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Date: 28th February 2020

FAO Estates and Facilities Department,

External Planned Maintenance,

Cambridge City Council, **DRAFT ONLY UNCONTROLLED ISSUE V1**

130 Cowley Road

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CB4 0DL

Preliminary Report on the Apparent Cracking within the External Façade Brickwork, Concrete Façade Panels and Year 2 Urgent Remedial Works of Princess and Hanover Courts, Cambridge, CB2 1JJ and CB21 JH

Introduction

The following report has been prepared at the request of our Client following the identification of apparent cracking within the external walls of the property in particular in the region of the gable end, flank and internal communal areas wall, identified by the contractors namely, Initially Kier and then Fosters Ltd and SJW Ltd while carrying out various planned works on the buildings.

For Year 1 works see separate report for the Year 1 urgent remedial works to the eastern load bearing piers and the corners of the building at the south eastern gable end corner of each building.

This report relates solely and specifically to the nature, causes and consequence of this reported apparent movement and cracking by others within the property and not specifically to any other aspect of the property or its condition.

This report is provided for the sole use of the client and is confidential to the client. No responsibility whatsoever is accepted or extended to any other party other than the client. Consequently, the contents or part thereof of this report are not to be relied upon by any third party whatsoever. The rights of any third party do not apply in any way to this report.

This report is confined to structural matters only and it does not cover the deterioration of the structure through fungal or insect attack, nor does it deal with other defects of a non-structural nature.

We have not inspected any parts of the structure and fabric unexposed or inaccessible and we are therefore unable to report that any such parts of the property are free from defect. Principally, no wall, floor or roof coverings were removed so the opinions expressed in this report are purely based mainly upon visual inspections. No drains were inspected, or manholes lifted to inspect any drains and any such inspection would be carried out by a specialist camera survey and report as instructed separately by our client.

Records: -

If any construction records, historical architectural and or building drawings are found then we will be able to comment further, but so far, no such records and or documents have been presented to us nor any brief to conduct such searches for such documents, specifications and drawings which may well have been lost in the passage of time due to the age of the property?

No asbestos survey was availible nor have we been briefed to comment upon such matters as to the prescence of asbestos in the property. No drainage and or services surveys were made availible to us.

We have not been instructed to check for the presence of High Alumina Cement (See Separate GBG HAC Report), Calcium Chloride or for the incidence of Alkali Aggregate Reaction within any concrete elements of the structure, thus we cannot confirm that any such structural elements are free from defect. We do recommend that such sampling and tests are undertaken on behalf of our client should any suspicion arise in regard to such matters but none are reported at present giving such concerns nor are we additionally briefed to comment upon such matters No asbestos survey was availible nor have we been briefed to comment upon such matters as to the prescence of asbestos in the property. The HAC survey has been conducted by GBG for Cambridge City Council and their sepaarte report is availible within the information pack.

We have not been furnished with any records, drawings, specifications, and or details of the construction of the property and its foundations.

Information regarding rights of way, easements, agreements, encroachments, disputes, statutory notices, adjacent ownership of the neighbouring properties and the precise location of the boundaries has not been made available to us during our inspections or whilst preparing this report.

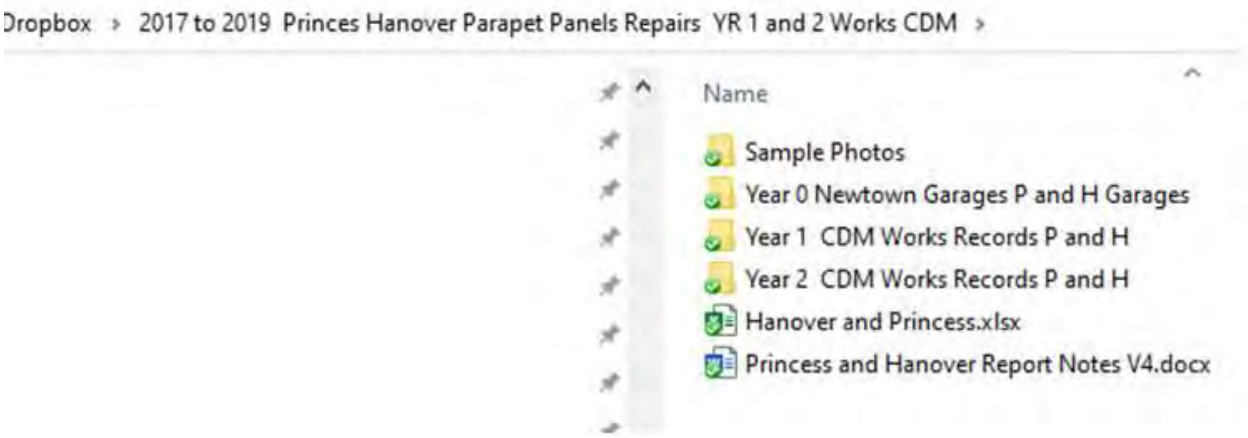
The inspections were generally carried out on clear days and in good visibility and recorded with photographs and contemporaneous notes on white boards by the contractor's inspectors.

The Objective of these visual surveys and report is to determine the likely cause of the apparent movement and cracking, prior to commencing any further verifying investigations in order to report on the apparent cracking observed by another contractor's surveyors, prior to commencing further repairs in Year 3 works to be specified by others following on from the records for Year 2.

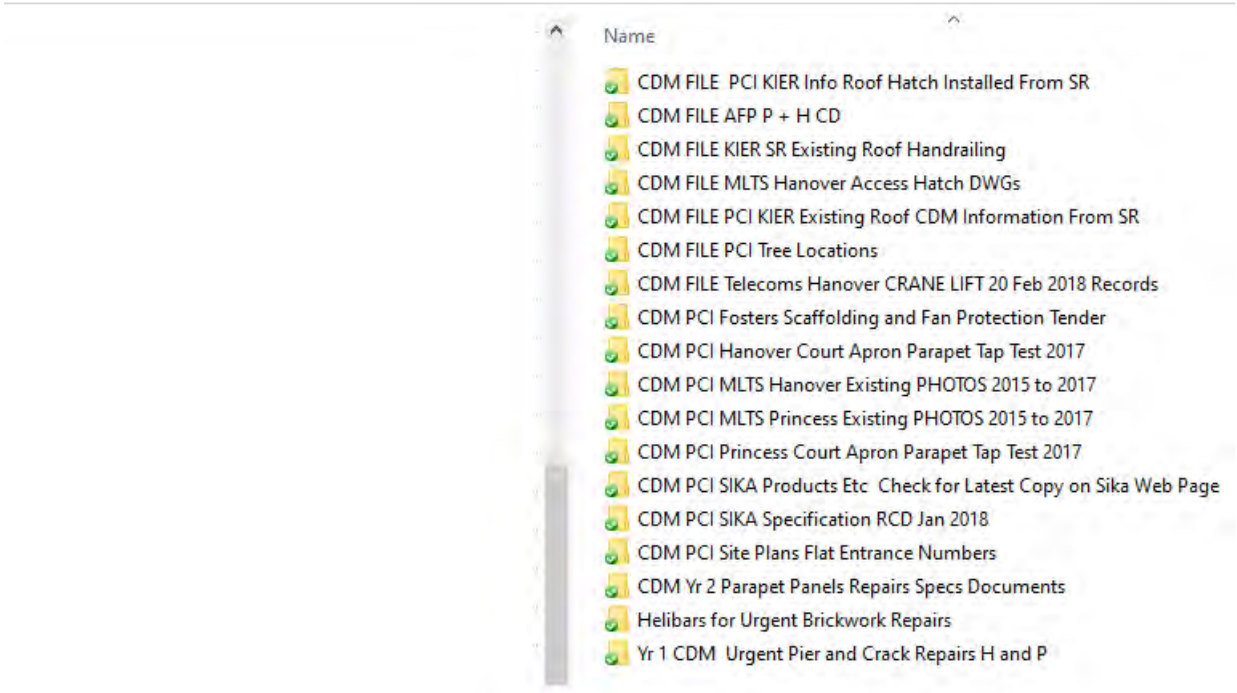
Contractors Surveys, Lists of Facade Defects and Repair Locations and Record Drawings by MLTS Ltd.

A considerable amount of information in the information pack has been handed over by MLTS Ltd to Millwards and thus Mace at the meeting on 13th February 2020 along with a A3 file of the drawings and list and other useful information including the Dropbox link. All this information is in the Dropbox and on a USB stick containing all the contractor's photographs, site records of the cracks and defects at each location along with the urgent repairs made in Year 2. The contractors Excel spreadsheet and MLTS Ltd record drawings based upon this information were also included. Also, included is the original SIKA repair specification and the Sika materials details and the Helical bar reinforcement materials. Due to the volume of this information, which is considerable, it has been handed over electronically a memory USB stick (Pink) at the handover meeting.

Year 1 Urgent Works - See SIKA Specification Folder and Specs and Documents Folder for Year 2 Documents and Urgent Repairs.



Documents Folder for Year 1 Documents and Urgent Repairs Report.

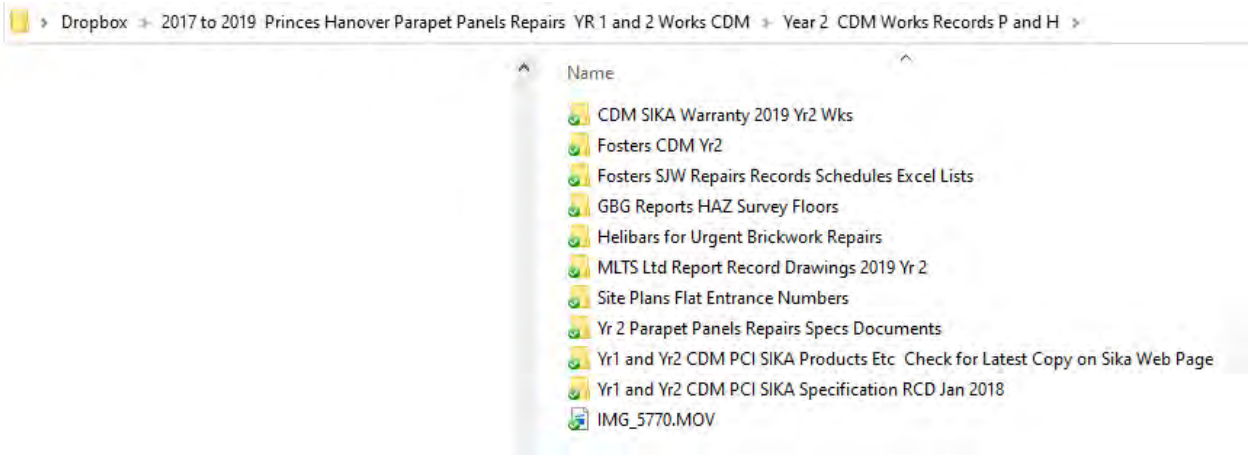


Year 2 MLTS Ltd Record Drawings see attached and MLTS 2019 Year 2 Folder and Fosters Records Folder below and in the Dropbox link shown in blue text.

For Sika Specification See Sika Specification Folder

For Helical Bar / Helifix Primer WB and Helibond Resin See Helibars for Urgent Repairs Folder

All in Folders below on USB Stick and in the Dropbox at
https://www.dropbox.com/sh/5d97kjzsdhsn4ur/AADsGC7RrhhyQgUluZnlQ8REa?dl=0



Introduction and Scope of Our Brief:-

The Project and Brief: - Our Original brief was initially set up by CCC as the Year 2 Parapet Panel Repairs Project following certain Year 1 urgent repairs to the eastern and gable low level brickwork cracking on Hanover and Princess Court buildings which identified various structural cracking and damage to the Parapet Panels. Due to, discarded and corroding scaffolding fixings left in the external facing brickwork and concrete parapet panels during previous roofing contracts to secure the temporary handrailing. In addition, certain damage due to deterioration of the concrete and reinforcement corrosion within the parapet panels over the life of the building, had also been identified.

Subsequent Further Investigations of the cracking within the facades and spalling and cracking concrete parapet and balcony panels were also commenced within Year 2 due to discoveries made during the Year 2 works once the buildings could be accessed above the second storey level.

A "Tap Test" was carried out and loose materials was taken of the concrete parapet panels which posed a dangerous hazard to people below particularly when entering or leaving the building or merely passing by and the parapet panels were repaired using the SIKA system as planned, to make these parapet panels safe.

During these initial Year 2 Concrete Parapet Works further findings on the facades of the buildings were discovered, including extensive brickwork cracking in the facades and the various towers, together with loose and spalling concrete due to concrete deterioration and reinforcement corrosion within the concrete balcony panels.

These discoveries have significantly expanded the survey and urgent brickwork repairs project during 2018 and 2019 due to the contractor's further findings on site, as they have had the benefit of close access (within arm's length from the building at high level).

Consequently, the contractors were commissioned further by CCC during the initial Year 2 Works and investigations to make photographic records of each location of a defect / brickwork crack / concrete spalling.

These additional Year 2 works also followed on from the brickwork repairs and stiffening piers at low level in Year 1 located on the eastern side.

All the contractors records have been recorded on site and written up in lists and these results have subsequently been reviewed and drawn up by MLTS Ltd. to illustrate and confirm the interpretation of these results only for internal use in respect of this report on Princess and Hanover Court residential buildings facades relating solely to the concrete and brickwork repairs and for no other purpose whatsoever.

The information contained within the records and record drawings is based upon the survey information from SJW Ltd and Fosters, but principally the daily SJW facade survey records. Any use a second or third party makes of these documents, or any reliance on or decisions to be made based on the documents, are the responsibility of such parties. MLTS Ltd. accepts no responsibility for damages, if any suffered by individuals or firms as a result of decisions made or actions taken based on these drawings and documents.

The copyrights to these drawings and documents are exclusively owned by the original authors i.e. SJW Ltd and Fosters in respect of their survey information and MLTS Ltd in respect of their further work on this survey data including the photographs and documentation supplied by SJW. The record drawings are only schematic and are strictly limited for the purpose of illustrating the general building layout and repair locations and are not to be used for any other purpose whatsoever.

This report and drawings and documents shall not be copied, reproduced, or altered in any way by any means or method, nor shall they be distributed to any individual or companies without prior written authorization from the original authors SJW, Fosters and MLTS Ltd.

Location of the Buildings and their Orientation

Location of the Two Buildings at Princess and Hanover Court View from the South.

Also See MLTS Drawings, Dropbox Folders, Flat Entrance Numbers.

Note the orientation of the buildings particularly Hanover to the east which stands well above the local topography at eight storeys high and is exposed to the dominant westerly winds.

Site Location Plan from Cambridge City Council

General Views of the Buildings: from the South showing the Fetch from the West.

View from the South showing the wind shielding topography from the East but much less shielding in the fetch to the West See above views and below from Google Earth and Bing Maps.

Another View from the South showing the wind shielding topography from the East but much less shielding in the fetch to the West See above views and below from Google Earth and Bing Maps.

Description of the Two Buildings at Princess and Hanover Court.

General View of the Tallest Block Hanover Court Eight Storey High – Eastern Elevation

Note: - The slender Bin Chute Tower located towards the left (south) of this view.

