BONACCI

The University of Sydney

ETP Stage 1

Structural Design Report

Prepared for The University of Sydney

THE UNIVERSITY OF SYDNEY

Report Amendment Register

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1. EXISTING CONDITIONS

1.1. Existing Building

1.1.1. Overview

The existing J03 Electrical Engineering Building is located within the Engineering Precinct of the University of Sydney Camperdown Campus, at the South Eastern side of the campus. The existing Electrical Engineering Building is approximately 50x50m and is bordered by Maze crescent to the west, PNR Building to the South, Engineering Link Building and Aeronautical/Mechanical Engineering Building to the East and Blackwattle Creek Lane to the North.

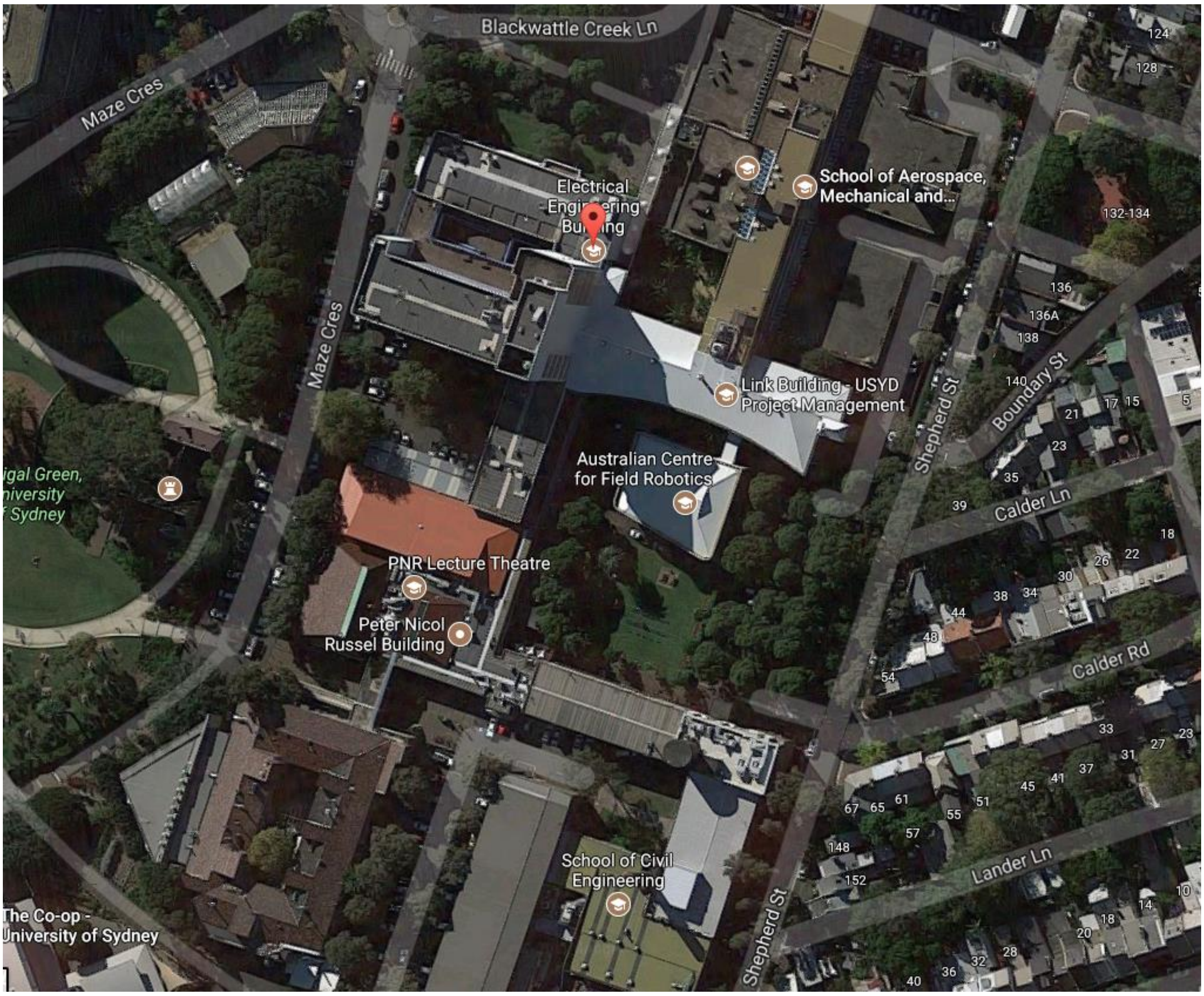


Figure 1 - University of Sydney Engineering Precinct

1.1.2. Structure

The existing building structure was designed in 1966 by Taylor-Thomson-Whitting (TTW). The structure consists mostly of one-way reinforced concrete slabs and beams supported by reinforced concrete columns and walls on piled foundations. The existing structure was likely designed in accordance with AS CA2 1963 which was the relevant design code of the time. It is unlikely that the building design and construction complies with modern codes, however this is expected for buildings designed prior to 1990s.

1.1.3. Seismic

At the time of original construction, there was no requirement to design buildings for seismic loading. However, there are some significant lateral restraint elements in the building including long shear walls at the façade and concrete fire stair cores and lift core. The piled foundations are detailed to take compression loads only, with no reinforcement detailed below the top 1m of pile.

1.1.4. Durability

