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Auditorium Ceiling Inspection Report

July 2020

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SYNOPSIS

The Harlington Centre was constructed in 1972 and the main element is predominantly a reinforced concrete structure with glazed and masonry facades beneath a timber roof. Ancillary areas were single and part two-storey and attached to each side of the auditorium. The building was severely damaged by a fire in 1991 and the subsequent refurbishment, designed in 1993, included removal of the existing auditorium ceiling and replacement with a lower suspended ceiling. This utilised the original ceiling grid supports from the timber roof structure.

In lowering the ceiling to its present level, there was no provision for maintenance access and inspection within the deep roof void created.

This was highlighted in a Building Condition Report of The Harlington which also identified the need to inspect the long span glued, laminated beams spanning across the Hall, together with the ceiling support system and ductwork.

This report records observations made at high level within accessible parts of the roof, off a scaffold system. It also includes a structural assessment of the principal elements and connections. Recommendations are given to address deficiencies / defects identified.

A J Piper – Project Director

Issue: First Issue

Revision: 2

Date: July 2020

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1.0 INTRODUCTION

1.1 This Report has been prepared on the instructions of Janet Stanton of Fleet Town Council.

1.2 The Building Condition Report for The Harlington, issued in January 2020, identified the complexity of the roof structure and ceiling support system over the Auditorium. It particularly noted the lack of effective maintenance access to the deep ceiling void. Subsequently an appraisal was made of the stage lighting support off one of the principal laminated timber beams. This appraisal was limited and caveated due to the lack of access to inspect the structural elements. Access has now been made available to the ceiling void to enable a more detailed inspection and appraisal to be undertaken.

1.3 The objectives of the Inspection and Report are to:

- Visually inspect accessible parts of the ceiling and the supporting roof structure.
- Provide a descriptive record of the nature and condition of the ceiling and its supports as part of the basement survey.
- Undertake a structural assessment of the principal supports.
- Review safe working loads for stage beams.
- Identify defects and provide recommendations for remedial action.

1.4 The ceiling inspection comprised a non-intrusive visual inspection of the accessible parts of the building including a limited inspection at high level where access could be safely achieved.

1.5 This specific Inspection Report is based on our investigation of the building to enable us to comment on the specific matters on which our opinion has been requested. No attempt has been made to inspect or examine other aspects of the property, including the risks of asbestos or asbestos products being present, which are unrelated to the subject to this Report and no warranty may be assumed or implied with regard to structural condition not specifically referred to in this report.

1.6 In accordance with our standard practice we must point out that this Report is based upon our inspection of the premises and any information made available to us, both written and oral, which we have assumed to be correct. This report is for the benefit of Fleet Town Council, together with their professional advisors. Cooper & Withycombe cannot accept any liability to any third party for the whole or part of its content.

2.0 BUILDING STRUCTURE DESCRIPTION IN RELATION TO THE AUDITORIUM

2.1 The Harlington was opened in 1972 as part of Fleet Town Councils civic development. The building is linked to Fleet Library and was originally opened as Fleet Civic Hall. The building complex contains a main auditorium, together with ancillary halls, meeting rooms and public facilities.

2.2 The Harlington is operated and managed by Fleet Town Council following its transfer to the Council from Hart District Council in 2010.

2.3 The centre and its facilities provide a social and entertainment focus to the Fleet community. Originally the Centre comprised a main hall with two function rooms, offices and general public areas. This has been developed further since then with the addition of a gymnasium (previous use), foyer coffee shop and Fleet Town Council offices.

2.4 The Harlington has a single, large auditorium at the centre of the building. This presently has a flat floor with a raised stage at the north-east end. There is a suspended ceiling over the whole of the auditorium which was installed circa 1993. This has feature coffer recesses set into the ceiling so that it is not entirely flat. This has reduced the effective height of the auditorium and created a large ceiling void over the auditorium which partially contain ventilation ducts.

2.5 The auditorium is the core part of the original building structure which comprised:

- Two storey reinforced concrete box frame to the auditorium and the common areas on the south-west side comprising the foyer, dance hall, studio and other facilities.

- A two-storey open “wrap-around” incorporating the dance hall and foyer, generally on the south-west side with a pre-cast concrete first floor supported on the concrete frame and a flat woodwool slab roof supported on pre-cast concrete joists above.

- The reinforced concrete frame to the auditorium is generally infilled with cavity masonry. Where there is an exposed external leaf, this is constructed of 300mm long x 100mm high clay brick units. Internally it is generally blockwork.

- There is a reinforced concrete framing / ring beam around the framed part of the building and to the main auditorium. Above this, in the auditorium, there is a timber frame construction of laminated timber posts supporting deep laminated beams which span across the auditorium and stage area.

- At the north-east corner of the auditorium there is a part-basement below the stage area that extends into a further semi-basement area forming the main plant room to the building.

- The stage itself is of timber construction but this has been strengthened with the introduction of new steel supports fire encased beneath the stage area. Along the rear, north-east wall to this there is a part-retaining wall.

2.6 Over the stage there is a limited steel-framed grid. It was noted there are no associated access walkways and fixing equipment for stage sets. Access to the stage areas has been noted as an issue.

2.7 Above the main auditorium there is no access within the ceiling void, particularly there are no access walkways to enable the void and ductwork within it to be readily accessed. Lighting bars are suspended from the roof beam at the front of the stage.

2.8 The upper part of the auditorium has a flat roof supported on timber joists and laminated timber beams that span across the hall. Beneath the roof there is a glazed timber frame wall around the perimeter of the hall, supported on the upper ring beam to the concrete frame. This wall has now been concealed by a fire-retardant material on the external face supported on further timber framing.

2.9 The original flat roof finish appears to have been a reflective coated mineral felt.

2.10 In 1993 improvements to the hall appear to have included the replacement of the suspended ceiling, suspended from the roof structure. This also conceals the roof structure and increases the ceiling void to approximately 3 metres.

2.11 Record details of the roof structure to the Auditorium are very limited, so details are only available from visual observations / inspection which, due to the lack of safe access within the ceiling void were limited until this inspection.

2.12 The Auditorium flat roof is of timber construction comprising timber boards supported on 50mm x 200mm softwood joists at 600mm centres onto glued, laminated beams (Glulam) spanning clear across the Hall at approximately 4.8 metre centres in four bay, with one bay of 5 metres.

2.13 The replacement ceiling is suspended by light metal framing from the original ceiling grid which was fixed to the underside of the timber roof joists and the laminated beams.

2.14 Air ducts are also located in the void and are suspended from the roof structure and ceiling grid.

2.15 The stage lighting bar is in the position shown on Hart District Council's drawing A302/11 dated August 1993, implying this was a design decision at the time. It is of tubular construction fixed to the soffit of one of the laminated beams.

3 INSPECTIONS

3.1 General

3.1.1 A high level inspection of the roof structure to the main auditorium was made on 15th June 2020.

3.1.2 The inspection was facilitated by a birdcage scaffold across the entire auditorium floor. This was extended locally to two of the laminated beams across the hall. It was appreciated that access to the high level was particularly difficult due to the complexity and density of the ceiling support hangers from the roof structure.

3.1.3 Observations made during the inspection are illustrated in the drawings in Appendix A and photographs included in Appendix B.

3.2 Roof Structure

3.2.1 Description of Structure

3.2.1.1 There is a flat, felted roof over the main auditorium with falls to the outer edges of the auditorium on the north-west and south-east sides.

3.2.1.2 The roof coverings are laid onto timber boards supported on 50 x 200mm softwood roof joists at 600mm centres. These are supported on the main laminated beams that span across the hall. The roof joists are butt jointed over the top of the laminated beams and fixed with two nails into the top of the beam. See Drawing 19-1962/91.

3.2.1.3 Between the joist and the bearing there are full depth noggins. These do not always align with each of the joists and hence provide an ineffective restraint.

3.2.1.4 Parallel to the main perimeter side walls there are triple joists set approximately 750mm from the auditorium wall. These support the perimeter gutter. There are no further joists between this and the external wall.

3.2.1.5 Further support is provided to this edge beam with inclined timber struts down to the base of the original glazed panel to the perimeter.

3.2.1.6 Originally the rainwater downpipes from the edge gutter ran as vertical pipes alongside the laminated timber bearings. Presumably as part of the previous alterations / extensions these have been diverted at high level through the perimeter wall. The end of the original pipe remains open and not sealed.

3.2.1.7 On each side of the auditorium the original glazed panels have been infilled with plywood.

3.2.1.8 The roof joists are supported on tapered, laminated timber beams at approximately 4.8m centres and span clear across the auditorium. The end bay has a slightly greater span at approximately 5m.

3.2.1.9 The laminated beams are of glued softwood and vary from 875mm depth at the centre to 785mm depth at the wall face of the support. The taper is assumed to allow a fall on the roof. The taper is achieved by reducing the top lamination depth from the centre and also reducing the total number of laminations from 20 to 19 at the edge. At the centre, the top lamination is 60mm deep compared to the 42mm–43mm depth elsewhere. The laminated beams are 215mm wide and along the ridge line there is a double timber joist to the roof.

3.2.1.10 At each support the laminated beams are supported on timber posts, also 215mm wide but deeper at approximately 270mm that appear to be approximately 1.1m high and extend down to the concrete ring beam. These timber posts are part encased in plywood and part built into the perimeter wall.

