COUCH Consulting Engineers
Civil & Structural

Structural Report:
Block A - Kidderminster Hospital & Treatment Centre

For: Worcester Hospitals Acute NHS Trust

Prepared By: Jermaine Spence
BEng (Hons) MSc MIStructE MICE CEng

COUCH Consulting Engineers
The Old Forge, Priory
London Road
Canwell
Sutton Coldfield
B75 5SH
0121 3087557

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REVISION RECORD

Rev	*Status*	*Amendment*	*Date*	*By*	*Checked*	*Approved*
-	First Issue	-	20 Aug 2021	JDS	JDS	GH
1	Second issue	Revised structural tender drawings added to the appendix following a site visit on the 13th September 2021.	17 Sept 2021	JDS	JDS	GH
2	Third issue	Revised structural tender drawing (option 1) added to the appendix.	27 Sept 2021	JDS	JDS	JDS

Contents

1.0 Brief

1.1 Couch Consulting Engineers (CCE) were appointed by Worcester Acute Hospitals NHS Trust (WAHNT) to undertake a survey of the Reinforced Autoclaved Aerated Concrete (RAAC) planks, in Block A, at the Kidderminster Hospital and Treatment Centre (KHTC).

2.0 Limitations

2.1 This report has been produced for WAHNT and no liability is extended to any third party for its contents in full or any part therein.

2.2 This report is predominantly based on the observations made during three site visits which were undertaken on the 9th,14th, and 23rd July 2021.

2.3 We have not received any existing structural drawings for the building.

2.4 No intrusive opening works were undertaken in respect to investigating the bearing of the RAAC planks on the existing steel frame.

2.5 Access to the roof top was limited to due the absence of a roof perimeter barrier.

2.6 Not all the RAAC plank soffits were visible due to obstructions.

3.0 Description

3.1 Block A forms part of KHTC. The building is predominantly 2 storeys and supported by a steel frame with precast concrete planks on the 1st floor and roof.

During an earlier structural inspection, it was revealed that most of the roof to the building is constructed using RAAC precast planks.

3.2 RAAC planks were predominantly used in the 1960-80s, and despite being called concrete, they cannot be treated as traditional concrete, and this was due to the way they were made. RAAC planks are much weaker than traditional concrete and have an expected life of around 30 years. Failures in RAAC planks can be sudden and without warning.

There have been notable structural failures of RAAC planks in several public buildings. A report issued by the Standing Committee on Structural Safety (Scoss) in 2019 recommended that all RAAC planks installed before 1980 are replaced.

3.3 The primary reasons for failures in RAAC planks are as follows:

Incorrect cover to tension steel, high span-to-depth ratios, insufficient provision of crossbars to provide anchorage for the longitudinal steel, failure in performance of roof membranes leading to water ingress and rapid worsening localised steel corrosion. There have also been excessive deflections due to creep and floor and roof planks acting independently, rather than as a single structural entity.

4.0 Observations & Discussion

4.1 CCE visited site on the following dates:

9th July 2021: Visual inspection of the soffit to the RAAC planks.
14th July 2021: Visual inspection of the rooftop.
23rd July 2021: Electronic survey of the bottom reinforcement cover to the RAAC planks.

4.2 Visual Inspection of the soffits to the RAAC planks:

A drawing showing the observed defects to the soffits of the RAAC planks with photographs is provided in appendix.

To summarise the observed defects to the RAAC plank are generally minor in nature i.e., minor hairline cracks and pitting to localised areas.

There is however a single plank above room references A1-19 & A1-44 which has an area of exposed reinforcement due to the spalling of concrete.

Immediate remedial works are required for this defect, and we would recommend the following:

Step 1: Remove any loose concrete around the defect.
Step 2: Apply a zinc rich protective coating (e.g., Fosroc Nitoprime Zincrich) to the exposed reinforcement.
Step 3 – Apply a Cementous protective coating and levelling mortar to replace the spalled concrete (e.g., Fosroc Renderoc ST 05)

No visible excessive deflections to the RAAC planks were observed.

4.3 Roof top inspection.

We observed no obvious sagging to the roof or areas of ponding water. From discussions with the estates department at KHTC, the building has considerable issues with rainwater leaking through the roof.

As stated in Section 3.0 a significant contributory factor to issues with RAAC planks failures is moisture content in the slab. The prolonged periods of water

ingress seeping through the slab has significantly increased the risk of failure to the RAAC planks.

4.4 Reinforcement concrete Cover Survey

The bottom concrete cover to the RAAC planks reinforcement varies considerably between planks. The values of cover range from 17mm to 33mm.

The allowable concrete cover must be compared to the requirements at the time of the buildings design. We envisage the design was undertaken to "CP 110-1:1972. Code of practice for the structural use of concrete. Design, materials and workmanship". This code was replaced in 1985.

CP110-1: 1972 specifies a minimum cover of 25mm for normal concrete with a mild exposure class. A mild exposure class is specified as the planks being protected against weather, or aggressive conditions, except for brief period of exposure to normal weather conditions during construction.

CP110-1: 1972 does not provide guidance for the concrete cover to autoclaved aerated concrete.

Due to the RAAC planks being in a mild environment and combined with a visual inspection of the RAAC planks the concrete cover to the bottom reinforcement is not an immediate point of concern.

