THE STAR

RIBBON BUILDING EXPANSION – STRUCTURAL BRIEF FOR PLANNING APPLICATIONS

PREPARED BY

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Notation	**Definition**
PT	Refers to Post Tensioned concrete whereby steel cables are stressed within ducts to compress the concrete elements
Temporary Works	Works associated with the construction of the building relating only to the construction stage (such as scaffolding etc)
Car Stacker	An automated parking system whereby a vehicle is placed on a platform, at which point the user exits the vehicle and the automated lift system places the car in a designated parking space
Composite Floor	A profiled steel tray acting as both temporary formwork and providing tensile reinforcement while in use
Formwork	Systems used to hold concrete in a specified shape while in its liquid form
Piled Foundations	Typically bored or driven steel or concrete elements which transmit load from the structure over to a soil or rock stratum capable of resisting the loads
Kelly Bar System	Extendable rods for use with a piling rig to allow operation in areas of limited height
Secant Pile Wall	A type of retaining wall where piles are drilled such that they overlap to form a semi impermeable barrier
Response Factor	A multiple of the typical human limit of perception for a given excitation frequency with 1 being the limit of human perception

Table 1 - Glossary of Terms

1 EXECUTIVE SUMMARY

This report outlines the Structural Engineering aspects of the works associated with the Modification 13 application. The aim of the report is to inform the reader of the assumptions made currently as well as highlight any items of complexity. The report also highlights any findings and recommendations from TTW as a result of our work on the project to date.

The proposed Ribbon Building Expansion, forming part of the overall Modification 13 works, comprises works associated with the fit out of the Level 5 Sky deck, the vertical extension to the existing Ribbon Building at Level 7, the new Recreation Deck at Level 7 above the existing Sports Bar and the 2 levels of plant below the recreation deck. Below the recreation deck and associated plant the existing Sports Bar at Level 1 and Retail Corridor/Back of House Area at Level 0 will also require structural modification as part of the works to support the new structure over. In addition the creation of a new automated basement ‘car stacker’ below the existing building adjacent to Pirrama Rd will provide additional parking servicing the new hotel and apartments.

An area of retail at the west of The Darling hotel is also proposed at Level 02 which may have some minor associated structural works.

The ‘Tower’ portion of the development is addressed in a separate structural engineering report.

The structural design must the buildability constraints, in particular the safety of both staff and public during construction over an existing 24 hour facility.

The form of construction must address the constructability around the operational facility. Significant temporary works are required to facilitate the construction of the permanent design. In particular the area around the north portion regarding the demolition ‘cut line’ and temporary support during construction of existing members during partial demolition must be considered in progressing the scheme.

By utilising steel frame construction the recycled content of the material used is increased while allowing for minimal concrete slab thicknesses reducing embodied CO_2. There is a significant environmental benefit in this form of construction. Once at the end of the project design life the materials are also much more easily able to be recycled than with traditional concrete frame construction.

TTW recommend that the structure should be steel framed supporting a lightweight floor system. TTW recommend that stainless steel options for the suspended swimming pools be considered due to the significant saving in weight. Where possible the ribbon structure should be isolated from the adjacent tower structure as they are likely to behave differently under lateral load conditions (wind and seismic). Where full isolation is not possible, joints must be detailed to allow the structures to move laterally independent of one another.

At the point of writing all the recommendations in the report have been incorporated into the design.

2 INTRODUCTION

This document outlines the design parameters provided to the architectural team in preparing submission for planning applications. The parameters have been developed based on a proposed extent of scheme as prepared by Francis-Jones Morehen Thorpe Architects (FJMT).

2.1 THE SITE

The Star occupies an irregularly shaped block in Pyrmont, being Lot 500 in Deposited Plan (DP) 1161507, Lots 301 and 302 DP 873212, and Lot 211 DP 870336. Figure 1 highlights the location of the star within the Sydney setting.

Figure 1 - The Star Casino Site

2.2 OUR UNDERSTANDING OF THE PROJECT

The following works comprise the portion of the Ribbon Building extension for which TTW are responsible:

- Provision of new footings to support proposed columns including
  - Initial design of piling following advice from geotechnical engineer and any associated pile caps
  - Constructability within the site constraints to be considered
- Provision of new columns to support proposed structure at Level 7
  - Form of construction to suit loading and site constraints
  - Detailing around interfaces with existing structure including review of load paths and effects on post tensioning
- Provision of new floor structure at Level 7
  - Floor structure to support new swimming pools, recreation deck and links to the existing casino
  - Form of construction to suit loading and site constraints
  - Floor framing to minimize works down through the existing building
- Provision of new plant space above existing Level 3
- Demolition of the existing steel 'Drum' structure and reinstatement of a new vertical circulation 'Drum'
  - Associated strengthening works to the surrounding structure as required to enable safe removal of the 'Drum'
  - Assessment of loads to be associated with the re-provisioned 'Drum' structure
- Partial demolition of the north extent of the existing casino building
  - Temporary works associated with the demolition as required
- Provision of new basement car stacker
  - Associated retaining wall system to support permanent excavation
  - Access to the car stacker, notionally to be at Level B3
- New food and beverage offering at the corner of Union St and Edward St including
  - New floor structure to support the proposed extents
  - New columns to support the new floor structure
- New awning to existing café at the corner of Union Street and Pirrama Rd
- Fit out associated with the new Sky Terrace at Level 5

EXISTING STRUCTURE

The structure of the existing Ribbon Building was designed by TTW initially in 2009 as part of the Pirrama Road Project with construction commencing in early 2010.

