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St Paul's Church Newport

Structural Appraisal of Existing Roof Structure Updated May 2015

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1.0 Introduction

General

1.1. St Pauls Church is a masonry building with a timber trussed roof structure, of Gothic inspiration and unconventional proportions. It is located off Commercial Street in Newport, South Wales.

1.2. Our Client is the PCC of St Pauls Church. Mann Williams was requested to carry out a structural appraisal, we were appointed to appraise the structure because of various defects that had been noted by the building users. These defects were confined to areas of suspected poor condition of timbers.

1.3. The appraisal was to record and assess the general condition of the roof structure, in order to gain a better understanding of the repair and maintenance requirements of the building. The appraisal was to identify defects and recommend approaches to repairs.

Emergency repairs

1.4. Within the main church space at eaves level large decorative brackets are located under the timber roof structure. After Mann Williams' appointment but before the appraisal could be carried out one of the truss brackets fell from its fixings. This prompted that an inspection should be carried out immediately, as while the brackets were not one of the initial reasons for the commissioning of the appraisal, it was urgently necessary to assess the risk of further brackets falling.

1.5. The initial issues that were to be investigated after the bracket fell were the following: the cause of the bracket falling and an appraisal of the remainder of the roof structure, focussed on the other brackets, in order to determine if works were required to alleviate the risk of further brackets falling.

1.6. The bracket which fell, did so out of building occupied hours, however it was caught on CCTV within the main hall. The bracket fell the height of the ceiling and caused some significant damage to the fit out of the building directly below the truss bearing.

1.7. After inspecting the bracket it was found to be of cast iron with timber packing and ornate plaster finishes with very little positive fixing to the wall. There were nominal keys into the bottom truss member.

1.8. Emergency works were instructed which consisted of tying the brackets to the bottom chord of the timber trusses. This was achieved with pairs of doubled up steel wires. A detailed repair sketch can be found in the appendix. This work was carried out on all the truss bearings with remaining brackets.

Appraisal constraints and second stage emergency repairs

1.9. The appraisal of the roof structure was carried out over two days. On the first day (01/11/13) a general visual inspection of the roof structure from the gutter and parapets was undertaken. On the second day (26/11/13) a full visual inspection of the roof trusses was conducted from with the attic space.

1.10. During the inspection, one of the trusses was found to have a significant partial failure of a timber connection. This required additional emergency work to stabilise the timber within the connection that were still working. It is likely that this failure is did not occur recently however there is no record or ability to determine when it occurred. The emergency works were carried out to provide additional support to the connection which is working under existing conditions but may be subjected to additional forces in severe weather.

1.11. Access in the attic space was available to the main body of the roof trusses and the steep gable roofs to the west end of the church. Limited access was also available to a second higher attic space in the main section of the building

1.12. It was not possible due to access constraints to appraise the roof structure beyond the Altar space including the bell tower and east gables.

1.13. From both the external visual inspection and the internal it was not possible to fully see or inspect the truss bearings, it was also not possible to view and inspect the truss bearings from below the ceiling line. No intrusive investigations were carried out.

Re-inspection April/May 2015

1.14. At the further request of the PCC, a re-inspection of the roof structure was undertaken on 24 April 2015. No repair works had been undertaken since the issuing of this report in January 2014.

1.15. The re-inspection comprised:

- General visual inspection from floor level in main space of ceiling structure and corbel brackets
- High level inspection from aluminium scaffolding tower of some truss bearing ends/corbel brackets (south end trusses 3-5, north end trusses 5-7). Access to remaining truss bearing ends from scaffolding tower is very difficult due to timber screens, kitchen area, etc.
- High level inspection of central joint in bottom chord of truss 5 (location of previous temporary
- Inspection of all truss bearing ends from attic space
- Inspection of truss connections generally in attic space (upper attic space not inspected)

1.16. The high level inspection revealed severe deterioration of the south bearing end of Truss 4, which led to the installation of temporary propping to Truss 4, and further detailed inspection of this area in May 2015. This propping and the inspection which included external inspection of the south parapet gutter from a local scaffold erected at Truss 4, has been reported on separately in Mann Williams' reports ref 6882_R_PR_03, 04 and 05, which are included in Appendix B.

1.17. The clauses added in version 4 of this report (May 2015) are:

- 1.14 to1.17
- 3.6A
- 3.8A
- 3.16A
- 3.28A
- 4.21 and 4.22
- 5.2A
- 5.3A
- 5.4 A to E
- 5.5A to 5.7A
- 5.8 A & B

2.0 Existing Structure – Overview and History

2.1. The existing structure comprises of a masonry building with a timber truss framed roof. The building was constructed in 1835, and is reported to be Grade 2 listed.

2.2. The main roof is formed by timber trusses spanning between the side walls. The trusses span approx. 17m clear between the walls.

2.3. Externally at eaves level the walls form parapets. Between the eaves line of the roof finishes and the parapets there is a formed slopped lead gutter.

2.4. The trusses consist of two connected elements, a lower truss of queen post arrangement which forms the primary structure and a secondary truss formed of smaller timbers in a king post arrangement which sits on top of the primary (see photo to right of king post section).

2.5. There are 7 trusses located between the west gable wall and the altar internal gable wall. These are located centrally between large windows at approx. 3m centres. The walls between the windows have external buttresses however from their thickness these would provide little horizontal resistance for any thrust from the roof.

2.6. Purlins span between the trusses and are located at node points of the truss. Common rafters span between the purlins and are notched onto the purlins.

2.7. The building has very steep gable roofs perpendicular to the main roof span at both the west and east gables. These are not trussed but are constructed from pitched common rafters. Remedial bracing has been added in the plane of the slope and horizontal members forming A-frames located at mid height.

2.8. The main hall of the church was originally constructed to have a 1st floor balcony around the sides and west end of the main hall. This balcony was supported off an internal ring of cast iron columns. Access granted from stairs at the east end of the building.

2.9. The balcony has since been removed and replaced with a 1st floor office over the first two bays from the west of the main hall. Access is only from an external porch in the North West corner.

2.10. Looking from within the main hall space a new partition wall has been built from the 1st floor to underside of ceiling to separate the spaces. This wall has been made to look like the edge of the previously constructed balcony however it does not line up with the recorded line of the historic balcony.

2.11. It is reported by Dean Roberts the church team Pastor that in the original design of the building, the main hall had a pitched ceiling, in line with the common rafters. The flat ceiling at eaves level along with subsequent timber panelling detail and ornate plaster work is reported to have been added at a later date. It is possible that the iron brackets were added at this time as the detailing matches.

2.12. From access into the attic space it is evident that this is true as there is existing lath and plaster found fixed to the common rafters. This forms a sloped ceiling, with a horizontal ceiling formed at the upper horizontal member of the trusses. The detailing of this ceiling suggests it was intended to be visible from the public space of the church.

2.13. The flat ceiling at eaves level along with the infill panelling wood detail, with plaster features was added at a later date. It is possible that the brackets located under the truss bearings, were added at this time. The brackets are non-structural, this is indicated by the lack of positive connections between the trusses and the brackets.

2.14. The original roof trusses were not designed for loading applied to it at this level. Therefore the self-weight, maintenance loading and location of this new ceiling (the bottom chord of the truss) is likely to have contributed to some of the defects noted with the trusses – please see section 3.

3.0 Existing Structure – Summary of Inspection

3.1. External inspection of the roof shows that generally the roof slope is planar and the ridge line is true. Therefore it suggests that problems with the roof structure are due to local defects and not systemic of the roof structure/design.

3.2. This is confirmed by the visual inspection of the roof timbers from with the attic space. Generally the condition of the timber members is sound. There are no obvious defects in the king post sections of the trusses (ie in the upper attic).There are some areas of the queen post sections of the roof trusses which show distress and are discussed within this section;

- Pull out of connections
- Truss bearing end decay
- Failure of half lap joint in truss 5.

Pull out of truss connections

3.3. General problems with the roof trusses include the pull out of the bracing member at the connections of the element to the vertical truss members.

3.4. The pull out of the connections has occurred as they appear to have been originally designed for compression load only. This is evident from the detailing of the connection, namely a mortise and tenon connection without pegs. The omission of pegs from the connection means that when tension is applied the tenon pulls out of the socket, as has been recorded for the majority of the trusses.

3.5. This pull out has occurred historically and is not clear with the level of survey carried out if it is ongoing (due to creep). Remedial work has been carried out previously with the strapping of the connections at the head of the braced member. The strapping has not been replicated at the base of the braced member. By not strapping the base the repair is ineffective as it will not prevent further pull out occurring, it will only mean that the pull out occurs in the base connection only

3.6. The pull out is not symmetrical or consistently greater at either the head or the base of the bracing connections for all the trusses in the building. It is worth noting that the two trusses which don't appear to have the central bracket connection in the bottom chord have the least pull out. This suggests that there may be a degree of rotation vertically at this connection contributing to the lower chord sagging generating the pull out of these connections.

3.6A **April 2015 re-inspection** – No significant change was noted to the pull-out of the truss connections. Minor changes recorded during the re-inspection are noted on revised truss elevations included in Appendix A. In some cases it seems likely that apparent small changes are in fact due to discrepancies in measurements (rather than actual movement of elements of the structure) between the two inspections. There is no evidence of significant deterioration or loss of integrity to the roof trusses.

Truss bearings

3.7. Truss 1 south bearing: due to its location in the first floor offices this truss bearing is easier to appraise from below than those in the main church space. The bottom chord of the truss shows significant distress at the bearing and a significant distance away from the wall (not accurately measured but in the order of 1.5m). The member is warping at the sides at the bearing, and large cracks are visible in the timber. The bearing does show some compression, due to the use of the floor space directly below the truss it was not possible to carry out a survey to determine how much compression of the decayed timber has occurred. The bracket in this location was strapped back to the wall due to the condition of the timbers.

3.8. Truss 1 bearings when inspected from within the attic space have a further connection in the form of the valley member supporting the west gable roofs. Limited access was available to inspect these members. From what was seen this member at the south bearing is also showing signs of decay due to water ingress, the north bearing appeared sound. The truss bearing is in a similar state as the valley bearing.

3.8 A **May 2015 re-inspection** - The south bearing end of truss 1 was inspected in more detail on 14 May 2015, and the findings are recorded in report 6882_R_PR_05 in Appendix B.

3.9. Truss 1 has partitioned office space along its length, unlike the rest of the trusses it is harder to appraise the truss as a whole. The truss appears to sag towards the centre of the bottom chord. The attic space bearing on truss 1 has been turned into a service zone for the occupied space beneath. This puts further additional loading on the truss compared to the remainder and therefore increased sagging on this truss would be expected.

3.10. Localised repairs to truss bearings have been carried out on the north ends of Truss 2 and Truss 6. The repairs consist of a pair of steel plates connecting the bottom truss member to the truss rafter. Truss 2's repair has included the removal of the existing bottom chord bearing and replacement with new timber. From visual inspection of this repair, the connection and bearing appear to be in good condition.

3.11. Truss 6's repair is of a similar nature, however the bearing timber of the bottom chord has not been replaced. Where the plates are bolted into the bottom chord the timber appears to be distressed and shows signs of degradation – large cracks in the timber and softening of the top of the timber. Further repair work will be required for this connection.

3.12. Truss 4 south bearing – localised sagging at the bearing connection has occurred, string line measuring of the ceiling from within the attic space has recorded a 60mm drop at the bearing relative to the trusses on either side. This has been confirmed by recording the levels of the ceiling from ground floor using a distometer.

3.13. External inspection of the roof from the gutter shows a visible depression in the roof line, at the approximate location of the truss 4 on the south side only.

3.14. The condition of the timber truss 4 from within the attic space appears sound. This suggests that any decay or degradation present in the bearing will be found on the underside of the bearing and/or embedded within the wall. This was not possible to confirm during the initial survey due to access issues.

3.15. The depression is in the same location as where the bracket fell. There is indication that the wall in this location has been subjected to water ingress. This has resulted in the timber elements of the bracket as well as the truss bearing decaying. The outcome of this was the fixings of the bracket to the wall failing causing the bracket to fall. It is also possible that the movement of the truss resulted in increased pressure on the vertical wall fixings aiding the failure of the fixings.

