NSW GOVERNMENT

TS 00174:1.0

Standard

# Car Parks

Issue date: 05 April 2024

Effective date: 05 April 2024

# Disclaimer

This document has been prepared by Transport for NSW (TfNSW) specifically for its own use and is also available for use by NSW public transport agencies for transport assets.

Any third parties considering use of this document should obtain their own independent professional advice about the appropriateness of using this document and the accuracy of its contents. TfNSW disclaims all responsibility and liability arising whether directly or indirectly out of or in connection with the contents or use of this document.

TfNSW makes no warranty or representation in relation to the accuracy, currency or adequacy of this document or that the document is fit for purpose.

The inclusion of any third party material in this document, does not represent an endorsement by TfNSW of any third party product or service.

For queries regarding this document, please email Transport for NSW Asset Management Branch at standards@transport.nsw.gov.au or visit www.transport.nsw.gov.au

# Document information

| | |
|---|---|
| **Owner:** | Director Interchanges and Buildings<br>Asset Management<br>Safety Environment and Regulation |
| **Mode:** | Roads |
| **Discipline:** | Interchanges and buildings |

# Document history

| Revision | Effective date | Summary of changes |
|---|---|---|
| 1.0 | 05/04/2024 | First issue |

# Preface

This is a first issue as TS 00174

This standard sets the functional, spatial, structural and building services requirements for the design of new and modifications to existing car parks at TfNSW stations and interchanges.

# Table of contents

# 1 Scope

This standard sets the minimum operational, functional, structural and building services design requirements for TfNSW car parks including the following:

- on-street parking
- at grade parking
- multi-storey parking
- underground parking
- temporary parking.

This document incorporates best practice approaches to the following:

- efficient urban planning, design outcomes, connectivity and integration of car parks
- efficient material selection, maintenance and whole of life outcomes
- innovation in design, construction and maintenance of car parks
- incorporation of sustainable outcomes
- encourage future proofing car parks.

This standard should be read in conjunction with all relevant TfNSW standards including:

- TS 04951.1
- TS 04955.1
- TS 00008.1.

This standard does not cover the following:

- road corridor design requirements beyond car parks
- traffic control systems
- non-TfNSW car parking.

# 2 Application

This standard applies to the whole-of-life of TfNSW architectural and structural assets in car parks in NSW. This document applies to TfNSW staff, TAOs and service providers involved in any asset life cycle stage relating to TfNSW car parks.

This standard applies to new car parks and alterations to existing car parks.

An alteration to an existing car park will not activate an upgrade of the existing car park unless required under legislation or the new works cause a non-compliance of the existing car park with relevant legislative requirements or TfNSW standards.

If the requirements of this standard are unclear, clarification should be sought from the AMB.

# 3 Referenced documents

The following documents are cited in the text. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document applies.

**International standards**

BS 8102 *Code of practice for protection of below ground structures against water ingress*

**Australian standards**

AS 1012.13 *Methods of testing concrete – Method 13: Determination of the drying shrinkage of concrete for samples prepared in the field or in the laboratory*

AS 1111.1 *ISO metric hexagon bolts and screws – Product grade C – Part 1:Bolts*

AS 1170.4 *Structural design actions – Part 4: Earthquake actions in Australia*

AS 1288 *Glass in buildings – Selection and installation*

AS 1289 5.1.1 *Methods of testing soils for engineering purposes – Method 5.1.1: Soil compaction and density tests – Determination of the dry density/moisture content relation of a soil using standard compactive effort*

AS 1289.5.4.1 *Methods of testing soils for engineering purposes – Method 5.4.1: Soil compaction and density tests – Compaction control test – Dry density ratio, moisture variation and moisture ratio*

AS 1289.5.7.1 *Methods of testing soils for engineering purposes – Method 5.7.1: Soil compaction and density tests – Compaction control test – Hilf density ratio and Hilf moisture variation (rapid method)*

AS 1319 *Safety signs for the occupational environment*

AS 1379 *Specification and supply of concrete*

AS 1428.1 *Design for access and mobility – Part 1:General requirements for access – New building work*

AS 1428.2:1992 *Design for access and mobility – Part 2: Enhanced and additional requirements – Buildings and facilities*

AS 1428.2 *Design for access and mobility – Part 2: Enhanced and additional requirements – Buildings and facilities*

AS 1657 *Fixed platforms, walkways, stairways and ladders – Design, construction and installation*

AS 1668.1 *The use of ventilation and air conditioning in buildings – Part 1: Fire and smoke control in buildings*

AS 1668.2 *The use of ventilation and air conditioning in buildings – Part 2: Mechanical ventilation in buildings*

AS 1668.4 *The use of ventilation and air conditioning in buildings – Part 4: Natural ventilation of buildings*

AS 1670.1 *Fire detection, warning, control and intercom systems – System design, installation and commissioning – Part 1: Fire*

AS 1726 *Geotechnical site investigations*

AS 1735.12 *Lifts, escalators and moving walks – Part 12: Facilities for persons with disabilities (EB 81-70:2018, MOD)*

AS 1742.11 *Manual of uniform traffic control devices – Part 11: Parking controls*

AS 1905.1 *Components for the protection of openings in fire-resistant walls –Part 1: Fire-resistant doorsets*

AS 2118.1 *Automatic fire sprinkler systems – Part 1: General systems*

AS 2150 *Asphalt – A guide to good practice*

AS 2159 *Piling – Design and installation*

AS 2419.1 *Fire hydrant installations – Part 1: System design, installation and commissioning*

AS 2419.1:2021 *Fire hydrant installations – Part 1: System design, installation and commissioning*

AS 2441 *Installation of hose reels*

AS 2444 *Portable fire extinguishers and fire blankets – Selection and location*

AS 2890.2 *Parking facilities – Part 2: Off-street commercial vehicle facilities*

AS 2890.3 *Parking facilities – Part 3: Bicycle parking*

AS 2890.5:2020 *Parking facilities – Part 5: On-street parking*

AS 2890.5 *Parking facilities – Part 5: On-street parking*

AS 3500.3–2019 *National plumbing and drainage code – Part 3: Stormwater drainage*

AS 3600 *Concrete structures*

AS 3610 *Formwork for concrete*

AS 3700 *Masonry structures*

AS 3798 *Guidelines on earthworks for commercial and residential developments*

AS 3990 *Mechanical equipment – Steelwork*

AS 3996:2019 *Access coves and grates*

AS 4100 *Steel structures*

AS 4419 *Soils for landscaping and garden use*

AS 4454 *Composts, soil conditioners and mulches*

AS 5100.3 *Bridge design – Part 3: Foundation and soil-supporting structures*

AS/NZS 1158.3.1:2020 *Lighting for roads and public spaces – Part 3.1: Pedestrian area (Category P) lighting – Performance and design requirements*

AS/NZS 1170.0 *Structural design actions – Part 0: General principles*

AS/NZS 1170.1 *Structural design actions – Part 1: Permanent, imposed and other actions*

AS/NZS 1170.1:2002 *Structural design actions – Part 1: Permanent, imposed and other actions*

AS/NZS 1170.2 *Structural design actions – Part 2: Wind actions*

AS/NZS 1170.3 *Structural design actions – Part 3: Snow and ice actions*

AS/NZS 1252 (series) *High strength steel fastener assemblies for structural engineering – Bolts, nuts and washers*

AS/NZS 1428.4.1 *Design for access and mobility – Part 4.1: Means to assist the orientation of people with vision impairment – Tactile ground surface indicators*

AS/NZS 1554.1 *Structural steel welding – Part 1: Welding of steel structures*

AS/NZS 1554.6 *Structural steel welding – Part 6: Welding stainless steels for structural purposes*

AS/NZS 1664.1 *Aluminium structures – Part 1: Limit state design*

AS/NZS 1665 *Welding of aluminium structures*

AS/NZS 1680.0 *Interior lighting – Part 0: Safe movement*

AS/NZS 1680.2.1 *Interior and workplace lighting – Part 2.1: Specific applications – Circulation spaces and other general areas*

