

**16-0159**

**A SUMMARY DOCUMENT OF INITIAL STRUCTURAL  
INVESTIGATIONS INTO INSITU CONCRETE FRAME TO  
UPPER FLOORS**

**AT**

**NEVILLE HOUSE,  
GEORGE STREET  
CORBY NN17 1QD**

**FOR**

**CORBY BOROUGH COUNCIL**

**REVISION 2.0**

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**Revision**

Revision	Date	Reason for issue
1.0	21.06.2016	First Issue (Draft)
2.0	15.07.2016	Second Issue

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## **PREFACE**

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The comments given in this report are based on limited visual inspections, onsite tests and laboratory testing as described. Full design and construction records and details of the concrete frame to Neville House, George Street, Corby are no longer available and considerations of time and cost have meant that we have had to undertake tests at a limited number of locations only.

We are unable to report on those areas of the concrete frame to Neville House that have not been investigated and are therefore unable to report that the concrete frame is free of defect in those areas not reported upon here.

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## **1.0 INTRODUCTION AND BRIEF**

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At the request of the client (Corby Borough Council), the Rolton Group Ltd coordinated investigations into the concrete frame to Neville House, in Corby in May 2016 as part of an overall strategy to carry out refurbishment to the residential areas and the associated stairwell and lobby. The works were generally limited to the residential areas at second, third and fourth floors and to the roof terrace only.

The investigations involved the carrying out of intrusive investigations to the concrete frame and external brickwork to Neville House structure and associated laboratory testing of recovered concrete samples. Investigations into the concrete frame and masonry were carried out during May 2016. Associated laboratory testing was carried out in early June 2016. The investigations have been limited, particularly with respect to external investigations due to limited access.

This summary report correlates the investigations carried out to date and relates specifically to the general condition of the concrete frame to Neville House, where only limited access was available and to no other issues.

Therefore this summary report does not therefore constitute a full structural survey of the concrete frame to Neville House.

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## **2.0 LIMITATION**

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Generally confined to the agreed terms of reference/preface.

This report does not constitute a full structural inspection of the concrete frame to Neville House, and is limited solely to those matters identified in the Terms of Reference.

Unless noted otherwise, we have not inspected any parts of the concrete frame to Neville House which are covered, unexposed or inaccessible and we are therefore unable to report that any such part of the concrete frame to Neville House is free from defect.

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## **3.0 BRIEF DESCRIPTION OF BUILDING**

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Neville house is a five storey building, with a roof terrace and is situated on George Street in Corby. It is understood that the building was probably constructed during the late 1960's. It is believed that the building has an insitu concrete frame with infill precast floors. The external elevations are infill panels. The infill panels are a mixture of aggregate panels, masonry panels and curtain walling.

The ground floor is currently used for shops and the first floor is office space. The remaining three upper floors, which this survey relates, are residential (flats). Currently the flats are unoccupied.

The general arrangement of the building is denoted on survey drawings produced by KPW Architects, which are contained within appendix A of this report.

---

## **4.0 INVESTIGATIONS**

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The following investigations were coordinated by the Rolton Group:-

1. A limited visual inspection of the concrete frame to Neville House was carried out by a specialist concrete testing company (Martech) to establish the general condition of the concrete during May 2016. External access was obtained via abseiling and internal access was from floor level/mobile scaffolding.
2. Limited intrusive investigations and insitu tests were carried out on the structure during May 2016 by a specialist concrete testing company (Martech) to establish the general condition of the concrete. External access was obtained via abseiling and internal access was from floor level/mobile scaffolding. In addition insitu concrete tests were carried out. The insitu tests included the following:-
  - Cover to reinforcement.
  - Carbonation tests.
3. During June 2016 laboratory tests were carried out on recovered samples from the site intrusive investigations, by a specialist testing laboratory (Quartz Scientific); in order to establish the general condition of the concrete. Laboratory tests were carried out for the following:-
  - Chlorides.
  - Cement content.
  - High Alumina Cement (HAC)

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## **5.0 FINDINGS**

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In addition to the items noted in section 3.0 "brief description of the building" the following observations were made from the above investigations:-

### **5.1 VISUAL INSPECTION OF THE STRUCTURE**

A copy of the specialist surveying company's report is contained within appendix B. However the following significant points were noted.

- 1) Evidence of historic and ongoing water ingress.
- 2) Failure of external surface coatings
- 3) Corrosion was noted to the handrails, predominately to the external balconies
- 4) Evidence of previously carried out repairs; some/most of the concrete repairs have failed or are failing.
- 5) Spalling and loose concrete.
- 6) Exposed and corroding reinforcement.
- 7) Spalling and loss of mortar to the joints in the external brickwork was noted.
- 8) Where loose material was noted in the survey area, this was removed on health and safety grounds.

### **5.2 INTRUSIVE INVESTIGATIONS TO THE STRUCTURE**

A copy of the specialist surveying company's report is contained within appendix B. However the following significant points were noted from the appended report.

- 1) 40 No concrete test areas (TA's) were investigated.
- 2) 13 No brickwork test areas (TA's) were investigated
- 3) Exposed and corroding reinforcement was identified.
- 4) Concrete cover appeared to vary significantly (2-65mm). A brief summary is as follows

- External roof beams, 5-52mm.
  - External roof columns, 11-45mm.
  - External wall support beams, 19-47mm.
  - Floor soffits, 11-65mm.
  - External floor soffits, 15-65mm.
  - Beams, 4-51mm.
  - External beams, 15-40mm.
  - Columns, 15-54mm
  - Balcony slabs, 5-38mm.
  - Aggregate panels, 5-56mm
  - Walls, 2-53mm.
  - Stair soffit, 17-43mm.
  - Stair landing, 18-41mm
- 5) Depth of Carbonation varied significantly (<5-45mm) and in some locations this was greater than the concrete cover. A brief summary is as follows
- External roof beams, 5mm.
  - External roof columns, <5-20mm.
  - External wall support beams, <5mm.
  - Floor soffits, <5-20mm.
  - External floor soffits, <5-5mm.
  - Beams, 15-40mm.
  - External beams, <5-20mm.
  - Columns, 10-20mm.
  - Balcony slabs, 10-15mm.
  - Aggregate panels, <5-5mm.
  - Walls, 15-50mm.
  - Stair soffit, <5-5mm
  - Stair landing, 5mm
- 6) The cavity width varied from 55-105mm
- 7) No corrosion was noted to the masonry ties.
- 8) Mortar debris was noted in the cavity, on both the ties and damp proof courses (DPC's)
- 9) Insulation was noted to some of the cavity walls

### **5.3 LABORATORY TESTING ON CONCRETE**

A copy of the specialist surveying company's report is contained within appendix B. However the following significant points were noted from the appended report.

- 1) 40 No samples were tested for Chloride content.
- 2) 6 No samples were tested for cement content
- 3) 8 No samples were tested for High Alumina Cement (HAC)
- 4) The Chloride content test results varied widely, from a low level of Chloride content to very/extremely high risk. A brief summary is as follows
- External roof beams, 0.07-0.48%.
  - External roof columns, 0.15-0.20%.
  - External wall support beams, 0.05%.
  - Floor soffits, <0.01-0.35%.
  - External floor soffits, <0.01-0.43%.
  - Beams, <0.01-1.57%.
  - External beams, <0.01-0.18%.
  - Columns, <0.01%.
  - Balcony slabs, 0.20-0.53%.
  - Aggregate panels, 0.48-1.08%.
  - Walls, 0.33-0.36%.
  - Stair soffit, 0.39-0.43%.
  - Stair landing, 0.57%.

- 5) The cement content results varied significantly, from 5.4% to 21.2%. The lowest value of 5.4% at test area TA9 was retested and a similar result was achieved.
- 6) No High Alumina Cement (HAC) was present in the 8 samples.

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## **6.0 COMMENTS AND CONCLUSIONS**

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From the above and foregoing discussion and from our experience of similar structures, we are of the considered opinion that the concrete frame to Neville House is starting to show significant signs of deterioration and will require remedial works in the near future if it is to remain in a serviceable condition.

The internal and external visual and intrusive investigations of the concrete structure frame indicated varying degrees of corrosion to the reinforcement and areas of spalling concrete. The Martech report has identified this as an ongoing issue that needs remedial works.

Internally water ingress was noted at the fourth floor from the flat roof above. It is assumed that this is due to the failure of the roof covering. The roof covering will need replacing during the proposed refurbishment works. In addition and although not part of our brief, consideration should be given to replacing and upgrading the insulation to the roof. It is suspect that although no spalling was noted, there is risk of corrosion to the reinforcement to precast concrete planks. Therefore further investigations and potentially remedial works will need to be carried out during the proposed refurbishment works/roof replacement.

There is evidence that historically remedial works have been carried out to the concrete frame. These have subsequently failed in some locations and for health and safety reasons areas of loose concrete have been removed during the survey works; where encountered. However there may be other areas that may not have been encountered and are a potential health and safety risk. We would therefore recommend that regular "safety surveys" are carried out to remove any loose or cracked areas. In our experience, failure of repairs is generally due to poor workmanship and/or failure to extend the remedial works far enough back in the structure to where the alkalinity of the concrete provides protection to the reinforcement from further corrosion. All of these areas will need to be identified by a further comprehensive survey and then appropriate remedial works will be required. Until a full remedial strategy can be fully implemented, regular inspections (between 6-12months) and removal of loose materials/concrete should be carried out for health and safety reasons.

The concrete cover to the reinforcement noted in the survey carried out by Martech indicated a significant variance. As noted earlier there is no record information available for the existing structure but we would expect the cover to be 20-35mm for durability, but this depends on the element and its exposure amongst other items. The results fall significantly outside this general criteria, cover is significantly less and greater than this estimation. This indicates poor workmanship. Due to the age of the structure carbonation issues noted should be expected. The depth of carbonation noted varies significantly and appears, in locations, to potentially extend beyond the cover to the reinforcement. Chlorides within the concrete were within certain concrete elements (e.g. beams and aggregate panels). The level of chloride content noted in the aggregate panels could significantly increase the risk of corrosion. The presence of chlorides could have come from additives which were added during the casting process, or contaminated mix water or aggregates. The presence of carbonation from the atmosphere and in certain locations added chlorides within the concrete indicate there is an increased risk of further and possibly accelerated corrosion of the reinforcement. Therefore it is important to give early consideration to providing protection against future corrosion. This could include a number of items depending on the further investigations (refer to later) for instance corrosion inhibitors and a protective paint system. However such systems have a limited life approximately 15-20 years and further works and inspections will be required, depending on the desired design life.

The cement content results varied widely. One sample (to a beam, location TA9) was very low. This is of concern and we would therefore recommend that further tests are carried out to assess whether this is local issue or a wide spread issue.

The main corrosion issue appears to be with the external aggregate panels. We understand that these are to be potentially removed and replaced with a light weight panel system during the proposed refurbishment works. From a structural perspective the replacement of the panels with lightweight cladding should not be an issue, provided that the replacement lightweight panel imposes less load than the aggregate panel.

At some time during the life of the structure a protective coating system has been applied. This has failed and in conjunction with other remedial works and will need to be replaced to ensure the future serviceability of the structure.

The proposed refurbishment works involve retaining the current use (as residential use/flats). From a structural perspective the structure should be adequate to continue support the loads imposed from a domestic use (currently 1.5 kN/m<sup>2</sup> plus lightweight stud partitions), provided remedial works are carried out in the near future. The degree of works will be vary depending on the "design life" required. The proposed refurbishment works will require full and comprehensive repairs to the concrete, involving breaking out of spalling/defective concrete, treatment/replacement of corroding reinforcement, replacement on spalled concrete etc., both internally and externally. In addition this will involve removing the existing failing paint system, finishes, and further detailed inspection prior to carrying out remedial works. The introduction of corrosion inhibitors and a new protective coating system will also be required

The ties to the masonry panels appear to be in a good condition when considering the age of the building. We suspect that the loss of mortar to the joints is due to weathering and the age of the building. The mortar debris noted in the cavity, on both the ties and damp proof courses (DPC's), is probably from the construction. Varying levels of insulation were noted in the cavity. If the masonry is to be retained during the proposed refurbishment works then consideration should be given to adding insulation (blown type) and the repointing as necessary to the joints.

The handrails rails to the balconies and roof terrace were noted to be corroded and in a poor state and therefore should be replaced.

In conclusion the structure is in a serviceable condition, but significant further investigations and remedial works will be required.

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## **7.0 RECOMMENDATIONS**

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Based on the investigations to date we would initially recommend the following are carried out.

- 1) For health and safety reasons further "safety surveys" and removal of all loose material be carried out on a regular basis.
- 2) Further cement tests are to be carried out to assess if there is an inherent weakness to the beam at test area TA9.
- 3) The roof covering and associated insulation should be replaced during the proposed refurbishment works. The opportunity should be taken to inspect both the insitu concrete frame and precast concrete units for evidence of corrosion. Remedial works may be required.
- 4) Either during or prior the proposed refurbishment works the ceiling to the fourth floor should be removed and further investigations carried out to establish whether any corrosion is occurring to the reinforcement to both the insitu concrete frame and precast concrete units.
- 5) Either during or prior the proposed refurbishment works full and comprehensive repairs should be carried out to the concrete, both internally and externally. However until further works described above are carried out it is impossible to exact details of all the works. Works that are likely include the following and full access will be required to carry this out these works.
  - Removing the existing failing paint system and finishes during the proposed refurbishment works.
  - A further detailed inspection during the proposed refurbishment works.
  - The replacement of the exposed aggregate panels during the proposed refurbishment.
  - Breaking out loose and spalling concrete (patch repairs).
  - The replacement and/or treatment of corroding reinforcement.

- The carrying out of specialist concrete repair.
- The introduction of corrosion inhibitors.
- A new decorative protective elastic anti-carbonation coating system.

These works are likely to vary between the various elements e.g. external beams, internal columns. Full details of these repairs and a suitable remedial specification will need to be developed with a specialist contractor, who should be approved by the supplier of a suitable repair material(s).

- 6) Where brickwork is retained it should be repointed and insulation should be added to the walls as necessary. Additional ties may also be required.
- 7) The handrails rails to the balconies and roof terrace should be replaced.

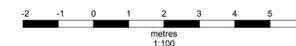
The above recommendations are here given in principle only and, before any remedial works are carried out, full and detailed specifications and drawings will be necessary and will be provided by this Practice upon the Client's further instruction.

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## **APPENDIX A**

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### **KPW SURVEY DRAWINGS**



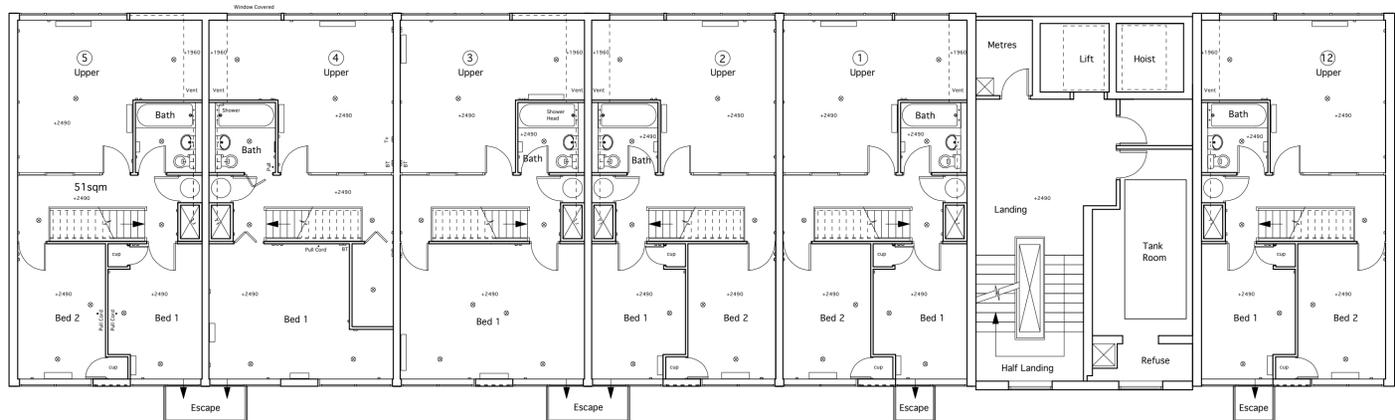
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GIA: 75sqm

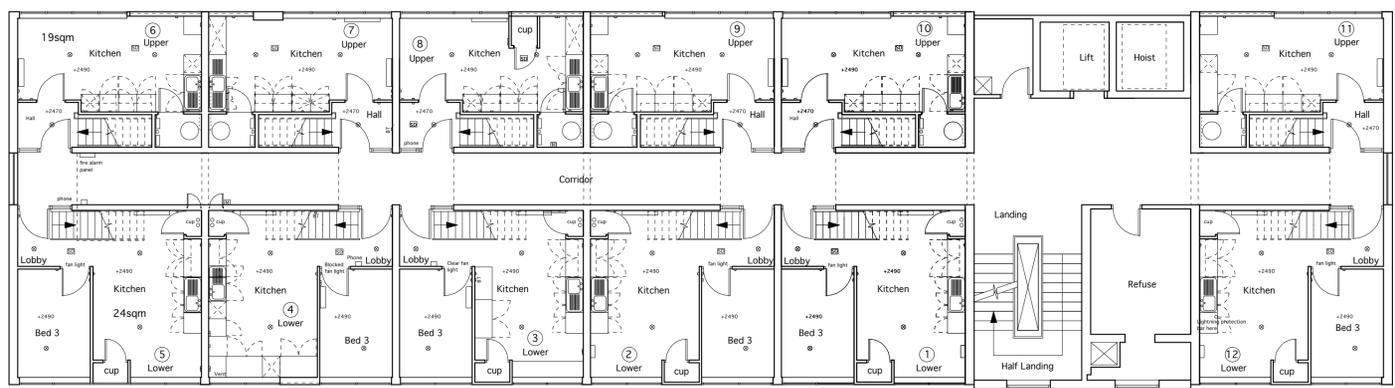
2 BED FLATS - 06  
GIA: 70sqm

TOTAL UNITS - 12

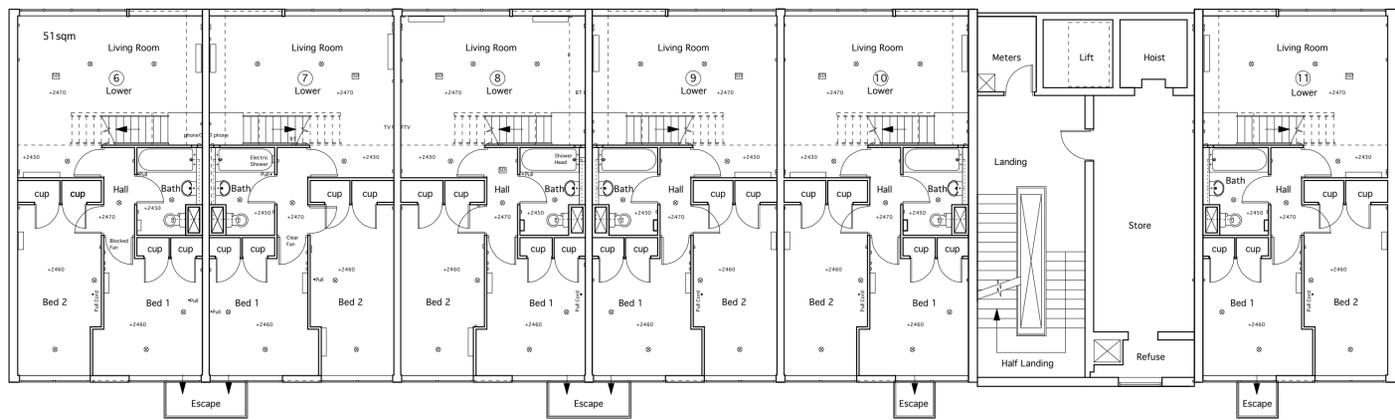
Floor 4



Floor 3



Floor 2



**DRAFT - FURTHER  
DETAILED SURVEY  
WORK TO BE COMPLETED**

AMENDMENTS: \_\_\_\_\_ DWN: \_\_\_\_\_ DATED: \_\_\_\_\_

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**Upper Floor Plans**

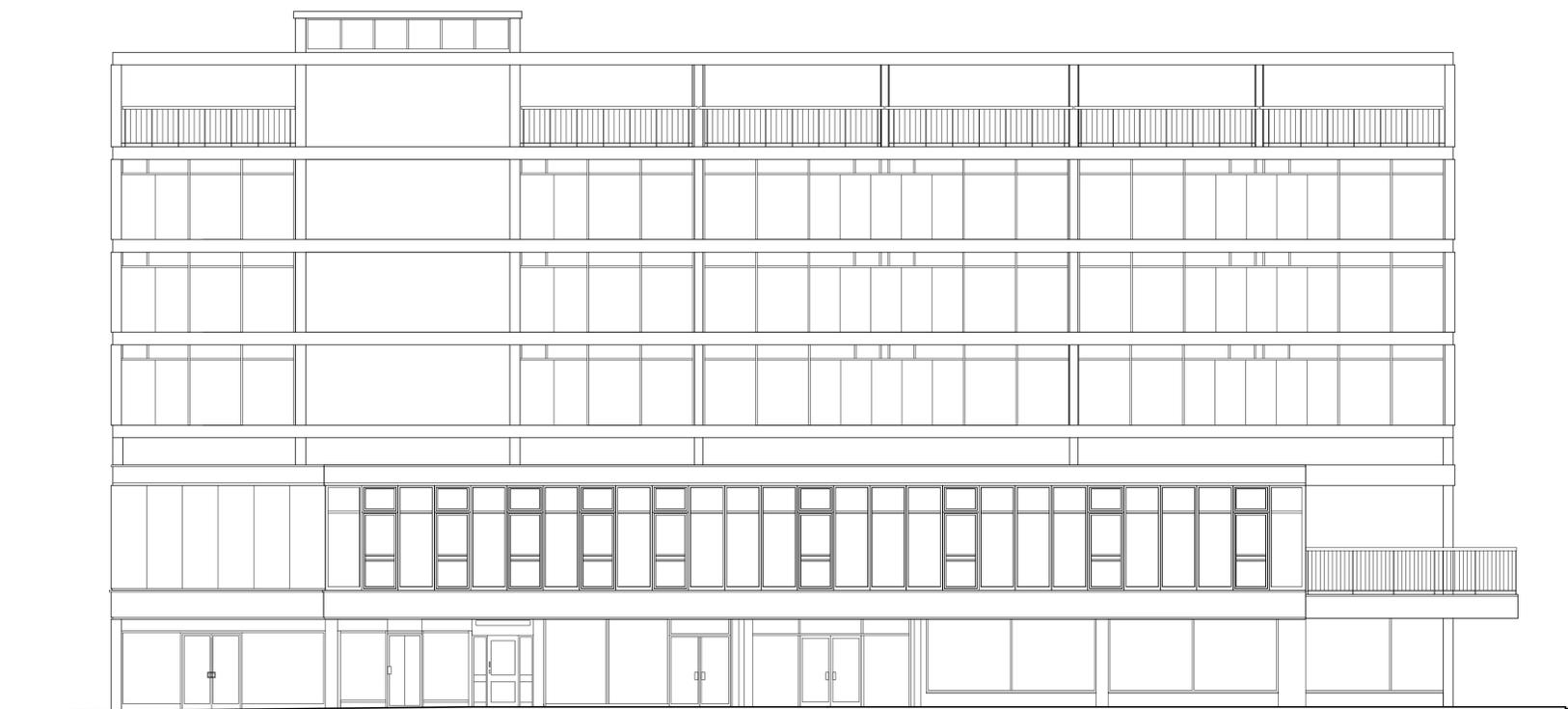
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Neville House, George Street,  
Corby NN17 1QD

