.

Patch repairs appear to have been carried out the masonry jack arches in the north west wing of the fourth floor. Refer to figure 27 which appears to show concrete patch repairs to the soffit of masonry.

The roof of the original waste house (fourth floor) has inadequate drainage and water in currently ponding on the roof at a large depth. This could be a cause of the significant corrosion of reinforcement within the roof slab which is described in section 3.2.9. Refer to figure 28.

See attached sketch mark-ups for specific locations of the damages in Appendix A

Figure 27: Damage to Masonry Jack Arch and Cast Iron Structure

Figure 28: Concrete Patch Repair to Arch Soffit

Figure 29: Water Ponding on Waste House Roof

The settling of rear wall described in previous sections continues throughout the lower levels. This occurs across 4No bays and is evident through visual signs of distress in the structure. There is an obvious drop in cill level across the four bays with associated cracking to adjacent spandrel panels and masonry panels beneath cills. With this there is also an obvious drop and undulation of the floor level. Refer to figure 29.

Figure 30: Obvious Drop in Cill and Floor Level

3.3.9 Third Floor

The third floor was accessed during a site visit of Wednesday 17th February 2021. The area is currently vacant and appears to have been for some time. The structural arrangement is as described in Section 3.2.

The below figures show the general layout of the third floor along with the structural form as previously described.

The structural condition of the third floor is generally in average condition with signs of structural distress.

The north west wing of third floor (fronting Bradford Road) is not of original construction. As described in section 3.2 this storey was added circa 1920.

The rooftop extension was formed using similar cast iron superstructure built off the cast iron below. Roof slabs are formed in insitu concrete supported by cast iron superstructure. Masonry walls are extended up and are built off original masonry walls below. Refer to figure 30 which shows the general layout of the third floor extension.

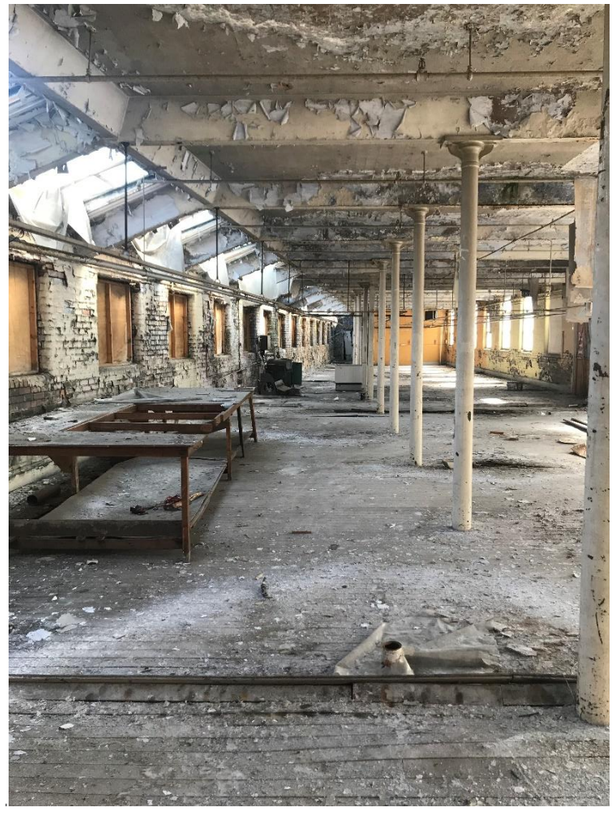

Figure 31: Third Floor Extension

Cast iron beams are partially encased in concrete to create a chamfered detail between roof slab and beams. Refer to figure 31.

Figure 32; Partially Encased Cast Iron Beam

Roof slab soffits are significantly damaged and present corrosion to the reinforcement throughout. In some instances, loss of cover to reinforcement has caused lapped reinforcement to become loose and peel away from concrete. Refer to figure 32.

Figure 33: Stained Slab Soffits and Corroded Reinforcement

Water ingress has also caused damaged to timber floor finishes. Timber boards have warped and distorted which is most probably caused by a combination of long-term saturation and swelling and water damage. Refer to figure 33.

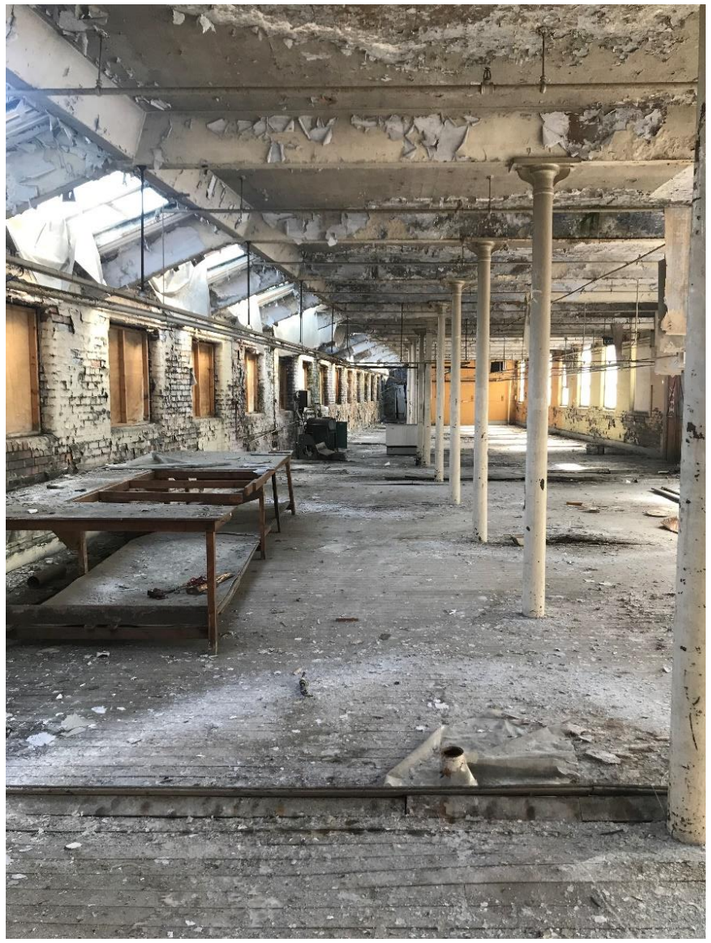

Figure 34: Warped Timber Floorboards

Within the brickwork it is evident that bed joint reinforcement has been used. Across the floor plate a singular bed joint has opened up due to the corrosion and subsequent expansion of the steel reinforcement within. Refer to figure 34. This may lead to the formation of a hinge in the wall and potential movement.

There is generally a lack of pointing to masonry and efflorescence staining to the internal masonry wall faces throughout the third floor extension. Refer to figure 35.

Figure 35: Corroded and Expanded Bed Joint Reinforcement

Figure 36: General Efflorescence Staining to Masonry

In the south west wing of the third floor lateral ties are present across each pier. Steel bars are threaded through both external piers to restrain walls laterally. Bars are suspended from cast iron super structure by moulded clamps. Refer to figure 36.

Figure 37: Lateral Tie Bars Between Piers

Access to the rear wing (fronting the Ashton Canal) has been blocked off by infilling of original openings. The reason for this is unknown. Access to the third floor rear wing was only available via the staircase within the north east wing.

As per other levels, the outer bays of the rear wing have been strengthened with underslung steel tie bars. Refer to figure 37.

Figure 38: Strengthened Inner and Outer Bays

The settling of rear wall described in previous sections continues throughout the lower levels. This occurs across 4No bays and is evident through visual signs of distress in the structure. There is an obvious drop in cill level across the four bays with associated cracking to adjacent spandrel panels and masonry panels beneath cills. With this there is also an obvious drop and undulation of the floor level. Refer to figure 38. Despite a drop in cill levels, apart from cracking observed, the mortar bed joints appear to be unaffected. It could therefore be that bed joints which have opened up due to the percieved drop in level have retrospecitively been repointed.

Figure 39: Settled Wall Fronting Ashton Canal

To the inner elevation (facing the courtyard) there appears to be historic tie plates embedded within the masonry piers. These are symmetrical about the elevation but do not appear to be currently serving a purpose. These could have formed part of a historic hoist. or fire escape staircase. Refer to figure 39.