AS/NZS 2208 *Safety glazing materials in buildings*

AS/NZS 2311 *Guide to the painting of buildings*

AS/NZS 2890.1:2004 *Parking facilities – Part 1: Off-street car parking*

AS/NZS 2890.1 *Parking facilities – Part 1: Off-street car parking*

AS/NZS 2890.6 *Parking facilities – Part 6: Off-street parking for people with disabilities*

AS/NZS 3000 *Electrical installations "Wiring Rules"*

AS/NZS 3500 (all parts) *Plumbing and drainage*

AS/NZS 4600 *Cold-formed steel structures*

AS/NZS 4680 *Hot-dip galvanized (zinc) coatings on fabricated ferrous articles*

AS/NZS 5131 *Structural steelwork – Fabrication and erection*

**Transport for NSW standards**

TS 00008.1 *Fire and Life Safety – Part 1: Principles*

TS 00033 *Supply of Bolts, Nuts and Washers (ATS 5420-20, Ed 1.0 MOD)*

TS 00040 (T MU EN 00007 GU) *Integrating Green Infrastructure*

TS 01506.1 *Development of Technical Maintenance Plans – Part 1: Development Process*

TS 01508 *Asset Handover Requirements*

TS 01713 (T HR CI 12020 ST) *Underbridges*

TS 01715 (T HR CI 12030 ST) *Overbridges and Footbridges*

TS 01718 (T HR CI 12060 ST) *Retaining Walls*

TS 01744.1 (IC-QA-B201) *Steelwork for Bridges – QA*

TS 01746.1 (IC-QA-B220) *Protective Treatment of Bridge Steelwork – QA*

TS 01751.2 (IC-DC-B246*) Manufacture and Supply of Minor Aluminium Items – DC*

TS 02159.1 (IC-QA-R40) *Horizontal Drains – QA*

TS 02163 (IC-QA-R56) *Ground Anchors (Schedule of Rates)*

TS 02164.2 (IC-DC-R57) *Design of Reinforced Soil Walls – DC*

TS 02168.2 (IC-DC-R64) *Soil Nailing – DC*

TS 02388 (T HR CI 12160 ST) *Boundary Fences*

TS 02391 (T HR CI 12200 ST) *Access Roads*

TS 02715 (GTD 2020/001) *Excavation adjacent to Transport for NSW Infrastructure*

TS 02716 (0000.000.PT.0009) *Subsurface Drainage Details – Volume 1 Design and Location (Sheet 1 to 12)*

TS 02717 (0000.000.PT.0010) *Subsurface Drainage Details – Volume 2 Granular pavement with bituminous surfacing details (Sheet 1 to 7)*

TS 02718 (0000.000.PT.0011) *Subsurface Drainage Details  Volume 3 Full depth asphalt pavement details (Sheet 1 to 7)*

TS 02719 (0000.000.PT.0012) *Subsurface Drainage Details – Volume 4 Asphalt over bound subbase pavement details (Sheet 1 to 7)*

TS 02720 (0000.000.PT.0013) *Subsurface Drainage Details – Volume 5 Rigid pavement details (Sheet 1 to 9)*

TS 02721 (0000.000.PT.0014) *Subsurface Drainage Details – Volume 6 Supplementary model drawings (Sheet 1 and 2)*

TS 02738 (DS2013/000067) *Typical Pavement profiles (Sheet 1 to 8)*

TS 03254.1 (IC-QA-R11) *Stormwater Drainage – QA*

TS 03255.1 (IC-QA-R15) *Kerbs and Channels (Gutters) – QA*

TS 03256.1 (IC-QA-R16) *Precast Reinforced Concrete Culverts – QA*

TS 03257.1 (IC-QA-R23) *Plastic Flexible Pipes – QA*

TS 03258.1 (IC-QA-R24) *Precast Concrete Arches*

TS 03259.1 (IC-QA-R31) *Vertical Wick Drains*

TS 03260.1 (IC-QA-R33) *Trench Drains – QA*

TS 03261.1 (IC-QA-R37) *Intra-Pavement Drains*

TS 03262.1 (IC-QA-R38) *Edge Drains – QA*

TS 03264.1 (IC-QA-R53) *Concrete for General Use*

TS 03283.1 (IC-QA-R116) *Heavy Duty Dense Graded Asphalt – QA*

TS 03291.2 *Safety Barrier Systems – DC*

TS 03954 *Low Voltage Electrical Installations*

TS 04003 (T MU RS 17002 ST) *Prohibited and Restricted Materials*

TS 04935 (T HR SS 80001 ST) *Infrastructure Lighting*

TS 04939 (T HR SS 90002 ST) *Barriers, Balustrades, Screens and Handrails*

TS 04941 (T MU SS 90001 ST) *Safe Pedestrian Surfaces*

TS 04943 (T MU SS 90007 ST) *Bicycle Parking Facilities*

TS 04951.1 *Functional Spaces – Part 1: Principles*

TS 04955.1 *Systems, Services and Equipment Principles – Part 1: Principles*

TS 04955.3 *Systems, Services and Equipment – Part 3: Lifts*

TS 04989 *Public Transport Closed Circuit Television Functional Requirements Standard*

TS 04992 *Surface Transport Fixed Infrastructure Physical Security Standard* (This document is not publicly available. To obtain access email standards@transport.nsw.gov.au)

TS 06303 (T MU SS 80007 ST) *Building Services for Commercial Tenancies in Public Transport Facilities*

**Legislation**

*Disability (Access to Premises – Buildings) Standards 2010* (Cth)

*Disability Standards for Accessible Public Transport 2002* (Cth)

*Environmental Planning and Assessment (Development Certification and Fire Safety) Regulation* 2021 (NSW)

*Heritage Act 1977* (NSW)

**Other referenced documents**

ARTC, *Section 170 Heritage and Conservation Register*

Austroads, *Guide to Pavement Technology Part 2– Pavement Structural Design*

Austroads, *Guide to Pavement Technology Part 4K – Selection and Design of Sprayed Seals*

Austroads*, Guide to Road Design Part 1 – Objectives of Road Design*

Austroads*, Guide to Road Design Part 3 – Geometric Design*

Austroads*, Guide to Road Design Part 4 – Intersections and Crossings: General*

Austroads*, Guide to Road Design Part 4A – Unsignalised and Signalised Intersections*

Austroads*, Guide to Road Design Part 4B – Roundabouts*

Austroads*, Guide to Road Design Part 4C – Interchanges*

Austroads*, Guide to Road Design Part 5 – Drainage – General and Hydrology Considerations*

Austroads*, Guide to Road Design Part 5A – Drainage: Road Surface, Networks, Basins and Subsurface*

Austroads*, Guide to Road Design Part 5B – Drainage – Open Channels, Culverts and Floodway Crossings*

Austroads*, Guide to Road Design Part 6 – Roadside Design, Safety and Barriers*

Austroads*, Guide to Road Design Part 6A – Paths for Walking and Cycling*

Austroads*, Guide to Road Design Part 6B – Roadside Environment*

Austroads*, Guide to Road Design Part 7 – New and Emerging Treatments*

Commonwealth of Australia, *Australian Rainfall & Runoff – A Guide to Flood Estimation*

Department of Finance, Services and Information, PBD-2016-03 *Construction standards and conformance*

Fire and Rescue NSW, *Fire safety guideline – Emergency services information package and tactical fire plans*

Government Architect of New South Wales, Design Guide, *Urban Design for Regional NSW*

Government Architect NSW, *Connecting with Country*

National Resource Management Ministerial Council, Environment Protection and Heritage Council, Australian Health Ministers Conference, 2006, *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1)*

NSW Department of Planning, Industry and Environment, *Service and Installation Rules of New South Wales*

NSW Government on behalf of the Senior Officers' Group, 2018, *A Guide to Australian Building Product Conformity comprised of representatives from the Commonwealth, states and territories*

NSW Justice, *NSW Car Park Guidelines for Crime Prevention*

RailCorp, 2004, *Guideline on Earthing and Bonding at Railway Stations*

RTA, *Guide to Traffic Generating Developments*

Sydney Water, 2021, *Onsite Stormwater Detention Policy*

TAHE, *Section 170 Heritage and Conservation Register*

TfNSW, *Commuter Car Park Program – Technical Specification (for D&C Contracts)* (This document is not publicly available. To obtain access email standards@transport.nsw.gov.au)