4.5 We are unable to comment on the RAAC planks regarding their fire resistance.

4.6 Review of RAAC Support Bearings

A review of the RAAC plank bearings onto steel beams was not undertaken. The opening up works required to undertake a review would have likely caused structurally distress to the RAAC plank and created significant issues with water ingress into the building. Any opening up works would be limited for practicality reasons to only a few locations and they would not have necessary provided a true representation for the entirety of the RAAC bearing supports.

5.0 Recommended Major Works

There are three main options to consider with regards to the approach to mitigate the risk due to the RAAC planks.

5.1 Option 1: Replace the Roof

Method: The existing RAAC planks are replaced with a light gauge insulated steel roof. Refer to drawing 7993-CCE-XX- RF-DR-S-0030-T02 in the appendix.

Advantages: The RAAC planks and associated residual risk are removed.

Disadvantages: If the ground floor is to remain occupied, careful consideration must be given to the programming of the works to ensure adequate weather protection is provided to the 1st floor. This is likely to increase the length of the construction programme.

5.2 Option 2: Introduction of steel roof deck below the existing RAAC planks

Method: A light gauge steel roof deck is constructed to the underside of the existing RAAC planks. The roof deck would be supported off new steel beams which are supported off the existing steelwork frame. Refer to drawing 7993-CCE-XX- RF-DR-S-0031-T01 in the appendix. The rooftop must receive the necessary repairs to ensure that it is watertight.

Advantages: The existing roof can remain in place, and we envisage the work can be undertaken while the ground floor remains occupied. The installed steel roof deck would act as a crash deck to the 1st floor thus removing the risk of a RAAC planks impacting onto the 1st floor.

Disadvantages: There are potential clashes with the existing mechanical and electrical services hung from the roof planks. This issue will particularly be acute above the 1st floor corridors. We classify this as temporary/ short term solution and ultimately the RAAC planks will require replacing at a future date subject to an annual structural inspection.

Residual Risk –The RAAC planks will still be in place and the aerated concrete is still prone to structural issues due to historic water ingress through the roof and inherent issues with the material itself. There will still be risk associated with access to the roof top and potential issues with waterproofing if the RAAC planks fail.

5.3 Option 3: Strengthening of the roof.

Method: A grillage of new supporting steelwork (refer to drawing 7993-CCE-XX-RF-DR-S-0032-T00 in the appendix) is introduced to support the RAAC planks. The new steelwork would be connected to the existing steelwork frame. In addition to the new steelwork the rooftop must receive the necessary repairs to ensure that it is watertight.

Advantages: The existing roof can remain in place, and we envisage the work can be undertaken while the ground floor remains occupied.

Disadvantages: There are potential clashes with the existing mechanical and electrical services hung from the roof planks. This issue will particularly be acute above the 1st floor corridors

Residual Risk – The RAAC planks will have there span halved and consequently the significant structural stress in the RAAC planks will be reduced by 75%. The RAAC planks will still be in place and the aerated concrete is still prone to structural issues due to historic water ingress through the roof and inherent issues with the material itself.

The introduction of the strengthening steelwork to a degree mitigates the risk but importantly does not eliminate the risk. This option is not a long-term solution and ultimately the RAAC plank will require replacing at a future date.

The risk must be assessed in the context of KHTC plans regarding the future life expectancy of the building. i.e., if the building were to be demolished and rebuilt in say the next five years then the risk might be deemed acceptable. We would recommend that an annual structural inspection is undertaken.

6.0 Conclusion

6.1 The observed defects do not indicate that there is an immediate risk of the RAAC planks failing. However, the above statement must be tempered due to failures in RAAC planks can be sudden and without warning. If there is a failure of a RAAC plank(s) it is envisaged that it will be localised in nature and the first-floor slab constructed using standard concrete will act as a crash deck to prevent injury to the occupants on the ground floor.

6.2 We recommend that KHTC continue to cordon off the area of the 1st floor with RAAC planks above and access onto the roof top is prevented until the recommended major works as stated in Section 5.0 are undertaken.

6.3 Immediate remedial works are required to the areas of exposed bottom reinforcement as stated in Section 3.0.

6.4 The RAAC planks must be replaced or provided with additional support as discussed in Section 5.0

6.5 To remove all risk associated with the RAAC planks they will have to be removed and replaced with a new roof construction (option 1 in this report).

