concrete repairs limited

CONCRETE SURVEY REPORT FOR RIVERSIDE UNDERCROFT, 136-140 WAPPING HIGH ST

REPORT REF: S0980/WHS/CJO&C/01

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LEAD TECHNICIAN: D McGUIRE

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AUTHORISED:

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APPENDIX

INTRODUCTION

During February 2015, APA Concrete Repairs Ltd was employed by CJ O'Shea & Company Ltd to undertake a defects survey & testing to externally exposed reinforced concrete elements as part of the riverside undercroft at 136-140 Wapping High Street, Tower Hamlets, London, E1W 2RP.

Some testing had previously been undertaken by GBG Ltd on site, details of their finding is contained in GBG Report 3848 of June 2014.

Dr John Broomfield of Broomfield Consultants was employed to visit the above site (by CJ O'Shea & Company Ltd) and discuss the findings of GBG Report 3848 of June 2014 in relation to the NHBC warranty requirements. Subsequently Broomfield Consultants provided additional survey recommendations and a series of repair options for consideration.

APA undertook the following survey recommendations;-

1. On the Down-stand beam, between & behind the projecting curved arch features which are to be removed, undertake:

    - Half-cell potential survey along the beam and to soffit beams & columns.

    - Chloride profiles at depth increments of 5-25, 25-45, 45-65, 65-85mm in 4 No. locations between features and 4 No. locations behind features as well as Carbonation tests and cover depth at each location.

    - Measure cover depth and carbonation depth on other beams and columns that will remain externally exposed (3 No. measurements at each representative location, up to 4 No. locations).

2. Electrical continuity of new steel and old steel in chloride contaminated concrete which could form a galvanic couple and accelerate corrosion in the relevant beams and columns. Minimum 4 locations per element (up to 5 No. elements).

3. Identify concrete defects and prepare a Bill of Quantities for Concrete Repair.

APA completed the testing on site during Monday 23rd February through to Thursday 26th February 2015.

SITE LOCATION MAPS

136-140 Wapping High Street is situated next to Wapping railway station.

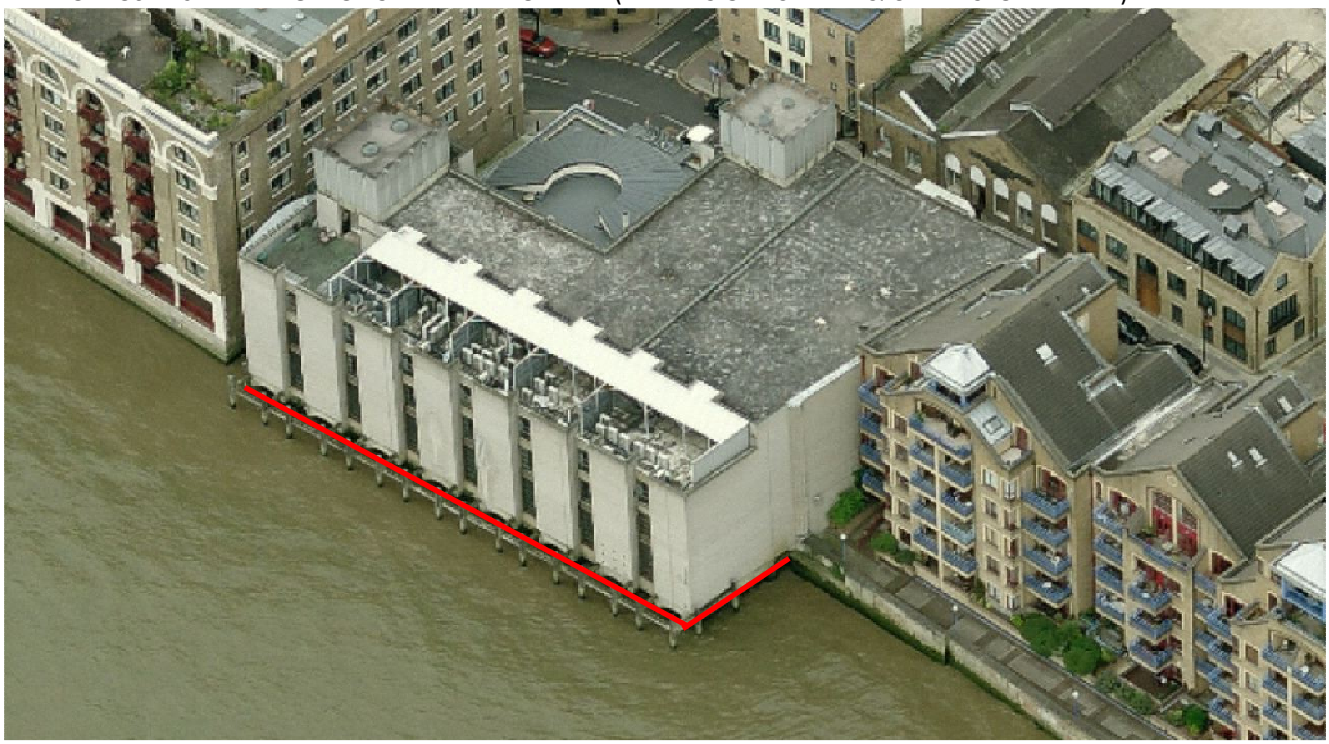
Address: 136-140 Wapping High Street, Tower Hamlets, London, E1W 2RP.

