London Borough of Hammersmith & Fulham

Hartopp Point & Lannoy Point

Structural Assessment

Issue 1 | 12 February 2019

Job number 259559-00

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ARUP

Contents

1 Executive Summary

Arup has been appointed by the London Borough of Hammersmith & Fulham (LBHF) to undertake a structural assessment of Hartopp and Lannoy Points.

The concrete has been locally broken out in nine flats across the two buildings to understand their construction and condition. Previous investigations were undertaken in a further three flats and the common parts by LBHF Building Control.

The main findings of the investigations and structural assessment are as follows:

- The buildings do not comply with the recommendations for the prevention of “disproportionate collapse” in the 2012 guidance produced by the Building Research Establishment (BRE) and the Ministry of Housing, Communities & Local Government [2]. This means that an accidental extreme event such as a gas explosion or vehicle impact could lead to the collapse of a disproportionately large part of the building (other examples of extreme events are given in Section 7.1).
- Wind loads are now known to be higher than are likely to have been assumed at the time of construction. The superstructure is adequate, but the strength of the foundations is unknown; there is particular uncertainty over the strength of the foundations to Lannoy Point because it is on piled foundations.

In view of this, it is recommended that the buildings are either demolished or strengthened as soon as reasonably practicable. Until then, the existing ban on the use of bottled gas (including oxygen cylinders) should be strictly enforced. There should also be a ban on any structural modifications, excessive loads on floors, or nearby deep excavations. If the buildings are retained and strengthened, some other minor repairs are also recommended as discussed Section 7.3.

2 Introduction and Brief

This report describes the structural assessments of Hartopp and Lannoy Points undertaken by Arup on behalf of LBHF.

Hartopp and Lannoy Points are 14-storey precast concrete Large Panel System (LPS) tower blocks. They were built for the Greater London Council (GLC) by Taylor Woodrow-Anglian (TWA), and are believed to have been completed by 1968 although the exact dates of construction are not known. It is believed that the gas supply was removed and strengthening works were undertaken following the Ronan Point collapse in 1968. Some of the strengthening works are visible, although full details are not known, and no original drawings are available because records were lost when the GLC was disbanded.

Arup has been asked to undertake the following:

- Review of the investigations undertaken by LBHF Building Control in three flats and in the common parts;
- Investigations in a further nine flats to confirm the construction and condition of the buildings, including any evidence of poor workmanship or deterioration. This included breaking out the concrete to understand the structural details and the condition of the concrete and the embedded steel reinforcement.
- Assess the resistance against disproportionate collapse, based on guidance in the 2012 handbook produced by the BRE and the Ministry of Housing, Communities & Local Government [2];
- Assess the resistance against wind loading, based on the latest wind loads in BS EN 1991 [10, 11, 12];
- Assessment of the condition of the structure based on guidance in the 2012 handbook produced by the BRE and the Ministry of Housing, Communities & Local Government [2];
- High level review the strengthening measures against disproportionate collapse proposed by LBHF Building Control in their report dated 8th October 2018 [16].

Arup has not reviewed any aspects of the buildings other than the matters described above. In particular Arup has not reviewed either building services or fire safety. It is understood that LBHF has appointed a fire specialist to assess the fire safety of the building. Arup has only seen the indicative drawings for the strengthening measures recommended by LBHF Building Control, and no calculations were made available, and so no calculations were carried out by Arup while reviewing them.

3 The Buildings

3.1 Description of the buildings

Hartopp Point and Lannoy Point are both 14 storeys high, with a floor to floor height of approximately 2.7m (Figure 1). Each has a ‘H-shaped’ floorplan, with two pairs of flats on each floor separated by a lift and stair core at the centre.

There are one and three bedroom flats up to level four, above which there are two bedroom flats. Floorplans vary slightly between one, two and three bedroom flats, as shown in Figure 2.

Figure 1 - Hartopp Point and Lannoy Point.

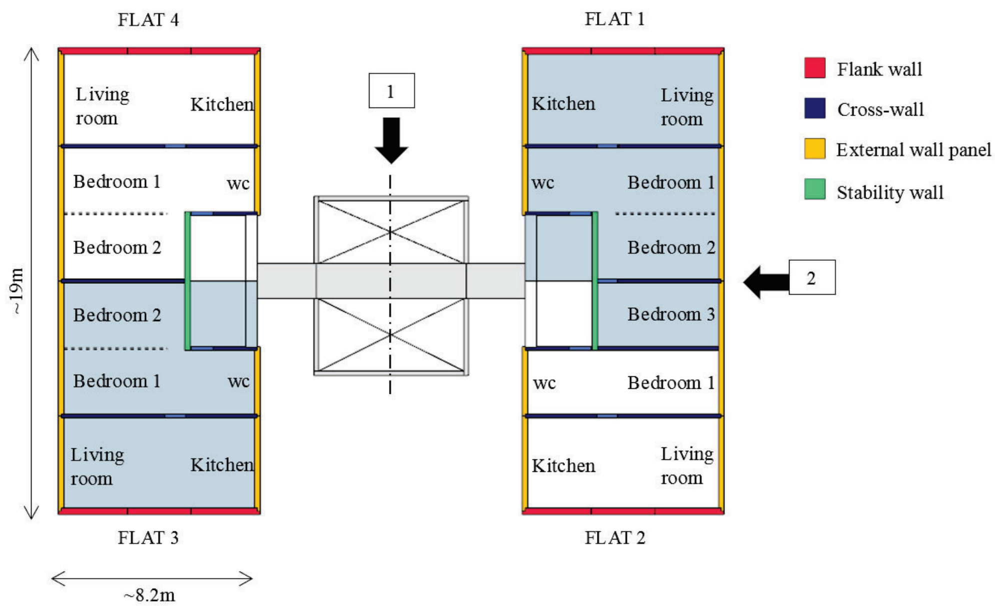

Figure 2 - Approximate floorplan of each block. For illustrative purposes a one and three bedroom flat layout is shown on the same floor as a two bedroom flat layout.

3.1.1 Structural form

Residential blocks

The tower blocks were constructed using a precast concrete Large Panel System (LPS), where the panels were built in factories and assembled on site. The floor slabs generally span one-way onto the internal cross-walls and the outer flank walls, except for the slabs adjacent to the stability wall, which also bear onto this wall.

The external wall panels are supported by the cross-walls.

The approximate floor plan of one residential block can be seen in Figure 3. Floor slab panels are coloured according to their span length.

There are additional thin concrete partitions supported by the floor slabs at each level which are not considered to be part of the main building structure and have been omitted in Figure 3.

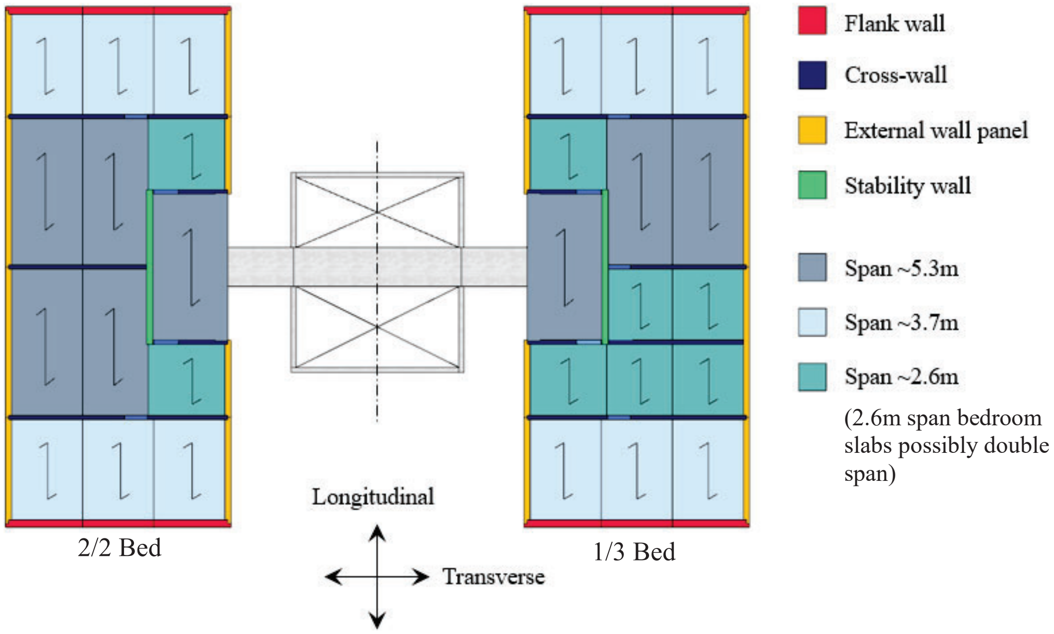

Figure 3 - Approximate floorplan of each block, illustrating the clear span dimensions. Again, for illustrative purposes, a one and three bedroom flat layout is shown on the same floor as a two bedroom flat layout.

Lift and stair core

The lift/stair core is comprised of three different wall panel types, which are stacked upon each other and bolted together at the corners (see Figure 4). All these wall panels are approximately 185mm thick and 2700mm high.

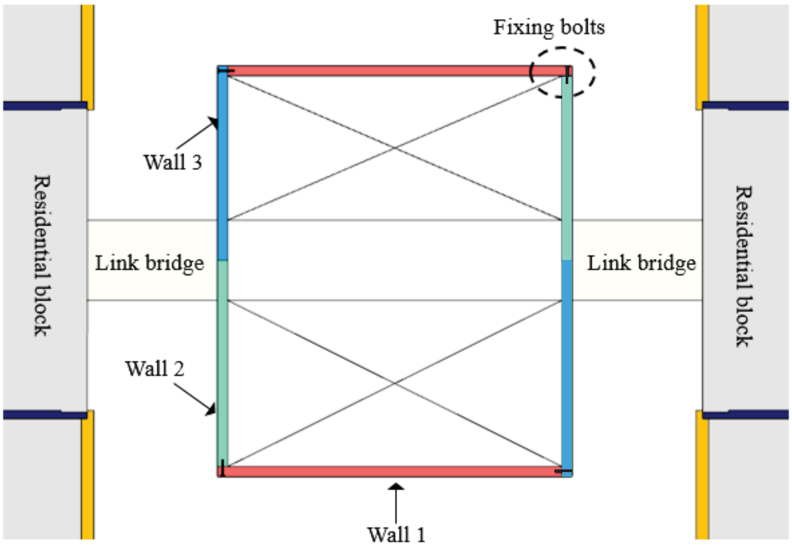

Figure 4 - Lift/stair core comprised of three different wall panel types, bolted together at the corners.

Wall types 2 and 3 are connected at the centre of the link bridge via a reinforced concrete coupling beam. The coupling beam extends from the wall panels on either side to form a bearing joint at the centre (see Figure 5).

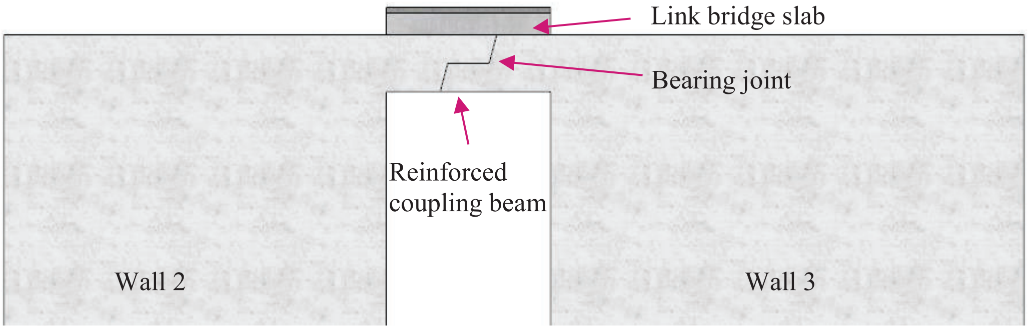

Figure 5 - The lift and stair core walls are connected via a coupling beam with a bearing joint at the centre.

3.1.2 Foundations

Based on information in the London Metropolitan Archives [17], it is known that Lannoy Point is on pile and beam foundations and that Hartopp Point is on a raft foundation.

3.2 History of Hartopp & Lannoy Points, and LPS buildings in general

Hartopp & Lannoy Point

Hartopp & Lannoy Point are located on the Aintree Estate. They were originally commissioned by the Greater London Council (GLC) in the 1960s, with ownership transferred to LBHF in the 1980s when the GLC was disbanded. Unfortunately, the original records of the buildings were lost during this transition process.

The buildings were built by Taylor Woodrow-Anglian (TWA) in about 1968. The exact dates of construction are not known. The TWA Large Panel System used is also known as the Larsen-Nielsen design.

The following sources have been searched for any information related to Hartopp & Lannoy Points:

- LBHF's archives;
- The London Metropolitan archives;
- The BRE archives;
- Taylor Woodrow's archives.

The only records found were a reference (dated 8th Jan 1968) in the London Metropolitan archives to the foundations to Lannoy Point having been changed from a raft to piles [17].

Ronan Point partially collapses

In May 1968, the Ronan Point tower block, also built by Taylor Woodrow-Anglian, suffered a partial collapse as a result of a gas explosion. The damage caused by the gas explosion was considered to be more extensive (i.e. caused more parts of the building structure to collapse) than should have occurred following an event of that magnitude. In response the Ministry of Housing and Local Government issued Circulars 62/68 [4] and 71/68 [5], which effectively acted as retrospective legislation.

Circular 62/68 issued

Circular 62/68 [4] required that all LPS blocks over six storeys in height should be appraised by a structural engineer and their ability to withstand a force equivalent to a static pressure of 34kPa without incurring disproportionate collapse be assessed. If this requirement was not met, the blocks were to be strengthened or gas removed. Additionally, all new LPS blocks were to be built to these same standards.

Circular 62/68 also stated that the current wind code (CP3 Chapter V 1952) was out-dated and recommended that all LPS blocks over six storeys be assessed in relation to their resistance to wind. It was recommended that until a revised wind code was available, designers should take note of current research papers by the Meterorological Office and the Institution of Civil Engineers [6][7].

It is believed that strengthening measures in the form of structural steel angles were adopted post-construction at Hartopp Point and Lannoy Point in response to Circular 62/68.

Circular 71/68 issued

Circular 71/68 [5] maintained that LPS blocks with piped gas should be assessed against a pressure of 34kPa. However, if the piped gas was removed, this figure could be reduced to 17kPa.

Amendment to the Building Regulations

The minimum requirements for preventing disproportionate collapse in any buildings of five or more storeys were introduced in 1970 in an amendment to the Building Regulations [8]. This is now captured in the current Building Regulations [9] by Requirement A3 in Approved Document A [3] which states:

"The building shall be constructed so that in the event of an accident the building will not suffer collapse to an extent disproportionate to the cause."

While Ronan Point was caused by a gas explosion, the current Building Regulations refer to an 'accident' in general (examples are given in Section 7.1) and therefore always apply, even if there is no gas supply in a building.

Amendment to UK wind codes

CP3: Chapter V: Part 2: 1970 [19] introduced significant changes to the national wind code in the UK, increasing design wind pressures for buildings compared to the previous code (CP3: Chapter V: 1952 [18]). This was updated again in 1972 (CP3: Chapter V: Part 2: 1972 [20]). Current codes of practice for UK building design (BS EN 1991-1-4 [12]) give similar design pressures to CP3: Chapter V: Part 2: 1972.

BRE research on LPS blocks

The BRE published a number of reports following the partial collapse of Ronan Point, including a report in 1985 [1], which specifically reviewed the Taylor Woodrow Anglian form of construction. Hartopp Point and Lannoy Point were referenced in this report, stating that these tower blocks had a similar joint between the slabs and the flank walls to that used at Ronan Point.

It stated: *"the conclusions drawn from the assessment of Ronan Point are likely to apply to some extent to all other TWA buildings and action is desirable to check the extent where that is not known already"*; and

"Most 'Type A' buildings are likely to have acceptable margins of safety in respect of normal loads in the H2 joints of the lower storeys if they are soundly constructed. The H2 joints in buildings of 14 or more storeys should be appraised. Consideration should be given to the appraisal of the H2 joints in other TWA buildings, having regard in particular to their height and plan arrangement."

BRE guidance on assessing LPS blocks

In 2012 BRE published the "Handbook for the structural appraisal of Large Panel System (LPS) dwelling blocks for accidental loads" [2]. This document was written in order to update the Government's 1968 guidance to take into account all of BRE's subsequent research, the general development of assessment methodologies and to align with current structural design codes. The document continues to recommend that LPS blocks with piped gas should be assessed against their ability to withstand a pressure of 34kPa. However, if piped gas is not present, this figure is reduced to 17kPa.

This document is considered the current best practice guidance for the appraisal of LPS buildings.

4 Site investigations

4.1 Scope

Investigations were undertaken to understand the construction and condition of the buildings.

Initial investigations in three flats and also the common parts were undertaken by LBHF Building Control in December 2017. The results are included in LBHF's report [16].

Further investigations were organised by Arup in an additional nine flats (spread between Hartopp and Lannoy), between August and November 2018. These were undertaken by concrete investigation specialists Concrete Repairs Limited (CRL), in the presence of an Arup engineer, and included a sample of one, two and three bedroom flats on various levels of the building.

Arup's investigations were carried out in two stages. Stage 1 looked at general structural details and condition in three flats from each building (six in total) to get a broad overview of the buildings. Extracts from CRL's report can be found in Appendix A showing the types of investigations carried out and the details found. Based on this information, preliminary calculations were carried out to get an initial understanding of the performance of the buildings. These highlighted specific areas of interest which were investigated in a further three flats in Stage 2. CRL's report for this stage of the investigations can be found in Appendix B. During this second stage of investigations, additional strengthening was required in some locations prior to breakouts to ensure that the structure was not weakened, damaged or undermined. Detailed calculations were then undertaken based on the findings, as explained in Sections 5 and 6.

4.2 Construction of the buildings

The relevant findings in relation to the resistance to disproportionate collapse and wind loading are discussed later in this report. Appendices A and B contain extracts from the reports summarising the findings from the investigations.

The Arup findings are similar to those found by LBHF Building Control. However, as more flats have now been vacated, Arup has been able to undertake a wider range of investigations. The construction details and quality of workmanship in the nine flats investigated have been found to be consistent within each building and also between the two buildings.

The buildings' external wall and flank wall panels are made out of a sandwich construction as shown in Figure 6. The outer layer of non-structural concrete is separated from the inner layer of structural concrete by a thin layer of polystyrene insulation. It is suspected that there are ties holding the two layers together, likely stainless steel.

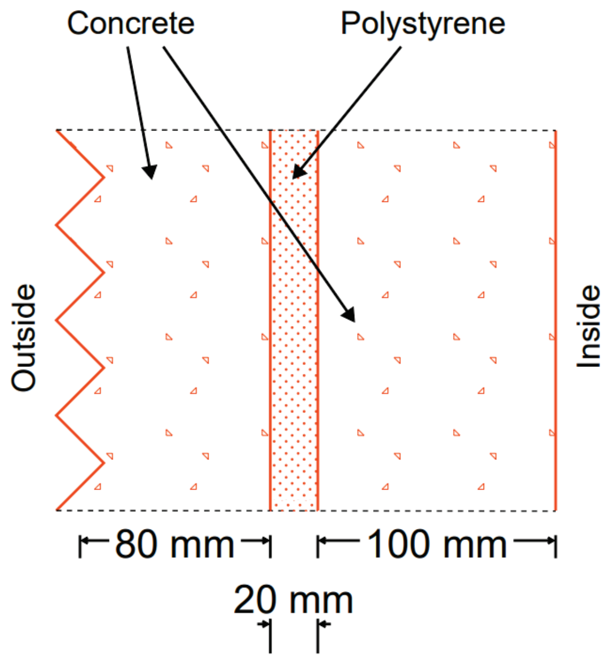

Figure 6 - Sandwich construction of external wall panels, including approximate dimensions.

4.3 Condition of the structure of the buildings

High chloride and carbonation levels in reinforced concrete can lead to the corrosion of the reinforcement, reducing the strength of the structure. Therefore, carbonation and chloride levels in the concrete were tested at several internal locations in the buildings. In all cases, the levels measured were found to be extremely low and not a concern. In addition, all reinforcement exposed during the Arup internal investigation works appeared to be in good condition with no significant corrosion. The LBHF Building Control investigations revealed corroded reinforcement in one flank wall panel in one ground floor flat, but this appears to be a localised issue due to water ingress noted in the vicinity.

Some minor cracking of the landing slabs had occurred on the upper floors. This is likely to be due to either thermal movements or possibly differential settlement. It is not considered to be structurally significant.

It was not possible to locate the ties connecting the leaves of the external wall panels and so it was not possible to inspect their condition. Refer Section 7.3 for more information.

5 Assessment of the resistance of the buildings to "disproportionate collapse"

5.1 Assessment criteria defined by BRE

The BRE document "Handbook for the structural appraisal of Large Panel System (LPS) dwelling blocks for accidental loads" [2] clearly defines three assessment criteria. If the building can be proven to satisfy any one of the three criteria, then it is considered to satisfy requirement A3 of the Building Regulations [9] (which is the requirement to avoid disproportionate collapse) in accordance with Approved Document A [3]. The following is an extract from the BRE assessment guide:

"An LPS dwelling block exceeding four storeys in height (i.e. five storeys or higher) will be considered to satisfy Requirement A3 of the Building Regulations if it meets one of the following criteria:

LPS Criterion 1: There is adequate provision of horizontal and vertical ties to comply with the current requirements for Class 2b buildings as set down in the codes and standards quoted in Approved Document A – Structure as meeting the requirements set down in the Building Regulations.

LPS Criterion 2: An adequate collapse resistance can be demonstrated for the foreseeable accidental loads and actions [which is defined as 34kPa for a block with piped gas or 17kPa for a block without piped gas]

LPS Criterion 3: Alternative paths of support that can be mobilised to carry the load, assuming the removal of a critical section of the load bearing wall in the manner defined for Class 2B buildings in Approved Document A – Structure or alternatively assuming the removal of adjacent floor slabs (taking the floor slabs bearing on one side wall at a time) providing lateral stability to the critical section of the load bearing wall being considered."

5.2 Do Hartopp & Lannoy meet Criterion 1?

LPS Criterion 1 is a prescriptive approach which defines design loads for the horizontal and vertical ties, between the structural elements in the buildings.

The different ties are categorised as follows:

- Internal ties, which connect floor slab units to each other;
- Peripheral ties, which connect floor slab units to each other around the edges of the floor plate;
- Vertical ties, which connect wall units to each other;
- Horizontal ties, which connect floor units to wall units;
- Anchorage, which is also concerned with the connections of floor units to wall units, but for which the design load is less onerous than for horizontal ties.

The ties were investigated in multiple locations across both buildings. Table 1 summarises whether these satisfied the above criteria.

Item	Is LPS Criterion 1 satisfied?	Primary reason for the criteron not being satisfied
Internal ties	No	No reinforcement tying internal floor panels to each other nor to cross-walls. Post-fixed steel angle brackets have insufficient capacity.
Peripheral ties	No	There is no continuous or lapped rebar around the periphery of the floorplate.
Vertical ties	No	There is no rebar connecting the cross-walls to each other nor the external wall panels to each other. Post-fixed steel angle brackets have insufficient capacity.

Table 1 - Assessment against LPS Criterion 1.

5.3 Do Hartopp & Lannoy meet Criterion 2?

In the absence of piped gas, key structural elements must be assessed for a collapse resistance under a pressure of 17kPa.

According to the BRE handbook [2]:

"Collapse resistance is a measure of the ability of a structural system to resist the effects of specified accidental loads or actions occurring at or below a defined threshold.

The overpressure should be applied simultaneously to all surfaces of a single room/bounding enclosure."

The structural assessment against this criterion is concerned with the resistances of the panels themselves against this defined pressure, as well as the connections between the panels. The form and condition of the panels and ties were investigated in multiple locations.

Table 2 summarises whether the structural elements within the buildings and the connections of these elements to each other satisfy these requirements.

Item	Is the LPS Criterion 2 satisfied?	Primary reason for the Criterion not being satisfied
Floor units	No	Insufficient reinforcement in the floor units.
Flank walls	No	Insufficient connection capacity between the flank walls and the floor slabs.
Cross-walls: Level eight upwards	No	No reinforcement in the cross-wall panels, together with lower vertical load from the structure above, means the cross-walls cannot develop sufficient arching resistance.
Cross-walls: party walls from ground to level four	No	Insufficient vertical load from the structure above the cross-walls at the higher levels so arching resistance cannot be developed, and also no reinforcement in the cross-wall panels.
Cross-walls: remainder	Yes	

Table 2 - Assessment against LPS Criterion 2.

5.4 Do Hartopp & Lannoy meet Criterion 3?

The third criterion considers whether or not alternative load paths could be mobilised in the event of removal of individual structural elements.

For the purposes of this assessment, the size of the element being removed is defined as a whole precast unit, or a wall of length 2.25H where H is the storey height, whichever is the smaller. The largest individual precast wall units are the cross-walls adjacent to bedrooms which are approximately 5.4m long.

Owing to the structural arrangement of the building, together with the limited amount of reinforcement which could be included in any justification of alternative load paths, it is not possible to find reliable alternative load paths for the existing floor loads.

5.5 Summary

The buildings have been assessed against the three separate design criteria, applicable to LPS buildings without piped gas.

The assessment shows that there is very little resistance to disproportionate collapse because the building structure does not fully satisfy the requirements in most respects. The building should therefore be strengthened (Section 7.1). Until this is done, mitigation measures should be put in place (Section 7.1).

6 Assessment of the resistance of the buildings to lateral loads including wind

6.1 Applied lateral loads

The buildings need to be able to resist the following lateral loads concurrently:

- Wind pressures acting on the tower blocks, calculated using the current wind code [12]. As noted in Section 3.2, these are higher than the original loads the buildings would have been designed to resist.
- Effective horizontal forces resulting from any lack of verticality of the structure, equal to a small proportion of the weight of the building, as dictated by the current concrete code [13]. A survey to measure the actual lack of verticality has been carried out by Warner Surveys [15].

6.2 Assessment

Based on the information from the intrusive investigations discussed in Section 4, a detailed assessment was carried out to check the buildings' resistances to lateral loading in accordance with modern design codes. In view of the increase in design wind loads since the buildings were built (refer Section 3.2) and the fact that there is only one shear wall in the North-South direction, alternative parallel load paths were considered such as through the external wall panels.

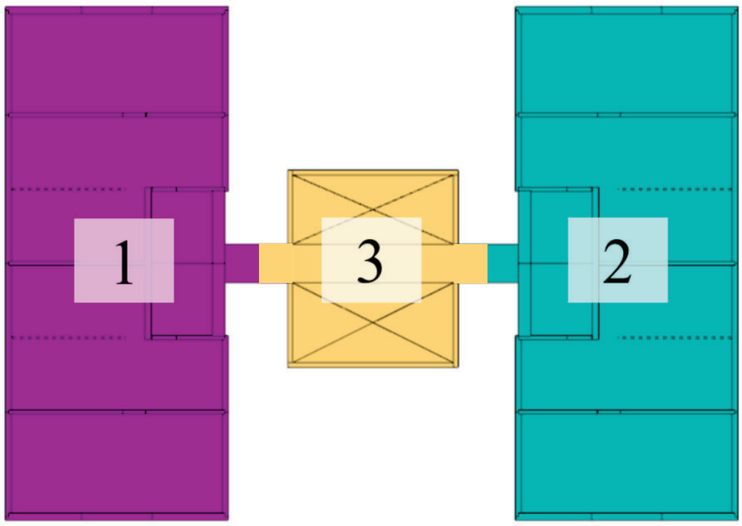

Figure 7 - Each tower block can be considered as three separate buildings; the two residential blocks and the lift/stair core.

6.3 How the buildings resist lateral loads

For the purposes of assessing wind resistance, each building has been taken as three separate structures, as shown in Figure 7.

6.3.1 Lift/stair core

The wind resistance of the lift and stair cores is provided by the outside walls of the lift and stair cores. The wall panels are connected to each other with bolted connections at the four corners and at the beam half-joints above the doors (Figure 5).

These walls and the connections were found to have adequate resistance to wind loads in all directions acting on the core.

6.3.2 Residential blocks

The two most onerous wind load cases on the residential blocks were considered – i.e. wind perpendicular to the faces of each residential block. East-West winds are resisted by the flank walls and cross-walls show on Figure 3. North-South winds are resisted by the stability wall, again shown on Figure 3. The resistance of the stability wall is assisted by the cross-walls which frame into it.

All walls and their connections were found to have adequate resistance to wind loads.

6.3.3 Foundations

No details are known about the foundations, except that Hartopp Point is on a raft foundation and Lannoy Point is on pile and beam foundations. In general, raft foundations are more robust in resisting overturning than pile and beam foundations. The foundations of Lannoy Point are likely to be adequate but this would be very difficult to prove because it is on piled foundations. See recommendations in Section 7.

7 Recommendations

7.1 Strength against disproportionate collapse

In order to meet current codified recommendations and best practice, structural strengthening measures are required to provide the buildings with sufficient resistance against disproportionate collapse.

Arup has reviewed the indicative measures shown in the LBHF report [16]. The measures are adequate for costing purposes only, but it is recommended to add additional angles and column sections to strengthen the ground to fourth floor party walls, and also additional brackets to connect the middle of the longer façade panels to the floor slabs at all levels.

It is recommended that the buildings are strengthened to improve their resistance to disproportionate collapse. Until this is done, it is recommended to undertake the mitigation measures summarised in Table 3.

Hazard	**Mitigation**
Gas explosion	There is no piped gas in the blocks. The existing ban on bottled gas (including oxygen cylinders) should be strictly enforced.
Vehicle impact	There is little risk of high speed vehicle impact because the buildings are sufficiently far away from the road (at least 10m) and are generally protected by embankments. No mitigation required.
Fire	It is understood that LBHF have appointed a fire specialist to address the fire safety of the building.
Hazards due to human errors during design and construction, or due to a lack of proper maintenance	The construction and condition of the blocks has been assessed as part of this report. With the exception of robustness against disproportionate collapse, the design and construction has been found to be satisfactory.
Unauthorised structural modifications	The reinforced concrete structural walls would be very difficult to modify. Nevertheless, a ban on any structural modifications should be strictly enforced.
Environmental hazards such as exceptionally strong winds or heavy snow on the roof	The superstructure has been checked for a wind which might be expected to occur once every 4000 years, and found to be satisfactory.
Hazards due to misuse such as overloading of a floor slab	The slabs will have been designed for residential loads (1.9 kPa). There should be a ban on any excessive loading which should be strictly enforced.
Land slip associated with nearby deep excavations, cuttings or changes in ground level.	There should be a ban on excavations within 5m of the building and more than 2m deep.

Table 3 - Hazards and mitigation measures relating to disproportionate collapse.

7.2 Strength under wind loads

The superstructure of each building meets wind loading requirements as defined by current design codes [10, 11, 12, 13], but the strength of the foundations is unknown; there is particular uncertainty over the strength of the foundations to Lannoy Point because it is on piles. It is therefore recommended that, as soon as reasonably practicable, either the buildings should be demolished or the foundations should be investigated to check their strength under wind loading and strengthened as required. The investigations would be very disruptive and would need the buildings to be vacated for safety reasons. It may be impossible to fully investigate the foundations of Lannoy Point because it is on piles.

7.3 Long term durability of the buildings

If the buildings are to be retained, a maintenance plan which includes proposed future assessment and inspection regimes should be formulated. The BRE outline proposed maintenance measures in their handbook [2].

It is also recommended that wall ties are provided to tie the inner and outer leaves of the external wall panels together. This applies to all of the flank walls and external wall panels on all two tower blocks. While it is believed that stainless steel or galvanized steel wall ties do currently exist [14], inspection to determine the number, location and condition of ties is extremely difficult. Additionally, in their 1985 report on TWA buildings [1], the BRE recommend that additional ties should be provided on the basis that they may have suffered from fatigue, due to the stresses induced by wind and thermal effects and the fact that no amount of sampling can eliminate this risk. The fixing of the external wall panels back to the building should also be improved.