3.2.1.11 The laminated beams are fixed to the posts with a vertical metal strap comprising 75mm wide x 8mm thick steel plate with two 16mm dia bolts at 250mm centres.

3.2.1.12 Horizontal ceiling grids supports are fixed to the face of the laminated beam along its length at approximately 1.2 metre centres.

3.2.1.13 On beam 3 in front of the stage there are supports for the lighting bar below. These are fixed to the beam soffit with a screwed socket and a circular tube fixed to it with a single bolt.

3.2.2 <u>Comments / Observations</u>

a) Roof Joists. Except between the south-west end wall and beam 1. There are no intermediate bridging or noggins between the roof joists along the length of their span.

The bearing of the roof joists onto the laminated beams is variable. There is only limited fixity at this point with 2 No nails in the bottom of the beam. Whilst there are noggins between them, these do not appear to be fixed to the roof joists themselves. In places these have been removed to facilitate the introduction of services.

Although not measured, it is clear that the joists deflect vertically along their length. Some of these are also warped horizontally along their length between the laminated beams.

Except for the perimeter edge beams there was no significant indication of water penetration or decay to these elements. The roof space was considered to be dry.

b) Laminated beams – General. The laminated beams taper from the centre to their outside edge. Effectively the 20 No laminations at the centre decrease to 19 at the outer edge. At the centre the top lamination appears to be 60mm depth. This ends approximately 3m from the centre line. The top lamination then diminishes further to the outer edge. Generally laminations appear to be approximately 42mm – 43mm thick.

With the uniform fall from the beam centre to the perimeter, it was not clear from the inspection as to whether the beams had originally been pre-cambered before installation to cater for anticipated permanent dead load deflections. This was quite often provided for at the time of construction.

At the laminated beam bearings, it is not certain whether there is any further fixity other than the vertical metal straps on each side of the beams. The laminated beams appear to rest directly onto the timber posts below which then subsequently rest onto the concrete ring beam at the lower level. Whilst the plate itself appears to be corrosion free, surface corrosion was evident to the bolted connection.

A typical defect in the laminated beams is a horizontal fracture / check just at the level of the top of the plate or just above it at each of the bearings. Typically this was in lamination four, from the top. The crack appears to extend between 500mm – 1,000mm from the face of the support, with a width of approximately 2mm. This may reflect slight rotation at the support causing high stress in the lamination above the bolt fixing.

c) Laminated Beam 1. See drawing 19-1962/93. This could only be viewed properly from one side. On the beam soffit there is a shake in the centre of the beam. The shake is discontinuous but continues along most of the beam soffit.

This beam exhibits cracks / checks at the south-west end, extending from the bearing almost along to the centre line. These cracks step from the bearing towards the centre line.

d) Laminated Beam 2. See drawing 19-1962/94. This was not accessible directly. However similar checks / cracks were apparent on the south-west side of the beam, to that visible on Beam 3. Cracks appear to be approximately 2mm width.

e) Laminated Beam 3. See drawing 19-1962/95. This is the lighting support beam. Horizontal fractures were visible running approximately in the middle of the beam, 430mm from the bottom face (on approximately the centre line of the beam).

f) Laminated Beam 3 – Lighting Bar. The lighting supports are screw fixed to the soffit. There was no sign of distress to these and the connections appear to be tight. Safety wires have been introduced to these fixings.

g) Laminated Beam 4. This is over the stage proscenium arch and was not accessible. When viewed from Beam 3 it was apparent there are similar defects to Beam 3.

h) The cracking noted in the glued, laminated beams is typically a result of either checking or delamination.

Checking of glulam timber typically appears as an opening or 'crack' running longitudinally along a portion of the length of the member, and is defined as the separation of wood fibres due to seasoning of the wood. It can normally be identified by the presence of torn wood fibres.

Delamination can be confused with checking. Delamination of a glulam member is separation of the individual laminations due to inadequate glue bond. In cases of delamination the surfaces of lamination along the separation will be smooth and free of torn wood fibres.

Typically checking is caused by moisture loss in the outer fibres of a glulam member. As these fibres lose moisture they begin to shrink, resulting in stresses perpendicular to the grain of the lamination. It is these stresses that typically cause checking. Such checking usually has a minimal effect on the strength of glulam members.

The cracking in the soffit to Beam 1 is discontinuous and with some separation of fibres. This may suggest it is primarily a shrinkage related crack, although as the beam supports different roof spans to each side may also reflect torsional stresses.

The fractures / checks on the beam faces, although relatively consistent they are not extensive either in terms of their length or number in the glued, laminated beam depths. These appear to be a separation of the glued joint. Frequently on one face only, but with some reflected on the opposing face, particularly at the bearings.

These cracks may reflect higher joint stresses in the beams as loads have been applied, deflections developed and shrinkage in the beam depth. The latter due to the location in a dry, heated environment. There was no indication of recent movement or development of the cracks nor was adverse deflection noted.

3.3 **Auditorium Ceiling**

3.3.1 Description of Ceiling Structure

The original ceiling structure was positioned at approximately the soffit level of the laminated beams. This also incorporated light boxes within the ceiling grid. See drawings 19-1962 / 90, 91 and 92.

The original ceiling grid was suspended directly off the roof joists at 1.2m centres in each direction, ie. alternate joists.

There are single fixings for the hanger rod to the joist. These are either small 35mm diameter screw or a 3mm diameter nail driven completely through the beam.

The original ceiling hangers appear to be 20mm x 20mm galvanised angle supports from which 35mm deep x 12mm wide galvanised metal ceiling suspension bars were supported.

The subsequent alteration to the building of lowering the ceiling, included a new grid which was installed at a lower level. This was suspended off the original high level grid, again with 20mm x 20mm galvanised suspension hangers supporting a 35mm x 12mm galvanised metal ceiling suspension bar. Beneath this are suspension wires supporting a t-bar grid system to the 1.2 metre square ceiling tile system at the present auditorium ceiling level. This is illustrated on drawing 19-1962 / 92 included in Appendix A.

The original, high level light boxes remain. These are supported within the original upper ceiling grid.

Mechanical services ductwork within the ceiling void is either supported off the ceiling grid, or direct from the roof joists over. Electrical cables and cable trays are also suspended within the void from the grid or roof structure over.

3.3.2 Comments / Observations

The ceiling grid reflects the size of the ceiling panels above the auditorium. These are 1.2m x 1.2m square and are fairly large. There is no access through these to the ceiling, except by removing complete ceiling panels. Difficulties have been previously experienced with the original ceiling tiles due to the manner in which they have been fixed. It is understood that many of these will be replaced as a consequence of the inspection work.

Overall the ceiling system appears to rely on a single fixing at each of the connection points. At upper level these appear to be a small, single screw into the side of the roof joists, or a nail fixing completely through the roof joist. The original nail fixings appear to be lightly corroding on the surface.

The ceiling support system is solely a vertical support system. No lateral bracing between supports was evident.

Within the ceiling void the air ducts were also suspended in a similar manner off the grid. It was noted that there were no access points to the ductwork. No distress was noted to the ceiling grid system or its connections to the timber roof structure.

There are no fire breaks within the ceiling void over the auditorium / stage. Perimeter walls have woodwool insulation and are fire lined. However, it was noted:

a) Penetrations of the external wall are not fire stopped.

b) There are no smoke or fire detectors in the roof space.

3.4 **Stage – Production / Lighting / Curtain Support**

3.4.1 Description

Over the main auditorium there is a single lighting bar suspended from laminated beam 3. In addition to this there are further lighting supports fixed to the concrete columns to each side of the auditorium in the same position.

Over the stage there are 5 No, 152mm x 89mm steel beams that run front to back across the stage to support curtains and production lighting.

The edge beams to this arrangement across the stage are supported directly on the wall at the rear above the concrete ring beam and the brick pier to the edge of the proscenium to the stage. The other three beams are also supported at the rear, directly on the wall and at the front cantilevered over and supported on the top flange of a further steel beam that spans across the stage, between the brick piers to each side of the stage proscenium opening. This beam supports the 152x89 UB beams and the front of house curtain together with the cinema screen. There is no fire curtain. Site measurements indicate this to be a 305mm x 165mm universal steel beam.

3.4.2 Comments / Observations

a) Auditorium Lighting Bar. The fixing to the soffit of the laminated beam is questionable as this is relying on 4 No, 8mm diameter coach bolt screws into the beam soffit providing a tension fixing. As previously noted to the client, these are not wholly reliable and would preferably need a fixing across the top of the beam. However, at present there is no sign of any distress in this lighting beam support.

b) Stage / Production Lighting Supports. These are at high level and there is no direct access to them. They are painted and appear in reasonable condition. The Hall staff advised that no safe working load had been designated to these beams. This was an issue that had been raised by the authorities / insurers. In view of this, a Structural Appraisal of their load capacity has been undertaken.

4 STRUCTURAL ASSESSMENT

4.1 A structural assessment has been undertaken of the capacity of the existing roof structure that supports the ceiling and production lighting bar.

4.2 The assessment was made of the capacity of the structure in relation to current British / European Standards which have been revised since the building was constructed.

