

NSW Health Infrastructure  
**Westmead Hospital -  
Darcy Rd Car Park**  
Structural Performance Specification

MSC-ARP-ST-SC-001

Draft | 6 November 2015

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 236482-30

Arup  
Arup Pty Ltd ABN 18 000 966 165



**Arup**  
Level 10 201 Kent Street  
PO Box 76 Millers Point  
Sydney 2000  
Australia  
[www.arup.com](http://www.arup.com)

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# Document Verification

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|                                                                                                                              |               | Name                                     | Peter Macdonald                                                                   | Nick Masters                                                                       | Peter Macdonald                                                                     |
|                                                                                                                              |               | Signature                                |  |  |  |
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# 1 Introduction

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## 1.1 The Project

This specification details the performance requirements for the structural engineering design of the new Multi-Storey Car Park (MSCP) at Westmead Hospital near the intersection of Darcy Rd & Institute Rd. The structure will house approximately 1250 car spaces as well as site-wide fire and hydraulics services plant and equipment.

The extent of works is defined by the architectural drawings and the structural engineering drawings listed in section 3.5 of this specification.

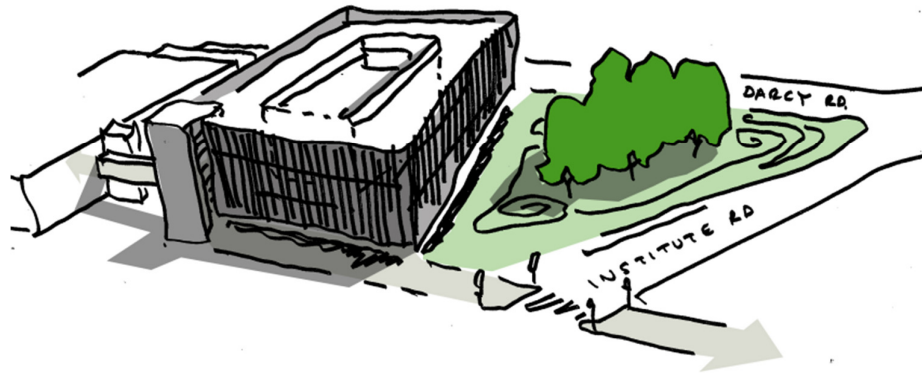


Figure 1 – Architectural Concept Sketch of MSCP Building

## 1.2 The Site

The building is located towards the north-west of the Westmead Hospital precinct which is located in the western suburbs of Sydney. With reference to the following image and project north defined as running parallel to Darcy Rd, the site is bounded by the Dental Building to the South, Darcy Rd to the West, and Institute Rd completing the triangle to the northeast.



Figure 2: Site Location Plan

The site area is approximately 4700m<sup>2</sup>, measuring approximately 91m long in the east-west direction and approximately 52m in the north-south direction. The site slopes gently down towards Toongabbie Creek to the north.

Key characteristics of the site that must be considered in the design and construction include:

- The site contains areas of fill including asbestos which must be considered – refer to the project asbestos consultant for details.
- Within the given footprint and proposed RLs, excavation is to be minimized wherever possible.
- The soil fill depth varies up to 1-2 m below ground level and is under laid by varying strength shale. Refer to the geotechnical investigation by Douglas Partners (Project 73603.00 January 2014) for more information.

## 2 Building and Performance Criteria

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### 2.1 Design Standards

The design of the MSCP building must comply with the requirements of the **current** National Construction Code of Australia and all relevant and current Australian Standards. Key Australian design standards include but are not limited to:

AS1170.0 – Structural design actions Part 0: General Principles

AS1170.1 – Structural design actions Part 1: Permanent, imposed and other actions

AS1170.2 – Structural design actions Part 2: Wind actions

AS1170.4 – Structural design actions Part 4: Earthquake actions in Australia

AS3600 – Concrete Structure

AS4100 – Steel Structures

AS2159 – Piling code

AS3850 – Precast Concrete

AS3700 – Masonry Structures

AS1720 – Timber Structures

AS2601 - Demolition

### 2.2 Loading

#### 2.2.1 Dead and Live Load

**Dead loads** shall be calculated based on the densities of materials defined by AS1170.1 and volumes calculated during design.

