



23 Birkdale Close, Manners Industrial Estate, Ilkeston, DE7 8YA

Tel.: 01332 916137

Email: info@structuralinvestigationservices.co.uk

Web: www.structuralinvestigationservices.co.uk



P1212 Ormond Building, Manchester

Structural Investigation Report

02/04/2022





This report is confidential to the Client. We accept no responsibility whatsoever to third parties to whom this report, or any part of which, is made known. Any such party relies upon the report at their own risk. This report shall not be used for engineering or contractual purposes unless signed by the approved author and the report state is final. This report relates to the elements, or an area inspected or tested as described in the following text and is used as a comparison with other areas at the reader's own risk.

Client:	RSK
Project/Structure:	Ormond Building, Manchester - Structural Investigation
Inspection/Survey Completion Date:	02/04/2022
Report Reference:	P1212/Report/001/R1

	<u>Name</u>	<u>Signature</u>	<u>Date</u>
Prepared by:	Stephen Seddon		28/04/2022
Checked and Reviewed by:	Mike Valentine		28/04/2022
Approved by (Client):			

Issue Status:	Final
Purpose of Issue:	For Client

TABLE OF CONTENTS

1	Introduction	4
2	Extent of Investigation	5
2.1	Site Testing	5
2.1.1	Reinforcement Survey	5
2.1.2	Measurement Survey	5
2.1.3	Carbonation Depth Testing	5
2.1.4	Concrete Dust Sampling	5
2.1.5	Concrete Core Drilling.....	5
2.2	Laboratory Testing	5
2.2.1	Chloride Ion Content Analysis	5
2.3	Reinstatement	5
3	Interpretation.....	6
3.1	Carbonation Depth.....	6
3.2	Chloride Ion Content	6
4	Results and Observations.....	7
4.1	Reinforcement Survey	7
4.2	Measurement Survey	7
4.3	Carbonation Depth.....	7
4.4	Chloride Ion Content Analysis.....	7
4.5	Slab Build Up.....	7

1 INTRODUCTION

Engineer(s)/Inspector(s):	Stephen Seddon, Ben Moran
Inspection/Survey Commencement Date:	02/04/2022
Equipment:	PPE, Combi Hammer Drill, Core Drill, Ferroskan, Petrol Generator, Portable Lighting, Light Hand Tools & Camera

Structural Investigation Services Limited were commissioned by RSK to undertake Structural Investigation at Ormond Building, Manchester.

The investigation was required to assess the extent of deterioration to the existing beams within the basement, and provide information pertinent to the surrounding elements, so that a suitable method of repair could be established.

2 EXTENT OF INVESTIGATION

Locations plans showing the approximate test positions are included in Appendix A.

2.1 SITE TESTING

The following works were carried out in locations as directed by the Client's onsite representative. All works were carried out in accordance with SIS' in-house technical procedures and equipment was used in accordance with manufacturer's instructions.

2.1.1 REINFORCEMENT SURVEY

Ferroskan surveys were carried out in 5No. locations to establish the size, depth and spacing of the reinforcement.

2.1.2 MEASUREMENT SURVEY

Concrete was removed around the steel beams in 2No. locations so that measurements of their residual dimensions could be made.

2.1.3 CARBONATION DEPTH TESTING

In-situ carbonation depth testing to determine carbonation ingress from the surface of the concrete was carried out at 5No. locations.

2.1.4 CONCRETE DUST SAMPLING

Concrete dust sampling was carried out at 5No. locations adjacent to each carbonation depth test to provide samples for laboratory chloride ion content analysis. Each sample comprised of 3No. 25mm incremental samples of 05-30mm, 30-55mm, 55-80mm.

2.1.5 CONCRETE CORE DRILLING

Core drilling was undertaken through the full depth of the basement slab in 2No. locations to provide details of slab build up.

2.2 LABORATORY TESTING

All extracted samples were individually labelled and stored for transport to Nicholls Colton Group's (NCG) laboratory for analysis.

Upon receipt of the samples at the laboratory, an entry was made in the Samples Received Record, (S.R.R.), and unique identification numbers allocated.

2.2.1 CHLORIDE ION CONTENT ANALYSIS

Samples for chloride ion content analysis were tested in accordance with in-house method statement MS - CL – Chloride in Hardened concrete by Aquakem.

Samples for alkaline content analysis were tested in accordance with BS 1881: Part 124: 2015 Clause 12.3

2.3 REINSTATEMENT

On completion of the works, sample holes were reinstated using an approved polymer modified cementitious repair mortar.