Modern structures designed to Australian standards generally have a design life for durability of 50 years. Reinforced concrete buildings designed in the 1960s were constructed with concrete cover less than required by the current Australian Standard AS3600:2009. It is recommended that a detailed investigation be undertaken to highlight any defects including concrete core samples, strength tests, measurement of concrete cover, carbonation testing, reinforcement yield strength and ductility tests etc.

1.1.5. Fire

In addition to durability, the existing structure design will not meet the deemed to satisfy provisions within AS3600. Should the building need to be upgraded to comply with AS3600 and the BCA, it will not meet the deemed to satisfy provisions and will need to be justified to Eurocode 2 and potentially require strengthening or fire protection.

1.1.6. Loading

Design live loads are summarised below based on the original TTW structural drawings.

Live Load – Roof	1.4kPa
Live Load – Plant	4.8kPa
Live Load – Water Tank Room (Level 11)	16.8kPa
Live Load – General (Classrooms, Laboratories, Offices, Corridors, Concourses)	2.9kPa
Live Load – Lecture Theatres, Level 2 Laboratories, Workshops, Level 4 Laboratories, Staircases	4.8kPa

1.1.7. Geotechnical

Referring to the geotechnical investigation report (84513.01 Revision 0) by Douglas Partners, it is evident that fill has been found across the university grounds to significant depths in some locations. The fill composition and quality is variable and is generally underlain by clay, followed by shale and bedrock. The existing building is founded generally on 1065mm diameter cast-in-place concrete piles with a minimum end bearing of 960kPa.

2. Proposed Development

2.1. General Description

The proposed redevelopment involves demolition of the northern portion of the existing electrical engineering building, and construction of a new 10 storey building with 4.2m floor to floor heights. It is proposed to link to the existing with "bridges" built out of lightweight framing, which will be sloped between floors of differing heights. There is also provision to design a new roof structure over the dangerous goods store and new awning structure to the west.