For and on Behalf of
Couch Consulting Engineers

Jermaine Spence
Associate
BEng (Hons) MSc MIStructE MICE CEng

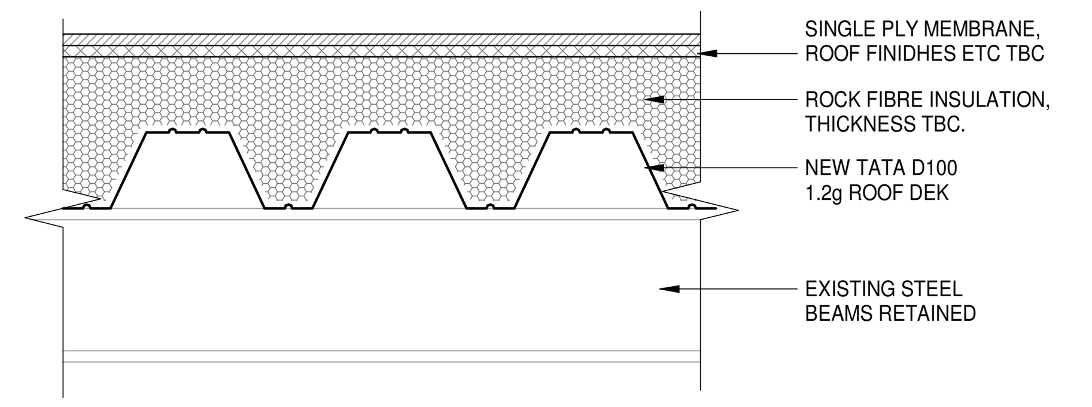
Appendix

ALL DIMENSIONS TO BE CHECKED BY CONTRACTOR

RF ROOF LEVEL - OPTION 1

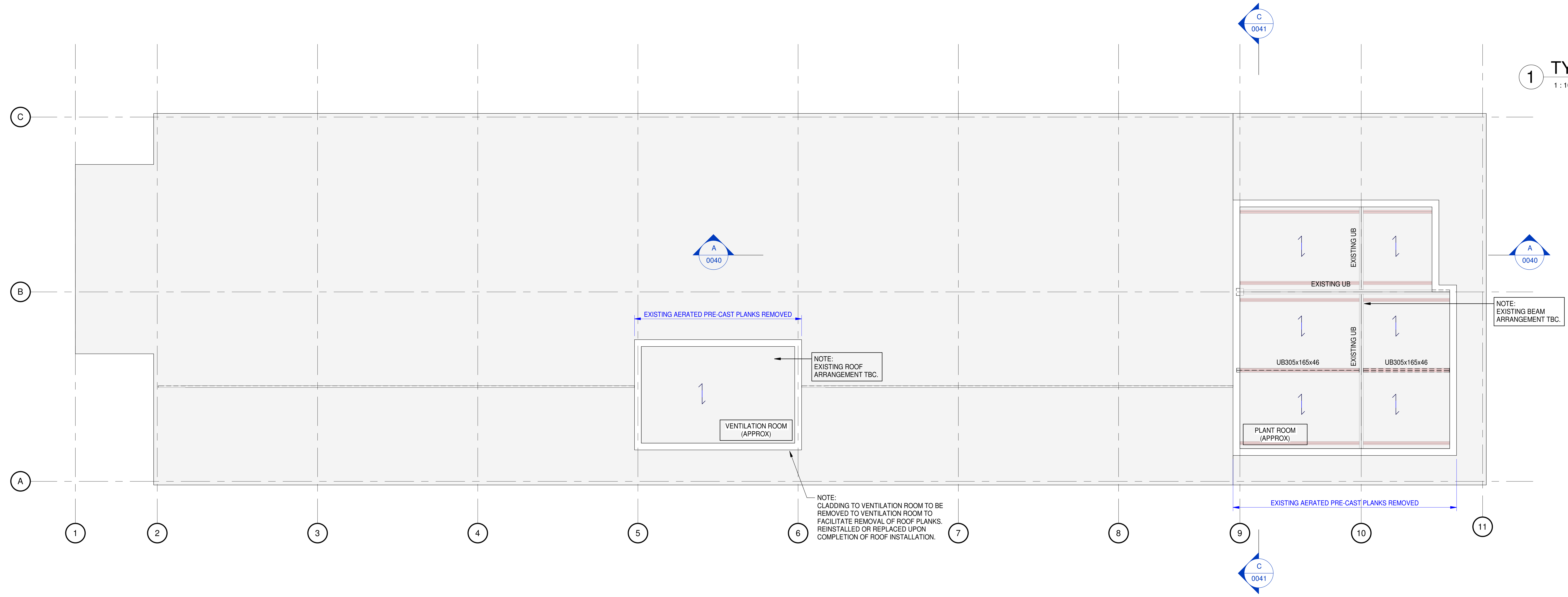
1 : 100

DENOTES DIRECTION OF SPAN OF TATA D100 1.2g ROOF DEK



1 TYPICAL ROOF SECTION - OPTION 1

1 : 10



UR UPPER ROOF LEVEL - OPTION 1

1 : 100

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General Notes

1. Do not scale from this drawing.

2. This drawing is to be read in conjunction with all relevant Architects, Engineers and Specialists drawings and specifications.

3. The Contractor is to check all dimensions on site prior to commencing work.

4. All dimensions are in millimetres unless noted otherwise.

5. For setting out refer to Architects detail.

6. The Contractor shall be responsible for the execution of the works in accordance with the drawings and the specification and for the accuracy of all dimensions and setting out on site.

7. The Contractor is to provide a method statement for the works outlined on this drawing for approval.

8. Details of the existing construction indicated on this drawing have been obtained from record drawings. Following the completion of the stripping out of non-structural items and prior to the commencement of any work or the ordering of materials, the contractor is to carry out the exploratory work described to establish full details of the existing construction where relevant to the proposed structural alterations. Any variations from the details of the existing construction indicated on this drawing are to be reported directly to the engineer.

9. All materials unless specified otherwise shall comply with the relevant British Standard. Sources of materials are to be agreed with the adopting authority in advance of the works.