DRAWING NUMBER  
**11011.04**

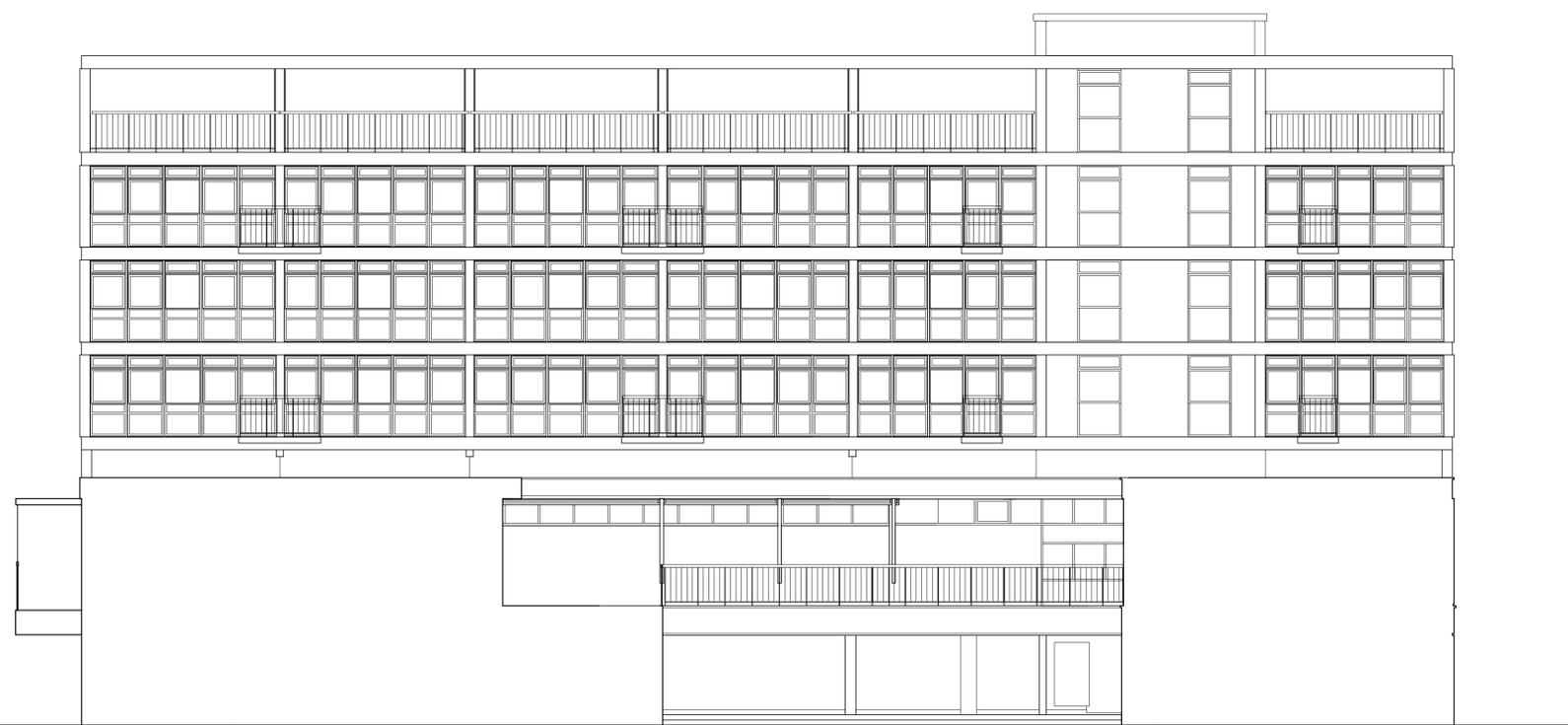
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DRAWN KMP CHECKED

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Front Elevation



Rear Elevation

**DRAFT - FURTHER  
DETAILED SURVEY  
WORK TO BE COMPLETED**

AMENDMENTS DWN DATED

DRAWING TITLE

**Front and Rear Elevations**

JOB TITLE  
Proposed Alterations to Residential Flats,  
Neville House, George Street,  
Corby NN17 1QD

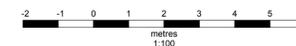
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**11011.05**

SCALE (A1) 1:100 DATE 07.02.12

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**DRAFT - FURTHER  
DETAILED SURVEY  
WORK TO BE COMPLETED**

AMENDMENTS DWN DATED

DRAWING TITLE

**Side Elevations**

JOB TITLE  
Proposed Alterations to Residential Flats,  
Neville House, George Street,  
Corby NN17 1QD

DRAWING NUMBER  
**11011.06**

SCALE (A1) 1:100 DATE 07.02.12

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## **APPENDIX B**

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### **STRUCTURAL INVESTIGATIONS AND ASSOCIATED LABORATORY TESTING**



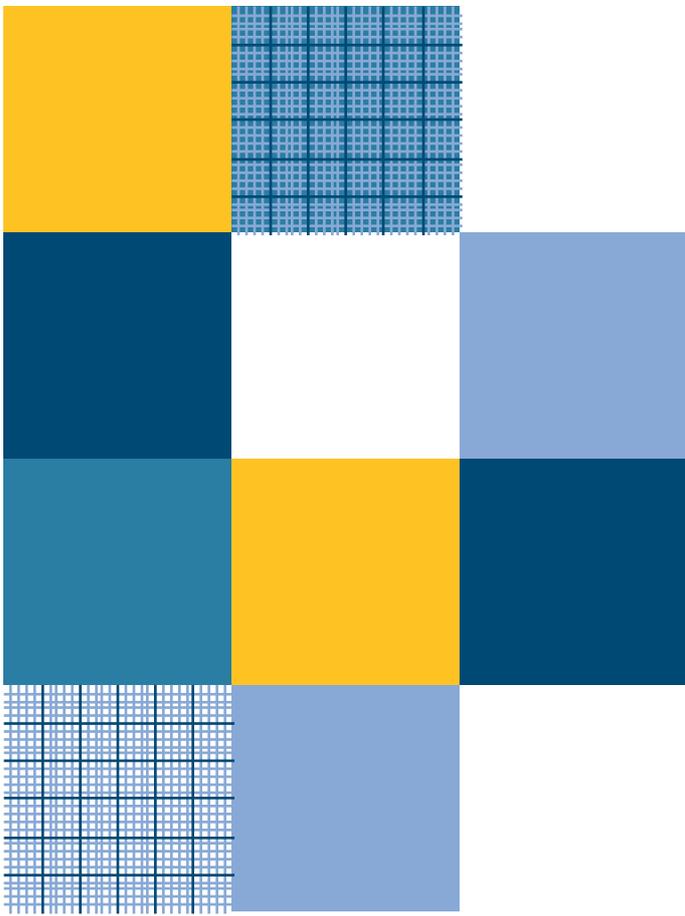
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report

Title:

Date:

Job No:



**MARTECH**

project  
summation  
introduction  
test results  
interpretation  
images  
lab results  
summary table  
background  
glossary  
company details  
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web links

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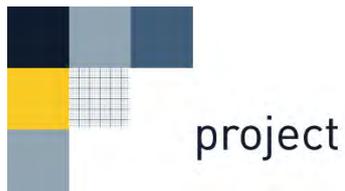
client

structure

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## **M** report

This entire document, as detailed on the home or front page, comprises Martech Report reference 16034, dated 9<sup>th</sup> June 2016. This interpretative report is on a concrete investigations and testing survey.

## **M** signature

The document has been put together for you by:

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**M structure**

Neville House is basically a three storey residential housing block on top of two storey offices/retail units (which are not part of this survey work). At the time of survey the dwellings are unoccupied.

The block has reinforced concrete elements including floor slabs (planks), and floor beams shown externally. The roof level has a storey height exposed reinforced concrete framework. There are infill glazing/cladding panels as well as some concrete panels and brickwork panels (notably at the two gable ends). On the east elevation there are emergency access private balconies. At roof level the gable brickwork panels are to full height and the off centre stair/lift core rises to above the exposed concrete framework.

The following photographs illustrate the structure:



Photograph 1: General view of the structure showing the west main elevation and north gable end.



Photograph 2: General view of the north gable.



Photograph 3: General view of the main east elevation.



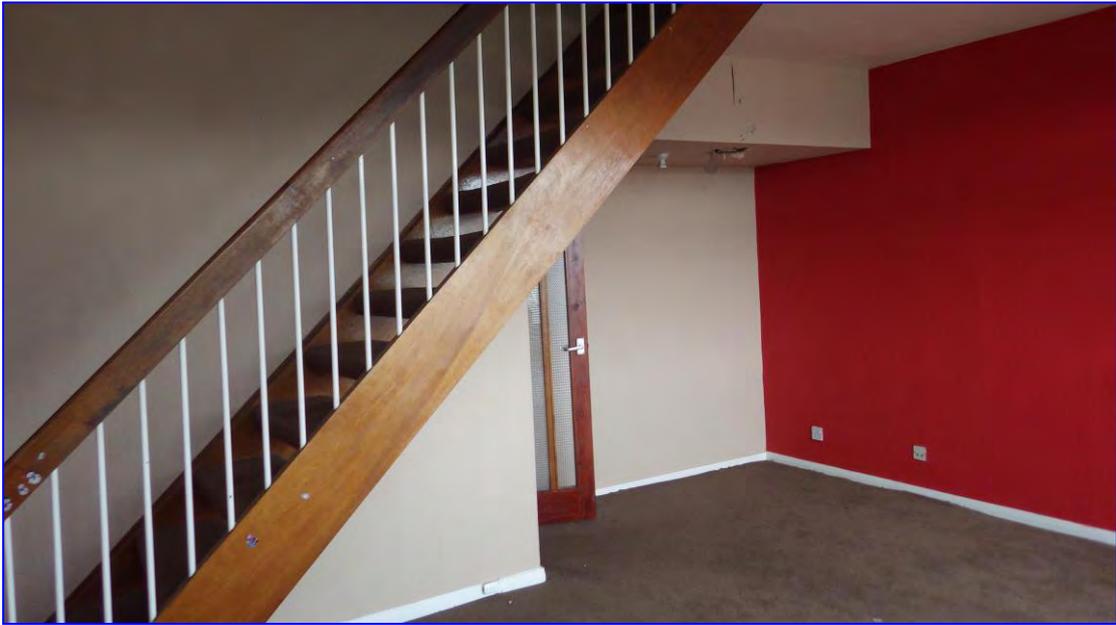
Photograph 4: General view of the south gable.



Photograph 5: General view at roof level.



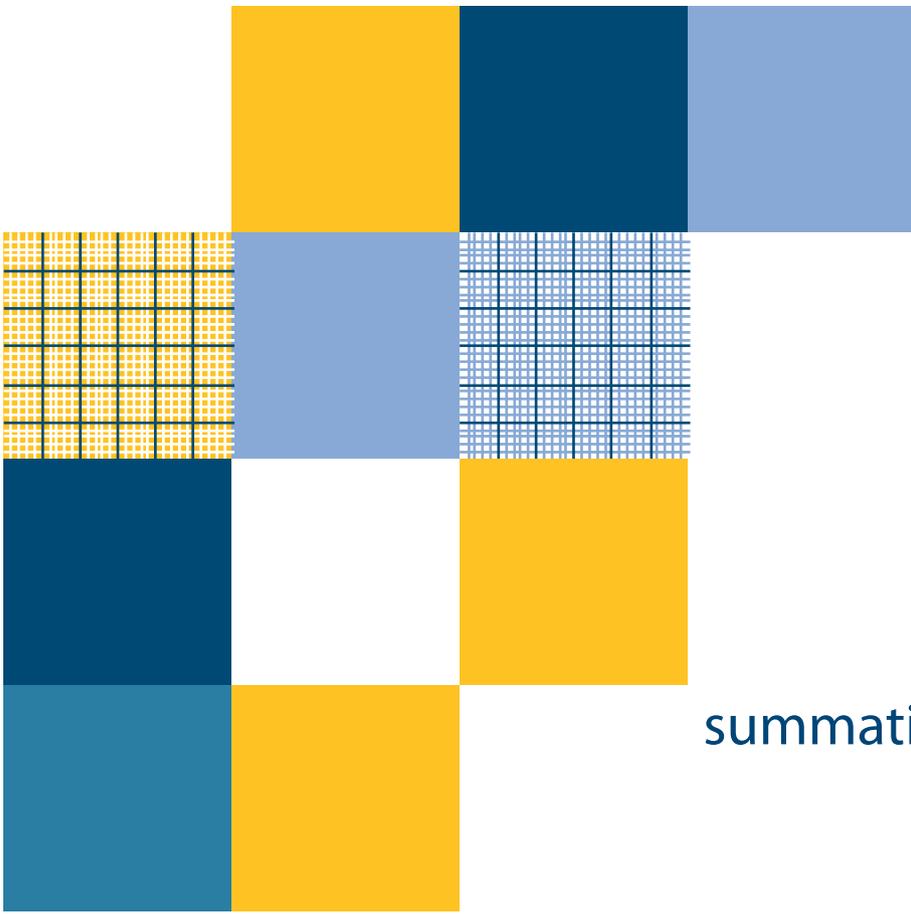
Photograph 6: General view in a typical central corridor.



Photograph 7: General view within a two storey dwelling.

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**MARTECH**

summation

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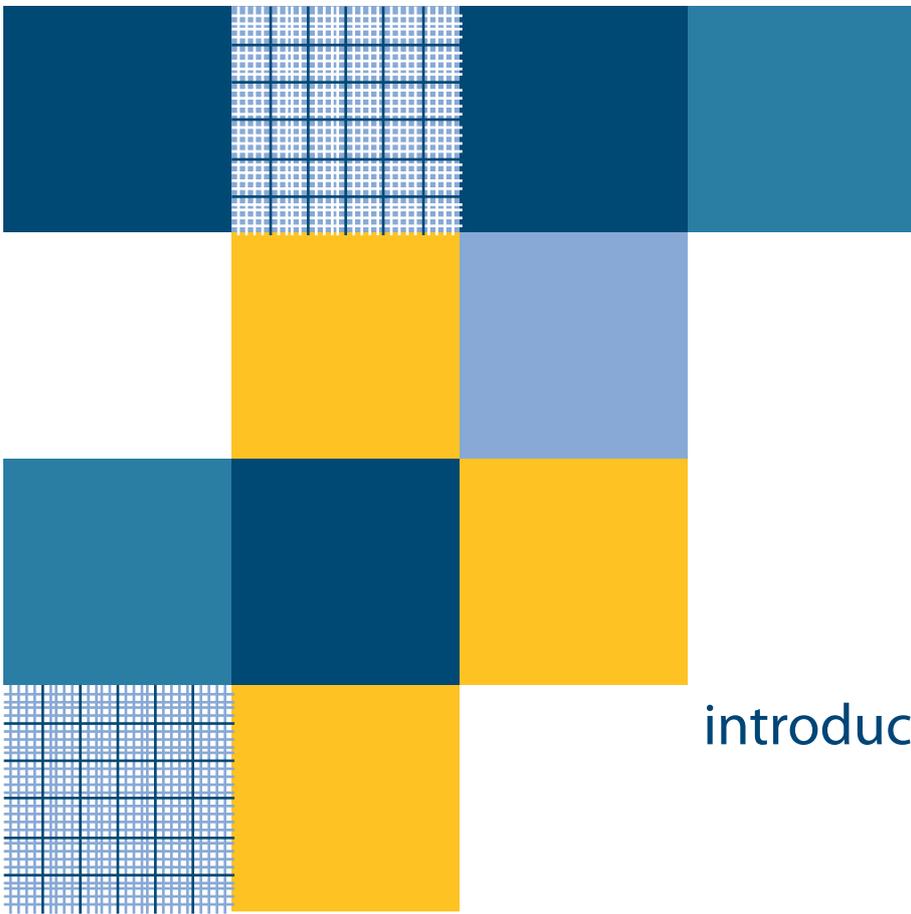
report

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## summation

<b>Key words:</b>	concrete, reinforcement corrosion, assessment, testing, cover, carbonation, chlorides, cement content, samples, laboratory testing, alkalinity, cracking, spalling, European Standard EN 1504, concrete repair, corrosion control, brick, wall ties, cavities.
<b>Objectives:</b>	Neville House was assessed and tested in order to gain knowledge on the exact cause and true extent of any concrete deterioration and reinforcement corrosion present. In addition the brickwork panels were also tested and inspected.
<b>Findings:</b>	The structure was found to be suffering from low cover in areas with the advancing carbonation having reached the reinforcement in places, as well as chloride contamination of the concrete in conjunction with carbonation to the reinforcement in places, and hence a reinforcement corrosion problem. The cast-in chloride levels found presented a <b>low to extremely high</b> risk of chloride attack on the reinforcement. The cement content test results were variable and generally satisfactory/high but one was very low (5.4%). The testing of samples for HAC found none present. The brickwork walls were found to be of cavity construction with flat twisted wall ties. The exposed aggregate panels had moderate to very high risk chlorides and spalling was noted to an external side but also internally at one of the panels inspected with borescope. There was also leakage damage internally. One spall was found to a roof beam which had extremely high chlorides as well as low cover and carbonation to the rebar.
<b>Repairs:</b>	We have recommended <b>that the findings be assessed by the client's Consulting Engineers</b> prior to remedial options being considered.
<b>Dateline:</b>	It is clear that the deterioration observed has been caused by a combination of factors. This has resulted in the readily visible effects of the reinforcement corrosion seen on the structure, plus the latent, or hidden, damage identified. The information contained within the report is only valid as presented in its entirety. The advice and interpretation given are representative of the state of the structure as found at the time of survey. As deterioration is clearly ongoing in the structure, the advice and contents of the report are only valid for a period of 12 months from the date of issue.



**MARTECH**

introduction

# test

report

to select the section you require,  
please click on the relevant heading



## introduction

### **M** the works

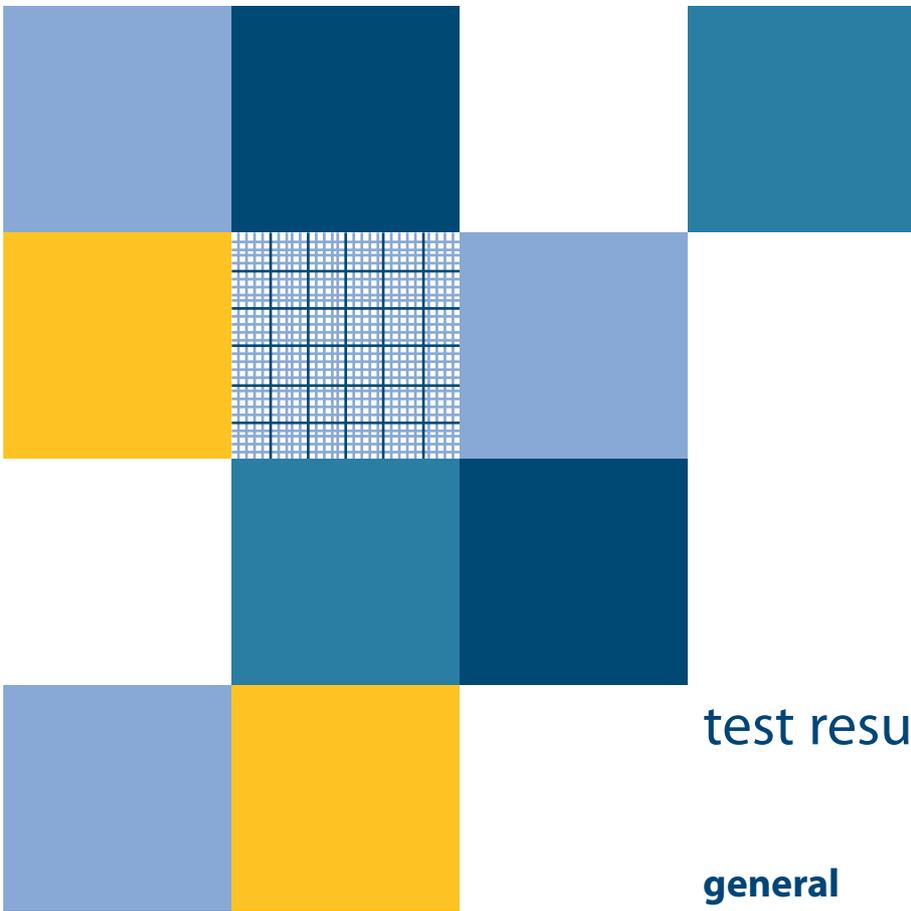
Martech Technical Services Ltd were requested by Mr Gareth Davis of the Corby Borough Council to carry out concrete investigations and testing survey on Neville House, Corby, in accordance with their official order no. 3A0083178 dated 23<sup>rd</sup> March 2016.

The works were carried out in accordance with our proposals in our quotation QJ03216/JDN/ajr dated 21<sup>st</sup> March 2016.

It was required to assess the nature and extent of concrete deterioration, to define the reinforcement corrosion condition, and to offer appropriate remediation and corrosion control proposals. In addition the brickwork was tested in several locations to confirm detailing and conditions.

The Structural Engineers for the work are the Rolton Group – contact: Andrew Chisem.

Our Engineers carried out the site work in the week commencing 9<sup>th</sup> May 2016 and their findings are the subject of this interpretative report.



**MARTECH**

test results

**general**

**visual**

**covermeter**

**carbonation**

**dust samples**

**breakout**

**brickwork**

**t e s t**  
**r e p o r t**

to select the section you require,  
please click on the relevant heading



## **M** general

Although a brief overall visual assessment was made, detailed testing work was only carried out in selected test areas.

The test area positions were selected on the basis of the visual assessment, in such a manner as to endeavour to sample the full range of concrete and reinforcement conditions present, and thus to maximise the information obtainable.

The following Test Results sub-sections of the report contain photographs illustrating various parts of the text. It is recommended that these be studied, with their explanatory captions, in conjunction with the accompanying text.

The most important test results are summarised, in a logical tabular form, in the Summary Tables section of this report.

The findings are recorded on survey sheets, to be found in the Images section of this report.

The Background section of this report contains more information on the test procedures under Testing.

Assessment and testing was carried out employing the following techniques:

**M visual**

Please note that our visual observations are based upon one of our Engineers carrying out a brief walk around survey of accessible areas, perhaps supplemented by areas accessed during the course of the detailed testing.

It was noted that there are concrete defects externally in the form of cracking and spalling dotted about the facades but most notably to the wet elevation floor beams. The external elements' surface coatings were deteriorated. Some of the spalls were also probably failed previous patch repairs. The mortar to one area of the brickwork panels was deteriorated. The railings to the small balconies were deteriorated (rusting). Internally leakage damage was noted to the roof slab soffits with the result that the precast floor planks were visible – no spalling was seen to the exposed planks. One spall was seen to a beam (at TA5).

The following photographs illustrate some of the defects noted:



Photograph 8: General view at roof level. Note deteriorated coatings apparent to the concrete elements. Note coping detail to support beam (see photograph 10).



Photograph 9: Cracking / spalling to a roof level column (TA19).



Photograph 10: A spall to the coping detail on the support beam (as per photograph 8).



Photograph 11: A spall to a roof beam face (TA24).



Photograph 12: A couple of spalls and deteriorated coating to a balcony soffit (TA28), east elevation.



Photograph 13: Spalling to a floor beam, west elevation.



Photograph 14: Spalling to another floor beam, west elevation.



Photograph 15: Another example of spalling to a floor beam, west elevation.



Photograph 16: A larger spall / failed previous repair to a floor beam (2<sup>nd</sup> floor, TA31).



Photograph 17: As p16 after failed section removed. Note corroded reinforcement, one bar being at low original cover.



Photograph 18: A spall to the edge of an exposed aggregate panel, west elevation (TA32). Note exposed corroded bar at low minimal original cover.



Photograph 19: A spall/failed previous repair to a floor beam (TA33). The bar had a total loss of section.



Photograph 20: The brickwork mortar joints were poor / deteriorated in places as shown here at BWK 8, 3<sup>rd</sup> floor, south gable.



Photograph 21: An example of leakage and associated deterioration seen in places internally. This photograph is at TA2, roof slab soffit, and where the plaster has fallen away a joint between precast planks is apparent.



Photograph 22: A spall noted internally to a 3<sup>rd</sup> floor beam (on the east elevation) seen at a stair landing.



Photograph 23: View at TA11, 3<sup>rd</sup> floor soffit, showing planks.



Photograph 24: Leakage damage noted in flat 12, roof slab soffit – not planks are visible as a result.



Photograph 25: A general view into the lift shaft.

## **M** covermeter

The covermeter results obtained at Neville House have been corrected wherever possible in line with observations at breakout locations.

The cover results are summarised in the following table:

Element	Depth of Cover (mm)		
	Minimum	Maximum	Mean
Roof Beams (external)	5	52	31
Roof Columns (ext)	11	45	24
Wall Support Beam (ext)	19	47	31
Floor Soffits	11	65	21
Floor Soffits (ext)	15	25	19
Beams	4	51	30
Beams (ext)	15	40	30
Columns	15	54	34
Balcony Slabs	5	38	24
Aggregate Panels	5	56	44
Walls	2	53	33
Stair Soffits	17	43	31
Stair Landing	18	41	30

The cover results were widely variable. Many of the elements had low minimum cover results.

## M carbonation

Please note that it is our policy to record carbonation results from in-situ tests to the nearest 5mm only. We do this in recognition of the fact that, in our opinion, the results across any concrete structure can vary significantly, as the concrete is frequently far from homogeneous across that structure. It is also true that the so-called carbonation front is not a parallel plane to the surface of the concrete, rather it is locally seen to be a very irregular plane roughly parallel to the surface. Readings across a single break out can vary by more than 5mm, which would be reflected in the results.

In accordance with BRE Digest 444: Part 2:2000 the progress of carbonation obeys an empirical formula:

$$\text{Simplified CBmm} = k \cdot \sqrt{t}$$

Where      CBmm = carbonation depth in mm  
               k        = a constant reflecting  
                               concrete quality  
               t        = time, in years

The results obtained at Neville House are summarised in the following table:

Element	Depth of Carbonation (mm)		
	Minimum	Maximum	Mean
Roof Beams (external)	5	5	5
Roof Columns (ext)	<5	20	9
Wall Support Beam (ext)	n/a	<5	n/a
Floor Soffits	<5	25	12
Floor Soffits (ext)	<5	5	<5
Beams	15	40	27
Beams (ext)	<5	20	6
Columns	10	20	15
Balcony Slabs	10	15	12
Aggregate Panels	<5	5	<5
Walls	15	50	28
Stair Soffits	<5	5	<5
Stair Landing	5	5	5

n/a = not applicable as single test result

As can be seen the carbonation results were widely variable.

**M** dust samples

Details of the laboratory test findings are to be found in the Lab Results section of this report.

In accordance with BRE Digest 444: Part 2:2000 the risks associated with chloride contamination of concrete are variable with source and age of structure. This has long been our opinion as the critical factor in chloride contamination is in fact the total amount of free chloride ion available to take part in chloride attack on reinforcement.

In simple terms cast-in chlorides tend to combine with the hydration products of the cement, and are therefore considered to be substantially bound. It is known that the carbonation process releases this chemical bond, which results in an accumulation of free chloride ion just ahead of the carbonation front.

