SOUTH MELBOURNE TOWN HALL ROOF STRUCTURE ASSESSMENT

Prepared for City of Port Phillip

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EXECUTIVE SUMMARY

Infracorr's investigation of the South Melbourne Town Hall in April 2020 provided a limited inspection of the roof structures, during which a number of notable concerns were identified. Some of the connections appeared to be inadequate as a result of changing the roof cladding; some of the timbers had rotted where in contact with the brickwork and the ceiling joist connections are inadequate.

This report documents the findings from the further roof structures inspections conducted in October 2020. A sample of key areas were inspected in the roofs across the various buildings of the town hall to better understand the condition of critical elements of the roof structure that had not yet been assessed. A summary of risks to all of the roof structures are presented in Section 2. Findings that are specific to certain roof structures are provided in Section 3, while findings that are common across multiple roof structures are provided in Section 4. The findings are further illustrated in the drawings and photos attached in Appendix A and B.

Three short videos have also been provided as part of this report (Appendix C). Viewing these is recommended prior to reading the report as they succinctly illustrate some of the main concerns that are documented here.

The findings and recommendations from the April 2020 inspection generally remain, with the further investigation revealing or confirming the following in October 2020:

- As a result of poor and rotted truss connections, a number of the masonry walls are unlikely to currently have the required lateral restraint by Australian standards.
- All of the brick corbels observed in the main hall had cracked and one corbel had been replaced with a strut. The corbels have potential to come loose and fall through the ceiling.
- Severely rotted trusses were identified in F8 and the F34, which were propped subsequently.
- The tie down of the roofing through the various connections is generally inadequate throughout the town hall.
- The nailed connections between battens and truss bottom chords are generally inadequate throughout the town hall.
- The additional loading placed on the bottom chord to queen post connection as a result of the out of balance loads from half original slate – half metal roof was initially noted in the April 2020 report. These were further explored and it was determined that these out of balance loads are not sufficient to be the sole cause of the joint failures observed.
- A number of local issues were identified in the various roof structures at areas had not been inspected as of the April 2020 report. For example, the newer flat roof areas are supported by exceptionally lightweight 12mm Dynabolts at rooms G34 to G48, and the attachment of the wall plate at F24 to F30 which is unlikely to provide sufficient tie down against wind loads.

In a number of cases, props were installed after severely rotted connections in the roof were identified.

1 INTRODUCTION

1.1 Background

The South Melbourne Town Hall, built between 1879-80, is an iconic structure of state heritage significance situated on Bank Street, South Melbourne, within the City of Port Phillip (CPP).

In approximately 2002, major renovation works reinstated the decorative roof turrets on the east and west ends of the south wing, iron crest, and restored the original external colourings.

In March 2020, Infracorr Consulting Pty Ltd (Infracorr) and ASSE Consultants Pty Ltd (ASSE) undertook an inspection of the South Melbourne Town Hall for the City of Port Phillip. A report of the findings titled “Building Assessment and Development of Remedial Strategies for South Melbourne Town Hall” was issued to City of Port Phillip in April 2020 (report number 2020.j032-doc1(0), herein referred to as the April 2020 report).

The April 2020 report highlighted a number of defects in the building which require attention. The primary concern was the roof framing from the original 1880s construction. Some of the connections appeared to be inadequate as a result of changing the roof cladding; some of the timbers had rotted where in contact with the brickwork and the ceiling joist connections are inadequate. The investigation was limited in that the roof structure of the town hall is extensive and complex, and only a limited inspection was possible due to the difficult access and time available. There remained a high level of uncertainty with regards to the condition of the roof structures at the town hall.

A supplementary report titled “Advice on Risks to South Melbourne Town Hall Roof Structure” was provided in July 2020 (report number 2020.j080-doc1(0), herein referred to as the July 2020 report) which explored the associated potential risks and consequences associated with the roof structure issues.

City of Port Phillip (Council) have subsequently engaged Infracorr and ASSE to assist with further detailed investigation to better understand the condition of critical elements of the roof structure that had not yet been assessed. This report provides the findings of the additional investigation work carried out in October 2020, and should ideally be read in conjunction with the April 2020 report.

1.2 Scope of works

The scope of work was to inspect critical areas of the roof structure based on recent investigation by Infracorr and ASSE, and to provide documentation to assist Council to proceed to the remediation design and engineering stage. The scope of work also included advice on estimated repairs required and possible associated costs, which are to be provided separately.

The works consisted of investigation and assessment of key areas of the roof structure by the consultant (Infracorr and ASSE) as well as supporting works by separate contractor I.G. Parker Pty Ltd to provide access, expose relevant areas of the building for inspection, and reinstate the exposed areas following inspection. The intended scope of works was detailed in a separate document prepared by Infracorr and ASSE titled "Scope of Works for Roof Investigation and South Melbourne Town Hall" (document number 2020.j090-doc1(0)), which includes the aims and exclusions associated with the works.

Although the agreed scope of work excluded structural assessment or calculations, a limited structural assessment has been performed on a sample of selected timber roof trusses and connections and a sample of the ceiling joist connections to assist with analysis of the findings.

Attached in Appendix A are plans of the various areas of the roof indicating the areas inspected, the defects observed and references to the supporting photographs. Appendix B contains the comprehensive supporting photographs.

1.3 Limitations

The findings herein are based on the following limitations.

- Inspection of the roof structure requires a level of compromise, due to the difficulty and time required to perform the inspections. The investigation is intended to include a sample of the areas of main concern and is not intended to cover all elements and features in the entire roof structure. It is also possible for defects to be obscured by the geometry of the elements being inspected as well as finishes and other building fabric.
- The inspection was limited to selected areas of roof framing that could be inspected from the access points in the agreed scope of works document 2020.j090-doc1(0).
- The condition of the framing outside the inspection points could be better or worse than those inspected.

2 SUMMARY OF RISKS TO ROOF STRUCTURES

The scope of work was to inspect critical areas of the roof structure based on recent investigation by Infracorr and ASSE. The following table outlines the items associated with key risks identified both during the inspection and upon detailed review of the inspection records.

All of the items listed are included because they do not comply with current Australian Standards. The Priority given in the table is based on our opinion of the consequence of a failure on the structure, rather than on the likelihood or expected timeframe to failure (which are difficult to estimate). The priorities are classified as shown in Table 1.

Table 1: Priority Classifications

Priority	Consequence
1	Large failure with significant consequences
2	Localised failure with potentially significant impact
3	Localised failure with minor impact

Table 2: Table of Risk Priorities

Item	Description	Possible Consequence / Compliance with Code	Priority
G36 – Ballantyne Room (Drawing S3)			
South Wall Gable	The gable wall is not attached into the roof structure and therefore there is no lateral restraint.	The wall does not comply with code robustness requirements.	1/2
North Wall Gable	The gable is out of plumb by approximately 75mm.	The plumb tolerance in AS3700 is 10mm over 3.0m.	2
Ceiling Joist to Truss Connection	In a number of locations, the ceiling joist to truss connection has failed. Refer to Section 4 for a detailed discussion.	The connection does not comply with AS 1720.	3
G34 to G38 (Drawing S4)			
Roof Purlin and fixing to wall	There is a large air handling unit over this room.	Capacity of fixing to wall inadequate for the weight of the air handling unit plus roof.	3
Lateral restraint of north and south walls	The walls are unrestrained along the top edge.	The wall is unlikely to comply with the AS3700 for lateral wind loads.	1/2
Raker fixed to wall	The raker has a fall along its length to match the roof slope. The 12mm diameter Dynabolts are fixed close to the edge of the bricks.	Loose of capacity of the bolts installed at edge of brick.	1

Item	Description	Possible Consequence / Compliance with Code	Priority
G39 -(- Anam Foyer to G48 – Toilets (Drawing S5)			
Raker fixed to wall	As above.	Loose of capacity of the bolts installed at edge of brick.	1
G49 - Foyer Glass Roof (Drawing S5)			
Nothing of note			
F24 to F29 (Drawing S6)			
Wall plate attachment to wall	The eastern wall plate is nail fixed to the brick wall.	The nailing of the wall plate to the brickwork is unlikely to provide sufficient tie down capacity against wind loads and restrain the wall.	1/2
Tie down of roof rafters	The tying down of the roof does not appear to have been considered when the roof was modified to a mono pitch metal deck roof.	The roof rafters should have additional tie down straps to tie the rafters down to the ceiling.	3
F33 – Chambers (Drawing S7)			
Ceiling Joist to Truss Connection	As above.	As above.	3
Rot at the end of RT33.5	Rot in the bottom chord of the truss where bearing on the wall.	Loss of timber section will reduce the load capacity of the truss.	2
G57 (Stairs) and F32 (Drawing S8)			
Hanger beam notch (F32)	Notch in hanger for fire service.	Sagging of the ceiling, potential for collapse.	3
Ceiling joist trimming (F32)	Ceiling joist not nailed to trimmer.	Collapse could occur if someone stands on it.	3
F34/F35/F36 (Drawing S9)			
Ceiling Joist to Truss Connection	As above.	As above.	3
Roof trusses RT36.1 and 36.2	Rot where built into the south wall.	Loss of timber section will reduce the load capacity of the truss.	1
South wall stability	With rot at the ends of the trusses the lateral restraint of the wall has been diminished.	No longer restrained by the roof trusses.	1
F2 (Drawing S9)			
Ceiling Joist to Truss Connection	As above.	As above.	3
Roof truss RT2.4	Failed queen post to bottom chord connection.	Loss of load capacity.	1

Item	Description	Possible Consequence / Compliance with Code	Priority
Roof trusses	Rot in the ends of the trusses along the southern wall.	Loss of load capacity.	1
Metal Roof	Fixings from the roof sheeting through the battens, rafters and underpurlins not adequate.	Roof not adequately tied down.	1/2
Southern Brick wall	Due to rot in the trusses the connection between the trusses and the wall has been lost.	No longer restrained by the roof trusses	1/2
F3 to F7 (Drawing S10)			
Ceiling Joist to Truss Connection	As above.	As above.	3
Metal Roof	As above.	As above.	1/2
F8 (Drawing S11)			
Ceiling Joist to Truss Connection	As above.	As above.	3
Metal Roof	As above.	As above.	1/2
Roof truss RT8.6	Extensive rot in bottom chord and bearing/eaves tie.	Loss of timber section will reduce the load capacity of the truss.	1
West wall	Only one positive tie between roof trusses and masonry found at RT8.4.	Stability of west wall is questionable.	1
F10 to F16 – Apartments (Drawing S12)			
Nothing of Note	-	-	-
F18/F19 (Drawing S13)			
Nothing of Note	-	-	-
F38 – Main Hall (Drawing S14)			
North wall	The underpurlins are not anchored into the north wall and the east side buttress wall has a significant diagonal crack in it. These items indicate that the wall has limited lateral restraint.	The wall does not comply with code robustness requirements.	1
Truss support corbels	Most of the corbels under the ends of the trusses have cracked away from the wall. Some of the corbels have completely broken away from the walls and are staying in place because they are wedged between the wall and the truss.	Brickwork is unstable and could potentially fall through the ceiling.	2

Item	Description	Possible Consequence / Compliance with Code	Priority
Rot in the bottom chord of the trusses where built into the wall	Most of the truss bottom chords (where built into the walls) or the timber bearing plates have rot in them.	Loss of timber section will reduce the load capacity of the truss.	1
Ceiling Joist to Truss Bottom Chord	As above.	As above.	3
Access way	In some locations the batten tie between the two planks has come loose. The planks should be re-connected, so they work together rather than as individual planks.	A single plank is likely to be over loaded.	3

3 AREA-SPECIFIC FINDINGS

3.1 G36 – Ballantyne Room

Refer to drawings S3 in Appendix A and photographs in Appendix B.

Access into the roof void for the inspection was gained by cutting access hatches in the ceiling from scaffolding and installing aluminium scaffolding planks to traverse across the trusses. The inspection of the roof framing was then performed from the aluminium scaffolding planks.

The trusses are in good condition for their age. Additional plates have been added between the king post and the bottom chord. It was not clear why this was done, presumably there had been an issue with the original connection. Without carrying out an assessment of the current connection, it would appear likely to be adequate to support the weight of the truss bottom chord and the ceiling. Note, the original lath and plaster ceiling has been removed and replaced with a plaster ceiling on metal battens.

The bottom chords of the trusses bear on top of the brick walls and have plenty of ventilation around them. This building also has eaves gutters which keep the rainwater outside the building envelope. Typically, the leaking of internal box gutters contributes to the rot in the timber trusses at the eaves. No rot in the bottom chord of the trusses was observed.

The northern brick gable was measured as out of plumb by 40mm over 1500mm. Further measurements of the roof trusses indicated that they are 75mm out of plumb over the full height. Also, at the southern brick gable wall, the ridge board has been cut and there is a 80mm gap between the sections of ridge board. It can therefore be concluded that the northern brick gable wall is in the order of 80mm out of plumb from the ceiling level up to the underside of the roof sheeting. The gable and roof trusses appear to have moved in unison. As there is a large amount of fenestration on the northern side of the gable, it is likely that this out of balance load has pulled the gable over. Once it began to move and pull the trusses with it, the weight of the roof on the out of plumb trusses would have pushed on the gable. To correct this, tie rods have evidently been provided connecting through the north gable near the top to the south gable just above ceiling level. The south gable is no longer connected to the ridge board and the underpurlins have only 60mm end bearing, i.e. they have pulled out on the wall around 50mm. The tying of the southern gable wall to the roof structure should be included with any renovation works to be undertaken with the building.

The attachment of the ceiling joists to the roof trusses is typical of the areas of the building constructed in the 1880s and discussed in detail in section 4 of the report.

It appears the slate on the roof has been recently replaced and sarking provided between the rafters and the roof battens. It would appear that some of the rafters on the east side had to be straightened. This has evidently been achieved by cutting the rafter over the underpurlin and providing a splicing cleat to the side of the rafter.

Figure 1: Ridge board cut at south gable

Figure 2: Underpurlin pulled out of wall

Figure 3: Underpurlin with 70mm end bearing. Pulled out of wall 40mm.

Figure 4: Underpurlin pulled out of wall

Figure 5: Rafter cut over the underpurlin

Figure 6: Splicing cleat to the side of the rafter

Figure 7: Plumb measurement on north gable

3.2 G34/35/37/38

Refer to drawing S4 in Appendix A and Photographs in Appendix B.

Access to inspect the roof framing in the above four rooms was achieved by utilising existing access hatches and cutting access holes in the ceiling. Inspections were carried out from platform ladders of required height.

The roof structure consists of galvanized steel purlins at 1200mm centres supported on 75mm angle rakers bolted to the brick walls with 12mm diameter ‘Dynabolts’ at 1200mm centres. The brick wall between room G34 and G35 has been built up to the underside of the purlins which span over rooms G34 and G35. It was unclear if the purlins provided lateral restraint to the brick wall.

In our opinion, 12mm diameter (M10) Dynabolts at 1200mm centres is an exceptionally lightweight solution for the support of a roof on a public building. As the 75mm angle rakers are graded at the pitch of the roof, at some areas the Dynabolts will have been drilled into the edge of a brick, significantly reducing the capacity of the anchors.

Over room G38, there is an air handling unit with a steel channel base frame supported on 3 number purlins. Assuming the air handling unit with frame weighs in the order of 600kg and with the ceiling consisting of two layers of 13mm plasterboard, the reaction on 1 Dynabolt is 4.6kN. The working load capacity of a single 12mm diameter Dynabolt in solid bricks is 4.4kN. These bolts are also required to laterally support the top of the external walls subject to wind loads. Where the bolts are located close to the edge of a brick, the ability of the Dynabolts to support load is questionable. Where the air-conditioning plant is located, consideration should be given to upgrading the fixing to the wall and upgrading the purlins under the air handling unit.

Where the roof has a suspended ceiling consisting of a single layer of plaster, the structure is not showing any signs of distress and appears to be preforming as intended.

Figure 8: Loose raker anchor bolt

Figure 9: AC plant over G38

Figure 10: Raker between G35 and G37 supported by a brick

Figure 11: Purlins between G34 and G35 supported on the brick wall. Wall restraint unclear.

3.3 G39 - Anam Foyer and G40 to G44 & G48 - Toilets

Refer to Drawing S5 in Appendix A and Photographs in Appendix B.

Access to inspect the roof framing in the above G40 to G44 and G48 was achieved by utilising existing access hatches and cutting access holes in the ceiling. Inspections were carried out from platform ladders. To inspect the roof framing over G39, scaffolding was setup in the foyer.

The roof over the toilets and the foyer is as described for G34 to G38 above. Although some of the Dynabolts were not tightened hard against the angle raker, we did not observe any movement that raised concern.

3.4 G49 Foyer glass roof

Refer to drawing S5 in Appendix A and Photographs in Appendix B.

The glass roof over the foyer was designed by Tattersall Engineers in 1996. A copy of the structural drawings for the roof were provided by Council for our information.

The steel roof framing was inspected from a platform ladder. No sign of movement or distress was observed.

3.5 F24 to F29

Refer to Drawing S6 in Appendix A and Photographs in Appendix B.

A drawing was received from the Council for alterations and additions for the town hall prepared by Roy Grounds & Company Pty Ltd Architects in 1968. These drawings show what is assumed to the original double pitched roof, with a valley down the centre of the building running north/south. The roof framing has been modified from the original double pitched arrangement to a mono pitched roof falling away from the street frontage. The original ceiling still appears to be in place and a suspended plasterboard ceiling has been added under the original ceiling.

The roof framing was inspected through two existing access hatches and by entering the roof void after lifting a roof sheet as shown on the drawing.

In general, the timber framing appeared to be in good condition and did not raise any major concerns.

However, the wall plate along the eastern parapet is supported off timber props down to the disused box gutter and the wall plate and prop are nailed to the brick wall. In some instances these connection are loose. It is unlikely that this type of fixing provides sufficient tie down against wind loads.

In order to address the above issue, additional hoop iron straps may need to be installed across this roof to tie it down to the ceiling.

3.6 F33 – Chambers

Refer to drawings S7 in Appendix A and Photographs in Appendix B.

Access into the roof space to inspect the framing was provided by installing aluminium planks spanning between the roof trusses and to the external wall plates.

We understand that the centre section of this roof was reinforced in approximately 2002 for the installation of the mansard turret over. As such, these trusses were not included in the inspection scope.

In general, the balance of the roof structure was adequate, with the exception of rot noted at the end of RT33.5.

3.7 G57 - Stairs

Refer to drawings S8 in Appendix A and Photographs in Appendix B.

Access to the roof void was gained via aluminium planks installed from the walkway over F37 to the truss RT57.1.

The framing over the stair void consists of pitched and collar tied rafters with the ceiling joist, supported mid span by a substantial under purlin.

From the inspection point at RT57.1 there was no observable distress in the timber framing. Two of the three sides of the roof have eave gutters. Eave gutters help to ensure that the roof water sheds outside the roof line.

3.8 F32

Refer to drawings S8 in Appendix A and Photographs in Appendix B.

Inspection of the timber framing was performed by accessing the ceiling space through an existing access hatch in the ceiling.

The roof framing consists of collar tied rafters and ceiling joists supported mid-span with a hanging beam.

Generally, the framing appeared in good condition without rot or distress.

However, it appears when services contractors have installed equipment the following has occurred:

1) The hanging beam has had the top notched out of it to allow for the installation of the fire service; and
2) When the ceiling AC duct was installed, the ceiling joists were cut and trimmed for the duct including the pine trimmer. Unfortunately, the ceiling joist was not securely fixed to the trimmer.

Figure 12: Ceiling joist hanger cut for fire service

Figure 13: Ceiling joist not fixed to pine trimmer

3.9 F34/F35/F36

Refer to drawings S9 in Appendix A and Photographs in Appendix B.

The trusses RT36.3 to RT36.5 have been strengthened with steel channels bolts to the side of the trusses. The channels extend into the brick wall and have been grouted in. This work appears to have been part of the 2002 Mansard turret roof works and therefore not part of the inspection scope.

Trusses RT36.1 and RT36.2 over room F34 had not been reinforced and were inspected as part of these works. Access out to the ends of the trusses was provided by laying aluminium scaffold planks between the trusses.

Roof truss RT36.1 (“Mayor’s Room”) had considerable rot in the bottom chord where built into the wall. At first the timber back in under the wall plate appeared in good condition and probing the timber around the brick wall line indicated the timber was solid. However, when probing the timber under the wall plate, the blade of the screwdriver went straight through the top of the timber. The timber in the probed area fell apart. It was impossible to inspect the soffit of the truss or the bearing plate as there was a ceiling joist up against the wall preventing inspection or probing of the truss. As the truss has dropped around 65mm, it is assumed that the bearing plate has rotted away. This truss was back propped down the floor below after these observations. All props should remain in place until the trusses are reinforced.

Under RT36.2 the bearing/wall plate has rotted away and the truss has dropped some 70mm. Probing around the truss with a screw driver indicated that there is also some rot in the soffit and at the end of the bottom chord. The extent of rot was not as significant as RT36.1 and was not back propped. However, this truss could present an issue in the near future if it is not repaired and made good.

There was also some local termite damage to one of the gutter board cleats. The damage didn't appear to have spread, and local replacement of termite damaged timber at the same time as other repairs would likely be a suitable means of remediation.

Figure 14: Extensive rot in the end of RT36.1

Figure 15: Some Rot under RT36.2

Figure 16: Some termite damage between RT36.2 and RT36.3

3.10 F2

Refer to drawings S9 in Appendix A and Photographs in Appendix B.

Access to inspect the framing was from aluminium scaffold which provided access to the underside of the trusses.

The scaffolding was used to remove three ceiling joists which were removed from the trusses along with a section of the batten they were attached to. The rafters were removed so a method can be developed to reinforce the rafters while they are in situ. It is envisaged during the design phase for the repair of the roof.

The April 2020 report included a review of the support of the trusses on the southern wall which were found to have a rotted where built into the wall. The trusses were subsequently back propped.

This report explores the reason the queen post to bottom chord joint failed, including a review the other queen post to bottom chord joints along the northern side and checking the end bearing of the trusses along the north wall. The analysis and assessment of the queen post to bottom chord connection is discussed in Section 4 of this report.

The balance of the queen post to bottom chord connections were reviewed and aside from some shrinkage cracks in the queen posts there was nothing observed that raised further concerns.

The bottom chords built into the brickwork along the north side were also inspected and no rot was observed in the trusses.

A hole has been knocked through the wall under the north end of roof truss RT2.3. This hole has been broken through the wall and not made good and no lintel installed. The edge of the brickwork should be rebuilt tying the skins of brickwork together and a lintel installed.

Figure 17: AC Ducts at north end of RT2.3

Figure 18: Vertical Splits in the queen post RT2.3

3.11 F3, F4, F5, F6 and F7

Refer to drawings S10 in Appendix A and Photographs in Appendix B.

This area of roof is part of the original 1880s structure. In circa 2002 the roof was modified and reinforced during the reinstatement of the mansard turrets. RT7.1 and RT7.2 were modified and strengthened as part of these works and therefore not included in the inspection scope.