10. Any discrepancies in the details shown on this drawing to be reported to the Engineer prior to construction.

REV	AMENDMENT	BY / CHK'D	DATE
T03	AMENDMENTS AS CLOUDED FOLLOWING ADDITIONAL SITE VISIT	JS / NT	14:09:21
T02	ADDITIONAL OPTION	JS / BoR	16:08:21
T01	ALTERNATIVE ROOF OPTION ADDED	JS / BoR	03:08:21
T00	TENDER ISSUE	JS / BoR	05:07:21

CE PROJECT EXECUTION CLASS: N/A

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DRAWING STATUS

TENDER

COUCH
Consulting Engineers
Civil & Structural

The Old Forge, Priory, London Road, Canwell, Sutton Coldfield. B75 5SH ☒
Tel: 0121 308 7557
info@cceng.co.uk

14-16 St. Nicholas, Church Street, Warwick. CV34 4JD ☐
Tel: 01926 409 036

Genesis Centre, 18 Innovation Way, Stoke-on-Trent. ST6 4BF ☐
Tel: 01782 366 160
www.cceng.co.uk

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PROJECT
PRE-OP, A BLOCK

DRAWING TITLE
ROOF LEVEL GA - OPTION 1

SHEET SIZE	SCALE	DATE	DRAWN	CHECKED	STATUS
A1	As indicated	08/03/21	BoR	GH	

CCE PROJECT No.	DRAWING No.	REV
C7993	7993-CCE-XX-RF-DR-S-0030	T03

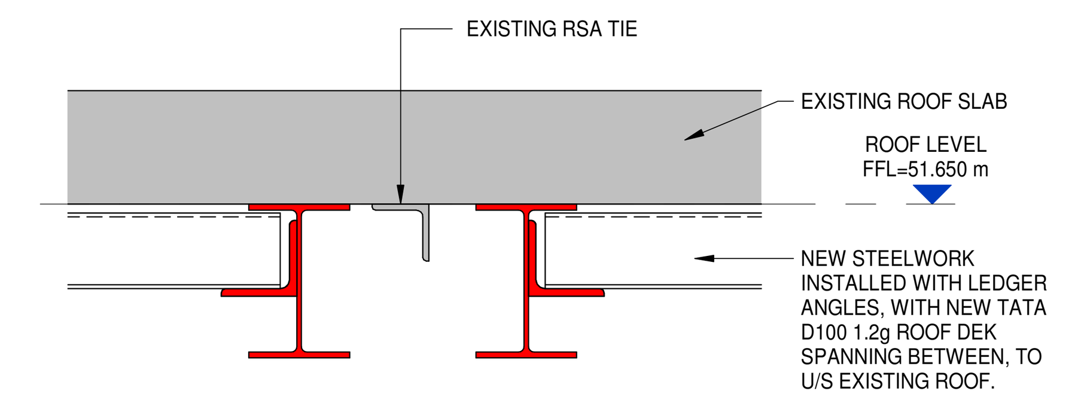
Model Path: F:\7993 - KHTC - A Block\01 - CCE\BIM\01-WIP\BIM_Models\7993-CCE-XX-ZZ-M3-S-0001.rvt

ALL DIMENSIONS TO BE CHECKED BY CONTRACTOR

RF ROOF LEVEL - OPTION 2

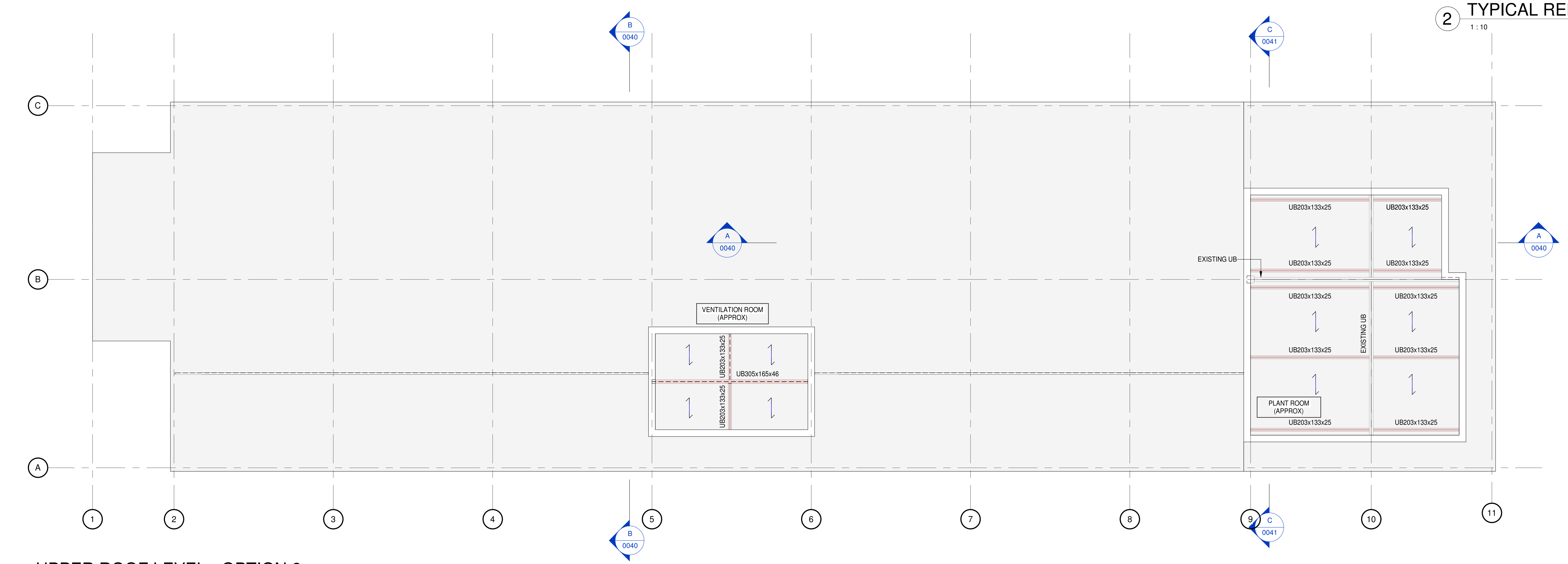
1 : 100

DENOTES DIRECTION OF SPAN OF TATA D100 1.2g ROOF DEK TO U/S EXISTING ROOF SLAB, ON LEDGER ANGLES TO NEW STEEL BEAMS.



