Revision: issue 2
Date: 30 June 2014

Apparel Gallery Ltd.

147-148, Norshinghpur, Asulia, Savar, Dhaka
(23.929985N,90.304914E)

23 March 2014

Structural Inspection Report

Observations & Actions

Authors: John Collins, Richard Hill
Checked by: Robert Mc Grath
Approved by: Peter Flynn

Category Amber

Category RED if Key actions on page 3 to 6 are not immediately progressed

DEA

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Executive summary

On **23 March 2014 Richard Hill and John Collins** carried out a visual structural survey of **Apparel Gallery Ltd.** factory at the address and coordinates given on the cover page of this report. We met with Mohd Obaidul Haque (Executive Director), Khan Md. Nuruzzaman (Executive Director Engineering) and we were provided access to all parts of the building for inspection.

The Apparel Gallery Ltd factory was comprised of an 7 Storey building including a basement level. The building is used for the general production of garments including sewing, finishing, packing. Storage of materials were housed in another 8 storey building of which Apparel Gallery occupy 2 floors.

We were shown copies of Permit drawings for building No. 1, these were signed and dated 18 May 2010. There were discrepancies between the permit and engineering drawings for building No. 1. Building No. 2 did not have permit drawings available.

We were also shown copies of Soil investigation report dated December 2005 for Building No. 1, the borehole logs are dated 23.11.05. Building No. 2 soil investigation report is dated May 2010, the borehole logs are dated 18.03.10

Building 1 shows evidence of repairs to slab soffits at underside of ground floor slab below where the raised floors for drainage have been constructed. There is some evidence of overloading in a zone to the West of the building on all floors. The remainder of the structure seems to function properly.

Executive Summary (Continued)

We do have some important concerns that need to be **addressed immediately**, which give rise to our recommendation for an immediate **reduction loading in areas specified and the investigation of ground floor build-up all as shown on pages 4,5 and 6** below and the immediate commencement of a **Detail Engineering Assessment** (see actions below).

The principal reasons for our concern is that columns at ground floor appear to be stressed to levels that require **immediate** review.

We would recommend that the Detail Engineering Assessment for this building be **completed within 6 weeks** of receiving the report.

If the Building owners are not in a position to complete these actions immediately, the **Factory Building** should be re-classified as **Category Red** and evacuated.

Building 1 – Load Reductions Required

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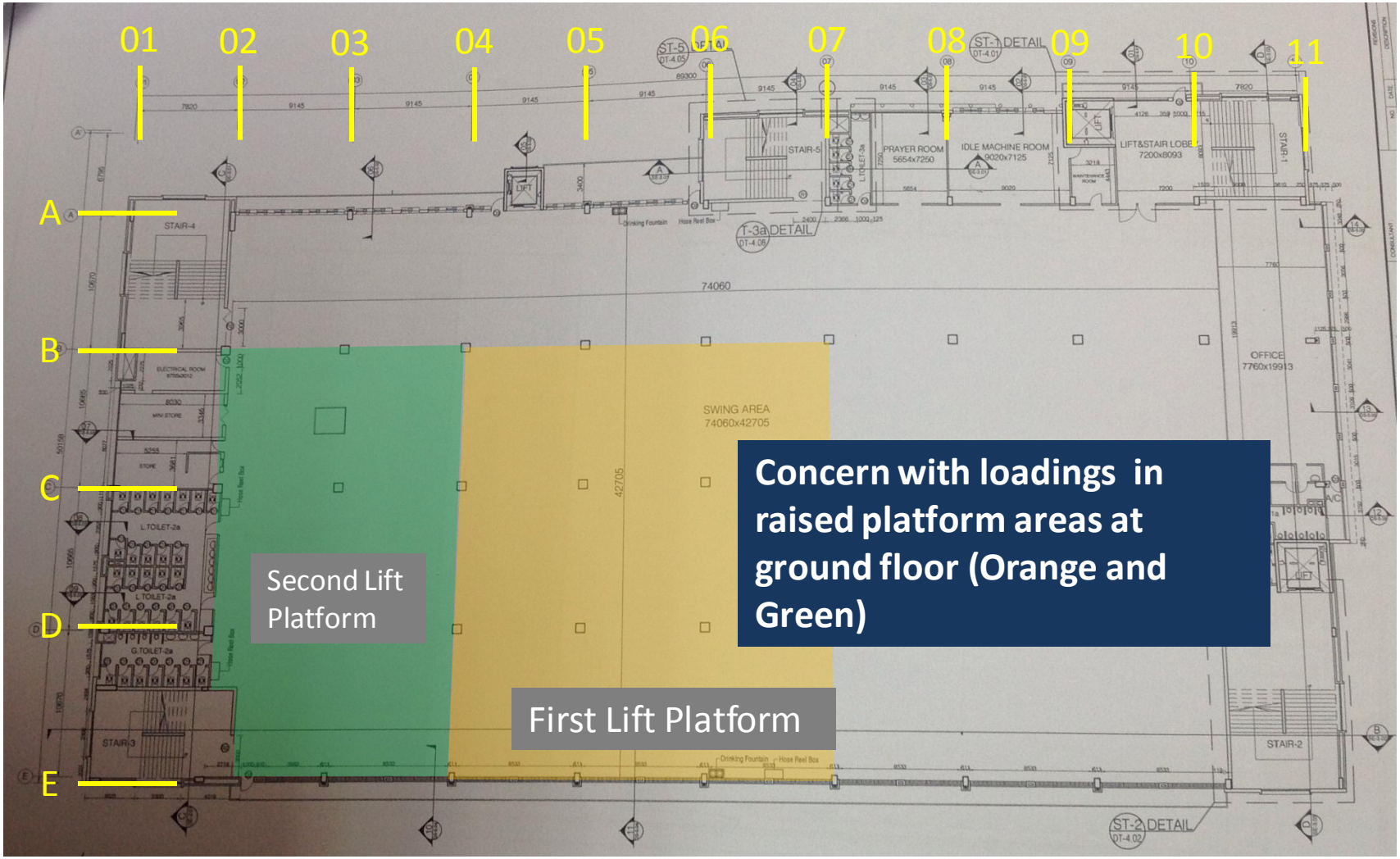
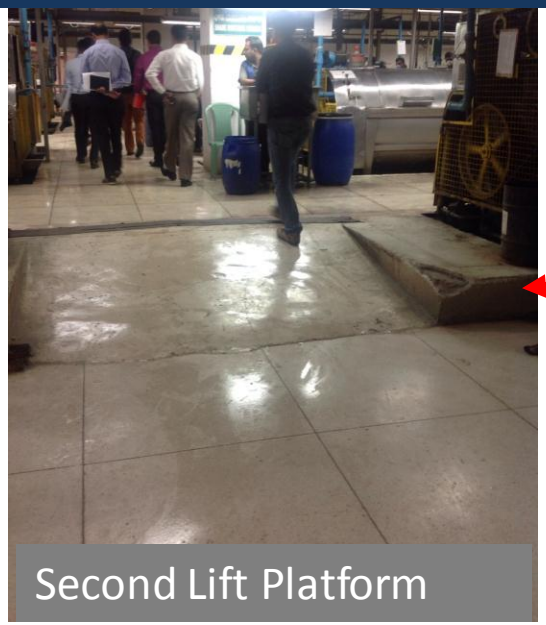
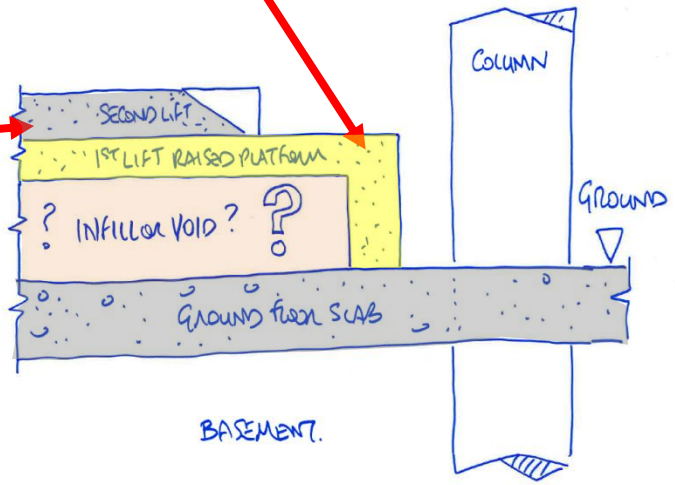