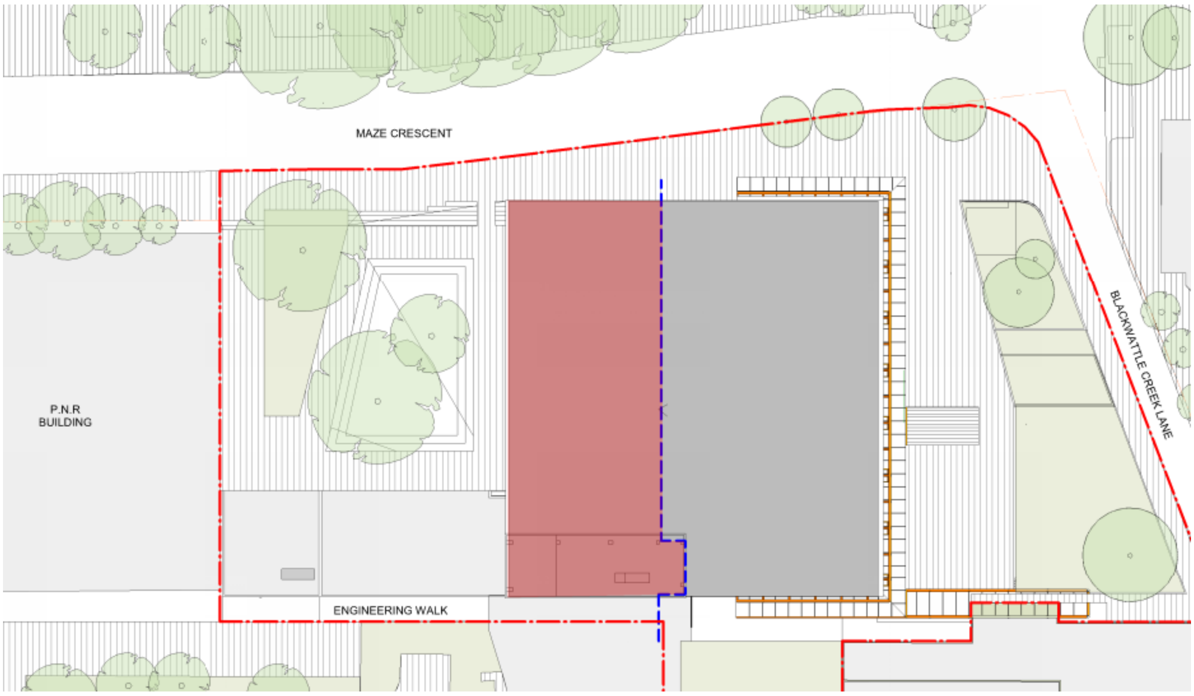


Figure 2 - Proposed Redevelopment of Existing Electrical Engineering Building

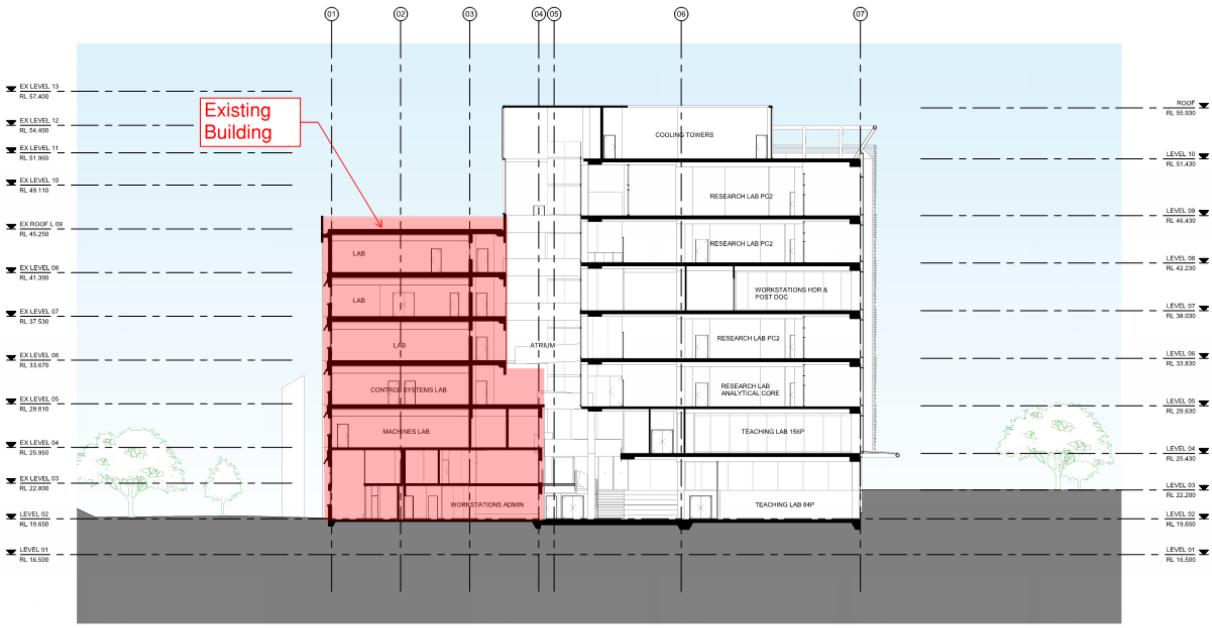


Figure 3 - Section Through Proposed Building

2.2. Geotechnical Conditions

As was the case with the existing building, footings will need to be piled down to shale or bedrock. While there were no specific soil or rock design parameters outlined in the geotechnical report it has been assumed that bearing capacity of shale is approximately 1000kPa based on the existing structure design.