TfNSW, CP22007 *Transport Security Strategy*

TfNSW, *Creativity Guidelines – for transport systems*

TfNSW, *Facade Design Guideline – Commuter Car Parks Program* (This document is not publicly available. To obtain access email standards@transport.nsw.gov.au)

TfNSW, *multi-level and at-grade – Commuter Car Parks – urban design guidelines* (This document is not publicly available. To obtain access email standards@transport.nsw.gov.au)

TfNSW, *Sustainable Design Guidelines*

TfNSW, *Transport for NSW (Roads and Maritime) S170 Heritage Register*

TfNSW, *Unexpected heritage items procedure*

TfNSW, *Walking Space Guide – Towards Pedestrian Comfort and Safety*

TfNSW*, Water sensitive urban design guideline*

TfNSW, *Wayfinding Planning Guide – Car parks* (This document is not publicly available. To obtain access email standards@transport.nsw.gov.au)

The Australian Building Codes Board, *National Construction Code*, *Building Code of Australia*, Volume 1

The Australian Building Codes Board, *National Construction Code*, *Plumbing Code of Australia*, Volume 3

UGL Regional Linx, *Section 170 Register – Country Rail Network – Heritage and Conservation Register*

# 4 Terms, definitions and abbreviations

The following terms, definitions and abbreviations apply in this document.

**access path** a path that permits independent travel for all passengers within public transport premises, infrastructure or conveyances (Source: DSAPT, 1.9 modified)

**AEP** annual exceedance probability

**AMB** Asset Management Branch

**ARI** average recurrence interval

**asset custodian** the TfNSW Division accountable for the end to end lifecycle management and performance of assets (including asset condition, risk and reporting) on behalf of the asset owner to achieve agreed customer and community outcomes

**asset steward – delivery** the entity responsible for:

- procuring assets from investment decision to commissioning
- delivering the benefits
- translating requirements from the client and managing delivery outcomes
- selecting the most appropriate supplier/s to meet project objectives.

**asset steward – operate or maintain** the entity responsible for day to day operations and maintenance of the asset once commissioned. May be a part of the asset custodian division or a separate entity. Operator and maintainer of the assets might be separate entities

**BCA** *National Construction Code*, *Building Code of Australia,* Volume 1

**CCP** commuter car park

**CCTV** closed circuit television

**CLT** cross-laminated timber

**DSAPT** *Disability Standards for Accessible Public Transport 2002*

**DTS** deemed to satisfy

**ESA/M** the ratio of exposed surface area to mass per unit length

**EV** electric vehicle

**facility** a zonal area (within a precinct boundary) that contains buildings, systems, plant and associated infrastructure assets to support the operation and maintenance of transport services

**FFL** finished floor level

**GPT** gross pollutant trap

**MUSIC** model for urban stormwater improvement conceptualisation

**OSD** onsite stormwater detention

**PCA** *National Construction Code*, *Plumbing Code of Australia,* Volume 3

**PT** post-tensioned

**PV** photovoltaic

**services** mechanical, electrical, hydraulic and communication services

**service provider** operator or maintainer, designer, constructor providing services to TfNSW to manage the day-to-day operation and maintenance of the TfNSW assets

**SCM** supplementary cementitious materials

**SFAIRP** so far as is reasonably practicable

**SID** safety in design

**SRS** system requirements specification

**TAO** Technically Assured Organisation

**TfNSW** Transport for NSW

# 5 Car park types and configurations

Sections 5.1 to 5.6 detail requirements for TfNSW car parks based on type and configuration.

## 5.1 Commuter car parks

CCPs provide parking for TfNSW commuters and are generally located near transport modes or multimodal transport facilities. This standard, along with the BCA and local council planning instruments establishes the design requirements for CCPs.

CCPs may be developed as either on-street or off-street parking arrangements.

CCPs may be comprised of one of the following:

- at grade
- multi-storey above ground
- multi-storey underground
- a combination of at grade, multi-storey above ground or multi-storey underground.

TfNSW shall prepare a site specific SRS for new car parks and alterations to existing car parks which shall define the following:

- site specific design, functional and configurational requirements
- number and configuration of vehicle spaces to be provided, including EV requirements
- specific requirements for motorcycle and bicycle parking
- specific fire and life and security requirements
- operational fit-out requirements
- vertical transport requirements
- specific operational and maintenance requirements.

## 5.2 Integrated commuter and local council car parks

Integrated commuter and local council car parks provide shared parking for TfNSW commuters and non-commuters. This type of car park is generally located near modal or multimodal transport facilities. This standard, along with the BCA, PCA and local council planning instruments establishes the design requirements for these car parks.

TfNSW shall prepare a site specific SRS for new car parks and alterations to existing car parks which shall define:

- site specific design, functional and configurational requirements
- number and configuration of vehicle spaces to be provided, including EV requirements
- battery energy storage system space provisioning and solar PV system requirements
- specific requirements for motorcycle and bicycle parking
- specific safety, fire and life safety and security requirements
- operational fit-out requirements
- vertical transport requirements
- specific operational and maintenance requirements.

Where car parks are vested with a local council, the local council shall be responsible for ongoing maintenance of the car park, unless otherwise agreed by the asset custodian.

The TAO or service provider shall ensure that TfNSW and council car parking configurations are fully coordinated to ensure an integrated approach to the overall car park configuration.

Integrated commuter and local council car parking shall be developed as either at grade, multi-storey above ground, multi-storey underground, or a combination of the above parking configurations.

## 5.3 Integrated commuter and commercial car parks

The objective of integrated commuter and commercial car parks is to provide the market with industry standard base build car parks to ensure that there is no risk rated reduction in any potential financial offer, as a result of departing from industry standards.

Transport specific fit-out requirements including park and ride barriers requirements, operational requirements and other site specific requirements shall be defined by the TfNSW site specific SRS. See Section 11.8 for details.

TfNSW shall prepare a site specific SRS for each CCP which defines the following:

- site specific design, functional, configuration and urban requirements
- number of vehicles including EV spaces to be provided
- space for battery energy storage systems
- space for solar PV systems
- specific requirements for motorcycle spaces
- specific requirements for bicycle spaces
- preferred location of CCP levels within the development
- operational fit-out requirements.

Integrated commuter and commercial car parking should be developed as multi-storey or underground parking configurations.

The following specific requirements apply to shared commuter and commercial car parks which shall be integrated with the requirements in this standard:

- CCP stratum shall be the top floors for above ground multi-storey car parks, or be the lowest floor for underground multi-storey car parks
- the CCP stratum will be constructed to a base build completion, the owner or operator shall be responsible for the completion of fit-out for operational requirements, including all markings, signage, management systems and so on.

Integrated commuter and commercial car parks should provide no less than 150 car parking spaces including disabled parking spaces in accordance with DSAPT.

## 5.4 Car parks vested with other entities

An example of this arrangement is where TfNSW occupies a number of parking levels in a car park that council constructed under a lease agreement with TfNSW.

TfNSW shall prepare a site specific SRS for each car park which includes the following:

- site specific design, functional, configuration and urban design requirements
- number and configuration of vehicle spaces to be provided, including EV requirements
- battery energy storage system space provisioning and solar PV system requirements
- specific requirements for motorcycle parking
- specific requirements for bicycle spaces
- location of the commuter stratum
- specific safety, fire and life safety and security requirements
- operational fit-out requirements
- specific operational and maintenance requirements
- primary contract for sale and development agreement.

Where car parks are vested with an entity under this arrangement the entity shall be responsible for the ongoing operational and maintenance activities of the car park until the lease has expired. Specific requirements under this type of agreement shall be arranged and facilitated through TfNSW.

Car parking vested with other entities shall be developed as on-street, at grade, multi-storey or underground parking configurations.

## 5.5 Development on third party properties

TfNSW car parking facilities may be erected on a third party's property under commercial arrangements. Where TfNSW development occurs on or encroaches a third party's property the TAO or service provider shall confirm that approval from relevant parties has been obtained. Development on third party property, for example, TfNSW development encroaching on council property such as public domain areas, footpaths and accessways adjacent to transport mode entry points.

