



STRUCTURAL REPORT
Carriage Shed, Buckley Wells Locomotive Works
Baron Street
Bury
for
East Lancashire Railway
Job No. 12889

Executive Summary

Booth King Partnership Limited attended the Carriage Shed on 4th February 2019 for a duration of 10 working days and undertook the structural inspection of the structural elements. Inspection for rot and infestation is a specialist field and is therefore outside the scope of this report. However, the findings for this can be found in the Timber Specialist's report along with supporting documentation in the Architect's report.

The defects which are apparent to the carriage shed are predominantly a result of prolonged water ingress issues. These water ingress issues have affected the following areas of the building;

- The bearing of the truss bottom chords either in external walls or at valley locations
- The bearing of purlins either in external gable walls or changes in roof profile
- Various issues associated with the valley beams below the defective valley gutter detail.
- A large percentage of the main rafters are showing signs of decay.
- A large percentage of the rooflight members are showing signs of decay.
- The deterioration of the pointing and brickwork locally to all elevations except for the West elevation which is extensive.

Over the life time of the building the above defects have become apparent and numerous forms of repairs have taken place some of which are acceptable and others which are not.

Basically, the slate roof, rooflights and rainwater system which forms the carriage shed roof have come to the end of their serviceable life and must be replaced to prevent further deterioration of the major structural elements.

We have produced a tally chart which summaries the quantity of defects across the entire carriage shed local to each truss which can be found in Appendix J.

Other defects which have been witnessed are weathered brickwork, defective rain water goods, poor connections to the below ground drainage system, minor corrosion to the base of the steel gantry crane columns and the head of cast iron columns, undersized timber members in various locations.

The ground floor concrete slabs across the shed are functional and not showing any major signs or deterioration and will require little remedial measures if any.

The service pit between the rail tracks are also in good condition and require little remedial measures if any.

The gantry crane steelwork is generally in good condition apart from the protective paint finish which needs to be addressed to increase the longevity of the structure.

The office building is generally in condition with respect to the external masonry and the roof structure and will require minimum intervention. However, the first floor overall is inadequate and must be replaced or strengthened. The non-original internal masonry / door infills also need to be addressed.

This report should be read in conjunction with the Architects and Timber Specialists reports.

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Carriage Shed Buckley Wells Locomotive Works.

Introduction.

Booth King Partnership Limited have been appointed by The East Lancashire Railway to provide a report on the Carriage Shed, Buckley Wells Locomotive works, Baron Street, Bury to support the application for Heritage Lottery Funding.

We received our brief during the initial and subsequent site walkovers on 17th May 2018 and 8th January 2019. It was agreed by all parties that the survey works would commence early February 2019.

On the 4th February 2019 for a duration of two full working weeks Booth King Partnership Limited in conjunction with Equilibrium Architects and Timberwise the Timber Specialists carried out the inspection of the carriage shed with the aim to provide a concise depiction of the current condition of the structure to allow costs for the restoration works to be quantified.

During the period of the inspection non-intrusive visual observations into the condition of the exposed and readily accessible, structural load bearing elements of the building were recorded. Intrusive investigations were not carried out to confirm thicknesses of cast iron columns, reinforcement content of slabs and pit walls as it is not the intent to change the loadings from that of the current construction.

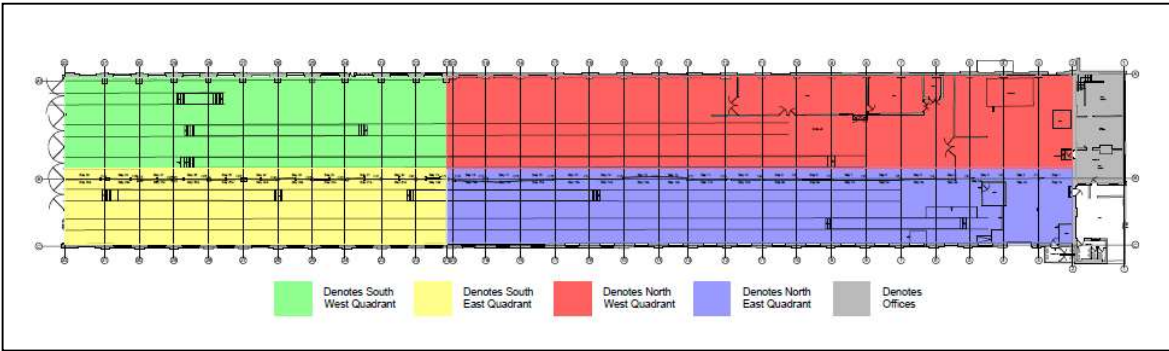
The building is currently operational and in a state of disrepair. The inspection of the building was limited to the areas considered to be safe and easily accessible either by ladder or mechanical access equipment.

The inspection did not cover drainage items, rain water systems, finishes or any other aspect which do not form part of the load bearing structure.

In the brief we have been asked to comment specifically upon;

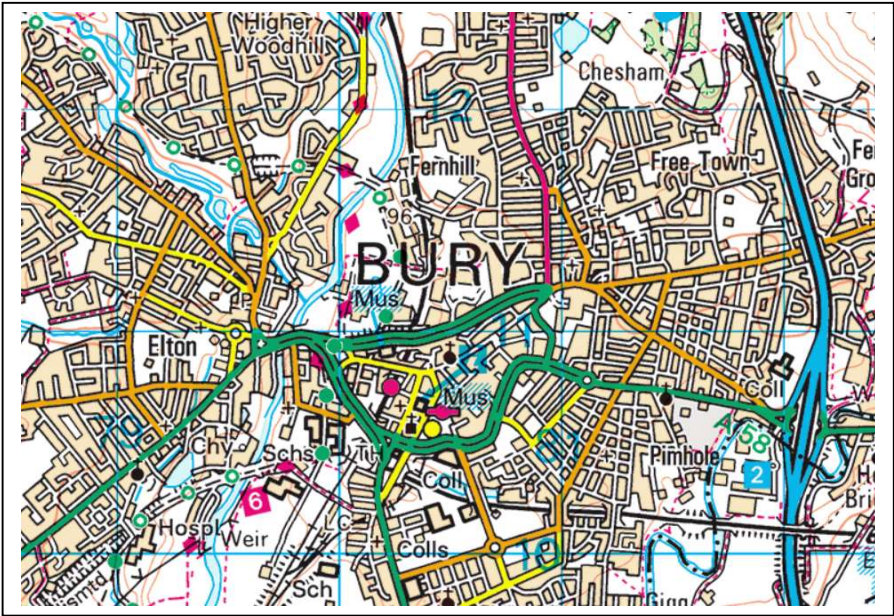
- The general condition of the masonry walls both internally and externally.
- The condition of the timber roof trusses, purlins, rafters and all other load bearing timber elements which form part of the roof structure.
- The condition of the load bearing columns. (Excluding the gantry crane structure)
- The condition of the internal floor slabs and railway pits.

For the purposes of the report, the building will be described in four parts, the North West quadrant (red), North East Quadrant (purple), South West Quadrant (green) and South East Quadrant (yellow). All four quadrants forming the Carriage Shed.

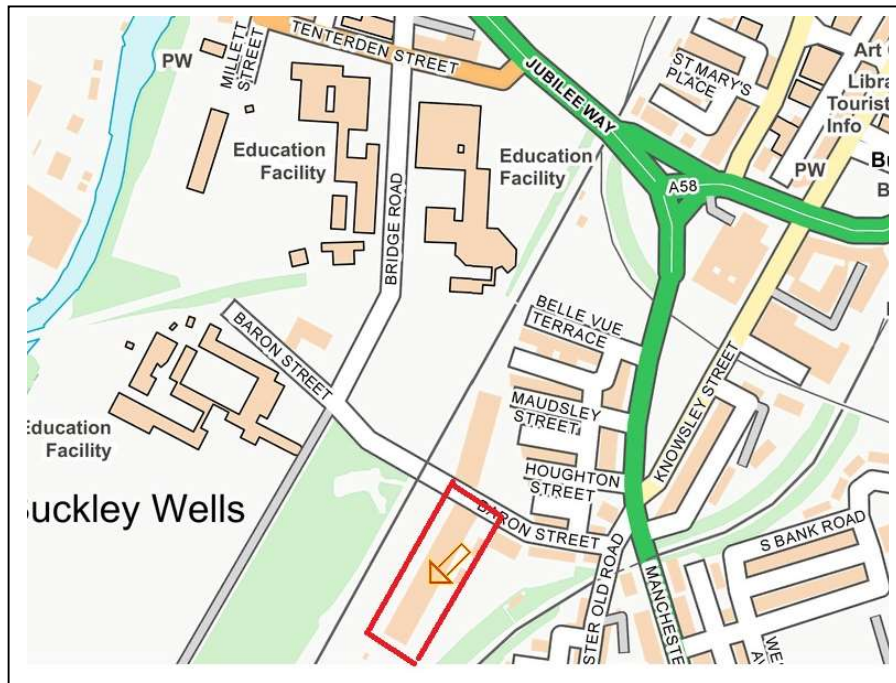


Building Quadrant Key.