3 INTERPRETATION

3.1 CARBONATION DEPTH

Carbonation is the reaction of carbon dioxide in the environment with the calcium hydroxide in the cement paste. This reaction produces calcium carbonate and lowers the pH to around 9. At this value the protective oxide layer surrounding the reinforcing steel breaks down and corrosion becomes possible.

The reaction of carbon dioxide and calcium hydroxide only occurs in solution and so in very dry concrete, carbonation will be slow. In saturated concrete, the moisture presents a barrier to the penetration of carbon dioxide and again carbonation will be slow. The most favourable condition for the carbonation reaction is when there is sufficient moisture for the reaction but not enough to act as a barrier. Where the entire concrete cover to steel is carbonated corrosion of the steel is likely to occur in conditions where moisture and oxygen ingress.

In most structures made with good quality concrete, carbonation will take several (or many) years to reach the level of the reinforcement.

3.2 CHLORIDE ION CONTENT

Chloride ions enter concrete through a variety of environmental conditions such exposure to seawater or de-icing salts. In addition, calcium chloride was used as an accelerating admixture in concrete up until the 1970s.

Where chloride ions penetrate to the level of reinforcing steel, the passivating layer is broken down locally and 'pitting corrosion' may occur. With sufficient available moisture and oxygen, corrosion may be rapid and severe, leading to local loss in section.

The depth/concentration profile for chloride, which has penetrated hardened concrete, will show levels decreasing further from the surface. Chlorides present in the fresh concrete will tend to be evenly distributed throughout. The effect of carbonation when present displaces the chloride ahead of the carbonation front and sweeps chloride inward, towards the reinforcement.

The Concrete Society Technical Report No. 32 suggests that the risk of chloride-induced corrosion is significant for levels greater than 0.6% by mass of cement. BS 8500-1:2015, Concrete, section A. 4.2, Table A. 8 limits the chloride ion content from all sources, by mass of cement, to 0.4% for normally reinforced concrete and to 0.1% for prestressed reinforced concrete.

4 RESULTS AND OBSERVATIONS

Photographic records from the investigation are included in Appendix F.

4.1 REINFORCEMENT SURVEY

Ferroskan results including a table of results showing the approximate bar dimensions, depths and spacings are included in Appendix B.

4.2 MEASUREMENT SURVEY

Beam dimensions showing the approximate beam sizes are included in Appendix C.

4.3 CARBONATION DEPTH

Details of the carbonation depths are included in the table below.

Location	Carbonation Depth (mm)	Exceeds Depth of Reinforcement? (Yes/No)
F1	10	N/A
F2	10	N/A
C1	70	Yes
C2	70	Yes

4.4 CHLORIDE ION CONTENT ANALYSIS

Laboratory test certificates indicating the chloride ion contents are included in Appendix D. The highest reading encountered over the test areas was 1.88.% w/w cement on the 1st incremental sample depth on the F2CH-Floor 2-a. This value is considered to be high and indicates a significant risk of corrosion occurring to the underlying reinforcement in this location. The subsequent increments in this area also produced elevated readings. All other floor sample locations returned at least one result above the BS 8500-1:2015 limit of 0.4% w/w cement.

4.5 SLAB BUILD UP

Details of slab build up are included in Appendix E. The ground bearing slab was formed upon saturated/wet very silty, clayey fine-grained sand with occasional sub-angular gravel inclusions. No waterproof membrane/barrier was encountered during the investigation.