4.3 The imposed and dead loads applied to the roof have been calculated in accordance with BS EN 1991.

4.4 Whilst ultimate and serviceability conditions are more conservative than the original design codes in the 1970s, Imposed Roof Loads have been slightly reduced.

4.5 Roof Structure

4.5.1 Roof Joists

a) An appraisal has been made of the existing 50mm x 200mm softwood rafters under four load conditions:

- Roof dead loads only
- Roof dead loads and imposed live loads
- Roof dead loads and ceiling hangers
- Roof dead and imposed loads and ceiling hangers

b) The appraisal assumed:

- Imposed live load on roof >0.6KN/m^2
- No imposed live load on ceiling grid as no maintenance access and the grid itself is unable to support personnel loadings.

It also considered two Timber Grades C15 and C24 as the grading could not be identified in the inspection. However, for the length of the roof joists and straightness of grain, together with lack of knots it is likely that the higher grade would apply.

c) The appraisal is summarised in the following table:

ROOF JOISTS - STRUCTURAL APPRAISAL

Load Case	Timber Grade: C16									
	Bending Stress N/mm2			Shear Stress N/mm2			Deflection mm			
	Limit	Applied	Uf	Limit	Applied	Uf	Limit	Inst.	Final	%
Roof Dead Load only (DL)	10.8	3.5	0.3	2.2	0.2	0.1	19.2	8.0	12.8	67%
Roof DL + Imposed Load (IL)	10.8	8.2	0.8	2.2	0.5	0.2	19.2	17.6	22.4	116%
Roof DL + Hanger	10.8	5.6	0.5	2.2	0.3	0.1	19.2	12.6	20.2	105%
Roof DL+IL+ Hanger	10.8	10.3	1.0	2.2	0.6	0.3	19.2	22.2	29.8	155%

Load Case	Timber Grade: C24									
	Bending Stress N/mm2			Shear Stress N/mm2			Deflection mm			
	Limit	Applied	Uf	Limit	Applied	Uf	Limit	Inst.	Final	%
Roof Dead Load only (DL)	16.3	3.5	0.2	2.7	0.2	0.1	19.2	5.8	9.3	48%
Roof DL + Imposed Load (IL)	16.3	8.2	0.5	2.7	0.5	0.2	19.2	12.8	16.3	85%
Roof DL + Hanger	16.3	5.6	0.3	2.7	0.3	0.1	19.2	9.2	14.7	77%
Roof DL+IL+ Hanger	16.3	10.3	0.6	2.7	0.6	0.2	19.2	16.2	21.7	113%

d) From the appraisal, the following is noted:

- For both timber grades, neither permissible bending or shear stresses are exceeded with Unity Factors (UF) either 1.0 or less.

- Deflection / serviceability limits are exceeded for the C16 Grade.

- Deflection / serviceability limits are generally within limits for the C24 Grade except for full load of dead, imposed and hanger. However, In terms of physical difference this amounts to an estimated 2.5mm increase in deflections over the limit which is probably acceptable given bending and shear stresses are not exceeded.

4.5.2 Laminated Beams

a) An appraisal has been made of the Glulam (laminated) beams that span clear across the Auditorium under three load conditions:

- Roof dead and imposed loads (considered to be the minimum load the beams would have been designed for).

- Roof dead and imposed loads and ceiling hanger system – applied either by the roof joists or direct to the laminated beam.

- Full load and stage production lighting bar to Beam 3.

b) As for the roof joists, the appraisal assumed:

- Imposed load of roof >0.6KN/m^2

- No imposed loads on ceiling grid

For this appraisal as the Glulam beam strength could not be identified, two Timber Grade GL24c and GL28c were considered.

c) The appraisal is summarised in the following table:

GLULAM ROOF BEAMS - STRUCTURAL APPRAISAL

Load Case	Timber Grade:	GL24c									
	Bending Stress N/mm2			Shear Stress N/mm2			Deflection mm				%
	Limit	Applied	Uf	Limit	Applied	Uf	Limit	Inst.	Final	%	Increase
Roof Dead and Imposed Load only	15.4	13.4	0.9	2.2	0.9	0.4	72.4	70.2	92.1	127%	
Roof DL + IL + Ceiling Hangers	15.4	15.0	1.0	2.2	1.0	0.5	72.4	79.2	106.5	147%	
Roof DL+IL+ Hanger Plus Lighting Bar (BM 3)	15.4	15.5	1.0	2.2	1.1	0.5	72.4	81.8	110.7	153%	4%
Load Case	Timber Grade:	GL28c									
	Bending Stress N/mm2			Shear Stress N/mm2			Deflection mm				%
	Limit	Applied	Uf	Limit	Applied	Uf	Limit	Inst.	Final	%	Increase
Roof Dead and Imposed Load only	17.9	13.5	0.8	2.2	0.9	0.4	72.4	62.3	81.9	113%	
Roof DL + IL + Ceiling Hangers	17.9	15.0	0.8	2.2	1.0	0.5	72.4	69.7	93.7	129%	
Roof DL+IL+ Hanger Plus Lighting Bar (BM 3)	17.9	15.5	0.9	2.2	1.1	0.5	72.4	72.0	97.4	135%	4%

d) From the appraisal the following is noted:

- For both timber grades neither permissible bending or shear stressing are exceeded with a Unity Factors of 1 or less.

- For the loading conditions without the lighting bars, deflection / serviceability limits are exceeded. However, as deflections for the flat roof would have been a design consideration it is likely the Glulam beams would have been pre-cambered to counter the effect of permanent dead load deflections, which amount to 60% - 66% of the total deflection. This would imply that in effect final deflection limits are not exceeded.

- For Beam 3, including the production lighting bar, stresses remain within limits with Unity Factors <1. Total deflections increase by about 4%, approximately 4mm, under full loads. This is considered acceptable.

4.6 Ceiling Structure

4.6.1 Hanger System

The hanger system uses proprietary cold rolled galvanised metal sections which, it is assumed, have been specifically designed / selected for the support of the suspended ceiling system. In this respect it is noted:

- Suspension hangers only provide a vertical support between the roof joists and hanger systems. No lateral forces appear to be applied.

- Tensile stresses in the suspension hangers are low.

- Connection loads are low.

- Generally suspension rods are aligned though the roof. Where intermediate loads are supported, these are carried on a proprietary galvanised steel channel. Bending stresses in these channels appear to be within normal limits.

4.6.2 Hanger Fixings

At the high level, the hangers are either screw or nail fixed direct to the timber structure. Only single screws or nails are provided at each connection point. The assessment assumed that only permanent loads were applied to the connection with no effective imposed personnel loads due to the light construction of the ceiling grid.

In relation to the assessment, the following is noted:

- Edge distances for the fixings are acceptable.

- Both the nail and screw fixing are just acceptable for the loads applied.

- There is no redundancy within the ceiling system in the event of a connection or member failure.

4.7 Stage Lighting / Support

4.7.1 Production Lighting / Stage Beams

These are steel beams that span clear across the stage from front to back. No safe working load has been assigned to them.

Assuming, except for their own eight, no other permanent loads are applied to them, the assessed safe working loads for 152mm x 89mm Universal Beams in accordance with BS EN 1993 with Grade 5275 steel is:

- Uniformly Distributed Loan 14KN total (1,400kg)

- Centre point load 8KN total (800kg)

These are given as a non-factored service applied load.

4.7.2 Proscenium Support Beam

This supports three of the production lighting / stage beams across the stage, together with the front of house curtain and a cinema screen. No fire curtain is supported.

For the safe working loads defined in 4.7.1, together with the stage grid loads advised in the Harlington's email dated 17th July 2020, the 305mm x 165mm Universal Beam across the stage is sufficient, assuming a minimum serial weight and Steel Grade S275.

5. CONCLUSIONS

5.1 Access has been made to part of the ceiling void and two of the laminated beams that span across the hall by a birdcage scaffold extended to the higher levels. By virtue of the nature of the ceiling construction and the height of the auditorium ceiling void, access has been difficult and has effectively limited the visual observations that can be made apart from those areas that were accessible. In this respect it should be noted that where visual access was not obtained, we were not able to advise on the condition of these elements of the roof. However, it is believed that with the access given a good general overview of the roof structure, together with the ceiling and their condition has been made as part of this inspection and report.

5.2 In relation to its condition the ceiling void was dry and no signs of recent water penetration were noted, nor was any damp or decayed timber found in the areas accessed for the purpose of the inspection.

5.3 The previous alterations, believed to have been carried out in 1993, included both the replacement of the suspended ceiling at a lower level, together with infilling the perimeter walls to the auditorium at high level. This infilling appears to have been simply boarding over the glazing which generally remains in place, together with alterations to the rainwater drainage system as it discharges down through the building. Where this has been undertaken the rainwater pipes are poorly supported and the original pipes that remain running down the auditorium walls are open at the top within the ceiling void. Neither of these are good practice, and leave the drainage system vulnerable to movement and also the ingress of rodents through the building.

5.4 There was no fire separation within the auditorium ceiling void. However, it was noted that the perimeter walls do contain insulation and it is assumed that fire boarding is provided on the external face of these into the adjacent roof areas. No fire or smoke detectors were observed within the roof space. Wall penetrations do not appear to be fire sealed.