Conversely, chlorides that have entered the concrete subsequent to hardening, referred to as ingressed chlorides, must be considered to be substantially free, and available to take part in chloride attack. Ingressed chloride will accumulate with the passage of time, being present in ever-greater concentrations, at ever-greater depth. It follows that this form of chloride contamination is the more aggressive in the normal run of events.

Classification of risk in accordance with BRE Digest 444: Part 2:2000 is a complex procedure that we follow in general terms. The categories of risk are defined as follows: *negligible, low, moderate, high, very high, and extremely high*. Categorisation varies with source of chloride, age of structure, extent of carbonation and environmental exposure condition.

The results obtained for Neville House are expressed as chloride ion by mass of cement, using an assumed cement content of 14% in the concrete and are summarised in the following table:

Element	Chloride Content (%)		
	Minimum	Maximum	Mean
Roof Beams (external)	0.07	0.48	0.21
Roof Columns (ext)	0.15	0.20	0.18
Wall Support Beam (ext)	n/a	0.05	n/a
Floor Soffits	<0.01	0.35	0.12
Floor Soffits (ext)	<0.01	0.43	0.29
Beams	<0.01	1.57	0.37
Beams (ext)	<0.01	0.18	0.12
Columns	<0.01	<0.01	<0.01
Balcony Slabs	0.20	0.53	0.37
Aggregate Panels	0.48	1.08	0.82
Walls	0.33	0.36	0.35
Stair Soffits	0.39	0.43	0.41
Stair Landing	n/a	0.57	n/a

n/a = not applicable as single test result

The table has been colour coded to show the risk of reinforcement corrosion occurring in uncarbonated concrete due to the presence of cast in chlorides in accordance with BRE Digest 444 Part 2: 2000, assuming that the structure is approximately 40 years old, as follows: -

Chlorides (%)	Risk of Corrosion
<0.45	LOW
0.46 – 0.70	MODERATE
0.71 – 1.00	HIGH
1.01 – 1.50	VERY HIGH
>1.50	EXTREMELY HIGH

The chloride results were found to vary widely. Many of the results were of low risk (in uncarbonated concrete). However there were a couple of very/extremely high risk chloride results and several moderate risk results. The results indicate varying levels of cast-in chlorides except to the aggregate panels which appear to have more consistently used chlorides (but then they are precast).

In carbonated concrete the risk category increases and so for example moderate risk results would become high risk results.

### **Cement Content Testing**

Six samples were tested for cement content. The results were widely variable. They were 18.6% (S2), 11.0% (S3), 18.8% (S4), 17.3% (S7), 5.4% (S9) and 21.2% (S28).

The lowest result of 5.4% from a (main) beam (at TA9), roof slab level, when retested gave the same very low result. The rest of the results **although variable are near or above the accepted "norm" of 14%**. Therefore 14% was used to calculate the chloride results.

### **High Alumina Cement Content Testing**

The testing of eight samples found none present.

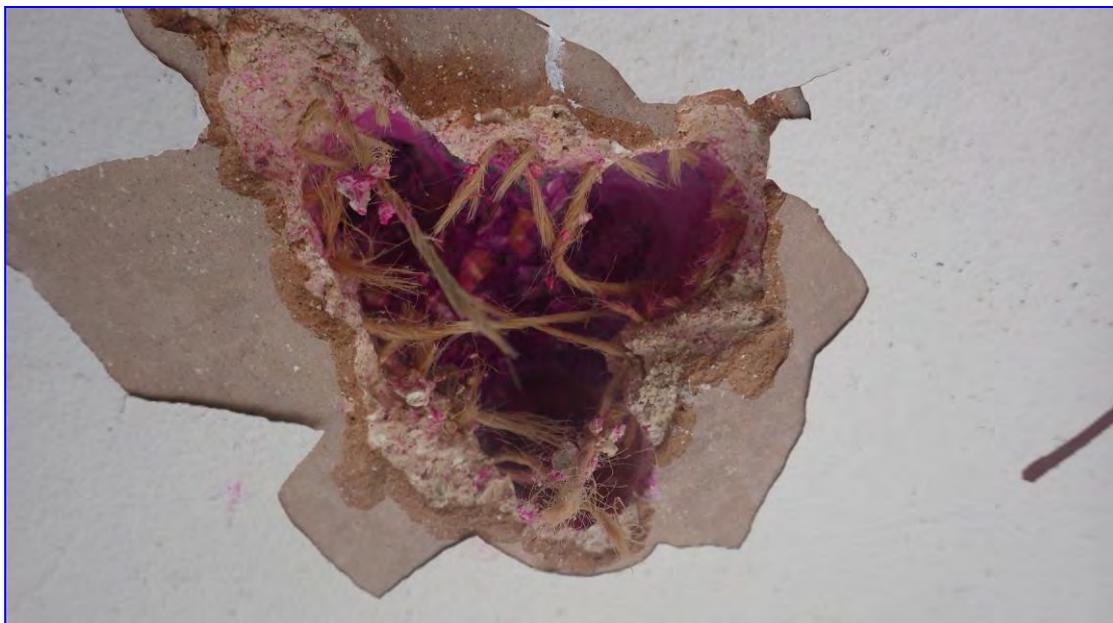
**M breakout**

Details of the exploratory break out findings are to be found on the relevant detailed test area survey sheets, in the Images Section to this report.

The breakouts confirmed that the floors have precast planks which are reinforced with 2 and 4 mm Ø longitudinal wires.

69% of the breakouts revealed clean and passive reinforcement in alkaline (uncarbonated) concrete. However the other 31% revealed reinforcement with slight or surface corrosion in carbonated concrete.

The following photographs illustrate a few of the breakouts:



Photograph 26: The sample / carbonation test at TA1, 4<sup>th</sup> floor soffit, revealing a render reinforced with a string covering the concrete.



Photograph 27: The breakout at TA2, roof slab soffit, revealing wire/small bar diameter reinforcement in a precast plank (in good condition).



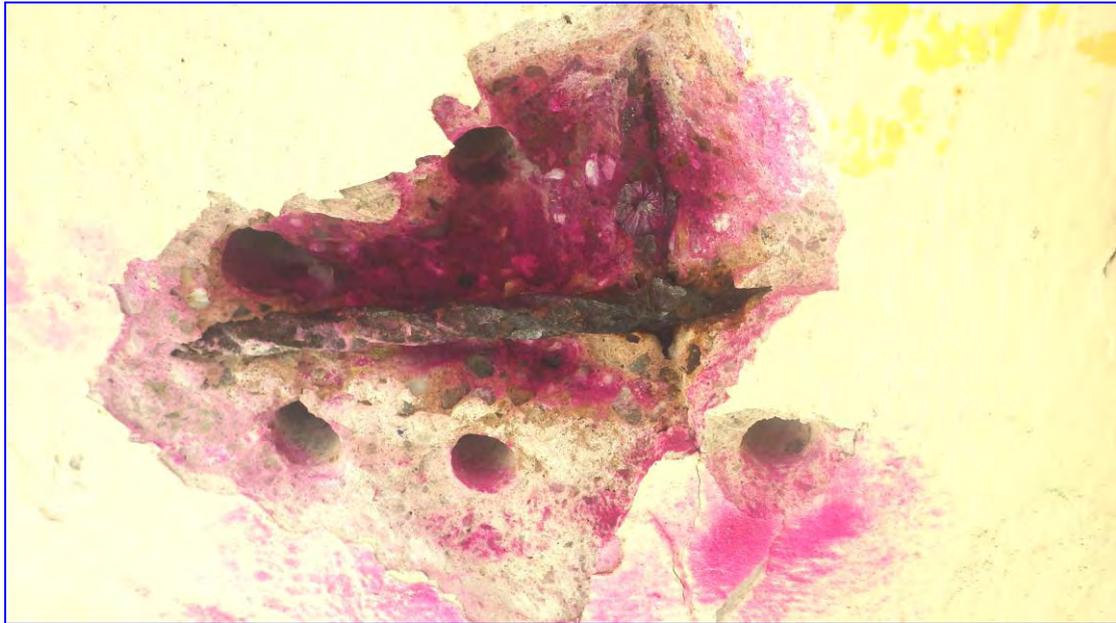
Photograph 28: The breakout at TA5, 3<sup>rd</sup> floor beam, revealing surface corrosion to a bar (vertical) in carbonated concrete, whilst the bar at deeper cover in alkaline concrete was clean and passive.



Photograph 29: The breakout at TA9, roof main beam, revealing bars with slight/surface corrosion in carbonated concrete.



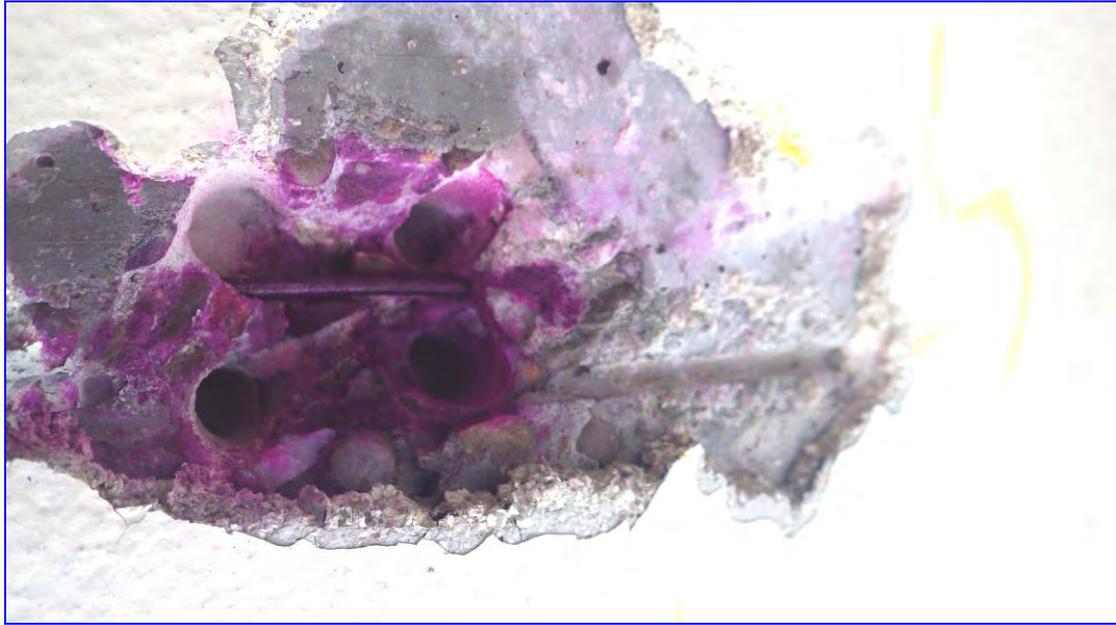
Photograph 30: The breakout at TA22, roof beam (external) revealing clean and passive reinforcement in alkaline concrete.



Photograph 31: The breakout at TA28, 2<sup>nd</sup> floor balcony soffit, revealing a bar at low cover in carbonated concrete with surface corrosion. The deeper bar was generally clean and passive.



Photograph 32: The breakout at TA32, exposed aggregate panel, revealing clean and passive reinforcement in alkaline concrete.



Photograph 33: The breakout at TA35, 2<sup>nd</sup> floor soffit (external) revealing another small diameter bar/wire (in a plank) in a clean and passive condition.

**M brickwork**

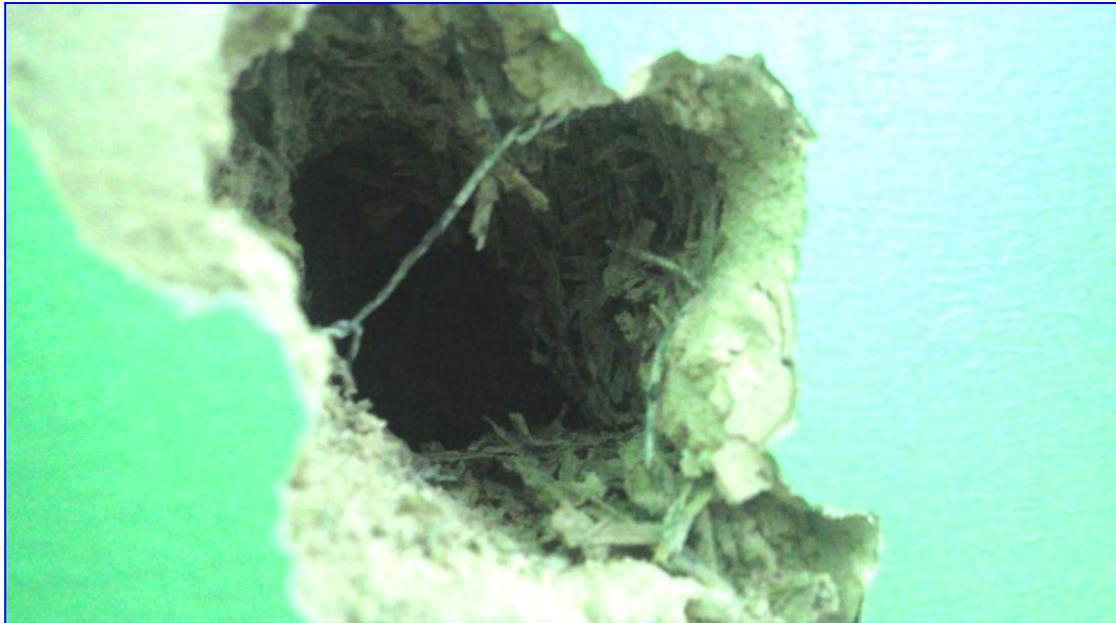
Testing to the roof level north gable end wall (at BWK 1) confirmed it to be a cavity wall with brick inner and outer leafs. The cavity was 75mm wide where inspected and there were mortar protrusions in the cavity but it was clear. The cavity tray was covered in mortar debris. The leafs are tied with flat twisted galvanised wall ties in a rough diamond pattern. The ties had some debris on them and no corrosion was seen.



Photograph 34: General view of the brickwork at BWK1 with wall tie locations marked in yellow chalk.

At BWK 2, roof plant room wall (west elevation), testing from the inside confirmed the wall is of cavity construction with blocks to the outer leaf and brick to the inner. The cavity was some 100mm wide and clear. The wall ties seen were of flat twist phosphor bronze type.

At BWK 3, 3<sup>rd</sup> floor west elevation, the wall was found to be an aggregate panel with a cavity behind (70mm wide) and an inner of woodwool which was internally plastered. Spalling concrete and bars at originally low cover were seen in the cavity to the rear of the aggregate panel.



Photograph 35: Hole made at BWK3 revealing woodwool inner, plastered over.

At BWK 4, 3<sup>rd</sup> floor, east elevation, the wall was found to be a cavity wall with brickwork inner and outer leafs. The wall had regular wall ties of the flat galvanised type. The cavity was some 60mm wide and had cavity wall insulation. The wall tie presence was confirmed by a small breakout internally.



Photograph 36: Breakout at BWK4 revealing clean flat end of a tie.

To the north gable at BWK 5, 3<sup>rd</sup> floor, the wall was confirmed as being of brickwork inner and outer leaves with a 75mm clear cavity and flat twisted ties (with no corrosion seen). On the inner (dwelling side) face the wall was covered with woodwool over which plaster was applied.



Photograph 37: Breakout at BWK5 from inside showing render over woodwool over brickwork.

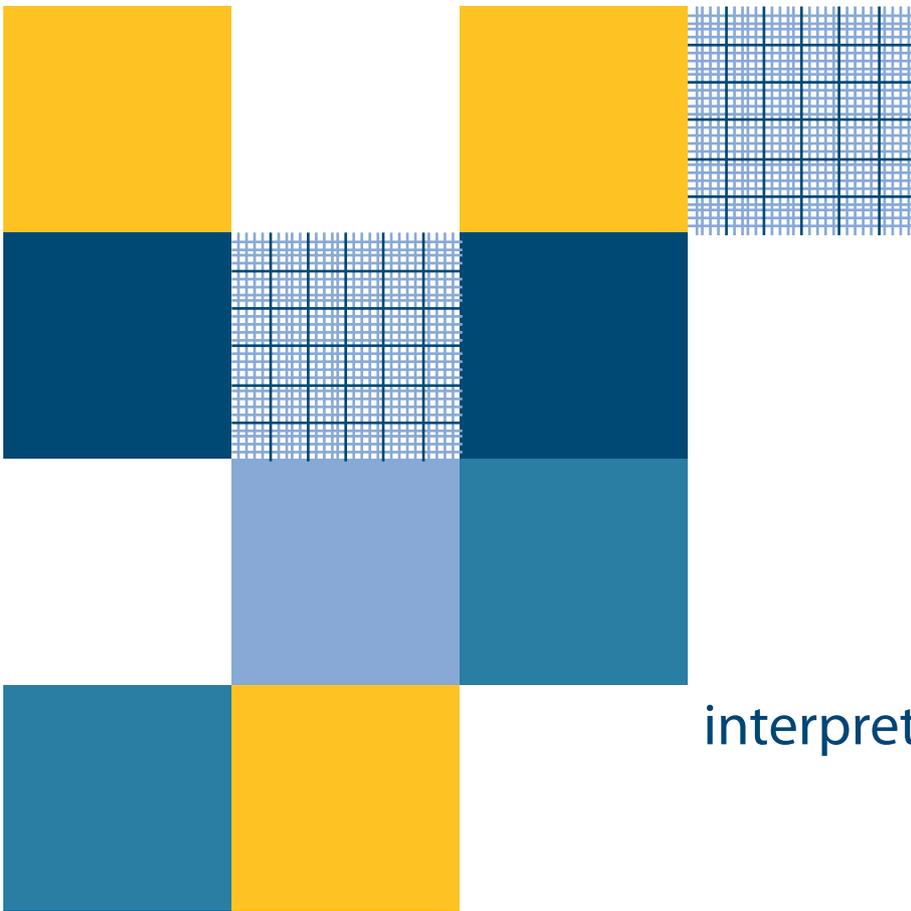
BWK 6 – 8 were on the south gable (roof, 4<sup>th</sup> and 3<sup>rd</sup> floor levels). Similar detailing was found to that seen on the north gable. At BWK 7 the cavity tray was seen to be a foil backed bituminous type. Also the inner leafs at BWK 6 & 7 were blockwork.

Testing at BWK9, 10 and 13 (2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> floor) of the blocks on the west elevation – as per BWK 2 – found similar detailing to BWK 2.



Photograph 38: Breakout at BWK9 revealing end of phosphor bronze tie.

Testing at BWK11 and 12 (4<sup>th</sup> floor), east elevation, found similar detailing to that seen at BWK 4.



**MARTECH**

interpretation

# test

report

to select the section you require,  
please click on the relevant heading



## interpretation

### **M** test report

The investigations and test results obtained at Neville House indicate there is significant deterioration both visible and latent to the concrete elements predominantly due to failed coatings, leakage, areas of low original cover, advancing carbonation and in some instances very/extremely high risk chlorides. There was also one very low cement content result. The brickwork appeared generally satisfactory for its age although there was some deterioration (weathering). The construction detailing e.g. wall build-ups were confirmed in test areas and are detailed in the results section and survey sheets to this report.

The visual appraisal of the structure noted visible concrete defects spread around the structure in the form of spalling concrete. Internally most surfaces are covered (plaster etc). Where leakage damage had occurred some of the concrete elements e.g. the precast floor planks were visible but no spalling was seen to them. One spall was seen internally to a beam (to the east elevation) seen from a stair landing.

The cover test results were widely variable and the minimum results ranged from 2mm to 19mm across the elements where tested. The carbonation test results were also variable and the maximum results ranged from <5mm to 50mm where tested. Therefore there is reinforcement within carbonated concrete.

The chloride test results were wide ranging being overall from <0.01% to 1.57% chloride ions by mass of cement using a cement content of 14%. The higher risk results were to the beams, aggregate panels and to a lesser extent the stair elements and balcony slabs. The results suggest the variable use of chlorides in the casting process be it to speed up the curing process or use of contaminated mix water or in the aggregates used.

The precast exposed aggregate panels had a range of results from 0.48% to 1.08% indicating cast-in on purpose and a notable latent damage issue. Spalling was seen to one of the panels at an outside edge (associated with very low cover) but was also seen to the rear (inner face) at one panel when viewed with a borescope – it is not known how extensive that may be at this stage.

The highest chloride of 1.57% was from a beam – at TA5, 3<sup>rd</sup> floor beam, internal, from stair landing and happened to be the beam to which a spall

was noted. At the spall/breakout low cover and carbonation beyond the bar at low cover were also noted.

The cement content test results ranged from 5.4% (very low and retested at the lab as a check) to 21.2%. The overall average was about 15% and **hence the usual "norm" of 14% was used to calculate the chloride results.** The next lowest cement content to the 5.4% (which was from a roof level main beam) was 11.0% (from a 4<sup>th</sup> floor column) and so the low cement issue may be isolated / localised.

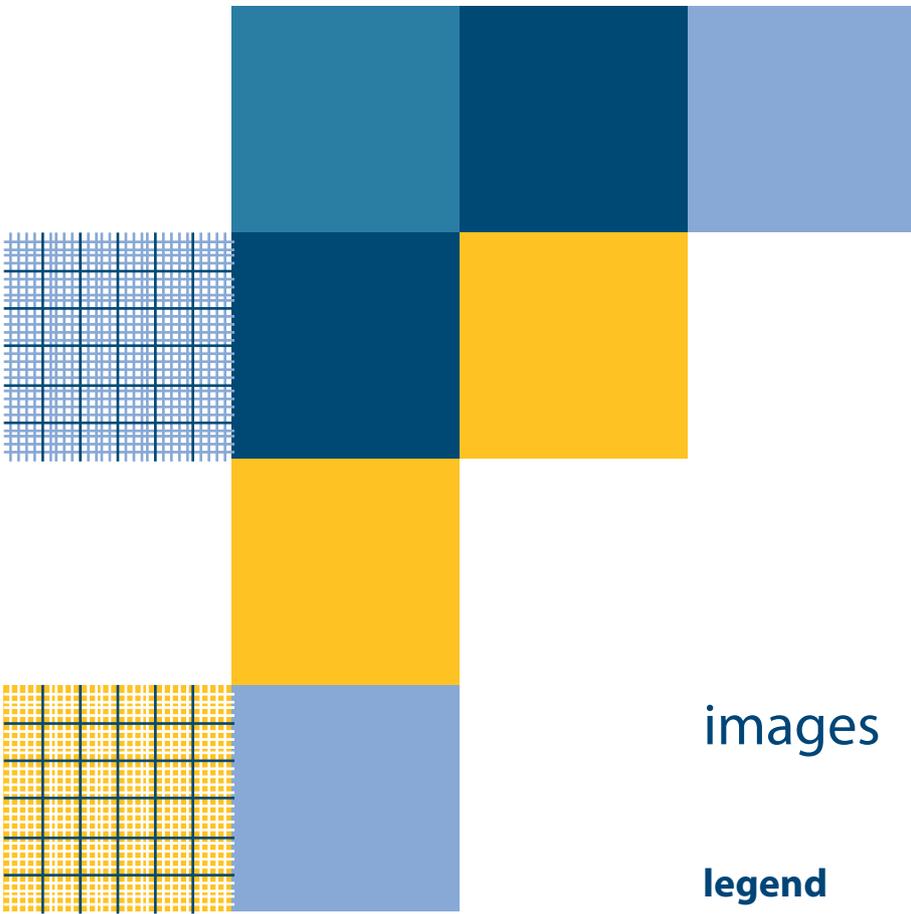
The testing of samples for HAC found none present.

The brickwork panels inspected had varying details but were generally of cavity build construction with brick inner and outer leafs and flat twisted wall ties in sufficient number. The panel at BWK 8 was noted to have deteriorated mortar joints to the top four or so courses. The internal build-up of layers was noted where tested.

The small block panels on the west elevation were also confirmed to have a cavity behind and wall ties present.

**The findings should be assessed by the client's Consulting Engineers.** This may lead to further investigations e.g. of the exposed aggregate panels to assess the extent of any deterioration to the rear/inner faces but also to determine if the low cement content found to a beam is isolated.

Assuming the structure is to be repaired the remedial advice will probably include traditional patch repairs to the external spalling concrete areas, possibly combined with the installation of corrosion inhibitors and or galvanic anodes in areas of high chlorides as well as the application of new coatings. It may be deemed appropriate to simply remove the exposed aggregate panels and replace with something modern and with better U values etc. Removal of the internal ceiling finishes would confirm if there are any spalls to the floor planks (as only a small proportion have been seen). The remedial advice will obviously depend on client requirements.