3.16. This degradation of the timber is likely to have occurred due to water ingress from the roof gutter. The eaves of the main church space have a gutter located between the parapet and the roof slope. From the building geometry it is likely that the gutter sits both in the line of the wall thickness, and above the bearings of the roof trusses. Without removing external finishes from along the gutter line this cannot be confirmed.

3.16A **May 2015 re-inspection** – This confirmed that the truss bearing ends do indeed extend under the full width of the parapet gutters, built into the wall. For more details see report 6882_R_PR_05 in Appendix B

3.17. Historical water ingress can be seen on the inside of the walls in the form of discolouration of the wall finishes. During the survey period the weather was dry, thus it was not possible to see if the water ingress was ongoing.

3.18. The most notable roof trusses showing this water ingress were the following;
North bearings – Truss 3 and truss 6, South bearings – truss 4.

3.19. External inspection of the gutter shows that the high point is centred on the middle of the length of the main church space. The gutter then falls away in steps towards the gable ends. It would appear in the location of truss 4 the gutter is also pitched inwards towards the centre of the building. This would encourage water ingress if the internal gutter upstand is not high enough. It is not possible to determine however if the gutter was initially pitched causing water ingress or if the pitch was generated by the movement of the truss bearing.

3.20. Localised failure of the gutter and waterproofing may have contributed to the water ingress. There were no obvious visual signs of water ingress in the first floor office space; however this area has had a more recent re decoration which may have hidden any evidence.

3.21. From a superficial visual inspection of the gutters, the main body of the gutter (formed by profiled lead work) has had multiple repairs along its length. These were and could remain the causes of water ingress. It is likely that there could be more defects located under the roof tile which over hangs the gutter. This was not possible to view during the survey.

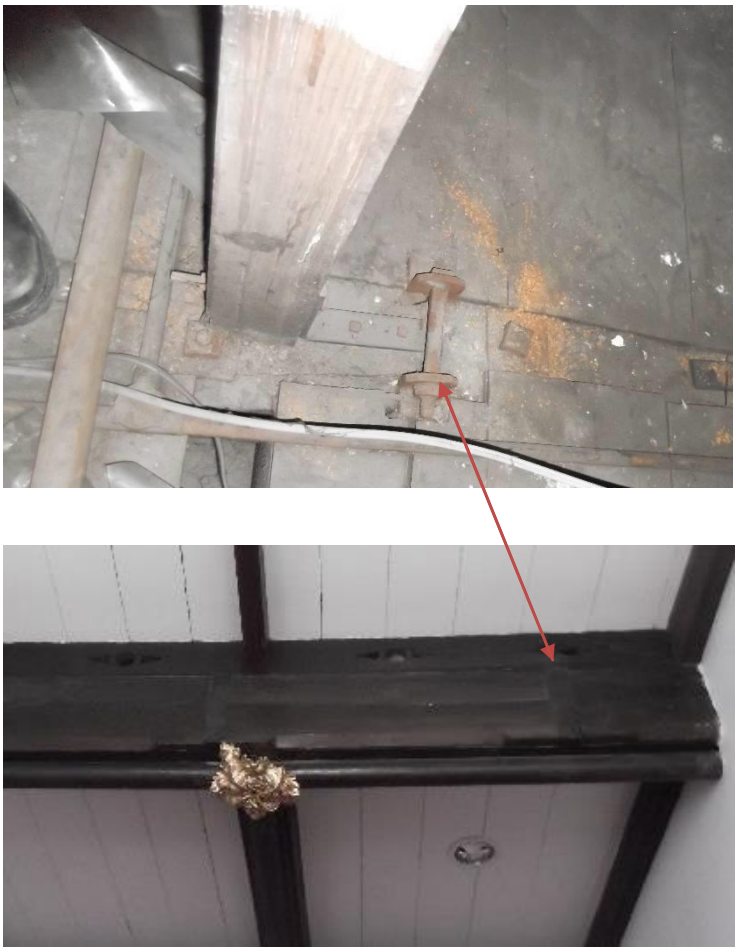
3.21A **April/May2015 re-inspection**: No material change was noted to the condition of the parapet gutter. However it was observed that a proprietary 'paint' repair had been applied to a defect in the lead directly above the bearing end of Truss 4.

Truss timber connections

3.22. The connections of the trusses are formed with mortise and tenon joints; the connections of the vertical members to the mid and lower horizontal members are strapped with original ironwork. No other connections were originally strapped. Remedial straps have been added to the top connection of the bracing member, but not to the bottom connection. As shown in photos paragraphs 3.4 and 3.5

3.23. In the centre of the truss are what appear to be non-structural vertical members tennoned into the horizontal truss members, these have been strapped into the head beam and are connected at the base via wrought iron angle brackets.

3.24. For five of the trusses the bottom chord of the truss is formed from two timber members. These are connected together near the middle of the span by a bolted cast iron plated connector. The timbers form a vertical half lap each with a lap length of est. 700mm. An iron plate is recessed into the base of the timbers. 4 bolts connect the plate to the timbers: two bolts per member, one through the main body and a second through the half lap near the tip. Iron straps wrap around the members at the tip of the half lap, these straps are through bolted above the top of the timber member.



3.25. It is not clear if the plate and the straps are cast as one element or if they are independent elements. Each of the five trusses have differing setting out of the connection and bolt-strap arrangements leading the opinion that the straps and plate are not connected together.

3.26. Two of the trusses do not appear to have this connection, it was not visible from the attic space, and no straps were visible from the main hall. This would suggest that in these locations the bottom chord timber is a single element spanning 17m.

3.27. A large crack was found within the connection located in the centre of the bottom truss chord. From visual inspection below the ceiling and from above one half of the half lap connection has failed in tension. This has produced the crack and a small rotation in the bracket. The connection is likely to still be working due to the loading on the connection being taken up entirely by the iron connection and the remaining timber section (approx. ½ the size of the timber chord).

The truss 5 bearings appear to be ok as seen from the attic space, which indicates that the failure in the bottom chord is not connected to other structural issues.

3.28. Emergency remedial work was carried out on this connection strapping the truss between the central primary vertical timbers, and strapping the timbers each side of the crack vertically to the upper horizontal truss member. The details of this are included at the end of this section.

3.28A **April 2015 re-inspection** – no discernible difference was noted to the condition of the connection, and the temporary straps remain in place and taut.

Gable roofs

3.29. West End Gables – the roofs of both the north and south gables show significant bowing in the plane of the roof slope. The bow is evident in each of the common rafters, becoming more significant towards the centre of the roof length (between the masonry gable wall and the apex of the main roof body. The previous remedial work in this area was presumably carried out to limit further bowing of the roof members.

3.30. Please refer to the appendix for detailed survey results annotated on truss elevations for each of the roof trusses.

4.0 Discussion

Pull out of Connections

4.1. There appear to be two possible primary causes for the pull out of the connections. These are the lack of pegs or strapping to the original connections, and the addition of the ceiling bearing on the bottom truss chord.

4.2. It is likely that both are true, and that the addition of the ceiling exacerbated the existing sag within the bottom chord causing the pull out.

4.3. The pull out is reduced on the trusses that do not appear to have a central connection to the bottom chord, however some pull out does occur on these trusses. This suggests that there isn't a significant contribution to the pull-out from these central connections.

4.4. Remedial works to these connections would consist of simply strapping the bottom end of the brace member to the adjacent vertical post of the truss in a manner similar to the existing repairs. This should prevent future pull out of these connections, improving the overall robustness of the trusses.

Truss End Bearings

4.5. There are 3 truss bearings that from the initial survey require remedial works carried out, Truss 1 south bearing, Truss 4 south bearing and Truss 6 North bearing. It is possible that more truss ends will require work however further investigation work will be required to determine the number and which bearings.

4.6. This further investigation work is likely to require input from of a timber decay specialist. This would give confirmation of which truss bearings require remedial work and to what extent. By drilling deep into the timber at the bearing the timber specialist should be able to assess the extent of decay of the timbers

4.7. Access will be needed to the bearing ends of the trusses, on or in the external wall. It may be possible to achieve this by dismantling the timber framing to the parapet gutters from above which may expose the top surface of the bottom chord. Alternatively It may be necessary to locally remove wall finishes (and possibly stonework) internally.

4.8. The bearing repairs are likely to consist of either steel plated flitch connections bolted to the lower truss chord or face plated as per the existing repairs. The use of each would depend on the extent and type of decay found. The affected timber would need to be cut from the truss and replaced with sound timber. The wrought connecting bar tying the truss rafter to the bottom chord may need to be removed if the remedial fixings cannot be arranged around it. If this is the case the repair detail will need to incorporate replacing the function of this connection.

4.9. Each truss end repair detail is likely to be different due to the extent of the decay, though the approach will be the same. Truss 1 from visual indication will require the largest connection due to the length of deterioration along the bottom chord.

4.10. Further to repairing the timber bearings, repair or replacement of the gutters and eaves waterproofing will be required to prevent further water ingress causing future issues with the repaired timbers. Improvement to the eaves details, and possibly the rainwater goods (downpipes) may be required to address risks posed by overtopping of the gutters if the capacity of the downpipes is exceeded.

4.11. During this work the common rafter bearings and valley beam bearings at eaves can be inspected further, local splice repairs may be required for decayed timber bearings and wall plates may need replacing as well. An allowance should be made for this, the full scope of the works will not be known however until the bearings are exposed.

Truss 5 lower truss chord connection failure

4.12. Due to the relatively good condition of the timbers in truss 5 and the lack of any obvious deterioration or movement of the bearing ends it is not clear at present what caused the failure of the connection at the centre of the bottom chord.

4.13. Further investigation is required to fully understand the theory and workings of the connection. This will include both further inspection of how the connection is constructed as well as the condition of the timbers in the locality of the failure. Timber finishes and decorative panelling/detailing would need to be removed for this to be carried out, to be reinstated once the work is complete. It seems possible that a stress concentration in the timber caused by the detailing of the half lap joint, may have coincided with a local defect (e.g. a large knot) in the timber, causing local over stresses and resulting in the tensile failure seen in the timber.

4.14. The remaining central connections do not show any obvious signs of distress, visually from below or from within the attic space.

4.15. Once further analysis and investigations have been carried out it should be possible to determine if the failure was caused by a local defect in the timber or construction of the connection. If not caused by this it may be possible to determine if the connection was under designed.

4.16. This should then allow a decision to be made on whether a repair detail is carried out only on Truss 5 with the connection failure, or if it should be carried out on all the connections as a preventative measure.

4.17. The repair will need to restore the formation of the half lap joint so that the load is shared between the two half timbers at the point. At present the whole load appears to be taken by one of the two half timbers. A form of steel strap/tie repair will be required, by-passing the existing damaged connection and transferring load directly between the two parts of the bottom chord, either side of the half lap section.

Cast Iron Brackets

4.18. Once further investigation into the condition of the truss bearings has been carried out, a final assessment of the bracket detailing can be made.

4.19. Due to the nature of the cast iron brackets, their current fixings to the timber and wall, and the ornate plasterwork and finishes, it may be preferable to leave the emergency wire ties in place as an honest repair as an alternative to a installing a more conventional remedial fixing.

4.20. This may be preferable as any bolted fixing of the bracket either to the wall, or to the timber truss chord, would require drilling through the cast iron of the bracket. This would be difficult to carry out due to the brittle nature of the iron, and its location at eaves level. It would also involve some damage to the historic plasterwork and finishes of the brackets, for little structural gain.

4.21. **Re inspection April /May 2015** – The information gained about the roof structure in the re-inspection, and particularly the detailed examination of the south bearing end of Truss 4, does not materially change any of the points discussed above.

4.22. The new information gained serves to reinforce our previous understanding of the condition of the structure and its defects. The principal area of concern remains the truss bearing ends, which are now known to extend well into/onto the walls, directly beneath the parapet gutters, remaining highly vulnerable to water ingress caused by any defects in them. The implications of this concern are discussed further in the conclusions below.

5.0 Conclusions

General

5.1. A visual inspection of the roof structure has been carried out, the results of which have been discussed within this report and recommendations on further action provided. Below is a summary of the key points

5.2. Overall the roof structure has been found to be in reasonable condition, given its age and scale. Some unusual details are present which, together with apparently inadequate rainwater goods which are in poor condition, have caused local defects. The addition of a flat ceiling over the main church space subsequent to its original construction has added load to the existing roof structure. Local areas requiring repairs, improvement or further investigation have been identified. Some of these are structurally quite significant, but if addressed appropriately, employing techniques sympathetic to the historic fabric, the roof structure, including the added flat ceiling, should continue to perform satisfactorily in the future.