5.5 The ceiling support grid has been extended downwards to support the new ceiling at the lower level. This is reliant on the original fixings of the ceiling support hangers to the timber roof structure. Each of these is a single, either nailed or screwed fixing, into the side of the roof joists that support the roof finishes above. Whilst for the loads applied these fixings appear to be just acceptable under current design standards, it was noted that there is no redundancy within the system to allow for any failure of hangers or their connections.

5.6 The ceiling hanger system connects to alternate joists that span between the principal beams across the hall. These joists sit on top of the glued, laminated beams across the hall and are spiked to them. The timber boarding to the roof is fixed to the top of the joists. It was noted that some of the joists had warped along their length and had also deflected. This reflects the high loading that is applied to them and the lack of any effective bridging between the joists within the span length. The only restraint being provided by the timber boarding. Design stresses in the timber joists are within acceptable limits but deflections are high. However, the appraisal does not take account of the likely composite action that may exist between the timber boarding and the timber joist which would effectively reduce deflections in the joists themselves. On this basis they are considered to be acceptable. It would be cautioned that care would need to be taken in applying any additional load direct to these roof joists.

5.7 The glued, laminated timber beams that span across the hall, supporting the roof and ceiling structure are tapered from the centre of the span to their support. At the centre these were measured at 875mm, reducing to 800mm at the face of the support column. The tapering in the beam is achieved by a reduction in the thickness of the top lamination from the centre outwards. The number of laminations also decrease from the centre to the outer support. The width of the glued, laminated beam was measured at 215mm. The grade of timber used in its construction is not known. This may affect its performance. The beam faces were also generally varnished.

5.8 Checks / fractures were noted in the beam faces along part of the length on part of each vertical face to the beams. These coincided with the lamination joints and were generally at approximately mid-height of the beam. On Beam 1 particularly, a further fracture was noted in the soffit of the beam running discontinuously along almost all of its length. Such checks / fractures may not necessarily be structurally significant and may relate to shrinkage of the timber themselves in the environment in which they are placed. However, it is also likely that with the high stresses within the laminated beams there may have been higher stresses on the laminations as the beams picked up loads and this is reflected in the movement along the lamination joint. No significant deflections were observed to the laminated beams and on this basis it is presently considered that this is not yet structurally significant but would need to be monitored in the long term. It would however be recommended for the checks/fractures to be repaired to ensure the full strength of the beams are assured.

5.9 The structural appraisal of the laminated beams indicate that in relation to design stresses the beam sizes are acceptable but deflections are high. It is considered likely that the beams were originally pre-cambered to cater for the length of span and the applied loads and that this is not considered within the appraisal. With this shallow fall from the centre of the roof to its perimeter, permanent deflections in the roof would have been a key consideration in their design, in order to maintain the fall. Hence, it is likely that the beams were originally pre-cambered and on this basis the deflection criteria is not considered to be significant.

5.10 Laminated beam 3 has additional load applied to its soffit from the production lighting bar. The appraisal has shown that loads increase due to the lighting production bar but deflections themselves only increase by approximately 4%, which is considered to be acceptable for the 300kg safe working load applied to the bar.

5.11 The laminated beams are supported on posts on the perimeter wall. These bear directly onto the concrete ring beam at the lower level and are partly built into the cavity wall above. Hence, lateral restraint to the post is only provided by the connection to the bottom, together with where it is built into the cavity wall. No other bracing was provided. The connection to the laminated beam itself is a simple plate fixed to the side of the laminated beam. This would also not provide effective restraint to the head of the post. It is clear from the observations that some rotation has occurred at the post position, possibly reflecting relaxation of any pre-camber in the laminated beam. The fracture just above the bulk connection may be a consequence of this.

5.12 For beam 3 supporting the lighting bar, the fixings to the lighting bar are tensile fixings only. In view of the nature of the timber beams above this is considered not to be sensible. It would be prudent to provide a fixing that extends to the top face of the beam in order to provide greater security.

5.13 Overall whilst the structural appraisal has indicated that the beams are acceptable for the present loads applied, it would be prudent to repair the check / fractures in the laminated beams and also provide corrosion protection to the bolts at their fixing.

5.14 The stage production lighting support system is independent of the roof structure. This is supported on the rear wall to the auditorium at the ring beam level and either on brick piers to each side of the proscenium opening or on a beam spanning between them at the front. An assessment has been made of the safe working loads that may be applied to the 152mm x 89mm universal beam spanning from front to back of the stage. This suggests that a universally distributed load of 14kN/m^2 (1,400kg) or a centre point load of 8kN (800kg) as a service load may be applied to each of these beams.

6.0 RECOMMENDATIONS

6.1 This report and the observations made, together with the structural appraisals, provide a base line for future inspections which is recommended should be undertaken on a regular basis. Particularly conditions within the ceiling void need to be maintained to ensure that decay does not develop within any of the timber components, nor does corrosion progress on any critical elements of the ceiling support structure.

6.1 In relation to the current inspection, the following remedial action is recommended:

a) Resin inject the open joints in all the glued, laminated beams, where checks/fractures have been noted and where they can be accessed.

b) Clean all connections to the laminated beam of any loose rust and paint with rust inhibitor before any further painting with an appropriate paint system. This relates to the laminated beam connections only.

c) Provided new strap fixing as shown on drawing 19-1962/105 included in Appendix A. This will provide additional support to the lighting bar and fix to the top face of the existing beams.

d) Seal all redundant rainwater downpipes within the voids with a plastic cap.

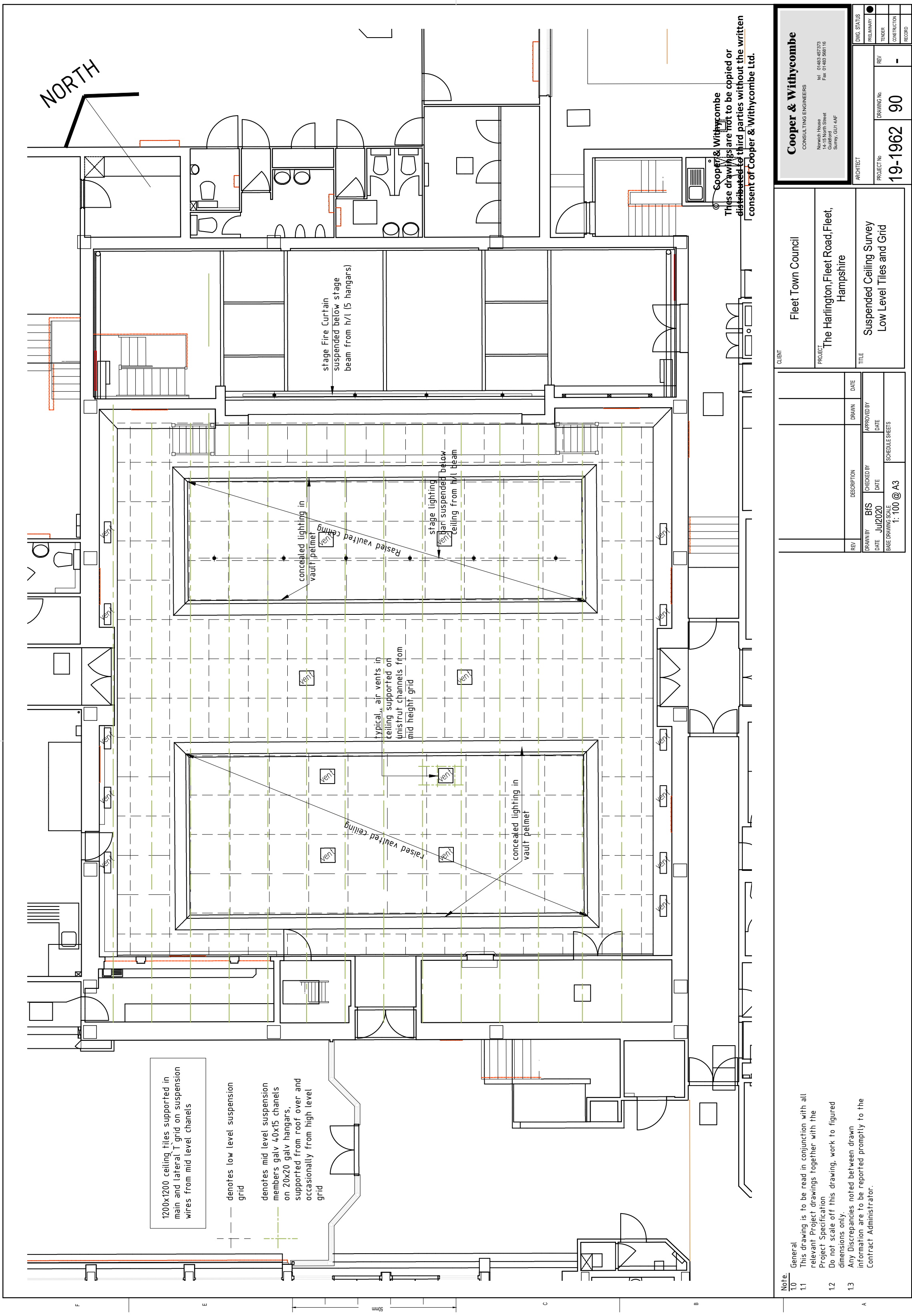
e) Provide support to the rainwater outlet bends, where they translate from the roof to the side wall.