Note: - the Lift Shaft Tower located at the far-right hand end of the building (north) emerging out of the Newton Road Car park building also built in the same brutalist style and in the same brown brickwork circa 1968

Hanover Court Western Elevation: - Note the grey SIKA 903 and Sika 610 temporary blinded areas on the concrete balcony panels. See SJW Photographs and lists of the defects and locations and MLTS Ltd Drawings for overall view of these records.

Princess and Hanover Blocks of Flats: - appear to be masonry "cross wall construction" buildings with transverse masonry gable ends and internal party walls providing transverse stability and resisting lateral wind load acting on either of the main Eastern and Western elevations.

The longitudinal external walls and some internal longitudinal walls provide longitudinal stability to resist wind loads acting on the gable ends.

The internal floors appear to be formed from precast prestressed concrete hollow core planks spanning from gable wall to party wall and so on in a sequence of individual spanning floor units from the southern gable wall until the reaching the northern gable end wall.

The brutalist architectural design has resulted in large openings in the main eastern and western facades and smaller openings in the gable walls causing various stress concentrations These openings and the internal offsets in the eastern flank walls located at ground floor and first floor levels complicate and intensify the stresses within the brickwork walls due to vertical loads and further more during heavy lateral wind load, particularly due to winds from the west causing increased vertical loading within the eastern façade to resist overturning of the whole structure. See Year 1 report for further evidence of caring due to vertical and wind loading.

Nb. The buildings do not appear to have a structural steel frame or a reinforced concrete framework of beams and supporting columns, and the structures are formed from masonry walls and cross walls and external piers instead i.e. cross wall construction.

Western Elevation of Hanover Court (Ditto, but only four storeys instead of eight for Princess Court)
Note: - the white painted concrete Balcony Panels on the eastern elevation of the building.

Investigations

The following investigations were carried out during the Year 2 Works to the two buildings following on from the remedial concrete repairs to the concrete parapet panels are summarised as follows: -

1) Tap Tests of the Balcony Concrete Panels and Visual Inspections of the external walls of the property including the main facades, the gable end walls and all the towers and their walkways and a certain amount of limited internal inspections within the external communal areas but excluding the staircases as instructed by CCC, which are to be include in Year 3 tap test investigations and recording each location with a photographs and a white board unique reference.

2) Digital Photographs to record the findings some of which are used in this report. Including detailed record photographs of each defect / crack and the urgent (class red) repairs which were undertaken by the contractors and all these records and photographs are in the information pack, CDM files for Year 2 works.

3) A desk study of the results of the all the above investigations and photographs together with any archive material sent to us by the client or information from other sources e.g. Google Earth and Bing.

Detailed Investigations and Contractors Works Year 2: -

a) Contractors investigations and photographic records of the façade defects including cracking and spalling of the brickwork and the balcony panels following on from the parapet panel repairs.
b) Subsequent repairs of the urgent / emergency items located within the brickwork and concrete parapet following on from Year 1 works and temporary balcony panel repairs and
c) Classification of the intermediate structural issues of the cracking and spalling (Red / Yellow) as instructed by CCC. NB. Red items have been repaired within Years 1 and 2.
d) Removal of loose concrete and temporary preparation and passivation with SIKA 903 and priming with SIKA 610 of the Balcony Concrete Panels on both buildings, pending year 3 concrete repairs.
e) Deferment of the remaining brickwork repairs (Yellow Class) to the east and west facades of the buildings to Year 3
f) Recording of the internal communal areas cracking with the façade brickwork within the buildings. Nb. this brickwork also helps to resist lateral wind loading.
g) Testing and sampling of the prestressed external staircase and internal walkway concrete panels for High Alumina Cement and HAC Conversion and Calcium Chloride, see separate GBG report, as recommended by MLTS Ltd.
h) Taking of various independent photographs and carbonation testing of spalled concrete and loose concrete arisings.
i) Sampling at limited locations by metal detection on the brickwork panels to ascertain the sample pattern of the brickwork ties within the masonry walls and opening up of a brickwork tie on a tower.
j) Testing, on a sample balcony panel on Hanover Court located at low level, of removing the old paint on the Existing Concrete Balcony Panels to determine suitability for repainting using Sika anti-carbonation paint 675c
k) Collation and drawing up of the contractors results into CAD drawings to interpret the results for writing up the record prior to others tendering the remaining works for year 3.

Note: - All Year 3 Investigations and remedial works to be quantified from Fosters and SJW lists and record photographs and specified by Millwards and MACE alone.

Summary of the Findings: -

The following findings were made from the investigations above: -

Example Findings - Starting with a Brief Review of Year 1 Works: Leading into Year 2 Works-

Eastern Side of Hanover Court Typical Entrance Structure Ditto Princess Court: -

Note the entrance crippling the supporting pier above and the concrete lintel over resting upon the staircase structure and brickwork, repaired Year 1.

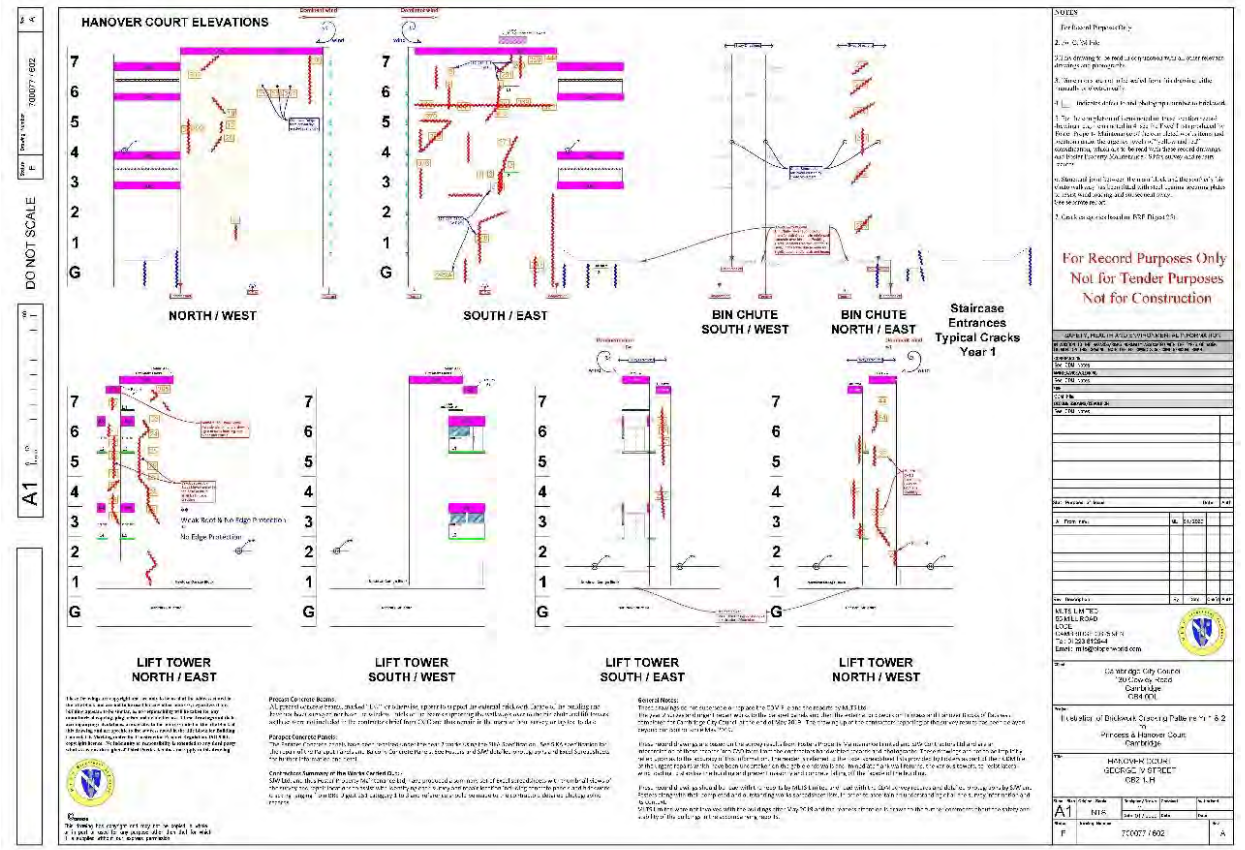
NB: - The main drains are understood to run along under these staircase structures and the eastern slender bin chute towers adding to the issuers and potential issues with structural movements caused by drains and trees.

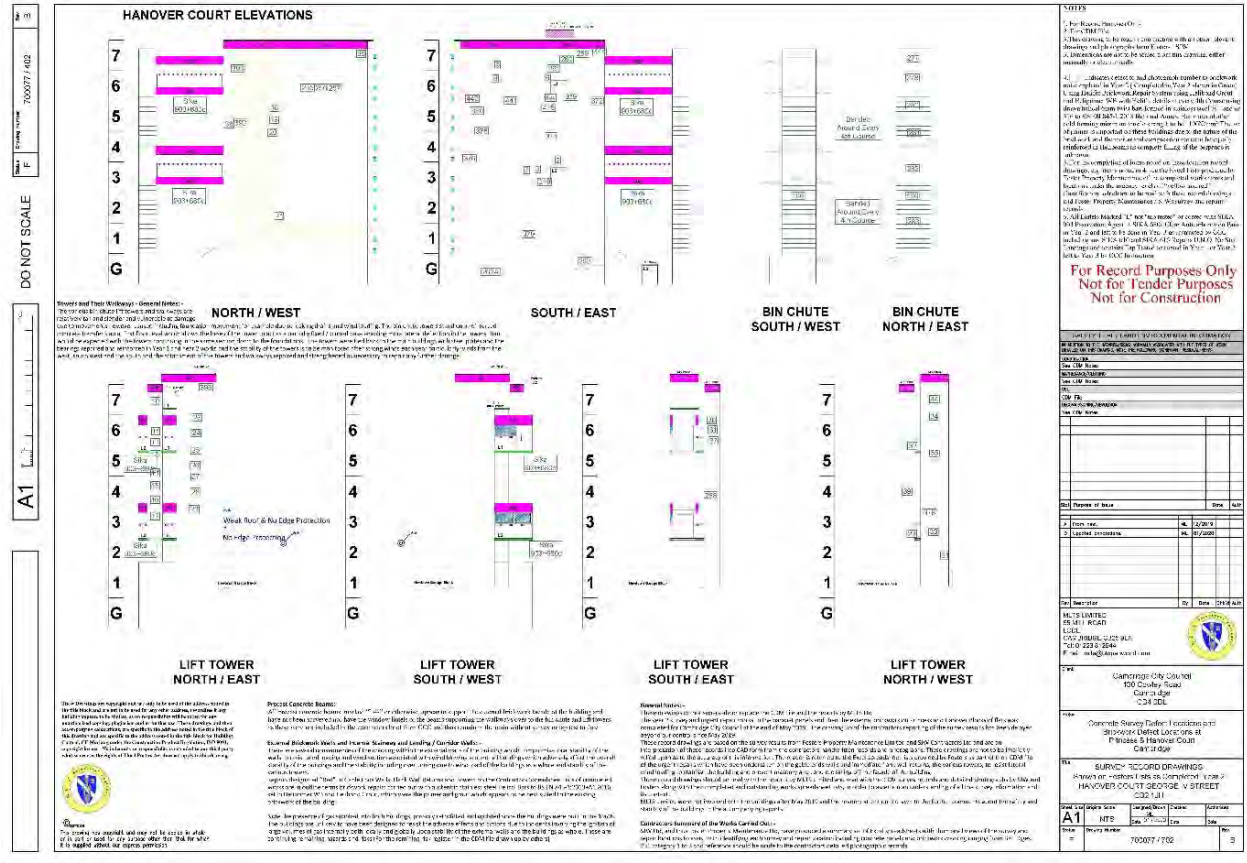
Corner of Hanover Court Before Year 1 Emergency / Urgent Repairs likely to be caused by strong wind loading causing lateral (east westerly direction) over tuning movement within the gable end wall.

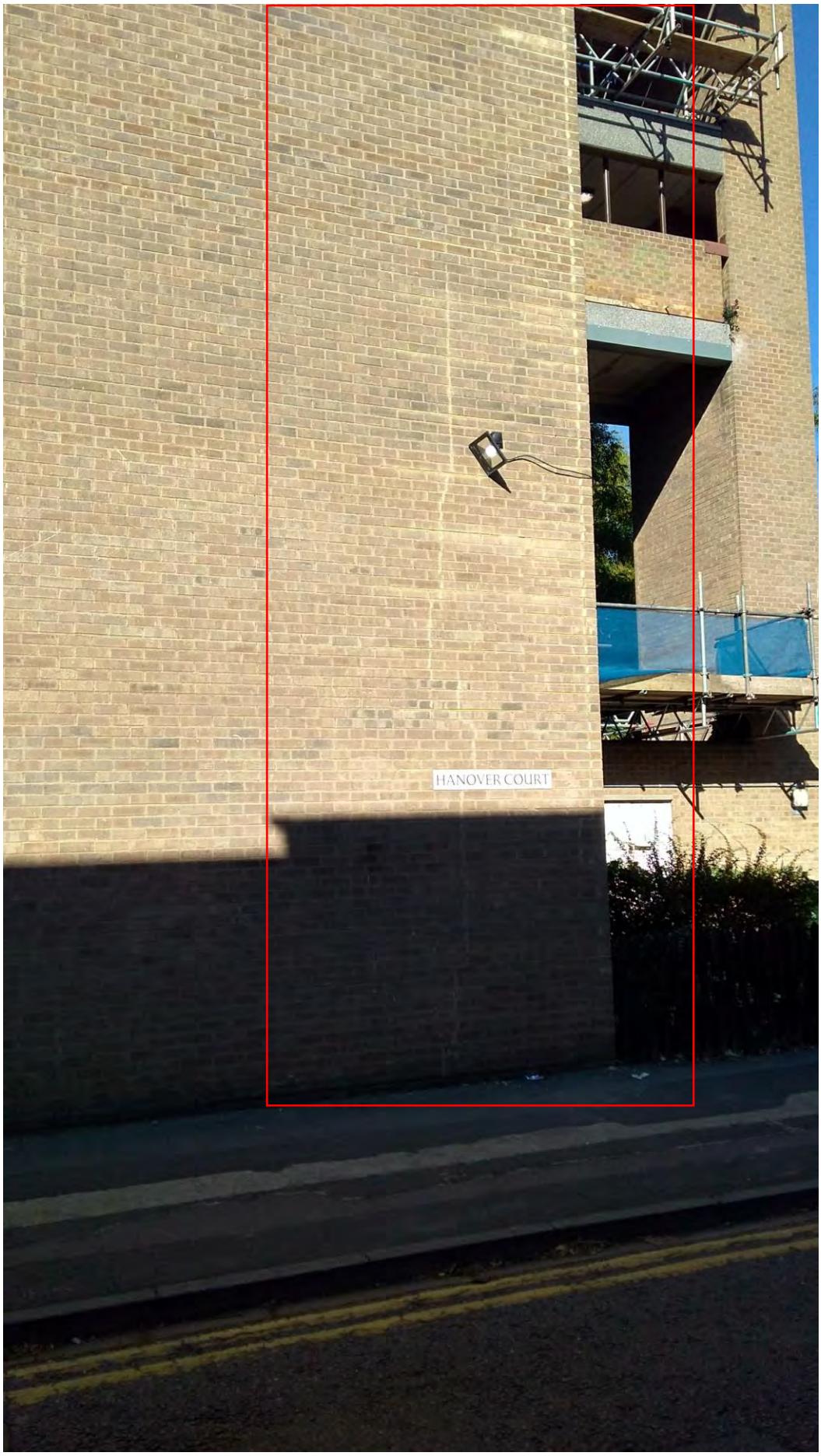
Year 1 and 2 Emergency Repairs due to wind loading acting with dead and live loading

Corner of Hanover Court after Urgent Repairs 2017 / 2019 (Year 1 and 2)

See Crack pattern drawings by MLTS Ltd 600 Series Drawings







Corner of Hanover Court after Repairs 2017 / 2019 Ditto Another View

Eastern Side of Hanover Court Typical Entrance Structure Cracking - Repaired in Year 1 Urgent Works

Note the entrance crippling the supporting pier above and the concrete lintel over resting upon the staircase structure and brickwork

NB: - The main drains are understood to run along under these staircase structures and the eastern slender bin chute towers adding to the issuers and potential issues with structural movements caused by drains and trees.