Location



General Location Plan, Bury, Greater Manchester (Above).



Exact Location Plan (outlined in red above).

History

The carriage shed at Buckley wells Locomotive Works was built in 1856. It was built by J S Perring for the East Lancashire Railway Company. It is the oldest surviving railway workshop and probably the only example still in use.

The shed has altered over the years. The Engine shed to the West of the Carriage Shed was demolished and the New East side of the Carriage shed constructed. Further alterations over the years have taken place with the length of the carriage shed reduced and a new modern structure incorporated into the South elevation.

Assessment of the Existing Structure.

Booth King Partnership Limited attended the Carriage Shed on 4th February 2019 for a duration of 10 working days and undertook the structural inspection of the structural elements listed above. No opening up works were carried out and no samples were taken for testing. Inspection for rot and infestation is a specialist field and is therefore outside the scope of this report. However, the findings for this can be found in the Timber Specialist's report along with supporting documentation in the Architect's report.

The inspection consisted of a walkaround of the perimeter of the building, where accessible, for a visual inspection of the elevations. The internal inspection adopted two approaches a walkaround to visually inspect at low level areas and mechanical access to inspect the high-level areas of the building.

Observations.

The overall impression of the Carriage Shed is that it was a high-quality impressive building at the time of its construction, but due to its age, in excess of 160 years, the building is now showing numerous signs of distress.

The building is typical of its time with thick masonry walls and a timber pitched slated roof. Lateral stability is presumed to be provided by the main thick masonry walls to both the East and West elevations and the return gable wall to the North elevation. To the South elevation the shed has been reduced in length at some point and a new modern (1970's) clad structure incorporating steelwork wind girders has been introduced which span the full width of each quadrant and transfer the loads back into the side masonry walls.

There are various issues which are contributing to the overall dilapidation of the building, most of which can be attributed to water ingress due to defective gutters, flashings and the general condition of the slated roof and glass rooflights.

In the next sections, we summarise our observations.

General

The shed has a long rectangular plan under a two-span roof in the East West direction. The length is formed with 29 structural bays, 11 of which at the South end are the higher bays, with pilastered side masonry walls with brick corbel tables to frieze in each bay portion and a continuous corbel table above as an additional feature. To the Southerly end of the shed in the high bay area the masonry walls house large segmental headed windows in each bay of the West elevation. On the opposite East elevation, the large segmental headed windows can be found in 27 of the 29 bays, one of these bays being utilised as an entrance doorway.

The central valley between the East and West roof pitches is formed by a structural timber beam supported by cast iron columns which coincide with each timber truss. The shorter span (East) formed using king post roof trusses with internal struts, the larger span (West) formed with a combination of Queen Post or Queen-bolt collar trusses with two internal struts to either side and a

King Post detail from the collar to the ridge. All roof slopes have canted purlins which support the main rafters.

The carriage shed roof also adopts a functional rooflight feature which can be found on the Western roof slope of the East roof and both roof slopes of the West roof in the Northerly quadrants, this changes in the Southerly higher bay quadrants where the rooflights are only present on the internal facing roof slopes, these rooflights forming an integral part of the building.

The Carriage shed is Grade II listed under the Planning Act 1990 for its special Architectural and historic interest.

North West Quadrant.

The North West quadrant roof is formed with a combination of Queen post and Queen bolt roof trusses with two internal diagonal struts and two internal vertical ties. The North West Quadrant is made up of 18 trusses in total and we have recorded our findings below and in Appendix A

Truss 1.

This truss has an existing repair detail at its bearing in the West external wall, we presume the repair was required due to historic water ingress issues. The truss eaves connection detail East at the central valley (B3) has failed in shear due to decay. This defect is a result of a defective valley gutter resulting in extensive decay of the bottom chord. Refer to Timber Specialist report for remedial details.

The top surface of the bottom chord at mid span is showing signs of decay.

The entire truss has a twist where the top and bottom chord are no longer in-line.

The central timber member which ties the heads of all the columns and provides the bearing for the trusses is showing signs of decay at either end. The lap joint at the head of the column has been constructed incorrectly originally as the member is too short, it is also showing signs of decay.

Two purlins in bay 1 (P5 and P6) are showing signs of decay at the bearing in the gable wall due to water ingress issues. Refer to Timber Specialists report for remedial details.

Truss 2

At the time of the visual inspection no signs of decay were apparent to any of the structural members.

Truss 3

At the time of the visual inspection no signs of decay were apparent to any of the structural members, however the existing bearing repair detail is inadequate, a full timber repair is required before the temporary scaffold support can be removed

Refer to Timber Specialists report for remedial details.

Truss 4

At the time of the visual inspection no signs of decay were apparent to any of the structural members, however the internal members and vertical tie rods of the truss are loose and not working as intended.

Truss 5

This truss has an existing repair detail at the bearing in the West wall, we presume the repair was required due to historic water ingress issues. The existing bearing repair detail is inadequate a full timber repair will be required before the bracket detail and existing timber prop can be removed.

Due to this existing repair the truss is also showing signs of movement, lozengeing as the internal timber members along with the vertical tie bars are loose and not working as intended.

Truss 6

At the time of the visual inspection no signs of decay were apparent to any of the structural members, however the truss is showing signs of movement, lozengeing as the internal members and vertical tie rods of the truss are loose and not working as intended.

Truss 7

At the time of the visual inspection no signs of decay were apparent to any of the structural members, however the truss bearing in the West wall has an existing scarf joint repair, we presume the repair was required due to historic water ingress issues. Due to this existing repair, the truss is also showing signs of movement, lozengeing as the internal timber members along with the vertical tie bars are loose and not working as intended.

Truss 8

At the time of the visual inspection no signs of decay were apparent to any of the structural members, however the truss is showing signs of movement, lozengeing as the internal members and vertical tie rods of the truss are loose and not working as intended.

Truss 9

The truss bearing in the West wall has an existing scarf joint repair which is showing signs of decay due to prolonged water ingress issues at the rainwater pipe location. Due to this defect the bearing of the purlin (P1) is also showing signs of decay. Refer to Timber Specialist report for remedial details.

As a result of this existing repair, the truss is also showing signs of movement, lozengeing as the internal timber members along with the vertical tie bars are loose and not working as intended. In one instance a strut is completely missing.

Truss 10

At the time of the visual inspection no signs of decay were apparent to any of the structural members, however the truss bearing in the West wall has an existing scarf joint repair, we presume the repair was required due to historic water ingress issues. Due to this existing repair, the truss is also showing signs of movement, lozengeing as the internal timber members along with the vertical tie bars are loose and not working as intended.

Truss 11

At the time of the visual inspection no signs of decay were apparent to any of the structural members, however the truss bearing in the West wall has an existing scarf joint repair, we presume the repair was required due to historic water ingress issues. Due to this existing repair, the truss is also showing signs of movement, lozengeing as the internal timber members along with the vertical tie bars are loose and not working as intended. In one instance a strut is completely missing.

Below the truss bearing in the West wall a small portion of brickwork has spalled due to water ingress issues.

Truss 12

At the time of the visual inspection no structural issues were apparent with any of the structural members.

Truss 13

In the two adjoining bays (13/14) the slate roof and parging has been replaced with a felt and slate system, this truss has an existing repair detail at its bearing in the West wall. We presumed these repairs were required due to historic water ingress issues.

Truss 14

This truss has an existing repair detail at its bearing in the West wall. We presumed these repairs were required due to historic water ingress issues.

The truss eaves connection detail at the central valley (B16) has failed in shear due to decay. This defect is a result of a defective valley gutter resulting in extensive decay of the bottom chord. Refer to Timber Specialist report for remedial details.

Truss 15

This truss has an existing repair detail at its bearing to the East above the central valley, this repair appears to be relatively new. We presume the repair was required due to historic water ingress issues due to a defective valley gutter and rainwater hopper detail.