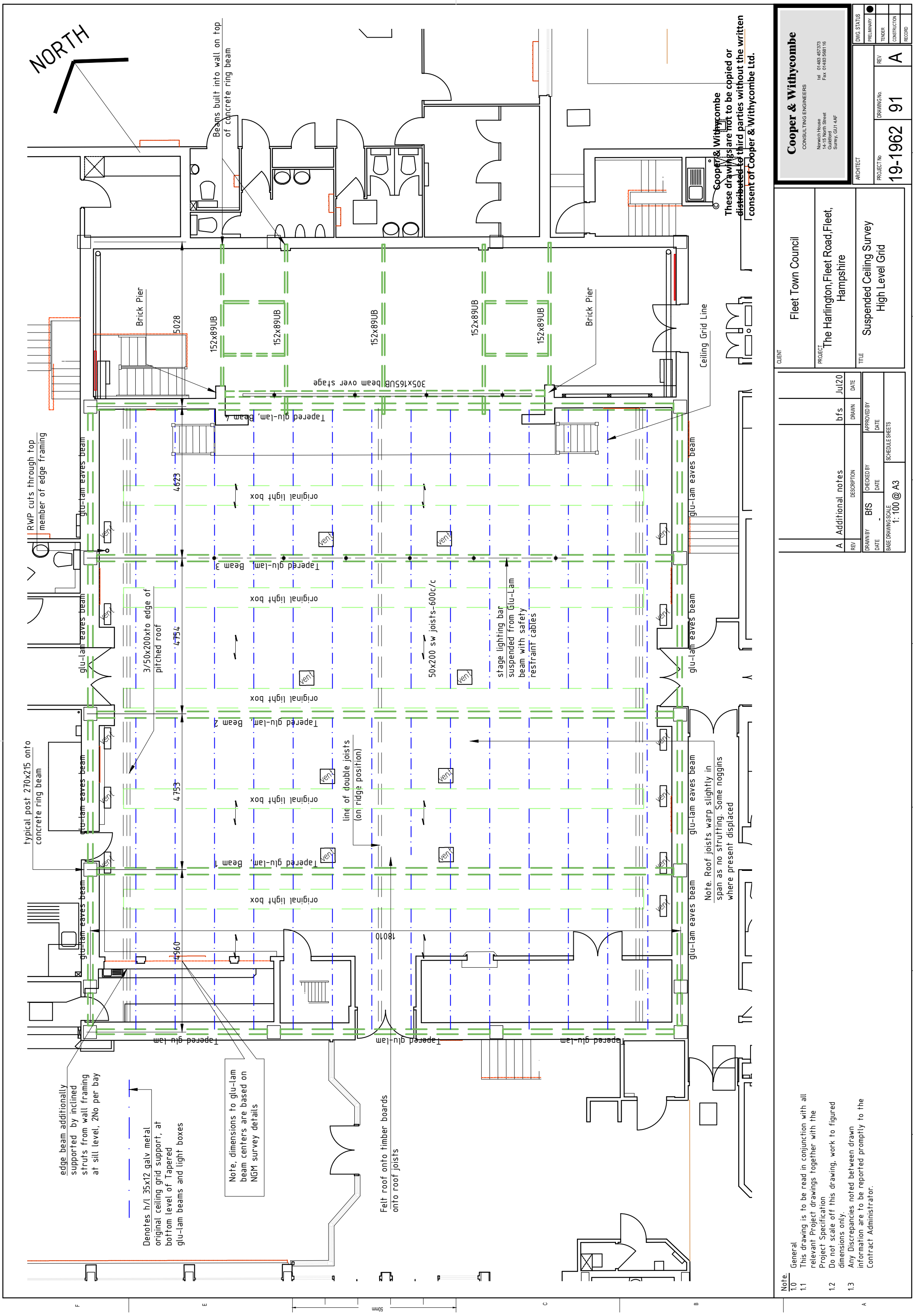
f) Check all external wall penetrations to ensure these are fire stopped.

g) Review present fire / smoke detection system within ceiling void and install new system if inadequate.

It would be financially beneficial to undertake these works whilst access is available:

Appendix A
Drawings


NORTH
© Cooper & Withycombe
These drawings are not to be copied or distributed to third parties without the written consent of Cooper & Withycombe Ltd.
stage Fire Curtain suspended below stage beam from h/l (5 hangars)
concealed lighting in vault pelmet
Rasied vaulted ceiling
stage lighting bar suspended below ceiling from h/l beam
typical, air vents in ceiling supported on unistrut channels from mid height grid
concealed lighting in vault pelmet
Raised vaulted ceiling
vent
1200x1200 ceiling tiles supported in main and lateral T grid on suspension wires from mid level chanels
denotes low level suspension grid
denotes mid level suspension members galv 40x15 chanels on 20x20 galv hangars, supported from roof over and occasionally from high level grid
Cooper & Withycombe
CONSULTING ENGINEERS
CLIENT
Fleet Town Council
PROJECT
The Harlington,Fleet Road,Fleet, Hampshire
TITLE
Suspended Ceiling Survey Low Level Tiles and Grid
BIS
Jul2020
1: 100 @ A3
19-1962
90
Note
1.0 General
1.1 This drawing is to be read in conjunction with all relevant Project drawings together with the Project Specification
1.2 Do not scale off this drawing, work to figured dimensions only.
1.3 Any Discrepancies noted between drawn information are to be reported promptly to the Contract Administrator.


