Hutton + Rostron
Environmental Investigations Limited

The Hope Project: Investigation of the ‘Fly Tower’ roof for condition, strength classes and construction

Site note 2 for 8 March 2018, job no. 146.89

CONTENTS

Attachments

Distribution:

James Morgan - Heyne Tillett Steel
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File: 146.89

1 INTRODUCTION

1.1 AUTHORITY AND REFERENCES

Hutton + Rostron Environmental Investigations Limited carried out a site visit to KOKO concert venue, 1A Camden High Street, Kings Cross, London NW1 on 08 March 2018 in accordance with instructions from James Morgan of Heyne Tillett Steel by email on 06 March 2018. Drawings provided by Andy Campbell of Heyne Tillett Steel were used for the identification of structures

1.2 AIM

The aim of the survey was to assess the condition of timber structural elements within the 'Fly Tower' roof, and to assign probable strength classes to the structural elements of 3 no. king post trusses and 2 no. half trusses by visual strength grading. Additionally, H+R assessed the condition and the adequacy of strengthened timber joints with steel plates

1.3 LIMITATIONS CONDITION ASSESSMENT)

This survey was confined to the accessible structures. Concealed timbers and cavities have been investigated where necessary by the use of high-powered fibre optics. The condition of concealed timbers may be deduced from the general condition and moisture content of the adjacent structure. Only demolition or exposure work can enable the condition of timber to be determined with certainty, and this destroys what it is intended to preserve. Specialist investigative techniques are therefore employed as aids to the surveyor. No such technique can be 100 per cent reliable, but their use allows deductions to be made about the most probable condition of materials at the time of examination. Structures were not examined in detail except as described in this report, and no liability can be accepted for defects that may exist in other parts of the building. We have not inspected woodwork or other parts of the structure which are covered, unexposed or inaccessible and we are therefore unable to report that any such part of the property is free from defect or in the event that such part of the property is not free from defect it will not contaminate and/or affect any other part of the property. Any design work carried out in conjunction with this report has taken account of available pre-construction or construction phase information to assist in the management of health and safety risks. The sample remedial details and other recommendations in this report are included to advise and inform the design team appointed by the client. The contents of this report do not imply the adoption of the role of Principal Designer by H+R for the purposes of the Construction Design and Management (CDM) Regulations 2015. No formal investigation of moisture distribution was made

1.4 LIMITATIONS (VISUAL STRENGTH GRADING)

The assessment of strength grade is based on physical observation of strength-reducing characteristics such as knots, rate of growth, fissures, wane distortions and bowing. The assessment of in-situ timbers therefore requires all of the faces to be examined. The technique is based on the judgement and experience of the grader and is inherently subjective. Properties such as density and notches, both of which have an important influence on stiffness, are not considered as part of the strength grading process but are reported on if these are known to be present. It was not possible, in all timbers, to assess slope of grain, rate of growth, knots, and other strength reducing defects. This was because the timbers were not fully accessible along their spans, however, from samples taken, the rate of growth fell well within the requirements of BS 4978: 2007 'Visual strength grading of softwood'. In view of these limitations, the visual strength grading procedure cannot be 100 per cent reliable. Accordingly, in all of the timbers inspected, the probable strength grade can only be deduced from the strength reducing features visible on exposed faces at the time of inspection

1.5 METHODOLOGY OF VISUAL STRENGTH GRADING

The timber elements were inspected on the basis of exhibiting strength reducing features such as knots, rate of growth, fissures, slope of grain, bowing and wane. A probable strength grade assessment of ungradeable (UG), general structural (GS) grade or special structural (SS) grade was made on the basis of measuring the features that were visible. The extent of strength reducing features that are permissible within strength grades are detailed in British Standard 4978: Specification for Visual Strength Grading of Softwood. Identification of timber species was carried out in representative elements. The samples were examined visually with a x10 lens to determine their gross characteristics. Thin sections were cut from each sample and examined microscopically. The anatomical features of each sample were compared with published information and where applicable with reference timber samples

2 STAFF ON SITE AND CONTACTS

2.1 H+R STAFF ON SITE

Vytas Liubertas
Jenny Brown
Clive Stonehill

2.2 PERSONNEL CONTACTED

KOKO concert venue staff

3 OBSERVATIONS AND RECOMMENDATIONS

3.1 CONSTRUCTION

3.1.1 Roof construction

The ‘Fly Tower’ roof comprised of softwood timber structural elements. All of the roof loading was transferred from timber rafters either to purlins or to underlying timber plates. Timber purlins of the west pitch were supported onto the principal rafter elements, of the king post truss systems, directly above the struts; whereas the remaining roof pitches comprised of 2 no. purlins, where the higher level purlins were bearing on the principal rafters directly above struts and the lower level purlins at the bearing ends of the king post trusses. The west bearing ends of the timber king post trusses were embedded into the masonry and the east ends were supported at the nodes of the steel truss. Along the north and south eaves, the roof void’s floor structure contained timber trusses which were supporting timber floor joists, spanning north-south, and the bearing ends of the half-timber trusses. It should be noted that 3 no. king post trusses had been strengthened with additional vertical steel elements at each half of the truss systems. Each vertical element composed of 2 no. steel flat plates which were glued with adhesives to the principal rafters and tie beams. These plates were acting in tension in order to support the tie beams of the king post trusses due to generated loadings which arose from the dead load of the supported floor structure and the lighting rigs

The roof structure comprised of the following structural elements:

1 Common/jack rafters: 125 x 60mm @ 370mm centres
2 Hip rafters: 230 x 70mm
3 Timber purlins: 245 x 150mm
4 Rafter plates: 100 x 100mm
5 Principal rafters: 245 x 145mm
6 King posts: 185 x 150mm
7 Struts: 90 x 145mm
8 Tie beams: 300 x 145mm
9 Strengthening steel plates of timber trusses: 147 x 10mm

3.1.2 Floor construction

The dead load of the floor structure and generated imposed load were transferred to the tie beams of timber trusses with the aid of steel hangers. Softwood main floor beams were positioned parallel under the tie beams with the aid of 3 no. hangers, which were located adjacent to the east and west ends of the tie beams and adjacent to the king posts. All of the floor beams had fixed timber ledger strips on both faces of the beams. The counter-spanning floor joists were notched over the ledger strips. A sketch of a sectional view of the floor structure is shown at the Attachment C