Building 1 – Investigation and possible removal of raised platforms at ground Level

Factory Engineer to open up sections of raised platforms at ground floor level to investigate build-ups, if infill areas are solid we would expect immediate platform removal or local evacuation in these areas until structure and foundation capacity is proven.





Building 1 – Investigation and possible removal of raised platforms at ground Level

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Executive Summary (Continued)

A high level and non exhaustive list of key concerns are:

Building No. 1

- Raised floor in 2 locations on Ground Floor, build up unknown but likely to be at least partially filled with sand, opening up works required by building engineer to confirm build up.
- Cracking in slabs, detailed design check required.
- Evidence of repairs to cracks in soffit of ground floor under raised floor area's, repair should be removed by local engineer and reinforcement behind check for possible signs of corrosion.
- Check on column loads and design required.
- Opening in floor with exposed reinforcement to be addressed by engineer and repaired.
- Evidence of water draining down façade of building causing possible reinforcement corrosion, remove source of water/divert and check slab edges for spalling/corrosion

- **Building No. 2**
- High storage loads at 1st to 3rd floors resulting in high column stresses.

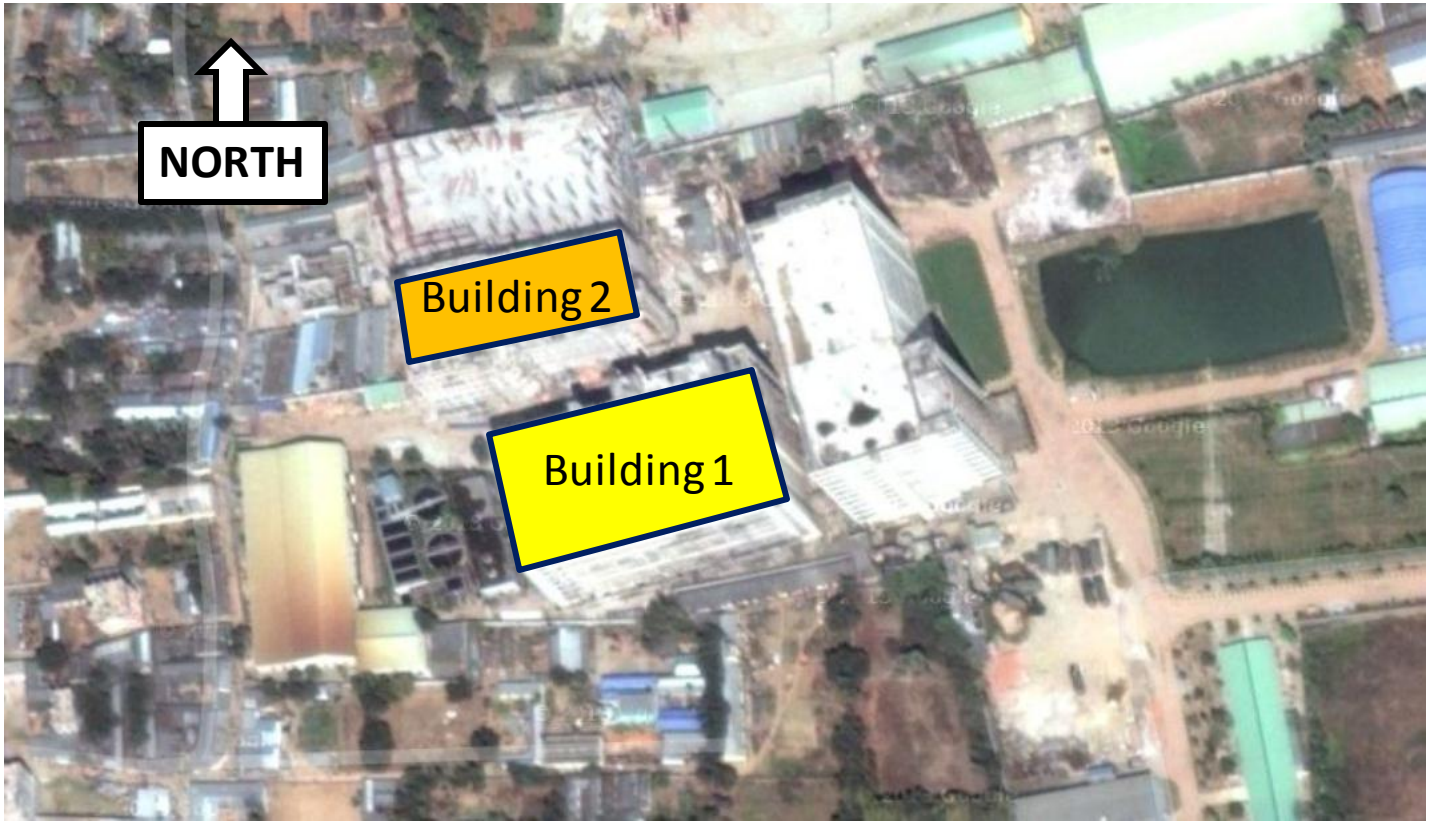
Executive Summary (Continued)

Further actions with associated priorities and timeframes are given at the end of this report. Please note that these actions should be completed as soon as practically possible and certainly within the timeframe noted.

