INTRUSIVE INVESTIGATIONS

AT

SPACEPORT BUILDING, SEACOMBE

JOB NO: Q20 - 004

Prepared for:

Liverpool City Region Combined Authority
1 Mann Island
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Prepared by:

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Date: 17th February 2020

LIABILITY AND CONFIDENTIALITY

This Survey Report may be relied upon by the Client, Liverpool City Region Combined Authority to whom we owe a duty of care. Our report must not be passed for information, or for any other purpose, to any third party without our express written consent, which consent will not be unreasonably withheld or delayed. Such consent, however, will not entitle the third party to place any reliance on the report and shall not confer on any third party any benefit or right pursuant to the Contracts (Rights of Third Parties) Act 1999.

CONTENTS

1 INTRODUCTION

1.1 Background Information

Conditions of damage to the external Portland stone faced colonnade at the Spaceport Building in Seacombe, Wallasey such as cracking, delaminating and spalling of Portland stone material was brought to the attention of the Client.

It was determined that intrusive investigation work needs to be carried out to aid in any condition assessment exercise, with the prospect that further investigation work may be necessary in order to determine the most suited and cost effective remedial solution in order to address the current and future health and safety issues and in particular to ensure ongoing durability and serviceability of the structure concerned.

Following various discussions and correspondence as to the requirements of the investigations required a quotation was submitted by ***Specialist UK Restorations Ltd*** on the 10th January 2020 for the works concerned.

That quotation was accepted, and instructions were given to ***Specialist UK Restorations Ltd*** by ***Liverpool City Region Combined Authority*** by way of an e-mail dated the 29th January 2020 in order to proceed with the investigation works concerned which includes the processes detailed in ***Section 2.0*** of this Report

No Instructions have been provided for undertaking any works of a ***"temporary make safe"*** nature which may subsequently be deemed necessary.

No drawings of original construction and/or historical records concerning the maintenance of the structure have been made available at the time of writing this report save that Report prepared by Merseytravel dated the 09th October 2019.

1.2 The Intrusive Investigations and Material Testing

Open up two areas of the Portland Stone facing in two different locations and one area of the column in order to determine the underlying construction detail and condition of same. Provide schematic record drawing and dimensional information showing the underlying construction detail together with photographs for inclusion in subsequent Reporting.

Chloride Analysis: The removal of a single depth dust sample from the underlying reinforced concrete construction at a column position for analysis all strictly in accordance with the relevant ***Building Research Establishment*** (BRE) and ***British Standards*** (BS) publications to determine the chloride-ion concentration. The sample is to be submitted to an independent ***UKAS*** testing house. Provision of a test certificate and analysis table in accordance with ***BRE*** Guidelines to be included in Reporting.

Carbonation Depth Testing: On-site testing of the underlying reinforced concrete construction at the column subject to intrusive investigations all strictly in accordance with the relevant ***BRE*** and ***BS*** publications to determine the extent of the carbonation front and recording of same on a schedule for inclusion in Reporting.

Portland Stone Cover to Embedded Steel: Random cover meter survey to establish and record the location of any embedded steel fixings and the like embedded in the Portland stone construction prior to the intrusive investigations, all strictly in accordance with ***BS 1881 Part 204.*** Any relevant information obtained as a result of the cover meter survey to be included in Reporting.

Structural Integrity: It is beyond the scope of the enquiries of this Intrusive Investigation to consider any elements of damage in relation to the structural integrity of the structure, either in part, in the locations where the damage is recorded, or in relation to the structure as a whole.

1.3 Procedures

The physical elements of the on-site survey work commenced on Monday the 3rd February 2020 and were carried out progressively over a period of approximately 3 working days and was completed on the evening of Wednesday the 5th February 2020.

All works were carried out in accordance with our normal specification and/or method statements.

All works were carried out in compliance with statutory, company and client safety policies and regulations.

Other methods and procedures employed during the works are detailed elsewhere in this report.

Other methods and procedures employed during the works are detailed elsewhere in this report as applicable.

On-site testing was carried out in accordance with the relevant parts of ***BS 1881*** and the appropriate ***BRE Documents.***

An independent testing laboratory with appropriate ***UKAS*** accreditation carried out analysis of samples.

The various construction elements were accessed by means of mobile alloy towers and hop ups were applicable.

2 SUMMARY OF RESULTS AND FINDINGS

2.1 Introduction

This section of the report summarises the results and findings of on-site and laboratory Concrete Tests.

The site records and laboratory results are included in ***Appendix 'A' – Site Records and Testing Results***.

2.2 Previous Repair Works

No information, with respect to previous repair and maintenance works to the external Portland Stone colonnade concerned have been made available at the time of writing this report.