**MARTECH**

images

legend

survey sheets

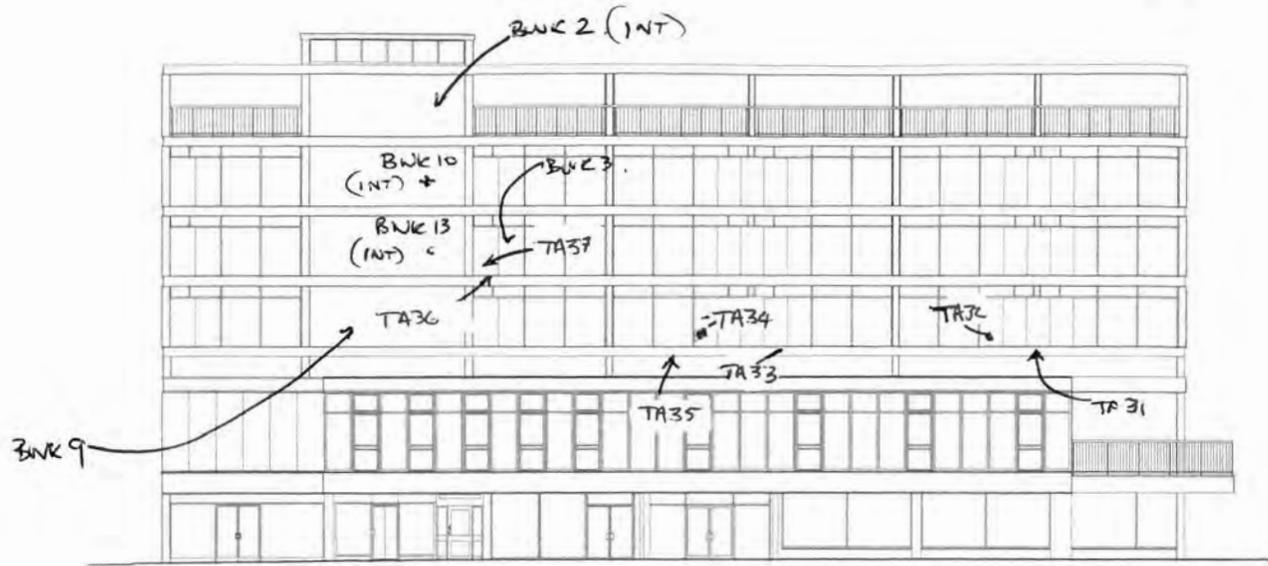
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report

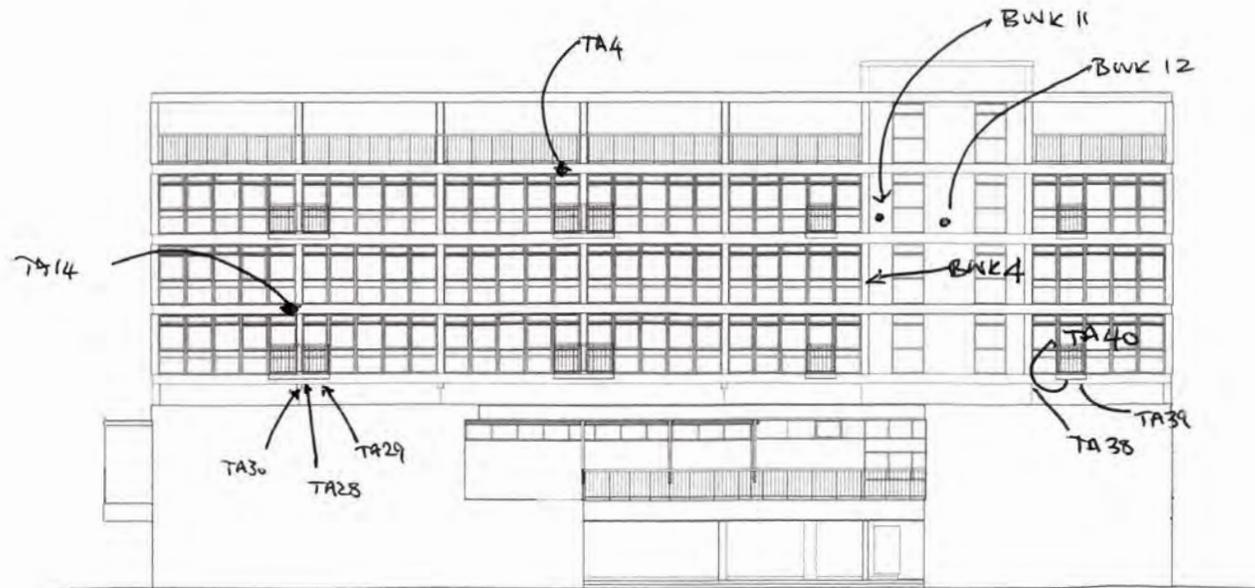
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**M** legend

TA	Test Area Location and Reference
⊕ S	Sample Location and Reference
CV	Depth of Cover (mm)
BWK	Brickwork
CB	Depth of Carbonation (mm)
C+P	Clean and Passive Steel
LOP	Loss of passivity
SP	Spall
PR	Previous Repair
FPR	Failed Previous Repair
TW	Tie Wire
RS	Rust Spot/Stain
PY	Pyrite
B/O	Breakout to Expose Reinforcement
FM	Facing Mix
BM	Backing Mix
{ c	Crack
VS	Visible Steel
BE	Bar end
45	Rebar Location and Depth of Cover (mm)
⊕ C1	Core Sample Location and Reference
SSC	Slight Surface Corrosion
SC	Surface Corrosion
H	Hollow



Front Elevation



Rear Elevation

**DRAFT - FURTHER  
DETAILED SURVEY  
WORK TO BE COMPLETED**

TEST AREA  
LOCATIONS

16034

0 1 2 3 4 5 6 7 8 9 10  
METER

AMENDMENTS

OWN / DATED

**Front and Rear Elevations**

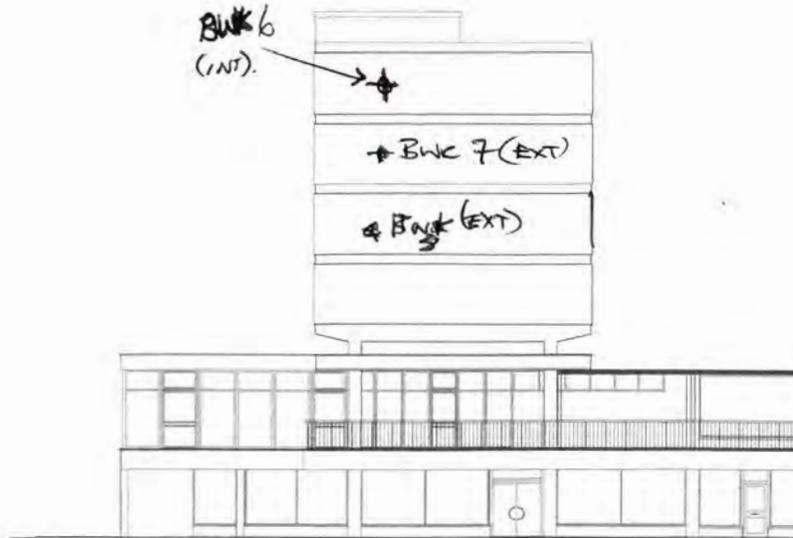
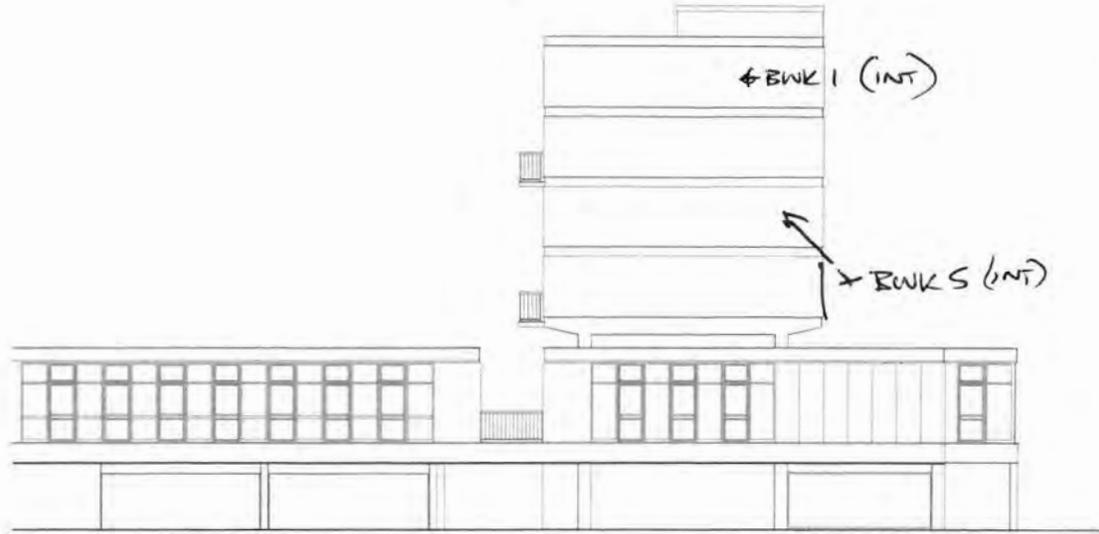
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Proposed Alterations to Residential Flats,  
Neville House, George Street,  
Corby NN17 1QD

DRAWING NUMBER  
**11011.05**

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DRAWN	KMP	CHECKED	

**KPW ARCHITECTS**  
170 Upper New Walk  
Leicester LE1 7QA  
t 0153 251 2279  
e admin@kpwarchitects.co.uk  
www.kpwarchitects.co.uk

Approved dimensions must be taken in accordance with British Standards and any discrepancies are accepted as the responsibility of the Client. Contractors should ensure that all dimensions are taken in accordance with the drawings and specifications. Any discrepancies are the responsibility of the Contractor.



TEST AREA  
LOCATIONS  
16034

DRAFT - FURTHER  
DETAILED SURVEY  
WORK TO BE COMPLETED

0 1 2 3 4 5 6 7 8 9 10  
1:500

AMENDMENTS: \_\_\_\_\_ DATE: \_\_\_\_\_

**Side Elevations**

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Proposed Alterations to Residential Flats,  
Neville House, George Street,  
Corby NN17 1QD

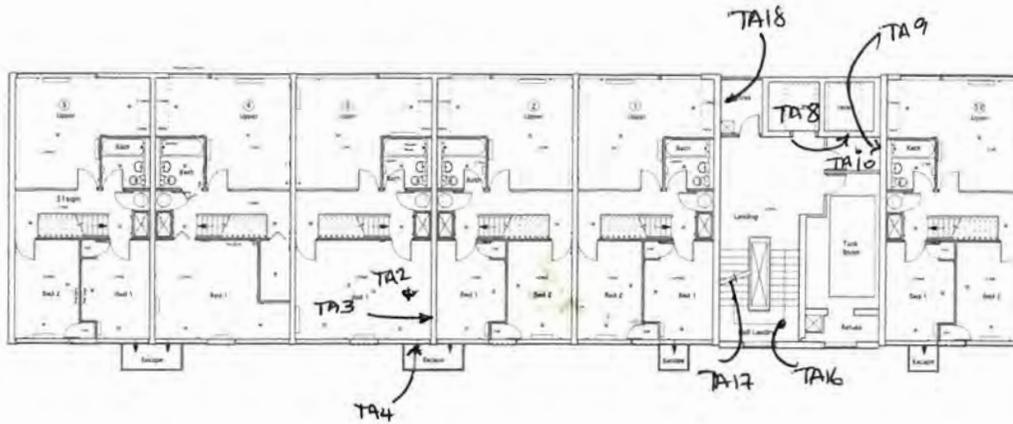
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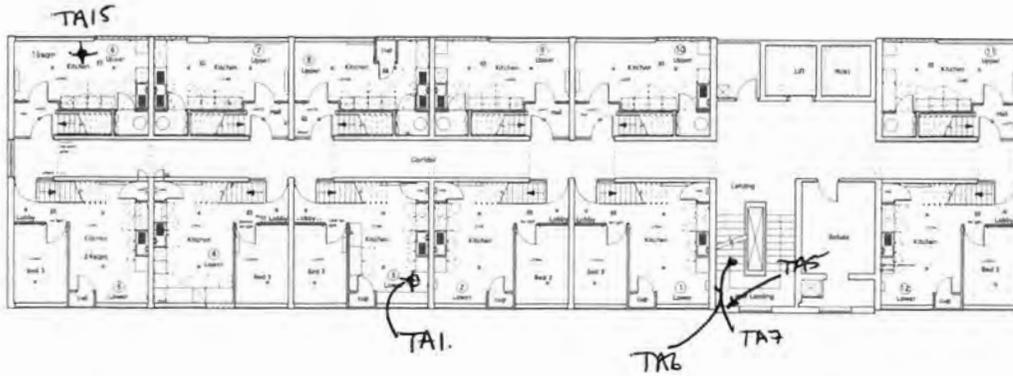
**KPW ARCHITECTS**  
170 Upper New Walk  
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t 0116 255 3279  
e admin@kpw-architects.co.uk  
www.kpw-architects.co.uk

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Floor 4



Floor 3



Floor 2



**DRAFT - FURTHER  
DETAILED SURVEY  
WORK TO BE COMPLETED**

MARTECH  
TA PLAN  
NEVILLE HOUSE  
16034



**ACCOMMODATION SCHEDULE**

3 BED FLATS - 06  
GIA: 75sqm  
2 BED FLATS - 06  
GIA: 70sqm  
TOTAL UNITS - 12

AMENDMENTS: DYN. DATE:

DRAWING TITLE

**Upper Floor Plans**

KW TITLE  
Proposed Alterations to Residential Flats,  
Neville House, George Street,  
Corby NN17 1QD

DRAWING NUMBER

**11011.04**

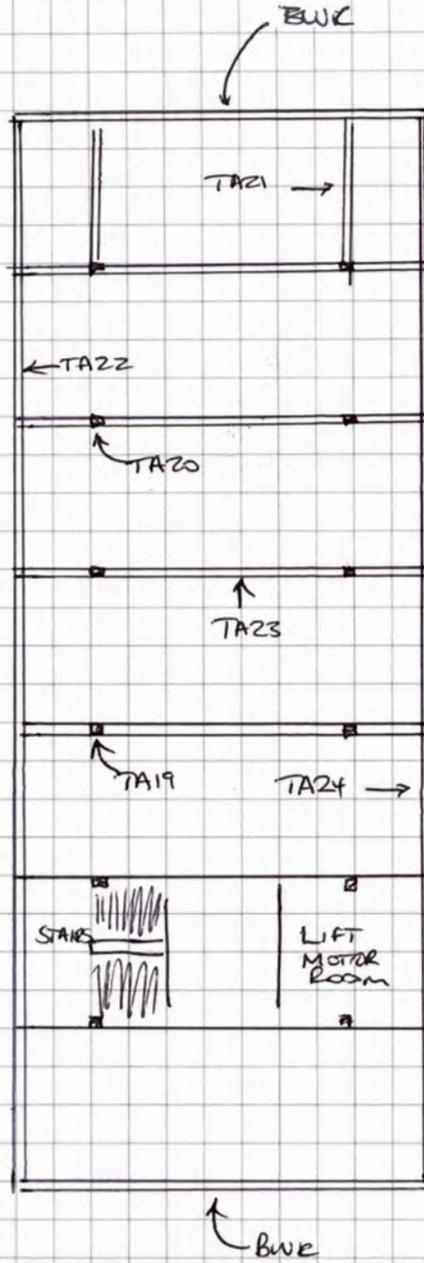
SCALE (A1) 1:500 DATE 07/02/12

DRAWN: EMP. CHECKED:



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Project Neville House

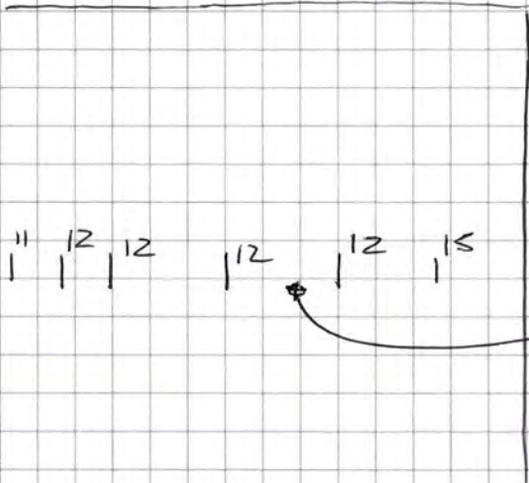
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Date .....

Report No 16034

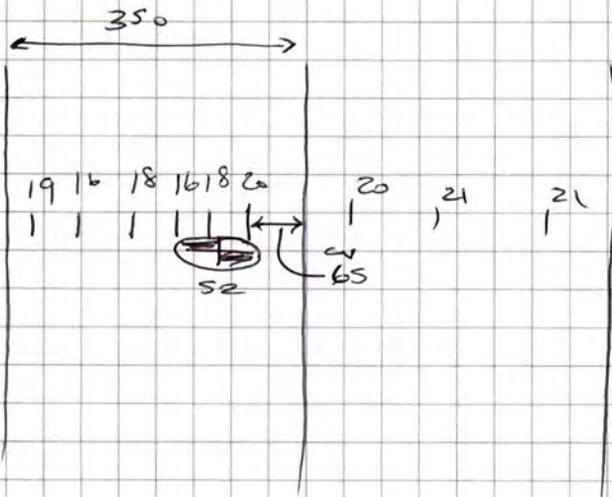
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TA1 4th Floor Soffit



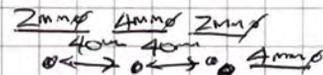
51 CBS.  
20mm RENDER (WITH 'STEELING' reinforcing)

TA2. Roof Soffit



10mm render - failing at joint from leakage

S2 4<sup>th</sup> plain bars C/P



65 16 18 20/21  
CBS.

Project NEWULU HSE

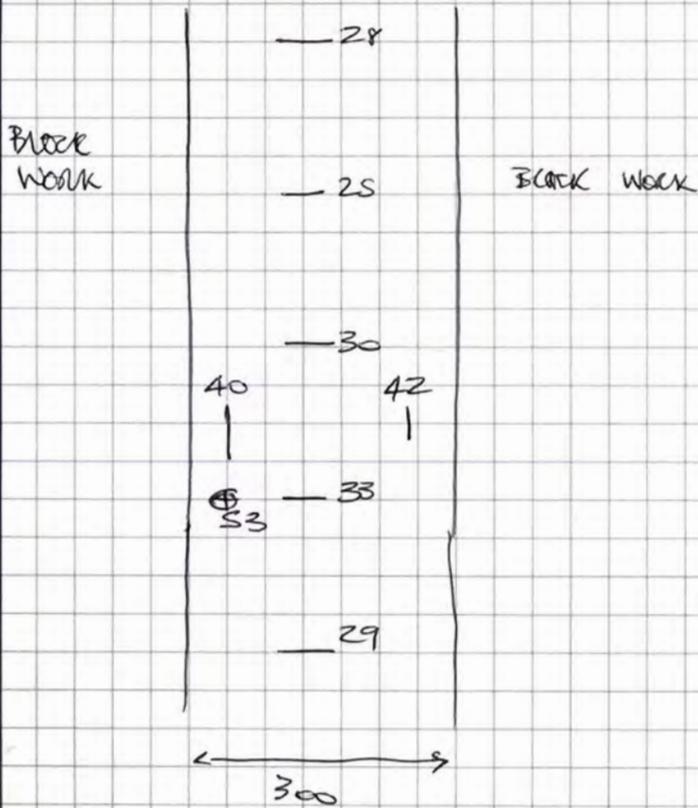
Location TA1-2

Date .....

Report No 16034

Sheet No .....

TA 3 4<sup>th</sup> Floor Column

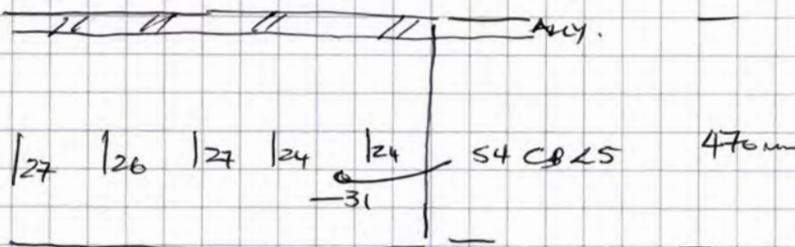


15mm Render

53 1x 28  $\phi$  plan plan bar c/c  
 w 44 face 40 side  
 1x 8  $\phi$  plan link bar c/c  
 w 33 face 30 side  
 CB 15-20

Spacing  $\downarrow$  220  
 $\leftarrow$  220

TA4 Roof BEAM (EXT)



Project NEVILLE HOUSE

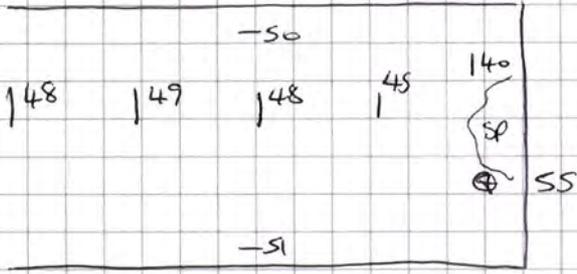
Location TA3-4

Date .....

Report No 16034

Sheet No .....

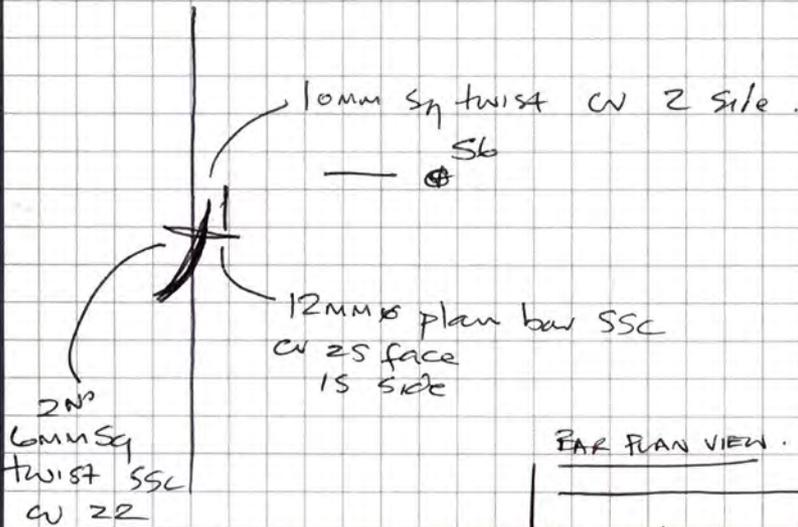
T1A S. 3<sup>RD</sup> floor BEAM



SS 1x10mm g vert plan bar GTP  
 cv 50  
 1x 10mm sq twist SC  
 CV 4  
 CB 15-20

Spacing ← 150  
 ↓ 300

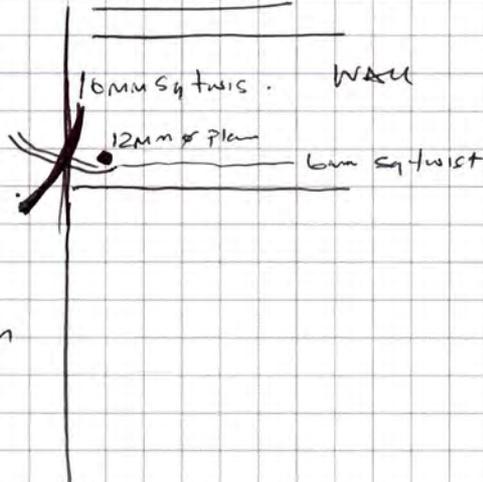
T1A6 3<sup>RD</sup> floor STAIR WALL



15mm render

S6 1x6mm sq twist SSC  
 cv 28  
 CB 50

BAR PLAN VIEW.



Project NEVILLE HOUSE

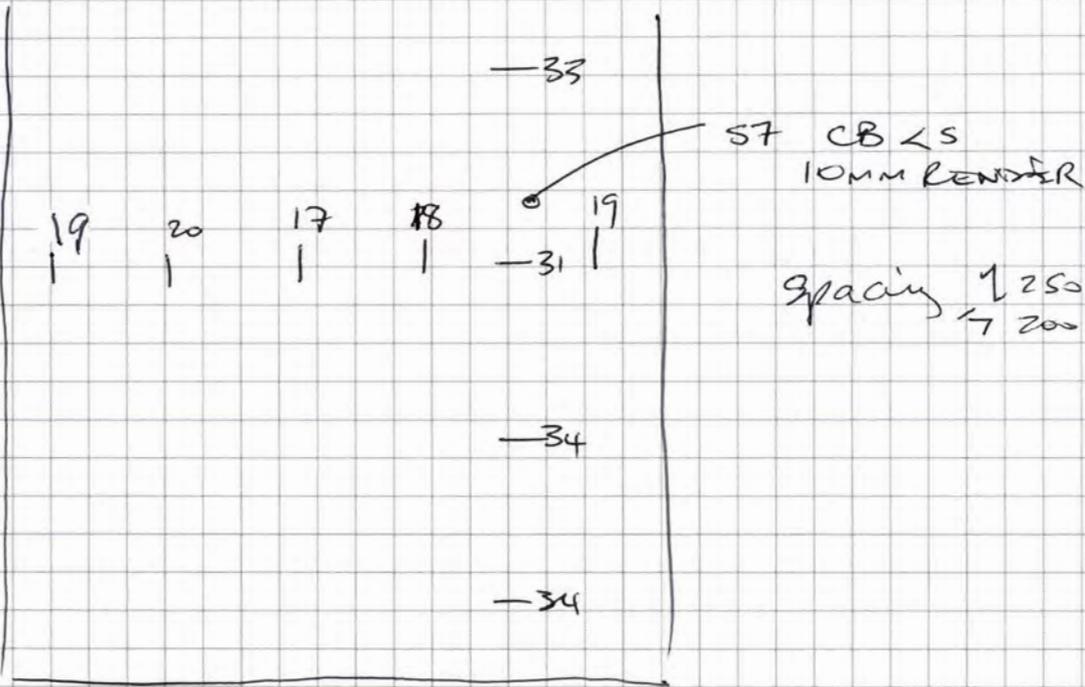
Location TAS-6

Date .....