The adjacent Main Casino building was designed by Arup (formerly Ove Arup and Partners) in 1994 with construction commencing in 1995.

2.3 BCA CLASSIFICATIONS

In accordance with the BCA (NCC) 2015 we understand the areas of the building being impacted consist/will consist of the following classifications:

Area	**BCA Class**	**Areas Pertaining to Development**
Office building used for professional or commercial purposes	5	Office space and back of house space with the development
A shop or other building for the sale of goods by retail or supply of services direct to the public	6	Level 0 restaurant/retail space, Level 5 Skydeck Restaurants, Level 7 Bars, Level 2 Retail in The Darling Hotel
A carpark	7a	Basement car stacker
An assembly building	9b	Level 5 Skydeck Areas in General, Level 7 Ribbon Areas and Recreation Deck
A swimming pool	10b	Level 5 Spa Pools and Swimming Pool, Level 7 Swimming Pools

Table 2 - BCA Classifications for the Existing Structure

2.4 FOUNDATIONS

2.4.1 Ribbon Building

The foundations for the existing structure comprise both single and multiple Continuous Flight Auger (CFA) piles supporting columns and cores. Multiple pile foundations are joined by cast in-situ reinforced concrete pilecaps. The piles have been founded in the sandstone bedrock comprising medium and high strength Hawkesbury Sandstone at between 7-10m below the existing ground level.

2.4.2 Main Casino

To the east of the diaphragm wall the main casino columns are founded on bored piles founded in rock with a 'minimum rock end bearing stress of 3.5MPa'.

2.5 FLOOR STRUCTURE

2.5.1 Ribbon Building

Floor slabs are typically post tensioned (PT) band beams supporting PT slabs with areas of reinforced concrete slabs.

2.5.2 Main Casino

The Main Casino floor slabs are typically PT band beams supporting PT slabs. The floor slabs immediately adjacent to the ribbon building feature diagonal beams supported by off grid columns. The nature of the floor slab thus becomes triangular in this area. The areas of diagonal beams have previously been strengthened to support the transfer loads from the columns constructed as part of the initial Ribbon Building works. Strengthening is in the form of carbon fibre strips bonded to the underside of the PT slabs.

2.6 ROOF STRUCTURE

2.6.1 Ribbon Building

The roof of the building found at Level 3 is an external deck formed from PT band beams supporting PT slabs.

The roof to the two elements protruding above Level 3 are lightweight roof cladding (purlins supporting roof sheeting) supported by steel beams.

2.6.2 Main Casino

The roof area immediately adjacent to the Ribbon Building is noted as the Podium Roof and is constructed from long span steel beam joists (typically 800mm deep) supporting typically a 175mm thick re-entrant composite deck (Bondek). The beam joists are supported by fabricated plate beams with depths up to 1800mm.

The roof area known as the 'green roof' (located directly north of the MUEF and south of the existing fly tower – refer to Figure 2) comprises a 125mm thick Bondek slab supported on long span Bisalloy trusses and long span steel beams. This area of roof has very limited capacity to sustain any additional load.

2.7 DRUM

The existing 'Drum structure is a steel framed, glazed atrium type space featuring viewing galleries and vertical circulation elements.

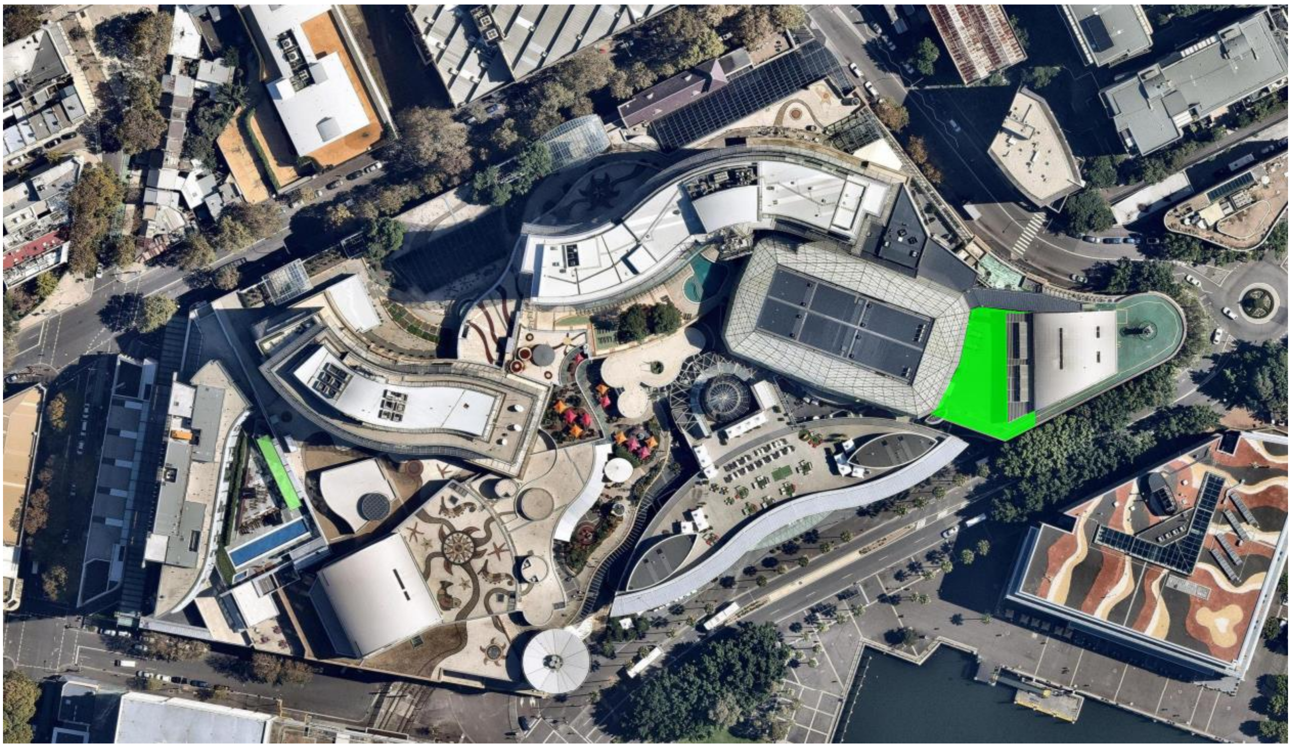


Figure 2 - Location of 'Green Roof'