N.B. Orange star indicates the location 136-140 Wapping High Street.

N.B. Orange star indicates the location 136-140 Wapping High Street.

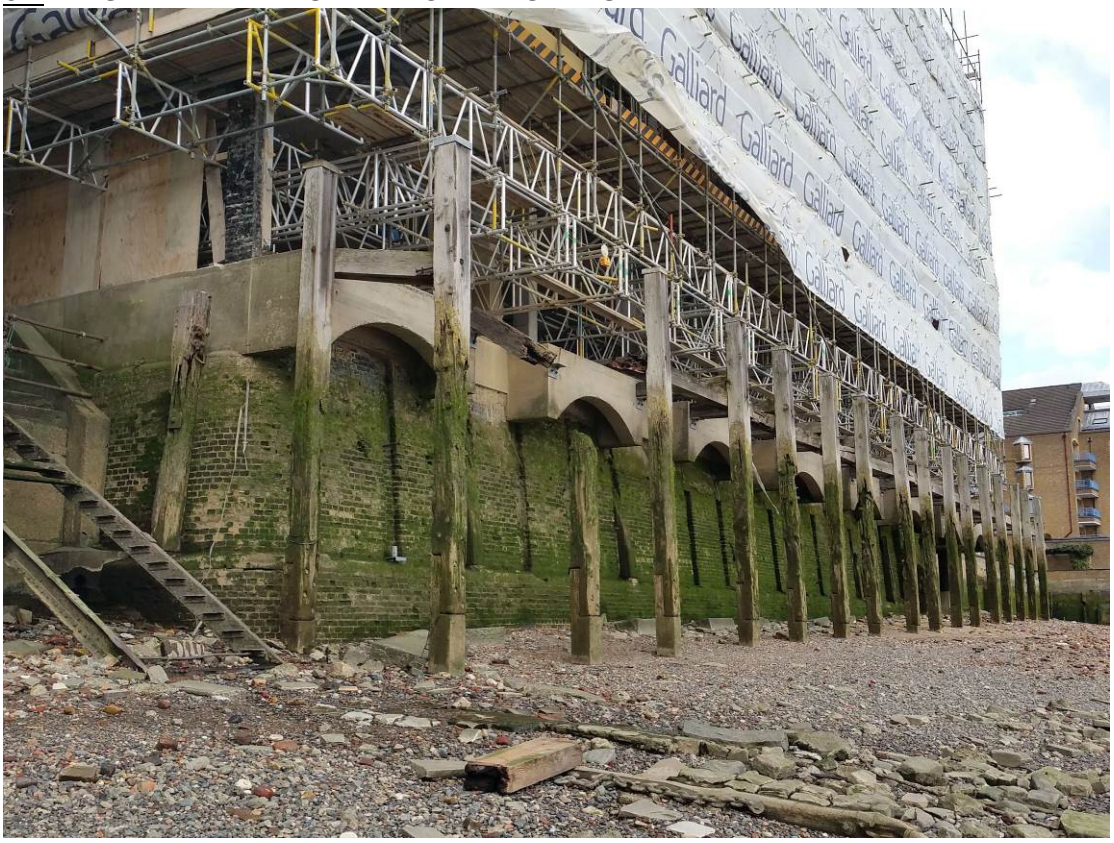
PLAN VIEW OF 136-140 WAPPING HIGH STREET AT LOW TIDE (EXTENTS OF RC BEAM & UNDERCROFT IN RED)

VIEW OF 136-140 WAPPING HIGH STREET AT HIGH TIDE (EXTENTS OF RC BEAM & UNDERCROFT IN RED)