NORTH
Beams built into wall on top of concrete ring beam
Brick Pier
152x89UB
305x165UB beam over stage
Tapered glu-lam, Beam 4
Tapered glu-lam, Beam 3
Tapered glu-lam, Beam 2
Tapered glu-lam, Beam 1
Tapered glu-lam
original light box
glu-lam eaves beam
Ceiling Grid Line
RWP cuts through top member of edge framing
3/50x200x to edge of pitched roof
50x200 sw joists-600c/c
stage lighting bar suspended from Glu-Lam beam with safety restraint cables
line of double joists (on ridge position)
typical post 270x215 onto concrete ring beam
Note. Roof joists warp slightly in span as no strutting. Some noggins where present displaced
edge beam additionally supported by inclined struts from wall framing at sill level. 2No per bay
Denotes h/l 35x12 galv metal original ceiling grid support, at bottom level of Tapered glu-lam beams and light boxes
Note, dimensions to glu-lam beam centers are based on NGM survey details
Felt roof onto timber boards onto roof joists
5028
4623
4754
4753
4960
18010
Cooper & Withycombe
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Cooper & Withycombe CONSULTING ENGINEERS
CLIENT Fleet Town Council
PROJECT The Harlington,Fleet Road,Fleet, Hampshire
TITLE Suspended Ceiling Survey High Level Grid
A Additional notes bfs Jul20
1: 100 @ A3
PROJECT No 19-1962
DRAWING No 91
REV A
Note
1.0 General
1.1 This drawing is to be read in conjunction with all relevant Project drawings together with the Project Specification
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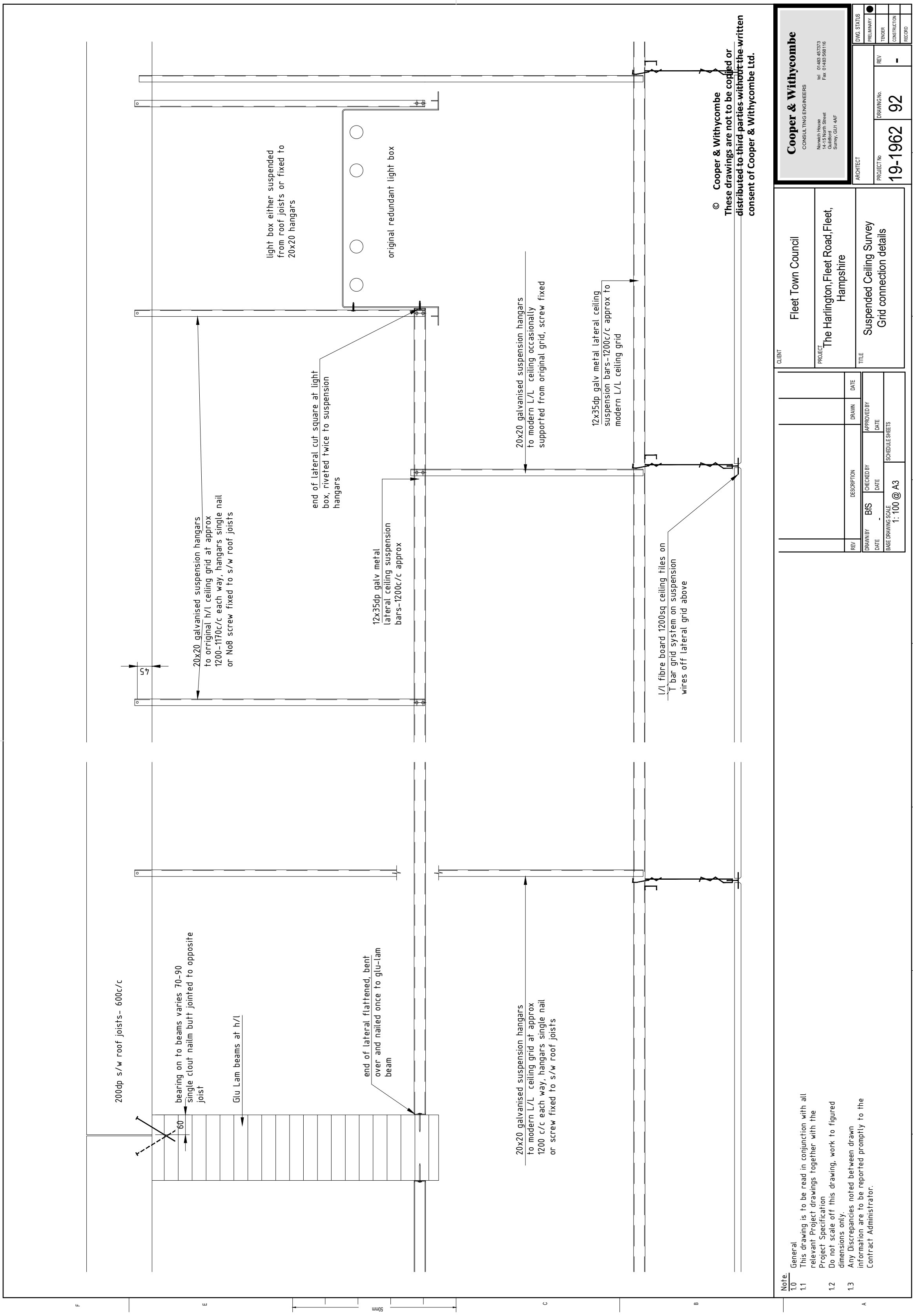
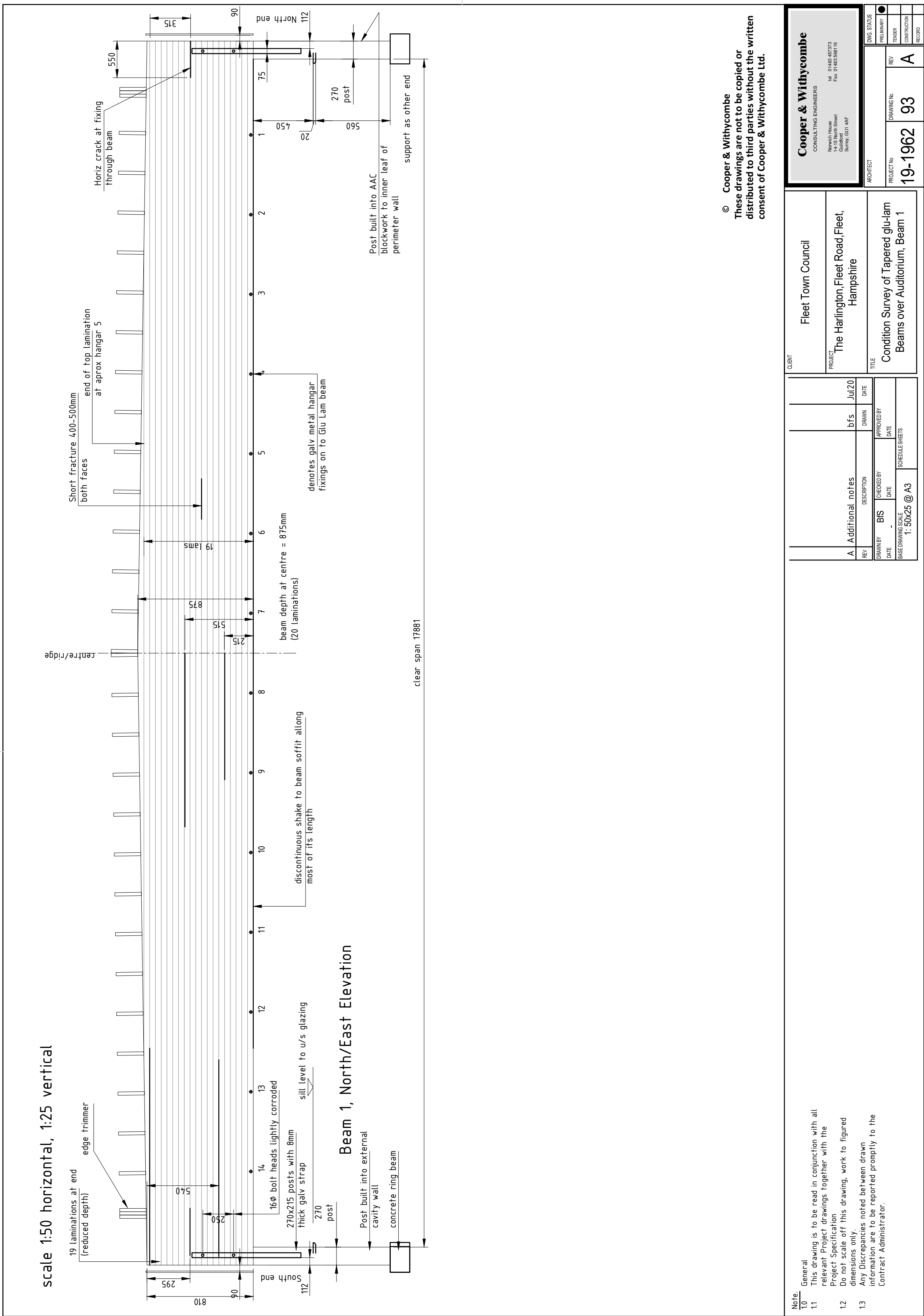

light box either suspended from roof joists or fixed to 20x20 hangars
original redundant light box
© Cooper & Withycombe
These drawings are not to be copied or distributed to third parties without the written consent of Cooper & Withycombe Ltd.
20x20 galvanised suspension hangars to modern L/L ceiling occasionally supported from original grid, screw fixed
12x35dp galv metal lateral ceiling suspension bars-1200c/c approx to modern L/L ceiling grid
end of lateral cut square at light box, riveted twice to suspension hangars
20x20 galvanised suspension hangars to orriginal h/l ceiling grid at approx 1200-1170c/c each way, hangars single nail or No8 screw fixed to s/w roof joists
12x35dp galv metal lateral ceiling suspension bars-1200c/c approx
45
L/L fibre board 1200sq ceiling tiles on T bar grid system on suspension wires off lateral grid above
200dp s/w roof joists- 600c/c
bearing on to beams varies 70-90 single clout nailm butt jointed to opposite joist
60
Glu Lam beams at h/l
end of lateral flattened, bent over and nailed once to glu-lam beam
20x20 galvanised suspension hangars to modern L/L ceiling grid at approx 1200 c/c each way, hangars single nail or screw fixed to s/w roof joists
Note
1.0 General
1.1 This drawing is to be read in conjunction with all relevant Project drawings together with the Project Specification
1.2 Do not scale off this drawing, work to figured dimensions only.
1.3 Any Discrepancies noted between drawn information are to be reported promptly to the Contract Administrator.
Cooper & Withycombe
CONSULTING ENGINEERS
CLIENT
Fleet Town Council
PROJECT
The Harlington,Fleet Road,Fleet, Hampshire
TITLE
Suspended Ceiling Survey
Grid connection details
DRAWN BY BfS
BASE DRAWING SCALE 1: 100 @ A3
PROJECT No 19-1962
DRAWING No. 92
REV -
DWG. STATUS
PRELIMINARY
TENDER
CONSTRUCTION
RECORD