Eastern Side of Hanover Court Typical Entrance Structure Cracking -Repaired in Year 1 Urgent Works: -

Note the entrance crippling the supporting pier above and the concrete lintel over resting upon the staircase structure and brickwork

NB: - The main drains are understood to run along under these staircase structures and the eastern slender bin chute towers adding to the issuers and potential issues with structural movements caused by drains and trees. Thus, it is imperative that the drains are maintained and do not leak and compromise the formation supporting the foundations.

Eastern Side of Hanover Court Typical Entrance Structure Cracking -Repaired in Year 1 Urgent Works

Note the entrance crippling the supporting pier above and the concrete lintel over resting upon the staircase structure and brickwork

NB: - The main drains are understood to run along under these staircase structures and the eastern slender bin chute towers adding to the issuers and potential issues with structural movements caused by drains and trees. Thus, it is imperative that the drains are maintained and do not leak and compromise the formation supporting the foundations.

Eastern Side of Hanover Court Typical Entrance Structure Cracking: Internal View - Repaired in Year 1 Urgent Works

Note the entrance crippling the supporting pier above and the concrete lintel over resting upon the staircase structure and brickwork

NB: - The main drains are understood to run along under these staircase structures and the eastern slender bin chute towers adding to the issuers and potential issues with structural movements caused by drains and trees. Thus, it is imperative that the drains are maintained and do not leak and compromise the formation supporting the foundations.

Eastern Staircase of Hanover Court Typical Entrance Structure - Cracking Internal Northern Side: Repaired in Year 1 Urgent Works

Typical example of the Eastern Flank Wall Cracking due to vertical load overloading by the two heavily concrete lintels on both sides supporting the brickwork façade above probably exacerbated by additional vertical load due wind load on the western side and possibly exacerbated by frost attack.

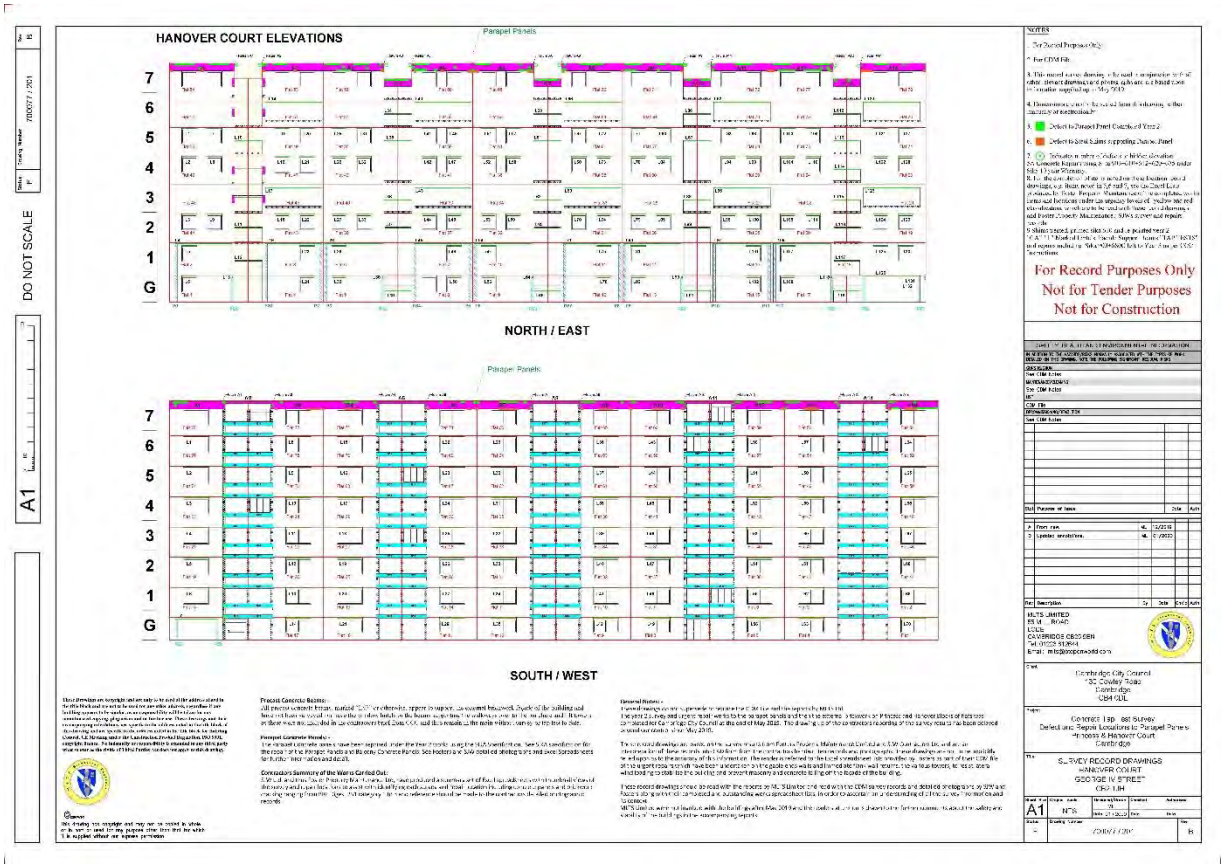
Note the very slender 225mm wide pier below and the stress concentration at the top of the pier under the lintels with 112mm of bearing at the most for each lintel.

Ditto a closer view. Repaired and Piers stiffened - Repaired in Year 1 Urgent Works

Note: - apparently only 100mm of bearing onto the central pier by both heavily loaded lintels on either side. Note the crushed bricks in the façade located immediately above the pier.

General View of North Eastern Elevation Typical Parapet Panel Tap Test in Year 1 Prior to Year 2 SIKA Repairs SIKA 903 SIKA 610 SIKA 612 and Anti-carbonation Coating SIKA 675

Year 2 Parapet Panel Repairs See MLTS Drawings 200 Series



Findings Continued – Comments on Natural Actions: - Thermal Movements and Wind Loading: -

Thermal Movements within the Buildings Facades, particularly the brickwork: -

During the life of the building it has been exposed to a cold winter followed by particularly hot summers causing severe thermal movements, stress and strains within the facades, particularly the medium to dark brown coloured brickwork, which is vulnerable to absorbing the suns radiation and heat in summer and radiating and losing the heat again during the winter

Movement Joints:- Although there is an apparent and obvious lack of brickwork movements joints within the brickwork facades, typical of buildings of this age, there are some compensations allowing some partial thermal stress relief due to the number of openings in the eastern façades and the returns, corners and balcony openings within the Western facades, mitigating some of the adverse effects of thermal movements and damage.

Cold weather allows the cold to penetrate into the relatively uninsulated structure and the fabric of the building raising moisture levels within the structure and fabric due to driven rain and condensation due to habitation of the building.

Recent Weather Patterns:- Long periods of sunshine during long summer days for example over several prolonged periods during 2018 / 2019 allow the heat to penetrate deep into the structure and the fabric of the building drying it out followed by rapid cooling of the facades due to rain. Thus, activating extreme thermal and dry to wet moisture movements with the brickwork, the bricks the mortar and the reinforced concrete beams, lintels and panels.

The amount of cracking within the facades has probably accumulated over the life of the building and added to the decades of cracking due to a complete lack of any movement joints.

Consideration of the Installation of Retro-fitted Movement Joints:- within the brickwork is likely to compromise the integrity of the brickwork panels to resist lateral loads particularly suction due to wind and nominal loads providing laterals restraints for the brickwork at floor and internal wall junctions to restrain the brickwork panels onto the main structure of the building. This could give rise to an increased risk of a panel or area of brickwork being sucked off the building.

Equally, minor cracks acting in patterns together can equally compromise the lateral wind loading integrity of the brickwork raising the risk of masonry falling off the surface of the building due to wind loading possibly exacerbated by the tendency for any brickwork to buckle under vertical loading, particularly if the brickwork is out of plumb or out of plane.

Lines of Likely Lateral Restraint of the Facades: - Year **3 Note: -**

See MLTS Ltd Drawings where red lines indicate the likely lines of lateral restraints between the building and the external walls which should be verified in Year 3 further investigations to ensure they are indeed of an adequate nature.

Internal inspections, inner leaf cracking and precast concrete floor plank bearings:- Unfortunately, an empty flat or flats has not been available to examine the internal floor to external wall joints both along the building and particularly at the gable ends which may be dry lined with asbestos boarding, which will have to be removed to inspect the inner leaf of the gable end cavity walls to ascertain if they are cracked in a similar manner and pattern to the outer brickwork, forming the gable end walls.

From the examination of the internal communal areas within the buildings this suggests that the floor concrete planks may only have 112mm at the most and maybe less than 90mm of bearing onto the internal walls and beams and the inner leaf of the gable end walls potentially compromising robustness to resist disproportionate collapse. Again, as empty flats have not been made available then no checks could be carried out.

Wind Loading: - Adds to the vertical dead and live loads within the sides of the building, the gable end walls and particularly in the slender tower structures, to resist sideways loading / sway due to wind loading: -

Historically for example the buildings during 2018 and 2019 and probably during the 1980s, have suffered from strong westerly winds acting upon the buildings,

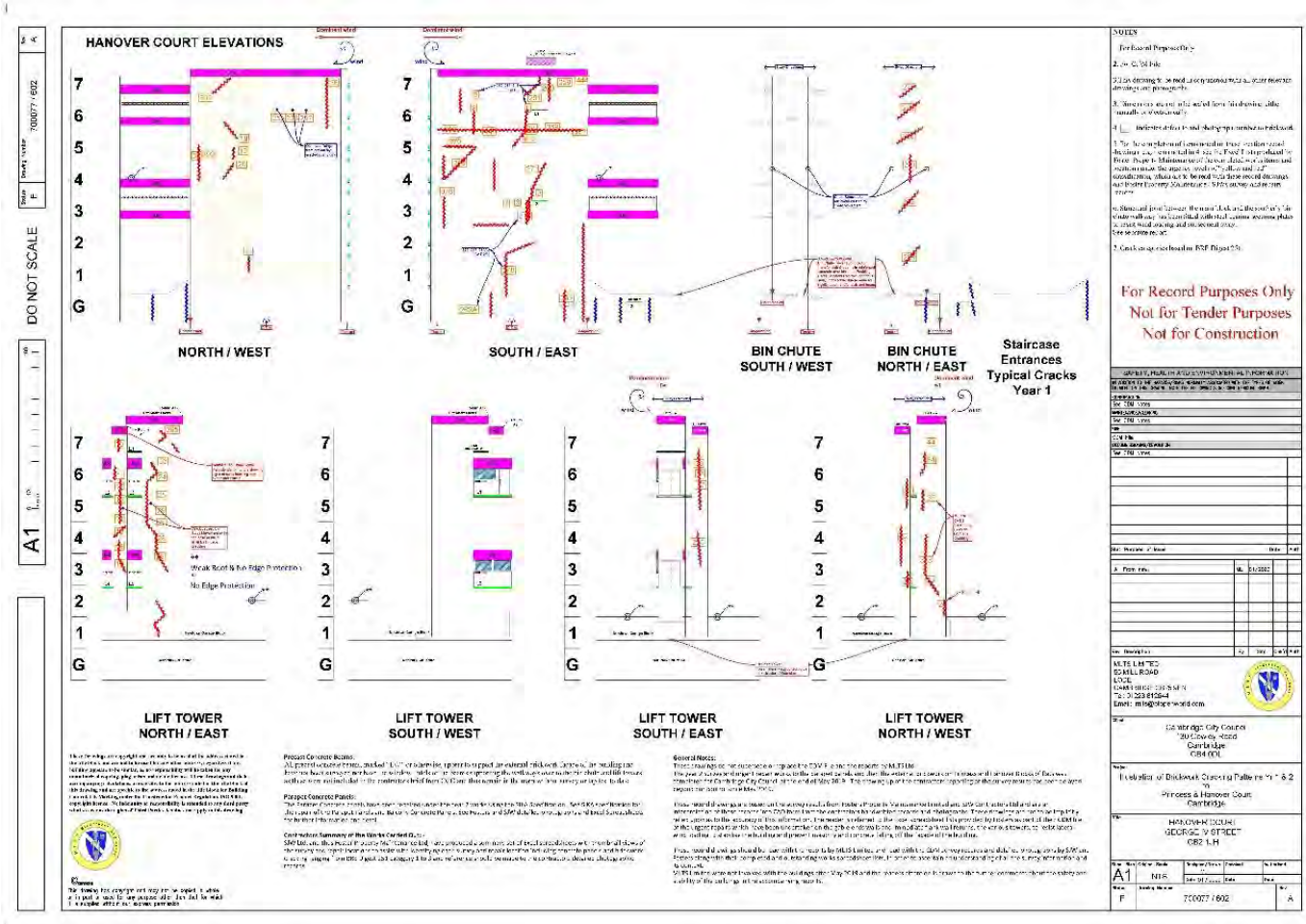
The gable end walls resist lateral loading / sway in order to stabilise the buildings, particularly against the westerly dominant and stronger winds acting on the main long western and eastern facades.

The cracking patterns within the gable end walls suggests damage principally due to wind loading acting on the structure due to the gables resisting lateral sway acting on the main building in order to stabilise the building.

The cracking patterns within the eastern and the western side walls also suggests damage principally due to wind loading acting on the structure due to the internal cross walls resisting lateral sway acting on the main building in order to stabilise the building.

The cracking patterns within the tower structures suggests damage principally due to wind loading acting on these structures due to their tall slender walls resisting lateral sway resisting wind loading.

See MLTS Ltd 600 Series drawings for illustration of the cracking patterns.



Towers: - These tall slender towers appear to act independently due their relatively slender nature, particularly the Bin Chute Towers.

These towers and are not rectangular in plan consistently right down their entire height particularly and critically at the bottom of the towers adding to their flexure of the towers in strong winds.

See photograph below taken in a typical bin store of the transfer slab over the bins supporting the bottom of the tower above reducing the tower stiffness at the transfer slab to resist lateral sway and so partially forming in structural terms, a partial pinned base and supporting arrangement at the transfer slab level. This arrangement naturally exacerbates the sway and the movement of the top of the tower structure above.

