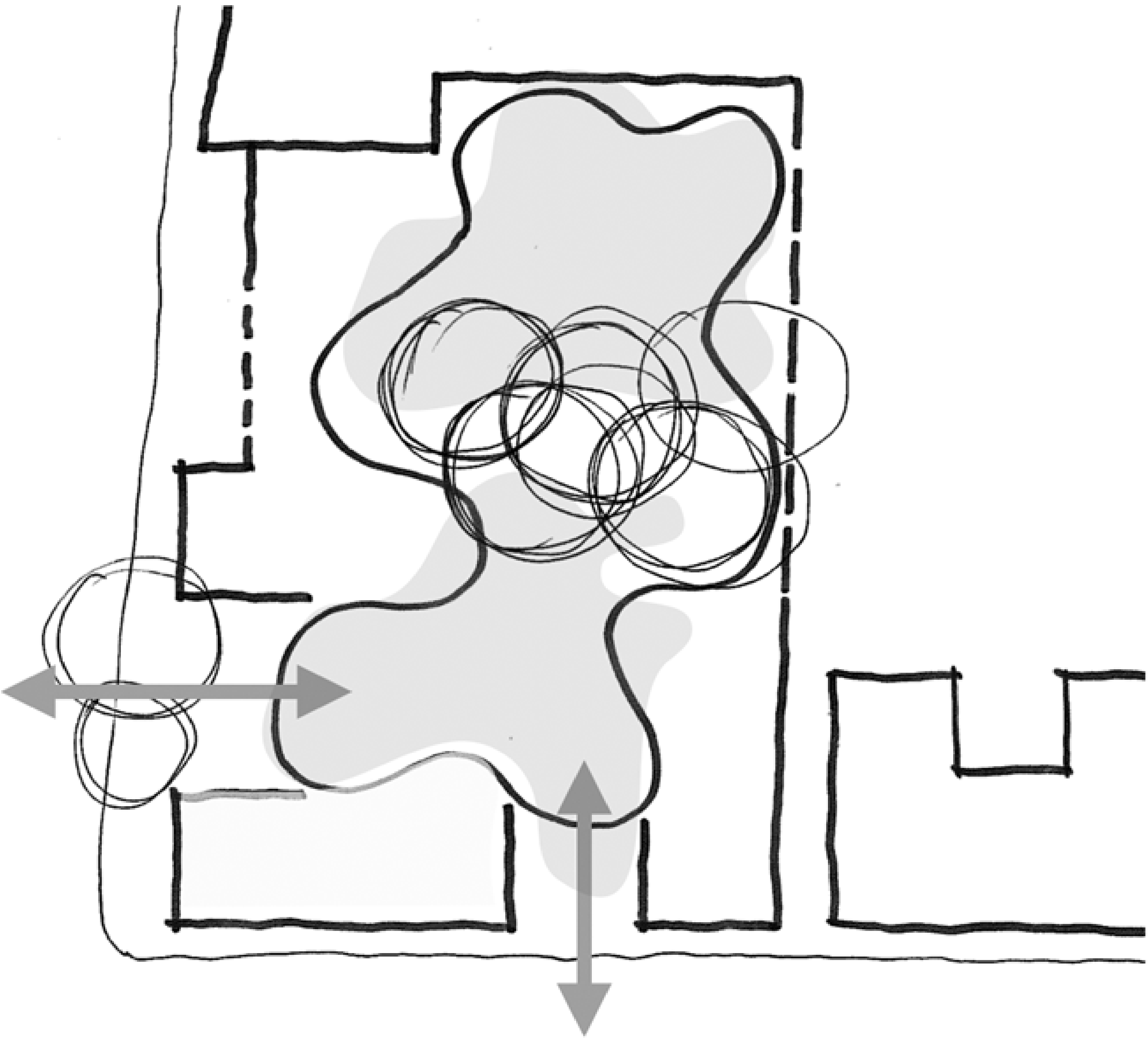
DARLINGTON PUBLIC SCHOOL REDEVELOPMENT

Appendix Z — Structural Report

SSD-9914

Prepared by Bonacci

For NSW Department of Education



Darlington Public School

State Significant Development –

Structural statement

Issued for:

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Report Amendment Register

Rev. No.	Section & Page No.	Issue/Amendment	Author/Initials		Reviewer/Initials		Date
0	-	SD Report for SSDA	Brian N	BN	Amir B	AB	06/04/20
1	6,8	Ethos Urban + MACE Comments	Brian N	BN	Amir B	AB	17/04/2020

Prepared by: Brian Naughton

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Discipline: Structural

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1. Introduction

Darlington Public School is located on the corner of Golden Grove Street and Abercrombie Street, Darlington, within the City of Sydney Local Government Area. The school is adjacent to the University of Sydney Darlington Campus and within walking distance to Redfern and Macdonaldtown train stations. The site is legally described as Lot 100 in DP 623500 and Lot 592 in DP 7523049. \

The SSD application seeks consent for demolition of existing school buildings and construction of a new part 2, part 3-storey building, increasing the school capacity from 230 to 437 students. The works also include replacement of the existing child-care facility (to the same capacity of 60 students), earthworks and landscaping. For a detailed project description refer to the EIS prepared by Ethos Urban.

Bonacci Group (NSW) Pty Ltd has been engaged by School Infrastructure NSW to provide civil and structural design services for Darlington Public School Redevelopment.

The Contents of this report summarizes the outcome of the investigation/analysis of the site conditions, authority requirements, relevant structural requirements, tested structural systems and provide the preferred structural scheme.

1.1. Scope

The scope of this report is to summaries the site conditions and the various structural design aspects of Darlington Public School, as follows:

This site conditions section will outline the following aspects

- Staging considerations
- Presence of heritage listed buildings
- Existing building condition
- Further investigations

The design section will outline the following:

- RC concrete column design;
- Concrete core walls
- PT slab (D&C contractor);
- Vibration criteria;
- Foundations such as pad footings/Pile design;
- Architectural features such as large span zones, sawtooth roof, curved façade

The Input Parameters section will outline the following:

- Loadings considered and referenced codes and building standards;
- Relevant performance criteria used in design;
- Fire Resistant Levels

2. Site Conditions

2.1. Location

Site is located on the corner of Golden Grove Street and Abercrombie Street, Chippendale. Darlington Public School is located within the City of Sydney Council adjacent to the University of Sydney Darlington Campus, close to Carriage works, Redfern & Macdonald town Train Stations.

It is surrounded by medium density residential units, terrace housing, St Michael's Melkite Cathedral and the University of Sydney Business School. The rear of the site abuts the University of Sydney Regiment Building, on the corner of Darlington Lane and Golden Grove Street. On the north side of Darlington Lane is a proposed student housing redevelopment of a row of terraces along Darlington Road.

Figure 1 - Locality Map (Nearmap)

2.2. Staging and Existing Buildings

The redevelopment is proposed to be in two stages. In stage 1 new buildings will be constructed in the north of the site. The existing building at south west of the site would be trimmed to allow construction of the northern building which would be up to three storey high. The existing south building will remain in stage 1. In stage 2 the existing south wing and the remainder of the south west corner building would be demolished and replaced with a new one storey building. The stage 1 north wing would be extended south in stage 2.

Retaining of the current Hall building at south west corner for stage 1 will require careful consideration of adjoining structures proposed to be demolished. The record drawings for the existing buildings provides insight to this. It is envisaged that installation of the temporary supports and footing would be needed at cut structural faces to ensure the stability of the remaining structure. See section 3.2.4 of this report for further discussion.

The existing buildings also show signs of concrete structure deterioration including signs of concrete spalling due to reinforcement corrosion hence if stage 2 works are not to follow the stage 1 works immediately then some repair works might be needed to address structural concrete defects.

The lot consolidation process is not expected to have any major impact on structure. The main consideration on this point is how it effects BCA requirements in terms of fire compartmentation and setbacks from boundaries.

2.3. Building Adjacent to the Heritage Listed Neighboring Property

There is an existing neighboring building in north west side of the site which is understood to be heritage listed and owned by Sydney University. A study of proposed FFL's and surveys indicates the proposed stage 1 building will have to excavate up to 1000mm below the existing structure to the north. There are potential issues with this including the risk of undermining the existing footing of the building-pending the new floor level in relation to the footing base level.