Measured cross-sectional dimensions of the floor structure elements were, as follows:

1 Steel hangers: 60 x 20mm
2 Principal floor beams: 300 x 100mm
3 Floor joists: 170 x 75mm @ 600mm centres
4 Ledger strips: 100 x 50mm

3.1.3 Steel truss system

The steel truss located parallel to the east eave of the roof was of a parallel chord, cross-braced truss construction. The truss system contained 6 no. bays. The top and bottom chords comprised of double parallel flanges and unequal angle sections. Each bay of the steel truss had 2 no. cross-braced diagonals, where each of these was of different section: unequal flange section and flat section. The vertical elements, below the node positions, were acting as struts and were of T sections. The sketch of the steel truss segment is shown at Attachment E and the cross-sectional dimensions are tabulated below

Element	Section type	Height (mm)	Width (mm)	Thickness (mm)	
				Flange	Web
Top chord	Parallel flange	150	60	9.6	8
Vertical element	T	76	152	9.8	10.6
Diagonal element (1)	Flat	76	12.5	-	-
Diagonal element (2)	Unequal angle	96	78	14.2	
Bottom chord	Unequal angle	90*	78	14.5	

*- The height of unequal angle section was not measured with accuracy as it was difficult to access it due to lack of safe access. Therefore, it can be stipulated that the height of the bottom chord was 96mm, as the rest of the dimensions match with the diagonal element (2) dimensions

3.1.4 Strengthened mechanical joints of timber trusses

Awaiting IR spectroscopy results of sampled adhesives. The results will allow an educated guess of the adhesive type. The results will be presented in Attachment D)

All traditional joints in the tie beams of the truss systems had been strengthened with steel plates by gluing them between 2 no. timber elements with, most likely, epoxy type of adhesive. In the case of the strengthened carpenter joint between the king post and tie beam, the glue has to match the shear strength and the tensile strength parallel and perpendicular to the grain. Assuming that the adhesive was of epoxy type, the latter requirement of the adhesive should not be an issue, as the glue will be stronger than the timber being connected. The strength of the glueline will be based on timber strengths. It should be noted that the contribution of mechanical fasteners should not be considered as these type of joints were of a different structural nature and their sole purpose was to fix the steel plate in position during the solidification process of adhesion

Modified mechanical joints should be checked for their structural adequacy

3.2 CONDITION

All timber elements were investigated visually and accessible vulnerable structural timber elements were subject to decay detection drilling at their bearing ends and/or along their longitudinal span at increments. This revealed that the majority of the timbers were in good condition with deep moisture content values generally below 12 per cent which indicated that fungal decay was not active. However, historic and partially active decay was observed to some localized areas as discussed below:

1 Jack rafters: The majority of the fungal decay affected timber elements were the jack rafter ends resting onto the hip rafters. This suggested that the hip flashings had been failing at multiple locations. The majority of the decayed elements had deep moisture content below 16 per cent, which indicated that the wet rot decay was not active at the time of survey, however original cross-sectional areas of the roof rafters had been reduced between 15 and 40 per cent due to historic decay. The quantitative findings of decayed jack rafter ends, supported onto the hip rafters, were, as follows: approximately 12 no. rafter ends onto the south-east hip rafters, approximately 6 no. timber rafter ends onto the south-west hip rafter, approximately 4 no. rafter ends onto the north-west hip rafter and approximately 3 no. rafter ends onto the north-east hip rafter. It should be noted that not all of the rafter ends were physically tested along the hip rafters due to lack of safe access

Further and future water ingress in the hip rafter areas should be stopped. Decayed bearing ends of the rafters should be cut back to sound timber for approximately 200mm and partnered with new structural timber. No chemical remedial treatments for fungal decay and wood boring insect are either necessary or recommended

2 Hip rafters: All of the hip rafters visually appeared to have reduced cross-sectional area due to superficial decay to the topsides. It was also anticipated that there might have been localized decay to the topside centres of non-accessed higher level span segments of the hip rafters. However, no significant decay was observed visually to these elements

The effective height of the hip rafters is recommended to be reduced by 10 per cent in structural calculations in order to allow for superficial and undetected decay at the higher level of the span segments. The hip rafters are recommended to be re-investigated in order to determine an actual loss of the cross-section, if any. No chemical remedial treatments for fungal decay and wood boring insect are either necessary or recommended

3 Sarking boards: The majority of the sarking boards were affected to some degree by the ingress moisture. This was observed by water staining to the underside of timber boards. The majority of the sarking boards appeared to be in relatively good condition, however it was anticipated that at least 60 per cent of them were suffering from the superficial decay. All of the timber boards around all 4 no. hip rafters were structurally effected and/or were considered to be inadequate due to partial decay. The extent of wet rot decay to the sarking boards varied from 100mm to 300mm on each side of the hip rafters. Additionally, 1 no. localised area to the south pitch of the roof, was observed to be suffering from wet rot decay. At least 6 no. boards in height and isolated between 3 no. rafters in width were structurally affected

All of the structurally affected sarking boards by wet rot should be cut back to sound timber and should be replaced with new softwood boards. All failed roof coverings should be replaced accordingly

4 Rafters between TR3 and TR4 trusses: 4 no. roof timber elements around the hatch opening, located to the west pitch of the roof, were structurally decayed: 2 no. trimmer rafters and 1 no. trimmer element were structurally decayed in their entirety and 1 trimming rafter, supporting the counter-spanning trimmer element, was decayed for approximately 400mm from the end grain. Additionally, 1 no. adjacent rafter, to the north of the hatch opening, was also structurally decayed for approximately 300mm from the end grain

Decayed elements in their entirety should be replaced with new structural elements as specified by the Structural Engineer. 2 no. decayed rafters at their feet should be cut back to sound timber and partnered with new timber elements

5 Timber plate along the west pitch: Only timber plates along the west pitch were accessible at the time of survey. Physical testing indicated that a segment of approximately 3m in length, between TR3 and TR4 trusses, was structurally decayed by wet rot. Timber plates located along the north, east and south masonry structures visually did not appear to be decayed