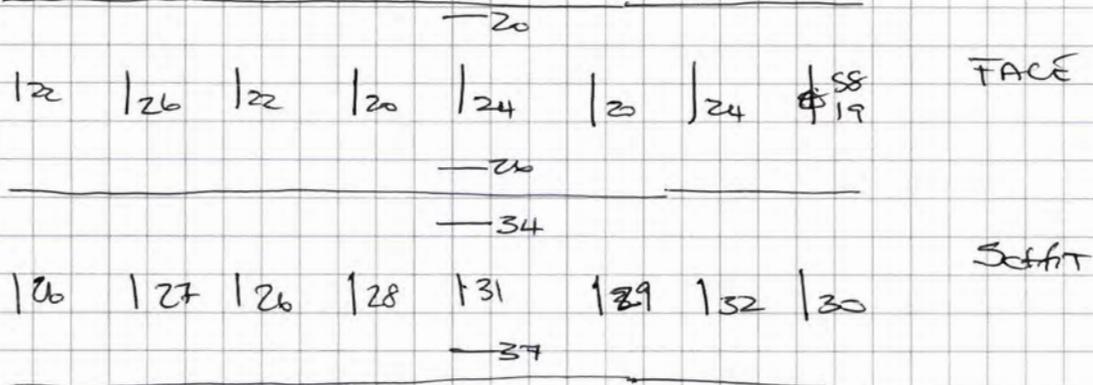
Report No 16034

Sheet No .....

TA7 2ND floor MID TO 3RD floor STAIR SOFFIT



TA8 Roof beam



S8 1x 8mm  $\varnothing$  plain bar SSC  
 CV 2f  
 CB 35-40

Project NEVILLE HOUSE

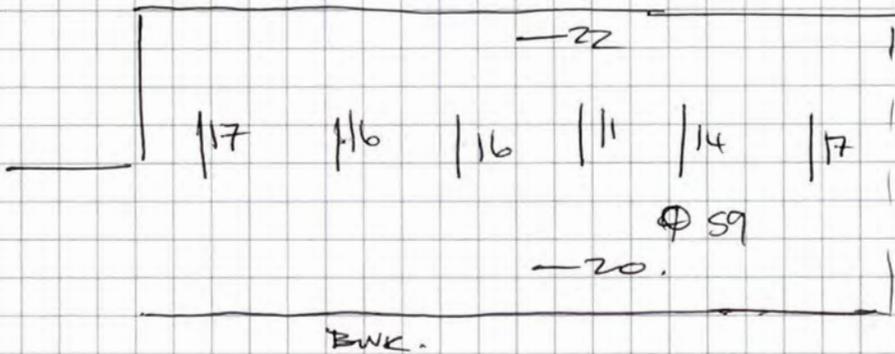
Location TA7-8

Date .....

Report No 16034

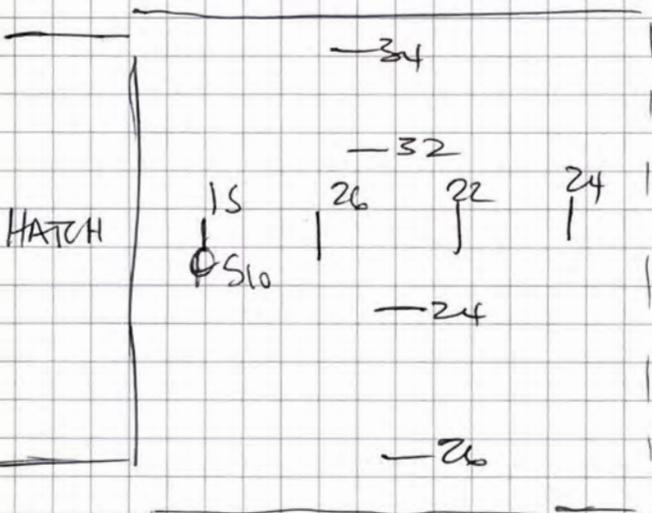
Sheet No .....

TA9 Roof MAIN BEAM



59 2x10mm  $\phi$  plan  
bars SSC  
CV 16 & 17  
CB 35-40

TA10 Roof Soffit



S10 1x12mm Sq twist  
bar c/c  
CV 31  
CB 20-25

Project NEVILLE HOUSE

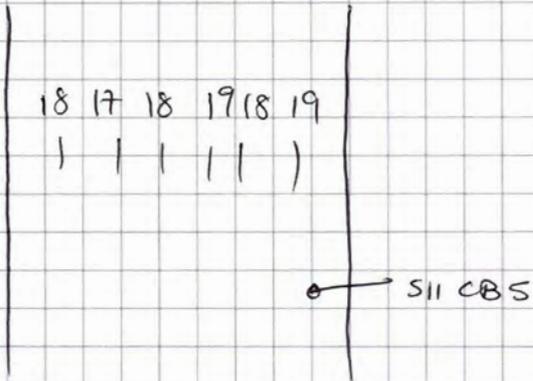
Location TA9-10

Date .....

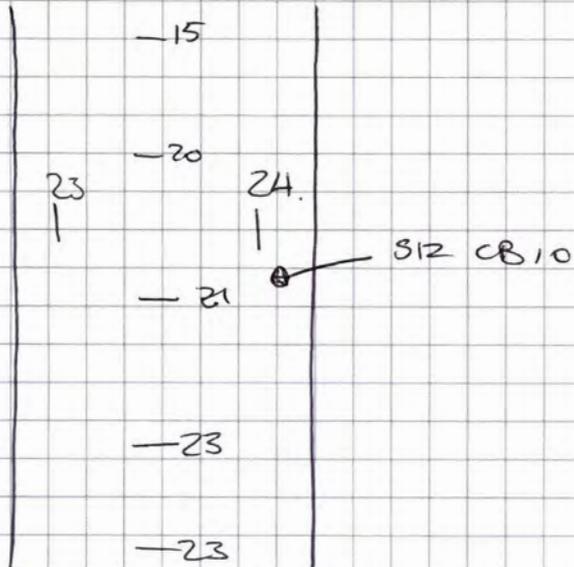
Report No 16034

Sheet No .....

TA 11 3RD Floor Slab



TA 12 2ND Floor COLUMN



Project NEVILLE HOUSE

Location TA11-12

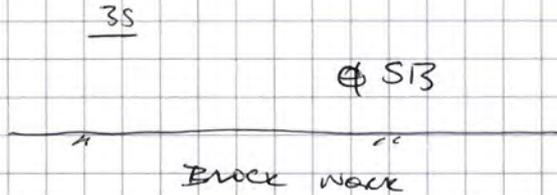
Date .....

Report No 16034

Sheet No .....

TA13 3RD floor BEAM

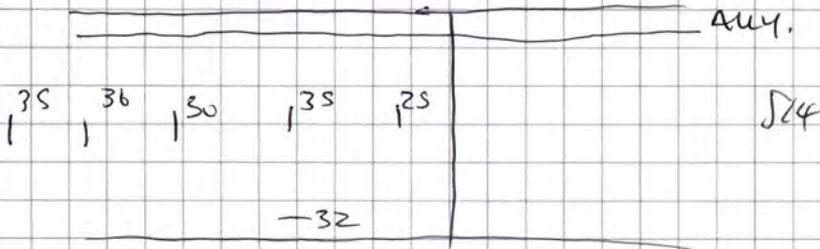
ONLY COVER PICKED UP



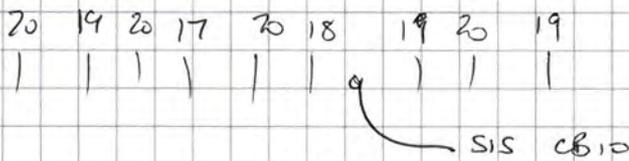
20mm render

S13 1x28mm  $\phi$  Ribbed Bar cut  
 CV 38  
 1x 12mm  $\phi$  plain link cut  
 CV 24  
 CB 15-20

TA14 3RD floor BEAM



TA15 4TH floor Slab



20mm render

Project NEVILLE HOUSE

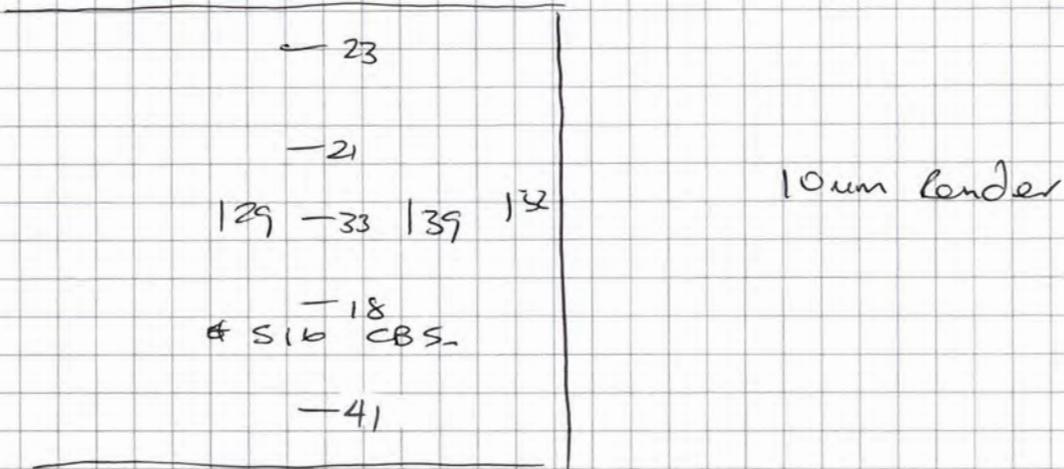
Location TA13-15

Date .....

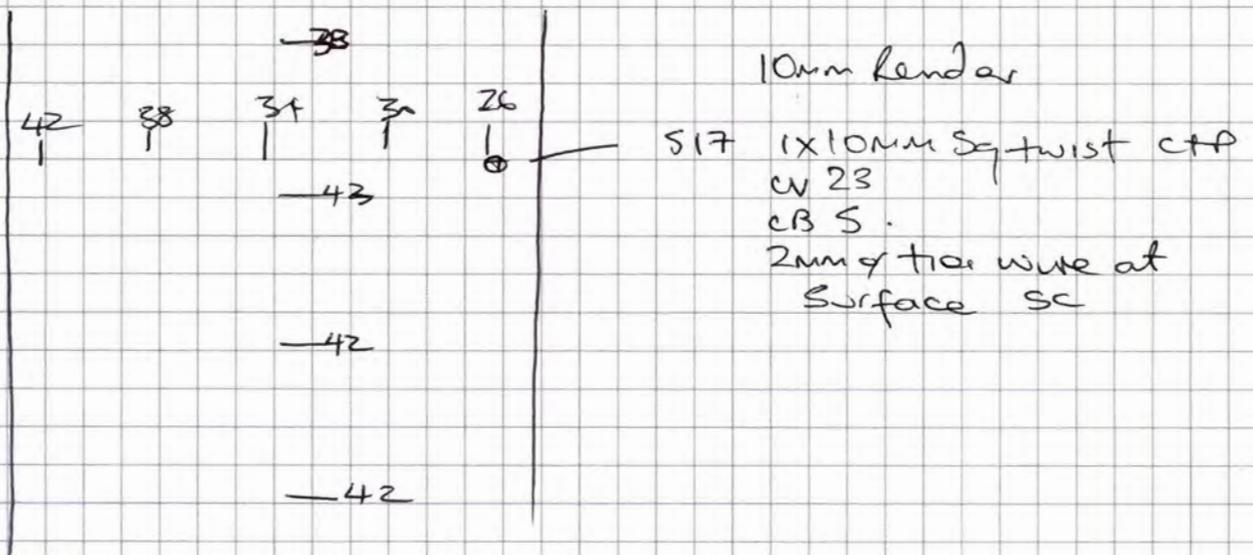
Report No 16034

Sheet No .....

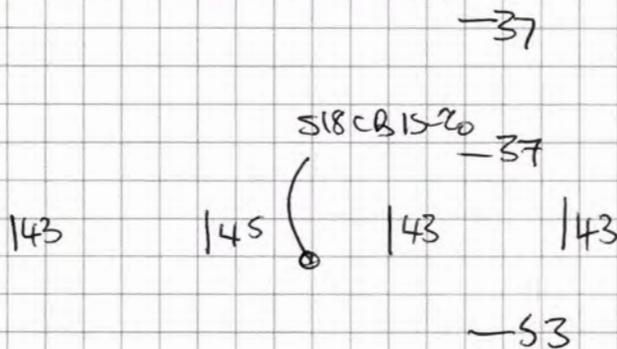
TA16 3<sup>rd</sup> floor TO 4<sup>th</sup> MID STAIR LANDING



TA17 4<sup>th</sup> floor MID → Roof STAIR SOFFIT



TA18 4<sup>th</sup> floor WAY



Project NEW LIFE HOUSE

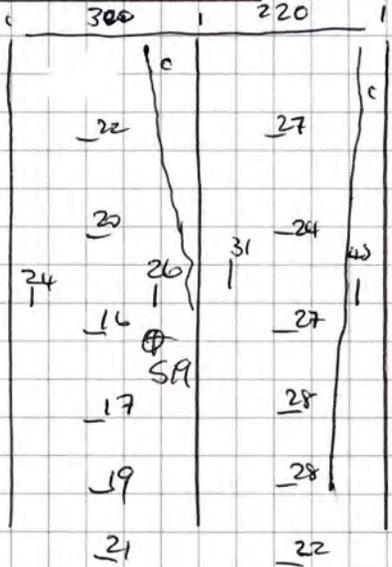
Location TA16-18

Date .....

Report No 16034

Sheet No .....

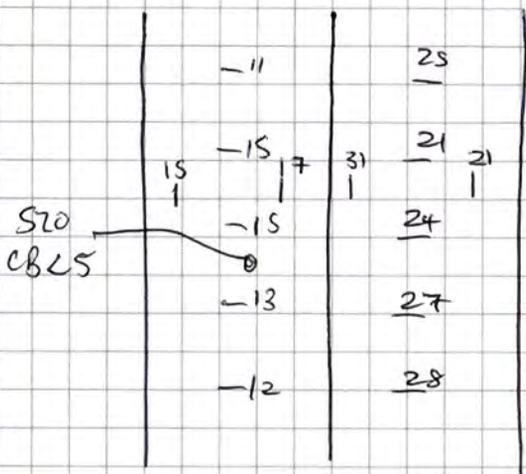
## TA19 Root Column (EXT)



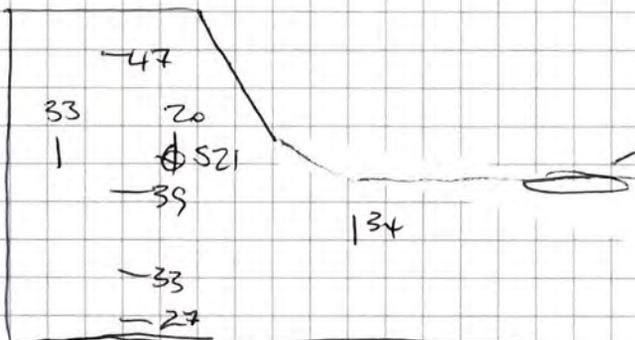
319 1x 28mm  $\phi$  main bar c+p plain  
 cv 36 face 40 side  
 2x 8mm  $\phi$  plain link c+p  
 cv 22 36 side  
 cb 20 @ sp, <S.

spacing  $\uparrow$  = 250  
 $\leftarrow$  200

## TA 20 Root Column (EXT)



## TA 21 WALL Support (EXT)



S21 1x 8mm  $\phi$  plain bar c+p  
 cv 19  
 cb <S.

sp on copying  
 vs org cv 30.

Project NEVILLE HOUSE

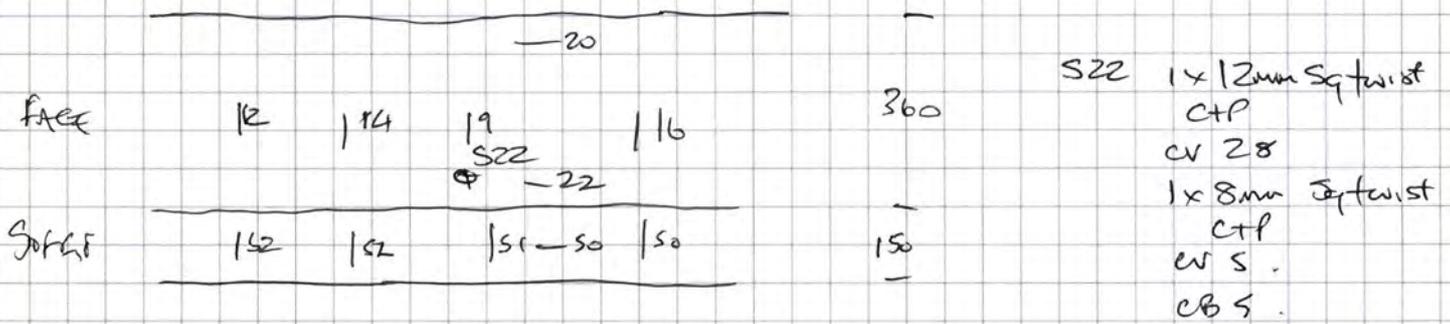
Location TA19-21

Date .....

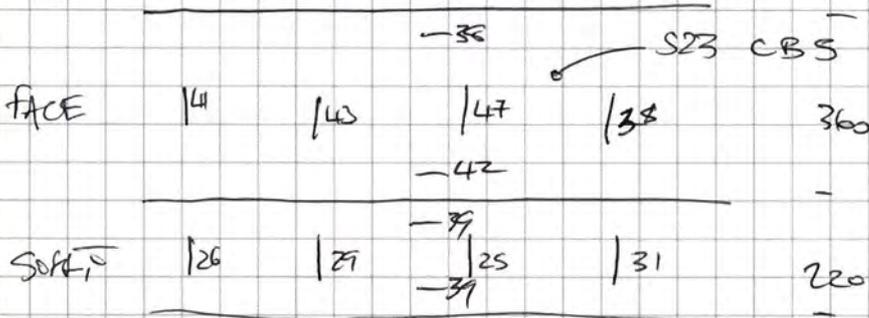
Report No 16034

Sheet No .....

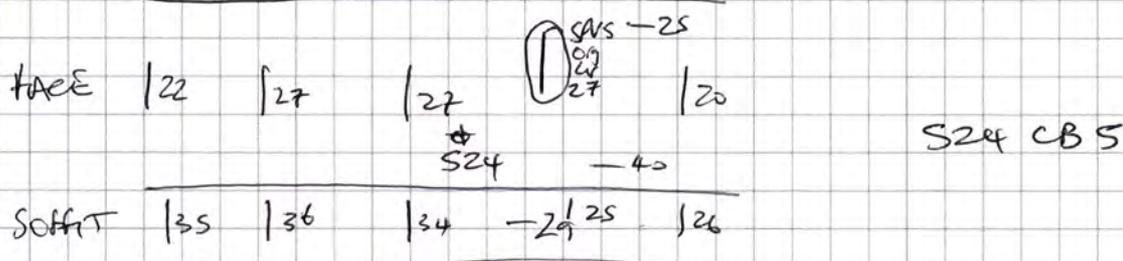
## TAZ2 Roof BEAM (EXT)



## TAZ3 Roof BEAM (EXT)



## TAZ4 Roof BEAM (EXT)



Project NEVILLE HOUSE

Location TAZ2-24

Date .....

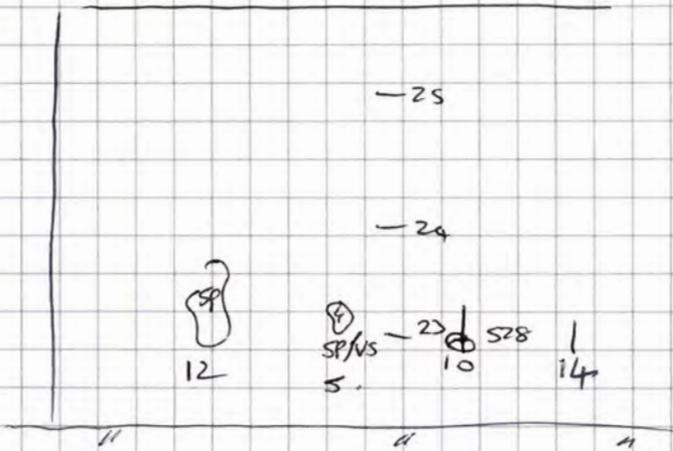
Report No 16034

65

Sheet No .....

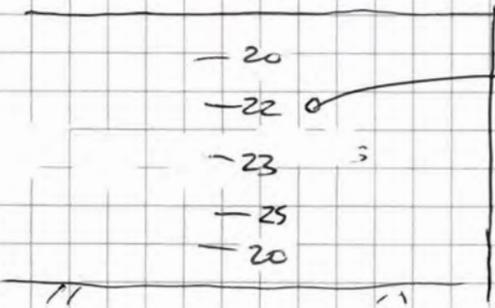


TAZ8 2ND floor BALCONY SOFFIT (EXT)



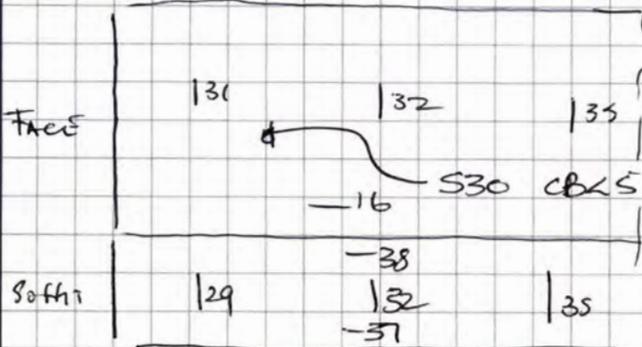
S28 1x 6mm Sqtwist SC  
 C10  
 1x 4mm Sqtwist CR  
 C18  
 CB10-15  
 ~5-10mm FACING MIX

TAZ9 2ND floor SOFFIT (EXT)



S29 CBS  
 5mm tender

TAZ30 2ND FLOOR BEAM (EXT)



Project NEVILLE HOUSE

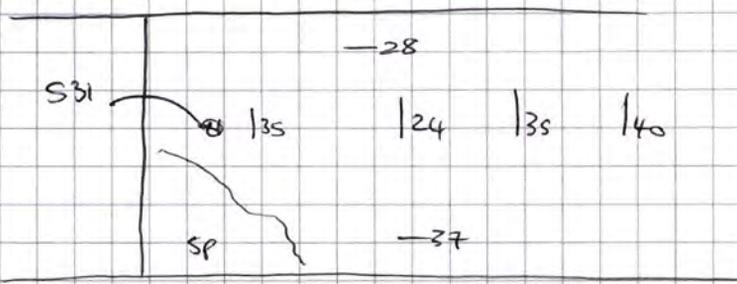
Location TAZ8-30

Date .....

Report No 16034

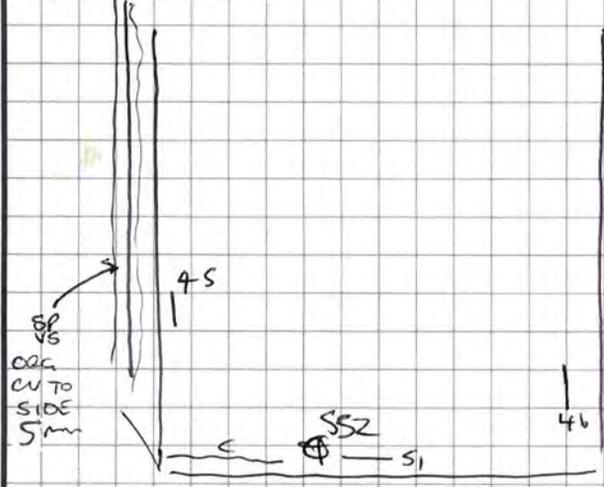
Sheet No .....