2 TYPICAL REMEDIAL BEAM DETAIL - OPTION 2

1 : 10



UR UPPER ROOF LEVEL - OPTION 2

1 : 100

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NEW ROOF: OPTION 2 - PROPOSED SEQUENCE OF WORKS

1. Install temporary roof enclosure over the section of roof typically the structural bay that is being worked on. This is to prevent rainfall entering the worked-on section of the roof.

2. Install sufficient debris/fall protection to the underside of the roof.

3. Remove waterproofing and any finishes to the existing RAAC plank to expose the planks bearings on the existing steelwork beams.

4. Assume there is insitu concrete in the joint between adjacent RAAC plank bearings at the steel beam locations. The insitu concrete at the joint is to be saw cut prior to lifting the RAAC plank to ensure that the adjacent plank is not damaged during the lifting of the RAAC plank.

5. Remove RAAC plank

6. Immediately replace section of roof with the removed plank with Tata D100 deck.

7. Repeat steps 1 to 6

8. When an appropriate area of roof has been replaced the insulation and finishes above the D100 roof deck are to be constructed.

9. Remove temporary roof enclosure

REV	AMENDMENT	BY / CHK'D	DATE
T02	AMENDMENTS AS CLOUDED FOLLOWING ADDITIONAL SITE VISIT	JS / NT	14:09:21
T01	ADDITIONAL OPTION	JS / BoR	16:08:21
T00	TENDER ISSUE	JS / BoR	03:08:21

PROJECT EXECUTION CLASS: N/A

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COUCH
Consulting Engineers
Civil & Structural

The Old Forge, Priory, London Road, Canwell, Sutton Coldfield. B75 5SH
Tel: 0121 308 7557
info@cceng.co.uk

14-16 St. Nicholas, Church Street, Warwick. CV34 4JD
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Tel: 01782 366 160
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PROJECT