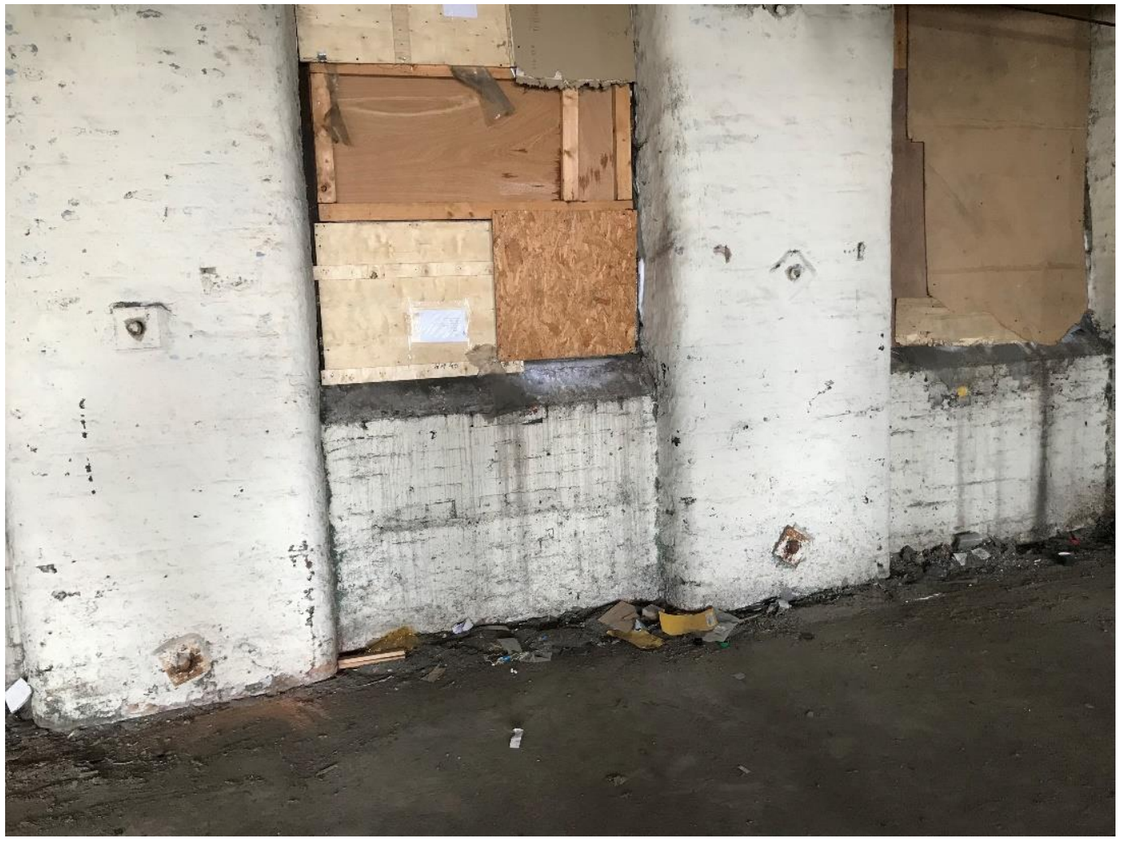

Figure 40: Tie Bars and Plates to Fixed Through Piers

As an extension the former waste house is formed in differing construction to the main mill. Floor slabs are constructed in reinforced concrete supported on cast iron superstructure.

Within the former waste house there is significant damage to the roof slab due to water ingress. As described in 3.3.8 the drainage of the roof above is poor and water is currently ponding. This may be the cause of water ingress and subsequent corrosion of reinforcement and loss of concrete to the soffit of the third floor. The condition of this roof is very poor and will require immediate attention. Refer to figure 40.

Within the waste house a single bearing support of the main cast iron steelwork has failed and caused the slab to drop. There appears to have been some attempt to resolve this though this is not particularly successful. Refer to figure 41.

Figure 41: Spalling of Concrete due to Water Ingress and Corrosion of Reinforcement

Figure 42: Failed Beam Bearing

A series of works recently undertaken were observed within the waste house at third floor. These have presumably been carried out as part of a repair strategy to a recent failure of lintels on the north east elevation of the waste house.

Referring to figure 42 scaffold can be seen to have been installed to temporarily support the roof slab as the lintels in questions where replaced. It is also apparent that the internal leaf of the masonry wall has also been rebuilt.

See attached sketch mark-ups for specific locations of the damages in Appendix A.

Figure 43: Propping Installed by Client to Third Floor Former Waste House and Repair work stared.

3.3.10 Second Floor

The second floor was accessed during a site visit of Wednesday 17th February 2021. The area is currently being used by a textile manufacturer with a series of heavy cotton spinning machines situated across the floor plate along with significant amounts of storage. The structural arrangement is as described in Section 3.2.

The below figures show the general layout of the second floor along with the structural form as previously described.

The structural condition of the second floor is generally in fine condition with no major signs of structural distress.

Figure 44: Looking North East into Former Waste House. Goods lift to Left.

The following were noted to be areas of consideration as part of the proposed works. This should be read in accordance with Civic Engineers sketches appended with Appendix A – Structural Investigation Notes.

Within the former waste house of the second storey the north eastern outer masonry wall has been tied back (at the head of the wall) to the most adjacent cast iron floor beam. This has been carried out to restrain the outer walls, shown in figure 45**.** It is unknown when this was installed.

In the western corner of the former waste house evidence of lateral movement can be seen. The corner pier appears to have peeled away from the main wing which may show sign of differential movement between the differing sections of the site. Refer to figure 46.

Figure 45: Looking South West into Main Wing

The internal bay (fronting the courtyard) in the north eastern wing shows evidence of damp patches to the soffit of level two. Refer to figure 47.

To the south west elevation of the main wing (fronting the Ashton Canal) significant water staining and damage is evident to a bricked up former opening. Refer to figure 48.

Within the south western wing the outer masonry walls (north eastern and south western) have been laterally tied (at the head of wall) to each other using steel bars. The bars span the full width of the wing and appear to have been installed to restrain the walls. It is unknown when this was installed. Refer to figure 49**.**

See attached sketch mark-ups for specific locations of the damages in Appendix A.

Figure 46: Restraint Bars to North Eastern Wall of Former Waste Room Second Floor

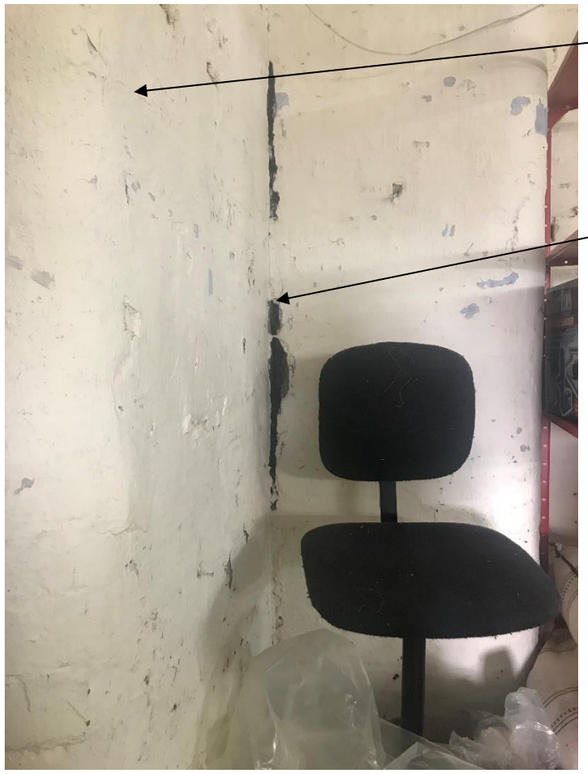

Figure 47: Vertical Crack Indicating Movement of Structure

Figure 48: Staining to Soffit of Second Floor (Internal Bay Only)

Figure 49: Significant Water Staining and Damage to Brickwork

Figure 50: Lateral Tie Bar South Eastern Wing

The second floor on the north west wing (fronting Bradford Road) was only accessible by a small staircase from the extended third floor above. A general view of this area is presented below in figure 50.

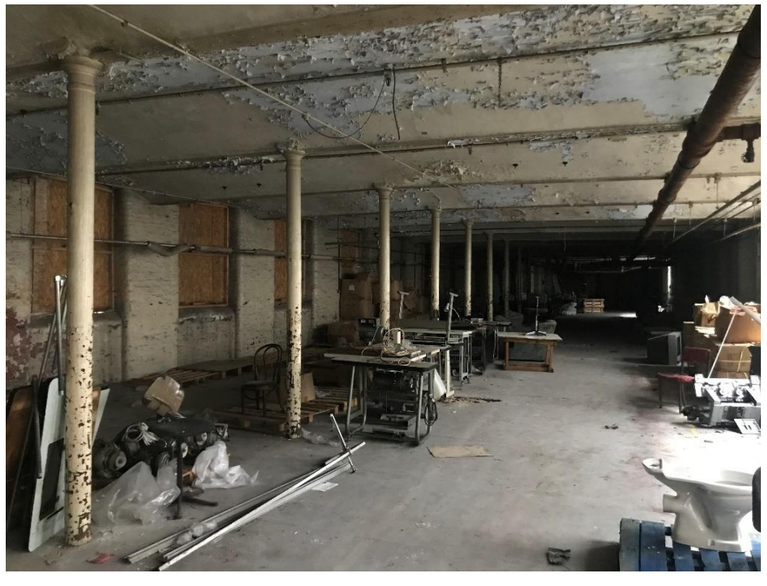

Figure 51: Second Floor North West Wing

Towards to northern end of the wing beams at high level have been strengthened as per other levels with underslung steel tie bars. Refer to figure 50.