Lateral support system will be required for all vertical excavation in fill and clay. It is recommended that shoring piles with shotcrete and ground anchors be used to ensure the stability of the excavation. The shoring system will be designed in accordance with the geotechnical engineer's recommendations.

2.3. Superstructure

The superstructure of the new portion of the building will be concrete columns, walls and floor slabs. Above level 04, lateral resistance is to be provided by the main lift core at the centre of the building and frame action from the columns and deep concrete beams/slabs. Below level 04, lateral restraint will be provided by additional shear walls and/or steel bracing trusses on the east and west sides of the building.

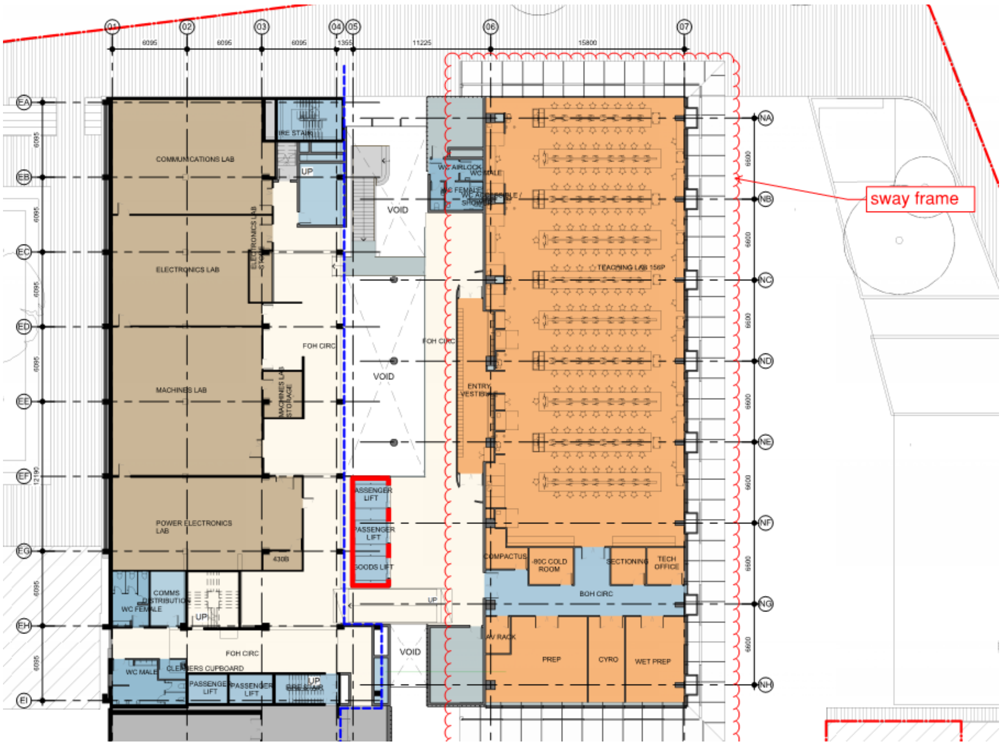


Figure 4 – L04+ Lateral Design

Below level 04, lateral restraint will be provided by additional shear walls and/or steel bracing trusses on the east and west sides of the building.