8 References

[1] The structure of Ronan Point and other Taylor Woodrow – Anglian buildings, Building Research Establishment, Department of Environment, 1985

[2] Handbook for the Structural Assessment of Large Panel System (LPS) Dwelling Blocks for Accidental Loading, Stuart Matthews and Barry Reeves, Building Research Establishment, 2012

[3] Approved Document A: Structure, The Building Regulations 2010, Department for Communities and Local Government

[4] Circular 62/68, Ministry of Housing and Local Government, 15 November 1968

[5] Circular 71/68, Ministry of Housing and Local Government, 20 December 1968

[6] C. Scruton and C. W. Newberry, On the estimation of wind loads for building and structural design, Proceedings of the Institute of Civil Engineers, Volume 25, Issue 2, 1963

[7] H.C. Shellard, Extreme wind speeds over the United Kingdom for periods ending in 1963, Meteorological Office Climatological Memorandum No 50

[8] Statutory Instruments 1970 No. 109, Building and Buildings, The Building (Fifth Amendment) Regulations 1970

[9] The Building Regulations 2010, Building and Buildings, England and Wales

[10] Eurocode: Basis of structural design, BS EN 1990:2002+A1:2005

[11] Eurocode 1: Actions on structures – Part 1-1: General actions – Densities, self-weight, imposed loads for buildings, BS EN 1991-1-1:2002

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[13] Eurocode 2: Design of concrete structures – Part 1-1: General rules and rules for buildings, BS EN 1992-1-2004+A1:2014

[14] Larsen and Nielsen system, Architect and Building News, Nov 14 1962

[15] Warner Surveys, G.3 Bedford House, 69-79 Fulham High Street, London, SW6 3JW

[16] Structural Assessment of Hartopp and Lannoy Highrise Buildings Aintree Estate, Stage (II) Report, 2017/01426/design, Oct 08 2018, The Structural Engineers, Building Control, LBHF

[17] Additional Costs – Blocks 1 and 2 and other work, Housing Committee, Report 8 Jan 1986 by the Architect, Metropolitan Archives reference

code GLC/DG/HG/12/001, Greater London Council, Hartopp Avenue Site, Hammersmith,

[18] CP3: Chapter V: 1952, Code of Basic data for the design of buildings, Chapter V. Loading, Reset and reprinted 1965, The Council for Codes of Practice, British Standards Institution

[19] CP3: Chapter V: Part 2: 1970, Code of Basic data for the design of buildings, Chapter V. Loading, Part 2. Wind loads, The Council for Codes of Practice, British Standards Institution

[20] CP3: Chapter V: Part 2: 1972, Code of Basic data for the design of buildings, Chapter V. Loading, Part 2. Wind loads, British Standards Institution

Appendix A

Extracts from Stage 1 Survey Report

(partially reproduced, with permission from CRL)

LIMITED INVESTIGATION WORKS
TO
HARTOPP & LANNOY POINTS
FOR
LONDON BOROUGH OF HAMMERSMITH & FULHAM

CONTRACT DETAILS

Contract No.:	SUR183482
Site:	Hartopp & Lannoy Points Fullham SW6 7NQ
Client:	London Borough of Hammersmith & Fulham 3rd Floor Hammersmith Town Hall Extension King Street Hammersmith London W6 9JU **For the attention of** [redacted]

FOR CRL SURVEYS

Documentation Authored By:	[redacted]		
Report Prepared By:	[redacted]	**Signed:**	[redacted]
Checked / Approved By:	[redacted]	**Signed:**	[redacted]

REPORT DETAILS

		Issue Record	
		Date	**Revision**
This Report Comprises:	11 pages of text Appendix A (98 Pages)	24th September 2018	0

CONTENTS

1 REPORT REVISIONS RECORDS

Revised by	Date	Revision Details

2 INTRODUCTION

2.1 REFERENCES

Arup c/o London Borough of Hammersmith & Fulham email CRL Surveys dated 27th April 2018.

CRL Surveys Quotation Letter Ref: ESUR1833500/SK/sk dated 30th April 2018.

CRL Surveys Revised Quotation Letter Ref: ESUR1833500/01/SK/sk dated 23rd May 2018.

London Borough of Hammersmith & Fulham email to CRL Surveys with instructions to proceed dated 24th May 2018.

2.2 GENERAL BACKGROUND

CRL Surveys were asked by [redacted] of London Borough of Hammersmith & Fulham to carry out investigation works to selected flats within the Hartopp and Lannoy Points buildings, working under the direction of Arup.

We were particularly asked to undertake ferroscan surveys along with exploratory breaking out to confirm construction details.

Our Technicians attended site during the period 6th to 10th and 28th to 31st August 2018 and their findings are detailed as follows.

4 PROCEDURES

4.1 TERMS OF REFERENCE

4.1.1 Site Records and Drawings

The default presentation of results is using Site Record Sheets and pro-forma, for recording observations, test data and details gathered on site, with either neat hand-drawn sketches, or Client supplied AutoCAD outlines, annotated by hand, with standardised schedules of dilapidations and defects, neatly annotated by hand.

Unless specifically requested, we have not re-processed these documents further.

4.1.2 Dimensional Measurement

Dimensional measurement is undertaken as an inherent part of many of the following activities and although all dimensions recorded should be taken as 'approximate', every effort has been made to ensure the precision and accuracy of the approximations.

All dimensional measurements less than, 'nominally', 300mm, e.g. where checking reinforcement bar diameters, measuring depths of drilling (dust samples), measuring depths of carbonation, or measuring small defects etc., were measured using calibrated steel rules, manufactured to EU Class I. Where steel rules would not fit, e.g. within small breakouts etc., engineers dividers were employed, with dimensions transferred from a calibrated steel rule manufactured to EU Class I. Such measurements were generally rounded to the nearest whole mm.

All dimensional measurements greater than, 'nominally', 300mm, e.g. where measuring larger defect sizes or structural dimensions, were undertaken using measuring tapes manufactured to EU Class I. [1] We again generally rounded such measurements to the nearest whole mm.

> **NB:** The condition of the steel rules, measuring tapes, and engineer's dividers were checked prior to every shift / measurement and only used if in good condition, i.e. the ends / edges / points were straight, sharp and undamaged, with the gradations / values / markings clearly legible.

4.2 STRUCTURAL DETAILS

4.2.1 Reinforcement Distribution and Detailing

The reinforcement beneath various surfaces was subjected to investigation using a Hilti Limited "Ferroscan", with the instrument used to carry out detailed scanning and / or quick scanning, as appropriate[2].

This procedure is covered by CRL Surveys UKAS Accreditation, UKAS Ref: 2728. For further details please visit www.ukas.org.

UKAS TESTING 2728

Detailed scanning of the concrete surfaces was carried out on a 600mm grid, with, as far as possible, the location, orientation, depth of cover and diameter of each bar within approximately 100mm of the surfaces identified and logged.

The instrument was re-calibrated on-site regularly and the cover readings obtained will frequently checked using reinforcement at various depths, including bars at probed locations.

Bar sizes and the likelihood of lapped, closely spaced or congested reinforcement, which all potentially effect the precision of the results were also be assessed at probed locations.

---

[1] Proprietary steel 'pocket' tapes were not used due to potential inaccuracies with the loose fixing and / or deterioration of the end 'hooks'.

[2] The format of the detector / scanning head to the instrument is such that a marginal area of approximately 85mm to 100mm width adjacent to internal corners cannot be scanned.

NB:
1. Whichever is the greater, over the working range given by the manufacturer
2. Whichever is the greater, for reinforcement at covers less than 100mm.
3. Detection limits, with respect to depth, vary significantly from instrument to instrument and generally, in our experience, with all but the more 'exotic' of instruments, resolutions deteriorate significantly with depths greater than around 100mm. Accuracy will also only be to the outermost layer of reinforcement and the performance and reliability of at least some instruments, and therefore the results obtained, can also be affected as described below:
i. The concrete surfaces should be smooth and flat. Any surface variations should be noted and taken into account when depths of cover are recorded. The thickness of any overlay boards should be recorded and subtracted from the cover values recorded.
ii. Steel type, e.g. some instruments have been manufactured for reinforcement comprising un-corroded mild-steel, with relative magnetic permeability of 85-105. Variations in results obtained where other common steel types have been used may be small, but could be as high as ±5%, or more, where high tensile pre-stressed steel has been used.
iii. Bar cross section: Minimum cover will be indicated, i.e. the closest point of a bar to the concrete surface, at the location of measurement. The presence of ribbed or square twisted bars should probably be established and the cover readings cross-checked with direct measurement, using the procedures described above.
iv. The reinforcement should be orientated parallel to the surfaces and 'square', i.e. rectilinear, with the angles between bars in both directions, and those between the bars and the directions of scanning, of $90^0 \pm 5^0$.
v. The bars should not be welded.
vi. Neighbouring bars should be of similar diameter and similar depth. The presence of closely spaced or multiple bars should be assessed; they may be compounded and 'appear' as single, larger diameter bars.
vii. There should be no interference from magnetic constituents within the cement or aggregates, and / or external magnetic fields.
viii. The presence of tie wire may adversely affect readings
ix. Temperature may have an effect on some instruments.
x. Severely corroded reinforcement, with heavy scaling and migration of corrosion products may give misleading results.

4.2.2 Site-specific Validation

At selected representative locations the preliminary images, produced on site, were used to focus on particular bars, or groups of bars. These bars were then exposed, by careful, 'keyhole', breaking-out and subjected to direct inspection and measurement.

Reinforcement bar types were identified using the classifications described within CIRIA Special Publication 118[3].

4.3 PRE-CAST FORM AND FIXING

4.3.1 General

At selected locations the form and relationship between adjacent, discrete, elements were investigated using a combination of non-destructive direct / indirect measurement, the removal of internal, finishing-panels and remote scanning, with, where necessary, increasingly damaging and intrusive techniques, including breaking-out.

Our intensions were to maximise the information gathered, whilst minimising the extent of disruptive and damaging intrusion.

4.3.2 Direct / Indirect Measurement and Internal Finishing-Panel Removal

Where possible, the assessment of cladding panel form and fixing details were achieved by accurate measurement of exposed surfaces, aided by various probes inserted into open joints etc., and the careful removal, and subsequent reinstatement, of internal finishing-panels.

[3] CIRIA Special Publication 118, 1995, "Steel Reinforcement".

4.3.3 Remote Scanning

The information obtained above was augmented by scanning the exposed surfaces using a Hilti Limited, "Ferroscan", or other similar instrument, in accordance with the manufacturer's instructions and in general accordance with British Standard BS1881[4].

> **NB:** Fixings have been available in a wide range of types, manufactured in a wide range of materials, including plastic / nylon, mild steel / galvanized mild-steel, alloy steels and stainless steel.
>
> Furthermore, even where fixings were manufactured from mild-steel / galvanized mild-steel detection limits, with respect to both depth and accurate positioning, vary significantly from instrument to instrument and generally, in our experience, resolutions deteriorate significantly with depths greater than around 100mm. Furthermore, in some cases, congested reinforcement and / or contamination of the concrete with magnetic constituents can result in erroneous responses which can be, at best, difficult and misleading to resolve.

4.3.4 Direct Inspection

In cases where the above could not satisfactorily resolve the required detail, or where further investigations of the cavities is considered appropriate and safe, such investigations were carried out, using small hand-held tools to carefully breakout the concrete.

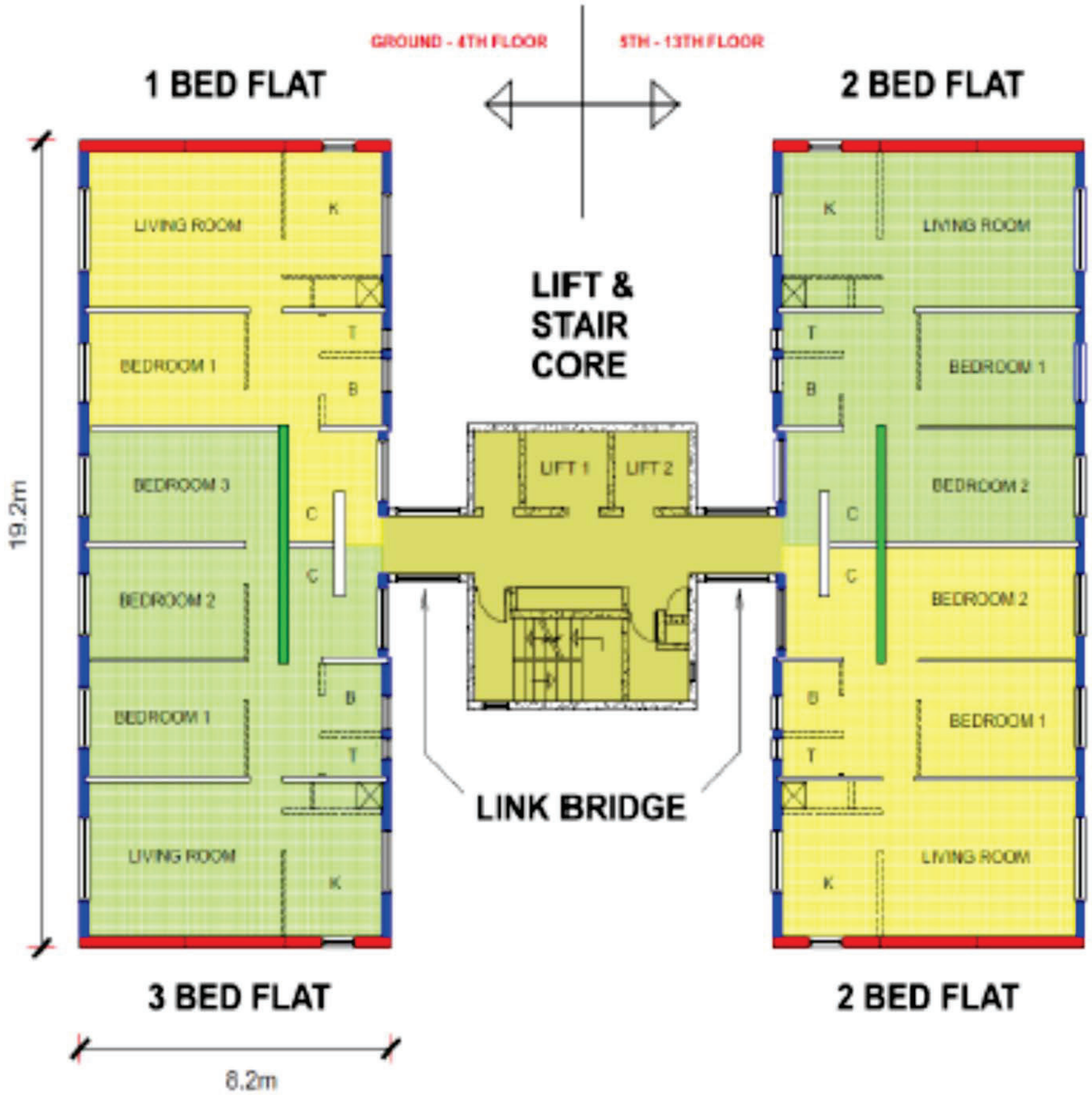
[4] BS1881 "Testing Concrete". Part 204: 1988 "Recommendations on the use of electromagnetic covermeters".

5 INVESTIGATION RESULTS

The detailed results of our investigations have been presented within **Appendix A**.

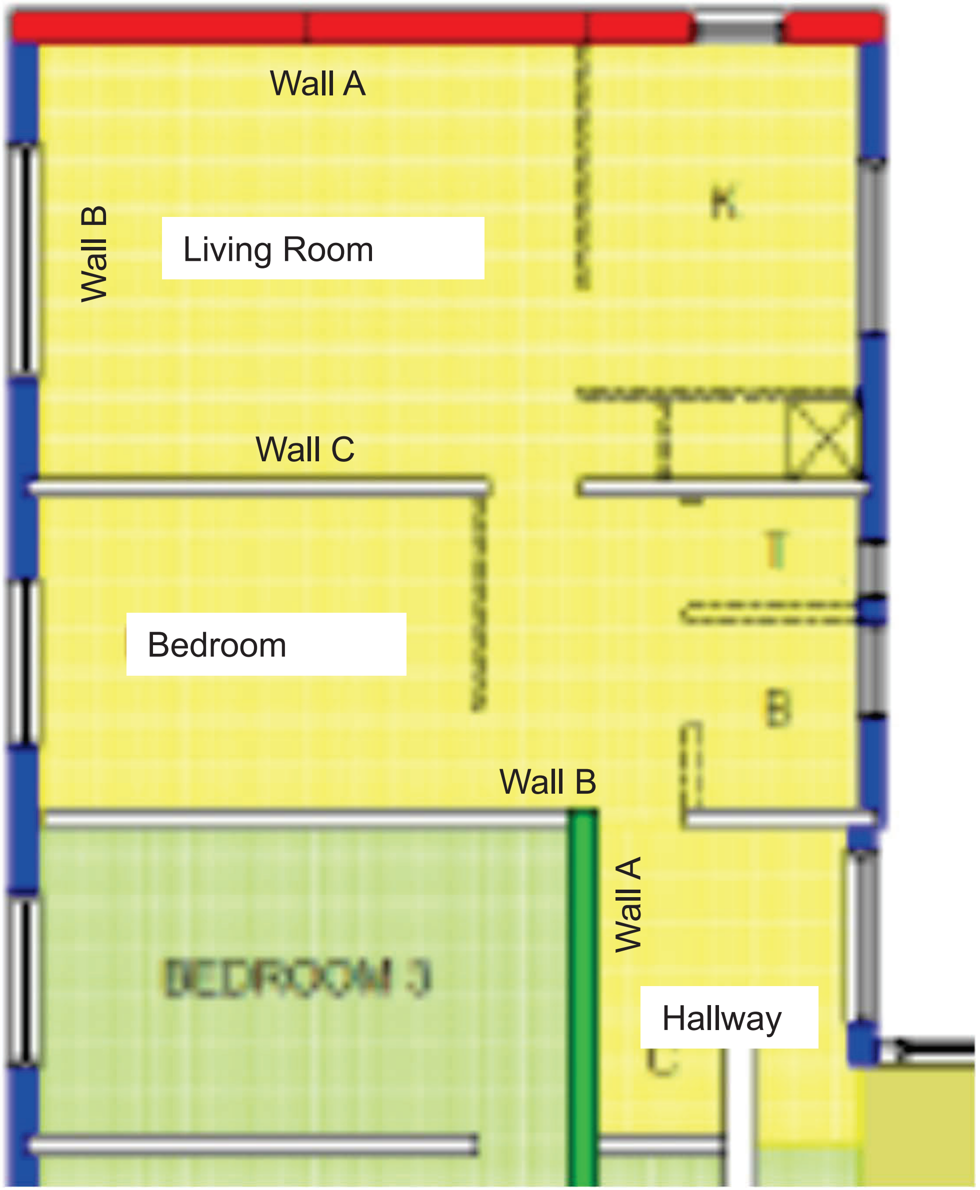
APPENDIX A: INVESTIGATION RESULTS

98 PAGES)



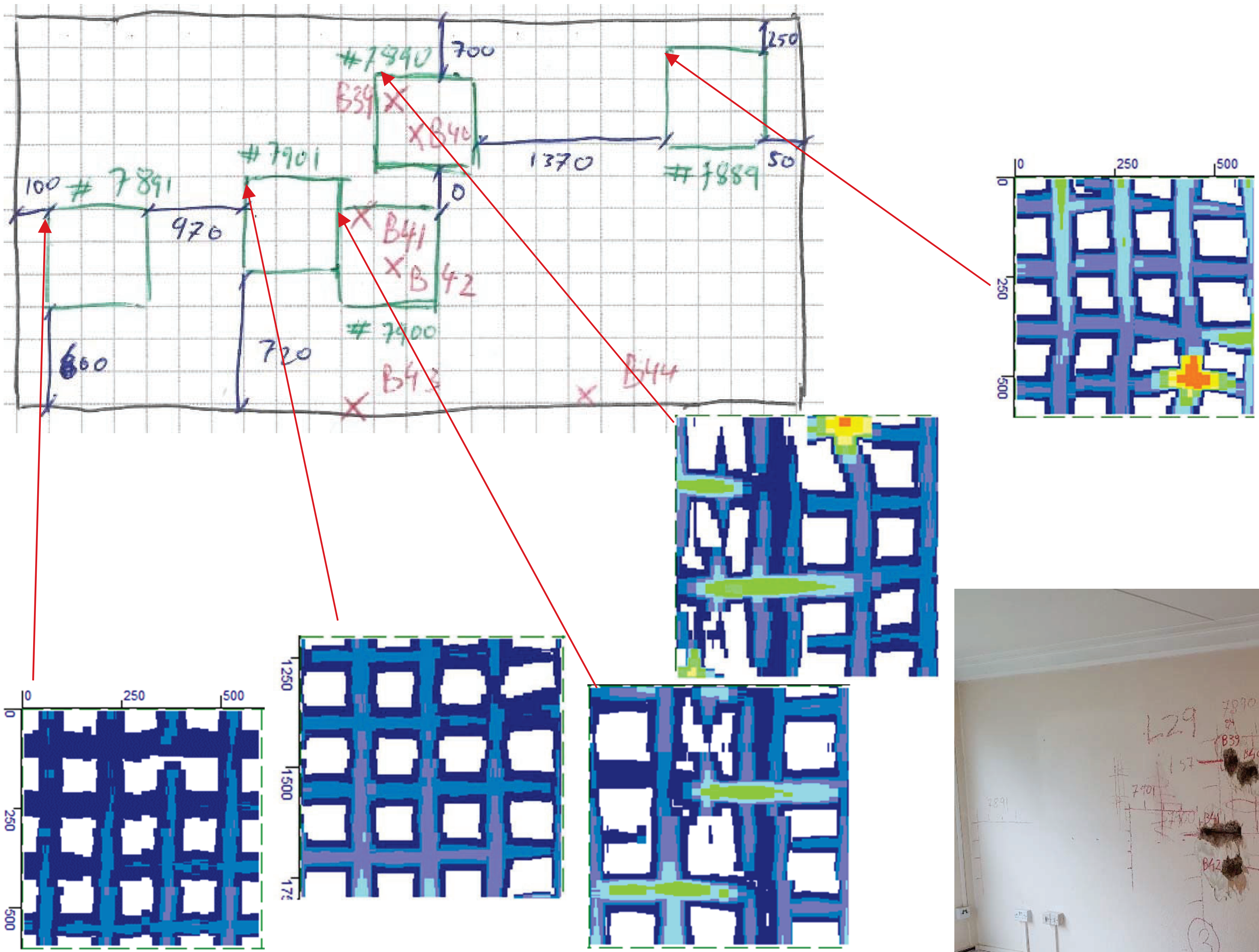
SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp and Lannoy	General Floor Layout for Hartopp Lannoy Building	August 2018	SUR183482	MAH/PW/ JI

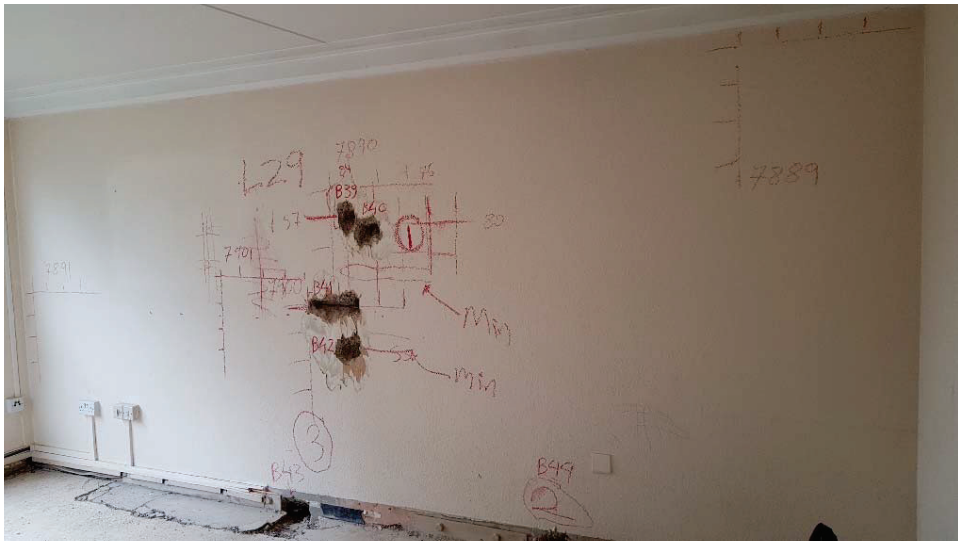
CRL SURVEYS
Structural and building assessment



SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp and Lannoy	Lannoy Building - Floor Plan – Flat 12	August 2018	SUR183482	MAH/PW/JI

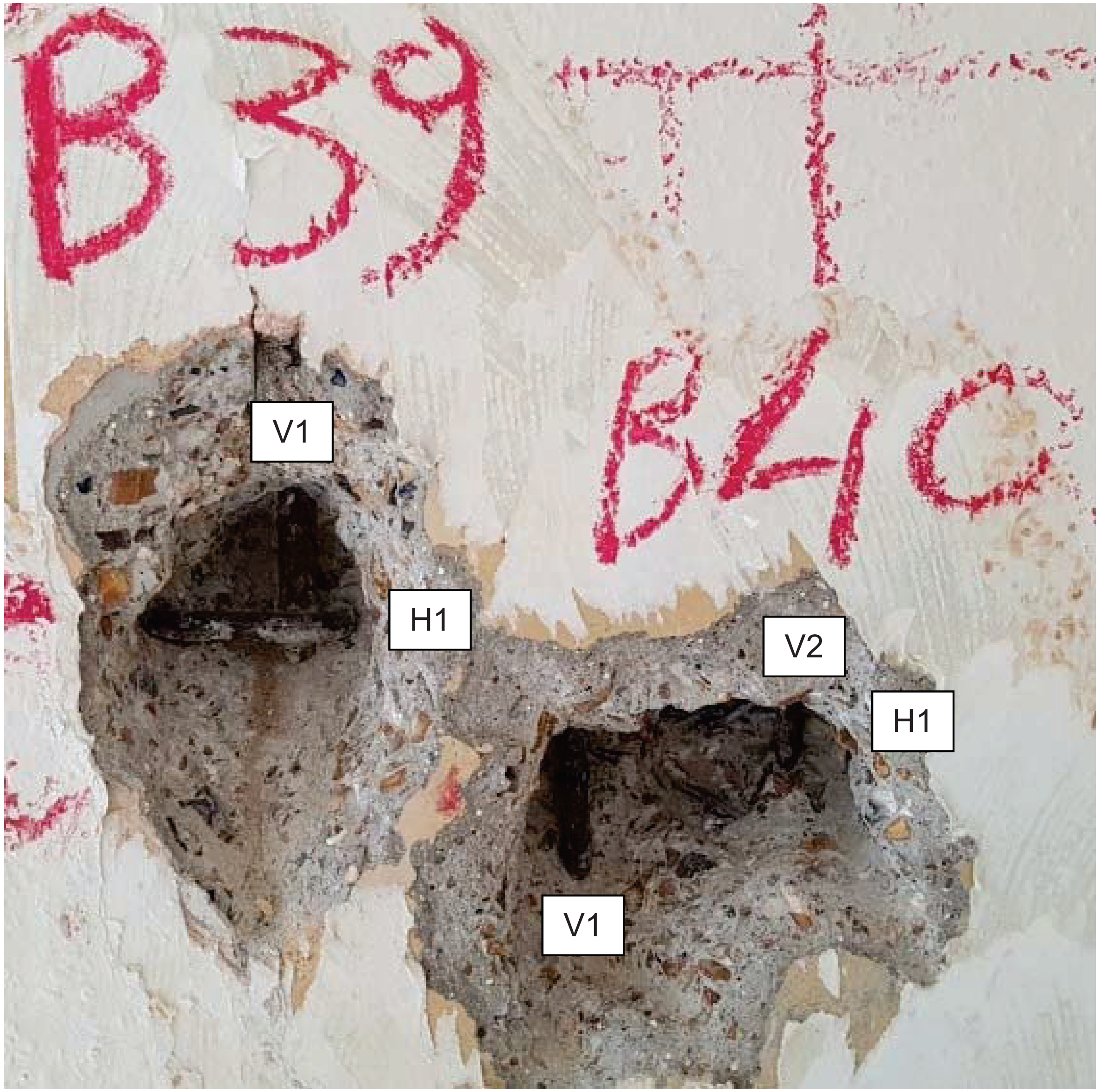
CRL SURVEYS
Structural and building assessment





SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Lannoy Building – Flat 12	Ferroscan Survey – Living Room Wall A	August 2018	SUR183482	MAH/PW/ JI

CRL SURVEYS
Structural and building assessment



B39	*V1*	*H1*
Bar Ø (mm)	12	10
Bar Type	Round, Smooth	Round, Smooth
Min. Cover (mm)	54	71
Condition	Light Surface Corrosion	Light Surface Corrosion

B40	*V1*	*V2*	*H2*
Bar Ø (mm)	12	6	6
Bar Type	Round, Smooth	Round, Smooth	Round, Smooth
Min. Cover (mm)	66	66	73
Condition	Good	Good	Good

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Lannoy Building – Flat 12	Breakout B39 & B40 – Living Room Wall A	August 2018	SUR183482	MAH/PW/ JI

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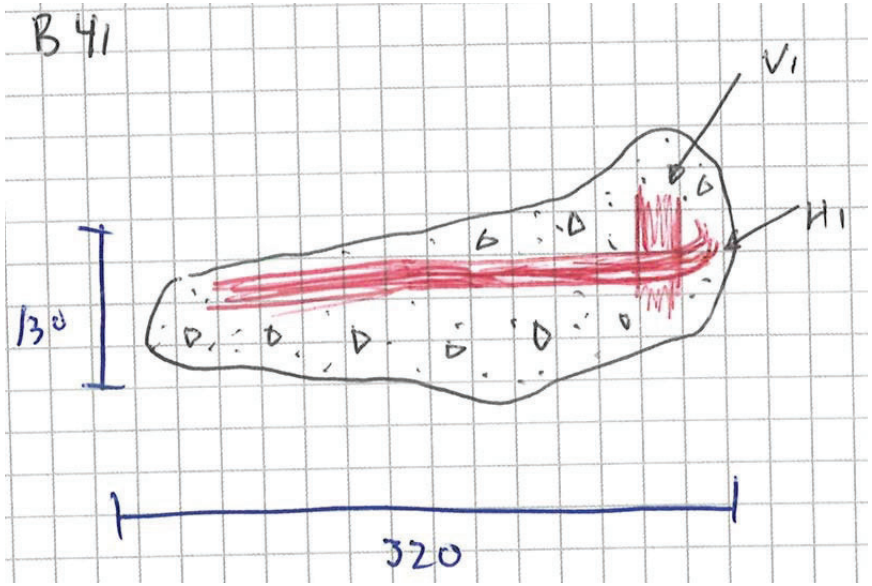
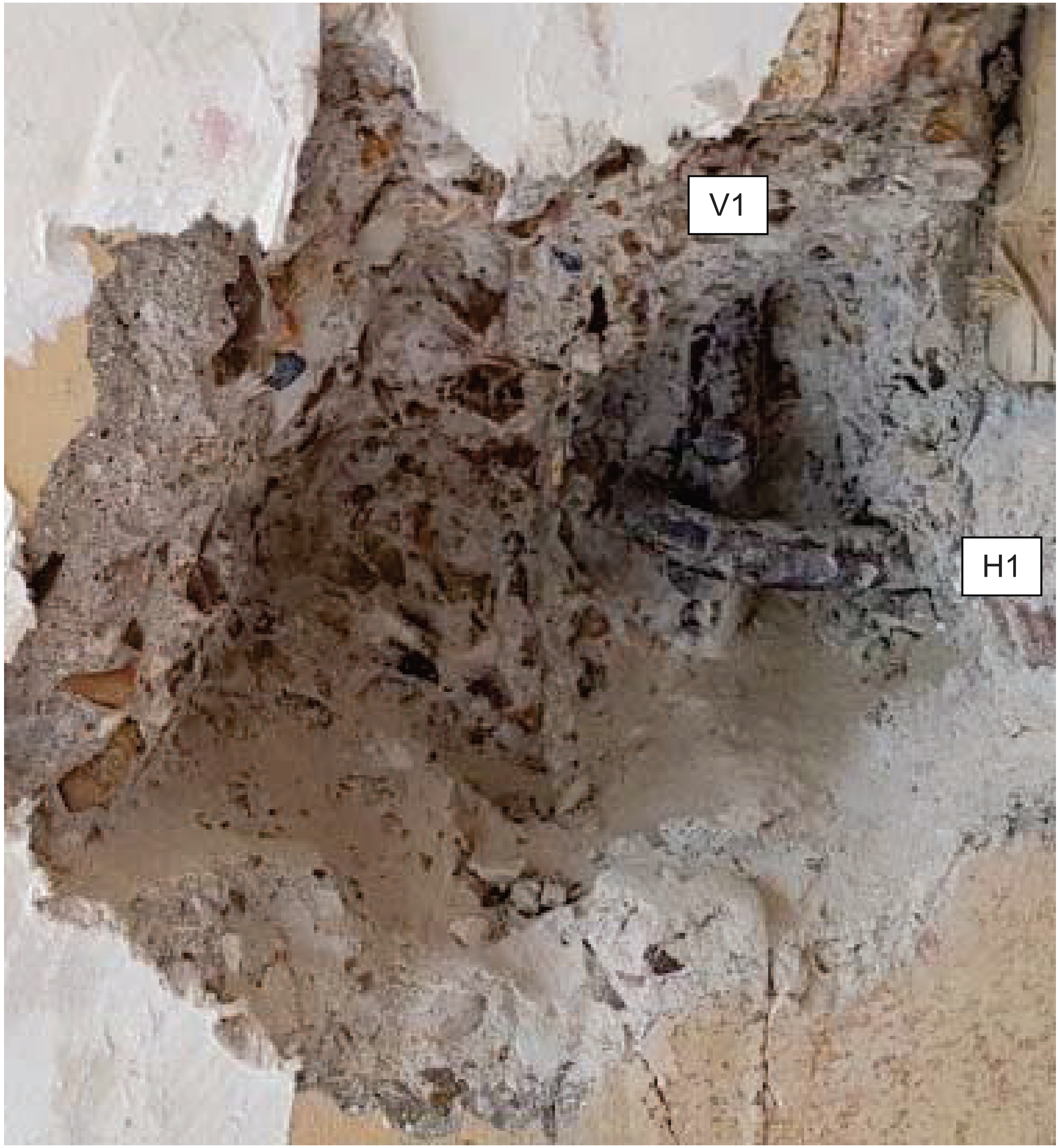
Structural and building assessment

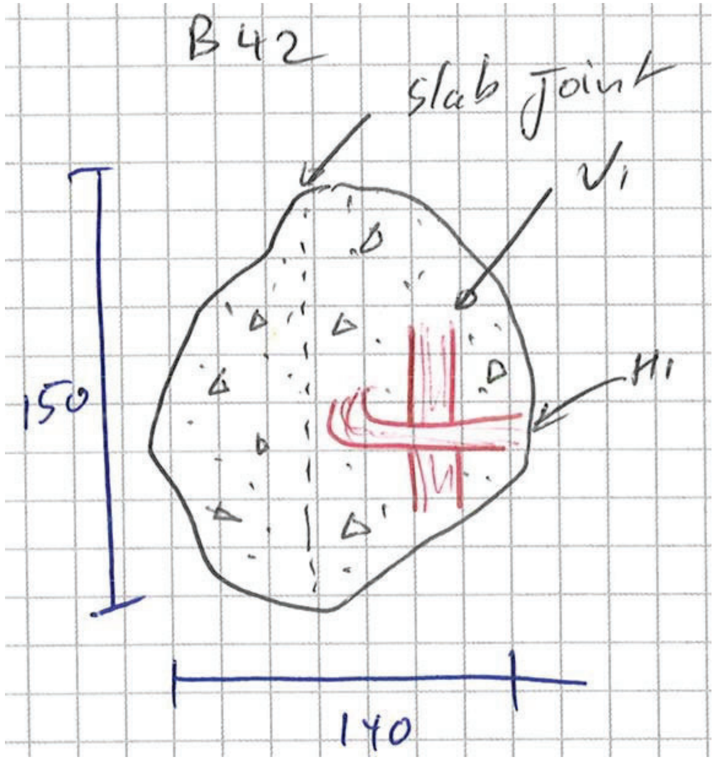


B41	*V1*	*H1*
Bar Ø (mm)	12	10
Bar Type	Round, Smooth	Round, Smooth
Min. Cover (mm)	71	60
Condition	Good	Light Surface Corrosion