2.3 Initial Observations

General Description

We understand that the building was constructed in the early 1930's and is listed by Historic England, Grade II. It is a steel framed building with sections of flat and pitched roof, external brick walls and an impressive Portland stone faced colonnade which was built as a ferry terminus with an associated carpark, bus terminus, workshops and offices.

The structure is located on a level site which is generally of a rectangular footprint and is bound by Victoria Place to the North and South and overlooks the Pier Head and the River Mersey at Seacombe in Wallasey.

The colonnade includes the canopy and it's supporting classically designed arrangement of columns that stretch across the front of the building. It also includes a metal balustrade and 3 no. original Art Deco lighting columns. These sit at the front of the canopy, surmounting the top of the stone-faced canopy beam. There is also an identical lighting column over the colonnade in front of the ferry terminal building and there is a further one at the junction between the two buildings.

The roof above the colonnade is a flat roof, covered with bitumen felt and with polycarbonate roof lights. There are parapet walls to the perimeter which are in-situ cast concrete with a render finish.

We also understand that in 2001, extensive repairs were carried out to the beams that lie behind the columns and which support the canopy roof and its rooflights.

Each column comprises 4 separate circular pieces, a separate capitol and base and all carved in solid Portland stone set on top of each other and shaped with a slight entasis (narrowing towards the capital). It is assumed that these are held together in the traditional manner – with a non-ferrous dowel at their centres. Most of the columns appear to be in a reasonable condition with some displaying deeper erosion damage than others but none to the extent that would give immediate rise for concern. It has been noted that a column at the corner of the junction with the adjoining ferry terminal had split.

The entablature (the horizontal member spanning between columns) is faced with Portland stone and is cracking in numerous places. We understand that assumptions have been made that it has a core of steel from which the stone facing is supported and will need to be confirmed by an intrusive investigation to determine its actual construction.

We also understand that of particular concern is the risk of sections of stone shearing off and falling onto the public space below particularly during the winter, and consideration has been given for some means of netting the affected areas to remove the risk of injury.

2.4 Visual Inspection of the Portland Stone Construction

The Visual Inspection recorded several different types of damage to a number of areas of the Portland stone. It is almost certain that the presence of deleterious materials and poorly executed previous repairs to the accessible Portland stone surfaces of all surveyed components will have prevented the recording of all damage present.

The findings are discussed in the following paragraphs: -

Portland Stone Construction Quality: We have noted that **t**here appears to be a number of defects which are more likely to be associated with the overall quality of the construction which may subsequently turn out to be more widespread than first thought. These in the main are concerned with deep erosion damage to the face of the Portland stone in localised areas, cracking in multiple locations, corrosion staining in localised areas, inadequate water tightness measures to the rear face of the Portland stone cornice, voiding in joints with vegetation, moss and litchen growths and the like.

Rust Staining in Portland Stone: The most likely cause of the identified incidences of rust staining are thought to be related to the corrosion of hidden embedded steel.

Moss & Litchen Growths: There is widespread moss and lichen growths in the horizontal joints of the projecting cornice. Contrary to popular belief lichen, moss and the like can cause damage to Portland stone surfaces. Moss and in particular lichen, will capitalise on any defect that there may be on the surface of the material, such as small (micro) cracks, pin holes and the like. Whilst moss is a simple plant form that doesn't have a root or a means to suck up or move water around inside its form, it absorbs moisture directly creating damp and moisture ladened surfaces which can be prone to frost damage. Lichen is a composite organism and can survive the very harshest of climate conditions. It develops roots which can develop into micro/macro pores in the stones surface resulting in the slow and ongoing expansion which progressively erodes the surface of the stone which increases the materials permeability, resulting in progressive cyclic weathering degradation.

Failed Previous Repairs: A number of poorly executed and/or failed previous repairs have been recorded in the Portland stone construction. No information is currently available as to what type of repair system has been used in the past to repair same. Repairs that have previously been made appear to have failed in a number of locations due to poor workmanship and/or inadequate specifications for repair methods and materials.

Cracking: Varying forms of cracking have been identified in the Portland stone construction. Knowledge of the history of the cracking is required in order to speculate on the cause(s) of this type of damage. However, we are of the view that the majority of the cracks observed are more likely to be associated with corrosion in hidden embedded steel as opposed to other causes.

Delaminating Portland Stone: Delaminating Portland stone facing has been recorded in the entablature which spans across the columns. Hollow areas of stone could be the result of poor construction and/or repair methods, although they are most often found to be associated with the corrosion of underlying steel sections and can be the precursor to spalling.

2.5 Intrusive Investigations

Intrusive investigations were carried out in three locations in order to reveal the underlying construction and condition of same. Refer to Ariel view drawing included in the Report showing the locations.