5.2A **Re-inspection April/May 2015** – No significant change to these overall conclusions result from the re-inspection. There has been no step change in the condition of the structure, though timber decay is continuing, in some cases affecting key structural elements

Timber connection pull out

5.3. The base connection of the main roof truss braces were identified as not having remedial strapping added to the connection as had been added to the top connections. Pull-out of some of the connections has occurred, weakening the trusses. The cause of this has been determined as being a combination of a lack of pegging detailed in the connection and the addition of a ceiling load to the bottom chord which would not have been part of the original design. Remedial straps should be added to these bottom brace connections on each roof truss.

5.3A **Re-inspection April/May 2015** – No discernible changes were identified. The recommendation of remedial straps is unchanged.

Truss Bearings

5.4. Several key truss bearings have been identified where timber decay is, or is likely to be present. These require further physical investigation to determine the severity and extent of decay. The timber decay has been noted as likely to have been caused by water ingress from the poor detailing and condition of the parapet gutters. Remedial work to the gutters is required to prevent further water ingress into the building causing further damage to the timber elements. Steel plate splice repairs to three truss bearing ends are definitely required, and allowance should be made for some further repairs once intrusive inspections of the affected areas are made. This may only be possible during a repairs contract due to access constraints. Allowance should also be made for local repairs to common rafter bearing ends and wall plates at eaves level

5.4A **Re-inspection April/May 2015** – The south end of Truss 4 has deteriorated significantly in the 18 months since the original inspection, and the south bearing end of Truss 1 has possibly deteriorated visibly over the same time period. The more detailed inspection of Truss 4, including access into the eaves void by removing lath and plaster of the upper ceiling, has enabled a better understanding to be gained of the arrangement of the truss bearing ends.

5.4B They are, as previously suspected, highly vulnerable to water ingress from the parapet gutters, as the entire, very generous 600mm long bearing of the truss is located beneath the gutter and embedded in the wall head. Water penetrating the roof or gutter finishes becomes trapped in a 'reservoir' within the wall, saturating the truss bearing and providing ideal conditions for severe timber decay to occur.

5.4C At Truss 4, the decay of the truss bearing in the wall has been total, requiring a significant steel splice repair of the type described above. It has been necessary to prop the truss in three locations to remove load from the failed bearing, until such time as the permanent repair is implemented. This repair will incorporate the complete dismantling and renewal of the parapet gutter and its supporting timbers local to the truss end.

5.4D It is still not known how many of the remaining truss ends will require repair, and this could only be determined by intrusive investigations similar to those carried out to Truss 4. There is however, little evidence at present in the main worship space of deterioration of the severity seen at Truss 4. This includes the significant drop in the level of the truss end relative to the rest of the ceiling, a clear indicator of decay at the bearing.

5.4E It remains a major concern that defects in the parapet gutters in other locations may be allowing water ingress at wall head, providing the conditions for decay of other truss bearings. This needs to be addressed urgently, by detailed inspection of the gutters, and if necessary temporary repairs or improvements to defects in the leadwork, in advance of a more general programme of repairs.

Truss 5 lower truss chord connection failure

5.5. The central bottom chord connections to the main roof trusses are an unusual bolted arrangement incorporating cast iron components. The partial tension failure of the connection on truss 5 has been inspected, reviewed and a repair detail suggested. Emergency works were carried out to secure the connection until permanent repairs can be implemented. This exact form the repair detail would take is dependent on further analysis of the truss so that connection forces can be calculated. Closer inspection of the connection is also required to try to establish whether there is an inherent fault with the original connection design affecting all the trusses, or a local defect in Truss 5 alone. At this stage the latter seems more likely, but this is not yet confirmed. It may be possible to carry out this closer inspection from scaffolding towers, which would have the advantage of reducing the degree of uncertainty in this element of the repairs prior to commencing work on site.

5.5A **Re-inspection April/May 2015** – No discernible change was noted to the connection and the recommendations are unchanged

Cast Iron Brackets

5.6. Large decorative cast iron brackets are present beneath the bearing ends of the main roof trusses, at high level in the main church space. One fell without warning when its fixings failed. The likely cause of why the bracket fell has been identified as to have been water ingress causing decay to the timber into which it was fixed.. Emergency works were carried out as a precaution to prevent further brackets from falling. Permanent remedial bolted connections of the brackets to the wall may be considered, though these would be difficult to implement. Alternatively retaining the emergency wire ties as a permanent measure is a possibility subject to discussions with the conservation authorities.

5.6A **Re-inspection April/May 2015** - No discernible change was noted and the recommendations are unchanged

Gable roofs

5.7. Significant bowing of the gable roofs has been noted. Whilst it is not evident at present that this poses a structural concern, local timber decay of one valley rafter has been noted and access to the gable roofs is limited. It would be prudent to allow for some local repairs and improvements to the structure as part of a more general roof works contract.

5.7A **Re-inspection April/May 2015** - No discernible change was noted and the recommendations are unchanged

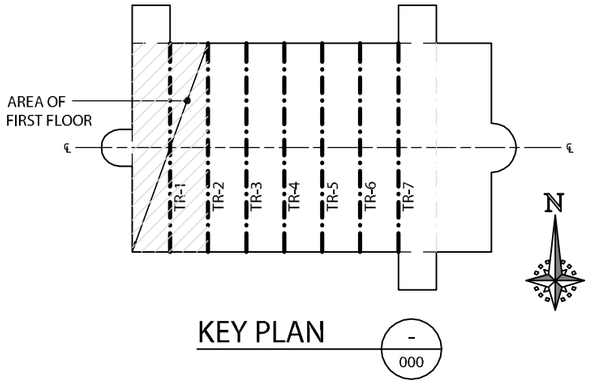
Recommended Programme for Repairs

5.8. It is difficult to define precisely a programme for the repairs which are required to the structure. In broad terms the repairs identified need to be implemented to secure the structure for the future. The emergency measures put in place already are not intended as permanent solutions. The structural repairs also logically need to be coordinated with other repairs required to the fabric of the building, most obviously the roof coverings, gutters and rainwater goods. It is imperative that sources of water ingress into the building structure and fabric, which are the root cause of most of the structural defects, are eliminated before or concurrent with the permanent structural repairs being undertaken. Subject to funding constraints, a target of 12 months for implementing permanent repairs would be sensible.

5.8A **Re-inspection April/May 2015** – In the 18 months since the original inspection, one truss bearing end has deteriorated significantly. There is no obvious evidence of more widespread deterioration of the truss bearing ends, but the recommendations above regarding works to eliminate sources of water ingress cannot be over-emphasised. Failure to do so leaves the roof structure, which is otherwise inherently reasonably sound, at severe risk of significant further structural deterioration at its most critical point, where it bears on the walls.

5.8B It is highly likely that these works will entail the renewal in their entirety of the parapet gutters and their supporting timbers. This will in turn expose each truss bearing end for inspection and repair as required. If repairs on this scale cannot be implemented reasonably soon due for example to funding constraints, a continued programme of visual inspections is strongly recommended in the interim, to monitor the condition of the truss ends. Given the speed of deterioration of Truss 4, and subject to the outcome of the parapet gutter inspection (see 5.4E above), a further inspection in 9 months is suggested.

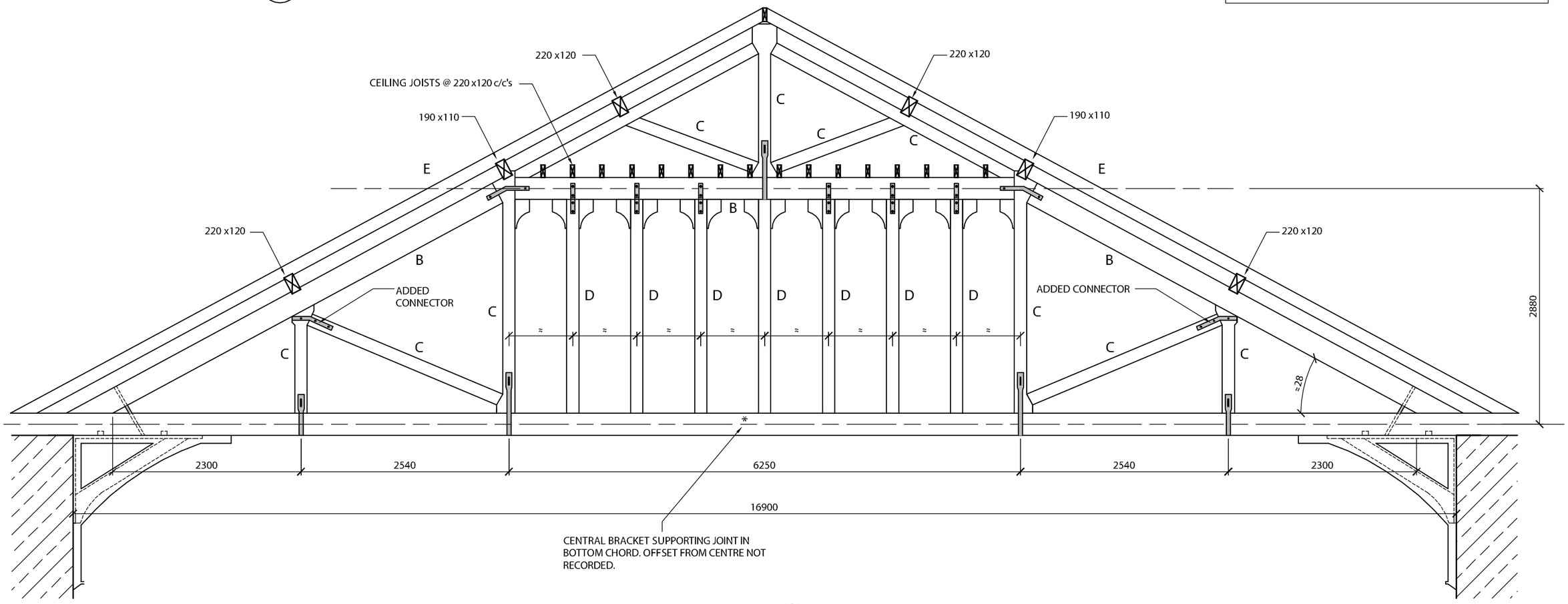
Appendix A- Drawings



KEY PLAN - 000

KEY:

		DEEP x WIDE
A	-	270 x 200
B	-	270 x150
C	-	150 x150
D	-	60 x 95 (FACE x SIDE)
E	-	120 x 40 @ 360 (COMMON RAFTER)



ELEVATION 1:50 — 001 — GENERAL TRUSS

NOTE: NO RECORD POSSIBLE OF CONDITION OF TRUSS BEARING BELOW.