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Lannoy Building – Flat 12	Breakout B41 – Living Room Wall A	August 2018	SUR183482	MAH/PW/JI

CRL SURVEYS
Structural and building assessment

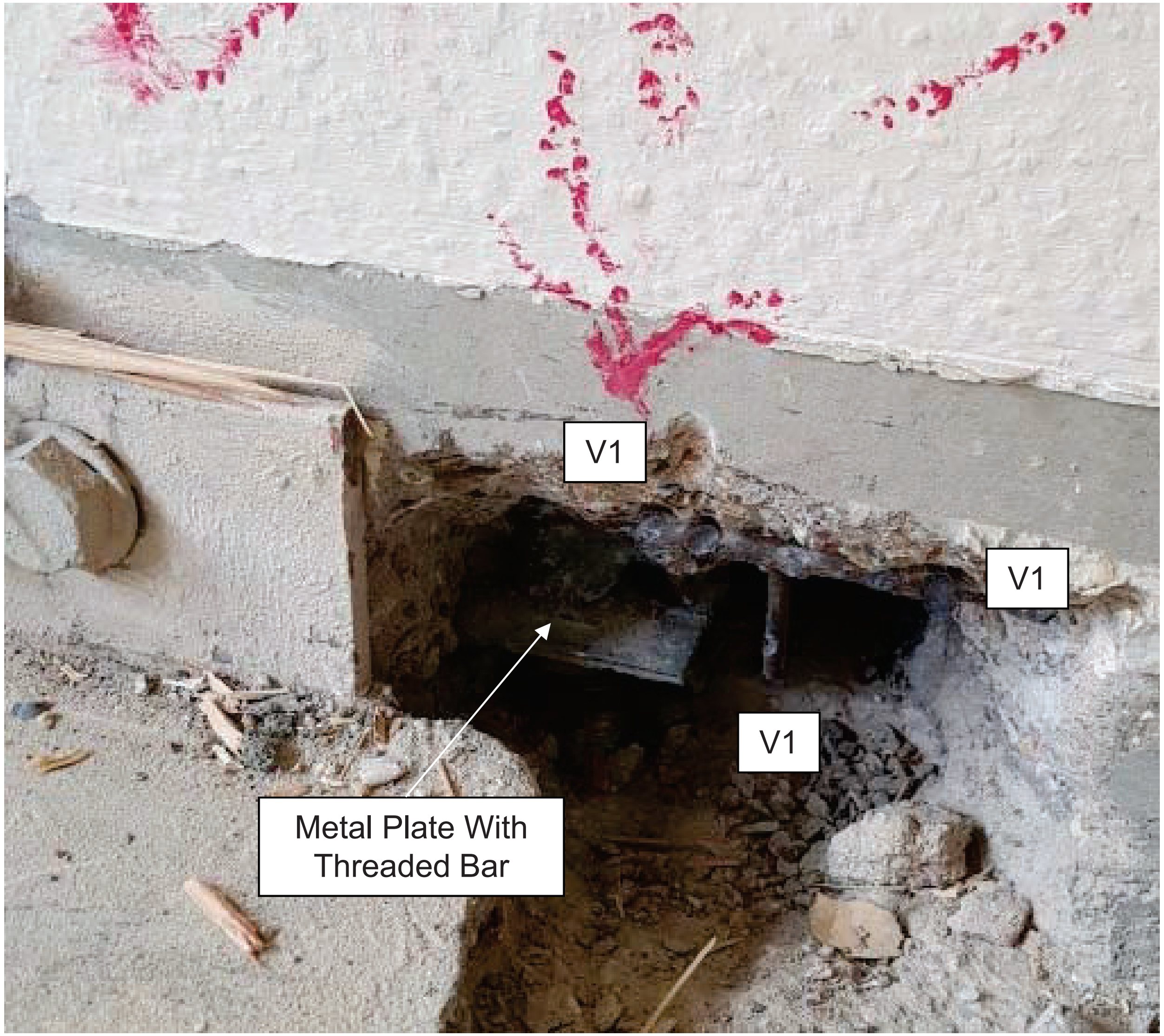


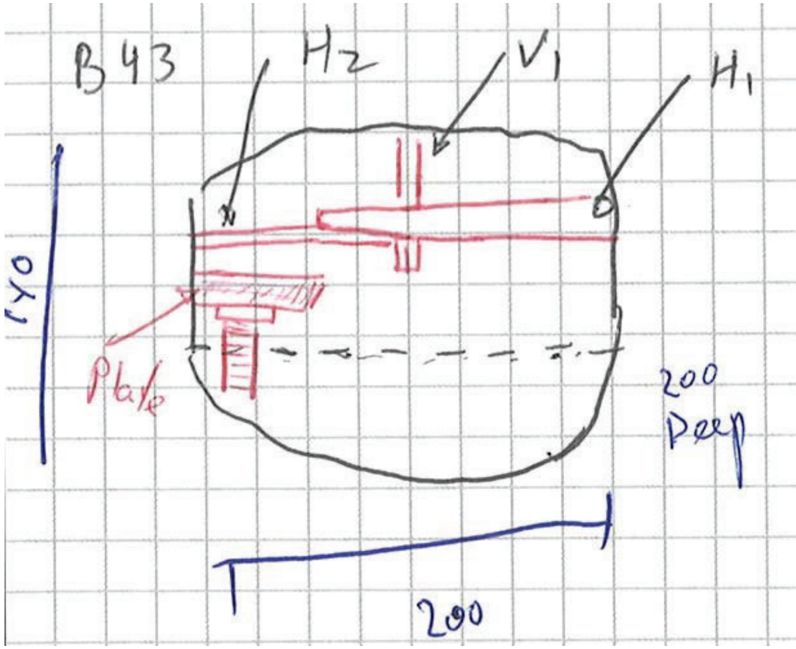


B42	*V1*	*H1*
Bar Ø (mm)	12	10
Bar Type	Round, Smooth	Round, Smooth
Min. Cover (mm)	70	51
Condition	Good	Good

SITE	**DETAILS**	**DATE**	**CONTRACT NO.**	**INITIALS**
Lannoy Building – Flat 12	Breakout B42 – Living Room Wall A	August 2018	SUR183482	MAH/PW/ JI

CRL SURVEYS
Structural and building assessment





B43	*V1*	*H1*	*H2*
Bar Ø (mm)	6	10	10
Bar Type	Round, Smooth	Round, Smooth	Round, Smooth
Min. Cover (mm)	42	30	48
Condition	Good	Good	Good

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Lannoy Building – Flat 12	Breakout B43 – Living Room Wall A	August 2018	SUR183482	MAH/PW/JI

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SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Lannoy Building – Flat 12	Breakout B44 – Living Room Wall A	August 2018	SUR183482	MAH/PW/JI

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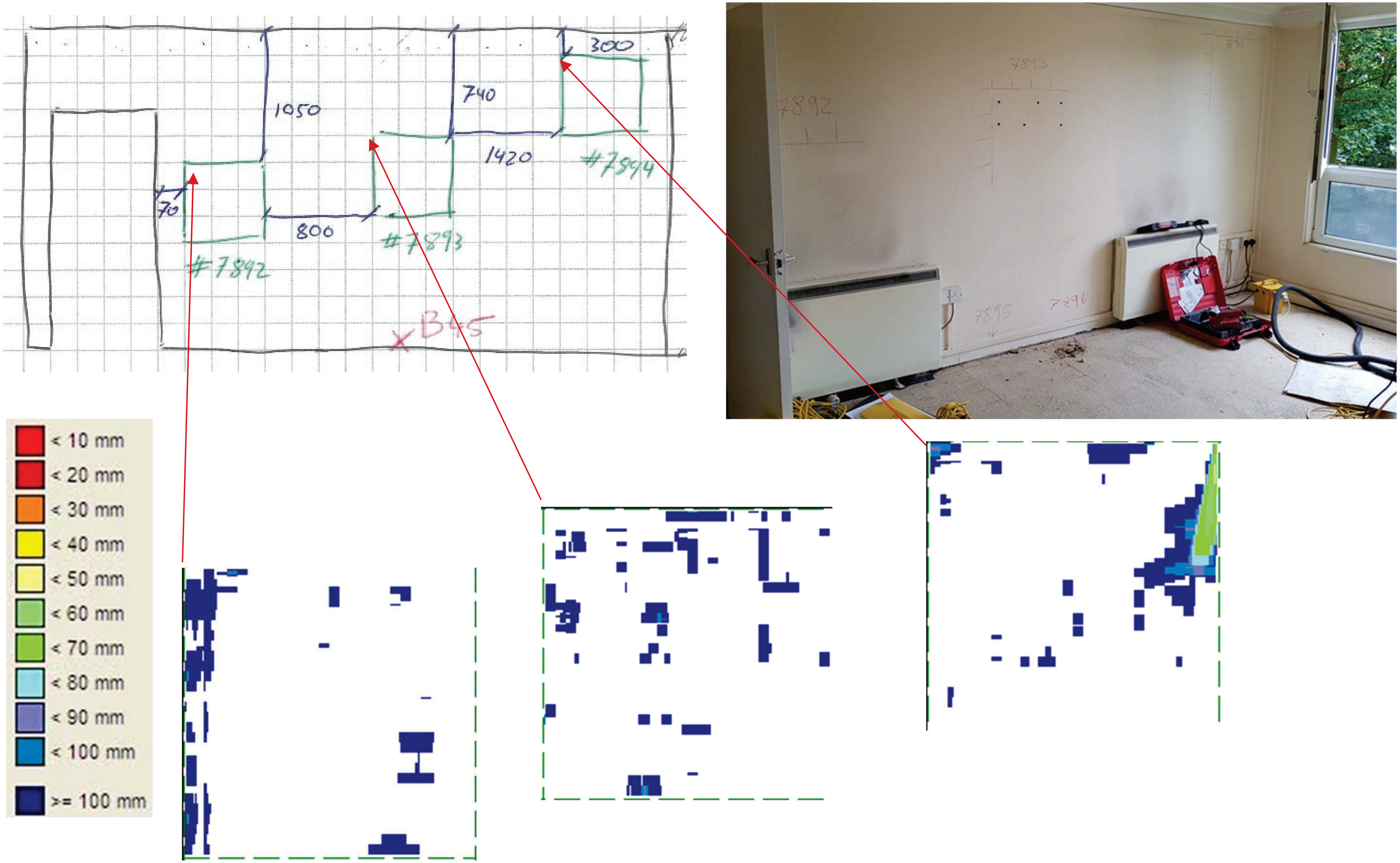

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Lannoy Building – Flat 12	Ferroscan Survey – Living Room Wall C	August 2018	SUR183482	MAH/PW/ JI

Structural and building assessment

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Lannoy Building – Flat 12	Breakout B45 – Living Room Wall C	August 2018	SUR183482	MAH/PW/ JI

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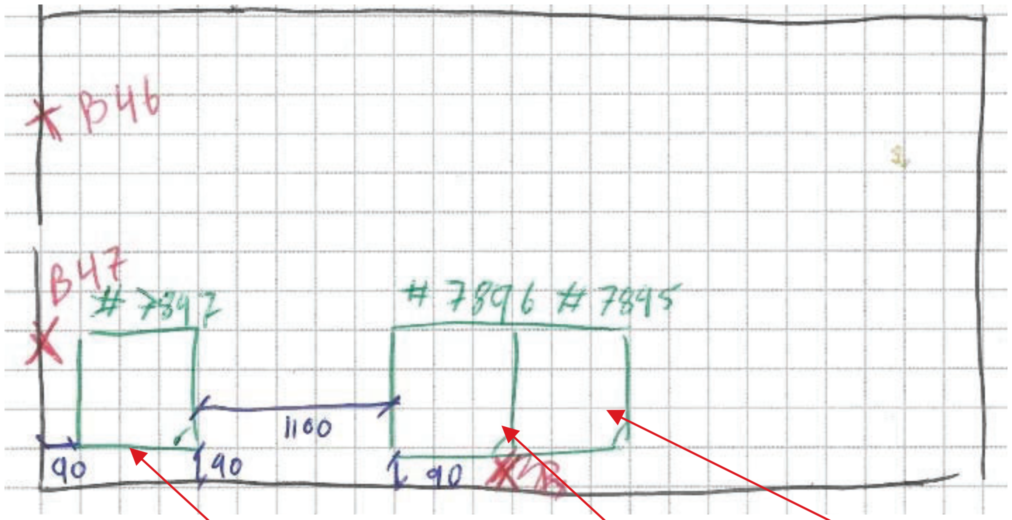

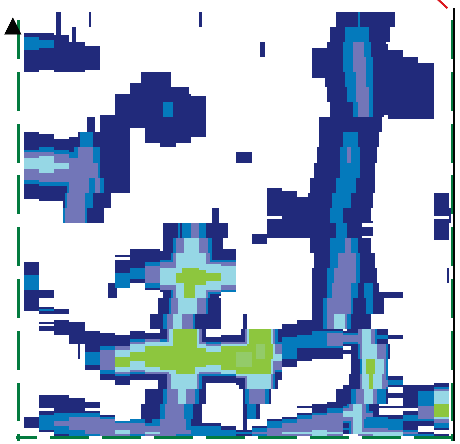

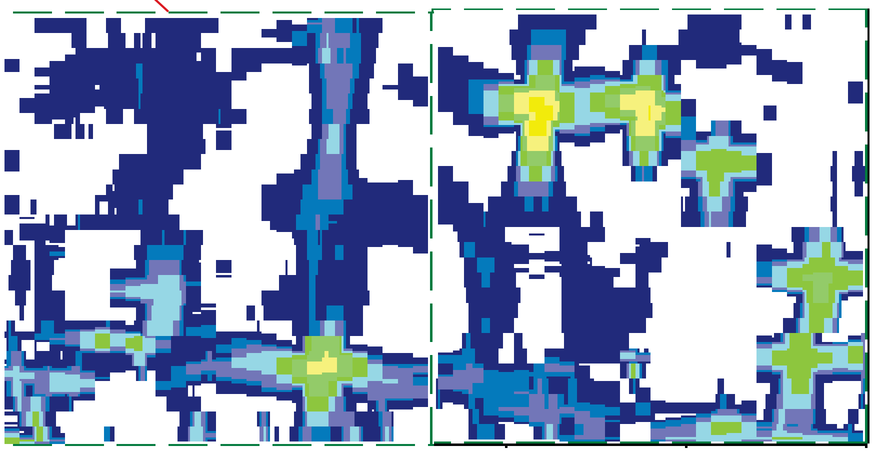

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Lannoy Building – Flat 12	Ferroscan Survey – Living Room Floor	August 2018	SUR183482	MAH/PW/ JI

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SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Lannoy Building – Flat 12	Breakout B46 & 47 – Living Room Floor	August 2018	SUR183482	MAH/PW/ JI

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Structural and building assessment

Breakout B48

Breakout B49

Breakout B50

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Lannoy Building – Flat 12	Breakout B48, B49 B50 – Bed Room - Floor	August 2018	SUR183482	MAH/PW/ JI

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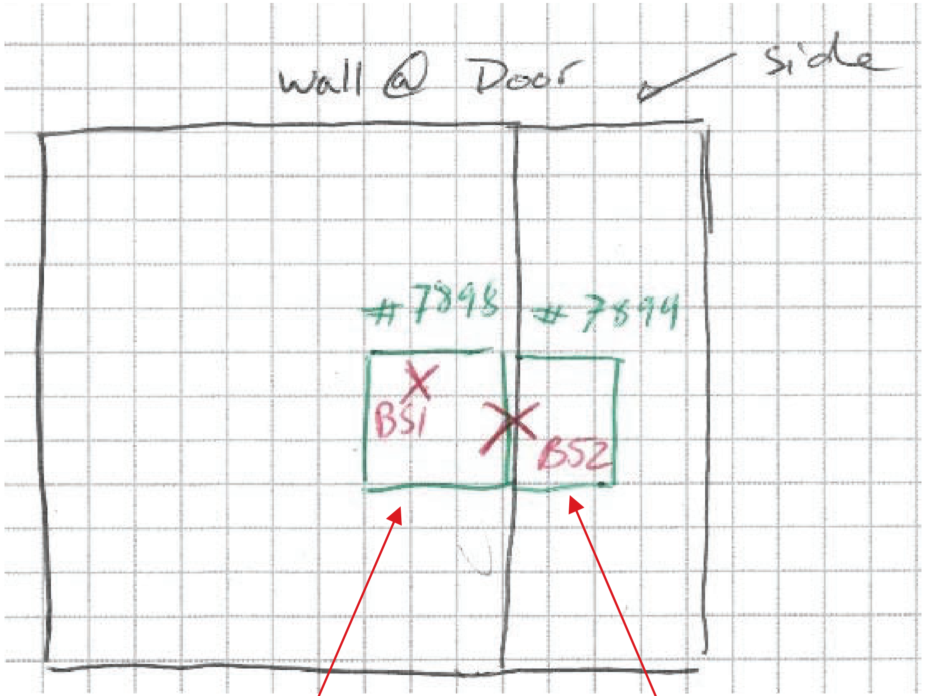
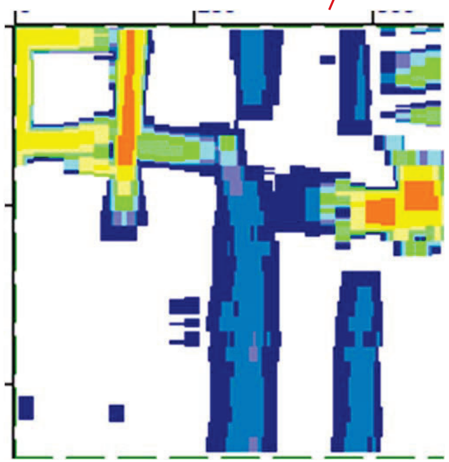
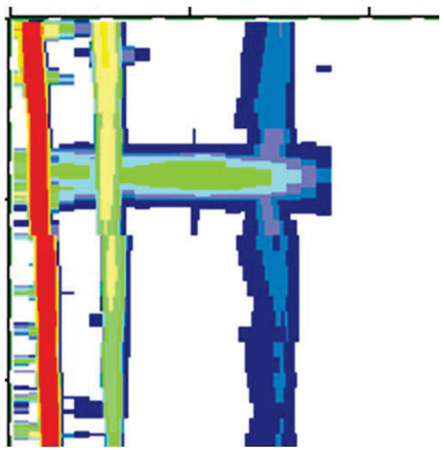
Structural and building assessment







SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Lannoy Building – Flat 12	Ferroscan Survey – Hallway Wall A / B	August 2018	SUR183482	MAH/PW/ JI

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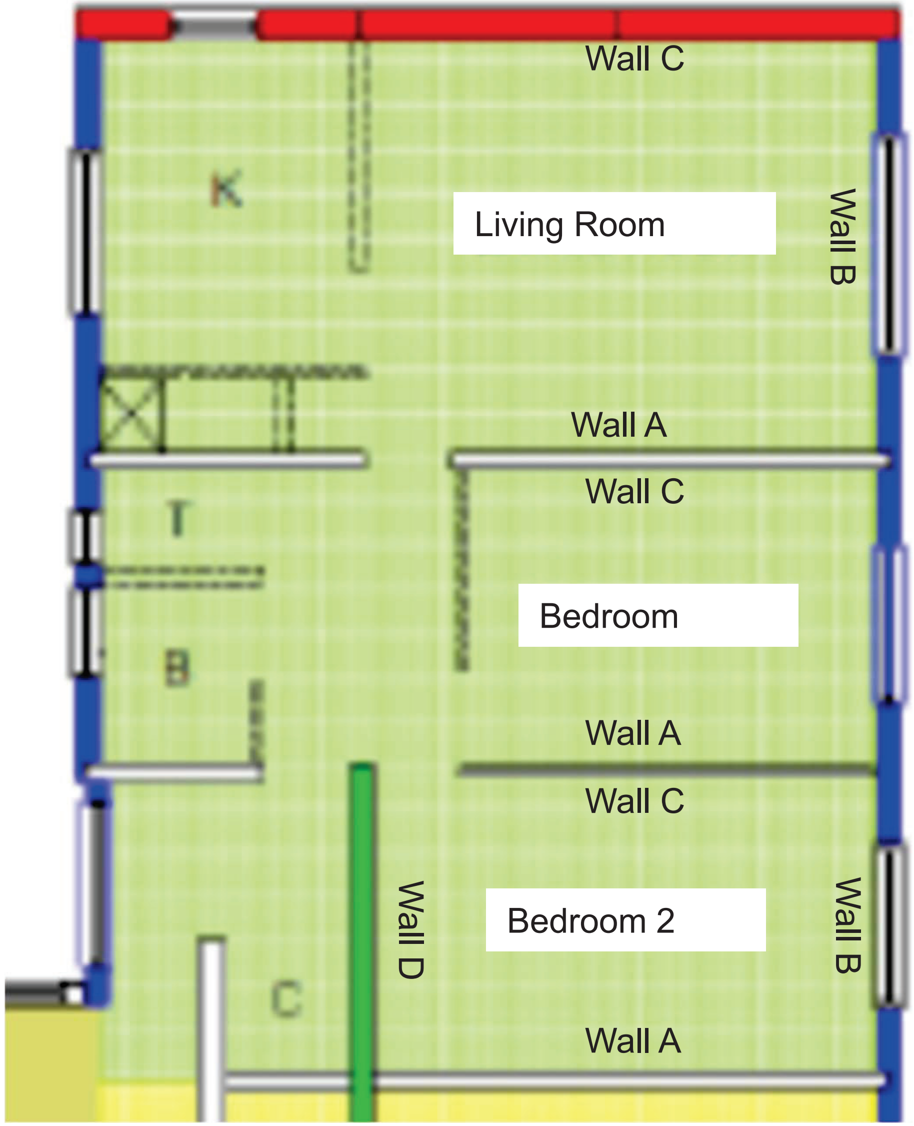
Breakout B51

Breakout B52

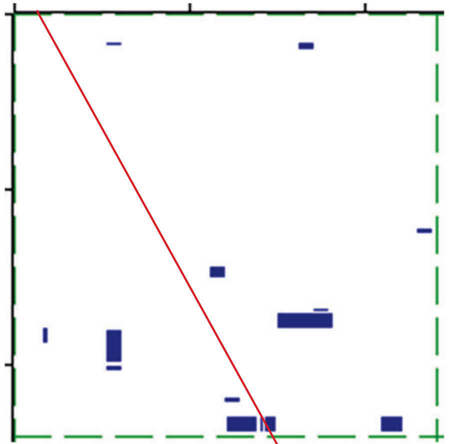
SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Lannoy Building – Flat 12	Breakout B51 & 52 – Hallway Wall A / B	August 2018	SUR183482	MAH/PW/ JI

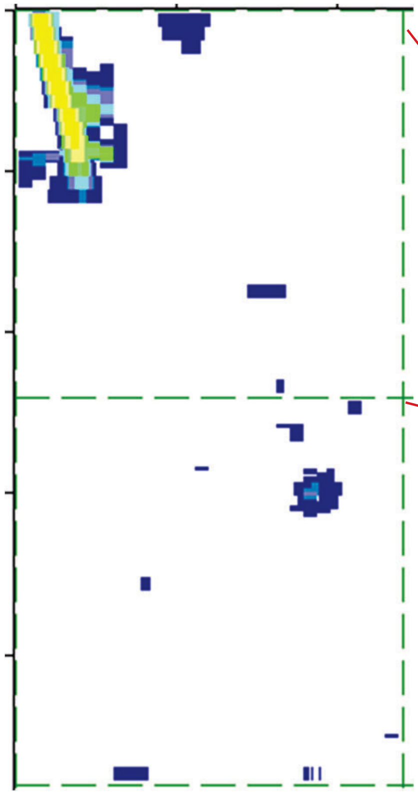
CRL SURVEYS
Structural and building assessment

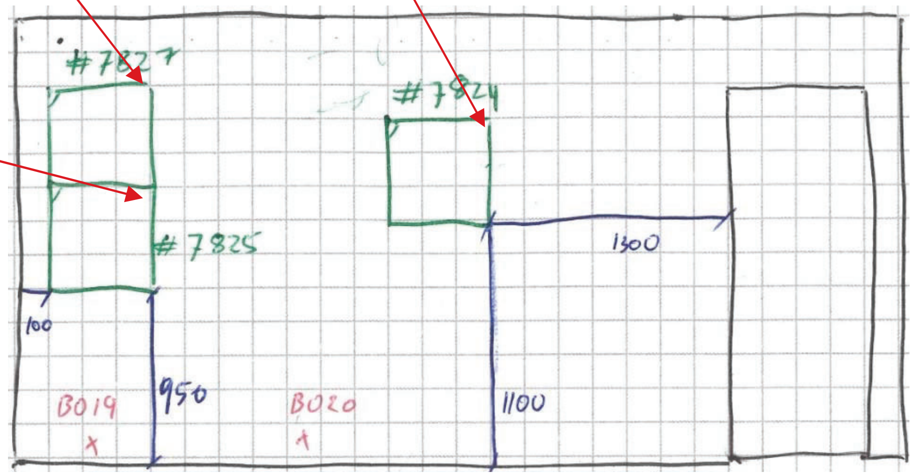


SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp and Lannoy	Hartopp Building - Floor Plan – Flat 35	August 2018	SUR183482	MAH/PW/ JI

CRL SURVEYS Structural and building assessment

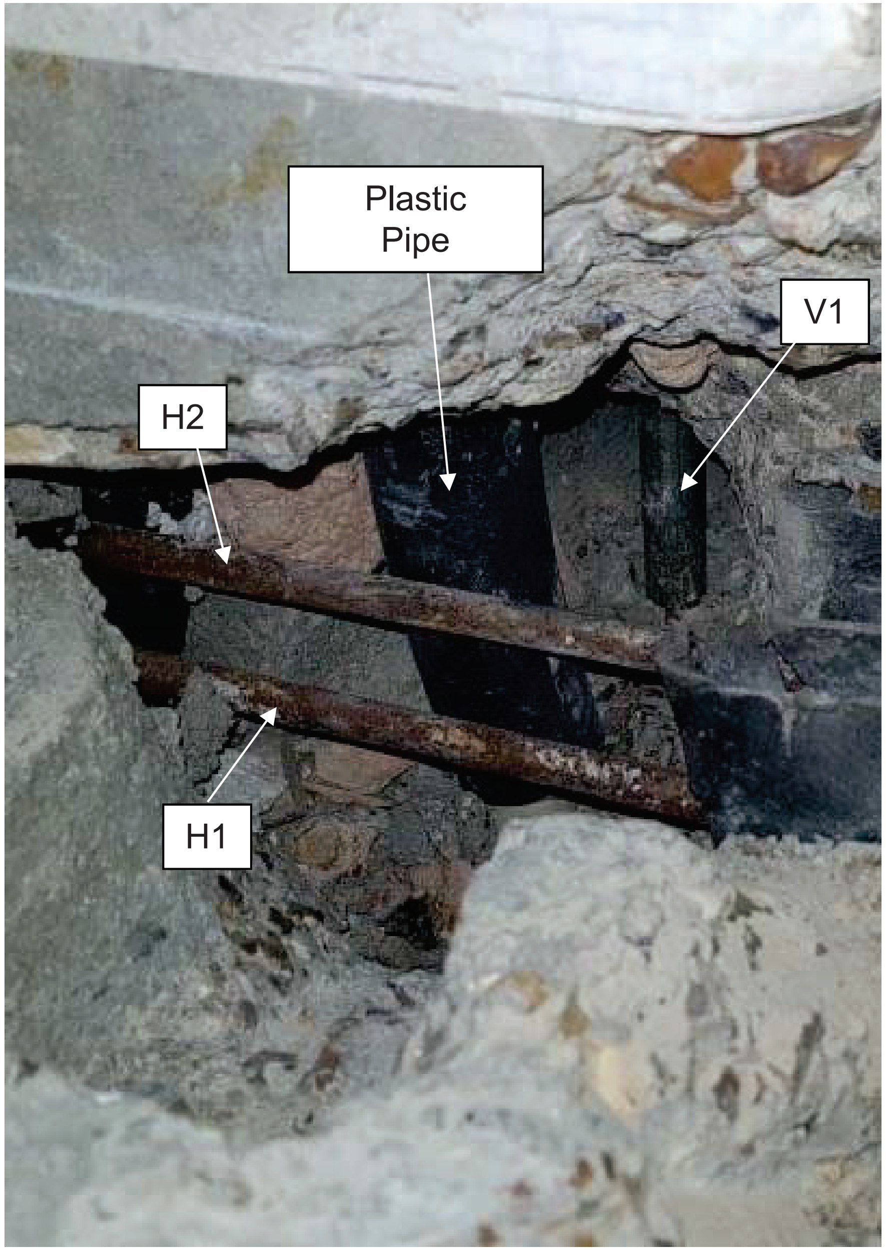


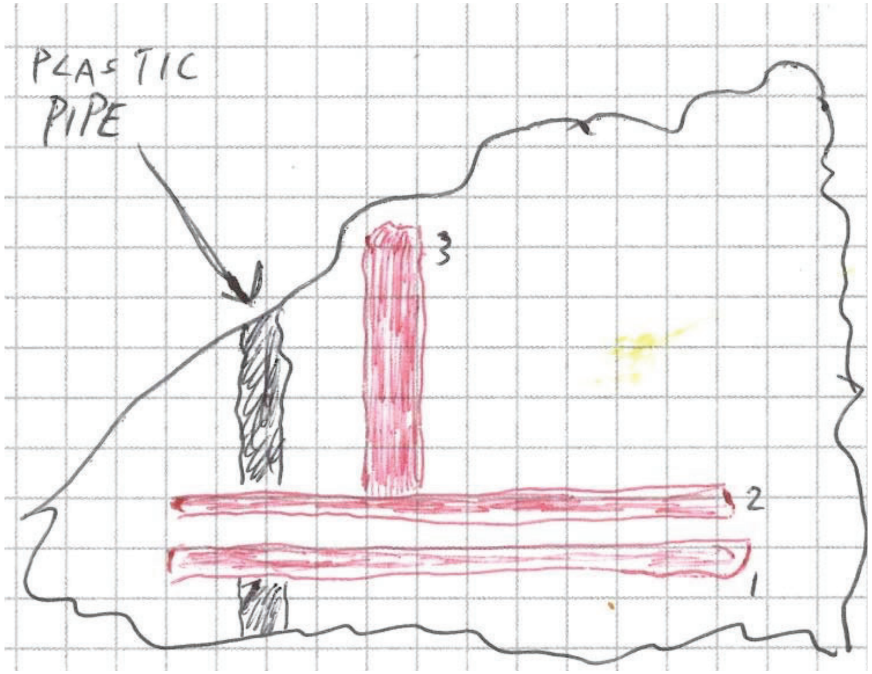




SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Ferro Scan Survey – Living Room Wall A	August 2018	SUR183482	MAH/PW/ JI