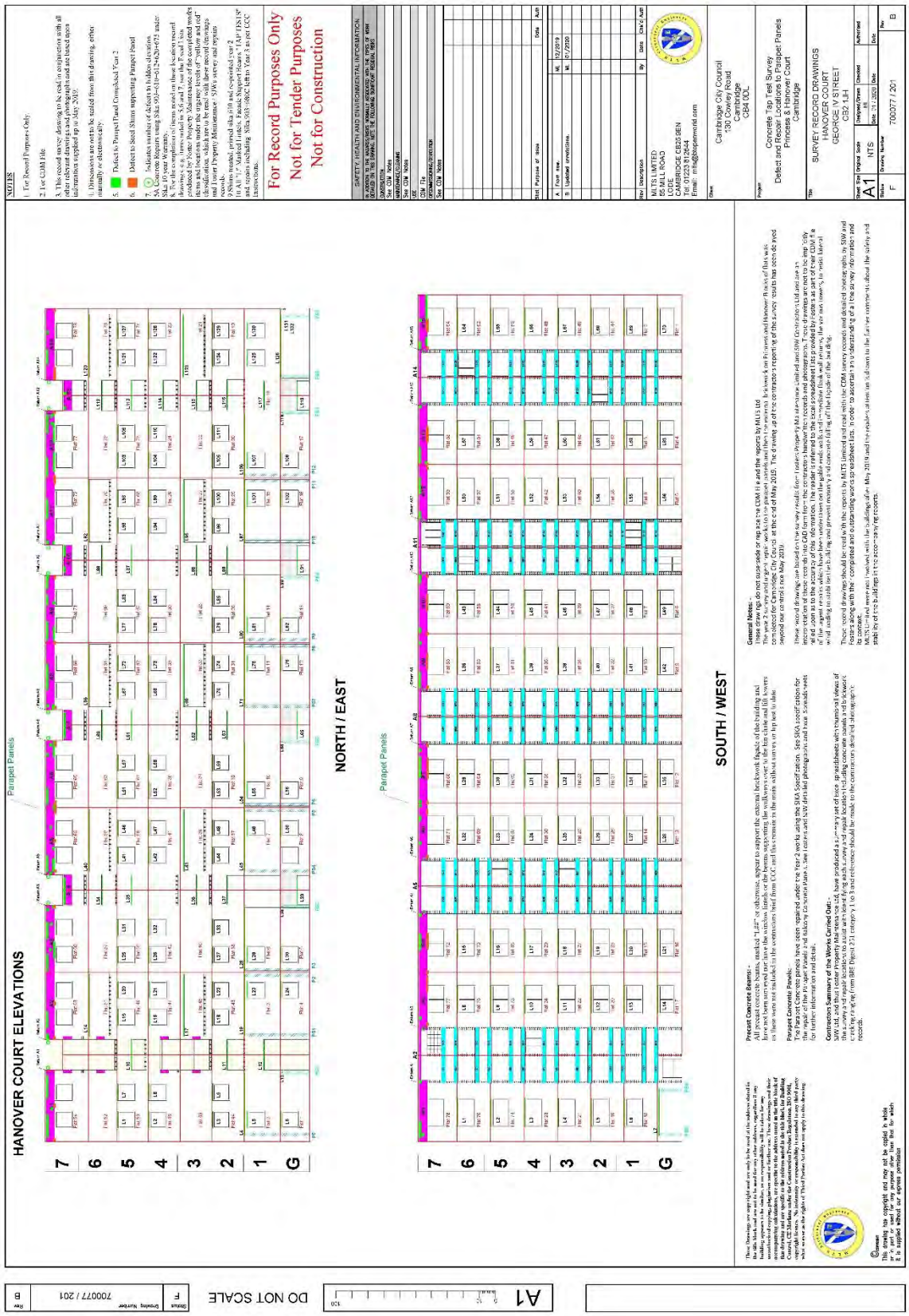
Note: -Bin Chute Tower supported over the bin store

Note: - the concrete beam supports two sides of the tower above.

The bin store walls to the right support the other two tower walls.

See later findings regarding the tower construction and MLTS Ltd 600 series drawings regarding cracking patterns within the towers.

Emergency Balcony Tap Testing of the Balcony Panels: - to remove loose concrete – previously painted over and hiding a hazard of concrete falling off the building, presumably by a previous contractor before Year 1?Due to Accessing the building to Carry out Year 2 Parapet panel repairs as per MLTS Ltd Record Drawing below



Hanover Western Side - Note the mobile access platform used to access and repair Hanover Court Building initially the Parapet panel Repairs and then the Balcony panels Tap Testing to remove loose concrete. .

Typical Site Record for each location of any defect resulting in SJW / Fosters Spreadsheet

Balcony Beam Typical Loose Concrete Removal: - Note the rusty square twist reinforcing bars buried within the precast concrete balcony panels.

Also note the crack in the masonry party wall on the western side due to the loading including wind loading compression load due to wind acting on the eastern side of the building.

Typical loose Balcony panel corner Removed Easily by Hand.

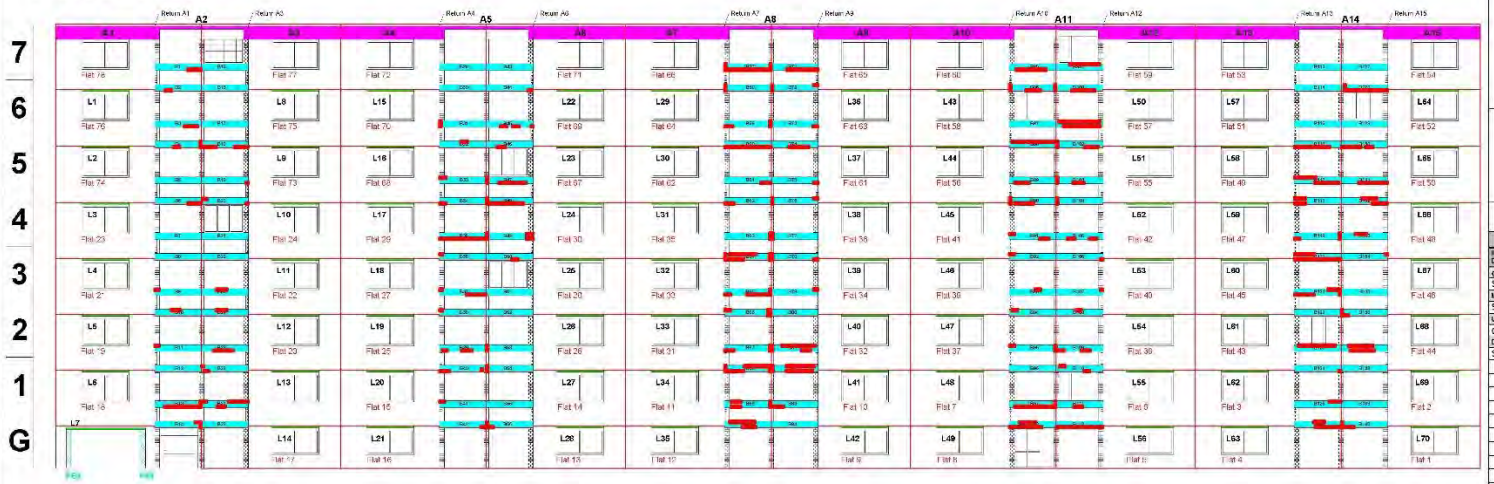
Hanover Court Tap Tested and Primed Panels with SIKA 903 and SIKA 610 Locally – Typical Example

Status F | Drawing Number 700077 / 501 | Rev B

DO NOT SCALE

A1

HANOVER COURT



SOUTH / WEST

NOTES

1. For Record Purposes Only.

2. For CDM File.

3. This record survey drawing to be read in conjunction with all other relevant drawings and photographs and are based upon information supplied up to May 2019.

4. Dimensions are not to be scaled from this drawing, either manually or electronically.

5. ■ Indicates defect to Concrete Balcony Beam / Panel Prepared and Treated with With Sika 903 Passivation and Sika 610 Primer in Year 2 Requiring Re-Preparation in Year 3 for Sika Warranty as per Sika Specification.

For Record Purposes Only
Not for Tender Purposes
Not for Construction

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
IN ADDITION TO THE HAZARDS/RISKS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING SIGNIFICANT RESIDUAL RISKS
CONSTRUCTION
See CDM Notes
MAINTENANCE/CLEANING
See CDM Notes
USE
CDM File
DECOMMISSIONING/DEMOLITION
See CDM Notes

Stat	Purpose of issue		Date	Auth
A	From new.	ML	12/2019	
B	Updated annotations.	ML	01/2020	

Rev	Description	By	Date	Chk'd	Auth

MLTS LIMITED
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Project
Concrete Tap Test Survey
Defect Locations to Balcony Beams
Princess & Hanover Court
Cambridge

Title
SURVEY RECORD DRAWINGS
HANOVER COURT
GEORGE IV STREET
CB2 1JH

Sheet Size	Original Scale	Designed/Drawn	Checked	Authorised
A1	NTS	ML Date 01/2020	Date	Date

Status	Drawing Number	Rev
F	700077 / 501	B

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Precast Concrete Beams: -
All precast concrete beams, marked "L##" or otherwise, appear to support the external brick work façade of the building and have not been surveyed nor have the window lintels or the beams supporting the walkways over to the bin chute and lift towers as these were not included in the contractors brief from CCC and thus remain in the main without survey or tap test to date.

Balcony Concrete Panels: -
The Balcony Concrete Panels have been partially prepared with SIKA 903+ Ferroguard to passivate the reinforcing steel and SIKA 610 Monotop Primer as a holding preparation after removing the loose concrete from the Balcony Concrete Panels.
See SIKA specification for the repair of the Parapet Panels and Balcony Concrete Panels. See Fosters and SJW detailed photographs and Excel Spreadsheets for further information and detail.

Contractors Summary of the Works Carried Out: -
SJW Ltd, and thus Foster Property Maintenance Ltd, have produced a summary set of Excel spreadsheets with thumbnail views of the survey and repair locations to assist with identifying each survey and repair location including concrete panels and brickwork cracking ranging from RRF Digest 251 category 1 to 3 and reference should be made to the contractors detailed photographic records.

General Notes: -
These drawings do not supersede or replace the CDM File and the reports by MLTS Ltd
The year 2 survey and urgent repair works to the parapet panels and then the external brickwork on Princess and Hanover Blocks of flats was completed for Cambridge City Council at the end of May 2019. The drawing up of the contractors reporting of the survey results has been delayed beyond our control since May 2019.

These record drawings are based on the survey results from Fosters Property Maintenance Limited and SJW Contractors Ltd and are an interpretation of these records into CAD form from the contractors handwritten records and photographs. These drawings are not to be implicitly relied upon as to the accuracy of this information. The reader is referred to the Excel spreadsheet lists provided by Fosters as part of their CDM file of the urgent repairs which have been undertaken on the gable ends walls and immediate flank wall returns, the various towers, to resist lateral wind loading to stabilise the building and prevent masonry and concrete falling off the façade of the building.

These record drawings should be read with the reports by MLTS Limited and read with the CDM survey records and detailed photographs by SJW and Fosters along with their completed and outstanding works spreadsheet lists, in order to ascertain an understanding of all the survey information and its context.
MLTS Limited were not involved with the buildings after May 2019 and the reader's attention is drawn to the further comments about the safety and stability of the buildings in the accompanying reports.

Parapet and Precast Concrete Balcony Panels - Carbonation

Note the only concrete retaining any alkalinity to help bars resist corrosion is turned pink by the carbonation test the remining concrete is carbonated and has lost its natural alkalinity due to exposure to the environment. Note: - the almost complete carbonation of the lower drip detail on the panels containing the corroded reinforcing bars.

Another View

Typical Removed Section of Balcony Panel Bottom Drip Detail found loose and painted over

Loosened due to steel bar corrosion

Basic Brickwork Materials common to Princess and Hanover Court and the previous Car park (Newton Road Garages) Emergency Works which are Relevant to the Construction of the Two main Buildings and their Towers.

Issues Discovered during Year 0 - Newton Road Garages Works (located aside Princess and Hanover Courts and the lessons learned for the Princess and Hanover Buildings built in apparently the same brickwork: -

General Views of the unstable access ramp wall

Removal by hand of the loose and frost damaged brickwork – Note the easy separation of the bed joint mortar from the bricks and at the perpend joints. Indicating that the bond between the mortar and the bricks was not especially good possibly as result of the early use of plasticizers to keep the mortar workable for longer periods. Note the clean mortar bed separation with the removed bricks.

Ditto another view: - Removal by hand of the loose and frost damaged brickwork – Note the easy separation of the bed joint mortar from the bricks and at the perpend joints. Indicating that the bond between the mortar and the bricks was not especially good possibly as result of the early use of plasticizers to keep the mortar workable for longer periods.

Note the apparent lack of brickwork ties to tie the brickwork together, causing the separation of the 225mm brickwork, a significant structural defect.

Note the clean mortar bed separation with the removed bricks.

Ditto: -Note the dislodged bed joints two courses below the removal beds suggesting lateral shear failure and separation of the bed joints.

Note the clean mortar bed separation with the removed bricks.

Removed Brickwork again - Another View of the brickwork in the waste skip

Removal by hand of the loose and frost damaged brickwork – Note the easy separation of the bed joint mortar from the bricks and at the perpend joints. Indicating that the bond between the mortar and the bricks was not especially good possibly as result of the early use of plasticizers to keep the mortar workable for longer periods.

Note: - the bricks are almost clean of mortar by the time they are placed in the skip without any intended cleaning up of the mortar off the bricks.

Note: - The clean perpends and beds and the partially filled brick voids, perhaps the only lateral bed joint shear available at any bed due to the increased deadload or weight of the brickwork above.

The bricks appear to be medium strength facing bricks set in type 3 mortar.

Comment for Prospective Year 3 Works: -

Finding: - The incomplete filling of the perpends at the end of each pair of bricks potentially seriously compromises any Helical Beam strengthening design e.g. under windows, as the perpends can close due to the incomplete filling with mortar there for any Helibeam details should be designed with not only tension reinforcement located at the bottom below the neutral axis, but also installed above the neutral axis, if deflection is to be properly controlled and the intended strength in the Helibeam is to be achieved at all.

External View - Before the Year 0 Remedial works

External View - after the Year 0 Remedial works and the reduced and tied back external wall located aside the car access ramp.

Findings Continued - Brickwork and Concrete Parapet Panel Defects Due to Old Abandoned Steel Scaffolding Fixings left in the Facade of the Buildings: -

Old Scaffolding Fixings Damage due to Corrosion Bursting the Brickwork Loosening the Brickwork causing the Hazard of Falling Masonry onto Persons below. Particularly locations near Corners e.g. at 8 Storeys High or 4 Storeys High and as shown under the parapet panels.

Typical Examples of Old Fixings left Rusting and Expanding within the Masonry Façade of the Buildings

Typical example of a badly corroded fixing, presumably used to laterally restrain scaffolding, removed from high up on one of the buildings note the apparent increase in diameter bursting the brickwork. On no account should such ferrous / steel fixings be used on the building again nor any type that causes expansion of the brickwork causing splitting of the bed joints, the perpends and the bricks.