NOTES

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NOTES CONTINUED

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REV	DESCRIPTION	BY	DATE
P1	PRELIMINARY ISSUE	RHO	09.01.14

P-PRELIMINARY T-TENDER CONSTRUCTION

PROJECT
ST PAUL'S CHURCH
NEWPORT

TITLE
TYPICAL TRUSS ELEVATION

EXISTING CONDITION

MANN WILLIAMS
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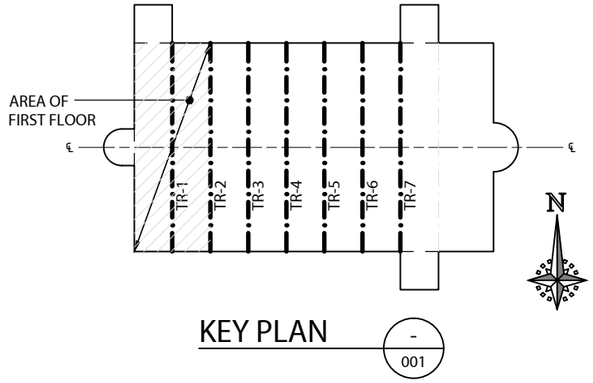
DRAWN	CHKD	SIZE	SCALE	DATE
RHO	NR	A3	AS NOTED	DEC'13

STATUS
PRELIMINARY

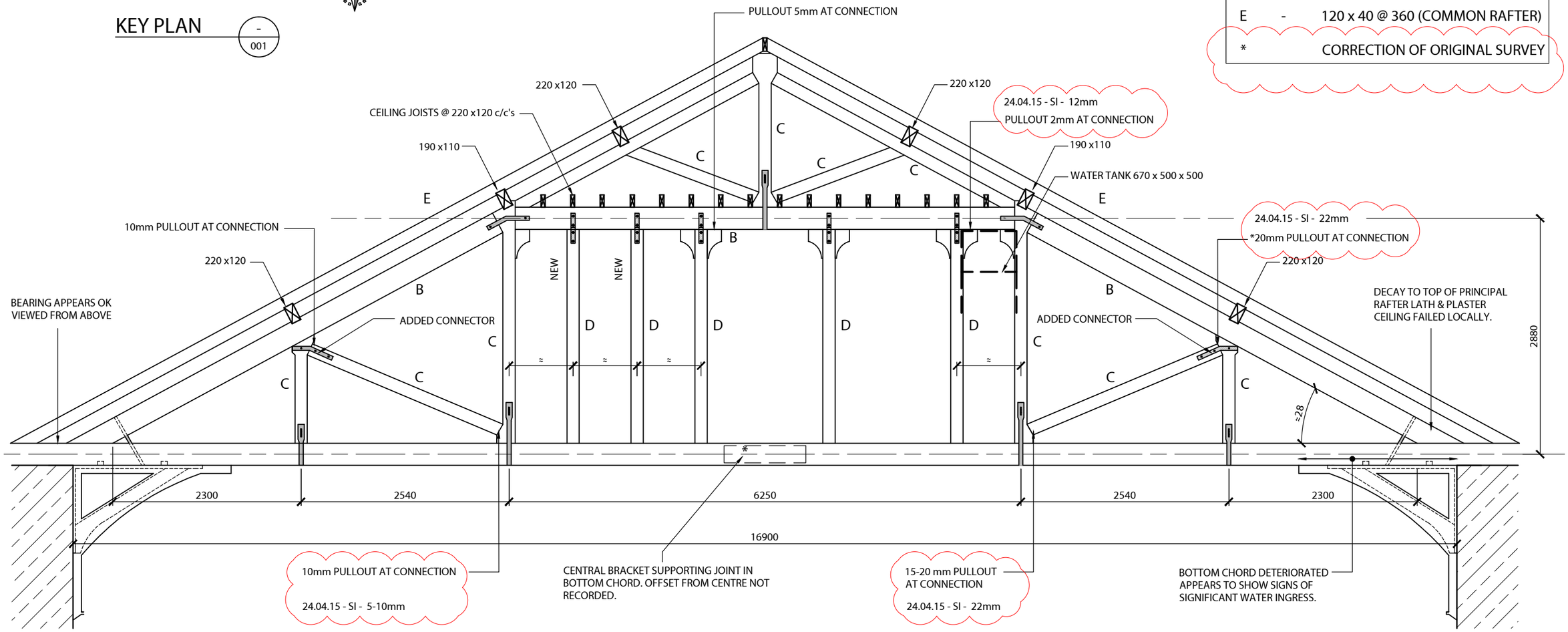
PROJECT	DRAWING	REV
6882	000	P1



KEY PLAN - 001

KEY:

		DEEP x WIDE
A	-	270 x 200
B	-	270 x150
C	-	150 x150
D	-	60 x 95 (FACE x SIDE)
E	-	120 x 40 @ 360 (COMMON RAFTER)
*		CORRECTION OF ORIGINAL SURVEY



ELEVATION 1:50 — 001 — TRUSS 01

NOTE: NO RECORD POSSIBLE OF CONDITION OF TRUSS BEARING BELOW.

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NOTES CONTINUED

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REV	DESCRIPTION	BY	DATE
P1	PRELIMINARY ISSUE	RHO	09.01.14
P2	UPDATED FOLLOWING SITE INSPECTION	BD	22.05.15

P-PRELIMINARY T-TENDER CONSTRUCTION

PROJECT
ST PAUL'S CHURCH
NEWPORT

TITLE
TRUSS 1 ELEVATION

EXISTING CONDITION

MANN WILLIAMS
CONSULTING CIVIL AND STRUCTURAL ENGINEERS
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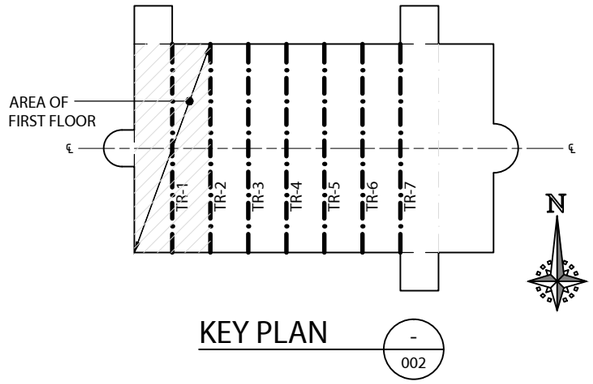
DRAWN	CHKD	SIZE	SCALE	DATE
RHO	NR	A3	AS NOTED	DEC'13

STATUS
PRELIMINARY

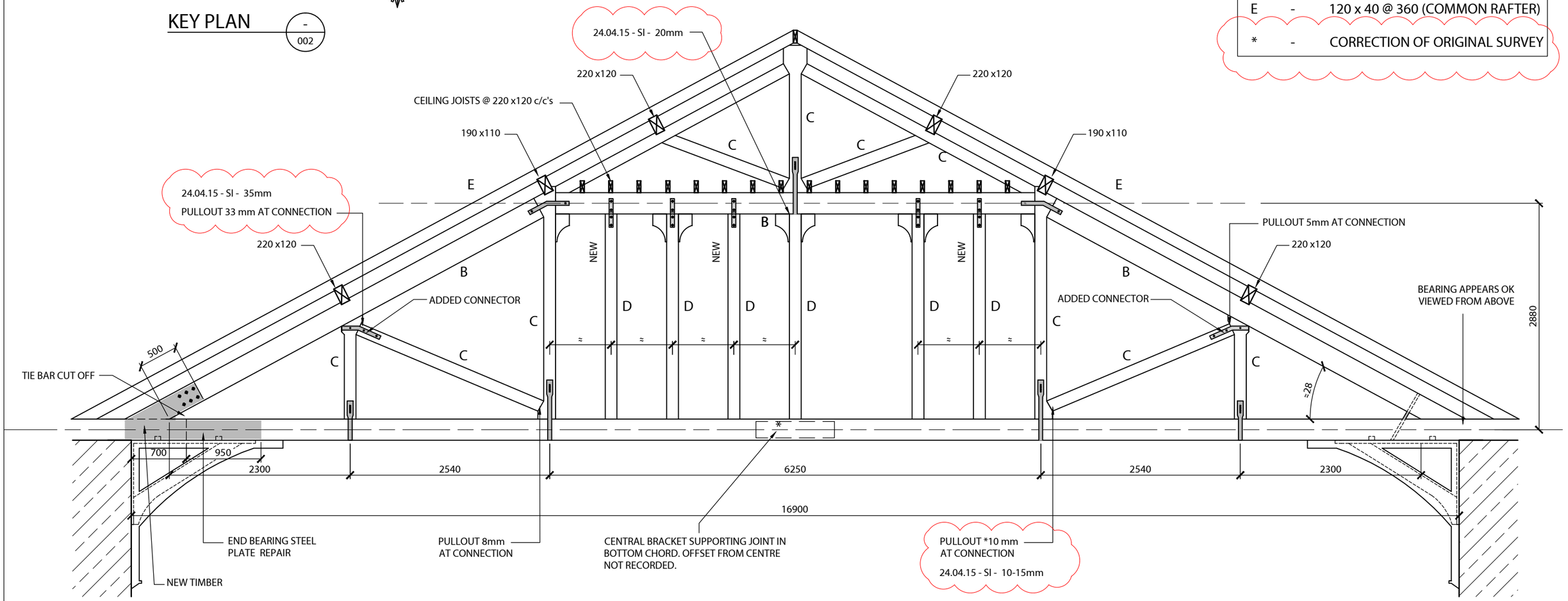
PROJECT	DRAWING	REV
6882	001	P2



KEY PLAN - 002

KEY:

		DEEP x WIDE
A	-	270 x 200
B	-	270 x150
C	-	150 x150
D	-	60 x 95 (FACE x SIDE)
E	-	120 x 40 @ 360 (COMMON RAFTER)
*	-	CORRECTION OF ORIGINAL SURVEY



ELEVATION 1:50 — TRUSS 02 — 002

NOTE: NO RECORD POSSIBLE OF CONDITION OF TRUSS BEARING BELOW.

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NOTES CONTINUED

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REV	DESCRIPTION	BY	DATE
P1	PRELIMINARY ISSUE	RHO	09.01.14
P2	UPDATED FOLLOWING SITE INSPECTION.	BD	22.05.15

P-PRELIMINARY T-TENDER CONSTRUCTION

PROJECT
ST PAUL'S CHURCH
NEWPORT

TITLE
TRUSS 2 ELEVATION

EXISTING CONDITION

MANN WILLIAMS
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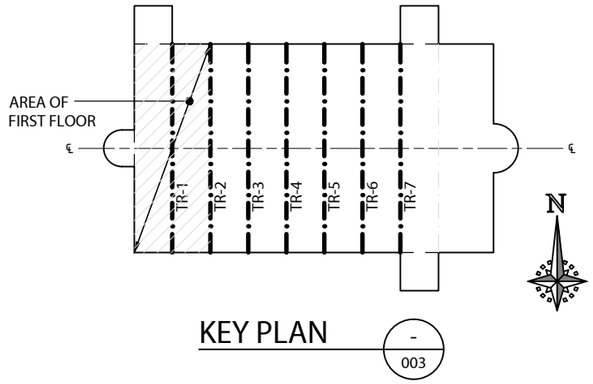
DRAWN	CHKD	SIZE	SCALE	DATE
RHO	NR	A3	AS NOTED	DEC'13

STATUS
PRELIMINARY

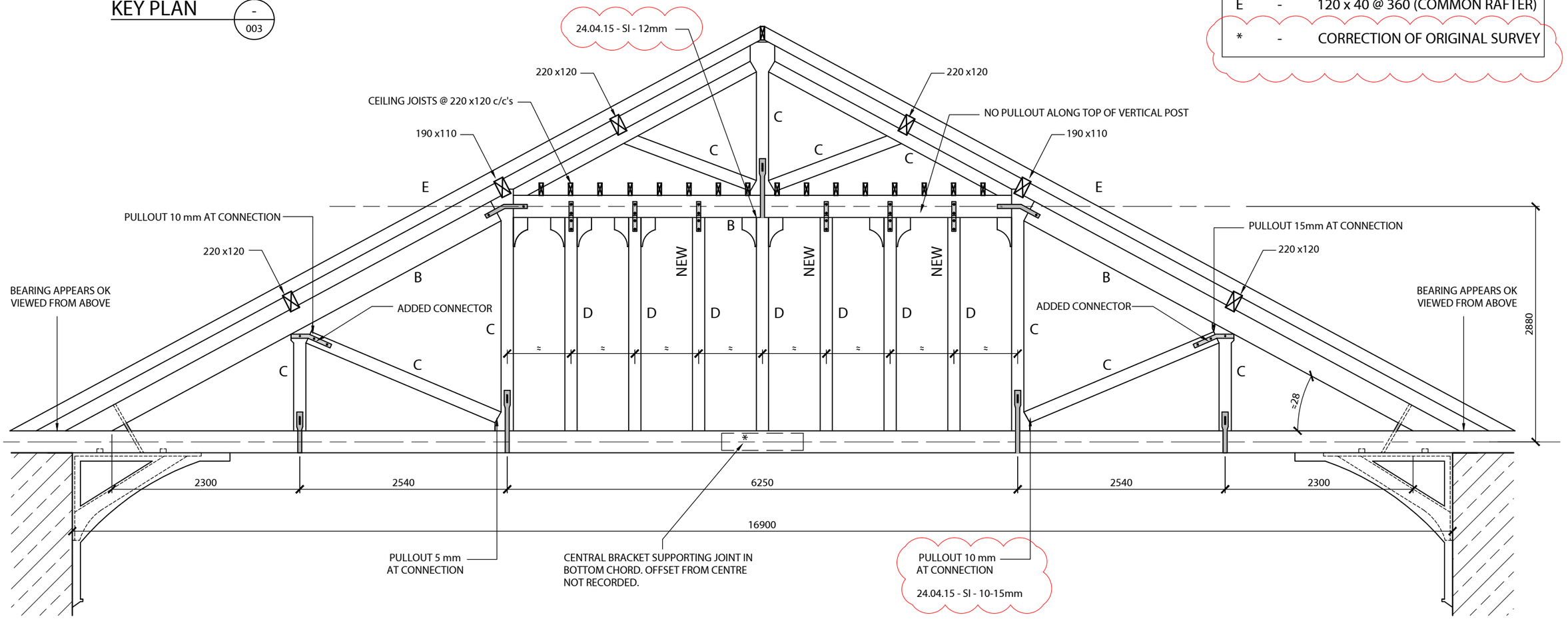
PROJECT	DRAWING	REV
6882	002	P2



KEY PLAN - 003

KEY:

		DEEP x WIDE
A	-	270 x 200
B	-	270 x150
C	-	150 x150
D	-	60 x 95 (FACE x SIDE)
E	-	120 x 40 @ 360 (COMMON RAFTER)
*	-	CORRECTION OF ORIGINAL SURVEY



ELEVATION 1:50 — TRUSS 03 — 003

NOTE: NO RECORD POSSIBLE OF CONDITION OF TRUSS BEARING BELOW.