Figure 52: Beam Strengthening.

Various openings have been infilled to the north east wing but also due to the construction of the courtyard two storey building. Refer to figure 52.

Figure 53: Infilled Openings

3.3.11 First Floor

The first floor was accessed during a site visit of Wednesday 17th February 2021. The area is currently being used as a music rehearsal space with a number of private rooms in all wings of Brunswick Mill except the wing fronting Bradford Road. The structural arrangement is as described in Section 3.2.

The structure on first floor was not visible due to the significant amount of finishes and partitions therefore an appraisal of this area is not covered within this report.

Access to the wing fronting Bradford Road was not available during site visits therefore an appraisal of this area is not covered within this report.

The first floor of the two storey building (within the courtyard) as observed from ground floor can be seen to be formed in traditional timber joists These timber joists are supported on the original internal masonry façade of the northwest wing and the masonry wall of the extension. Refer to figure 53.

Figure 54: Two Storey Courtyard Building. First Floor Timber Construction Observed from Ground

3.3.12 Ground Floor

The Ground floor was accessed during a site visit of Wednesday 17th February 2021. The area is currently being used by a textile manufacturer with a series of textile machines situated across the floor plate along with significant amounts of storage. The structural arrangement is as described in Section 3.2.

The below figures show the general layout of the ground floor along with the structural form as previously described.

The structural condition of the ground floor is generally in fine condition with no major signs of structural distress.

Access to ground floor was limited with some areas unavailable for review. Accessible areas were as follows, south west wing (fronting Ashton Canal), north east wing and extension behind and small two storey extension within courtyard. Along with these areas we were able to access a couple of fit-out spaces at ground floor level. One of these fit out spaces had suspended ceilings and wall partitions, so the structure was not accessible/visible, the other had parts of damp. A small portion of the north west wing was also available. Remaining areas are not covered within this report.

See attached sketch mark-ups for specific locations of the damages in Appendix A.

Figure 55: Ground Floor Textile Manufacturer

Figure 56: General Storage Throughout Ground Floor

To the southern end of ground floor there is a local infill of what appears to be reinforced concrete structure. Evidence of a concrete beam can be seen though the reason for this is unknown. Refer to figure 56.

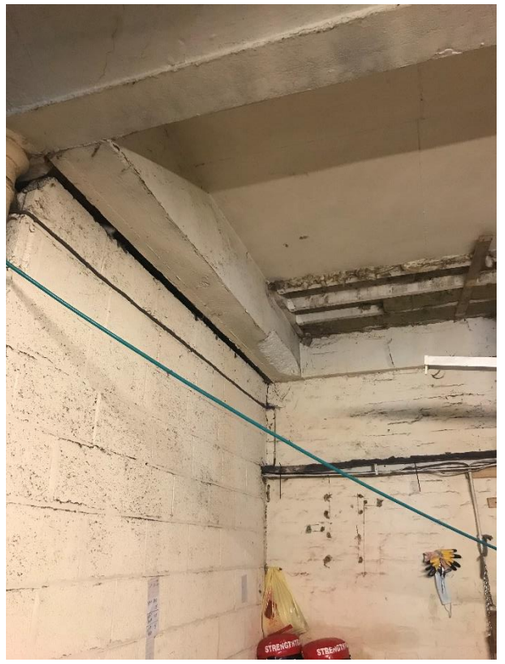

Figure 57: Local Concrete Beam with Damage

Within a small portion of the north east wing (fronting Bradford Road) the ground floor area shows significant staining due to smoke and dust. The use and former use of this area is unknown. Refer to figure 57.

Figure 58: Significant Staining to Walls

Within the two-storey electrification tower semi basement there is significant water staining of walls and slabs due to ingress and flooding. A sump pump has retrospectively been fitted in the last two years (as advised by Maryland Securities). Refer to figure 58.

There has been significant flooding in this area, presumably caused by leakages in the roof, leaving the area flooded suggesting the pump to not be operating. As a result the area was not available for access.. Foundations were not exposed as part of the investigation.

The walls within the semi basement appear to show corbelling of the original masonry elevations. However, the colour and condition of these bricks would indicate these to have been installed recently. The reason for this is unknown. Refer to figure 60.

Figure 59: Sump Pump Installed

Figure 60: Corbelled Walls

3.3.13 Elevation 1 – North West External

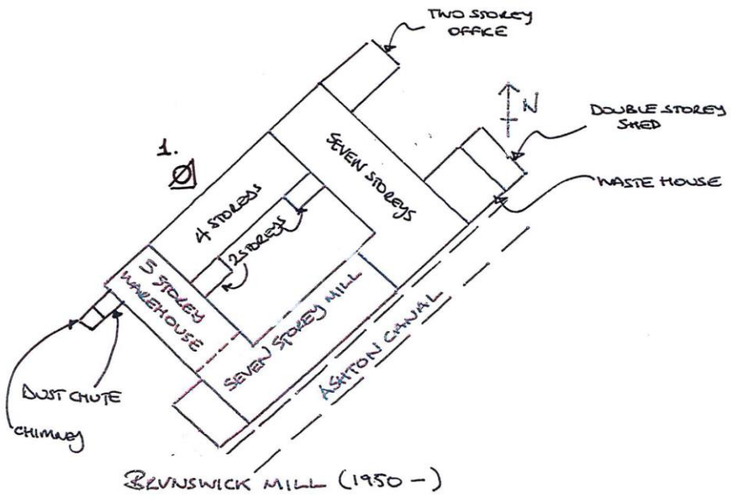

Figure 61: Elevation 1 Key Plan

The following should be read in conjunction with Civic Engineers sketches presented in Appendix A – Structural Investigation Notes

Elevation 1 is generally in reasonable structural condition with no signs of major structural distress. The following were noted to be areas of consideration as part of the proposed works.

Overgrown vegetation can be seen to the parapet of the former waste house and head of third floor (former roof) of the four storey wing. Cracking is evident to a large percentage of lintels and along with associated local cracking of masonry panels due to this.

At the junction of the four storey and seven storey wings, between first and ground floor, vertical cracking indicates that the structural masonry pier has “peeled away” from the structure. The pier appears to bow outwards towards Bradford Road indicating a lack of lateral restraint. With this the adjacent masonry panels have distorted which may have added further to the distress of the lintels in this area. Refer to figures 61 and 62.

There is a general loss of masonry pointing throughout with some areas of spalled and missing masonry units. Refer to figure 63.

There is general cracking to lintels and masonry throughout. Approximately 20% of lintels are cracked. There is also an indication of lintel replacement where form is different.

See attached sketch mark-ups for specific locations of the damages in Appendix A.