Ditto Another Closer View: - Typical example of a badly corroded fixing, presumably used to laterally restrain scaffolding, removed from high up on one of the buildings note the apparent increase in diameter bursting the brickwork. On no account should such ferrous / steel fixings be used on the building again nor any type that causes expansion of the brickwork causing splitting of the bed joints, the perpends and the bricks.

Scaffolding Products

ST 127 Ringbolt

Ring inside diameter (approx. 52mm) accepts scaffold tube.
Fits HKD anchors (For tensile loads only), HIS resin sockets and MFP-GP16 base plates
Stamped with "1270 Kgs MAX"

ST 127 ringbolt 00058253

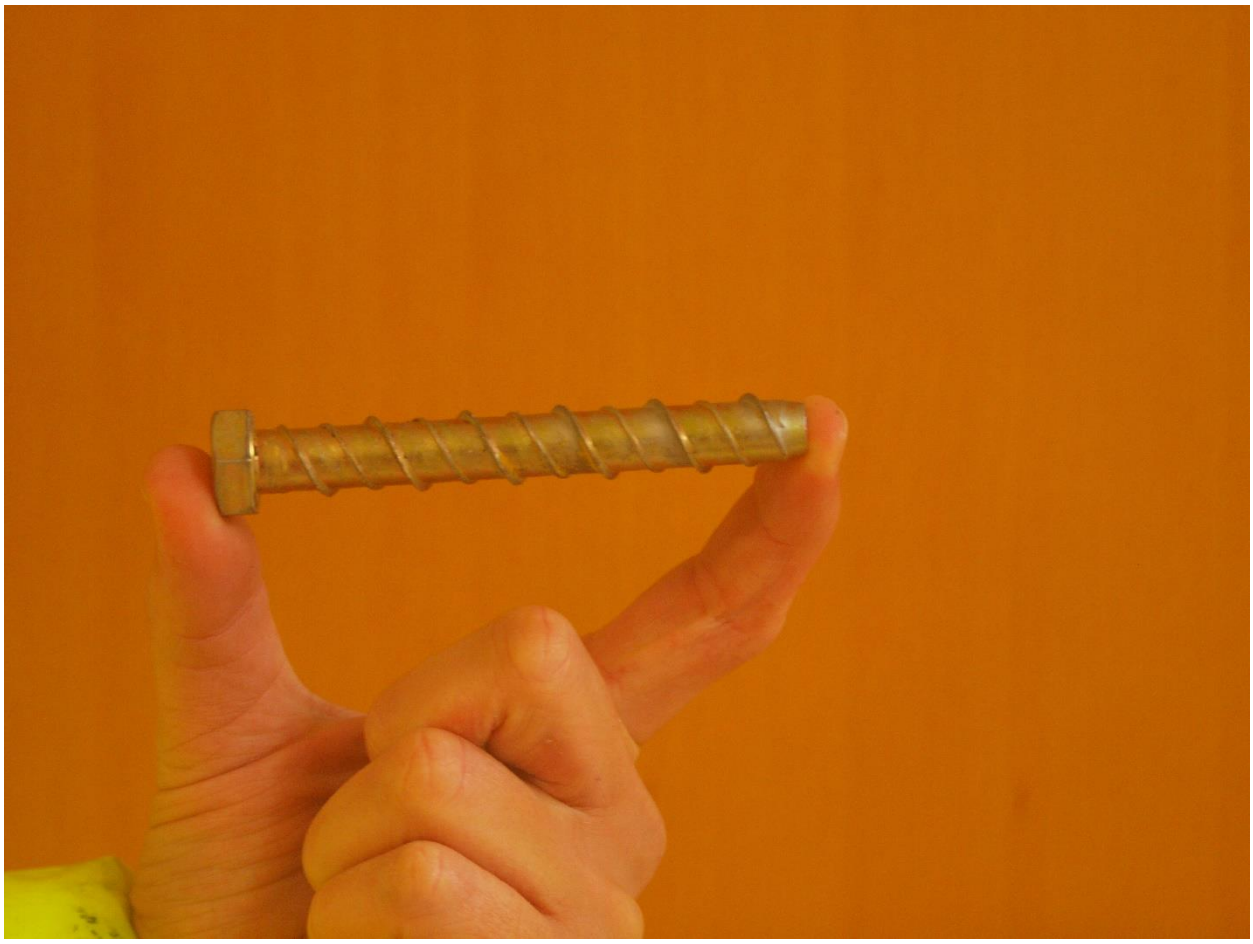
Knock-in anchor

Shallow embedment depth anchor for use in "uncracked" mass concrete
It may work in other base materials but must be proved by site test and will probably require the capacity of the ties to be reduced leading to a consequential increase in the number of ties.
Note the minimum edge distances required.

HKV M16 x 65 socket 00384973

Typical example of a type of fixing, presumably used to laterally restrain scaffolding, removed from high up on one of the buildings note the apparent increase in diameter bursting the brickwork.

On no account should such ferrous / steel fixings be used on the building again nor any type that causes expansion of the brickwork causing splitting of the bed joints, the perpends and the bricks.



Similar fixing which is removable but is installed in a predrilled hole and wound in and out with a battery powered impact hammer thus splitting the reinforced concrete and brickwork – Again a type of fixing to be avoided for use on the buildings which could split the bricks, the bed joints and the perpends or will split the concrete panels.

Typical example of the brickwork splitting under the weight of the parapet panels and thermal / moisture movements at the corners - located at the corner over a communal stairwell. Note the typical failure through the beds and perpends and the bricks under the weight of the concrete panel above exacerbated over years of cyclic freezing and thawing and thermal stress pushing out the brickwork locally at the corners. Helical Repair required at every fourth course to the brickwork back into the building – Note the height this is occurring at the very top of the buildings. Note the stress under the parapet panel Shims see Blue Arrow

Top of Princess Court Bin Chute Tower corroded old Scaffold Fixing bursting the brickwork at High level

Bin Chute Towers Construction - Brickwork: -

Galvanised Butterfly Ties, securing the Outer Skin of the Facing Brickwork –

No Cavity just a 10mm to 12mm wide vertical open joint between the two layers of Brickwork.

Note: - the hole for the Dry Riser effectively weakening the tower near its base against both vertical and lateral loading.

Brickwork: - Only appears to be an overall with both layers of brickwork to be in the order of 225mm thick.

Note the butterfly ties are not sufficient to transfer shear between the layers of brickwork for composite action to occur they merely tie the brickwork together thus reducing the effective lateral stiffness of Brickwork to two layers acting alone rather than cross bonding the brickwork together to from one solid and much stiffer wall forming the bin chute tower structures.

(Shear applied to the butterfly ties due to lateral sway from Wind, per mm of height = S.A.Y/I considering a rectangular section of the tower viewed on plan) See Earlier comments about the partial pinned base support arrangement of the bottom of the towers over the two bin stores.

Note: - the galvanising on the butterfly ties appears to still be sound possibly due to the density of the mortar and the facing bricks?

Sample Panels Detecting Brick cavity wall Ties Patterns: -

Princess Court Sample Panel – Tracing Brickwork Ties with metal detectors

Hanover Court Sample Gable End Panel Tracing Brickwork Ties – Note the unusual pattern

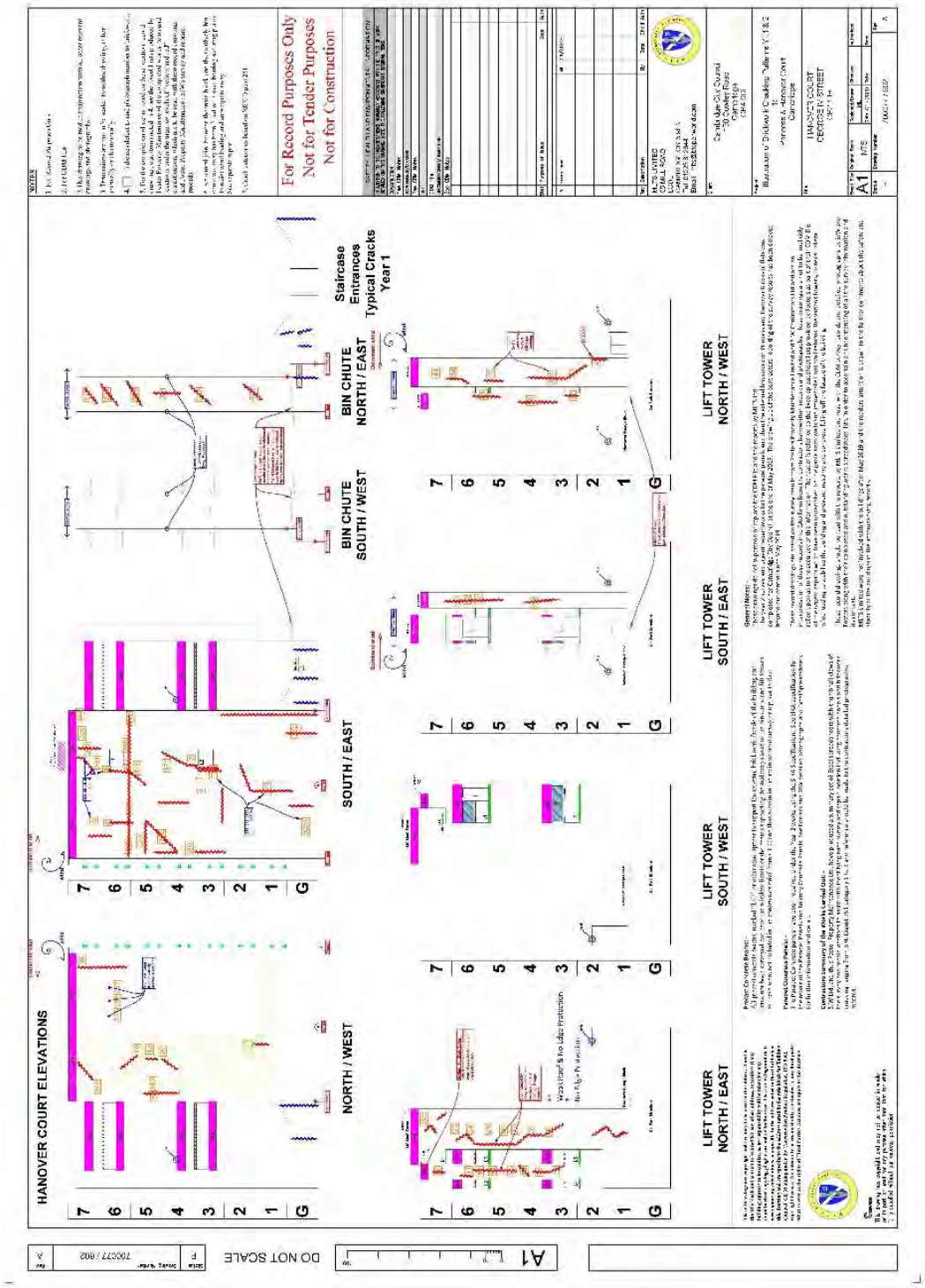
Ditto a view higher up note the short horizontal chalk marks for the tie locations.

SUMMARY DRAWINGS BY MLTS LIMITED: - EXAMPLES

The illustrative drawings prepared from the results of the contractor's surveys suggests that the cracking patterns within the brickwork facades are more associated with wind loading rather than purely thermal moisture movements. Cracking around the bin chute tower walkway bridges bearings onto to the main building's facades has been discovered needing urgent repairs.

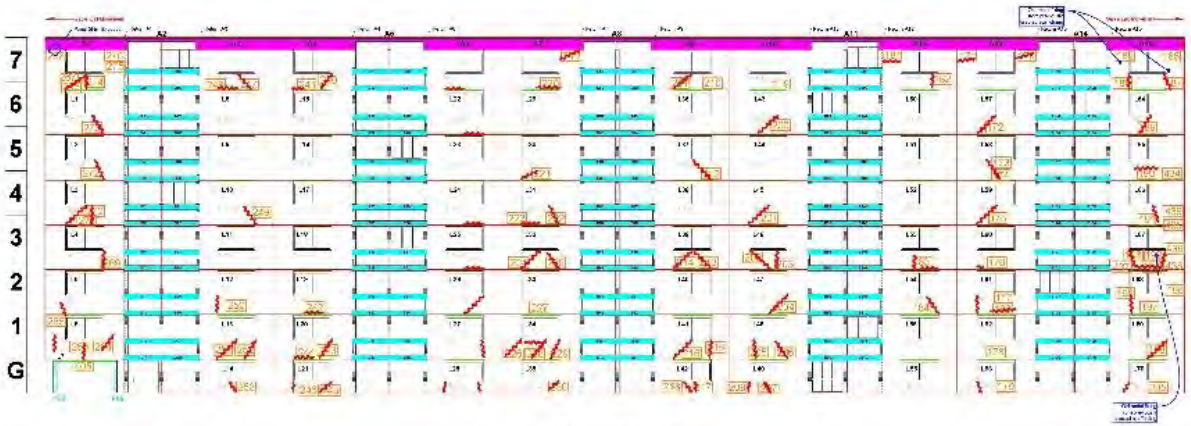
See Below Hanover for example and then Princess Court 600 Series Drawings Cracking Patterns

Note: - to read properly See A1 size Prints or A3 size at the minimum of the PDF files of these drawings located in the Dropbox.



HANOVER COURT ELEVATIONS

NORTH / EAST



SOUTH / WEST

Precast Concrete Beams
All precast concrete beams, marked 'L01' or similar, support the external brickwork cavity wall and internal cross walls/party walls. Do not cut or core window lintels or the beam supporting the wall/piers or remove the brick cloth and dpc moves as shown on the load bearing wall/piers drawings from MLTS and the manufacturer's main contractor survey or replies to date.

Precast Concrete Panels
The Precast Concrete Panels have been replaced during the Year 2 works using the Bova Specification. See SW's specification for the repair of the Precast Concrete Panels. See letter dated 5.2.19 between SW and the structural engineers for further information and details.

Contractor's Summary of the Works Carried Out:
A MLTS structural engineer visited the site on a number of occasions to carry out inspections of the external brickwork and concrete panels and to provide advice on the repair works. The inspections were carried out from ground level using binoculars and a camera. Where defects were identified, photographs were taken and recorded on a drawing showing the location of the defect. The defects were then categorised in accordance with the BRE Digest 251 category 1 to 3 and the type of defect recorded, for example spalling, cracking etc.

General Notes:
These drawings do not supersede or comprise the CDM File and this is held by MLTS Ltd
The repair works and impact investigations to the precast concrete panels have been completed for Cambridge City Council in the end of May 2019. The drawings of the concrete showing the survey results has been received from our architect dated May 2019.

These drawings have been prepared from the survey results from Lucas Property Maintenance Limited and SW Construction. Information in the preparation of these drawings is from CAD files from the contractors and/or client's consultants and photographs. These drawings are not to be solely relied upon as the accuracy of this information is not guaranteed by MLTS. The contractor is responsible for checking all dimensions on site prior to the commencement of any work and to notify MLTS of any discrepancies found between the drawings and the actual site conditions. Any work carried out before such notification is received will be at the contractor's own risk. Do not scale from these drawings. Figured dimensions only are to be taken from these drawings.

These drawings are to be read in conjunction with the specification prepared by MLTS Limited and all relevant structural engineer's drawings and details. Any discrepancies found between these drawings and the specification or structural engineer's drawings and details are to be reported to MLTS Limited before any work is commenced.