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NOTES CONTINUED

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REV	DESCRIPTION	BY	DATE
P1	PRELIMINARY ISSUE	RHO	09.01.14
P2	UPDATED FOLLOWING SITE INSPECTION.	BD	22.05.15

P-PRELIMINARY T-TENDER CONSTRUCTION

PROJECT
ST PAUL'S CHURCH
NEWPORT

TITLE
TRUSS 3 ELEVATION

EXISTING CONDITION

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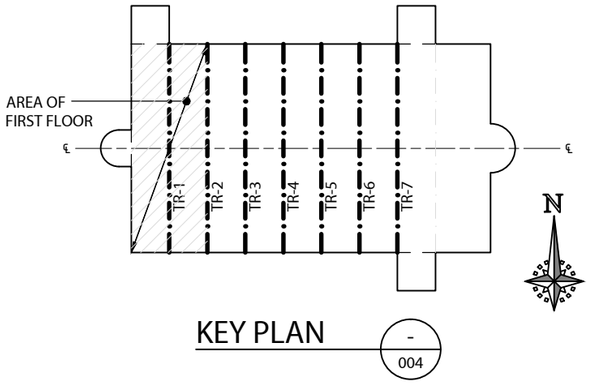
DRAWN	CHKD	SIZE	SCALE	DATE
RHO	NR	A3	AS NOTED	DEC'13

STATUS
PRELIMINARY

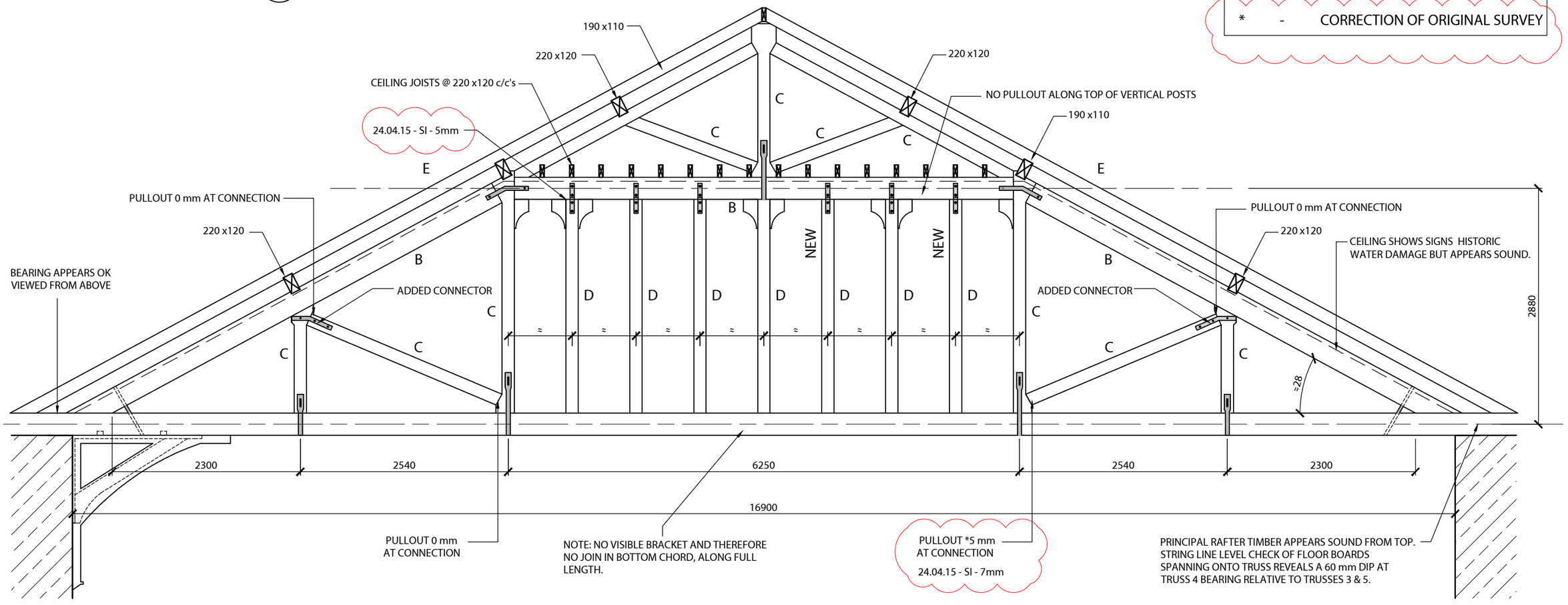
PROJECT	DRAWING	REV
6882	003	P2



KEY PLAN - 004

KEY:

		DEEP x WIDE
A	-	270 x 200
B	-	270 x150
C	-	150 x150
D	-	60 x 95 (FACE x SIDE)
E	-	120 x 40 @ 360 (COMMON RAFTER)
*	-	CORRECTION OF ORIGINAL SURVEY



NORTH

SOUTH

ELEVATION 1:50 — 004 — TRUSS 04

NOTE: NO RECORD POSSIBLE OF CONDITION OF TRUSS BEARING BELOW.

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NOTES CONTINUED

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REV	DESCRIPTION	BY	DATE
P1	PRELIMINARY ISSUE	RHO	09.01.14
P2	UPDATED FOLLOWING SITE INSPECTION.	BD	22.05.15

P-PRELIMINARY T-TENDER CONSTRUCTION

PROJECT
ST PAUL'S CHURCH
NEWPORT

TITLE
TRUSS 4 ELEVATION

EXISTING CONDITION

MANN WILLIAMS
CONSULTING CIVIL AND STRUCTURAL ENGINEERS
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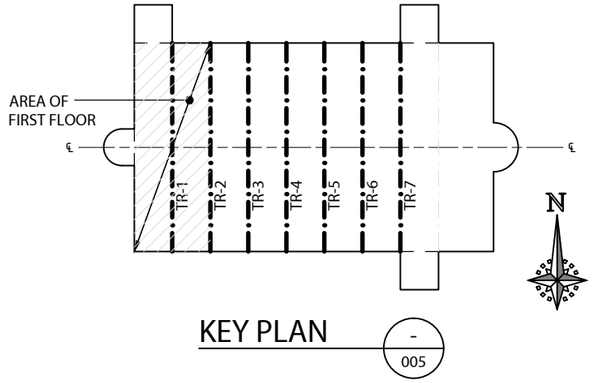
DRAWN	CHKD	SIZE	SCALE	DATE
RHO	NR	A3	AS NOTED	DEC'13

STATUS
PRELIMINARY

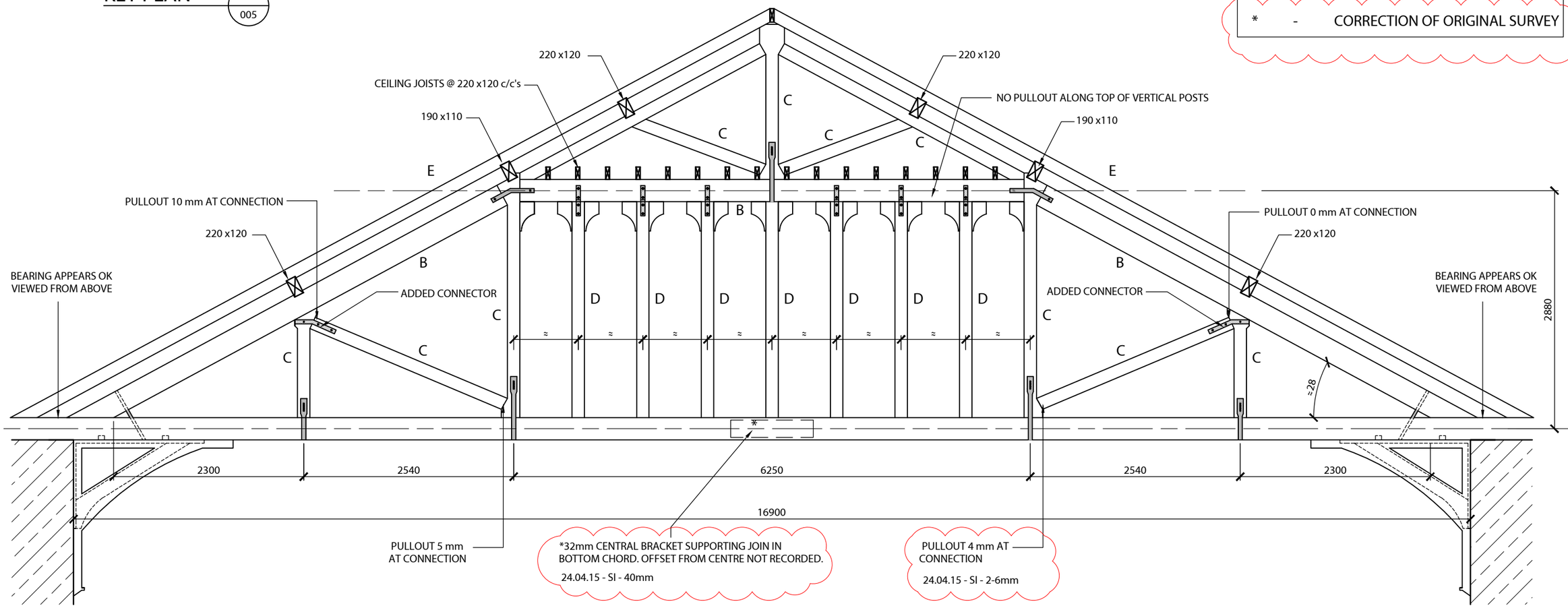
PROJECT	DRAWING	REV
6882	004	P2



KEY PLAN - 005

KEY:

		DEEP x WIDE
A	-	270 x 200
B	-	270 x150
C	-	150 x150
D	-	60 x 95 (FACE x SIDE)
E	-	120 x 40 @ 360 (COMMON RAFTER)
*	-	CORRECTION OF ORIGINAL SURVEY



ELEVATION 1:50 - 005 TRUSS 05

NOTE: NO RECORD POSSIBLE OF CONDITION OF TRUSS BEARING BELOW.

