28-32 BOURKE ROAD, ALEXANDRIA

STRUCTURAL DESIGN REPORT

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ISSUE AUTHORISATION

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A	06/05/22	Stage 1 SSDA Design Report	PRC	WSM	WSM
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C	06/06/22	Stage 1 SSDA Design Report	PRC	WSM	WSM
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Executive Summary

enstruct have been engaged by Alexandria Property Development to develop the structural engineering principles of the proposed mixed-use commercial and medical centre building development at 28-32 Bourke Road, Alexandria NSW for the Stage 1 State Significant Development Application (SSSDA) design phase. This report describes the structural outcomes and advice provided throughout this design phase. The key structural systems and principles implemented during the design are presented within this report.

The structure developed utilises conventional and buildable methodologies common to the Sydney market to ensure an economical and feasible structural solution for the project.

A critical structural consideration at this stage is the development of the lateral stability system - i.e. the elements resisting the natural wind and earthquake forces on the building. This has remained a key point of discussion throughout this design phase. The primary elements contributing to this lateral system primarily include the reinforced concrete lift core walls and reinforced concrete stair core walls.

Several options for the core design were developed throughout this design phase, with the aim of rationally and efficiently maximising available NLA on the typical floorplates. The preferred option was further progressed and co-ordinated throughout this design phase.

Several options for the structural floorplate designs were developed and tested during this design phase to achieve the minimum structural floorplate depth possible. The structural advice provided to date is cognisant of allowing post-tensioned concrete to be efficiently achieved on the typical floors. In our experience, for this type of site, a post-tensioned concrete structure will be proven by a competitive market to be the most economical outcome for the project.

Fortify Geotech (geotechnical project engineer) have provided a geotechnical investigation report. The results indicated the presence of uncontrolled fill on the site, with the building foundations recommended to be founded on the underlying sandstone bedrock. Traditional foundation methodologies involving pile caps and pile foundations will be utilised in the structural design to support the building loads. Groundwater was encountered from 1.8 metres to 3.0 metres below the existing ground surface level.

Basement excavation is to be limited in depth where possible to minimise the amount of uncontrolled fill to be removed from the site and limit any exposure to existing groundwater on the site. Temporary and permanent site retention will need to be provided for any basement excavation directly adjacent existing structures to ensure that adjacent structures are not adversely affected by the proposed basement excavation. Site retention systems to be designed to accommodate all required adjacent surcharge loadings (such as surcharge loading from adjacent roads).

Contents

1 Project Description

Development consent is sought for a concept proposal for the 'Alexandria Health Centre' comprising medical centre uses and anchored by a mental health hospital. Specifically, the application seeks concept approval for:

- In principle arrangements for the demolition of existing structures on the site and excavation to accommodate a single level of basement car parking (partially below ground level).
- A building envelope to a maximum height of 45 m (RL 53.41) (including architectural roof features and building plant). The podium will have a maximum height of RL 28.41.
- A maximum gross floor area of 11,442.20 sqm, which equates to a maximum FSR of 3.85:1. The total FSR will comprise a base FSR of 2:1, a community infrastructure bonus FSR of 1.5:1 and a 10% design excellence bonus FSR (subject to a competitive design alternatives process).
- Indicative use of the building as follows:
  - Mental health hospital at levels 5-7.
  - Medical centre uses at levels 1-4; and
  - Ground level reception/lobby and pharmacy.
- Principles for future vehicular ingress and egress from Bourke Road along the site's western frontage.
- Subject to agreement on a public benefit offer submitted with this application, the proposal includes the indicative dedication of the following land to Council as envisaged by the Draft Sydney Development Control Plan 2012 – Southern Enterprise Area Amendment (Draft DCP):
  - A 2.4m wide strip of land along the site's frontage to Bourke Road for the purpose of footpath widening
  - A 3m wide lane along the site's western boundary contributing towards a 6m wide lane (it is noted that the concept proposal will allocate an additional 3 m strip of land within the site along the western boundary to enable two-way vehicle movement into and out of the site).
  - A 3m wide lane along the site's southern boundary, contributing towards a 9m wide lane.