Where the truss interfaces with the West wall the truss is showing signs of decay and a repair is required.

As with the truss bearing, the purlins (P1/P2) to the West are also showing signs of decay at their bearing.

Truss 16

At the time of the visual inspection no signs of decay were apparent to any of the structural members, however the truss bearing in the West wall has an existing scarf joint repair, we presume the repair was required due to historic water ingress issues.

Truss 17

At the time of the visual inspection no signs of decay were apparent to any of the structural members, however the truss has existing repairs to both bearings. We presume the repair was required due to historic water ingress issues. The existing repair detail to the West bearing is inadequate by inspection. Due to inadequacy of the repair the truss is showing signs of movement, lozenging as the internal timber members along with the vertical tie bars are loose and not working as intended.

At the East bearing above the central valley, a much more robust repair detail has been adopted. New sections of timber have been spliced to both the top and bottom chords of the truss using thin steel plate either side of the timber members which are through bolted.

Truss 18 HAZARD! URGENT ATTENTION REQUIRED

The configuration to this truss has changed as the purlins no longer notch over the top chord of the truss, purlin blocks have been adopted. At the lowest purlin position (P1) the purlin is suspended taking zero support for the truss. This defect requires immediate attention!

In addition to the above at the same location a timber “wedge” has been forced below the truss bearing in the West wall. This is showing signs of decay along with the bottom chord of the truss, repairs will be required, refer to Timber Specialists report for remedial detail.

South West Quadrant.

The South West quadrant roof is formed with a combination of Queen post and Queen bolt roof trusses with two internal diagonal struts and two internal vertical ties. The South West Quadrant is made up of 11 trusses in total and we have recorded our findings below and in Appendix B

Truss 19

At the time of the visual inspection no signs of decay were apparent to any of the structural members, however the relatively new valley gutter boarding and valley beam are saturated due to a defective valley gutter.

Truss 20

At the time of the visual inspection no signs of decay were apparent to any of the structural members, however the relatively new valley gutter boarding and valley beam are saturated due to a defective valley gutter.

Truss 21

This truss has an existing repair details at both bearings. The West bearing remedial detail utilising rolled steel angles (RSA's) 150x90x10 with M16 through bolts, by inspection this detail is inadequate and will require a new remedial detail. Refer to the Timber Specialists report for remedial details

At the opposite East end a much more robust repair detail has been adopted, new sections of timber have been spliced to both the top and bottom chords of the truss using thin steel plate either side of the timber members which are through bolted.

Truss 22

This truss has existing repair details at both bearings. The West bearing remedial detail utilising rolled steel angles (RSA's) 150x90x10 with M16 through bolts, by inspection this detail is inadequate and will require a new remedial detail. Refer to the Timber Specialists report for remedial details

At the opposite East end, a much more robust repair detail has been adopted, new sections of timber have been spliced to both the top and bottom chords of the truss using thin steel plate either side of the timber members which are through bolted.

Truss 23

This truss has an existing remedial detail at the West bearing which utilises rolled steel angles (RSA's) 150x90x10 with M16 through bolts. By inspection, this detail is inadequate and will require a new remedial detail. Refer to the Timber Specialists report for remedial details.

Truss 24

This truss has existing repair details at both bearings. The West bearing remedial detail utilising rolled steel angles (RSA's) 150x90x10 with M16 through bolts. By inspection, this detail is inadequate and will require a new remedial detail. Refer to the Timber Specialist report for remedial details.

At the opposite East end, a much more robust repair detail has been adopted, new sections of timber have been spliced to both the top and bottom chords of the truss using thin steel plate either side of the timber members which are through bolted.

Truss 25

This truss has existing repair details at both bearings. The West bearing remedial detail utilising rolled steel angles (RSA's) 150x90x10 with M16 through bolts; by inspection this detail is inadequate and will require a new remedial detail. Refer to the Timber Specialist report for remedial details.

At the opposite East end, a much more robust repair detail has been adopted, new sections of timber have been spliced to both the top and bottom chords of the truss using thin steel plate either side of the timber members which are through bolted.

It should be noted that several rafters and a purlin have recently been replaced which are showing continued signs of water ingress.

Truss 26

This truss has existing repair details at the West bearing, the remedial detail utilising rolled steel angles (RSA's) 150x90x10 with M16 through bolts, by inspection this detail is inadequate and will require a new remedial detail. Refer to the Timber Specialist report for remedial details.

At the opposite East end, a much more robust repair detail has been adopted, new sections of timber have been spliced to both the top and bottom chords of the truss using thin steel plate either side of the timber members which are through bolted.

Truss 27

This truss has existing repair details at the West bearing, the remedial detail utilising rolled steel angles (RSA's) 150x90x10 with M16 through bolts, by inspection this detail is inadequate and will require a new remedial detail. Refer to the Timber Specialist report for remedial details.

At the opposite East end, a much more robust repair detail has been adopted, new sections of timber have been spliced to both the top and bottom chords of the truss using thin steel plate either side of the timber members which are through bolted.

It should be noted that several rafter feet have been replaced to the West elevation and the entire bay (27) of rooflight glazing members have also been replaced.

Truss 28

This truss has existing repair details at the West bearing, the remedial detail utilising rolled steel angles (RSA's) 150x90x10 with M16 through bolts, by inspection this detail is inadequate and will require a new remedial detail. Refer to the Timber Specialist report for remedial details.

At the opposite East end of the truss is showing signs of water ingress with staining of the timber. The ingress of water is evident at both the valley gutter and rooflight locations. The purlin (P18) below the rooflights and the rooflight glazing members have extensive decay and the entire bay (27) will need to be replaced.

Truss 29 HAZARD! URGENT ATTENTION REQUIRED

The truss bearing in the West external wall and the end of purlin (P13) is showing signs of extensive decay due to prolonged water ingress from the defective cladding system. This defect requires immediate attention and restricted access imposed on the flat roof area until a temporary or permanent solution is in place.

Due to the defective cladding i.e. side flashing missing the internal masonry is saturated at high level.

South East Quadrant.

The South East quadrant roof is formed with King post trusses with two internal diagonal struts. The South East Quadrant is made up of 11 trusses in total and we have recorded our findings below and in Appendix C

Truss 30

The truss bearing in the East external wall has extensive decay, the wallplate and rafter feet at the top of the wall are saturated and showing signs of extensive decay for the entire bay (28a). The above defects are a result of a defective parapet gutter, not only has this defective gutter affected the timber elements it has also saturated the internal face of the brickwork wall which has extensive mold coverage. Refer to Timber Specialist report for remedial details.

To the opposite West end of the truss new gutter boarding and valley beam have been introduced this is presumed to be due to prolonged water ingress issues due to a defective valley gutter. Even though these repairs have taken place the valley beam is still showing signs of water ingress.

Truss 31

This truss has an existing repair detail at the East bearing, the remedial detail utilises railway track with metal plate strapping at three locations, by inspection this detail is inadequate and will require a new remedial detail. Refer to the Timber Specialist report for remedial details.

To the opposite West end of the truss new gutter boarding and valley beam have been introduced this is presumed to be due to prolonged water ingress issues due to a defective valley gutter. Even though these repairs have taken place the valley beam is still showing signs of water ingress.

Truss 32

This truss has an existing repair detail at the East bearing, the remedial detail utilises railway track with metal plate strapping at three locations, by inspection this detail is inadequate and will require a new remedial detail. Due to the inadequacy of the repair the truss is showing signs of movement, lozenging as the internal timber members are loose and not working as intended. Refer to the Timber Specialist report for remedial details.

The wallplate and rafter feet at the top of the wall are also saturated and showing signs of extensive decay for the entire bay (26a). The above defects are a result of a defective parapet gutter, not only has this defective gutter affected the timber elements it has also saturated the internal face of the brickwork wall which has extensive mold coverage.

To the opposite West end of the truss new gutter boarding, valley beam and rafters have been introduced this is presumed to be due to prolonged water ingress issues due to a defective valley gutter. Even though these repairs have taken place the valley beam is still showing signs of water ingress.

Truss 33

This truss has an existing repair detail at the East bearing, the remedial detail utilises railway track with metal plate strapping at three locations, by inspection this detail is inadequate and will require a new remedial detail. Refer to the Timber Specialist report for remedial details.

To the opposite West end of the truss new gutter boarding, valley beam and rafters have been introduced this is presumed to be due to prolonged water ingress issues due to a defective valley gutter. Even though these repairs have taken place the valley beam is still showing signs of water ingress.