Access out to the ends of the trusses was provided by laying aluminium scaffold planks between the trusses.

The ends of roof trusses RT7.4, RT7.5 and RT7.3 were probed with a screwdriver and no signs of rot were observed. There was very little gap between the top of the bottom chord and underside of the rafter wall plate which would indicate that the bearing/eave tie plate has not rotted.

3.12 F8

Refer to drawings S11 in Appendix A and Photographs in Appendix B.

Access to inspect the framing was from aluminium scaffold which provided access to the underside of the trusses.

All of the trusses were inspected where they bear on the brick walls, as well as the queen post to bottom chord connections. The following was noted during the inspection;

1) Only RT8.4 was anchored into the brick walls at each end. The anchor consisted of a steel plate which was embedded into the brickwork and hooked over the top of the bottom chord. The plate was also bolted to the bottom chord with a bolt running through the chord and a washer provided on the opposite side.
   None of the other trusses were found to be anchored down the in the same way. This was confirmed visually, or if the brickwork was built up to the truss a piece of metal was slid between the brickwork and the truss in an effort to locate an anchor plate.
2) Roof truss RT8.6 has rot/borers in the west end of the truss bottom chord where built into the brickwork. The extent of the damage meant that there was very little of the truss bearing on the brickwork. A prop was subsequently installed under the truss, extending down to a steel beam within the floor structure.
3) Roof truss RT8.7 is of similar but different type of construction to the other roof trusses. In relation to the ends of the underpurlins the truss has been constructed approximately 250mm to the north of where the original truss would have been located. It would appear that there was an issue with the original truss and a new truss was constructed alongside the original before it was removed. The underpurlins were extended by a lapped length of timber on the side of the existing underpurlins.
4) As shown in the photographs there is a gap between the bottom of the queen post and the top of the bottom chord. This gap can range from a few millimetres up to around 10mm. In each instance the connections were closely inspected to see if the connection had started to fail similarly to the one in room F2. No signs of any of the connections failing was observed. It is most likely that some of the timber used in the manufacture of the trusses was greener that in others. The radial shrinkage of the timber has left a gap in the joint. This is not considered an issue as the joint is in tension and unlikely to close up.

Based on the member sizes and dimensions taken on site, a computer model of the trusses was developed and analysed. The analysis and assessment of the queen post to bottom chord connection is discussed in section 4 of this report.

Figure 19: Anchor detail at RT8.4

Figure 20: Truss RT8.7 queen post to Bottom chord connection

Figure 21: Truss RT8.6 Rot/borer damage

Figure 22: Truss RT8.6 Rot/borer damage

3.13 F10 to F16 - Apartments

Refer to drawings S12 in Appendix A and Photographs in Appendix B.

The roof over the apartments appears to be part of the original 1880s construction with a pitched Oregon framed roof. As there are box gutters along the west and north sides, there is potential that if water has been leaking from the box gutters then rot would result in these timbers.

In order to inspect the framing under the box gutter, access hatches were cut in the ceiling in rooms F10, F11 and F12 and the framing inspected from a platform ladder. There was no rot or current moisture observed at the inspection locations. Water staining was observed on some of the rafters but no rot or current dampness.

Access up into the ceiling space was through an existing access hatch in room F15.

The framing for the roof is a conventional pitched roof, i.e. pitched rafters, underpurlins, collar ties and ceiling joists supported with hanging beams.

Generally, the framing was in good condition with nothing observed that raised structural concern.

3.14 F18/F19

Refer to drawings S13 in Appendix A and Photographs in Appendix B.

The roof framing in this area was inspected through existing access hatches and holes cut in the ceiling from a platform ladder.

The arrangement of the framing is shown on drawing S12. From these access points we did not observe any distress or rot that raised structural concern.

3.15 F38 Main Hall

Refer to drawings S14 in Appendix A and Photographs in Appendix B.

Access into the roof space to inspect the framing was provided by installing aluminium planks spanning between the roof trusses and to the external wall plates.

The roof over the Main Hall appears to have originally been a slate roof and at some point in time the slate has been replaced with metal decking.

3.15.1 Lateral restraint of the North Gable wall

The connection of the underpurlins to the North gable wall were inspected by lifting a roof sheet on the North West end of the building. The intent of the inspection was to investigate if the underpurlins had rotted where built into the wall.

The inspection found that there was no rot in the ends of the underpurlins, however , the underpurlins had pulled out of the wall approximately 30mm. This indicates that the underpurlins are not tied into the wall.

From the roof it was observed that the brick buttress wall has a diagonal crack leading up from ceiling level (behind the stage) at approximately 60 degrees toward the south (shown in the figure below). Diagonal cracking in the walls of the main hall (below ceiling level) was also discussed in the April 2020 report.

The wall area of masonry above the ceiling level is intended to be restrained by the underpurlins and buttress walls, and the side walls is approximately 6.0m high and 18.6m wide. The parapet was measured as 400mm wide on the horizontal section running from the side walls back towards the ridge. It is therefore likely that the wall consists of three skins of masonry plus render, i.e. 350mm masonry plus 2x25mm of render. This is a large area of wall with very little lateral restraint. This could be addressed by tying this wall back into the roof framing and reinforcing the buttress. Refer to section 4 for further discussion on the Robustness of Masonry.

Figure 23: Underpurlin seating in brick wall

Figure 24: Cracked Buttress wall

3.15.2 Brick Corbels

All of the brick corbels inspected had fractured vertically at the junction with the wall. Some had some minor cracking and others had come away completely and are likely only in-place because they are wedged between the wall, ceiling joists and truss. One of the corbels has been completely removed and replaced with a timber strut (at truss RT38.9). As a minimum, the loose corbels would need to be removed to address the potential for one to come loose and fall through the ceiling.

Figure 25: RT38.3 East- Corbel broken away from wall and wedged between ceiling, wall and truss.

Figure 26: RT38.9 East – Corbel removed and replaced with a timber strut.

3.15.3 Rot in the bottom chord and bearing plates

There was rot in five of the seven truss bottom chords inspected along with the bearing/eaves tie plate. This varied from the soffit of the truss being soft when probed with a screwdriver, to complete loss of the bearing/eaves tie plate. The degree of rot in the timber has led to increasing damage to the brick corbel as the truss has imparted more load onto the corbel. As noted above, the corbel at RT38.9 has failed completely and been replaced with a timber strut.

Figure 27: Truss RT38.2 – Rot in the bearing plate and soffit of bottom chord

Figure 28: Piece of timber has come loose from the top of the bottom chord under the wall plate.

Figure 29: RT38.9 East Wall

Figure 30: RT38.9 East Wall

3.15.4 Access Way

From previous experience with scaffolding boards and accessways, the accessway boards in the main hall are likely only adequate for light duty loading in accordance with the scaffolding code AS 1576.1 Scaffolding Part 1 – General Requirements.

For these boards to be compliant, as a minimum the tie between the boards needs to be adequate. In some locations the ties have become loose. These should be reinstated if the access way is to continue to be used. This is further explored in the April 2020 report.

3.15.5 Repairs to the ends of the truss and bearing/wall plates

To repair the ends of the roof trusses, repair the bear/wall plates and remove the corbels, it is envisaged that the trusses will need to be propped from floor ground level and scaffolding constructed to provide access up to the ends of the trusses to provide a working platform. The repair could then be completed, for example, the trusses could then be jacked up to their original location, the corbel removed, the bearing plate/eaves tie replaced with a steel section and the bottom chord reinforced locally with some steel framing.

4 GLOBAL FINDINGS AND DISCUSSION

4.1 Tie down of the roofing

To prevent the roof sheeting from being lifted off the roof of the building in high winds, the roof sheeting must be adequately fixed to the roofing batters, the battens fixed to the rafters, the rafters fixed to the under purlins, the underpurlins fixed to the trusses and lastly the trusses fixed to the brickwork.

A failure of any one of the above connections could lead to the loss of a section of the roof. The loss of a roof is a high-risk event that can cause damage to adjacent building, injury to persons and significant loss to the building occupants.

At the town hall, this effect is more likely to occur with the metal deck roofs, which have been adopted to replace the slate roofs on the original building on the elevations which are hidden from the main street elevations.

To determine how the tie down has been achieved, an area of roof was inspected form the walkway over room F37 as these were readily accessible and appeared to be representative of the other roof areas where the slate has been replaced with corrugated metal sheeting.

4.1.1 Roof Sheeting

The NCC (National Construction Code) 2019 Volume Two (Housing Provisions) requires that corrugated roof sheeting be fixed as follows.

Table 3: Corrugated Roof Fixing Requirements from NCC

	Fixing: End Span	Fixing: Internal Span
Sheet Roof Profile: Corrugated	Side lap and every second rib	Side lap and every third rib

As it can be seen from the below photograph, of the internal spans on the main hall, the fixing spacing varies from every third rib to every forth rib and fifth rib. This is clearly not in accordance with the NCC.

Figure 31: Example of roof sheeting over main hall showing spacing between fixings

4.1.2 Battens to Rafters

The nails were measured to be 90mm long by approximately 3.75mm diameter. In our opinion, these nails have sufficient capacity as a general fixing but do not have sufficient capacity near the ridge and eaves where local pressure factors could increase the uplift pressure by 30%.

Figure 32: Example of batten nails

Figure 33: Typical nail diameter

Figure 34: Typical rafter nail to underpurlin

Figure 35: Typical rafter nail to underpurlin

4.1.3 Rafters to Underpurlins

Typically, the rafters have been skew-nailed to the underpurlin with two nails: one on either side. A review of this connection has found it to be slightly under capacity. For a slate roof as originally intended, the connection between the rafter and underpurlin is adequate. Unfortunately, not all the rafter to underpurlin connections are as pristine as the one shown in the below photograph. In a number of areas, the roof line has been straightened by lifting the rafters off the underpurlin and installing packers. Where this has been done the capacity of the connection to resist uplift has been lost.

Figure 36: Rafter in Main Hall not tied down

Probably the worst example of this is at the North/East end of the Main Hall where the trusses have dropped due to rot at the supports, the rafters have been straightened by packing between the rafters and the underpurlin. The photograph above shows the rafter has split at the nail location indicating that this connection has no uplift capacity.

4.1.4 Underpurlin to Trusses

To tie the underpurlins to the trusses it appears that two skew nails have been used. At the Northern end of the Main Hall (at least), due to the trusses dropping, the underpurlins have come away from the trusses and there is no connection between the underpurlin and the truss.

For underpurlins at 2.0m centres and trusses at 3.0m centres, the ultimate wind uplift force is estimated to be 5.1kN. The weight of the roof is estimated in the order of 1.1kN leaving a estimated required tie down force of 4.0kN. The two number skew nails, where intact, are not sufficient to resist this force.

Figure 37: No fixing between underpurlin and truss at top chord

Figure 38: Skewed nails between queen post and underpurlin

Figure 39: Underpurlin on the farside of the image has lifted off truss in the main hall

4.2 Ceiling joist connection to the roof truss bottom chord

The photograph below is a typical ceiling joist to bottom chord connection through the 1880s East, West and South wings of the building. It consists of a 130mm x 35mm Oregon ceiling joist notched around a 45mm deep x 35mm wide batten nailed to the bottom chord of the truss with 3.5mm square hand forged nails with 35mm penetration.

The load capacity of the notched ceiling joist was assessed to AS 1720.1-2010 (Timber Structures - Part 1: Design Methods) section 3.2.5 and appendix E9 Notched Beams.

The nailed joint between the batten and the truss bottom chord has been assessed in accordance with AS 1720.1-2010 section 4.2.

The loads loading adopted for the assessment are;

DL (Dead Load) – Ceiling Joists + Lath and plaster ceiling + Plaster ceiling + Light weight suspended ceiling = 40 kg/m^2.

LL (Live Load) – Point Load 140kg from AS/NZS 1170.

Figure 40: Typical ceiling joist to bottom chord connection through the 1880s East, West and South wings of the building

Figure 41: Typical nail spacing for ceiling support batten.

4.2.1 All 1880s buildings except the Main Hall

The results of the assessment are as shown below. The connections are not adequate for the estimated applied loads.

Table 4: Assessment for connection between batten and truss bottom chord

Item	Applied load	Capacity working	Outcome
Ceiling joist	DL = 0.35kN	0.5kN	Ok
	DL+LL =1.75kN		Not Adequate
Batten	DL =0.35kN	0.5kN	Ok
	DL +LL =2.0kN		Not Adequate

4.2.2 Main Hall

In the main hall, the ends of the ceiling joists appear to have been attached to the side of the roof trusses with two skew nails. For a typical tight joint, it is expected each nail would have a working load capacity of 50kg. So, for a joint relying on two nails, capacity could be 100kg, which would be inadequate to support the force imposed by a person. With a gap between the ceiling joist and the truss, the capacity of the joist would be substantially less than this. However, it may be possible that there could be a timber bearing plate nailed to the side of the truss bottom chord that the ceiling joists sit on, and the skew nails only serve to hold the ceiling joist in place. This would need to be confirmed during remedial works in order to ensure the connections are adequate.

Figure 42: Two skewed nails

Figure 43: Three skewed nails. One through the top and two through the side.

Figure 44: Packing between ceiling joist and truss bottom chord

4.3 Diagonal Chord to Bottom Chord Connection

As part of a conservative review of this connection, the trusses were analysed for a full slate roof along with the original lath and plaster ceiling and a plaster ceiling battened under the existing ceiling and live load applied to the roof (Figure 48 to Figure 55). For the Main Hall the analysis also considered the slate roof replaced with a metal roof reducing the dead loads by 40kg/m^2.

The capacity of this connection is a function of the length of timber in the bottom chord past the end of the diagonal chord (see Figure 45). Based on AS 1720.1-2010, the ultimate shear stress in a connection for strength group SD5 (seasoned, Douglas Fir) is f'sj = 5.4N/mm^2 and for S5 (unseasoned, Douglas Fir) is f'sj = 3.3N/mm^2.

The allowable shear stress (v), assuming a conservative load factor of 1.35 (i.e. all Dead Load) for seasoned timber is:

v(working) = 0.65x0.57x5.4/1.35 = 1.48N/mm^2.

When the roof was constructed it is assumed that the timber was unseasoned, i.e.:

v(working) = 0.65x0.57x3.3/1.35 = 0.91N/mm^2.

Based on the above shear stresses the required shear length is as follows.

Table 5: Require Shear Lengths

Truss Location	1880s Full slate roof with lath & plaster ceiling		Full Slate roof with lath and plaster ceiling plus battened plaster ceiling		Metal Roof with lath and plaster ceiling plus battened plaster ceiling.	
	Tie force	Shear Length required for green timber	Tie force	Shear Length required for seasoned timber	Tie Force	Shear Length required for seasoned timber
Main Hall	78kN	390mm	85kN	260mm	59kN	180mm
Wing Buildings	28kN	280mm	-	-	31kN	190mm
Ballantine room	18kN	180mm	-	-	-	-

From the analysis, the length of the shear plane required was greatest when the roof was constructed, and the timber is assumed to be unseasoned. As the timber dries to below a 15% moisture content (seasoned), the shear strength of the timber increases by around 60%, reducing the length of the shear plane required to resist the load imparted on the bottom chord by the diagonal chord.

Typically, the length of the bottom chord between the brick wall and the end of the diagonal chord is a minimum of 240mm and therefore the rot observed so far in the end of the trusses will not have reduced the capacity of these joints.

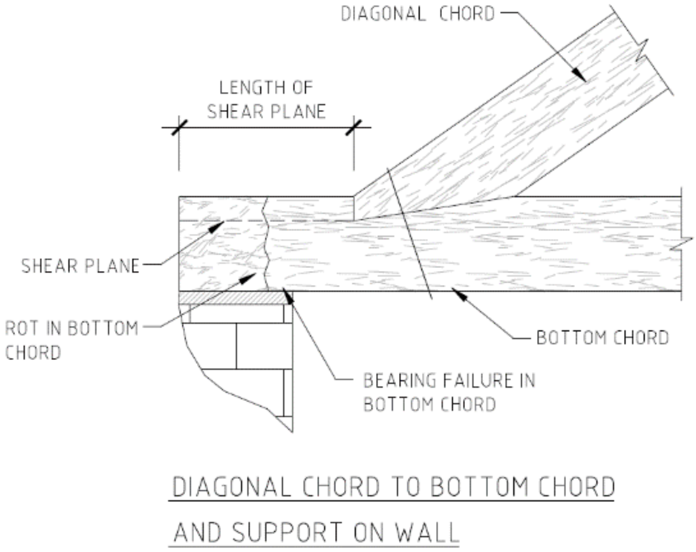


Figure 45: Sketch of truss eave connection

Figure 46: Typical dimension from wall to diagonal chord other than Main Hall which had a longer length of shear plane

Figure 47: Rot in the end of RT8.6

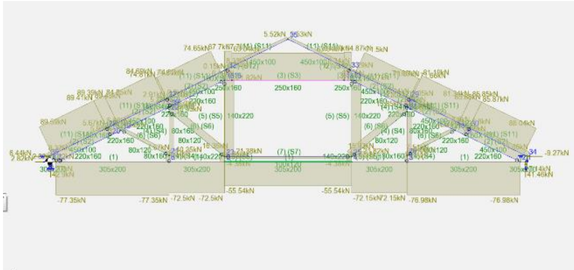


Figure 48: Analysis of Main Hall with slate roof

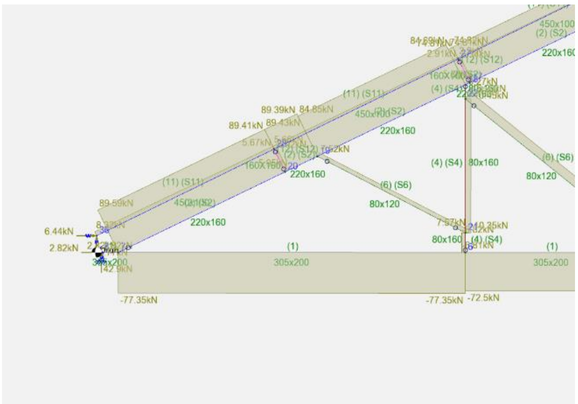


Figure 49: Associated eave joint loads

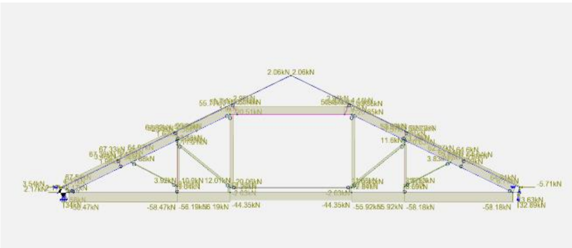


Figure 50: Analysis of Main Hall with metal roof

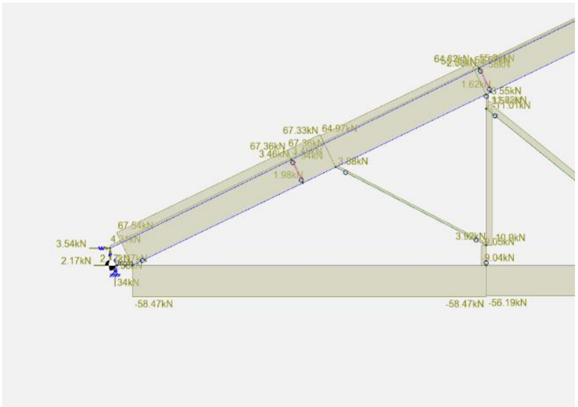


Figure 51: Associated eave joint loads

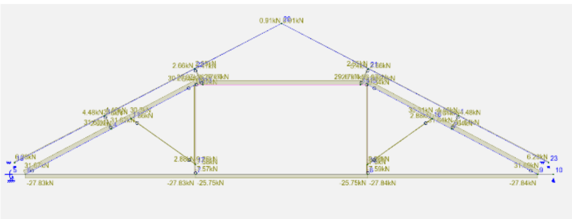


Figure 52: Analysis of Wing Buildings

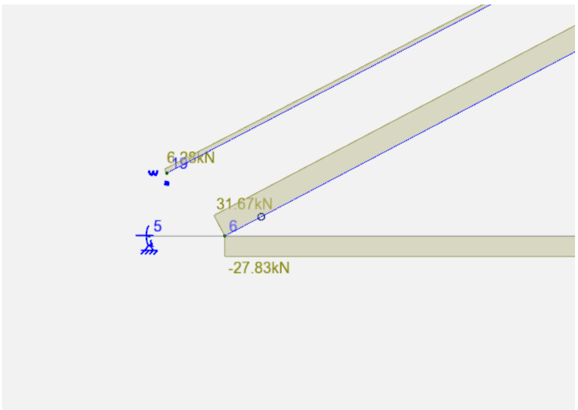


Figure 53: Associated eave joint loads

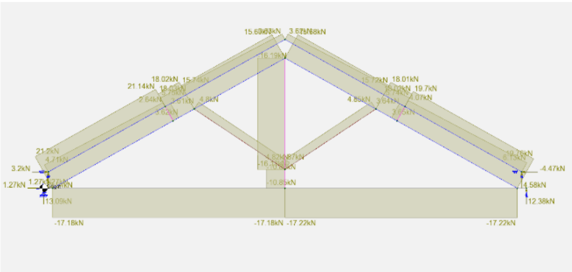


Figure 54: Analysis of Ballantyne Room

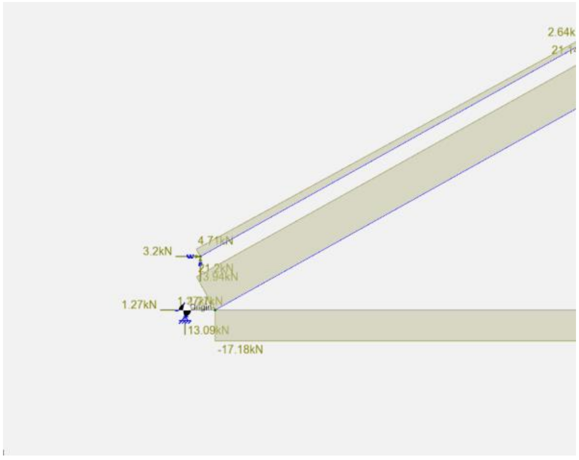


Figure 55: Associated eave joint loads

4.4 End bearing

As many of the trusses have either rot in the bearing plate on which they are seated, or the end of the truss bottom chord has rot, it is worthwhile determining how much of the bottom chord is required to bear on the wall before the truss support is likely to fail.

It is noted that the trusses typically bear 230mm onto a 350mm thick wall for the East/West and South Wings and 350mm onto the walls for the Main Hall.

Although, as shown in Table 6 below, this length of bearing is not required to support the weight of the truss, the length of bearing was most likely chosen to load the wall within the middle third of the wall. With the ends of the trusses rotted, the bearing point moves towards the inside face of the wall providing an eccentric load on the wall, reducing its stability. In most cases the wall/bearing plate on which the trusses are seated has also rotted away. The ends of the trusses are now largely bearing locally directly on the brickwork. In this case the length of the truss bottom chord bearing on the wall should be a minimum of 110mm to ensure the brickwork locally stable.