3 EXTENT OF DEMOLITION

The demolition of the existing building considers the following:

- Amenity of the new development, for example:
  - Planning of the new columns around the existing Porte Cochere
  - The proposed curved façade and walkway zone
- Maintaining operation of the MUEF throughout the works including:
  - Maintaining operation of the loading dock and goods lift
- Support of the existing structure during and after demolition including
  - Vertical support of beams trimming into existing stair core
  - Lateral stability of building during and after the demolition and construction works
- Impacts on the existing business, in particular:
  - Impacts at Level 1 sports bar
  - Provision of fire egress points
- Buildability of the proposed solution

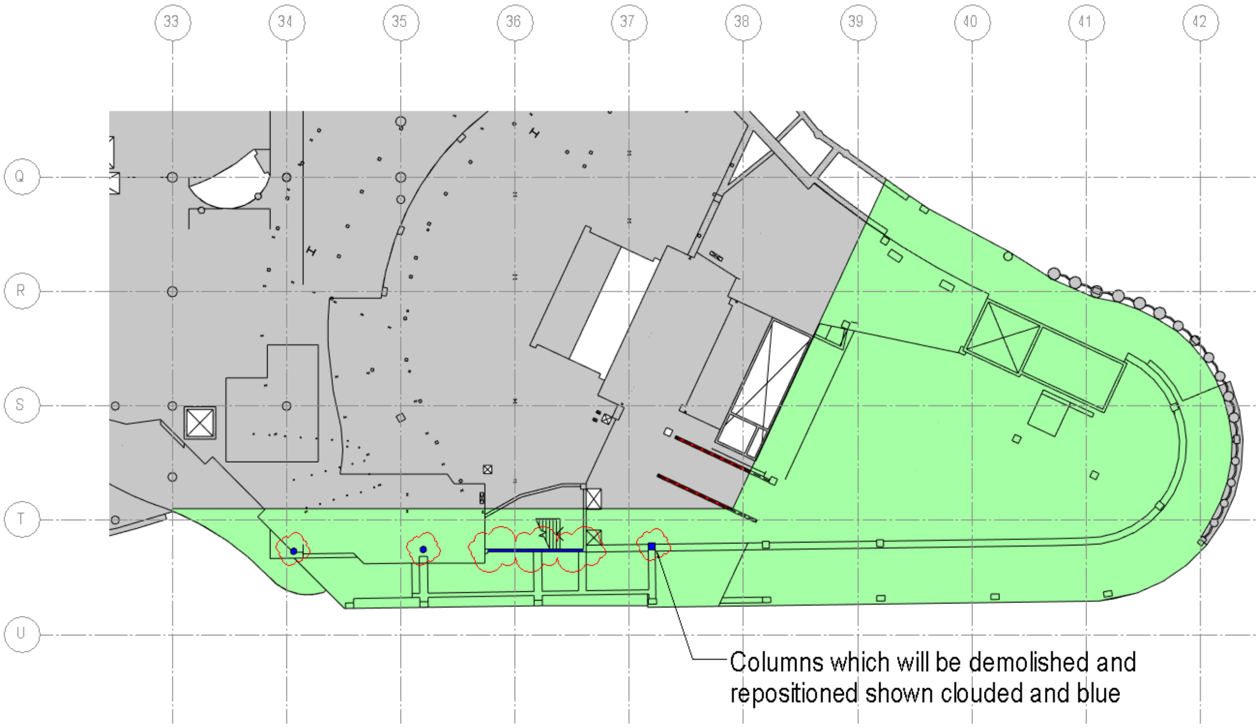


Figure 3 - Proposed Demolition Extent at Level 0 (demolition shown green)

A notional cut line for demolition can be seen on Figure 3. The cut line runs past the columns immediately to the north of the existing goods lift and returns south to the east of the columns between gridline T & U (see Figure 4). The columns from Level B2 to Level 1 are proposed to be demolished and the structure re-supported on new columns and truss structures sympathetic to the new architecture (the columns which will be demolished and replaced are shown blue in Figure 4 and Figure 5.