Truss 34

This truss has an existing repair detail at the East bearing, the remedial detail utilises railway track with metal plate strapping at three locations, by inspection this detail is inadequate and will require a new remedial detail. Refer to the Timber Specialist report for remedial details.

The wallplate and rafter feet at the top of the wall are also saturated for the entire bay (24a). The above defects are a result of a defective parapet gutter, not only has this defective gutter affected the timber elements it has also saturated the internal face of the brickwork wall which has extensive mold coverage and localised spalled bricks at high level.

Truss 35

This truss has an existing repair detail at the East bearing, the remedial detail utilises railway track with metal plate strapping at three locations, by inspection this detail is inadequate and will require a new remedial detail. Refer to the Timber Specialist report for remedial details.

The wallplate and rafter feet at the top of the wall are also saturated for the entire bay (24a). The above defects are a result of a defective parapet gutter, not only has this defective gutter affected the timber elements it has also saturated the internal face of the brickwork wall which has extensive mold coverage and localised spalled bricks at high level.

At the opposite West end, a much more robust repair detail has been adopted, new sections of timber have been spliced to both the top and bottom chords of the truss using thin steel plate either side of the timber members which are through bolted.

New gutter boarding, valley beam and rafters have been introduced, this is presumed to be due to historic water ingress issues due to a defective valley gutter. Even though these repairs have taken place the valley beam is still showing signs of water ingress.

Truss 36

This truss has an existing repair detail at the East bearing, the remedial detail utilises railway track with metal plate strapping at three locations, by inspection this detail is inadequate and will require a new remedial detail. The lowest 6"x3" purlin in bay 22a is showing signs of overstress with large deflections visible this will need to be replaced as a check calculation has confirmed the purlin is undersized. Refer to the Timber Specialist report for remedial details.

The defective parapet gutter, is the main cause for the corrosion to the current truss bearing remedial detail, not only has this defective gutter affected the truss it has also saturated the internal face of the brickwork wall which has extensive mold coverage and localised spalled bricks at high level.

At the opposite West end, new gutter boarding and valley beam have been introduced this is presumed to be due to prolonged water ingress issues due to a defective valley gutter. Even though this repair has taken place the valley beam and gutter boarding are still showing signs of water ingress.

Truss 37

This truss has an existing repair detail at the East bearing, the remedial detail utilises railway track with metal plate strapping at three locations, by inspection this detail is inadequate and will require a new remedial detail. The lowest 6"x4" purlin in bay 21a is showing signs of overstress with large deflections visible this will need to be replaced as a check calculation has confirmed the purlin is undersized. Refer to the Timber Specialist report for remedial details.

The defective parapet gutter, is the main cause for the corrosion to the current truss bearing remedial detail, not only has this defective gutter affected the truss it has also saturated the internal face of the brickwork wall which has extensive mold coverage.

At the opposite West end, a much more robust repair detail has been adopted, new sections of timber have been spliced to both the top and bottom chords of the truss using thin steel plate either side of the timber members are through bolted. During the time of these repairs the truss has suffered minor movement, lozenging as the internal timber members are loose and not working as intended.

New gutter boarding and valley beam have been introduced, this is presumed to be due to prolonged water ingress issues due to a defective valley gutter. Even though these repairs have taken place the valley beam is still showing signs of water ingress.

Truss 38

This truss has an existing repair detail at the East bearing, the remedial detail utilises railway track with metal plate strapping at three locations, by inspection this detail is inadequate and will require a new remedial detail. The lowest 6"x3" purlin in bay 20a is showing signs of overstress with large deflections visible this will need to be replaced as a check calculation has confirmed the purlin is undersized. Refer to the Timber Specialist report for remedial details.

The defective parapet gutter, is the main cause for the corrosion to the current truss bearing remedial detail, not only has this defective gutter affected the truss it has also saturated the internal face of the brickwork wall which has extensive mold coverage.

At the opposite West end, a much more robust repair detail has been adopted, new sections of timber have been spliced to both the top and bottom chords of the truss using thin steel plate either side of the timber members are through bolted. During the time of these repairs the truss has suffered minor movement, lozenging as the internal timber members are loose and not working as intended.

New gutter boarding and valley beam have been introduced; this is presumed to be due to historic water ingress issues due to a defective valley gutter. Even though these repairs have taken place the valley beam is still showing signs of water ingress.

Truss 39

This truss has an existing repair detail at the East bearing, the remedial detail utilises railway track with metal plate strapping at three locations, by inspection this detail is inadequate and will require a new remedial detail. The lowest 6"x3" purlin in bay 19a is showing signs of overstress with large deflections visible this will need to be replaced as a check calculation has confirmed the purlin is undersized. Refer to the Timber Specialist report for remedial details.

The defective parapet gutter, is the main cause for the corrosion to the current truss bearing remedial detail, not only has this defective gutter affected the truss it has also saturated the internal face of the brickwork wall which has extensive mold coverage.

Truss 40

The defective parapet gutter and disconnected rainwater pipe are the main cause for the saturated internal face of the brickwork wall which has extensive mold coverage.

At the opposite West end new gutter boarding and valley beam have been introduced, this is presumed to be due to historic water ingress issues due to a defective valley gutter. Even though these repairs have taken place the valley beam is saturated, and the rafter feet in this bay (19a) have signs of decay. Refer to the Timber Specialist report for remedial details.

North East Quadrant.

The North East quadrant roof is formed with King post trusses with two internal diagonal struts. The South East Quadrant is made up of 18 trusses in total and we have recorded our findings below and in Appendix D

Truss 41

At the time of the visual inspection no signs of decay were apparent to any of the structural members, however there are continued, and historic signs of water ingress from the valley gutter. These areas have recent repairs with a new valley beam and gutter boarding.

The column (C18) at the valley location which supports trusses 18 and 41 has a concrete surround detail at the base, we have been advised by East Lancashire Railway this column had extensive decay, unfortunately this could not be inspected therefore further intrusive investigations at this location will be required.

Truss 42

At the time of the visual inspection no structural issues were apparent with any of the structural members.

At the West end, a robust repair detail has been adopted, new sections of timber have been spliced to both the top and bottom chords of the truss using thin steel plate either side of the timber members which are through bolted.

New gutter boarding, valley beam and column tie have been introduced, this is presumed to be due to historic water ingress issues due to a defective valley gutter. Even though these repairs have taken place the valley beam is still showing signs of water ingress.

Truss 43

The truss bearing in the East external wall has extensive decay, the wallplate and rafter feet at the top of the wall are saturated and are also showing signs of extensive decay for the entire bay (16a). Refer to Timber Specialist report for remedial details.

To the opposite West end of the truss new gutter boarding and valley beam have been introduced, this is presumed to be due to historic water ingress issues due to a defective valley gutter. Even though these repairs have taken place the valley beam is still showing signs of water ingress.

Truss 44

At the time of the visual inspection no structural issues were apparent with any of the structural members.

At the West end, a robust repair detail has been adopted, new sections of timber have been spliced to both the top and bottom chords of the truss using thin steel plate either side of the timber members which are through bolted.

New gutter boarding, valley beam and column ties have been introduced, this is presumed to be due to historic water ingress issues due to a defective valley gutter. Even though these repairs have taken place the valley beam is still showing signs of water ingress.

The cast iron column (C14) which supports the column tie beam and both trusses T14 & T44 has minor corrosion to the first metre.

Truss 45

The truss bearing in the East external wall has extensive decay as the bottom chord and bearing timber have both compressed. Refer to Timber Specialist report for remedial details.

To the opposite West end of the truss new gutter boarding and valley beam have been introduced, this is presumed to be due to historic water ingress issues due to a defective valley gutter. Even though these repairs have taken place the valley beam is still showing signs of water ingress.

Truss 46

At the time of the visual inspection no structural issues were apparent with any of the structural members apart from the truss bearing to the West which could not be surveyed due to fixed obstructions at eaves level.

The gutter boarding and valley beam are both showing signs of historic and continued water ingress issues due to a defective valley gutter.

Truss 47

At the time of the visual inspection no structural issues were apparent with any of the structural members apart from the truss bearing to the West which could not be surveyed due to fixed obstructions at eaves level.

The gutter boarding and valley beam are both showing signs of historic and continued water ingress issues due to a defective valley gutter which has resulted in the decay of a few rafter feet in this bay (12a).