2 Structural Overview

A structural system has been developed in conjunction with the architect throughout this design phase to develop the proposed building design and ensure an efficient structural solution.

The structural floorplate system consists of a long span post tensioned band beam and one-way slab concrete floor structure for each of the floor plates typically. The column grid has been developed to achieve efficient floor framing, whilst minimising beam depths.

The structural lateral system for this building comprises a reinforced concrete core structure which includes the main lift cores and the stair cores. The core walls are reinforced concrete extending from base level of the building to top of the building, dropping off as the core diminishes through the height of the building.

The building is founded on pile caps and pile foundations due to the site geology, which is underlain by underlying sandstone bedrock at significant depths underneath layers of uncontrolled fill. The buildings core is to be founded on a raft foundation that is supported by pile foundations socketed into the underlying sandstone bedrock. At this stage, it has been determined that the core foundations will be taken below the basement floorplate.

The principal structural elements of the building are:

Floor Plates:	Post tensioned concrete band beams/one-way slab
Lateral Structure:	Reinforced concrete core wall system
Columns:	Reinforced high strength concrete
Foundations	Pile caps and pile foundations founded on underlying bedrock

All structural elements have been designed to utilise conventional construction techniques which will allow for an efficient structural program for the building construction with the structural components and their arrangement being consistent with conventional Australian construction practice.

3 Site Context

3.1 Geology

The geotechnical investigation report [MM/S1413 dated February 2022] was issued by Fortify Geotech during this design phase.

The geotechnical investigation report Section 4.1 notes that the site is underlain by the layers of uncontrolled fill, alluvial/residual soils, and sandstone bedrock. The layer of uncontrolled fill is directly below the surface level and has been estimated to be between 600mm to 1900mm thick. The sandstone bedrock layer begins at a depth in the order of 7.3 metres to 8.5 metres below the surface level. The sandstone bedrock layer typically achieves Class III bedrock at a depth in the order of 8.1 metres to 9 metres below the surface level. The underlying sandstone bedrock provides an excellent founding material for the support of the columns and core below the bulk excavation level. Pile foundations are to be provided so that the columns and core can be founded on the underlying sandstone bedrock layer.

Vibration during excavation activities and installation of site retention systems may impact the amenity or condition of adjacent buildings during construction. The geotechnical engineer will advise on appropriate vibration criteria levels to mitigate these effects which will require monitoring during excavation and construction. The specific requirements imposed by adjacent building owners and tenants may need to be considered in the development of vibration limits – and the associated program implications considered. The site retention system (in both the temporary and permanent conditions) will need to be provided to ensure that any basement excavation does not adversely affect any adjacent structures during the proposed excavation and construction. Basement excavation is to be limited in depth where possible to minimise the amount of uncontrolled fill to be removed from the site and limit any exposure to existing groundwater on the site.

On adjacent site boundaries, it has been assumed that the proposed basement excavation does not undermine the existing building foundations of the adjacent building structures typically. However, this will need to be verified and confirmed through detailed surveys, etc. during the following design phases for this project. Site retention systems to be designed to accommodate all required adjacent surcharge loadings (such as surcharge loading from adjacent roads).

3.2 Groundwater

The Fortify Geotech geotechnical investigation report [MM/S1413 dated February 2022] Section 4.3 indicates that the groundwater table will be likely below the lowest basement level provided that the basement excavation depth is limited to a maximum of 1 metre. Seepage of groundwater may be expected to occur in small quantities. Drainage systems should be installed (spoon drains and lowest level underfloor) to capture these modest inflows and pump out.

4 Design Standards

The structural design shall be in accordance with the latest issue of all relevant structural Australian Standards, relevant structural sections of the BCA and other statutory requirements.