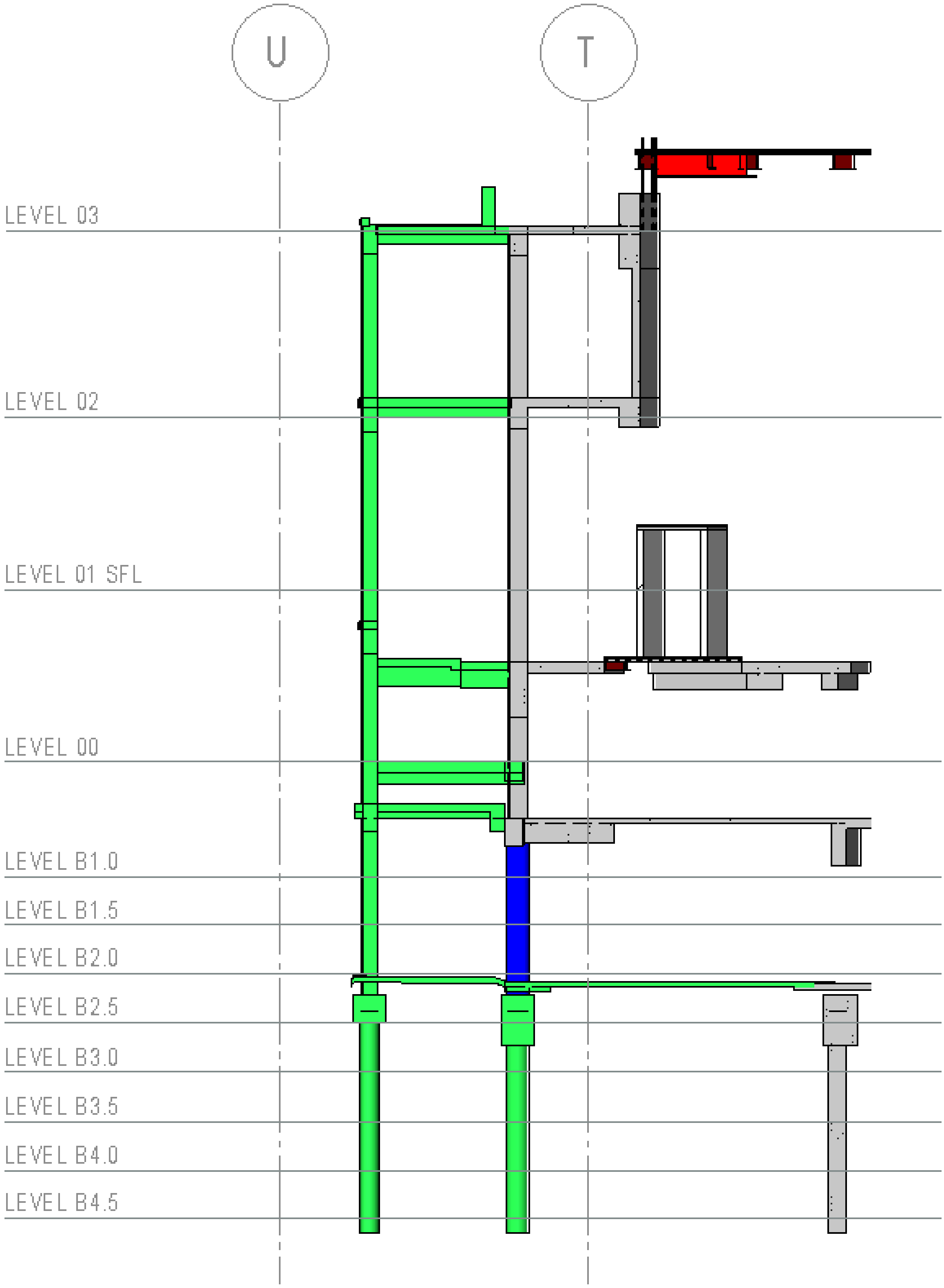


Figure 4 - Demolition Section (demolition shown green)

4 PROPOSED METHODS OF CONSTRUCTION

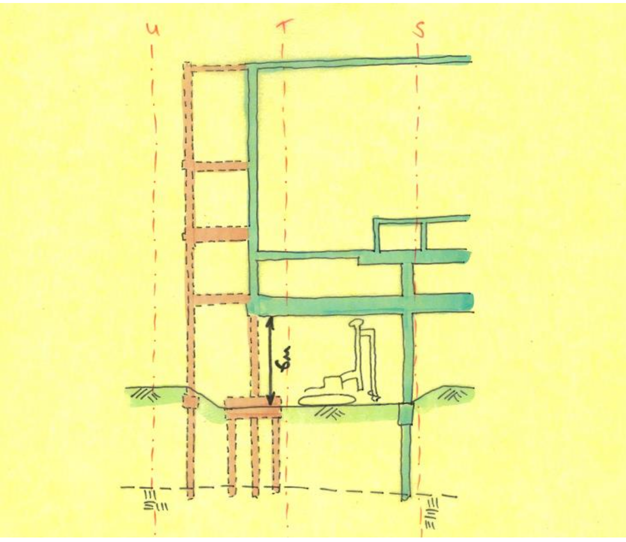
The following methods of construction are proposed by TTW for the various building elements.