Superimposed dead loads must as a minimum include:

- General allowance for services, kerbs and hobs 0.5kPa
- Plinths for tanks, pumps, transformers, etc to be calculated by volume and density as required subject to final design
- Façade load calculated by volume and density – assumed to be light weight aluminium (0.5kPa on elevation) to be confirmed during detailed design stage.

## Live Loads

The design live load must consider the following loads:

- A typical uniformly distributed load of 2.5kPa on the car park areas, and any relevant point loads as defined by AS1170.1
- A minimum uniformly distributed load of 5.0kPa at lobby and plant areas
- The actual weight of the installed plant and equipment
- Water tanks on Level LG designed for 2m of water head pressure.
- Non-trafficable roof live loads to be a minimum of 0.25kPa
- Traffic barrier loads for car parks as defined by AS1170.1

### 2.2.2 Wind Loads

Importance level (NCC Table B1.2a) = 2

Annual probability of exceedance (NCC Table B1.2b) – 1:500

Wind region – A2

Ultimate limit state wind speed (Vuls) 45 metres/sec.

Serviceability limit state wind speed (Vsls) 36 metres/sec.

Terrain category 3

### 2.2.3 Earthquake Loads

Importance level 2

Annual probability of exceedance (NCC Table B1.2b) – 1:500

Site sub soil class - Ce

Earthquake design category II

### 2.2.4 Other Loads

Other loads such as temperature, foundation movement, creep, shrinkage etc shall be considered in accordance with the relevant Australian Standard.

## 2.3 Deflection limits

The Post Tensioned (PT) and reinforced concrete elements are to be sized to limit deflections to the values given in AS3600 Table 2.4.2.

| Type of Member                        | Deflection to be considered                                                    | Deflection limitation for spans                                                   | Deflection limitation for cantilevers                                             |
|---------------------------------------|--------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| All members                           | Total deflection                                                               | 1/250                                                                             | 1/125                                                                             |
| Members supporting masonry partitions | The deflection which occurs after the addition or attachment of the partitions | 1/500 where provision is made to minimize the effect of movement otherwise 1/1000 | 1/250 where provision is made to minimize the effect of movement, otherwise 1/500 |

The stability elements are to be designed to limit the inter-storey lateral drift to 1/500 under seismic loads.

## **2.4 Structural Fire Resistance Levels**

Fire resistance levels for structural elements shall be determined in accordance with the NCC of Australia and any subsequent approved relaxations as prescribed by the fire engineer.

## **2.5 Construction**

Construction of the new MSCP will be taking place in the middle of a fully functioning major teaching hospital. Construction methods must therefore be tailored to ensure minimal disruption to the operation of the Hospital.

## 3 Reference Scheme Design

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A reference scheme design has been developed for coordination and costing purposes. Details of the scheme are outlined below for information. The Contractor and their designers are free to adopt this structural scheme and develop it to completion or develop a different structural scheme that complies with the performance requirements in this document. In any case all designs are subject to client approval and the requirements of other contract documents.

### 3.1 Foundations

Preliminary Geotechnical report (Project 73630.00 – January 2014) prepared by Douglas Partners has determined a geological profile at the Westmead site to be typically comprising of shale of differing strengths overlain by natural clayey soils overlain by fill. The depth to medium strength (or stronger) rock varies and is approximately 6.5m.

With column grid as shown on the drawings the typical working loads on a single foundation are approximately 4,400kN.

Given the lack of a substantive basement and the fact that the upper soil layers are loose fill and clayey soil, 900mm diameter RC bored piles have been adopted for the reference design.

### 3.2 Basement

The MSCP building contains a single half-level basement (Level LG) that houses OSD tanks, fire and hydraulic services tanks and associated pump rooms, along with car spaces and the start of the central ramp. The northern edge of Level LG footprint approximately aligns with existing ground level, so some excavation is required heading south to obtain the volume required for the functional use of the space.