Location 1 comprised of the removal of a section of facing stone located at the head of the column in order to fully reveal the underlying construction detail, refer to the sectional drawing, photographs and descriptions included in the Report.

Location 2 comprised of the removal of a section of facing stone located at the head of the column in order to fully reveal the underlying construction detail. The underlying construction detail was similar in all respects to location 1 albeit in this instance we revealed the type and condition of the metal fixing in the vertical joint. We also carried out an intrusive investigation to the column in this location which comprised of the removal of a section of the Portland stone cladding in order to fully reveal the underlying construction and condition of same. Refer to the photographs and descriptions included in the Report.

2.6 Chloride Analysis of Concrete Samples

Introduction

It was considered prudent to obtain samples from the concrete core to the column subject to opening up works in order to determine the presence of chloride ions.

The presence of chloride ion in concrete above certain concentrations, can stimulate the corrosion of steel.

Chloride can exist in the concrete by introduction as part of the mix ingredients of the concrete prior to setting (***Cast-in Chlorides***) i.e. contaminated aggregates, admixtures and the like or by introduction during the life of the component through the environment (***Migratory Chlorides***). The two most common sources of Migratory Chlorides are from ***airborne salts*** (associated with structures situated at coastal regions) and ***de-icing salts***.

British Standards

In current ***British Standards***, limits are placed on chloride concentrations in admixtures and on the acceptable amount of natural chloride in aggregates. At present, ***95 %*** of the test results should show a chloride content of the concrete mix not greater than ***0.35*** expressed as percentage of chloride ion by weight of cement; ***none of the results*** should be greater than ***0.50 %.***

Of the randomly selected location sampled from the in-situ concrete core of the column subject to intrusive investigations we found that the sample returned a testing result greater than ***0.35%*** chloride ion by weight of cement and further with a test result greater than ***0.50%,*** placing this species outside current British Standards.

Building Research Establishment

Additionally, the ***Building Research Establishment***, in their ***Digest 444***, suggest that ***corrosion risk*** in relation to chloride ion concentration can be placed into various categories, which are detailed in the ***Analysis Table within Appendix A*** of this report.

In order to calculate corrosion risk in accordance with BRE Digest 444 one needs to have accurate and factual information concerning concrete alkalinity, percentage of chloride ion by weight of cement, cover concrete depth to reinforcement and an understanding of the environmental conditions present in each location sampled, as well as those matters which are associated with concrete quality.

The information supplied by the BRE however, must be treated with ***some caution***, in that the values given are: -

- Relative to the presence of pre-hydration chlorides in either carbonated or non-carbonated concrete – the chlorides are described as ***cast-in*** and may have been used as an admixture or, as a result of an aggregate with unacceptably high chloride content. In either case, up to 90% of the chloride may be chemically bound.
- Relative to the presence of surface migratory chlorides in non-carbonated concrete – where chlorides are present in carbonated concrete, the values in relation to corrosion risk are likely to be ***higher***, with the resultant likelihood of an ***early effect***, in terms of corrosion.

The Analysis Table included within Appendix A summarises the Test Certificate, considering the ***Estimated Risk of Steel Reinforcement Corrosion*** with respect to the sample location, associated with carbonation in relation to depth of concrete cover and ***cast-in*** chloride content in both ***dry*** and ***damp conditions***.

Although it is evident that a number of the recorded levels of chloride ion are in excess of those permitted by current codes as laid down in ***British Standards***, the above categorisations of results must be considered in relation to the ***origins*** of any chloride ions as suggested by ***BRE Digest 444.***

2.7 Carbonation Depth Testing

A further consideration of defects, in relation to the corrosion of steel reinforcement, is given in relation to the depth of the carbonation front which has been established in the concrete core material located in the column. The recorded carbonation result is also considered in relation to the depth of concrete cover over the embedded steel reinforcement where known.

Carbonation is generally an attack on the concrete by neutralising the high pH level of the cement binder. This is caused by the reaction of the carbon dioxide in the atmosphere with the hydroxyl content of the concrete.

In the event that the carbonation front is found to have extended up to or beyond the level of the embedded steel reinforcement, the alkalinity of the concrete in these areas can be assumed to be at such levels that the passivation of the steel reinforcement is at risk.

From the tabulated results of the ***Carbonation Depth Testing included in the Analysis Table within Appendix A*** of this report it can be seen that the carbonation depth of the in-situ concrete in the column subject to intrusive investigations varied from ***25mm to 30mm*** and when compared with the variable levels of concrete cover to embedded steel recorded in the locations which was the subject of measurement, the carbonation front ***had extended*** up to or beyond the embedded steel in the area subject to sampling.