4.1 FOUNDATIONS

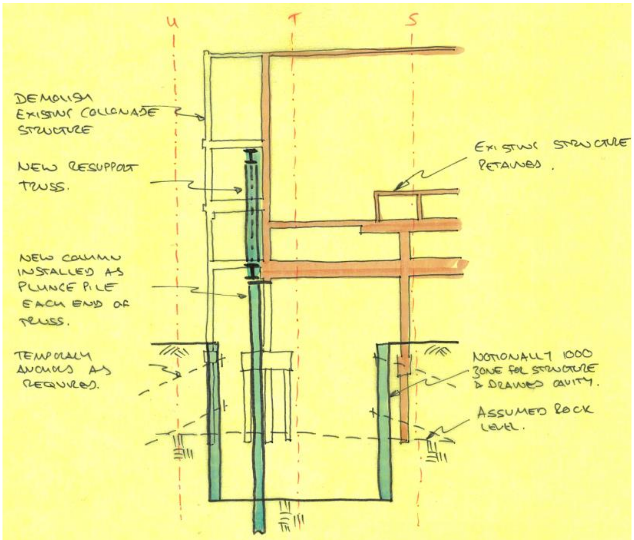
4.1.1 Proposed Building Foundations

The proposed foundations for the new building will be constructed in a limited head height of approximately 5000mm. It may be preferable to, in some areas, locally reduce the level by around 1000mm to allow for a 'full height' rig to operate. Alternatively TTW have contacted a number of Sydney based piling contractors regarding the use of 'low height rigs' in this area and would propose that CFA piles be socketed into the Hawkesbury Sandstone bedrock at approximate 7-10m depths below existing ground level. A rotary drilling rig using a Kelly Bar system will be required to work in the low clearance zone. Our previous experience has shown that a design and construct (D&C) piling package is usually the most cost effective option and ensures that the completion of this package and the responsibility for certification lies with those undertaking the works. As such at this stage we would assume that the piling package is to be a D&C item.

Around the proposed Porte Cochere, the reconfigured column layout requires that the existing columns running adjacent to gridline T be reconfigured. In this location the new columns should be located east of the proposed demolition extent over to allow a full height rig to operate in this area (refer Figure 5 left for details). Columns are likely to be constructed as plunge piles (refer Figure 5 right for details), as such the footings within the car stacker are likely to be piled footings given the nature of construction.



Reduced Levels to Allow Full Height Piling Rig



Proposed Column Line Outside of Demolition Zone

Figure 5 - Foundation Construction Options

Given the proximity to the adjacent building foundations, care must be taken when installing the foundations to ensure that excessive removal of the granular material (sandy fill etc) does not occur. TTW would propose to liaise with various Sydney based piling contractors to best understand the control measures available to ensure that minimal settlement of the existing footings occurs as a result of the new footing construction. It may be necessary/prudent to arrange monitoring works during the piling operations to ensure that settlement is not occurring.

4.1.2 Proposed Basement Construction

The basement car stacker is proposed to be founded around 26m below Level B2. Typically in the area proposed, there is fill (comprising ripped sandstone) of between 4m and 6m in depth, underlain by sandstone typically increasing with strength to depth. Full geotechnical information from deep boreholes are at this point in time not available nor is information relating to the degree of water ingress into the proposed basement. As such the current proposal is to install a ø600mm secant pile wall (hard-soft type) for the full depth of the excavation with a drained cavity to the front to deal with any residual water ingress.

An overall build-up for a secant pile wall should be around 2100mm as a minimum, the overall basement wall build up should comprise:

Item	**Size/Deviation (mm)**	**Comments**
Out of Position Placement Tolerance	75mm	To AS2159
Pile Diameter	600mm	Typically this is the most economic size however smaller piles are possible where constraints exist
Pile Out of Verticality Tolerance	350mm	Verticality of 1:75
Drained Cavity	75mm	
Face Wall	140mm	Block wall assumed

* Diaphragm walls installed using a hydrofraise cutter head can readily achieve deviations of 1% from verticality (300mm), this may be reduced to 0.3% as a minimum if electronic monitoring equipment is installed on the rig and operating speeds are reduced

Table 3 - Secant Pile Wall Thicknesses

4.2 SUPERSTRUCTURE

4.2.1 Proposed Columns

The proposed columns are assumed to be steel in construction to match the construction typology of the proposed floor system. Columns will require fire protection to achieve the values as per Table 20, this may be in the form of fire boarding, gypsum vermiculite spray, intumescent paint or other suitable fire resisting constructions.

Steel columns would be installed faster than equivalent concrete columns which would minimise the disruption within the existing building during installation. Steel columns also offer better connection points for the proposed steel beams at Level 7.

Columns from Level 5 to Level 7 may be able to rake to provide better locations for the support of the main steelwork. Further coordination with the architectural team is required to determine exact column layout positions at Level 5 and Level 7.

Existing columns are also proposed to support additional load below Level 5.

4.2.2 Proposed Floors

The floors are currently proposed to be constructed from long span steel beams and trusses supporting a composite type floor system. It is proposed to use the depth of the swimming pool to limit the depth of the long span steelwork, essentially 'trimming' the pool with the main structural elements with shallower secondary elements under the pool as required.

4.2.3 Proposed Stability System

The proposed building stability system uses an extension to the existing stair cores of the existing Ribbon structure and the floor plate is tied back to the main structural diaphragm at Level 3 and 5.

Strengthening of the existing stair core may be required depending on the configuration of the steel supports, and associated loads, at Level 7 full design and analysis will be required to determine the extent of strengthening if required at all.

4.2.4 Proposed Swimming Pools

The swimming pools could be constructed in either in-situ concrete or in fabricated stainless steel. Stainless steel would minimise the on-site works and typically weighs 1/3 that of a comparable in-situ concrete system. The main supplier of stainless steel pools however is based in the USA and as such the delivery time should be factored in to the decision.

Regardless of the construction of the pool, it will require full acoustic isolation from the rest of the structure in the form of isolation mounts.

5 STRUCTURAL DESIGN PARAMETERS FOR RIBBON BUILDING NEW STRUCTURE

Listed below are the assumed structural design parameters that TTW propose for use in designing the new Ribbon Building structure.

5.1 DESIGN ACTIONS (LOADING)

Typically all loads and load combinations shall be in accordance with AS 1170 parts 0 to 4 'Structural Design Actions'. Live load reductions will be taken as per AS 1170.1.

5.2 PERMANENT ACTIONS (FLOOR / ROOF)

The permanent dead loads applied to the structure shall be considered as the material self-weight plus additional Superimposed Dead Loads (SDL) proposed below. Pending further architectural development more loading types may be required.