Truss 48

The rafter feet along the valley are saturated and showing signs of decay this is for the entire bay (11a). The above defect is a result of prolonged water ingress from the defective rainwater hopper detail and valley gutter. The valley beam is showing continued signs of water ingress with watermarks on the surface.

Truss 49

At the time of the visual inspection no signs of decay were apparent to any of the structural members.

The corbel support detail to the East bearing has cracked and should be replaced. This defect could be the cause for the gap which has formed in the mortice and tenon joint to the base of the King post at the interface with the bottom chord. There are no other signs of movement in this truss.

New felted roof has been introduced in this bay (10a) this is presumed to be due to historic water ingress issues due to a defective slate roof covering. Even though these repairs have taken place the valley gutter is still showing signs of water ingress.

Truss 50- HAZARD! URGENT ATTENTION REQUIRED

At the time of the visual inspection no structural issues were apparent with most of the structural members apart from the valley beam. Due to prolonged water ingress from the defective valley gutter the valley beam has extensive decay. Because of the vast amount of decay, the timber section is overstressed which is clearly apparent with the large deflections on show. This defect requires immediate attention and restricted access imposed on the valley gutter until a temporary or permanent solution is in place. Refer to Timber Specialists report for remedial details.

Truss 51

At the time of the visual inspection no structural issues were apparent with most of the structural members apart from the rafter feet in the valley. There is evidence in bay (9a) of water ingress from a defective valley gutter with several rafter feet showing signs of decay. Refer to the Timber Specialist report for remedial details.

Truss 52 – HAZARD! URGENT ATTENTION REQUIRED

At the time of the visual inspection no structural issues were apparent with most of the structural members apart from the valley beam. Due to prolonged water ingress from the defective valley gutter the valley beam has extensive decay. Because of the vast amount of decay, the timber section is overstressed which is clearly apparent with the large deflections on show. This defect requires immediate attention and restricted access imposed on the valley gutter until a temporary or permanent solution is in place. Refer to Timber Specialists report for remedial details.

Truss 53

Minor decay to the top surface of the valley tie is apparent due to water ingress from the valley gutter. At the time of the inspection this was a non-structural defect, but treatment is required, refer to Timber Specialists report for details.

Truss 54

At the time of the visual inspection no structural issues were apparent with any of the structural members.

Truss 55

Due to immovable obstructions at ground level (train) this truss / bay was not surveyed using the cherry picker. A visual survey from ground level was performed.

At the time of the visual inspection no structural issues were apparent with any of the structural members, however the valley beam, gutter boarding is showing continued signs of water ingress.

Truss 56

At the time of the visual inspection no structural issues were apparent with any of the structural members, however the valley beam, gutter boarding and ridge repairs are showing continued signs of water ingress.

Truss 57

At the time of the visual inspection no structural issues were apparent with any of the structural members, however the valley beam and gutter boards are showing continued signs of water ingress.

Truss 58 HAZARD! URGENT ATTENTION REQUIRED

At the time of the visual inspection no structural issues were apparent with most of the structural members apart from the valley beam. Due to prolonged water ingress from the defective valley gutter the valley beam has extensive decay. Because of the vast amount of decay, the timber section is overstressed which is clearly apparent with the large deflections on show. This defect requires immediate attention and restricted access imposed on the valley gutter until a temporary or permanent solution is in place.

The masonry corbel detail to the West which provides an increased bearing area for the bottom chord of the truss has cracked and must be repaired.

The purlin (P9) which takes bearing in the gable masonry wall is showing signs of decay. Refer to the Timber Specialists report for remedial actions.

Rooflights

The carriage shed roof also adopts a functional rooflight feature which can be found on the Western roof slope of the East roof and both roof slopes of the West roof in the Northerly quadrants, this changes in the Southerly higher bay quadrants where the rooflights are only present on the internal facing roof slopes, these rooflights forming an integral part of the building.

Over the life of the building there have been issues with the rooflight where decay of the structural members due to water ingress issue has resulted, in the worst-case panes of glass falling into the shed. In these areas the glazing has been removed and repair works implemented.

Different forms of repair have taken place over the years these include removing the glazing and over boarding with a bitumen roof system to polyethene sheeting internally which doesn't address the source of the problem.

Based on the condition of the rafters / glazing members at the rooflight locations we would recommend an allowance of 25% replacement is included. The extent of the decay will only become apparent once the external slate roof covering is removed and the top surface of the timber member exposed. Refer to the Architects and Timber Specialists reports for further details.

External Masonry Elevations

There are several types of masonry defects most of which are quite minor and not detrimental to the structural performance of the building. Refer to Appendix E for photographs.

- Spalling of brickwork both internally and externally.
- Pointing
- Horizontal cracking.
 - Vegetation Growth.
 - Corrosion of embedded metal.

The two main masonry elevations are the East and West elevations. The West elevation is showing more severe signs of dilapidation towards that of the East elevation. This is understandable as the West facing elevation has generally been exposed to the worst weather conditions during its circa 160-year life.

The main defects on the West elevation are predominately spalled brickwork and loss of mortar in the bed joints. The most likely cause is frost action due to the continued dampness of the facing brickwork. In the worst locations this has resulted in whole bricks becoming detached. Once the hard face of the stock brick has spalled, the soft core is exposed and is extremely vulnerable to the elements and continued erosion.

For the extent of the repairs which are required on each elevation please refer to the Architects report, as a suggestion, the following categories for local repairs, can be adopted.

- Bricks broken or more than 50% of the section missing, remove brick and replace with new brick.
- Bricks up to 50% missing, where suitable remove brick, clean, reverse and replace.
- Fine cracks, clean and seal with appropriate sealant to prevent future damage by water ingress.

On a whole the pointing of the masonry is generally in good condition except for the North West portion of the West elevation, this has extensive loss of mortar in the bed joints and will require much of the elevation re pointing, refer to Architects report for details.

The remainder of the masonry elevations have localised instances which will require re-pointing and replacing of local bricks, further details of these instances can be found in the Architect's report.

Due to an infrequent maintenance program for the external facing brickwork, vegetation growth is apparent to the East elevation, this is in the form of self-seeding saplings and small flora.

In bay 28a we have an instance where a sapling has been allowed to root deep into the brickwork which has exerted tremendous pressure on the bed joint and developed into a large horizontal crack along most of this bay. The very existence of the vegetation in this wall illustrates the brickwork must have a high moisture content as a result of the historic issues with the parapet gutter along this East elevation. To prevent further damaged we would recommend all roots are completely removed with partial demolition of the wall if deemed necessary.

Further along this East elevation in the lower bays we have more horizontal cracking which is localised to steel pegs which have been driven into the brickwork bed joints. These pegs appear to be redundant and are coming to the end of their serviceable life, corrosion is apparent which has delaminated the steel embedded in the wall which has exerted tremendous pressure on the bed joint and developed into a horizontal crack.

At the eaves on the East Elevation to the lower bay area we have a localised instance of what can only be described as a brick slip detail, which have proceeded to fall away local to the rafter feet. This defect is exposing the timber rafters to the external elements and over time will lead to decay of these exposed timber members. Further detail on this can be found in the Architects report.

Internal Masonry Elevations

Overall the condition of the masonry internally is in good condition except for the East elevation of the South East quadrant which is saturated and has extensive mold growth. Other defects internally include spalled bricks and cracked corbel details below truss bearings.

Columns

Overall the cast iron columns in the middle of the building (gridline B) are generally in good condition with no major structural issues to report. The issues which are apparent are damaged holding down bolts at the bases to the Southern Quadrants and missing coach bolts at the head connection detail with the timber tie member in the Northern quadrants.

In one instance column C14 which supports trusses T14 and T44 has minor corrosion to the first 1.0m, this will need cleaning and the surface prepared to accept an anti-corrosion paint and the desired Architects finishes. Refer to Appendix F for photographs of each defect.

Column C1 this is a timber column which has split at the head where it connects with the timber tie member detail. Refer to Timber Specialist report for remedial detail.

Due to prolonged water ingress issues at the end of the valley gutter column C18 has decay at its base. The extent of the decay is currently unknown as the base of the column has a concrete surround detail. Further intrusive investigations at this location will be required to determine if remedial actions are required.

Floor Slabs

The types of floor construction vary across the whole shed. Most of the shed appears to have a ground bearing concrete slab construction which is showing some signs of wear which is expected due to its age. In very localised areas, the slab is showing signs of differential movement which could be potential trips hazards which will need some form of remedial repair to rectify. Refer to Appendix F for photographs and Architects report for further details.

