SANDBERG

REPORT 61351/S/1

SHELDON HOUSE, TEDDINGTON

INVESTIGATION OF MASONRY WALLS

Sandberg LLP
5 Carpenters Place
Clapham High Street
London SW4 7TD

Tel: 020 7565 7000
Fax: 020 7565 7101
email: mail@sandberg.co.uk
web: www.sandberg.co.uk

SANDBERG
CONSULTING ENGINEERS
INVESTIGATION INSPECTION
MATERIALS TESTING

Sandberg LLP
5 Carpenters Place
London SW4 7TD
Tel: 020 7565 7000
Fax: 020 7565 7101
email: clapham@sandberg.co.uk
web: www.sandberg.co.uk

REPORT 61351/S/1

SHELDON HOUSE, TEDDINGTON

INVESTIGATION OF MASONRY WALLS

Checkel-Dalton Associates
Unit 23 Abbeville Mews
88 Clapham Park Road
London
SW4 7BX

This report comprises
7 pages of text
Figures 1 to 27
Appendix A of 4 sheets
Appendix B of 4 sheets

For the attention of Mr Peter Dalton

31 January 2018

SANDBERG
CONSULTING ENGINEERS
INVESTIGATION INSPECTION
MATERIALS TESTING

REPORT 61126/S/1

SHELDON HOUSE, TEDDINGTON

INVESTIGATION OF MASONRY WALLS

Instruction: Letter from Mr Peter Dalton of Checkel Dalton Associates referenced PTD/CS/1381.

1. INTRODUCTION

Sandberg was instructed to carry out investigation of the exterior masonry walls at Sheldon House, Cromwell Road, Teddington TN11 9EJ.

The building has full masonry facades and brick slips covering the concrete floor slab edges and window lintels. It has been noticed that some of these brick slips were loose or had become detached. Our brief was to examine these slab edges and lintels to determine the present state of the masonry and concrete and investigate the possible causes for the defects. In some areas of the window lintels the brick slips had been removed by others prior to our investigation.

The intrusive investigation and survey comprised the following:

a) Inspection of brick slips, their arrangement and how they are fixed/supported.
b) Assessment of concrete condition to lintels and slab edges.
c) Sampling and testing of concrete for compressive strength, cement content, cover, depth of carbonation and chloride content.
d) Inspection of concrete reinforcement.
e) Inspection of masonry, cavity and cavity tray by videoscope inspection and removal of bricks.
f) Determination of wall tie type and arrangement.
g) Sampling and testing of mortar for composition.

The site works were performed in the period 9 January to 11 January 2018.

2. TEST METHODS

In order to examine the brickwork and concrete to the exterior elevations at Sheldon House a close-up visual inspection was carried out from a mobile elevated work platform.

Bricks and brick slips were removed using a medium duty 110V electric breaker with brick chisel. Some areas of brick slips had previously been removed by others and inspection was made of the concrete lintels and slab edges.

A metal detector (Sandberg Equipment Ref S872) and GPR Structurescan (Sandberg Equipment Ref E31.1) were used to detect metalwork such a wall ties within the walls. The detected ties and metal elements were marked on the wall and typical spacings measured and recorded.

A Ferroscan (Sandberg Equipment Ref 30.1) was used to detect reinforcement with the concrete and measure cover.

The depth of carbonation of the concrete was measured on freshly fractured surfaces using phenolphthalein indicator solution while following the procedure described in BRE IP6/81. A colour change shows the position of the carbonation front and hence the depth of carbonation from the concrete surface.

The chloride content was measured from dust samples. 20mm diameter drill holes were formed using a hammer drill. The dust extracted was collected representing concrete from the cover zone. The first 5mm at each position was discarded to reduce the effects of surface contaminants. The samples were prepared and analysed for chloride content in accordance with BS 1881: Part 124:1988 'Methods for analysis of hardened concrete'.

Concrete core specimens were extracted at required locations using 110v electric powered coring equipment. The cutter used was a nominally 100mm diameter diamond tipped core barrel. The cutting operation was lubricated and flushed using water from a lightly pressurised reservoir.

The recovered core specimens were subjected to brief visual examination, then prepared and tested for strength and density in accordance with BS EN 12504-1:2009, BS 1881:Part 120:1983 (withdrawn), BS EN 12390-3:2009 and BS EN 12390-7:2009.

The samples were also prepared and analysed in accordance with BS 1881: Part 124:2015 'Methods for the analysis of hardened concrete'. For cement content. The cement contents were calculated from the acid soluble calcium contents.

The mortar samples were prepared and analysed using documented in-house methods based on BS 4551:2005 + A2:2013 “Methods of test for mortar”.

As examination of the analysis data for indicated that the mixes consisted of either Portland cement and sand or of Portland cement, lime and sand, the mix proportions were calculated on these assumptions, following the directions given in Table 3 of BS 4551.

3. FINDINGS

The construction and condition of the brick slips over the window lintels and floor slab edges and the condition of the concrete and reinforcement was examined at 15No. locations around the block. Findings are shown in detail in Figures 2 to 19.

3.1 Bricks Slips over Window Lintels

The brick slips over window lintels consisted of some original construction and some that had been replaced in the past. Additional some areas of slips had been removed to expose the concrete lintel prior top our inspection.

The facing brickwork in these areas consisted of two courses of brick slips with full bricks above and the window opening below.

Hollow sounding slips were found to a number of original and replaced areas. Vertical mortar packing behind the slips was the only means of fixing to the slips to the concrete lintel behind. At several locations the mortar was only “dabs” or spots on the back of the slips.

At 2No. locations a gap was noted between the concrete lintel and the vertical mortar joint and the slips were “bulging” out i.e. the slips were debonded from the concrete substrate - see Figures 6 and 7.

3.2 Brick Slips over Slab Edges

The facing masonry at the slab edges away from the windows comprise three courses of brick slips with full bricks above and below.

All slips appear to be original. Some slips were hollow sounding and some were found to have only a partial backing mortar bedding behind them. The slips over the edge beam do have some additional support at the bottom, as they rest on a complete brick.

3.3 Concrete Condition

The concrete to the lintels and slab edges was general poor with several areas of honeycombing evident.

At 10No. random locations on the lintels, the depth of cover to the reinforcement and concrete carbonation depth was measured. At 8No. locations dust samples were also extracted for chloride content. The results of these are presented in Appendix A and summarised in table below.

Location No.	Location	Minimum Cover (mm)	Depth of Carbonation (mm)	Chloride Content (% by mass of cement)
1	Rear 3rd Floor Lintel	5	~	~
2	Rear 2nd Floor Slab	No steel*	~	~
3	Rear 4th Floor Lintel	13	>13	~
4	Rear 3rd Floor Lintel	8	15	<0.03
5	Rear 2nd Floor Lintel	14	30	0.04
6	Rear 4th Floor Lintel	10	>10	~
7	Rear 3rd Floor Lintel	10	>25	<0.03
8	Rear 4th Floor Lintel	~	~	~
9	Rear 1st Floor Lintel	12	>12	<0.03
10	Side 4th Floor Slab	No steel*	~	~
11	Side 2nd Floor Slab	No steel*	~	~
12	Side 1st Floor Slab	No steel*	10	<0.03
13	Side 1st Floor Lintel	15	25	0.09
14	Front 5th Floor Lintel	13	>13	<0.03
15	Rear 2nd Floor Lintel	8	>8	<0.03

* No reinforcement steel detected within 100mm of surface.

Average cover to the reinforcement was 10mm and this is considered low. The depth of carbonation exceeded the cover at all the locations tested. This indicates that the concrete surrounding the steel is no longer alkaline and therefore the steel is vulnerable to corrosion if water and oxygen are present.

Chloride contents in percent by mass of cement were consistently low (maximum 0.09%). All results were below the threshold value for chloride content of 0.4% by weight of cement as set in BS 8500-1:2002 for new construction in reinforcement concrete.

At 2No. locations samples were also tested for cement content and test results are shown in Appendix A. Values recorded were 16.2% and 16.8% by weight of dry hardened concrete and these are considered reasonably high.

At three locations cores were extracted for concrete compressive strength testing. The results together with core descriptions and photographs are shown in Appendix B and summarised in the table below.

Core No.	Location	Density (kg/m^3)	Corrected Insitu Cube Strength (N/mm^2)
1	Front 4th lintel	2270	31.2
2	Front 3rd lintel	2290	43.8
3	Rear 2nd lintel	2300	44.9

The compressive strength of core were moderately high - mean 40.0N/mm^2.

Slight honeycombing was noted throughout the entire length (180mm) of Core 3.