Test Pits were carried out by Douglas and Partners to establish the levels and composition of existing heritage footings to the north west side of the site. We have since provided several options, each providing alternate load paths to prevent loading existing foundations. One such option is that the final ground floor slab would be suspended supported by piles drilled away from the heritage wall to avoid damaging the wall/foundations – Refer to SD Drawings in Appendix A of this report. The excavation induced vibration should also be managed through onsite vibration monitoring during construction.

2.4. Site Contamination

Contamination report indicates that different types of contaminants being present in the fill on site including TRH, PAH and lead. While mostly sealed by hard paving's, some hazardous materials are identified to be exposed especially in north zone. This include asbestos traces. The disturbance to the fill on site must be kept to the absolute minimum needed. This will ensure no costly treatment or disposal processes. Refer contamination report no. 922277.01-R-002 by Douglas Partners and associated RAP. Section 3 of this report describes how the proposed structural scheme minimizes any soil disturbance.

2.5. Existing Live Services

There is possibility of existing services on site buried under the existing buildings that could be damaged during demolition. The site must be thoroughly investigated during the construction works to ensure no damage to the existing live services.

2.6. Geotechnical Investigation

A geotechnical and contamination investigation has been carried out by Douglas Partners in February 2019. The site consists of deep filling of up to 2.4m depth over hard clay layer followed by low strength bedrock at 2-3.5m depth. Medium strength bedrock is encountered in depths of 9.8 to 10.44m. No groundwater was encountered during investigation. The existing buildings are noted to be piled based on the record structural drawings. Refer Geotechnical report no. 92277.01-R.001 by Douglas Partners.

2.7. Risks

	Item	Risk	Mitigation
Sitewide	In ground contamination	Hazardous material potentially present in fill	Limit the proposed excavation- further investigation might be needed
	Existing Live Services	Services disrupted/damaged during site works- WHS issues	Identify all the existing services early on through further survey, DBYD etc…
Neighbouring heritage building	Proximity of the proposed building to the heritage listed building	Damaging/undermining the heritage building	Plan the new building away from the heritage building or alternatively incorporate the appropriate footing system to redistribute loads.
Staging	Retaining the existing building	Temporary structural works required	Demolish if possible- Alternatively investigate the existing structure through further site inspection/review of the record drawings
	Construction activities	Site occupant health and safety during the construction	The demolition works are to be carried out in school holidays where possible- the construction zone is physically separated from the rest of the site.
	Extended time gap in between stages	Further deterioration to the concrete structure	No delay in between stages or repair to the defective structure to increase its life or mitigate the associated structural risks

Table 1 - Major risk items

3. Structural Design

Several structural systems were considered during Concept Design Stage. This included a CLT option- cross laminated timber- followed by post tensioned concrete structure, lightweight steel floors i.e. post strut floors, precast planks i.e. Ultra Floor or hollow core floors. The CLT option was ruled out based on NCC and EFSG compliance issues as well as high maintenance concerns.

A few different footing systems were also proposed based on limited floor level information in concept stage. Refer to preliminary structural concepts issued 6th September 2019.

This section of the report outlines the final structural systems selected, which is not only compliant with the National Construction Code- performance requirements- i.e. fire rating and acoustic- EFSG guideline and as per quantity surveyor advice. The preferred footing system has also been chosen based on mitigating the risk of disturbing the contaminated soil on site.

3.1. Footing System

According to the geotechnical investigation, the depth of rock varies across site. Due to the stepping nature of the natural ground levels, and due to the presence of contaminated soil, we are proceeding with a bored pier/screw pile solution with a suspended ground floor slab. This prevents the need for excess excavation and treatment of uncontrolled fill, as outlined in Douglas Partners geotechnical report, section 7.4.1. It also minimizes any disturbance of contaminated soils. Refer to appendix A, Bon-SK-01 for proposed footing layout. For consistency during installation of piles, we have proposed 600mm piles throughout the site.

Piles supporting RC columns will be 600mm Diameter, with 750*750*450mm Deep Pile caps, refer to figure 2 below for typical section. Piles supporting higher loads of the superstructure columns must bear on Class III shale, and socket min 4500mm into Class IV Shale above. Intermediate piles supporting suspended slab on ground are lightly loaded hence these piles could bear on class IV shale, and socketed a minimum 300mm into class IV Shale. Refer to table 01 below for Overview of piling required.