TfNSW shall prepare a site specific SRS for each new car park which shall define the following:

- specific design, functional, configuration and urban requirements
- number and configuration of vehicle spaces to be provided, including EV requirements
- battery energy storage system space provisioning and solar PV system requirements
- specific requirements for motorcycle parking
- specific requirements for bicycle spaces
- specific safety, fire and life safety and security requirements

- operational fit-out requirements
- specific operational and maintenance requirements
- primary contract for sale and development agreement.

Car parking developed on third party property shall be developed as ‘off street’, ‘at grade’, multi-storey or underground parking configurations.

## 5.6 TfNSW operational facility staff car parks

Operational facility (non-commuter) car parks incorporate TfNSW staff parking at operational locations, including signalling huts, substations, maintenance centres, stabling yards and office accommodation.

TfNSW shall prepare a site specific SRS for each new car park which shall define:

- site specific design, functional, configuration and urban requirements
- number and configuration of vehicle spaces to be provided, including EV requirements
- battery energy storage system space provisioning and solar PV system requirements
- specific requirements for motorcycle parking
- specific requirements of bicycle spaces
- specific safety, fire and life safety and security requirements
- operational fit-out requirements
- specific operational and maintenance requirements.

Operational facilities car parks should be developed as at-grade, multi-storey or underground parking configurations.

# 6 General planning requirements

The TAO or service provider shall comply with the requirements of TS 04951.1 and the car park specific requirements in Sections 6.1 to 6.16.

Refer to Appendix A for urban context and life cycle considerations.

## 6.1 TfNSW strategies and policies

Car parks shall be designed in accordance with TS 04951.1. TfNSW guidelines should also be considered, including but not limited to the following:

- *NSW Car Park Guidelines for Crime Prevention*
- *Facade Design Guideline – Commuter Car Parks Program*

- *multi-level and at-grade – Commuter Car Parks – urban design guidelines*
- *Walking Space Guide – Towards Pedestrian Comfort and Safety.*
- *Urban Design Guide for Regional NSW.*
- *Guide to Traffic Generating Developments*
- *Sustainable Design Guidelines*
- CP22007

## 6.2 Design development

In addition to legislative requirements, the general layout and physical geometry of car parks shall be in accordance with the requirements of, including but not limited to, the following:

- AS 1428.1
- AS 1428.2
- AS 2890.2
- AS 2890.3
- AS 2890.5
- AS/NZS 1428.4.1
- AS/NZS 2890.1
- AS/NZS 2890.6.

Car parks shall be designed and developed in consultation with TfNSW.

The TAO or service provider shall submit proposed designs at incremental design stages for endorsement by TfNSW. Design submissions shall align with TfNSW procurement requirements.

## 6.3 Safety in design

SID principles shall be incorporated early into the design process.

SID principles shall be applied in developing the following:

- configuration layout
- material selection
- construction methodology
- maintenance requirements and procedures

- operations requirements and procedures
- decommissioning procedures.

## 6.4 Public domain and urban design

Car parks shall be located to enhance modal and multimodal connectivity and provide safe, reliable and visual integration within the surrounding environment. The built form, scale and connectivity shall seamlessly integrate with the surrounding contextual settings.

Contextual settings of car park sites may fall into one of the following categories:

- rural settings
- undeveloped greenfield or brownfield settings
- new suburban centre settings
- established town centre settings
- inner city settings.

Unless addressed by local council requirements or guidelines, car parks should consider the following:

- in rural settings urban design outcomes should be in accordance with the *Urban Design for Regional NSW*
- in non-rural settings, urban design outcomes should be in accordance with *multi-level and at-grade – Commuter Car Parks – urban design guidelines.* See Section A.1 for typical characteristics and example of sites.

## 6.5 Site context

The TAO or service provider shall develop car park designs that incorporate site constraints including the following:

- site boundaries, easements and land ownership
- site geotechnical conditions
- existing and future services locations
- access and connectivity
- climate and orientation
- climate change impact risks
- flooding and site drainage
- local government requirements

- overlooking and overshadowing of neighbouring properties
- other site specific constraints.

## 6.6 Green infrastructure

Landscape design shall use species indigenous to the local area. Landscape design may include the following:

- diverse and appropriate planting
- bio-filtration gardens
- appropriate planting of shading trees
- green roof or walls.
- permeable surfaces
- cooling sealants on asphalt areas
- enhanced soft landscaping
- approaches to reduce urban heat island impacts
- water sensitive urban design approaches
- harvested rainwater for irrigation

Deep soil zones which support growth of medium to large trees should be included where appropriate, without impacting above and underground services. Where appropriate for specific sites, deep soil zones should be no less than 7% of the site area.

Where trees are incorporated into the car park landscape design controls should be incorporated to ensure trees do not damage footpaths, underground services or create slip, trip or fall risks.

Landscape works shall be constructed in accordance with AS 4419, AS 4454 and TS 04992.

Refer to TS 00040 for additional guidance.

## 6.7 Heritage and site artefacts

Early in the design process the TAO or service provider shall identify potential impacts on heritage assets. The design of new car parks and upgrades to existing car parks shall be complementary to the visual significance of existing heritage assets. Refer to TS 04951.1 for heritage requirements.

The TAO or service provider shall ensure the asset steward – operate or maintain is made aware of any unexpected or confirmed heritage items identified on site and any further management requirements arising from the unexpected heritage items.

The TAO or service provider shall refer to *Unexpected heritage items procedure* for further information on the discovery of unexpected heritage items.

Assets with heritage value require specific assessment and approval of impacts. This may include car parks which themselves have no heritage value but are located within a heritage area. Heritage assets are identified in the NSW State Heritage Inventory or as a heritage item on a statutory Section 170 Heritage and Conservation Register in accordance with the *Heritage Act 1977.* Applicable Section 170 registers include the *following:*

- *Section 170 Heritage and Conservation Register (ARTC)*
- *Section 170 Heritage and Conservation Register (TAHE)*
- *Section 170 Register – Country Rail Network – Heritage and Conservation Register.*
- *Transport for NSW (Roads and Maritime) S170 Heritage Register*

TAOs shall minimise the impact on items of recognised heritage value when making any modifications to buildings, for example, to comply with the *Disability (Access to Premises – Buildings) Standards 2010* requirements. Where competing interests from heritage requirements and other legislative requirements arise, the TAOs should develop a range of options to evaluate and select the option that provides the best-balanced outcome.

## 6.8 Designing for Country

The TAO or service provider shall refer to *Connecting with Country* which provides good practice guidance on how to respond to Country in the planning, design and delivery of built environment projects in NSW.

## 6.9 Public artwork

Consideration should be given to the adoption of public artwork. The need for the inclusion of public artwork may be as a result of, without limitation, the following:

- heritage interpretation
- prevention of vandalism
- activation of transport precincts
- enhancement of spatial quality based on the architectural intent.

Where the requirements of public artwork have not been determined, the TAO shall consult and agree with TfNSW to determine the requirement of public artworks specific to the site.

The content and placement of public artwork shall take into account the safety and security of persons who have line of sight to the proposed installation location as well as customers at the proposed installation location.

Public artwork shall not obstruct vision of, or conflict with, exit signage, passive surveillance or CCTV.

Refer to *Creativity Guidelines – for transport systems* for additional information.

Refer to TS 04992 for physical security requirements.

## 6.10 Modular infrastructure

New car parks should be designed in a modular configuration where practicable. Modular configuration should allow for:

- minimal in situ construction
- reduced embodied carbon emissions
- efficient maintenance
- ease of modification for future expansion
- ease of reduction
- future repurposing
- ease of relocation and disposal.

Alterations to existing car parks should be designed in a modular configuration where practicable that facilitates easy integration with the existing car park configuration, systems and services.

Refer to Appendix B for examples of car park strategies.

## 6.11 Future proofing

New car parks and upgrades to existing car parks shall be appropriately future proofed to facilitate alterations, or adaptive reuse. Future proofing shall be proportionate, and achieve a balance between cost, risk and performance. Elements that shall be taken into account for future proofing strategy include but not limited to the following:

- operational and functional requirements
- environmental impacts
- spatial configuration
- structural elements
- services equipment and conduits
- EV charging requirements.