CRL SURVEYS
Structural and building assessment

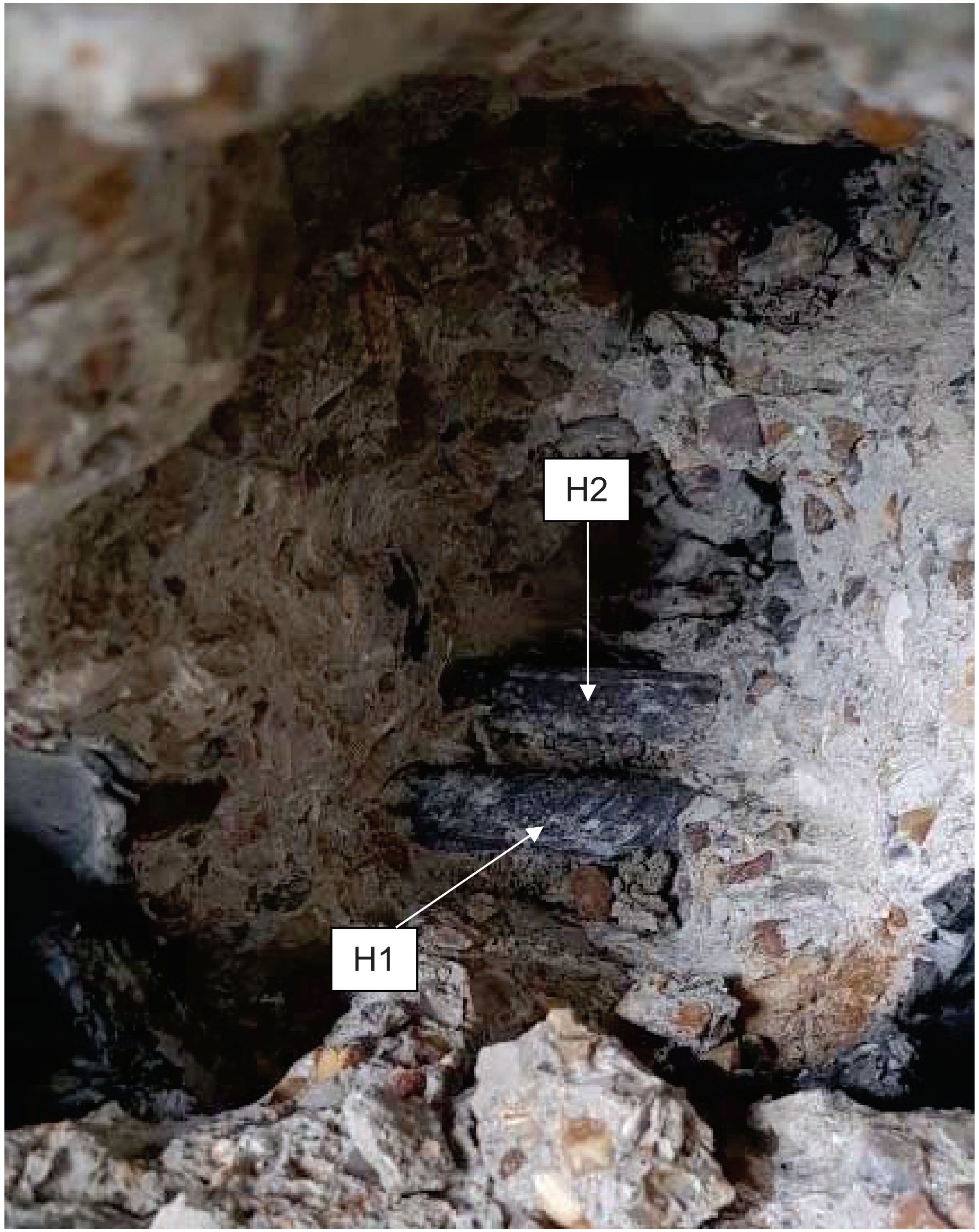


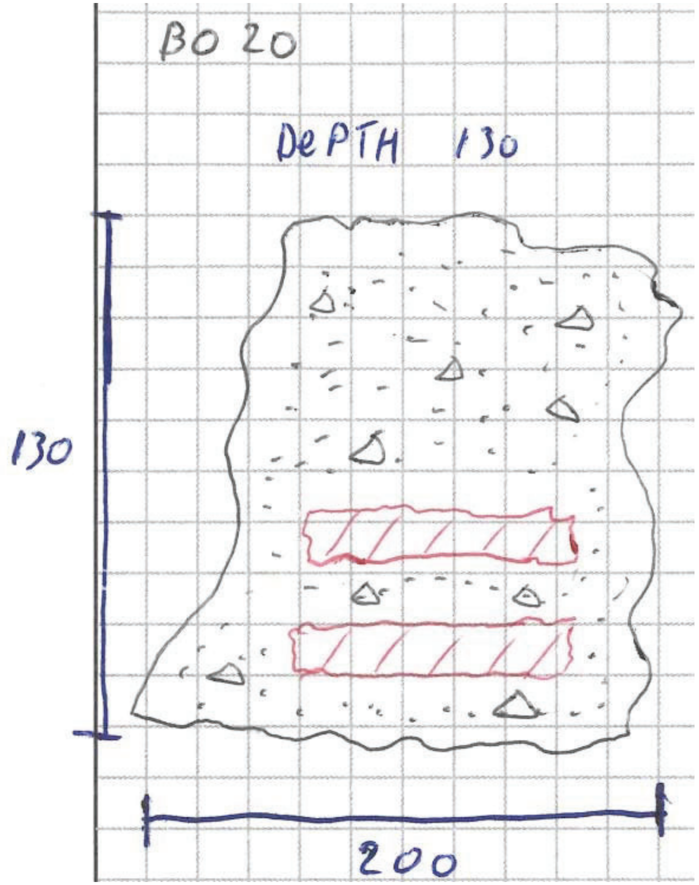


B19	1	2	3
Bar Ø (mm)	8	8	14
Bar Type	Round, Smooth	Round, Smooth	Round, Smooth
Min. Cover (mm)	80	80	250
Condition	Light Surface Corrosion	Light Surface Corrosion	Light Surface Corrosio n

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Breakout B19 – Living Room Wall A	August 2018	SUR183482	MAH/PW/ JI

CRL SURVEYS Structural and building assessment

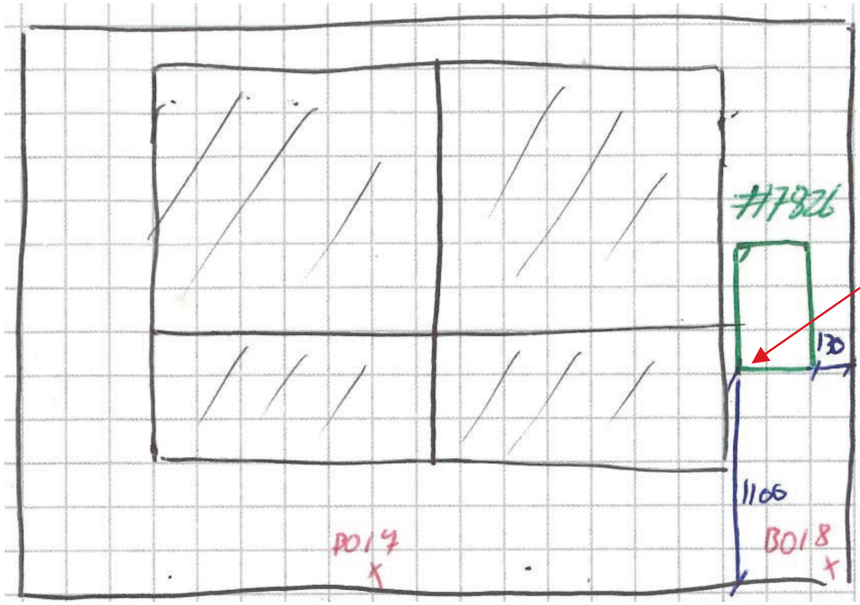


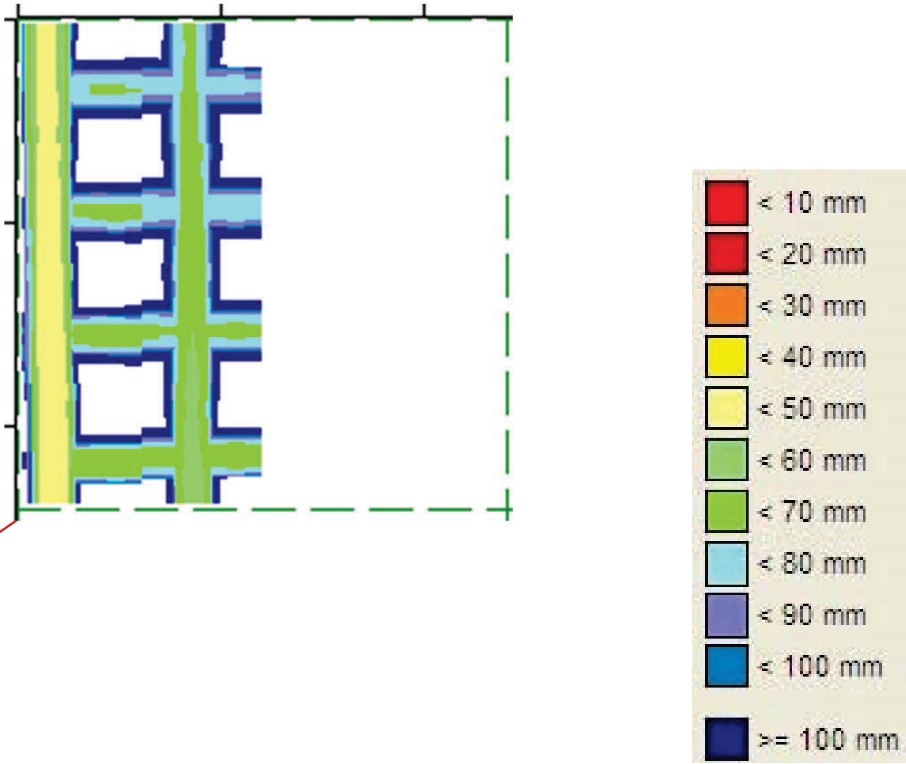


B20	1	2
Bar Ø (mm)	12	12
Bar Type	Round, Smooth	Round, Smooth
Min. Cover (mm)	55	55
Condition	Ribbed, Round	Ribbed, Round

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Breakout B20 – Living Room Wall A	August 2018	SUR183482	MAH/PW/JI

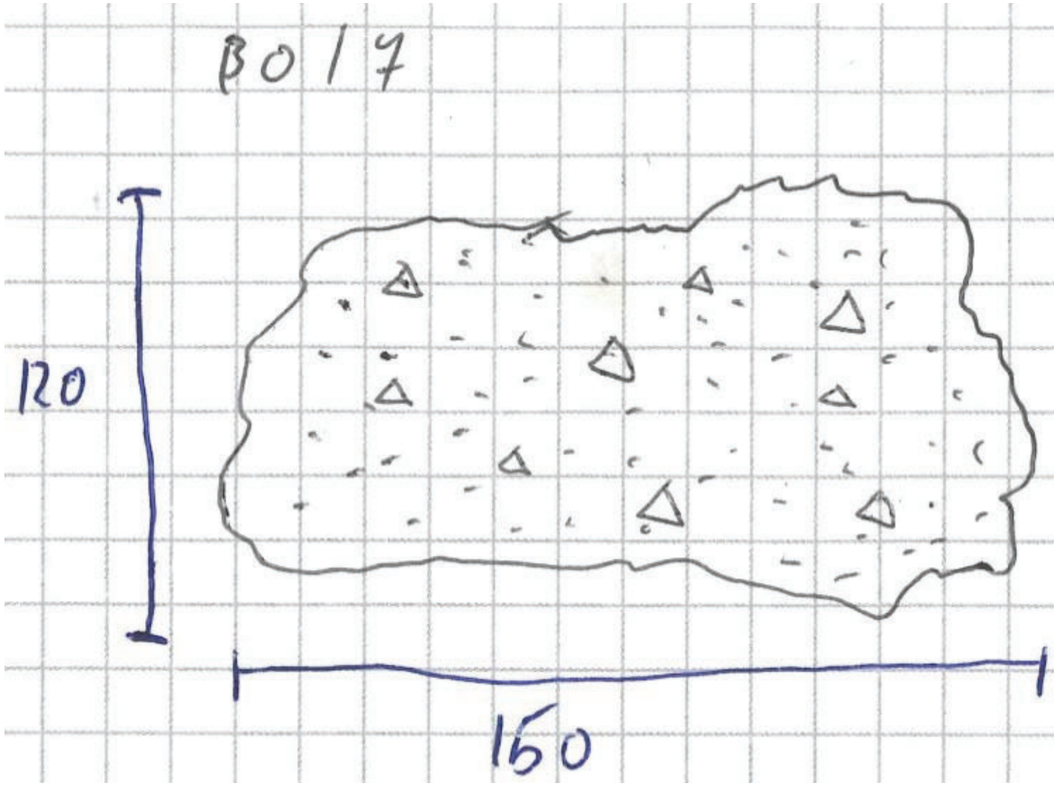
CRL SURVEYS
Structural and building assessment





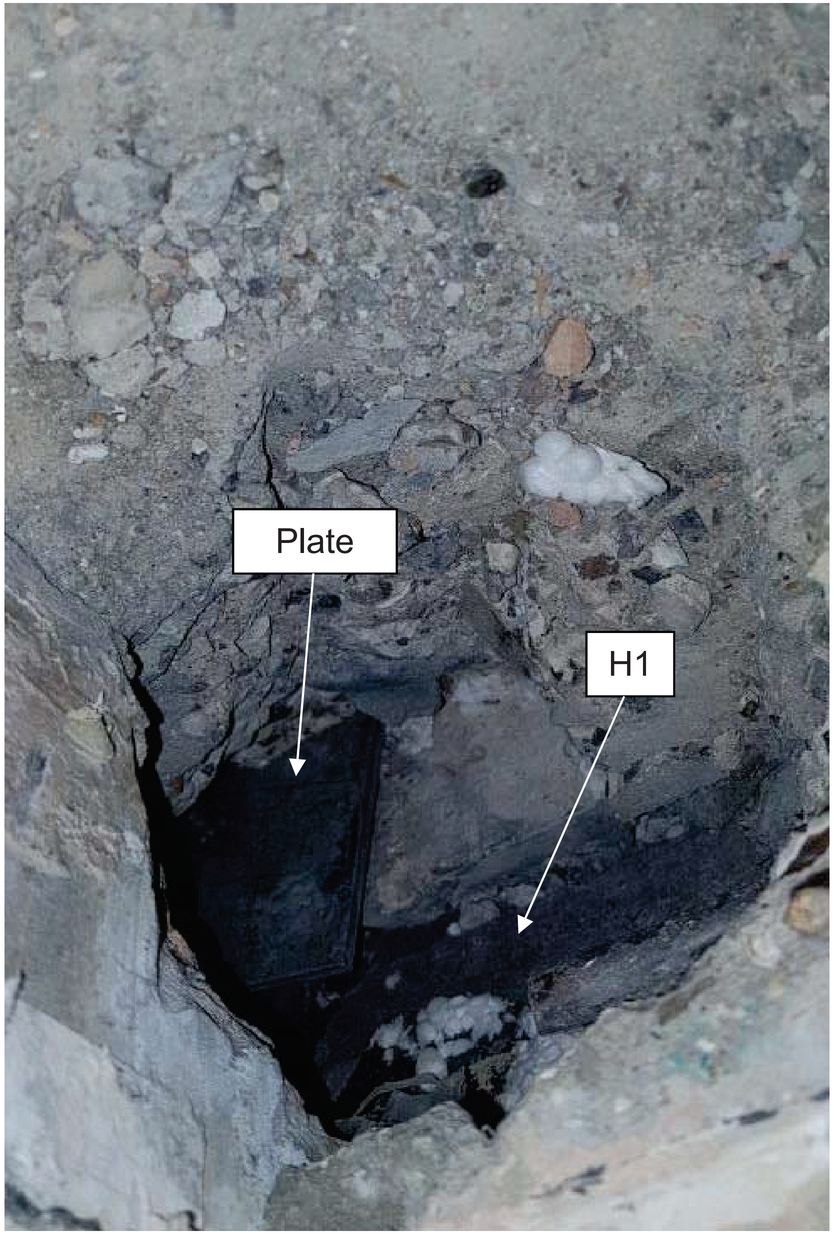
SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Ferro Scan Survey – Living Room Wall B	August 2018	SUR183482	MAH/PW/ JI

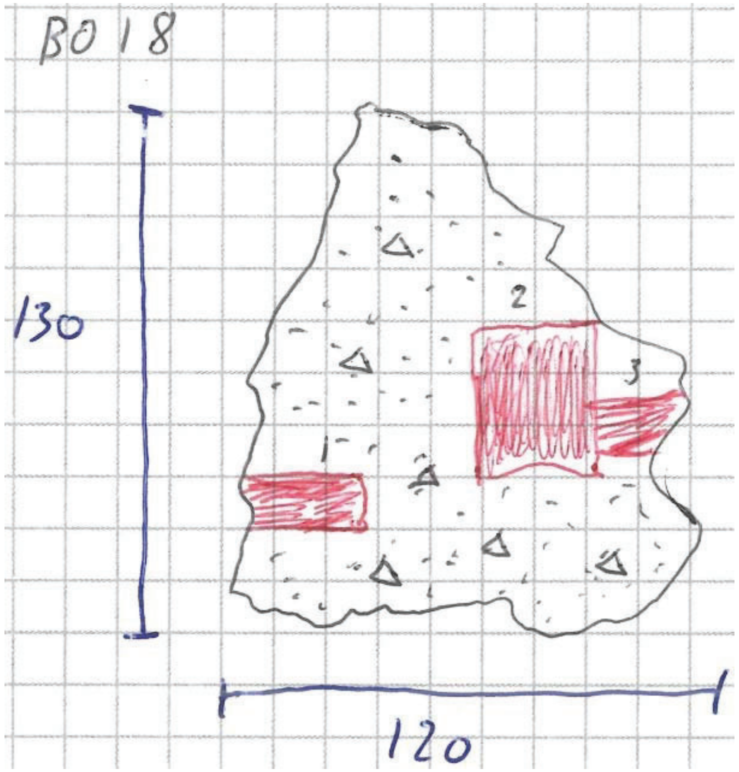
CRL SURVEYS Structural and building assessment



SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Breakout B17 – Living Room Wall B	August 2018	SUR183482	MAH/PW/JI

CRL SURVEYS
Structural and building assessment

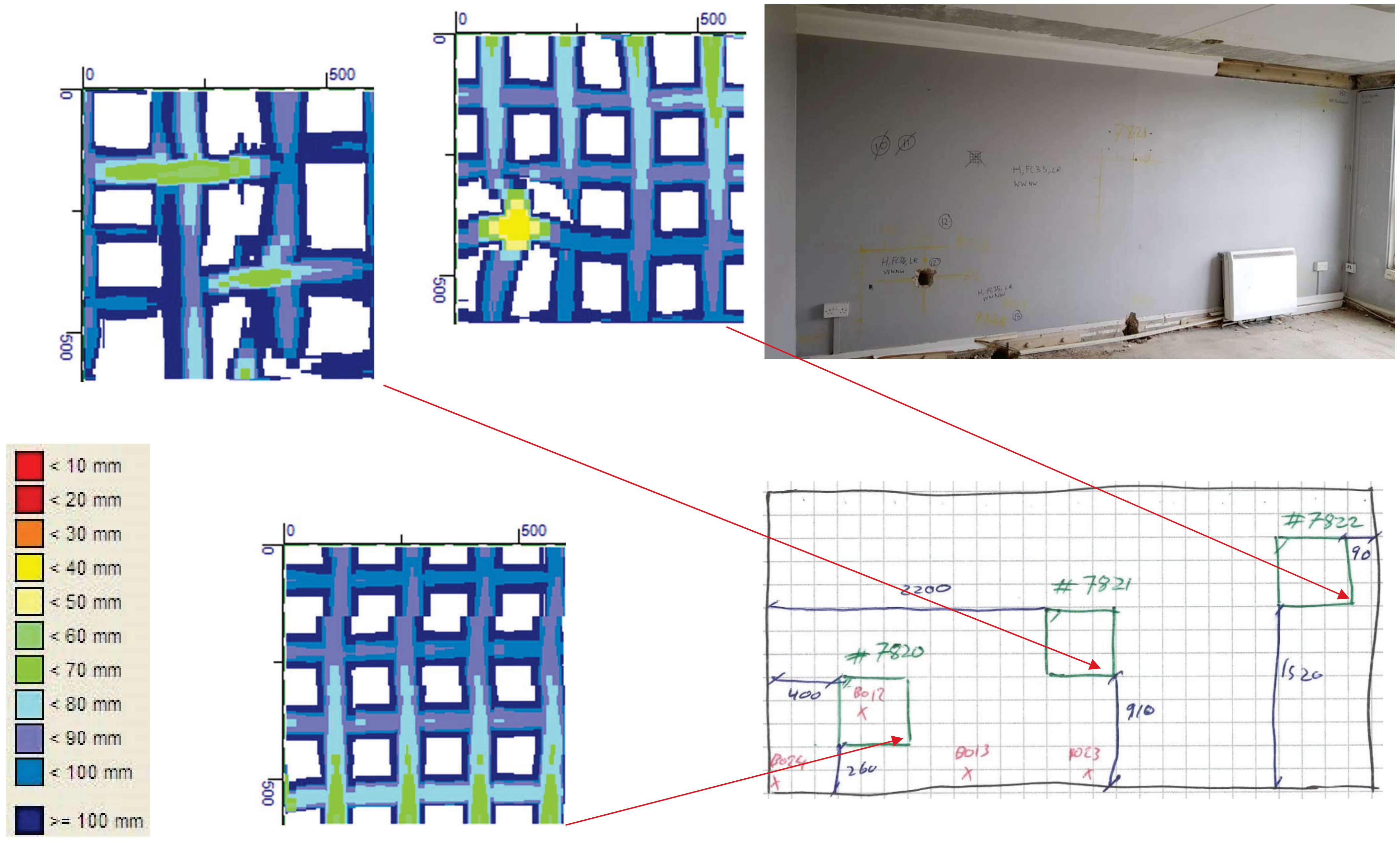




B18	*1*	*2*	*Plate 1*
Bar Ø (mm)	10	8	6
Bar Type	Round, Smooth	Round, Smooth	6mm Thick Plate
Min. Cover (mm)	33	90	120
Condition	Good	Good	Good

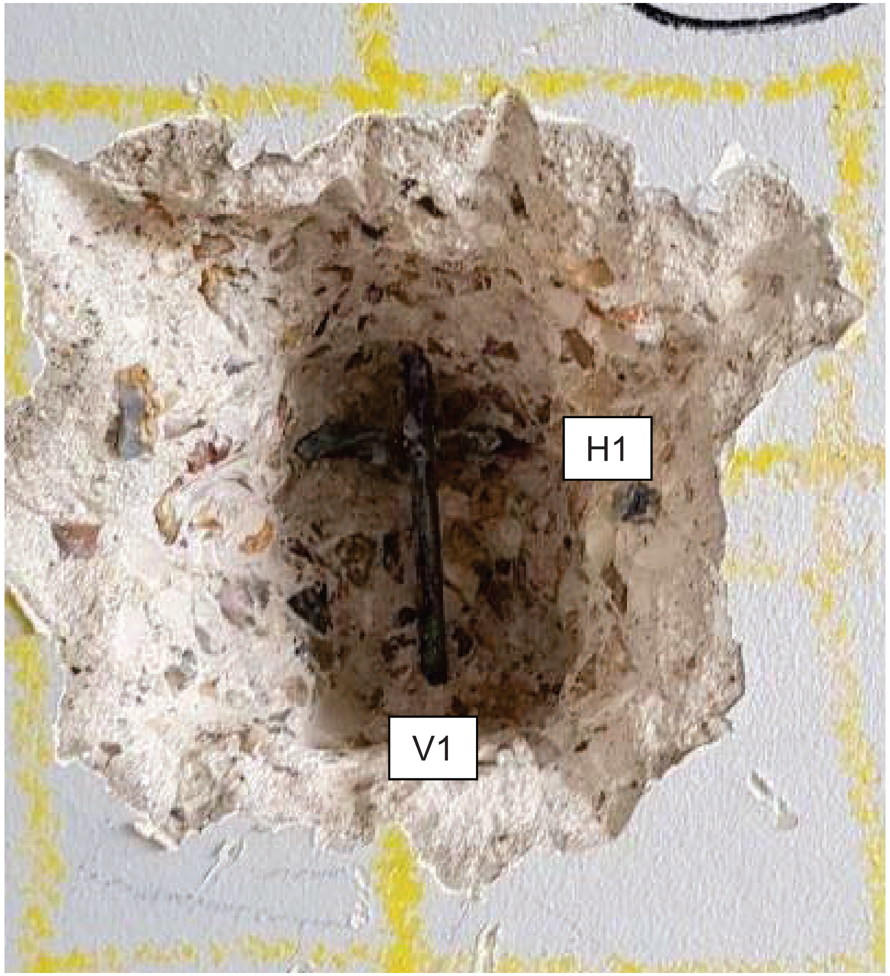
SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Breakout B18 – Living Room Wall B	August 2018	SUR183482	MAH/PW/ JI

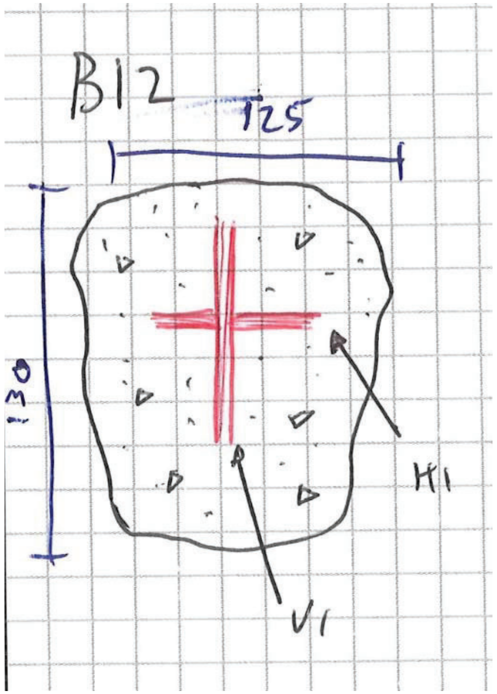
CRL SURVEYS
Structural and building assessment



SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Ferro Scan Survey – Living Room Wall C	August 2018	SUR183482	MAH/PW/ JI

CRL SURVEYS Structural and building assessment

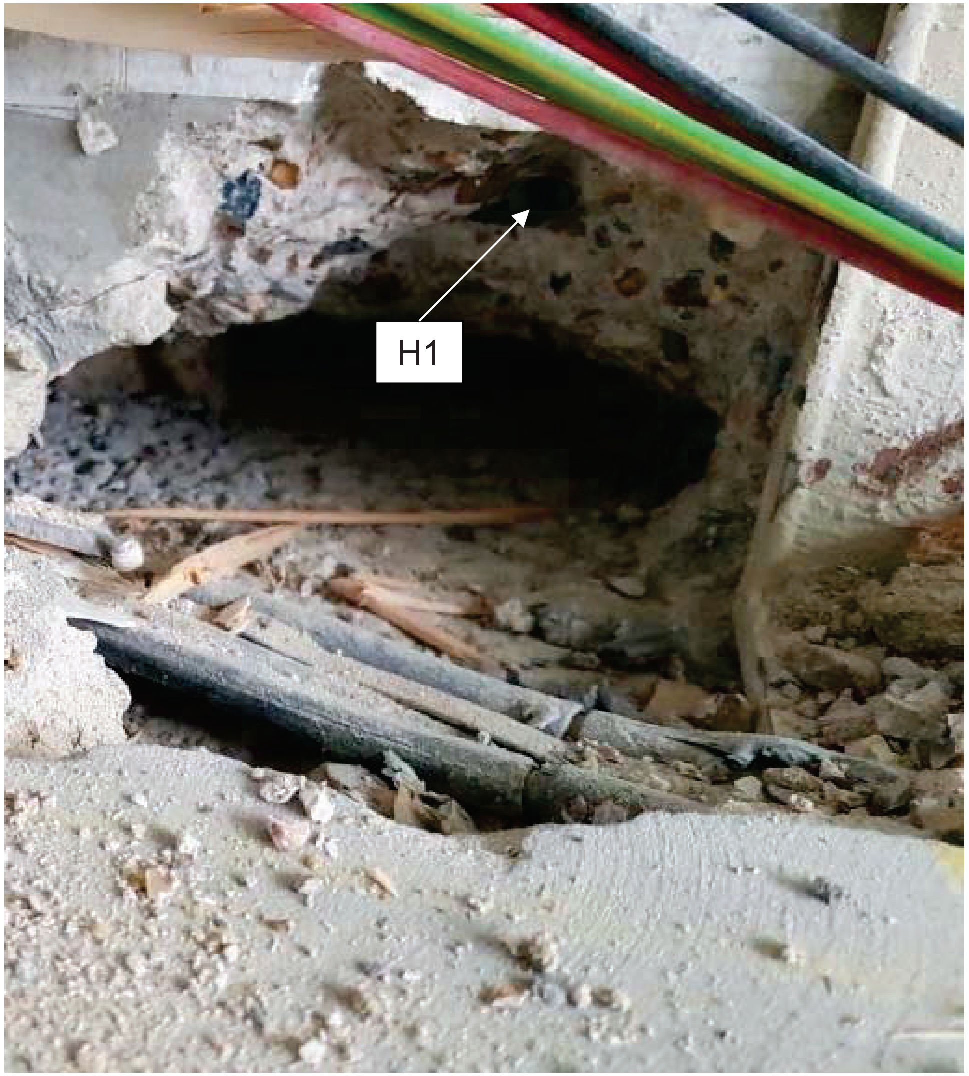


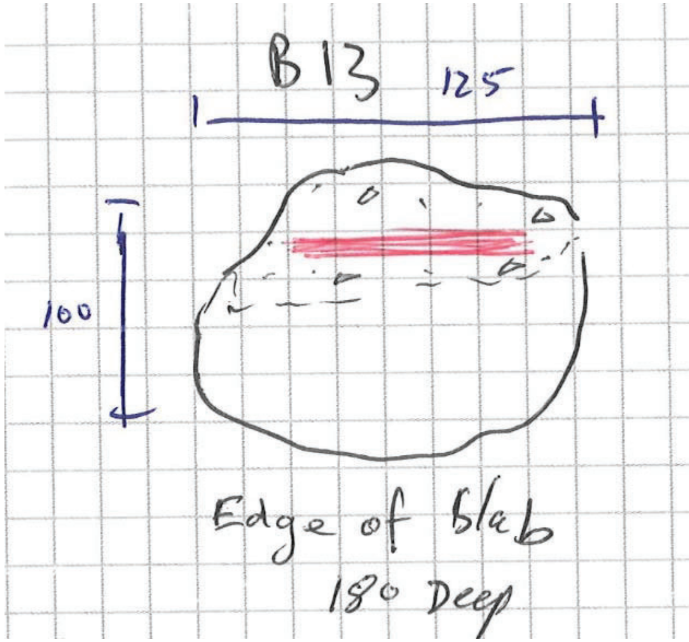


B12	*V1*	*H1*
Bar Ø (mm)	6	6
Bar Type	Round, Smooth	Round, Smooth
Min. Cover (mm)	72	77
Condition	Good	Good

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Breakout B12 – Living Room Wall C	August 2018	SUR183482	MAH/PW/ JI

CRL SURVEYS
Structural and building assessment

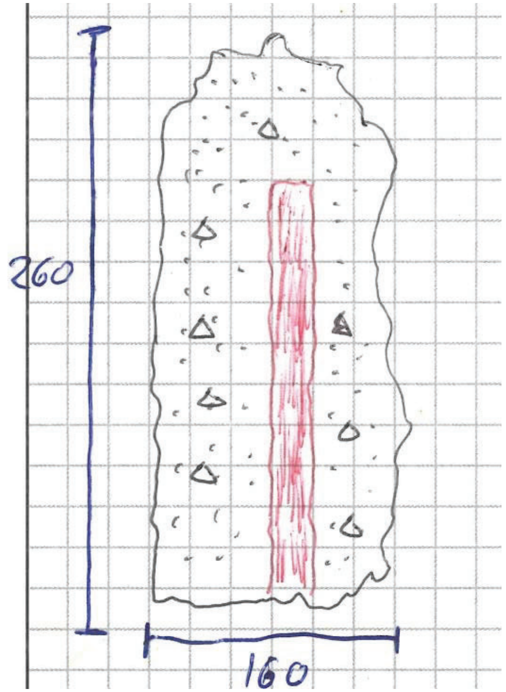




B13	*H1*
Bar Ø (mm)	10
Bar Type	Round, Smooth
Min. Cover (mm)	41
Condition	Good

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Breakout B13 – Living Room Wall C	August 2018	SUR183482	MAH/PW/JI

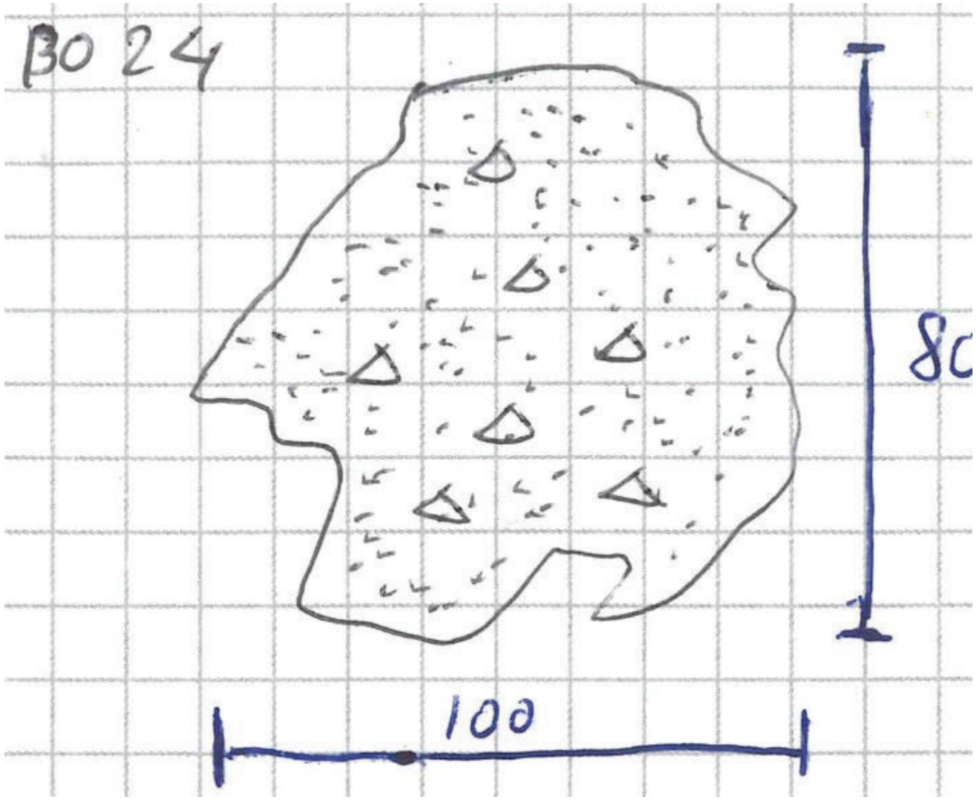
CRL SURVEYS Structural and building assessment



B23	*1*
Bar Ø (mm)	12
Bar Type	Round, Smooth
Min. Cover (mm)	62
Condition	Light Surface Corrosion