We have reviewed the property from an outline seismic perspective and would consider that the building along with many others in the Dhaka region to have a significant risk in a major Seismic event.

Our Limitations and Assumptions are also noted at the end of this report.

Building Extents



Building Extents

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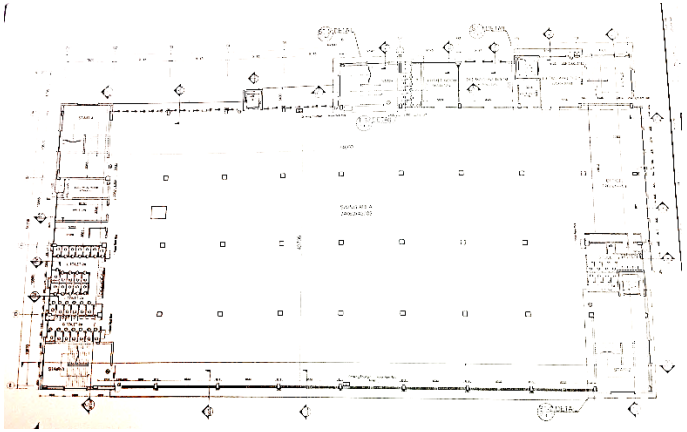
Building 1
Garments building
(7 storeys including basement) with roof structure removed.
Started 2003
Completed 2005.
Permit for a 6 storey plus basement dated 18/05/2010 from LG.
No permit for extension



Building 1 Extents

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North Elevation

South Elevation

East Elevation

West Elevation

Building 1 Extents

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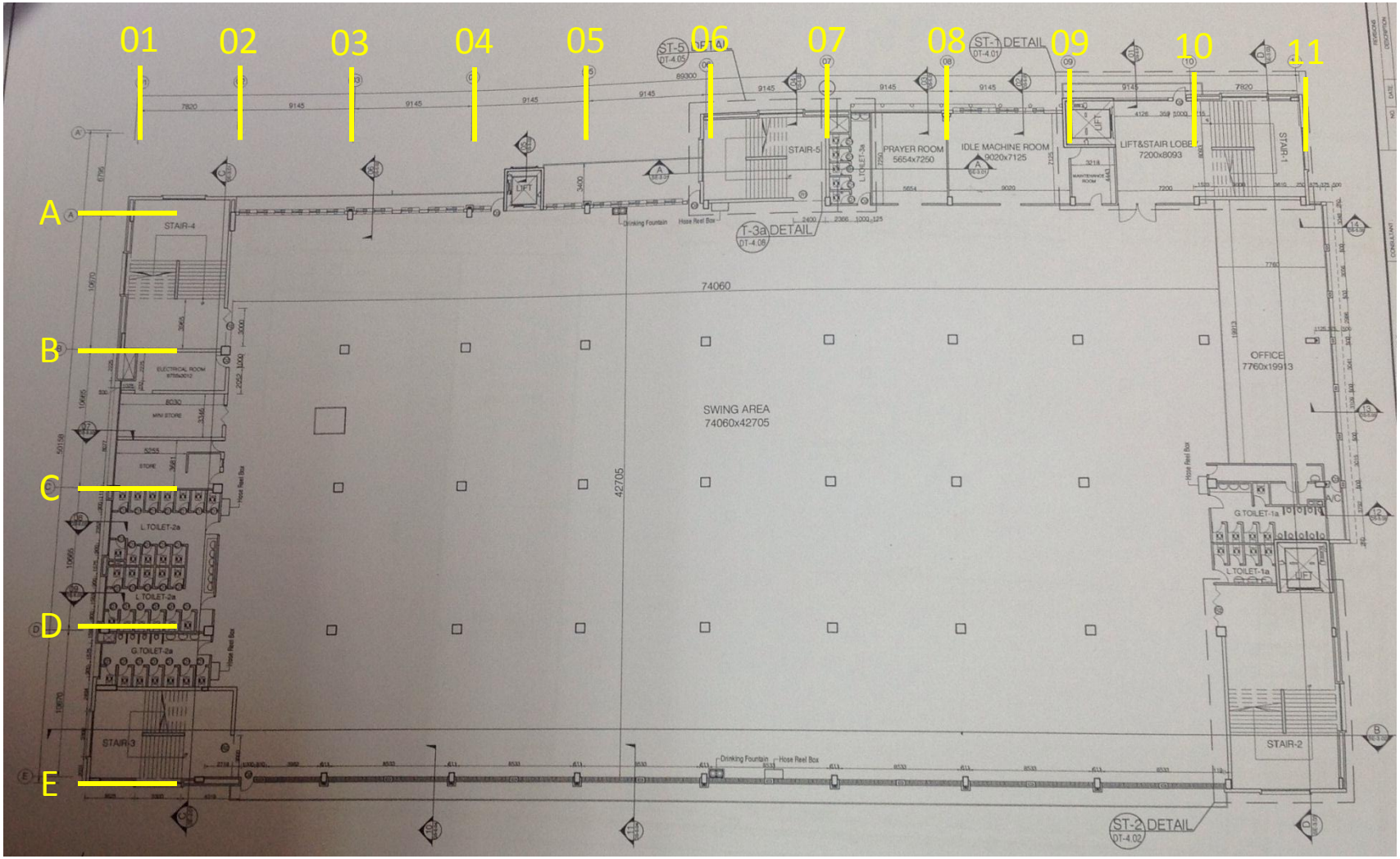

Building 1 - Grid Layout

BUILDING 2

Building 2
Garments/Storage building (8 storeys).
Completed in 2013.
No Permit drawings available