Table 6: Required bearing lengths

Truss location	Full slate roof	Full metal roof	Estimated required bearing length on wall
Main Hall	50kN	-	50mm
		35kN	30mm
Wing Buildings	23kN	-	45mm

From these calculated bearing lengths, the seven of the main hall trusses that were inspected have adequate bearing length remaining but should be made good as soon as practical. It is expected that the balance of the trusses would be in similar condition.

The trusses that have been propped in the south and west wing should remain propped until they are made good.

4.5 Queen Post to Bottom Chord Connection

In our April 2020 report, it was suggested that the out of balance load on the roof may have contributed to the failure of the connection between the queen post and the bottom chord. The diagram below is indicative of the displaced shape of the truss due to the out of balance roof loads.

When the roof loads are equal on both sides of the roof, the structure is balanced and the connection between the queen post and the bottom chord is only required to support the bottom chord, the weight of the ceiling and services and temporary maintenance loads.

With the roof loads being out of balance, the connection below the metal roof is also required to tie the queen post down to the bottom chord to stop the roof skewing to one side.

The question is; whether this out of balance is significant enough to cause this connection to fail, and whether the other trusses likely to fail in the same manner.

To explore this, a frame analysis was undertaken which considered the following three load cases;

1) Roof as originally constructed in 1880 – slate roof and lath and plaster ceiling.
2) Half the roof changed to corrugated metal – slate/metal roof with lath and plaster ceiling
3) As for item 2) but with an additional plaster ceiling and suspended grid ceiling.

The analysis conservatively applies the roof live load of 0.25kN/m^2 (25kg/m^2) at ceiling level rather than at roof level. This has been done as the ceiling space is accessible and will produce the greatest load on the connection.

The results of the analysis are compared against the capacity of the connection determined against AS 1720.1-2010 and against the 1862 document “A Manual of Civil Engineering”. “A Manual of Civil Engineering” suggests in section 320 that the shear strength for Fir (Douglas (Oregon)) timber can be taken as 600 lbs per square inch (4.2 N/mm^2) and four (4) is a sufficient value for the factor of safety.

Table 7: Analysis of queen post to bottom chord connection

Load Case	Analysis result	Capacity as per AS 1720 Reduced to a Working Load Capacity	Capacity as per "A Manual of Civil Engineering" Working Load
Tension in connection under slate roof			
1)	8.3kN	19.5kN	21.6kN
2)	6.1kN	19.3kN	21.6kN
3)	8.6kN	19.5kN	21.6kN
Tension in connection under metal roof			
2)	9.9kN	19.3kN	21.6kN
3)	12.5kN	19.5kN	21.6kN

From the table it can be seen that it can be seen that the change from a slate/slate roof to a slate/metal roof has only increased the load on the connection by 1.6kN (160kg) in the second load case. This is not significant when compared to the capacity of the connection. The table of results also shows that the connection should have had sufficient capacity to support the additional ceiling loads and a live load in the ceiling (third load case).

Judging by the colour of the timber exposed in the failed connection, it is likely that the failure is recent. We understand that the ceiling in the area was removed after there was a partial collapse of the ceiling near the clock tower. It is possible that during the demolition of the ceiling additional loads were applied to the bottom chord causing the connection to fail.

From the analysis it is unclear what has caused the failure and whether it can happen again. As shown in the table, the loads in the connection under the slate roof are lower than in the connection under the metal roof.

If the roof trusses are to be maintained for another 50 years, it may be prudent to reinforce all these joints to ensure another similar failure does not occur. Ideally, the trusses would be jacked up straight and the reinforcing plates installed to reduce some of the load on the existing connections.

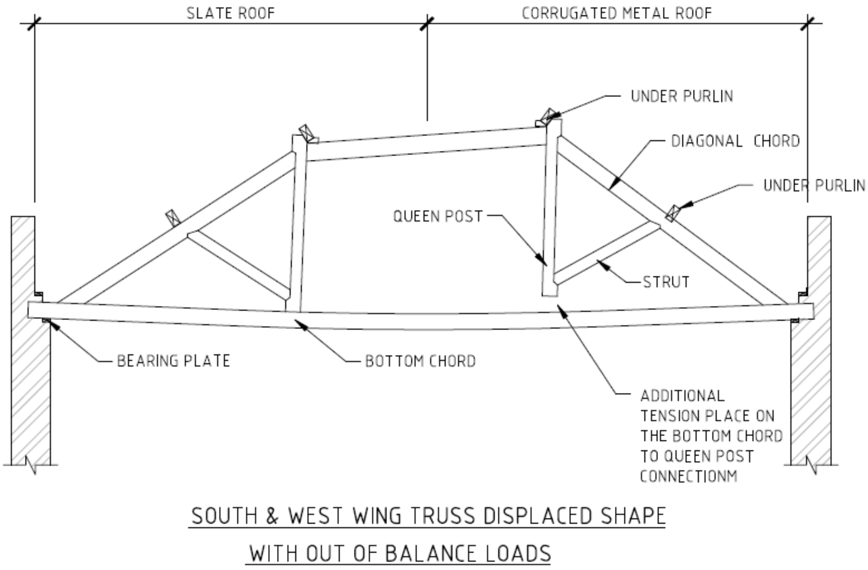


Figure 56: Representation of displaced shape of the truss without of balance roof loads applied

Figure 57: Width of failure block

Figure 58: Length of failure block

Figure 59: Anchorage depth of bottom chord support bolt

4.6 Robustness of Masonry

The lateral restraint of the walls is required to be provided with a defined load path to transfer lateral loads down to the ground. These loads should include wind loads, seismic loads and a minimum lateral load from AS 3700 (Masonry Structures) Section 2.6.3, of 0.5kN/m^2, to ensure the masonry walls are robust. The codes also require that there are positive connections between the members.

The chart of robustness limits for masonry walls in Figure 61 below is based on the AS 3700 requirement for robustness of masonry panels. This chart covers 110mm and 230mm thick masonry walls. The north wall of the Main Hall (Figure 60) appears to be 350mm thick masonry. The panel of masonry at the north end of the main hall is approximately 5.5m high above the back of stage ceiling and 18.3m wide, assuming the underpurlins provide no restraint to the wall. Examining this panel of masonry by extrapolating the chart in Figure 61, the maximum width of unsupported masonry is approximately $\sqrt{(350^2/230^2) \times 7.5^2} \approx 11.4$m. This is less than the existing 18.3m between return walls. Wind loads and seismic loads are likely to exceed the minimum robustness requirements.

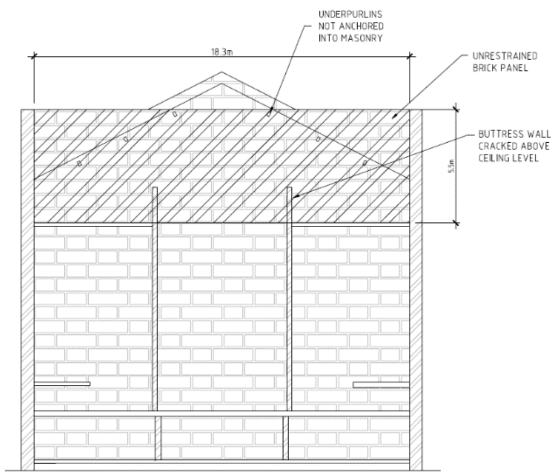


Figure 60: Elevation of Hall North Wall from Inside

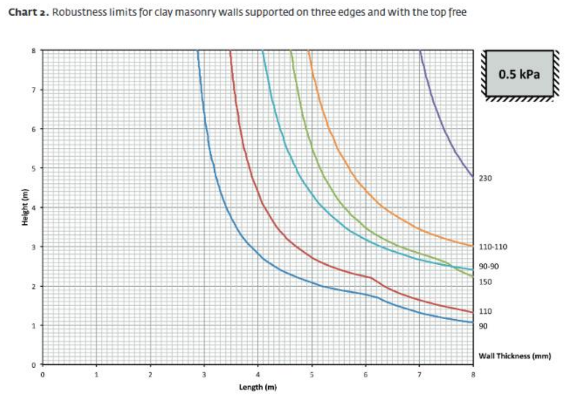
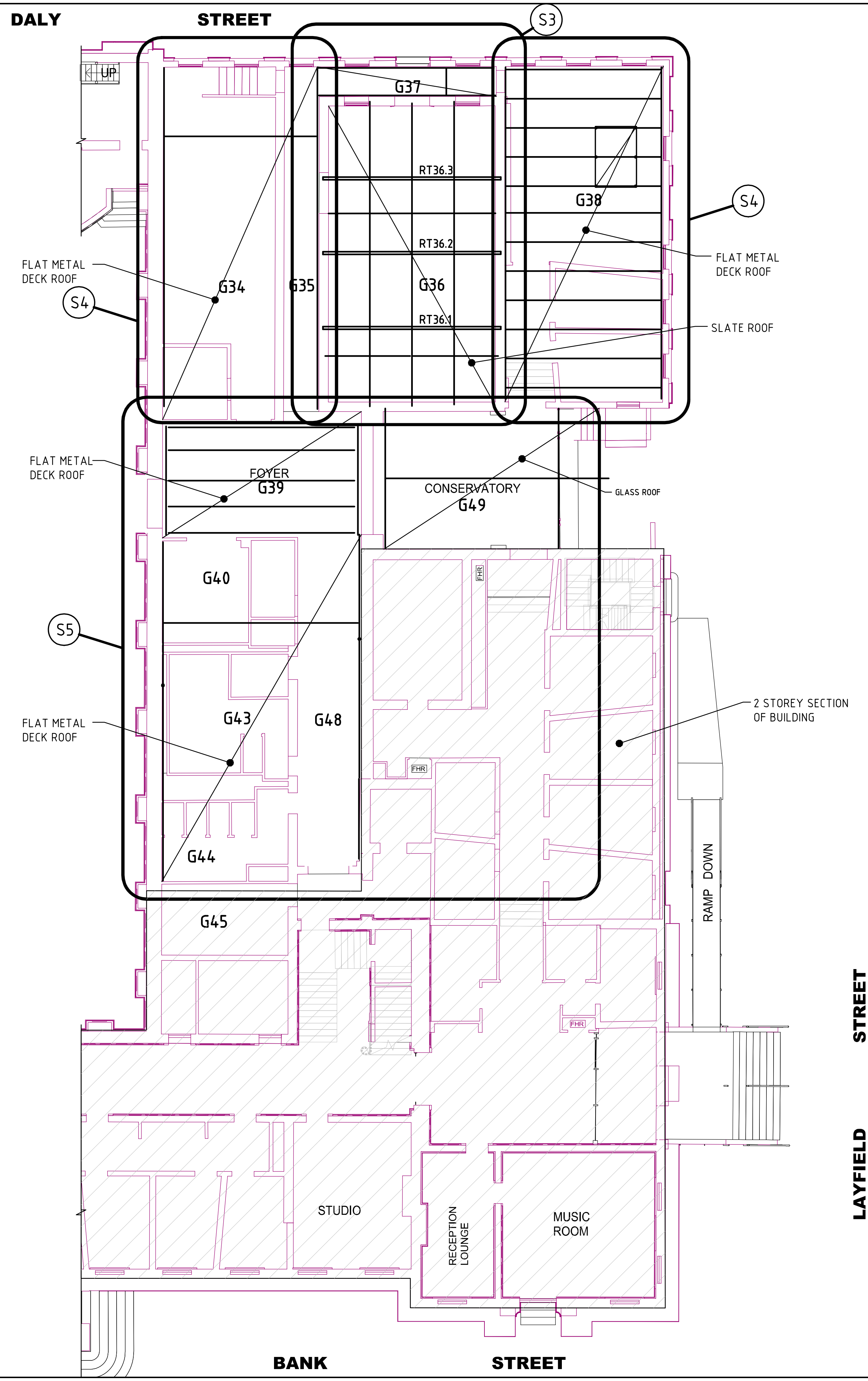


Figure 61: Robustness Limits for Thick Brick – Manual 7 – Design of Clay Masonry for Serviceability – Chart 2

The walls around the exterior of the 1880s buildings are supporting the roof trusses with rotted bearing plates and rot in the bottom chords to varying extent. These rotted connections are unlikely to be providing the lateral restraint to the wall required by the various Australian Standards. When the rotted timber is repaired, consideration must be given to providing a positive connection between the walls and the roof framing. The load path transferring these lateral loads down to the ground should also be considered.

APPENDICES

APPENDIX A: GROUND AND FIRST FLOOR ANNOTATED PLANS



Rev	Date	Description
A	3/12/2020	REPORT ISSUE

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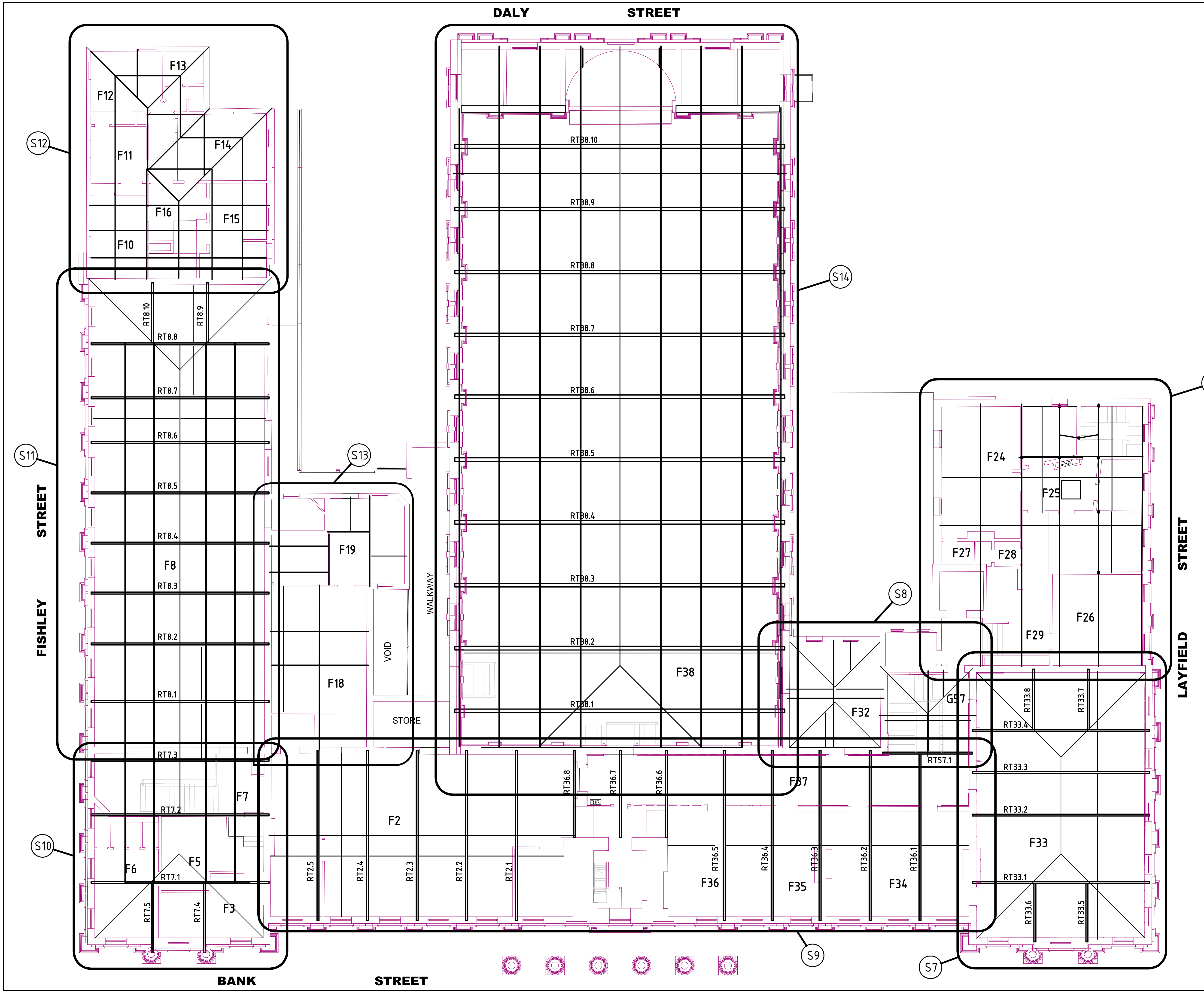
Drawing Title
GROUND FLOOR ROOF KEY PLAN

Client
CITY OF PORT PHILLIP

Project
SOUTH MELBOURNE TOWN HALL DETAILED ROOF INVESTIGATION

Designed	Date
-	OCT 2020
Drawn: B LITTLE	Scale (@ A1): 1:100 1:20

220014 S1 of 14 -



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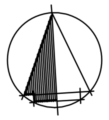
Drawing Title
FIRST FLOOR ROOF
KEY PLAN

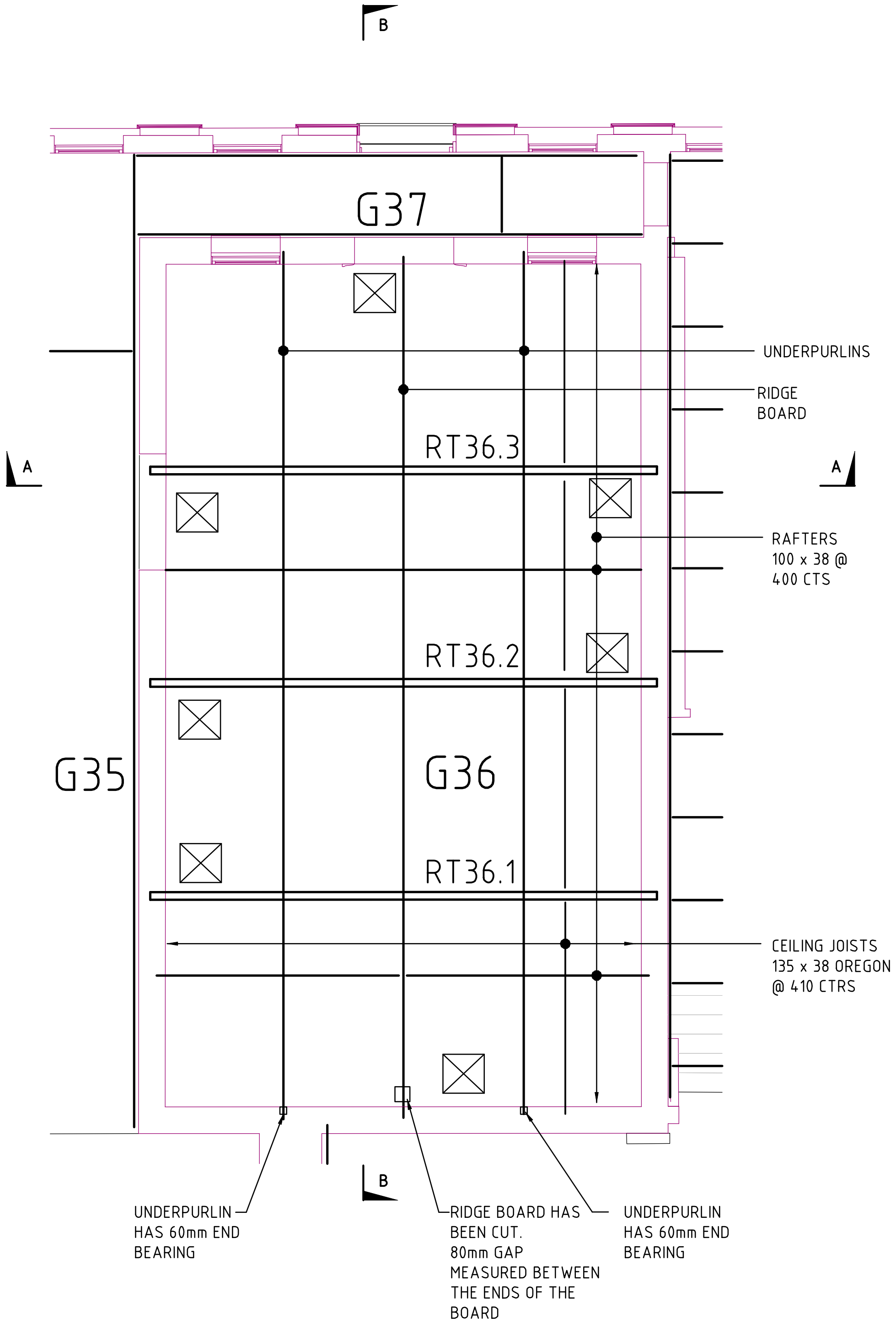
Client
CITY OF PORT PHILLIP

Project
SOUTH MELBOURNE TOWN HALL
DETAILED ROOF INVESTIGATION

Designed	-	Date	OCT 2020
Drawn	B LITTLE	Scale (@ A1)	1:100 1:20

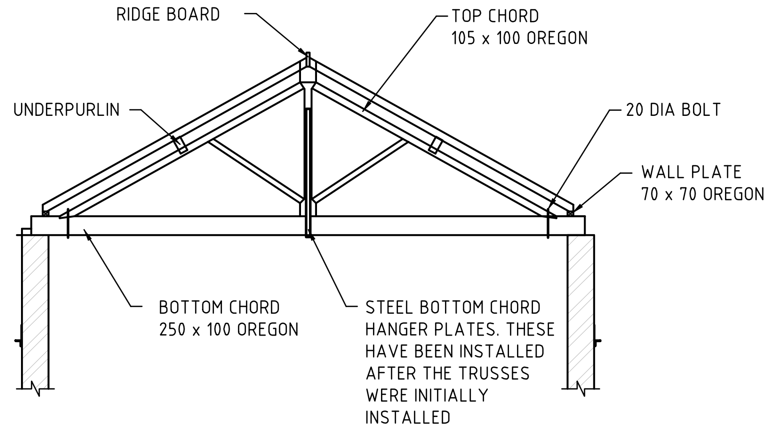
220014 S2 of 14 -



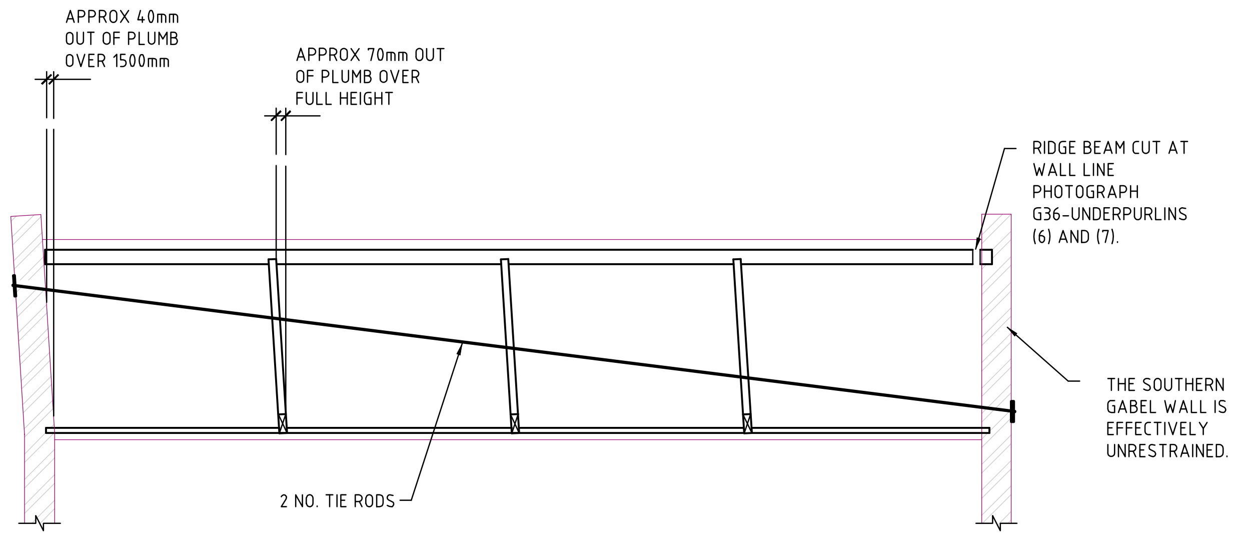


ROOF PLAN

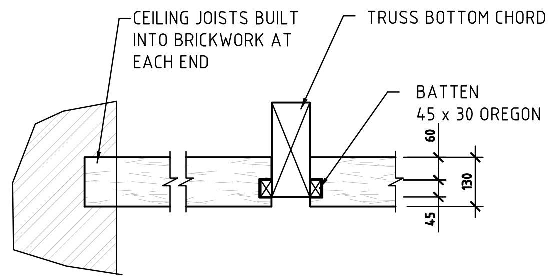
☒ INSPECTION POINTS.
ACCESS TO THE INSPECTION POINTS WAS PROVIDE BY LAYING ALUMINIUM SCAFFOLDING PLANKS BETWEEN THE TRUSSES PROVIDING A WALK/CRAWL WAY OUT TO THE ENDS OF THE TRUSSES.