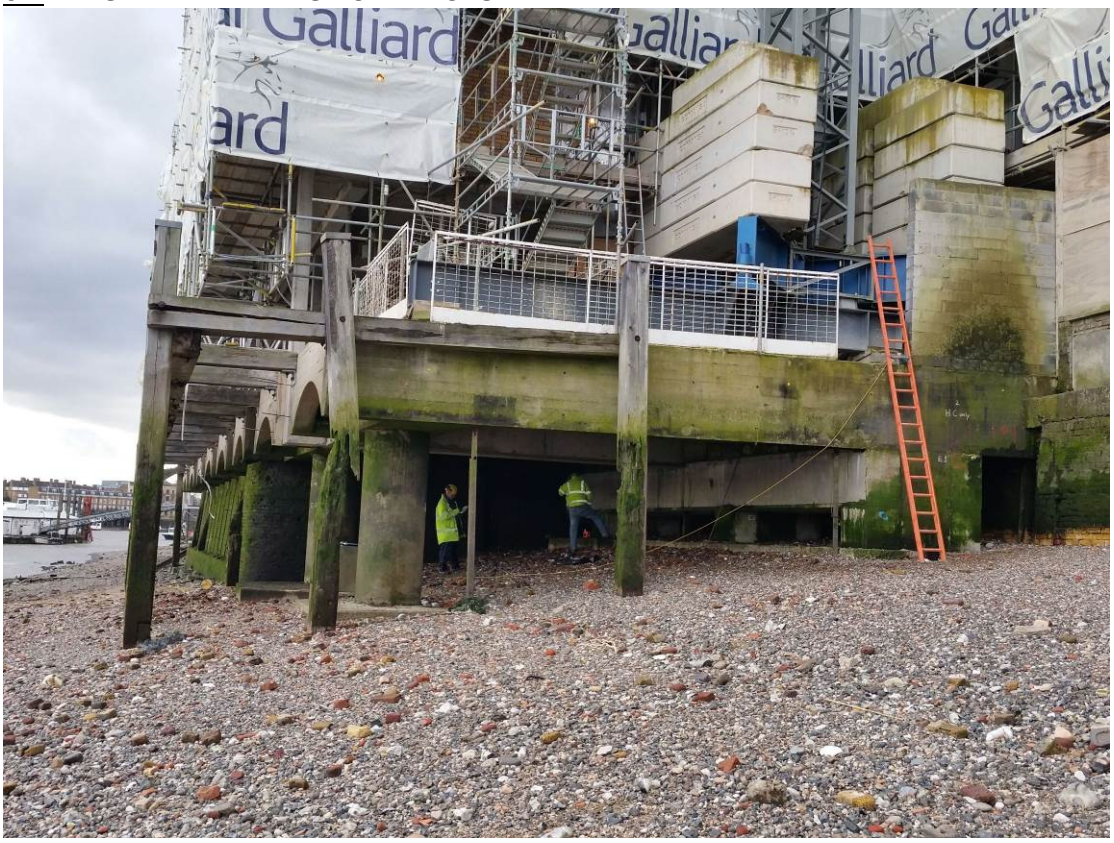


PHOTOGRAPHS

01. GENERAL VIEW OF RIVERSIDE FRONTAGE



02. GENERAL VIEW OF UNDERCROFT



03. UNDERCROFT – SOFFIT OF RC BEAM WITH EXPOSED TIE WIRES

04. UNDERCROFT – SOFFIT SLAB WITH SPALLED & DELAMINATED CONCRETE

05. UNDERCROFT – SOFFIT SLAB WITH EVIDENCE OF POOR COMPACTION

06. UNDERCROFT – SIDE OF RC BEAM WITH EXPOSED TIE BARS

07. UNDERCROFT – SIDE OF RC BEAM SHOWING CRACKS & LECHATE DEPOSITS

08. UNDERCROFT – LECHATE DEPOSITS ON SIDE OF RC BEAM

TESTING

Chloride Profiling

A sample node was selected at each of the twelve representative test locations. Concrete dust samples were extracted from 4 depth ranges from each of the nodes (5-25, 25-45, 45-65 & 65-85mm). The first 5mm of concrete dust was discarded.

Carbonation depth

A total of 16 No. locations were tested using Phenolphthalein solution. At each location a small hole (20mm dia) was drilled into the concrete and the freshly exposed concrete surfaces inside the drill hole were cleaned to remove surface dust before then applying the Phenolphthalein solution. The solution was left to react before then measuring the depth of carbonation, at each location.