Floor Use	**SDL (kPa)**
External Deck Areas	5.0
Pool Surround	5.0
Pool	0.5 (tiling and adhesive only)
Plant Areas	0.5 (Allow for additional 100mm concrete for plinths)
Office Areas	1.0
Lightweight Roof/Canopies	0.5

Table 4 - Typical Superimposed Dead Loads

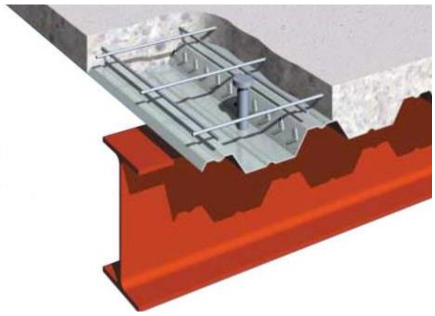
We have explored a number of structural options for the floor system and list them below from lightest to heaviest:

Floor Type	***Span***	***Self-Weight (inc. steel beams)***
Trapezoidal Composite Slab	3.32m	2.99kPa (4.21kPa)
Re-entrant Composite Slab	3.32m	3.22kPa (4.44kPa)
Deep Deck Composite Slab	5.6m	TBC
Precast Hollowcore Planks 1	5.6m	3.80kPa (4.60kPa)
Precast Hollowcore Planks 2	8.3m	4.44kPa (5.25kPa)
Precast Vaulted Slab	8.3m	TBC

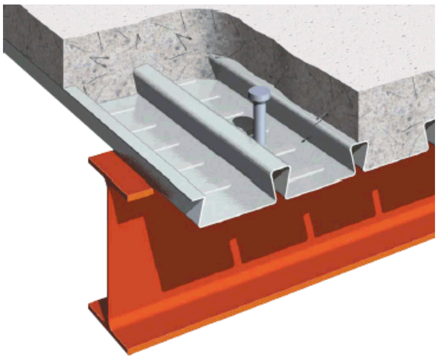
Note that the above weights are based on continuous spans with an assumed SDL=5.0kPa and LL=5.0kPa

Table 5 - Typical Slab System Weights

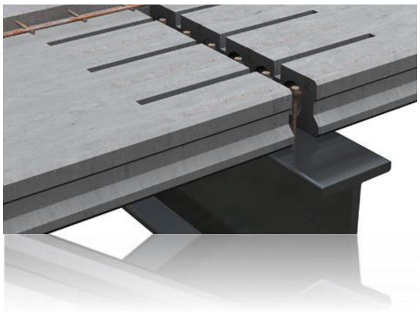
It is worth noting that the steel framing weight of an equivalent Hollowcore plank system is approximately 75% that of a composite slab system. Below are images describing each of the systems.



Trapezoidal type deck



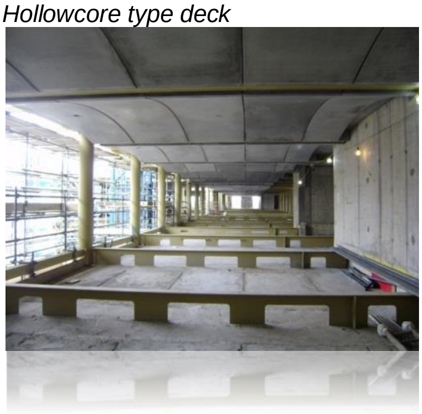
Re-entrant type deck



Hollowcore type deck

Precast vaulted slab (optional chilled beam/slab system)

Polished concrete finishes



Chilled slab systems

Table 6 - Options for Floor Slab Construction

Below are listed some of the potential build ups contained in the typical Superimposed Dead Load allowances:

Up to 2.5kPa	***Up to 5kPa***	***Up to 10kPa***	***Up to 20kPa***
Terrazzo tiles on raised floor	Stone tiles on raised floor	Heavy stone outdoor furniture	Shallow swimming pools (say up to 1.6m deep)
Extensive green roof system (sedum type)	Intensive green roof system (sedum type) with small planters	Soil planted roof system with distributed small trees	
	Shallow water feature (say up to 300mm deep)	Deep water feature (say up to 800mm deep)	
	Timber decked lounge with some planting		

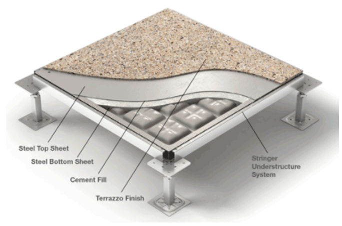


Table 7 - Superimposed Dead Load References

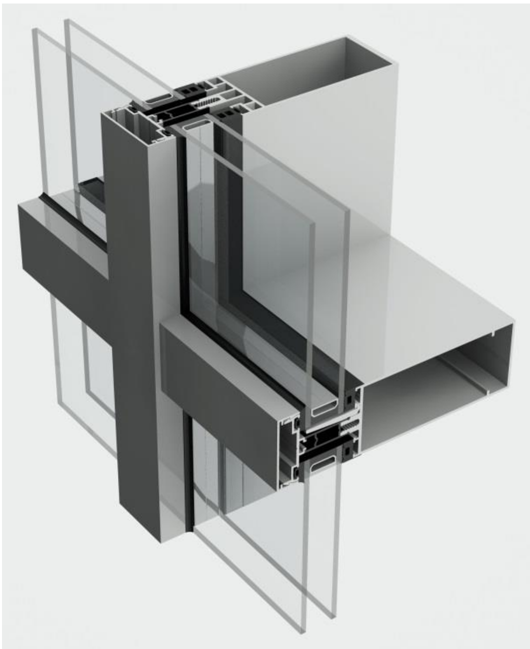
5.3 PERMANENT ACTIONS (FAÇADE)

It is understood that the majority of the façade will be open, however areas of enclosed façade will be required for weather tightness and are assumed to be formed from lightweight cladding components.