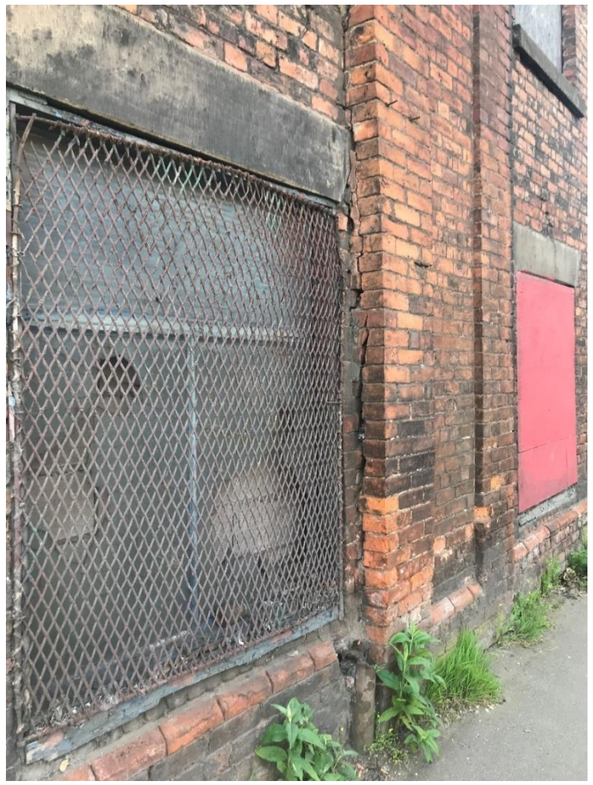

Figure 62: "Peeling Away" of Masonry Pier

Figure 63:Damaged Masonry Pier and Associated Lintels

Figure 64: General Loss of Masonry and Pointing

3.3.14 Elevation 2 – North East External

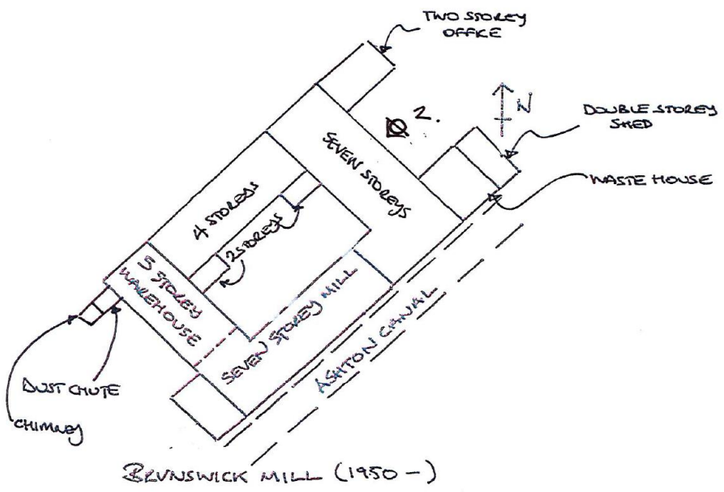

Figure 65: Elevation 2 Key Plan

The following should be read in conjunction with Civic Engineers sketches presented in Appendix A – Structural Investigation Notes

Elevation 2 is generally in reasonable condition with no signs of major structural distress. The following were noted to be areas of consideration as part of the proposed works.

To the corner parapet of the former waste house the third floor lintel has previously failed This areas has recently undergone a series of repair works which are described in previous sections. Refer to figure 65.

To the right of elevation 2 there appears to have been recent works to repoint an area of brickwork between levels three and four. This appears to coincide with the replacement of a rainwater pipe fixed to the elevation. Refer to figure 66.

To the right of elevation 2, at the interface with elevation 1, the pier shows localised loss of masonry units. As intrusive investigations are yet to be carried out it is inconclusive whether the area of section loss extends through the full width of pier and has been retrospectively bricked up internally or there has only been a loss of one skin of brickwork. However, it is most likely that the former is the case. Refer to figure 67.

There is a general loss of masonry pointing throughout with some areas of spalled and missing masonry units.

There is general cracking to lintels throughout. Approximately 20% of lintels are cracked. There is also an indication of lintel replacement where form is different.

See attached sketch mark-ups for specific locations of the damages in Appendix A.

Figure 66: Repaired Masonry Elevation

Figure 66: Localised Loss of Masonry to Pier

Figure 67: Localised Loss of Masonry to Pier

3.3.15 Elevation 3 – South Eastern External

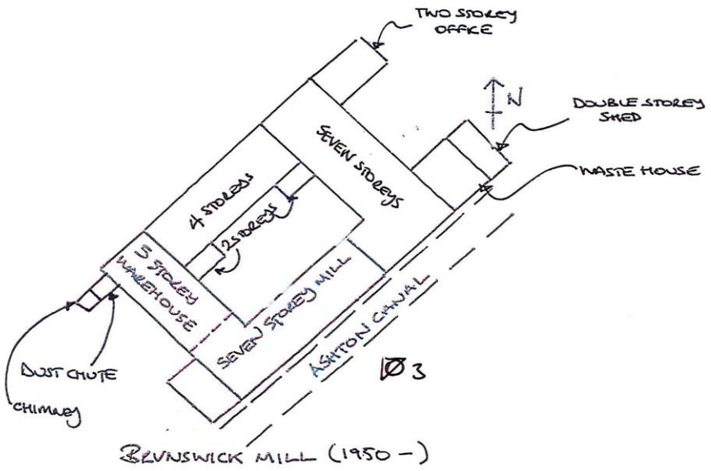

Figure 68: Elevation 3 Key Plan

The following should be read in conjunction with Civic Engineers sketches presented in Appendix A – Structural Investigation Notes

Elevation 3 is generally in average condition with some signs of structural distress. The following were noted to be areas of consideration as part of the proposed works.

Lintel failures exist all along elevation 3. This includes cracking of the concrete lintels with some evidence of dropping and cracking of the masonry panels above. This has recently been addressed by the installation of a series of steel acro props. Thee act to temporarily support the lintels and mitigate against any further deterioration. The locations of these interventions are shown in Appendix A – Structural Investigation Notes and can also be seen in Figure 69.

Figure 69: Lintel Props Elevation 3

Overgrown vegetation can be seen along areas of the parapet and façade, At the interface with the former boiler house to the south of elevation 3 a large tree has been cut back though roots are still present which are continuing to grow and displace brickwork units further. Refer to figure 70.

To the right of elevation 3 towards the interface with elevation 2 the parapet appears to be “peeling away” from the adjacent areas. This correlates to the area observed on the roof where the parapet appears to be leaning outwards. (Figure 70.a) The brickwork in this area appears to be in poor condition. In this location overgrown vegetation can be seen, it is most likely this is the cause of poor condition of masonry parapet in this location**.** Refer to figure 71.

Figure 70: Vegetation Growth Through Pier

Figure 70a: Bowing Parapet.

A series of steel plates have been retrofit to the lintels at ground floor in the adjacent bays to those which appear to have dropped. The reason for this is unknown though this could have been to address cracking of the lintels prior to the more recent acro prop installation.

To the southern end of façade at the location of the former boiler house a significant amount of spalling has occurred across the façade. The end panel to boiler has historically been rebuilt in engineering brick. Refer to figure 71.

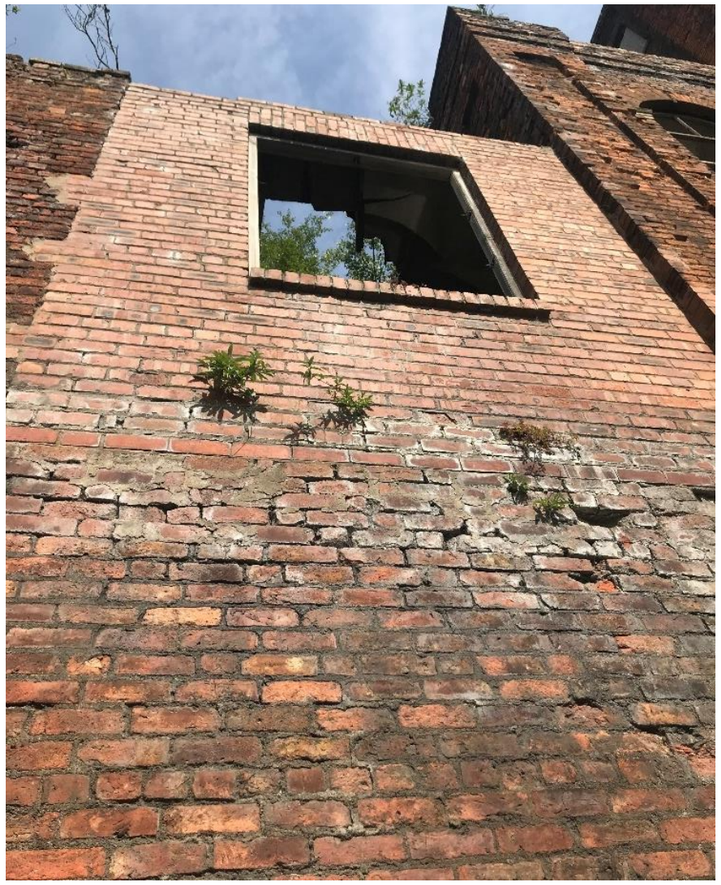

Figure 71: Reconstructed Boiler House Wall

Areas including former windows have been infilled with engineering brick and steel plates for the assumed reason of preventing access from the adjacent towpath. .

At ground floor in approximately the second quarter of elevation (south to north) the wall appears spandrel panels and lintels. It is evident the masonry piers in this area have been repaired and/or strengthened using engineering bricks sometime in the past. Refer to figure 72.

There is a general loss of masonry pointing throughout with some areas of spalled and missing masonry units.