MLTS Limited does not take responsibility for any errors, omissions or discrepancies in the drawings or specification that may be contained within any information provided by others. MLTS Limited does not take responsibility for any errors, omissions or discrepancies in the drawings or specification that may be contained within any information provided by others.

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NOTES
1. For Record Purposes Only
2. See CDM File
3. This drawing is to be read in conjunction with all other relevant drawings and documents.
4. Dimensions are not to be scaled from this drawing, either manually or electronically.
5. [illegible] indicates to be confirmed on site [illegible]
6. For the consolidated items listed on these documents and drawings, see items 1 to 4, above the level of risk presented to Client Property Maintenance of the completed works, plans and location made, the urgency levels of the work and cost/disadvantage, which are to be read with these records, drawings and Tender Property Maintenance's survey and reports.
7. Structural engineer's details and [illegible]

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Not for Tender Purposes
Not for Construction

SAFETY, HEALTH AND ENVIRONMENTAL [illegible]

CDM File
Refer to CDM Notes

Rev	Description	By	Date	Check	Auth
A	First Issue	BL	07.2020		

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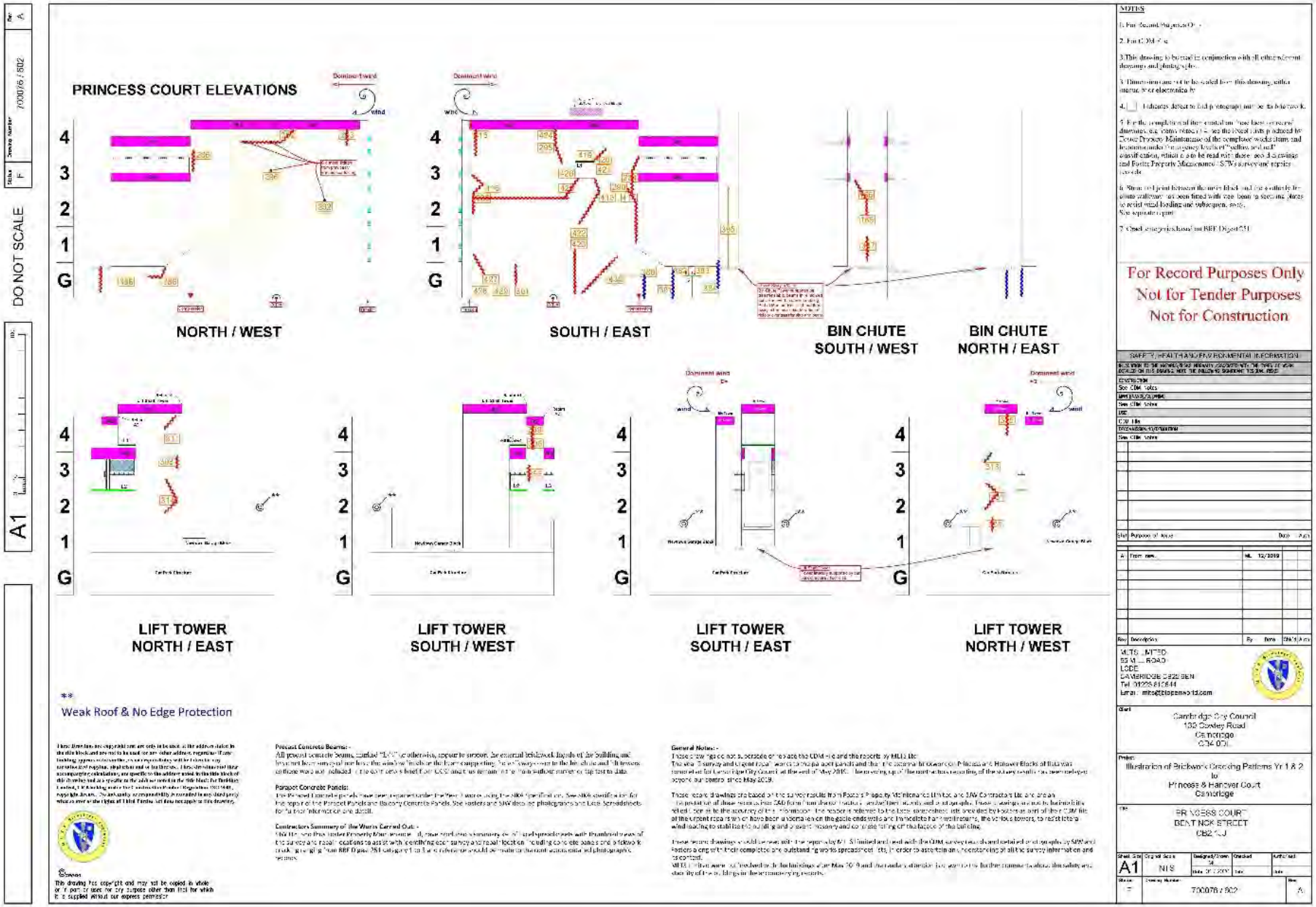
Project
Installation of Brickwork Cracking Patterns Yr.1 & 2
to
Phase A - Hanover Court
Cambridge

Title
HANOVER COURT
ELEVATIONS
CB2 1JT

Sheet Size	Drawing Scale	Drawing Status	Checked	Authorised
A1	NTS	Issue	Date	Date
		Date 6.7.2020		

Status: F
Drawing No: 700037/4001
Rev: A

DO NOT SCALE
A1
Rev: A
Status: F
Drawing Number: 700077/4001


PRINCESS COURT ELEVATIONS
NORTH / WEST
SOUTH / EAST
BIN CHUTE SOUTH / WEST
BIN CHUTE NORTH / EAST
LIFT TOWER NORTH / EAST
LIFT TOWER SOUTH / WEST
LIFT TOWER SOUTH / EAST
LIFT TOWER NORTH / WEST
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A1
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Illustration of Brickwork Dressing Patterns Yr 1 & 2
for
Princess & Hanover Court
Cambridge
PRINCESS COURT
BENNETT STREET
CB2 3QJ
A1
NTS
700076 / 902
Weak Roof & No Edge Protection
Precast Concrete Beams:-
Parapet Concrete Panels:
Contractors Summary of the Works Carried Out:-
General Notes:-
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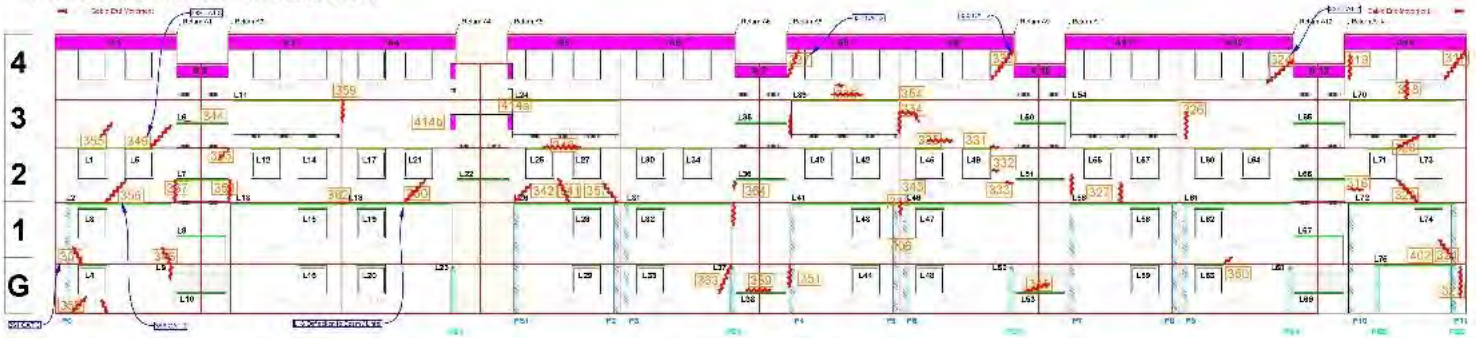
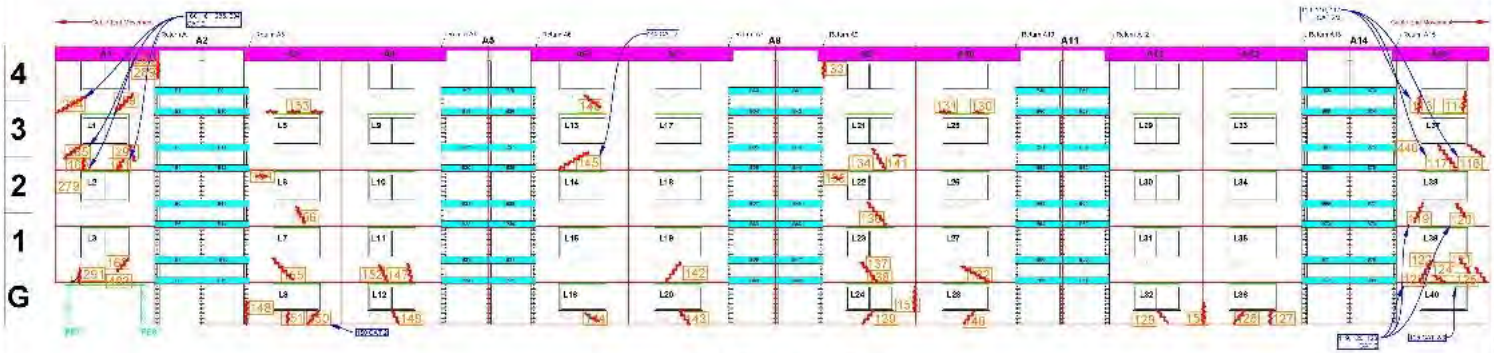
Rev A | Drawing Number 700076 / 501 | Status F | DO NOT SCALE | A1 | ins

PRINCESS COURT ELEVATIONS



NORTH / EAST



SOUTH / WEST

NOTES

1. For Record Purposes Only
2. Not for CDM Purposes
3. This drawing to be read in conjunction with all other relevant drawings and photographs.
4. Dimensions are not to be scaled from this drawing, either manually or electronically.
5. [illegible] indicates defect to fill pointing/repair mortar to brickwork.
6. For the completion of the original survey these elevations were drawn up from a combination of existing record drawings, site visits, notes and photographs taken by MLTS Ltd. Some Drawings were produced by Cyclic Property Maintenance of the complete works items and locations under the agency brief of "cutting and infill" classification, which can be read with these elevations. Cambridge City Council and Foster Property Maintenance - S.M.'s survey and repairs records.
7. Structural joint between the main block and the southerly lift/stair wall/tower has been filled with mastic bonding agent to allow for differential wind loading and subsequent swing. See separate report.
8. Check setting out/levels on RBF Digest 351

For Record Purposes Only
Not for Tender Purposes
Not for Construction

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION
IN ADDITION TO THE NORMAL RISKS ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, NOTE THE FOLLOWING SIGNIFICANT REMAINING RISKS:

CONSTRUCTION
See CDM - Notes

MAINTENANCE/CLEANING
See CDM - Notes

USE
C2A - Flats

DEMOLITION/DISMANTLING
See CDM - Notes

Ref	Purpose of Issue	Date	Auth
A	First issue...	ML 21/2020	

Rev	Description	By	Date	Chkd	Auth

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Project
Illustration of Brickwork Cracking Patterns Yr 1 & 2 to
Princess & Hanover Court
Cambridge

Title
PRINCESS COURT
BENTNICK STREET
CB2 3QJ

Sheet Size	Original Scale	Designed/Drawn	Checked	Authorised
A1	NTS	ML 21/2020		

Status F | Drawing Number 700076 / 501 | Rev A

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Precast Concrete Beams: -
All precast concrete beams, marked "PCB" or otherwise, appear to sound. The external brickwork façade of the building and the internal beam supporting walls are in good condition. No cracking was noted in the brickwork and all lintels on these walls are included in the above schedule. Further CCTV inspections will be undertaken in due course.

Precast Concrete Panels:
The Precast Concrete panels have been inspected under the Year 1 survey during the HSE specification for the repair of the Precast Reinforced Balcony Concrete Panels. See folders and SMV description photographs and Data Spreadsheets for further information and details.

Contractors Summary of the Works Carried Out: -
Cyclic Property Maintenance Limited's summary of the works undertaken with the numbered areas of the survey and reference locations to assist with identifying each survey and repair location, including concrete bands and brickwork cracking, are given from RBF Digest 351 Category 1 and 2 as a reference should be made to the relevant accompanying photographic sections.

General Notes: -
These drawings are to be read in conjunction with the CDM notes and the reports by MLTS Ltd.
The Visual Survey and Urgent Repair Works to the pavement parapet and the Concrete Balconies of Princess and Hanover Blocks of flats was commenced for Cambridge City Council on the week of May 2019. The monitoring of the movement recording of the structure results has been undertaken by our consultancy since May 2019.

These record drawings are based on the survey results from Foster's Property Maintenance Limited and SMV Contractors Ltd, and are an interpretation of those results from CAD format from these Contractors' specifications, drawings and photographs. These drawings are not to be limited to the selection as to the accuracy of the information. The reader is referred to the Data Spreadsheets as provided by both as part of the CDM file of the urgent repairs which have been undertaken on the gable ends with anchor/wall straps, the various towers, to resist lateral wind loading to stabilise the building and prevent masonry and concrete falling on the people of the building.

These record drawings should be read with the reports by MLTS Limited and read with the CDM survey records and notated photographs by SMV and Fosters along with their completion and outstanding works spreadsheet lists, in order to ascertain any inconsistencies of all the survey information and assessment.
MLTS Limited were not involved in the buildings after May 2019 and therefore cannot comment on any further movement, the safety and stability of these buildings in the surrounding records.

Cracked Walkway Beam Bearing onto the Hanover Court Building – Note the tracing of the brickwork ties

Bin Chute Tower Walkways (giving access to the bin chutes from the building)

Typical Bearing onto the brickwork in the Building note the forces pulling the walkways support beams in and out! Of the building due to sway caused by wind loading causing the cracking at the bearings.

