BASSETLAW HOSPITAL, PHASE 1

STRUCTURAL INSPECTION REPORT

22nd October 2021

RAAC PLANK INSPECTION

AJP Ref: 221-007

PREPARED BY MIKE CARR

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RAAC PLANK INSPECTION

Client Ref: 221-007

DONCASTER AND BASSETLAW TEACHING HOSPITALS NHS FOUNDATION TRUST

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01	Mike Carr - Senior Structural Engineer	Initial issue for trust comments	22.10.2021

Contents

1. INTRODUCTION

The Alan Johnston Partnership LTD have been appointed by *Doncaster and Bassetlaw Teaching Hospitals NHS Foundation Trust* to undertake a structural review of several buildings within the hospital estate where RAAC planks have been identified in their construction. This report includes the building known as "Phase 1" or "building 43", which houses the Emergency Department (ED), operating theatres and plant rooms. It should be noted that AJP conducted a previous survey in February 2021 simply to identify the construction and any immediate defects.

FIGURE 1 - BUILDING LOCATION WITHIN THE SITE

The area highlighted above has a roof constructed from Reinforced Autoclaved Aerated Concrete (RAAC), a construction which has been identified as problematic in certain circumstances and is subject to a checking instruction from the NHSI. This report details the findings of the inspection carried out on the 15th of October, and outlines various recommendations in managing the risks identified.

2. REINFORCED AUTOCLAVED AERATED CONCRETE

Autoclaved aerated concrete is different from normal dense concrete. There are no coarse aggregates and the concrete is filled with chemically induced gas bubbles to reduce its weight. It is relatively weak and was used widely in the 1960's – 1980's for roof construction. Several instances of sudden collapse have been attributed to RAAC, which has a useful lifespan estimated to be around 30 years.

In late 2019, the Local Government Association (LGA) drew attention to potential structural issues surrounding RAAC roof plank and made recommendations relating to maintenance and inspection regimes. This was followed by a publication by the Standing Committee on Structural Safety (SCOSS) which highlights the findings of testing/case studies.

The common causes of failure were identified by the report are as follows:

- Incorrect/insufficient cover to reinforcement
- Creep (continued deflection over time) due to a low stiffness
- Insufficient anchorage of reinforcement at support points
- Water ingress and the associated reinforcement corrosion, particularly at support points
- Failed waterproofing membranes
- Insufficient bearing or reinforcement at support points

The main manufacturer of the planks, Siporex, published technical literature in 1972 which lays out the principles to be adopted when using RAAC planks in roof construction.

Failures can be anticipated if the planks are cracking or bowing significantly. Failures can also occur suddenly and without warning if defects are hidden beyond the observable surface. Refer to the illustration below.

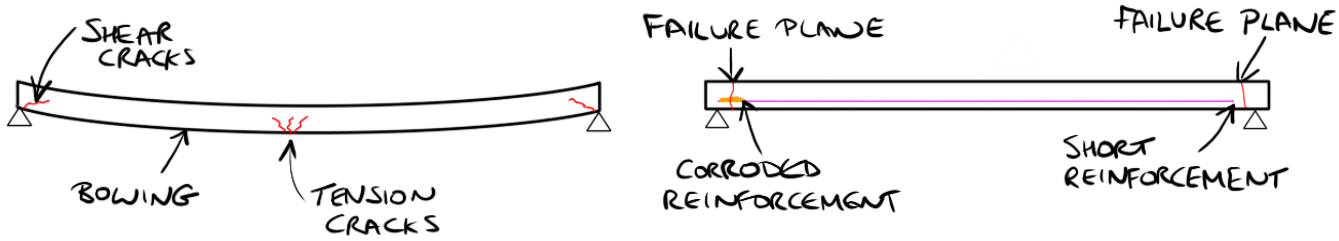


FIGURE 2 – INDICATIONS OF ANTICIPATED FAILURES (LEFT) AND EXAMPLES OF SUDDEN FAILURES (RIGHT)

3. STRUCTURAL ASSESSMENT METHOD

Inspections were undertaken during normal daytime operation hours with assistance from estates staff. The weather was dry, but rain had clearly fallen in the previous days.