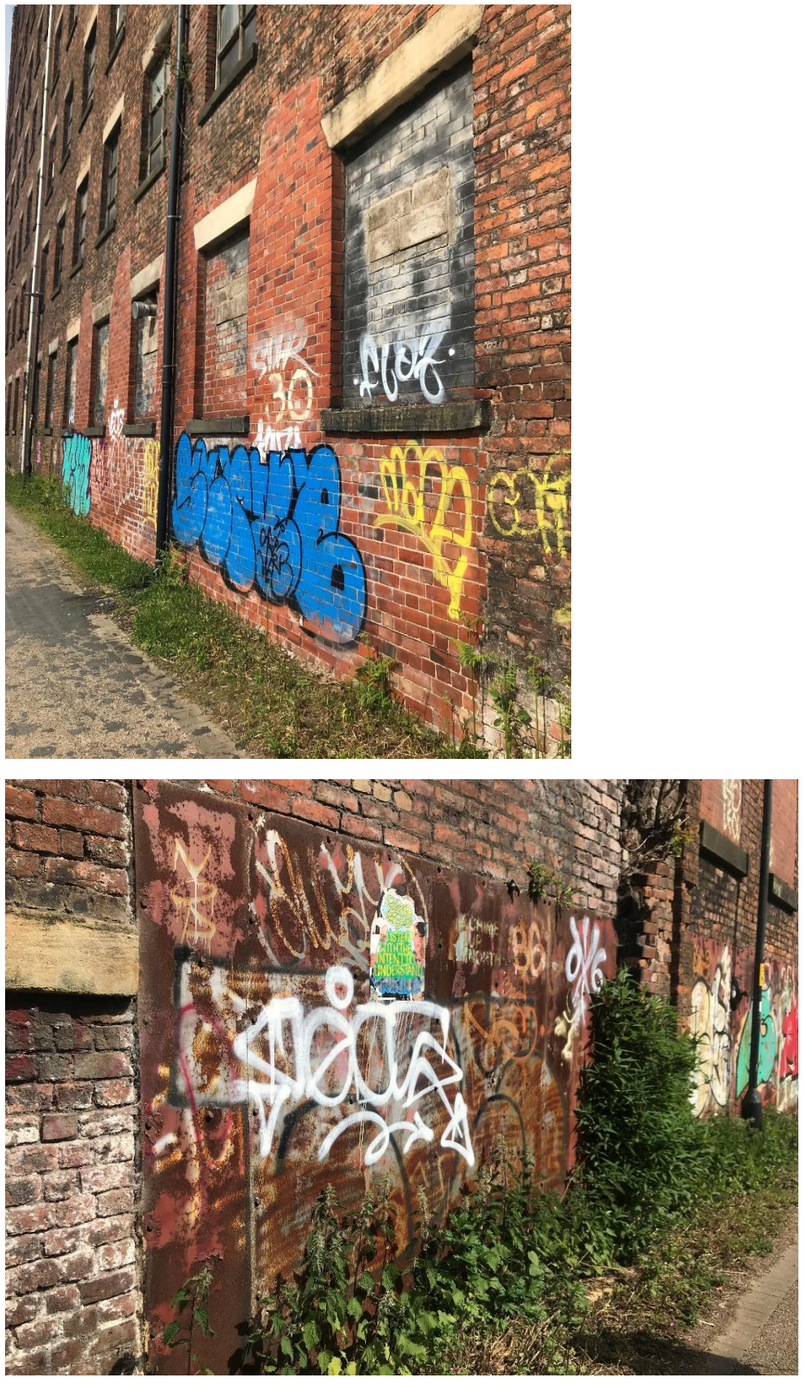

Figure 72: Infill to Historic Openings

There is evidence, to the southern end of elevation 3, of an additional archway structure which has been demolished previously. This is not indicated on the site boundary of the historic Brunswick Mill and is thought to have formed part of India Mill which was demolished along with Pooleys Mill in the site south west of Brunswick Mill. Refer to figure 73 and 74.

Figure 73: Archway Structure

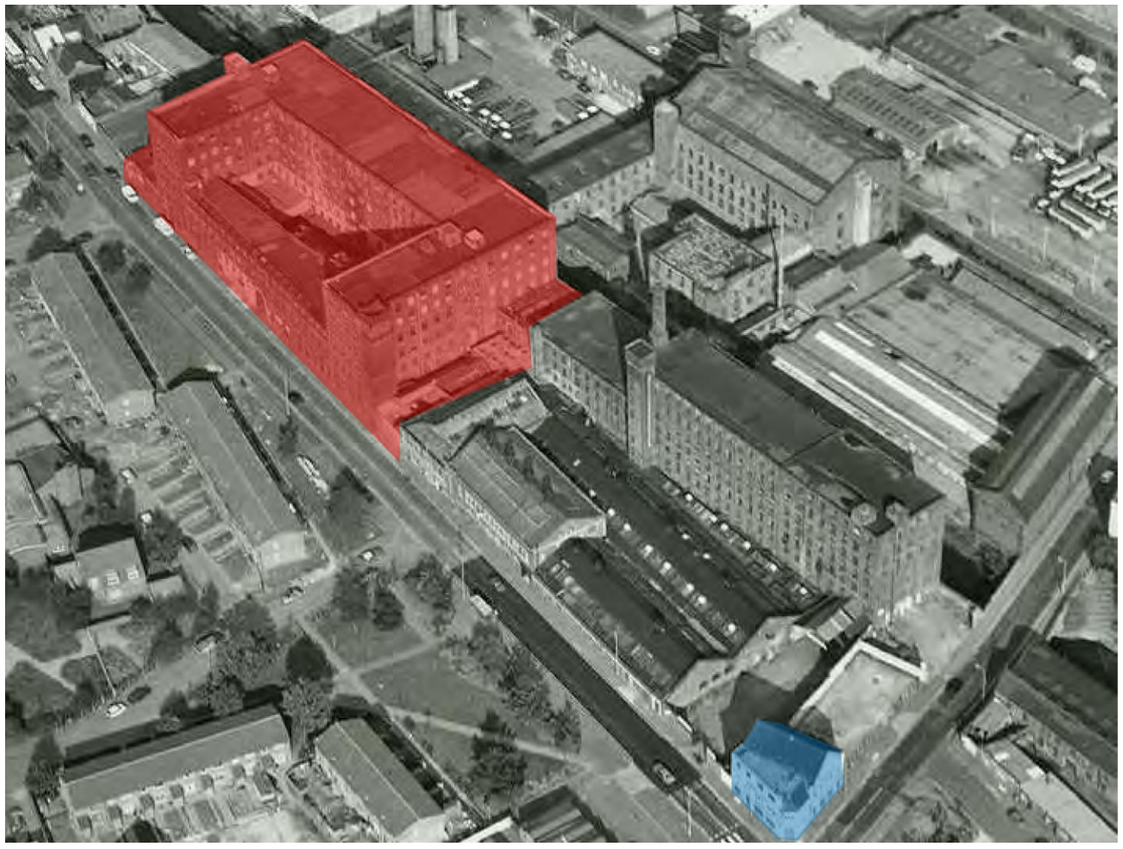

Figure 74: Former (Now Demolished) India Mill to the South East (as viewing image) of Brunswick Mill (in pink)

3.3.16 Elevation 4 – South West External

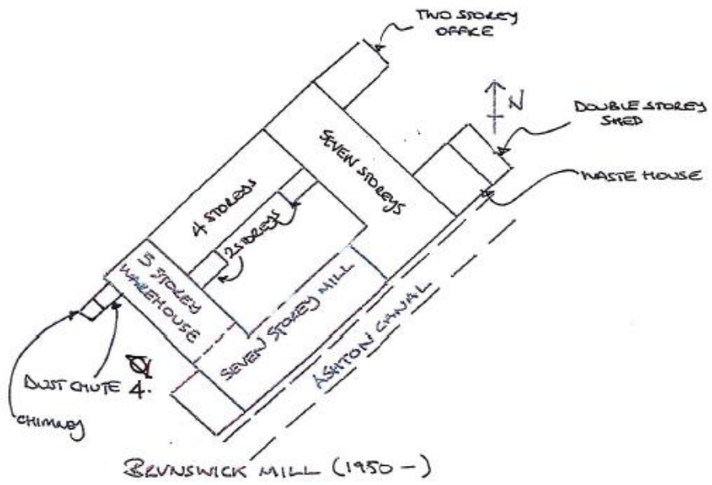

Figure 75: Elevation 4 Key Plan

Elevation 4 was not accessible due to presence of hoarding around the perimeter of the site but also overgrown vegetation within and significant amounts of what appears to be demolition rubbish and general waste.