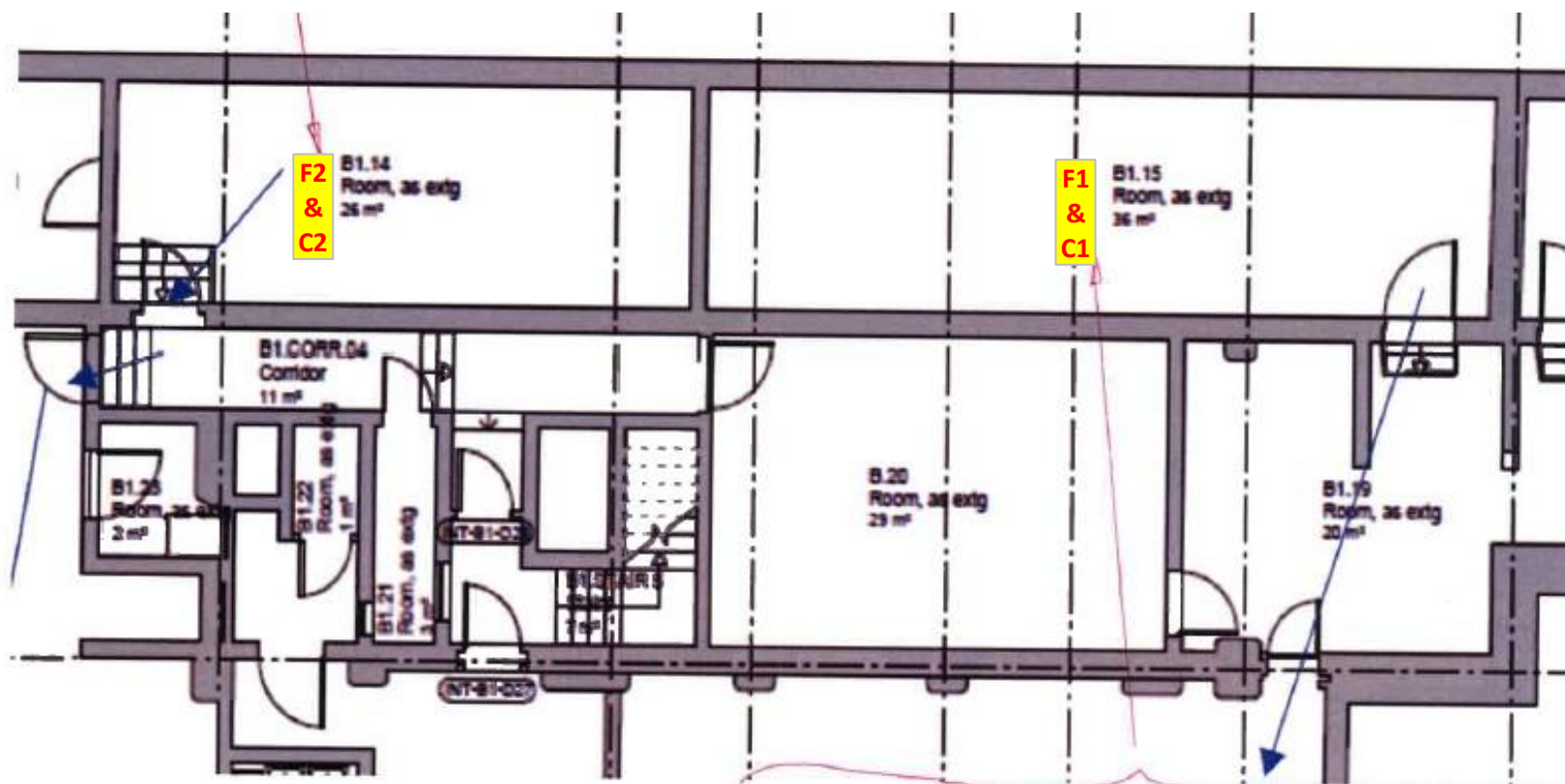
Core 1 was made up of three parts with the first layer being 22mm of screed the second layer being 25mm of concrete with an aggregate size 6mm, and the third layer being 55mm of concrete with an aggregate size of 32mm.

Core 2 was made up of two layers of concrete with the first being 90mm in length with 6mm aggregate and the second layer being 95mm in length with 22mm aggregate.



Appendix A

Location Plan



Key



Test Lotion

Scale: DO NOT SCALE

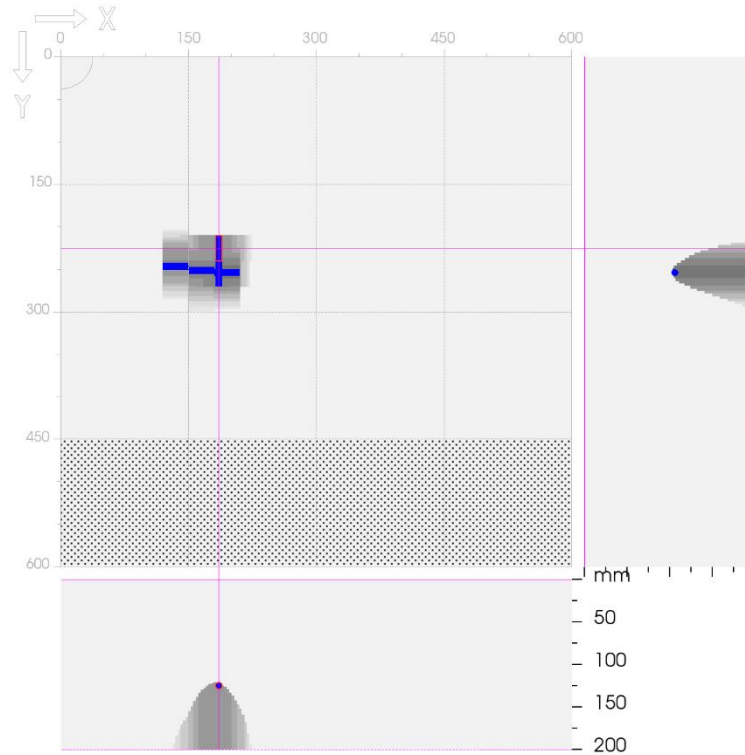
Location Plan	
Project Name	Ormond Building, Manchester
Project No.	P1212
Client	RSK
Survey Date	19/04/2022