TA31 2ND FLOOR BEAM (EXT)



S31 CB L5, 20mm FM/PR  
 CV 15 Side  
 @ SP 16mm Sq twist SC  
 CV 19 Soffit  
 10mm Sq twist SC

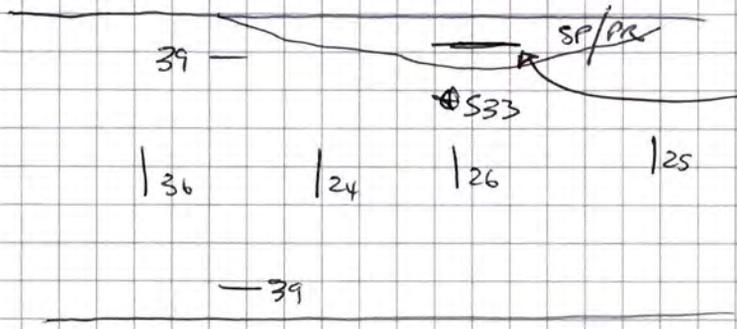
TA32 2ND FLOOR ACS PANEL (EXT)



S32

2ND 4mm x plan CR  
 CV 40 144  
 1x 10mm x plan CR  
 CV 46 face  
 20 Soffit  
 CB 5

TA33 2ND FLOOR BEAM (EXT)



TOTAL LOS org w 40 to top & side

S33 1x 10mm Sq twist CR  
 CV 30  
 1x 6mm Sq twist CR  
 CV 38  
 CB L5  
 FM 20

Project NGVILLE House

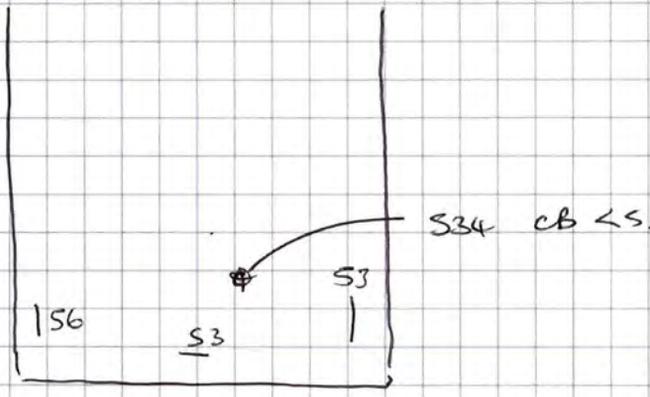
Location TA31-33

Date

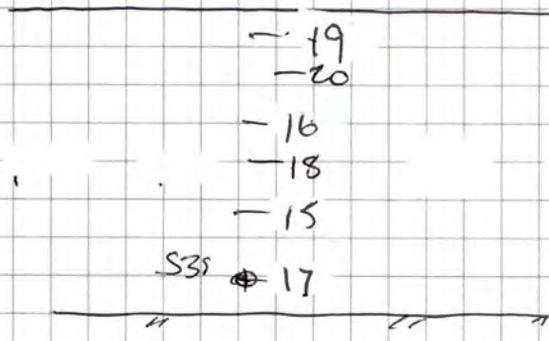
Report No 16034

Sheet No

TAB34 2ND floor ACC PANEL (EXT)

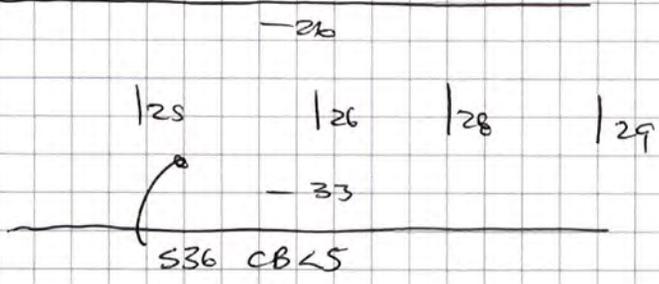


TAB35 2ND Floor Slab (EXT)



S35 1x3mm plan bar c/c  
 W17  
 CBS.  
 PRE CAST PLANK.  
 5mm render.

TAB36 3RD floor BEAM (EXT)



Project ..... NEVILLE HOUSE .....

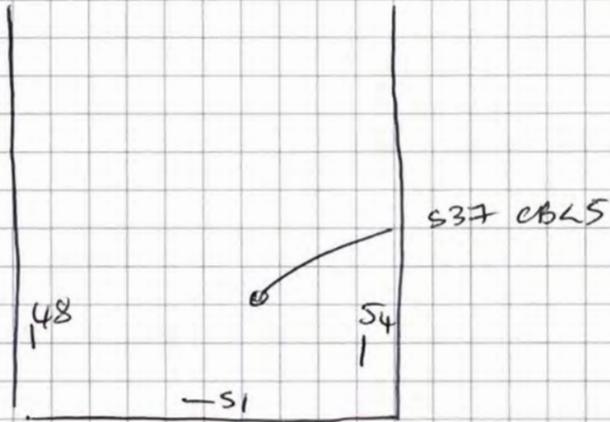
Location ..... TAB34 -36 .....

Date .....

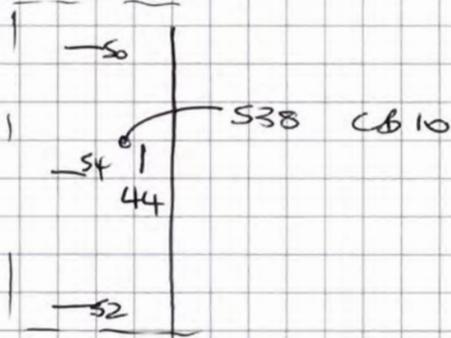
Report No ..... 16034 .....

Sheet No .....

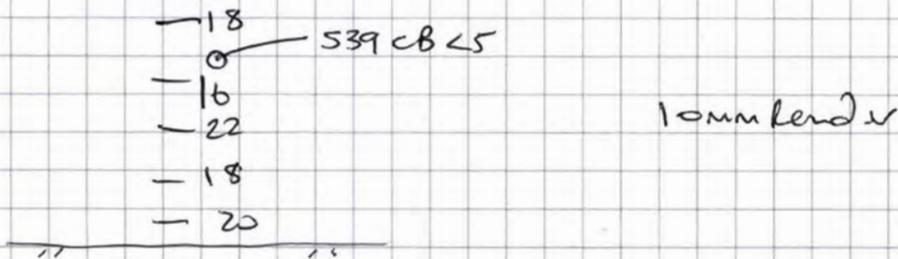
TA37 3<sup>RD</sup> FLOOR AGG PAVCE (EXT)



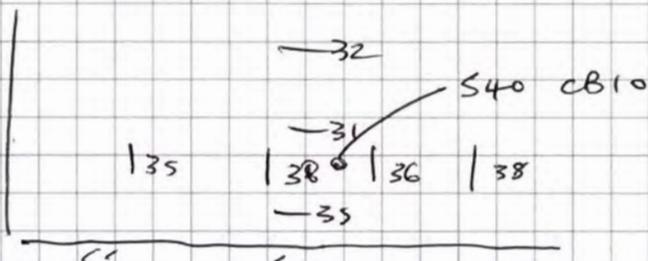
TA38 1<sup>ST</sup> FLOOR COLUMN (EXT)



TA39 2<sup>ND</sup> FLOOR SOFFIT (EXT)



TA40 2<sup>ND</sup> FLOOR BALCONY SOFFIT (EXT)



Project ..... NEVILLE HOUSE .....

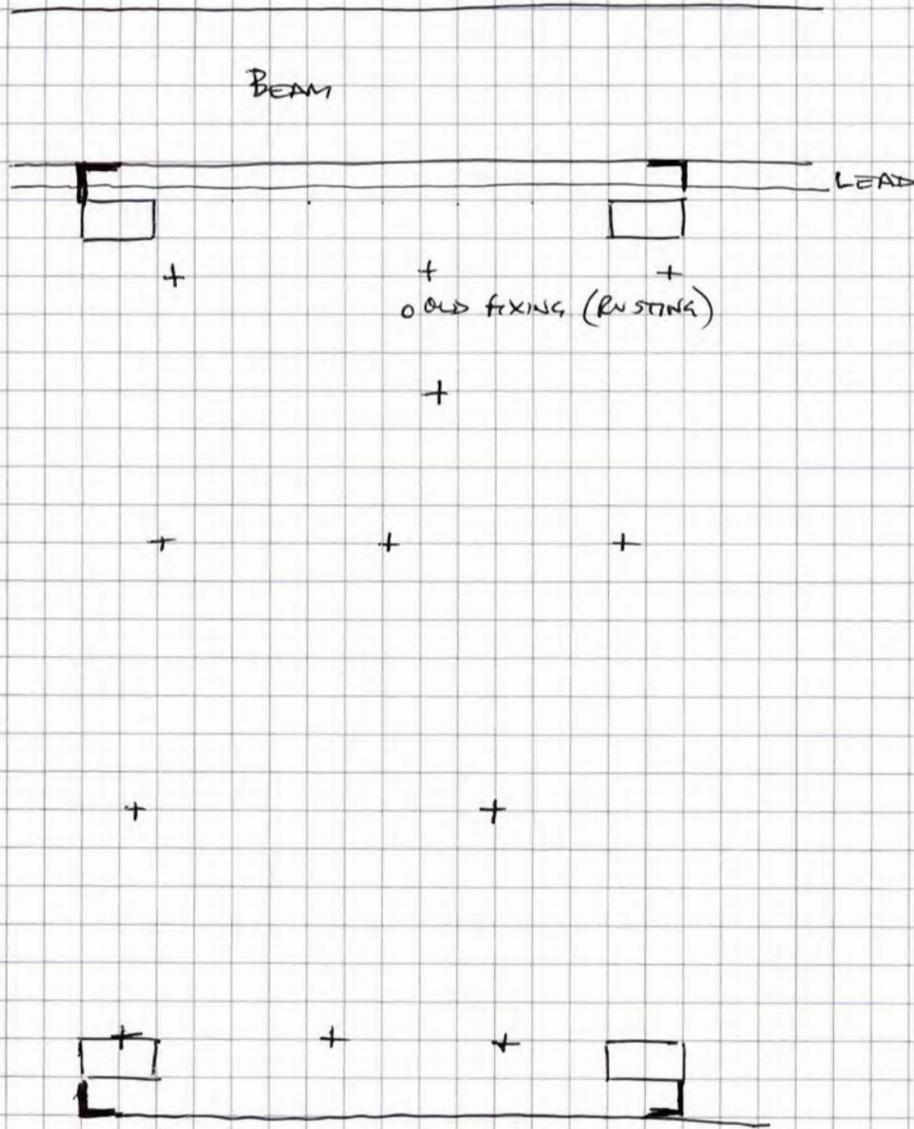
Location ..... TA37 - 40 .....

Date .....

Report No ..... 16034 .....

Sheet No .....

BWk 1. Roof PARAPET WALL (INT)



ASPHALT & LEAD TUCK.

BRICKWORK INNER & OUTER. STRETCHER BOND.  
 MORTAR OK. SLIGHT MORTAR PROTRUSIONS.  
 CAVITY CLEAN, DEBRIS IN CAVITY TRAY  
 CAVITY 75MM WIDE  
 12<sup>Nº</sup> TIES SEEN FLAT TWIST  
 GALVANISED, N<sup>º</sup> CORROSION, SOME DEBRIS ON THEM.  
 EMBEDMENT GOOD.

Project NEVILLE HOUSE

Location BWk 1

Date .....

Report No 116034

Sheet No .....

## BWK 2. Roof Motor Room Wall (INT)

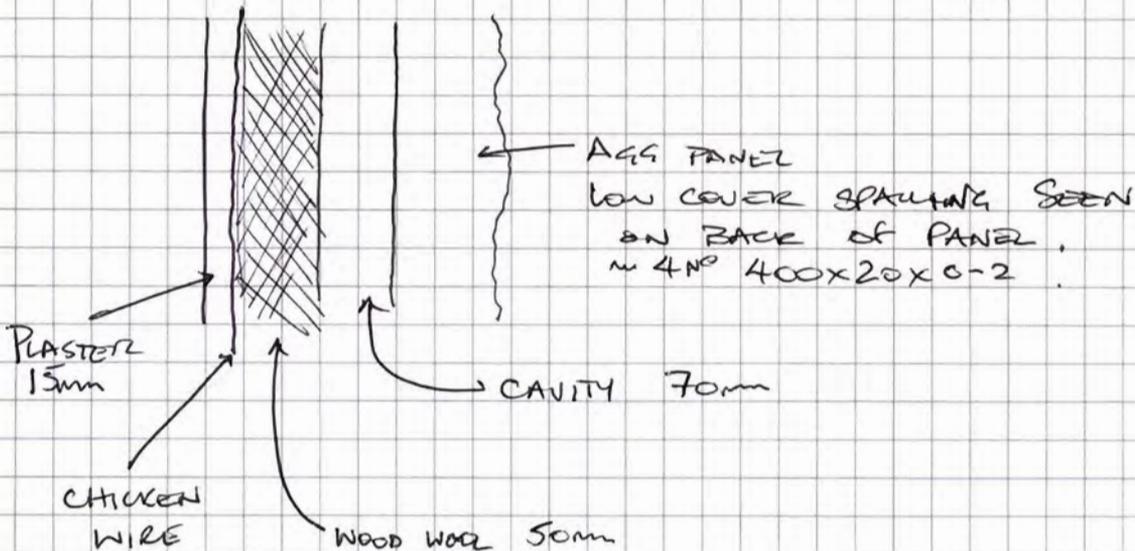
220x220x90 CONCRETE BLOCK WORK OUTER  
BRICKWORK INNER.

CAVITY CLEAN - 100MM WIDE

FLAT TWIST PHOSPHOR BRONZE TIES SEEN  
NO CORROSION.

RESTRICTED ACCESS FROM INTERNALLY.

## BWK 3. 3RD floor CONCRETE PANEL



Project NEVILLE HOUSE

Location BWK 2 #3

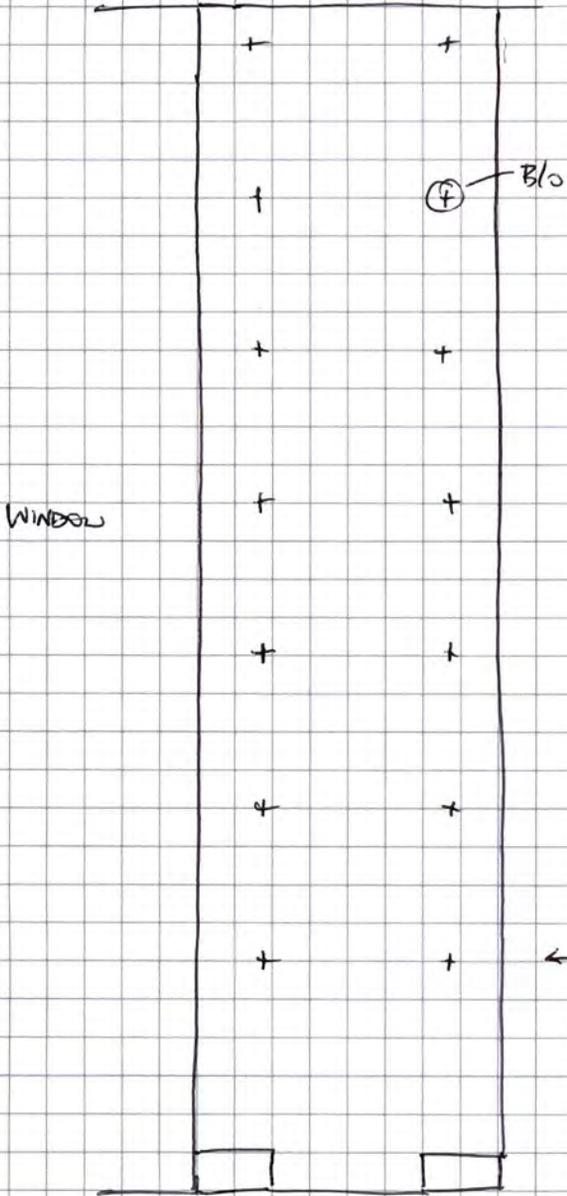
Date .....

Report No 16034

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Sheet No .....

## BANK 4. 3<sup>RD</sup> floor BANK WALL (INT)



14<sup>Nº</sup> TIES DETECTED.

B/o FLAT GALVANISED TIE  
NO CORROSION.

BRICKWORK INNER & OUTER  
STRETCHER BOND.

60mm WIDE CAVITY.  
CAVITY WALL INSULATION.

← DRILLED ON TIES.

Project ... NEVILLE HOUSE

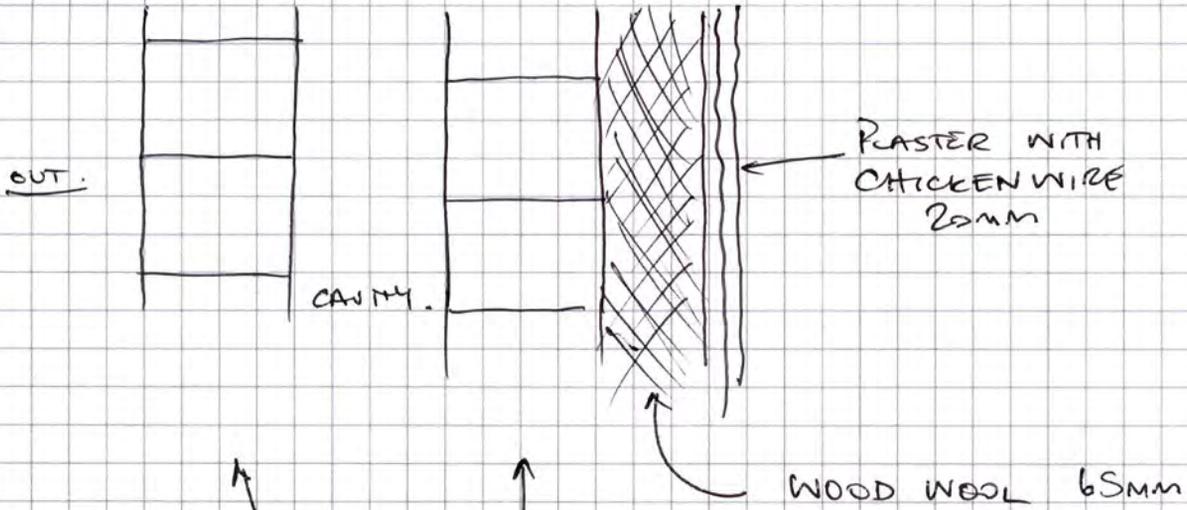
Location ... BANK 4

Date .....

Report No ... 16034

Sheet No .....

## BWK 5. 3RD floor WALL (INT)



BACKWORK INNER & OUTER.  
SLIGHT MORTAR PROTRUSIONS IN CAVITY.  
CAVITY CLEAN 75MM WIDE  
FLAT TWIST TIES SEEN - NO CORROSION  
CALANISED. SLIGHT DEBRIS ON THEM.

Project NEVILLE HOUSE

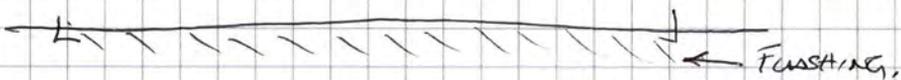
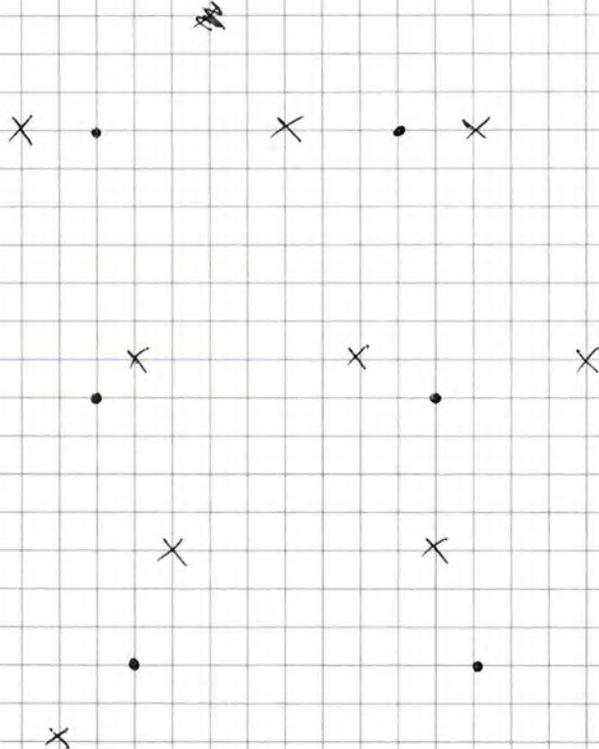
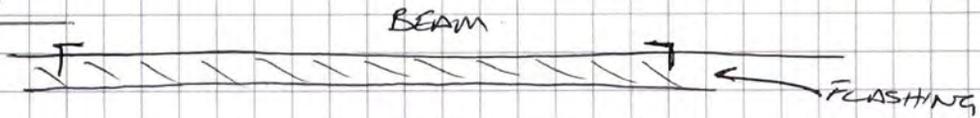
Location BWK 5

Date .....

Report No 16034

Sheet No .....

BWK 6.



- AREA SURVEYED FROM INNER SIDE (ROOF)
- SLICE OUTER, SLICE INNER
- 9 NO GIMS FLAT TIGHT TIES
- EMBEDMENT OK, NO CORROSION
- SOME MARGINAL SNOTS ON TIES
- SS IN CAVITY, SMALL AMOUNT OF MATERIAL PROTRUSION
- SOME DEBRIS COVERING CAVITY TRAY

Project ..... NEURIG HOUSE

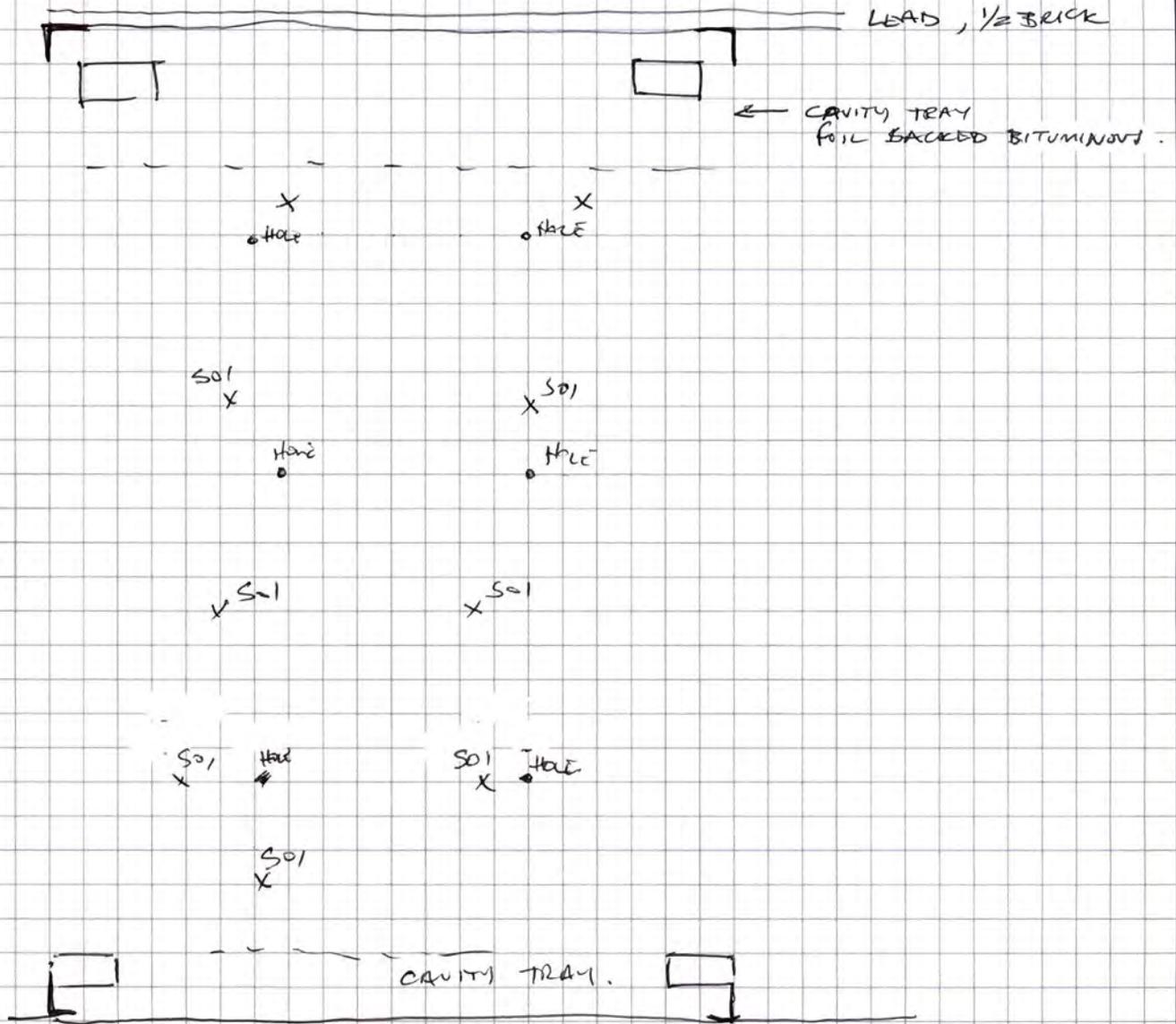
Location ..... BWK 6, ROOF LEVEL SOUTH GABLE

Date .....

Report No ..... 16034

Sheet No .....