SECTION A-A



SECTION B-B



CEILING JOIST DETAILS

PHOTOGRAPHS

CEILING JOISTS
G36-CEILING JOISTS-(1) TO (6)

NORTH WALL
G36-NORTH WALL-(1) TO (3)

RAFTERS
G36-RAFTERS-(1) TO (7)

SOUTH WALL
G36-SOUTH WALL-(1)

TRUSSES
G36-TRUSSES-(1) TO (17)

UNDERPURLINS
G36-UNDERPURLINS-(1) TO (8)

DEFECTS

1) CEILING JOISTS CONNECTIONS TO TRUSS BOTTOM CHORDS.

2) STABILITY OF NORTH WALL GABLE.

3) STABILITY OF SOUTH WALL GABLE.

Rev	Date	Description
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Drawing Title
G36-BALLANTYNE ROOM
ROOF FRAMING

Client
CITY OF PORT PHILLIP

Project
SOUTH MELBOURNE TOWN HALL
DETAILED ROOF INVESTIGATION

Designed	-	Date	OCT 2020
Drawn	B LITTLE	Scale (@ A1)	1:100 1:20

220014 S3 of 14 -

DALY STREET

FROM THE INSPECTION ACCESS POINT, THIS WALL IS NOT TIED INTO THE ROOF FRAMING STRUCTURE. THE WALL IS 230TH BRICKWORK AND SHOULD HAVE AN EAVES TIE.

PHOTOGRAPHS G34-2- (1)

PHOTOGRAPHS G35-1- (1) TO (6)

PHOTOGRAPHS G37.1

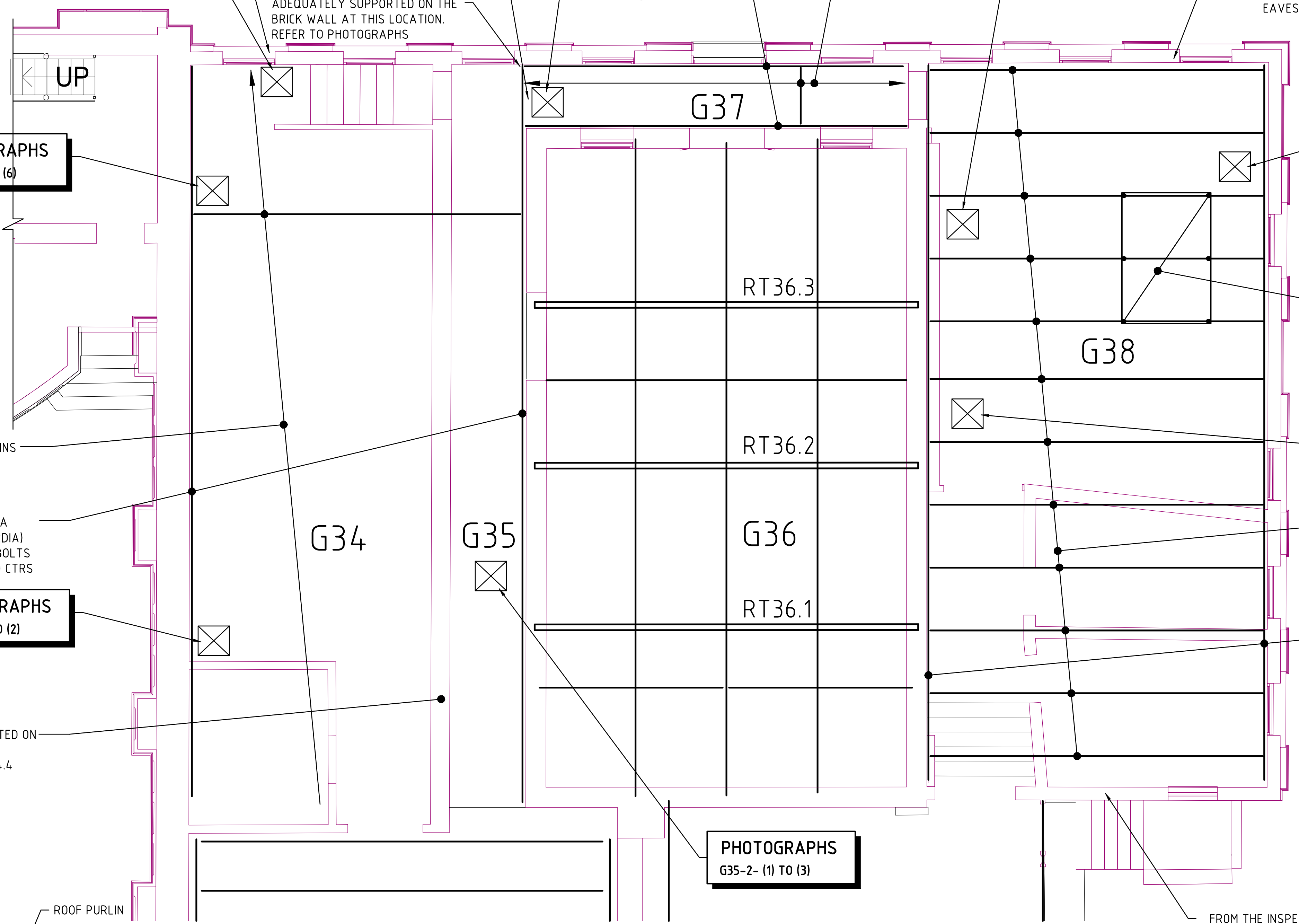
NOTE: RAKER IS NOT ADEQUATELY SUPPORTED ON THE BRICK WALL AT THIS LOCATION. REFER TO PHOTOGRAPHS

76x6 EA M10 (12DIA) DYNABOLTS @ 1200 CTRS

C100 PURLINS @ 1200 CTRS

PHOTOGRAPHS G38-1- (1) TO (5)

FROM THE INSPECTION ACCESS POINT, THIS WALL DOES NOT APPEAR TO BE TIED INTO THE ROOF FRAMING STRUCTURE. THE WALL IS 230TH BRICKWORK AND SHOULD HAVE AN EAVES TIE.



PHOTOGRAPHS G34-1- (1) TO (6)

PHOTOGRAPHS G38-3- (1) TO (4)

AIRCONDITIONING AIR HANDLING UNIT ON STEEL FRAME SUPPORTED ON TUBE LEGS ON THE PURLINS.

C20012/15? PURLINS @ 1200 CTRS

76x6 EA M10 (12DIA) DYNABOLTS @ 1200 CTRS

PHOTOGRAPHS G38-2- (1) TO (3)

C20012/15? PURLINS @ 1200 CTRS

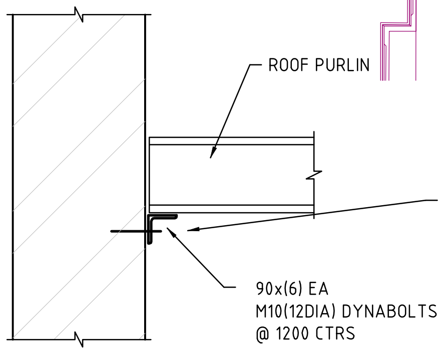
76x6 EA M10(12DIA) DYNABOLTS @ 1200 CTRS

PHOTOGRAPHS G34-3- (1) TO (2)

PURLINS SUPPORTED ON WALL REFER TO PHOTOGRAPH G34.4

PHOTOGRAPHS G35-2- (1) TO (3)

FROM THE INSPECTION ACCESS POINTS, WE WERE NOT ABLE TO INSPECT THIS WALL. HOWEVER BASED ON THE NORTH WALL IT IS UNLIKELY THAT THIS WALL IS TIED INTO THE ROOF FRAMING SYSTEM. THE WALL IS 230TH BRICKWORK AND SHOULD HAVE AN EAVES TIE.
IF THE ORIGINAL DESIGN DRAWINGS ARE AVAILABLE THE LATERAL SUPPORT OF THE WALL CAN BE CONFIRMED.



AS THE RAKER IS INSTALLED ALONG THE FALL OF THE ROOF THE HEIGHT OF THE DYNABOLT INTO THE BRICK WILL VARY ALONG THE LENGTH OF THE WALL. THEREFORE SOME OF THE BOLTS WILL BE INSTALLED ADJACENT TO THE EDGE OF THE BRICK. THIS WILL HAVE A SIGNIFICANT IMPACT ON THE CAPACITY OF THE ANCHORS.
IN OUR OPINION THESE ANCHORS ARE TOO SMALL IN PARTICULAR WHERE THEY ARE SUPPORTING THE AC UNIT.

PURLIN /RAKER TO BRICK WALL CONNECTION DETAIL

ROOF PLAN

☒ INSPECTION POINTS.
ACCESS TO THE INSPECTION POINTS WAS OFF LADDER.
ACCESS WAS PROVIDED THROUGH EXISTING ACCESS HATCHES OR NEW HOLES CUT IN THE CEILING

DEFECTS

1) ADDITIONAL SUPPORT OF THE AC UNIT ON THE ROOF SHOULD BE PROVIDED.

2) ADDITIONAL ANCHORS SHOULD BE PROVIDED TO THE WALL RACKER WHERE THE EXISTING 12 DIA DYNA BOLTS ARE INSTALLED CLOSE TO THE EDGE OF THE BRICKS

3) NORTH AND SOUTH WALLS SHOULD HAVE AN EAVES TIE INSTALLED. (REVIEW ORIGINAL DESIGN DRAWINGS TO DETERMINE HOW RESTRAINT WAS TO BE PRIVIDED)

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A	3/12/2020	REPORT ISSUE

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Drawing Title: G34/G35/G37/G38 ROOF FRAMING

Client: CITY OF PORT PHILLIP

Project: SOUTH MELBOURNE TOWN HALL DETAILED ROOF INVESTIGATION

Designed	-	Date	OCT 2020
Drawn	B LITTLE	Scale (@ A1)	1:100 1:20

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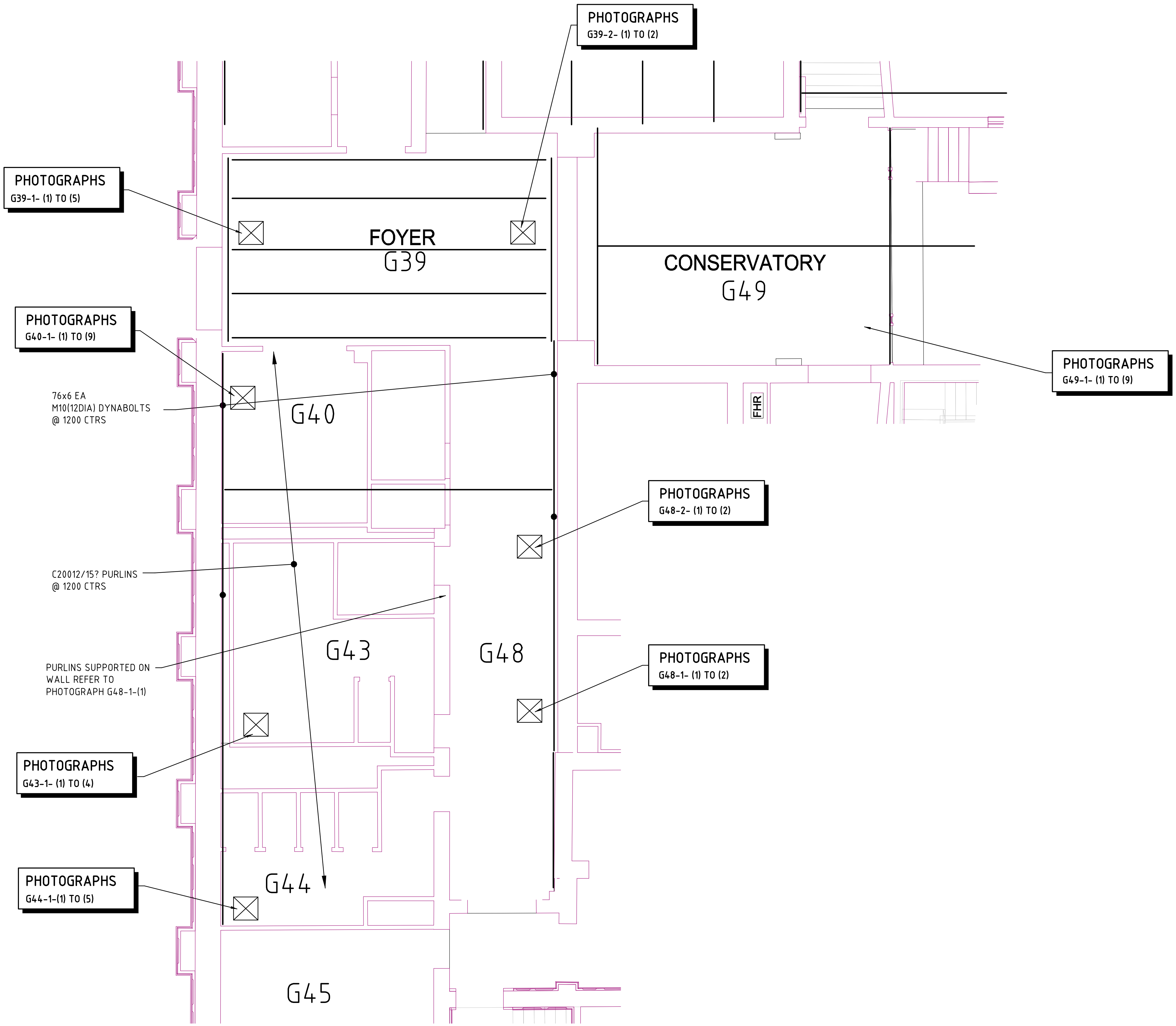

ROOF PLAN

INSPECTION POINTS.
ACCESS TO THE INSPECTION POINTS WAS OFF LADDERS OR SCAFFOLDING.
ACCESS WAS PROVIDED THROUGH EXISTING ACCESS HATCHES OR NEW HOLES CUT IN THE CEILING

DEFECTS

1) ADDITIONAL ANCHORS SHOULD BE PROVIDED TO THE WALL RACKER WHERE THE EXISTING 12 DIA DYNA BOLTS ARE INSTALLED CLOSE TO THE EDGE OF THE BRICKS

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Drawing Title
TOILETS/FOYER & CONSERVATORY ROOF FRAMING

Client
CITY OF PORT PHILLIP

Project
SOUTH MELBOURNE TOWN HALL
DETAILED ROOF INVESTIGATION

Designed	-	Date	OCT 2020
Drawn	B LITTLE	Scale (@ A1)	1:100 1:20

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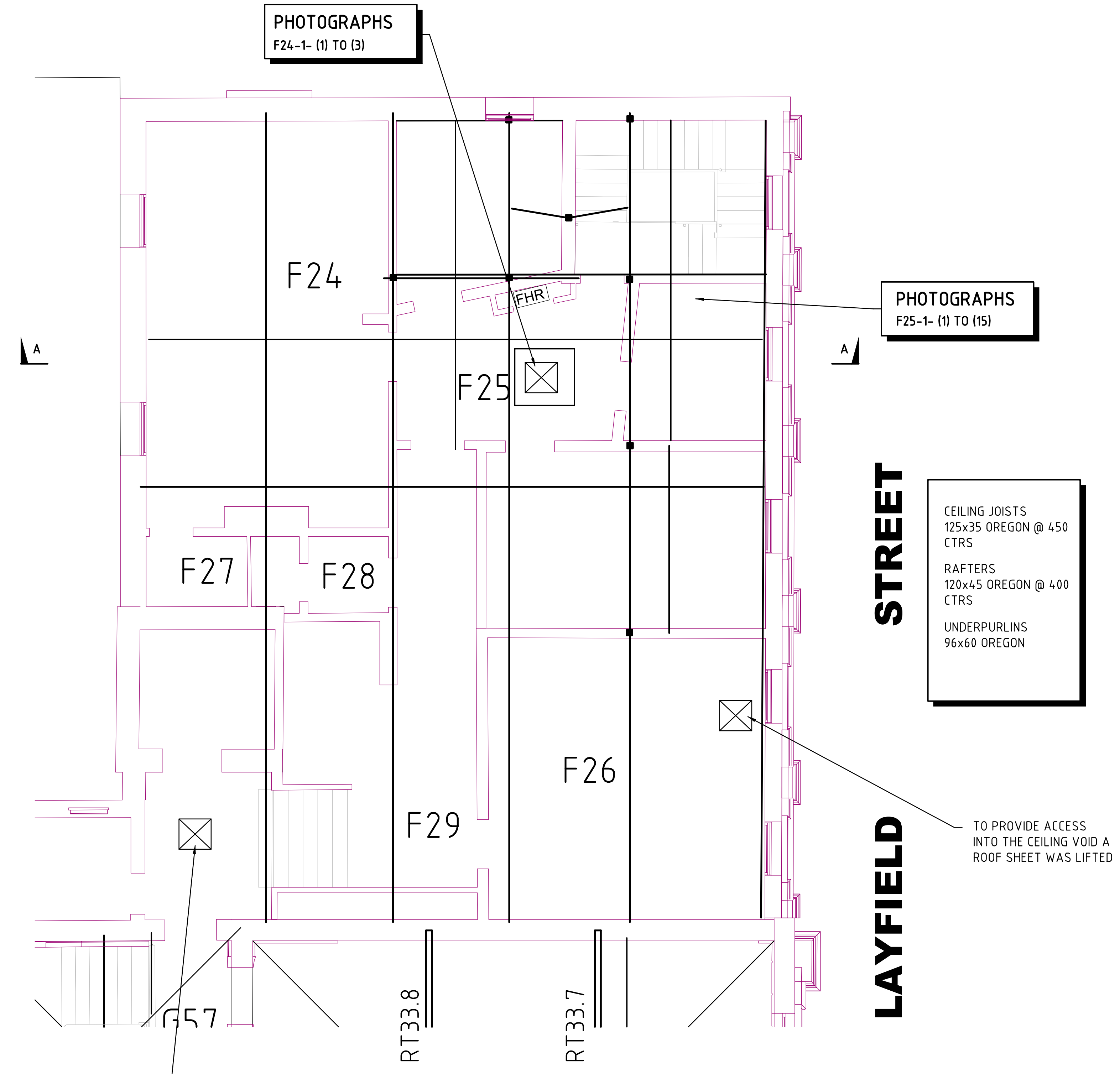
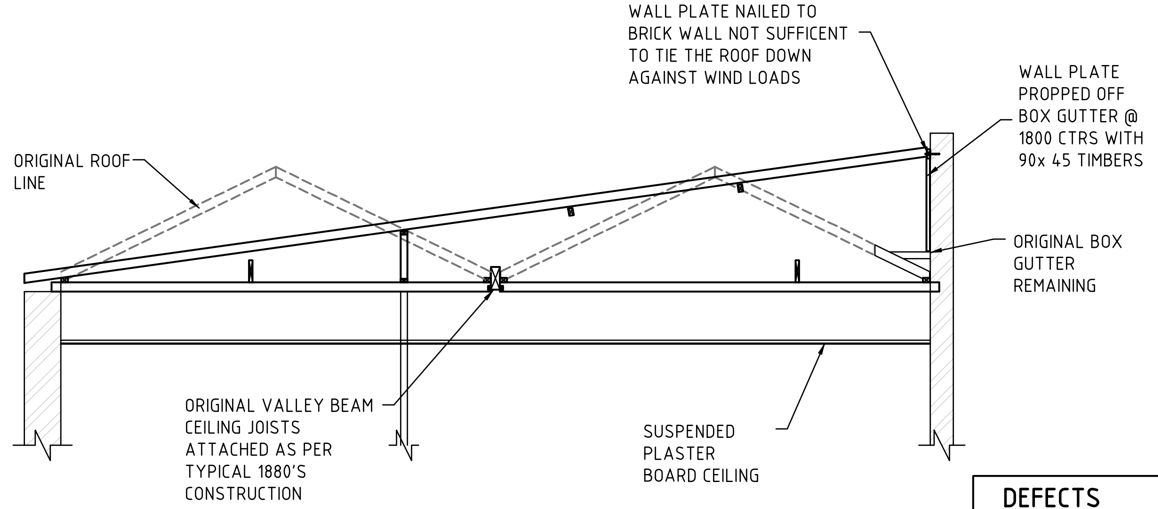


ROOF PLAN

INSPECTION POINTS.
ACCESS TO THE INSPECTION POINTS WAS OFF LADDERS OR SCAFFOLDING.
ACCESS WAS PROVIDED THROUGH EXISTING ACCESS HATCHES OR NEW HOLES CUT IN THE CEILING



SECTION A-A

DEFECTS

1) WALL PLATE ON EAST WALL NOT ADEQUATELY ATTACHED TO THE WALL TO RESIST WIND UPLIFT.