2.8 Concrete Cover to Embedded Reinforcement

The results of the concrete cover depth of embedded reinforcement is summarised in the Analysis Table within Appendix A of this report and would further comment as follows: -

We consider that we have carried out a sufficiently comprehensive cover meter survey using deep scanning techniques in the area concerned to make a reasonable judgement of the likely conditions present throughout the structure as a whole.

In this Report, the results are considered in relation to the depth of carbonation front progression, which is summarised as follows: -

The variation in depth of concrete cover is generally a major contributory factor in the corrosion of embedded steel in concrete often leading to expansive corrosion, cracking, delamination and spalling of cover material.

In the area selected for intrusive investigations were the concrete core material was revealed and the cover concrete was found to be damaged and/or unsound, the underlying steel was exposed, and we found that the cover depth to embedded steel would under normal circumstances be considered as acceptable provided that good quality construction practice had been followed.

3 CONCLUSIONS

3.1 Damage to Portland Stone

Various forms of damage have been identified in this intrusive investigation and are discussed in the preceding sections of this report.

From these findings, it is apparent that the majority of the damage to the entablature is associated with the corrosion of steel embedded within the construction which has been exacerbated as a result of inadequate construction and water tightness measures (Refer to photographs and descriptions attached) and it is likely that this damage is part of a process of ***on-going and potentially accelerating deterioration.***

3.2 Concrete Analysis

From the findings of the concrete testing carried out to the in-situ concrete core material in the columns during this investigation and having in mind that the structure is situated in a geographical location where damp and salt ladened conditions are commonplace, we have reached the view that the various construction elements that comprise of the colonnade accessed to date do contain attributes that could accelerate the risk of corrosion or initiate ongoing corrosion of the embedded steel construction.

Carbonation Front: Since the carbonation front in the in-situ concrete core to the columns had extended up to or beyond the embedded steel in the test location subject to examination, it is likely that this condition is a contributory defect to the risk of corrosion of embedded steel and as such ***should not be ignored***.

Chloride-ion Concentrations: As the sample obtained from the in- situ concrete core of the column subject the intrusive investigation demonstrated circumstances of concern, we are of the view that the risk of corrosion of embedded steel due to the presence of chloride ions ***should again not be ignored.***

3.3 Conclusion

Recorded damage to the various construction elements that comprise of the colonnade concerned has as its primary source of defect, causes to be found in association with the corrosion of embedded steel contained within the Portland stone construction. The causes which have resulted in this corrosion are to be found to be an amalgam of the following elements:

i. Cyclic weathering degradation resulting in damage to the concrete and render coated capping to the top of the cornice and to the face of the Portland stone columns and entablature in localised areas and in particular to the joints in the Portland stone cladding generally.

ii. Inadequacies in the maintenance of the structure arising from the absence of correctly determined strategies and planned maintenance programmes generally and in particular as a result of inadequacies in water tightness measures.

iii. Localised areas of permeable in-situ concrete core material located in the Portland stone columns allowing, initially, the ingress of carbon dioxide into the concrete to combine with pore water, resulting in reduced levels of alkalinity, followed by the ingress of oxygen and water to levels where the de-passivated steel is exposed to the initiation of corrosion.

iv. The presence of chloride ions in the in-situ concrete core material located in the Portland stone columns in excess of those levels permitted by current codes.

In our view the ***primary causes*** of damage and defect in the construction can be associated with inadequacies at the time of original construction and in particular in the maintenance of the structure, both in terms of workmanship and materials, when considered in relation to current codes and ‘best practices’.

4 RECOMMENDATIONS

4.1 Generally

It is important to have in mind that the principal aim of the Concrete Condition Survey was to establish the current condition of the original structure concerned in ***representative areas only***.

Completion of this investigation concerned has established the ***"primary causes"*** of the damage evident to only those areas which have been the subject of intrusive investigation activity and further we believe has provided sufficient good quality information as to the likely conditions present to other areas of the structure in order that a suited way forward for the repair of same can be developed.

4.2 Health and Safety Issues

There was no requirement for us to carry out a temporary make safe exercise to those areas of the Portland stone cladding which is showing signs of cracking and spalling of cover material in order to ensure matters of public safety.

Notwithstanding the fact that this work has not been carried out, if the proposed repair work is not carried out in the ***very near future*** i.e. within 3 months, then ***serious consideration*** will need to be given to carrying out a make safe exercise thereafter with immediate effect in order to remove any areas of loose Portland stone material to ensure an ***adequate level of safety*** to staff and users of the ferry terminal and Spaceport building generally.

4.3 Historical Information

Drawings of original construction could prove to be extremely helpful in assisting in the development of the various remedial options in order to meet client objectives. To this end a search of Client and / or Local Authority records should be carried out to determine whether the necessary information either in part or in whole is available.

