# Lumbini Ltd

Meghla, Bandarban, Chittagong
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24th June 2014

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ARUP

# Observations

# Extensive cracking to the suspended floor slabs of the main building

Extensive cracking of the floor slab was observed at all suspended floor levels. The cracking is in the structure, as the finishes are negligible. Repair works to cracks were also observed.

Cracking to top of slab

Cracking to top of slab

Cracking to top of slab

Cracking to soffit of the slab

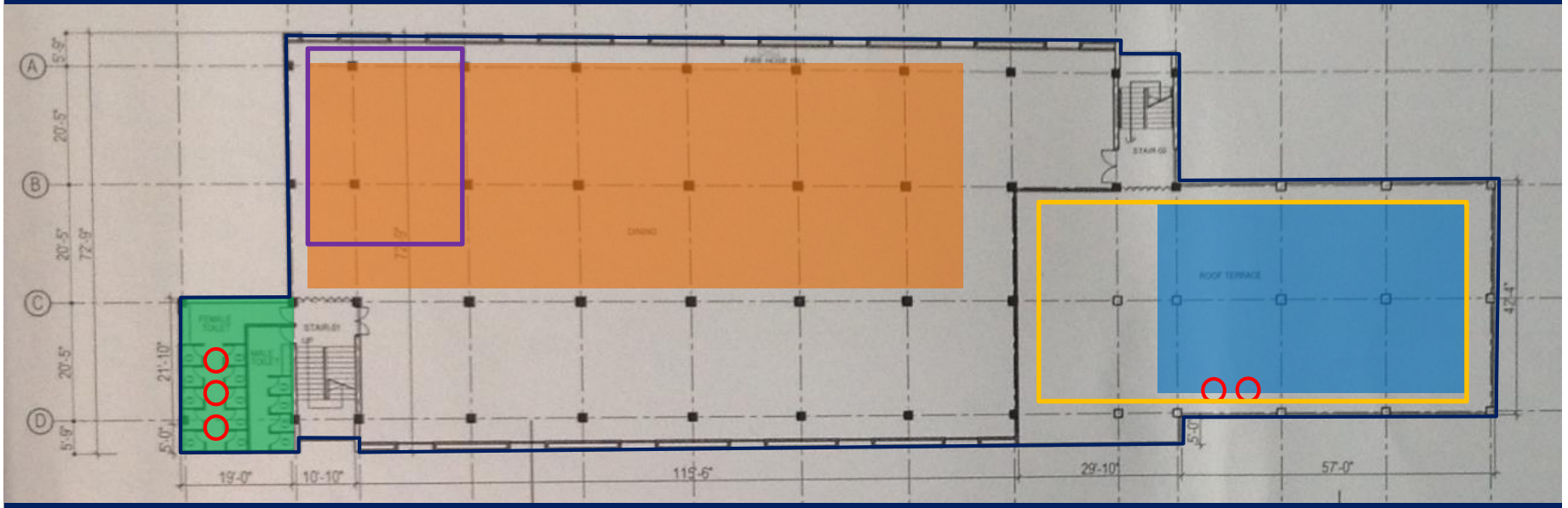
# Extensive cracking of slab

# Heavy floor loading and lack of a loading plan in the main building

Areas of high loading were observed in:

- The storage areas at all floor levels
- The water tanks at 4th Floor/roof
- Jacquard machines at 2nd Floor level
- Toilet floor build-up at all floor levels.

While floor loading limits were displayed, these did not appear to be implemented.




Typical Floor Plan

Gazi water tanks at 4th floor level (capacity 2,000 to 5,000 l)

190mm (avg.) toilet floor build-up at all floor levels

Storage distribution at 1st and 2nd floor levels

Storage at 4th floor level

Storage at 3rd floor level

Jacquard machines at 2nd Floor

# Heavy floor loading



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2,000 to 5,000 litre water tanks at 4th floor level

Yarn storage at 4th floor level

Jacquard machines at 2nd Floor level

# Heavy Floor Loading



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Storage area at 3rd floor level

Storage distribution area at 2nd floor level

Storage area at 1st floor level

Toilet build-up at all floor levels

# Heavy Floor Loading



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# Omissions and irregularities in design documentation


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There are a number of key omissions from the design documents, as well as inconsistencies between the design documents and the constructed building. The following is a non-exhaustive list of issues:

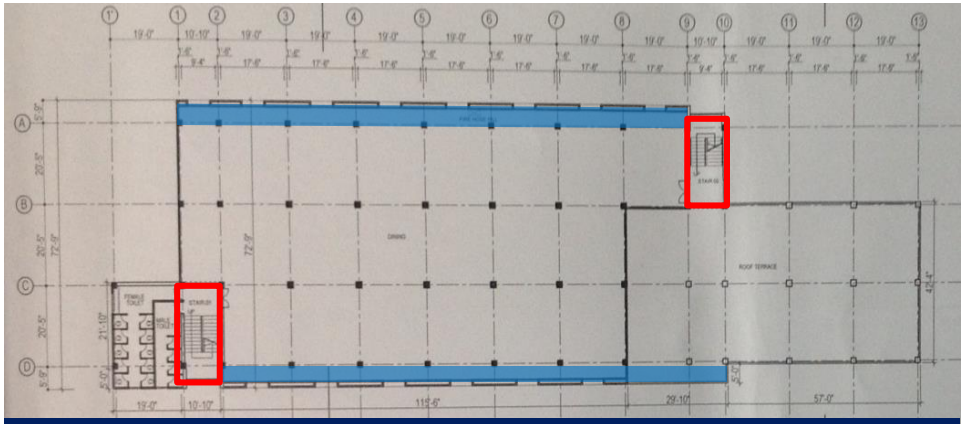
- There is a concern about the stability system for lateral loading conditions. The lateral stability of the building would appear to be provided primarily by moment-frame action; however, there is insufficient information in the design documents about the connection details between the primary steel beams and the RC columns – design check required.

- A number of steel beams are smaller than specified: for example, the structural drawings indicate 400mm deep beams along gridlines B and C, whereas these were measured to be 300mm deep – design check required.

- The structural drawings indicate an expansion joint between gridlines 9 and 10, which does not appear to have been incorporated. It is planned that the building will be extended South beyond the proposed location of the movement joint – design check required.

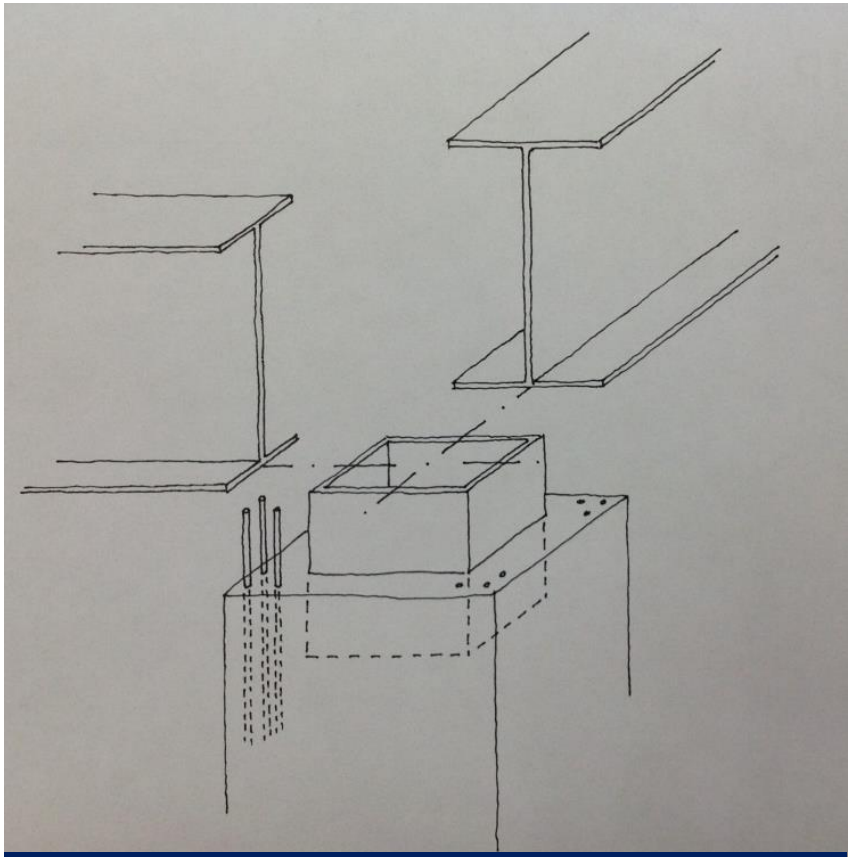
- The foundation recommendations provided in the soil investigation report make reference to a 3 storey building, not a 5 storey building – clarification required.