In particular, the structural design will be in accordance with the following relevant Australian Standards:

Standard	Year	Title
AS/NZS 1170.0	2002	Structural Design Actions Part 0 General Principles
AS/NZS 1170.1	2002	Structural Design Actions Part 1 Permanent, Imposed and Other Actions
AS/NZS 1170.2	2011	Structural Design Actions Part 2 Wind Loads
AS 1170.4	2007	Structural Design Actions Part 4 Earthquake Actions in Australia
AS 1940	2004	The storage and handling of flammable and combustible liquids
AS 2159	2009	Piling – Design and Installation
AS/NZS 2312.1	2014	Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings – Part 1: Paint Coatings
AS/NZS 2312.2	2014	Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings – Part 2: Hot dip galvanizing
AS 2670.1	2001	Evaluation of Human Exposure to Whole-Body Vibration – General Requirements
AS 2670.2	1990	Evaluation of Human Exposure to Whole-Body Vibration – Continuous and Shock-Induced Vibration in Buildings (1 to 80Hz)
AS 2870	2011	Residential Slabs and Footings
AS 3600	2018	Concrete Structures
AS 3700	2018	Masonry Structures
AS 3735	2001	Concrete Structures for Retaining Liquids
AS 3826	1998	Strengthening existing buildings for earthquake
AS 4100	2020	Steel Structures
AS 4678	2002	Earth Retaining Structures
NCC	2022	National Construction Code

4.1 Computer programs

The following programs will be used in the design, analysis and documentation of the structure:

Program	Function
Revit	A Building Information Model will be used as the basis for documenting the building. All structural documentation will generated from an Autodesk Revit model
Spacegass	General structural analysis
RAPT	Reinforced and post-tensioned concrete design
Excel	Spreadsheets
Word	Word processing
Limcon	Structural steel connection design
Etabs	Building frame finite element analysis package
Strand7	Finite element analysis package
Ram Concept	Floor plate analysis package
RC Building	3D Design and analysis package

4.2 Project Specific Document References

We note the following project specific documents have been considered in the development of the structural design:

- Design meeting minutes, agendas, and other design requirements as issued via email correspondence
- Architectural design drawings throughout this design phase
- Fortify Geotech geotechnical investigation report MM/S1413 dated February 2022

4.3 Design Life

The building structure will be designed for a 50-year design life.

5 Materials

The following structural materials are proposed to be used in the works. Typical values for the properties of these materials are listed. These values are to be adjusted where appropriate.

5.1 Concrete

5.1.1.1 Properties

Co-efficient of thermal expansion	10×10^{-6} per ^{0}C
Basic shrinkage strain	In accordance with AS 3600 Clause 3.1.7
Basic creep factor	In accordance with AS 3600 Clause 3.1.8
Poisson's ratio	0.2
Density	25 kN/m^3

5.1.1.2 Proposed Concrete Grades

Footings and Piles	50 to 65MPa
Suspended Slabs and Beams	40MPa
Columns	50 to 65MPa
Walls	40 to 65MPa
Other areas (UNO)	40MPa

5.1.1.3 Reinforcement

Plain bars (R)	fsy = 250MPa
Deformed bars (N)	fsy = 500MPa
Welded wire fabric (L)	fsy = 500MPa
Young's modulus	200 x 10^{3}MPa

5.2 Structural steel

Grade (UNO)	300MPa
Steelwork density:	7850 kg/m^3
Young's modulus:	2.05 x 10^{5}MPa
Poisson's ratio:	0.3
Coefficient of thermal expansion:	12 x 10 $^{-6}$ per ^{0}C

5.3 Blockwork

Characteristic Strength	15MPa
Mortar mix (cement:lime:sand)	1 : 1 : 6 Unreinforced Blockwork 1 :0.5: 4.5 Reinforced Blockwork
Core fill grout	25MPa

5.4 Foundation materials

As defined in the Fortify Geotech geotechnical investigation report MM/S1413 dated February 2022.