Table 1.0 – Carbonation depth & chloride profiles

Test Site Ref:	**Location**	**Structural Element**	**Carbonation Depth** (mm)	**Chloride Ion Content (% by mass of cement)** Depth Range (mm)			
				5-25	**25-45**	**45-65**	**65-85**
TS 01	Side of Beam Between P1 & P2	RC Beam	**<1**	**0.68**	**0.63**	**0.43**	0.31
TS 02	Side of Beam at P2	RC Beam	**1**	**0.82**	**0.60**	**0.41**	0.30
TS 03	Side of Beam Between P3 & P4	RC Beam	**1**	**0.61**	**0.56**	**0.55**	**0.38**
TS 04	Side of Beam at P4	RC Beam	**<1**	**0.45**	**1.19**	**0.92**	**0.87**
TS 05	Side of Beam Between P5 & P6	RC Beam	**1**	**0.94**	**0.58**	**0.88**	**0.42**
TS 06	Side of Beam at P6	RC Beam	**3**	**1.12**	**1.14**	**1.06**	**0.88**
TS 07	Side of Beam Between P7 & P8	RC Beam	**3**	0.31	**0.36**	0.25	0.29
TS 08	Side of Beam at P8	RC Beam	**<1**	**1.00**	**0.84**	**0.56**	**0.47**
TS 09	Soffit of Beam Between P7 & P8	RC Beam	**<1**	**0.76**	**0.89**	**0.61**	**0.60**
TS 10	Soffit of Beam at P8	RC Beam	**3**	**1.08**	**1.05**	**0.89**	**0.72**
TS 11	Side of Beam at West Return	RC Beam	**<1**	**1.35**	**0.86**	**0.48**	**0.37**
TS 12	Beam Support (Pier 2)	RC Column	**<1**	**1.68**	**1.15**	**0.99**	**0.92**

N.B. **-** Assumed cement content of 14% used for calculations.
- Values in RED indicate chloride ion levels that are high and therefore present a high risk of corrosion in damp reinforced concrete where the pH is <10 (with reference to BRE Digest 444 pt2, risk table for 40-year old concrete structures).

See appendix B. For laboratory certificates for Chloride ion content

Table 2.0 – Additional Carbonation depth & cover measurements

Test Site Ref:	Location	Structural Element	Carbonation Depth (mm)			Concrete Cover Depth (mm)		
			#1	#2	#3	#1	#2	#3
E1	Beam Support (Pier 3 East face)	RC Column	2	3	1	59	84	83
E2	Side of South Facing Beam	RC Beam	<1	<1	<1	43	15	17
E3	Beam Support (Pier 2 East face)	RC Column	1	<1	<1	40	144	28
E4	Column No. 1	RC Column	<1	<1	<1	78	79	76

Half-cell Potential Mapping

Half-cell potentials measurements were taken from across the seawall at each test location. Various mapping grids were used to suit each type of location.

Small sections of reinforcement were exposed in the seawall, close to the mapping areas, using a light duty hydraulic breaker. Doing so allowed good electrical contact between the reinforcement and the Half-Cell equipment. The condition of reinforcement was observed at each pocket breakout location. All breakouts were reinstated with a cementitious hand applied repair mortar prior to leaving site.

All values are measured in millivolts (mV)

A Traffic Light System has been implemented to give a visual indication corrosion risk ranges from half-cell data obtained:

Red = Value more negative than -350mV (<90% probability of corrosion)

Orange = -200 to -350mV (Corrosion activity is uncertain)

Green = Value more negative than -200mV (Low probability of corrosion)

Half-cell potentials were measured using a calibrated *Hammond Concrete Digital Half Cell Unit*.

Concrete Cover Mapping

Concrete cover measurements were taken at each test location. Various mapping grids were used to suit each type of location. All concrete cover measurements were taken using a calibrated *Elcometer*.

Concrete cover specifications vary depending on a range of variables, for example the maximum size of aggregate specified for inclusion in the concrete mix and the type of conditions that the concrete is likely to be exposed to.

The original concrete design specification was unknown to APA at the time of reporting, however the undercroft and surrounding elements are frequently exposed to brackish tidal water spray and is within a tidal zone, these are 'conditions of exposure' that are considered 'most severe' within BS 8110 Structural Use of Concrete. The same BS indicates a Nominal cover of 50mm in order to meet durability requirements. (Reference to BS 8110-1:1997 Structural Use of Concrete – Part 1: Code of practice for design and construction).

Cover values that are less than 50mm have been highlighted in Red.

Continuity Testing

Electrical continuity was tested between new steel and old steel embedded within the various reinforced concrete elements at representative locations using a calibrated Megger Meter.

Four locations were tested on five elements, the results were as follows:

#1 - South Facing Elevation of New Beam to South Facing Elevation of Original Beam

1.27Ω, 1.27Ω, 0.88Ω, 1.38Ω

#2 - South Facing Elevation of New Beam (East side of centre beam) to West Facing Elevation of Original Down stand Beam

EXCEDED MEASURABLE RANGE, 1.33Ω, 0.91Ω, 1.21Ω

#3 - South Facing Elevation of New Beam (West side of centre beam) to South Facing Elevation of Original Beam

1.39Ω, 0.32Ω, 0.33Ω, 0.14Ω

#4 - Original pier (centre) to South Facing Elevation of New Beam

<1Ω, <1Ω, <1Ω, <1Ω

#5 - North Facing Elevation of New Beam to original soffit slab adjacent

0.74Ω, 1.24Ω, 0.70Ω, 0.65Ω

See next page for Cover mapping & Hal-cell results

Cover Mapping (mm)

Half-cell (mV)