In localised areas the floor construction changes and incorporates a timber infill detail. At the South end of the shed the timber detail (sleepers) is subject to continued wetting and drying by driving rain and the day to day activities in the shed, and this has resulted in the softening and over time the decay of these timber members which we believe are replaced on a regular basis.

Pits

All the railway pits in both sides of the shed are generally in good condition considering their age and usage. The only defect, which was apparent, was localised areas of missing brickwork in the side walls at what appeared to be the original lamp locations. Refer to Architects report and Appendix F for photographs of the condition of the pits.

The railway tracks for the locomotives extend into the carriage shed with two lanes in each side of the shed. These tracks are either side of the pits, in places the railway tracks have a timber sleeper detail which for the most part have been replaced with a concrete detail. The remaining lengths of the track which are still there adopt this timber detail and will need to be removed and replaced as the day to day operations has resulted in the softening and decay.

South Extension

Over its life the carriage shed has been altered in length, the original footprint of the shed would have been circa 50m longer than the current layout. At some point in time the length of the shed has been reduced to the present layout. At the South elevation where the main large entrance doors can be found for access and egress of the locomotives, a modern cladding, circa 1970's structure has been constructed. The condition of the steel structural elements is generally good with no defects to report. The main defects which are apparent are in relation to the external cladding which is showing signs that it has reached the end of its serviceable life and will need to be replaced. Further details on the cladding and this area of the building can be found in the Architects report.

Gantry Crane

The gantry crane in the South West quadrant of the carriage shed has a safe weight limit of 10 Tons and appears to be in good working order. The inspection of the crane itself is a specialist field and is therefore outside the scope of this report. The inspection of the gantry crane covered all load bearing elements as follows;

- The main masonry piers to the West Elevation.
- The main steel columns along gridline B.
- The overall stability of the gantry crane.

The masonry piers along gridline A1 between 21 and 31 inclusive are circa 27" inch square and are in good condition with no major defects to report. Refer to Appendix G for photographs and Architects report for further details.

The steel columns which support the gantry crane runway beams are generally in good condition with no signs of any structural defects. The main noticeable defect is the paint system is flaking away from the steelwork and will need to be cleaned down accordingly and a new paint system applied. In some locations mainly at the column bases a more aggressive clean process may be required to clean away minor corrosion prior to an anti-corrosion paint system being applied.

Office Building

The office building which is located to the North of the carriage shed is of the same construction as the main carriage shed with masonry external and internal walls, timber first floor and a timber roof formed with a single truss with purlins and rafters.

The external masonry walls appear to be in good condition with no signs of significant movement or defects. On the West elevation there is areas of spalled brickwork which is much the same as the main carriage shed brickwork along this elevation but not as severe.

The internal walls are generally ok where original but in some locations both at ground floor and first floor blockwork walls have been constructed to infill original door openings. These have been constructed to a low standard and in places will need to be demolished and rebuilt. The infill panel at first floor has utilised expanding foam to fill in mortar joints which is not acceptable and provides no structural properties. This will need to be racked out and replaced with a suitable dry pack mortar.

On the ground floor where a new doorway has been formed the masonry detail has left an unbonded 9" pier to a door jamb. This will need to be demolished and replaced with a fully bonded blockwork pier to support the lintel and floor above and construct a more robust detail. Refer to appendix H for photographs.

HAZARD! URGENT ATTENTION REQUIRED - The first-floor construction utilises 9" x 3" grade C16 timber joists at circa 18" centres with double joists as required, refer to plan below for floor joist layout. The main floor joists and the trimmer joists are over stressed based on a floor imposed load of 2.5kN/m² which is low for its current usage which appears to be for storage purposes. In accordance with the current British Standards the floor should be designed for 5kN/m² if used for storage.

We would advise all the heavy items on the first floor are relocated to an alternative ground floor location until the remedial / replacement works have been implemented as the floor in its current state is a hazard! and requires urgent attention.

To ensure this floor conforms to current British Standards and building regulations a full replacement or strengthening steelwork will be required to reduce the spans of the main trimmer joists as at present they span in excess of 20' feet which is far too great for 2No. 9" x 3" joists bolted together carrying an oncoming span of circa 18' feet with the current loadings.

The timber bearing detail 4" x 3" section bolted to the walls are also poorly fixed and would require further testing (pull out tests) to check the capacity of fixings and adequacy.

Other detailing which is not present throughout the office floor construction is strapping to restrain the masonry at this floor level, these straps will need to be introduced.

Based on our findings for the first-floor construction there are two options;

- Replace the whole floor with an engineered floor joist design.
- Introduce steelwork to reduce the spans of the current construction.

Both options will need to be agreed with the conservation officer and confirmed as acceptable.

The roof construction is formed with loose rafters and purlins and appears to be in reasonable condition considering it has been subject to some form of fire damage at some point during its lifespan.

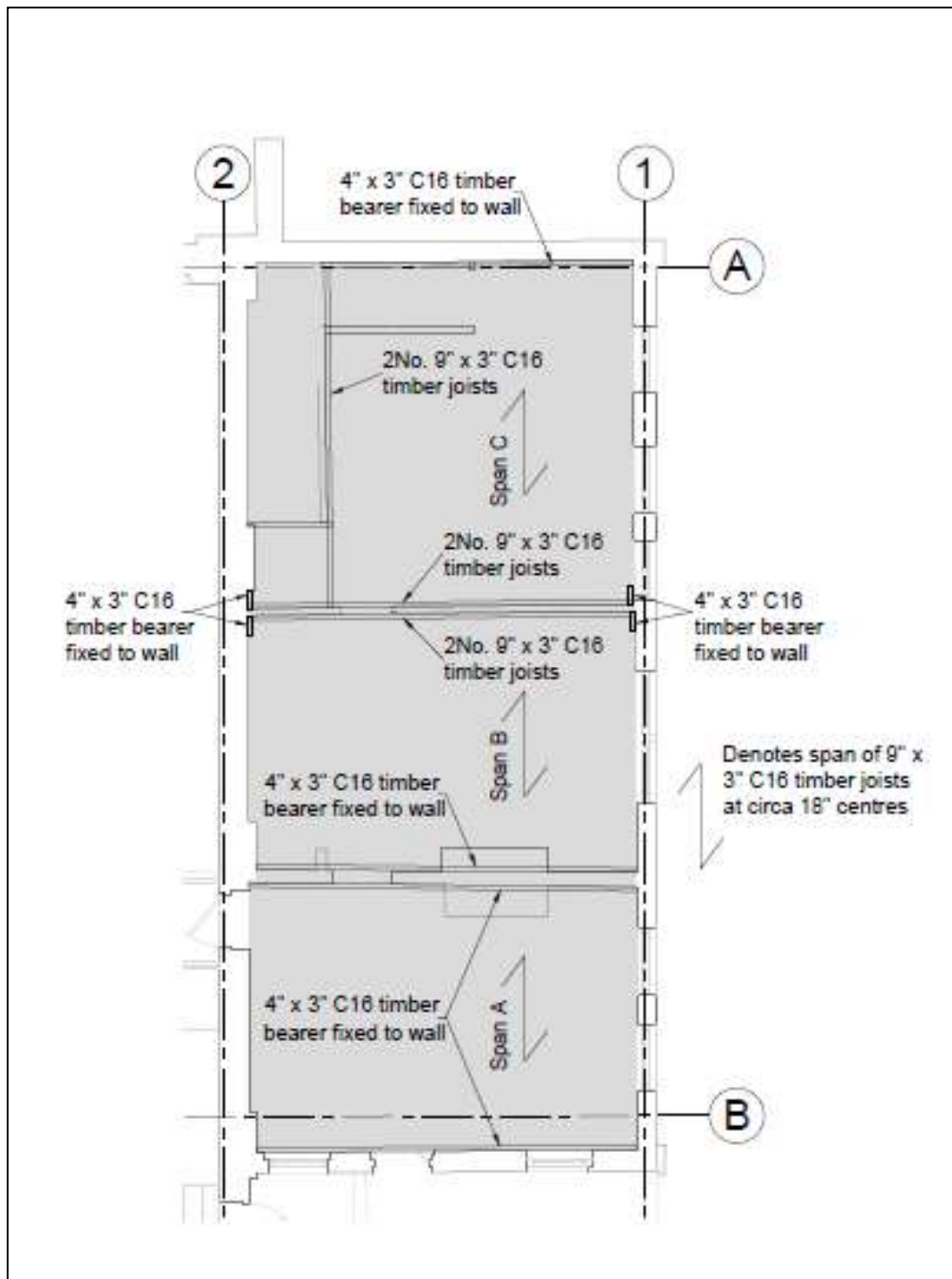
A visual inspection has been performed and the timber elements would appear to be unaffected by fire damage. However, please refer to the timber specialist report for details on any necessary remedial measures.