6 Loading

6.1 Vertical

	SDL - Finishes/Fit-Out/Services (kPa)	Uniform Live Load (kPa)	Point Live Load (kN)
Medical Centre	2.0	3.0	2.7
Wards	2.0	3.0	2.7
Lift Lobbies/Corridors	1.5	4.0	4.5
Entrance Lobby	3.0	5.0	4.5
Stairs	0.5	4.0	4.5
Non-Accessible Roof Areas	2.5	2.5*	4.5
Accessible Roof Areas	5.0	4.0	4.5
Compactus	1.0	10.0	TBC
Car-parking	0.25	2.5	13.0
Loading Dock	0.5	15.0	38.0
Retail	4.0	5.0	4.5
Plant rooms	2.4	5.0*	4.5
Substations	7.5	10.0*	TBC
Terrace	5.0***	4.0	TBC***

Notes:-
* or as advised by services engineers.
** indicates live load reduction allowable to AS/NZS1170.1
*** or as advised by the landscape architect

6.2 Horizontal Imposed loads and Impact Loading

All horizontal imposed loads are to be in accordance with AS/NZS 1170.1. The following categories are to be addressed individually:

- Handrails (generally) – 0.75 kN/m
- Handrails subject to crowd loading – 3.0 kN/m
- Carpark parapets, walls, barriers – 1.5kN/m.

Design parameters for impact loading shall be determined in accordance with AS1170.1.

Carpark columns and barriers	- A live load of 30kN for typical areas at a height of 0.5m - A live load of 240kN at a height of 0.5m for barriers at the end of straight ramps exceeding 20m in length and intended for downward travel

6.3 *Imposed movements*

The effect of imposed movements on the structure will be considered in the calculations. These include the following types of movement:

Settlement	either absolute or differential
Temperature range	either absolute or differential
Shrinkage	when restrained between stiff elements
Foundation movement	include shrink/swell under slab on grade

6.4 *Soil Loading*

Earth retaining structures to be designed in accordance with the recommendations of the Geotechnical Reports.

It has been assumed that lightweight soil is to be used on all suspended structures typically. Landscape architect to confirm.

6.5 *Dead Loads*

- Self-weight of slab 24kN/m^3

6.5.1.1 *Superimposed Dead Loads*

Concrete plinths for plant	2.5 kPa
Finishes	Refer Section 6.1

6.6 *Facade*

- TBC by façade engineer. Allowance of 0.75kPa has been made at this stage.

6.7 *Wind*

Wind loading in accordance with AS/NZS 1170.2 – Structural Design Actions – Wind Actions with the following parameters:

- Annual probability of exceedance – 1:1000;
- Region A2;
- V_{1000} = 46m/s
- Terrain Category TC3

6.8 *Robustness*

Robustness loading generally in accordance with AS/NZS 1170.0 – Structural Design Actions General Principles with the following parameters:

- 1.5% of (G + ψ_cQ) load case;

6.9 *Earthquake*

Earthquake loading in accordance with AS 1170.4 – Structural Design Actions – Earthquake Actions for Australia with the following parameters:

- Importance Level: 3
- Annual probability of exceedance – 1:1000;
- k_p = 1.3;
- Z = 0.08;
- Site Sub-Soil Class –Ce (refer to Fortify Geotech report Section 5.8)
- Earthquake Design Category II;

7 Serviceability

7.1 Deflection limits

7.1.1 Vertical

Deflection Limits				
	Span		Cantilever	
	Long Term	Incremental	Long Term	Incremental
GENERAL	SPAN/250	SPAN/500	CANTILEVER LENGTH/125	CANTLEVER LENGTH/250
	Maximum 35mm		Maximum 30mm	
TRANSFER	SPAN/1000	SPAN/1000	CANTILEVER LENGTH/500	CANTILEVER LENGTH/500
		Maximum 10mm		Maximum 10mm

Note: The combined long-term deflection (cumulative slab plus beam) in some atypical long span slab and beam elements shall not exceed 45mm. The combined (cantilever plus edge beam) long term deflection in some long span scenarios shall not exceed 40mm.

7.1.2 Lateral

The lateral drift (globally and inter-storey) of the building will be limited to the following:

- Under Serviceability Wind Actions:
  - To be agreed with the façade and vertical transport engineers in future design phases
- Under Earthquake Actions (AS 1170.4 clause 7.5) – Height/67.