TS01

62	55	59	55	55
60	59	62	62	66
59	58	58	58	58

-151	-165	-142	-133	-112
-179	-155	-148	-120	-139
-188	-162	-156	-141	-134

TS02

85	68	68	68	69	51	83	85
58	61	62	65	66	75	70	81

-266	-251	-187	-197	-179	-173	-194	-181
-180	-175	-191	-218	-188	-207	-219	-224

TS03

112	101	85	85	82
113	108	108	96	122
157	141	141	138	143

-137	-143	-144	-145	-160
-182	-176	-191	-197	-176
-256	-262	-246	-247	-238

TS04

133	120	101	125	106	98	97	73
129	122	87	105	108	104	81	65

-175	-182	-166	-180	-182	-192	-195	-194
-286	-248	-254	-293	-257	-244	-257	-254

TS05

26	25	22	23	20
53	47	50	51	57
45	50	56	60	62

-150	-151	-159	-166	-182
-175	-190	-180	-194	-195
-266	-281	-276	-266	-282

TS06

57	54	55	48	54	56	66	77
85	82	79	81	80	88	80	81

-261	-247	-260	-243	-247	-252	-251	-239
-236	-231	-253	-258	-246	-245	-256	-245

TS07

25	22	20	20
37	41	30	35
45	47	46	47
55	46	52	54

-210	-256	-263	-286
-269	-245	-283	-291
-194	-277	-283	-282
-329	-324	-328	-311

TS08

44	41	46	51
50	49	67	61
47	48	51	55
36	36	39	37

-312	-356	-381	-375
-308	-364	-384	-354
-332	-340	-356	-357
-433	-450	-377	-358

TS09

57	44	59	30
55	47	44	39
48	52	38	54
64	62	38	35

-422	-374	-338	-333
-390	-372	-345	-378
-380	-367	-356	-377
-411	-371	-347	-366

TS10

60	38	52	47
72	52	48	77
42	40	44	50
42	40	43	46

-246	-260	-242	-200
-231	-237	-192	-219
-231	-244	-222	-234
-212	-237	-219	-254

TS11

70	69	82	101
110	73	76	104
93	71	74	157
88	51	76	126

-306	-337	-310	-300
-327	-356	-347	-290
-346	-356	-347	-290
-338	-333	-304	-288

ADDITIONAL HALF-CELL # 2

-463	-491	-475	-490
-411	-433	-475	-485
-394	-410	-450	-469
-382	-405	-487	-486

ADDITIONAL HALF-CELL # 1

-304	-284	-256	-281
-262	-272	-252	-282
-303	-265	-260	-346
-262	-279	-278	-338

N.B

No Half-cell survey was undertaken at TS12 due to site constraints.

APPENDIX A.

BILL OF QUANTITIES

136-140 Wapping High Street, Tower Hamlets - Riverside Undercroft

Item	Description	Quantity	Unit	Rate £	Amount £
	CONCRETE REPAIRS				
	WITHIN AREAS OF CEILINGS OR SOFFITS OF SLABS				
	Depth exceeding 25mm but not 50mm				
A	area not exceeding 0.01m²	3	No		
B	area exceeding 0.01m² but not 0.05m²	11	No		
C	area exceeding 0.05m² but not 0.10m²	3	No		
D	area exceeding 0.10m² but not 0.25m²	1	No		
E	area exceeding 0.25m² but not 0.50m²	1	No		
F	area exceeding 0.50m² but not 1.00m²	1	No		
	Areas exceeding 1.00m²				
G	area A1	1.68	m²		
	SIDES & SOFFITS OF BEAMS & LINTELS				
	Depth exceeding 25mm but not 50mm				
H	area not exceeding 0.01m²	4	No		
I	area exceeding 0.01m² but not 0.05m²	1	No		
	CRACK REPAIRS				
	IN SURFACES OF WALLS, COLUMNS, ETC.				
	After cutting out, width 10mm, depth 20mm				
J	crack length exceeding 300mm but not 1.00m	9	No		
	PORE/BLOW HOLE FILLERS				
	WALLS, COLUMNS etc.				
K	width not exceeding 150mm	0.8	m		
L	width over 150mm not exceeding 300mm	0.9	m		
	CEILINGS, BEAMS etc.				
M	width exceeding 300mm	1.75	m²		
N	isolated surfaces of ceilings (In No.)	0.5	m²		
	MISCELLANEOUS REPAIRS				
	WITHIN AREAS OF CEILINGS OR SOFFITS OF SLABS				
	Depth exceeding 25mm but not 50mm				
O	Repair Type A - area not exceeding 0.01m²	12	No		
P	Repair Type A - area exceeding 0.01m² but not 0.05m²	1	No		
	SIDES & SOFFITS OF BEAMS & LINTELS				
Q	Repair Type B - length exceeding 300mm but not 1.00m	7	No		
				Carried to collection	£

APPENDIX B.