Copies of any previous survey reports and investigations would again prove helpful and may well assist in the development of the various remedial options available in order to meet client objectives. Various enquiries should therefore be made with the Client to enquire whether such information exists and obtain copies of same.

Clearly remedial works have been carried out in the past and any more information which could be made available about this work could again prove extremely helpful. Again, various enquiries should be made with the Client to enquire whether such information exists and obtain copies of same.

4.4 Remedial Options

Important Note

Due to the potential nature and extent of repairs required to the entablature and columns, we would recommend that the repair works are carried out and completed at the earliest opportunity otherwise repair costs could ***increase exponentially with time.***

Generally

The problems associated with the cracking of the Portland stone is best dealt with using more traditional masonry techniques.

In most cases, the most significant sections of damaged Portland stone should be removed, and any underlying exposed corroded steel cleaned and prepared and should be reinstated with new sections of pre-cut/preformed Portland stone material to match existing back to original line and level.

Any minor areas of damage to the Portland stone should be repaired in-situ using traditional hand repair techniques with appropriate materials including the cleaning and preparation of any exposed embedded corroded steel, as applicable.

These measures will effectively repair areas of damage that exist at this time, however, other than the provision of a measure of protection to the embedded steel by means of the specification used for the recently repaired areas these measures will only deal with ***existing*** damage.

Important Note: We have noted that some consideration is being given to installing a CP System in order to provide protection to the corroded steel of the embedded RSJ. You will have noted in our Report that upon carrying out the intrusive investigations to the entablature in order to fully expose the embedded RSJ little or no cementitious grout was found to exist between the rear face of the Portland stone and the front face of the web of the RSJ. Upon inserting wire probes to a depth of one meter in both directions this voiding appeared to be continuous and widespread. Whilst we are not corrosion engineers experienced in the design of CP systems but merely installers of same, we are of a view that the installation of a CP system in such circumstances may present some difficulties, as follows:

a) ***CP system only addresses corrosion, any structural concerns remain the same.***

b) ***A CP designer may accept a small amount of voiding so the extent of voiding would need to be established. To much voiding would require complete***

grouting of the void. This could prove extremely difficult to achieve and virtually impossible to prove.

4.5 Arresting Defects in the Portland Stone Colonnade

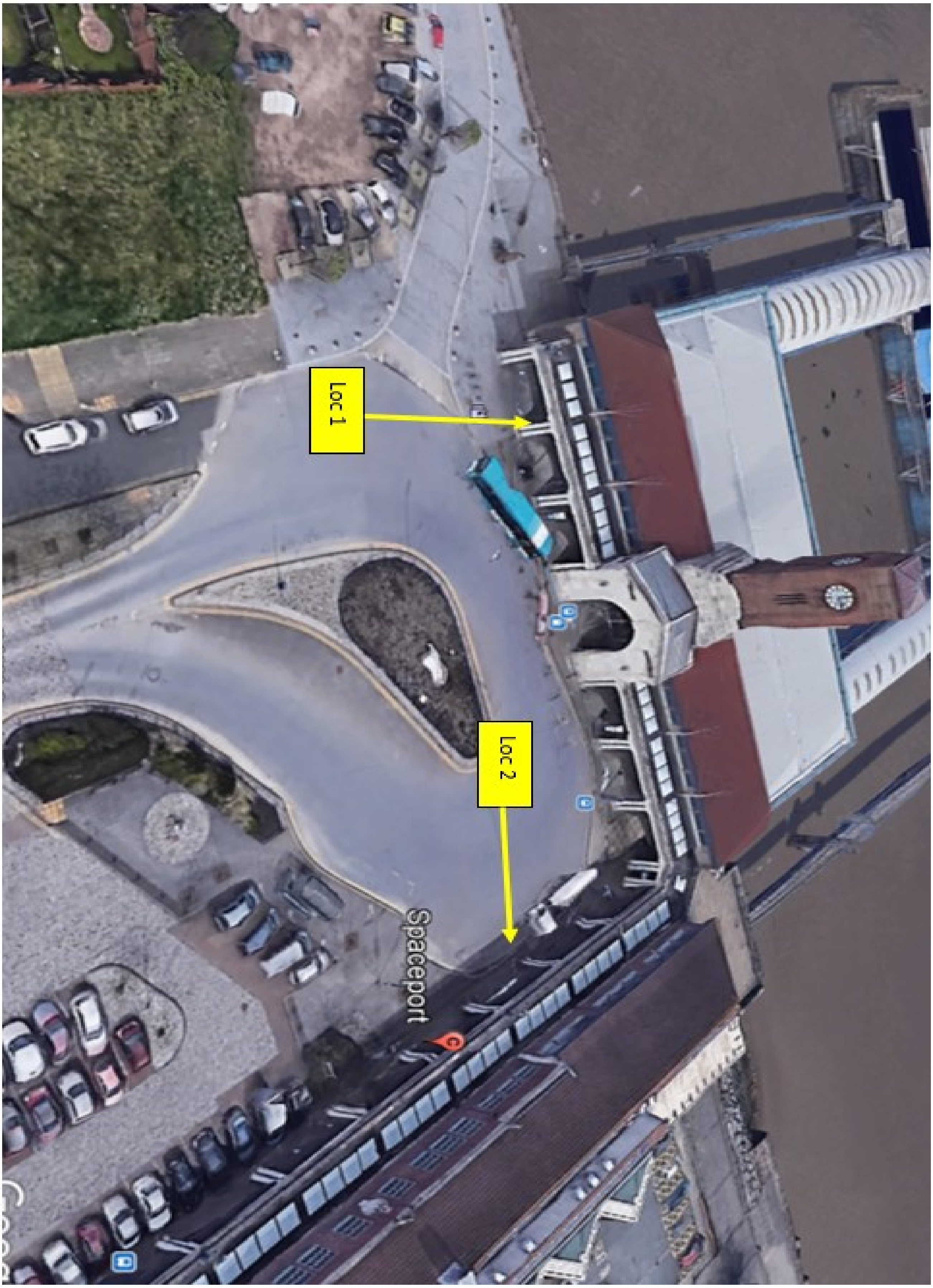
It is necessary to address factors that have caused the damage and which, if left unchecked will result in ***progressive deterioration and inevitable failure*** throughout the Portland stone construction as a whole. Further measures are required to restrict the existing corrosion levels of the embedded steel by removing one or more of those factors, which are a requirement in the initiation and progression of corrosion.