BWK 7 4th floor wall



BRICKWORK INNER  
 BRICKWORK OUTER  
 STRETCHED BOND  
 53mm CAVITY

9 NR GSM TIES FLAT TWIST  
 NO CORROSION SOME MORTAR DEBRIS  
 POOR EMBELEMNT SCEN TO INTERNAL LEAF  
 DEBRIS IN CAVITY

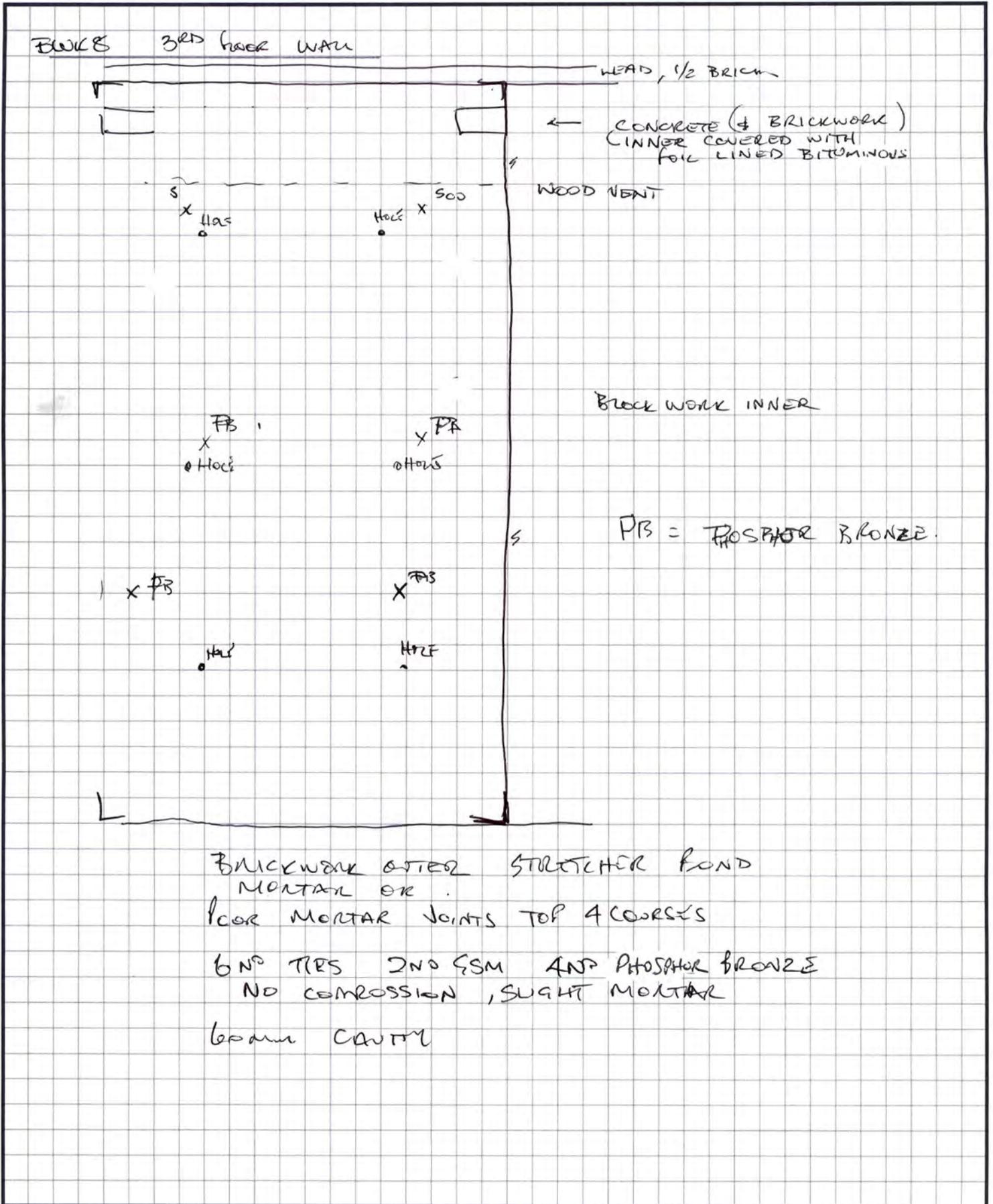
Project ... NEVILLE House .....

Location ... BWK 7 .....

Date .....

Report No ... 16034 .....

Sheet No .....



Project NEVILLE HOUSE

Location BWK 8

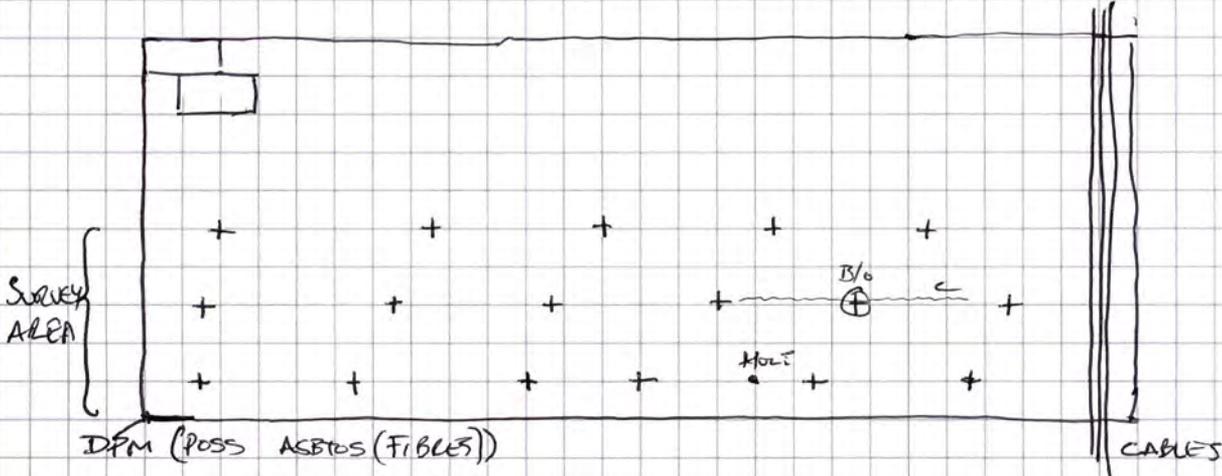
Date .....

Report No 16034

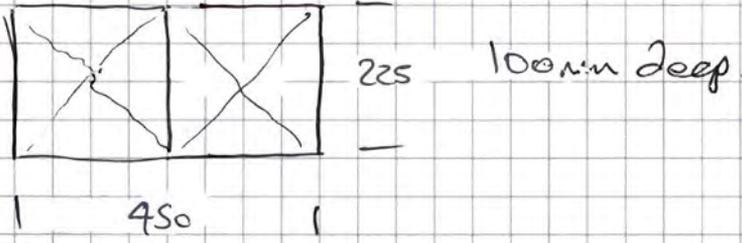
77

Sheet No .....

BWK 9 2ND floor brick wall



TYPICAL BLOCK (CONCRETE)



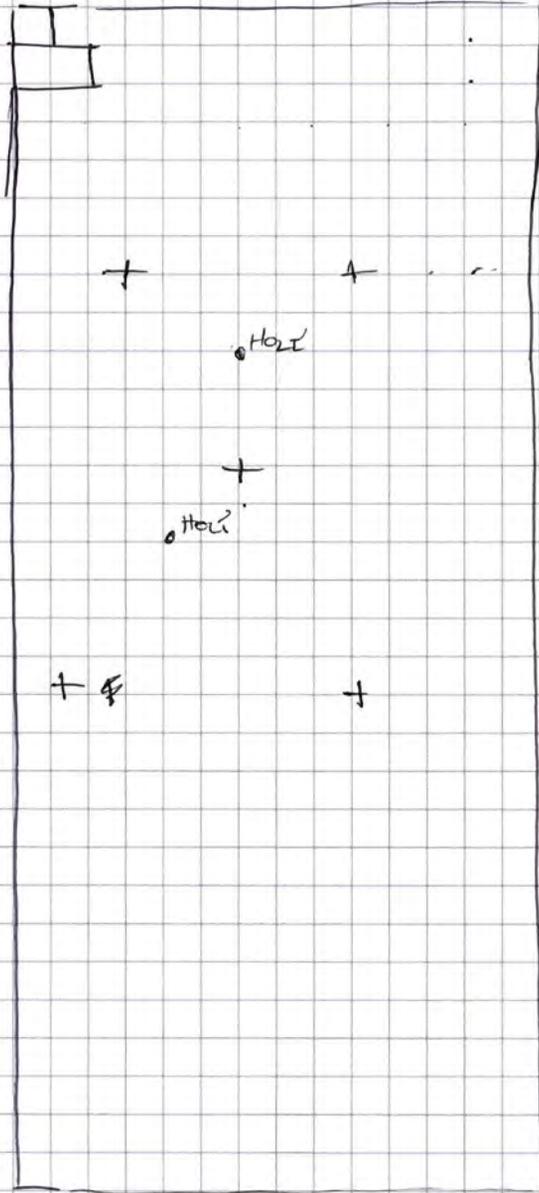
B/O PHOSPHOR BRONZE TIE  
 FLAT TWIST  
 NO CORROSION  
 CRACK NOT CORROSION RELATED

90mm CAVITY. CLEAN.  
 SOME DEBRIS ON TIES.  
 BRICKWORK INNER.

Project NEVILLE HOUSE Location BWK 9

Date ..... Report No 16034 78 Sheet No .....

BWK 10 4th floor wall (INT)



BLOCK OUTER  
BRICKWORK INNER OR.

5/2 PHOSPHOR BRASS TIES.  
NO CORROSION, SLIGHT  
MORTAR PROTRUSIONS

105MM WIDR CAVITY.  
CLEAN.

BWK 11 & 12.

SMALL BRICK WALLS - BRICKWORK INNER & OUTER  
CAVITY WALL INSULATION  
TIES DETECTED  
AS BWK 4

Project NEVILLE HOUSE

Location BWK 10-12

Date .....

Report No 16034

Sheet No .....

BWR 13 3rd floor block work (INT)

CONCRETE BLOCK OUTER.

BRICKWORK INNER RENDERED OVER (20mm)

SAME TIE PATTERN AS OTHER FLOOR

PHOSPHOR BRONZE TIES. SLIGHT MORTAR ON TIES  
NO CORROSION

CAVITY 100mm WIDE - CLEAN

Project NEVILLE HOUSE

Location BWR 13

Date .....

Report No 16034

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Sheet No .....



**MARTECH**

lab results

sample list

lab results

# test report

to select the section you require,  
please click on the relevant heading

**Sample List –  
Neville House, Corby**

Sample	Test Area	Element/Location
S1	1	4 <sup>TH</sup> Floor Soffit
S2	2	Roof Soffit
S3	3	4 <sup>th</sup> Floor Column
S4	4	Roof Beam
S5	5	3 <sup>rd</sup> Floor Beam
S6	6	3 <sup>rd</sup> Floor Stair Wall
S7	7	2nd Floor Mid to 3 <sup>rd</sup> Floor Stair Soffit
S8	8	Roof Beam
S9	9	Roof Main Beam
S10	10	Roof Soffit
S11	11	3 <sup>rd</sup> Floor Soffit
S12	12	2 <sup>nd</sup> Floor Column
S13	13	3 <sup>rd</sup> Floor Beam
S14	14	3 <sup>rd</sup> Floor Beam
S15	15	4 <sup>th</sup> Floor Soffit
S16	16	3 <sup>rd</sup> Floor -> 4 <sup>th</sup> Floor Mid Stair Landing
S17	17	4 <sup>th</sup> Floor Mid → Roof Stair Soffit
S18	18	4 <sup>th</sup> Floor Wall
S19	19	Roof Column
S20	20	Roof Column
S21	21	Wall Support
S22	22	Roof Beam
S23	23	Roof Beam
S24	24	Roof Beam
S25	25	1 <sup>st</sup> Floor Column
S26	26	2 <sup>nd</sup> Floor Soffit
S27	27	2 <sup>nd</sup> Floor Beam
S28	28	2 <sup>nd</sup> Floor Balcony Soffit
S29	29	2 <sup>nd</sup> Floor Soffit
S30	30	2 <sup>nd</sup> Floor Beam
S31	31	2 <sup>nd</sup> Floor Beam
S32	32	2 <sup>nd</sup> Floor Agg Panel
S33	33	2 <sup>nd</sup> Floor Beam
S34	34	2 <sup>nd</sup> Floor Agg Panel
S35	35	2 <sup>nd</sup> Floor Soffit
S36	36	3 <sup>rd</sup> Floor Beam
S37	37	3 <sup>rd</sup> Floor Agg Panel
S38	38	1 <sup>st</sup> Floor Column
S39	39	2 <sup>nd</sup> Floor Soffit
S40	40	2 <sup>nd</sup> Floor Balcony Soffit



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26 May 2016  
 MA/12758/isj  
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## CERTIFICATE of ANALYSIS

**Neville House, Corby**  
 Cement content of concrete samples

Sample ref.:	6682	6683	6684	6687
Client's ref.:	S2	S3	S4	S7
Date received:	13 May 2016			
Mass received (g) :	45	70	20	35
Type of sample:	concrete dust			
Date of analysis:	24 May 2016			
<b><i>Determined values</i></b>				
Insoluble residue (%)	73.4	57.7	41.3	46.6
Soluble silica (%)	4.1	2.7	4.2	3.9
Calcium oxide (%)	12.1	19.0	30.0	23.2
<b><i>Calculated values</i></b>				
<b><i>Cement content (%)</i></b>				
ex silica	18.3	11.0	18.8	17.3
ex lime	18.8	29.5	46.5	36.0
preferred/mean value %	<b>18.6</b>	<b>11.0</b>	<b>18.8</b>	<b>17.3</b>
<b><i>Aggregate content (%)</i></b>				
ex silica	77.5	86.5	76.9	78.8
ex lime	76.9	63.8	42.8	55.8
preferred/mean value	<b>77.2</b>	<b>86.5</b>	<b>76.9</b>	<b>78.8</b>
<b><i>Aggregate/cement ratio</i></b>				
ex silica	4.2	7.9	4.1	4.6
ex lime	4.1	2.2	0.9	1.6
preferred/mean value	<b>4.2</b>	<b>7.9</b>	<b>4.1</b>	<b>4.6</b>

Sample ref.:	6689	6708
Client's ref.:	S9	S28
Date received:	13 May 2016	
Mass received (g) :	30	28
Type of sample:	concrete dust	
Date of analysis:	24 May 2016	
<b><i>Determined values</i></b>		
Insoluble residue (%)	61.7	55.8
Soluble silica (%)	1.6	4.7
Calcium oxide (%)	17.4	19.1
<b><i>Calculated values</i></b>		
<b><i>Cement content (%)</i></b>		
ex silica	5.4	21.2
ex lime	27.0	29.6
preferred/mean value %	<b>5.4</b>	<b>21.2</b>
<b><i>Aggregate content (%)</i></b>		
ex silica	93.4	73.9
ex lime	66.8	63.7
preferred/mean value	<b>93.4</b>	<b>73.9</b>
<b><i>Aggregate/cement ratio</i></b>		
ex silica	17.4	3.5
ex lime	2.5	2.2

The cement contents were determined in accordance with B.S. 1881:Part 124:1988. The silica content was determined by atomic absorption spectrophotometric method.

Assumptions used for the cement and aggregate content calculations:

Silica content of cement = 20.2 %  
 Soluble silica content of aggregate = 0.5 %  
 Calcium oxide content of cement = 64.5 %

◆◆◆◆

### Chloride and high alumina cement content of concrete samples

Date received : 13 May 2016  
 Mass received : 15 to 69 g  
 Type of sample : concrete dust  
 Date of analysis : 20 and 26 May 2016  
 Method of testing : B.S.1881:Part 124:1988 and BRE IS 15/74.

Sample ref.	Client's ref.	Presence of HAC	Chloride content	
			% by mass of	
			sample	cement
6681	S1		0.01	0.05
6682	S2	not present	0.01	0.04
6683	S3	not present	<0.01	<0.01
6684	S4	not present	0.02	0.13
6685	S5		0.22	1.57
6686	S6		0.05	0.33
6687	S7		0.05	0.39
6688	S8		0.05	0.35
6689	S9		0.03	0.18
6690	S10		0.05	0.35
6691	S11	not present	<0.01	<0.01
6692	S12		<0.01	<0.01
6693	S13		<0.01	<0.01
6694	S14		0.02	0.12
6695	S15	not present	0.04	0.28
6696	S16		0.08	0.57
6697	S17	not present	0.06	0.43
6698	S18	not present	0.05	0.36
6699	S19		0.02	0.15
6700	S20		0.03	0.20
6701	S21	not present	0.01	0.05
6702	S22		0.01	0.07
6703	S23		0.07	0.48
6704	S24		0.01	0.09
6705	S25		<0.01	<0.01
6706	S26		<0.01	<0.01
6707	S27		<0.01	<0.01
6708	S28		0.07	0.53
6709	S29		0.06	0.43
6710	S30		<0.01	<0.01
6711	S31		0.02	0.17

Sample ref.	Client's ref.	Presence of HAC	Chloride content	
			% by mass of	
			sample	cement
6712	S32		0.12	0.89
6713	S33		0.03	0.18
6714	S34		0.15	1.08
6715	S35		<0.01	<0.01
6716	S36		0.02	0.12
6717	S37	not present	0.07	0.48
6718	S38		<0.01	<0.01
6719	S39		0.06	0.43
6720	S40	not present	0.03	0.20

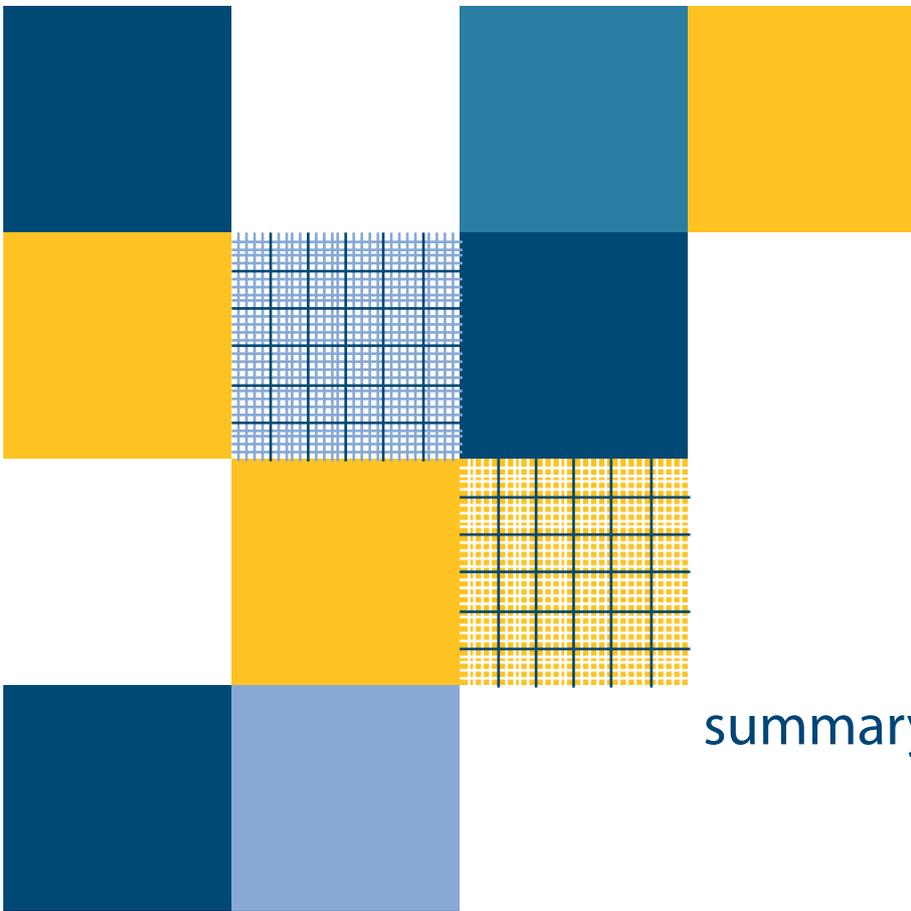
Note: 14 % cement content was assumed for the calculations.

End of report

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Iren S. Jasko MSc EurChem CSci CChem FRSC  
Technical Manager



**MARTECH**

summary table

# test report

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## Summary of Test Results

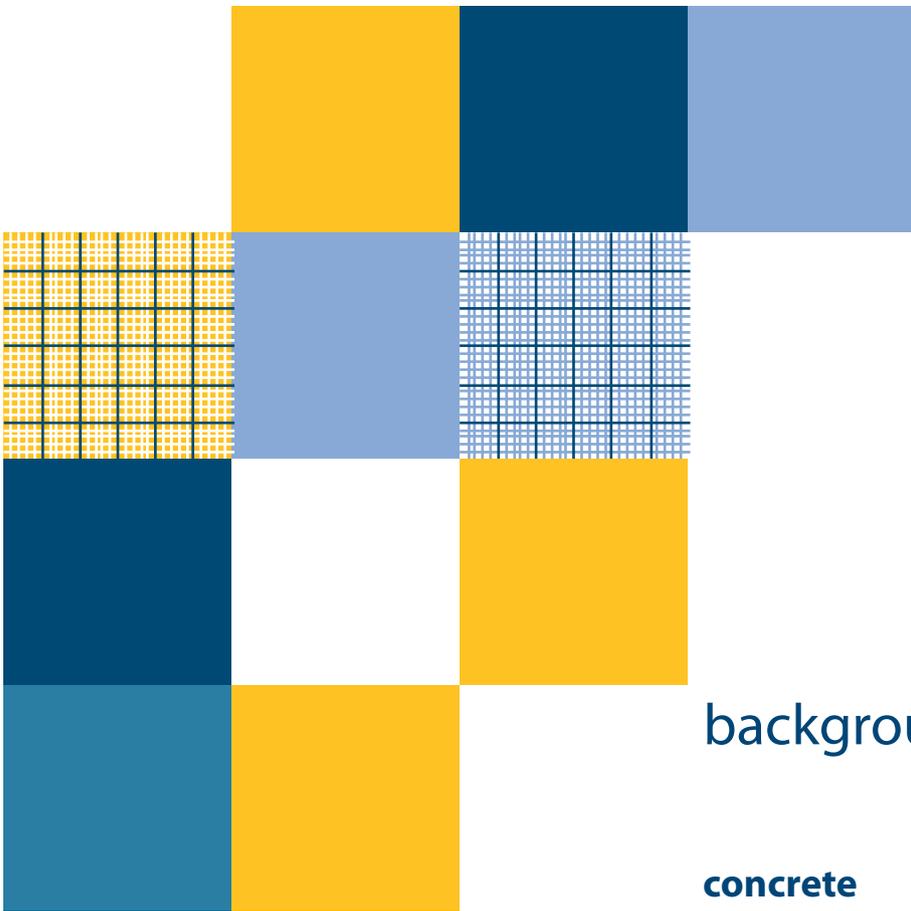
Neville House, Corby

Element	Depth of Cover (mm)			Depth of Carbonation (mm)			Chloride Content (%) *		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Roof Beams (Ext)	5	52	31	5	5	5	0.07	0.48	0.21
Roof Columns (Ext)	11	45	24	<5	20	9	0.15	0.20	0.18
Wall Support Beam (Ext)	19	47	31	n/a	<5	n/a	n/a	0.05	n/a
Floor Soffits	11	65	21	<5	25	12	<0.01	0.35	0.12
Floor Soffits (Ext)	15	25	19	<5	5	<5	<0.01	0.43	0.29
Beams	4	51	30	15	40	27	<0.01	1.57	0.37
Beams (Ext)	15	40	30	<5	20	6	<0.01	0.18	0.12
Columns	15	54	34	10	20	15	<0.01	<0.01	<0.01
Balcony Slabs	5	38	24	10	15	12	0.20	0.53	0.37
Aggregate Panels	5	56	44	<5	5	<5	0.48	1.08	0.82
Walls	2	53	33	15	50	28	0.33	0.36	0.35
Stair Soffits	17	43	31	<5	5	<5	0.39	0.43	0.41
Stair Landing	18	41	30	5	5	5	n/a	0.57	n/a

\*Chlorides expressed as % ions by mass of cement using 14% as cement content

Testing of 6 samples for cement content gave results of 18.6%, 11.0%, 18.8%, 17.3%, 5.4% and 21.2%

Testing of 8 samples for HAC none present.



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## **M** concrete

Concrete is a highly alkaline substance and it is this alkalinity that protects the reinforcement from corrosion, despite the almost inevitable simultaneous presence of oxygen and moisture - the fuel of corrosion. The air around us is however relatively acidic, mainly by virtue of the carbon dioxide content, and tends to neutralise any concrete it comes into contact with gradually from the surface inwards. A chemical reaction takes place in which alkaline hydroxide compounds are converted into carbonate compounds - hence carbonation.

Were the carbonation front to reach the reinforcement, the protective passive layer around the bars maintained by alkalinity would be lost and active corrosion would ensue. This occurs in the form of microcell corrosion, or generalised surface corrosion, which leads to latent (or incipient) damage, and later to the classic symptoms of reinforcement corrosion - cracking and spalling of the cover concrete. For this reason the steel should have adequate cover (say 40 mm+) when built.

The presence of free chlorides in significant quantities can lead to localised breakdown of the passive layer on reinforcement, often in otherwise sound alkaline concrete, which results in intensive localised pitting corrosion of the steel. This is often termed macrocell corrosion, and can occur irrespective of cover. This form of reinforcement corrosion has associated with it a considerable excess of cathode over anode area, and corrosion rates can be relatively high. Care is needed in the rare situations where the oxygen supply to the steel is limited, as a non-expansive form of corrosion (black rust) can occur, which could ultimately lead to dissolution of the steel in the absence of the usual surface manifestations.

## **M** testing

### **Visual Observations**

Pertinent observations on the structure are generally recorded on a brief overall visual assessment, mainly on a walk around survey of accessible areas, supplemented by areas accessed during the course of the detailed testing.

### **Covermeter Survey**

A representative portion of each detailed test area is generally subject to a covermeter survey, which measures the concrete cover, in millimetres, over the reinforcing steel. Measurements were carried out in general accordance with BS1881: Part 204.

The instrument used by us is an Elcometer 331, ProfoScope or Kolectric Micro Electronic Covermeter. In order to obtain precise results exact bar sizes need to be known or assessed, otherwise small errors in cover readings can result. This effect is however, much more marked with shallow depths of cover concrete, where there can be evidence of correct bar sizes. Multiple, parallel or intersecting bars, give incorrect readings unless identified and avoided, or adjusted for.

### **Carbonation Testing**

The depth of carbonation of the concrete is generally assessed and measured in situ in all detailed test areas. This is carried out in general accordance with BRE recommendations, from information paper IP 6/81. We always carry out the test on freshly broken concrete surfaces, as it is our opinion that this gives the most accurate results. The broken surface is blown clean and sprayed with phenolphthalein indicator solution. The solution gives a vivid pink coloration on sound alkaline concrete, with no colour change on carbonated surfaces, which merely look wet.