Structurally decayed timber plate should be cut back to sound timber and replaced with new structural timber. New timber element should be isolated from the masonry with a damp-proof membrane

All of the structurally decayed elements are indicated on the plan at Attachment F and general photographs of decayed elements are shown in the photographs of Attachment A

3.3 VISUAL STRENGTH GRADING OF TIMBER TRUSSES

3.3.1 Species identification

Representative samples of timber were extracted from the investigated timber truss elements on 08 March 2018. The visual inspection of timber samples under 3 no. planes of orientation: transversal, radial and tangential, indicated anatomical features consistent with those of the *Pinus palustris group*, which includes the Pitch Pine species. This was evident by the presence of the resin canals on the transversal plane, uniseriate tails above and below the resin canal region on the tangential plane, and by the presence of the dentated ray tracheids and pinoids pits on the radial plane. The microscopic views of wood samples are shown in the photographs of Attachment B. Pitch Pine can be visually graded in accordance with BS 4978: 2007 to SS (special structural) or GS (general structural) giving strength classes C24 or C16 respectively

3.3.2 Strength grades and classes of truss elements

Visual strength grading inspection revealed that the probable strength grade of all structural timber elements of the truss systems were of special structural [SS] grade. Special structural visual grade of Pitch Pine elements give a probable strength class of C24. The findings of the structural elements of the visual strength grading survey are tabulated below

Element	Approximate dimensions (mm)	Allocated probable grade	Timber species	Allocated probable strength class	Comment
Principal rafter	245 x 145	SS	PP	C24	
King post	185 x 150	SS	PP	C24	
Struts	90 x 145	SS	PP	C24	
Tie beams	300 x 145	SS	PP	C24	

SS = Special Structural GS = General Structural PP= Pitch Pine

3.3.3 Structural issues

No signs of flexural nor shear failure was observed to the tie beams. It was noted that the tenons of mechanical joints of timber trusses had been partially dislodged at multiple locations, however these joints had been strengthened with epoxy type adhesive and steel plates which stopped further failure of mechanical joints. Nevertheless, 1 no. localised structural issue was observed:

1 Bearing end of the TR 1: The south bearing end of the half truss was bearing on a minimum effective bearing plane. This was considered to be structurally inadequate

The south bearing end of the half truss should be re-supported in order to provide structurally efficient effective area

4 H+R WORK ON SITE

4.1 H+R inspected all accessible structural elements, as necessary, so as to determine their construction type and condition

4.2 H+R assigned probable strength class to structural timber elements of timber truss systems

4.3 H+R inspected the condition of strengthened mechanical joints and sampled 2 no. joints in order to determine the type and make-up of the adhesive

5 PROPOSED ACTION BY H+R

5.1 H+R will advise on remedial detailing, so as to minimise the risk of damp and decay problems after refurbishment, if instructed

5.2 H+R will review proposed remedial details as these become available, if instructed

5.3 H+R will return to site to inspect sample remedial details if instructed, if instructed

5.4 H+R will liaise with conservation and historic building authorities, if instructed, so as to ensure the cost-effective conservation of original fabric

6 INFORMATION REQUIRED BY H+R

6.1 H+R require copies of up-to-date copies of project programmes, as these become available

6.2 H+R require copies of up-to-date lists of project personnel and contact lists as these become available

6.3 H+R require copies of proposed remedial details for comment as these become available

6.4 H+R should be informed as a matter of urgency if further significant water penetration occurs onto site; so that advice can be given on cost-effective remedial measures, to minimise the risk of cost or programme overruns and so as to minimise the risk of damp or decay problems during the latent defect period

7 ADMINISTRATION REQUIREMENTS

7.1 H+R require formal instructions for further investigations and consultancy on this project

7.2 H+R require confirmation of distribution of digital and printed copies of reports and site notes

Appendix A

Fig 1:

Timber roof elements between TR2 truss and south-east corner of the roof: showing general view of the roof structure. Rafters and purlins were in good condition in this area. Notice that sarking timber boards were slightly degraded, however this was not considered to be structurally significant

Fig 2:

South-east hip rafter: showing general view of south-east hip rafter and jack rafters. Approximately 12 no. jack rafters along the hip rafter span were structurally decayed at their bearing ends. Additionally, the sarking boards around the hip rafter were decayed, where decay extended between 100mm and 300mm on each side of the hip rafter

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Fig 3:

South-east corner looking to the west: showing timber truss system which spanned parallel to the south eave. Timber truss was supporting floor joists and half timber truss (TR1). No structural issues nor fungal decay was observed visually

Fig 4:

Timber elements between south-east hip rafter and half truss (TR1): showing general view of timber rafters and underlying plate, which were in good condition. Noticed localised decay to the sarking boards which had been degrading due to failed roof finishes

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Fig 5:

East plane of the half truss (TR1): showing general view of the half truss system. All of the structural elements of the truss system were strength graded to the strength class C24

Fig 6:

South bearing end of the half truss (TR1): showing general structural configuration of the south bearing end of the half truss. Note that the tie beam was bearing onto a small piece of timber element which was providing minimum bearing length, no more than 15mm

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Fig 7:

Intersection between timber half truss (TR1) and king post truss (TR2): showing strengthened timber joint between the king posts and tie beams with epoxy based adhesive and steel angle section. Note that the screw fasteners should not be considered in structural verification of the joint, as they were only holding steel element in place until the solidification of the adhesive from the liquid state

Fig 8:

King post of the half timber truss (TR1): showing fissures in the king post which were of drying characteristics and were not considered to be structurally significant

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Fig 9:

Intersection between timber half truss (TR1) and king post truss (TR2): showing strengthened timber joint between the king posts and tie beams with epoxy based adhesive and steel angle section. Note that the screw fasteners should not be considered in structural verification of the joint, as they were only holding steel element in place until the solidification of the adhesive from the liquid state

Fig 10:

Joint of the half timber truss (TR1): showing general view of the joint between the strut and king post which were held by 1 no. fastener. This structural configuration of the joint may not be structurally adequate in resisting internal tension forces in the strut

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Fig 11:

Joint of the half timber truss (TR1): showing general view of the joint between the king post and tie beam. Note that the tenon had been slightly dislodged due to additional internal bending forces generated from the lighting rigs and supported floor structure. Initial design of this joint was to support post in compression, however due to additional loading to timber tie beams, the joint was acting in tension, hence the instalment of the steel angle