3.3.17 Elevation 5 – North West Courtyard

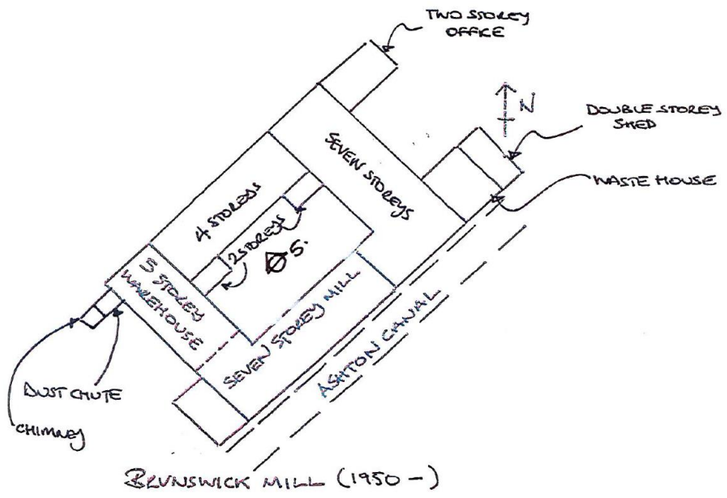

Figure 76: Elevation 5 Key Plan

The following should be read in conjunction with Civic Engineers sketches presented in Appendix A – Structural Investigation Notes

Elevation 5 is generally in average condition with no signs of major structural distress. The following were noted to be areas of consideration as part of the proposed works.

On the top floor (historic addition) areas of parapet to the south of elevation appear to show signs of loose and missing brickwork with associated opening of joints. Refer to figure 77.

Within the courtyard a steel lean-to canopy has been constructed against the historic two storey structure. The canopy is not believed to be of historic construction, this is evident from its connection into the existing elevation which shows steel beam to bear directly onto newly installed engineering brickwork. Refer to figure 78 and 79.

At ground floor, within the structural pier adjacent to the northern two storey structure, there is evidence of former steelwork built into the pier. Steel beam ends are still present within the pier and openings have been bricked around. This could suggest the presence of a historic platform which coincides with a high level beam and opening to form a hoist. Refer to figure 80 and 81.

There is a general loss of masonry pointing throughout with some areas of spalled and missing masonry units and vegetation growth through the parapet.

There is general cracking to lintels throughout. Approximately 20% of lintels are cracked. There is also an indication of lintel replacement where form is different.

See attached sketch mark-ups for specific locations of the damages in Appendix A.

Figure 77: Open Joints and Loos Brickwork

Figure 78: External Steel Lean to Canopy Installed

Figure 79: Engineering Brick Supporting Steelwork

Figure 80: Steel Beam Ends Built into Masonry Pier

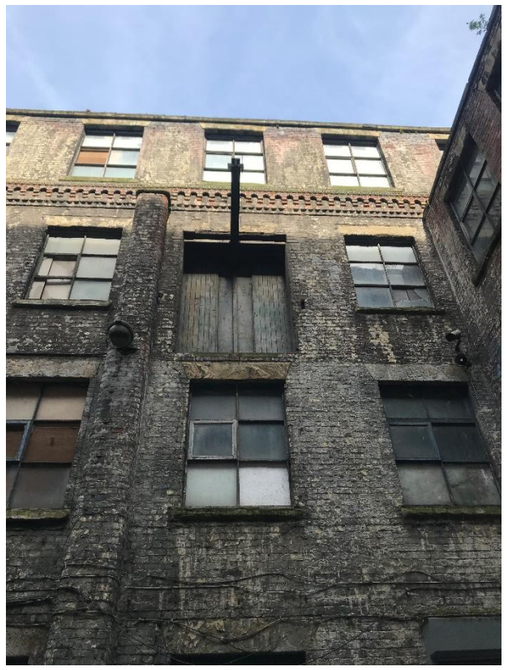

Figure 81: High Level Beam Coinciding with Beams Below. Possible Former Hoist

3.3.18 Elevation 6 – North East Courtyard

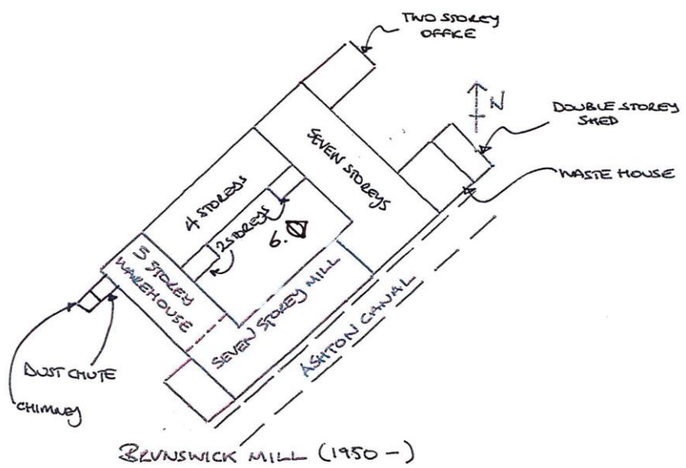

Figure 82: Elevation 6 Key Plan

The following should be read in conjunction with Civic Engineers sketches presented in Appendix A – Structural Investigation Notes.

Elevation 6 is generally in fine condition with no signs of major structural distress. The following were noted to be areas of consideration as part of the proposed works.

A vertical crack can be seen at the interface of the two storey building with Elevation 5. It is evident, where this crack has opened up, that the later two storey additions have not been toothed into the wing which fronts onto Bradford Road. Therefore, differential movement of these two structures has caused the area to "peel away". Refer to figure 83**.**

Observing the high level windows of elevation 6 it could be concluded that the wall may have settled as windows appear to have differing levels. However, on closer inspection it can be seen these opening have purposely been formed at different levels. As shown in figure 84 the left hand window is constructed three courses down from the decorative cornicing whereas the right hand window is constructed four courses down.

There is a general loss of masonry pointing throughout with some areas of spalled and missing masonry units and vegetation overgrowth in the parapet .

There is general cracking to lintels throughout. Approximately 20% of lintels are cracked. There is also an indication of lintel replacement where form is different.

See attached sketch mark-ups for specific locations of the damages in Appendix A.

Figure 83: Differential Movement Causing Peeling Away of Two Storey Structure

Figure 84: Differing Opening Levels

3.3.19 Elevation 7 – South East Courtyard

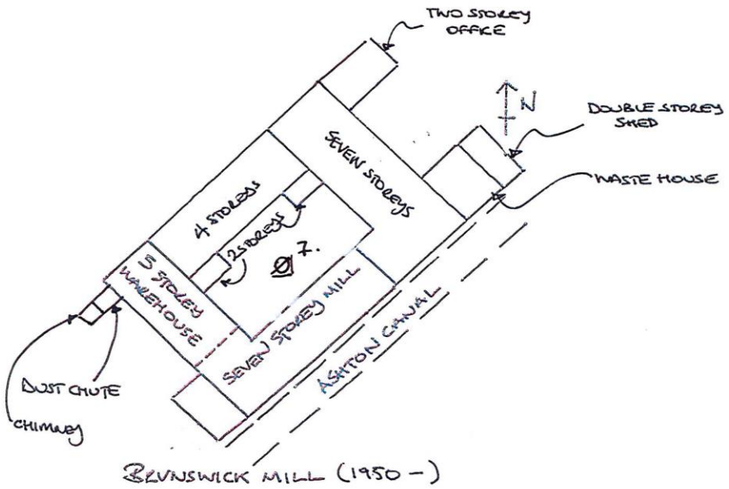

Figure 85 Elevation 7 Key Plan

The following should be read in conjunction with Civic Engineers sketches presented in Appendix A – Structural Investigation Notes.

Elevation 7 is generally in fine condition with no signs of major structural distress. The following were noted to be areas of consideration as part of the proposed works.

To the northern end of elevation 7 there appears to have been recent works to repoint an area of brickwork between level 2 and the roof. This appears to coincide with the replacement of a rain water pipe fixed to the elevation. Refer to figure 89**.** At lower levels, in this location, underneath later installed steel canopy there is significant staining of brickwork behind the rain water pipe. Refer to figure 86.

In 2No locations, north and south, symmetrically about elevation 7 a series of former opening across all levels have been infilled with engineering brickwork and blockwork units sometime in the past. This includes the parapet at high level. The reason for this is unknown though it may well have been a former location of a hoist to or provided egress as a fire escape a per the adjacent bays. Refer to figure 89.

To the centre of the elevation a historic external staircase is present though this is no longer is use. The openings in levels to which the stair historically served have been infilled with engineering brickwork at some time in the past. The topflight of staircase has been removed which may suggest that the adjacent infilled bays (described above) also served as access routes for external staircases. Refer to figure 90.

To the south of elevation 7 at the interface with elevation 8, window openings are formed on the interface line. This would suggest reduced restraint to the masonry panel at this location across the full height of the building. Refer to fig 94**.**

There is a general loss of masonry pointing throughout with some areas of spalled and missing masonry units.