# Design documentation



Typical Floor Plan

Rigidity of RC column to beam connection is not clear



Sketch – Typical beam-column detail is unclear

Masonry walls supported on cantilever beams

Stairs cores comprising brick infill walls

Lateral stability concerns – There is insufficient information about the structure / connection between members to justify moment-frame action

# Design documentation



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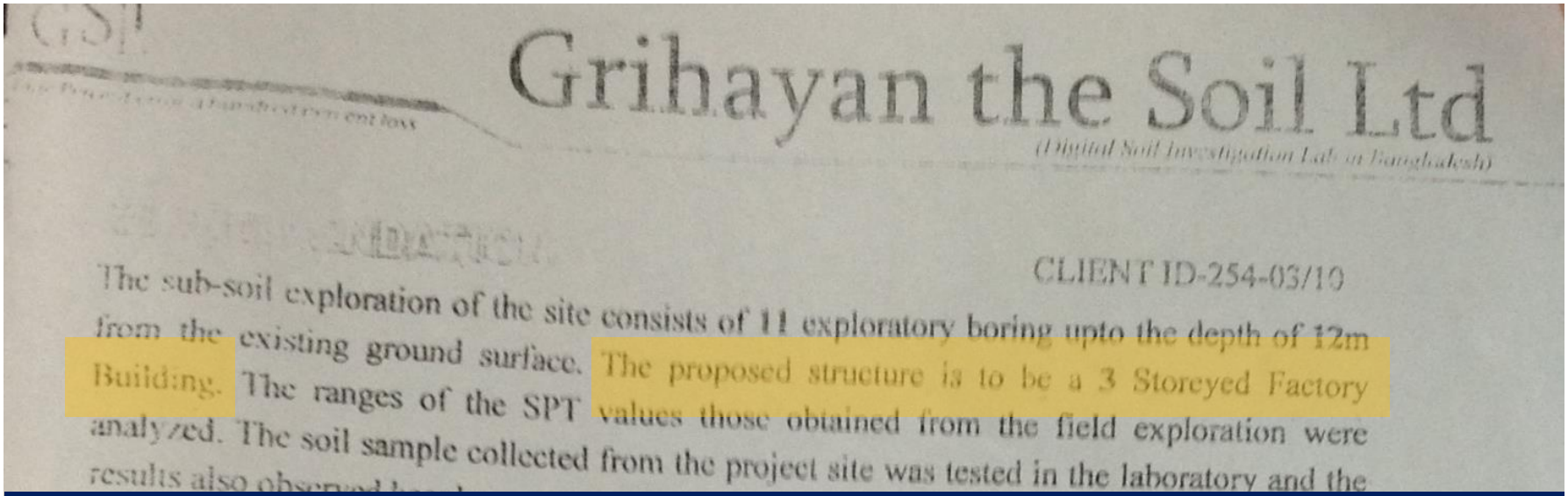


Extract from soil investigation report references a 3 storey , not a 5 storey, building


Expansion joint indicated on the as-built structural drawings – not apparent on site