Facade Element	SDL (kPa)
Lightweight and Glazed Typ.	1.0
Sandstone Cladding	1.5 (TBC)

Table 8 - Assumed Typical Facade Loads

Some examples of typical façade systems can be seen below:

Facade Element	*SDL (kPa)*
 *Aluminium Cladding System*	 *Curtain Walling System*

Sandstone Cladding System

Table 9 - Typical Facade Elements

5.4 IMPOSED ACTIONS (FLOOR / ROOF)

The following live load excerpts are from AS1170.1, which are relevant to the proposed development, with associated descriptions:

Occupancy	**Occupancy Type to AS1170.1**	**Uniformly Distributed (kPa)**	**Concentrated Action (kN)**
Office	B	3.0	2.7
Kitchen	E	5.0	4.5
Toilet	A2	2.0	1.8
Plant Rooms	E	5.0	4.5
Back of House Corridors and Front of House Circulation Subject to Wheeled Vehicles	C3	5.0	31
Roof	R2	1.8/A + 0.12 but not less than 0.25	1.4

Table 10 - Typical Imposed (Live) Floor Actions

Images of the loading types can be seen below:

Areas with tables

Offices for general use

Areas with fixed seating

Areas without obstacles for moving people subject to trolleys etc.

Dance Halls

Shop floors for sale of merchandise

Table 11 - Examples of Imposed Floor Actions

5.5 WIND

Wind loadings for all elements will be designed in accordance with AS1170.2 using the parameters listed below:

Item	**Value**
Building Importance Level	III (Major structures affecting crowds)
Terrain Category	3 (general) 2 (north direction)
Region	A2
Annual Probability of Exceedance	1:1000
Regional Wind Speed	V_R=46m/s

Table 12 - Typical Design Wind Parameters

5.6 SEISMIC

Item	**Value**
Building Importance Level	III (Major structures affecting crowds)
Annual Probability of Exceedance	1:1000
Probability Factor	1.3
Site Hazard Factor	0.08
Site Sub-Soil Class	C_e (TBC by geotechnical engineer)
Structural Ductility Factor	2
Structural Performance Factor	0.77

Table 13 - Typical Design Seismic Parameters

5.7 LOAD COMBINATIONS

Load combinations will be derived in accordance with AS1170.0 section 4. We would propose the following basic combinations:

Load Combination	G	Q	W_u	E_u
1	1.2	1.5		
2	1.2	Ψ_c	1.0	
3	1.0	Ψ_c		1.0
4	1.2	1.5* Ψ_l		
5	1.35			
6	0.9		1.0 (up)	

Table 14 - Typical Basic Ultimate Load Combinations

The basic load combinations used for serviceability limit states shall be as follows (derived from AS1170.4 section 4):

Load Combination	G	Q	W_s	E_s
10	1.0			
11		Ψ_s		
12		Ψ_l		
13			1.0	
14				1.0

Table 15 - Typical Basic Serviceability Load Combinations

The following abbreviations have been used in the above tables:

Abbreviation	**Description**
G	Structure self-weight plus superimposed dead loads
Q	Imposed actions
W_u	Ultimate wind action
W_s	Serviceability wind action
E_u	Ultimate earthquake action
E_s	Serviceability earthquake action
ψ_c	Combination factor for imposed action
ψ_s	Short term loading factor
ψ_l	Long term loading factor

Table 16 - Abbreviations

5.8 SERVICEABILITY

The building shall be designed to operate within specific pre-designed limits when functioning under normal loading conditions. Outlined below are the proposed limits the TTW propose to use when designing the expansion works.

5.8.1 Deflection Limits (Floor / Roof)

Deflection limits shall typically be as per Table C1 of AS1170.0, Table 2.3.2 of AS3600 and the serviceability provisions associated with AS1170.4.

Areas requiring more stringent deflection criteria such as operable wall supports will be determined as the project progresses.

5.8.2 Deflection Limits (Façade)

With long spans (up to 16m) between façade supports, the total deflections are likely to be relatively large. Detailing of the façade connections should allow for this; initially we would propose to limit façade deflections in the long span areas as below:

Façade Type	**Proposed Deflection Limits**	
	Short Term	**Long Term**
Lightweight Flexible Facade	Span/800 (20mm)	Span/500 (32mm)
Curtain Walling	Span/1000 (16mm)	Span/800 (20mm)

Table 17 - Typical Maximum Deflection Limits

5.8.3 Vibration

Floor vibrations as a response to footfall loading shall be analysed using in house software developed in line with industry leading techniques. Response Factors (RF) will be calculated which represent a frequency weighted multiple of the average threshold of human perception. The response factors and their associated description (based on Pratt, 'Floor Vibration: Requirements for Laboratories and Micro-Electronics Facilities' Seminar 2001) for each area can be found in the table below:

Area	**RF**	**Max. RMS Velocity (µm/s)***	**Typical Description**
Circulation Spaces, Toilets, Back of House	8	800	Distinctly perceptible vibration. Appropriate to workshops and non-sensitive areas
Floor Area Typically	4	400	Perceptible vibration. Appropriate for offices and non-sensitive areas

* - As measured in one-third octave bands of frequency over the frequency range 8-100Hz.