The measures generally involve the application of various water tightness measures, which effectively seal the surfaces of the Portland stone construction against the continued ingress of water and other deleterious contamination. These systems generally comprise of the preparation of surfaces and the application of a liquid applied materials to the concrete and render coated capping to the top of the cornice after localised repairs to the render covering and lifting of the existing lead flashing and re-fixing of the felt upstand. Further measures will also be necessary involving the removal of all existing mortar pointing to Portland stone joints and repointing of same using traditional masonry techniques.

AERIAL VIEW OF THE COLONNADE

SHOWING LOCATIONS SUBJECT TO

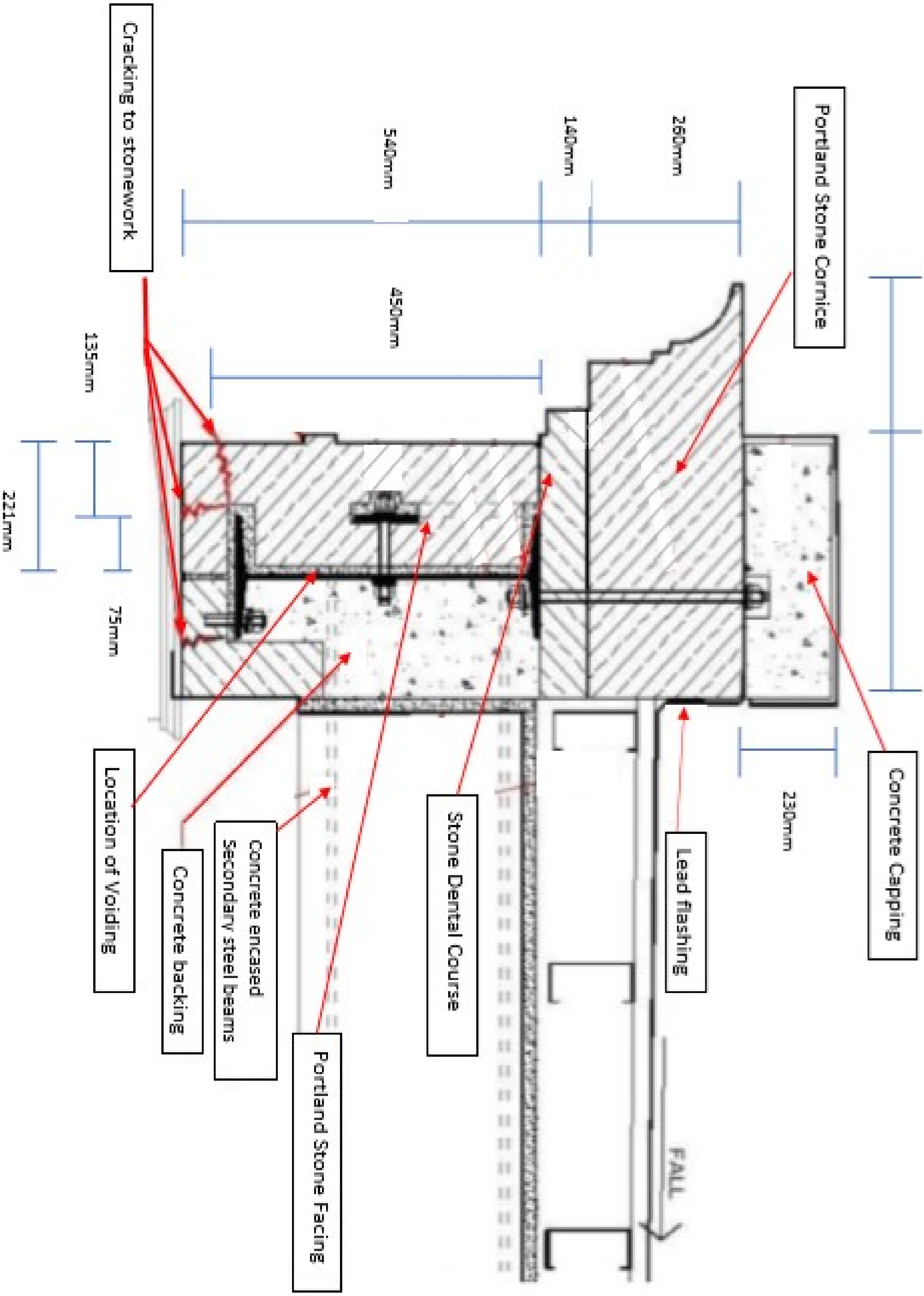
INTRUSIVE INVESTIGATIONS


Loc 1
Loc 2
Spaceport

SCHEMATIC RECORD DRAWING

SHOWING TYPICAL CONCTRUCTION

DETAIL IN LOCATION 1


Cracking to stonework
540mm
140mm
260mm
Portland Stone Cornice
450mm
310mm
135mm
221mm
75mm
430mm
230mm
Concrete Capping
Lead flashing
Stone Dental Course
Concrete encased
Secondary steel beams
Concrete backing
Location of Voiding
Portland Stone Facing
FALL

PHOTOGRAPHS AND DESCRIPTIONS

OF LOCATIONS SUBJECT TO

INTRUSIVE INVESTIGATIONS

PHOTOGRAPH SHEET – ONE	
Description:	General view showing the first location were intrusive investigations were carried out in order to establish the underlying construction and condition of same.

PHOTOGRAPH SHEET – TWO	
Description:	Close up view of that area as shown in the previous photograph which was selected for the intrusive investigation. Note it is an area where damage is clearly evident in the lower section of the Portland stone facing where it is anticipated that the bottom flange of the embedded RSJ steel section is located

PHOTOGRAPH SHEET – THREE	
Description:	Further close up view of that area as shown in the previous photograph where the removal of a vertical section of the Portland stone was removed in order to fully reveal the underlying construction detail. The lower section of the RSJ steel web and flange were found to be heavily corroded. A crack was evident in the freshly exposed edge of the Portland stone in the location were the bottom flange was located, which extended to the outer face.