## 6.12 Commercial tenancies

Where required in the project specific SRS the TAO or service provider shall provide recommendations to TfNSW for incorporating cost effective commercial tenancy in car parks. Tenancies shall comply with local council and TfNSW tenancy requirements. Tenancies should be located on ground level in areas with high customer exposure and access. The TAO or service provider shall consult with local councils to establish specific council requirements and to ensure their coordination with TfNSW requirements.

Refer to TS 06303 for commercial tenancies services and fit-out requirements.

## 6.13 Driveway entries and exits

Driveway entries and exits shall be located to ensure safe and reliable access to the car park. Driveway entry and exists shall provide safe sight distances.

Vehicle access shall be through separate dedicated points of entry and exit. Vehicle access shall be separated from pedestrian entry and exit points. For entries, the number of entry lanes at each entry point shall be determined by queuing capacity in front of the boom gate. If more than 1 exit lane is provided, the exit lanes shall merge into one lane prior to crossing a pedestrian walkway. Additional exit lanes may be required depending on queuing capacity at the location of the exit boom gate.

Frontage access to highways and arterial roads shall not be permitted unless agreed by the asset steward – delivery. Refer to AS/NZS 2890.1 for driveway requirements.

## 6.14 Traffic management

Car parks shall be designed to exclude public vehicle through traffic and to provide safe, efficient and reliable traffic movement throughout the facility. Traffic movement configuration shall comply with AS/NZS 2890.1.

Car park entries and exits and internal circulation lanes should eliminate conflict between pedestrian movement and vehicular traffic.

## 6.15 Fire brigade vehicle access

Refer to the BCA for emergency vehicles access requirements. Additionally, a hardstand area for emergency vehicles shall be provided in accordance with AS 2419.1 to the car park on the unpaid side of entry barrier gates. The emergency vehicle hardstand area should not impede commuter access to or from the car park.

## 6.16 Pedestrian access

Pedestrian entries and exits shall be separated from vehicle entries and exits.

Pedestrians shall have a safe means of access to the car park. Where pedestrians are required to cross busy roadways, they shall be guided to a safe crossing point having adequate sight distances, pavement, and signage.

Pedestrian access paths shall have adequate lighting, signage, slip resistance and sight distance.

Refer to the DSAPT, AS/NZS 1680.2.1 and AS/NZS 1158.3.1:2020 for lighting requirements.

Refer to TS 04935 for infrastructure lighting.

Refer to the BCA and TS 04941 for slip resistance requirements.

## 6.17 Cyclist access

Cyclists shall have a safe and direct means of access to bicycle parking facilities located within car parks. Where cyclists are required to cross busy roadways, they shall be guided to a safe crossing point having adequate sight distances, pavement and signage.

Entry and exit points shall:

- be separated from vehicle entries and exits
- allow direct access to the bicycle parking facility from the footpath, shared path or dedicated cycleway
- avoid conflict with pedestrians and commuters waiting to embark or disembark from public transport.

Cyclist access paths shall have adequate lighting, signage, slip resistance and sight distance.

# 7 Commuter car park general design requirements

## 7.1 General car parking configuration

CCPs should be configured to provide cost effective, flexible, easy entry and exit and congestion free design outcomes for both pedestrian and vehicle movements.

Car parks shall be designed to mitigate acts of self-harm, unlawful climbing and unlawful access to roof top areas. The TAO or service provider shall demonstrate to TfNSW that adequate risk analysis and measures have been considered and incorporated into the proposed design to mitigate such risks to a level acceptable to TfNSW.

Aboveground multi-level car parks should have an open deck configuration with high visual connectivity to the outside environment.

Refer to the BCA for requirements related to the percentage of open area needed to naturally ventilate open-deck car parks.

Travel distance measurements for emergency egress shall be based on the path of travel based on the assumption that all parking spaces are occupied.

Car parks shall be designed in accordance with AS/NZS 2890.1.

The design life for car parks shall be a maximum of 25 years for modular car parks and a minimum of 50 years for all other car parks.

Refer to Appendix C for considerations of car park design strategies and Appendix C for examples of car park strategies.

## 7.2 Parking bays

The size of car parking bays shall be based on user class 2 or higher as defined in AS/NZS 2890.1:2004, unless agreed otherwise with the asset steward – delivery.

A percentage of car parking bays may include small car spaces. The percentage of small car spaces with dimensions as defined in AS/NZS 2890.1, shall not exceed 10% of total car spaces for car parks of up to 250 spaces, and not exceed 15% for car parks of 500 spaces or greater unless agreed otherwise by the asset steward – delivery. Refer to *Commuter Car Park Program – Technical Specification (for D&C Contracts)* for parking space and user type requirements

## 7.3 On-street parking bays

The size of on street car parking bays should be based on the dimensions of the low classification in table 3.3 of AS 2890.5:2020. The medium and high classifications in table 3.3 of AS 2890.5:2020 may also be used where there is sufficient space.

## 7.4 Accessible car parking bays

Notwithstanding any provision in the DSAPT, BCA or AS/NZS 2890.1 accessible car park bays shall be provided at not less than 2% (rounded up to the nearest whole number) of the total number of parking spaces provided. In the first instance, accessible car park bays shall be allocated to each car park within a precinct. If this is not possible due to physical site constraints, the number of accessible car parking bays may be considered as a percentage of the overall precinct parking allocation.

Accessible car park bays shall be located close to the main pedestrian entry or car park lifts SFAIRP.

Off-street accessible car park bays shall comply with AS 1428.2 and AS/NZS 2890.6.

On-street accessible car park bays shall comply with clause 4.5 of AS 2890.5:2020.

## 7.5 Dedicated TfNSW employee parking

Dedicated TfNSW employee car parking shall be determined by the site-specific SRS.

## 7.6 Motorcycle parking bays

Requirements for motorcycle parking bays shall comply with site specific SRS.

Where a site-specific SRS is unavailable, a minimum of 1 dedicated motorcycle space per 50 car parking spaces shall be provided.

Motorcycle parking bays should be grouped together in an area dedicated for motorcycles.

Motorcycle parking bays should be situated where there is insufficient space for a car park bay.

Motorcycle parking spaces shall comply with AS 2890.1.

## 7.7 Bicycle parking

Dedicated bicycle parking facilities shall be provided at each car park in accordance with TS 04951. Bicycle parking should be located within the car park structure.

Bicycle parking facilities shall comply with TS 04943 and AS 2890.3.

## 7.8 Accessible paths

An access path provides unhindered passage to all customer areas.

Where practicable, continuous access paths shall be provided between the accessible car park bays and other modes of public transport which the car parks are intended to serve (regardless of whether it is within a site, or between multiple sites).

Refer to the SRS for specific requirements where there is no existing accessible path connecting a new CCP to a transport mode. The DSAPT contains requirements related to accessible paths.

Where it is impracticable to provide continuous access paths between sites, TAOs or service providers shall analyse the need and implement strategies to benefit people with a disability SFAIRP.

Access paths shall be provided in accordance with clause 7 of AS 1428.2:1992.

## 7.9 Floors

External pavements and floors subject to rainfall shall comply with the following minimum falls to provide adequate drainage discharge.

- minimum 1 in 100 fall for concrete surfaces
- minimum 1 in 50 fall for asphalt surfaces.

Design falls shall consider construction tolerances.

Car park open roof floors shall have falls to prevent water ponding and allow for surface water flows away from enclosed rooms such as lift shafts, stair wells, services and equipment rooms.

Where practicable, threshold ramps may be used at entry to lifts, stairs and stair shafts.

Floor surfaces shall be designed to prevent slips, trips and falls.

## 7.10 Gradients within parking spaces

Maximum gradients for parking spaces shall comply with AS/NZS 2890.1.

> Note: While AS/NZS 2890.1 requires a minimum gradient of 1 in 200 for drainage of covered areas, level floor surfaces may be permitted in covered parking areas where minimal water is expected.

## 7.11 Height requirements

Parking aisles and car spaces shall provide a minimum clear height between the FFL and soffit, ceiling or any other obstructions such as lighting, services or signage in accordance with AS/NZS 2890.1.