NOTES

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NOTES CONTINUED

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REV	DESCRIPTION	BY	DATE
P1	PRELIMINARY ISSUE	RHO	09.01.14
P2	UPDATED FOLLOWING SITE INSPECTION.	BD	22.05.15

P-PRELIMINARY T-TENDER CONSTRUCTION

PROJECT
ST PAUL'S CHURCH
NEWPORT

TITLE
TRUSS 5 ELEVATION

EXISTING CONDITION

MANN WILLIAMS
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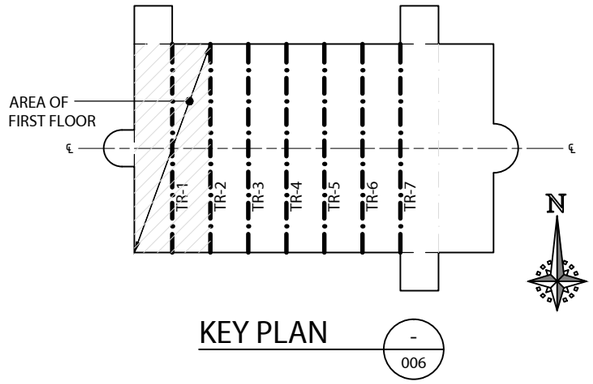
DRAWN	CHKD	SIZE	SCALE	DATE
RHO	NR	A3	AS NOTED	DEC'13

STATUS
PRELIMINARY

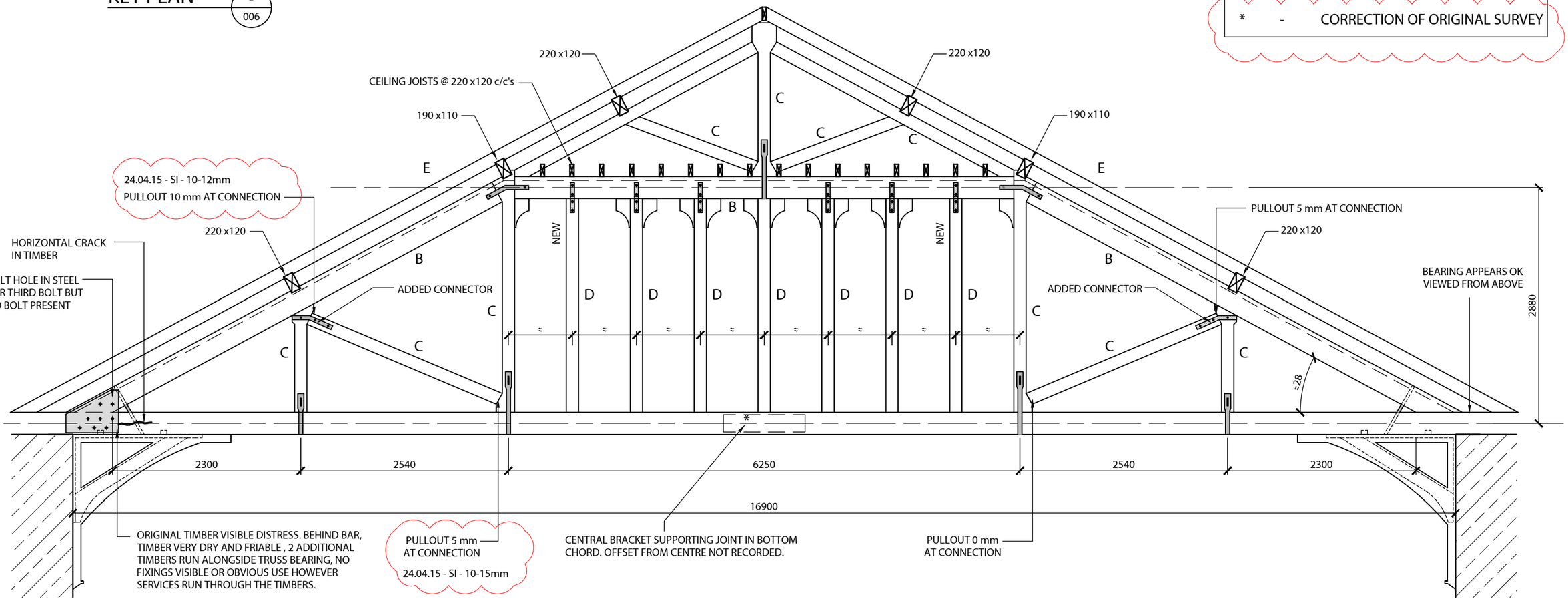
PROJECT	DRAWING	REV
6882	005	P2



KEY PLAN - 006

KEY:

		DEEP x WIDE
A	-	270 x 200
B	-	270 x150
C	-	150 x150
D	-	60 x 95 (FACE x SIDE)
E	-	120 x 40 @ 360 (COMMON RAFTER)
*	-	CORRECTION OF ORIGINAL SURVEY



ELEVATION 1:50 — TRUSS 06 — 006

NOTE: NO RECORD POSSIBLE OF CONDITION OF TRUSS BEARING BELOW.

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NOTES CONTINUED

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REV	DESCRIPTION	BY	DATE
P1	PRELIMINARY ISSUE	RHO	09.01.14
P2	UPDATED FOLLOWING SITE INSPECTION.	BD	22.05.15

P-PRELIMINARY T-TENDER CONSTRUCTION

PROJECT
ST PAUL'S CHURCH
NEWPORT

TITLE
TRUSS 6 ELEVATION

EXISTING CONDITION

MANN WILLIAMS
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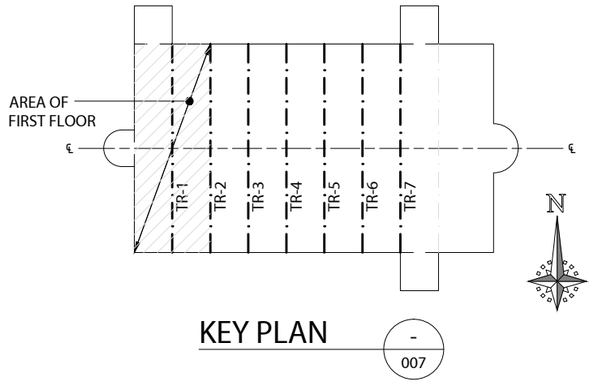
DRAWN	CHKD	SIZE	SCALE	DATE
RHO	NR	A3	AS NOTED	DEC'13

STATUS
PRELIMINARY

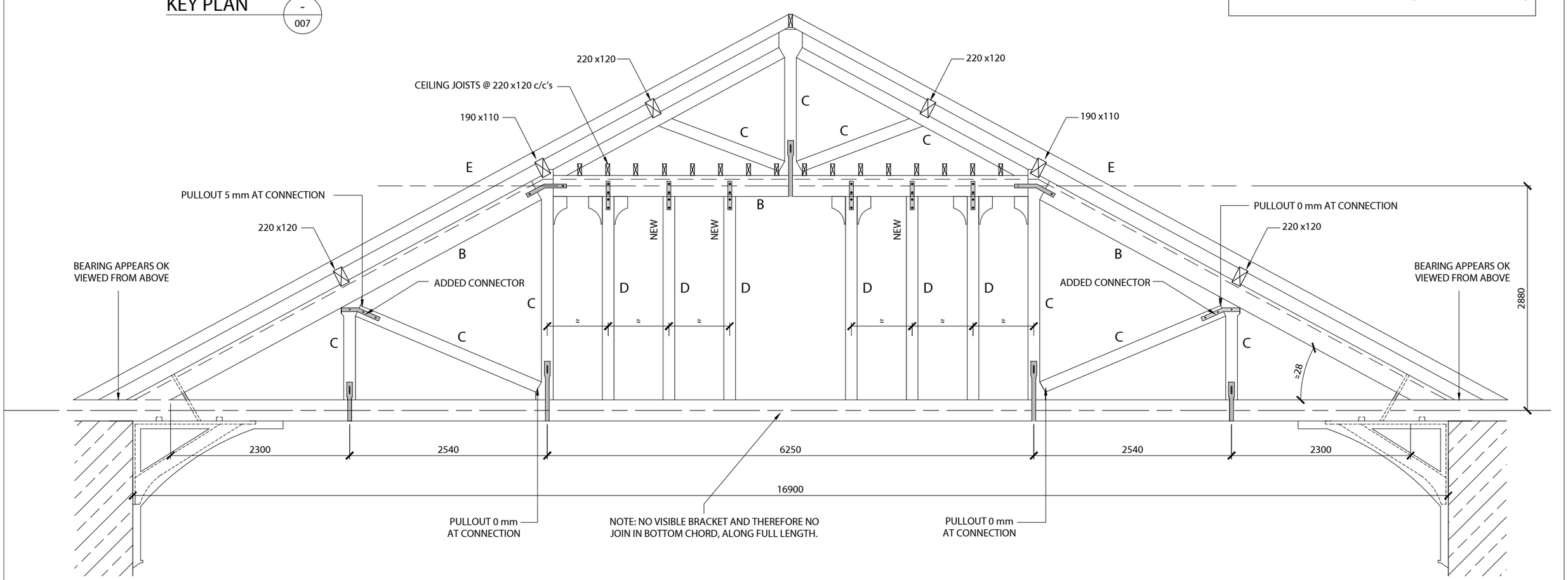
PROJECT	DRAWING	REV
6882	006	P2



KEY PLAN - 007

KEY:

		DEEP x WIDE
A	-	270 x 200
B	-	270 x150
C	-	150 x150
D	-	60 x 95 (FACE x SIDE)
E	-	120 x 40 @ 360 (COMMON RAFTER)



ELEVATION 1:50 — TRUSS 07 — 007

NOTE: NO RECORD POSSIBLE OF CONDITION OF TRUSS BEARING BELOW.

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NOTES CONTINUED

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REV	DESCRIPTION	BY	DATE
P1	PRELIMINARY ISSUE	RHO	09.01.14

P-PRELIMINARY T-TENDER CONSTRUCTION

PROJECT
ST PAUL'S CHURCH
NEWPORT

TITLE
TRUSS 7 ELEVATION

EXISTING CONDITION

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DRAWN	CHKD	SIZE	SCALE	DATE
RHO	NR	A3	AS NOTED	DEC'13

STATUS
PRELIMINARY

PROJECT	DRAWING	REV
6882	007	P1

Appendix B- Reports Regarding Truss 4 Bearing

Site Visit Report

Mann Williams
Consulting Civil and Structural Engineers

53 Mount Stuart Square, Cardiff CF10 5LR
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Project No:	6882		
Project:	St Paul's Newport	Report No:	**SVR 03**
Engineer:	Pat Ruddock	Page:	1 of 4
Date of visit:	24 April 2015		
Present:	Rev Justin Groves (part)		

Weather: Dry, mild

Site Notes **Urgent works required to decayed truss bearing end over main worship space**

During a structural inspection of the roof structure on 24th April 2015, it was noted that the bearing end of one of the roof trusses over the main worship space was severely decayed, and that immediate action was required to support it, until permanent repairs can be undertaken.

The inspection was being undertaken as a follow up review, following the overall structural appraisal of the roof structure, and implementation of emergency repairs to elements of the roof structure in early 2014. These works are described in our previous report ref 6882_R_NM_02_03 dated January 2014.

This report deals only with the newly discovered severely decayed truss end as this requires urgent attention: a further report will follow summarizing the findings of the remainder of the roof inspection.

The truss end affected is the south end of Truss 4, where the cast iron corbel bracket previously fell, in November 2013.

When inspected following the collapse of the bracket, no immediate distress was found to the truss bearing end, as reported at the time.

The photo shows the bearing end of the bottom chord of the truss in 2013.

Distribution				
	Client (PCC St Pauls))	x	Project Manager	☐
	RBCIW	X	Quantity Surveyor	☐
	Landscape Architect	☐	M&E	☐
	File	☐	Contractor	X

On inspection in 2015, it was found that the bottom chord of the truss was severely decayed at its bearing into the wall and for a distance of some 300-400mm away from it.

At least the bottom half of the 300mm deep bottom chord is completely decayed at the face of the wall: it is not possible to access the full depth from below.

There is evidence of a significant fungal attack of the timber, visible on the underside. This will have contributed to the deterioration of the timber, and is almost certainly caused by continuing water ingress from the parapet gutter above the truss bearing.

The weather at the time of inspection and for the preceding couple of weeks had been dry, but there is significant damp staining on the wall at the truss location.

The images below (upper:2013, lower 2015) show the overall deflection of the bearing end of truss 4 relative to the adjacent trusses, and also the extent of the damp staining. It is clear that the defects are progressive, and the effects are spreading laterally across the ceiling, to the secondary timbers midway between the truss ends, which are being pulled away from the wall also.

This suggests that the continuing deterioration of the truss bearing is leading to load being shed into adjacent timbers which are not intended to carry it.

Conclusion - Urgent actions required

The structural integrity of the remainder of the south bearing end of Truss 4 is not known and likely to be very poor. A full repair of the truss end is required, which is likely to entail the insertion of steel plates to replace the function of the decayed timber. This work will require the removal and renewal of roof finishes, and almost certainly a section of the parapet gutter above the truss end.