The inspection was visual, and allowed the condition of each roof planks to be assessed from the underside. The following signs of deterioration/defects were checked for:

- Excessive deflection (typically causing visible bowing)
- Signs of water ingress or corrosion of reinforcement
- Insufficient end bearing (less than 45mm)
- Cracking
- Spalling
- Discolouration/staining
- Non-standard planks sizes
- Penetrations or cuts that may weaken the planks
- Ponding of water at roof level

4. BUILDING INTRODUCTION

Based on a desktop study of historical maps, phase 1 appears to have been constructed circa 1980. The building is primarily a three-storey loadbearing masonry construction, with elements of steel framing and in-situ concrete. RAAC roof planks span onto steel trusses to form a flat roof, which is accessible by means of a permanent ladder.

The roof void houses an abundance of services/ducts which connect to the operating theatres below. The majority of the ducts are suspended from the RAAC planks above using drilled fixings. A small area of the roof void is double height to facilitate incoming services from an adjacent taller section of the building. The roof construction over this double height area is of a lightweight metal deck and steel beam/column arrangement.

5. RAAC SUMMARY AND DEFECTS IDENTIFIED

Refer to AJP drg BLH-AJP-ZZ-RF-DR_S-0001 in the appendix. 267 no. RAAC planks were identified in the building generally measuring 600mm in width, and 6” (152mm) in depth based on site measurements. A small number of planks were measured between 250mm and 450mm in width. Although several planks were partially obscured by ducts and services, AJP were able to uniquely identify each plank within the roof void. The external roof condition was inspected from above; build-up over the planks is likely to contain insulation topped with waterproof finishes.

A variety of general defects were identified, as follows:

- Severe water damaged ply boarding forming the floor due to water ingress, this occurs immediately adjacent to the steel plant room door (photo 1)
- Saw cut holes, plank 15 (photo 2)
- Loose and structurally inadequate barriers preventing access onto ventilation units, occurs above theatres 6, 5 and 4 (photo 3)

- Roughly cut units exposing reinforcement, planks 102, 111, 143, 166, 199, 222 and 245 (photo 4)
- Untreated exposed reinforcement, plank 15 (photo 5)
- Loosely fitting and missing holding down clips (photo 6)
- Long term ponding of water at roof level (photo 7A and 7B)
- Water ingress through roof build-up, plank staining and moderate floor damage particularly above theatre 4 (photo 8A and 8B)
- Unprotected falls from height, occurs where roof ladder is positioned (photo 9)

Generally, bearing lengths appeared to be in excess of 80mm and reinforcement cover was found to be 20mm to 30mm. Main tension reinforcement in the bottom of each plank was consistently found to be at 75mm centres. Refer to photo 10 for a visual aid. Span/depth ratios are around Span/22. None of these geometric values are cause for concern.