Location	Pile Diameter	Base Resistance (Rock Strata)	Socket Length (Rock Strata)	Approximate Max Loading (Working) (kN)
Piles supporting RC columns	600mm	Class III Shale	4500mm (Class IV Shale)	1650
Intermediate Piles	600mm	Class IV Shale	300mm (Class IV Shale)	280

Table 2 – Summary of piled footings required

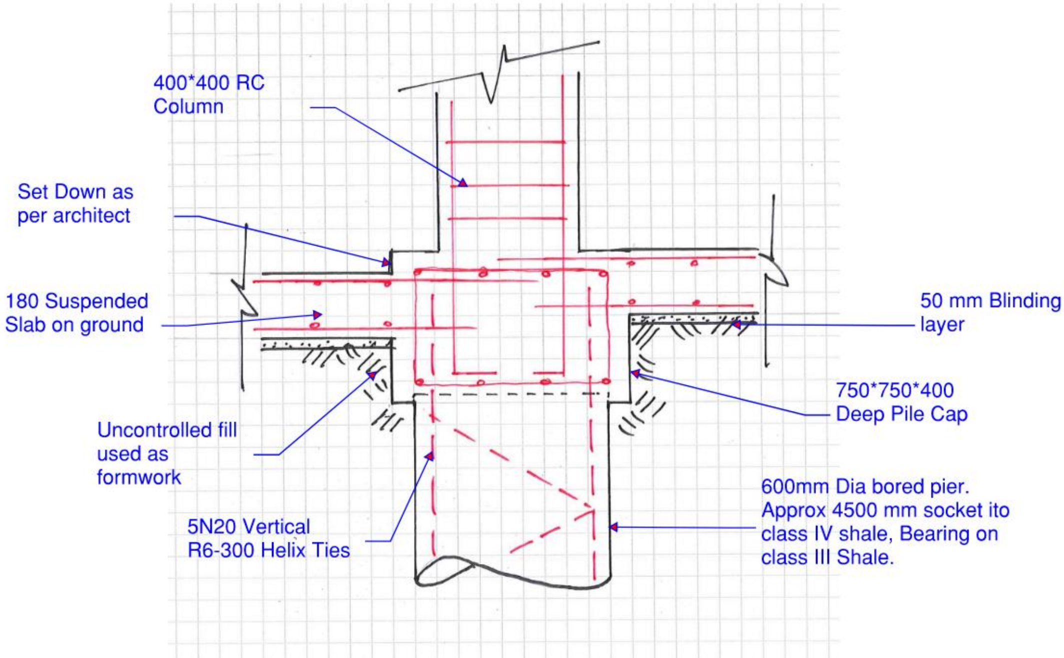

Figure 2 - Typical section at Pile Cap

3.1.1. Suspended Slab on Ground

Due to the presence of uncontrolled fill throughout the site, a suspended slab on ground is the most economical system to prevent the requirement for excavation and treatment of existing contaminated soils, as per geotechnical report section 7.4.1. This will utilise the site fill material as formwork during construction until the floor has gained enough strength to span in between the support piles.

3.2. Superstructure

Following concept design stage a concrete framed structure with post tensioned banded slab as floor structure was chosen as the preferred option based on the following:

- Complies easily with performance requirements including NCC and EFSG requirements such as durability and fire performance.
- Ability to achieve large column free spaces, allowing future flexibility for home base unit spaces as well as school entry column free space as per architectural requirements.
- Quantity Surveyor input confirming it the most economical solution.
- Post tensioned structure being lighter that conventionally reinforced structure need less/smaller footings hence less risk of disturbing the contaminated soil on site.

3.2.1. PT Bands and Slab

PT beam are generally 1200mm wide with depth ranging from 400mm to 500mm depending on spans, refer to drawings in appendix A for sizes. One-way slabs between beams are generally 160mm thick.

3.2.2. Vertical Elements

400mm square RC Columns have been nominated to achieve required fire rating as per NCC Report. If required, these may be modified in certain areas to suit architectural requirements.

200 thick RC walls have been nominated to provide both vertical and lateral support. These walls will extend to roof level where possible to remove the requirement to fire rate alternate steel columns. Where not allowed by architectural requirements, fire rated steel columns have been adopted to support the roof loads.