Wherever possible, retaining walls have been avoided and the use of permanent batters is employed (refer to Civil Engineer's drawings for details). This was done in order to save on retaining wall construction and associated backfilling operations, considering that the fill has a contamination risk and assuming it is not feasible to use the ACM as fill. There are some areas where space constraints and proposed finished levels confer the need for retaining walls – namely, for a short length along the western edge and around the lift and stair lobby in the south-eastern corner.

### 3.3 Floor Framing

The selection of a floor structural solution at the outset that is cost effective, fast to build and can be procured without delay is important to help achieve the project budgetary requirement and time constraints. The post-tensioned banded slab design achieves these objectives with the minimum structural depth required.

We propose the building to be a concrete frame with post-tensioned (PT) wide beam and slabs with reinforced columns and walls. A PT floor system is considered the most appropriate construction for the following reasons:

1. PT construction technique reduces the volume of construction materials – concrete and reinforcement.
2. This skilled construction method is common in the local market and is therefore a good, cost-effective solution.
3. Short lead time, fast slab turn-around time
4. Wider column grids, good for flexibility in floor space.
5. Reduced depth of beams and slabs – good for services distribution and reduced overall storey height and thus column and foundation requirements.
6. Concrete construction requires no additional fire and corrosion protection compared with steel construction. Concrete has inherent fire resistance and does not need continuing maintenance.
7. Less susceptible to vibration.

Further to the above general points, the slabs are proposed to be poured on Bondek formwork which will remain in place permanently. This has the advantage of removing the need for costly and timely stripping of the slabs. The other advantage of post-tensioned concrete is that once the floor is stressed (typically 3 days after concrete pour) the props can be removed since the floor has already achieved most of its strength.

The car park layout was chosen based on attempting to maximize planning efficiency by minimizing the area required per car space. This results in flat structure around the outer circulation aisle with the central ramp structure at 1:20 slope in the middle of the floorplate. Due to the discontinuity between the flat and ramped structure a double cantilever scheme is shown, where the beams align with the cantilever direction and the drive aisle generally forms the backspan. Generally a oneway PT slab spans between the band beams.

An 8.2m grid has generally been adopted in the east-west slab span direction, with varying north-south grid to suit the planning requirements. The floorplate contains no transfer structures, resulting in an economic structural solution and allowing the opportunity for construction process optimisation.

### 3.4 Lateral Stability

For building lateral stability we propose to use the stair and lift shafts as reinforced concrete shear walls. The shear walls receive the wind and seismic loads that are delivered by the floor diaphragms at each level and then carry these lateral loads down into the foundation system. Alternatively, a building moment frame or combination of moment frame and shear wall could be adopted to provide overall stability.

Due to the massing of the building the size of the lateral stability elements are governed by seismic loads. The wind loads are relatively small due to the low building height and façade system, which is taken as 50% perforated. The seismic loads have been calculated based on structural ductility and performance factor as specified in the Design Loads on the General Notes Drawing (MSC-ARP-ST-DG-0001). These parameters are based on the use of ductile shear walls in Table 6.5(A) of AS1170.4 and need to be detailed as such with the appropriate cross ties in the boundary elements per Appendix C5 of AS3600. An alternate system with less ductile shear walls may be designed and lead to less stringent wall detailing

requirements, however this will increase the building loads and may therefore result in increased wall and foundation sizes compared to the reference design.

### 3.5 Buildability

With any PT floor structure restrained in the permanent case by shear walls, due consideration must be made to restraint force build-up due to temperature, creep and shrinkage effects and to prestress loss when stressing against stiff elements and due to exceedingly long lengths of prestress runs.

Being at a design development stage, with detailed design to follow by the D&C Contractor, the reference design has made certain assumptions about construction methods and sequencing that will need to be accounted for and confirmed in the detailed design. Alternative systems may be pursued by the D&C Contractor that satisfy the design intent.