The full extent of repairs required will not be known until better access is gained, with the truss propped and scaffolding erected internally and externally. These works would naturally form part of the wider programme of structure and fabric repairs identified in our January 2014 report.

It is therefore essential if the church is to remain in use, that temporary propping is put in place now, to support the decayed truss end until permanent repairs can be implemented.

It is proposed that this propping take the form of a small tower of scaffolding (traditional steel scaffolding, not a demountable aluminium access tower) erected under the truss, within the 'corridor' along the south wall.

A sketch proposal will be prepared by Mann Williams, for pricing and implementation by a suitably experienced contractor. It is strongly recommended that the propping is put in place as soon as is practicable, and in any event within 14 days of the date of this report.

Site Visit Report

Mann Williams
Consulting Civil and Structural Engineers

53 Mount Stuart Square, Cardiff CF10 5LR
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Project No:	6882		
Project:	St Paul's Newport	Report No:	**SVR 04**
Engineer:	Pat Ruddock	Page:	1 of 2
Date of visit:	12 May 2015		
Present:	Rev Justin Groves	Isabel Thompson – Monmouth DAC	
	Mike Williams – Taliesin Conservation		
Weather:	Dry, mild		

Site Notes **Urgent propping required to Truss 4 over main worship space**

Mann Williams visited site to discuss the proposed propping to the south bearing end of Truss 4 with the contractor, due to be implemented today.

It was noted that plaster had fallen from the south wall at the bearing of a secondary ceiling timber midway between Truss 4 and Truss 3.

This suggests that the roof structure is pulling away from the wall here, which may be associated with the continuing deterioration of the end of Truss 4

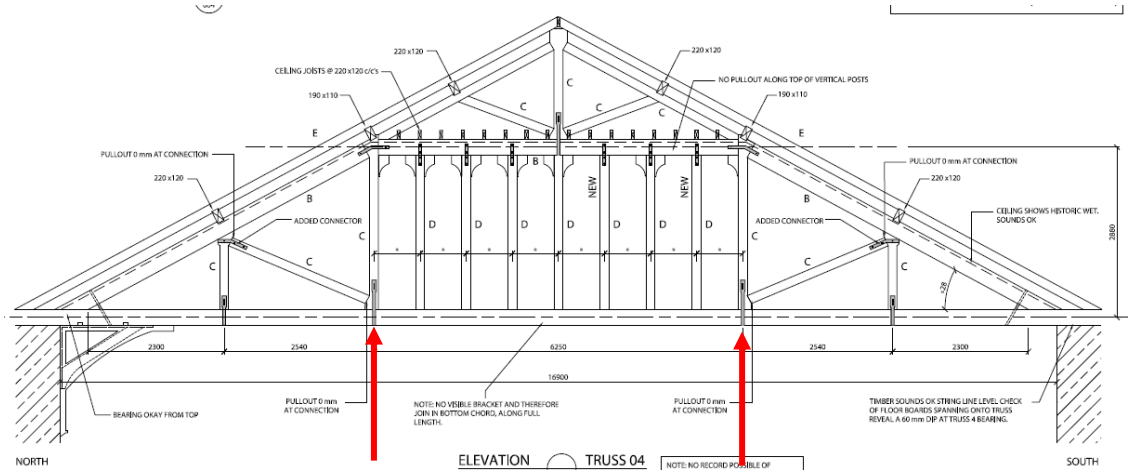
Viewed from below, there also appears fairly clear evidence that Truss 4 is pulling away from the wall.

Distribution				
	Client (PCC St Pauls))	x	Project Manager	☐
	RBCIW	X	Quantity Surveyor	☐
	Landscape Architect	☐	M&E	☐
	File	☐	Contractor	X

Conclusion - Urgent actions required

The condition of the bearing end of Truss 4 remains unknown, but it seems clear that it is likely to be actively deteriorating. The further plaster fall in the 2 weeks since the last inspection emphasises this.

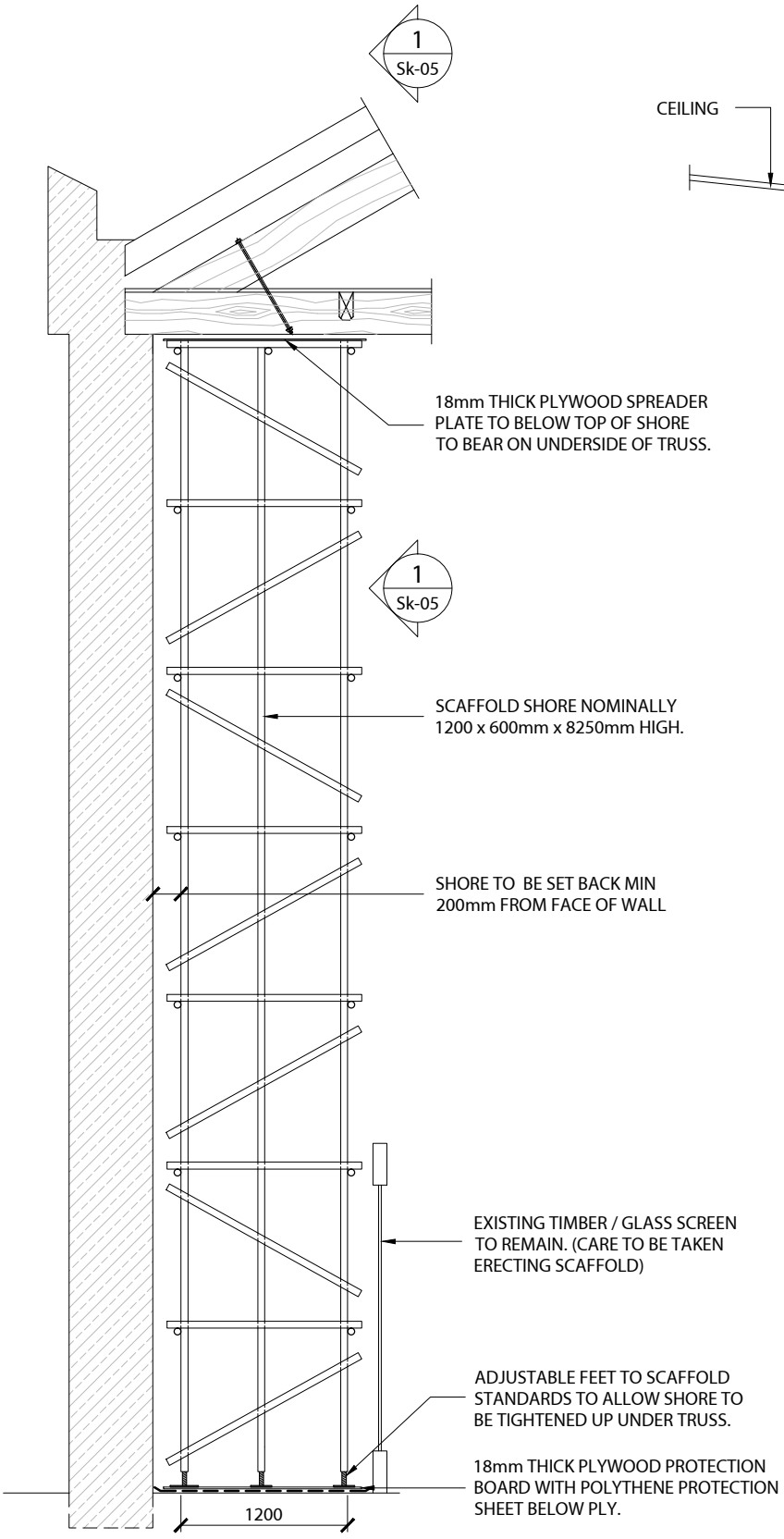
The overall integrity of Truss 4 is therefore at risk. The currently proposed propping to the south bearing end will not address this, as it is intended to provide local support only. This is still required, but it is proposed that the truss be further propped at two other key support points:



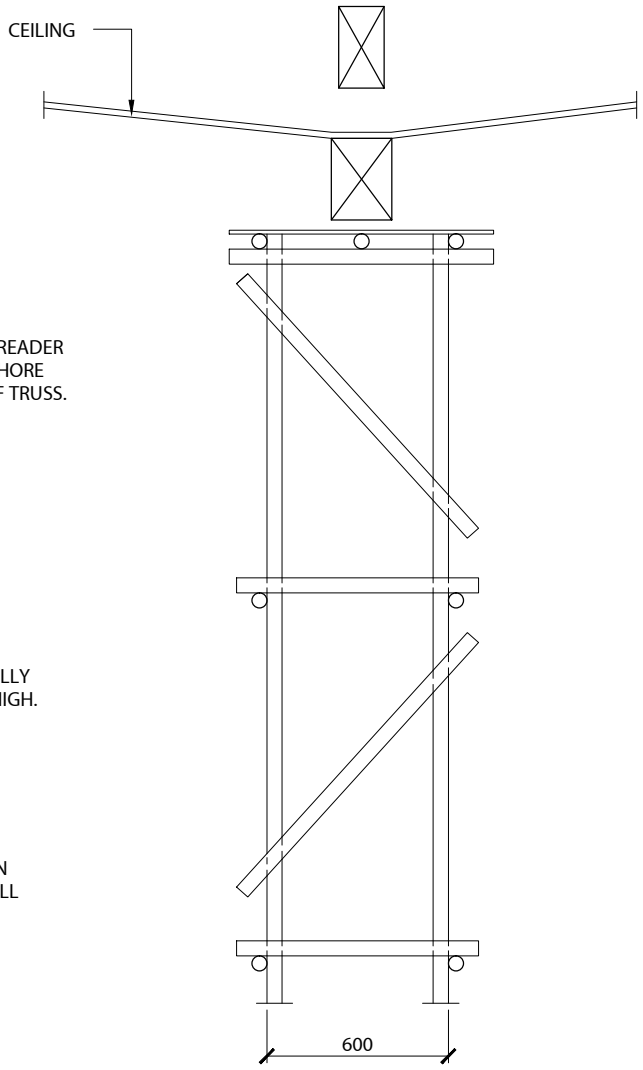
It is proposed that this propping take the form of towers of scaffolding (traditional steel scaffolding, not a demountable aluminium access tower) erected under the truss, similar to that proposed for the south bearing end (see sketch 6882/SK05 attached). The towers are to be clad in solid boarding (plywood or similar) to a height of 1.8m to prevent unauthorized access to the scaffolding. The towers are to provide support to the bottom chord of the truss, but no attempt is to be made to jack it up.

Given the urgency of the structural condition of the truss, these works were verbally instructed on site, and the contractor commenced them immediately.

The remaining propping works already planned are also to be implemented, and the investigations of the south bearing end of Truss 4 will then be carried out.



SECTION A-A (Sk-05)
1:100



SECTION 1-1 (Sk-05)
1:25

NOTES

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2. All drawings are to be read in conjunction with the project specification with all works carried out in accordance with the latest British Standards and codes of practice.
3. Any ambiguities or discrepancies between this drawing and any other information given elsewhere must be reported to Mann Williams for clarification before work proceeds.
4. All dimensions to be checked on site and any discrepancies reported to the engineer before work commences.
5. Only figured or calculated dimensions should be used and no drawing , in any format should be scaled.

REV	DESCRIPTION	BY	DATE
C1	CONSTRUCTION ISSUE	BD	27.04.15

P-PRELIMINARY T-TENDER CONSTRUCTION

PROJECT
St Pauls Church,

Newport

TITLE
Temporary Proping to South End of Truss 4

MANN WILLIAMS
CONSULTING CIVIL AND STRUCTURAL ENGINEERS
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CARDIFF CF10 5LR
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DRAWN	CHKD	SIZE	SCALE	DATE
BD	PR	A4	AS NOTED	APRIL '15

STATUS
CONSTRUCTION

PROJECT	DRAWING	REV
6882	Sk-05	C1

Site Visit Report

Mann Williams
Consulting Civil and Structural Engineers

53 Mount Stuart Square, Cardiff CF10 5LR
T: 02920 480333 www.mannwilliams.co.uk

Project No:	6882		
Project:	St Paul's Newport	Report No:	**SVR 05**
Engineer:	Pat Ruddock	Page:	1 of 10
Date of visit:	14 May 2015		
Present:	Rev Justin Groves (part)		
Weather:	Heavy rain, mild		

Site Notes **Inspection of south bearing end of Truss 4 over main worship space**

Mann Williams visited site to inspect the south bearing end of Truss 4, following the installation of temporary propping top the truss.