3.2.3. Steelwork

Steel structure will be adopted for the upper roof. This will comprise of primary steel structure supporting proprietary sawtooth roof trusses. Layout of roof structure was on hold at the time of writing this report, preliminary design an be seen in Appedix A.

The proprietary sawtooth roof will be either timber or steel trusses at approximately 1200 mm centers, designed by D&C contractor.

3.2.4. Link Between old and new structure during staging

Following reviewal of record architectural and structural documentation the proposed break line between stage 1 and 2 appears to occur through the mono-pitched timber roof as illustrated below. It is believed that prior to demolition of existing load bearing double skin brick, the truss must be propped, and additional structural posts and footings installed.

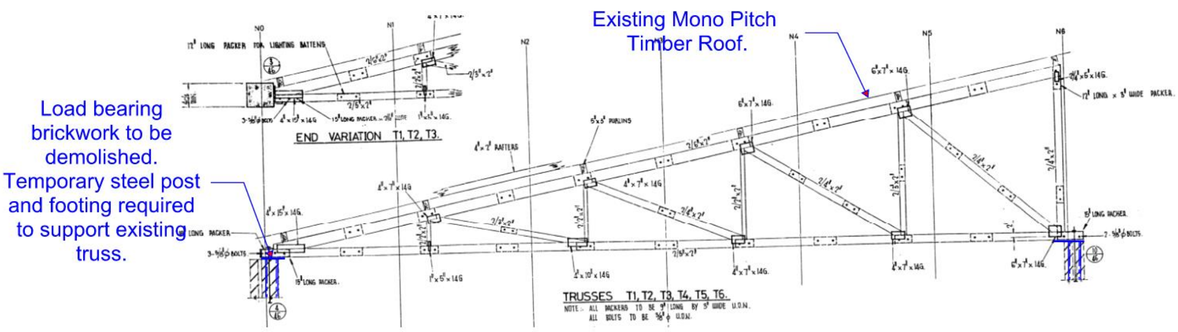

Figure 3 -Typical section of existing structure, at the link between stage 1 and 2.

Note this is an initial review based on record drawings hence consultation with contractor and further investigation/ opening up work will be required to confirm the works.

4. Design Parameters

4.1. Australian Standards and NCC

The following Australian Standards in combination with NCC 2019 are used in the structural design of this project.

- AS/NZS 1170.0/2002 – Part 0: Structural design actions
- AS/NZS 1170.1/2002 – Part 1: Permanent, imposed and other actions
- AS/NZS 1170.2/2011 – Part 2: Wind actions
- AS/NZS 1170.4/2007– Part 4: Earthquake loads
- AS3600 – 2018: Concrete structures
- AS4100 – 1998: Steel structures
- AS1720- 2010: Timber Structures
- AS3700 – 2018: Masonry Structures
- AS2159 – 1995: Piling
- AS/NZS4600 – 2001: Cold-formed steel structures
- AS/NZS3828 – Guidelines for the erection of building steelwork

4.2. Design Loading Information

Loads and their appropriate load combinations will be in accordance with AS1170.0, AS1170.1, AS1170.2 and AS1170.4. The applied loading is summarised in this section of this design brief.

This section is to be read in conjunction with the structural drawings, which will indicate the design loads of each floor on the concrete outline drawing. Note, masonry walls loads are excluded from these loading drawings and should be taken from the relevant architectural drawings.

4.2.1. Self-Weight Loads

Self-Weight loads shall be calculated as provided for in the current version of AS1170. Part 1: Permanent, imposed and other actions.

Material densities are taken from AS1170.1.

4.2.2. Super Imposed Dead Loads and live loads

Live loads are taken from AS1170. Part 1: Permanent, imposed and other actions. The following table describes the more significant loading on the project, and further clarification of floor loads can be obtained by referring to the loading diagrams in the structural set of drawings.

Pattern Live loads shall be considered if applicable in accordance with Clause 2.4.4 of AS3600. Live load reduction shall be applied to AS1170.1 if appropriate for vertical elements.