PHOTOGRAPH SHEET – FOUR	
Description:	Further close up view of the previous photograph revealed that the depth of corrosion to the bottom flange and web of the RSJ was some 15 to 20mm. Whilst grout was evident both in the location of the top and bottom flange no grout was evident to the rear face of the Portland stone were abutting the web of the RSJ. A one-meter long tracer probe was inserted in the gap between the rear face of the Portland stone and the front face of the web of the RSJ in both directions with little or no restriction. We consider that this condition is likely to be widespread.

PHOTOGRAPH SHEET – FIVE	
Description:	General view showing the second location were intrusive investigations were carried out in order to establish the underlying construction and condition of same. Note that this area was selected in order to provide a balance view as to condition as no damage to the stone Portland stone facing was evident.

PHOTOGRAPH SHEET – SIX	
Description:	Close up view of location 2 showing were removal of the Portland stone facing was being carried out.

PHOTOGRAPH SHEET – SEVEN	
Description:	Close up view of that area shown in the previous photograph after completion of the intrusive investigation in order to reveal the underlying condition.

PHOTOGRAPH SHEET – EIGHT	
Description:	A further close up view of the previous photograph showing the location, type and condition of metal fixing used in the vertical joint in the Portland stone facing. Also note that the condition of the underlying RSJ steel section was in better condition than that found in Location 1. Whilst corrosion was evident on the top and bottom flange it was considered as being minimal considering the age of the structure and the environmental conditions present, no corrosion was evident on the web of the RSJ. As in location 1 grout was evident both in the location of the top and bottom flange with minimal grout evident to the rear face of the Portland stone were abutting the web of the RSJ. A one-meter long tracer probe was inserted in the gap between the rear face of the Portland stone and the front face of the web of the RSJ in both directions with little or no restriction. We consider that this condition is likely to be widespread.