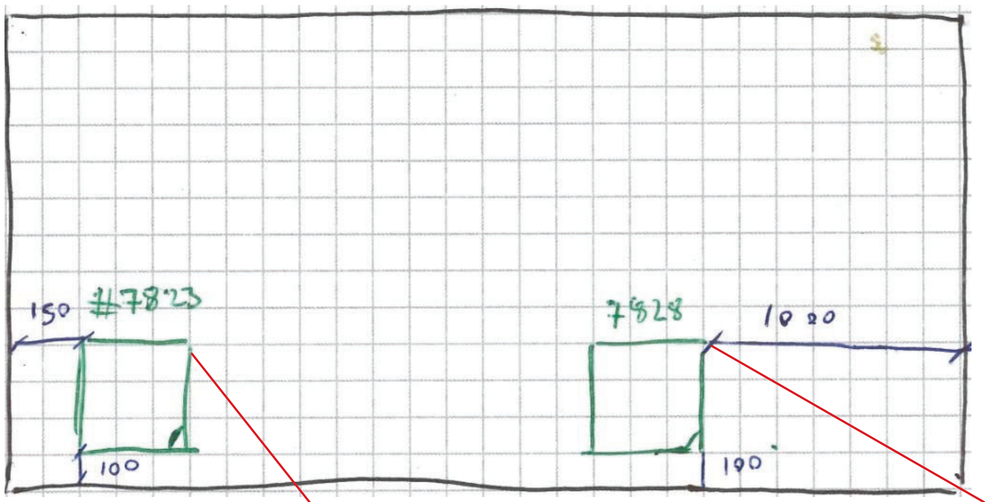
SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Breakout B23 – Living Room Wall C	August 2018	SUR183482	MAH/PW/JI

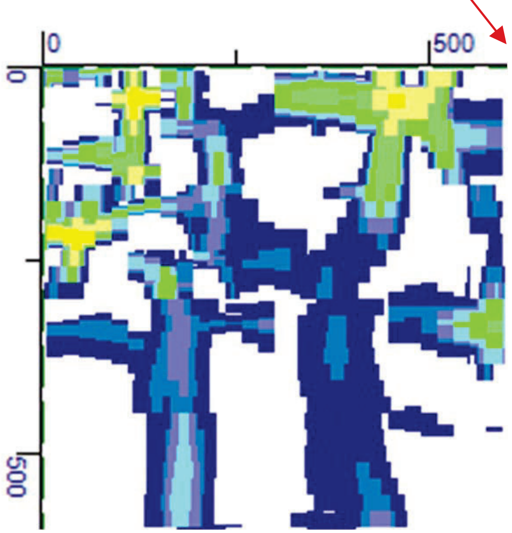
CRL SURVEYS
Structural and building assessment

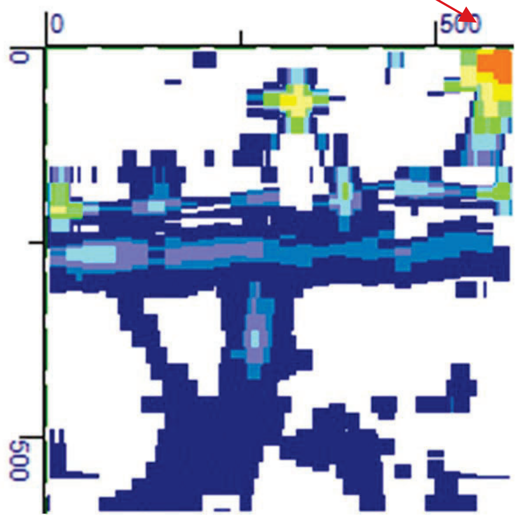


SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Breakout B24 – Living Room Wall C	August 2018	SUR183482	MAH/PW/ JI

CRL SURVEYS
Structural and building assessment







SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Ferro Scan Survey – Living Room Floor	August 2018	SUR183482	MAH/PW/ JI

CRL SURVEYS
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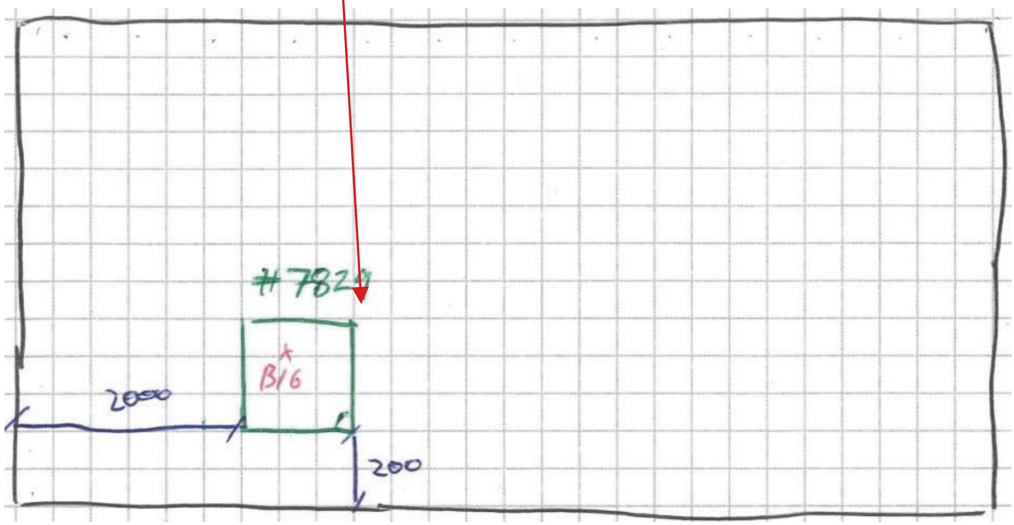
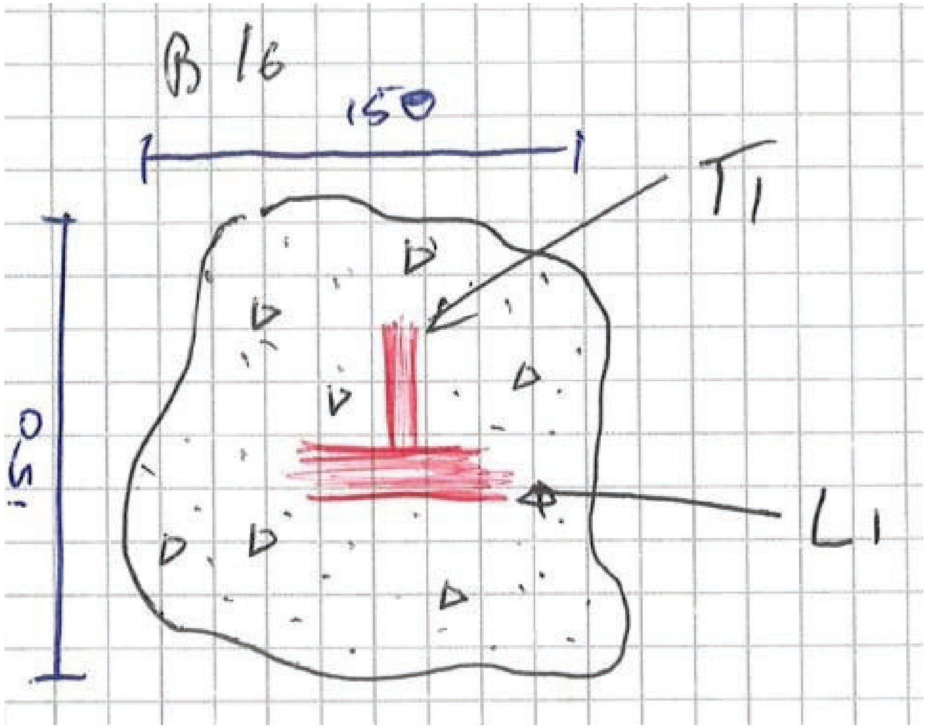


SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Ferro Scan Survey – Living Room Soffit	August 2018	SUR183482	MAH/PW/ JI

CRL SURVEYS
Structural and building assessment



B16	*L1*	*T1*
Bar Ø (mm)	12	6
Bar Type	Round, Smooth	Round, Smooth
Min. Cover (mm)	18	31
Condition	Good	Good

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Breakout B16 – Living Room Soffit	August 2018	SUR183482	MAH/PW/ JI

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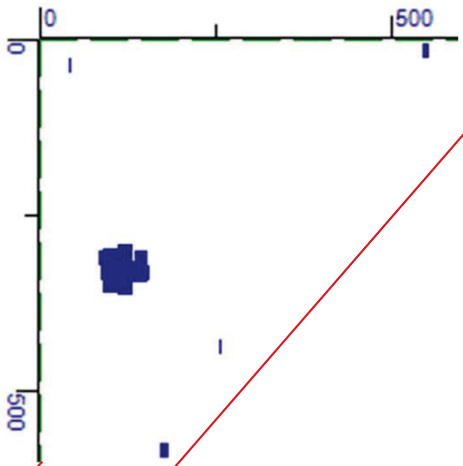

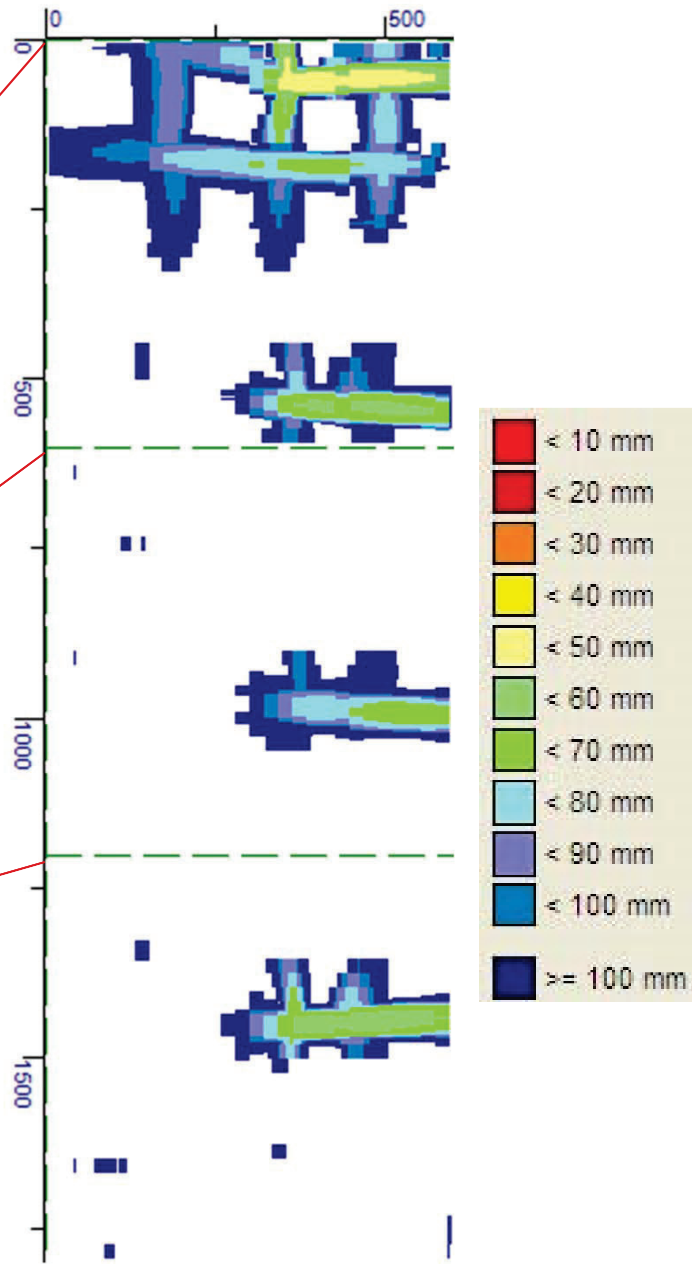

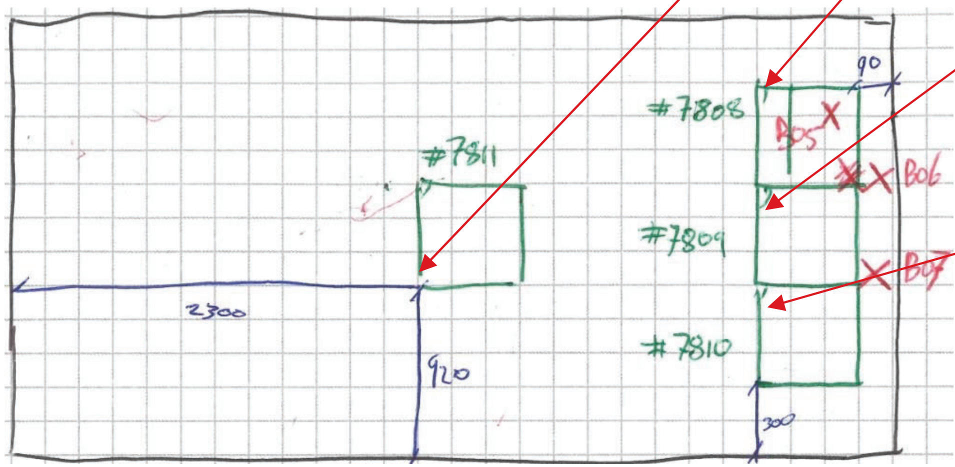

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Ferro Scan Survey – Bed Room 2 Wall A	August 2018	SUR183482	MAH/PW/ JI

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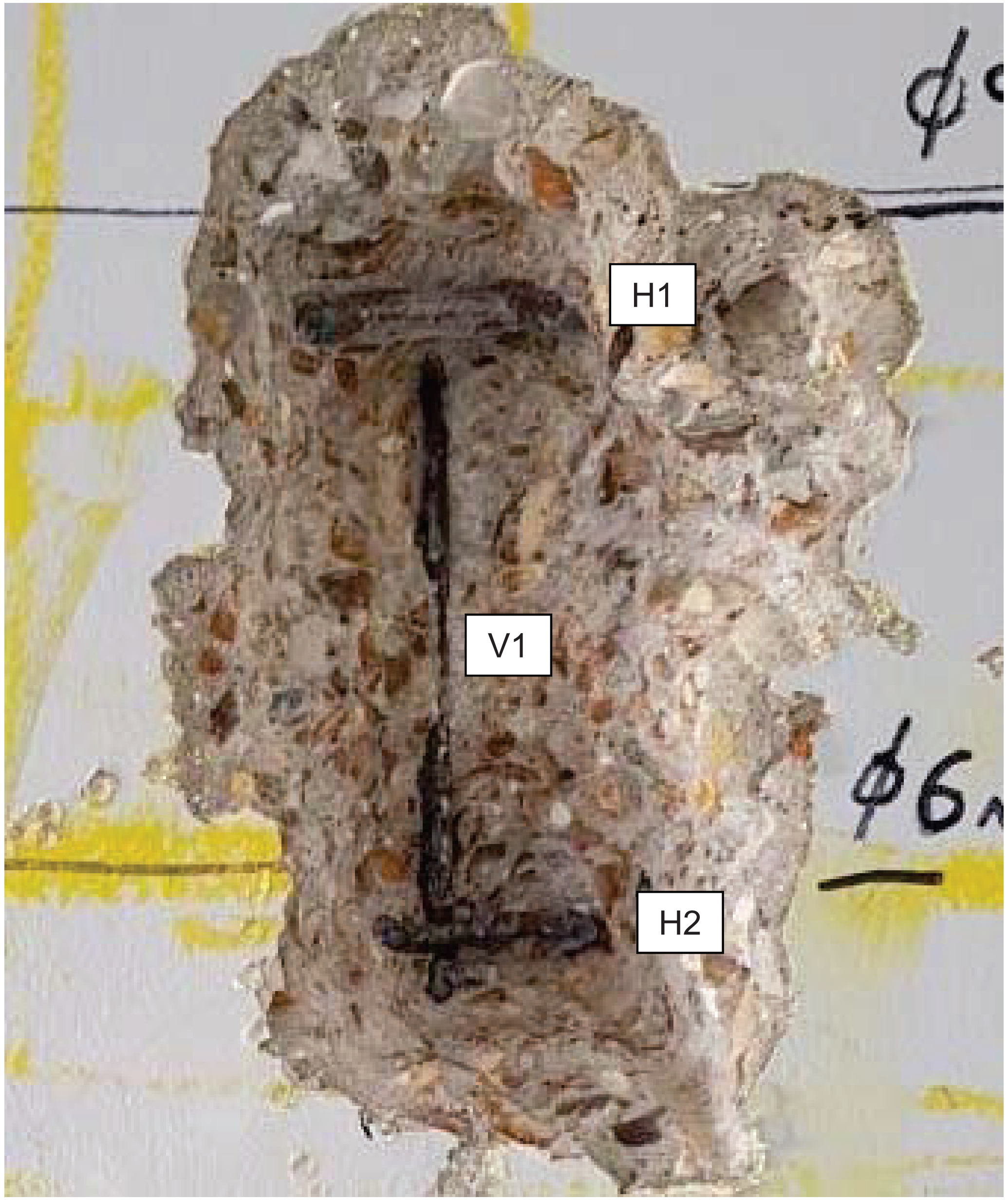

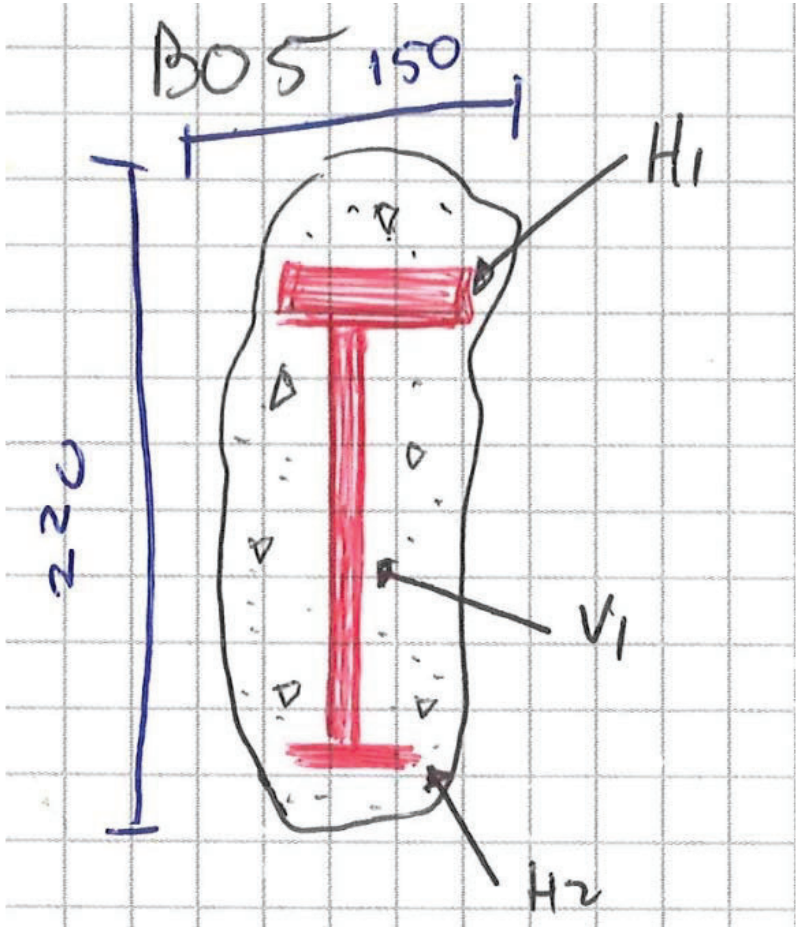

B05	*H1*	*H2*	*V1*
Bar Ø (mm)	10	6	6
Bar Type	Round, Smooth	Round, Smooth	Round, Smooth
Min. Cover (mm)	33	48	55
Condition	Good	Good	Good

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Breakout B05 – Bed Room 2 Wall A	August 2018	SUR183482	MAH/PW/ JI

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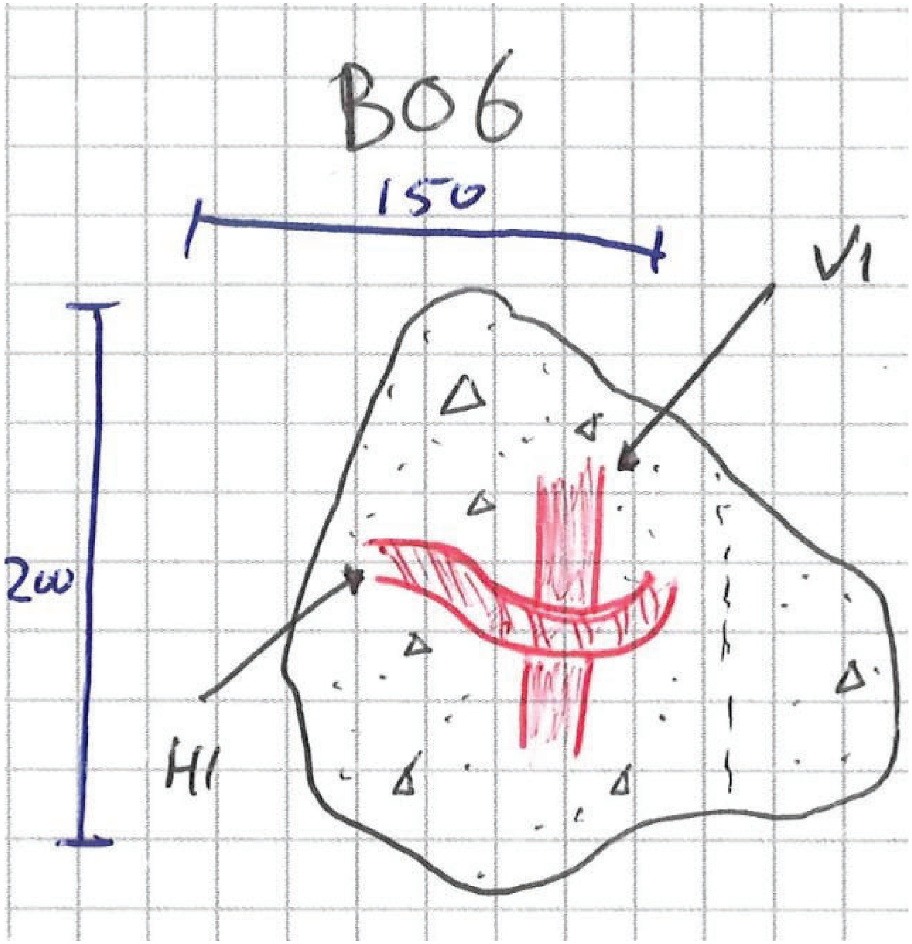

B06	*V1*	*H1*
Bar Ø (mm)	14	10
Bar Type	Round, Smooth	Round, Ribbed
Min. Cover (mm)	82	49
Condition	Good	Good

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Breakout B06 – Bed Room 2 Wall A	August 2018	SUR183482	MAH/PW/JI

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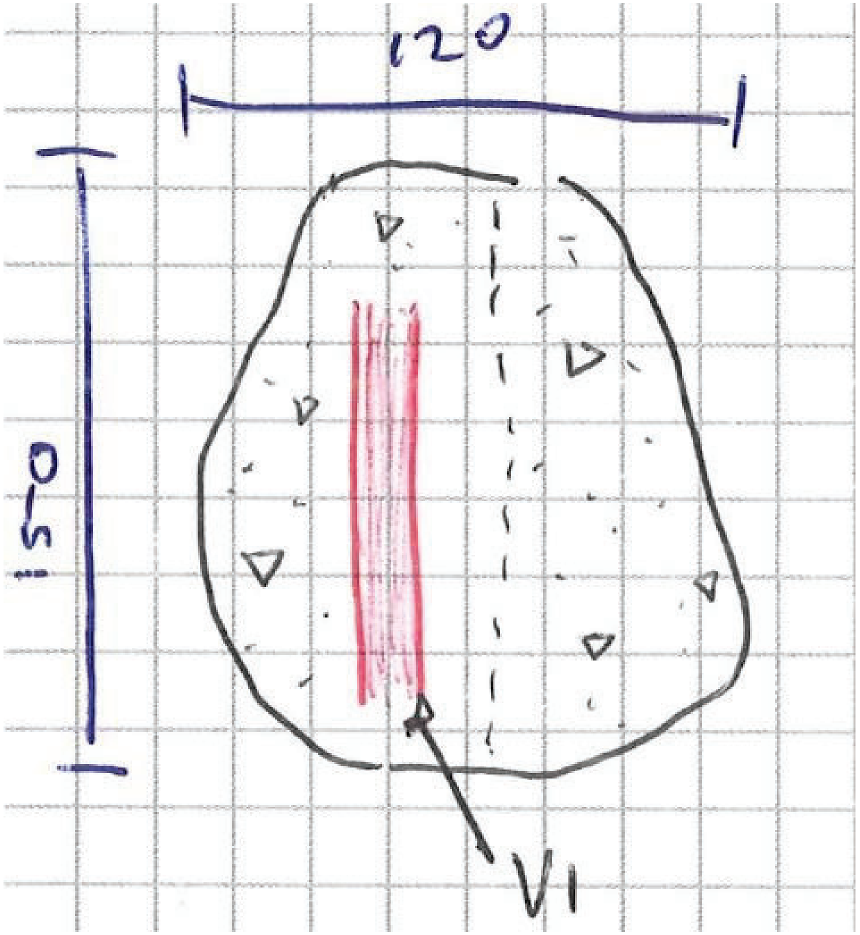
Structural and building assessment



B07	*V1*
Bar Ø (mm)	14
Bar Type	Round, Smooth
Min. Cover (mm)	76
Condition	Good

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Breakout B07 – Bed Room 2 Wall A	August 2018	SUR183482	MAH/PW/ JI

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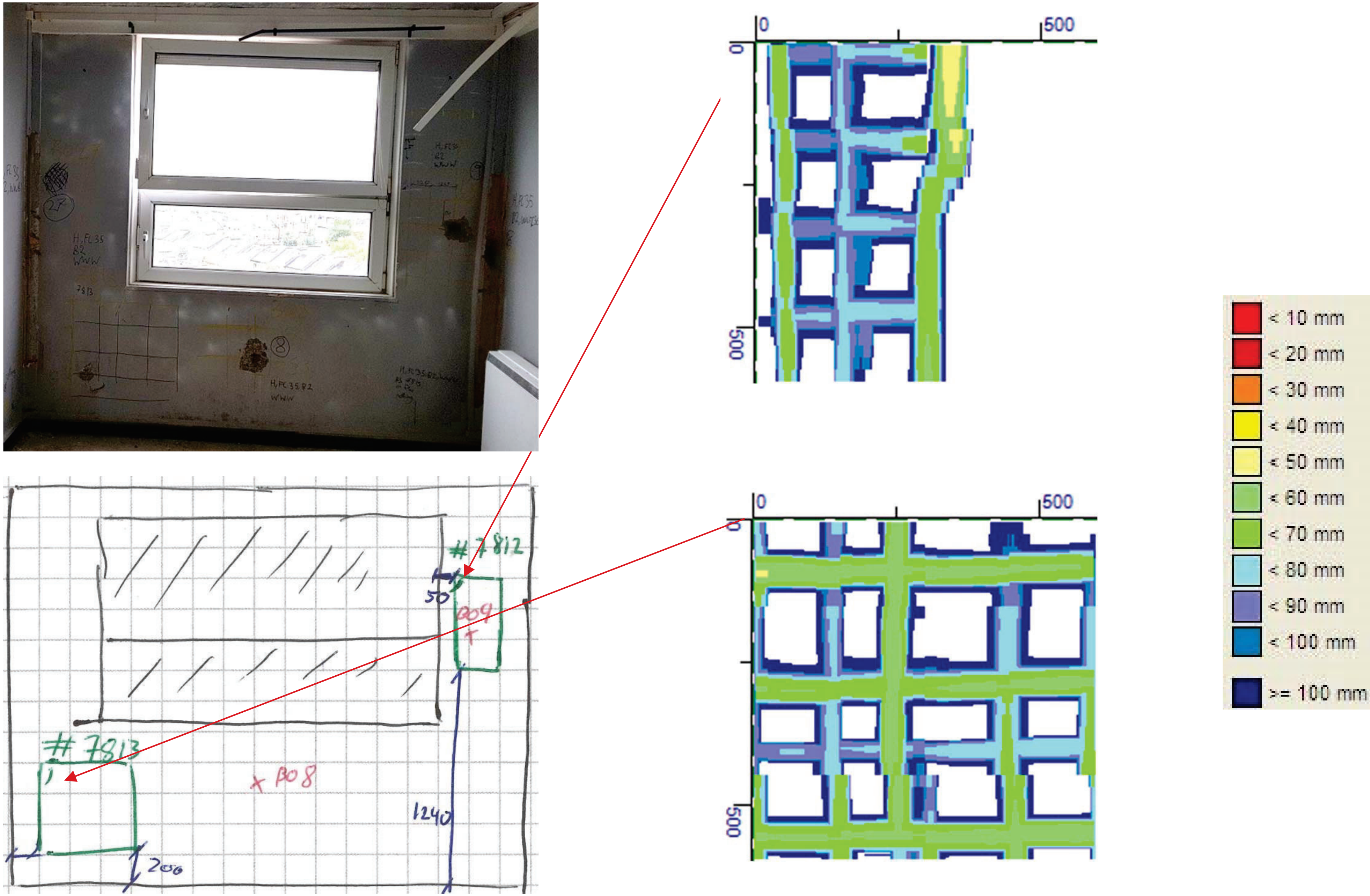
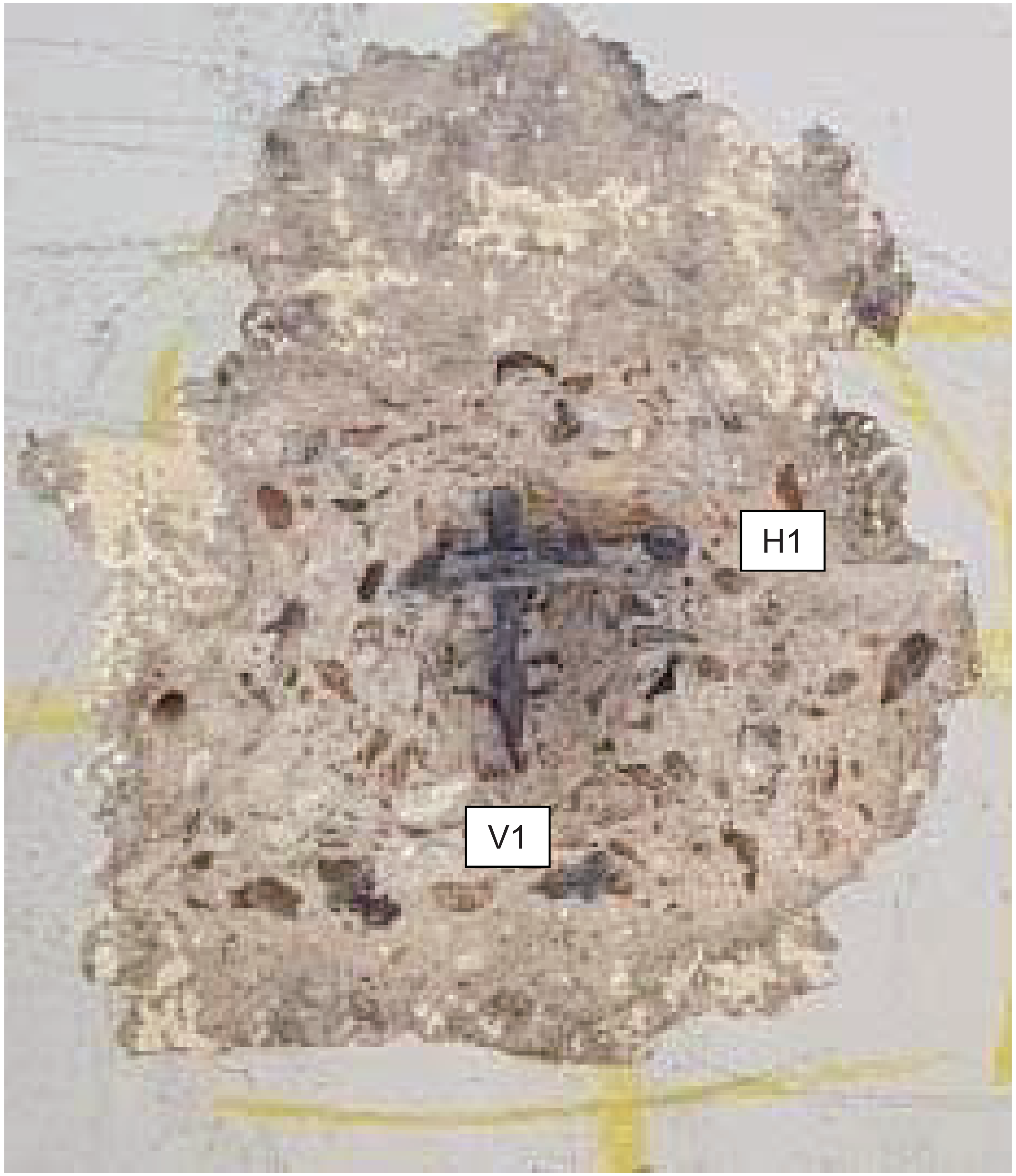
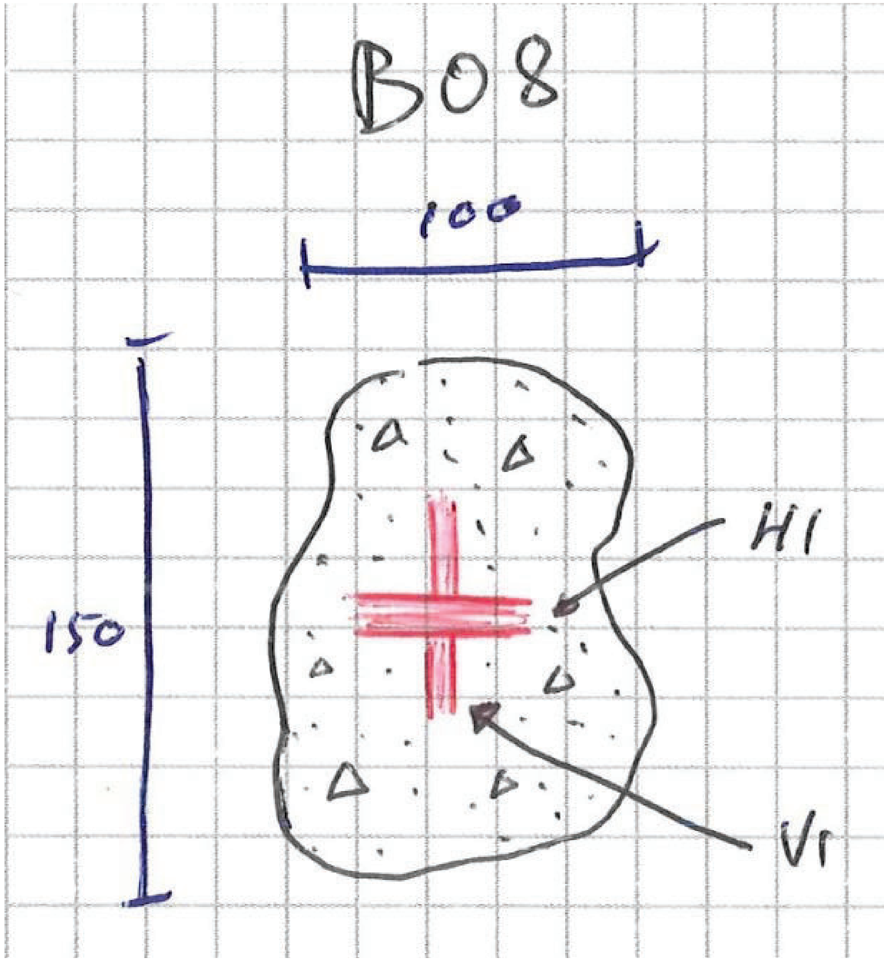


SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Ferro Scan Survey – Bed Room 2 Wall B	August 2018	SUR183482	MAH/PW/ JI

CRL SURVEYS
Structural and building assessment

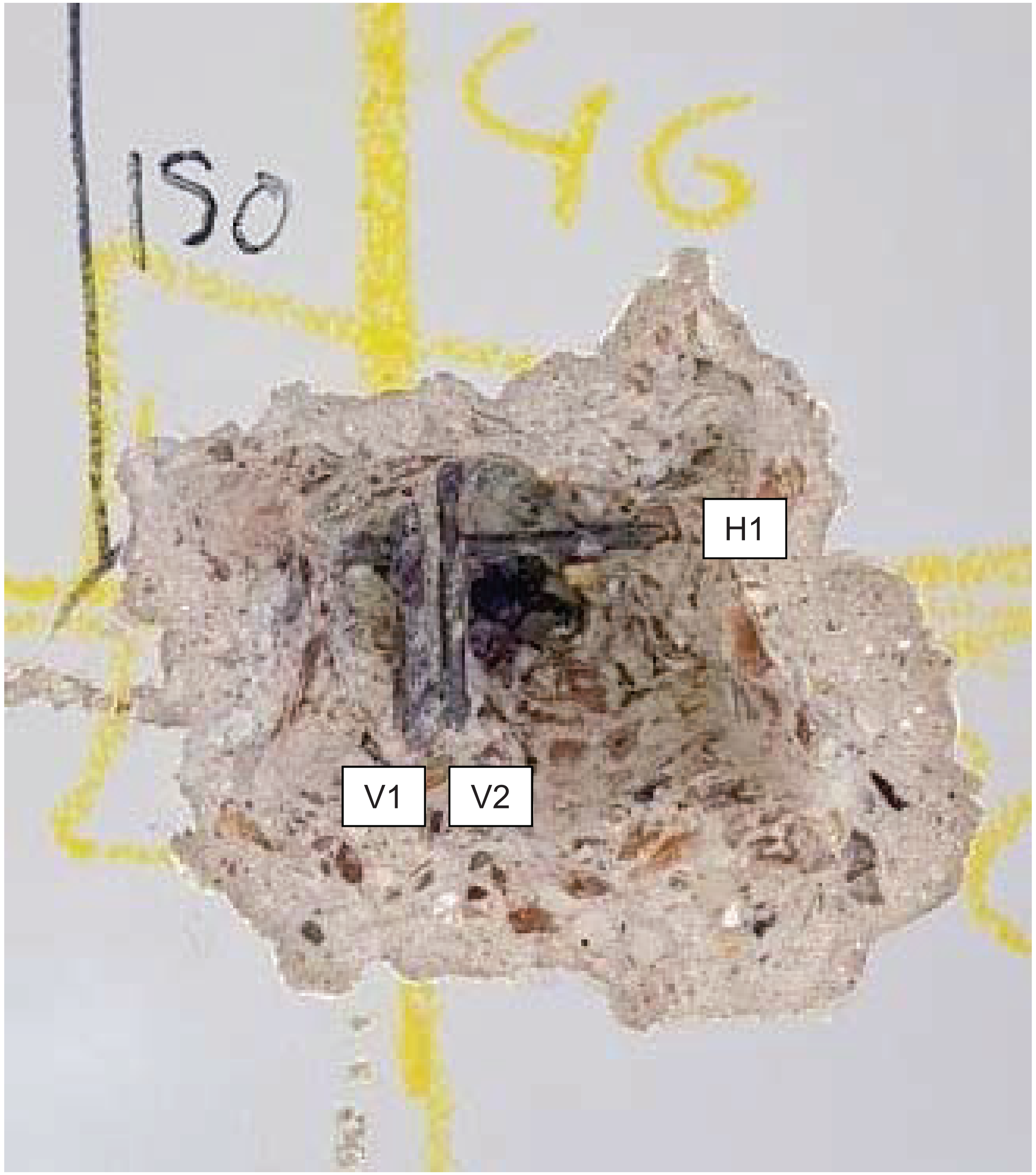


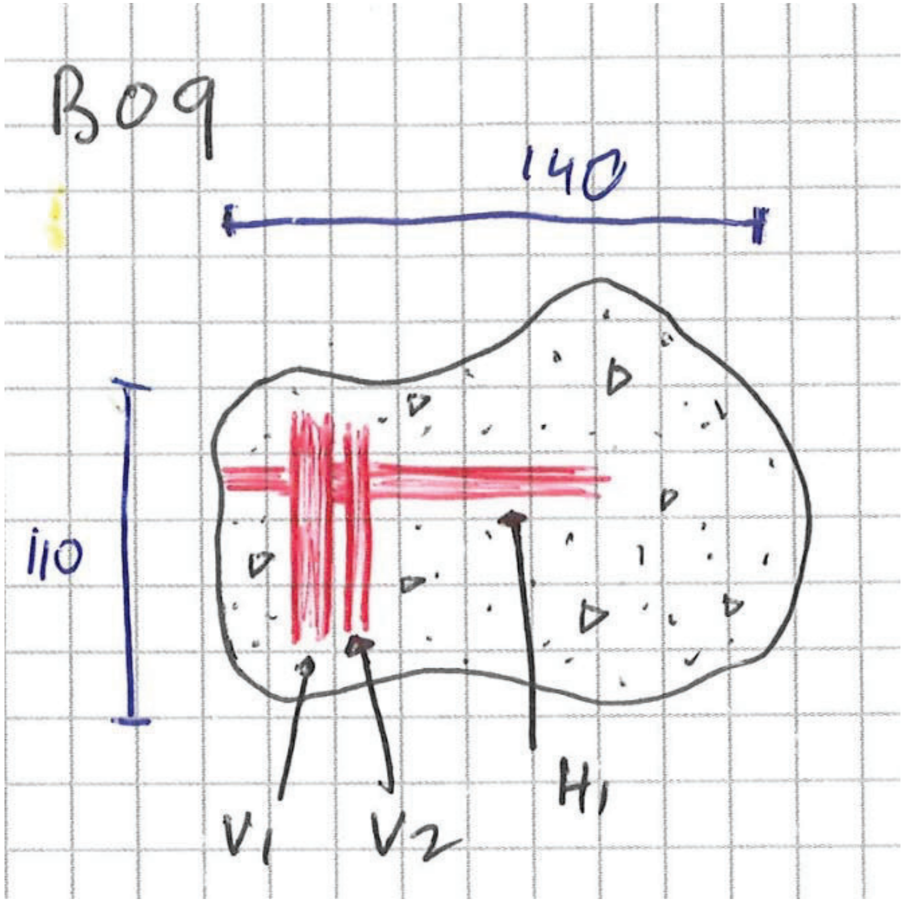


B08	*V1*	*H1*
Bar Ø (mm)	6	9
Bar Type	Round, Smooth	Round, Smooth
Min. Cover (mm)	43	36
Condition	Good	Good

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Breakout B08 – Bed Room 2 Wall B	August 2018	SUR183482	MAH/PW/JI

CRL SURVEYS
Structural and building assessment

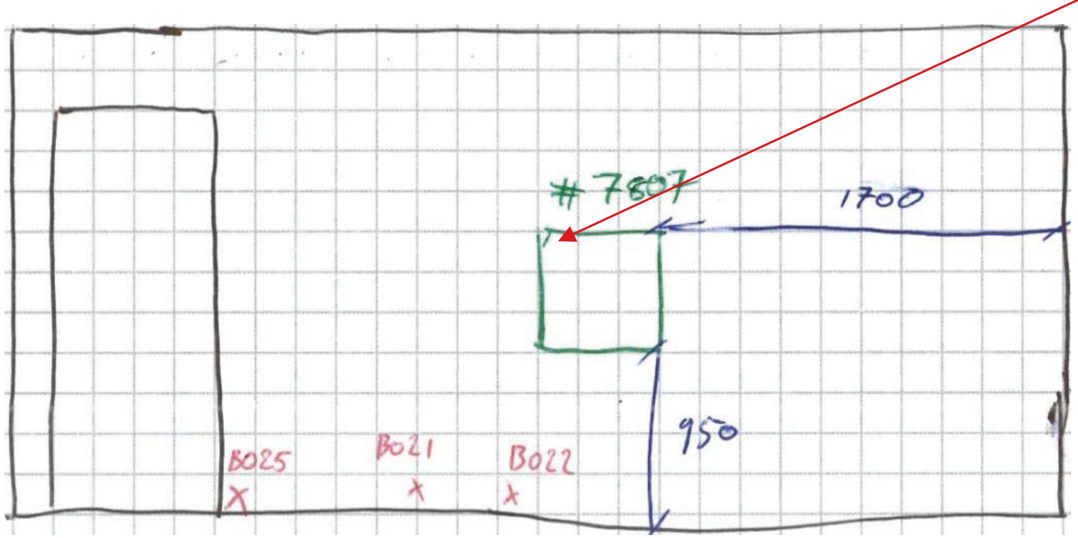


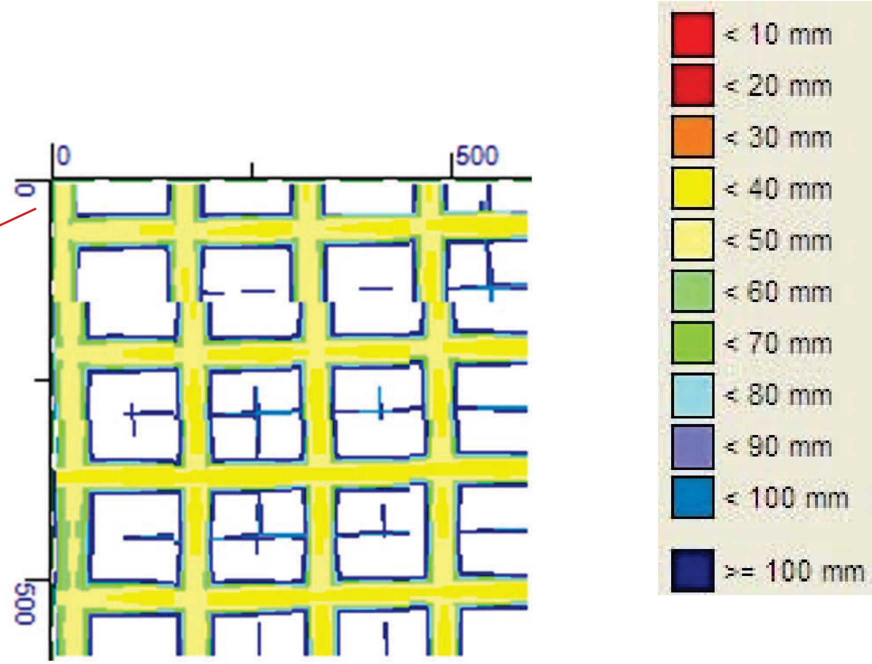


B09	V1	V2	H1
Bar Ø (mm)	6	4	4
Bar Type	Round, Smooth	Round, Smooth	Round, Smooth
Min. Cover (mm)	46	48	53
Condition	Good	Good	Good

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Breakout B09 – Bed Room 2 Wall B	August 2018	SUR183482	MAH/PW/ JI

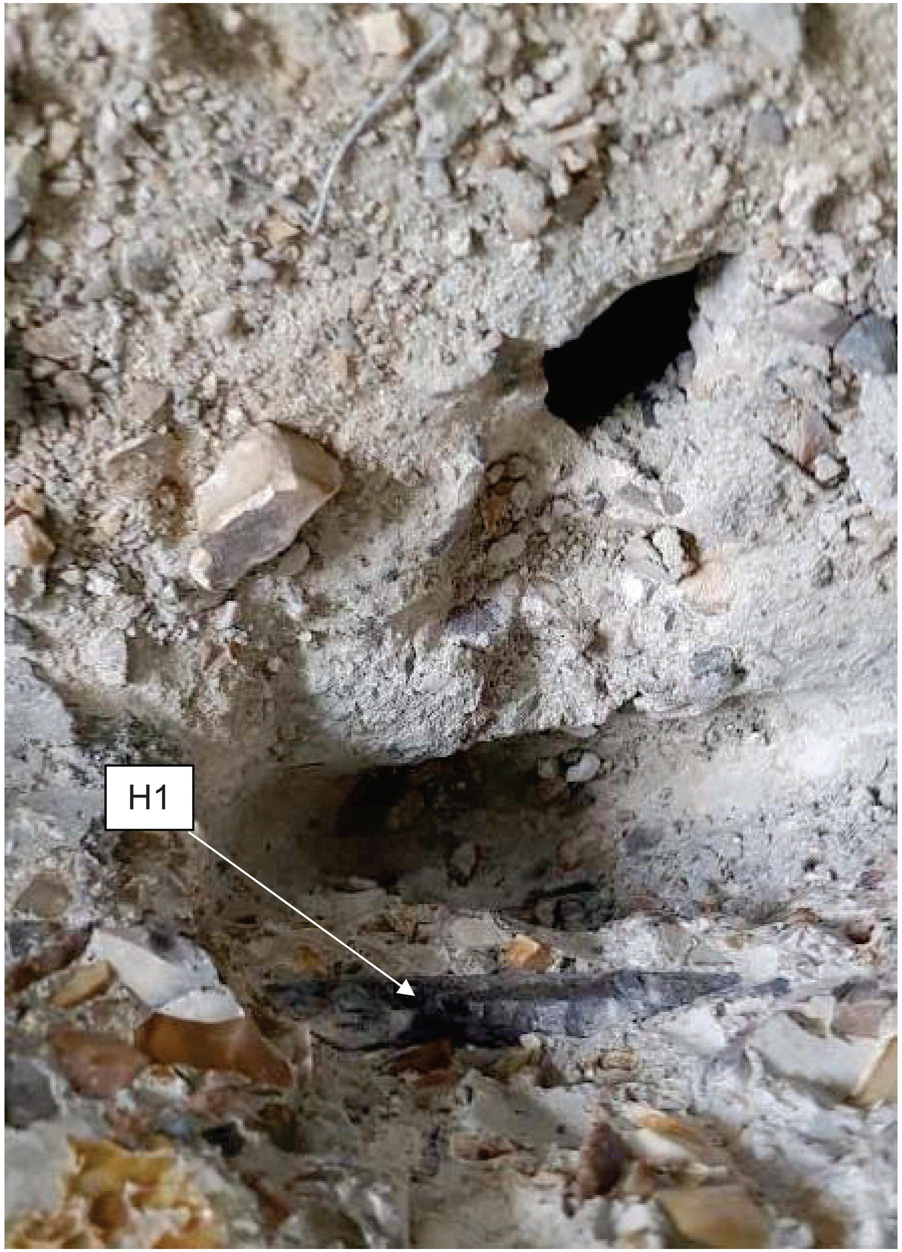
CRL SURVEYS
Structural and building assessment

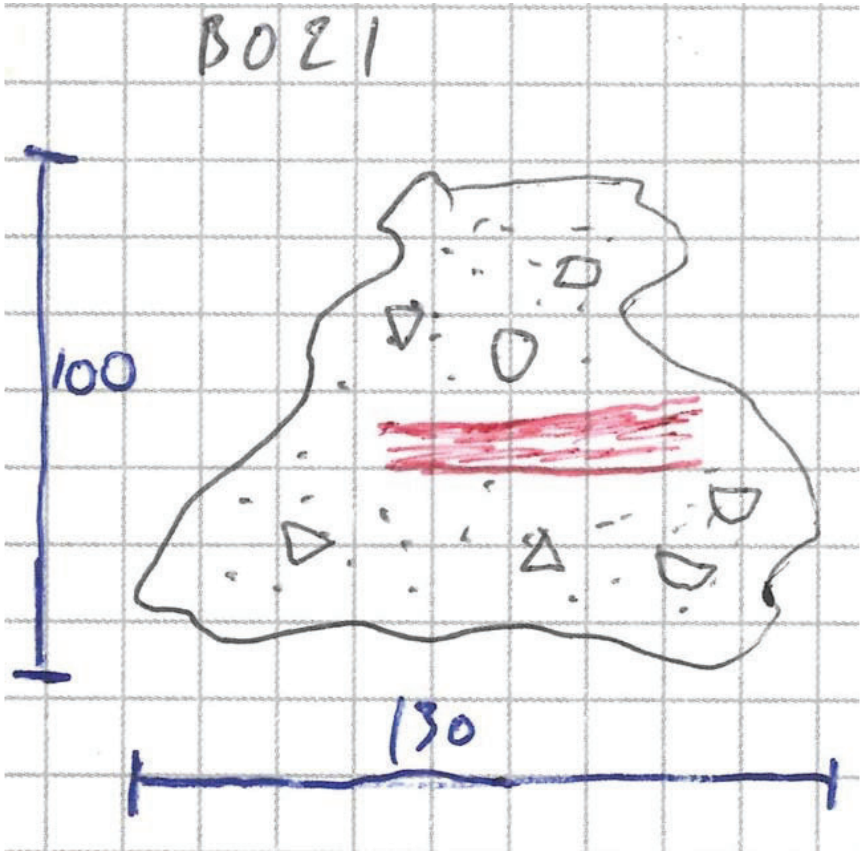




SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Ferro Scan Survey – Bed Room 2 Wall C	August 2018	SUR183482	MAH/PW/JI

CRL SURVEYS
Structural and building assessment

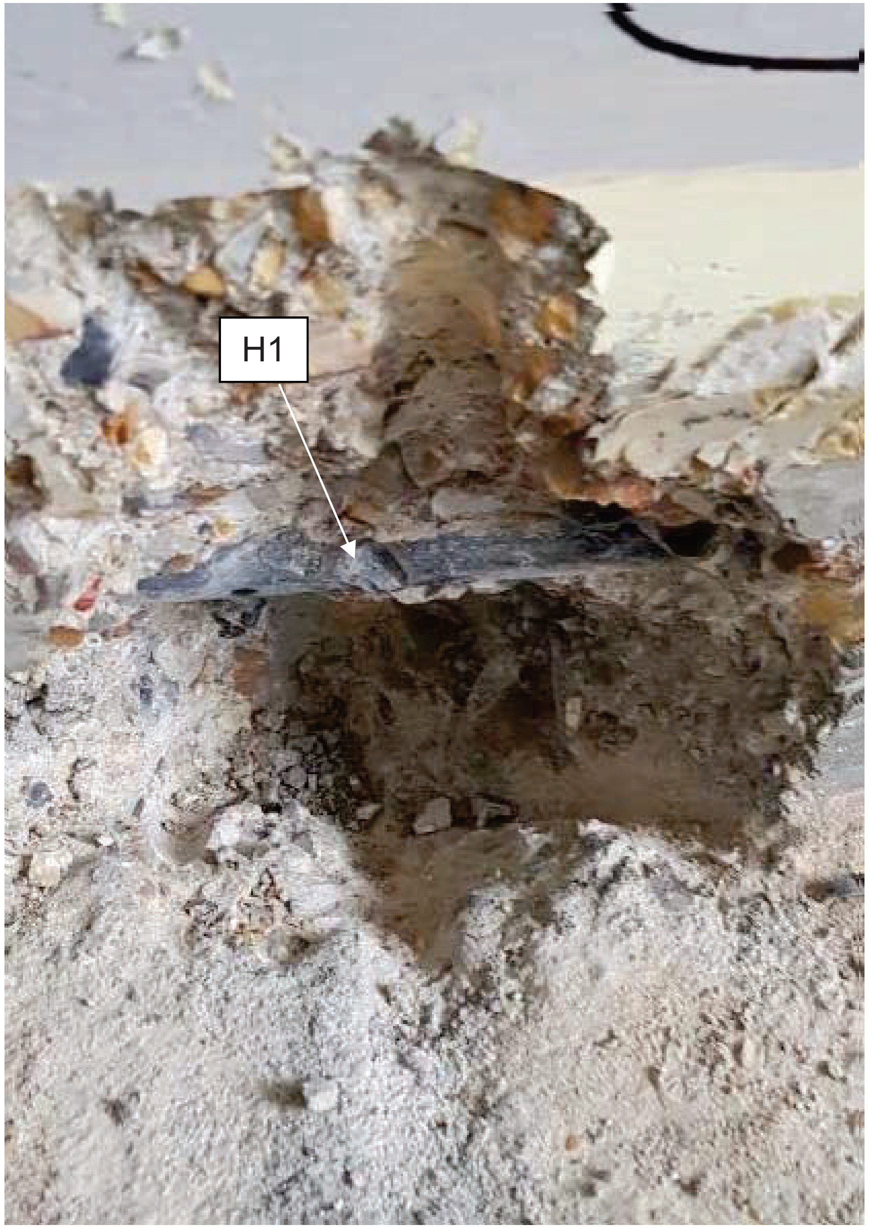


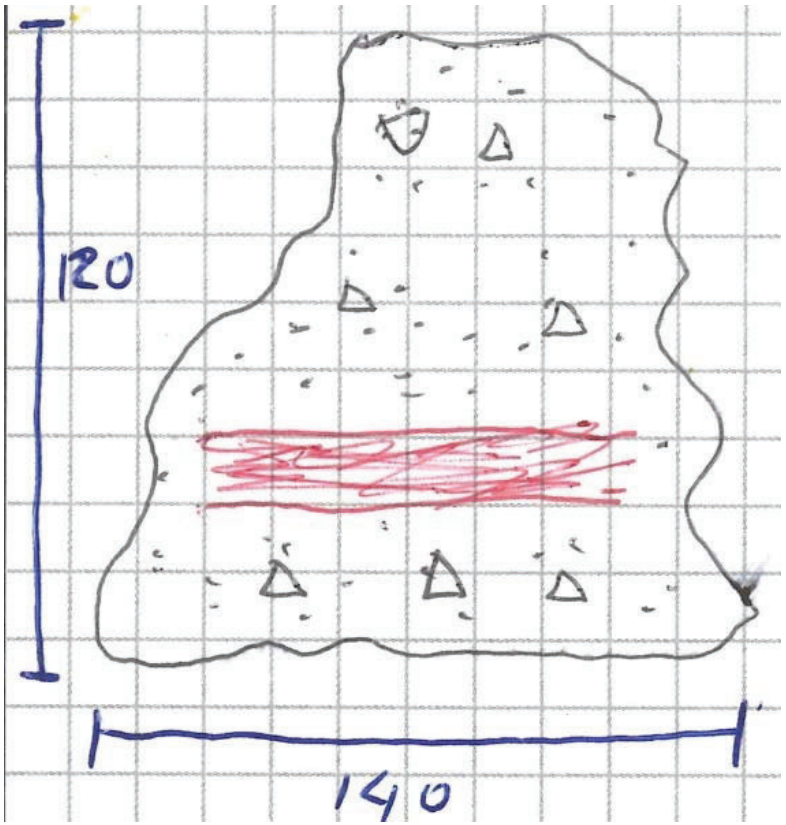


B21	1
Bar Ø (mm)	10
Bar Type	Round Smooth
Min. Cover (mm)	19
Condition	Good

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Breakout B21 – Bed Room 2 Wall C	August 2018	SUR183482	MAH/PW/JI

CRL SURVEYS Structural and building assessment

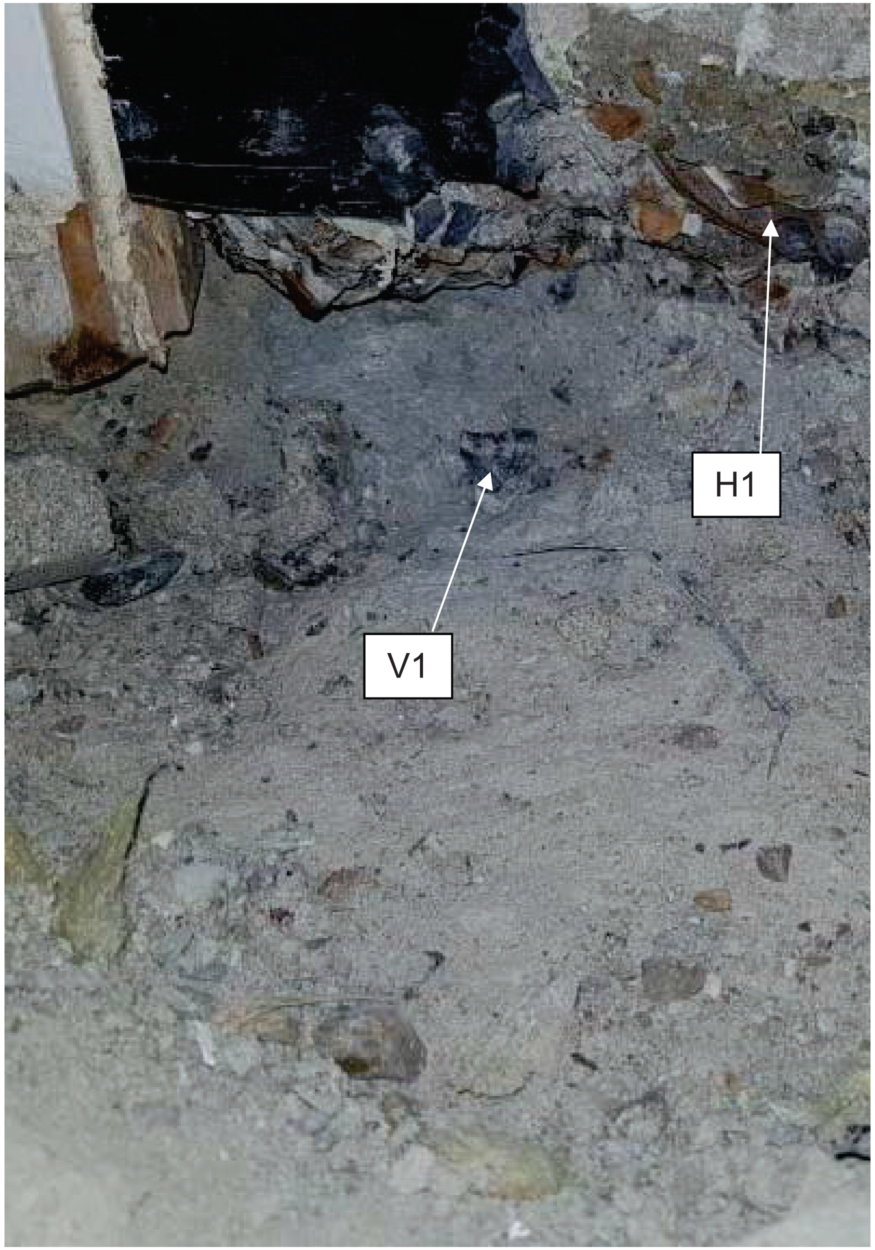


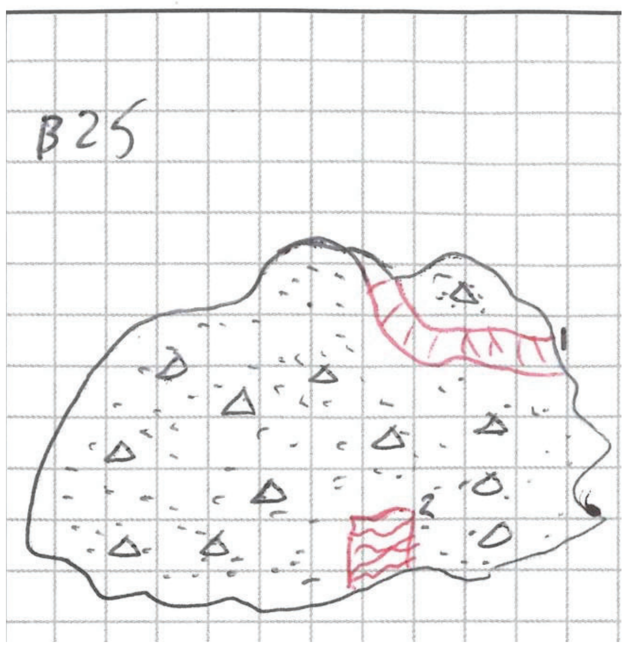


B22	*1*
Bar Ø (mm)	10
Bar Type	Round, Smooth
Min. Cover (mm)	18
Condition	Good

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Breakout B22 – Bed Room 2 Wall C	August 2018	SUR183482	MAH/PW/JI

CRL SURVEYS Structural and building assessment

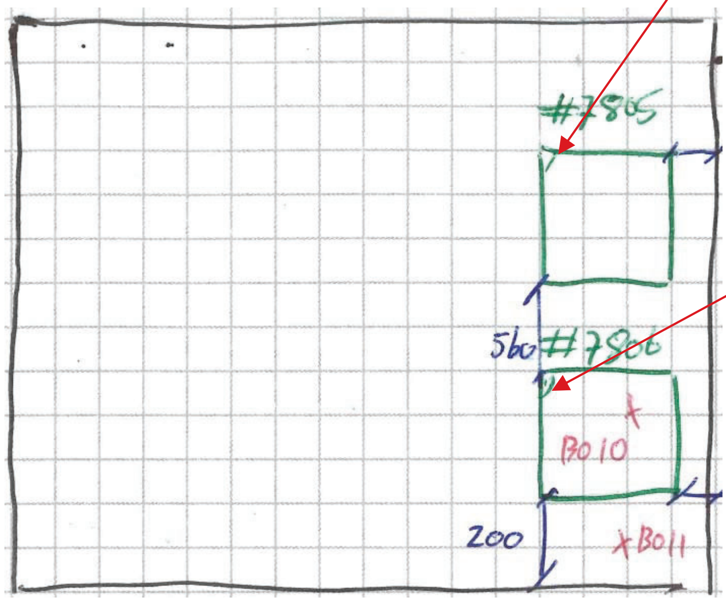


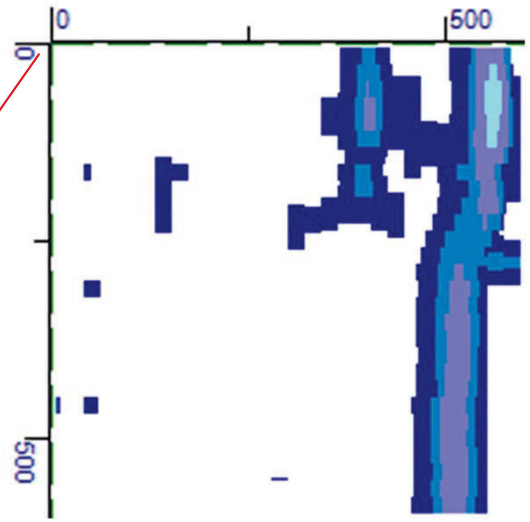


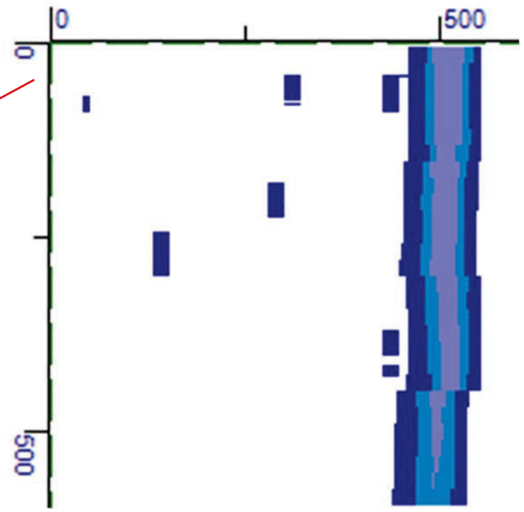
B25	*1*	*2*
Bar Ø (mm)	10	14
Bar Type	Ribbed, Round	Ribbed, Round
Min. Cover (mm)	9	25
Condition	Good	Good

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Breakout B25 – Bed Room 2 Wall C	August 2018	SUR183482	MAH/PW/ JI

CRL SURVEYS
Structural and building assessment

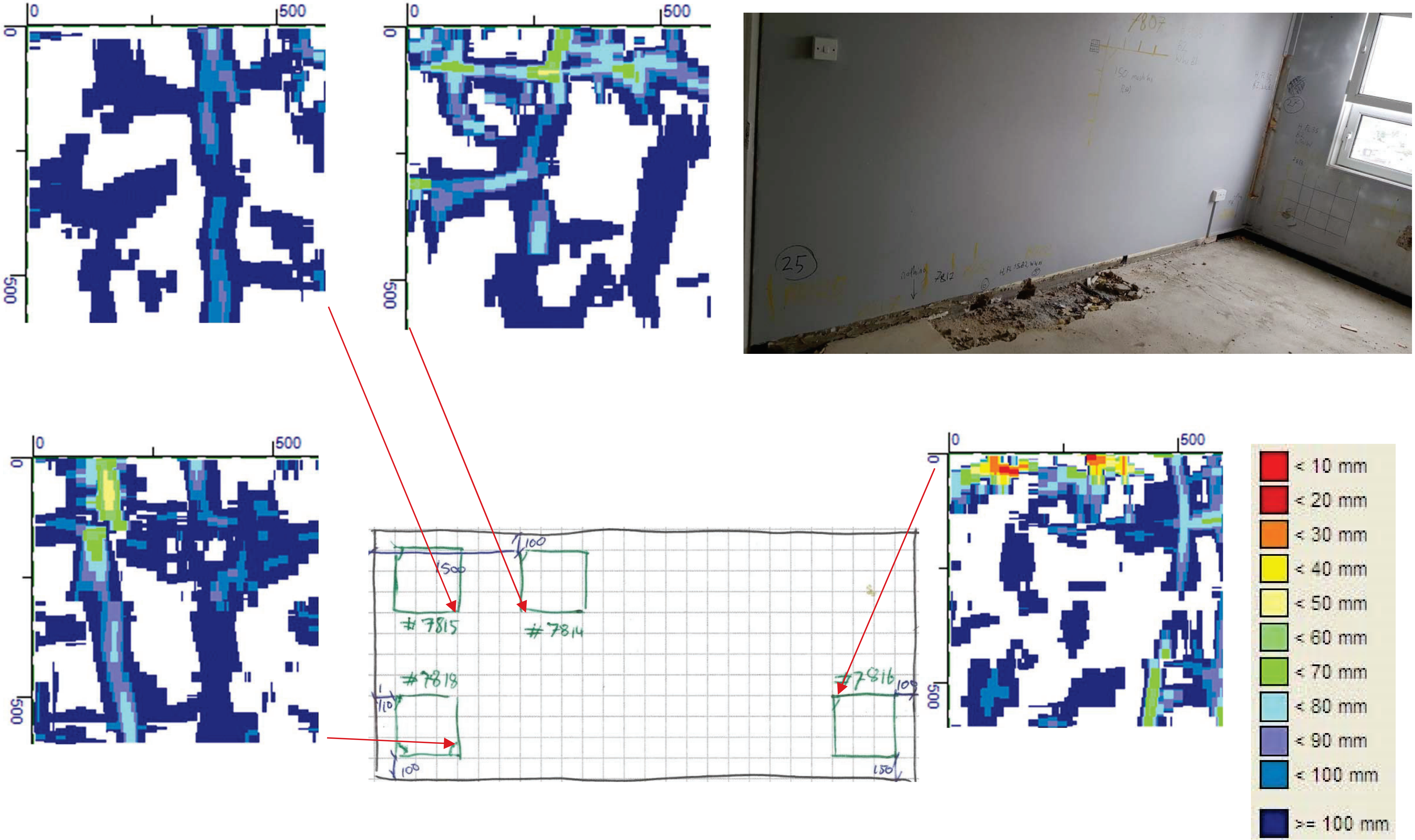






< 10 mm
< 20 mm
< 30 mm
< 40 mm
< 50 mm
< 60 mm
< 70 mm
< 80 mm
< 90 mm
< 100 mm
>= 100 mm

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Ferro Scan Survey – Bed Room 2 Wall D	August 2018	SUR183482	MAH/PW/ JI



SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building - Flat 35	Ferro Scan Survey – Bed Room 2 Floor	August 2018	SUR183482	MAH/PW/ JI

CRL SURVEYS
Structural and building assessment

END OF REPORT

Appendix B

Extracts from Stage 2 Survey Report

(partially reproduced, with permission from CRL)

LIMITED INVESTIGATION WORKS
TO
HARTOPP & LANNOY POINTS
FOR
LONDON BOROUGH OF HAMMERSMITH & FULHAM

CONTRACT DETAILS			
Contract No.:	SUR183696		
Site:	Hartopp & Lannoy Points Fullham SW6 7NQ		
Client:	London Borough of Hammersmith & Fulham 3rd Floor Hammersmith Town Hall Extension King Street Hammersmith London W6 9JU **For the attention of** [redacted]		
FOR CRL SURVEYS			
Documentation Authored By:	[redacted]		
Report Prepared By:	[redacted]	**Signed:**	[redacted]
Checked / Approved By:	[redacted]	**Signed:**	[redacted]
REPORT DETAILS			
This Report Comprises:	11 pages of text Appendix A (25 Pages)	**Issue Record**	
		Date	**Revision**
		6th December 2018	0

UKAS Accreditation Address:- CRL Surveys, No.2 The Stables, 46 Castle Hill, Kenilworth CV8 1NB
Only testing bearing the UKAS mark is included in the UKAS accreditation schedule for this organisation.
Opinions and interpretations expressed are outside the scope of UKAS accreditation.