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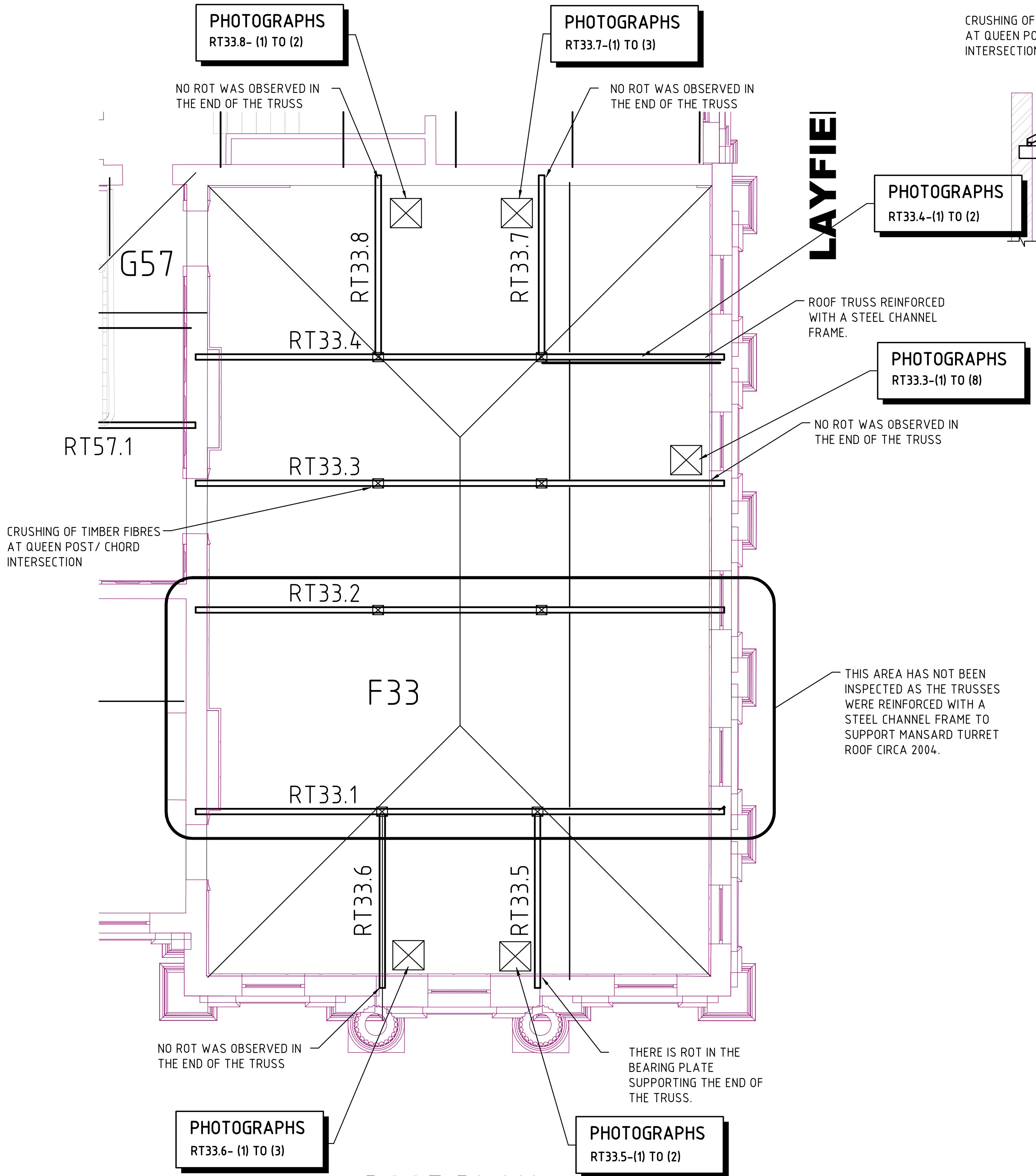
Drawing Title
F24/F25/F26/F27/F28/F29 ROOF FRAMING

Client
CITY OF PORT PHILLIP

Project
SOUTH MELBOURNE TOWN HALL DETAILED ROOF INVESTIGATION

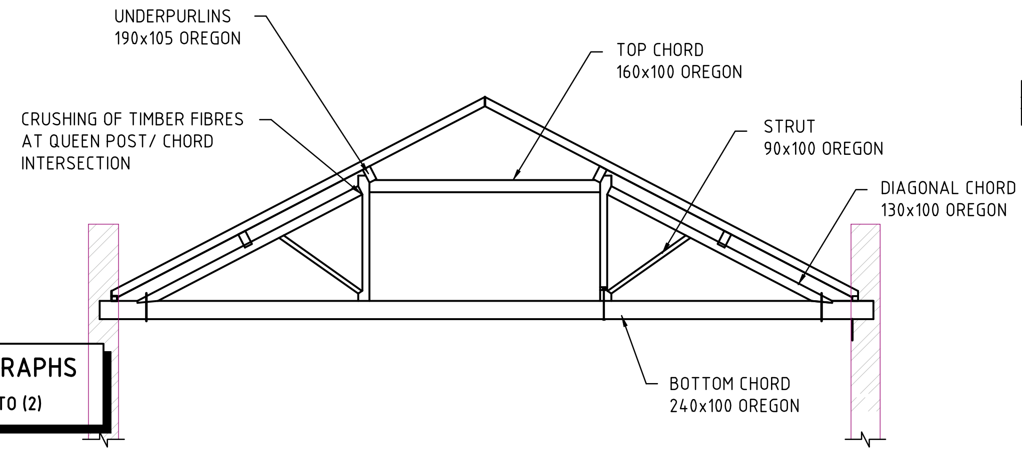
Designed	-	Date	OCT 2020
Drawn	B LITTLE	Scale (@ A1)	1:100 1:20

220014 S6 of 14 -

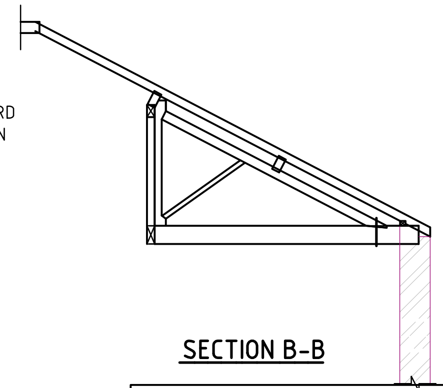


ROOF PLAN

☒ INSPECTION POINTS.
ACCESS TO THE INSPECTION POINTS WAS PROVIDE BY LAYING ALUMINIUM SCAFFOLDING PLANKS BETWEEN THE TRUSSES PROVIDING A WALK/CRAWL WAY OUT TO THE ENDS OF THE TRUSSES.



SECTION A-A



SECTION B-B

DEFECTS

1) CEILING JOISTS CONNECTIONS TO TRUSS BOTTOM CHORDS.
2) ROT AT THE END OF RT33.5 WHERE BUILT INTO THE WALL.STABILITY OF NORTH WALL GABLE.

Rev	Date	Description
A	3/12/2020	REPORT ISSUE

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Drawing Title
G33-CHAMBERS
ROOF FRAMING

Client
CITY OF PORT PHILLIP

Project
SOUTH MELBOURNE TOWN HALL
DETAILED ROOF INVESTIGATION

Designed	Date
-	OCT 2020
Drawn: B LITTLE	Scale (@ A1): 1:100 1:20

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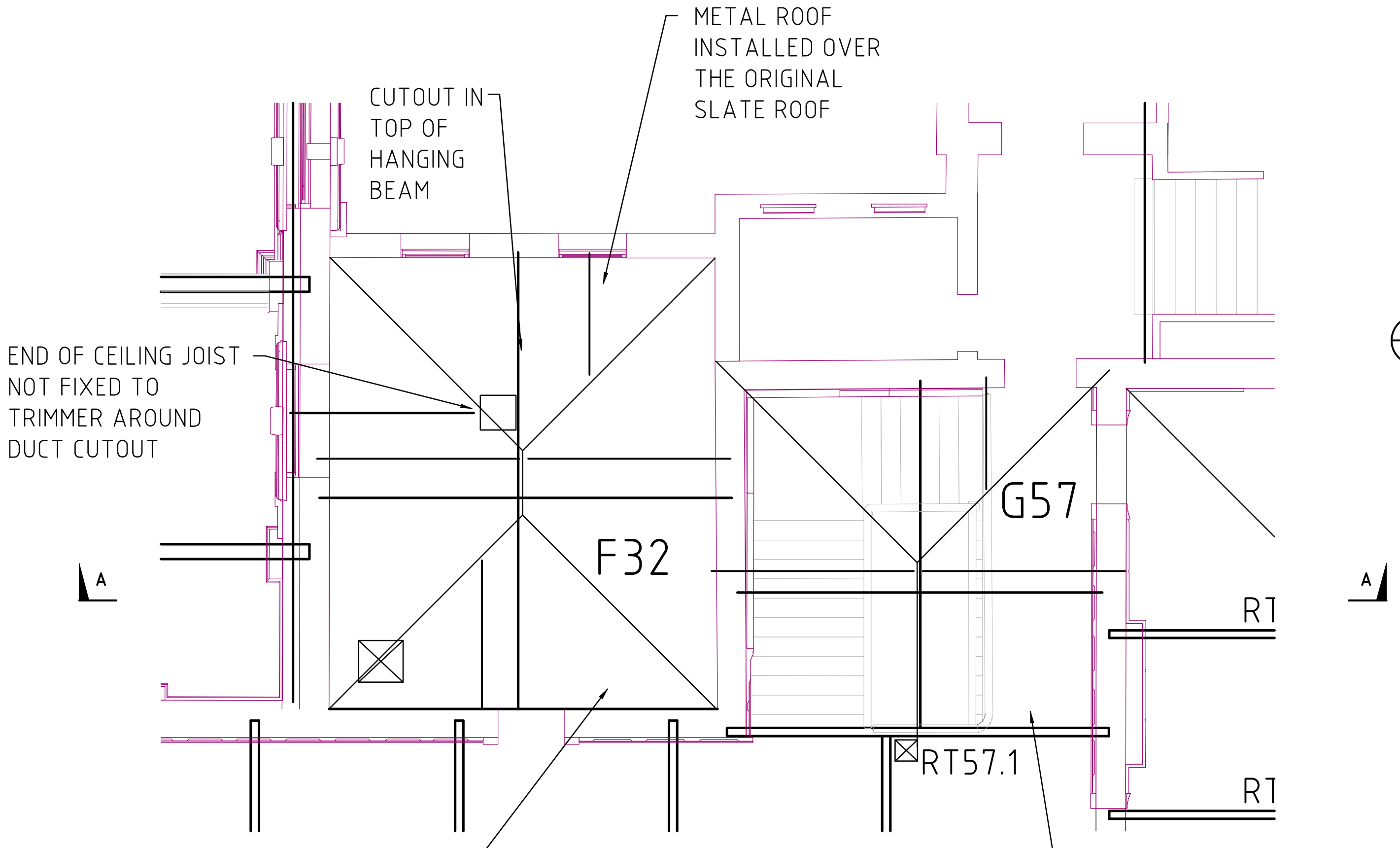


PHOTOGRAPHS

F32-1- (1) TO (13)

ROOF PLAN

☒ INSPECTION POINTS.
ACCESS TO THE INSPECTION POINTS WAS PROVIDE BY LAYING ALUMINIUM SCAFFOLDING PLANKS BETWEEN THE TRUSSES PROVIDING A WALK/CRAWL WAY OUT TO THE ENDS OF THE TRUSSES.

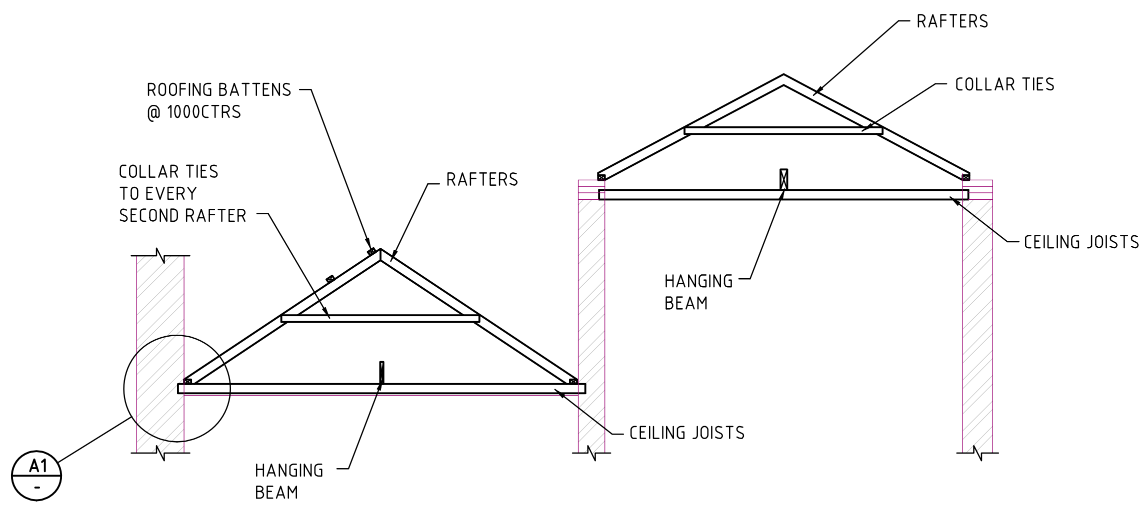
PHOTOGRAPHS

CEILING JOISTS
G57-CEILING JOISTS-(1) TO (2)

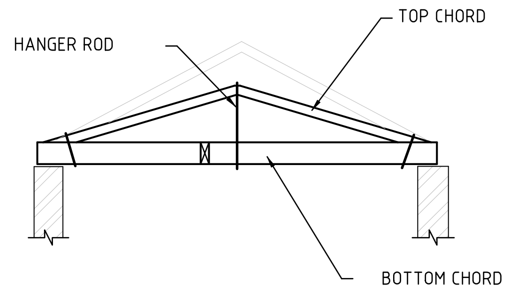
RAFTERS
G57-RAFTERS-(1) TO (2)

TRUSSES
G57-TRUSSES-(1) TO (6)

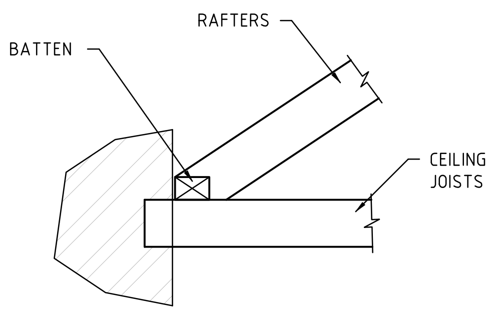
HANGING BEAM
G57-HANGING BEAM-(1) TO (5)



SECTION A-A



ROOF TRUSS RT57.1 ELEVATION



DETAIL A1 -

DEFECTS

1) HANGING BEAM NOTCHED FOR FIRE SERVICE.

2) CEILING JOIST NOT ATTACHED AT TRIMMER.

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Drawing Title: F32 AND G57 STAIR ROOF FRAMING

Client: CITY OF PORT PHILLIP

Project: SOUTH MELBOURNE TOWN HALL DETAILED ROOF INVESTIGATION

Designed	-	Date	OCT 2020
Drawn	B LITTLE	Scale (@ A1)	1:100 1:20

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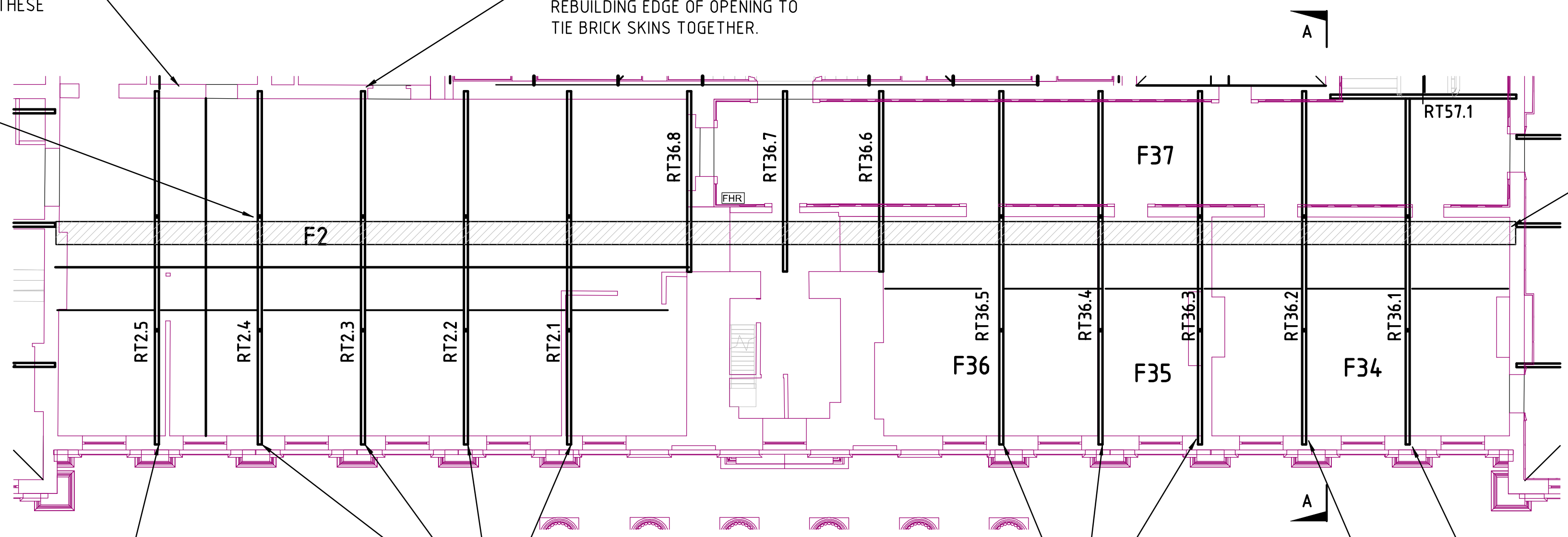


NO ROT OBSERVED IN THE NORTH END OF THESE TRUSSES

AN OPENING HAS BEEN BROKEN OUT IN THIS WALL FOR AN AC DUCT. MAKE GOOD BRICKWORK BY REBUILDING EDGE OF OPENING TO TIE BRICK SKINS TOGETHER.

FAILED QUEEN POST TO BOTTOM CHORD CONNECTION

ACCESS WAY

THIS TRUSS HAS BEEN REINFORCED WITH A STEEL FRAME

THESE TRUSSES HAVE ROT IN THE END OF THE BOTTOM CHORD WHERE IT IS BUILT INTO THE BRICKWORK. THE TRUSS WILL NEED TO BE MADE GOOD. THEY WERE BACK PROPPED AS PART OF THE PREVIOUS INSPECTION WORK.

ROOF PLAN

THESE THREE TRUSSES HAVE BEEN REINFORCED WITH STEEL FRAMES AS PART OF THE CIRCA 2004 MANSARD ROOF WORKS. THEY WERE INSPECTED VISUALLY FROM THE ACCESS WAY AND THE STEEL REINFORCING CHANNEL HAS BEEN BUILT INTO THE BRICKWORK TO SUPPORT THE TRUSSES

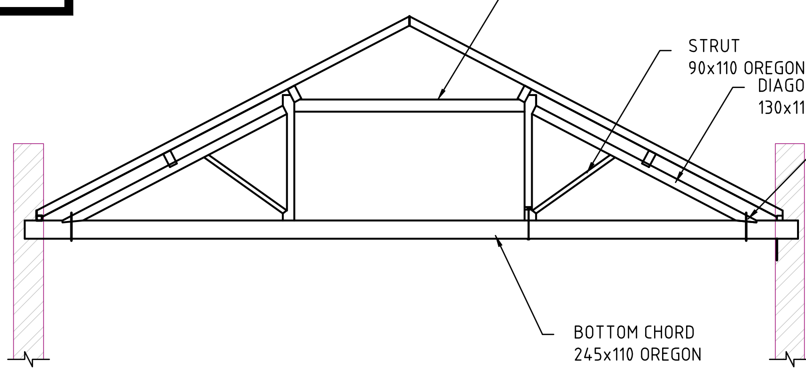
THE END OF THIS TRUSS HAS ROT IN THE END OF THE BOTTOM CHORD WHERE IT IS BUILT INTO THE BRICKWORK. THE TRUSS WILL NEED TO BE MADE GOOD

THE END OF THIS TRUSS HAS CONSIDERABLE ROT IN THE END OF THE BOTTOM CHORD WHERE IT IS BUILT INTO THE BRICKWORK. TO HELP SUPPORT THIS TRUSS A PROP AND SPREADER BEAM WAS ADDED UNDER THE TRUSS

PHOTOGRAPHS
RT2.1-NORTH/SOUTH- (X) TO (Y)
RT2.2-NORTH/SOUTH- (X) TO (Y)
RT2.3-NORTH/SOUTH- (X) TO (Y)
RT2.5-NORTH/SOUTH- (X) TO (Y)
F2- CEILING JOISTS- (X) TO (Y)

PHOTOGRAPHS
RT36.2-1- (1) TO (X)

PHOTOGRAPHS
F36.1- (1) TO (X)



SECTION A-A

DEFECTS

1) CEILING JOISTS CONNECTIONS TO TRUSS BOTTOM CHORDS.

2) METAL ROOF NOT ADEQUATELY TIED DOWN.

3) ROT IN THE BOTTOM CHORD OF TRUSSES WHERE BUILT INTO THE WALL ALONG THE SOUTH FACADE.

4) FAIL QUEEN POST TO BOTTOM CHORD CONNECTION RT2.4.

5) AS THE BOTTOM CHORD OF THE ROOF TRUSSES WHERE BEARING ON THE WALL HAS MOSTLY ROTTED AWAY THE WALL IS NO LONGER TIED INTO THE ROOF FRAMING.