PHOTO 1 – SEVERE WATER DAMAGED PLY BOARDING

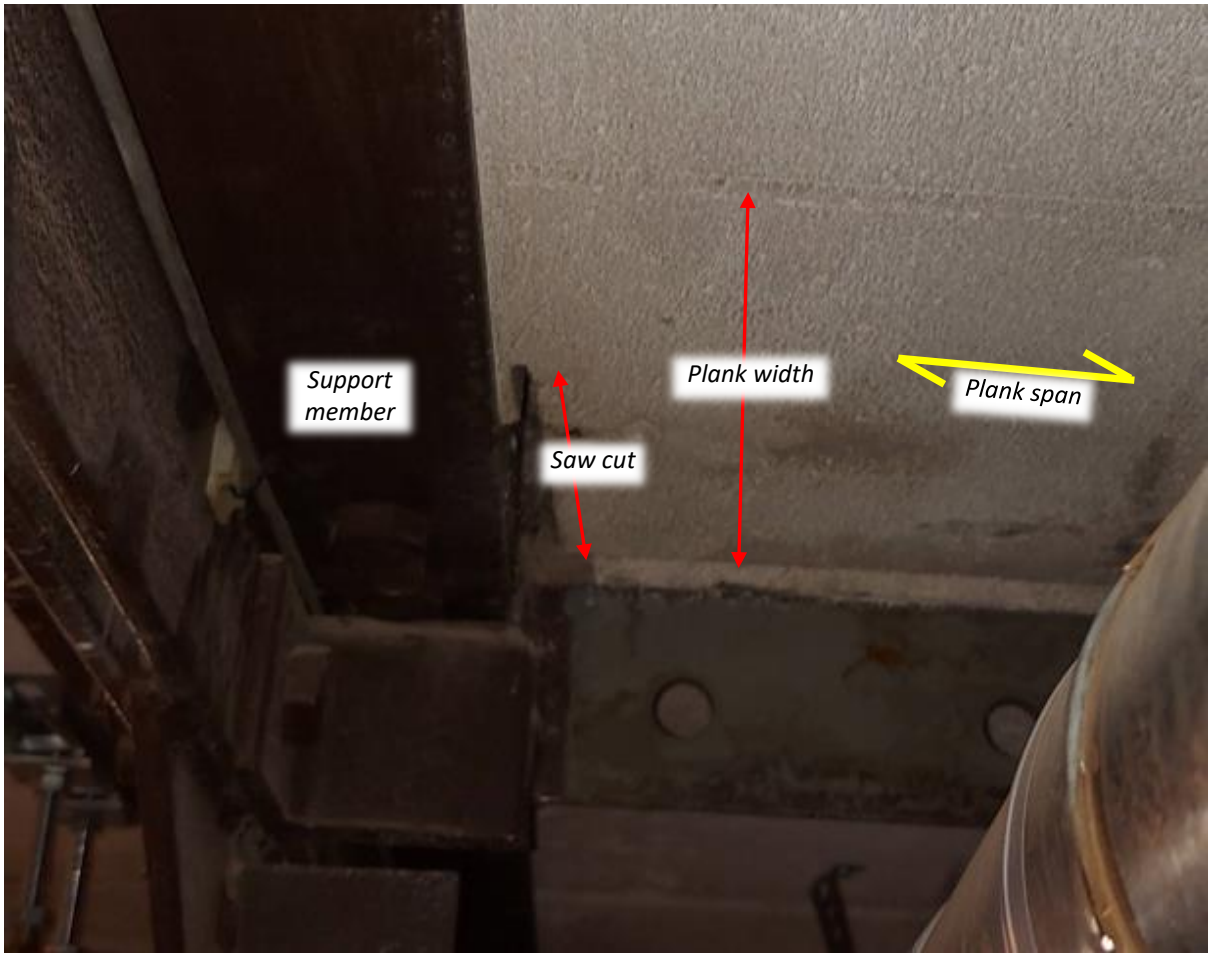


PHOTO 2 – RAAC PANEL CUT AT SUPPORT LOCATION

PHOTO 3 – LOOSE HANDRAILS

PHOTO 4 – ROUGHLY CUT RAAC PLANK

PHOTO 5 – CORROSION OF UNPROTECTED REINFORCEMENT

PHOTO 6 – MISSING PLANK CLIPS FOR HOLDING DOWN

PHOTO 7A – PONDING, PHOTOGRAPH FEBRUARY 2021

PHOTO 7B – PONDING, PHOTOGRAPH OCTOBER 2021

PHOTO 8A – WATER INGRESS AND STAINING OF PLANKS

PHOTO 8B – MODERATE WATER DAMAGE BELOW WATER INGRESS LOCATIONS

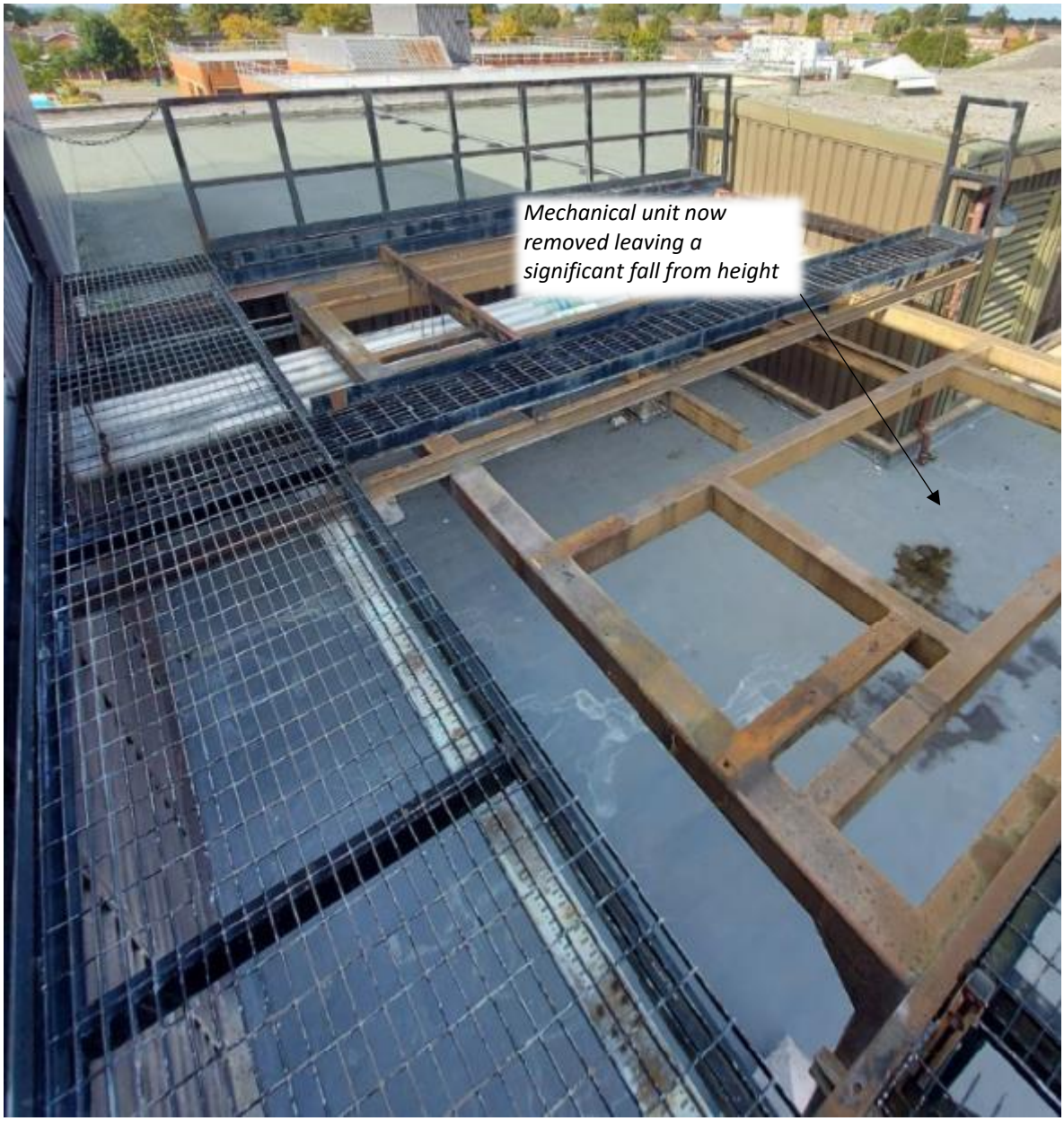


PHOTO 9 – UNPROTECTED FALLS FROM HEIGHT

PHOTO 10 – REINFORCEMENT ARRANGEMENT

6. RECOMMENDATIONS

Based on the building age and survey findings, it is suggested that the RAAC planks are nearing the end of their useful life (50 years). Although the planks appear to be in reasonable condition and are not displaying any indications of overstress (cracking or deflecting) it is not possible to identify defects which lie beneath the observable surfaces, and a very small number of recent failures in the UK have occurred suddenly without warning. It is recommended that plank 15 is re-supported to account for the significant cut which appears to coincide with reinforcement. This may involve a timber beam arrangement fixed between the trusses. AJP are to advise further on the re-support detail upon receipt of NHS trust comments. Any visibly exposed unpainted/untreated reinforcement should be thoroughly wire brushed and protected. The damaged ply flooring has a very reduced lifespan and it should be replaced at the earliest suitable opportunity.