Fig 12:

Timber elements between the south-west hip rafter and king post truss (TR2): showing general view of timber rafters and underlying plate, which were in good condition. Note discoloration to the sarking boards. This suggest that there might be superficial decay to the topside of the boards. No structurally significant decay to the sarking boards was observed from the inside

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Fig 13:

North plane of the king post truss (TR2): showing general view of the king post truss, where all of the structural elements of this system were strength graded to the strength class C24

Fig 14:

East bearing end of the king post truss (TR2): showing general view of the bearing end. Note that the joint between the tie beam and principal rafter had been strengthened with steel plate. The contribution of the screw fasteners should not be considered in the joint structural verification. Additionally note that the tie beam had been restrained against the rotation to the top chord of the steel truss

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Fig 15:

Joint of the king post truss (TR2): showing general view of strengthened timber joint with steel plate between the king post and tie beam. The contribution of the screw fasteners should not be considered to contribute to the strength of the joint. Additionally note original fastener which was laterally supporting the tie beam of the half truss (TR1)

Fig 16:

Structural roof timber elements between TR2 and TR3 king post trusses to the west: showing general view of timber rafters and underlying plate, which were in good condition. Note discoloration to the sarking boards. This suggest that there might be superficial decay to the topside of the boards. No structurally significant decay to the sarking boards was observed from the inside

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Fig 17:

West bearing end of the truss (TR2): showing general view of embedded bearing end of the truss. No structurally significant decay was detected upon deep drilling

Fig 18:

South plane of the king post truss (TR3): showing general view of the king post truss, where all of the structural elements of this system were strength graded to the strength class C24

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Fig 19:

East bearing end of the king post truss (TR3): showing general view of the bearing end. Note that the joint between the tie beam and principal rafter had been strengthened with steel plate on each side. The contribution of the screw fasteners should not be considered to contribute to the strength of the joint. Additionally note that the tie beam had been restrained against the rotation to the top chord of the steel truss

Fig 20:

West bearing end of the truss (TR3): showing general view of embedded bearing end of the truss. No structurally significant decay was detected upon deep drilling

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Fig 21:

East bearing end of the king post truss (TR4): showing general view of the bearing end. Note that the joint between the tie beam and principal rafter had been strengthened with steel plate on each side. The contribution of the screw fasteners should not be considered in the join structural verification. Additionally note that the tie beam had been restrained against the rotation to the top chord of the steel truss

Fig 22:

Timber joint of the king post truss (TR4): showing general view of strengthened timber joint with steel plate between the king post and tie beam. The contribution of the screw fasteners should not be considered to contribute to the strength of the joint. All of the structural timber elements of the truss system (TR4) were strength graded to the strength class C24

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Fig 23:

Upper section of the king post truss (TR4): showing general view of the apex area of the truss system. Note discoloration to the ridge element and sarking boards. This suggested that there might have been some superficial decay to the topside of the sarking boards. The ridge board was not accessible for physical decay detection drilling, however no visual structural decay was observed to the ridge and sarking boards

Fig 24:

West half of the king post truss (TR4): showing 2 no. additional steel plates which were installed on either side of the truss to all of the king post trusses

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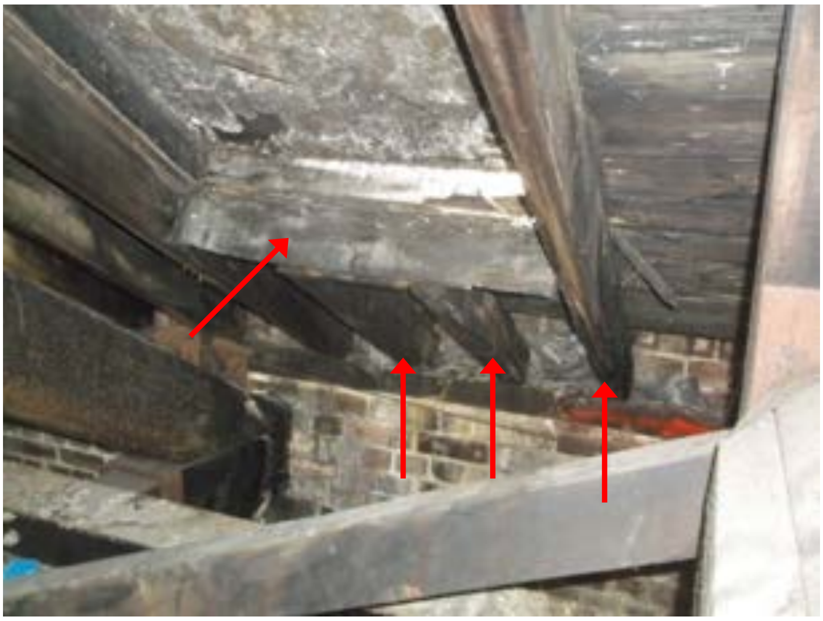

Fig 25:

Hatch between TR3 and TR4 truss systems, to the west pitch: showing general view of structurally decayed 2 no. trimmed rafters and 1 no. trimmer element in their entirety. Additionally, the trimming rafter was structurally decayed for approximately 300mm

Fig 26:

Timber roof elements between TR3 and TR4: showing structurally decayed 1 no. rafter foot for approximately 300mm and underlying timber plate for approximately 3m

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Fig 27:

North-west hip rafter: showing general view of south-east hip rafter and jack rafters. Approximately 4 no. jack rafters along the hip rafter span were structurally decayed at their bearing ends. Additionally, the sarking boards around the hip rafter were decayed, where wet rot decay extended between 100mm and 300mm on the each side of the hip rafter

Fig 28:

North-west hip rafter: showing close-up view of structurally decayed sarking boards

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Fig 29:

North-east hip rafter: showing general view of south-east hip rafter and jack rafters. Approximately 3 no. jack rafters along the hip rafter span were structurally decayed at their bearing ends. Additionally, the sarking boards around the hip rafter were decayed, where the wet rot decay extended between 100mm and 300mm on the each side of the hip rafter

Fig 30:

Intersection between timber half truss (TR5) and king post truss (TR4): showing strengthened timber joint between the king posts and tie beams with epoxy based adhesive and steel angle section. Note that the screw fasteners should not be considered to contribute to the strength of the joint, as their sole use was for holding the steel element in place until the end of solidification process of the adhesive from the liquid state

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Fig 31:

North bearing end of the half truss (TR5): showing general structural configuration of the south bearing end of the half truss. Note signs of mould on timber tie beam

Fig 32:

Timber truss long the north pitch: showing general view of timber truss system which visually appeared to be in good condition

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Fig 33:

Roof timber elements between TR3 and TR4 timber trusses: showing general view of the ridge board and sarking boards. Note that these elements had water staining signs. It was anticipated that there was superficial decay to the top side of the sarking boards, however no visual decay was observed to ridge and sarking boards

Fig 34:

Purlin along the west pitch between TR3 and TR4 trusses: showing structurally decayed timber purlin at localised area with a cross-sectional loss of approximately 25 per cent

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Fig 35:

North-east corner of the roof: showing general view of the first bay , counting from the north, of the steel truss

Fig 36:

Steel truss along the east pitch: showing general view of the upper node between the first and second bays of steel truss system

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Fig 37:

East bearing end of TR4 truss system: showing truss bearing end supported at node position. Note that each element of the steel truss comprised of different sections

Fig 38:

Upper section of steel truss between TR3 and TR4 timber trusses: showing general view of the steel truss. Note that east bearing ends of timber trusses were supported at steel truss node positions

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Fig 39:

Steel truss along the east pitch: showing general view of the node between the first and second bays, counting from the south. Note that each element was of different section type

Fig 40:

South-east corner of the roof: showing general view of the first bay , counting from the south, of the steel truss

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Appendix B

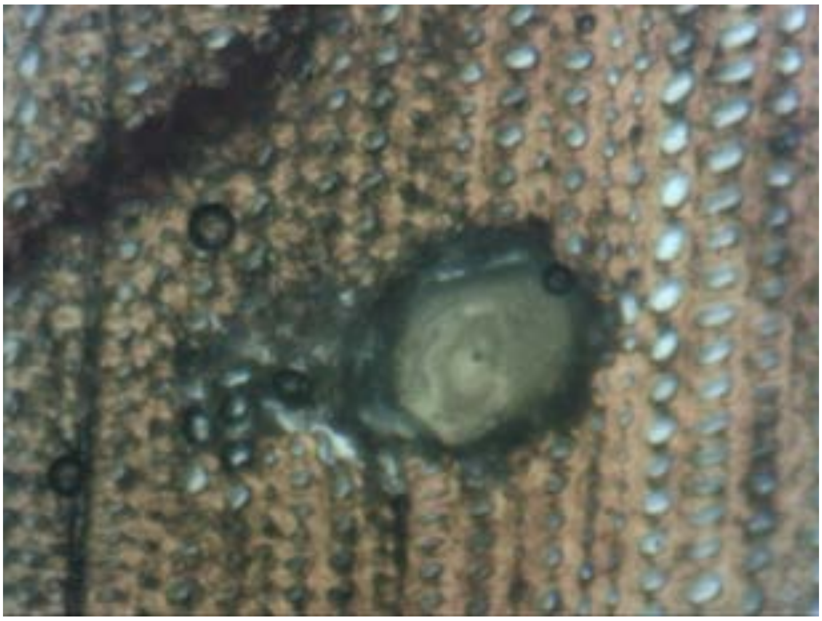

Fig 1:

Showing transverse section of the timber sample on microscopic level. Note the presence of the resin canal. This is a common feature of Pitch Pine timbers

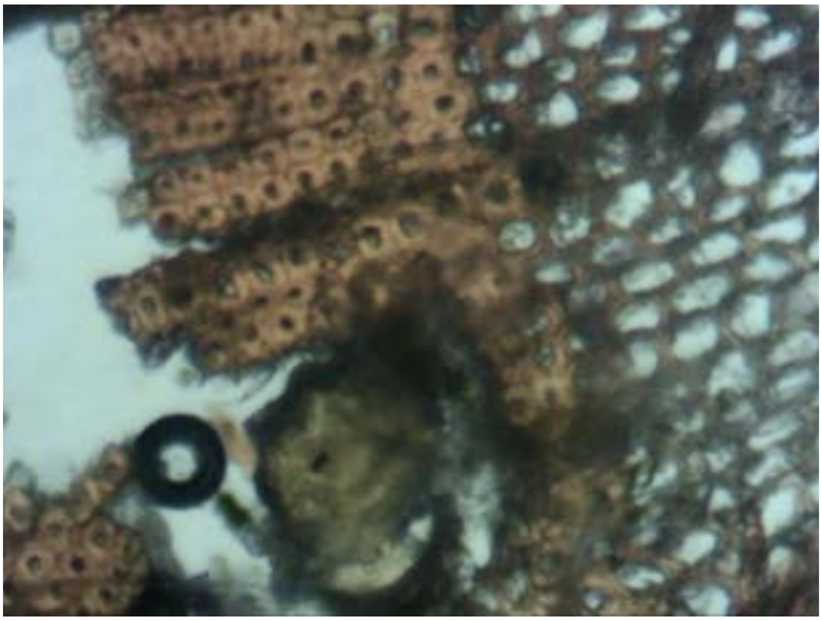

Fig 2:

Showing transverse section of the timber sample on microscopic level. Note sudden change between latewood and earlywood and the presence of the resin canal. These are common features of Pitch Pine timbers