Ditto another view

Note: - The typical crumbling and cracking brickwork due to the combined vertical and horizontal loadings

With tie back plate to reduce the risk of the walkways and bin chute towers pulling out of and away from the building

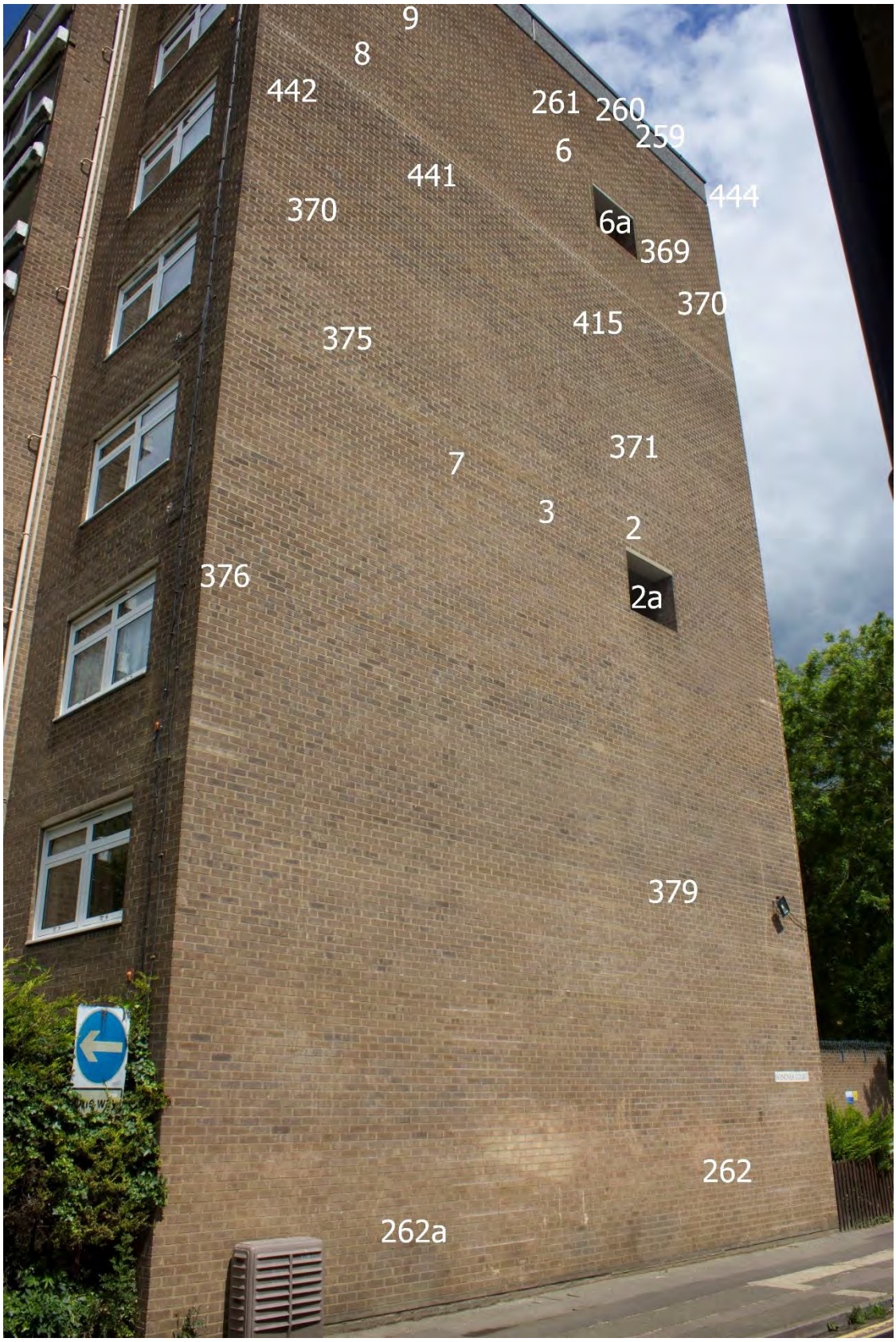
Walkways support beams deterioration of the concrete beams and the bottom brickwork bed joints inadequately restraining these brickwork panels from overturning out of the building - prior to remedial works. Note defects to walkway flooring and walkway beam understood to be treated with SIKA 903 and 680c Anti-carbonation paint.

Walkway side panels restraint posts fitted in Year 1 and Year 2 to prevent occupants pushing the unrestrained side walls with gaps at the ends removing any lateral restraint at the ends form overturning into the communal areas below.

Example Repairs on Princess Tower

Example of - Crack Tracing on Princess Bin Chute Tower prior to Year 2 repairs

Hanover lift shaft tower repairs chased out ready for helical bar reinforcements showing the nature of the cracking presumably caused by the lift cage expanding during hot weather and binding in the gauge of the vertical rails within the tower itself causing bursting forces. Possibly exacerbated by wind loading. Note the lift rails will wear more towards the bottom of the lift than the top as the car always returns to the ground floor no matter what flor the lift serves as required by the user. If the cracking does not abate then consideration should eb given to binding the tower all around the tower with reinforcement at for example every fourth bed courses to contain the bursting forces.



Typical Noted Elevation on Hanover court of Repair Locations Recording Defects and Repairs by Photograph Number using a whit wipe board

Discussion and Conclusions: -

All the findings to date regarding Princess and Hanover Courts including the site records, lists, reports, drawings etc from Years 1 and Year 2 and including Year 0 Works on the Newton Road Garages, indicate the following: -

Previously in 2016 and 2017- known as Year 1 Works: - CCCs and their contractors had identified issues on the eastern piers and staircase entrances due to overloading, probably during strong winds acting on the building as a whole. This has exposed issues with the original design of the buildings at ground and first floor levels due to heavily loaded slender piers, inappropriate location of the staircase entrances crippling these load bearing piers and the inset façade at ground level all on the Eastern facades of the buildings. The facade survey and remedial works were intended to continue on from Hanover onto Princess in Year 2 and the last stages were to be completed on Princess within Year 3 works – See drawings and Year 1 Report.

CCC and their contractors had also previously identified issues with loose and damaged areas of concrete within the parapet panels on both buildings during roof level inspection and Year 1 remedial works and this was to be repaired in Year 2.

The remedial works to the concrete parapet panels were the initial works planned for Year 2 works with the surveys of the external brickwork, the balcony beams and towers commencing in Year 2 due to serious concerns regarding the findings made on site during the course of the Year 2 works. The remaining survey and remedial works are now intended to be completed within Year 3.

Summary of the Façade Issues: - Basically, the buildings are suffering from cracking of the concrete elements due to their ongoing deterioration due to heavy atmospheric carbonation particularly the exposed aggregate decorative panels located around the parapet and the balconies. In addition, and to a lesser degree, the concrete lintels and beams supporting the brickwork facades and walkways around the various openings within the buildings. The staircases and landings were excluded from the Year 1 and 2 works and thus we cannot comment, only to say that these staircases are also reinforced concrete elements similar to the Kingsway Flats, which were found with deterioration and steel bar corrosion issues.

The Brickwork forming the facade cladding has various cracking issues due to combined dead, live and wind loadings. The bearings forming the supports to the reinforced concrete walkway support beams, the main lintels in the eastern elevations and the internal floor support beams within the open communal areas within the building, exhibit numerous examples of split and cracked masonry bearings needing urgent attention in order to restore the safety of the building. The apparent minimal 112mm maximum bearing lengths onto the masonry supporting the heavily loaded long span lintels over the large façade openings within the eastern facades are a safety concern.

Gable End Brickwork Cracking within Each Building: -

Previously, prior to Year 2 survey and repairs, the brickwork gable ends of the buildings were acting a set of dislocated masonry plates rather than a complete gable end wall, to resist overturning of the building. This dislocation of the gable end facades consequently significantly reduced the capacity of the gable end walls to resist lateral wind loading applied to the main western and eastern facades of the building, particularly near the ends of the building at the southern end, as there was no shelter from the wind at low level (the bottom three storeys) from for example the car park structure at the northern end of the buildings.

A set of cracked areas of brickwork or plates are also more likely to be sucked out into the public highway / street at the southern end.

Note:- On a positive note, the removal of the communications equipment occurring before the commencement of Year 2 works, which was standing significantly above the level of the roof on Hanover Court has slightly reduced the wind loading applied to this building at the highest level, slightly reducing the overturning forces acting on the eight storey building and thus on the gable ends and the piers on the eastern sides particularly during storm winds coming from the west.

Particular Observations Made During the Course of the Year 2 Works: -

a) The buildings had cracked further due to the wind loading, over the first half of the Year 2 surveys during he winter storms.

b) Comparison with the surveys in November 2018 confirmed this.

Consideration should be given in the future if the ongoing annual monitoring of the buildings demonstrates if the gable end cracking continues again i.e. during strong storms from the west, to considering banding the whole width of the gables at each floor level and returning around each corner of the building over to the balconies on the western side, the stairwell corners on the eastern side to strengthen the gables and provide some peripheral ties at each floor level to assist with resistance to disproportionate collapse, as well as future addressing wind loading damage to the facing brickwork.

Rebuilding the gable end walls could be considered as an alternative or prestressing them down from the top down to the foundations with internal stressing bars to improve overturning resistance, but this option may not be practical? This is matter for the Year 3 Engineers to consider and investigate in Year 3 works when further investigations can be arranged when a gable end flat becomes vacant to investigate the inner leaf cracking within the gable end and flank walls and the tying in of the facades to the internal walls and floor structures.

We have also previously recommended that the edges of the floors and the ceilings are investigated to determine the tying in of the masonry facades, the gable end walls and the floor plank bearings into the gables and the cross walls, by initially opening up and exposing the structure within a selected sample flat. This is now deferred to the Year 3 investigations for the year 3 Engineers to ascertain the robustness rating of the building.

Façade Brickwork Masonry Bearings:- supporting the walkway beams, the long lintels or beams over the wide openings in the eastern elevations and the internal beams over the internal communal walkways within the buildings have been noted as cracking and failing under the loading imposed upon them and all these bearings need to be repaired in order to maintain the safety of the building and its current robust rating and integrity when the building which was built in 1968 when standards were not so exacting for disproportionate collapse and robust details. Some of these masonry bearings have been repaired in Year 2 Works but others remain still to be repaired in the Year 3 Works.

See contractors lists, MLTS Ltd drawings, Contractors internal defects drawings in the communal areas and Fosters Spreadsheets and site survey records and photographs.

Balcony Panels – **Tap Test Results**: - See site records and photographs and MLTS Ltd Drawings

These are the decorative reinforced concrete panels on the western faces of both buildings.

It appears that in the past a previous contractors have just painted over mould lichen, cracks and loose material disguising the defects and deterioration of the reinforced concrete from view, allowing deterioration to continue until 2018, when with close examination with mobile access equipment the concrete panels exhibited large amounts of dangerous loose materials ready to fall off onto persons below and an emergency safety Tap Test of all the Balcony Panels was

commissioned by CCC. A sample Balcony panel was cleaned off during the Year 2 works to ascertain if mechanical means could indeed adequately clean off the poor quality loose and split paintwork off these panels enabling the application of Sika 903 and Sika 675 Anti-carbonation paint.

Bin Chute Towers at Hanover and Princess Courts

Various serious cracking patterns were discovered within the bin chute towers adversely affecting the integrity and stability of the towers which were repaired during Year 2 works

Lift Shaft Towers Particularly Hanover Lift Shaft – One particularly noteworthy initial report arose during the Year 2 survey of a vertical crack / split, was discovered by the rope access team, running down from the top of the Hanover lift Shaft Tower. (29 Courses) possibly due to lift cage crabbing towards the top of the tower aggravated by thermal and moisture movements of the tower and thermal movements of the lift cage etc, requiring further investigation of the lift shaft internal dimensions, lift cage shape, rail wear and gauging and overall settings and clearances at each floor level, thus has also been deferred to Year 3 after these cracks were repaired in Year 2 and left to be monitored.

Note: - The Year 2 Brief only relates to the Parapet (Apron) Concrete Panels and Previously Localised Overloading of the Façade Slender Piers and Entrance Stairwell Walls all below 2nd Floor Level in Year 1 Brief and did not include the staircases and landings.

Consideration of Year 3 Works by Others: - Summaries below based upon Year 2 Findings

Outline List of Considerations of the Future Brief for the Engineers going into Year 3 Works i.e. Messers Millards and MACE

- **Original Building Design** - shortcomings – slender pillars, wind loading, water ingress, heat / thermal effect lack of movement joints in the brickwork and the structure.
- **Local overloading** of the facades e.g. piers and stairwell walls.
- **WIND LOADING additional to Dead and Live Loading**. Brickwork cracking apparently suggesting over stressing beyond 25 % overstress DL+LL+WL allowance in the faced brickwork.
- **Poor Maintenance / Painting** over the years, leading to degradation of the concrete surfaces due to using non-breathable and non-compliant Anti-carbonation coatings. *See Trial panel on Hanover western elevation to mechanically remove the poor quality cracked and peeling paintwork*
- **Ongoing Dangerous Condition of the external and internal concrete façade surfaces** but reduced due to Year 2 works but still ongoing into Year 3 works, danger of falling masonry – see site photos & samples of the balcony panels lintels beams and stairwell stairs and landings.
- **Emergency Repairs / Remedial Works** - to date and future planned emergency and repair works to the facades, including brickwork repairs following on from Year 2 into Year 3.
- **Emergency Remedial and Repair works to the towers and the walkway bridges** mostly complete within Year 2 works
- **Internal cracking surveys within the communal areas –** significant amount complete in Year 2 works ongoing into Year 3 works
- **Internal tap test survey of all the reinforced concrete staircases and landings –** not included at all in Year 2.
- **Prioritised Urgent (Red rated urgent) of the Year 2 to Year 3 repair works** to the concrete elements, the brickwork, the tower structures and gable ends completing the stairwell and pier works already nearly completed, except for Princes Court eastern façade. See Year 1 Report. See Fosters Lists Yellow rated items deferred to Year 3
- **Further investigations** - drainage, foundations floor, walls structure internally.
- **Photographic Recording System of each defect and repair**- used by the contractors on site and drawing up records and Excel lists to be maintained in order to record who has made what repair and when on the facades of the buildings.

- **Calcium Chloride testing** See GBG Report and Year 3 Facade Beams, Lintels and Panels (Balcony Beams Parapet Aprons yet to Test)
- **High Alumina Cement Testing** See Separate GBG Report (Potentially Terminal - HAC Conversion)
- **Butterfly Cavity Wall Tie Locations, Patterns and Spacing –** Partial Sampling carried out in Year 2 Full Survey deferred to Year 3 Works
- **Wall Tie Surveys** - condition corrosion / life more sampling deferred to Year 3 Works
- Window and Openings Lintel and Beam passivation and anti-carbonation coloured, and clear coatings deferred to Year 3 with SIKA 903 and SIKA 680c
- **External Walls – Surveys for** plumb / bowing / buckling remainder deferred to Year 3 Works and to be included in ongoing Monitoring
- **Further Review of Building Life** versus maintenance costs per annum using costs to date and initial estimates CCC surveyors.
- **COSTS** – Balcony Beam / Panel Concrete and brickwork repairs and contractors' warranties
- **Desk study of contractor's surveys and photographs** - plus CCC and MLTS Ltd Photos to be extended into Year 3 Works to ensure full traceability of all repairs on the buildings and to enable which contractor carried out what work on the buildings
- **Further Reporting of findings -** using photographs of site white wipe boards noting each defect and repair location to be continued into Year 3 works**.**
- **Original Heating and Cooking Appliances Assumed in Original Design as Electric only.**
- **Gas Supply has apparently been retrofitted to the buildings** and consideration should be given to removing gas appliances in favour of electric appliances in accordance with Ronan Point report and other and standards since to reduce the risk of disproportionate collapse even in masonry cross wall construction buildings particular Hanover Court, a Class 2b building.
- **GAS Safety –** Continue to Review Annually the stringent Gas Safe Checks and Certification for all flats to be strictly monitored by CCC so no unsafe appliances likely to explode can occur**.**
- **Preliminary Review / Assessment of Building Life** versus maintenance costs per annum using more accurate data and costs (5 Year, 10 year and beyond life) to be passed back to CCC and Millards and MACE to maintain and undertake.
- **Completed Year 1 and Year 2 Works to be periodically Monitored –** Including Hanover Piers and Stairwell Wall openings located at ground / first floor levels. The repairs are completed and are to be monitored particularly after strong winds - Princess Court only Partly completed in Year 1 and 2 and remainder of these works have been deferred to Year 3 works
- **Bin Chute Walkway** Brickwork pedestrian restraint panels new restraints in brown steel posts completed to stabilise these unsafe masonry panels.
- **Bin Chute Walkway Beams "TIE Back" -" Meccano plates"** majority installed, some still to do but subject to ongoing monitoring after strong winds to retsina the tower against wind sway and to prevent these beams pulling off the short masonry bearings and collapsing.
- **Roof Access Hatches** completed on Princess and Hanover Buildings but Sure Safe roof perimeter handrailing's to replace the old handrails to be installed on princess Court roof to match Hanover Court – Details are in the CDM file.
- **Permit to work system** to be implemented and maintained for all roof access.
- **Roof Perimeter Safety Handrailing - completed on Hanover deferred to Year 3 Princess Court**
- **Staircase Handrailing improvements** remedials and repairs to staircases / walkways and communal areas. To be completed as part of CCC handrailing upgrade schedules, but can be compromised by crumbling, splitting, spalling, stair and landing edge concrete i.e. near the handrail fixings and so mentioned here as part of CCC Year 3 Handrailing and Surveys Schedules.
- (**Monitoring / Visual Inspections of the Facades -** Annual Inspections and 3 yearly inspections and surveys e.g. 3 yearly using access equipment or rope access.
- **Repair and Planned Maintenance Schedules –** to be updated e.g. to exclude the use of masonry paint in favour of anti-carbonation paint SIKA 675 and Sika 680c Clear.
- **Tree Policy - No new planting without Structural Engineers prior approval**. No planting over DRAINS !!! or aside the Building - Removal of self-seeded and tenants / leaseholders' trees as Structural Engineer sees necessary, to be removed.