6.1 Option 1 – Retain RAAC planks, repair leaks, and undertake ongoing inspections

As part of the works, it is recommended that the trust appoint a specialist subcontractor to undertake GPR ferro-scans from above, thereby allowing AJP to verify the reinforcement content of the planks in all instances and identify any planks which may be more susceptible to sudden failure. Referring to the previous AJP report, residual imposed load capacity of the planks was identified as 1.25kN/m² (allowing for 1kN/m² finishes + services). The subcontractor should take account of this in their risk assessment/method statement.

It is recommended the gullies at roof level are inspected by estates during periods of heavy rain to ensure they are draining freely. Several gullies were missing caps which prevent blockages, these should be re-fitted if possible. Consideration should be given to identifying any surface damage where water is able to penetrate, and sealing with a synthetic rubber patching system. Unless the roof is re-surfaced with tapered insulation or similar to achieve a minimum fall it will be challenging to fully address the standing water issue.

Given the condition of the planks, and relatively short spans, AJP suggest that ongoing inspections should be undertaken annually. Frequency of inspection may change if signs of deterioration appear in the coming years, or if industry guidance is updated.

6.2. Option 2 – Remove RAAC planks and replace roof with suitable construction

Eradication of the planks will eliminate the need for any future inspections. It is unlikely that this option will be feasible due to the criticality of the theatres below. Following the removal of the existing roof finishes, an appropriate method of removing the RAAC planks from the roof will need to be devised and developed with a suitably experienced demolition contractor. Temporary stability of the walls will need consideration, as they may rely on the planks to resist wind loading. All ductwork supported by the RAAC planks will need removing or re-supporting. Based on the roof span, it is likely that a timber roof with insulation laid to falls and waterproofing will be an economical solution.

7. SUMMARY OF RECOMMENDATIONS

TABLE 1: BENEFITS AND DRAWBACKS FOR OPTIONS 1 AND 2

	Benefits	Drawbacks
Option 1 – Retain RAAC	Small amounts of immediate term works are required. Minimal/no impact on hospital functionality.	RAAC remains on site and is an ongoing risk requiring routine inspection annually. Additional GPR ferro-scanning works required. Roof ponding will not be remediated without re-roofing works.
Option 2 – Replace roof	RAAC risk entirely eradicated, modern construction will improve overall building performance. Roof ponding will be addressed.	Full de-cant of the theatres will be required as the works take place. ED access will be temporarily affected. Logistically challenging to remove the planks, external walls may need temporary support

In addition to the above options, the items below confirm further recommendations. Those in green should be risk assessed by the trust, whereas those in red are considered by AJP as essential.

- Demarcation of areas with loose barriers (see photo 3)
- Installation of a barrier to prevent fall from height (see photo 9)
- Patch repair of roof leaks where ponding has occurred if planks retained
- Refit missing gulley caps at roof level if planks retained
- Inspect the gullies during heavy rain to check they drain freely if planks retained
- Re-support of plank 15 if planks are to be retained
- Treatment and protection of exposed/corroding reinforcement if planks retained
- GPR ferro-scanning from above if planks are to be retained
- Repair of damaged ply flooring (see photo 1 and 8B)

AJP suggest that the following course of action is suitable:

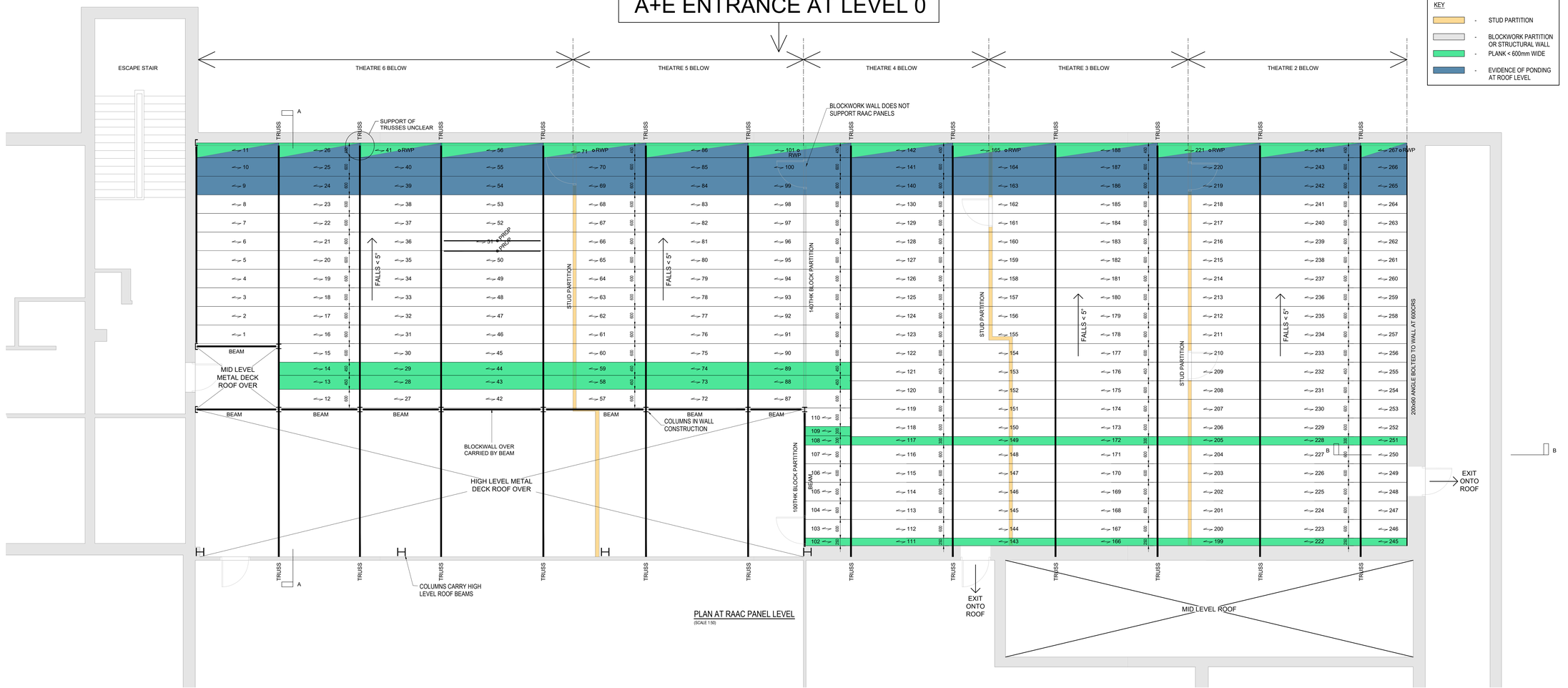
1. NHS Trust to evaluate the contents of this report and provide any relevant feedback
2. AJP to develop proposals in full, including drawings and specifications
3. NHS Trust to approach suitably experienced contractors and sub consultants where necessary capable of undertaking the works
4. AJP to work with contractor/UET to develop a suitable method of works
5. Works to be completed at a suitable time

APPENDICES

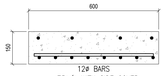
Appendix A – AJP drg BLH-AJP-ZZ-RF-DR-S-0001, overall layout of the building showing RAAC planks

A+E ENTRANCE AT LEVEL 0

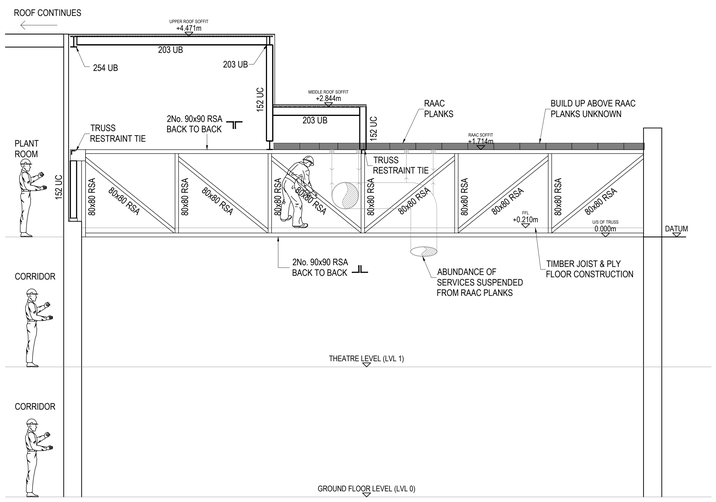
KEY
- STUD PARTITION
- BLOCKWORK PARTITION OR STRUCTURAL WALL
- PLANK < 600mm WIDE
- EVIDENCE OF PONDING AT ROOF LEVEL