Building 2 Extents

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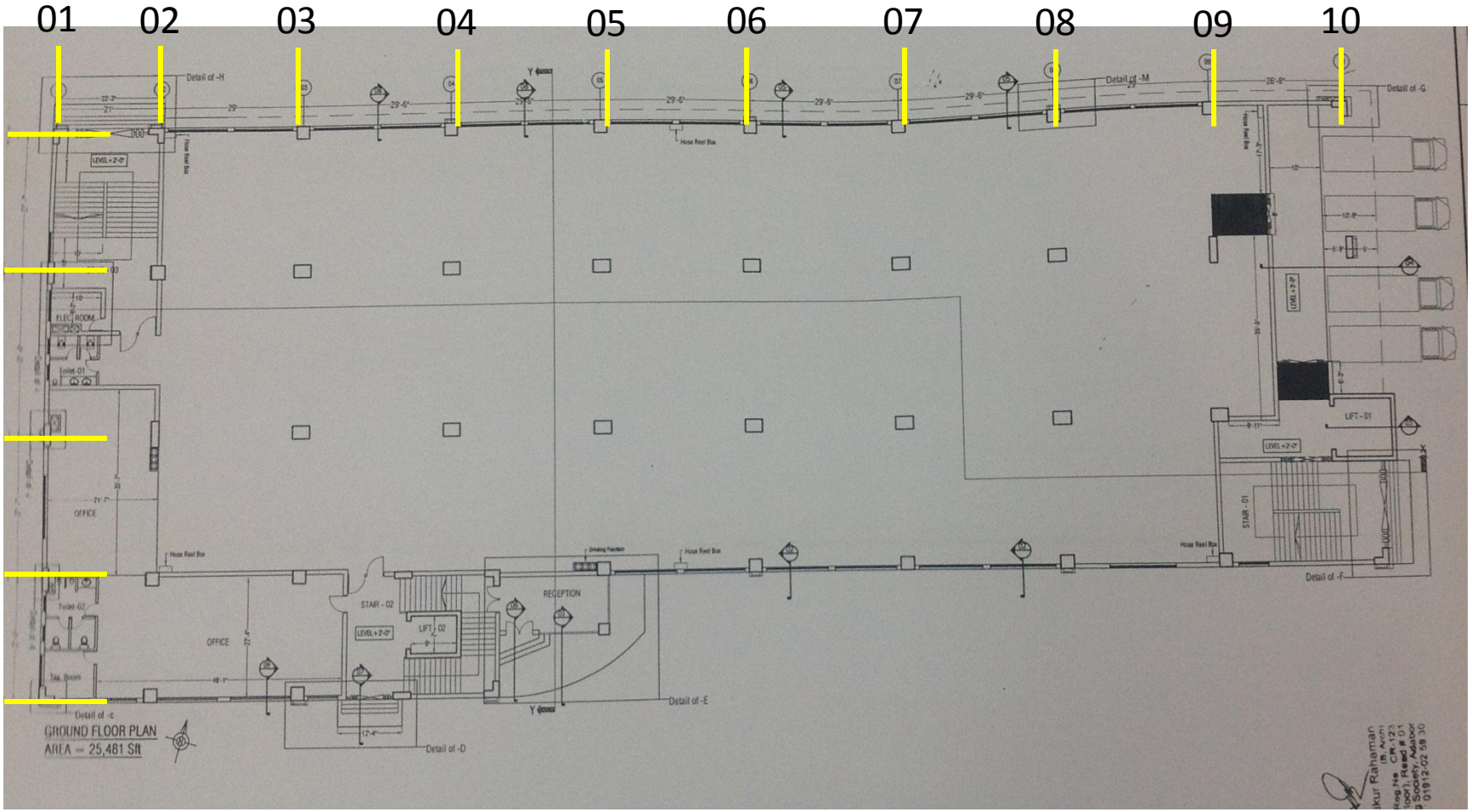

Building 2 - Grid Layout

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Structural Systems

Building 1

Main structure comprised of Post Tensioned flat slab with drop heads at column locations.

Moment Frame with R.C Staircores - stability system.

6 Storey + Basement building

Pad foundation system.

Grid: 10.665 x 9.145 m
Column size: 670x670mm
Shear Head size: 3050 x 3550x105 mm deep
Slab thickness: 240mm

Structural system

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Alterations/Repairs to Building 1

Steel roof structure with corrugated roof removed recently following BGMEA request for open areas on roof slab.

Building 2

Main structure composed of Post Tensioned flat slab with drop heads at column locations.

Moment Frame with R.C Staircores - stability system.

8 storey building

Pad foundation system.

Grid: 9.0 x 9.63 m
Column size: 760x1000mm
Shear Head size: 3050 x 3550x105 mm deep
Slab thickness: 320mm

Structural system

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Observations

Building 1

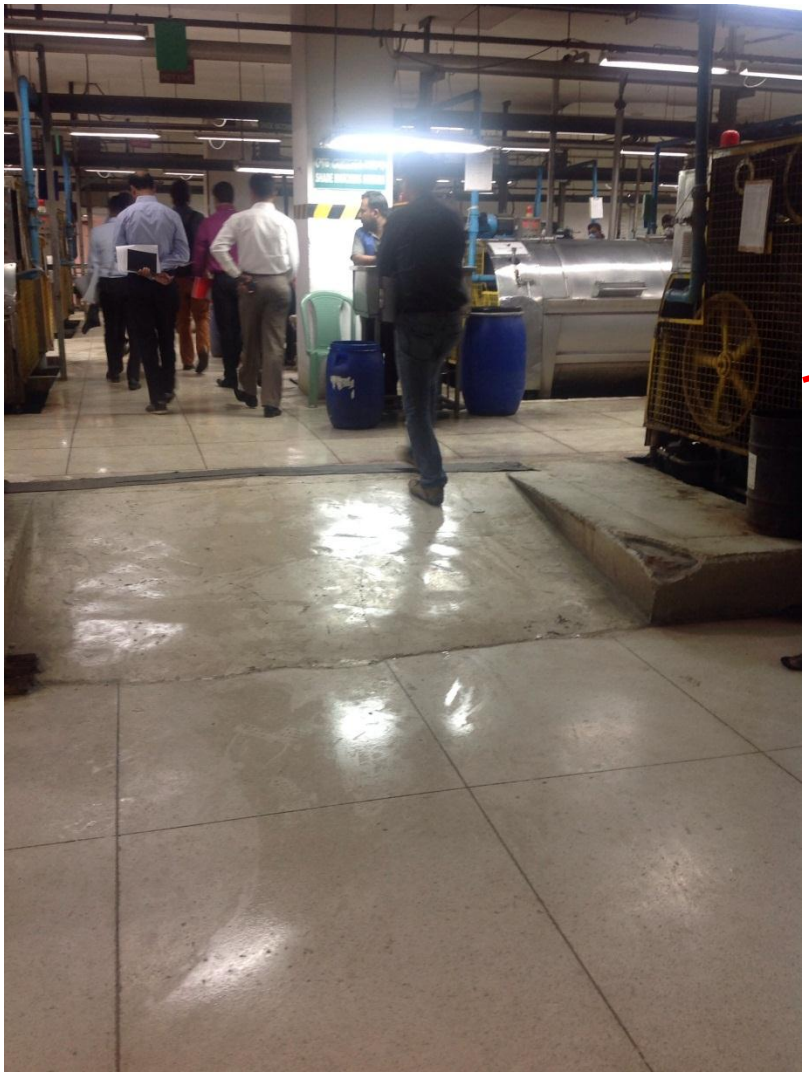
Heavy loading due to raised floor area on Ground Floor

Building 1

Raised floor area, build up unknown.