At both gable walls the main purlins do not take bearing from the masonry due to the length being too short. A steelwork shoe has been adopted and bolted to the end of the purlins to make up this shortfall. By inspection this detail is inadequate and will need to be replaced with a resin anchor detail or similar, refer to timber specialist report for further details.

At some point in time the building has been subject to water ingress through the coping detail on the gable parapet walls. This defect has been rectified by apply a felt covering over the stone copings. At the time of the survey no visible signs of water ingress were apparent internally.

The slate roof covering appears to be in good condition. This would be a result of repair works or possibly a full re-slate as a relatively modern felt and new gutter boards have been introduced. No signs of water ingress are apparent.

The timber king post truss and main roof members appear to be in good condition with no signs of any defects. However, please refer to the timber specialist report for further details.



Office Building Floor Plan.

Conclusions and Recommendations

For the carriage shed most of the defects noted can be attributed to the effects of water. Water has been allowed to enter the building through the roof, due to missing glazing, slates, flashings and defective gutters and downpipes.

The carriage shed slate roof covering and glazed rooflights have basically come to the end of their serviceable life and the roof requires a complete overhaul with replacement structural member and remedial measures as highlighted in this report.

The general condition of the rainwater goods is very poor and will lead to structural problems if not repaired or replaced. It can be seen from the photographs in Appendix E the connections for the rainwater pipes appear to be blocked. We would recommend jetting and a CCTV survey of the surface water system is completed. If the rainwater continues to discharge straight to ground in such close proximity to the external walls, it could lead to defects associated with the building foundations in the not so distant future.

Further investigations are required to determine the extent of decay to column C18.

Pointing of the West elevation will be extensive as will the replacement of brickwork in certain locations.

Minor remedial repairs will be required to the slab to rectify any potential trip hazards.

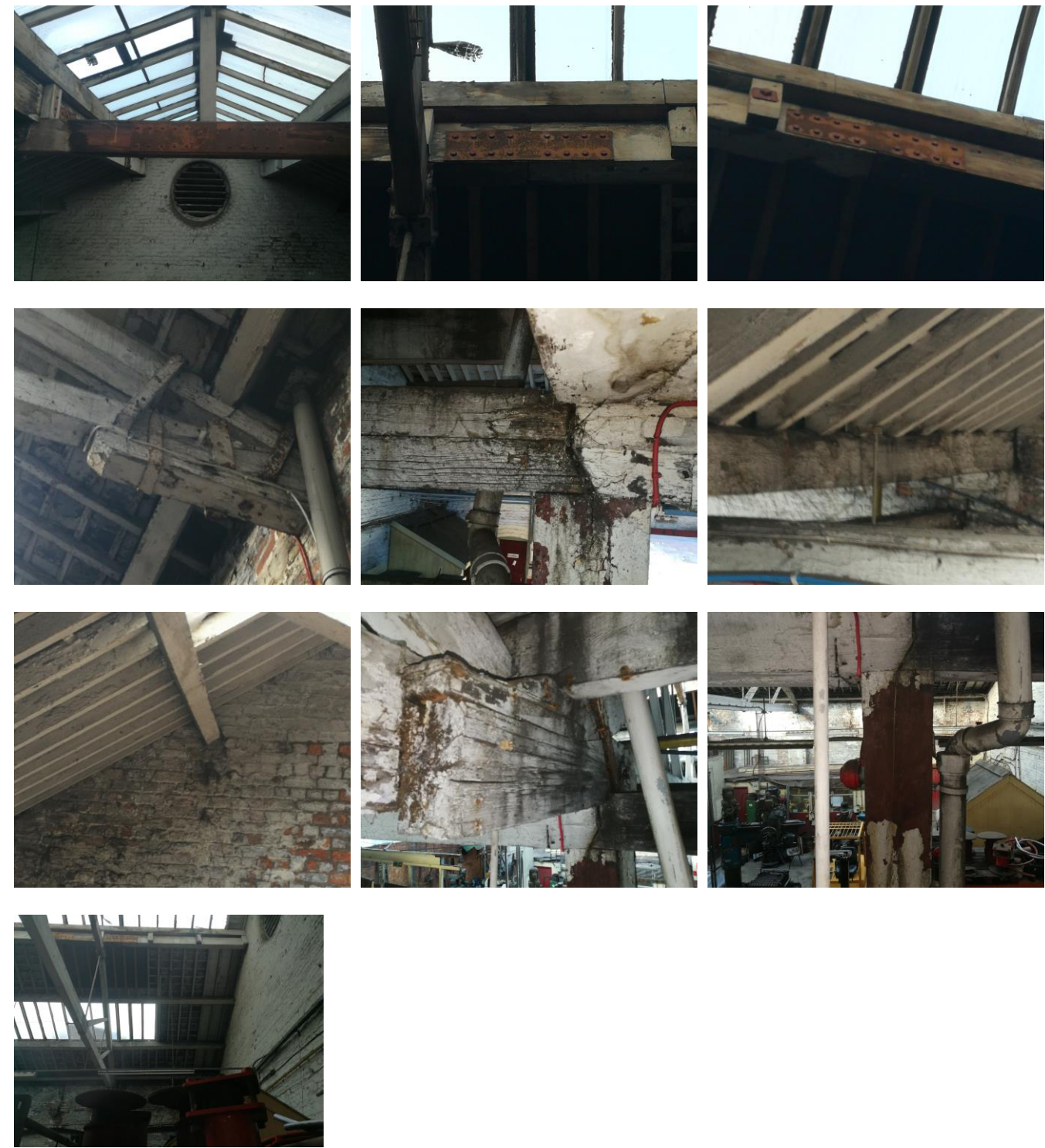
The office building doesn't have any signs of water ingress like the carriage shed but the first-floor needs replacing or strengthening due to poor initial joist sizing and detailing. The masonry overall is in good condition except for small areas where existing door openings have been infilled and poor workmanship has been adopted. These infill sections of masonry must be rebuilt.

This report should be read in conjunction with the Architects and Timber Specialists reports.