Appendix B

Ferrosan Results

.Hilti PROFIS Detection Report

Scan File: Room 2 Top of Basement Slab.fscan
Serial number: 310200011
Date / Time: 2022-04-02 07:24:03
Comment: -

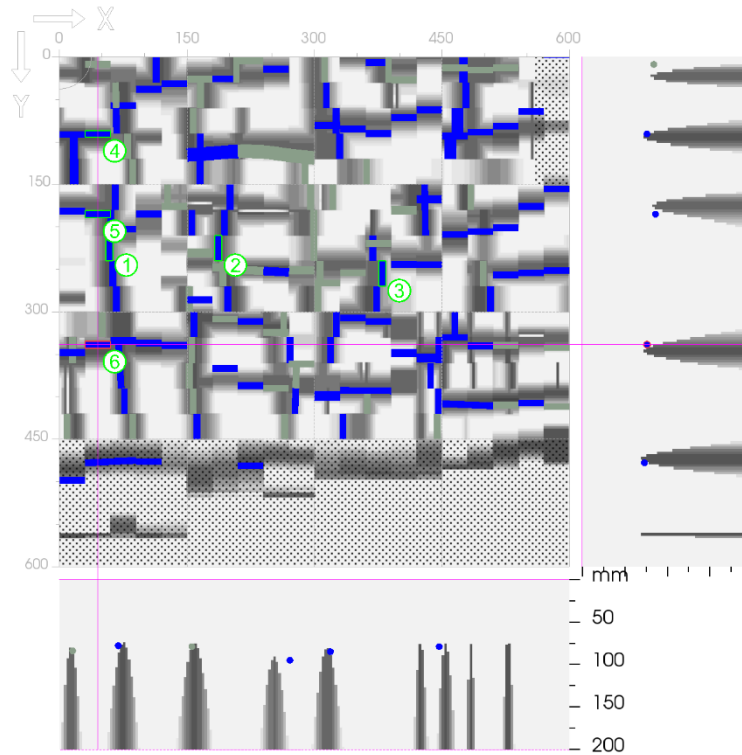


x: 186 mm y: 225 mm z: 0 mm Thickness: 200 mm
Overlay: - mm

Project name:	Manchester University	Customer:	RSK
Location:	Ormond Building	Object:	-
User:	BM / SS		
Comment:	Unable to detect clear reinforcement pattern		
Ø Horizontal:	14 mm +/- 6 mm	Type:	Input
Ø Vertical:	14 mm +/- 6 mm	Type:	Input
Cover Horizontal:	Auto	Cover Vertical:	Auto
Detection mode:	Auto		

.Hilti PROFIS Detection Report

Scan File: Room 2 Soffit of Ground Floor Slab.fscan
 Serial number: 310200011
 Date / Time: 2022-04-02 07:08:08
 Comment: -