Existing structure

Planned expansion

# Design documentation



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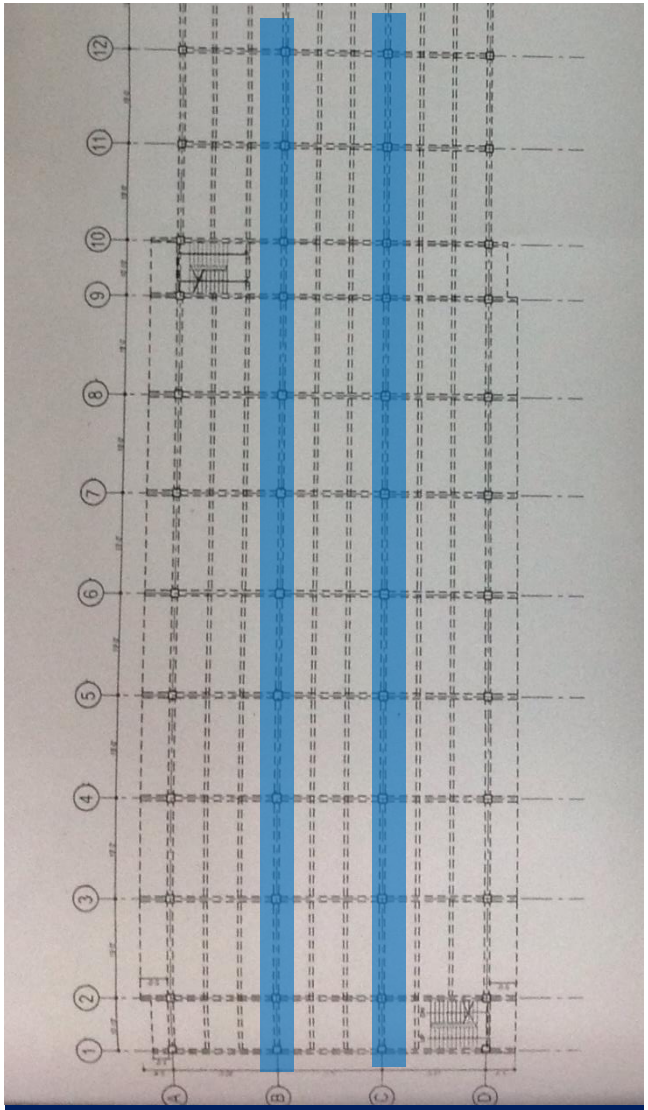
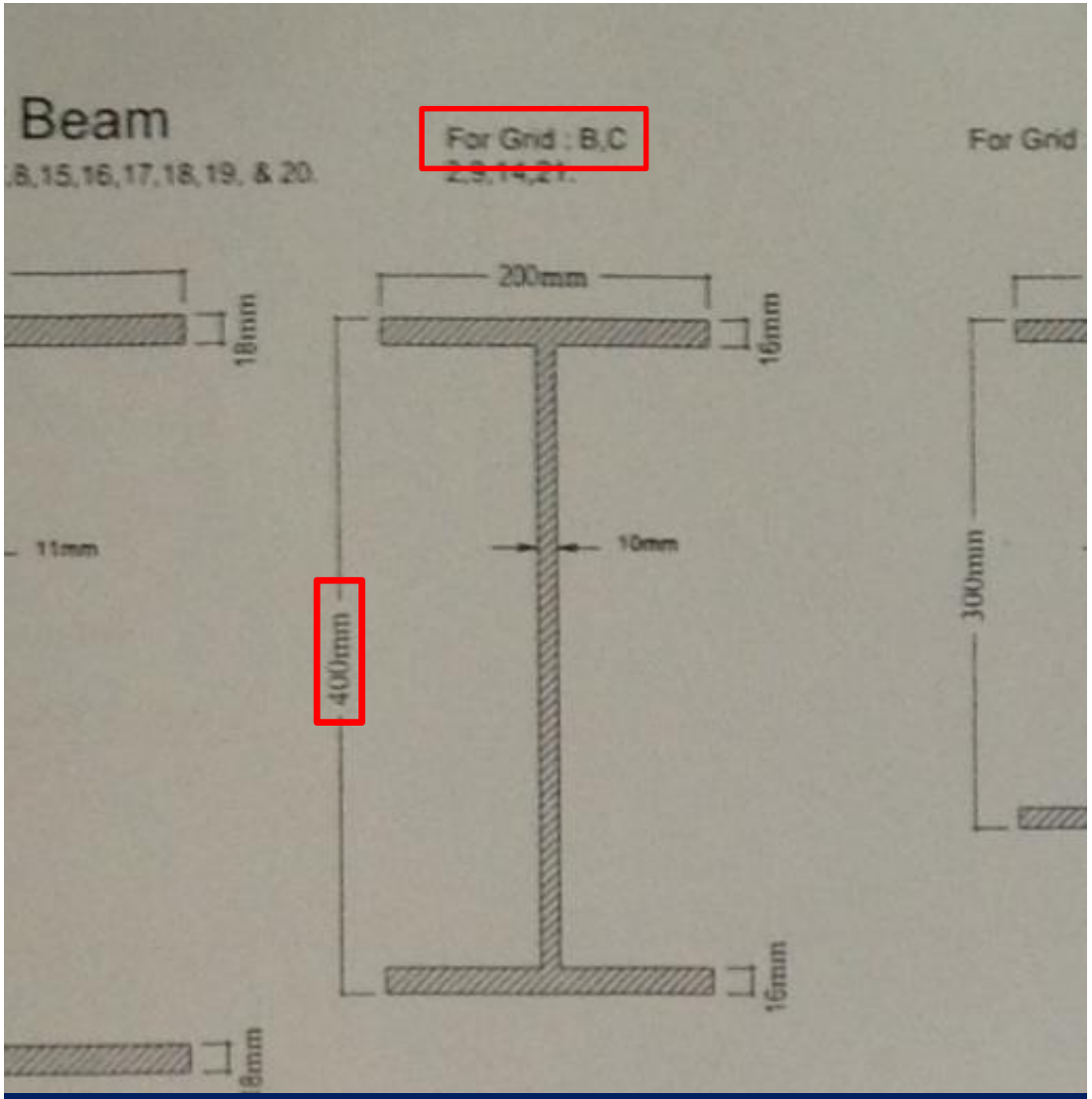