8 Structural Systems

8.1 Foundations

Foundations for columns and walls consist of pile caps and pile foundations that are founded on the underlying sandstone bedrock. The Fortify Geotech geotechnical investigation report notes that sandstone rock will be at least 8.1 metres to 9 metres below the surface level typically. The report also indicates the allowable bearing pressure (ABP) will be in the order of 3MPa for this layer of sandstone rock. This will need to be confirmed via on-site testing and presented in the geotechnical report.

8.2 Site Retention

Along the eastern boundary, the temporary and permanent site retention system will need to be installed to ensure that the stability of the adjacent existing structure is not adversely affected. This may involve a separate temporary and permanent site retention systems consisting of steel sheet piles and permanent reinforced concrete retaining walls. Alternatively, a site retention system that is suitable for both temporary and permanent conditions, such as a secant pile wall system or soldier pile wall system, may be installed.

Along the other site boundaries, it is expected that temporary batters can be implemented in accordance with the geotechnical engineer’s recommendations to allow the basement excavation to safely occur along these boundaries. A reinforced concrete retaining wall system will be provided to provide the permanent site retention along these boundaries.

8.3 Columns

Columns have been designed based on the use of higher strength concrete ranging from 50MPa to 65MPa. The use of higher strength concrete for the columns achieves an efficient column design allowing both reinforcing quantities and column size to be minimised adding to the efficiency of the large column free floor plate. Columns are typically square or rectangular with minimal size changes to ensure they can be quickly and efficiently constructed.

It is expected that prefabricated column reinforcement cages will be used in the construction of the columns to allow construction of the columns to occur in minimal time. The current architecture indicates that column shapes are consistent and aligned throughout the height of the building typically.

8.4 Lateral Stability

The lateral structure system consists of conventional reinforced concrete lift cores and stair cores throughout the height of the building. The lateral system has been designed to accommodate code calculated wind, earthquake, and robustness loading for both strength and serviceability requirements. Design of the building lateral structure will be refined as the project progresses. Under serviceability wind loading, the deflection criteria (including inter-storey drift requirements) will be further developed in conjunction with the requirements of the façade and vertical transport engineers.

The core walls utilise the solid walls required for planning (i.e. services risers, lift shafts and fire stairs) to ensure that the lateral system has nil impact on the functionality and flexibility of the typical floor plates. The closed arrangement of the core boxes that form part of the lateral structure at each level provides a high level of torsional stiffness to the building. Link beams are provided over each doorway to effectively couple all core wall elements into a single monolithic core structure. The core structure will be supported by a raft foundation on pile foundations socketed into the underlying sandstone bedrock layer.

The concrete core walls do not typically vary in plan arrangement from foundation level to roof level (other than walls dropping off due to the lift-rise terminating and wall thicknesses reducing) allowing the core structure to be readily constructed with a jump form system. The construction of the cores with a jump form system will allow construction to progress rapidly and efficiently so as to move off the project program critical path early in the construction program.

Additionally, as part of the structural core design, link beams (also known as 'header beams') are required over the top of door openings and lobby entries. These assist in linking the walls on either side of the opening to form a monolithic structure. It is critical that the link beams are of a maximum depth to link the walls together – specifically over the larger lobby openings.

8.5 Floorplates

All floorplates for this building development are typically post-tensioned suspended concrete floorplates. The floorplates generally consist of post-tensioned concrete band beams spanning between columns and walls, with post-tensioned one-way concrete slabs spanning between the band beams typically. The post-tensioned concrete band beam and one-way slab system was selected as this was the most structurally efficient floor system to support the required design loadings at the minimum depth. The concrete band beams are typically oriented to span in the longer direction between columns, with the post-tensioned one-way concrete slabs spanning in the shorter direction between columns to maximise the structural efficiency. There has been no allowance in the structural design of the post-tensioned floorplates, as this was not required in the design brief. Additionally, any services penetrations required in the floorplates will need to be coordinated with the architect and services consultants in future design phases to ensure these requirements can be incorporated into the structural design.

8.6 Fire Resistance

Fire resistance levels for structural elements will be in accordance with the structural requirements of the NCC and will be developed with the project NCC and Fire Engineering consultants. Design of individual structural elements to achieve the required FRL will be in accordance with the appropriate materials design code.