x: 45 mm y: 339 mm z: 0 mm Thickness: 200 mm
 Overlay: - mm

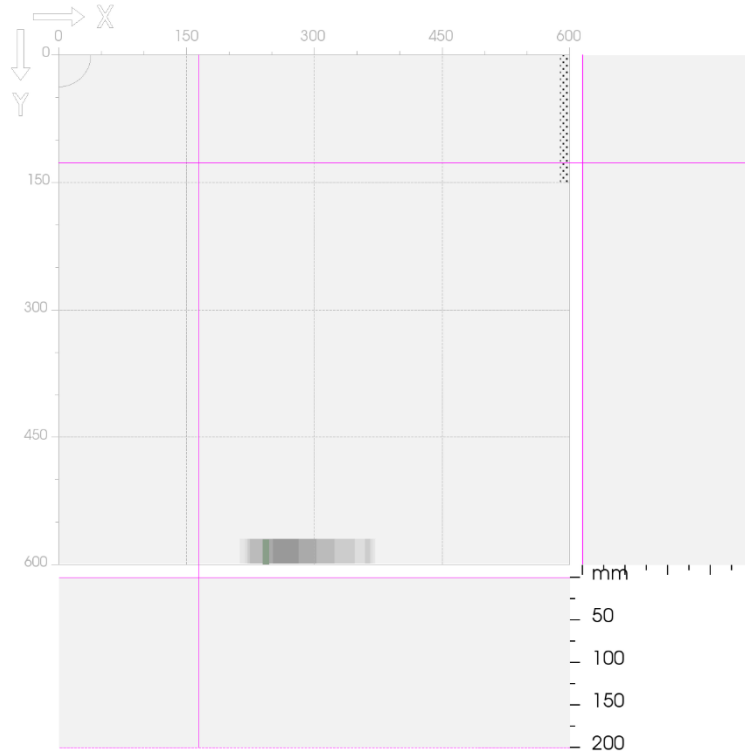
Project name:	Manchester University	Customer:	RSK
Location:	Ormond Building	Object:	-
User:	BM / SS		
Comment:	-		

Ø Horizontal:	14 mm +/- 6 mm	Type:	Input
Ø Vertical:	14 mm +/- 6 mm	Type:	Input
Cover Horizontal:	Auto	Cover Vertical:	Auto
Detection mode:	Auto		

Recorded measurements:	x:	y:	Cover:	Ø:	Orientation:	Quality:
1.	59 mm	225 mm	98 mm	8 mm	Vertical	High
2.	187 mm	225 mm	90 mm	8 mm	Vertical	High
3.	380 mm	255 mm	82 mm	8 mm	Vertical	High
4.	45 mm	90 mm	72 mm	8 mm	Horizontal	High
5.	45 mm	185 mm	82 mm	8 mm	Horizontal	High
6.	45 mm	339 mm	72 mm	8 mm	Horizontal	High

.Hilti PROFIS Detection Report

Scan File: Room 1 Top of Basement Slab.fscan
Serial number: 310200011
Date / Time: 2022-04-02 07:15:37
Comment: -

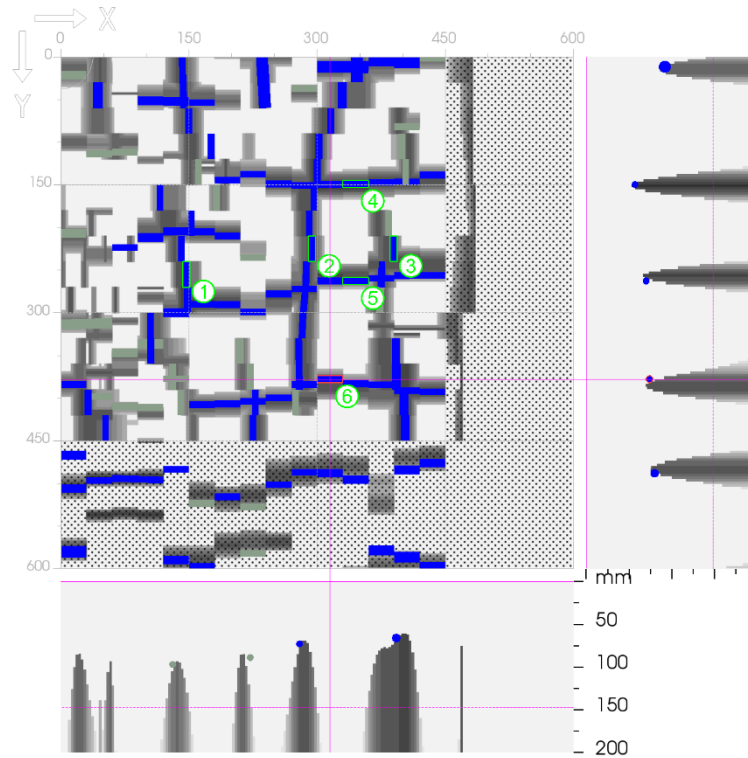


x: 164 mm y: 127 mm z: 0 mm Thickness: 200 mm
Overlay: - mm

Project name:	Manchester University	Customer:	RSK
Location:	Ormond Building	Object:	-
User:	BM / SS		
Comment:	Unable to detect clear reinforcement pattern		
Ø Horizontal:	14 mm +/- 6 mm	Type:	Input
Ø Vertical:	14 mm +/- 6 mm	Type:	Input
Cover Horizontal:	Auto	Cover Vertical:	Auto
Detection mode:	Auto		