Additional height requirements for accessible parking bays and their path of travel apply.

Where supported by the business case, appropriate sections of a ground floor car park shall provide sufficient clear height to facilitate the incorporation of potential commercial tenancies. Where such provision has been made, the clear height of potential commercial tenancies should be no less than 2.7 m.

Floor to ceiling height for canopy installations shall be not less than 2.4 m at the lowest point.

## 7.12 Humps

Humps shall comply with AS/NZS 2890.1.

## 7.13 Sight distances

Sight distances shall comply with AS/NZS 2890.1.

## 7.14 Parking and circulation aisles

Parking and circulation aisles shall comply with AS/NZS 2890.1. Additionally, car park aisles should be no less than 6.0 m wide where it is spatially practicable.

## 7.15 Vehicle queuing areas

Vehicle queuing requirements shall comply with AS/NZS 2890.1.

## 7.16 Vehicle ramps

Vehicle ramps shall comply with AS/NZS 2890.1.

## 7.17 Blind aisles

Car parks shall not include blind aisles unless approved by the asset steward – delivery.

## 7.18 Mechanical parking

Car parks shall not include mechanical parking devices such as car stackers unless approved by the asset steward – operate or maintain, and asset steward – delivery.

## 7.19 Line marking

Line marking for internal car spaces shall be water-based acrylic to comply with AS/NZS 2890.1.

Line marking on external and adjacent roads shall comply with local planning authority standards.

Line marking for accessible car parking spaces shall be water-based paint with reflective beads. Paint colour shall comply with AS/NZS 2890.6.

Pavement line marking and raised pavement line marking shall comply with AS/NZS 2890.1.

## 7.20 Facades

The design of car park facades shall consider the following:

- car park building ventilation strategies
- car park building type and configuration
- structural design strategies
- urban design considerations and contextual settings
- material selection, thickness and weight
- wind loading
- fire rating
- water proofing
- acoustic performance
- light spillage from vehicular headlights and internal lighting
- operation, maintenance and durability.

Refer to *Facade Design Guideline – Commuter Car Parks Program* and *multi-level and at-grade Commuter Car Parks urban design guidelines* for additional guide.

Refer to Appendix B for examples of facade design strategies.

## 7.21 Vehicle guardrails, spandrels and upstands

Vehicle guardrail safety barriers, spandrels and upstands shall be provided to prevent vehicles from running over the edge of a raised platform or deck of a multi-storey car park including the perimeter of all car park storeys.

Vehicle guardrail safety barriers shall be hot dip galvanised or paint finish.

Vehicle guardrail safety barriers shall comply with AS/NZS 2890.1 and where applicable TS 03291.2.

## 7.22 Wheel stops and protective devices

Wheel stops shall be provided at parking spaces located at the perimeter of car park buildings to prevent vehicles from hitting or encroaching upon vehicle guardrails, spandrels, upstands or footpaths. Wheel stops shall be provided where a drop in level from the edge of the car spaces is greater than 150 mm, or where parking bays back onto internal walls such as lift shafts, stair wells and services rooms.

Configuration of wheel stops shall comply with AS/NZS 2890.1.

Wheel stops shall be constructed of concrete.

Other protective devices such as bollards shall be provided in accordance with AS/NZS 2890.1.

## 7.23 Balustrades and handrails

Balustrades and handrails shall comply with TS 04939.

## 7.24 Vehicle security barriers

Vehicle security barriers shall comply with TS 04992.

The instillation requirements of vehicle security barriers shall be determined by a detailed security risk assessment.

## 7.25 Tactile ground surface indicators

Tactile ground surface indicators (TGSIs) shall comply with AS/NZS 1428.4.1.

# 7.26 Vertical circulation

## 7.26.1 Open stairs

Stairs should be located as close as possible to transport modes. Stairs should be located on the outside edge of the car park structure to increase opportunities for passive surveillance.

Stairs shall comply with the following:

- FLS strategy of the respective project, or in the absence of a project FLS strategy, the DTS provisions of the BCA
- TS 00008.1
- TS 04941
- the BCA in relation to stair width.

Stairs shall be of sufficient dimensions to manoeuvre a stretcher measuring 2000 mm by 600 mm.

Artworks or advertising shall not be placed on stair risers.

Where the CCP is physically linked to another mode of public transport such as by bridges or underpasses, the dimensions of the risers and goings of the stairs shall comply with clause 13.2 of AS 1428.2:1992. Where the CCP is not physically linked to another mode of public transport the dimensions of the risers and goings should be in accordance with clause 13.2 of AS 1428.2:1992 where practicable.

## 7.26.2 Fire isolated stairs

Fire isolated stairs shall comply with the following:

- FLS strategy of the respective project, or in the absence of a project FLS strategy, the DTS provisions of BCA
- TS 00008.1
- TS 04941
- The BCA in relation to stair width.

Fire doors shall be provided with damage resistant kick plates. Fire doors shall be certified in accordance with AS 1905.1. Fire doors exposed to weather elements shall be provided with weather deflector strips above the top of the door frames to protect the door and direct water away from the top of the door.

### 7.26.3 Pedestrain ramps

Ramps shall be of sufficient dimensions to manoeuvre a stretcher measuring 2000 mm by 600 mm.

Pedestrian ramps shall comply with AS 1428.2

External ramps should be weather protected.

Unit pavers with uneven surfaces or bevelled edges shall not be used on ramps surfaces.

### 7.26.4 Lifts

Lifts shall be provided in car parks with buildings heights equivalent to two or more car park floor levels.

Lifts shall be installed in accordance with TS 04955.1 and TS 04955.3. In addition to the requirements detailed in TS 04955.3, lift installations shall meet the following requirements:

- lift entries shall be located as close as possible to transport modes
- lifts shall be located on the outside edge of the car park structure to increase opportunities for passive surveillance
- lifts shall be located in positions that are not impacted by fire pump damage and flooding.

# 8 Materials and finishes

Materials and finishes shall be consistent, co-ordinated and fit for purpose with a focus on meeting the needs of customers and the asset steward – operate or maintain within station environments.

Materials and finishes for car parks and the external areas to the carpark that interface with adjoining land shall be selected to take into account the following:

- enhancement of spatial quality, visual surveillance and permeability
- coordination with surrounding urban environments
- coordination with any heritage item affected by the car park
- coordination with public artwork, signage and advertising
- minimisation of discoloration, leaching, corrosion, mould growth and deterioration due to wildlife, weathering and UV light
- minimisation of hazards to customers such as slip, trip and falls, rips and cuts, heat and glare
- easily cleanable and maintainable without disruption to operations or material performance

- capability for spot repairs in the case of minor damage and easy replacement without the removal of adjacent materials and components
- discouragement of vandalism through appropriate materials and coatings with high level of vandal resistance
- consideration of options that have a lower embodied carbon impact
- minimisation of horizontal surfaces and ledges that collect dust, dirt and soiling
- the use of suitable materials and coatings to discourage malicious damage in accordance with TS 04992.

Materials shall be selected based on balance of performance, management of risk and whole-of-life cost.

Refer to Table 1 for applicable Australian standards of materials or components.

**Table 1 – Materials used in structural work**

| Item | Material or component | Standard |
|---|---|---|
| A | Aluminium | AS/NZS 1664.1 and TS 01751.2 |
| B | Steel or similar | AS/NZS 4600, AS 3990 and AS 4100, TS 01744.2, TS 01746.2 |
| C | Concrete | AS 3600, AS 1379, and TS 03264.1 |
| D | Welding | AS/NZS 1554.1, AS/NZS 1554.6 and AS/NZS 1665 |
| E | Bolts | AS 1111.1, AS/NZS 1252 (series) and TS 00033 |
| F | Glass | AS/NZS 2208 |

Structural steel components shall comply with AS/NZS 5131.

Galvanised steel shall comply with AS/NZS 4680.

The BCA contains additional requirements to those stated in Table 1.

Earthing and bonding measures shall be incorporated to mitigate touch potential where required.