PHOTOGRAPH SHEET – NINE	
Description:	Close up view of a column adjacent to location 2 were intrusive investigations were carried out to reveal the underlying construction.

PHOTOGRAPH SHEET – TEN	
Description:	Close up view of that area of the column as shown in the previous photograph were the intrusive investigations was carried out. Note that the construction comprised of a central core of steel encased concrete (presumably reinforcing bar) with a Portland stone outer face.

PHOTOGRAPH SHEET – ELEVEN	
Description:	Close up view of the steel reinforcing bar as shown in the previous photograph. Note the presence of heavy corrosion which is likely to have resulted in loss of cross-sectional area.

PHOTOGRAPH SHEET – TWELVE	
Description:	Close up view of the concrete cap located on the top of the Portland stone cornice. Note the damage evident. This condition is not isolated.

PHOTOGRAPH SHEET – THIRTEEN	
Description:	Close up view of the render coating which has been applied to the concrete cap as shown in the previous photograph. These sections of render were removed with little more than finger pressure. This condition is widespread.

PHOTOGRAPH SHEET – FOURTEEN	
Description:	Close up view of the top of the Portland stone cornice at joint locations. Note that the mortar pointing has completely eroded allowing easy access for rainwater and other deleterious materials to gain access to the underlying construction. This condition is typical and widespread.

PHOTOGRAPH SHEET – FIFTEEN	
Description:	Close up view of the lead flashing to the rear of the Portland stone cornice. Note this lead flashing is not continuous and terminates at handrail palm plate fixing locations. This condition is typical at all handrail fixing positions.

PHOTOGRAPH SHEET – SIXTEEN	
Description:	Upon lifting the lead flashing as shown in the previous photograph we found that the felt had not been bonded/secured to the rear of the Portland stone cornice thus allowing easy access of rainwater and other deleterious materials to the underlying construction. This condition is typical at all handrail palm plate locations

ANALYSIS TABLE SHOWING

ESTIMATED CORROSION RISK

OF EMBEDDED STEEL

IN THE COLUMN CONCRETE CORE

ANALYSIS OF SAMPLES IN RESPECT OF CHLORIDE ION CONTENT, RECORD OF CARBONATION DEPTHS AND CONCRETE COVER TO STEEL REINFORCEMENT														ESTIMATED RISK OF STEEL REINFORCEMENT CORROSION AS PER BRE DIGEST 444 PART 2		
Sample Reference Letter		Sample/Testing Location		Concrete Cover to Steel			Carbonation Depth			Sample Increment Depth (mm)	% Chloride ion content (by weight of sample)	% Chloride ion content (by weight of cement, assumed 14%)	Carbonated concrete at reinforcement depth	Associated with carbonation in relation to depth of concrete cover and cast-in chloride content		Associated with Ingressed chloride in the absence of carbonation
		Elevation	Component	Max (mm)	Min (mm)	Avge (mm)	Max (mm)	Min (mm)	Avge (mm)					In damp conditions	In dry conditions	
DS	A	1	Column	15	15	15	25	23	24	LUMP	0.097	0.69	YES	VERY HIGH	HIGH	EXTREMELY HIGH

Photocopy of 'Certificate of Analysis' from Independent Testing Laboratory

The following 'Certificate of Analysis', was issued by James Fisher Testing Services Limited on the 12th February 2020 in respect of those samples submitted for analysis.

James Fisher Testing Services Limited
Ruby House, 40A Hardwick Grange
Warrington,WA1 4RF
Tel: 01925 286 880

LABORATORY TEST REPORT

Chloride ion Determination

Project :	Unit 6, Heaton Court, Scarisbrick - Spaceport Building	**Job No.:**	36099
		Lab Ref No.:	36099/12
Client :	Specialist UK Restorations Ltd	**Date Received:**	07/02/2020
		Date Tested:	11/02/2020
		Date Reported:	12/02/2020
Originator:	**Ryan Pirrie**	**Material:**	Concrete Dust

Sampled by:	Client	**Sampling Certificate Received:**	No
Sample Type:	Dust		

Reference:	*Increment (mm)*	*Chloride Ion Content*	
		% w/w sample	*% w/w cement**
Column	-	0.097	0.69

Tested In Accordance With DIHM WI09

LOD - 0.010% w/w Sample

Assumed Cement Content Sample = 14.0% (Not UKAS)

The Results Given In This Report Relate To The Samples Tested Only

K.Monks

Approved Signature
James Fisher Testing Services Limited
Karl Monks, Lab Team Leader

James Fisher Testing Services Limited, a company registered in England and Wales with registration number: 01182561
Registered office: Fisher House, PO Box 4, Barrow-in-Furness, Cumbria, LA14 1HR
RS53 Issue 1