Beam 1, North/East Elevation
scale 1:50 horizontal, 1:25 vertical
North end
South end
Horiz crack at fixing through beam
end of top lamination at aprox hangar 5
Short fracture 400-500mm both faces
denotes galv metal hangar fixings on to Glu Lam beam
beam depth at centre = 875mm (20 laminations)
19 lams
centre/ridge
discontinuous shake to beam soffit allong most of its length
clear span 17881
Post built into AAC blockwork to inner leaf of perimeter wall
support as other end
19 laminations at end (reduced depth)
edge trimmer
16Ø bolt heads lightly corroded
270x215 posts with 8mm thick galv strap
sill level to u/s glazing
Post built into external cavity wall
concrete ring beam
270 post
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Note.
1.0 General
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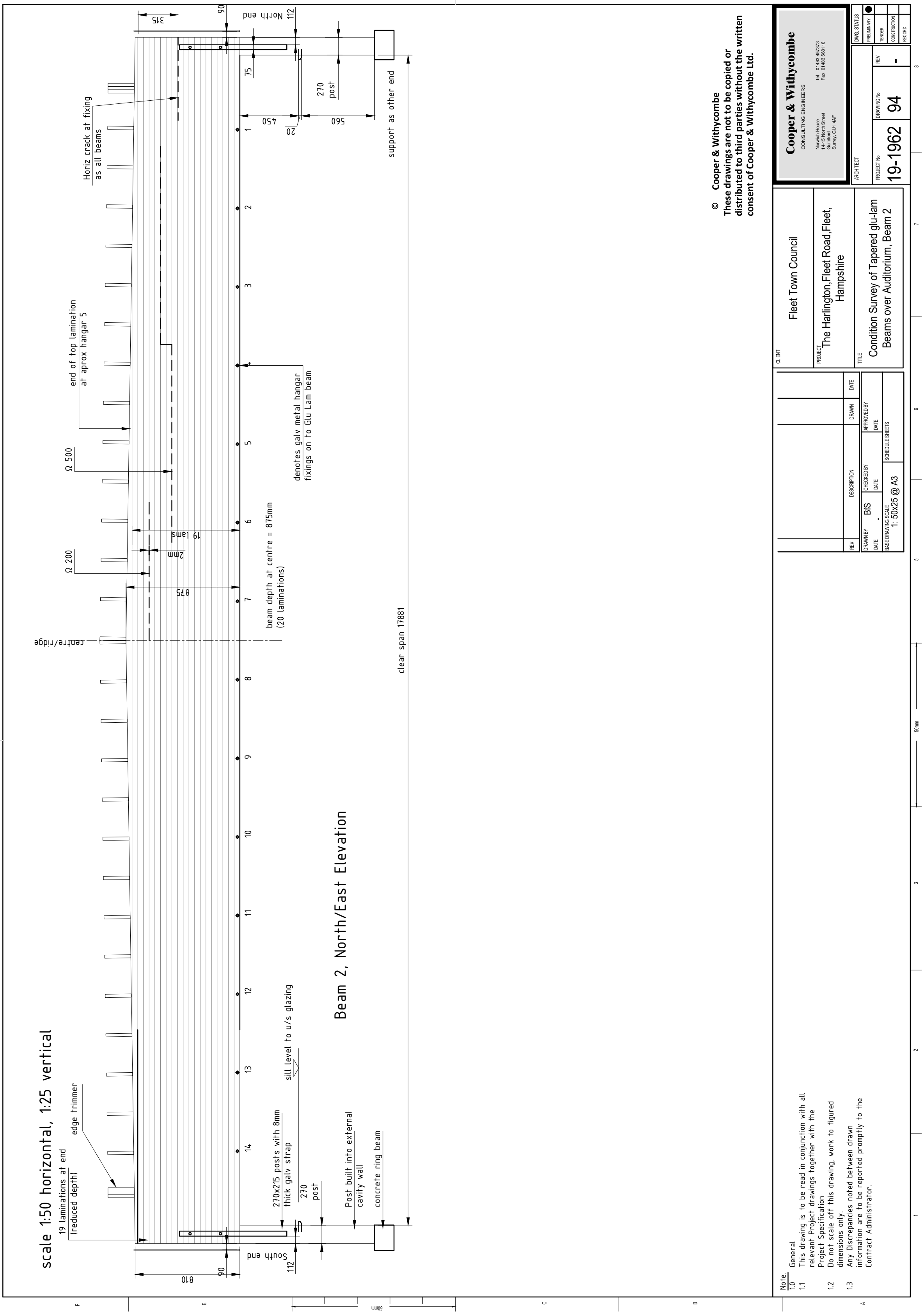
A Additional notes bfs Jul20
Fleet Town Council
The Harlington,Fleet Road,Fleet, Hampshire
Condition Survey of Tapered glu-lam Beams over Auditorium, Beam 1
Cooper & Withycombe
CONSULTING ENGINEERS
19-1962
93
A
1: 50x25 @ A3


Beam 2, North/East Elevation
scale 1:50 horizontal, 1:25 vertical
North end
South end
Horiz crack at fixing as all beams
end of top lamination at aprox hangar 5
denotes galv metal hangar fixings on to Glu Lam beam
beam depth at centre = 875mm (20 laminations)
19 lams
2mm
875
centre/ridge
clear span 17881
support as other end
270 post
sill level to u/s glazing
270x215 posts with 8mm thick galv strap
Post built into external cavity wall
concrete ring beam
19 laminations at end (reduced depth)
edge trimmer
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Cooper & Withycombe CONSULTING ENGINEERS
Fleet Town Council
The Harlington,Fleet Road,Fleet, Hampshire
Condition Survey of Tapered glu-lam Beams over Auditorium, Beam 2
19-1962
94
1:50x25 @ A3
Note.
1.0 General
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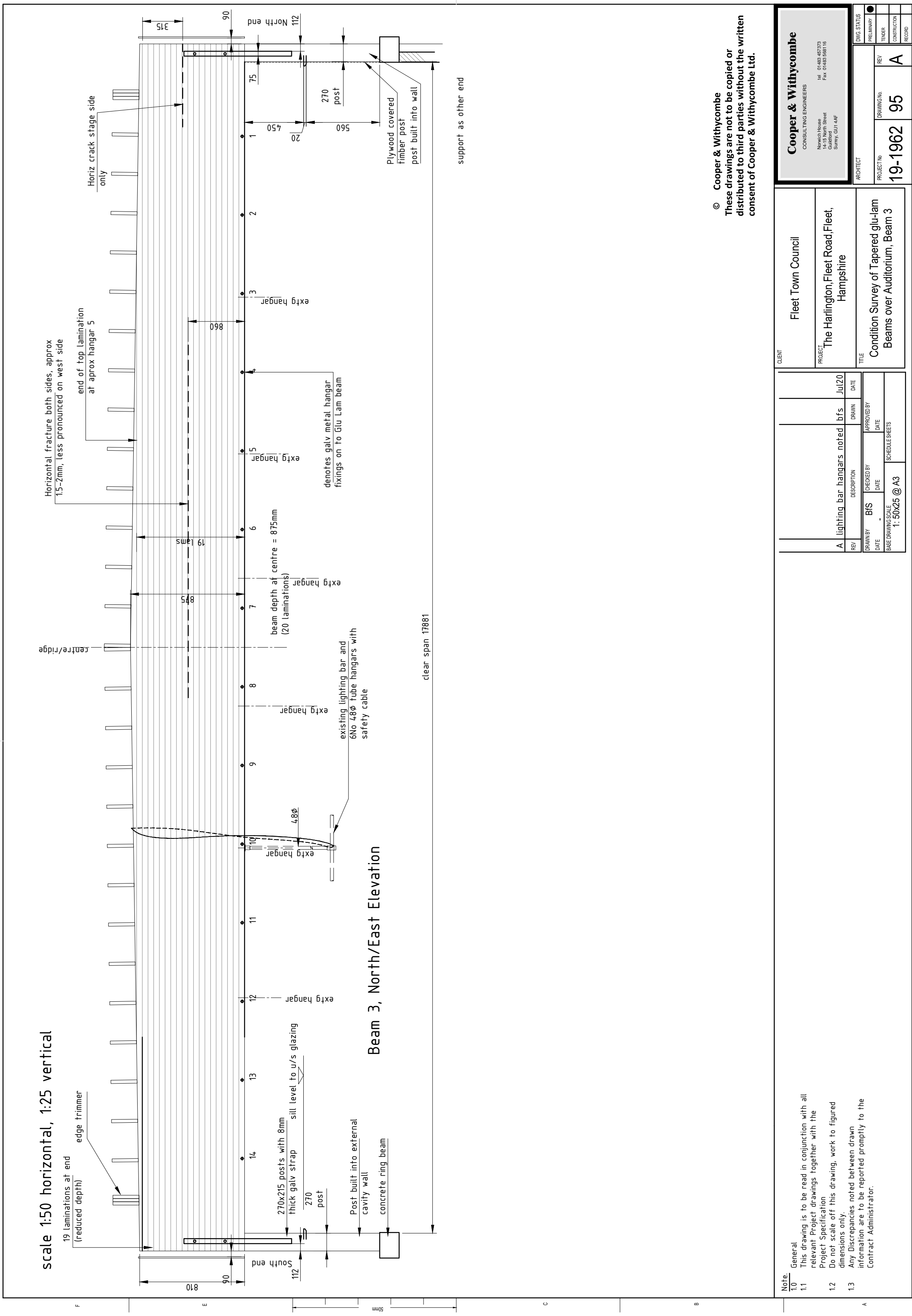
scale 1:50 horizontal, 1:25 vertical
Beam 3, North/East Elevation
North end
South end
centre/ridge
clear span 17881
support as other end
beam depth at centre = 875mm (20 laminations)
19 lams
Horizontal fracture both sides, approx 1.5-2mm, less pronounced on west side
end of top lamination at aprox hangar 5
Horiz crack stage side only
19 laminations at end (reduced depth)
edge trimmer
exfg hangar
denotes galv metal hangar fixings on to Glu Lam beam
existing lighting bar and 6No 48Ø tube hangars with safety cable
Plywood covered timber post post built into wall
270x215 posts with 8mm thick galv strap
sill level to u/s glazing
Post built into external cavity wall
concrete ring beam
© Cooper & Withycombe
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Cooper & Withycombe
CONSULTING ENGINEERS
Fleet Town Council
The Harlington,Fleet Road,Fleet, Hampshire
Condition Survey of Tapered glu-lam Beams over Auditorium, Beam 3
A lighting bar hangars noted bfs Jul20
BfS
1:50x25 @ A3
19-1962
95
A
Note.
1.0 General
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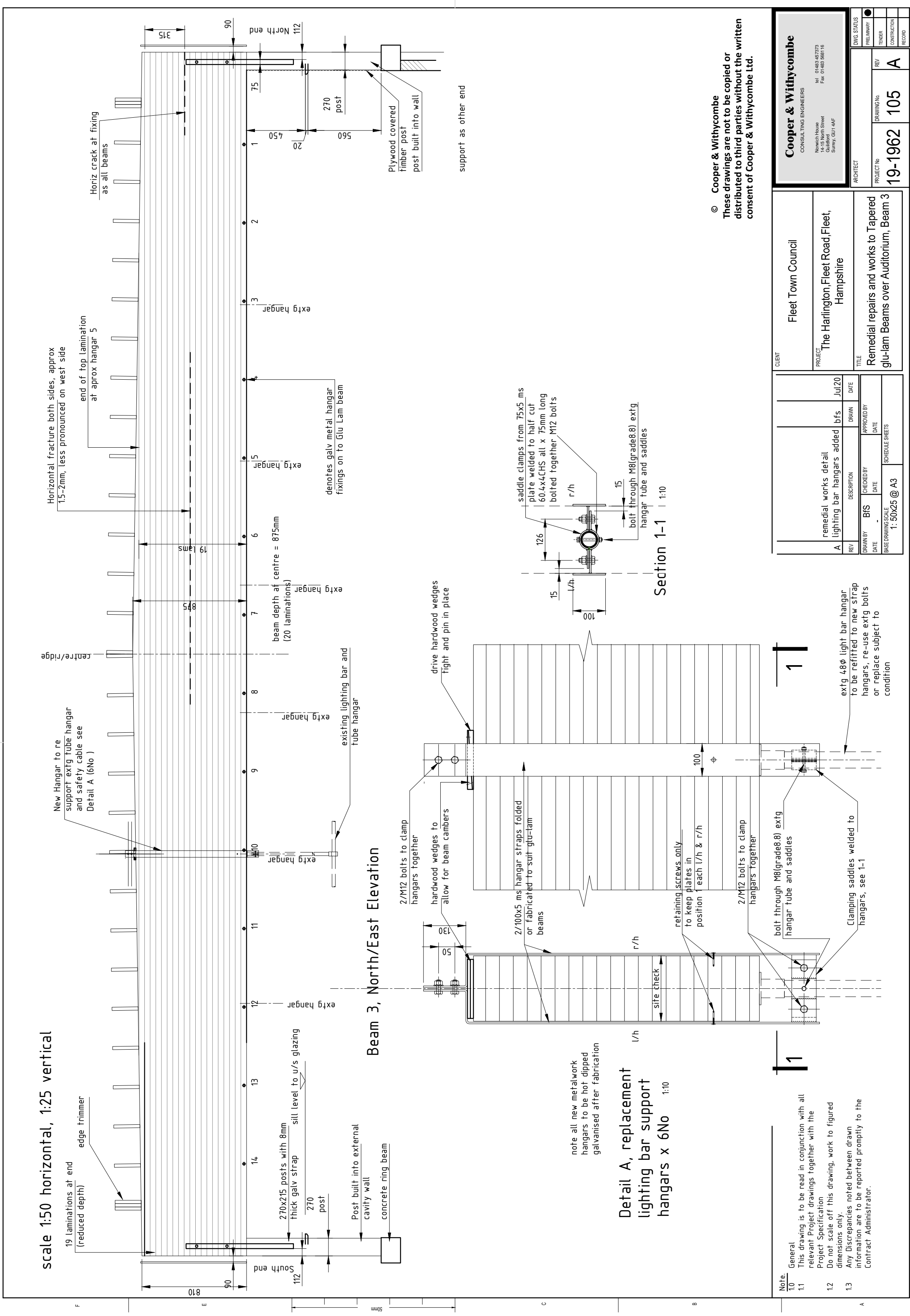
Beam 3, North/East Elevation
scale 1:50 horizontal, 1:25 vertical
North end
South end
centre/ridge
19 lams
895
beam depth at centre = 875mm
(20 laminations)
extg hangar
denotes galv metal hangar fixings on to Glu Lam beam
Horiz crack at fixing as all beams
Horizontal fracture both sides, approx 1.5–2mm, less pronounced on west side
end of top lamination at aprox hangar 5
New Hangar to re support extg tube hangar and safety cable see Detail A (6No)
existing lighting bar and tube hangar
19 laminations at end (reduced depth)
edge trimmer
270x215 posts with 8mm thick galv strap
sill level to u/s glazing
270 post
Post built into external cavity wall
concrete ring beam
Plywood covered timber post
post built into wall
support as other end
Detail A, replacement lighting bar support hangars x 6No 1:10
Section 1-1 1:10
saddle clamps from 75x5 ms plate welded to half cut 60.4x4CHS all x 75mm long bolted together M12 bolts
bolt through M8(grade8.8) extg hangar tube and saddles
drive hardwood wedges tight and pin in place
2/M12 bolts to clamp hangars together
hardwood wedges to allow for beam cambers
2/100x5 ms hangar straps folded or fabricated to suit glu-lam beams
retaining screws only to keep plates in position 1 each l/h & r/h
Clamping saddles welded to hangars, see 1-1
extg 48Ø light bar hangar to be refitted to new strap hangars, re-use extg bolts or replace subject to condition
site check
note all new metalwork hangars to be hot dipped galvanised after fabrication
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Note. General
1.0 This drawing is to be read in conjunction with all relevant Project drawings together with the Project Specification
1.1 Do not scale off this drawing, work to figured dimensions only.
1.2 Any Discrepancies noted between drawn information are to be reported promptly to the Contract Administrator.
A remedial works detail lighting bar hangars added bfs Jul20
Client Fleet Town Council
Project The Harlington Fleet Road,Fleet, Hampshire
Title Remedial repairs and works to Tapered glu-lam Beams over Auditorium, Beam 3
Drawn by BfS
1: 50x25 @ A3
Cooper & Withycombe CONSULTING ENGINEERS
Project No 19-1962
Drawing No 105
Rev A