LABORATORY CERTIFICATE

UKAS TESTING
0320

NICHOLLS COLTON
ANALYTICAL

Nicholls Colton & Partners Limited
7-11 Harding Street, Leicester, LE1 4DH
Tel: 0116 253 6333. Fax: 0116 251 4709
e-mail: testing@nicholls-colton.co.uk
website: www.nicholls-colton.co.uk

TEST REPORT

BS1881 CHLORIDE CONTENT

Concrete Testing – 136-140 Wapping High Street, London

Report no. L15/0470/APA/001 – Amendment A	
Order reference: S0980 M6190	Date of testing: 21/03/2015
Date of receipt: 11/03/2015	Date of issue: 23/03/2015

NCA sample reference:	Client sample identification:	Sample type	Sample Depth (mm)	**Chloride Ion Content (% by mass of concrete)**	**Chloride Ion Content (% by mass of cement)**
1	TS01	Concrete Dust	5-25	**0.120**	**0.86**
2		Concrete Dust	25-45	**0.088**	**0.63**
3		Concrete Dust	45-65	**0.060**	**0.43**
4		Concrete Dust	65-85	**0.043**	**0.31**
5	TS02	Concrete Dust	5-25	**0.114**	**0.82**
6		Concrete Dust	25-45	**0.084**	**0.60**
7		Concrete Dust	45-65	**0.057**	**0.41**
8		Concrete Dust	65-85	**0.042**	**0.30**
9	TS03	Concrete Dust	5-25	**0.085**	**0.61**
10		Concrete Dust	25-45	**0.078**	**0.56**
11		Concrete Dust	45-65	**0.077**	**0.55**
12		Concrete Dust	65-85	**0.053**	**0.38**
13	TS04	Concrete Dust	5-25	**0.064**	**0.45**
14		Concrete Dust	25-45	**0.166**	**1.19**
15		Concrete Dust	45-65	**0.129**	**0.92**
16		Concrete Dust	65-85	**0.122**	**0.87**
17	TS05	Concrete Dust	5-25	**0.131**	**0.94**
18		Concrete Dust	25-45	**0.081**	**0.58**
19		Concrete Dust	45-65	**0.123**	**0.88**
20		Concrete Dust	65-85	**0.059**	**0.42**

L15/0470/APA/001

NCA sample reference:	Client sample identification:	Sample type	Sample Depth (mm)	**Chloride Ion Content (% by mass of concrete)**	**Chloride Ion Content (% by mass of cement)**
21	TS06	Concrete Dust	5-25	**0.157**	**1.12**
22		Concrete Dust	25-45	**0.160**	**1.14**
23		Concrete Dust	45-65	**0.148**	**1.06**
24		Concrete Dust	65-85	**0.123**	**0.88**
25	TS07	Concrete Dust	5-25	**0.043**	**0.31**
26		Concrete Dust	25-45	**0.050**	**0.36**
27		Concrete Dust	45-65	**0.035**	**0.25**
28		Concrete Dust	65-85	**0.041**	**0.29**
29	TS08	Concrete Dust	5-25	**0.140**	**1.00**
30		Concrete Dust	25-45	**0.118**	**0.84**
31		Concrete Dust	45-65	**0.078**	**0.56**
32		Concrete Dust	65-85	**0.065**	**0.47**
33	TS09	Concrete Dust	5-25	**0.106**	**0.76**
34		Concrete Dust	25-45	**0.125**	**0.89**
35		Concrete Dust	45-65	**0.086**	**0.61**
36		Concrete Dust	65-85	**0.084**	**0.60**
37	TS10	Concrete Dust	5-25	**0.151**	**1.08**
38		Concrete Dust	25-45	**0.147**	**1.05**
39		Concrete Dust	45-65	**0.125**	**0.89**
40		Concrete Dust	65-85	**0.100**	**0.72**
41	TS11	Concrete Dust	5-25	**0.189**	**1.35**
42		Concrete Dust	25-45	**0.120**	**0.86**
43		Concrete Dust	45-65	**0.067**	**0.48**
44		Concrete Dust	65-85	**0.052**	**0.37**

L15/0470/APA/001

NCA sample reference:	Client sample identification:	Sample type	Sample Depths (mm)	**Chloride Ion Content (% by mass of concrete)**	**Chloride Ion Content (% by mass of cement)**
45	TS12	Concrete Dust	5-25	**0.235**	**1.68**
46		Concrete Dust	25-45	**0.162**	**1.15**
47		Concrete Dust	45-65	**0.139**	**0.99**
48		Concrete Dust	65-85	**0.129**	**0.92**

NOTES:
1. Testing was in accordance with BS 1881: Part 124: 1988 Clause 10.2 using potentiometric titration.
2. A cement content of 14.0% was used in the calculation of chloride ion content.
3. Samples received were smaller than required by Clause 3.2 BS 1881 : Part 124 : 1988.
4. Samples were not passed over the 150micron BS Test Sieve before testing.
5. Quality control samples are tested with each batch of samples.