Column and beam layout




Gridlines B and C Steel beam cross section

Steel beams along G.L. B and C – Specified as 400mm deep on the drawings, but measured as 300mm deep

# Design documentation



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# Double-height columns at risk of impact loading


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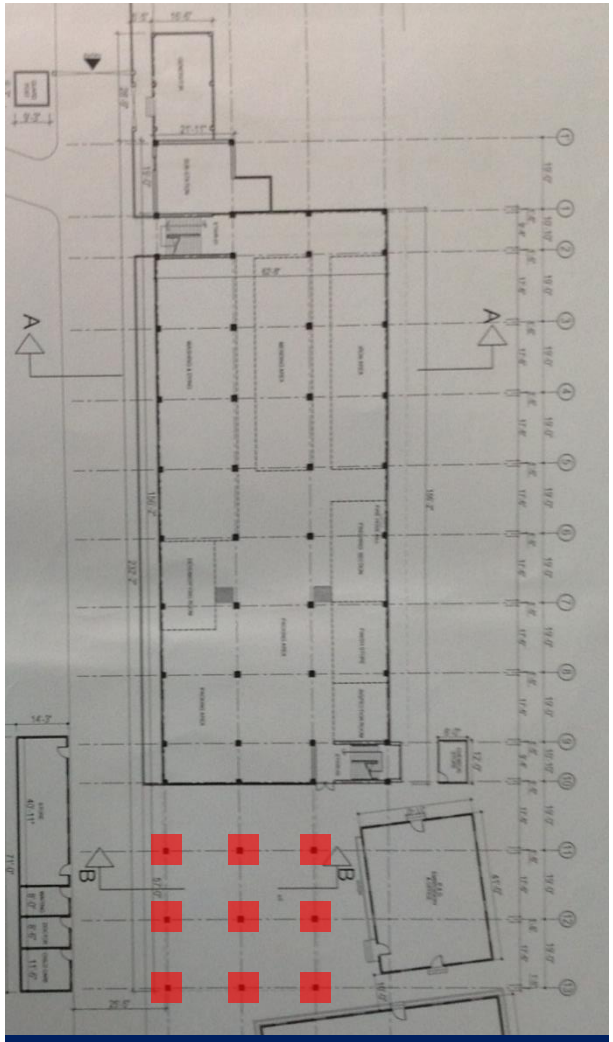
The double-height columns to the south of the building, adjacent to the delivery entrance, are at risk of being accidentally struck by a vehicle. The existing column protection appears inadequate.