There is general cracking to lintels throughout. Approximately 20% of lintels are cracked. There is also an indication of lintel replacement where form is different.

See attached sketch mark-ups for specific locations of the damages in Appendix A.

Figure 86 Repointed Brickwork

Figure 87: Brickwork Staining at Lower Levels Behind RWP

Figure 88 Infilled Openings to Southern End of Elevation 7

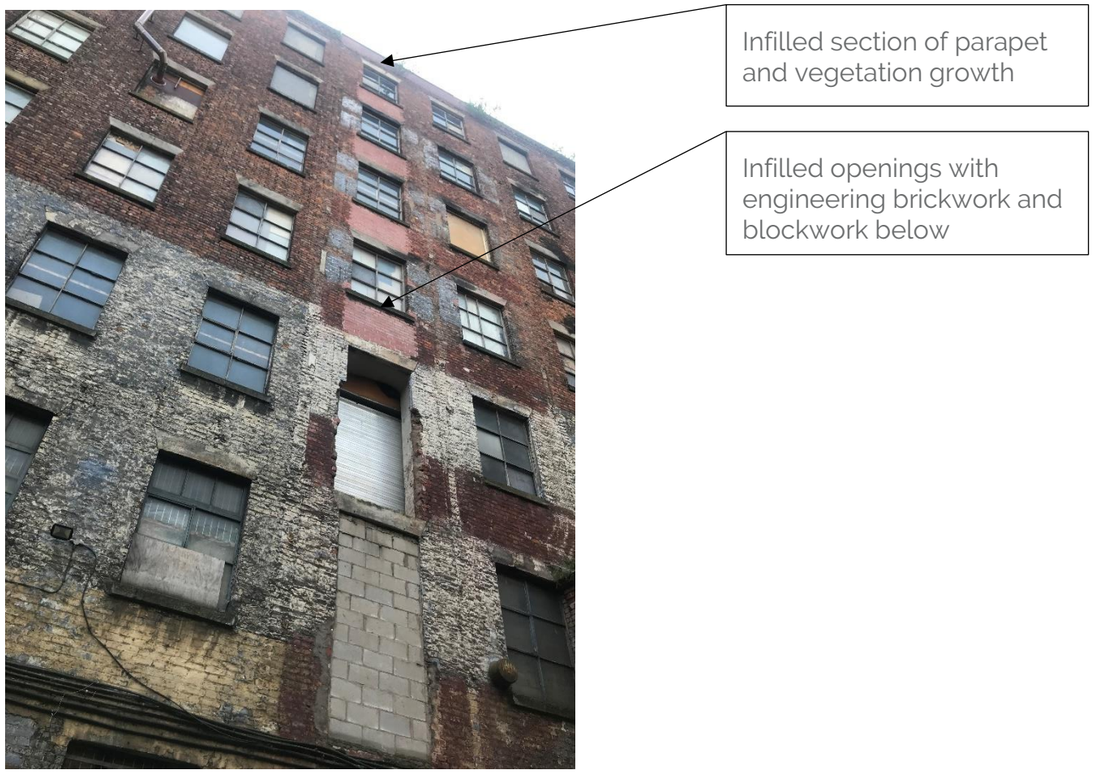

Figure 89: Infilled Openings to Northern End of Elevation 7

Figure 90; Historic Staircase and Associated Openings Infilled with Engineering Brick

Figure 91: Opening Line Corresponding with Wing Interface Line

3.3.20 Elevation 8 – South West Courtyard

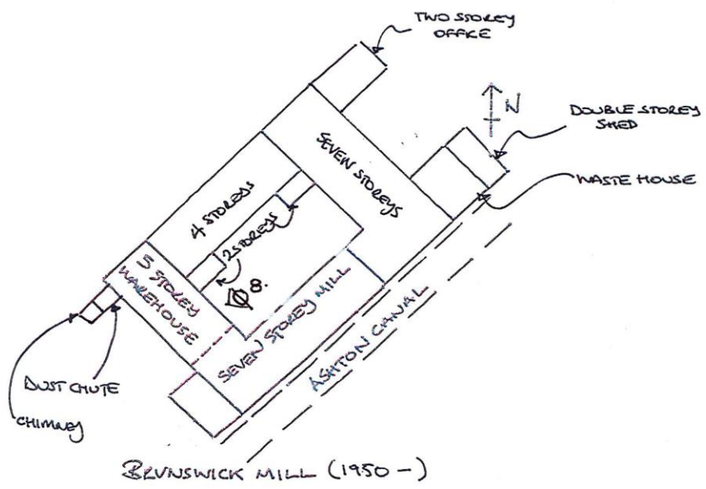

Figure 92: Elevation 8 Key Plan

The following should be read in conjunction with Civic Engineers sketches presented in Appendix A – Structural Investigation Notes.

Elevation 8 is generally in reasonable condition with no signs of major structural distress. The following were noted to be areas of consideration as part of the proposed works.

Lower level lintels appear to generally in a poor condition compared to those at higher levels. They present significant amounts of spalling with vertical cracks also. Small localised cracking can be seen in the masonry panels which is concurrent with the poor condition of lintels. Refer to figure 92**.**

There is a general loss of masonry pointing throughout with some areas of spalled and missing masonry units and vegetation growth in the parapet.

There is general cracking to lintels throughout. Approximately 20% of lintels are cracked.

See attached sketch mark-ups for specific locations of the damages in Appendix A.

Figure 92 Localised Cracking to Masonry Panel and Lintels of Poor Condition

4. Recommended Remedial Works

A series of remedial works are presented and discussed below to address those items raised within this report. These are proposed to support the listed building application for this development.

The remedial works suggested are as follows:

4.1 Lintel Failures

As described most elevations present failed lintels over openings which will be addressed. At present it is estimated that circa 20% of all lintels require attention and are showing signs of structural distress. See figures below showing typical lintel failures.

Figure 93: Typical Lintel Failure

A sympathetic approach to repair to retain structure where possible is proposed to address these issues. Repair in the form of proprietary concrete repair mortars is proposed to those lintels which present minor cracking and present no evidence of masonry disturbance above. An indicative sketch of this is shown below in figure 94.

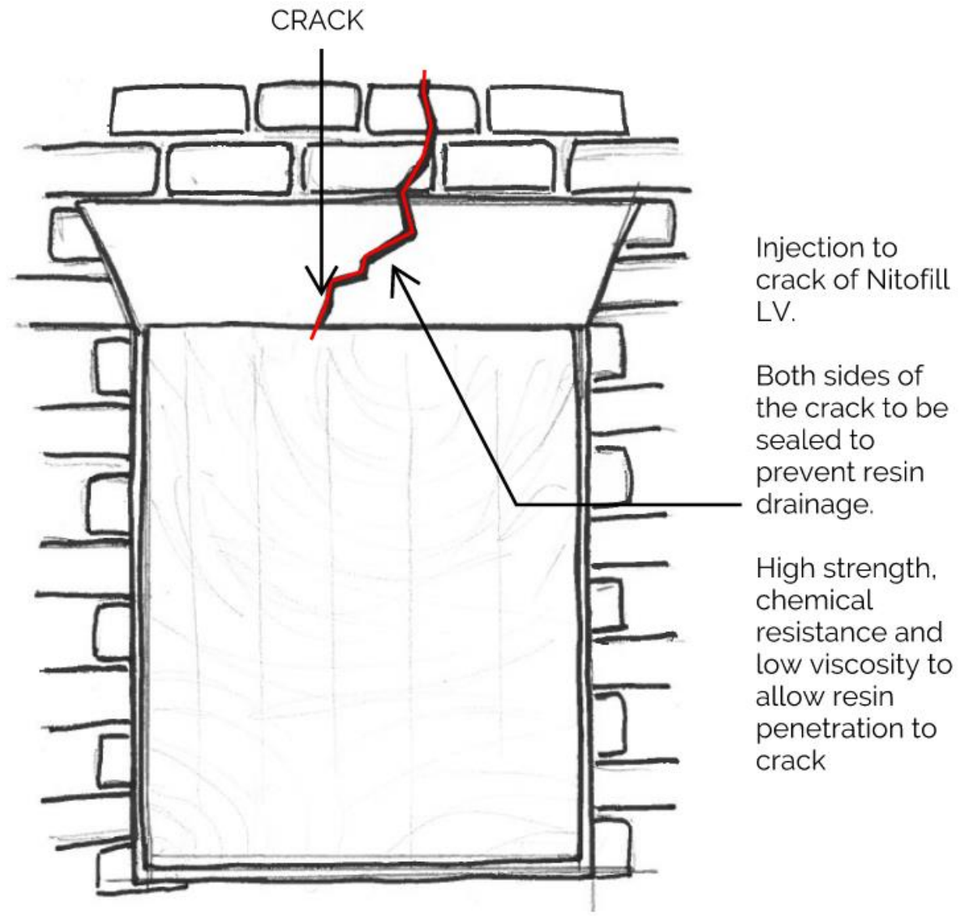

Figure 94: Typical Lintel Repair

In areas of more significant structural distress, for instance figure 93, a programme of lintel replacement should be adopted. In this instance the lintel can be seen to have sheared, causing the masonry above to drop and crack. In this instance a new lintel would be required.