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Drawing Title
F2 , F34/F35/F36/F37 ROOF FRAMING

Client
CITY OF PORT PHILLIP

Project
SOUTH MELBOURNE TOWN HALL DETAILED ROOF INVESTIGATION

Designed	-	Date	OCT 2020
Drawn	B LITTLE	Scale (@ A1)	1:100 1:20

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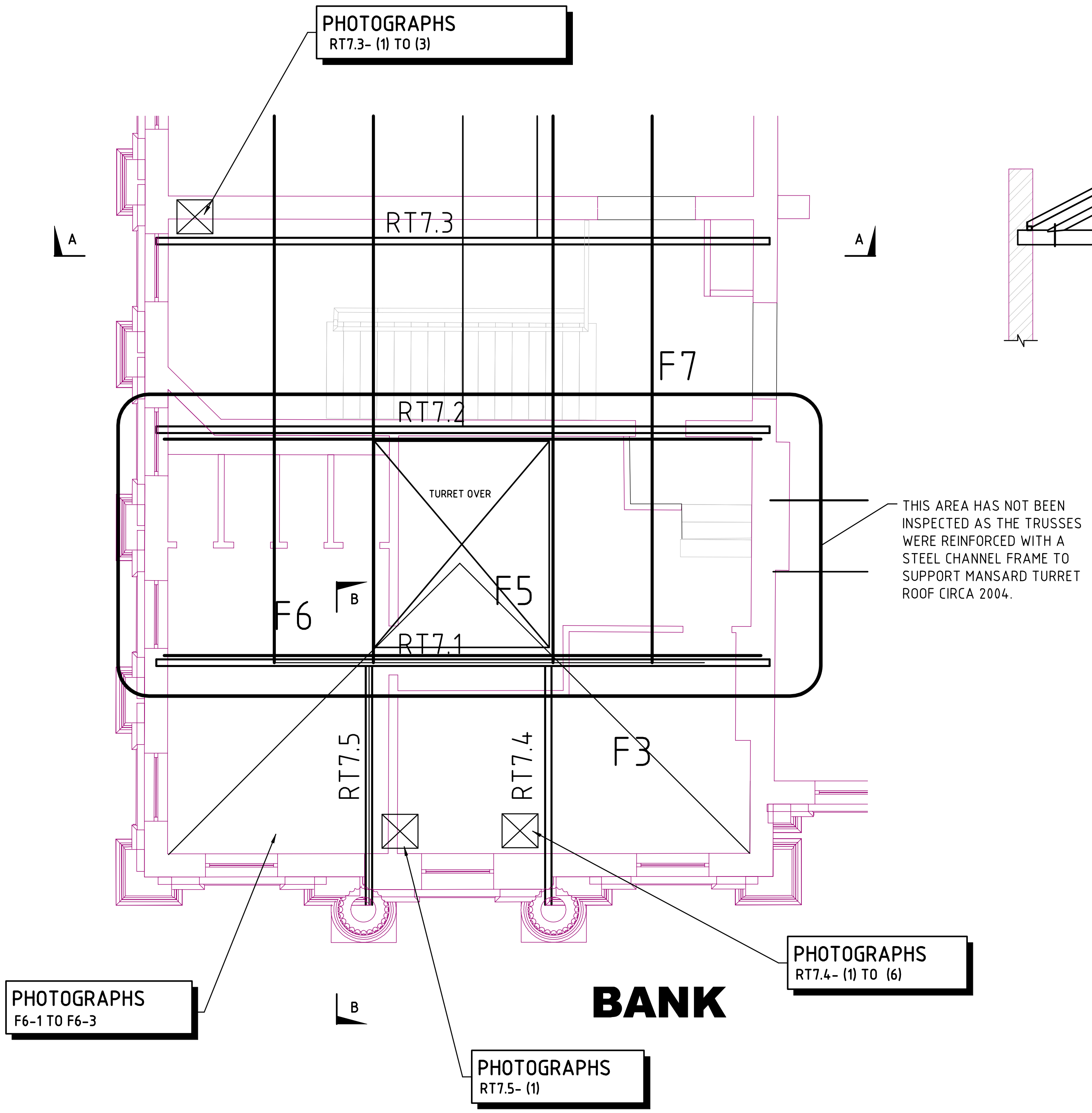
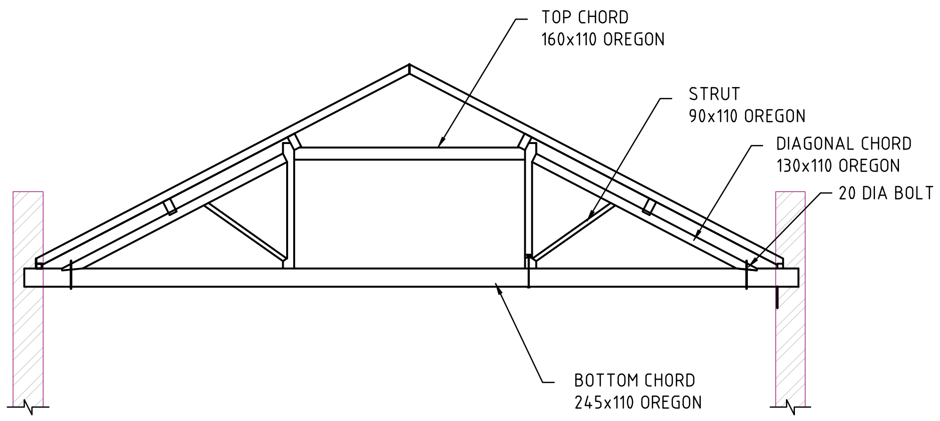
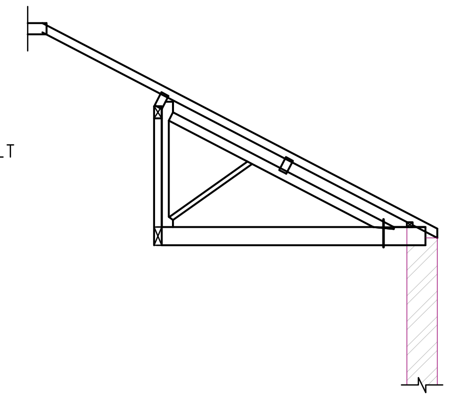


ROOF PLAN

☒ INSPECTION POINTS.
ACCESS TO THE INSPECTION POINTS WAS PROVIDE BY LAYING ALUMINIUM SCAFFOLDING PLANKS BETWEEN THE TRUSSES PROVIDING A WALK/CRAWL WAY OUT TO THE ENDS OF THE TRUSSES.



SECTION A-A



SECTION B-B

DEFECTS

1) CEILING JOISTS CONNECTIONS TO TRUSS BOTTOM CHORDS.

2) METAL ROOF TIE DOWN IS NOT ADEQUATE.

Rev	Date	Description
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Drawing Title
F3/F4/F5/F6/F7
ROOF FRAMING

Client
CITY OF PORT PHILLIP

Project
SOUTH MELBOURNE TOWN HALL
DETAILED ROOF INVESTIGATION

Designed	-	Date	OCT 2020
Drawn	B LITTLE	Scale (@ A1)	1:100 1:20

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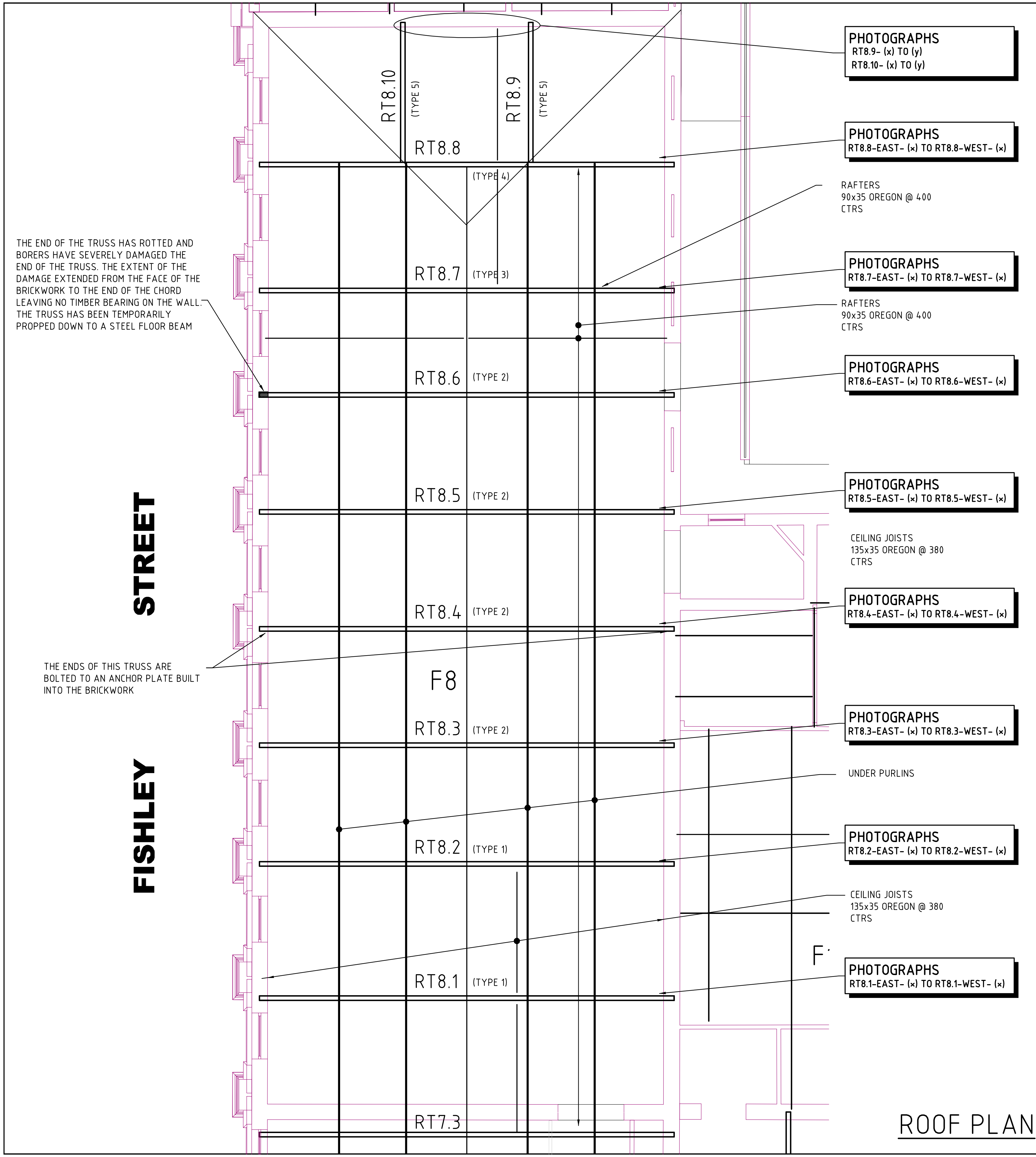
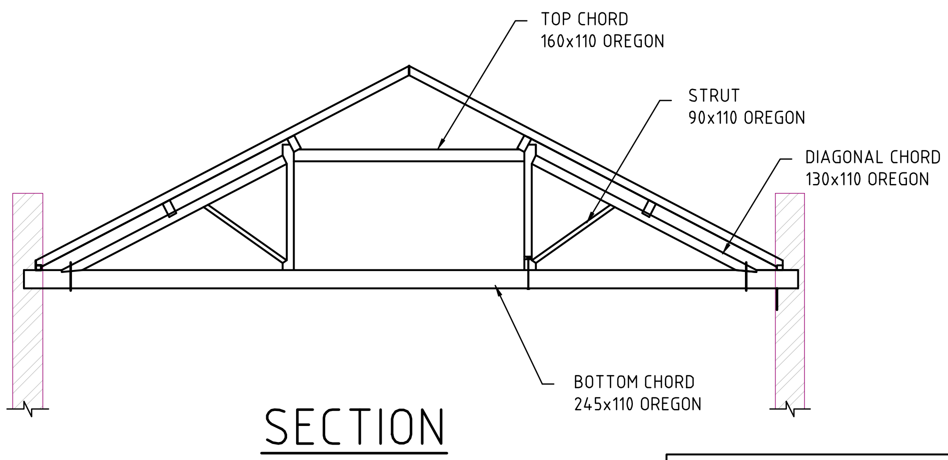


ROOF PLAN



SECTION

DEFECTS

1) CEILING JOISTS CONNECTIONS TO TRUSS BOTTOM CHORDS.

2) STABILITY OF WEST WALL IS QUESTIONABLE.

3) METAL ROOF NOT ADEQUATELY TIED DOWN.

4) RT8.6 - ROT AT WEST END OF TRUSS WHERE BUILT INTO THE WALL.

Rev	Date	Description
A	3/12/2020	REPORT ISSUE

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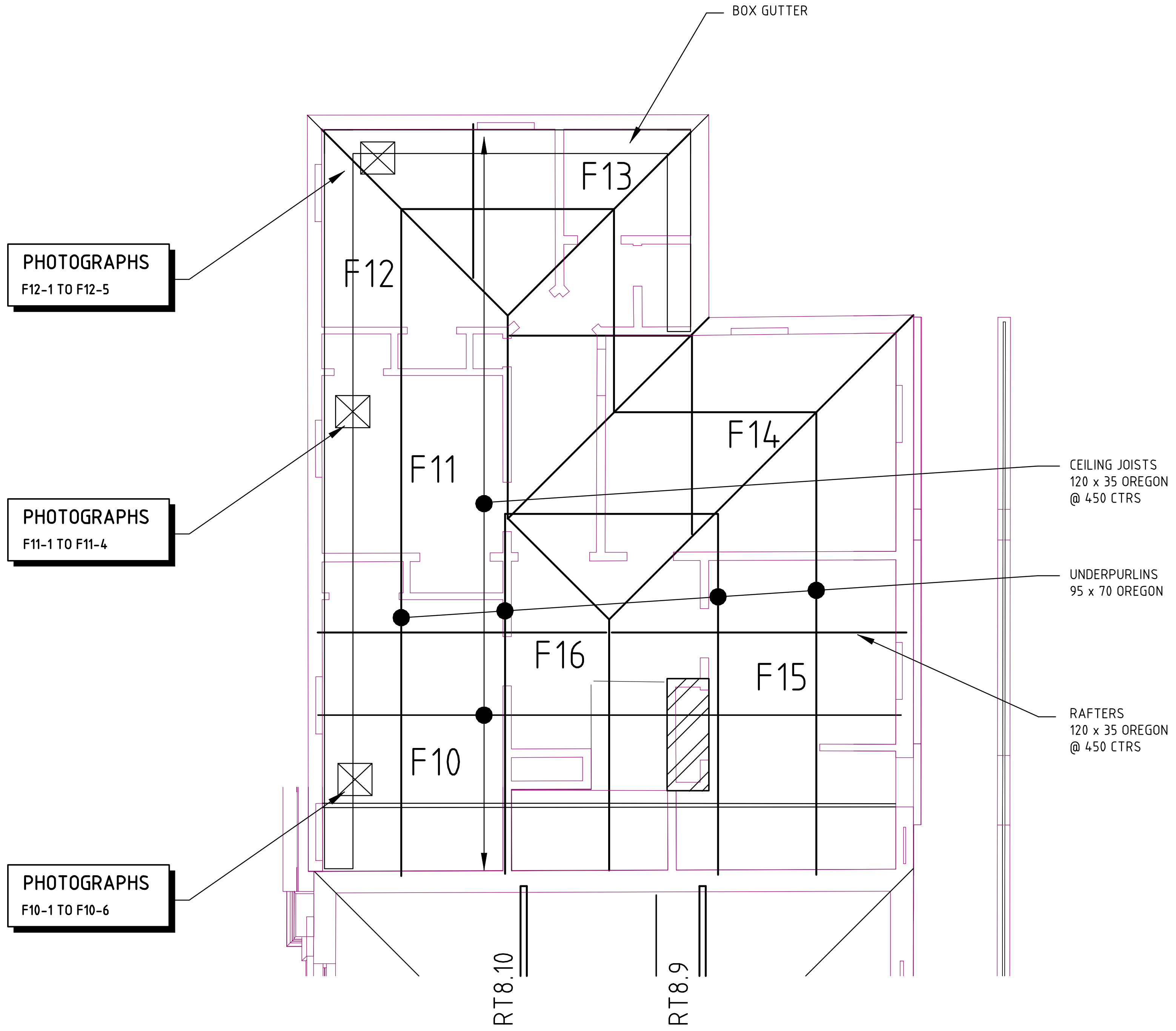
Drawing Title
F8
ROOF FRAMING

Client
CITY OF PORT PHILLIP

Project
SOUTH MELBOURNE TOWN HALL
DETAILED ROOF INVESTIGATION

Designed	Date
-	OCT 2020
Drawn: B LITTLE	Scale (@ A1): 1:100 1:20

220014 S11 of 14 -



ROOF PLAN

INSPECTION HOLES CUT IN THE CEILING.

PHOTOGRAPHS
F16-ROOF- (1) TO (16)

DEFECTS

1) NOTHING OF NOTE.

Rev	Date	Description
A	3/12/2020	REPORT ISSUE

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Drawing Title
F10/F11/F12/F13/F14/F15/F16
APARTMENTS
ROOF FRAMING

Client
CITY OF PORT PHILLIP

Project
SOUTH MELBOURNE TOWN HALL
DETAILED ROOF INVESTIGATION

Designed	-	Date	OCT 2020
Drawn	B LITTLE	Scale (@ A1)	1:100 1:20

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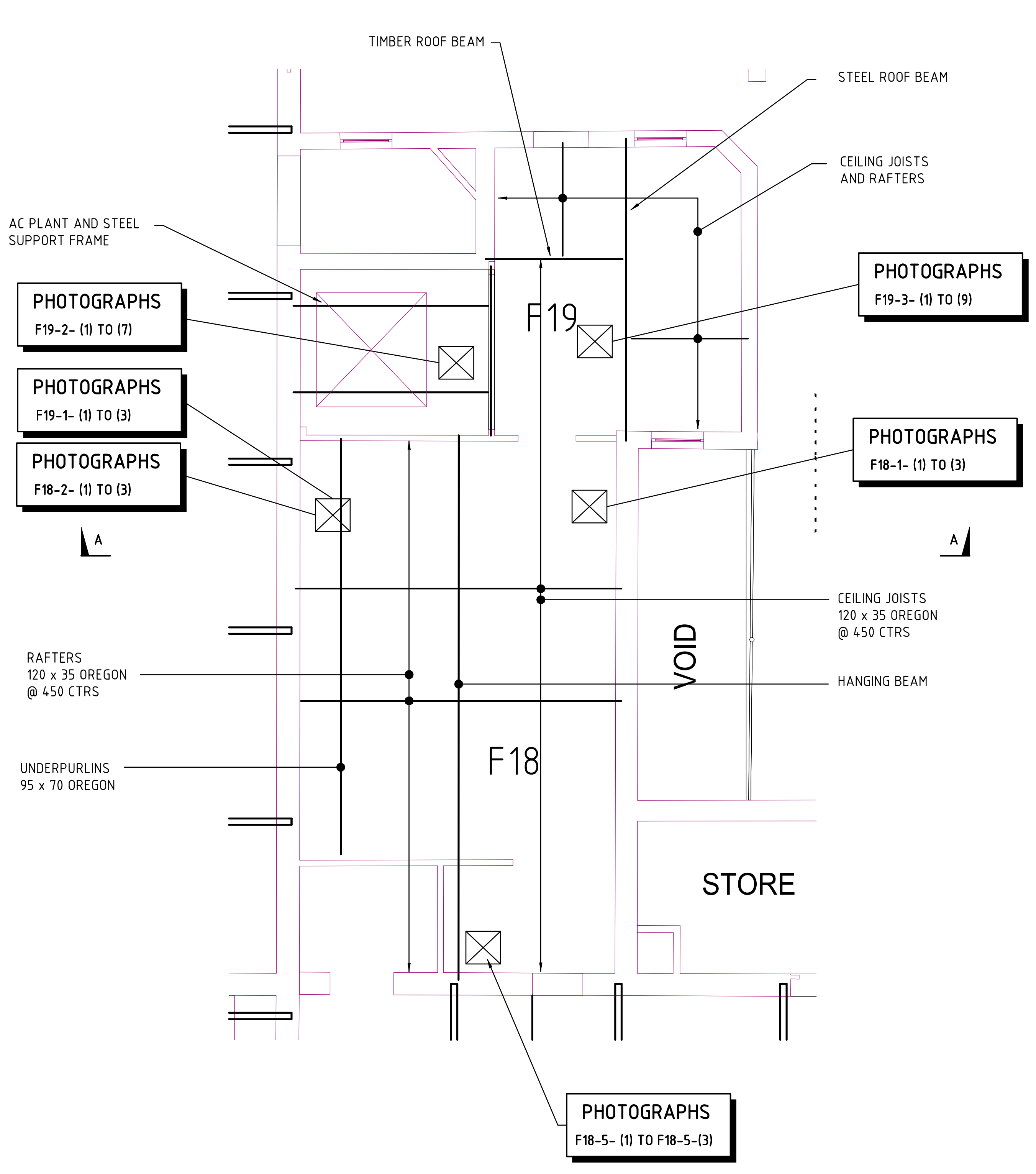
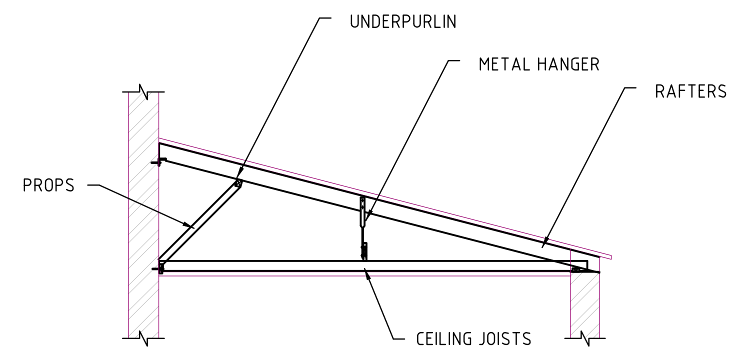


ROOF PLAN

INSPECTION HOLES CUT IN THE CEILING OR EXISTING.



SECTION A-A

DEFECTS

1) NOTHING OF NOTE.

Rev	Date	Description
A	3/12/2020	REPORT ISSUE

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Drawing Title
F18/F19
ROOF FRAMING

Client
CITY OF PORT PHILLIP

Project
SOUTH MELBOURNE TOWN HALL
DETAILED ROOF INVESTIGATION

Designed	-	Date	OCT 2020
Drawn	B LITTLE	Scale (@ A1)	1:100 1:20

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THIS WALL HAS A DIAGONAL CRACK IN IT. PRESUMABLY THIS WALL RESTRAINS THE NORTH WALL FACADE.

NO ROT WAS OBSERVED IN THE ENDS OF THE UNDERPURLINS WHERE THEY ARE BUILT INTO THE WALL. HOWEVER, THE UNDERPURLINS HAVE PULLED OUT OF THE WALL APPROXIMATELY 20mm INDICATING THE THE UNDERPURLINS ARE NOT TIED INTO THE BRICKWORK. PRESUMABLY THE UNDERPURLINS SHOULD BE BRACING/SUPPORTING THE TOP OF THE NORTH FACADE WALL

PHOTOGRAPHS
F38-NORTH WALL UNDERPURLINS- (1) TO (15)

A ROOF SHEET WAS LIFTED TO GET ACCESS TO THE ENDS OF THE UNDER PURLINS

THE UNDER PURLINS ARE SUPPORTED ON THE BRICKWALL ALONG THIS LINE. AS RT38.10 HAS DROPPED DUE TO ROT IN THE TIMBER BEARING PLATE THE UNDERPURLINS HAVE LIFTED OFF RT38.10.

CONSIDERABLE ROT AT THE END OF THIS TRUSS

PHOTOGRAPHS
RT38.10- (1) TO (5)

PHOTOGRAPHS
RT38.09-EAST- (1) TO (5)

CONSIDERABLE ROT AT THE END OF THIS TRUSS

PHOTOGRAPHS
RT38.08-EAST- (1) TO (2)

LINE OF SOUND AND LIGHTING BAR

UNDERPURLINS

ACCESS WAY
BATTENS TYING THE TWO BOARDS TOGETHER NEED TO BE REPAIRED WHERE THEY HAVE COME LOOSE.