PRE-OP, A BLOCK

DRAWING TITLE

ROOF LEVEL GA - OPTION 2

SHEET SIZE	SCALE	DATE	DRAWN	CHECKED	STATUS
A1	As indicated	08/16/21	BoR	JS	

CCE PROJECT No.	DRAWING No.	REV
C7993	7993-CCE-XX-RF-DR-S-0031	T02

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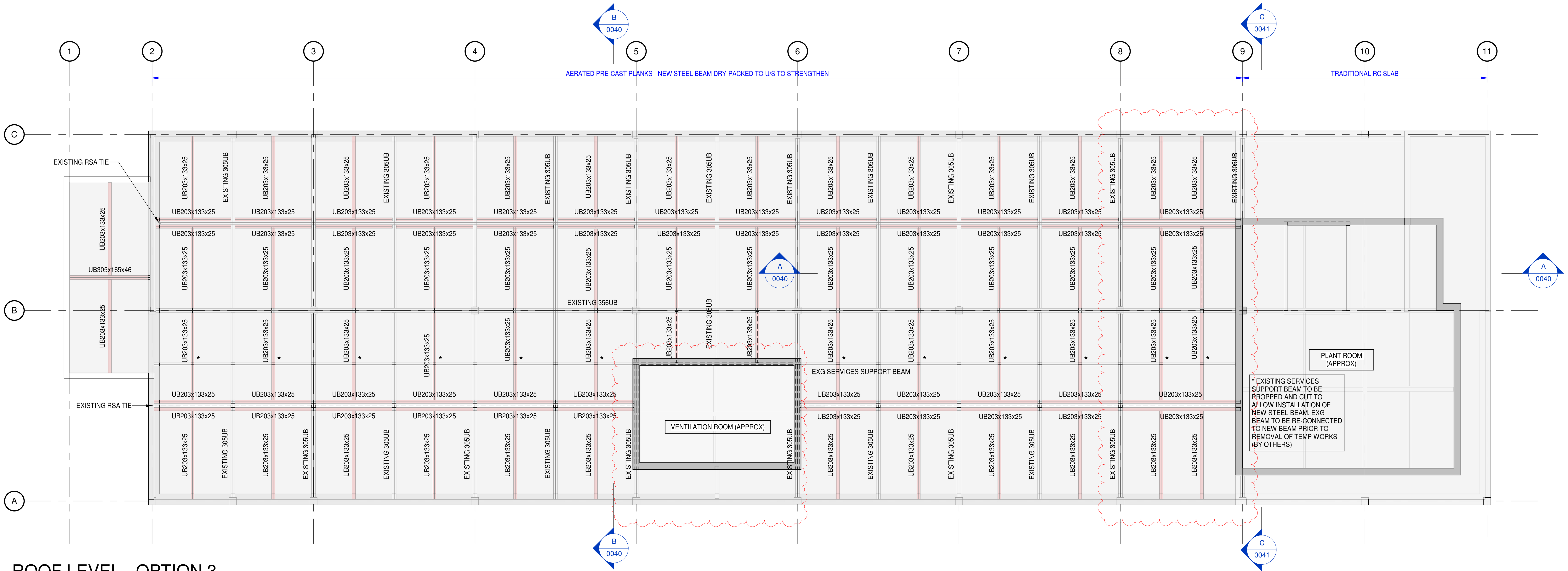
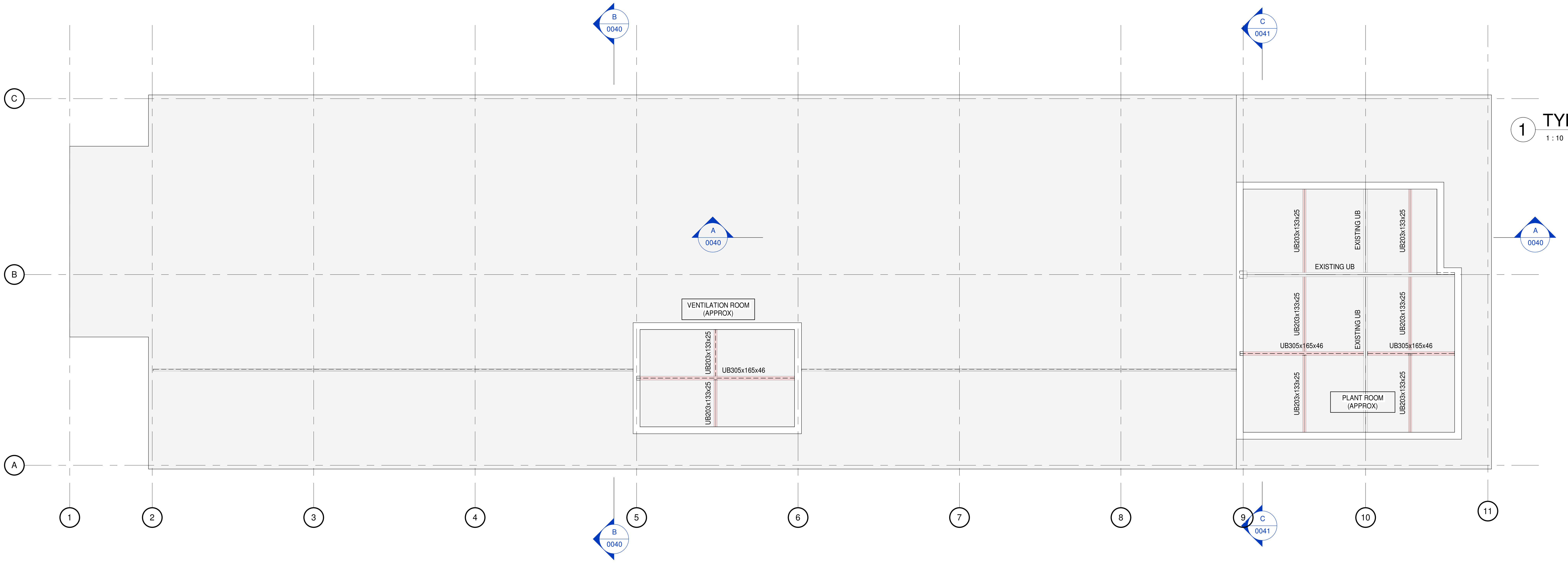


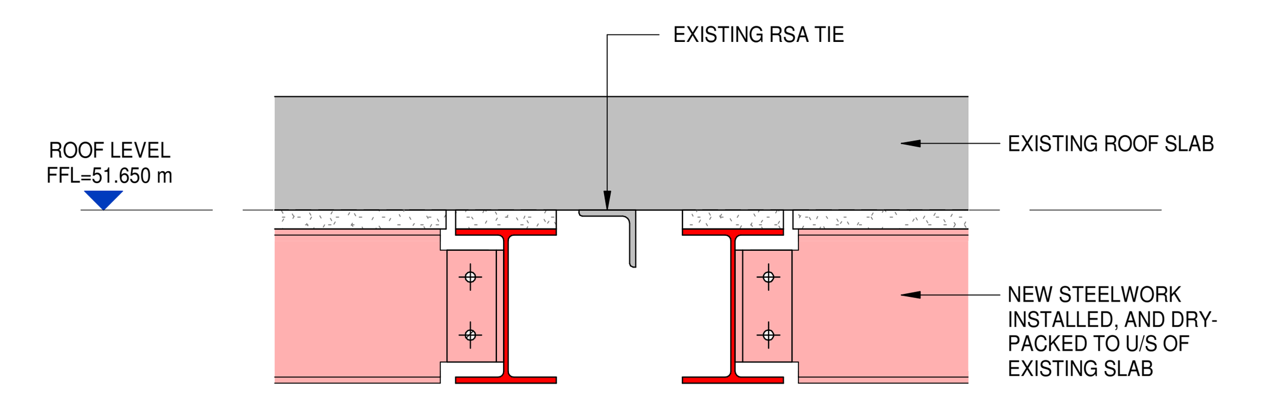
RF ROOF LEVEL - OPTION 3

1 : 100



UR UPPER ROOF LEVEL - OPTION 3

1 : 100



1 TYPICAL REMEDIAL BEAM DETAIL - OPTION 3

1 : 10

General Notes

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Steelwork Notes

1. Set out and erection of steelwork frame to be to BS.5950:Part 2. Provide all temporary erection bracing necessary to ensure stability during erection

2. The Contractor will be responsible for accurately positioning, leveling and plumbing all steelwork in accordance with the drawings. All stanchion bases, beam and girder bearings etc. are to be securely supported on suitable steel packs.