- **Drains Surveys and Maintenance Policy -** Gathering together and collection of Drains Surveys to date and implementing any and all repairs.
- **Painting Policy** E.g. Concrete elements - Anti-carbonation Paint e.g. SIKA 680c or 675 Only see above. No Masonry Paints to be used.
- **CDM** Policy for the buildings and CDM file continuing to updated.
- **Balcony – Pedestrian Part K of the Building Regulations -** Balcony mesh in fill panels (black) corroded and CCC have been exploring themselves various alternative replacements to these grills e.g. using solid or nominally perforated stainless steel platework.
- **Safety Mesh Grills** and means of escape CCC Exploring in filling openings in the facades and safety issues.
- **Continuation Maintenance of the fire brigade dry risers** and their valve gear for firefighting.
- **This list is not exhaustive and merely lists items which have come up during the course of the works and come to the clients renewed / current attention.**
- **CCC Clients own list** for example of their own scheduled repairs mentioned below for information purposes only as follows:
- ***CCC Clients Own Summary dated 2018 of the - Remaining Work***
- *Yellow work to Princess and Hanover, H West elevation, P West and East elevations*
- *Repair to balcony beams, concrete spalling*
- *Replacement of metal screens to balconies*
- *Modification of roof drainage, to include re-routing downpipes, modification to underground drainage*
- *Re-Setting handrails and adjustments to Hanover Court.*
- *Adaption of roof cut-out guard rails*
- *Upgrade handrails at Princess court*
- *Additional protection around loft access points.*
- *Glazed enclosure and small roofs to lift end bin chute area*
- *Modification to bin chute roofs, lift end both blocks*
- *Alteration of walkway drainage, adjacent Hanover lift, stopping damp problems in adjacent flats*
- *HHSRS upgrades to all stairs*
- *HHSRS modification to Coronation Street wall openings*
- *Repairs/adjustments to Hanover Court lift*

These two buildings have facade structural problems and other problems yet to be investigated and beyond the mere brief of the facade issues: - The buildings built in 1968 are moving towards the end of their design life whatever that was originally. Arguably the buildings had design issues and construction issues compared to modern standards and will need a large financial investment to bring them up to standard or simply to slow the deterioration of the buildings by cycles of annual monitoring and maintenance.

The defects were categorised into yearly works schedule now embodied into the contractors site spreadsheets after the urgent items were completed. See contractors' defects lists and spreadsheets.

No doubt some of the outstanding defects recorded will continue to deteriorate, particularly if not addressed.

The task for Year 3 is to complete ala the surveys and repairs and move onto a cyclic and normal annual visual maintenance, inspection management and repair system, supplemented by 3-year high level accessed "Periodic" inspections to examine the facade elevations at each and every level above ground up to the roof.

Therefore, Consider Managing the Buildings in Accordance with Civil Engineering Procedure: -

Example of Civil Engineering Procedure for Repairs Maintenance and Monitoring the Buildings in outline terms of: -

1) Visual Surveys, W.A.S. walk around surveys.
2) Identify the obvious visually observed issues and defects high definition zoom cameras should be used.
3) Initiate obvious simple remedial works e.g. clear blocked gullies drains, gutters and flashings etc. etc etc
4) Investigate further any issues by various means with various professional assistance
5) Review and re-investigate and or extend the investigations e.g. survey at height……
6) Laboratory and other testing etc e.g. locating reinforcement in concrete and taking samples
7) Review, desk study and report.
8) Design remedial works
9) Schedule
10) Cost
11) Budget
12) Execute and that may involve another cycle of items 1 to 8 etc and so forth, annually, biannually or every 3 to 5 years and so one for the remaining life of the building.

Recommendations: -

These recommendations are here given in principal only and any further investigations and remedial works will be subject to further advice consultation and specification of such remedial works in detail before any works whatsoever are undertaken on site.

Part 1 - Basic General and Typical Relevant Recommendations for such the Buildings for example: -

1) *The trees located immediately around the property are managed to prevent tree root damage to the formation supporting the foundations by the City Council Tree Officers in order to monitor, minimise or abate any impact on the stability of the property.*
2) *We recommend the excavation of trial holes to ascertain the depth of foundation and any tree root activity in the clay and under the foundations.*
3) *Trial holes should be excavated carefully by hand after determining the exact routes of the electricity gas and water services in order to make an assessment of the state of the formation and foundation stability risk, in accordance with NHBC 4.2 guidelines, for example.*
4) *The drainage investigations and any repairs should be completed following CCTV camera surveys.*
5) *We recommend monitoring the properties every year to ascertain if the mature trees have an adverse effect upon foundation stability.*
6) *Maintenance of the rainwater gutters, gullies, drains, should be maintained to ensure that the rainwater does not overtop the gutters and escape down to the formation under the foundations causing foundation movement.*
7) *Keeping any trees self-seeded and or otherwise, away from the property as ascertained by the NHBC and BRE guidance regarding trees and buildings chapter 4.2 see http://www.nhbc.co.uk/builders/productsandservices/techzone/nhbcstandards/technicalguidancedocuments/*
8) *If tree roots from the trees in the public areas or the gardens are ever identified as pervading under or near the footings of the property in the future, then we recommend such the investigations of the foundations and use the LTA Joint Mitigation Protocol to have the tree managed or felled by the owners of the tree / trees*.

Part 2: - Main Recommendations: -

A cost benefit analysis should be undertaken for the buildings bearing in mind their age and year of construction 1968 along with their ability to resist disproportionate collapse, with consideration of the findings of various reports concerning disproportionate collapse of masonary cross wall buildings and latterly the Grenfell Tower Reports, particularly in the case of Hanover Court including the changes to standards, legislation and particularly the management and qualifications of those parties managing Class 2a and Class 2b buildings, now being currently being reviewed along with updates to multiple occupancy building management systems.

The Year 3 Works including the ongoing surveys and for example the concrete repairs to the balcony beams and the remaining brickwork repairs etc as previously discussed, should be undertaken without further delay to repair the integrity of the facades which in the case of the brickwork appear to contribute to the overall stability of the buildings. In particular, Hanover Court due to its eight storey height and being a class 2b building of simple cross wall construction built in the 1968 when building standards particular structure etc were not as exacting and given that gas apparently has been retrospectively installed in the building as maintaining the integrity of the building is paramount to maintain stability particularly during an accidental event.

Consideration should be given to diligently maintaining gas safety standards in both the leaseholder and tenanted flats and the buildings as a whole, as the buildings were built before 1972 /1976 and do not appear to have been strengthened as a result of the Ronan Point Report possibly as the buildings were seen as masonry cross wall construction buildings and so perhaps been overlooked by the industry and government. Eight storey cross wall construction buildings are not particularly common as steel and reinforced concrete framed buildings which were more economic and quicker to build at the time.

Main Buildings Facades: -

Periodic Surveys of the Facades: - The buildings should be monitored every third year (and no later than 4 years) preferably in good sunny spring weather to enable close access with a high level using mobile access platforms. Concrete repairs to be carried out in dry warm not hot conditions in a timely manner. Certainly, above 5 degrees centigrade air and surface temperature and preferably 10 to 15 degrees, but no more as the summer heat can adversely affect the repair materials subject to SIKA recommendations for optimum repair material performance.

Inspections: - In particular the gable end walls and towers should be inspected with care and initial and interim investigations can to a limited degree be conducted with telephoto lens from the ground but this has proved not to be reliable as its only identifies areas where material has already dangerously already fallen off the building.

As drone technology and software stitching 50-megapixel views together forming a seamless detailed view of each face of the building and this software and techniques progresses, then this method becomes a far more economic interim survey method. If more information is sort in this respect, then may we refer the new engineers to GBG Downing Park, Swaffham Bulbeck, Cambridge, CB25 0NW who we understand can undertake such specialist drone façade surveys of the brickwork and concrete items in the facades. See http://www.gbg.co.uk/

Consideration ought to be given, as discussed, during year one and two works, to taking the opportunity to study the internal structure of the building for example by entering an empty flat or flats located aside a gable end wall at each end of the each building to examine any dry lining, which may not be in asbestos boarding and to enable test drillings and opening up of the masonry forming the internal leaf of the cavity wall and the party wall. To, determine if the bearings of the internal precast concrete flooring units forming the concrete floors, comply with robust details both into the gable end wall and the

internal party walls. Also, to ascertain of the external gable brickwork cracking is occurring in the masonry inner leaf of the cavity walls.

Masonry Bearings Under Beams and Lintels – Cracking and Failures: - Serious issues remain at the bearings of the facade support beams and internal load bearing beams to be repaired in Year 3 – see previous notes in findings and conclusions and record drawings and lists.

The nature and extent of the bearings of the main façade supporting long span, concrete lintels ought to be verified as they appear to be only 112mm or less certainly it would seem not more To ascertain if the nature of these bearings are sufficient to form robust details and resist disproportionate collapse, in both buildings due to accidental damage, particularly in Hanover Court.

Lifts and Lift Towers:- A survey of the gauge of the lift shaft rails and running clearances with the lift towers should be undertaken to ensure that the lists do not bind between the rails particularly in hot weather including at the top three floors making a binding noise, as this will impart bursting forces within the lift towers which they are clearly from the cracking are damage not able to sustain. Indeed, this issue is particularly as structural concern as the lift towers are built external to the building in a form which would normally be constrained by being within the building and retained all a around the masonry lift shaft at every floor level. If this issue is not addressed, resolved and maintained so it does not occur again then a serious structural failure of the lift and or the lift towers could occur. Given the design, nature and construction of the lift towers then serious consideration ought to be given to banding the towers with Helifix every fourth course proceeding vertically above the car park structure level 3 to render an adequate factor of safety for the lift towers where they are not confined within the floor slabs of the garage building.

Bin Chute Tower Walkways: - On no account should the bin chute tower walkways be enclosed with fitting windows as this will increase the windage on the towers causing them to sway along the building causing further damage of the bearings of the walkways into the building brickwork and the brickwork forming the towers.

Drainage: - The drainage and water systems should be investigated and maintained so as not to cause damage to the foundations and the stability of the buildings.

Overall Stability:- Given that the external facades apparently, assist and contribute to the lateral support of the buildings against wind loading, a major stability requirement, the attachment of the facades to the structure buildings and cavity wall ties and spacings should be additionally surveyed in detail and recorded to ensure that the facades can continue resit wind suction and any accidental loadings for example due to the use of gas within the building. See MLTS Ltd Crack pattern Drawings 600 series.

Maintenance: - The brickwork facades, the lintels and the concrete elements should be maintained.

Durability of Concrete Elements: - Consideration given to improving their durability from for example, coating with SIKA 902 and SIKA 680c clear anti-carbonation paint.

Painting: - ON NO ACCOUNT should any concrete lintel or element be painted with any other paint unless it is a certified tested anti-carbonation paint. Masonry paints should not be used on concrete elements. From experience on Kingsway Flats, masonry paints or poor-quality paints cause condensation behind the impermeable paint membrane. Due to the internal inhabited environment, condensation behind the paint causes reinforcement corrosion and frost damage of the concrete located any poor-quality paint. BEWARE PAINT PRODUCTS claiming to have anti-carbonation and vapour breathable quality! Careful control of the paints used on these buildings is critical to durability.

Brickwork Helical Bar Remedial Repairs should be carried out using a grout primer e.g. Helifix Primer and Helibond grout for example to maximise and improve the bond considering the tendency for the existing mortar to separate along the bed joints.

The Concrete Repairs have been commenced using SIKA products it makes logical sense and for continuity to continue to use the SIKA products and their warranty.

Gables and Towers Banding with Helical Repairs: - Particularly the Lift Shaft Towers – serious consideration should be given to "banding" the gable end walls and the towers every fourth course if cracking continues as per two of the Bin Chute Towers as continued monitoring for the life of the buildings determines. See previous comments and discussions.

Lift Shaft Towers Banding: - however without determining the cause of the cracking from the lift equipment for example, banding may not rectify the problems and a new lift shaft tower may have to be considered.

Consideration of Helically Reinforced Beams: - Located under windows e.g. at the northern end of the western facades forming the gable end reruns stabilising the gable end walls.

Previous Notes from Findings: - *the bricks are almost clean of mortar by the time they are placed in the skip without any intended cleaning up of the mortar off the bricks.*

The clean perpends and beds and the partially filled brick voids, perhaps the only lateral bed joint shear available at any bed due to the increased deadload or weight of the brickwork above.

The bricks appear to be medium strength facing bricks set in type 3 mortar.

The incomplete filling of the perpends at the end of each pair of bricks potentially seriously compromises any Helical Beam strengthening design e.g. under windows, as the perpends can close due to the incomplete filling with mortar there for any Helibeam details should be designed with not only tension reinforcement located at the bottom below the neutral axis, but also installed above the neutral axis as compression reinforcement, if deflection of the brickwork and lintel is to be properly controlled and the intended strength in the Helibeam is to be achieved at all.

Consideration of the Removal of the Car Park Structure: - which is restraining the first three floors of the lift shafts particularly Hanover Court lift tower at the northern end. See previous comments but the lift towers appear to be of a construction suitable for location inside a building laterally restrained at every floor level by the internal floors. Removal of the car park structure could cause failure of the external lift shaft towers as they try to stand on their own.

All Year 3 Investigations and Remedial works to be quantified from Fosters and SJW lists and record photographs and specified by Millwards and MACE.

This summary report is intended as an introductory summary and not as any instruction to carry out any work which is a matter for our clients and their contractors under the terms of the 2015 CDM Regulations and thus further design work and details will be required, as separate and additional brief, accordingly to advance to clarify and determine the pre-construction stage under CDM 2015.

Signed

For and on behalf of MLTS Limited,

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