The TAO or service provider shall demonstrate to TfNSW that nominated materials and finishes have taken into consideration the following whole-of-life factors:

- use of materials from renewable or replaceable sources
- use of materials that have low embodied carbon
- use of recycled materials or materials with recycled content
- use of materials that are locally and readily available
- use of materials that have a low lifecycle environmental impact

- use of cost efficient materials and finishes
- use of materials that are easy to transport to site
- use of materials that are easy and safe to demolish and recycle.

Cladding panels should be constructed to ensure minimal gaps between adjacent panels, floor finishes and structural members.

Where a car park is constructed or upgraded adjacent to 1500 V dc assets, gaps between materials and structures for earthing and bonding, shall comply with *Guideline on Earthing and Bonding at Railway Stations*.

## 8.1 Prohibited materials and systems

Refer to TS 04003 for a list of prohibited materials.

Tiles shall not be used on externally facades unless agreed otherwise by the asset steward – delivery.

Aluminium composite cladding and fibreboard cladding shall not be used unless agreed otherwise by the asset steward – delivery.

For requirements on product conformity with Australian building laws and standards refer *A Guide to Australian Building Product Conformity.*

## 8.2 Pedestrian pavements

Pedestrian pavement materials and finishes shall be robust, slip resistant, durable, easy to clean, sympathetic to the surrounding environment and vandal resistant.

Pavement materials shall be positively drained surface with no pooling or ponding.

Pavement finishes shall be comprised of either of the following:

- flexible type, including asphaltic or bituminous toppings
- rigid type, including concrete, cementitious slabs or natural stone paving or tiling units.

Suspended paving systems shall not be used unless endorsed by the asset steward – delivery.

Selection of pavement materials may include consideration of permeable alternatives. Alternative materials may be used where endorsed by the asset steward – delivery.

Pavement materials shall be positively drained surfaces with no pooling or ponding and a minimum 1 in 50 fall externally unless approved otherwise by the asset steward – delivery.

Pavement materials shall comply with TS 04941.

Refer to *Guide to Pavement Technology Part 2 – Pavement Structural Design* for additional guide.

## 8.3 Concrete finishes

Formed concrete finishes shall be class 3 or better as specified in AS 3610.

Colour control of concrete shall comply with AS 1012.13 and AS 3610.

## 8.4 Ground surfaces

Trafficable surfaces shall be finished so vehicular traffic does not cause tyre squeal.

Unformed concrete finishes on trafficable surfaces shall be steel trowel, broom or chevron finishes.

Performance of floor finishes shall comply with TS 04941.

## 8.5 Waterproofing

### 8.5.1 Roof deck surfaces

Roof deck surface waterproofing systems shall meet the following criteria:

- be positively drained watertight roof deck
- be highly resistant to vehicle traffic movement
- be UV resistant and impervious to water and chemicals
- highly resistant to punctures
- provide high level of crack bridging properties
- be low maintenance and easy to clean
- contain low volatile organic compounds and be solvent free
- have a durability life of a minimum of 15 years.

Chemical waterproofing additives to the concrete mix may be used in additional to external positive water proofing membrane. Refer to project specific SRS for waterproofing materials.

### 8.5.2 Intermediate deck surfaces

Intermediate structural floor surfaces shall include waterproofing designs to prevent water leakage to floors below, including at construction joints and slab edges. Refer to project specific SRS for waterproofing materials.

## 8.6 Facades

Facade materials shall be comprised of either one, or a combination of, the following:

- concrete
- metal cladding
- glass
- fibre cement panels
- glass reinforced concrete
- copper
- masonry (face brick or face blockwork).

Other materials may be used where endorsed by the asset steward – delivery.

Durable lightweight facade systems should be used.

Where practicable facades should have a glare index level not greater than 20 daylight glare index for locations along the main path of travel for pedestrian and motorist.

## 8.7 Pedestrian guardrails and handrails

Materials for pedestrian guardrails and handrails shall be comprised of either of the following:

- aluminium sections with powder coated or anodised finish
- steel with paint finish or hot dip galvanised
- 316 grade stainless steel or where welded joints are present, 316L grade stainless steel.

## 8.8 Internal walls and cladding

Internal walls to stairs, service rooms and storerooms shall be concrete, blockwork, smooth face brick with anti-graffiti treatment applied 3 m above any foot hold level on public facing sides of walls.

Dry wall partitions shall be steel stud with durable cladding material and paint finish.

Blockwork walls facing parking areas shall be core filled to at least 600 mm from FFL.

## 8.9 Enclosed stairs

Walls to enclosed stairs shall be comprised of either fair faced blockwork or concrete. Surfaces shall be painted or be applied with clear sealer. Walls shall extend to the floor level immediately below to eliminate the potential for rough sleeping.

Anti-graffiti treatments shall be applied to all internal wall surfaces to a height of 2.5 m above floor level.

## 8.10 Glazing in car parks

Glazing shall comply with TS 04992 and AS 1288 where in car parks.

## 8.11 Paint systems

Paint systems shall comply with AS/NZS 2311 and TfNSW *Commuter Car Park Program – Technical Specification (for D&C Contracts)*.

## 8.12 Doors and door hardware

Doors and door hardware shall be based on industry accepted standards for their use and specific built environment in which they are intended to be installed.

Doors and door hardware (including door keys) shall comply with TfNSW *Commuter Car Park Program – Technical Specification (for D&C Contracts)*.

Doors nominated to be locked shall have anti tamper, anti-jemmy plates installed.

Doors and hardware should be subject to a security risk assessment depending on location and therefore may need to be compliant with TS 04992. Assessment of whether a risk assessment is necessary shall be conducted at design stage by the TAO.

# 9 Structural

## 9.1 General requirements

Car park structural systems shall maximise structural efficiencies and enhance visibility and vehicle manoeuvrability.

Provisions shall be made for loadings in accordance with, but not limited to, AS/NZS 1170.2, AS/NZS 1170.3 and AS 1170.4 in locations where wind, snow or earthquakes may have an impact.

Design loadings shall comply with AS/NZS 1170.0 and AS/NZS 1170.1.

Floor design loads shall take into account the dead load of the designed structure plus one of the following minimum imposed loadings depending on which produces the least adverse effect:

- car park floors shall be capable of supporting vehicles:
    - where vehicle entry is restricted by 2.2 m design headroom, adopt activity/occupancy type F light vehicle traffic areas in table 3.1 in AS/NZS 1170.1:2002

    - where vehicle entry is not restricted by 2.2 m design headroom, adopt activity/occupancy type G medium vehicle traffic areas in AS/NZS 1170.1:2002

- superimposed live loading of not less than 2.5 kPa uniformly distributed (vertical load)
- superimposed live loading greater than 2.5 kPa uniformly distributed (vertical load) shall comply with *Commuter Car Park Program – Technical Specification (for D&C Contracts)*
- concentrated loading applied through a 100 mm x 100 mm pad shall comply with AS/NZS 1170.1

Car parks shall be designed to resist vehicle impact loads in accordance with AS 1170.1.

Parameters such as site hazard factors to be assessed and site sub soil classification shall be adopted.

Aggressivity of foundation soils shall be assessed in accordance with AS 2159.

The placement of engineered fill shall be carried out in accordance with AS 3798. The fill shall be compacted in accordance with AS 1289 5.1.1, AS 1289.5.4.1 and AS 1289.5.7.1.

Site classification should be carried out in accordance with AS 2870 based on natural soil profile and site geology.

Soil nailing shall be designed and constructed in accordance with TS 02164.2 and TS 02168.2.

Ground anchors shall be designed in accordance with AS 5100.3 and constructed in accordance with TS 02163.

Deep excavation requirements adjacent to TfNSW asset shall comply with TS 02715.

Foundation loadings shall comply with AS 3600.

Geotechnical site investigations shall be carried out in accordance with AS 1726.Piling and settlement

Pile design and construction shall be in accordance with AS 2159. Pile layout including pile size, pile capacity, construction requirements and considerations shall be shown on the design drawings that form part of the design package.

Differential settlement and deflection shall be considered in accordance with the requirements of AS 2159.

The works shall be designed so that no adverse movement of adjacent properties, structures, inground services occur during or after construction relating to any works or temporary works.