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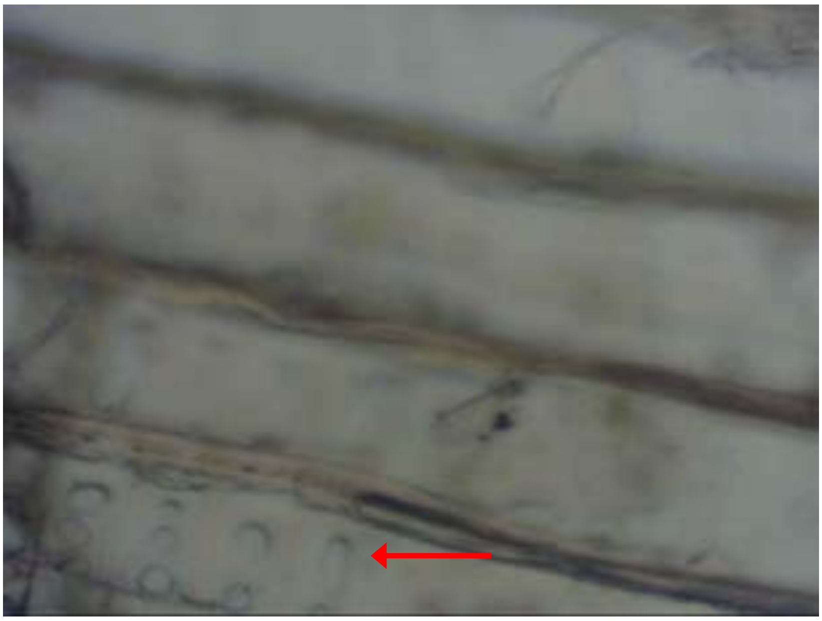

Fig 3:

Showing radial longitudinal section of the timber sample on microscopic level. Note pinoid pitting in the cross field. This is a common feature of Pitch Pine timbers

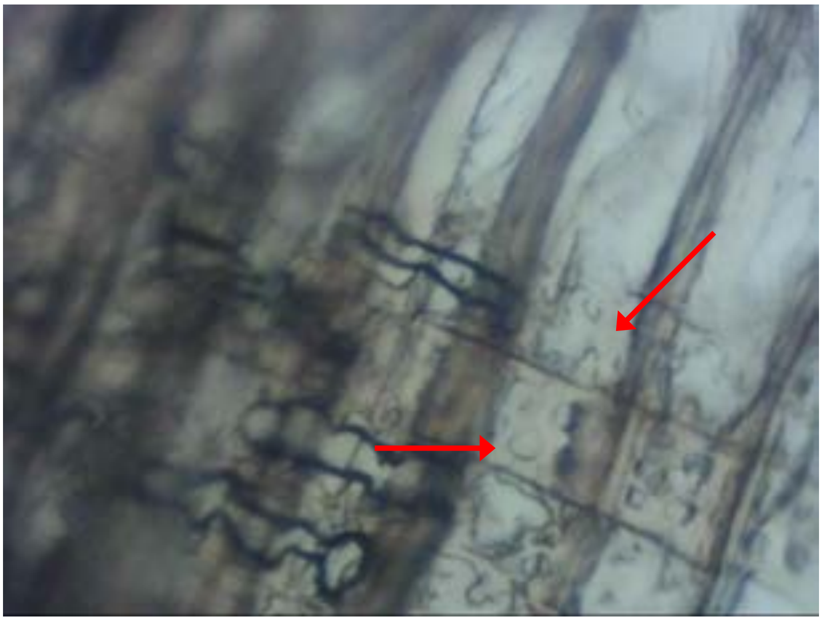

Fig 4:

Showing radial longitudinal section of the timber sample on microscopic level. Note pinoid pitting in the cross field and dentate ray tracheid. These are common features of Pitch Pine timbers

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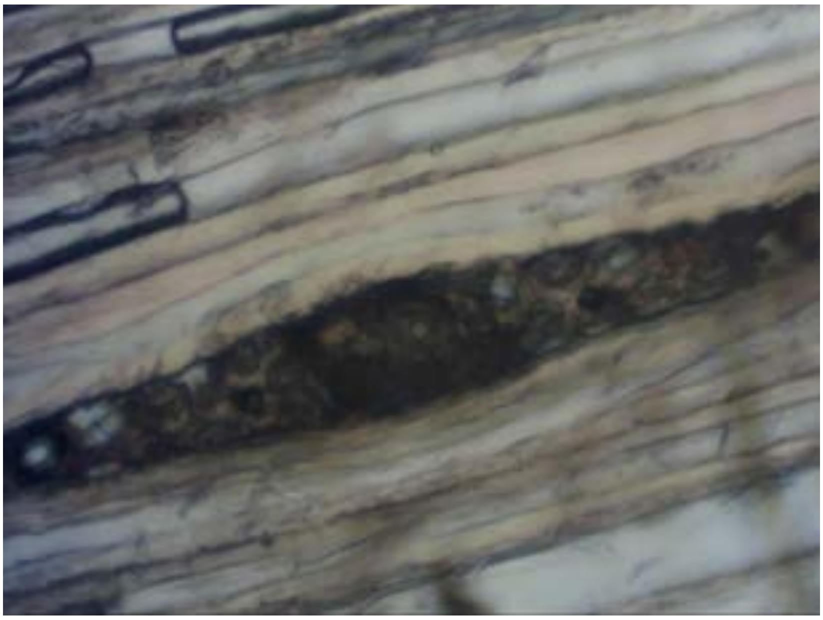

Fig 5:

Showing tangential section of the timber sample on microscopic level. Note resin canal in ray with thin-walled epithelial cells. These are common features of Pitch Pine timbers