Ground Floor Plan

Columns adjacent to parking area

Two-storey Ground Floor columns at risk of vehicle impact

# Column Impact Loading



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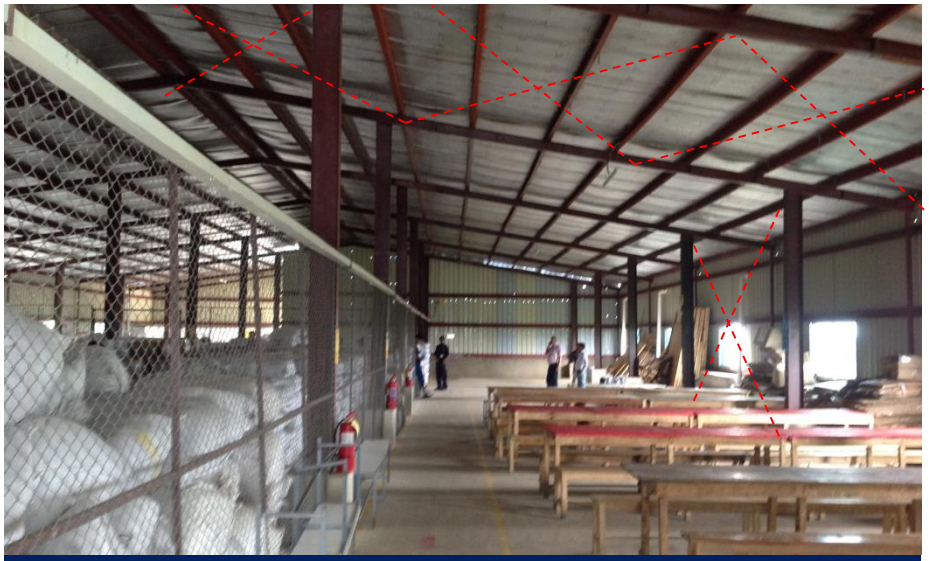
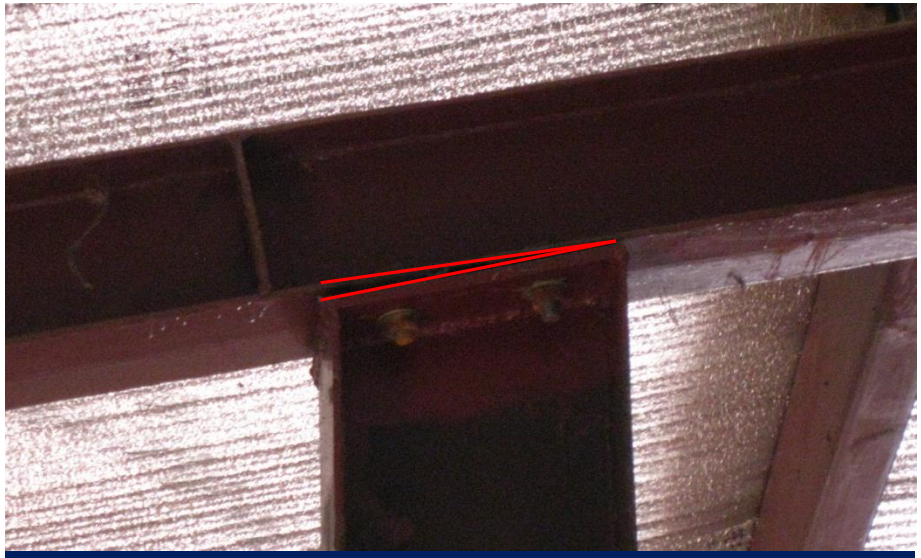
# Lightweight and non-engineered structures

The factory compound includes a number of buildings with lightweight structures, such as the embroidery building, the winding building, the majority of the utility buildings and the roof of the main factory building.
There are elements of these structures which appear to be non-engineered and not designed to resist uplift forces and lateral loads, particularly in relation to bracing and connection details.



Roof shed - lack of horizontal bracing



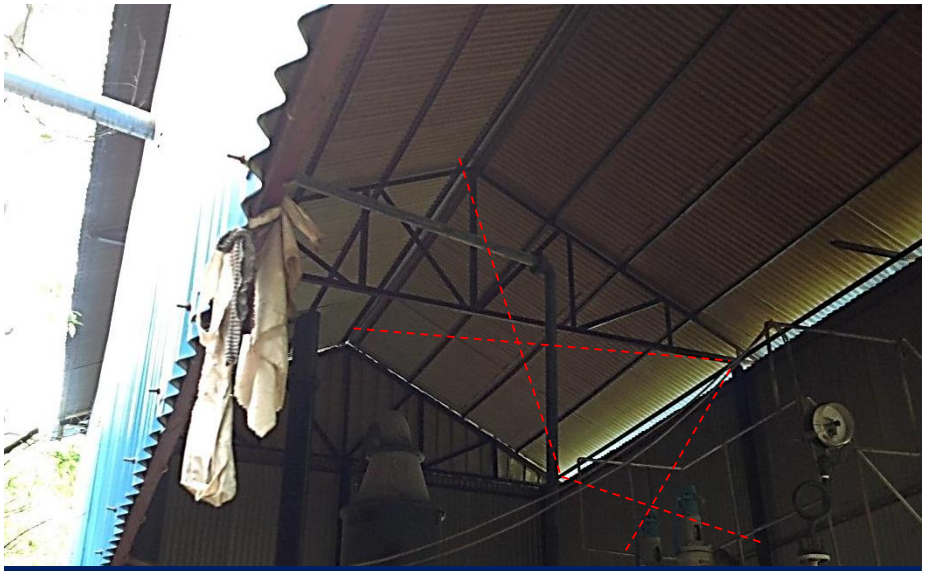
Inadequate bearing at beam-column connections