Location	Dead Load	Live Load
Basement Storage, Library, Bulk storage rooms, Stage, Kiln dry	0.5 kPa	5.0 kPa
Other stores, canteen, gymnasium, technology, food, preparation areas, applied studies, computer areas, arts, plants	0.5 kPa	5 kPa
Classrooms	1 kPa	3.0 kPa
Gym	2.0 kPa	5.0 kPa
Community Facilities	2.0 kPa	5.0 kPa
Corridors	1.5 kPa	4.0 kPa
Lobbies, Corridors and stairs etc	1.5 kPa	4.0 kPa
Trafficable concrete roofs	2.5 kPa (Inclusive of Falls)	5.0 kPa
Lift Lids	1.5 kPa	2.0 kPa or Lifting loads
Roof top plant loads	2.5 kPa	7.5 kPa or plant loads, whichever is greater
Fire Stairs	0.5kPa	4.0kPa

4.2.3. Façade Loading

Assumed to be masonry veneer with internal dry stick plasterboard with 20% openings, the line load on a typical floor is equivalent to.

- Masonry = (19x0.11 + 0.01x24 + 0.1) x 2.8m high
- Adopt = 7.5 kN/m

4.2.4. Balustrade Loading

According to AS1170.1 Table 3.3, horizontal balustrade loading for 1.5kN/m for C1/C2 Occupancy, and 0.75kN/m for C3 occupancy.

If perforated metal façade is required, the horizontal loading will be approx. 1.0kPA, applied to the first 1200mm from the base, or a point load of 0.5 kN applied over a panel of 2000 mm^2 or over two adjacent vertical balustrades, as appropriate.

4.2.5. Earthquake

Project will be designed in accordance with AS1170.4-2007 and NCC 2019.

- Hazard Factor: Z = 0.08
- Life Span: 50 years
- Site subsoil TBC
- Probability of exceedance kp = 1.3
- Importance Level 2

4.2.6. Wind

To AS1170.2 for a Region A2 wind and a Terrain Category 3.

4.2.7. Robustness

In accordance with the requirements of AS1170.0/2002 Amendment 3 the robustness load is taken as 1.5% of the gravity load (G + ψcQ).

4.2.8. Blast and impact loading

It is noted that the design of the building and structure and boundary walls if any, has not been designed for any vehicle impact loads (other than car-park barriers loads taken from AS1170.1), nor has the building or its structure been designed for any blast/explosion loadings or terrorist induced loading events.

4.3. Limit State Design Criteria for structural elements

4.3.1. General Design Approach

The limit state design for strength, serviceability and stability of the relevant structural elements within the building will generally follow the established criteria in the relevant material design codes AS4100 and AS3600 unless noted otherwise below.

4.3.2. Structural Movements

Building Sways (Deflection) subject to service wind loads shall satisfy;

- Total lateral deflection to not exceed height/500.
- Inter-storey deflection to not exceed inter-storey/500 or 12mm, whichever is lesser

Floor Deflections to AS3600 and AS4100, limited to span/250 total and span/500 incremental for flexible partitions, and span/500 total and span/1000 incremental for (non flexible) rigid partition walls without regularly spaced movement joints. Deflections for transfer elements shall be limited to the lesser of Span/360 or 10mm max total deflection.

4.3.3. Fire Resistance

Fire rating to AS3600/AS3700/AS4100.

4.3.4. Crack Control

Generally, all internal suspended slabs will be designed for a moderate degree of crack control, except for external roof slabs over living areas where a strong degree of crack control will be adopted. For Post tension slabs, this will result in a minimum post tension stress of 1.4MPa and 2.0MPa for moderate and strong degree of crack control, respectively. Refer to Section 4.8 for further minimum requirement to external slabs over living areas.

Pour strips or Temporary Movement Joints (TMJs) will be introduced where appropriate to minimise the long-term creep and shrinkage effect of the concrete and these will be coordinated with the builder construction programe.

4.3.5. Minimum Connection Requirements and Ties

All connections, including but not limited to beam/slabs to columns/wall, precast, etc, shall be designed to clause 6.2.3 AS1170.1 for the transfer of the lateral loads and robustness.

4.3.6. Durability

Durability to be to AS3600/AS4100/AS2311 / 2312. Maintenance levels and design life are to be nominated by the client regarding surface coatings.

4.3.7. Column Stiffness

For the purposes of both post tension and reinforced slab designs, column stiffness's are to be limited to a maximum of 20% for the slab flexure and one-way shear design, but 80% for punching shear design.