3. The structural steelwork has been designed to BS.5950 where applicable.

4. Steel grades BS EN 10025 - S355.

5. Design and detailing of connections to be by specialist contractor in accordance with BS.5950. Bolts to be grade 8.8 with a minimum diameter of 16mm and at least two bolts per connection. Welds to be a minimum of 6mm fillet.

6. Connections are to be designed for loadings provided by structural engineer, including those to resist disproportionate collapse for type 2B building in accordance with section A3 of Building Regulations Approved Document A and section 1.2.5 of BS.5950-1:2000.

7. Debris and moisture to be removed from hollow sections prior to sealing ends and openings.

8. Steelwork generally to be blast cleaned to BS EN ISO 8501-1, preparation grade Sa21/2 and shop primed with a high build zinc phosphate primer to a minimum dry film thickness of 80 micrometers.

9. If intumescent coating is required to fire protect steelwork ensure compatibility with primer or galvanised steelwork.

REV	AMENDMENT	BY / CHK'D	DATE
T01	AMENDMENTS AS CLOUDED FOLLOWING ADDITIONAL SITE VISIT	JS / NT	14:09:21
T00	TENDER ISSUE	JS / BoR	16:08:21

CE PROJECT EXECUTION CLASS: N/A

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COUCH Consulting Engineers
Civil & Structural

The Old Forge, Priory, London Road, Canwell, Sutton Coldfield. B75 5SH ☒
Tel: 0121 308 7557
info@cceng.co.uk

14-16 St. Nicholas, Church Street, Warwick. CV34 4JD ☐
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PROJECT

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DRAWING TITLE

ROOF LEVEL GA - OPTION 3

SHEET SIZE	SCALE	DATE	DRAWN	CHECKED	STATUS
A1	As indicated	06/29/21	BoR	GH	

CCE PROJECT No.	DRAWING No.	REV
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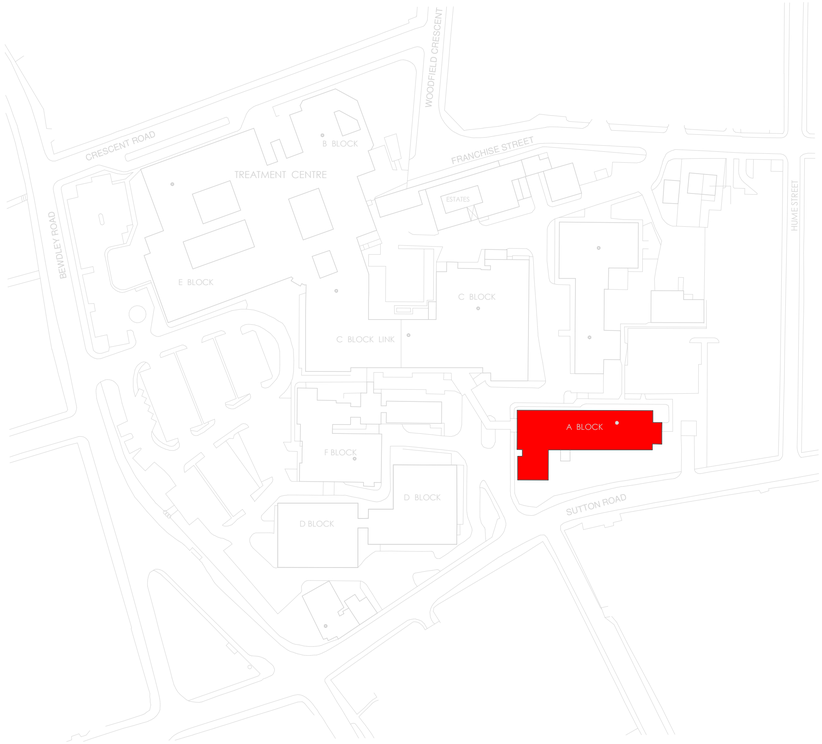