A schedule of lintel repairs and replacement should be produced in future design stages to identify the level of works required to specific occurrences.

4.2 Brickwork Repair

The mill presents various areas of masonry cracking, including those associated with failed concrete lintels, See figure 95.

Cracking to masonry should be addressed using a proprietary brickwork repair and tie system. An indicative sketch of this is shown figure 96.

Figure 95: Cracked Masonry on External Elevation

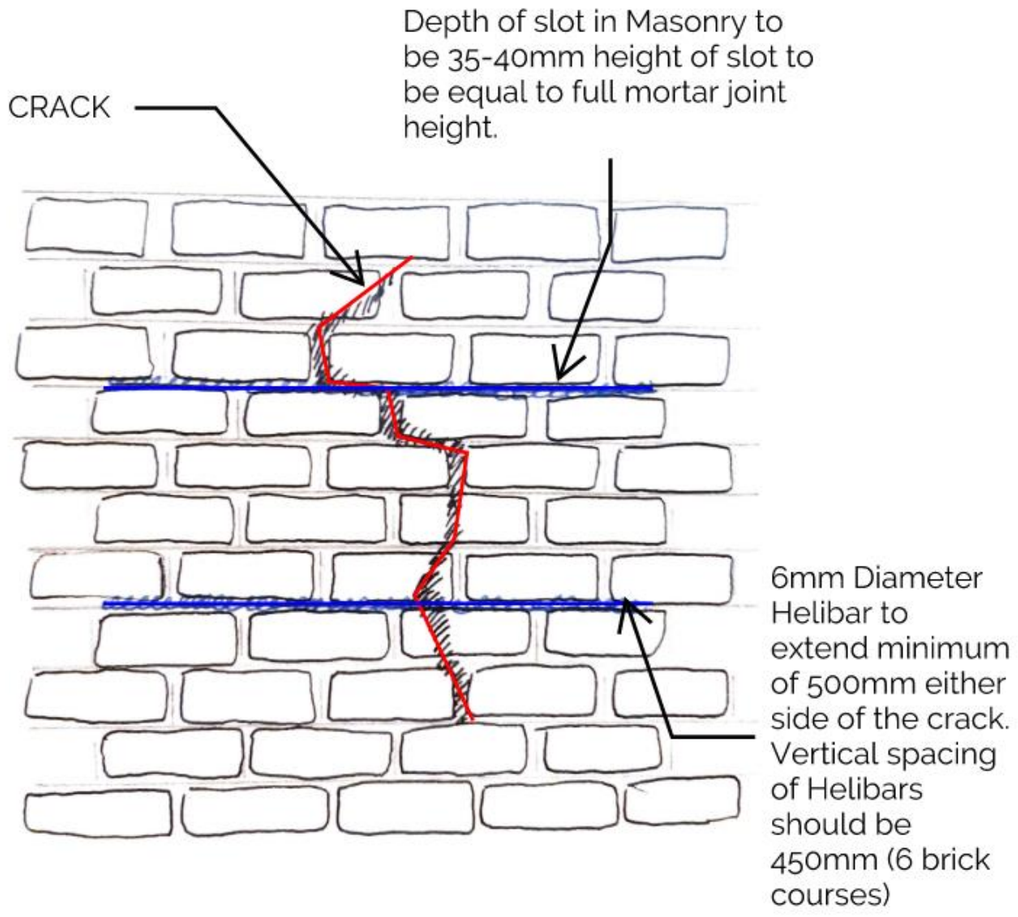

Figure 96: Indicative Crack Repair Detail

Depending on the type and location of crack different methods of crack stitching may be adopted. A schedule of cracking should be produced in future design stages to identify the level of works required to specific occurrences with input from a specialist.

4.3 General Masonry Repair and Pointing

Throughout the structure there is a general loss of masonry units and pointing within the bed joints. A general strategy of unit replacement and bed joint repointing, where necessary, should be allowed for.

A schedule of brickwork condition should be produced in future design stages to identify the level of works required to specific occurrences.

Figure 97: Masonry loss of pointing on External Elevation

5. Conclusions and Next Steps

Civic Engineers visited Brunswick Mill to carry out a Structural Appraisal of the existing structure on Wednesday 17th February 2021. This site walkover was carried out to report on the structural form and condition of the building to support a planning application to Manchester City Council for the redevelopment of the site to residential apartments.

The main findings of this report and subsequent proposals for the appropriate next steps which relate to the structural integrity of the building are as follows.

- The mill is generally in fair condition though will need attention to rectify and address certain elements.
- No movement joints within the masonry walls were observed.
- There is substantial cracking to lintels on all elevations. Cracks are observed on approximately 20% of all lintels. A lintel schedule should be prepared during future stages of the design to identify lintels which need either replacing or repair. A proprietary method of repair to address these areas is offered within this report within section 4.
- Associated cracking of brickwork is evident which includes those as a result of the failure and cracking of various lintels. A masonry specialist should be consulted to discuss possible repair options to areas of cracked masonry. A proprietary method of repair to address these areas is offered within this report.
- There is a general loss of brickwork units and pointing on all elevations. A schedule should be developed to identify those areas which require repointing. A proprietary method of repair to address these areas is offered within this report.
- There is general overgrowth of vegetation across the parapets on all elevations. This should be addressed to avoid damage, or in some instances prevent further damage to masonry.
- Internally there are large amounts of water damage to masonry soffits, walls and structural cast iron beams and columns. This is associated with poor roof drainage, broken and or missing windows, missing masonry units and a general lack of waterproofing and insulation. Plaster to soffits should be removed to understand condition of masonry arches underneath to prepare a schedule of repair.
- Material testing should be carried out on the cast iron sections to understand material composition and subsequent structural capacities and also residual capacities where sections have been damaged by water ingress.
- Depending on the proposals for redevelopment local opening up of foundations may be required to ascertain type and formation level.
- The observed drop in rear wall should be studied in further detail to understand possible causes. One possibility could be the failure of canal wall in this area. This could lead to washing out of fines within the supporting sub soil and hence a drop in structure. Although cracking of masonry has occurred due to this drop in level, there are no initial concerns with the structural integrity of the building because of this.
- In areas of reinforced concrete construction spalling and associated corrosion of reinforcement is evident. A strategy for concrete and reinforcement repair will need to be prepared to ensure the integrity and longevity of these areas of structure though it may be that replacement is the only feasible option due to the current state of disrepair.
- Within the staircases the existing stonework treads will need to be investigated further. Capping screed has most likely been added to address wear of the historic treads and to restore levels. The stone treads should be checked to ensure structural integrity.
- There is currently no additional fire protection to cast iron structure, steel structure or masonry jack arches. Depending on architectural intent and fire strategy this will need to be addressed either through sufficient fire boarding or intumescent painting to achieve required fire ratings. A specialist should be consulted to determine the fire rating of masonry jack arches.

The intention to convert the mill to residential apartments will need to be studied in detail with regards to load. Historic Codes of Practice would suggest that the design live load for structures of this nature is typically low and less than contemporary loading residential purposes. However, observing the first-floor rehearsal studios, which could be reasoned to impose similar loads to that of a residential space i.e., a regular grid of partitions with similar floor loading. The proposal for a conversion will most likely be feasible on the existing floor plates.

Although the current mill has been used for some time with no major signs of structural distress it would be necessary to further review the structural arrangement of all levels. Further investigations will be required to assess any impact on the superstructure and supporting foundations to ascertain their load carrying capacity.

This could be carried out in one of the following ways

- Opening up of all structural elements where not already observed, detailed survey of structural sizes and possible material sampling and testing to back calculate capacities. Trial pits would also be required to confirm foundation arrangement and ensure the capacity of these and the underlying subsoil would not be exceeded. A Phase II Site Investigation would supplement the above by testing of the soil to confirm bearing capacities.
- Historical Codes of Practice, applicable at the time of construction of Brunswick Mill can be researched and studied to understand the loads the building will have once been designed for, providing it can be confirmed the main structural elements are of original construction. These loads can then be compared with the current Codes of Practice for the prescribed residential loading to observe any change.

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