Table 18 - Typical Design Vibration Limits

Any plant or machinery which is capable of producing vibration should be isolated from the building structure typically. TTW would analyse any residual impact with regards to human perception of vibration. It is understood that there is no specific vibration sensitive equipment to be installed as part of the development.

Ground borne vibrations arising from piling operations should be minimal given the bored nature of the proposed piles, as such we would not see this as an issue.

5.8.4 Crack Control

Cracking to a degree is inherent in almost all concrete structures and arises from a variety of causes. Typically the extent of cracking is controlled by the amount and spacing of reinforcement and prestressing provided to the concrete; particularly for flexural elements such as beams and slabs.

Typically for the enabling works there will be no change in condition to the existing flexural elements of the building and as such crack control is not relevant for these items.

5.9 DURABILITY

5.9.1 Concrete

Exposure classifications to be adopted for the design of concrete elements (including RC Jacket strengthening works) are to be in accordance with AS3600 Table 4.3 and are noted below:

Element	AS3600 Exposure Classification
Internal	A2
External	B2
In Ground	A2
External Protected By Membrane	B1*

* - For external surfaces protected by a membrane the exposure classification could be said to reduce to A2 since the membrane provides protection from the aggressive environment however since this area is not available for visual inspection and without wanting to be conservative in the design assumptions it is proposed that these areas have a compromise exposure condition of B1.

Table 19 - Typical Durability Exposure Classifications

5.9.2 Steelwork

Protection to steelwork shall be in accordance with AS 2312 and ISO 2063. A proposed life to first maintenance of 15 years should be achievable with coating suppliers typically issuing warranties for this period.

5.10 FIRE RESISTANCE

The existing building being greater than 4 stories in height would have required Type A construction for fire resistance in accordance with the BCA so no further upgrade to this is required.

For all new areas the typical proposed fire resistance for structural adequacy is proposed as below:

Area	FRL (mins)		
	Walls	Columns	Floors
Retail Areas	180	180	180
Office Areas	120	120	120
Carpark	120	120	120
Assembly Areas (Theatres etc)	120	120	120

Table 20 - Typical Fire Resistance Levels to BCA Typically

For concrete elements fire resistance shall be provided by meeting the requirements typically of AS3600 for slabs, beams and walls and Eurocode 2 for columns (as referred to as suitable method by AS3600).

For steel elements fire resistance shall take the form of either gypsum vermiculite spray, intumescent paint of fireboard cladding. Lightweight roof elements will typically not require fire resistance.

5.11 STRUCTURAL DESIGN CODES & STANDARDS

In undertaking this design TTW will design to all relevant Australian codes and standards including:

Reference	**Code Description**
BCA 2013	Building Code of Australia 2015
AS1170 all parts	Structural Design Actions
AS2159	Piling Design and Installation
AS2312	Corrosion Protection of Structural Steel
AS3600	Concrete Structures
AS3700	Masonry Structures
AS4100	Steel Structures

Table 21 - Typical Design Codes

6 GEOTECHNICAL DESIGN PARAMETERS

Based on our previous work in and around the proposed site TTW are very familiar with the ground conditions.

Existing geotechnical investigations have been undertaken in the vicinity, the reports and dates are listed below:

Report No.	**Date**	**Undertaken By**
14844	March 1993	Douglas Partners
10466W/a	July 1994	Jeffery and Katauskas
45648.01	September 2008	Douglas Partners
45608.2	September 2008	Douglas Partners
N/A	No Date – Prepared for MOD13	JK Geotechnics

Table 22 - Existing Geotechnical Reports

Based on the information contained within these reports we understand the ground conditions to be areas of fill underlain by sand on a Hawkesbury Sandstone bedrock.

Across the proposed development we would expect the bedrock to be between approximately 7-10m below ground level.

The previous geotechnical reports were prepared based on 'allowable bearing pressures' which under characteristic (unfactored) loading will yield settlements typically less than 1% of the footing diameter. Since this project there has been a shift within the industry to align geotechnical design parameters with the 'limit state' parameters used elsewhere in structural design. Limit state parameters allow the engineer to design the foundations for both the worst 'ultimate' case and for the 'serviceability' case where settlement of the ground is of interest. This change in approach can often yield more economical foundation designs. As such we would propose to commission a desktop study based on the available data to provide limit state design parameters. In obtaining limit state parameters it would also be possible to calculate the effects of the additional loading on the building footings as well as the deformation of the new building footings.

7 CONCLUSION

Where possible any new loading to the existing structure should be minimised. TTW recommend that the form of construction be typically steel beams supporting composite steel and concrete floors since this is both lightweight and able to achieve the long spans which are proposed. Stainless steel pool systems such as those available from Bradfor Products should be considered for elevated pools since they are significantly lighter than a concrete counterpart and not prone to problems associated with concrete shrinkage.

The Ribbon Building should be isolated from the adjacent tower structure as they are likely to behave differently under lateral load conditions (wind and seismic). Where full isolation is not possible, joints must be detailed to allow the structures to move laterally independent of one another.

Temporary propping methods should inherently form part of the permanent works documentation due to the complexity of the demolition and requirement to retain portions of the existing structure.

The construction of the basement car stacker shall limit water ingress to a maximum of 3Ml/year.

By constructing from steel with a composite floor, the amount of recycled material in the structure is increased substantially (over 60% of steel can be sourced from recycled material if specified). The embodied CO_2 in the concrete portion is also reduced since the slabs are typically around 40% thinner than those used in post tensioned construction for a similar building.

At the point of writing all the recommendations in the report have been incorporated into the design.