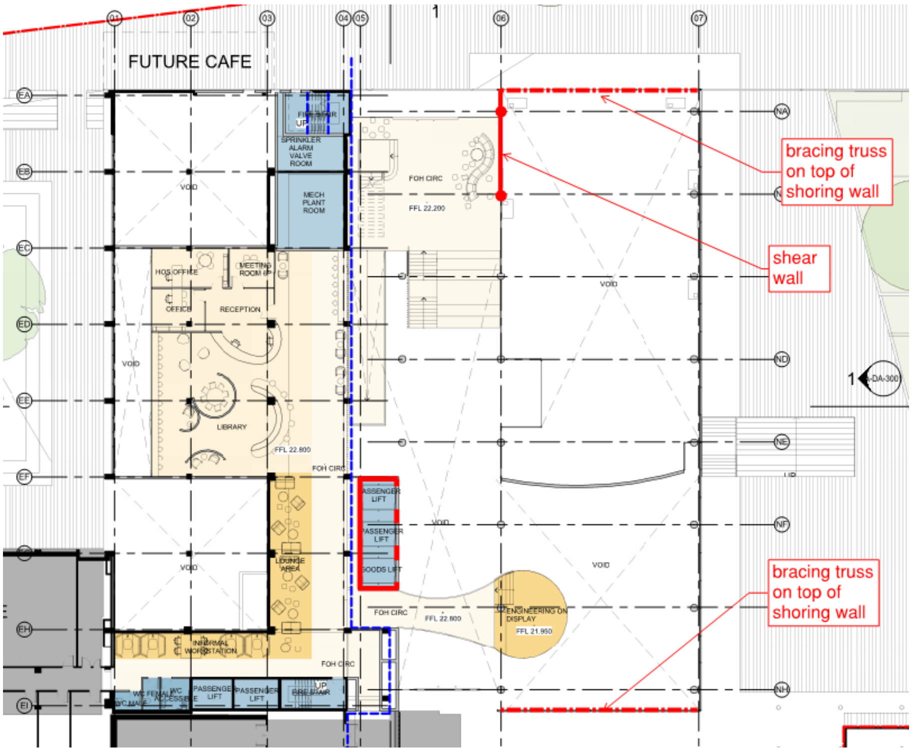


Figure 5 - Level 02-03 Lateral Design

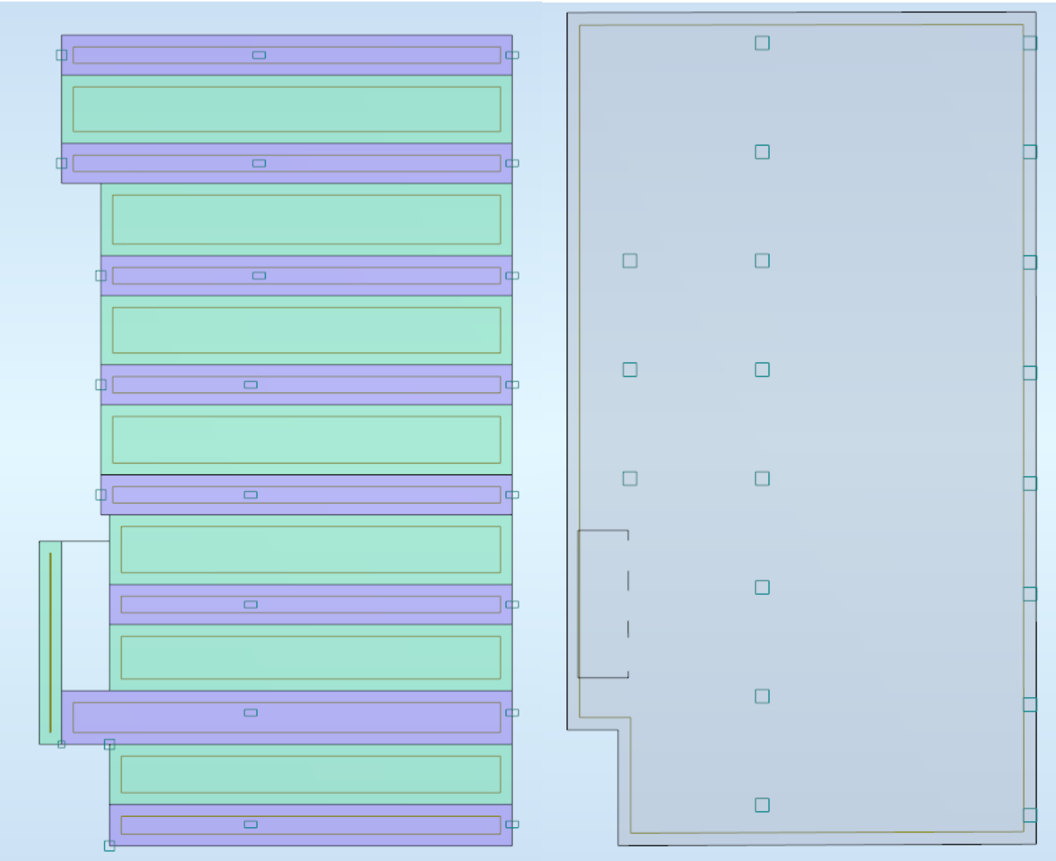
Figure 6 - Isometric View of the Building Structure

2.3.1. Floor Systems

We have provided a few feasible options for comparison.

1. 700D beams and one-way spanning slabs (below left). This option has flexibility to utilise alternative formwork systems for the one way slabs such as metal decking, ultraflor, hollowcore etc but reduces flexibility with services within the ceiling zone.