Heavy loading due to raised floor area on Ground Floor

Building 1



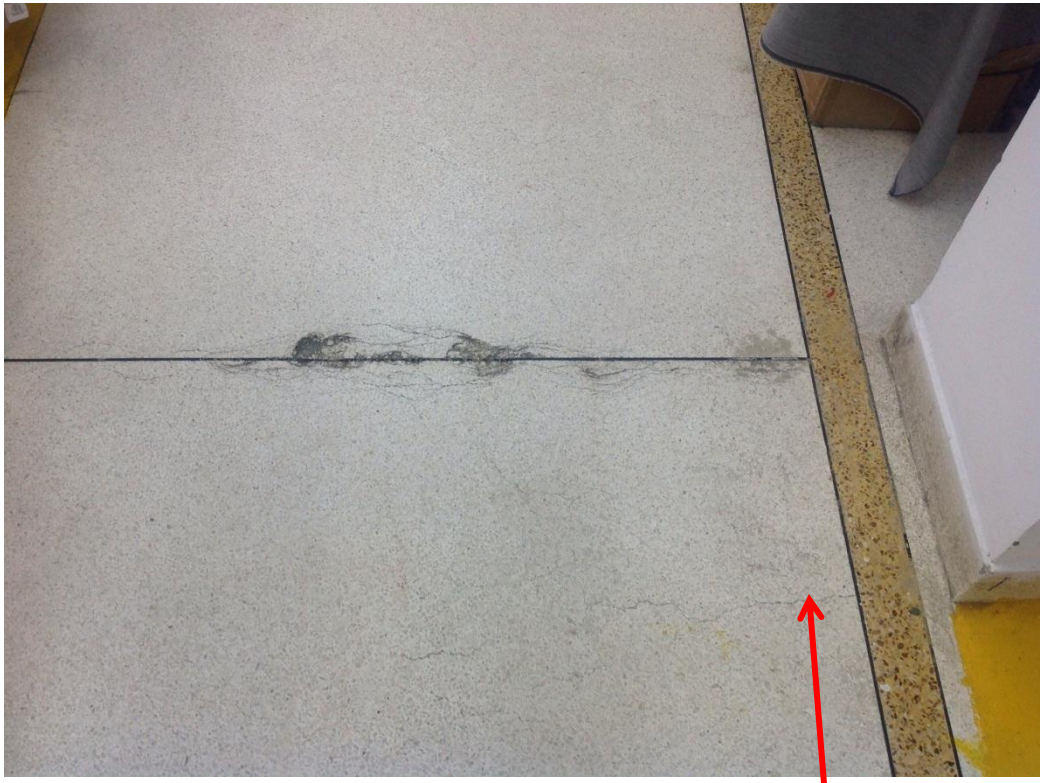
Raised floor area on top of raise area, not identified on drawings. Build up unknown.

Heavy loading due to raised floor area on Ground Floor

Building 1

Floor cracking.

Building 1



Multiple cracking in floor finish.

Floor cracking

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Building 1

Opening in floor with exposed reinforcement and water ingress.

Building 1

Water draining through opening affecting exposed reinforcement.

Opening in slab, exposed reinforcement.

Opening in floor with exposed reinforcement and water ingress.

Building 1

Repaired cracking in soffit of ground floor slab.

Building 1

Recently repaired cracking in Soffit of ground floor slab adjacent to column with Basement slab cracking.

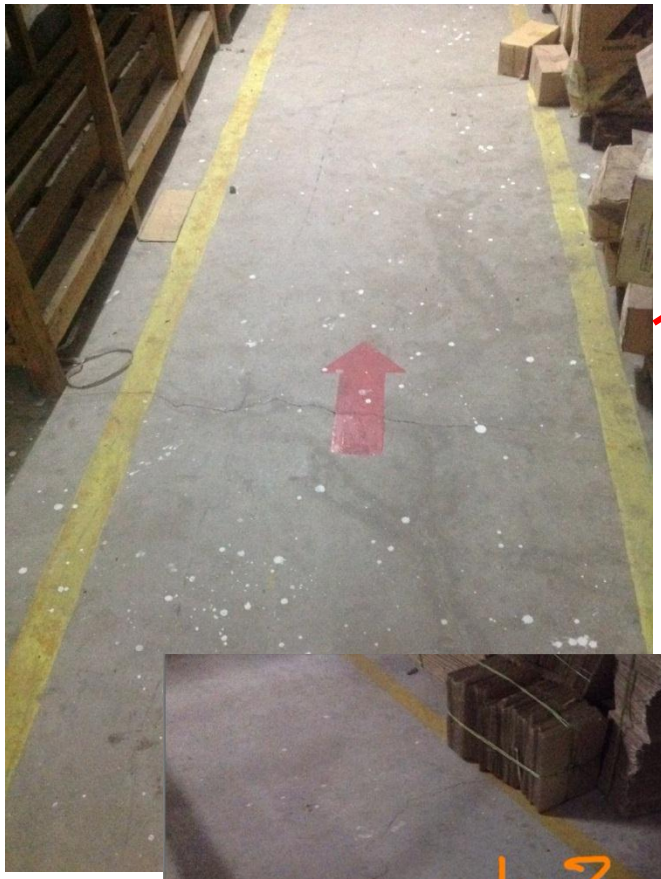
Repaired cracking in soffit of ground floor slab.

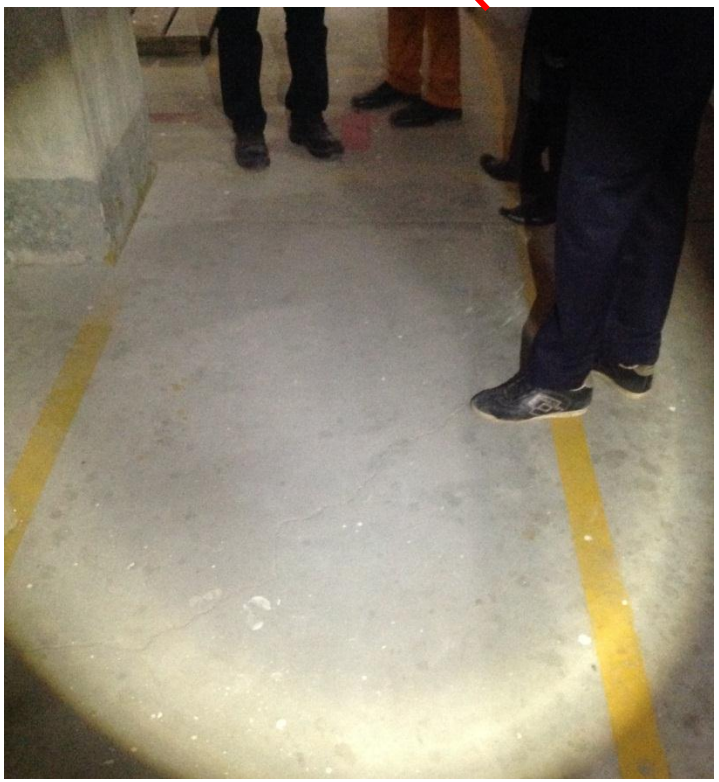
Building 1

Cracking in basement slab.