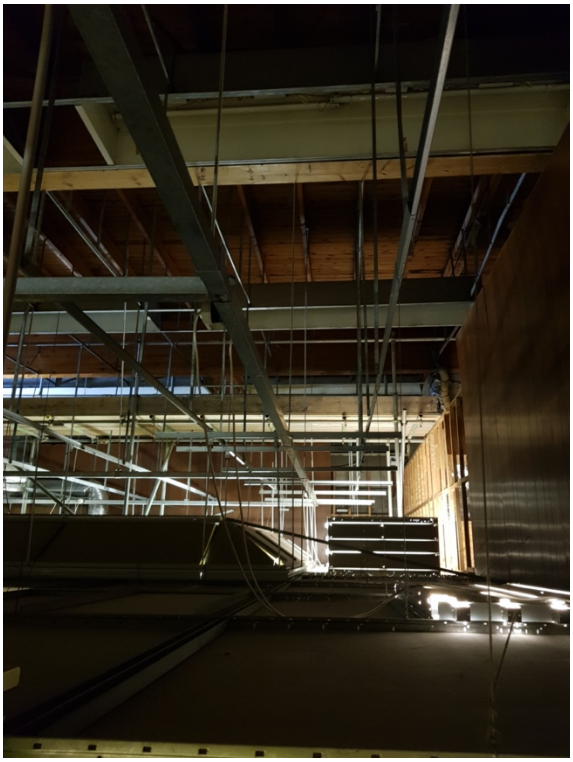
Appendix B
Photos

R1 Auditorium view north-east

R2 Auditorium view south-west

R3 Auditorium stage

R4 Auditorium lighting bar



R5 Typical view within ceiling void above Auditorium

R6 Typical view – Upper roof structure

R7 Roof structure – ceiling support, alternate joist

R8 Roof edge gutter with struts to perimeter wall

R9 Roof edge beam. Historic water penetration.

R10 Butt joint of roof joists over laminated beam

R11 Typical screw fixing for ceiling hanger

R12 Typical nail fixing to ceiling joist

R13 Typical laminated beam span across hall

R14 Laminated beam onto ply cased post

R15 Re-routed rainwater downpipe at laminated beam bearing

R16 Timber post below Glulam beam bearing

R17 Post sits direct onto concrete ring beam

R18 Post to Glulam

R19 Open ended redundant pipe

R20 Laminated beam post fixiing

R21 Beam 3 – Horizontal crack

R22 Beam 3 – Horizontal check / crack

R23 Lighting bar support – Beam 3

R24 Beam 3 – Safety wire

R25 Lighting bar fixing

R26 Beam 3 – Fracture to beam soffit

R27 Beam 1 – Check / crack above beam fixing

R28 Beam 1 – Check / crack at beam bearing

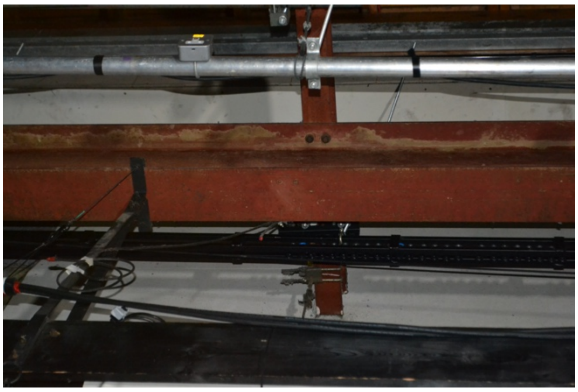
R29 Typical ceiling grid fixing to Glulam

R30 Ceiling support grid

R31 Ceiling grid and redundant lights

R32 Ceiling grid

R33 Light grid. Support above stage.



R34 Secondary beam supported on beam over proscenium

R35 Beam built into brick pier

R36 Proscenium beam bearing

R37 Secondary beam