3.4 Reinforcement

The concrete reinforcement was exposed at 11No. random locations on the lintels. At only one location was the reinforcement found to be clean and corrosion free

There were numerous shallow areas of surface honeycombing noted on the exposed face of the lintels, where corroding reinforcement was visible at typically 10mm cover. On 2o. two lintels severe concrete spalling was noted, exposing corroding reinforcement, with a 100% loss of horizontal steel section noted at one of these.

No reinforcement was visible or detected with a cover meter on the slab edges.

3.5 Brickwork Mortar

Mix proportions of the vertical packing mortar behind the slips was determined at two locations. The results are shown in Appendix A and summarised below.

Sample Reference	Location	Mix Type	Mix proportions by volume	Designation from BS 4551 : 2005
S49997	Loc 1 - 3rd Fl	Portland cement : sand	1 : 3.5	ii
S50010	Loc 13 - 1st Fl	Portland cement : lime : sand	1 : 0.7 : 5.3	iii

The mortar is considered a good quality hard mortar.

3.6 Brickwork and Cavity

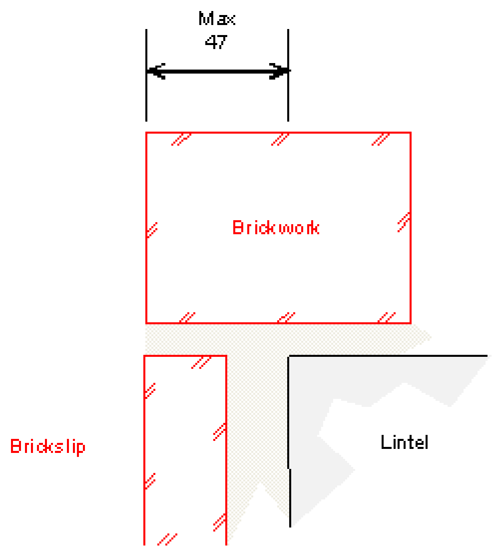
Further examination of the surrounding brickwork, cavity, wall ties and cavity tray was performed at 6No. areas. Findings are shown in detail in Figures 20 to 25 and summarised below:

A cavity tray was visible above all the lintels and edge beams examined. At two locations a brick was removed to inspect the tray. The tray was found to be filled with mortar and construction debris at both locations. At one location (11) where brick slips over the edge beam were removed, the tray was misplaced so that its bottom was aligned with the middle of a brick slip, not above it.

At one location a brick was removed to inspect a wall tie. The tie was a twisted fishtail type (Figure 20). The tie was clean and unbridged, but poorly embedded in the inner leaf and could be moved about. A small map of the ties (Figure 21) found them to be evenly and well distributed. At a second location above the lintels, an expanded metal lath was found in a horizontal brickwork joint (Figure 22).

Blown fibre insulation within the cavity prevented any further endoscope inspection of ties and the cavity tray.

The brick forming the outer leaf is of standard width and sits on the concrete lintel. Up to 47mm of it overhangs the lintel and this may cause strain on the slips below and wall above - see sketch below.



Other brickwork defects noted included vertical cracking, and water seeping out of a horizontal mortar joint when it was disturbed. Illustrative photographs included as Figures 26 and 27.

4. **COMMENTS**

The brick slips, mortar and other bricks appeared to be in a reasonable condition.

The concrete was of reasonable quality but honeycombing was observed in several areas. This could allow easy ingress of water into the concrete to the steel depth and may increase the likelihood of steel corrosion. The concrete strengths and cement content were satisfactory and chloride levels were low.

There were many areas of window lintels where steel corrosion has occurred, some to a severe extent. This is likely to have been caused by low cover depth, carbonation of the concrete around the steel and ingress of air and water. Exposed steel, spalling and cracking has occurred and is likely to have caused or been a contributory factor to the brick slips being pushed off the concrete.

The slips were debonded at several areas under the lower slip resulting in water ingress which may accelerate concrete deterioration.

In all the window lintel areas consideration should be given to removal of all brick slips to prevent these falling from the building.

Notwithstanding the defects noted cement based mortars of the type used and applied here are not generally considered to be an adequate means of adhering brick slips, in our view

The brick slips on the slab edges away from the windows may be better supported by brickwork below and the reinforcement within the concrete appears to be at a greater depth (>100mm). Although carbonation is still deep, it does not yet appear to have affected the steel.

The cavity tray although present is in some areas inadequate. The cavity contains mortar debris which is also blocking the efficient drainage.

Checkel-Dalton Associates
Unit 23 Abbeville Mews
88 Clapham Park Road
London
SW4 7BX

For the attention of Mr Peter Dalton

DB/RL/sjh/Inspection

File: 61135s1 Report.wpd

for Sandberg LLP

Roger Lucas
Associate

31 January 2018

FIGURES

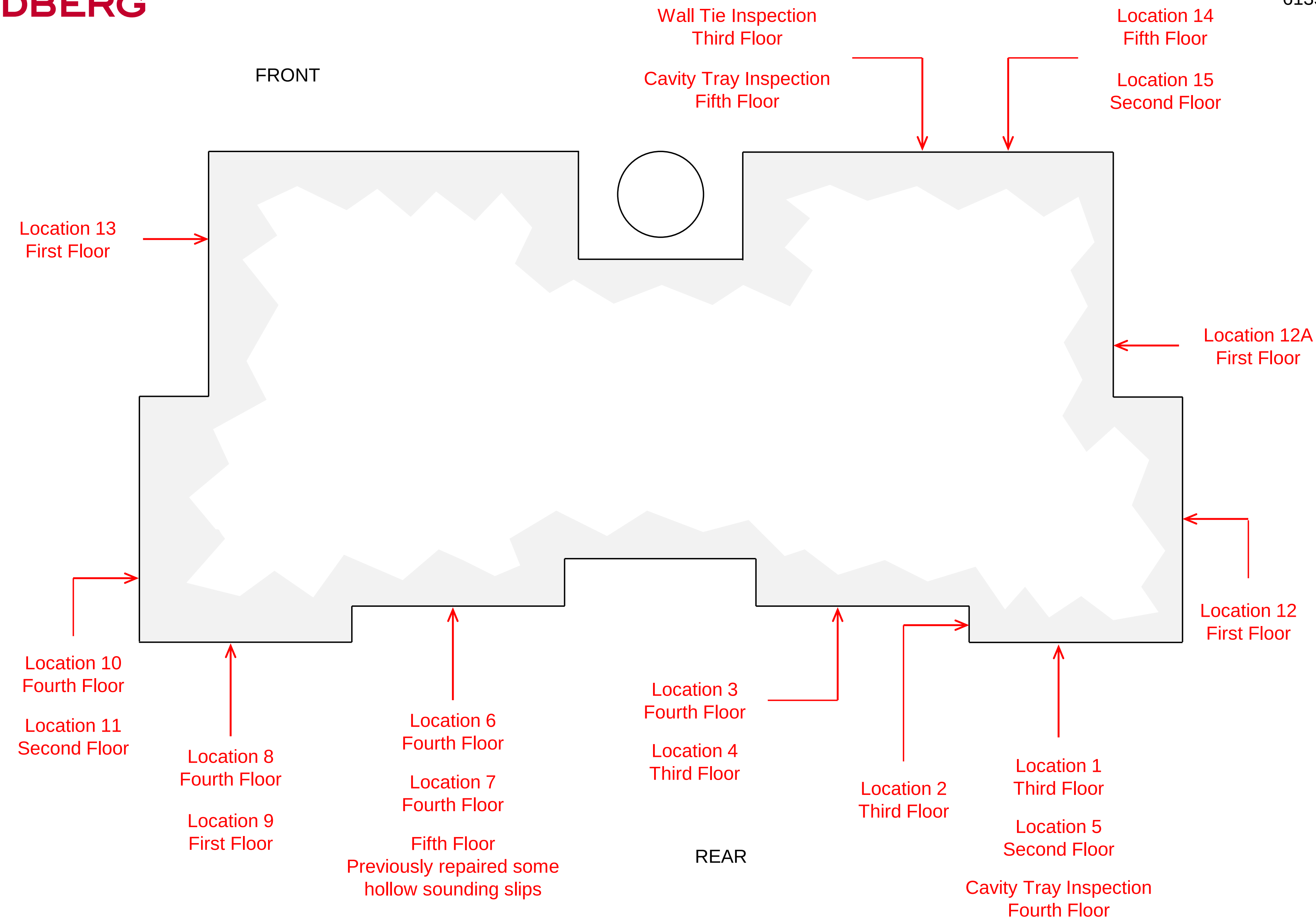
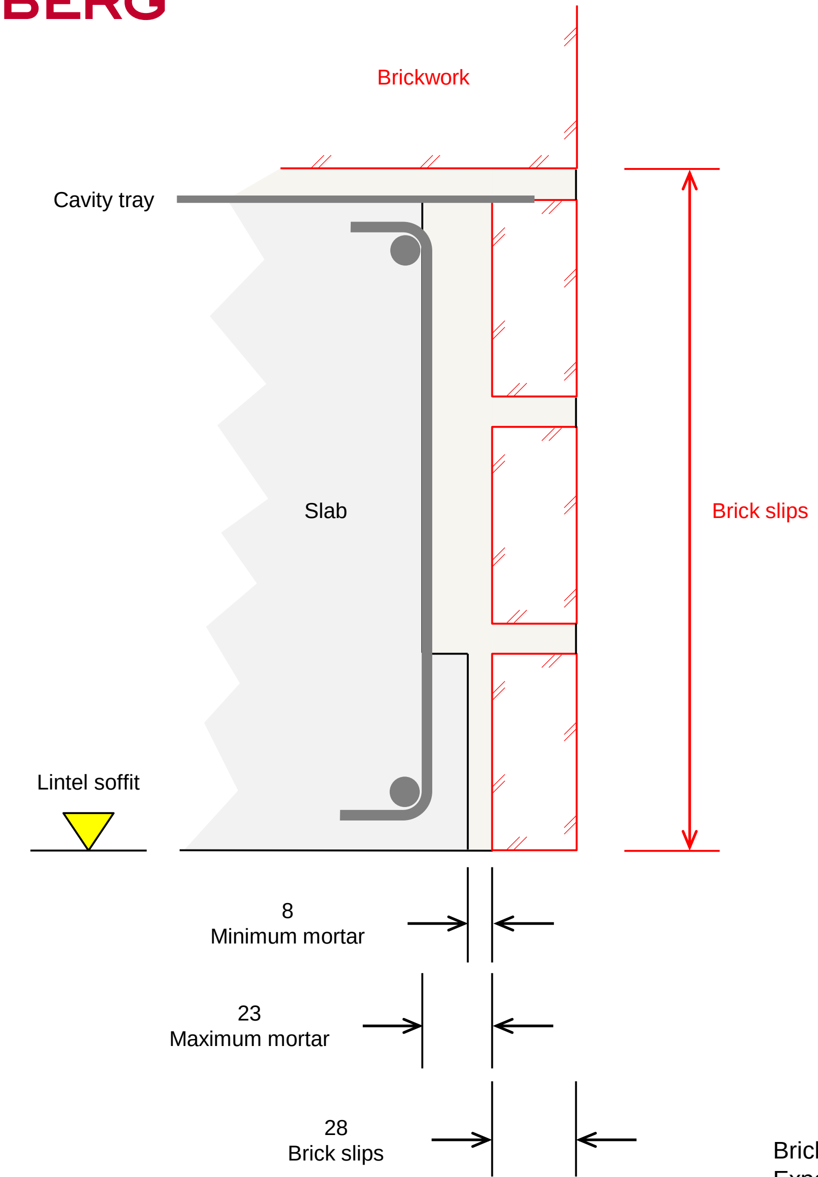