Building 1

Cracking in Basement slab around column perimeter.





Cracking in basement slab

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Building 1

Timber roof

Building 1

Lightweight timber roof on steel beam cut at one end

Connection to be checked.

Timber roof

Building 1

Façade cracking/spalling

Building 1

Vertical Crack between cantilever and main structure.

Check if crack is structural or cosmetic.

Building 1

Horizontal Crack.

Horizontal Crack.

Check if cracks are structural or cosmetic.

Building 1

Spalling/Cracking, possibly due to corrosion of reinforcement.

Check for corrosion of reinforcement

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Building 1

Water falling onto edges of all slabs, possible corrosion of reinforcement.

Check for corrosion of reinforcement

Building 1

Cracking in column face.
Remove render to check.

Diagonal Crack.
Remove render to check.

Check if crack is structural or cosmetic.

Building 1

Drainage outlet falling onto cantilever edge below.

Cracking/Spalling. Confirm if reinforcement is corroded.

Building 1

Façade steps out at 6th floor level possibly due to construction tolerances.

Building 2

Water ponding

Building 2

Water ponding on unprotected concrete slab (roof structure removed)

Building 2

Water Storage

Building 2

6 No. 2500L water tanks. (Currently not connected or filled)

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Building 2

Heavy Storage Loading

Building 2

High storage loads

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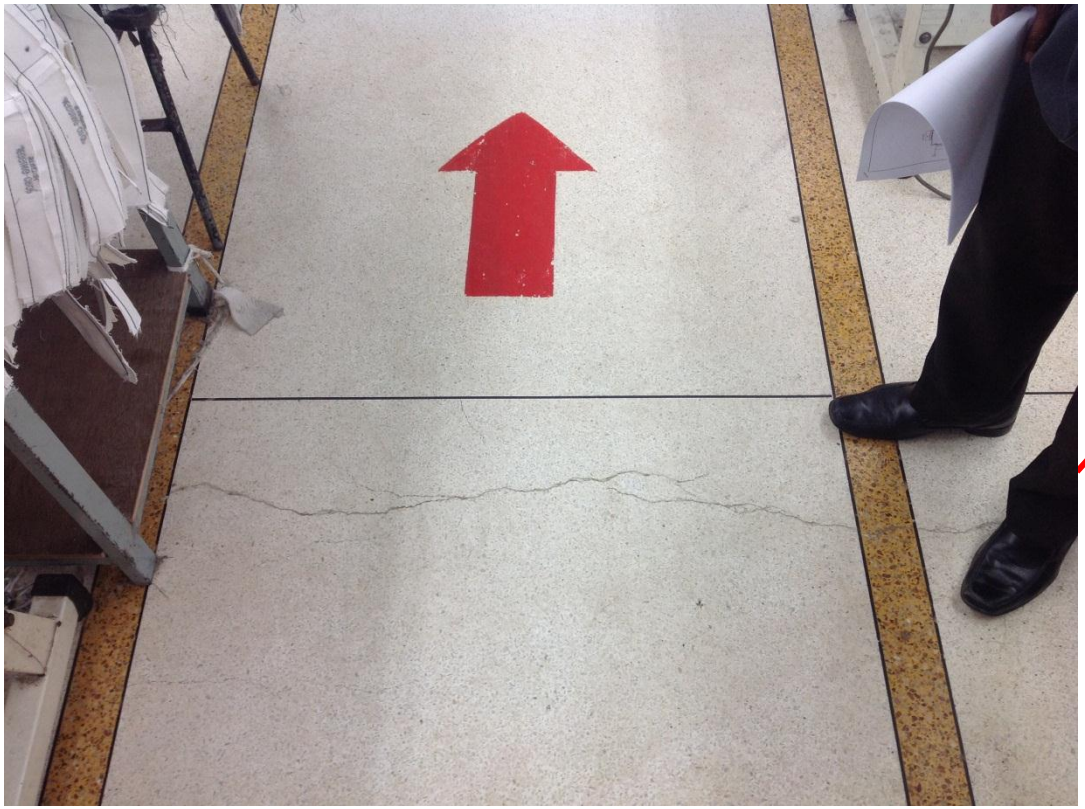
Building 2

Floor Cracking

Building 2



Cracking on column line.

Building 2

Column without vehicle protection

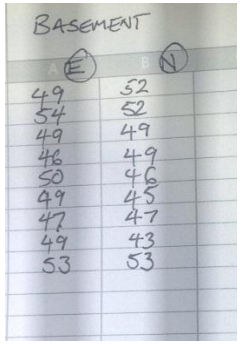
Building 2

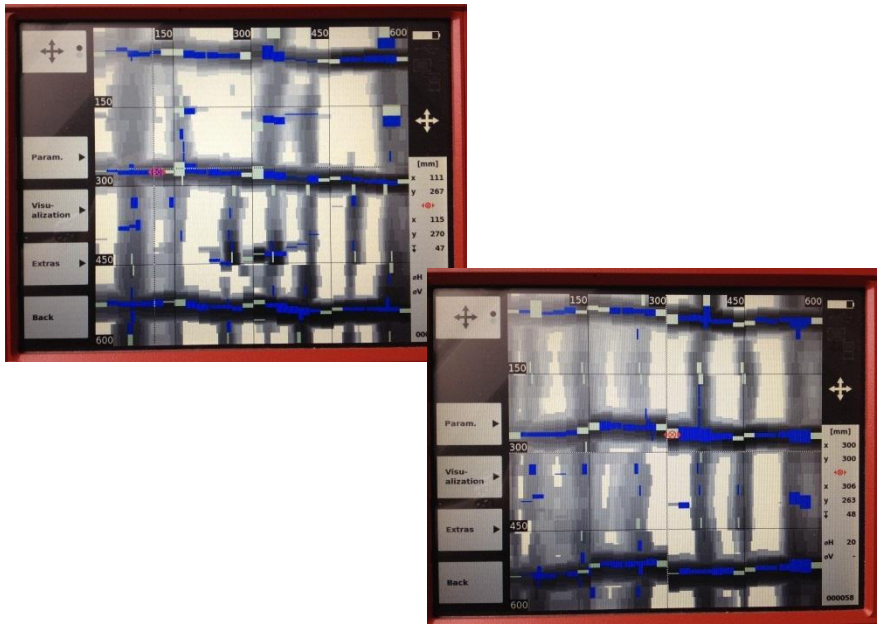
Column in loading bay vulnerable to vehicle impact.

Impact protection should be provided.