The mean depth of carbonation is measured, within 30 seconds of spraying, as the distance from the concrete surface to the boundary of the uncoloured zone.

It is important to record any slow development of colour, or creep back of coloration towards the surface of the concrete, as either condition can be indicative of partially carbonated concrete.

## **Concrete Dust Sampling**

Concrete dust samples are generally collected in the detailed test areas for laboratory analysis in respect of chloride content, plus in some instances sulfate and cement content. The samples are drilled using a heavy duty rotary-percussive drill and 20 mm bit from at least two holes per location, with the first 5 mm of sample from each hole discarded as being non representative. Sampling is carried out in general accordance with BRE recommendations, from information paper IP 21/86.

If the location of the structure is such that any chloride present in the concrete is likely to have been cast-in at the time of construction, the samples are obtained in single increments of 5-50mm.

Conversely the location and nature of the structure could be such that chloride is likely to have ingressed the concrete, from an external source, and subsequent to construction. In this instance the samples are collected in 3no. separate depth increments of 5-25, 25-50 and 50-75mm, and suffixed A, B, and C respectively.

The nature of a car park structure is such that chloride is likely to have ingressed the deck concrete surfaces, from vehicular traffic bringing in de-icing salts. The samples on these elements are therefore collected in 3no. separate depth increments of 5-25, 25-50 and 50-75mm, and again suffixed A, B, and C respectively. The other concrete elements on car park structures are generally such that any chloride present in the concrete is likely to have been cast-in at the time of construction. The samples in these areas are therefore obtained in single increments of 5-50mm.

Dust samples for chloride, sulfate, and cement content analyses are generally collected in plastic sample bags, labelled appropriately, and submitted to a UKAS accredited laboratory for analysis, in accordance with BS1881: Part 124.

## **Concrete Core Sampling**

Concrete core samples, when required, are generally collected in a number of test areas, for submission to the laboratory for further analyses.

A UKAS accredited laboratory can be requested to analyse the cores in respect of a description and photograph, prior to compressive strength testing in accordance with BS1881: Part 120.

In addition a specialist laboratory can be requested to analyse the cores via petrographic techniques. This involves the vacuum impregnation of core slices with fluorescent resin, which are then further prepared. Generally polished slices are prepared for observation under a relatively low powered microscope. They also prepare thin section microscopy slides, in which a small but representative sub-sample of the concrete,

often including the surface, is glued onto a glass slide. The concrete is then ground down until translucent and examined under a high-powered specialist petrological microscope.

This process enables exact detail of aggregate types, cement types, original mix, and so forth to be determined, but also details of all chemical changes, cracking and deterioration to be recorded. Photomicrographs at various magnifications are normally provided.

### **Corrosion Potential Measurements**

Each detailed test area of 2 or 4m<sup>2</sup> or so, or a whole element such as a car park deck, can be subject to corrosion potential measurements, also referred to as half-cell testing. Essentially this technique measures the electrical potential of the reinforcement in the concrete, in millivolts (mV), via a surface applied instrument coupled to a high impedance multimeter.

The measurements are generally carried out on every node of a 0.5m or 1.0m orthogonal grid, generally employing a Copper/Copper Sulfate half-cell.

Corrosion of the reinforcement is an electrical phenomenon, with a build up of electrical potential in corroding or anodic areas, and a negative charge by convention on the affected portion of steel.

The presence of chlorides, where associated with loss of passivation, results in the development of very active corrosion cells, often with intense localised pitting of the reinforcement.

Our corrosion potential measurements are carried out in general accordance with ASTM C-876, Standard Test Method for Half-Cell Potentials of Uncoated Reinforcing Steel in Concrete. We do however recognise that the method only gives corrosion potentials, i.e. the probability of corrosion occurring, as opposed to rates; and it must be understood that the method is empirical, or qualitative.

We additionally recognise that the given parametric criteria really only apply to an external chloride contaminated concrete. Any other application will require fresh criteria to be established by visual correlation.

### **Exploratory Breaking Out**

In selected detailed test areas exploratory breakouts are generally made in order to gain further knowledge of reinforcement condition, and other detail.

This also allows correlation of other test data, and in particular physical checks on reinforcement size, plus of course correct measured concrete cover. Surface corrosion condition of the reinforcement is always recorded.

## **M** concrete repair

The concrete remediation and corrosion control process must generally ensure that the concrete becomes stable and the reinforcement passive. Clearly the original condition of the now deteriorated concrete was such that failures have occurred well within the designers projected life for the structure.

Successful concrete repair involves the treatment and control of all corrosion on the reinforcement, i.e. all the latent (or hidden), as well as the visible deterioration identified. It is not unusual for the latent damage element to be considerably more extensive than the visible damage.

Having identified the exact nature and the true extent of the corrosion problem, a method of concrete remediation and corrosion control must be arrived at by reference to BS DD ENV 1504:Part 9:1997, the European standard for concrete repair. This is done in accordance with the clients wishes and expectations as regards issues such as: life expectancy of the repair, life expectancy of the structure, intended use, as well as issues regarding cost and funding, in conjunction with the frequency and number of repair cycles desired. There is nowadays no reason why a durable repair should not be achieved straight away in the majority of cases.

The European Standard lists eleven repair principles, of which five are specifically related to reinforcement corrosion, as opposed to defects in concrete, and these five are as follows:

<b>Principal 7 [RP]</b>	<i>Preserving or Restoring Passivity</i>
	This involves creating conditions in which the surface of the reinforcement is maintained or is returned to a passive condition. This can be achieved via additional cover, replacing contaminated or carbonated concrete, or electrochemical remediation of concrete.
<b>Principal 8 [IR]</b>	<i>Increasing Resistivity</i>
	This involves increasing the electrical resistivity of the concrete, for instance by limiting moisture content via surface treatments, coatings or sheltering.
<b>Principal 9 [CC]</b>	<i>Cathodic Control</i>
	This involves creating conditions in which cathodic areas of reinforcement cannot drive an anodic reaction. It may be achieved by limiting oxygen content by saturation or surface coating.
<b>Principal 10 [CP]</b>	<i>Cathodic Protection</i>
	This involves corrosion control via the establishment of an external anode, and may be via an applied current (ICCP) or by galvanic means (GCP). The method is dealt with by BS EN 12696:2000, Cathodic Protection of Steel in Concrete.
<b>Principal 11 [CA]</b>	<i>Control of Anodic Areas</i>

This involves creating conditions in which anodic areas of reinforcement are not able to take part in the corrosion reaction. It may be achieved by coating the reinforcement or applying corrosion inhibitors to the concrete.

**General Note**

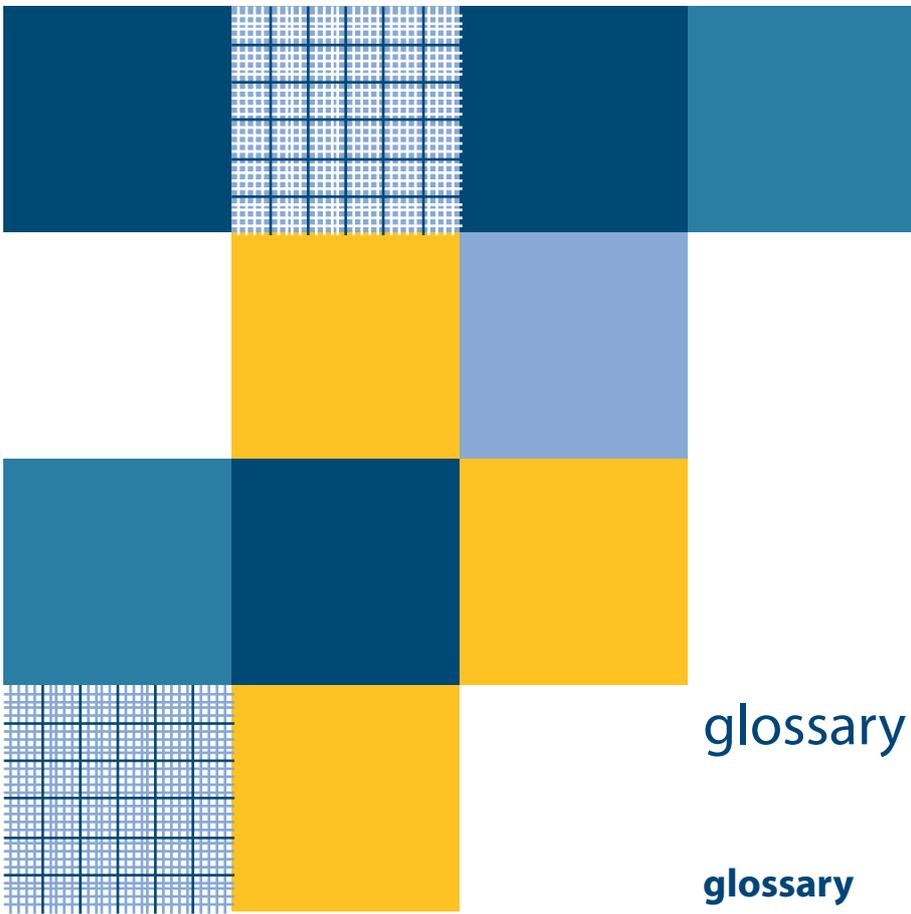
*The above is not reproduced verbatim from the standard, it is our précis. It is noted in the standard that the inclusion of methods does not imply their approval, and that the methods may make use of products or systems not covered by the EN 1504 series.*

*The principals are listed in full for completeness, some are rarely, if ever, used by UK concrete repair contractors.*

The full range of successful concrete repair and remediation techniques that may be employed in corrosion control, are best viewed as a toolbox, and one must seek to select and apply techniques appropriate to the various parts of the structure, having given consideration to specific client requirements and expectations.

It is usual in concrete repair for a coating to be applied to the carefully repaired and prepared surface, being free of blowholes and other surface defects, which resists further carbonation, and the ingress of aggressive agents. It is often preferable for this product to be elastomeric and durable.

In our opinion the preferred route forward, in procuring the necessary repair services, is in the formation of partnerships and term contracts with a suitable contractor. It is important to seek a satisfactory outcome for all **parties, in which the client's needs and wishes are fully** encompassed. Negotiation and Construction Partnering, as advocated in the Egan Report, should really take a preference over the traditional method of competitive tendering, which in the final analysis can only serve to reduce every aspect of a job to its lowest common denominator.



**MARTECH**

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## glossary

### **M** common terms

#### **HEALTH CHECK**

It is important to treat concrete to an occasional health check or MOT like one would a vehicle. Whilst properly designed and built concrete might be considered to be maintenance free, it is in practice an extremely rare commodity.

Just like other components of a structure the concrete should be periodically examined by an expert and if necessary subjected to a program of testing.

This would often include at least a detailed visual examination, as well as tests for **cover depth, carbonation, chlorides**, and could possibly also include tests for **HAC, sulfates, ASR** and any other tests deemed necessary.

#### **COVER DEPTH**

This is a term applied to the depth or thickness of concrete over the layers of reinforcing steel that are closest to the exposed surface. It is important that this parameter is appropriate to the concrete quality and the degree of exposure of the concrete, in order in particular to prevent **carbonation** from reaching the steel.

In UK construction it is historically not uncommon for inappropriate cover to result from poor standards of design and/or build. Shallow covers lead to early deterioration.

#### **PASSIVATION**

This is a term that is applied to the protection of reinforcing steel in concrete by the high alkalinity of concrete as cast. This alkaline environment supports a film of passive oxides on the steel, which, despite the almost inevitable simultaneous presence of oxygen and moisture prevents reinforcement corrosion.

## **CARBONATION**

Concrete as cast is highly alkaline which affords the reinforcing steel corrosion protection. The atmosphere around us, mainly by virtue of the carbon dioxide content, is slightly acidic which tends to neutralize the concrete from the surface inwards. This is the natural weathering process of concrete and is termed *carbonation*.

The carbonation process in no way harms concrete, in fact in many ways it enhances the physical properties, but it does reduce the high alkalinity that results in a loss of **passivation**, should the process reach the steel.

This in effect means that active corrosion of the steel will ensue with the all too familiar signs of corrosion in the form of cracking, spalling, and physical distress to the concrete cover.

The process of carbonation progresses into concrete as a somewhat irregular front, as concrete is not truly homogenous, in approximate reverse exponential advance in relation to time, at a true rate dependant upon concrete quality.

## **CHLORIDES**

Chlorides in concrete are present either because they were *cast in* at the time of construction or because they have *ingressed* the concrete after construction.

Cast in chlorides tend to be present in the UK historically in precast concrete construction where they are derived from the use of calcium chloride based accelerating **admixtures commonly used in the 1960's**. They could also of course be present due to contaminated ingredients, such as for instance marine dredged aggregates. This form of chloride contamination tends to combine with the hydration products of cement, and hence tends to exist in a substantially chemically bound condition.

Ingressed chlorides can be present from a variety of sources such as deicing salts on trafficked surfaces, spray and leakage of deicing salts, marine environments, salt laden air in coastal areas, aswell as influences such as industrial processes. This form of chloride contamination tends to be present in a free ion form. The amount of chloride present in concrete from external contamination is ever increasing with time, as is the depth of penetration.

It should be noted that it is the *free* chloride ion content of concrete that dictates the vulnerability to chloride attack. The mechanism of attack is the localized break down of the **passivation** of the steel, which leads to often intensive pitting corrosion. It is not possible to easily specify a limiting chloride content below which corrosion will not be initiated, as there are so many other factors to take into consideration.

## **CARBONATION AND CHLORIDES**

The process of **carbonation** in a concrete containing **chlorides** is potentially much more serious. This occurs because the carbonation process effectively releases the chemically bound chloride leaving it free to attack the reinforcing steel. It can be seen that the carbonation can thus be a trigger for chloride attack. This form of chloride attack frequently occurs just ahead of the carbonation front.

## **SULFATES**

The presence of sulfates in above ground concrete construction in the UK is most frequently due to external contamination such as industrial sources. In sufficient quantity sulfates break down the binding qualities of cement by chemical attack, which will ultimately result in a dangerous loss of strength.

## **HIGH ALUMINA CEMENT**

This HAC form of cement differs from ordinary portland cement (OPC) in that it has a higher alumina content. This results in cement that sets much more quickly, a property that was historically exploited in the manufacture of precast concrete construction in the UK.

It has more recently come to light that under certain conditions of temperature and moisture this type of cement undergoes certain chemical changes, often termed *conversion*, which results in a drastic and often unacceptable loss of strength. Some degree of, if not total conversion, tends to be the norm in UK HAC.

## **ALKALI SILICA REACTION**

This is a form of alkali aggregate reaction, which was seized upon by the non-specialist press in the UK when it first came to prominence, and commonly termed concrete cancer by them. It is ironically only really found in limited geographical areas, most frequently in parts of the southwest and midlands.

The reaction requires a particular combination of cement and aggregate properties to coexist to trigger it, and consists essentially of a chemical attack on the aggregate leading to the formation of an expansive gel, which in sufficient quantity can disrupt the concrete matrix. The reaction is very much moisture dependant and frequently has a finite life.

Ironically there have been less than a handful of notorious cases in the UK, which have required demolition. The reaction is by no means common and can frequently be controlled by elimination of moisture. It is

sometimes found microscopically that a degree of the reaction is present in a minor way, which may need some preventative measure.

It is however fairly common in UK aggregates to find types present in concrete under petrographic examination which are said to be classified as potentially reactive with alkali. This is not normally a cause for concern unless the reaction itself is observed to any significant degree.

### **MECHANICAL DAMAGE**

Mechanical or physical damage to concrete is commonly seen due to vehicular or industrial plant impact. It could however include abrasion. On some precast concrete one can find physical damage, particularly on corners, as a result of erection damage.

This kind of damage requires to be treated like a proper concrete repair, particularly where the reinforcement has become exposed. It is also important to ensure that any repair includes protection from renewed damage.

### **FROST DAMAGE**

This kind of damage is seen frequently on very exposed and often saturated components of concrete construction. It manifests itself in the form of lots of pop outs on a generally friable surface, often also including lineations of calcareous deposits. It is important to deal with these situations and install preventative measures.

### **LEAKAGE**

Signs of leakage through concrete often manifest themselves in the form of calcareous deposits and stalactites, frequently on cracks in soffits. In the long term, particularly if salts are present, this can lead to significant durability problems. The continuous saturation and passage of water through concrete can lead to undesirable chemical changes. It is therefore important to deal with these situations and install remedial measures.

### **FIRE DAMAGE**

The effects of fire upon a concrete surface will vary greatly dependant upon the proximity of the fire, the heat, and the physical qualities of the concrete. On the one hand the effects can be limited to severe soot contamination but on the other hand to extensive and deep physical damage.

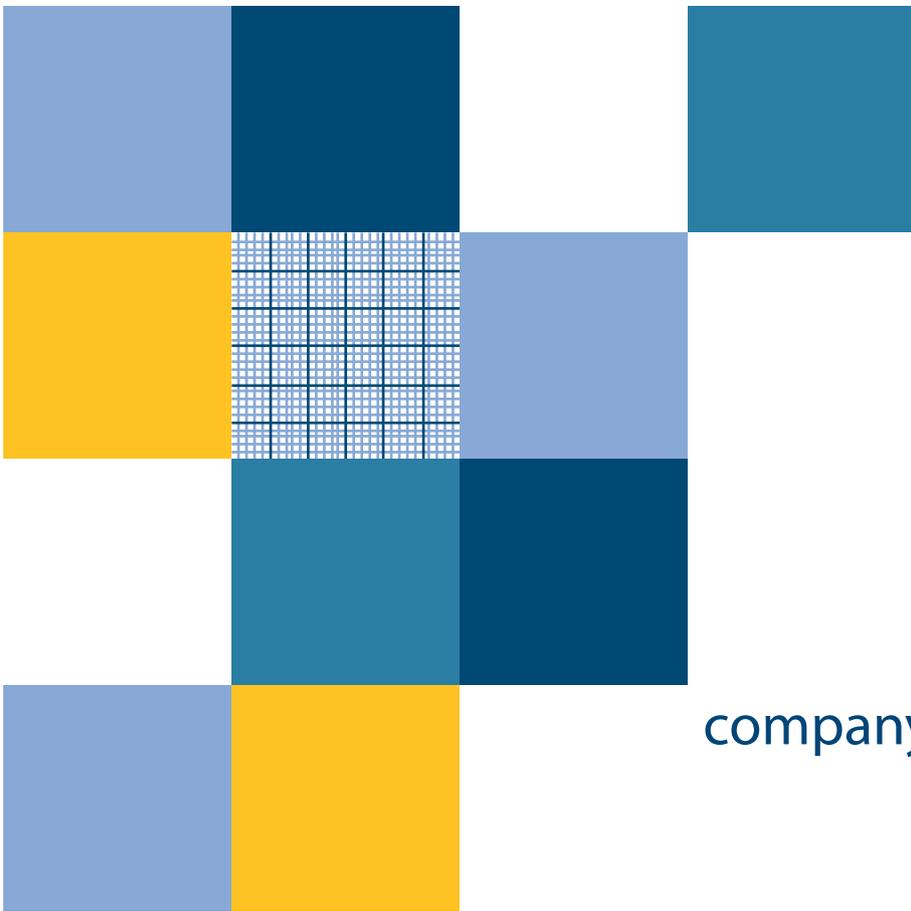
The main effect of exposure of concrete to fire is the differential expansion of the constituent parts leading to physical distress. This can range from surface pop outs over aggregate particles, to a friable surface, to spalling,

and ultimately possibly even to the permanent deformation of any exposed reinforcing steel. It is common for the surface layer of exposed concrete to exhibit a discoloration to pink, but this is dependent upon temperature reached.

Most frequent repair is in the form of removal of all loose, friable, and discolored concrete followed by reinstatement in an appropriate manner.

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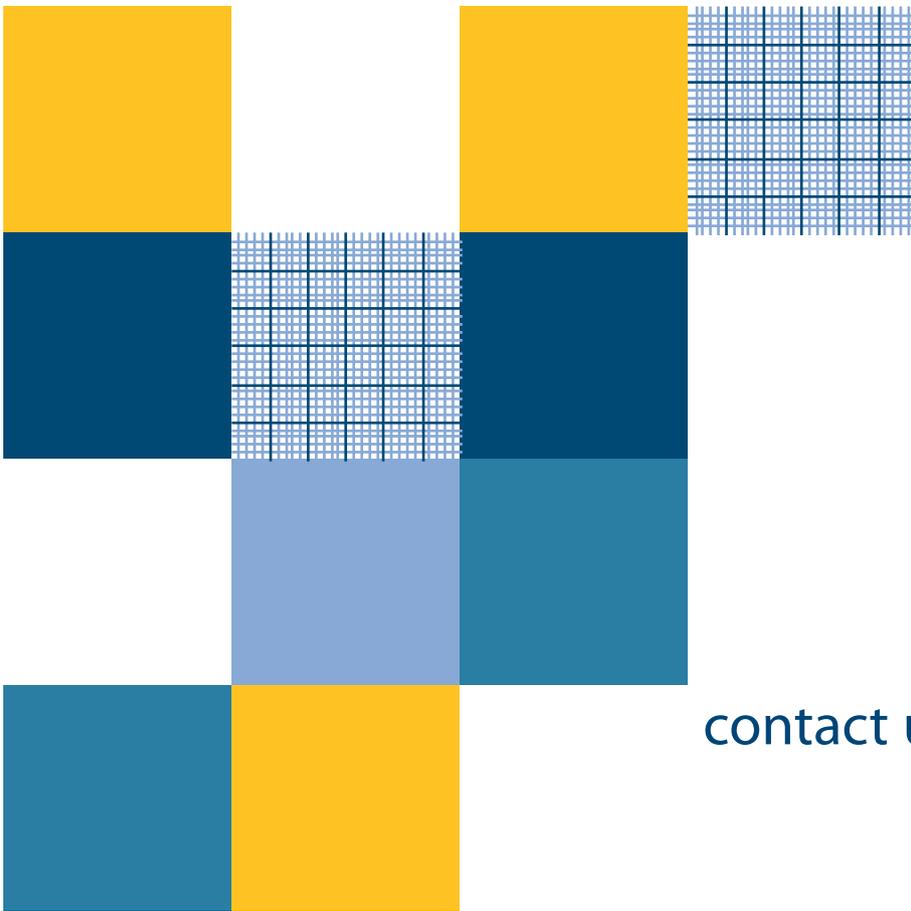
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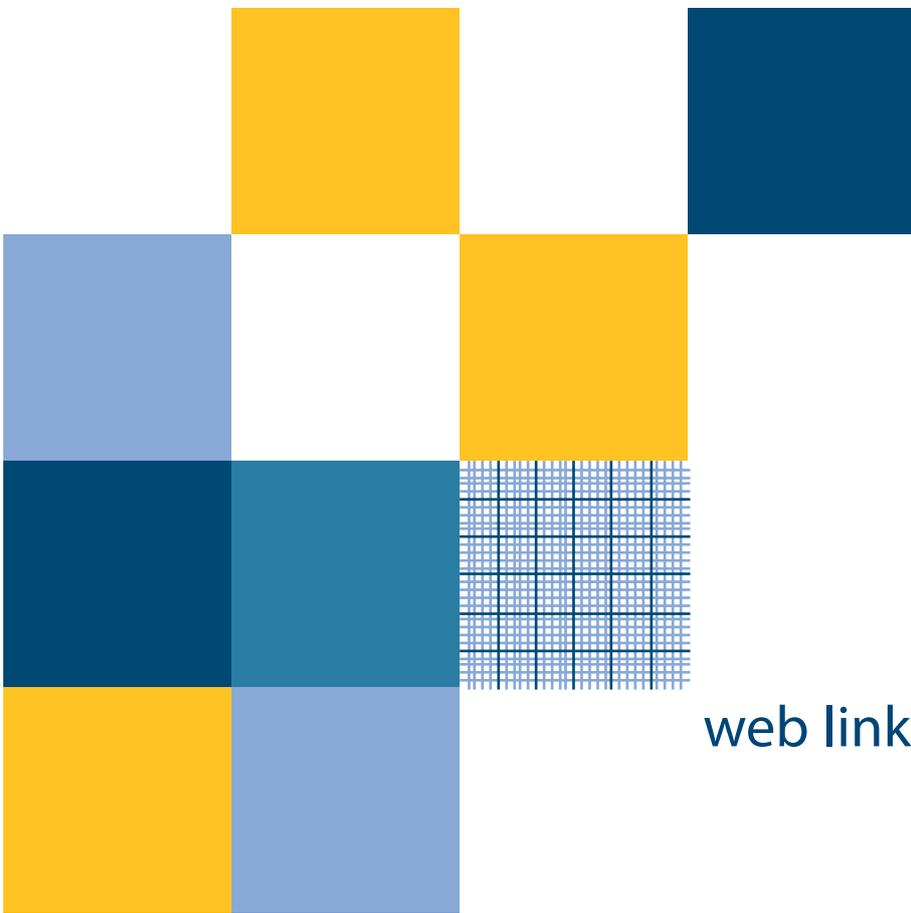
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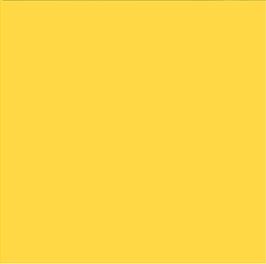
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## WEB LINKS

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**The Client: Corby Borough Council**

**The Development: A Summary document of initial structural investigations into insitu concrete to upper floors to Neville House, Corby.**

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