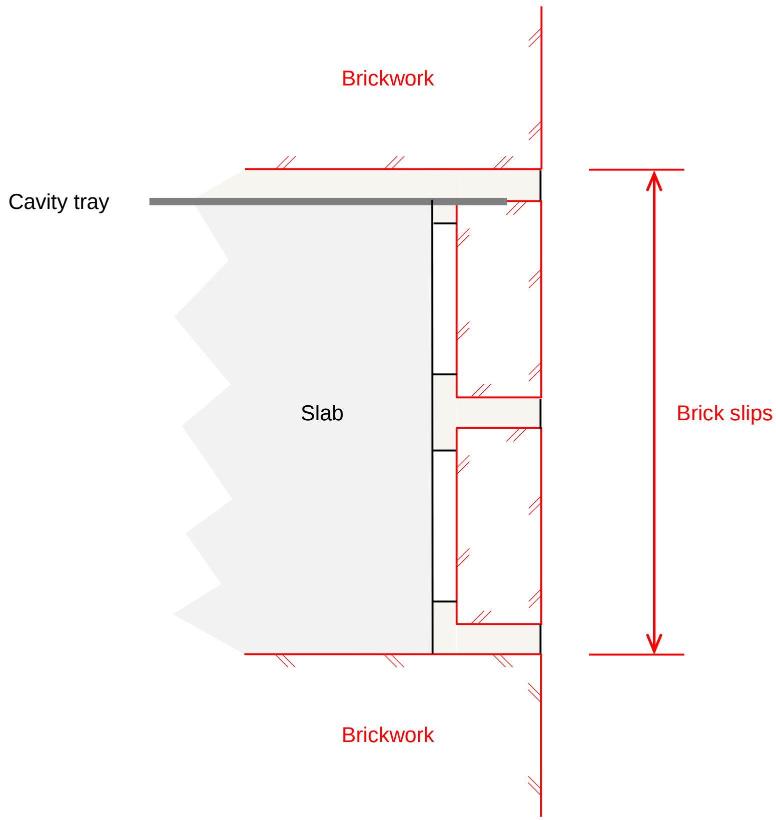
Figure 1. Sample and Inspection Location Plan.



Section

Brick slips over the window lintel partially removed (by others)
Exposed corroding reinforcement visible.
The concrete cover (nominal 5 to 10mm) appears to have been mechanically removed / broken away.
Tip of cavity tray exposed.
Some remaining brick slips sound hollow. Slips away from the lintel were sound.

Figure 2. Location 1. Rear Elevation. Third Floor. Window Lintel. Brick Slips Removed.



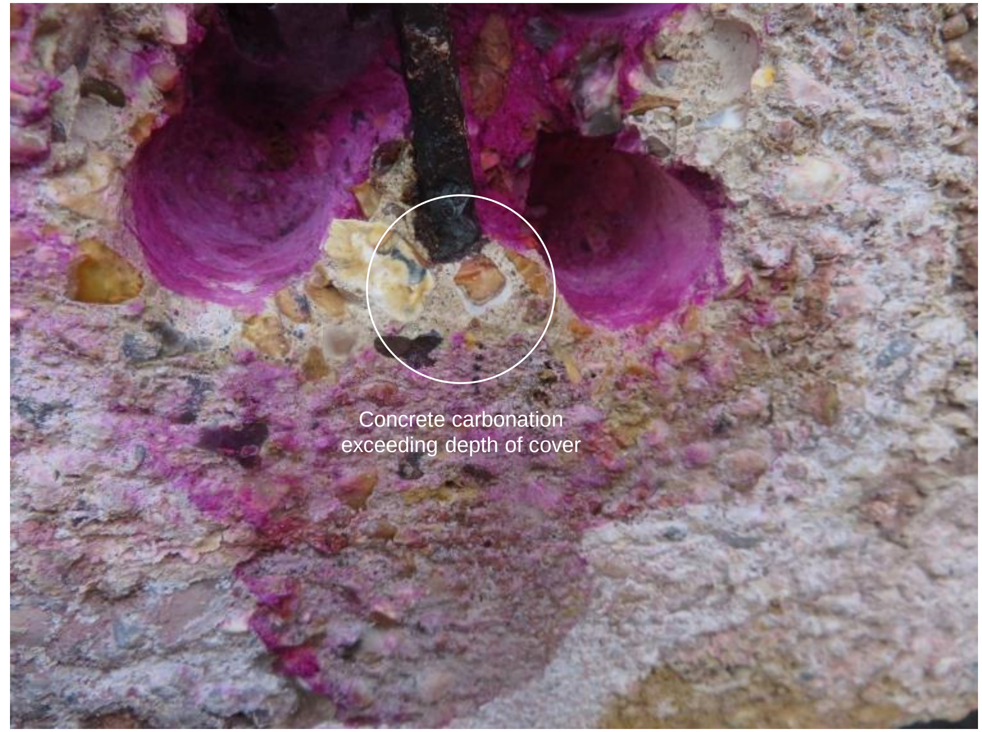
Section

Brick slips over the slab edge removed. Only two slips compared to three on the lintels.
Exposed slab edge had a rough concrete finish. Unable to locate reinforcement.
Mortar behind slips only “dabs”
Tip of cavity tray exposed.

Figure 3. Location 2. Rear Elevation. Third Floor. Slab Edge. Brick Slips Intact.

A hollow sounding brick slip, over the window lintel was partially removed.
The seventeen millimetre vertical mortar bed behind the slip was uniform and moderately hard.
The concrete forming the slab edge behind was soft or spalled.
Upon removing the concrete, corroding reinforcement at thirteen millimetre cover was exposed.
Depth of concrete carbonation exceeded cover.
Tip of cavity tray exposed.