CONTENTS

1 REPORT REVISIONS RECORDS

Revised by	Date	Revision Details

2 INTRODUCTION

2.1 REFERENCES

Arup c/o London Borough of Hammersmith & Fulham email CRL Surveys dated 23rd October 2018.

CRL Surveys Quotation Letter Ref: ESUR1834347/SK/sk dated 30th October 2018.

London Borough of Hammersmith & Fulham email to CRL Surveys with Purchase Order Ref: PO [redacted] dated 7th November 2018.

2.2 GENERAL BACKGROUND

CRL Surveys were asked by [redacted] of London Borough of Hammersmith & Fulham to carry out investigation works to selected flats within the Hartopp and Lannoy Points buildings, working under the direction of Arup.

We were particularly asked to undertake ferroscan surveys along with exploratory breaking out to confirm construction details.

Our Technicians attended site on the 12th, 13th and 20th November 2018 and their findings are detailed as follows.

4 PROCEDURES

4.1 TERMS OF REFERENCE

4.1.1 Site Records and Drawings

The default presentation of results is using Site Record Sheets and pro-forma, for recording observations, test data and details gathered on site, with either neat hand-drawn sketches, or Client supplied AutoCAD outlines, annotated by hand, with standardised schedules of dilapidations and defects, neatly annotated by hand.

Unless specifically requested, we have not re-processed these documents further.

4.1.2 Dimensional Measurement

Dimensional measurement is undertaken as an inherent part of many of the following activities and although all dimensions recorded should be taken as 'approximate', every effort has been made to ensure the precision and accuracy of the approximations.

All dimensional measurements less than, 'nominally', 300mm, e.g. where checking reinforcement bar diameters, measuring depths of drilling (dust samples), measuring depths of carbonation, or measuring small defects etc., were measured using calibrated steel rules, manufactured to EU Class I. Where steel rules would not fit, e.g. within small breakouts etc., engineers dividers were employed, with dimensions transferred from a calibrated steel rule manufactured to EU Class I. Such measurements were generally rounded to the nearest whole mm.

All dimensional measurements greater than, 'nominally', 300mm, e.g. where measuring larger defect sizes or structural dimensions, were undertaken using measuring tapes manufactured to EU Class I. [1] We again generally rounded such measurements to the nearest whole mm.

> **NB:** The condition of the steel rules, measuring tapes, and engineer's dividers were checked prior to every shift / measurement and only used if in good condition, i.e. the ends / edges / points were straight, sharp and undamaged, with the gradations / values / markings clearly legible.

4.2 STRUCTURAL DETAILS

4.2.1 Reinforcement Distribution and Detailing

The reinforcement beneath various surfaces was subjected to investigation using a Hilti Limited "Ferroscan", with the instrument used to carry out detailed scanning and / or quick scanning, as appropriate[2].

This procedure is covered by CRL Surveys UKAS Accreditation, UKAS Ref: 2728. For further details please visit www.ukas.org.

UKAS TESTING
2728

Detailed scanning of the concrete surfaces was carried out on a 600mm grid, with, as far as possible, the location, orientation, depth of cover and diameter of each bar within approximately 100mm of the surfaces identified and logged.

The instrument was re-calibrated on-site regularly and the cover readings obtained will frequently checked using reinforcement at various depths, including bars at probed locations.

Bar sizes and the likelihood of lapped, closely spaced or congested reinforcement, which all potentially effect the precision of the results were also be assessed at probed locations.

---

[1] Proprietary steel 'pocket' tapes were not used due to potential inaccuracies with the loose fixing and / or deterioration of the end 'hooks'.
[2] The format of the detector / scanning head to the instrument is such that a marginal area of approximately 85mm to 100mm width adjacent to internal corners cannot be scanned.

NB:

1. Whichever is the greater, over the working range given by the manufacturer
2. Whichever is the greater, for reinforcement at covers less than 100mm.
3. Detection limits, with respect to depth, vary significantly from instrument to instrument and generally, in our experience, with all but the more 'exotic' of instruments, resolutions deteriorate significantly with depths greater than around 100mm. Accuracy will also only be to the outermost layer of reinforcement and the performance and reliability of at least some instruments, and therefore the results obtained, can also be affected as described below:

i. The concrete surfaces should be smooth and flat. Any surface variations should be noted and taken into account when depths of cover are recorded. The thickness of any overlay boards should be recorded and subtracted from the cover values recorded.
ii. Steel type, e.g. some instruments have been manufactured for reinforcement comprising un-corroded mild-steel, with relative magnetic permeability of 85-105. Variations in results obtained where other common steel types have been used may be small, but could be as high as ±5%, or more, where high tensile pre-stressed steel has been used.
iii. Bar cross section: Minimum cover will be indicated, i.e. the closest point of a bar to the concrete surface, at the location of measurement. The presence of ribbed or square twisted bars should probably be established and the cover readings cross-checked with direct measurement, using the procedures described above.
iv. The reinforcement should be orientated parallel to the surfaces and 'square', i.e. rectilinear, with the angles between bars in both directions, and those between the bars and the directions of scanning, of $90^0 \pm 5^0$.
v. The bars should not be welded.
vi. Neighbouring bars should be of similar diameter and similar depth. The presence of closely spaced or multiple bars should be assessed; they may be compounded and 'appear' as single, larger diameter bars.
vii. There should be no interference from magnetic constituents within the cement or aggregates, and / or external magnetic fields.
viii. The presence of tie wire may adversely affect readings
ix. Temperature may have an effect on some instruments.
x. Severely corroded reinforcement, with heavy scaling and migration of corrosion products may give misleading results.

4.2.2 Site-specific Validation

At selected representative locations the preliminary images, produced on site, were used to focus on particular bars, or groups of bars. These bars were then exposed, by careful, 'keyhole', breaking-out and subjected to direct inspection and measurement.

Reinforcement bar types were identified using the classifications described within CIRIA Special Publication 118[3].

4.3 PRE-CAST FORM AND FIXING

4.3.1 General

At selected locations the form and relationship between adjacent, discrete, elements were investigated using a combination of non-destructive direct / indirect measurement, the removal of internal, finishing-panels and remote scanning, with, where necessary, increasingly damaging and intrusive techniques, including breaking-out.

Our intensions were to maximise the information gathered, whilst minimising the extent of disruptive and damaging intrusion.

4.3.2 Direct / Indirect Measurement and Internal Finishing-Panel Removal

Where possible, the assessment of cladding panel form and fixing details were achieved by accurate measurement of exposed surfaces, aided by various probes inserted into open joints etc., and the careful removal, and subsequent reinstatement, of internal finishing-panels.

[3] CIRIA Special Publication 118, 1995, "Steel Reinforcement".

4.3.3 Remote Scanning

The information obtained above was augmented by scanning the exposed surfaces using a Hilti Limited, "Ferroscan", or other similar instrument, in accordance with the manufacturer's instructions and in general accordance with British Standard BS1881[4].

> **NB:** Fixings have been available in a wide range of types, manufactured in a wide range of materials, including plastic / nylon, mild steel / galvanized mild-steel, alloy steels and stainless steel.
>
> Furthermore, even where fixings were manufactured from mild-steel / galvanized mild-steel detection limits, with respect to both depth and accurate positioning, vary significantly from instrument to instrument and generally, in our experience, resolutions deteriorate significantly with depths greater than around 100mm. Furthermore, in some cases, congested reinforcement and / or contamination of the concrete with magnetic constituents can result in erroneous responses which can be, at best, difficult and misleading to resolve.

4.3.4 Direct Inspection

In cases where the above could not satisfactorily resolve the required detail, or where further investigations of the cavities is considered appropriate and safe, such investigations were carried out, using small hand-held tools to carefully breakout the concrete.

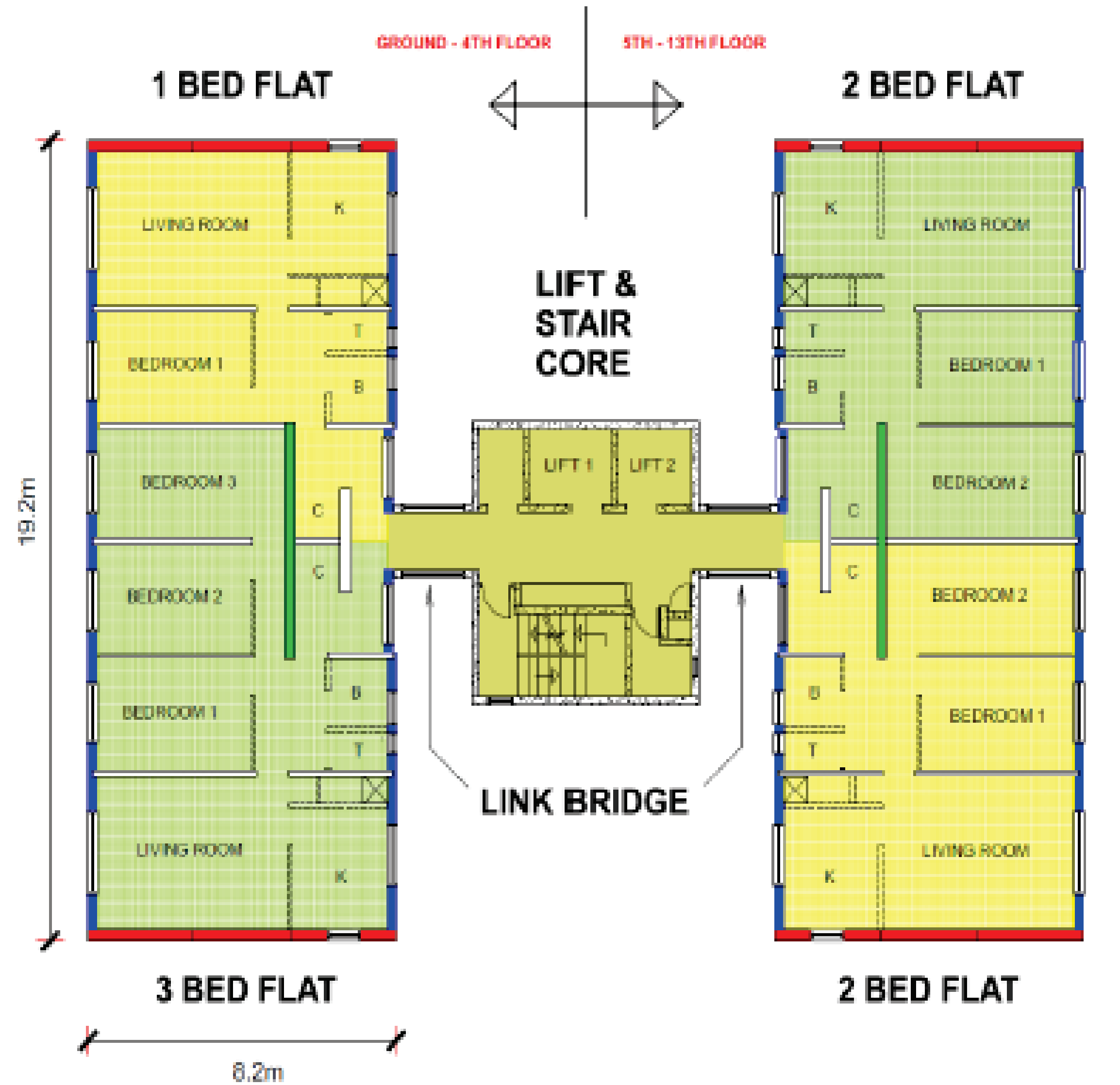
[4] BS1881 "Testing Concrete". Part 204: 1988 "Recommendations on the use of electromagnetic covermeters".

5 INVESTIGATION RESULTS

The detailed results of our investigations have been presented within **Appendix A**.

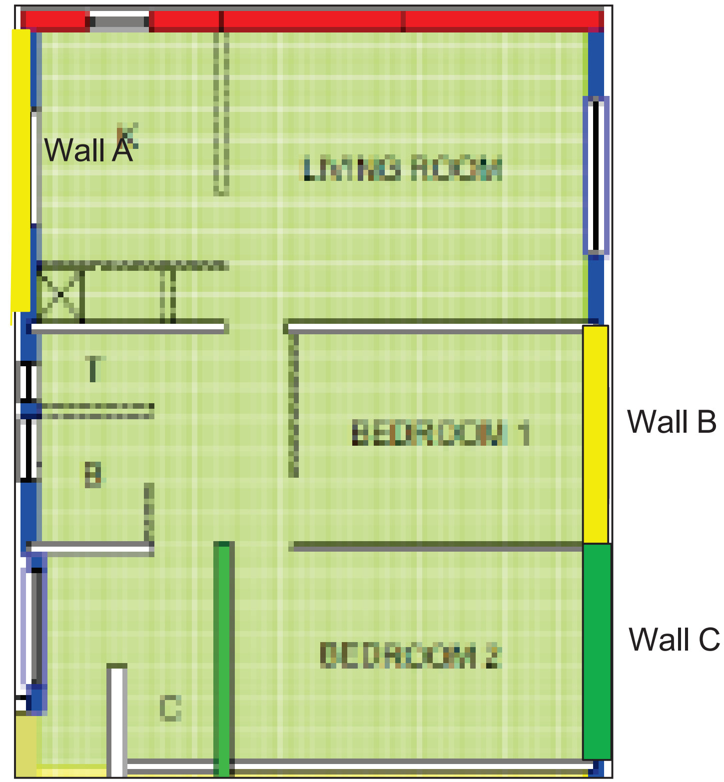
APPENDIX A: INVESTIGATION RESULTS

25 PAGES)



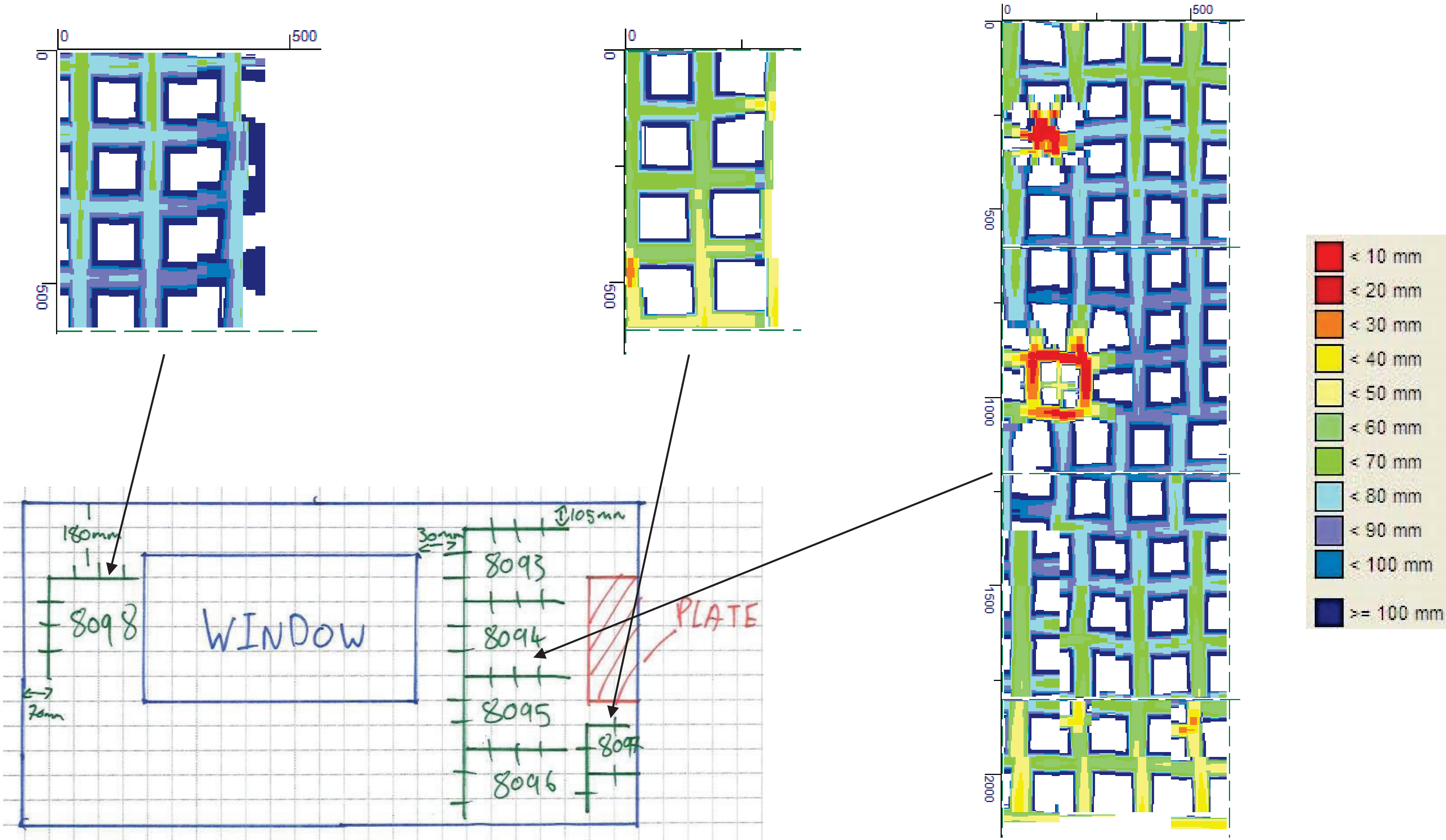
SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building – Flat 53	General Floor Layout for Hartopp & Lannoy Building	November 2018	SUR183696	MAH

CRL SURVEYS Structural and building assessment



SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building – Flat 53	Key Plan	November 2018	SUR183696	MAH

CRL SURVEYS
Structural and building assessment



SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building – Flat 53	Ferro Scan Survey – Wall A	November 2018	SUR183696	MAH

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SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building – Flat 53	Ferro Scan Survey – Wall A Breakout 2	November 2018	SUR183696	MAH

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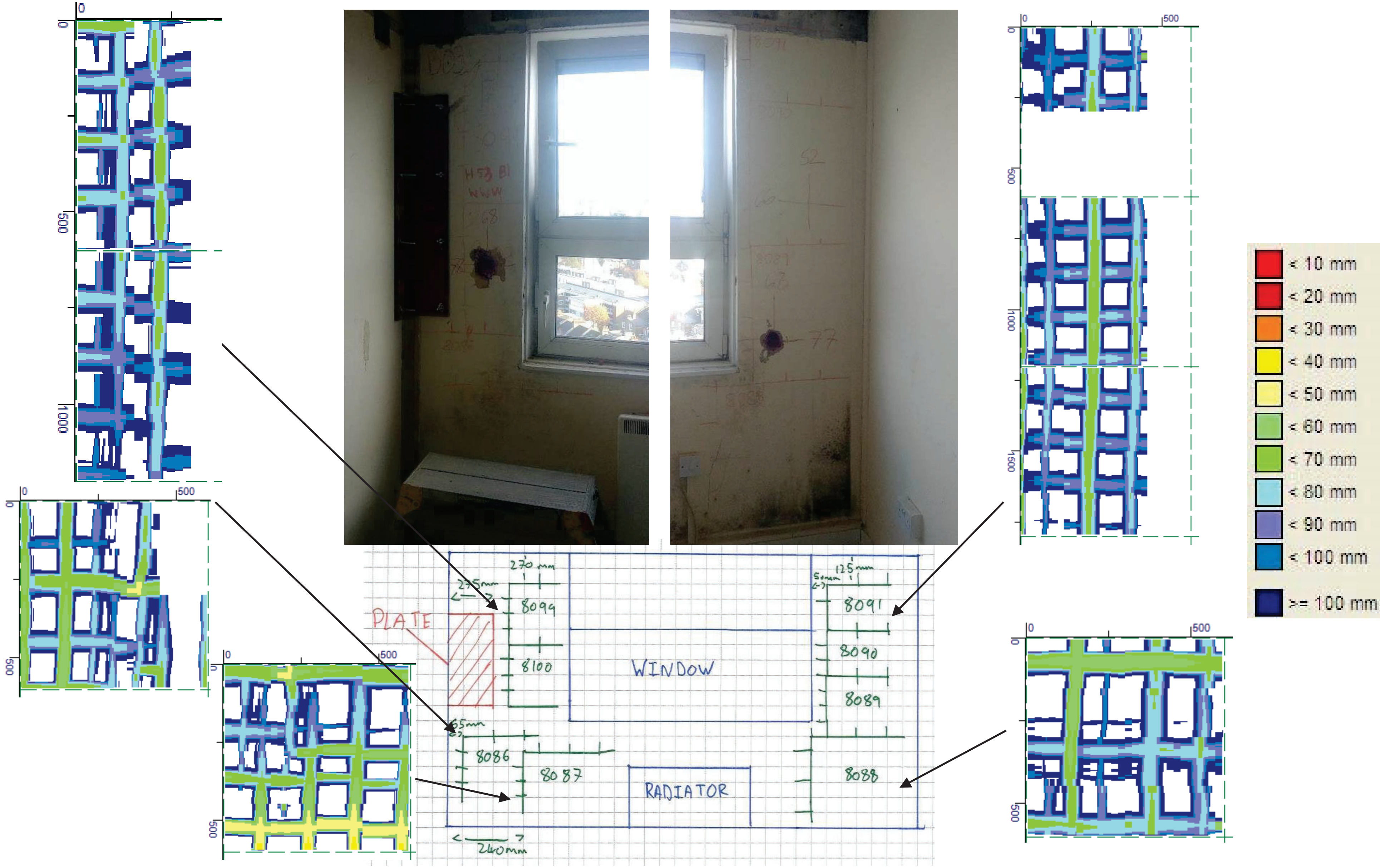

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building – Flat 53	Ferro Scan Survey – Wall B	November 2018	SUR183696	MAH

Structural and building assessment

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building – Flat 53	Ferro Scan Survey – Wall B Breakout 3	November 2018	SUR183696	MAH

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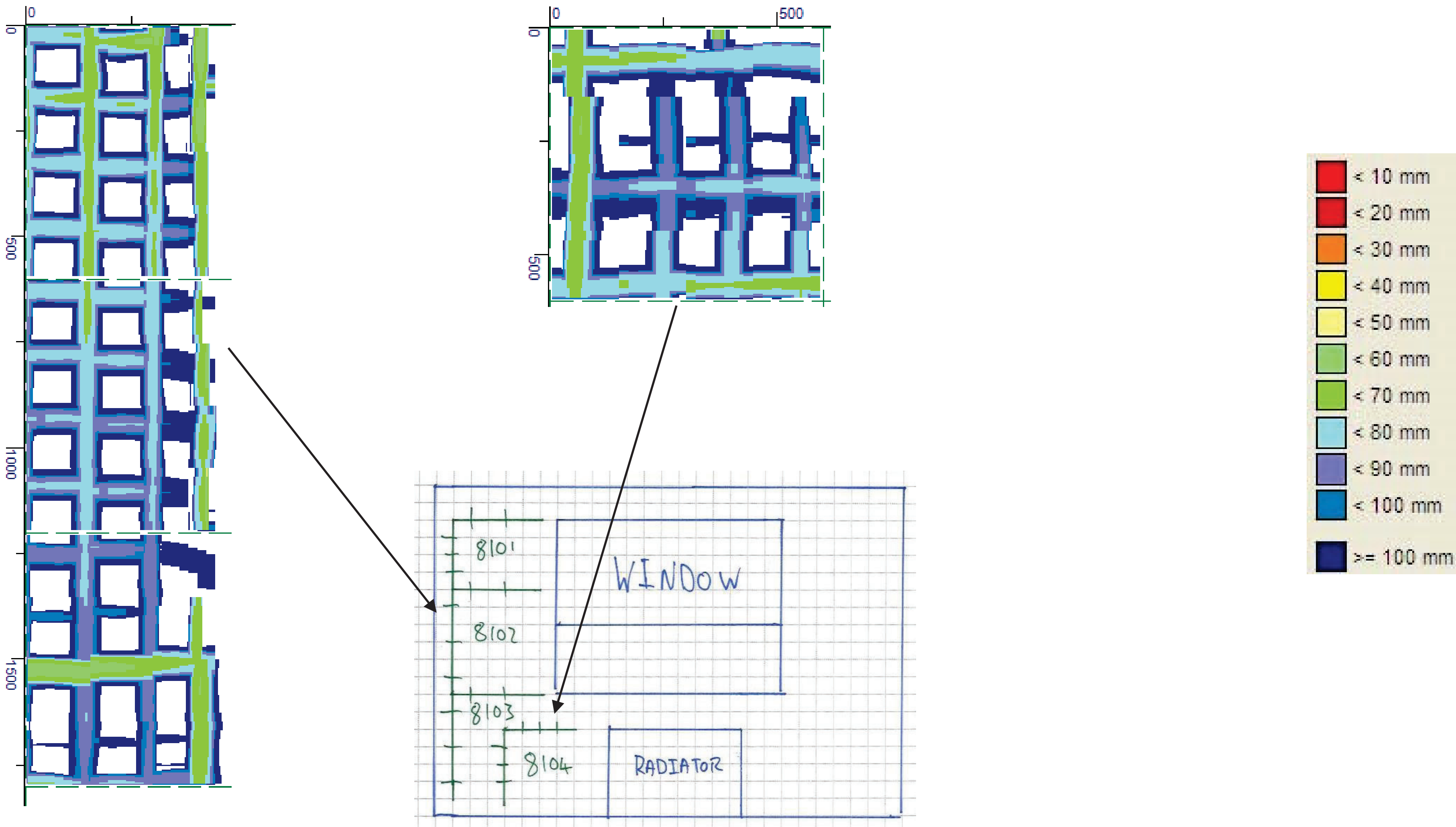
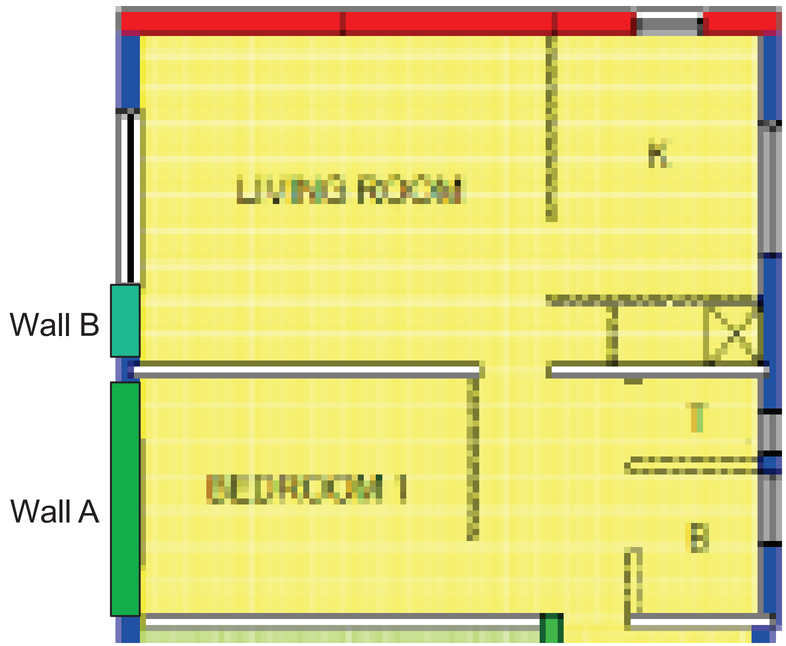


SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building – Flat 53	Ferro Scan Survey – Wall C	November 2018	SUR183696	MAH

CRL SURVEYS
Structural and building assessment

1 BED FLAT



SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building – Flat 10	Key Plan	November 2018	SUR183696	MAH

CRL SURVEYS
Structural and building assessment

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building – Flat 10	Ferro Scan Survey – Wall A	November 2018	SUR183696	MAH

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Structural and building assessment

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building – Flat 10	Ferro Scan Survey – Wall A Breakout 10	November 2018	SUR183696	MAH