2. 380 deep two-way spanning flat slab (below right). This option maximises head height and simplifies formwork at the cost of additional concrete and PT.



The two way post-tensioned flat slab is the preferred option at this stage due to formwork simplicity and flexibility for mechanical ductwork and other services.

3. Design Criteria

3.1. BCA Classification

- Type of Construction: A

- Classes of Building:

  - Class 5 Office Building
  - Class 8 Laboratory
  - Class 9b Assembly Building

Building Matrix		
Levels	**BCA Class**	**Use**
Level 1	Class 5, Class 8	Labs, Maintenance Office, Back of House Storages and waste, delivery area
Level 2	Class 5, Class 9b	Offices, Teaching lab, Students areas, Front of House, Building plant & equipment
Level 3	Class 5, Class 9b	Offices, Teaching lab, Students areas, Front of House, Building plant & equipment
Level 4	Class 8, Class 9b	Tech Labs, Labs, Students work areas, Building plant & equipment
Level 5	Class 8, Class 9b	Board Room, Labs, Students work areas, Building plant & equipment
Level 6	Class 8, Class 9b	Labs, Students work areas, Building plant & equipment
Level 7	Class 8, Class 9b	Labs, Students work areas, Building plant & equipment
Level 8	Class 8, Class 9b	Labs, Students work areas, Building plant & equipment
Level 9	Class 8, Class 9b	Labs, Students work areas, Building plant & equipment
Level 10	Class 8, Class 9b	Building plant & equipment

Figure 7 - BCA Extract

3.2. Design Codes

The structural design of the project will be carried out in accordance with the following Australian Standard Codes of Practice.

- Building Code of Australia
- AS1170 Part 0 General Principles
- AS1170 Part 1 Permanent imposed and other actions
- AS1170 Part 2 Wind actions
- AS1170 Part 4 Earthquake Actions in Australia
- AS3600 Concrete Structures
- AS3700 Masonry Structures
- AS4100 Steel Structures Code
- AS4600 Cold-formed Steel Structures

3.3. Design Loads

Table 1 - Floor Loads

Floor Type	Uniform Imposed Load (kPa)	Super Imposed Dead Load (kPa)
Stairs, ramps	4.0	0.75
Corridors, circulation areas and foyer spaces	5.0	1.5
Offices, lecture spaces	4.0	0.75
Plant rooms	5.0	0.75
Construction Loading	T.B.C	-
Library	5.0	1.5
Compactus	10.0	1.5
Truck Dock	10.0	0.25
Carpark	2.5	0.25
Store Rooms	5	0.25
Staff Areas, design studio	4.0	1.5
Steel Roofs	0.25	0.5

3.4. Wind Loads

Wind Load will be assessed in accordance with AS1170. 2, using following parameters:

Table 2 - Wind Loads

Item	Value
Location	Region A2
Importance Level	3
Vu	46m/s
Vs	37m/s
Ms	1.0
Mt	1.0
Md	1.0
Terrain Category	3.0

3.5. Earthquake Loads

Earthquake loads will be assessed in accordance with AS1170.4-2007, and the design parameters are as follow:

Table 3 - Earthquake Loads

Item	Value
Importance Level	3
Probability Factor, Kp	1.3
Hazard Factor, Z	0.08
Sub-Soil Class	Ce
Earthquake Design Category	ii
Structural Ductility Factor, μ	2
Structural Performance Factor, Sp	0.77

3.6. Deflection Criteria

3.6.1. Vertical Deflection

- Incremental slab deflection less than span/500
- Total long-term deflection less than span/250
- Cantilever slab – Total long term deflection - span/150

3.6.2. Lateral Deflection

- Interstorey drift due to wind – Storey height/ 500 (serviceability)
- Interstorey drift due to earthquake actions – 1.5% storey height(serviceability)

3.7. Footfall induced vibrations

All laboratory slabs will be designed for a minimum response factor (R) of 1. An option will be provided to reduce this down to 0.5 by either introducing columns or increasing the depth of the slab.

4. CONCLUSION

After reviewing the existing structures, geotechnical conditions, floor system design, lateral design and the footfall vibration criteria, it appears that the structural schematic design of the additional structure satisfies various design criteria, and the existing structure can be modified to accommodate the additions and alterations works.