Figure 4. Location 3. Rear Elevation. Fourth Floor. Window Lintel. Brick Slips Intact.



Brick slips over the window lintel removed (by others)
Concrete cover to the reinforcement was 8mm.
The concrete carbonation depth exceeded cover.
Surface corrosion on the reinforcement.

Figure 5. Location 4. Rear Elevation. Third Floor. Window Lintel. Brick Slips Removed.

Brick slips over the window lintel removed (by others)
Top 1mm of mortar in the vertical slip joints, and mortar remnants on the concrete, pink in colour.
The reinforcement exposed at the concrete breakout had severe corrosion.
Some corrosion products were leaching out in to the surrounding cement paste.
The depth of concrete carbonation exceeded cover. Cover was 14mm, Carbonation 30mm.
The remaining slips at the end of the lintel were well mortared / vertically bedded.
Tip of cavity tray visible.

Figure 6. Location 5. Rear Elevation. Second Floor. Window Lintel. Brick Slips Removed.

Brick slips over the window lintel visually bulging out.
Vertical bedding joint well mortared.
Concrete behind, believed to have spalled over the reinforcement.
The reinforcement at 10mm concrete cover had surface corrosion.
The depth of concrete carbonation exceeded cover.
Tip of cavity tray exposed.

Figure 7. Location 6. Rear Elevation. Fourth Floor. Window Lintel. Brick Slips Intact.

The reinforcement had surface corrosion.

Visible gap between the concrete lintel and the vertical bedding mortar.

Figure 8. Location 6. Rear Elevation. Fourth Floor. Window Lintel. Brick Slips Intact.

The reinforcement had 10mm concrete cover.
The reinforcement was clean.
The depth of concrete carbonation exceeded cover.

Figure 9. Location 7. Rear Elevation. Third Floor. Window Lintel. Brick Slips Removed.

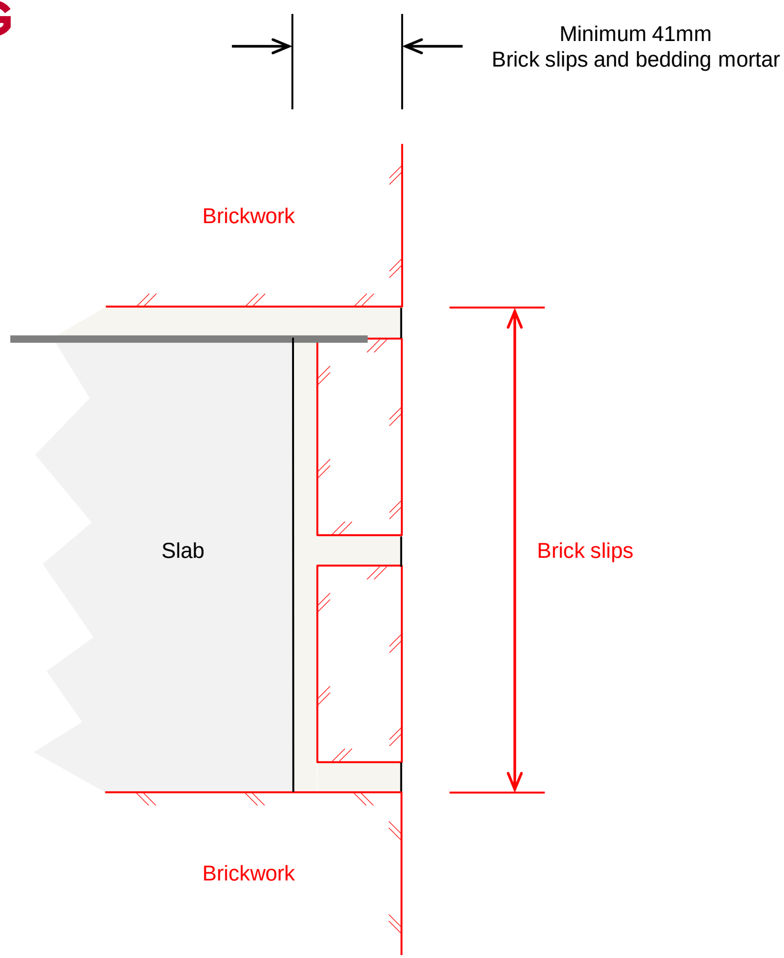
The brick slips had been previously replaced.
Concrete lintel behind severe cracking and spalling.
Corroding reinforcement under.
Slips sound hollow.
Fifth floor above slips replaced, hollow sounding at the end of the lintel.

Figure 10. Location 8. Rear Elevation. Fourth Floor. Window Lintel. Brick Slips Intact.

The brick slips sounded slightly hollow.
Concrete lintel behind had slight surface honeycombing and a rough exposed aggregate finish.
Brick slips and vertical bedding mortar 40mm thick.
Concrete cover was 12mm and the exposed bar had surface corrosion.
Carbonation depth exceeded cover.

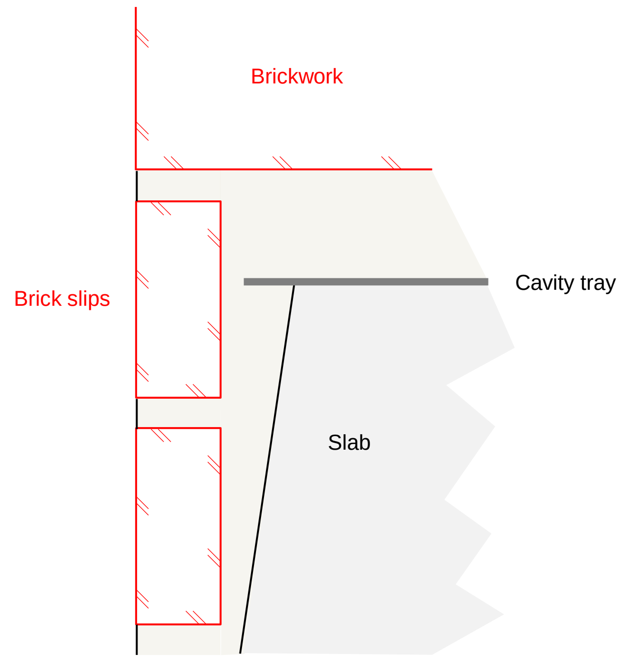
Figure 11. Location 9. Rear Elevation. First Floor. Window Lintel. Brick Slips Intact.

Section

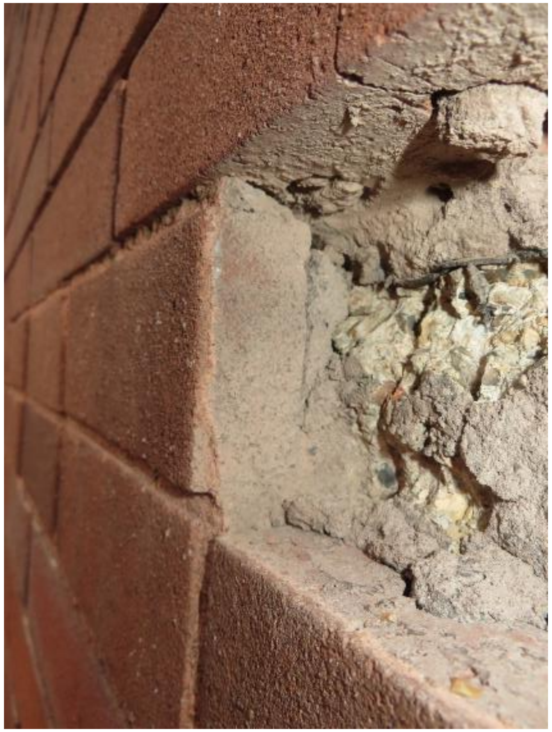


Brick slips over the slab edge removed. Only two slips compared to three on the lintels.
Slips removed over an isolated hollow sounding area.
Exposed slab edge had a rough concrete finish. Possible joint in concrete.
Unable to locate reinforcement.
Vertical bedding joint well mortared.
Tip of cavity tray exposed.

Figure 12. Location 10. Side Elevation. Fourth Floor. Slab Edge.