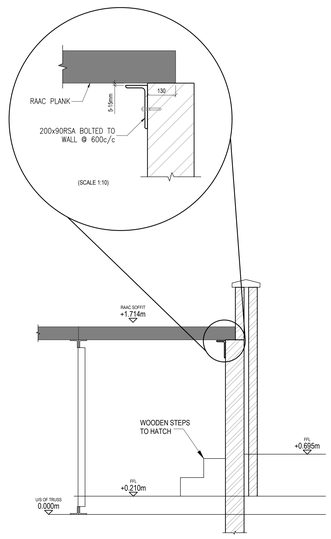
PLAN AT RAAC PANEL LEVEL
(SCALE 1:50)



TYPICAL RAAC PLANK SECTION
(SCALE 1:10)



SECTION A-A
(SCALE 1:50)



SECTION B-B
(SCALE 1:25)

PLANK SCHEDULE		
Unit No.	Width (mm)	Depth (mm)
1	600	150
2	600	150
3	600	150
4	600	150
5	600	150
6	600	150
7	600	150
8	600	150
9	600	150
10	600	150
11	450	150
12	600	150
13	450	150
14	450	150
15	600	150
16	600	150
17	600	150
18	600	150
19	600	150
20	600	150
21	600	150
22	600	150
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24	600	150
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39	600	150
40	600	150
41	450	150
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43	450	150
44	450	150
45	600	150
46	600	150
47	600	150
48	600	150
49	600	150
50	600	150

PLANK SCHEDULE		
Unit No.	Width (mm)	Depth (mm)
51	600	150
52	600	150
53	600	150
54	600	150
55	600	150
56	450	150
57	600	150
58	450	150
59	450	150
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92	600	150
93	600	150
94	600	150
95	600	150
96	600	150
97	600	150
98	600	150
99	600	150
100	600	150

PLANK SCHEDULE		
Unit No.	Width (mm)	Depth (mm)
101	450	150
102	250	150
103	600	150
104	600	150
105	600	150
106	600	150
107	600	150
108	300	150
109	300	150
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141	600	150
142	450	150
143	250	150
144	600	150
145	600	150
146	600	150
147	600	150
148	600	150
149	300	150
150	600	150

PLANK SCHEDULE		
Unit No.	Width (mm)	Depth (mm)
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154	600	150
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191	600	150
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193	600	150
194	600	150
195	600	150
196	600	150
197	600	150
198	600	150
199	250	150
200	600	150

PLANK SCHEDULE		
Unit No.	Width (mm)	Depth (mm)
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202	600	150
203	600	150
204	600	150
205	300	150
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243	600	150
244	450	150
245	250	150
246	600	150
247	600	150
248	600	150
249	600	150
250	600	150

PLANK SCHEDULE		
Unit No.	Width (mm)	Depth (mm)
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252	600	150
253	600	150
254	600	150
255	600	150
256	600	150
257	600	150
258	600	150
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260	600	150
261	600	150
262	600	150
263	600	150
264	600	150
265	600	150
266	600	150
267	450	150

REV	DATE	DESCRIPTION	BY	CHK	APP
P01	22.10.2021	FOR INFORMATION	CD	MC	MC

DRAWING STATUS: **FOR INFORMATION**

CLIENT: BASSETLAW HOSPITAL

ARCHITECT:

PROJECT: BASSETLAW HOSPITAL
RAAC PANEL SURVEY

TITLE: RAAC PANEL SURVEY
E.D / THEATRES

STATUS:	PROJECT No.	PROJECT	ORIGINATOR	VOL/SYS	LEVEL	TYPE	ROLE	DRAWING No.	REV.
S2	221-007	BLH -	AJP -	ZZ -	RF -	DR -		S - 0001	P01

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1:50	MC	CD	MC	MC	OCT 2021

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