2 SITE PLAN
1 : 1250

1 EXISTING CRACK REPAIR TO 1No. PLANK *PLANK A/6-3*

2 MINOR LOCALISED PITTING TO 2No. PLANKS *PLANKS A/6-6&7*

3 MINOR LONG INDENT TO 1No. PLANK *PLANK B/6-6*

4 MINOR HAIRLINE CRACK IN A SINGLE PLANK (≤ 0.5mm) *PLANK B/5-6*

5 450mm LENGTH OF EXPOSED REINFORCEMENT IN A SINGLE PLANK *PLANK A/5-7*

6 DAMAGE TO SLAB EDGE - POSSIBLY DUE TO ATTEMPTED INSTALLATION OF PLANK *PLANKS A/4-8&9*

7 MINOR DAMAGE TO PLANK BEARING *PLANK B/5-7*

8 MINOR DAMAGE TO SOFFIT *PLANK A/1-7*

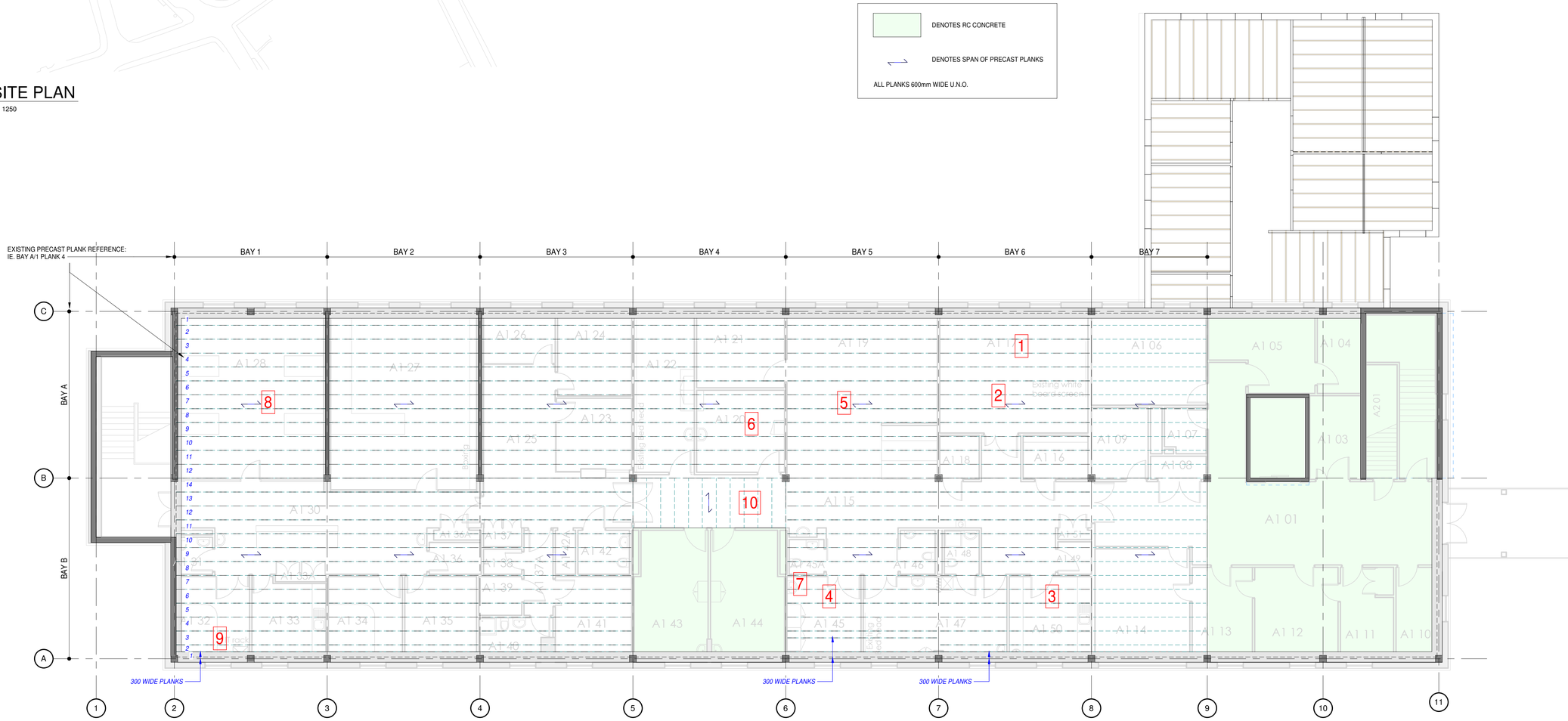
9 LONG HAIRLINE CRACK (≤ 0.5mm) *PLANK B/1-3*

10 SMALL NUMBER OF EXISTING PATCH REPAIRS AROUND EXISTING FIXINGS *3RD PLANK FROM GRID 6*

DENOTES RC CONCRETE

DENOTES SPAN OF PRECAST PLANKS

ALL PLANKS 600mm WIDE U.N.O.



REV	AMENDMENT	BY CHK'D	DATE

CE

PROJECT EXECUTION CLASS: N/A

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INFORMATION

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Consulting Engineers
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The Old Forge, Priory, London Road, Canwell, Sutton Coldfield. B75 5SH
Tel: 0121 308 7557
info@cceng.co.uk

14-16 St. Nicholas, Church Street, Warwick. CV34 4JD
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PROJECT
PRE-OP, A BLOCK

DRAWING TITLE
VISUAL INSPECTION OF ROOF RAAC PLANK SOFFIT

SHEET SIZE	SCALE	DATE	DRAWN	CHECKED	STATUS
A1	As indicated	08/20/21	NT	JS	

CCE PROJECT No.	DRAWING No.	REV
C7993	SK01	-

Model Path: P:\7993 - WHTC - A Block\01 - CCE (BIM)\01-WIP\BIM_Models\7993-CCE-XX-ZZ-M3-S-0001.rvt

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1. Existing crack repair

2. Minor localised pitting to soffit

3. Minor long indent to slab soffit

4. Minor hairline crack

5. Exposed length of the exposed reinforcement

6. Damage to slab edge

7. Damage adjacent side bearing

8. Minor damage to soffit

9. Long hairline crack

10. Existing patch repairs