.Hilti PROFIS Detection Report

Scan File: Room 1 Soffit of Ground Floor Slab.fscan
Serial number: 310200011
Date / Time: 2022-04-02 06:48:29
Comment: -



x: 315 mm y: 378 mm z: 0 mm Thickness: 148 mm
Overlay: 0 mm

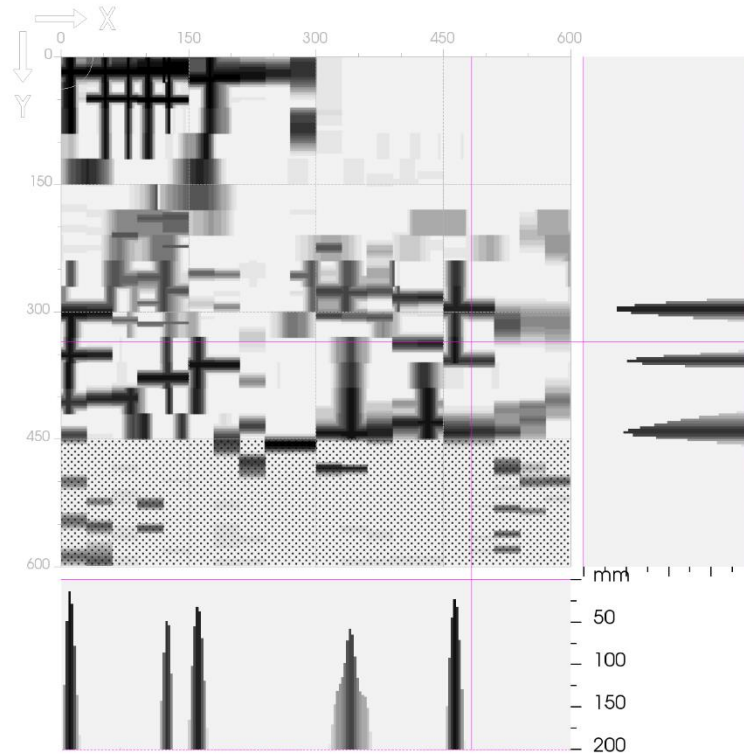
Project name:	Manchester University	Customer:	RSK
Location:	Ormond Building	Object:	-
User:	BM / SS		
Comment:	Reinforcement Grid 150 x 150		

Ø Horizontal:	14 mm +/- 6 mm	Type:	Input
Ø Vertical:	14 mm +/- 6 mm	Type:	Input
Cover Horizontal:	Auto	Cover Vertical:	Auto
Detection mode:	Auto		

Recorded measurements:	x:	y:	Cover:	Ø:	Orientation:	Quality:
1.	147 mm	255 mm	67 mm	8 mm	Vertical	High
2.	294 mm	225 mm	75 mm	8 mm	Vertical	High
3.	390 mm	225 mm	75 mm	8 mm	Vertical	High
4.	345 mm	149 mm	59 mm	8 mm	Horizontal	High
5.	345 mm	263 mm	71 mm	8 mm	Horizontal	High
6.	315 mm	378 mm	70 mm	8 mm	Horizontal	High

.Hilti PROFIS Detection Report

Scan File: Room 2 Top of Plinth.fscan
Serial number: 310200011
Date / Time: 2022-04-02 07:26:55
Comment: -



x: 483 mm
Overlay: - mm

y: 335 mm

z: 0 mm

Thickness: 200 mm

Project name:	Manchester University	Customer:	RSK
Location:	Ormond Building	Object:	-
User:	BM / SS		
Comment:	Unable to detect clear reinforcement pattern		