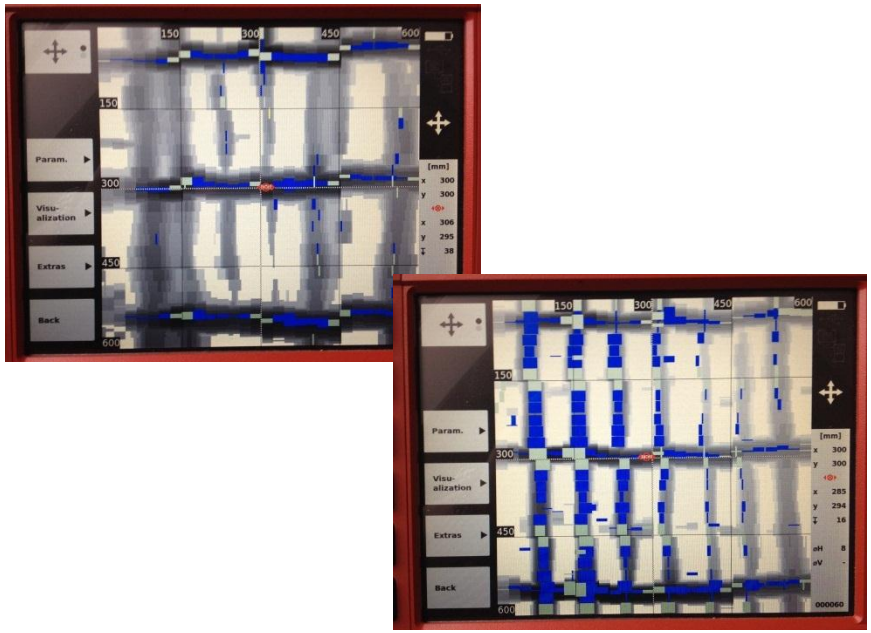
Tests carried out
Building 1

Building 1





Rebound test & Ferroscaner Unit 1



Rebound test & Ferroscaner Unit 2

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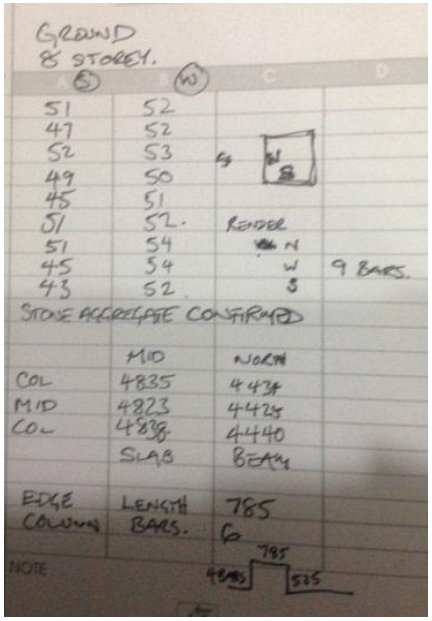
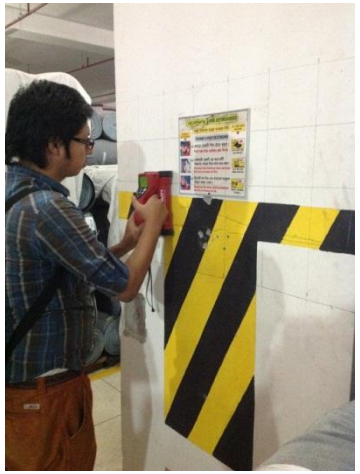
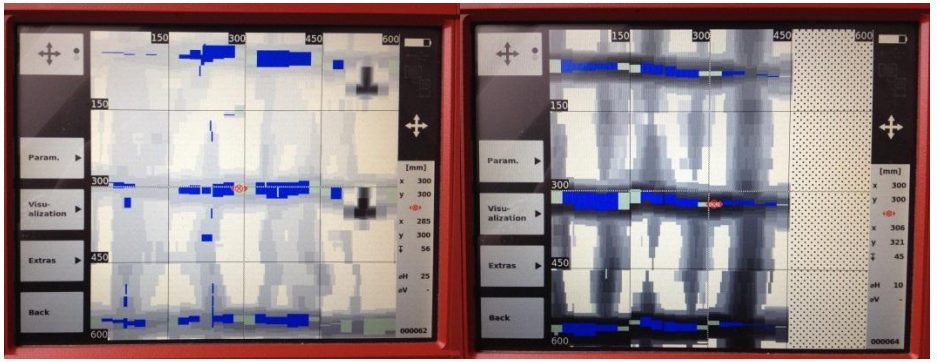
Tests carried out
Building 2

Building 2







Column face 1 (south)

Column face 2 (west)

Rebound test & Ferroscaner Column

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Priority Actions

Problems Observed – Building 1

1. High Concrete Stresses in platform area as indicated in page 5 in Raised floor in 2 locations on Ground Floor, build up unknown but likely to be at least partially filled with sand, urgent opening up works required by building engineer to confirm build up.
2. Cracking in slabs, detailed design check required.
3. Evidence of repairs to cracks in soffit of ground floor under raised floor area's, repair should be removed by local engineer and reinforcement behind check for possible signs of corrosion.
4. Opening in floor with exposed reinforcement to be addressed by the Building Engineer and repaired.
5. Evidence of water draining down façade of building causing possible reinforcement corrosion, remove source of water/divert and check slab edges for spalling/corrosion
6. Check adequacy of timber roof (connections for uplift) following part removal of roof.

Problems Observed – Building 2

7. **Building 2** - Check on column loads and design required in order to inform loading limits in warehouse.
8. **Building 2** - Column without vehicle protection

Item 1 and Load reduction actions and immediate review Building 1

Priority 1

(Immediate - Now)

- A full **Detailed Engineering Assessment** is to be commenced for columns in the area of the raised platform at ground floor (Grid B2 to E7 noting the further build up between B2 and E4.
- Until DEA is complete reduce load at all levels to less than 1.5kN/m^2 and especially from stacked garments from area highlighted on page 5
- At ground floor (grid B2-D4) remove the second lift of raised platform and investigate the construction of the lower platform. If found to be solid or filled with sand, remove material or evacuate areas above until structure and foundations proven.
- Conduct concrete tests to prove concrete strength.
- DEA to prove adequacy of foundations in the area B2 to E7 noting the cracking to basement slab at column D3. DEA to confirm if movement is still live as it was noted that the soffit of the ground floor slab had been freshly painted.

Priority 2

(within 6-weeks)

- Detail Engineering Assessment and strengthening / remedial works as specified by the building engineer to be completed.

Priority 3

(within 6-months)

- Produce and actively manage a loading plan for all floor plates within the factory giving consideration to floor capacity and column capacity.

Detail Engineering Assessment

This Schedule develops a minimum level of information, Analysis and testing expected as part of a Detail Engineering Assessment.
The Building(s) have been visually assessed and it is deemed necessary that a detailed engineering assessment be carried out by a competent Engineering Team employed by the factory Owner.
This Request should be read in conjunction with the BUET developed Tripartite Guideline document for Assessment of Structural Integrity of Existing RMG Factory Buildings in Bangladesh (Tripartite Document), the latest version of this document should be referenced. This document also gives guidance on required competency of Engineering Team.