# Lightweight Structures

Shed to roof – Beam to RC column connection unclear


Embroidery building – corrugated roof on timber purlins

Winding building - corrugated roof on timber purlins



Boiler shed – Lack of horizontal and vertical bracing



# Lightweight Structures

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Welfare Shed – Corrugated roof on timber purlins

Store Shed – Lack of horizontal and vertical bracing

Generator Shed – Roof connection details unclear

Wastage store – Sagging timber purlins

# Lightweight Structures

# Priority Actions

# Problems Observed

1. Extensive cracking to the top and soffit of suspended floor slabs of the main building
2. Heavy floor loading and lack of a loading plan in the main building
3. Omissions and irregularities in design documentation
4. Double-height columns at risk of impact loading
5. Lightweight and non-engineered structures

| Item No. | Observation | Recommended Action Plan | Recommended Timeline |
|---|---|---|---|
| 1 | Extensive cracking to the top and soffit of suspended floor slabs of the main building | Reduce loading on all floor plates to 2kPa pending review by Building Engineer. | **Immediate - Now** |
| 2 | Extensive cracking to the top and soffit of suspended floor slabs of the main building | Building Engineer to review extent of cracking to suspended floor slabs, and to prepare a schedule of actions, as required. | **Immediate - Now** |
| 3 | Extensive cracking to the top and soffit of suspended floor slabs of the main building | A Detail Engineering Assessment (DEA) of the main factory building to be commenced, see attached Scope. | **Immediate - Now** |
| 4 | Extensive cracking to the top and soffit of suspended floor slabs of the main building | Detail Engineering Assessment for the factory building to be completed. | **6-weeks** |
| 5 | Extensive cracking to the top and soffit of suspended floor slabs of the main building | Building Engineer to implement any actions as identified following the review and DEA, including load reduction / repair / strengthening of the slab if required. | **6-weeks** |
| 6 | Extensive cracking to the top and soffit of suspended floor slabs of the main building | Building Engineer to supervise any remedial works. | **6-weeks** |

# 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. T his 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 No. | Observation | Recommended Action Plan | Recommended Timeline |
|---|---|---|---|
| 7 | Heavy floor loading and lack of a loading plan in the main building | As part of the Detail Engineering Assessment, Building Engineer to carry out a design check for loads due to water tanks, toilet areas, machines and storage areas (including temporary), and to advise on any necessary remedial works | **6-weeks** |
| 8 | Heavy floor loading and lack of a loading plan in the main building | Produce and actively manage a loading plan for all floor plates within the factory giving consideration to floor capacity and column capacity. | **6-weeks** |
| 9 | Heavy floor loading and lack of a loading plan in the main building | Factory Management to actively implement and manage a Loading Plans at each floor level. | **6-months** |
| 10 | Omissions and irregularities in design documentation | As part of the Detail Engineering Assessment, Building Engineer to carry out a design check to assess the safety and serviceability of the building, particularly in relation to lateral stability and element sizes. | **Immediate - Now** |
| 11 | Omissions and irregularities in design documentation | Building Engineer to survey all areas of the building, collect information and prepare a full and accurate set of "as-constructed" drawings, with special emphasis on connection details. | **6-weeks** |
| 12 | Omissions and irregularities in design documentation | Building Engineer to carry out comparison between design specified member sizes and as constructed structure. | **6-weeks** |
| 13 | Omissions and irregularities in design documentation | Building Engineer to implement any actions / supervise any remedial works as identified following the design check. | **6-months** |

| Item No. | Observation | Recommended Action Plan | Recommended Timeline |
|---|---|---|---|
| 14 | Double-height columns at risk of impact loading | As part of the Detail Engineering Assessment, Building Engineer to assess whether the columns have been adequately designed for impact loading. | **6-weeks** |
| 15 | Double-height columns at risk of impact loading | Suitable column protection barriers to be designed and constructed. | **6-weeks** |
| 16 | Lightweight and non-engineered structures | Building Engineer to review the design of all lightweight structures within the compound and assess their ability to withstand wind loading pressure, suction and uplift forces, with special emphasis on connections and bracing. | **6-weeks** |
| 17 | Lightweight and non-engineered structures | Building Engineer to implement any actions / supervise any remedial works as identified following the review. | **6-months** |