Section

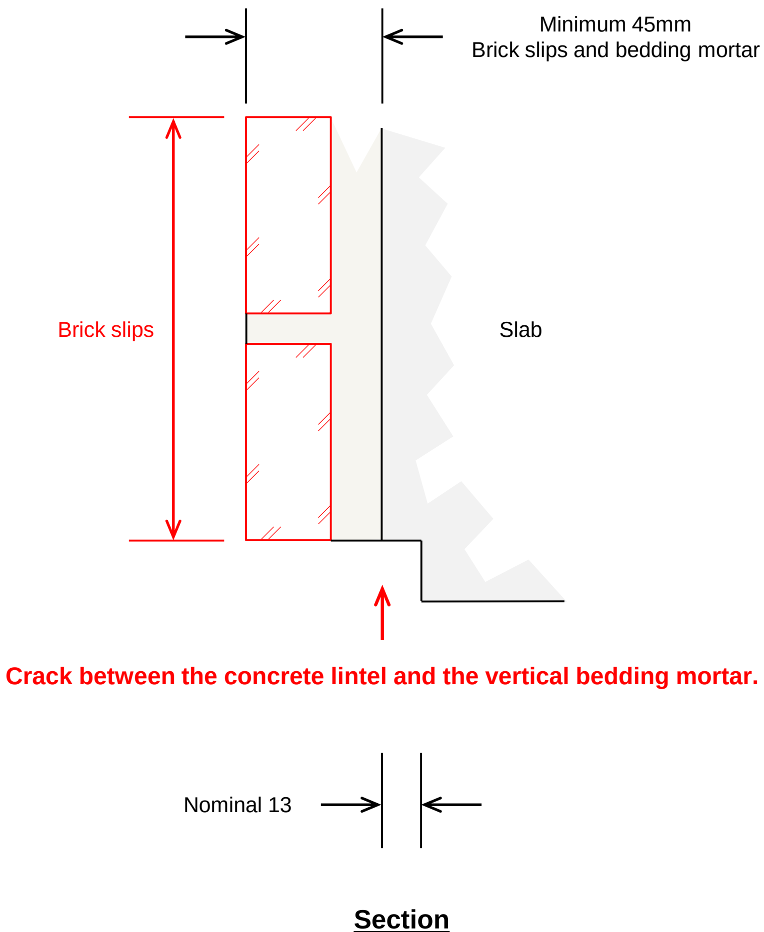


Brick slips over the slab edge removed. Only two slips compared to three on the lintels.
Exposed slab edge had a rough concrete finish.
Unable to locate reinforcement.
Vertical bedding joint well mortared.
Tip of cavity tray exposed, but the tray is lower than the joint between the slips.
Cobwebs behind the vertical mortar joint indicate the slips are delaminated.

Figure 13. Location 11. Side Elevation. Second Floor. Slab Edge.

Third, second and first floor slips inspected for hollow sounding areas.
One small hollow area identified on the first floor.
Vertical bedding joint behind slips only partially mortared.
Brick slips and vertical mortar bedding, minimum 42mm thickness.
Unable to locate reinforcement. Concrete carbonation depth was 10mm.
Holes were drilled above the cavity tray to allow inspection with an endoscope, blown fibre insulation prevented viewing.

Figure 14. Location 12. Side Elevation. First Floor. Slab Edge.



Crack between the concrete lintel and the vertical bedding mortar.

Brick slips over the small windows.
Crack visible between concrete lintel and the mortar in the vertical packing.
Brick slips sound hollow.

Figure 15. Location 12A. Side Elevation. First Floor. Window Lintel. Brick Slips Intact.

Bottom slips previously removed (by others) upper two courses of slips easily removed.
Vertical bedding joint well mortared. Slips and vertical mortar joint 47mm thick.
Concrete behind had a rough cast finish.
The reinforcement at 15mm concrete cover was clean.
The depth of concrete carbonation exceeded cover.
Tip of cavity tray exposed.

Figure 16. Location 13. Side Elevation. First Floor. Window Lintel. Brick Slips Partially Removed.

Apparent crack / de-bonding between the concrete lintel and the vertical bedding mortar.

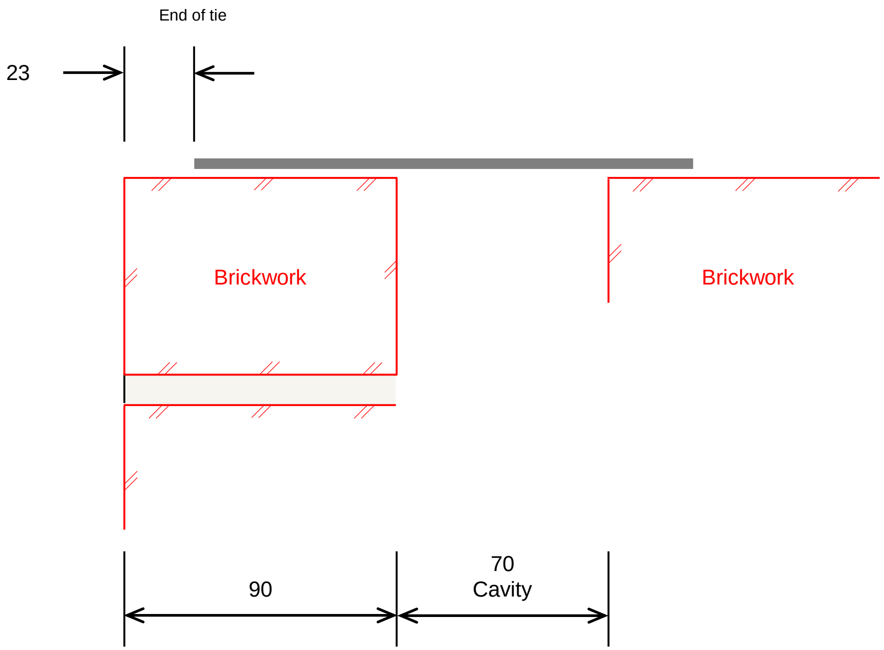
Figure 17. Location 13. Side Elevation. First Floor. Window Lintel. Brick Slips Partially Removed.

The brick slips had been removed (by others)
Concrete lintel behind had very slight surface honeycombing and a rough exposed aggregate finish.
Concrete cover was 13mm and the exposed bar had very slight patchy surface corrosion.
Carbonation depth exceeded cover.
Brick slips on the fourth floor replaced. Sound hollow.

Figure 18. Location 14. Front Elevation. Fifth Floor. Window Lintel. Brick Slips Removed.

The brick slips had been removed (by others)
Concrete lintel behind had very slight surface honeycombing and a rough exposed aggregate finish.
Concrete cover was 8mm and the exposed bar had very slight patchy surface corrosion.
Carbonation depth exceeded cover.

Figure 19. Location 15. Front Elevation. Second Floor. Window Lintel. Brick Slips Replaced.



Note. Bricks non-standard size. 292 x 90 x 65mm

Section

Twisted fish-tail tie.
Clean and not bridged with mortar.
Blown fibre insulation within cavity.
Tie poorly embedded in inner brick leaf. Tie can be moved by hand, but not pulled out.

Figure 20. Wall Tie Inspection. Front Elevation. Third Floor.