Appendix A

Appendix A

Truss 1



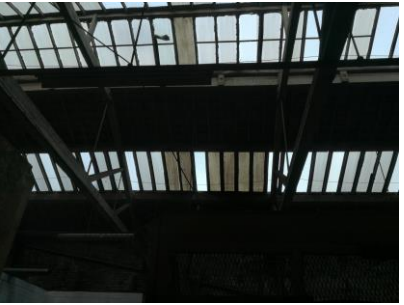
Truss 2



Truss 3



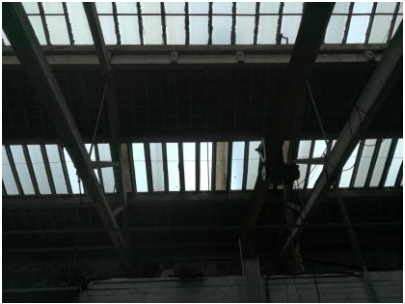
Truss 4



Truss 5



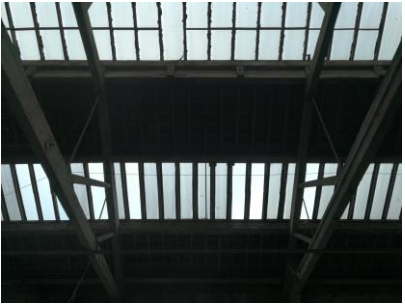
Truss 6



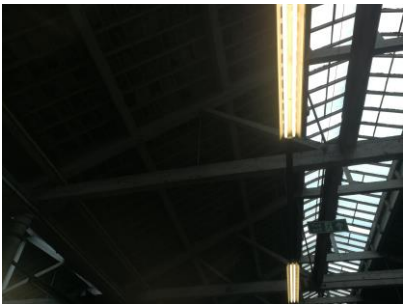
Truss 7



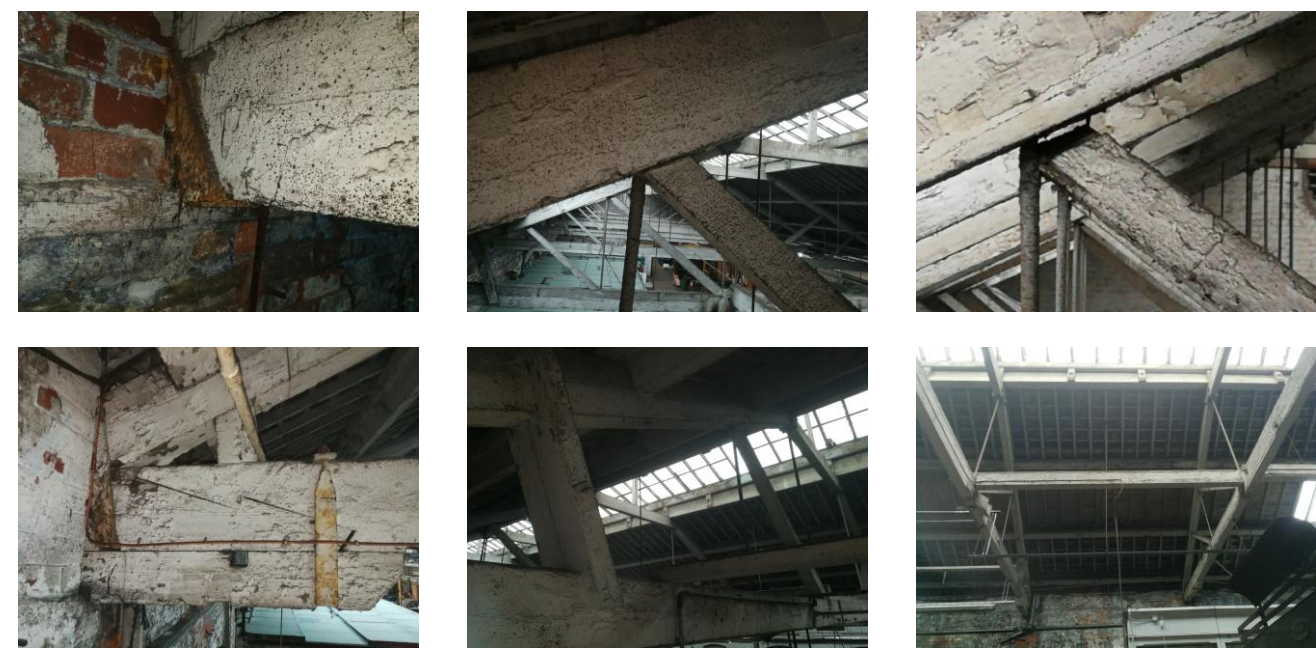
Truss 8



Truss 9



Truss 10



Truss 11



Truss 12



Truss 13



Truss 14



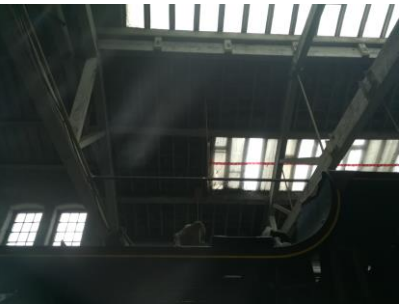
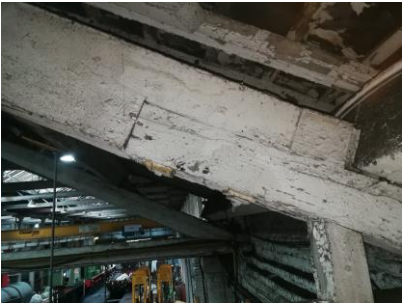
Truss 15



Truss 16



Truss 17



Truss 18



Appendix B

Appendix B

Truss 19



Truss 22



Truss 23



Truss 25



Truss 27



Truss 28



Truss 29



Appendix C

Appendix C

Truss 30



Truss 31



Truss 32



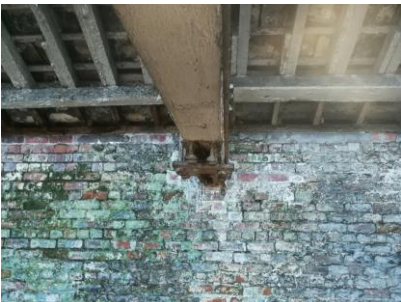
Truss 33



Truss 34



Truss 35



Truss 36



Truss 37



Truss 38



Truss 39



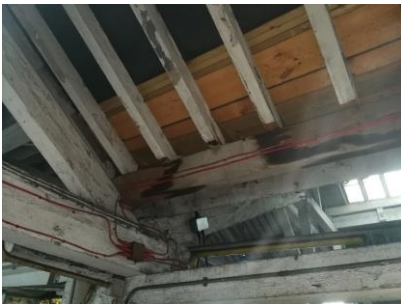
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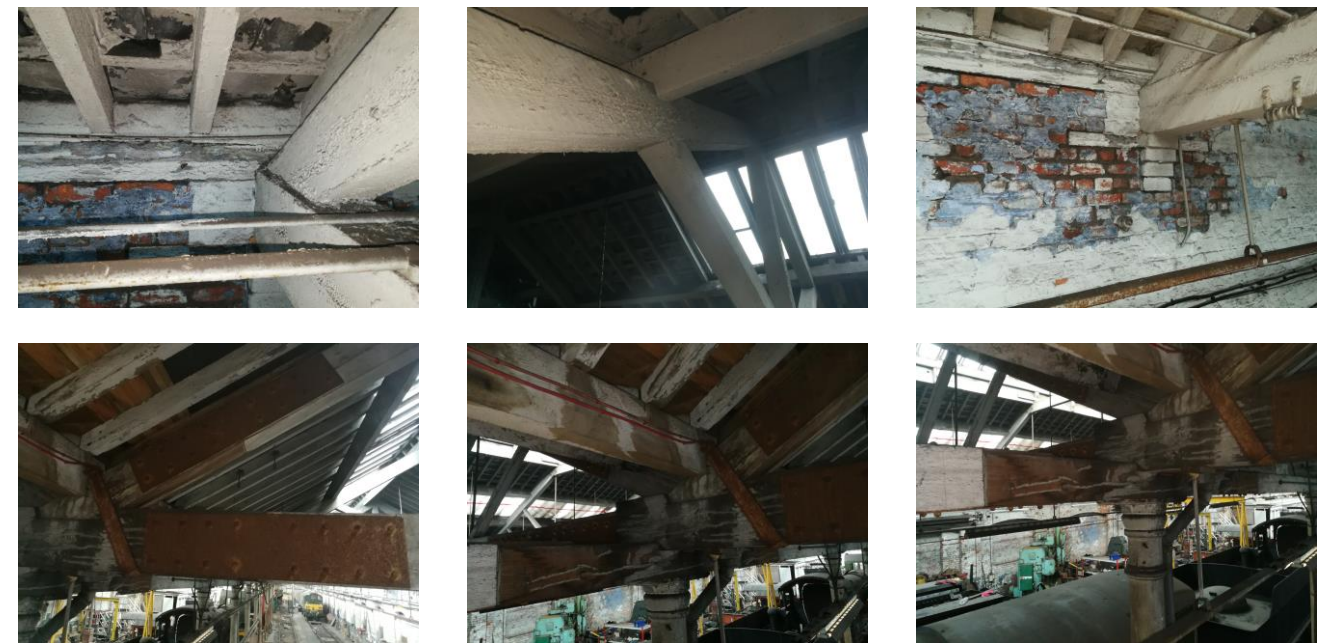
Appendix D

Appendix D

Truss 41



Truss 42



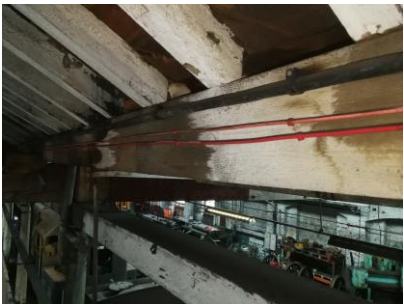
Truss 43



Truss 44



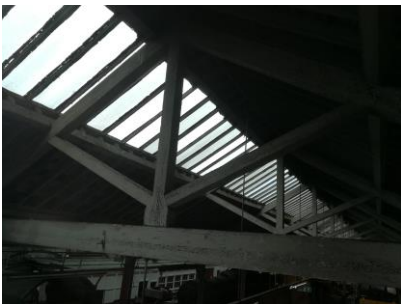
Truss 45



Truss 46



Truss 47



Truss 48



Truss 49