Depth: -

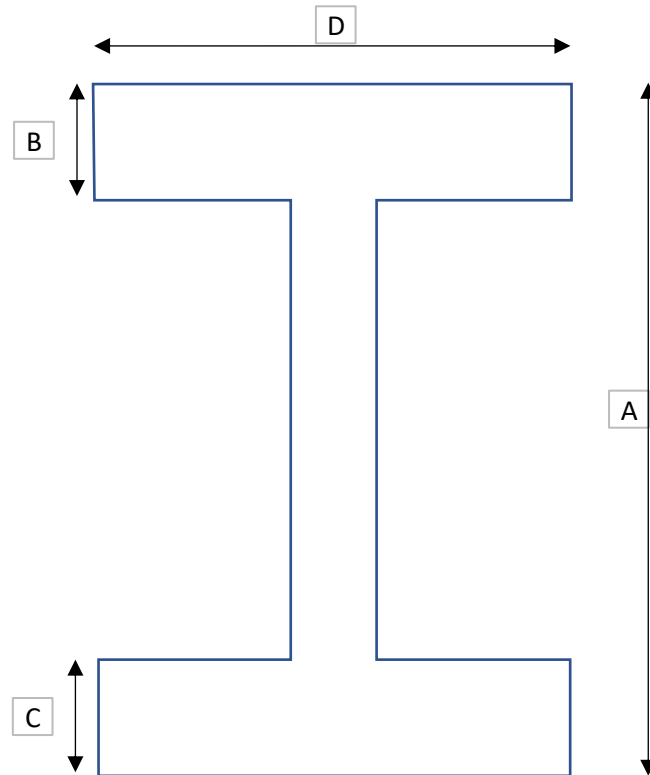
Appendix C

Measurement Survey

Beam Dimensions

Project Name	Ormond Building, Manchester	Project No.	P1212
Client	RSK	Survey Date	02/04/2022

Beam D1



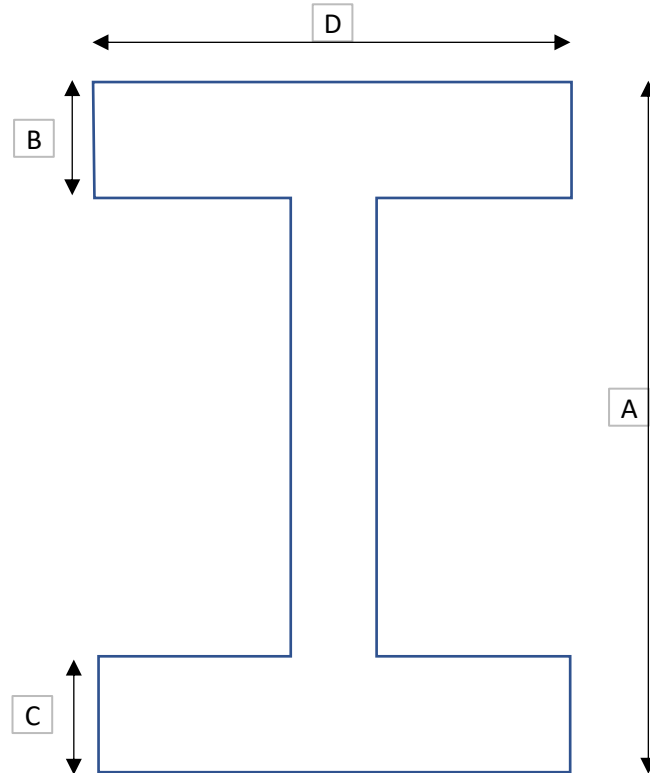
Pre Corrosion Removal		
Reference	Element	mm
A	Beam Depth	140.25
B	Top Flange	23.94
C	Bottom Flange	17.68
D	Flange Width	118.90

Post Corrosion Removal		
Reference	Element	mm
A	Beam Depth	125.89
B	Top Flange	6.98
C	Bottom Flange	14.38
D	Flange Width	117.77

Beam Dimensions

Project Name	Ormond Building, Manchester	Project No.	P1212
Client	RSK	Survey Date	02/04/2022

Beam D2



Pre Corrosion Removal		
Reference	Element	mm
A	Beam Depth	127.96
B	Top Flange	10.96
C	Bottom Flange	12.32
D	Flange Width	115.30

Post Corrosion Removal		
Reference	Element	mm
A	Beam Depth	127.18
B	Top Flange	10.39
C	Bottom Flange	11.22
D	Flange Width	115.30

Appendix D

Laboratory Results



Nicholls Colton Group
7 - 11 Harding Street
Leicester
LE1 4DH

Structural Investigation Services Ltd
23 Birkdale Close
Manners Industrial Estate
Ilkeston
DE7 8YA

Analytical Test Report: L22/01834/SIS - 22-25461

Your Project Reference:	P1212 Ormond Building Manchester		
Your Order Number:	386	Testing Received / Instructed:	05/04/2022 / 05/04/2022
Report Issue Number:	1	Sample Tested:	05/04 to 14/04/2022
Samples Analysed:	15 dust samples	Report issued:	20/04/2022

Signed

James Gane
Analytical Services Manager
Nicholls Colton Group

Notes:

Samples will be retained for 14 days after issue of this report unless otherwise requested.

The results included within the report are representative of the samples submitted for analysis.

A certificate of sampling was not supplied

Samples were supplied by customer, results apply to the samples as received.