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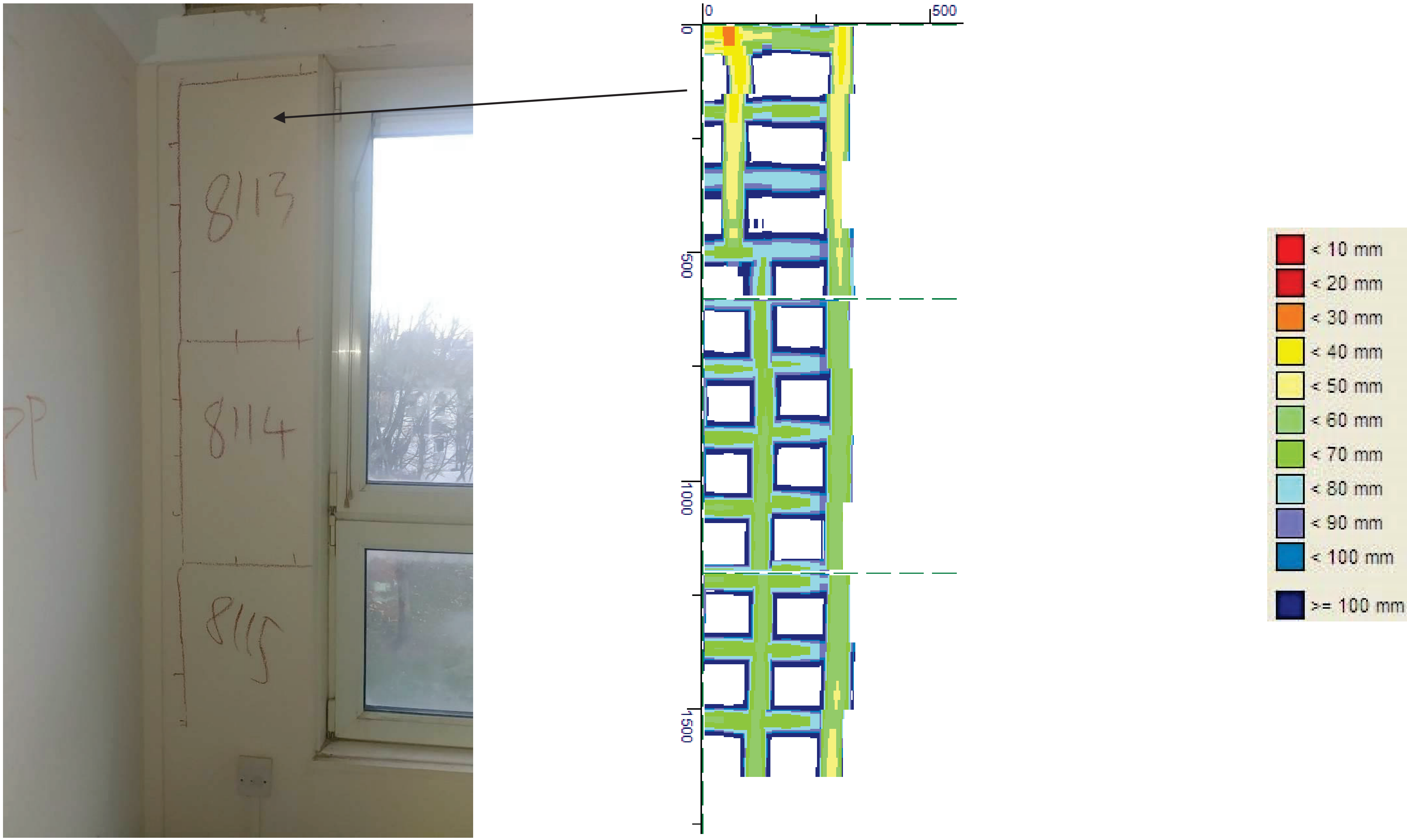
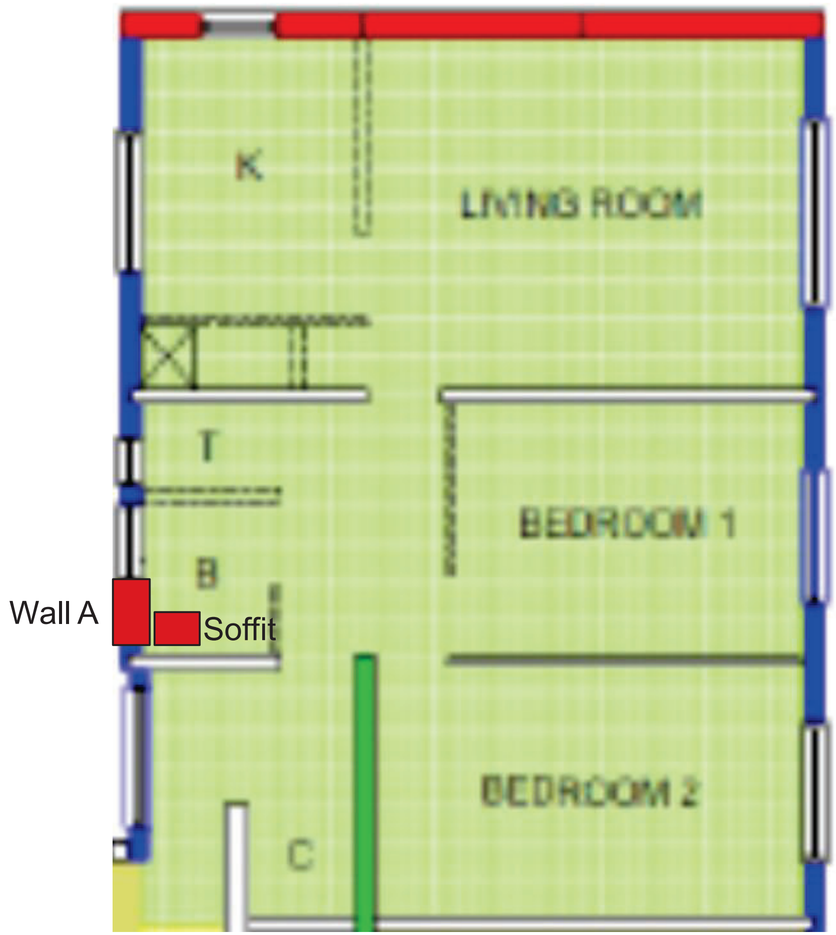


SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp Building – Flat 10	Ferro Scan Survey – Wall B	November 2018	SUR183696	MAH

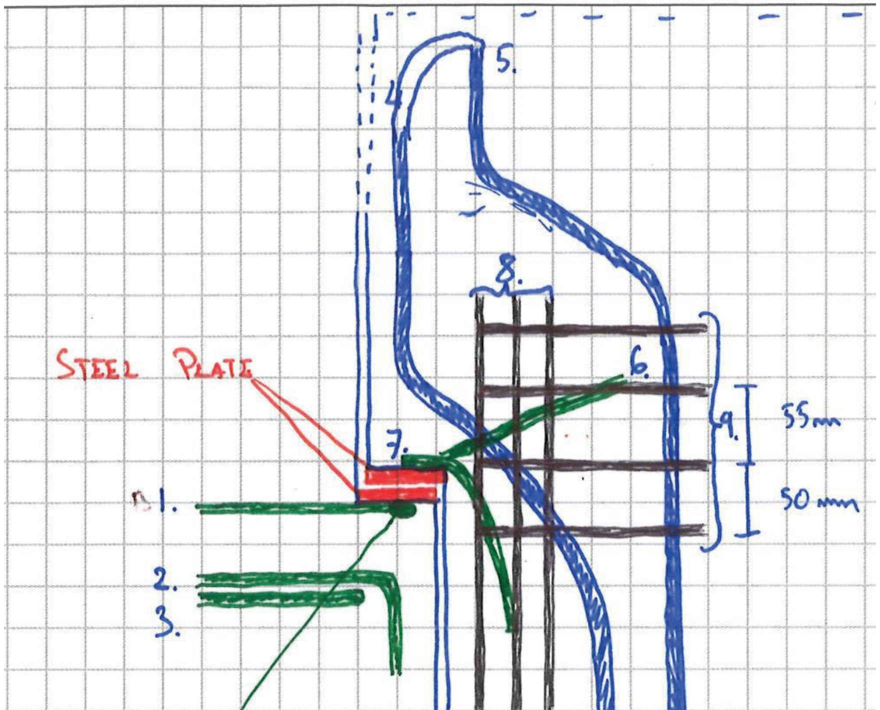
CRL SURVEYS
Structural and building assessment

2 BED FLAT



SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Lannoy Building – Flat	Key Plan	November 2018	SUR183696	MAH

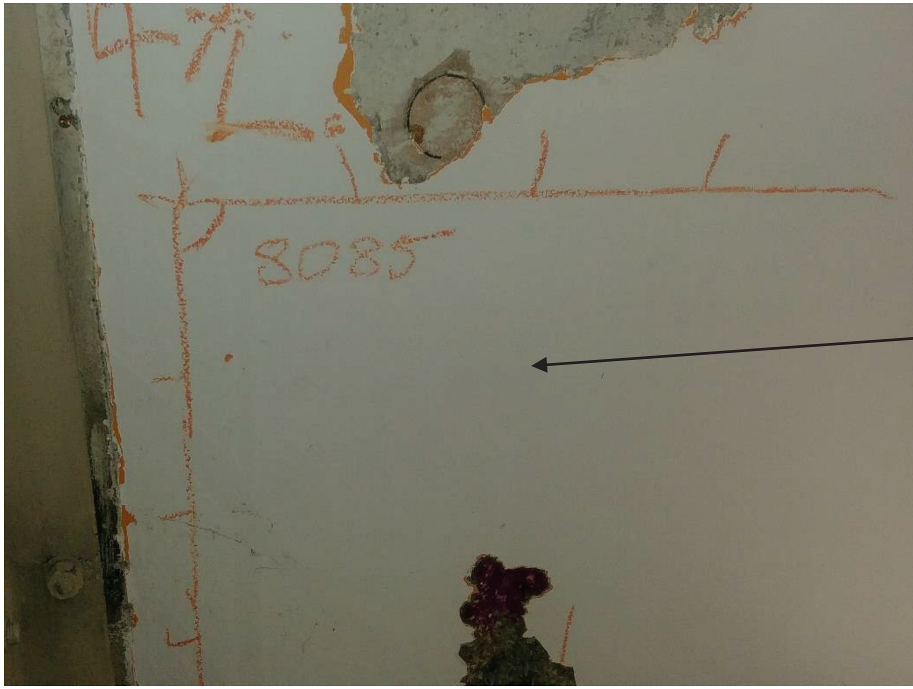
CRL SURVEYS Structural and building assessment

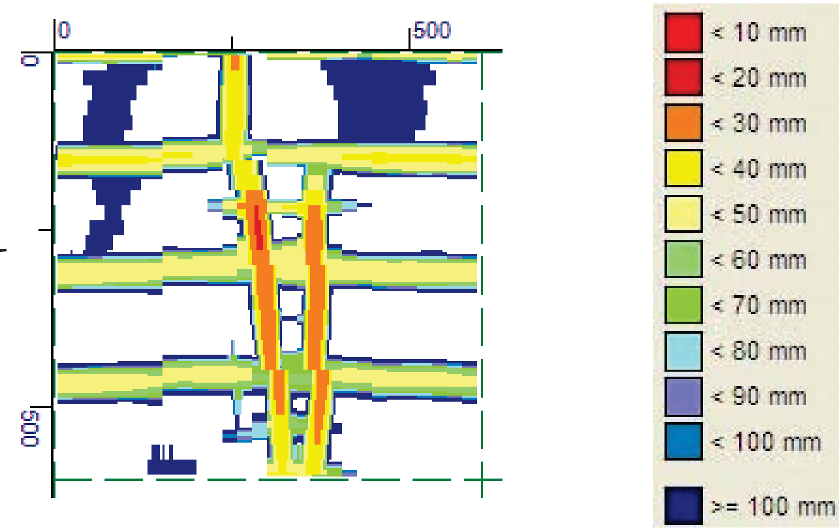


BAR	1	2	3	4	5	6	7	8	9
SIZE	10mm	10mm	10mm	17mm	17mm	10mm	10mm	6mm	6mm
TYPE	PLAIN	PLAIN	PLAIN	PLAIN	PLAIN	PLAIN	PLAIN	PLAIN	PLAIN
COVER	21mm	25mm	33mm	16mm	16mm	35-47	49mm	35-39	30-32

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Lannoy Building – Flat	Breakout Records – Bathroom	November 2018	SUR183696	MAH

CRL SURVEYS
Structural and building assessment





SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Lannoy Building – Flat	Ferro Scan Survey – Bathroom Soffit	November 2018	SUR183696	MAH

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2 BED FLAT

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp & Lannoy – Phase 2	Hartopp Flat 13 Floor Plan	November 2018	SUR183696	MAH

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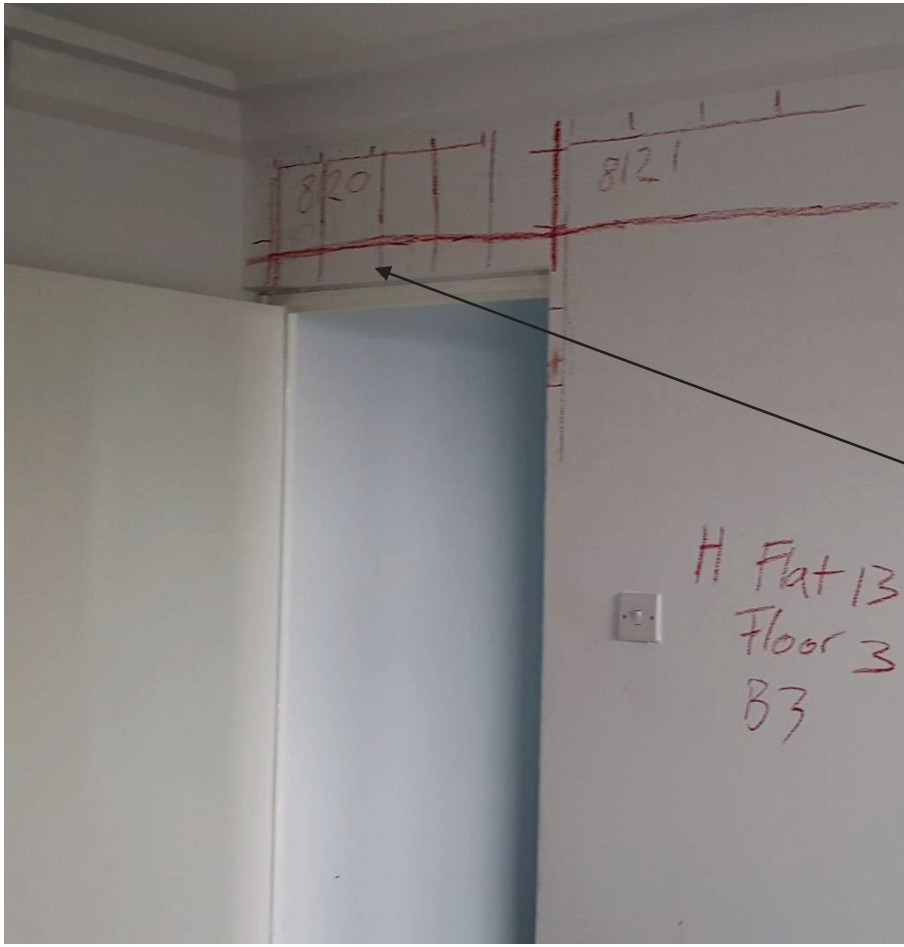
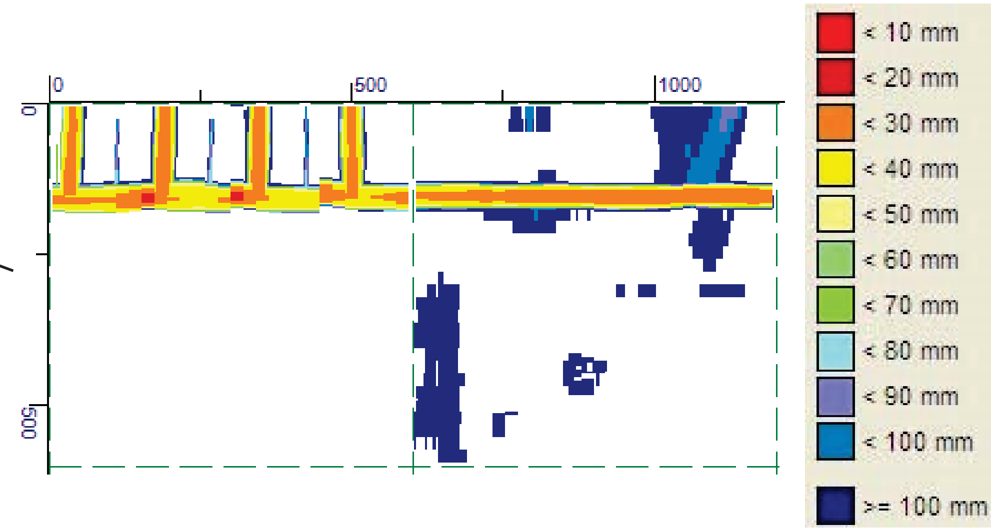
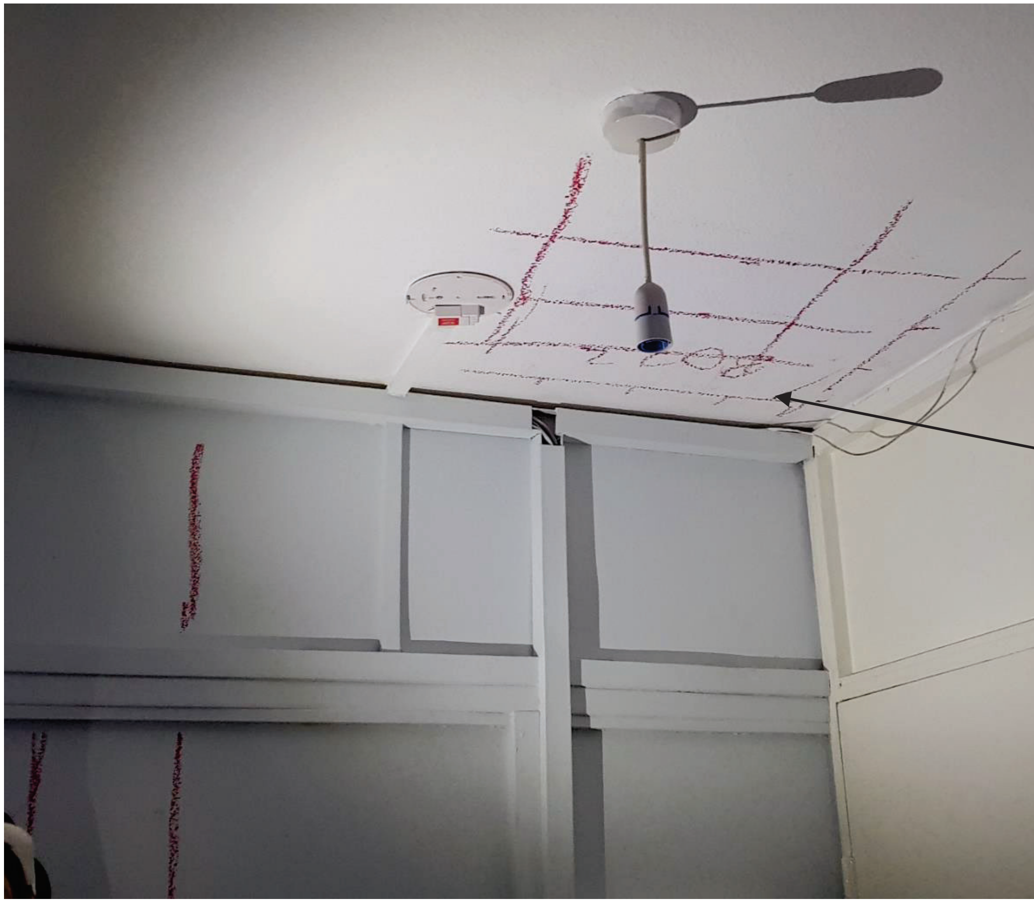
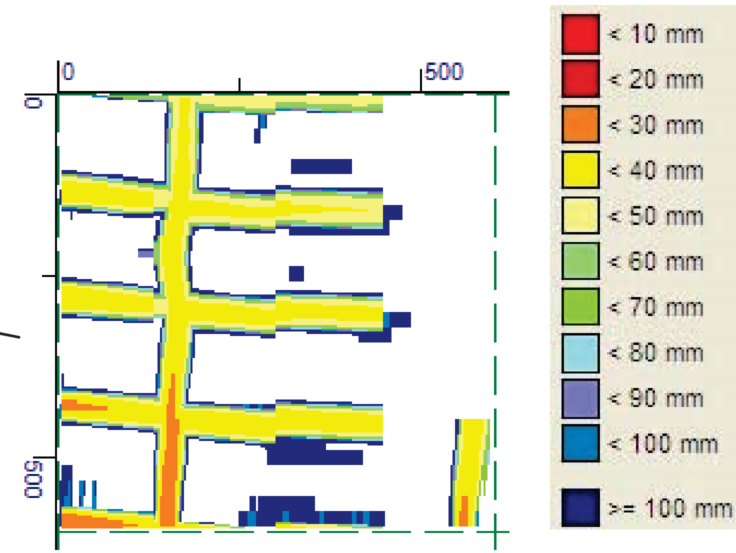


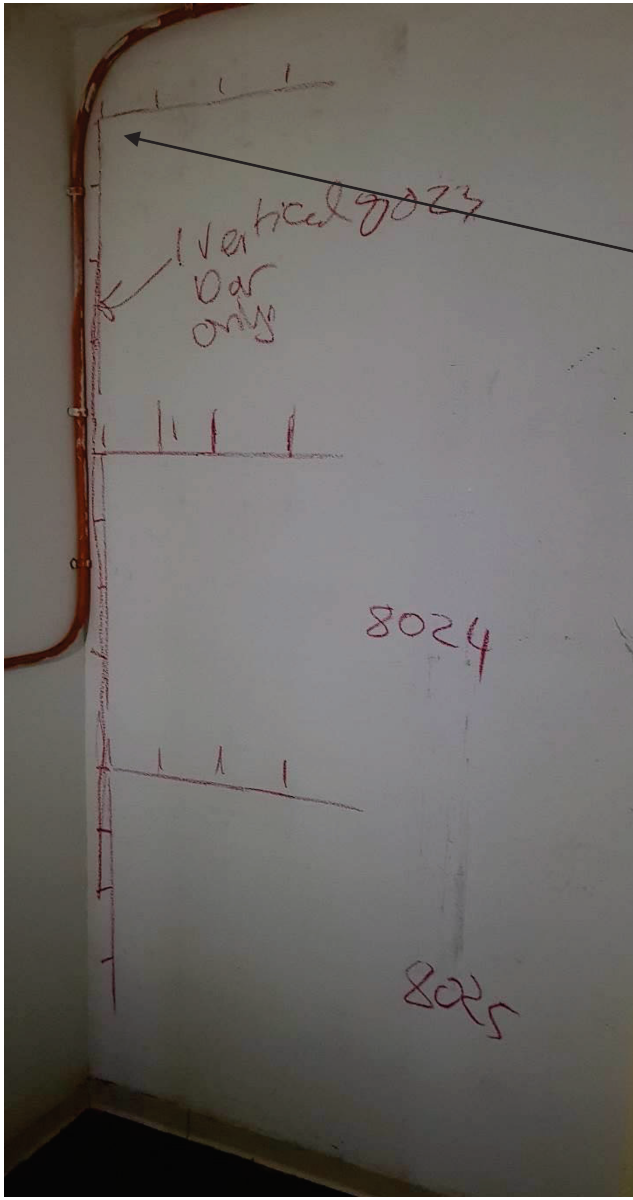


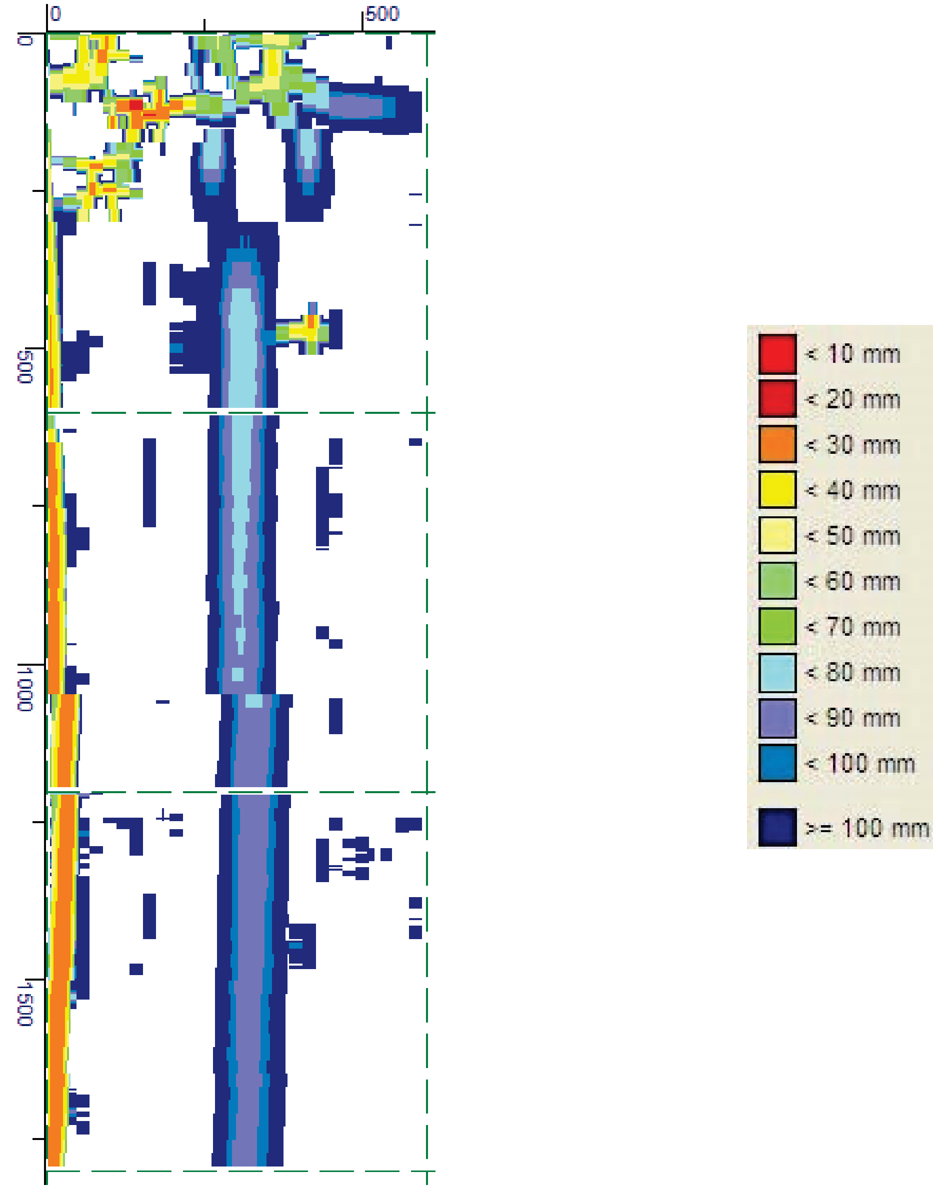
SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp & Lannoy – Phase 2	Ferro Scan Survey – Hartopp Flat 13 Wall C	November 2018	SUR183696	MAH





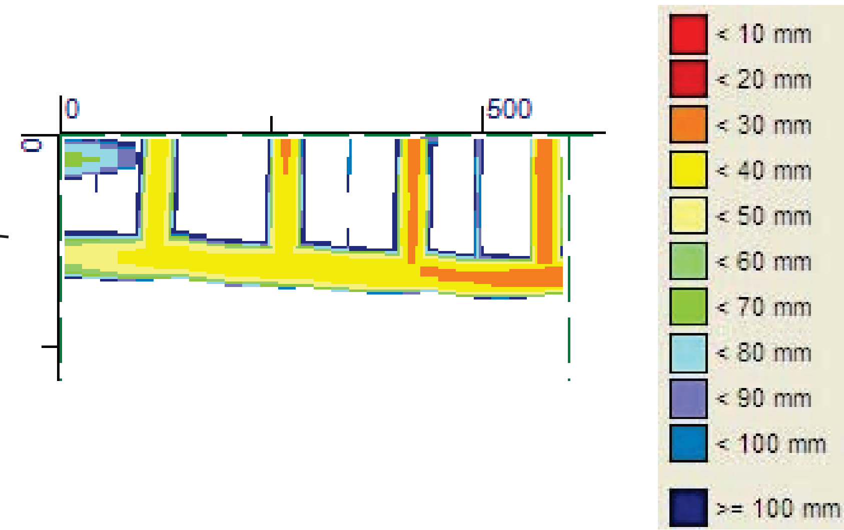
SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp & Lannoy – Phase 2	Ferro Scan Survey – Hartopp Flat 13 Soffit	November 2018	SUR183696	MAH





SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp & Lannoy – Phase 2	Ferro Scan Survey – Hartopp Flat 13 Wall E	November 2018	SUR183696	MAH

CRL SURVEYS
Structural and building assessment



SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp & Lannoy – Phase 2	Ferro Scan Survey – Hartopp Flat 13 Wall F	November 2018	SUR183696	MAH

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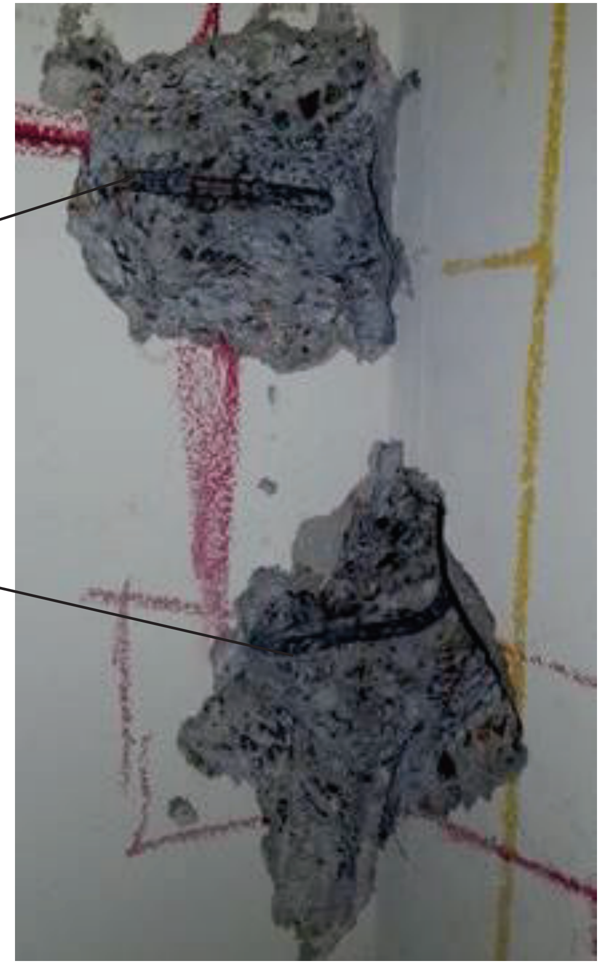
2 BED FLAT

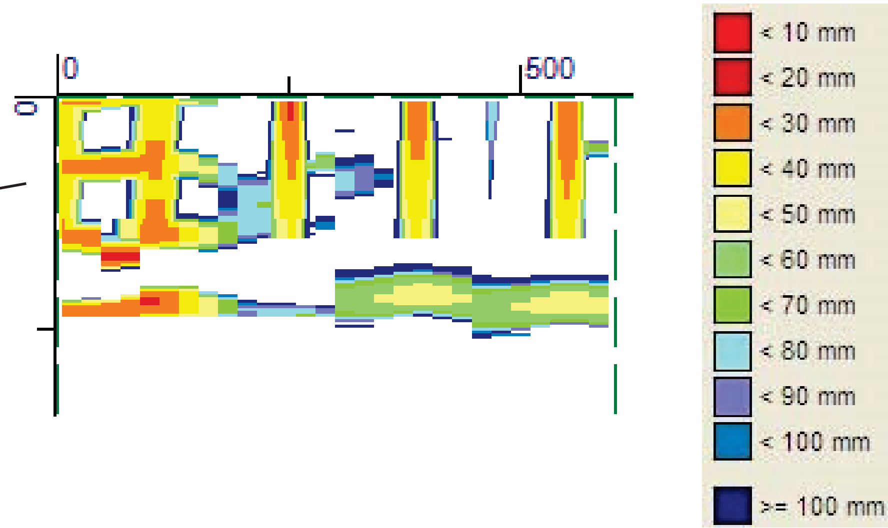
SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp & Lannoy – Phase 2	Ferro Scan Survey – Hartopp Flat 53 Wall F	November 2018	SUR183696	MAH

CRL SURVEYS
Structural and building assessment



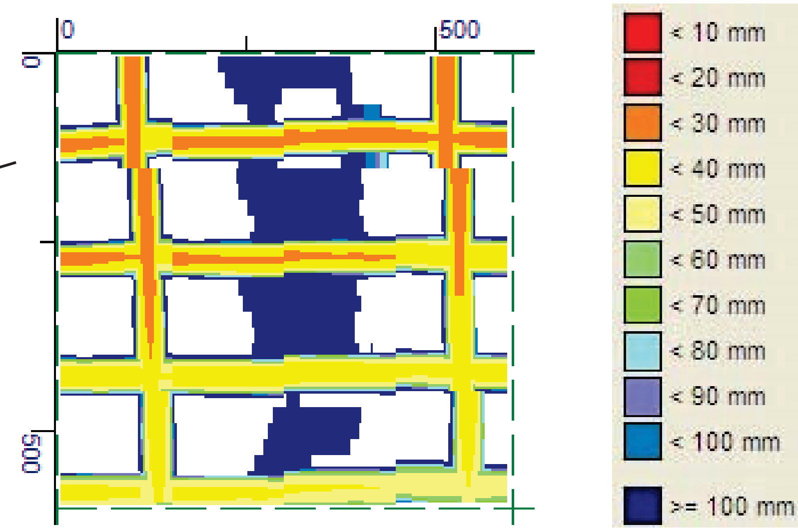
SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp & Lannoy – Phase 2	Ferro Scan Survey – Hartopp Flat 53 Wall A	November 2018	SUR183696	MAH

CRL SURVEYS
Structural and building assessment



SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp & Lannoy – Phase 2	Ferro Scan Survey – Hartopp Flat 53 Wall F	November 2018	SUR183696	MAH

CRL SURVEYS Structural and building assessment



SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp & Lannoy – Phase 2	Ferro Scan Survey – Hartopp Flat 53 Soffit	November 2018	SUR183696	MAH

CRL SURVEYS Structural and building assessment

3 BED FLAT

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp & Lannoy – Phase 2	Hartopp Floor Plan – Flat 51	November 2018	SUR183696	MAH

CRL SURVEYS
Structural and building assessment

SITE	DETAILS	DATE	CONTRACT NO.	INITIALS
Hartopp & Lannoy – Phase 2	Ferro Scan Survey – Hartopp Flat 51 Wall G	November 2018	SUR183696	MAH

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END OF REPORT