UNDERSIDE OF TRUSS BOTTOM CHORD ROTTED AND BEARING PLATE ROTTED

PHOTOGRAPHS
RT38.03-EAST- (1) TO (5)

EAVES TIE BETWEEN TRUSSES ROTTED

MINOR ROT OBSERVED BUT IT APPEARED THE BEARING PLATE/ EAVES TIE HAD PREVIOUSLY ROTTED AND BEEN REPLACED WITH BRICKWORK

PHOTOGRAPHS
RT38.02-EAST- (1) TO (9)

PHOTOGRAPHS
RT38.01-EAST- (1)

PHOTOGRAPHS
RT38.09-WEST- (1)

PHOTOGRAPHS
RT38.08WEST- (1) TO (4)

PHOTOGRAPHS
RT38.07-WEST- (1) TO (6)

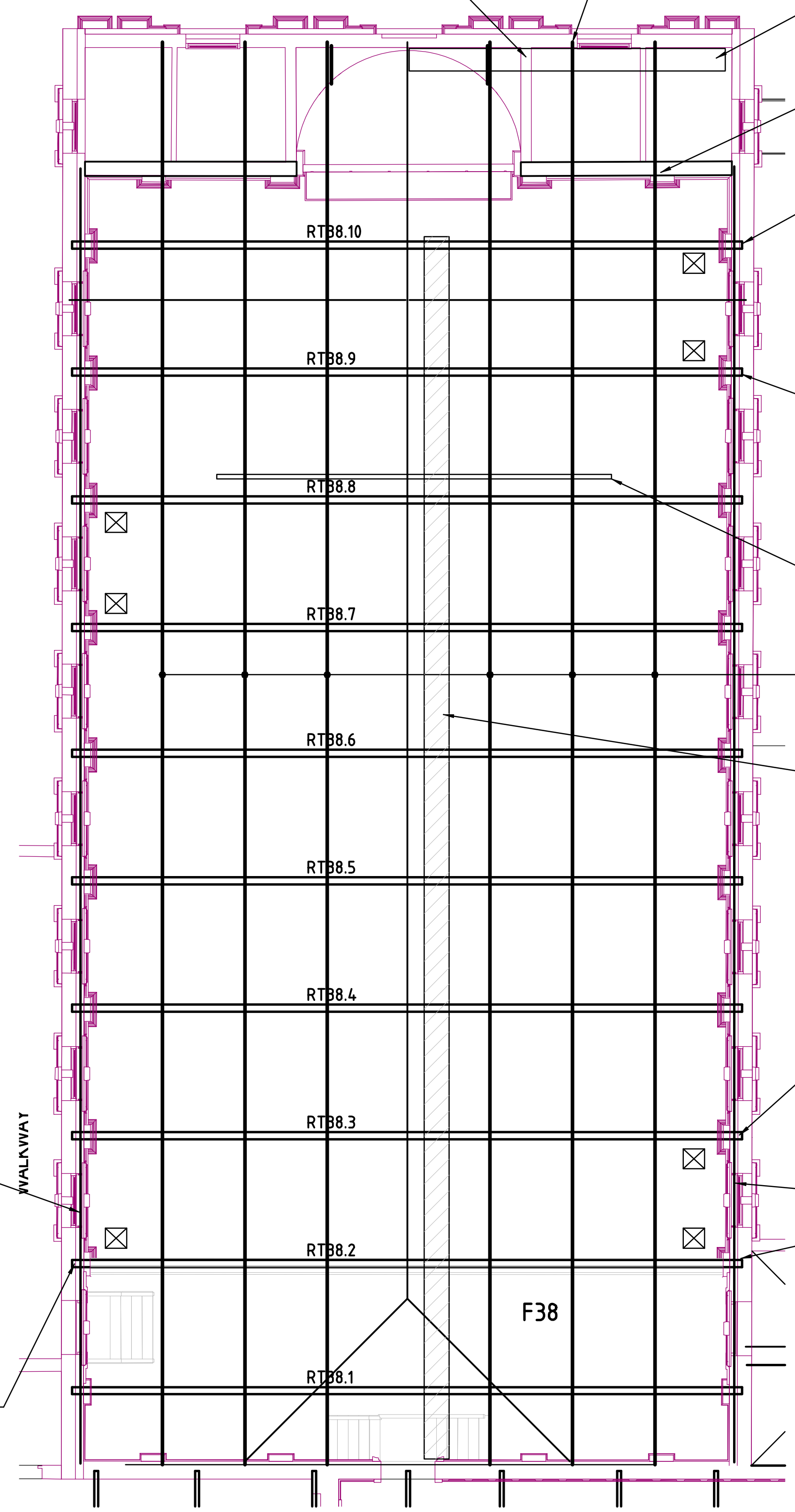
PHOTOGRAPHS
RT38.06-WEST (1) TO (3)

PHOTOGRAPHS
RT38.3-WEST- (1) TO (2)

CONSIDERABLE ROT IN THE EAVES TIE

PHOTOGRAPHS
RT38.02-WEST- (1) TO (10)

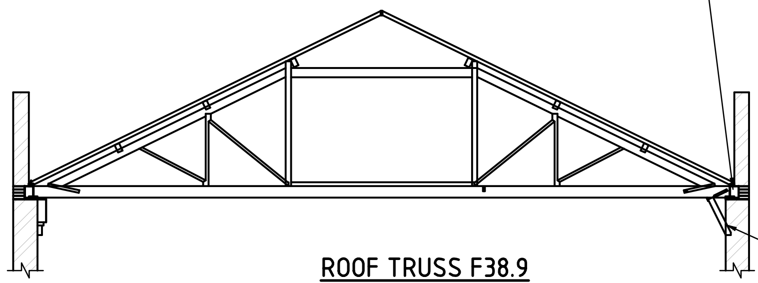
CONSIDERABLE ROT IN THE UNDERSIDE OF THE TRUSS BOTTOM CHORD AND BEARING/EAVES TIE



ROOF PLAN

⊠ INSPECTION POINTS.
ACCESS TO THE INSPECTION POINTS WAS PROVIDE BY LAYING ALUMINIUM SCAFFOLDING PLANKS BETWEEN THE TRUSSES PROVIDING A WALK/CRAWL WAY OUT TO THE ENDS OF THE TRUSSES.

BEARING PLATE HAS ROTTED UNDER THE TRUSS BOTTOM CHORD ALLOWING THE TRUSS TO BEAR DIRECTLY ON THE BRICKWORK.
THE BOTTOM 50mm (odd) OF THE TRUSS BOTTOM CHORD HAS ALSO ROTTED OVER THE BRICKWORK



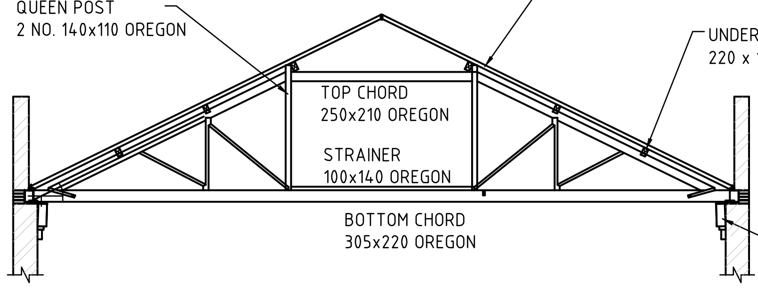
BRICK CORBLE PREVIOUSLY BROKEN AWAY FROM WALL AND A TIMBER PROP ADDED IN ITS' PLACE. JUDGING BY THE TYPE OF CONSTRUCTION THIS WAS MOST LIKELY DONE PRE 1940.

ROOF TRUSS F38.9

QUEEN POST
2 NO. 140x110 OREGON

RAFTERS
100x50 OREGON @ 420 CTRS

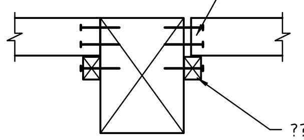
UNDERPURLINS
220 x 130 OREGON (TYP)



BRICK CORBEL CRACKED AND ROTATED AWAY FROM WALL. THIS HAS OCCURED ON BOTH SIDE OF THE BUILDING.

ROOF TRUSSES F38.1 TO F38.8 AND F38.10

TWO SKEW NAILS.



?? IS THERE A SILL PLATE UNDER THE ENDS OF THE CEILING JOISTS? THIS SHOULD BE CONFIRMED AS A TWO NAIL JOINT IS INCONSISTANT WITH THE REST OF THE STRUCTURE.

CEILING JOISTS TO TRUSS BOTTOM CHORD

FROM OUR INSPECTION, 2 SKEW NAILS WERE OBSERVED BETWEEN THE CEILING JOISTS AND THE TRUSS BOTTOM CHORD. IN SOME CASES THERE WAS A GAP OF 10mm BETWEEN THE END OF THE CEILING JOIST AND THE TRUSS. THE WORKING LOAD CAPACITY OF A SINGLE NAIL, IN A TIGHT JOINT, IS IN THE ORDER OF 50Kg. THIS WOULD BE SUFFICIENT TO SUPPORT THE WEIGHT OF THE CEILING BUT THE CEILING SHOULD NOT BE TRAFFICKED.
THERE MAY BE A SILL PLATE SUPPORTING THE CEILING JOISTS THAT WE DID NOT OBSERVE.

PHOTOGRAPHS
CEILING JOISTS
F38-CEILING JOISTS-(1) TO (6)

NORTH WALL
F38-NORTH WALL-(1) TO (3)

RAFTERS
F38-RAFTERS-(1) TO (7)

SOUTH WALL
F38-SOUTH WALL-(1)

TRUSSES
F38-TRUSSES-(1) TO (17)

UNDERPURLINS
F38-UNDERPURLINS-(1) TO (8)

DEFECTS
1) CEILING JOISTS CONNECTIONS TO TRUSS BOTTOM CHORDS.
2) STABILITY OF NORTH WALL GABLE.
3) TRUSS SUPPORT CORBLES FRACTURED AT CONNECTION WITH WALL.
4) ROT IN BOTTOM CHORD OF TRUSSES WHERE BUILT INTO THE WALL.
5) ACCESS WAY SHOULD HAVE THE BATTENS BETWEEN THE PLANKS REPAIRED.

Rev	Date	Description
A	3/12/2020	REPORT ISSUE

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infracorr

Drawing Title
F38-MAIN HALL ROOF FRAMING

Client
CITY OF PORT PHILLIP

Project
SOUTH MELBOURNE TOWN HALL DETAILED ROOF INVESTIGATION

Designed	-	Date	OCT 2020
Drawn	B LITTLE	Scale (@ A1)	1:100 1:20

220014 S14 of 14 -

APPENDIX B: PHOTOGRAPHS

F2-CEILING JOISTS- (1).JPG

F2-CEILING JOISTS- (2).JPG

F2-CEILING JOISTS- (3).JPG

F2-CEILING JOISTS REMOVED- (1).JPG


F2-CEILING JOISTS REMOVED- (2).JPG


F2-CEILING JOISTS REMOVED- (3).JPG


F2-CEILING JOISTS REMOVED- (4).JPG


F2-CEILING JOISTS REMOVED- (5).JPG


F6-1.JPG


F6-2.JPG


F6-3.JPG


F8-Ceiling Joists- (1).JPG

F8-Ceiling Joists- (2).JPG

F8-RAFTERS-(1).JPG

F8-Underpurlins- (1).JPG

F8-Underpurlins- (2).JPG


F10- (1).JPG


F10- (2).JPG


F10- (3).JPG


F10- (4).JPG

F10- (5).JPG

F10- (6).JPG

F11- (1).JPG

F11- (2).JPG


F11- (3).JPG


F11- (4).JPG


F12- (1).JPG


F12- (2).JPG


F12- (3).JPG


F12- (4).JPG


F12- (5).JPG


F16-ROOF- (1).JPG


F16-ROOF- (2).JPG


F16-ROOF- (3).JPG


F16-ROOF- (4).JPG

F16-ROOF- (5).JPG

F16-ROOF- (6).JPG

F16-ROOF- (7).JPG

F16-ROOF- (8).JPG

F16-ROOF- (9).JPG

F16-ROOF- (10).JPG

F16-ROOF- (11).JPG

F16-ROOF- (12).JPG

F16-ROOF- (13).JPG

F16-ROOF- (14).JPG

F16-ROOF- (15).JPG

F16-ROOF- (16).JPG

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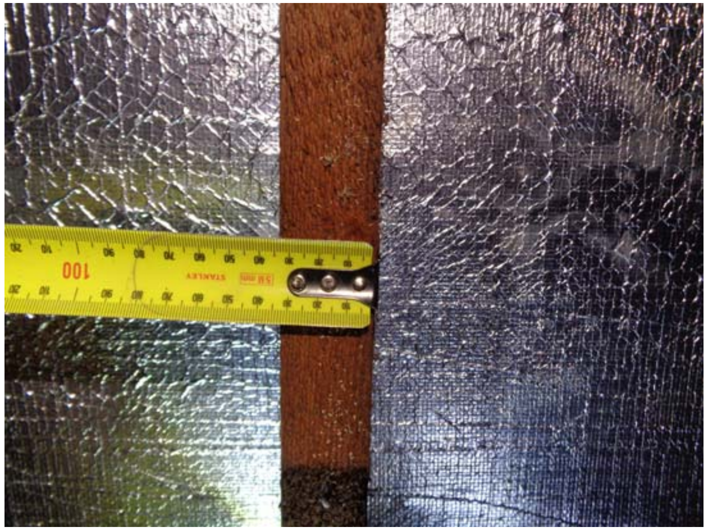
F16-ROOF- (3).JPG


F16-ROOF- (5).JPG


F16-ROOF- (20).JPG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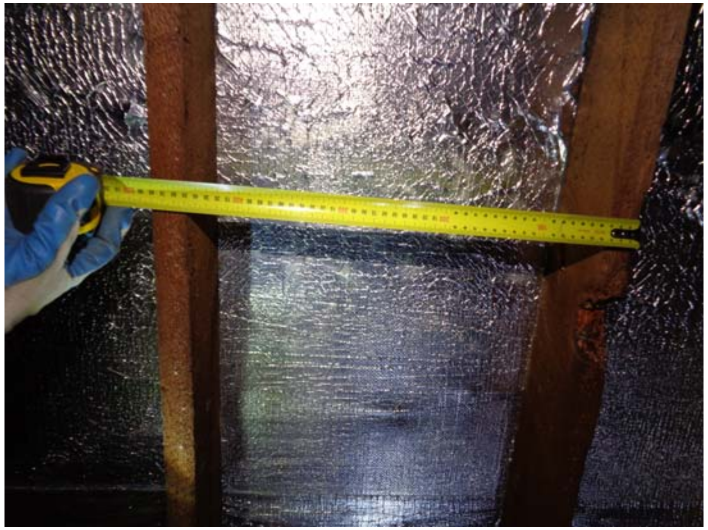

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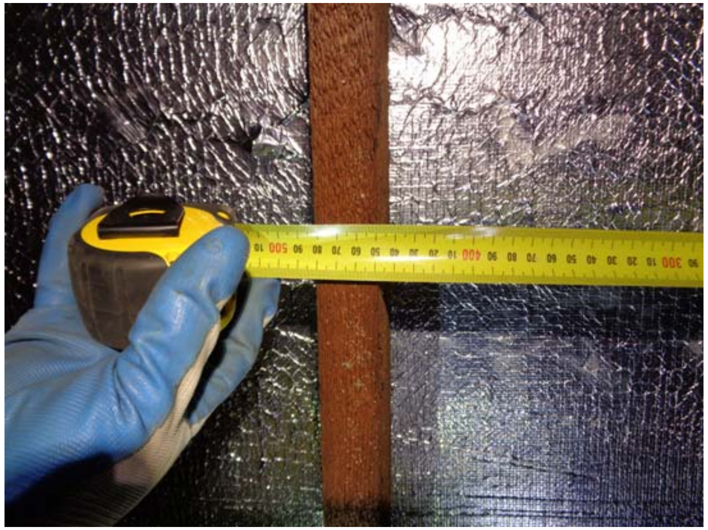
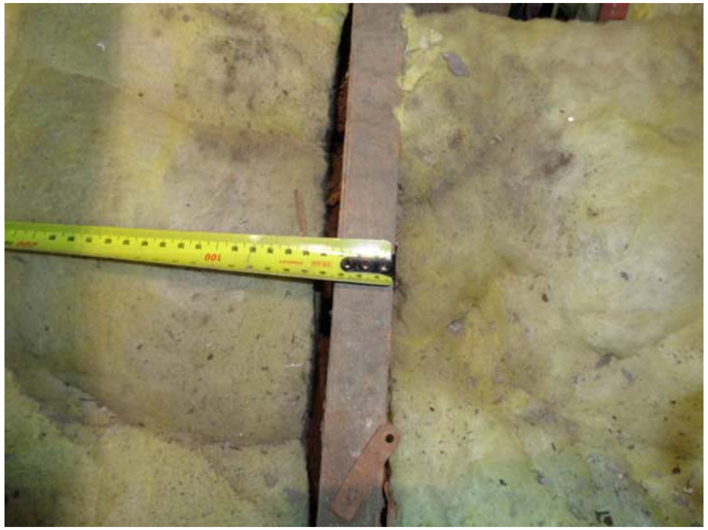


F16-ROOF- (23).JPG

F16-ROOF- (24).JPG

F16-ROOF- (25).JPG


F16-ROOF- (26).JPG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F16-ROOF- (28).JPG


F18-1- (1).JPG


F18-1- (2).JPG


F18-1- (3).JPG


F18-1- (4).JPG


F18-2- (1).JPG

F18-2- (2).JPG

F18-2- (3).JPG

F18-2- (4).JPG

F18-2-(5).JPG

F18-2-(6).JPG

f18-3- (1).JPG

f18-3- (2).JPG

f18-3- (3).JPG


f18-3- (4).JPG


f18-3- (5).JPG


F19-1- (1).JPG


F19-1- (2).JPG


F19-1- (3).JPG


F19-2- (1).JPG


F19-2- (2).JPG


F19-2- (3).JPG


F19-2-   (4).JPG


F19-2-   (5).JPG


F19-2-   (6).JPG


F19-2-   (7).JPG


f19-3-　(1).JPG


f19-3-　(2).JPG


f19-3-　(3).JPG


f19-3-　(4).JPG


f19-3-   (5).JPG


f19-3-   (6).JPG


f19-3- (8).JPG


F24-1- (1).JPG


F24-1- (2).JPG


F24-1- (3).JPG


F25-1- (1).JPG


F25-1- (2).JPG

F25-1- (3).JPG

F25-1- (4).JPG

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F25-1- (9).JPG

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F25-1- (11).JPG


F25-1- (12).JPG


F25-1- (13).JPG


F25-1- (14).JPG

F25-1- (15).JPG

F25-202009221546 (19).JPG

F25-202009221546 (20).JPG

F25-202009221546 (21).JPG


F25-202009221546 (23).JPG


F25-202009221546 (29).JPG


F29-1- (1).JPG


F29-1- (2).JPG


F29-1- (3).JPG


F29-1- (4).JPG


F29-1- (5).JPG


F32-1- (1).JPG


F32-1- (2).JPG


F32-1- (3).JPG


F32-1- (4).JPG


F32-1- (5).JPG


F32-1- (6).JPG


F32-1- (7).JPG


F32-1- (8).JPG


F32-1- (9).JPG


F32-1- (10).JPG


F32-1- (11).JPG


F32-1- (12).JPG


F32-1- (13).JPG

F38-CEILING JOISTS- (1).JPG

F38-CEILING JOISTS- (2).JPG

F38-CEILING JOISTS- (3).JPG

F38-CEILING JOISTS- (4).JPG


F38-north wall under purlins - (1).JPG


F38-north wall under purlins - (2).JPG


F38-north wall under purlins - (3).JPG


F38-north wall under purlins - (4).JPG


F38-north wall under purlins - (5).JPG

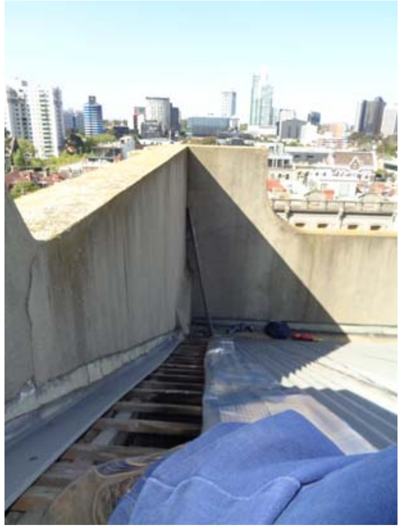

F38-north wall under purlins - (6).JPG


F38-north wall under purlins - (7).JPG


F38-north wall under purlins - (8).JPG

F38-north wall under purlins - (9).JPG

F38-north wall under purlins - (10).JPG



F38-north wall under purlins - (11).JPG

F38-north wall under purlins - (12).JPG


F38-north wall under purlins - (13).JPG


F38-north wall under purlins - (14).JPG


F38-north wall under purlins - (15).JPG


G34-1- (1).JPG

G34-1- (2).JPG

G34-1- (3).JPG

G34-1- (4).JPG

G34-1- (5).JPG


G34-1- (6).JPG


G34-2- (1).JPG


G34-3- (1).JPG


G34-3- (2).JPG

G35-1- (1).JPG

G35-1- (2).JPG

G35-1- (3).JPG

G35-1- (4).JPG


G35-1- (5).JPG


G35-1- (6).JPG


G35-2- (1).JPG


G35-2- (2).JPG


G35-2- (3).JPG


G36-CEILING JOISTS- (1).JPG


G36-CEILING JOISTS- (2).JPG


G36-CEILING JOISTS- (3).JPG


G36-CEILING JOISTS- (4).JPG


G36-CEILING JOISTS- (5).JPG


G36-CEILING JOISTS- (6).JPG


G36-NORTH WALL- (1).JPG


G36-NORTH WALL- (2).JPG


G36-NORTH WALL- (3).JPG


G36-RAFTERS- (1).JPG


G36-RAFTERS- (2).JPG


G36-RAFTERS- (3).JPG


G36-RAFTERS- (4).JPG


G36-RAFTERS- (5).JPG


G36-RAFTERS- (6).JPG


G36-RAFTERS- (7).JPG


G36-SOUTH WALL -(1).JPG


G36-TRUSSES- (1).JPG


G36-TRUSSES- (2).JPG

G36-TRUSSES- (3).JPG

G36-TRUSSES- (4).JPG

G36-TRUSSES- (5).JPG

G36-TRUSSES- (6).JPG


G36-TRUSSES- (7).JPG


G36-TRUSSES- (8).JPG


G36-TRUSSES- (9).JPG


G36-TRUSSES- (10).JPG


G36-TRUSSES- (11).JPG


G36-TRUSSES- (12).JPG


G36-TRUSSES- (13).JPG


G36-TRUSSES- (14).JPG


G36-TRUSSES- (15).JPG


G36-TRUSSES- (16).JPG


G36-TRUSSES- (17).JPG


G36-UNDERPURLINS- (1).JPG


G36-UNDERPURLINS- (2).JPG


G36-UNDERPURLINS- (3).JPG


G36-UNDERPURLINS- (4).JPG


G36-UNDERPURLINS- (5).JPG

G36-UNDERPURLINS- (6).JPG

G36-UNDERPURLINS- (7).JPG

G36-UNDERPURLINS- (8).JPG

G37-(1).JPG


G38-1- (1).JPG


G38-1- (2).JPG


G38-1- (3).JPG


G38-1- (4).JPG


G38-1- (5).JPG


G38-2- (1).JPG


G38-2- (2).JPG


G38-2- (3).JPG


G38-3- (1).JPG


G38-3- (2).JPG


G38-3- (3).JPG


G38-3- (4).JPG


G38-AC Unit- (1).JPG


G38-AC UNIT- (2).JPG


G39-1- (1).JPG


G39-1- (2).JPG

G39-1- (3).JPG

G39-1- (4).JPG

G39-1- (5).JPG

G39-2- (1).JPG


G39-2- (2).JPG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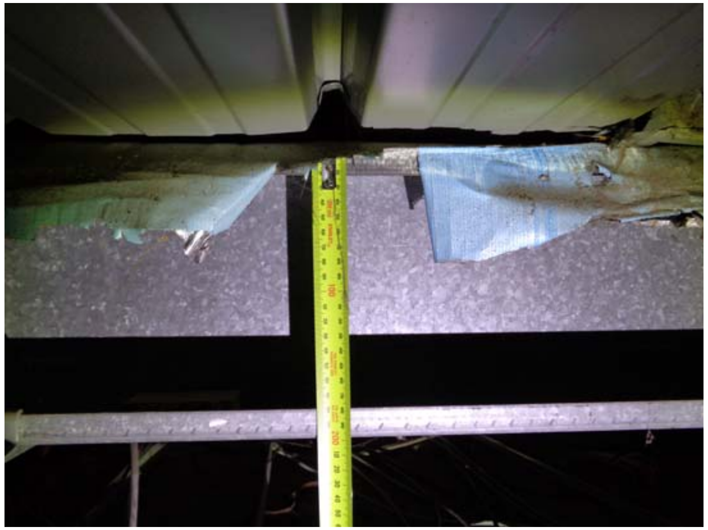
G40-1- (5).JPG