We expect that the following will be carried out:

1. Development of Full Engineering As-Built Drawings showing Structure, loading, elements, dimensions , levels, foundations and framing on Plan, Section and Elevational drawings .
2. The Engineering team are to carry out supporting calculations with a model based design check to assess the safety and serviceability of the building against loading as set out in BNBC-2006, Lower rate provisions can be applied in accordance with the Tripartite Guidelines following international engineering practice, justification for these lower rate provisions must be made .
3. A geotechnical Report describing ground conditions and commenting on foundation systems used/proposed.
4. A report on Engineering tests carried out to justify material strengths and reinforcement content in all key elements studied.
5. Detailed load plans shall be prepared for each level showing current and potential future loading with all key equipment items shown with associated loads.
6. The Engineering team will prepare an assessment report that covers the following:
    - As-Built drawings including
        - Plans at each level calling up and dimensioning all structural components
        - Cross sectional drawings showing structural beams, slabs, floor to floor heights, roof build-ups and Basic design information of the structure
    - Highlight any variation between As-built compared to the designed structure
    - Results of testing for strength and materials
    - Results of geotechnical assessment and testing/investigation
    - Details of loading, inputs and results of computer modelling
    - Commentary on adequacy/inadequacy of elements of the structure
    - Schedule of any required retrofitting required for safety or performance of Structure

Any proposals for Retrofitting to follow guidance developed in the Tripartite Document

Item 2 and actions

Building 1

A check on slab design is required due to consistent cracking observed across all floors.

Priority 1 (Immediate - Now)	• None required.
Priority 2 (within 6-weeks)	• None required.
Priority 3 (within 6-months)	• **Create controlled loading plans for all floors,** designating where storage can be placed and can not be placed. • **Provide calculations showing the structural adequacy of all slabs/beams,** taking into account the loading plans and all built structure including additions beyond the original design. Provide concrete strength tests.

Item 3 and actions

Building 1

Evidence of repairs to cracks in soffit of ground floor under raised floor area's under area of raised platforms at ground floor. Water observed in areas below raised platform, thus risk of water ingress to cracks leading to corrosion,

Priority 1 (Immediate - Now)	• None required.
Priority 2 (within 6-weeks)	• Evidence of repairs to cracks in soffit of ground floor under raised floor area's, repair should be removed by Building Engineer and reinforcement behind check for possible signs of corrosion.
Priority 3 (within 6-months)	• Repairs as detailed by the Building Engineer to be completed should investigations above reveal corrosion of reinforcement.

Item 4 and actions

Building 1

Opening in floor with exposed reinforcement to be addressed by engineer and repaired.

Priority 1 (Immediate - Now)	• None required.
Priority 2 (within 6-weeks)	• Remove source of water to avoid further corrosion to reinforcement. Clean all affected reinforcement back to bare steel. Repair concrete using suitable structural mortar.
Priority 3 (within 6-months)	• Provide calculations showing the structural adequacy of floor with opening.

Item 5 and actions

Building 1

Evidence of water draining down façade of building causing possible reinforcement corrosion, remove source of water/divert and check slab edges for spalling/corrosion

Priority 1 (Immediate - Now)	• None required.
Priority 2 (within 6-weeks)	• None required.
Priority 3 (within 6-months)	• Engineer to inspect water leakage and damaged structure including the exterior and propose a suitable repair.

Item 6 and actions

Building 1

Roof partially removed. Timber joists and connection of cut steel rafters to be checked for uplift

Priority 1 (Immediate - Now)	• None required.
Priority 2 (within 6-weeks)	• Building Engineer to inspect section of roof that remains and verify its adequacy against uplift giving consideration to open door on roof.
Priority 3 (within 6-months)	• None required.

Item 7 and actions

Building 2

Verify concrete strengths in columns in locations supporting bonded warehouse areas due to high observed loads.

Priority 1 (Immediate - Now)	• Factory Engineer to review design, loads and columns stresses in area identified above. • Verify insitu concrete stresses either by cores or existing cylinder strength data for columns. We note that cylinders have been provided for slabs and foundations but also note that these elements were specified with a different concrete mix and target strength.
Priority 2 (within 6-weeks)	• Produce and actively manage a loading plan for all floor plates within the factory giving consideration to floor capacity and column capacity.
Priority 3 (within 6-months)	• Continue to implement load plan

Item 8 and actions

Building 2

Column in loading bay vulnerable to vehicle impact.

Priority 1 (Immediate - Now)	• None required
Priority 2 (within 6-weeks)	• Impact protection should be provided.
Priority 3 (within 6-months)	• None required

Survey Limitations and Assumptions

This report is for the private and confidential use of Accord for whom it was prepared together with their professional advisors as appropriate. It should not be reproduced in whole or in part or relied upon by third parties for any use without the express written permission of Arup.

This report can be used in discussion with the supplier or factory owner as a means to rectify or address any observations made. The report is not comprehensive and is limited to what could be observed during a visual inspection of the building.

This Report is not intended to be treated as a generalised inspection and does not cover the deterioration of structural members through dampness, fungal or insect attack, nor does it deal with problems and defects of a non-structural nature. Other non structural aspects of the building such as fire safety have not been assessed in this survey.

Except as otherwise noted, drains and other services were not viewed or tested during our inspection and are therefore similarly excluded from this Report. We have not inspected any parts of the structure which are covered, unexposed or inaccessible and we are therefore unable to report that any such part of the property is free from defect.

External inspection of the façade walls has generally been carried out from ground level only by visual sighting. No opening up works were carried out (except as noted) and we rely on the Architects and Engineers drawings provided to us for our views on concealed parts of the structure and in particular foundations. Strengths of materials and components are untested and we recommend that the factory owners Building Engineer carries out insitu testing over and above those suggested to satisfy themselves with the material strengths and component details.

Recommendations, where given, are for the purpose of providing indicative advice only, are not exhaustive, relate solely to identifying key and obvious structural defects as identified in this presentation, and do not take the form of or constitute a specification for works. We take no responsibility for the works as constructed. This report does not interfere with the factory owners Building Engineers responsibility for the structural performance of this building, The Building Engineer remains fully responsible for the structural adequacy of the building.

This report does not comment in detail on the future seismic performance of the building and only highlights the fact that the building may experience significant damage or collapse in a seismic event along with many others in the Dhaka region.

The observations in this report are based on the Engineering Judgement of the lead surveyor/engineer at the time of the survey. We assume in making these observations that no covering up of faults defects, filling or plastering over cracking or significant repair work has been carried out by the building owner. Any future alteration or additional work by the building owner will void this report.