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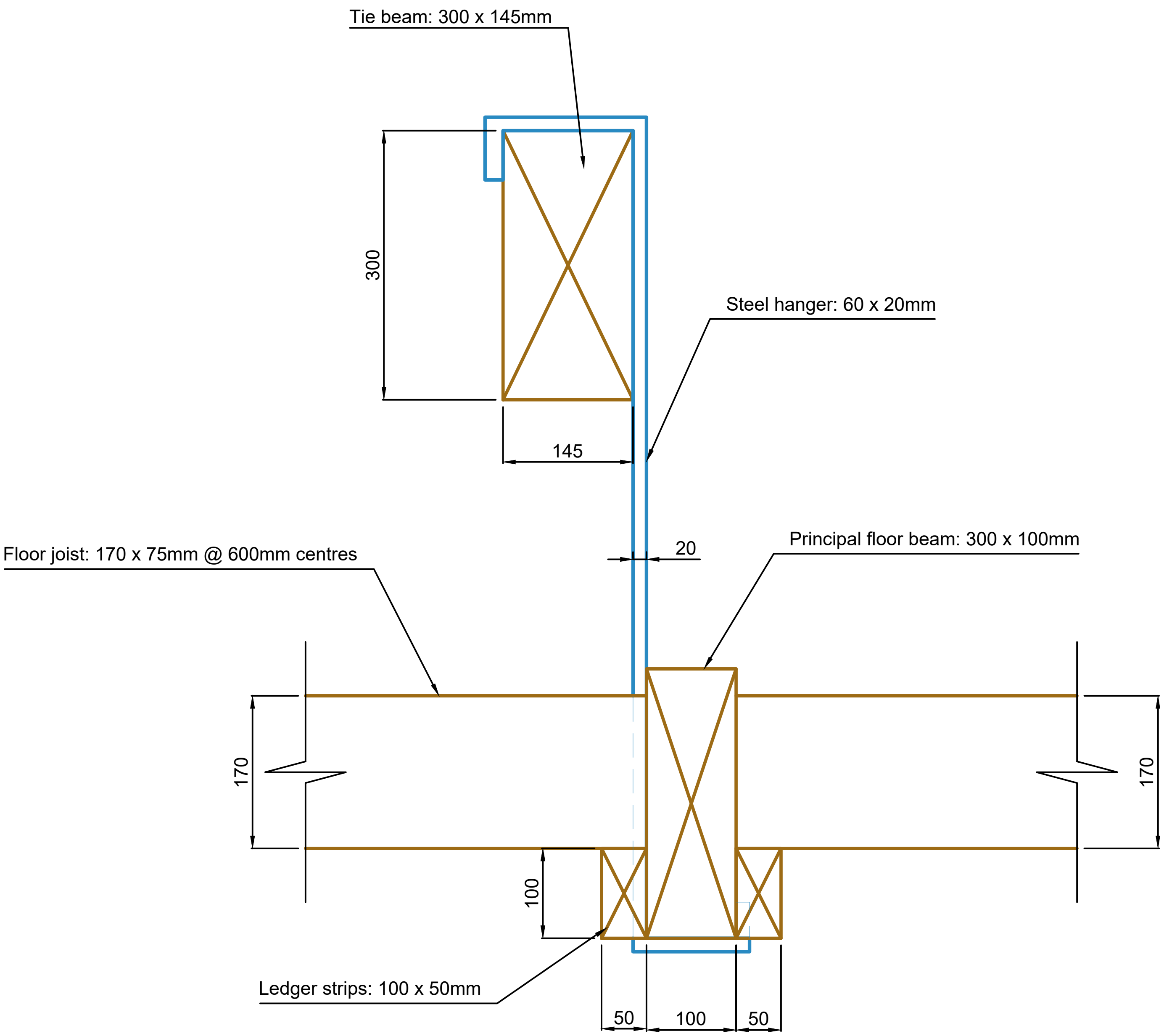
Appendix C

DRAFT

Section of Floor Structure



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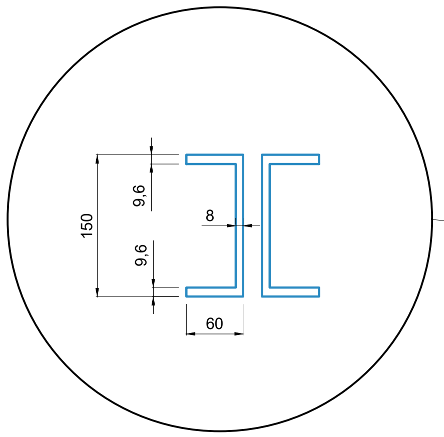
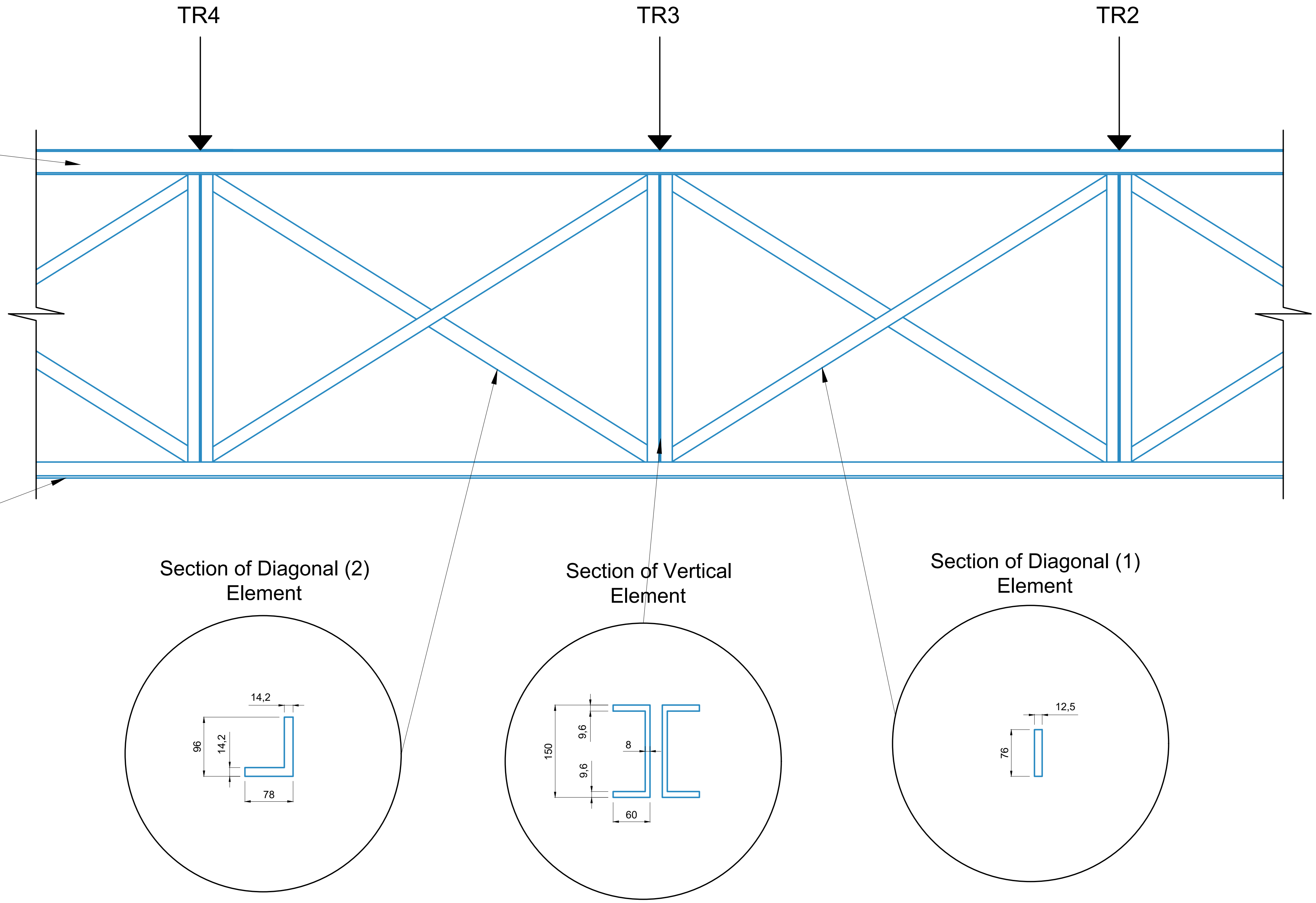
Appendix D