Within the report any information provided by the client is identified with a '#'

Where specification limits are included these are for guidance only. Where a measured value has been highlighted this is not implying acceptance or failure and certainty of measurement values have not been taken into account.

Uncertainty of measurement values are available on request.

Accreditation Key

UKAS = UKAS Accreditation, u = Unaccredited

Date of Issue 10/12/2020

Owned by Emily Blissett - Commercial Reporting Supervisor

Authorised by Lee Harbottle - GCM Operations Manager

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Nicholls Colton Group
7 - 11 Harding Street
Leicester
LE1 4DH

L22/01834/SIS - 22-25461

Project Reference - P1212 Ormond Building Manchester

Analytical Test Results - Chloride Ion Content of Hardened Concrete

NC Reference	Client Sample Reference	Client Sample Location	Client Sample Location	Sample Depth (top) (mm)	Sample Depth (Bottom) (mm)	Sample Matrix / Type	Cement content used for calculation (%)	Chloride Ion by mass of Sample (%)	Chloride Ion by mass of Cement (%)
228729	F1CH-C122 M-a	-	-	5	30	Dust	14.0	0.048	0.35
228730	F1CH-C122 Mtb	-	-	30	55	Dust	14.0	0.020	0.14
228731	F1CH-C122 Mtc	-	-	55	80	Dust	14.0	0.027	0.19
228732	F2CH-Floor 2 - a	-	-	5	30	Dust	14.0	0.263	1.88
228733	F2CH-Floor 2 - b	-	-	30	55	Dust	14.0	0.141	1.01
228734	F2CH-Floor 2 - c	-	-	55	80	Dust	14.0	0.118	0.85
228735	F2CH- Plinth - a	-	-	5	30	Dust	14.0	0.078	0.55
228736	F2CH- Plinth - b	-	-	30	55	Dust	14.0	0.072	0.52
228737	F2CH- Plinth - c	-	-	55	80	Dust	14.0	0.053	0.38
228738	C1CH-C122 M-a	-	-	5	30	Dust	14.0	0.042	0.30
228739	C1CH-C122 Mtb	-	-	30	55	Dust	14.0	0.026	0.18
228740	C1CH-C122 Mtc	-	-	55	80	Dust	14.0	0.022	0.16
228741	C2CH-Soffit 2 - a	-	-	5	30	Dust	14.0	0.151	1.08
228742	C2CH-Soffit 2 - b	-	-	30	55	Dust	14.0	0.029	0.21
228743	C2CH-Soffit 2 - c	-	-	55	80	Dust	14.0	0.031	0.22

L22/01834/SIS - 22-25461

Project Reference - P1212 Ormond Building Manchester

Analysis Methodologies

Test Title	Details and Test method used
Acid Soluble Chloride in Concrete	1. Testing was in accordance with in house method statement MS - CL – Chloride in Hardened concrete by Aquakem.

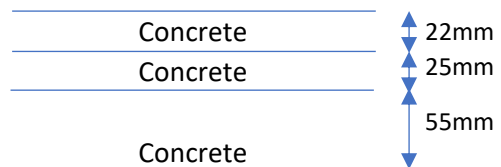
by Aquakem

Appendix E

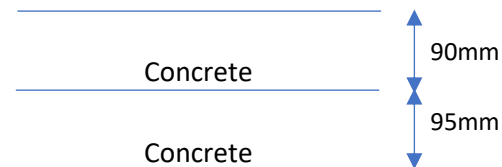
Slab Build Up

Slab Build Up

F1



F2



Layer 1 poorly compacted
10mm void below slab

Slab Build Up	
Project Name	Ormond Building, Manchester
Project No.	P1212
Client	RSK
Survey Date	02/04/22

Scale: DO NOT SCALE

Appendix F

Photographic Records

Photographic Records

Project Name	Ormond Building, Manchester	Project No.	P1212
Client	RSK	Survey Date	02/04/2022

Photo Ref.	1	
Location	D1	
Description	D1 Pre Corrosion Removal	

Photo Ref.	2	
Location	D1	
Description	Post Corrosion Removal	

Photo Ref.	3	
Location	F1	
Dimensions (mm)	L 102	
Description	Extracted Core	

Photographic Records

Project Name	Ormond Building, Manchester	Project No.	P1212
Client	RSK	Survey Date	02/04/2022

Photo Ref. 4

Location D2

Description Pre Corrosion Removal



Photo Ref. 5

Location D2

Description Post Corrosion Removal



Photo Ref. 6

Location F2

Dimensions (mm) L 185/195

Description Extracted Core