4.3.8. Concrete Roof Slabs

External suspended slabs that form part of a roof will have the following minimum design measures to improve the performance of the slab and minimise the risk of water egress directly under them. However, the slab will not be designed to retain water alone and waterproofing measures to both the slab and joints are to be in accordance with the waterproofing consultant details.

Roof slabs immediately over living spaces below will include a minimum of the following;

- A concrete strength of 40 MPa
- A minimum post tension stress of 2.0MPa, and
- A minimum of SL82 top reinforcement throughout.

Waterproofing membranes and concrete additives to Architects and waterproofing subcontractor's details.

4.3.9. Floor Vibrations

Floors shall be designed to ensure that there are only slight perceptible vibrations under footfall effects, or from other internal or external sources.

Floors shall be designed to ensure they comply with the recommended acceleration and velocity limits in the relevant standards. The R value method outlined in Annex A of AS2670.2 and Appendix A of BS6472 will be used. A dynamic assessment shall be undertaken in accordance with SCI p354 Design Guidelines or approved equivalent. The floor structures shall be designed to achieve a maximum "Multiplying Factor" R value as appropriate.

The following parameters shall be used for the analysis:

- Weight of 1 person 746N (76kg x 9.81)
- Dynamic Concrete Modulus – of 1.2 x Ec as provided in AS3600 is to be used

Slabs are not designed for vibration emanating from plant equipment, ducting, fans etc. All vibrations from plant are to be isolated at the source with dampers and vibration isolation devices.

4.3.10. Vertical Deflection Criteria for Structural Steel

The design criteria for vertical deflections of structural steel rafters and beams are as follows;

Total Deflection (after precambers)

Self-Weight and Dead Load:	Span/300 or 20mm
Self-Weight, Dead Load and short-term Live Load:	Span/250
Incremental Deflection	
Short Term Live Load or Wind Load:	Span/200 or 30mm
Ceiling Dead Load only:	Span/500

Notes:

Note these deflection limitations are as per the Australian standard, rather than EFSG limitations.

Incremental and Total Deflection criteria are based on AS1170.0:2002 Table C1 for Rippling, sagging and cracking limit requirements for hung ceilings

Incremental deflections to rafters and primary beams can be additional and consideration of suitable deflection heads to walls is required.

It is assumed that appropriate movement and expansion joints are installed into brittle ceiling finishes and fixtures to assist in controlling cracking from the roof deflections described above.

For Cantilever beams and rafters, the deflection limit at the ends of the cantilevers are based on the above limits but with the span being equivalent to twice the distance from the support to the end of the cantilever.

5. Construction Materials: Codes, Properties and Construction Practices

5.1. Concrete

The design, material properties and construction of all reinforced and pre-stressed concrete elements shall comply with the provisions of AS3600 and any other relevant reference noted in this brief

For detailed information on the specification of concrete elements refer to the Concrete Specification.

Take note of the curing requirements within the specification to prevent shrinkage and drying shrinkage cracking.

5.2. Structural steel

The design, material properties and construction of all structural steel elements shall comply with the provisions of AS4100 and any other relevant reference noted in this brief

For detailed information on the specification of steel elements refer to the Structural Steel Specification.

5.3. Masonry

The design, material properties and construction of all masonry elements shall comply with the provisions of AS3700 and any other relevant reference noted in this brief

Bonacci Group will provide generic details of masonry walls and stiffeners for guidance on the joint locations and stiffeners for the use of the architect to place this information on their masonry drawings.

6. Certification

Design certification will be issued on completion of the detailed design and documentation.

A Site Inspection Certificate will be issued after construction.

7. Design certification by others

Design and construct elements must be certified by relevant qualified designer, such as the following elements.

7.1. Design and Certification of Waterproofing

All roofs, retaining walls, hydrostatic basement slabs, and balconies that require waterproofing will not be structurally designed to be watertight. It is not intended to rely on the inherent crack resistance of the reinforce/post-tensioned slabs and walls to resist water ingress. The crack control measures adopted for these concrete elements cannot be solely relied upon for water tightness. As such, the water tightness of the slab shall be achieved through the application of appropriate waterproofing membranes that are applied, designed, specified, and certified by another consultant.

7.2. Design and certification of PT Slabs

We have carried out initial design checks for the PT banded option. However, the detailed design, installation and certification of PT elements will be carried out by specialist D&C contractor.

Appendix A – Structural Concept Sketches