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J. Gane
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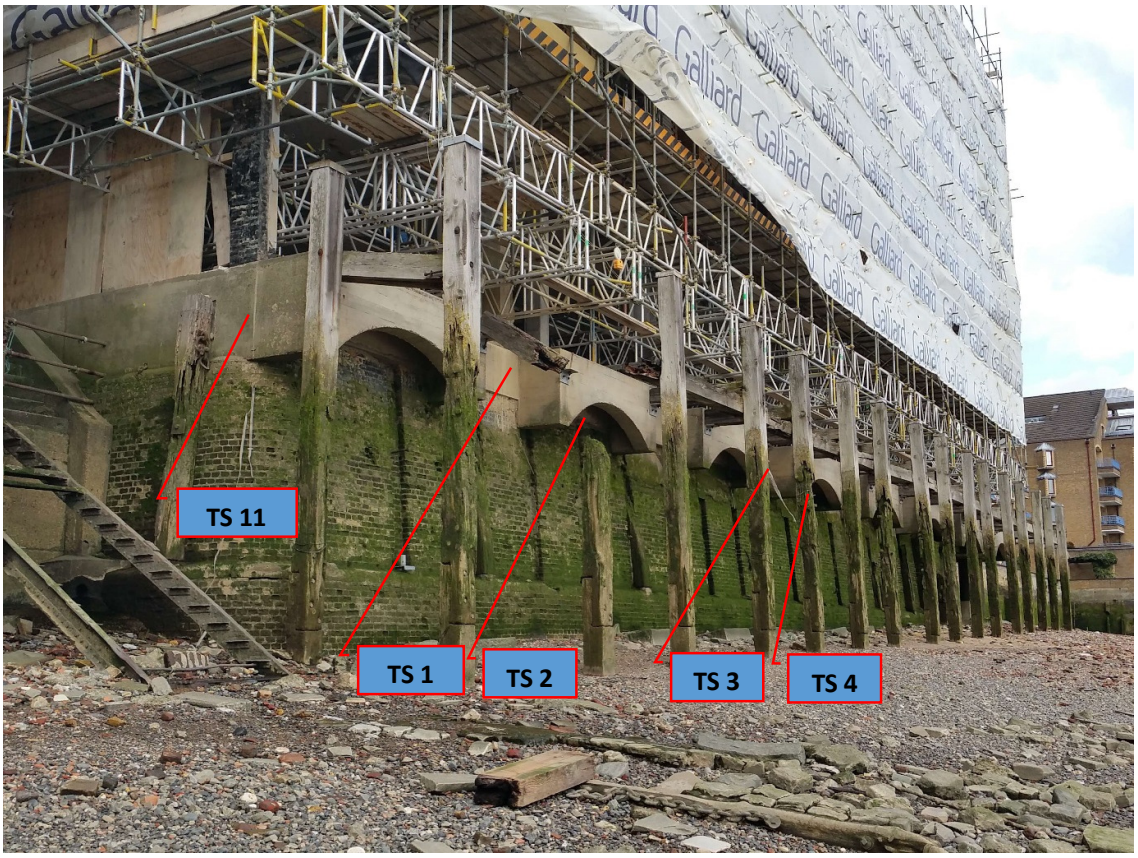
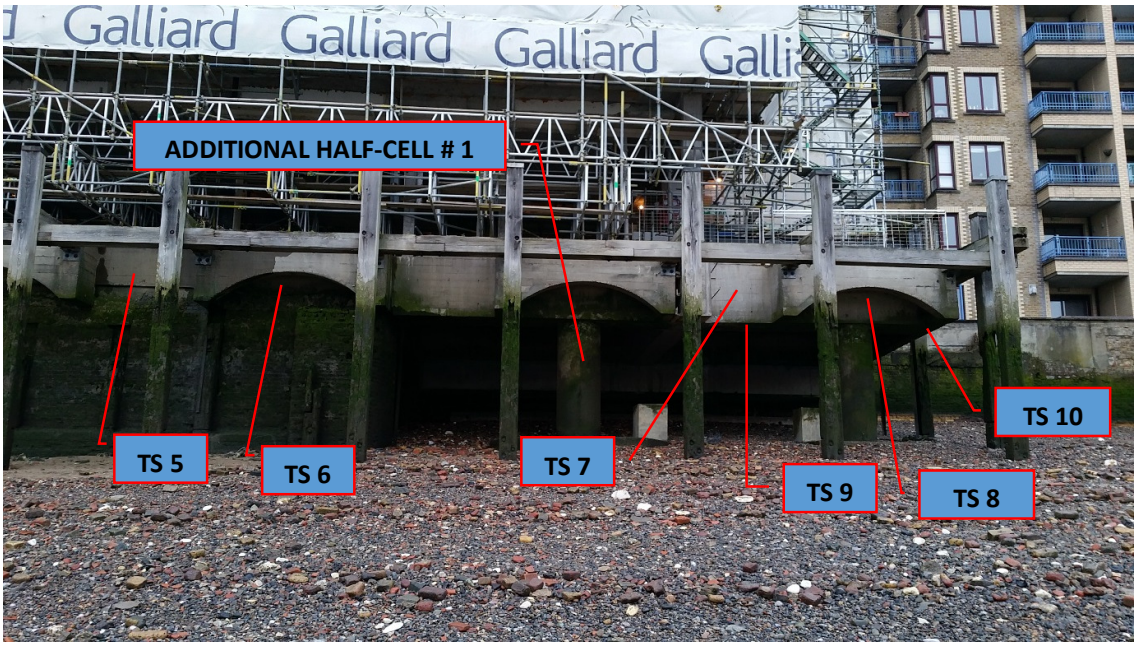
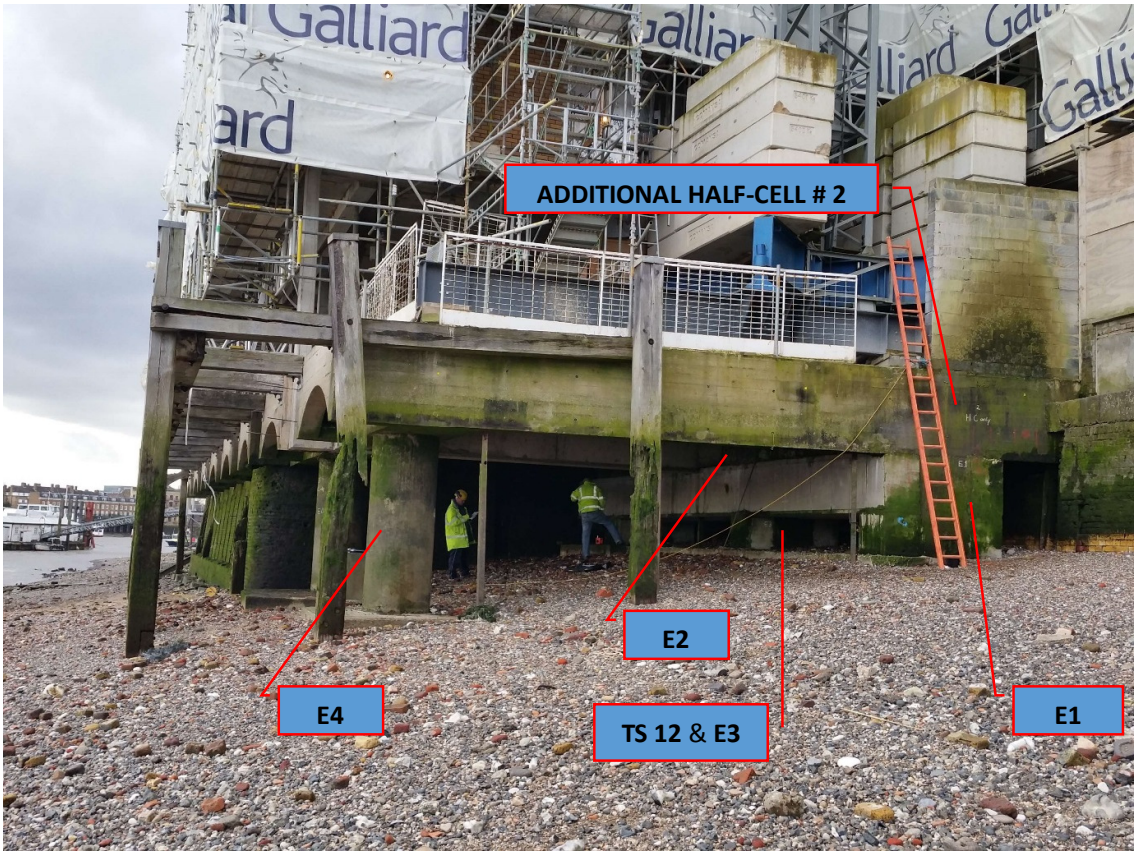
APPENDIX C.

INDICATIVE TEST LOCATIONS


TS 11
TS 1
TS 2
TS 3
TS 4


Galliard Galliard Galliard
ADDITIONAL HALF-CELL # 1
TS 5
TS 6
TS 7
TS 9
TS 8
TS 10


ADDITIONAL HALF-CELL # 2
E2
E4
TS 12 & E3
E1

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