DRAFT

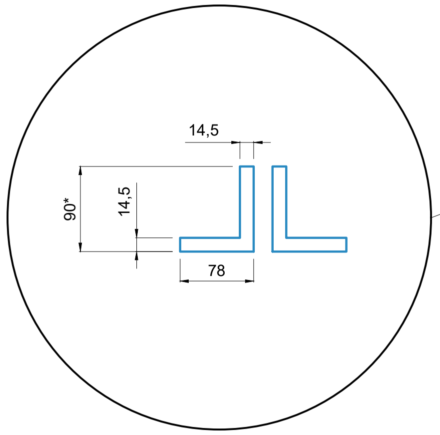
Segment of Steel Truss

Section of Top Chord





Section of Bottom Chord



*- The height of the unequal angle section was not measured with high accuracy as the element was difficult to assess due to lack of safe access. Therefore, it can be stipulated that the height of the bottom chord was 96mm, as the rest of the dimensions agree well with the diagonal element (2) dimensions

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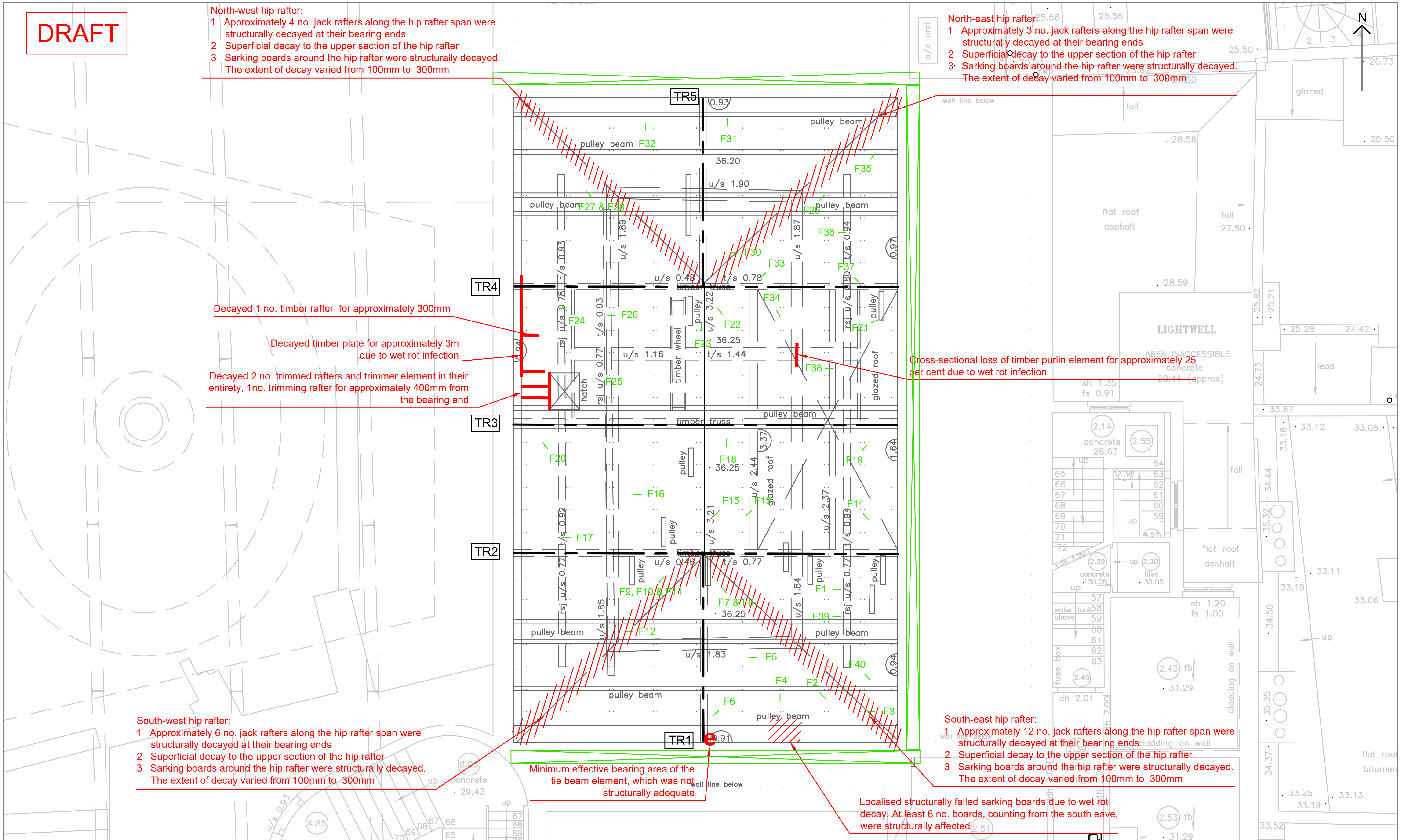
146-89 Site Note 2 March 2018 -Not to scale-

Appendix E

Appendix F



The Hope Project - Fly Tower Roof

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08 March 2018

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146-89 Site Note 2 March 2018 -Not to scale-

Key:

- Area subject to rot infection/ timber decay
- Structurally decayed timber element
- e Structural issue
- F Photograph location
- Approximate location of timber trusses
- Not accessed timber plates or rafter feet for physical investigation