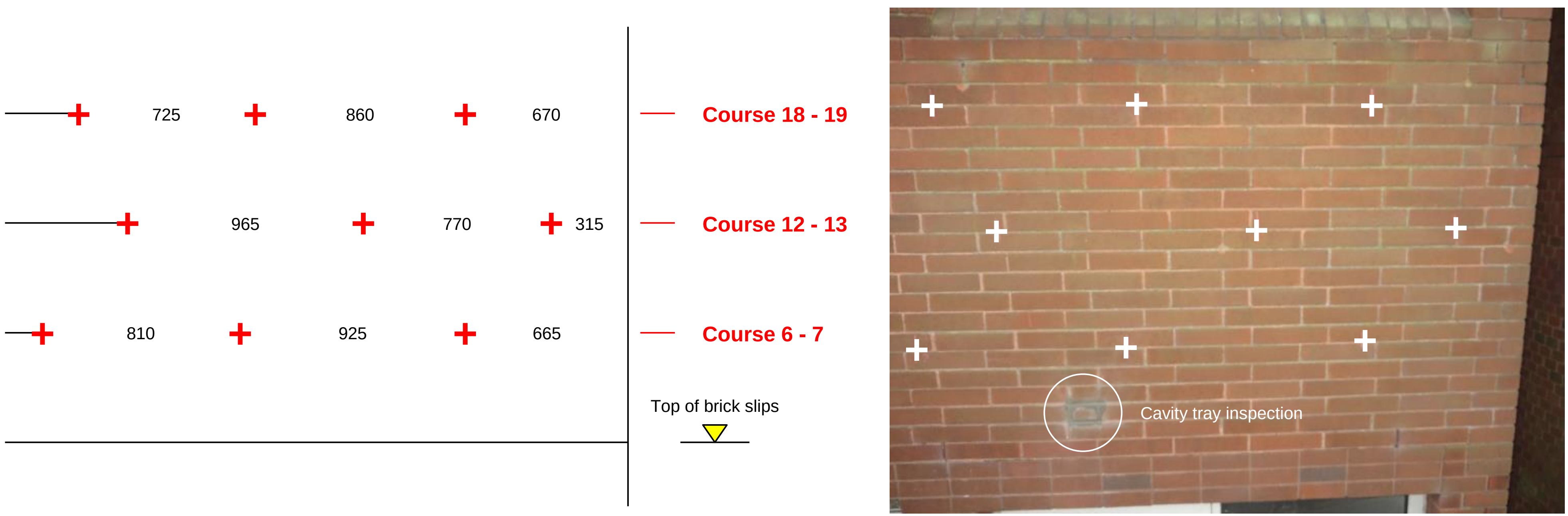
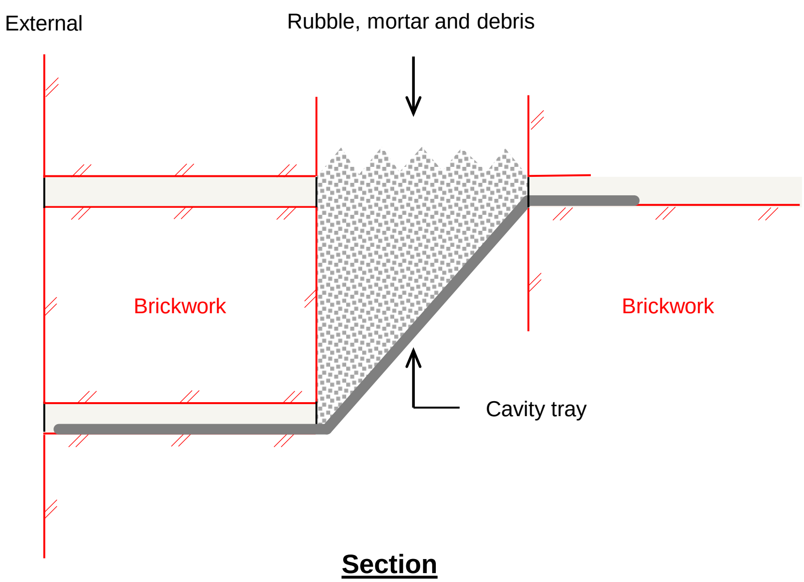


Figure 21. Wall Tie Map. Front Elevation. Fifth Floor.

Three courses above the brick slips.
Expanded metal mesh within the horizontal brickwork joint.

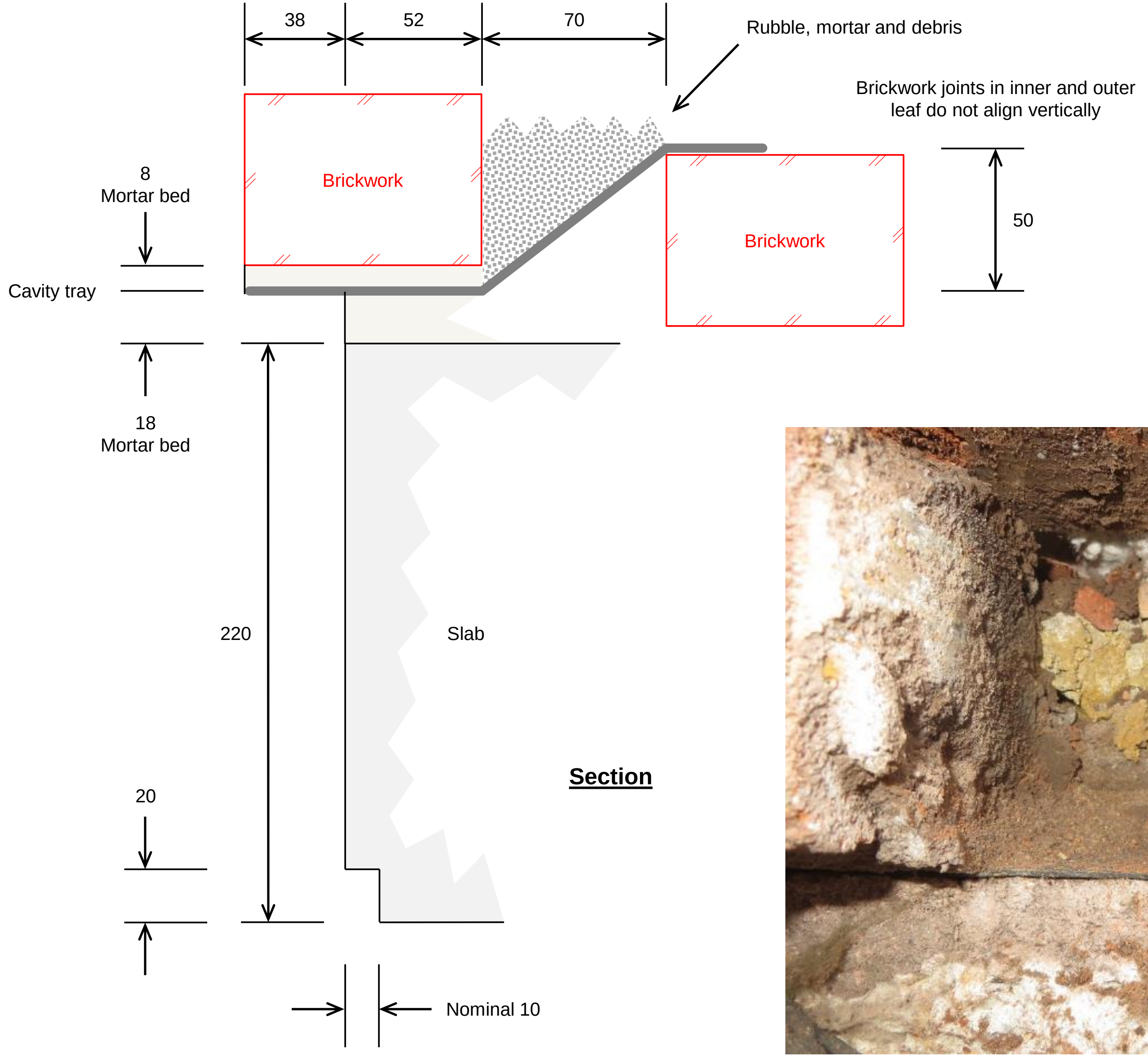
Figure 22. Wall Tie Map. Rear Elevation. Third Floor. Beneath Windows.



Detail of the debris sitting on the cavity tray.

Cavity tray bituminous sheet.
Cavity tray height, one brick course.
Cavity tray covered in mortar and construction debris.
Blown fibre insulation within cavity.

Figure 23. Cavity Tray Inspection. Front Elevation. Fifth Floor.



Debris and mortar above the cavity tray

Figure 24. Cavity Tray Inspection. Rear Elevation. Fourth Floor.

Cavity tray bituminous sheet.
Cavity tray height only 50mm. Joints in inner and outer leaf's don't align vertically.
Cavity tray covered in mortar and construction debris.
Blown fibre insulation within cavity.

Figure 25. Cavity Tray Inspection. Rear Elevation. Fourth Floor.

First floor rear elevation. Typical surface honeycombing, corroding reinforcement visible.

Third floor rear elevation.
One hundred percent loss of section to the horizontal top reinforcement.

Figure 26. Typical illustrative photographs

Vertical cracking in the brickwork above a lintel.

During an investigation into the wall ties on the third floor rear elevation. Water seeped out of the horizontal mortar joint, when it was disturbed.