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G40-1- (9).JPG


G43-1- (1).JPG


G43-1- (2).JPG


G43-1- (3).JPG


G43-1- (4).JPG


G44-1- (1).JPG


G44-1- (2).JPG


G44-1- (3).JPG


G44-1- (4).JPG


G44-1- (5).JPG


G48-1- (1).JPG


G48-1- (2).JPG


G48-2- (1).JPG


G48-2- (2).JPG


G49-1- (1).JPG


G49-1- (2).JPG


G49-1- (3).JPG


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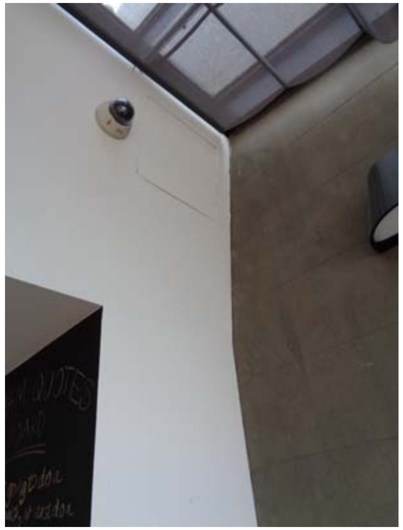
G49-1- (8).JPG



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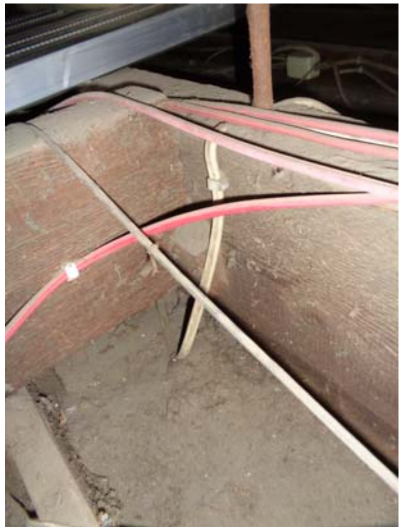
G57-Ceiling Joists- (1).JPG

G57-ceiling Joists- (2).JPG

G57-Hanging Beam- (1).JPG



G57-Hanging Beam- (2).JPG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G57-Hanging Beam- (4).JPG


G57-Hanging Beam- (5).JPG


G57-Rafter- (1).JPG

G57-Rafter- (2).JPG

G57-Truss RT37.1 - (1).JPG

G57-Truss RT37.1 - (2).JPG

G57-Truss RT37.1 - (3).JPG


G57-Truss RT37.1 - (4).JPG


G57-Truss RT37.1 - (5).JPG


G57-Truss RT37.1 - (6).JPG


RT2.1-NORTH QUEEN POST-   (1).JPG


RT2.1-NORTH QUEEN POST- (2).JPG


RT2.1-NORTH QUEEN POST- (3).JPG


RT2.1-NORTH QUEEN POST- (4).JPG


RT2.1-SOUTH QUEEN POST- (1).JPG

RT2.1-SOUTH QUEEN POST- (2).JPG

RT2.1-SOUTH QUEEN POST- (3).JPG

RT2.1-SOUTH QUEEN POST- (4).JPG

RT2.1-SOUTH QUEEN POST- (5).JPG


RT2.2-NORTH- (1).JPG


RT2.2-NORTH- (2).JPG


RT2.2-NORTH- (3).JPG


RT2.2-NORTH- (4).JPG


RT2.2-NORTH- (5).JPG


RT2.2-NORTH- (6).JPG


RT2.2-NORTH- (7).JPG


RT2.2-NORTH QUEEN POST- (1).JPG


RT2.2-NORTH QUEEN POST- (2).JPG


RT2.2-NORTH QUEEN POST- (3).JPG


RT2.2-NORTH QUEEN POST- (4).JPG


RT2.3-NORTH- (1).JPG


RT2.3-NORTH- (2).JPG


RT2.3-NORTH- (3).JPG


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RT2.3-NORTH- (5).JPG

RT2.3-NORTH- (6).JPG

RT2.3-NORTH QUEEN POST- (1).JPG

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RT2.3-NORTH QUEEN POST- (3).JPG


RT2.3-NORTH QUEEN POST-   (4).JPG


RT2.3-NORTH QUEEN POST-   (5).JPG


RT2.3-SOUTH QUEEN POST-   (1).JPG


RT2.3-SOUTH QUEEN POST-   (2).JPG


RT2.3-SOUTH QUEEN POST-   (3).JPG


RT2.3-SOUTH QUEEN POST-   (4).JPG


RT2.3-SOUTH QUEEN POST-   (5).JPG


RT2.4-NORTH QUEEN POST- (1).JPG


RT2.4-NORTH QUEEN POST- (2).JPG


RT2.4-NORTH QUEEN POST- (3).JPG


RT2.4-NORTH QUEEN POST- (4).JPG


RT2.4-NORTH QUEEN POST- (5).JPG

RT2.4-NORTH QUEEN POST- (6).JPG

RT2.4-NORTH QUEEN POST- (7).JPG

RT2.4-NORTH QUEEN POST- (8).JPG

RT2.4-NORTH QUEEN POST- (9).JPG


RT2.4-NORTH WALL- (1).JPG


RT2.4-NORTH WALL- (2).JPG


RT2.4-NORTH WALL- (3).JPG


RT2.4-SOUTH QUEEN POST- (1).JPG


RT2.4-SOUTH QUEEN POST- (2).JPG


RT2.4-SOUTH QUEEN POST- (3).JPG


RT2.4-SOUTH QUEEN POST- (4).JPG


RT2.4-SOUTH QUEEN POST- (5).JPG

RT2.4-SOUTH QUEEN POST-   (6).JPG

RT2.4-SOUTH QUEEN POST-   (7).JPG

RT2.4-SOUTH QUEEN POST-   (8).JPG

RT2.5-NORTH QUEEN POST-   (1).JPG

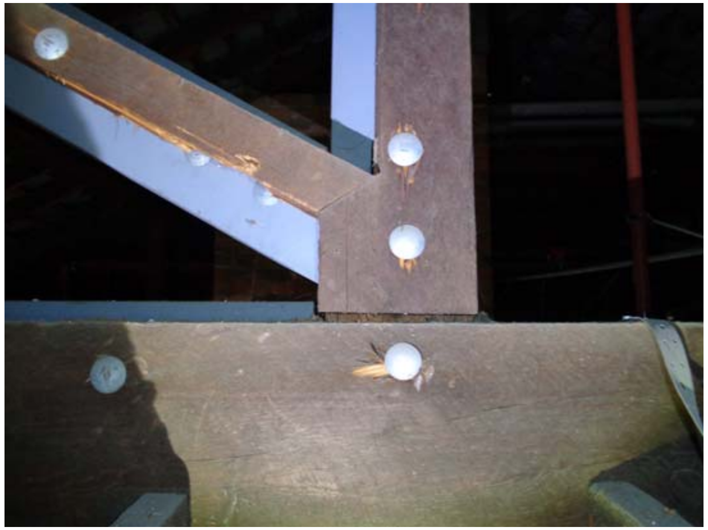
RT2.5-NORTH QUEEN POST- (2).JPG

RT2.5-NORTH QUEEN POST- (3).JPG

RT2.5-NORTH QUEEN POST- (4).JPG

RT2.5-NORTH WALL- (1).JPG

RT2.5-NORTH WALL- (2).JPG



RT2.5-SOUTH QUEEN POST- (1).JPG

RT2.5-SOUTH QUEEN POST- (2).JPG

RT2.5-SOUTH QUEEN POST- (3).JPG


RT2.5-SOUTH QUEEN POST- (4).JPG


RT7.3- (1).JPG


RT7.3- (2).JPG


RT7.3- (3).JPG


RT7.4- (1).JPG


RT7.4- (2).JPG


RT7.4- (3).JPG


RT7.4- (4).JPG


RT7.4- (5).JPG


RT7.4- (6).JPG


RT7.5-(1).JPG


RT8.01-East- (1).JPG


RT8.01-East- (2).JPG


RT8.01-East- (3).JPG


RT8.01-East- (4).JPG


RT8.01-East- (5).JPG

RT8.01-East- (6).JPG

RT8.01-East- (7).JPG

RT8.01-East- (8).JPG

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RT8.01-East- (12).JPG


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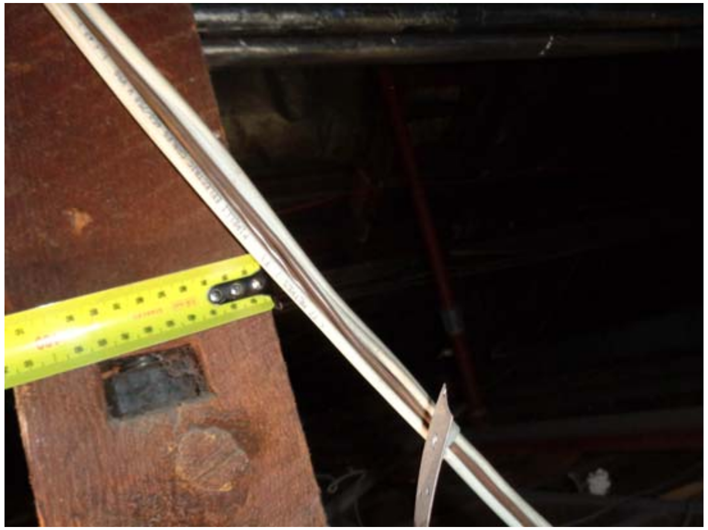
RT8.01-East- (16).JPG



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RT8.01-East- (19).JPG

RT8.01-West- (1).jpg

RT8.01-West- (2).jpg


RT8.01-West- (3).jpg


RT8.01-West- (4).jpg


RT8.01-West- (5).jpg


RT8.01-West- (6).jpg

RT8.01-West- (7).jpg

RT8.2-EAST- (1).JPG

RT8.2-EAST- (2).JPG

RT8.2-EAST- (3).JPG

RT8.2-EAST- (4).JPG

RT8.2-EAST- (5).JPG

RT8.2-EAST- (6).JPG

RT8.2-WEST- (1).jpg


RT8.2-WEST- (2).jpg


RT8.2-WEST- (3).jpg


RT8.2-WEST- (4).jpg


RT8.2-WEST- (5).jpg

RT8.2-WEST- (6).jpg

RT8.3-EAST- (1).JPG

RT8.3-EAST- (2).JPG

RT8.3-EAST- (3).JPG

RT8.3-EAST- (4).JPG

RT8.3-EAST- (5).JPG

RT8.3-EAST- (6).JPG

RT8.3-EAST- (7).JPG


RT8.3-EAST- (8).JPG


RT8.3-WEST- (1).jpg


RT8.3-WEST- (2).jpg


RT8.3-WEST- (3).jpg

RT8.3-WEST- (4).jpg

RT8.3-WEST- (5).jpg

RT8.4-EAST- (1).JPG

RT8.4-EAST- (2).JPG

RT8.4-EAST- (3).JPG

RT8.4-EAST- (4).JPG

RT8.4-EAST- (5).JPG

RT8.4-WEST- (1).jpg


RT8.4-WEST- (2).jpg


RT8.4-WEST- (3).jpg


RT8.4-WEST- (4).jpg


RT8.4-WEST- (5).jpg


RT8.4-WEST- (6).jpg


RT8.4-WEST- (7).jpg


RT8.5-EAST- (1).JPG


RT8.5-EAST- (2).JPG


RT8.5-EAST- (3).JPG


RT8.5-EAST- (4).JPG


RT8.5-EAST- (5).JPG


RT8.5-EAST- (6).JPG

RT8.5-EAST- (7).JPG

RT8.5-EAST- (8).JPG

RT8.5-WEST- (1).jpg

RT8.5-WEST- (2).jpg


RT8.5-WEST- (3).jpg


RT8.5-WEST- (4).jpg


RT8.5-WEST- (5).jpg


RT8.6-PROPPING- (1).JPG

RT8.6-PROPPING- (2).JPG

RT8.6-PROPPING- (3).JPG

RT8.6-PROPPING- (4).JPG

RT8.6-PROPPING- (5).JPG


RT8.07-EAST- (1).JPG


RT8.07-EAST- (2).JPG


RT8.07-EAST- (3).JPG


RT8.07-EAST- (4).JPG

RT8.07-EAST- (5).JPG

RT8.07-EAST- (6).JPG

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RT8.07-EAST- (9).JPG


RT8.07-EAST- (10).JPG


RT8.07-EAST- (11).JPG


RT8.07-EAST- (12).JPG


RT8.07-WEST- (1).jpg


RT8.07-WEST- (2).jpg


RT8.07-WEST- (3).jpg


RT8.07-WEST- (4).jpg


RT8.07-WEST- (5).jpg


RT8.07-WEST- (6).jpg


RT8.07-WEST- (7).jpg


RT8.8-EAST - (1).JPG


RT8.8-EAST - (2).JPG


RT8.8-EAST - (3).JPG


RT8.8-EAST - (4).JPG


RT8.8-EAST - (5).JPG


RT8.8-EAST - (6).JPG


RT8.8-EAST - (7).JPG


RT8.8-EAST - (8).JPG


RT8.8-EAST - (9).JPG


RT8.8-EAST - (15).JPG


RT8.8-WEST - (1).jpg


RT8.8-WEST - (2).jpg


RT8.8-WEST - (3).jpg


RT8.8-WEST - (4).jpg


RT8.8-WEST - (5).jpg


RT8.8-WEST - (1).jpg


RT8.9 - (1).JPG


RT8.9 - (2).JPG


RT8.9 - (3).JPG


RT8.9 - (4).JPG


RT8.9 - (5).JPG

RT8.9 - (6).JPG

RT8.10- (1).jpg

RT8.10- (2).jpg

RT8.10- (3).jpg


RT8.10- (4).jpg


RT33.3- (1).JPG


RT33.3- (2).JPG


RT33.3- (3).JPG


RT33.3- (4).JPG


RT33.3- (5).JPG


RT33.3- (6).JPG


RT33.3- (7).JPG


RT33.3- (8).JPG


RT33.3- WEST-(1).JPG


RT33.4- (1).JPG


RT33.4- (2).JPG


RT33.5- (1).JPG


RT33.5- (2).JPG


RT33.6- (1).JPG


RT33.6- (2).JPG


RT33.6- (3).JPG


RT33.7- (1).JPG


RT33.7- (2).JPG


RT33.7- (3).JPG


RT33.8- (1).JPG


RT33.8- (2).JPG


RT33.8- (3).JPG


RT36.1-(1).JPG


RT36.1-(2).JPG


RT36.1-NORTH.JPG


RT36.2- (1).JPG


RT36.2- (2).JPG

RT36.2- (3).JPG

RT36.2- (4).JPG

RT36.2- (5).JPG

RT36.3- (1).JPG


RT36.3- (2).JPG


RT36.4 AND RT36.5.JPG


RT38.8-EAST- (1).JPG


RT38.8-EAST- (2).JPG


RT38.8-WEST-DSC03169.JPG


RT38-01-EAST-(1).JPG


RT38-02-EAST- (1).JPG


RT38-02-EAST- (2).JPG


RT38-02-EAST- (3).JPG


RT38-02-EAST- (4).JPG


RT38-02-EAST- (5).JPG


RT38-02-EAST- (6).JPG


RT38-02-EAST- (7).JPG


RT38-02-EAST- (8).JPG


RT38-02-EAST- (9).JPG


RT38-02-WEST- (1).JPG


RT38-02-WEST- (2).JPG


RT38-02-WEST- (3).JPG


RT38-02-WEST- (4).JPG


RT38-02-WEST- (5).JPG


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RT38-02-WEST- (7).JPG


RT38-02-WEST- (8).JPG


RT38-02-WEST- (9).JPG


RT38-02-WEST- (10).JPG


RT38-03-EAST- (1).JPG


RT38-03-EAST- (2).JPG


RT38-03-EAST- (3).JPG

RT38-03-EAST- (4).JPG

RT38-03-EAST- (5).JPG

RT38-03-WEST - (1).JPG

RT38-03-WEST - (2).JPG


RT38-06-WEST- (1).JPG


RT38-06-WEST- (2).JPG


RT38-06-WEST- (3).JPG


RT38-07-WEST- (1).JPG


RT38-07-WEST- (2).JPG


RT38-07-WEST- (3).JPG


RT38-07-WEST- (4).JPG


RT38-07-WEST- (5).JPG


RT38-07-WEST- (6).JPG


RT38-08-EAST- (4).JPG


RT38-08-EAST- (5).JPG


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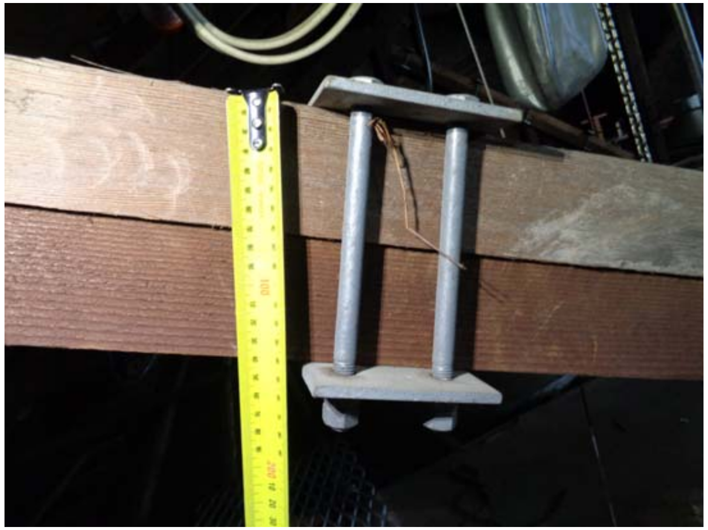
RT38-08-EAST- (9).JPG



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RT38-08-EAST- (14).JPG


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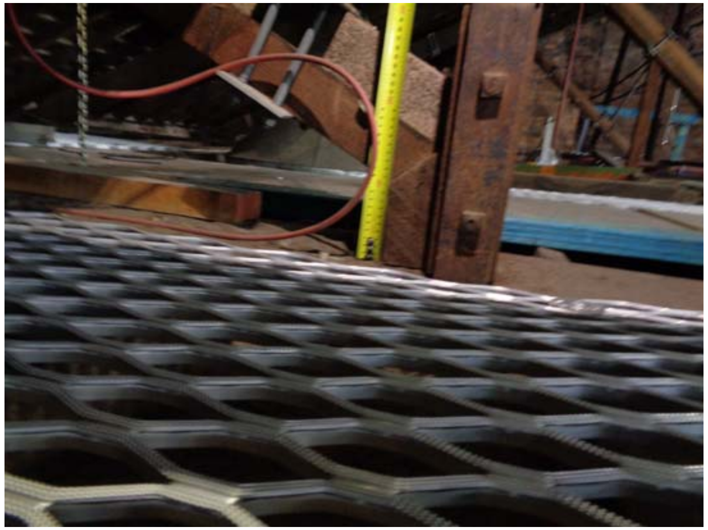
RT38-08-EAST- (19).JPG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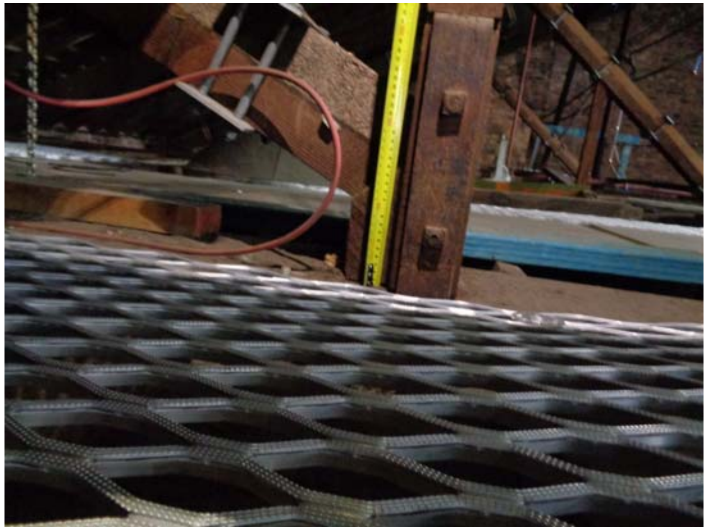
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RT38-08-EAST- (23).JPG


RT38-08-EAST- (24).JPG


RT38-08-EAST- (25).JPG


RT38-08-EAST- (26).JPG


RT38-08-EAST- (27).JPG


RT38-08-EAST- (28).JPG


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RT38-08-EAST- (31).JPG


RT38-08-EAST- (32).JPG


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RT38-08-WEST- (1).JPG


RT38-08-WEST- (2).JPG


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RT38-08-WEST- (9).JPG


RT38-08-WEST- (37).JPG


RT38-08-WESTT- (35).JPG


RT38-08-WESTT- (36).JPG


RT38-09-EAST- (1).JPG


RT38-09-EAST- (2).JPG


RT38-09-EAST- (3).JPG


RT38-09-EAST- (4).JPG


RT38-09-EAST- (5).JPG


RT38-09-WEST-(1).JPG


RT38-10-EAST- (1).JPG


RT38-10-EAST- (2).JPG


RT38-10-EAST- (3).JPG


RT38-10-EAST- (4).JPG


RT38-10-EAST- (5).JPG

APPENDIX C: LIST OF VIDEOS PROVIDED

Video List

The following videos have been provided as supporting information to this report:

1. RT36.1-South-20201019.mp4
2. RT38.2-West-20201005.mp4
3. RT38.9-East-20201006.mp4