Namely, major assumptions made on the reference design are as follows:

- Walls to be built floor to floor conventionally without the use of slip/jump-forming
- Flat outer floors to be poured first with central ramp poured in between
- Edge stressing to be used wherever possible with pans being used where access from the edge is not allowed.
- Temporary movement joint (TMJ) as shown on the suspended levels is provided in order to split up the long east-west length of stressing and to isolate the stiff corner cores in the temporary case. The 90 days pour strip as called up by the detail allows the horizontal structure to “breathe” in the temporary case – allowing the major component of temperature and shrinkage forces to be minimized and to allow the stressed floor to move towards the stiff element without large prestress loss. The TMJ does impose the constraint of coming back after the 90 days and pouring the infill slab to “lock-in” the floor. Other methods may be chosen that avoid this time and labour constraint but may have additional cost. For example the use of Ancon or similar equivalent lockable dowels that avoid pour strip but allow the horizontal structure to move in the temporary case and can be tied in in the permanent case.
- Balustrade options in steel and concrete have been provided and have been assumed to be post-fixed to the structure. Allowance has been made in the edge beam size to allow typically 1 stressing duct and enough space adjacent to allow post-fixing of the balustrade. However, it is recommended that coordination take place such that any requirements of the chosen balustrade system be incorporated into the design so that cast-in starter bars (RC option) and/or hold-down bolts (steel option) can be incorporated into the design to avoid post-fixing.

### 3.6 Drawings

The structural scheme design is defined by the following drawings:

MSC-ARP-ST-DG-0000 Cover Sheet  
MSC-ARP-ST-DG-0001 General Notes – Sheet 1  
MSC-ARP-ST-DG-0002 General Notes – Sheet 2  
MSC-ARP-ST-DG-0003 Costing Notes  
MSC-ARP-ST-DG-0004 Costing Table – Sheet 1  
MSC-ARP-ST-DG-0006 Typical Reinforcement Lap & Development Tables  
MSC-ARP-ST-DG-0007 Typical Piling Details  
MSC-ARP-ST-DG-0009 Typical Footing Details  
MSC-ARP-ST-DG-0010 Typical Slab on Ground Details  
MSC-ARP-ST-DG-0012 Typical Suspended Slab Details  
MSC-ARP-ST-DG-0013 Typical Post Tensioning Details - Sheet 1  
MSC-ARP-ST-DG-0014 Typical Post Tensioning Details - Sheet 2  
MSC-ARP-ST-DG-0015 Typical Post Tensioning Details - Sheet 3  
MSC-ARP-ST-DG-0016 Typical Post Tensioning Details - Sheet 4  
MSC-ARP-ST-DG-0017 Typical Blockwork Details - Sheet 1  
MSC-ARP-ST-DG-0018 Typical Blockwork Details - Sheet 2  
MSC-ARP-ST-DG-0019 Typical Blockwork Details - Sheet 3  
MSC-ARP-ST-DG-0020 Typical Column Details  
MSC-ARP-ST-DG-0021 Typical Wall Details - Sheet 1  
MSC-ARP-ST-DG-0022 Typical Wall Details - Sheet 2  
MSC-ARP-ST-DG-0023 Typical Steelwork Details - Sheet 1  
MSC-ARP-ST-DG-0024 Typical Steelwork Details - Sheet 2  
MSC-ARP-ST-DG-0025 Typical Stair Details  
MSC-ARP-ST-DG-0200 Footings General Arrangement Plan  
MSC-ARP-ST-DG-0210 Footings Section & Details  
MSC-ARP-ST-DG-1000 Level LG - Lower Ground - General Arrangement Plan  
MSC-ARP-ST-DG-1100 Level LG - Lower Ground - Sections & Details - Sheet 1  
MSC-ARP-ST-DG-2000 Level G - Ground - General Arrangement Plan  
MSC-ARP-ST-DG-3000 Level 1 - General Arrangement Plan  
MSC-ARP-ST-DG-4000 Level 2 - General Arrangement Plan  
MSC-ARP-ST-DG-4300 Link Bridge - Details  
MSC-ARP-ST-DG-5000 Level 3 - General Arrangement Plan  
MSC-ARP-ST-DG-6000 Level 4 - General Arrangement Plan  
MSC-ARP-ST-DG-7000 Level 5 - General Arrangement Plan  
MSC-ARP-ST-DG-8000 Level 6 - General Arrangement Plan  
MSC-ARP-ST-DG-8100 Suspended Levels Sections & Details - Sheet 1  
MSC-ARP-ST-DG-9000 Core Lids - General Arrangement Plan