Figure 27. Typical illustrative photographs

APPENDIX A

Chemical Test Results

SANDBERG

UKAS TESTING 0262

61351/S
Appendix /Sheet A/1
Date of Test 19-22/01/18

ANALYSIS OF HARDENED CONCRETE

BS 1881:Part 124:2015 and Documented In-house Methods(*)

Sandberg Reference	S49995	S49996		
Client Reference	2	3		
Details	Core	Core		
CHEMICAL ANALYSIS		% by mass		
Soluble silica, SiO_2*	4.58	4.20		
Acid soluble Alumina, Al_2O_3*	-	-		
Acid soluble Iron, Fe_2O_3*	-	-		
Acid soluble Calcium, CaO	10.48	10.81		
Acid soluble Potassium, K_2O	-	-		
Acid soluble Sodium, Na_2O	-	-		
Acid soluble Sulphate, SO_3	-	-		
Chloride, Cl^-*	-	-		

Dry density, kg/m^3	2160	2170		

Calculated cement content				
% by mass of dry mass	16.2	16.8		
kg/m^3	350	365		
Aggregate/cement ratio	4.9	4.7		

Sulphate % by mass of cement	-	-		
Chloride % by mass of cement	-	-		
Total alkalies % by mass of cement	-	-		
Probable cement type	PC	PC		
Calculation route #	B	B		

Assumptions used in calculations	SiO_2 %	CaO %	combined water	
Aggregate	0.5	0.0	-	
Portland cement	20.2	64.5	23	

Calculation route: A using soluble silica B using acid soluble calcium oxide

SANDBERG

UKAS TESTING 0262

61351/S
Appendix/Sheet A/2
Date of Test 21-25/07/17

MORTAR - CHEMICAL ANALYSIS
DETERMINATION OF MIX PROPORTIONS

Documented In-house Methods 34.1(*) and BS 4551:2005+A2:2013

Sandberg Reference	S49997			
Client Reference	Loc 1			
Details	3rd Fl			
CHEMICAL ANALYSIS	% by mass			
Insoluble Residue	73.48			
Soluble Silica, SiO_2*	4.81			
Acid soluble Alumina, Al_2O_3*	0.86			
Acid soluble Iron, Fe_2O_3*	0.66			
Acid soluble Calcium, CaO	12.07			
Acid soluble Magnesium, MgO	0.34			
Acid soluble Sulphate, SO_3	0.74			
Loss on Ignition	6.87			
Total	99.83			

Calculated Mix Proportions				
Composition to nearest 0.5%	% by mass of dry mass			
Portland cement : sand				
Portland cement	20.0			
Sand	80.0			
Calculated volume	1 : 3.5			
Mortar Designation From Table 4, BS4551 : 2005	ii			
Sulphate % by mass of cement	4.0			

Assumptions used in calculations	SiO_2 %	CaO %	bulk density kg/m^3	material type
Sand	0.2	0.0	1675	Siliceous
Portland cement	20.5	64.5	1450	OPC

SANDBERG

UKAS TESTING 0262

61351/S
Appendix/Sheet A/3
Date of Test 21-25/07/17

MORTAR - CHEMICAL ANALYSIS
DETERMINATION OF MIX PROPORTIONS

Documented In-house Methods 34.1(*) and BS 4551:2005+A2:2013

Sandberg Reference	S50010			
Client Reference	Loc 13			
Details	1st FI			
CHEMICAL ANALYSIS	% by mass			
Insoluble Residue	75.89			
Soluble Silica, SiO_2*	2.68			
Acid soluble Alumina, Al_2O_3*	0.62			
Acid soluble Iron, Fe_2O_3*	0.48			
Acid soluble Calcium, CaO	10.17			
Acid soluble Magnesium, MgO	0.37			
Acid soluble Sulphate, SO_3	0.43			
Loss on Ignition	9.00			
Total	99.64			

Calculated Mix Proportions				
Composition to nearest 0.5%	% by mass of dry mass			
Portland cement : lime : sand				
Portland cement	13.5			
Lime, dry $Ca(OH)_2$	3.5			
Sand	83.0			
Calculated volume	1 : 0.7 : 5.3			
Mortar Designation From Table 7, BS4551 : 2005	iii (nearest)			
Sulphate % by mass of cement	3.5			
Possible alternative mix	PC : sand 1 : 5.8			

Assumptions used in calculations	SiO_2 %	CaO %	bulk density kg/m^3	material type
Sand	0.2	0.0	1675	Siliceous
Portland cement	20.5	64.5	1450	OPC
Lime, hydrated	0.0	72.7	575	

SANDBERG

UKAS TESTING 0262

61351/S
Appendix/Sheet A/4
Date of Test 15/01/2018

CONCRETE - CHEMICAL ANALYSIS
DETERMINATION OF CHLORIDE CONTENT
Documented in-house methods 14.8

Sandberg Reference	Client Reference	Details	Cement content by mass (assumed)	Chloride Cl^- % by mass of		Mass of sample rec'd, g
		Sheldon House Teddington	%	sample	cement	
S49999	Loc 4	Dust	16.6	<0.004	<0.03	64
S50001	Loc 5	Dust	16.6	0.007	0.04	56
S50003	Loc 7	Dust	16.6	<0.004	<0.03	42
S50005	Loc 9	Dust	16.6	<0.004	<0.03	41
S50008	Loc 12	Dust	16.6	<0.004	<0.03	55
S50011	Loc 13	Dust	16.6	0.014	0.09	51
S50012	Loc 14	Dust	16.6	<0.004	<0.03	58
S50013	Loc 15	Dust	16.6	<0.004	<0.03	64

APPENDIX B

Core Strength Results

SANDBERG

0262

61351/S/1
Appendix/Sheet B/1
Date of Test 18/1/2017

CONCRETE TEST RESULTS
COMPRESSIVE STRENGTH AND DENSITY OF CORES

BS EN 12504-1:2009, BS EN 12390-3:2009 and BS EN 12390-7:2009

Sandberg Reference		S49994	S49995	Sf9996
Site Mark/Client Reference		C1	C2	C3
Details: - Location - Date of coring		4th Fl Slab Edge -	3rd Fl Slab Edge -	2nd Fl Slab Edge -
Date Received		15/1/2017	15/1/2017	15/1/2017
Presence of abnormalities		None	None	Honeycombed
Reinforcement, (diameter/distance)[1]	mm	None	None	None
Aggregate, maximum nominal size	mm	12	12	10
Age at Test	days	NA	NA	NA
Method of end preparation		HAC	HAC	HAC
Surface Moisture Condition at test		Damp	Damp	Damp
Actual Core Lengths - Minimum length, as received - Maximum length, as received - Prepared length - Relation to length, as-received	 mm mm mm mm	 110 123 77 20-90	 135 150 77 30-100	 165 181 77 40-110
Mean Core Diameter (d_m)	mm	69	69	69
Length/Diameter Ratio, λ		1.12	1.12	1.12
Density[2] - Air dry condition Density[2] - Saturated condition	kg/m³ kg/m³	- 2270	- 2290	- 2300
Saturation before Test	days	4	4	4
Maximum Load at Failure	kN	112	157	161
Mode of Failure[4]		Normal	Normal	Normal
Compressive Strength[3] (Measured Core Strength)	MPa (N/mm²)	30.0	42.0	43.1

Reinforcement Correction[5]		-	-	-
Compressive Strength[3] **Corrected In-situ Cube Strength[5]**	MPa (N/mm²)	31.2	43.8	44.9

1 Centre of bar to core end, before and after end preparation (eg. 20/100/40 = 20mm diameter bar, 100mm from the core end as-received and 40mm
2 Volume by water displacement, densities given to nearest 10kg/m³.
3 Compressive strength values given to nearest 0.1 MPa (N/mm²).
4 'Normal' (symmetrical failure) or otherwise as described.
5 BS EN 12504-1 National Annex NA.3 - corrected in-situ cube (no adjustment for direction of drilling).

ND = Not determined. NA = Not applicable. SSD = Saturated Surface Dry

SANDBERG

UKAS TESTING 0262

61351/S/1
Appendix/Sheet B/2
Date of Test 15/1/2018

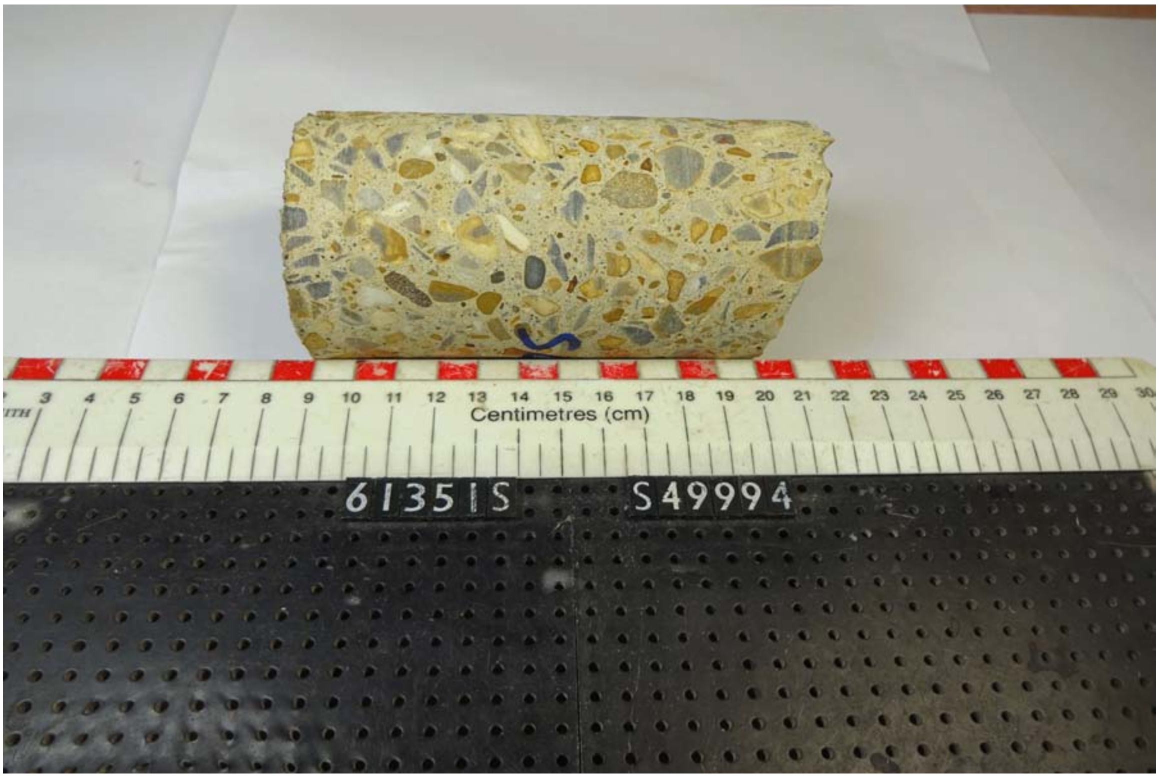
CONCRETE TEST RESULTS
BRIEF VISUAL EXAMINATION OF CORES