The bearing end was inspected from three locations:

- Internally within the worship space from an aluminium scaffolding tower
- Internally from within the roof space, following local removal of lath and plaster ceiling finishes to the underside of the roof pitch
- Externally from a local scaffold erected to allow access to the parapet gutter

This report presents the findings from the inspection regarding the form and condition of the truss end and the adjacent roof structure, and makes strategic recommendations for the approach to repairs.

If the principles of the recommendations are agreed by relevant parties (the PCC, the Diocesan Advisory Committee and the Representative Body of the Church in Wales), proposals can be drawn up for the repairs sufficient to seek costings from suitably experienced contractors.

Internal Inspection – from Worship Space

The three scaffold props are now in place, two beneath the queen post locations (see report SVR04), and one at the south bearing end.

Distribution				
	Client (PCC St Pauls))	x	Project Manager	☐
	RBCIW	X	Quantity Surveyor	☐
	Landscape Architect	☐	M&E	☐
	File	☐	Contractor	X

The bottom chord (tie beam) of the truss was found to be completely decayed at its bearing onto the wall. The structure of the timber has lost all capacity and crushed/torn, allowing the truss end to drop approximately 110mm vertically from its original position.

The timber wall plate on which it bears is also severely degraded and has crushed significantly locally under the truss bearing end.

However, when the tie beam was drilled to assess its integrity away from the face of the wall, it was found to be reasonably sound 200mm from the wall, and apparently undamaged 340mm from the face of the wall.

The ceiling beam between trusses 3 and 4 is pulling significantly out of the wall, and has minimal bearing remaining. The gap behind the timber moulding parallel to the wall is approximately 40mm.

For comparison, the bearing end of Truss 3 was inspected, to establish the original relationship of the truss bearing end and the wall.

A small notch in the bottom chord is visible where it bears on the wall.

The timber is in reasonable condition.

Internal Inspection - from roof space

The roof space inspection confirmed that the roof structure includes separate ceiling joists (spanning between the roof trusses) and common rafters (spanning between purlins).

It is clear that the tie beam once extended a significant distance onto the wall head. A bearing length of approximately 570mm was recorded, but all of this timber is now totally degraded.

The image shows the top of the tie beam within the wall (circled) with the underside of the parapet gutter framing above and the top chord of the truss bottom left.

There is a purlin towards the bottom of the roof slope, which has separated from its bearing on the top chord of the truss. The purlin is continuous over the truss, probably spliced at trusses 3 and 5 on either side.

A vertical gap of about 45mm has opened up at the bearing onto truss 4, presumably demonstrating that the purlin is now spanning twice as far as originally intended, and providing unintentional support to the truss end, which is now to some extent hanging from it.

Beyond the purlin, further into the eaves, the underside of what appears to be the parapet gutter construction is partly visible. The timbers here are of various ages and in variable condition, suggesting a number of phases of maintenance/repair.

External inspection – parapet gutter

The parapet gutter to the south elevation was inspected via the scaffold access.

Truss 4 occurs at the high point of the gutter, which then falls away in both directions to rainwater outlets

The lead lengths between steps are relatively long, at around 2250mm. The final section leading to the outlet is around 2800mm long.

There is evidence of a proprietary 'painted' repair to a split in the lead of the gutter immediately above the bearing end of truss 4. It is not known when this repair was undertaken, and for how long the split was present prior to it being repaired.

It is also noted that the upstand to the slates at the high point of the gutter is only about 50mm. The extent to which lead is dressed up under the slates is not known.

The gutter falls noticeably laterally towards the interior of the building.

At the outlet at the west end (adjacent to the bearing end of Truss 1) the gutter is holding water and the lead detailing at the junction with the valley gutter appears untidy.

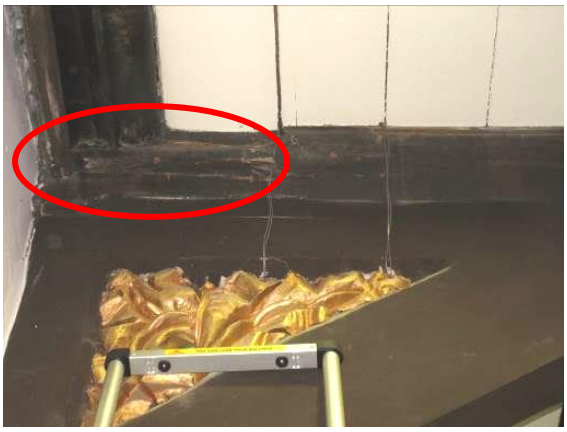
It is not clear if this may be contributing to the poor condition of the truss end below (in the first floor office).

Inspection of Truss 1 south bearing end

The end bearing of Truss 1 (exposed in the first floor office) was inspected, and drilled to test the integrity of the timber.

Decay has occurred to the upper part of the bottom chord close to the bearing. This is in evidence on both sides of the timber.

Similar to Truss 4, the timber is in very poor condition close to the bearing but improves quite rapidly away from the wall.



Access for inspection of the bearing in the roof space is more limited than at Truss 4, due to the roof geometry (Truss 1 is located at the junction of the main roof and the smaller steeply pitched roofs which run at right angles to the main pitch at each end)

The image shows the valley 'blade' (circled) and the principal rafter of Truss 1 to the left.

There is clear evidence of historic water ingress beneath the valley, in terms of damp staining to plaster, etc.

It was not possible to inspect the bearing end of the Truss at the wall head.

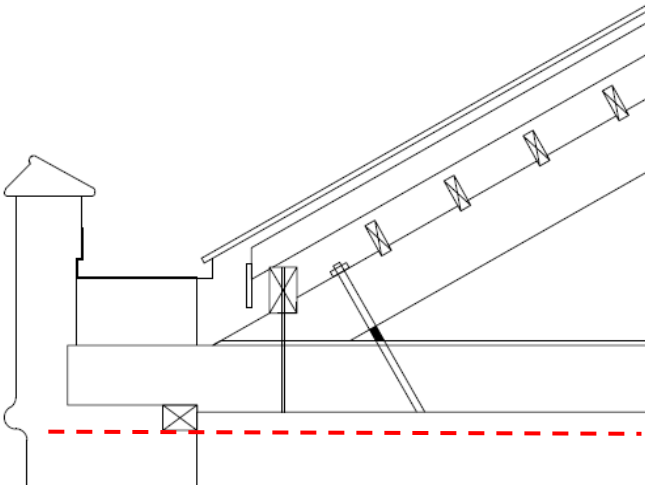
Discussion

The investigations confirm the very poor condition of the south bearing end of Truss 4, and the structural failure of the bottom chord or tie beam, where it bears on the external wall.

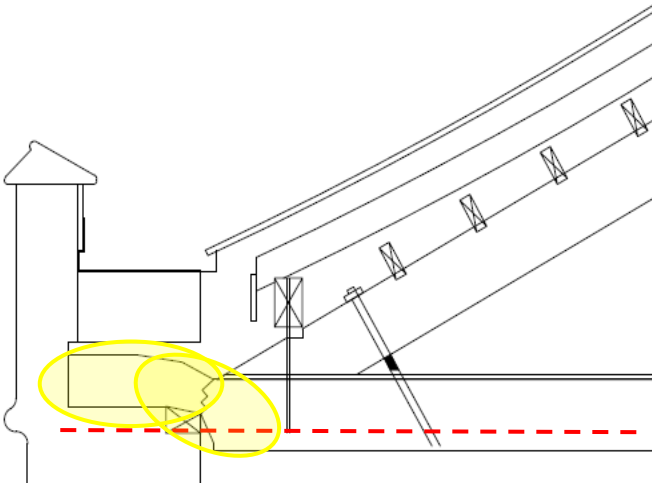
It is clear that the roof structure is now working in ways that were never intended, such as the lowest purlin spanning approximately 6.4m from Truss 3 to Truss 5, unsupported at Truss 4. This is inducing loads and stresses in timbers well beyond the intentions of the original design.

The truss has dropped significantly at its bearing, as shown in the photographs above and the two sketch sections below, compiled from our site records. The upper shows the truss geometry 'as built', the lower Truss 4 as now found on site.

The red dashed lines provide a horizontal datum; the yellow highlighted area is the zone of severe, verging on total, timber decay.



'As built'



Current condition

The condition of the secondary timbers, such as those supporting the parapet gutter is not known in detail, but the evidence points to a sustained period of water ingress at the wall head, via defects in and/or poor detailing of the parapet gutter. In addition to causing the total decay and failure of the truss tie beam, it is highly likely to have compromised the associated secondary timbers.

Actions Required

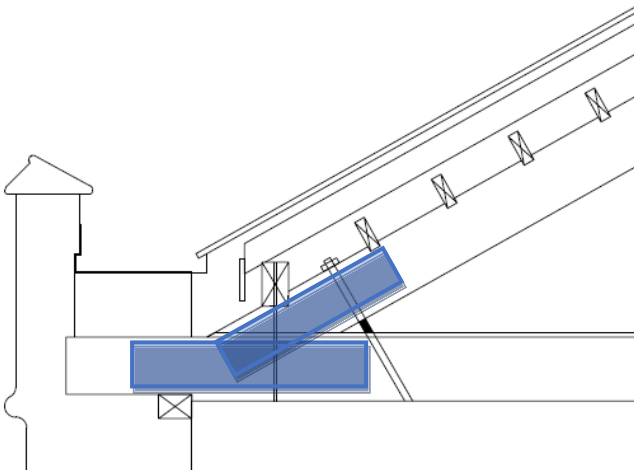
Truss 4 is now supported on the three scaffolding props erected within the main worship space.

Given the essentially complete structural failure of the truss at its bearing, these props cannot be removed until a permanent repair is implemented.

The repair is likely to comprise renewal of the bearing end of the truss in steel plate, flitched into the timber (ie located on its centerline) to reduce the visual impact on the truss tie beam where it is visible in the main worship space. The likely extent of the steel plate is shown indicatively on the sketch below. It will be held in place by steel through bolts, and the deteriorated timber will be renewed to match the existing, A concrete padstone will be cast in the wall for the new steelwork to bear on.

Associated works to facilitate the primary structural repair, and to complement it, will include:

Stripping of the slate roof finishes local to the truss end, removal of a section of the parapet gutter and its framing, renewal of anticipated decayed common rafter ends, renewal of decayed wall plate, renewal of gutter framing and leadwork, making good of finishes internally.



Structural calculations are required to determine the dimensions of the steelwork. It will also be necessary to consider carefully the sequence of installation. Given the constructed working space at the wall head, it may be necessary to fabricate the steelwork in two sections, to be bolted together once installed.

Given the significant drop in the level of the truss end which has occurred due to decay, it seems sensible to consider attempting to carefully jack the south bearing of Truss 4 back closer to its original levels. This is not a process to be undertaken lightly, given the risks of causing secondary damage to elements which have taken up deformed shapes as a result of the structural decay, but the benefits, both aesthetic and in terms of the building fabric (reducing the current 'dip' in the roof finishes) mean that it is worthy of discussion.

The condition and arrangement of the existing leadwork to the parapet gutters needs further review. Access to the south gutter is currently available via the external scaffolding and it is proposed that a suitably experienced professional (eg conservation architect) or specialist leadwork contractor, is asked to carry out such an inspection.

The objectives would be:

- To determine if the existing leadwork detailing meets current standards
- To advise if any immediate improvements/repairs are needed to areas away from Truss 4, in advance of an anticipated general renewal of the gutters as part of a wider roofing repair contract
- To consider how a partial renewal of the parapet gutter, as part of the Truss 4 works, can be detailed in such a way as to be integrated into such a future gutter renewal

Finally, consideration also needs to be given to how the cast iron decorative bracket which fell from this location in late 2013, is to be repaired and re-installed.

Recommendations

It is recommended that the design of the permanent repairs to the south bearing end of Truss 4 is instructed now, with a view to implementing the repairs as soon as is practicable, to restore the integrity of the structure and fabric of this key part of the historic building.

As part of this design process, the current condition of the south bearing end of Truss 1 should also be considered further, to determine within what timeframe repairs are required here.

The review of the leadwork of the south parapet gutter should also be instructed