BS EN 12504-1:2009 and BS 1881:Part 120:1983 (withdrawn Dec 2003)

Sandberg Reference:	S49994		
Site Mark/Client Reference:	Core 1		
Details:	4th Floor Slab Edge Front		
Core Dimensions, as-received: - Average Diameter, mm - Minimum/Maximum Lengths, mm	 69 110-123	Compaction and Cracks: - Mean Excess Voidage, %[1] - Small Voids (0.5 to 3mm) - Medium Voids (3 to 6mm) - Large Voids (>6mm) - Honeycombing - Cracks	 2.0 Numerous Few Few None None
Aggregate: - Maximum Size, mm - Petrological Description² - Particle Shape² - Distribution of Materials	 12 Flint Irregular Even	Reinforcement: - Number of Bars - Diameter of Bars, mm - Axis-End, as received, mm	 None
Other Details:	Top: Rough as cast, cementitious slurry on surface. Bottom: Broken.		

ND = Not Determined. NA = Not Applicable.
[1] = To nearest 0.5%.
[2] = Terms according to BS812.

Note: BS 1881:Part 120:1983 was replaced in 2004 by BS EN 12504-1:2000. However this new standard does not include a method for visual examination although the method for assessing excess voidage is given in BS EN 12504-1:2009, National Annex NA4.2.



SANDBERG

UKAS TESTING 0262

61351/S/1

Appendix/Sheet

B/3

Date of Test

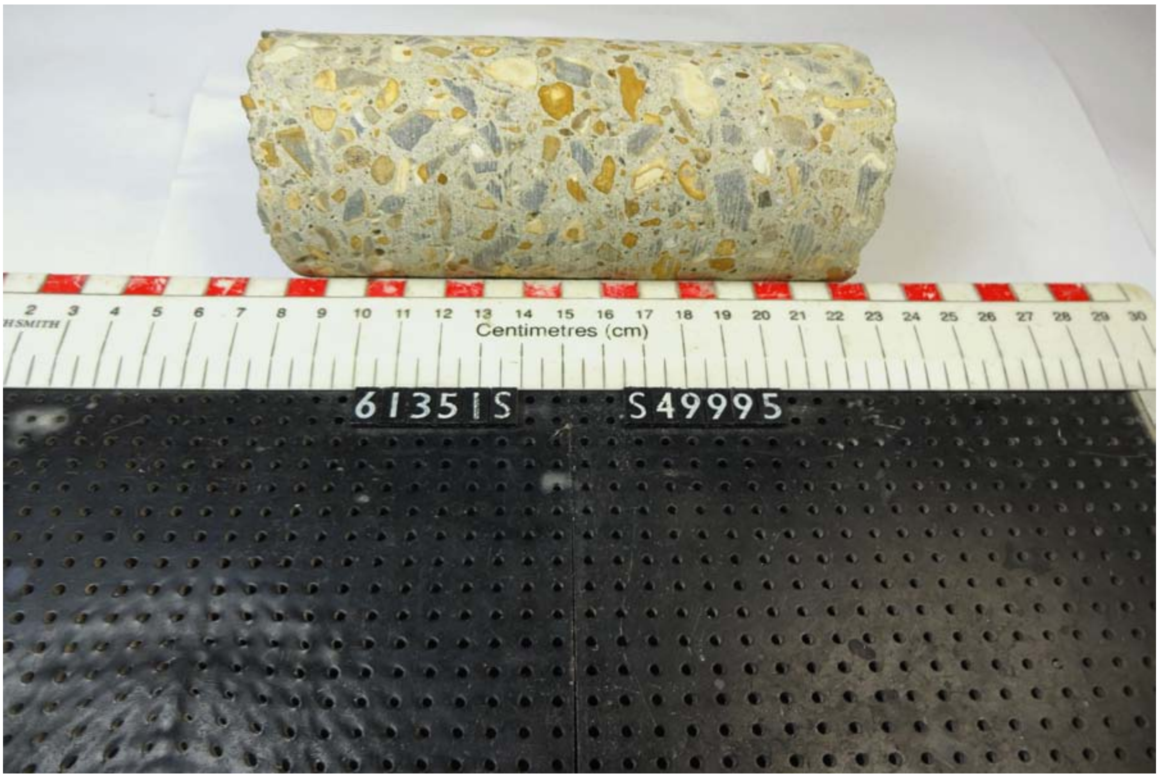
15/1/2018

CONCRETE TEST RESULTS
BRIEF VISUAL EXAMINATION OF CORES
BS EN 12504-1:2009 and BS 1881:Part 120:1983 (withdrawn Dec 2003)

Sandberg Reference:	S49995		
Site Mark/Client Reference:	Core 2		
Details:	3rd Floor Slab Edge Front		
Core Dimensions, as-received: - Average Diameter, mm - Minimum/Maximum Lengths, mm	 69 135-150	Compaction and Cracks: - Mean Excess Voidage, %[1] - Small Voids (0.5 to 3mm) - Medium Voids (3 to 6mm) - Large Voids (>6mm) - Honeycombing - Cracks	 2.0 Few Few None None None
Aggregate: - Maximum Size, mm - Petrological Description² - Particle Shape² - Distribution of Materials	 12 Flint Irregular Even	Reinforcement: - Number of Bars - Diameter of Bars, mm - Axis-End, as received, mm	 None
Other Details:	Top: Rough as cast, exposed aggregate, pink cementitious slurry on surface. Bottom: Broken.		

ND = Not Determined. NA = Not Applicable.
[1] = To nearest 0.5%.
[2] = Terms according to BS812.

Note: BS 1881:Part 120:1983 was replaced in 2004 by BS EN 12504-1:2000. However this new standard does not include a method for visual examination although the method for assessing excess voidage is given in BS EN 12504-1:2009, National Annex NA4.2.



SANDBERG

UKAS TESTING 0262

61351/S/1
Appendix/Sheet B/4
Date of Test 15/1/2018

CONCRETE TEST RESULTS
BRIEF VISUAL EXAMINATION OF CORES
BS EN 12504-1:2009 and BS 1881:Part 120:1983 (withdrawn Dec 2003)

Sandberg Reference:	S49996		
Site Mark/Client Reference:	Core 3		
Details:	2nd Floor Slab Edge Rear		
Core Dimensions, as-received: - Average Diameter, mm - Minimum/Maximum Lengths, mm	69 165-181	Compaction and Cracks: - Mean Excess Voidage, %[1] - Small Voids (0.5 to 3mm) - Medium Voids (3 to 6mm) - Large Voids (>6mm) - Honeycombing - Cracks	10.0 Numerous Numerous Numerous Full Depth None
Aggregate: - Maximum Size, mm - Petrological Description[2] - Particle Shape[2] - Distribution of Materials	1063 Flint Irregular Even	Reinforcement: - Number of Bars - Diameter of Bars, mm - Axis-End, as received, mm	None
Other Details:	Top: Rough as cast, exposed aggregate, pink cementitious slurry on surface. Bottom: Broken.		

ND = Not Determined. NA = Not Applicable.
[1] = To nearest 0.5%.
[2] = Terms according to BS812.

Note: BS 1881:Part 120:1983 was replaced in 2004 by BS EN 12504-1:2000. However this new standard does not include a method for visual examination although the method for assessing excess voidage is given in BS EN 12504-1:2009, National Annex NA4.2.

SANDBERG
CONSULTING ENGINEERS

INVESTIGATION INSPECTION
MATERIALS TESTING