## 9.2 Designing for movement

Car park structures are susceptible to movement during and after construction. Designs with appropriate joints shall be provided to accommodate such movement.

Non-structural cracking can lead to premature deterioration of structural elements. Structural design shall control such cracking. Where required movement joints shall be installed in hydraulic services including stormwater pits and pipes affected by building movement and settlement.

The effects of temperature induced movement shall be specifically considered and addressed.

Careful consideration shall be given to the location and interaction of lateral stability systems to avoid the large forces being generated by restrained thermal movement.

Allowance shall be made for all joints in the car park structures to accommodate shrinkage, creep, thermal effects, dead and live loads, and settlement of reinforced or prestressed concrete structures. Expansion joints should be flush to substrate.

## 9.3 Structural deflection

Designs shall include an estimation of the long term service deflection to confirm that the finished floor level grades are sufficient to prevent the ponding of water on surfaces or in the drainage channels.

The serviceability requirements of the building design shall include:

- deflection control under dead and imposed loads
- structure sway and inter storey drift limits under wind load limited to building height/500
- structural inter-storey drift at the ultimate limit state under seismic load not exceeding the limits in AS 1170.4.

Suspended floor deflections shall be limited to ensure the floor space is suitable for its proposed usage. Deflections shall also be limited by the requirements of the building elements it supports such as;

- facade systems
- sensitive internal partitions
- other non-structural items.

The suspended floor deflections shall be limited according to, and subject to, vehicular and pedestrian traffic as follows:

- total deflection – span/250 or 25 mm
- total deflection for cantilevers of – span/125
- incremental deflection – span/500
- incremental deflection for cantilevers of – span/250

The limits for calculated vertical deflections of beams and slabs shall be in accordance with AS 3600.

## 9.4 Structural shrinkage and crack control

Shrinkage in concrete shall be accounted for in the design.

Internal suspended floor structures, columns, walls and beams shall be designed for a moderate degree of crack control to in accordance with AS 3600.

External suspended floor structures, columns, walls and beams shall be designed for a high degree of crack control in accordance with AS 3600.

Additional localised detailed reinforcement for crack control mitigation at slabs, beams and walls junctions shall be provided where required.

## 9.5 Geotechnical requirements

The following minimum geotechnical investigations and design requirements shall be considered in the car park foundations, slopes and retaining wall design:

- site description and geology
- soil profiles
- subsurface conditions
- ground water levels including short term and long-term monitoring results
- erosion potential and soil aggressivity assessment to concrete and steel
- excavation conditions and construction constraints
- detailed geotechnical design parameters for foundation (shallow and pile foundations), slopes and retaining wall
- detailed geotechnical design requirements for slopes, foundations and retaining walls including factor of safety (short term and long term), bearing capacity, settlements, lateral loadings and so on
- site drainage requirements
- assessment of poor ground and ground improvement requirements
- field and laboratory test results for pavement design and construction
- instrumentation monitoring and action plans for foundation, slopes and retaining walls.

## 9.6 Accidental impact load

The design of structural members shall incorporate controls to mitigate accidental loading due to low-speed vehicle impact. Accidental loading shall be no less than 30kN in accordance with clause 3.8 of AS/NZS 1170.1:2002.

Refer to *Commuter Car Park Program – Technical Specification (for D&C Contracts)* and AS/NZS 1170.1 for additional requirements relating to accidental impact.

## 9.7 Structural steel

Structural steelwork shall be in accordance with AS 4100 and any relevant project SRS requirements. All structural steelwork shall have hot dip galvanised surface protection treatment in accordance with AS/NZS 4680.

Steel hollow sections shall be hot dip galvanised in accordance with AS/NZS 4680.Steel checker plate shall comply with AS 1657.

Design and fabrication of steelwork shall comply with PBD-2016-03AS/NZS 5131 and TfNSW specifications TS 01744.1, TS 01746.1 and TS 00033.

Specific attention shall be given to the requirement for pre-qualification of steel fabricators within B201.

Safety steel grating and expanded steel shall comply with AS 1657.

The selection of metals and finishes shall not lead to dissimilar metal reactions or galvanic corrosion.

## 9.8 Structural steel fixing

Steel fixing plates, bolts and connections shall not be concealed allowing for visual inspection and maintenance accessibility. Steel base plates on concrete shall be founded on minimum 20 mm non-shrink grout or equivalent.

## 9.9 Concrete

All concrete works shall comply with AS 3600 and any relevant project SRS requirements.

## 9.10 Columns

Column positions shall comply with AS/NZS 2890.1.

Columns shall be designed to resist vehicle impact loading.

Steel columns shall comply with AS 4100.

Concrete columns shall comply with AS 3600.

Columns should be rectangular or elliptical in cross-section to minimise the impact on car spaces in the car park, unless otherwise agreed with asset steward – delivery.

All columns located on roof levels shall be extended by at least 1300 mm vertically to serve as impact bollards for lighting poles or roof canopies, and to allow for any possible carpark extensions. The design of these column extensions shall avoid the risk of being used as a

potential climbing aid to the upper roof or the roof boundary fence. The length of the column extension shall ensure that all reinforcement required for any possible carpark extension works can be fully developed and the reinforcement be properly protected for possible future extension.

## 9.11 Beams

Structural beams shall be comprised of steel or concrete. Steel structural beams shall comply with AS 4100.

Concrete structural beams shall comply with AS 3600.

## 9.12 Bracing elements

Structural bracing elements shall be comprised of steel or concrete.

Steel structural bracing shall comply with AS 4100.

Concrete structural bracing shall comply with AS 3600.

## 9.13 Floors

Floors may be comprised of in situ concrete, precast concrete, prefabricated steel cassettes or other innovative systems (such as cross laminated timber (CLT) slabs) that are endorsed by the asset steward – delivery.

## 9.14 Construction joints (control and expansion joints)

Construction joints shall be designed to be functional in all types of weather.

Where required construction joints shall be waterproof.

Construction joints shall have joint covers with adequate loading capacity for the functionality of car parks. Construction joint covers shall not be placed in such a way that causes a non-compliance with AS 1428.1 or the DSAPT. Construction joints located along access paths shall not hinder the continuity of the access paths.

The TAO or service provider shall specify an appropriate joint cover for the functionality of the car park. Joint covers shall be either high strength aluminium, stainless steel or rubber. Refer to project specific SRS for material type.

## 9.15 Retaining walls

Retaining walls shall comply with TS 01718.

All retaining walls, unless approved otherwise by the asset steward – delivery, shall have appropriate sub-soil drainage, waterproofing and be lined with a geofabric to protect against migration of fines through the wall.

## 9.16 Masonry walls

Masonry walls shall comply with AS 3700.

# 10 Road pavements

Road pavements for internal roadworks shall be reinforced concrete, or dense graded asphalt in accordance with TS 03283.1, (unless approved by the asset steward – delivery). Road pavements shall be designed and constructed in accordance with *Guide to Pavement Technology Part 2 – Pavement Structural Design*. The asset steward – delivery shall be consulted for additional project specific requirements.

The finished layer of asphalt wearing course shall be no greater than 14 mm stone size, unless agreed otherwise by the asset steward – delivery.

All concrete pavements shall be a minimum of 32 MPa unless otherwise agreed with the asset steward – delivery. Fibre-reinforced concrete may be considered for ground supported floors. If fibre-reinforced concrete is used, a durable cover layer over the concrete shall be laid to ensure that all fibres are fully encapsulated.

Where the car park vehicular access also forms part of a rail corridor vehicular access way, it shall be designed to comply with the requirements of TS 02391.

Sub base and base course material, placement, finishing and testing shall be in accordance with TS 03283.1 and *Guide to Pavement Technology Part 2 – Pavement Structural Design.*

Materials test certificates shall be provided for sub base and base course materials in accordance with TS 03283.1 and *Guide to Pavement Technology Part 2 – Pavement Structural Design* which includes flexible pavement requirements.

Flexible pavement base course granular material shall have a sprayed seal in accordance with *Guide to Pavement Technology Part 4K – Selection and Design of Sprayed Seals* concrete and bituminous materials shall comply with AS 2150.

The minimum design life of asphaltic concrete and bitumen shall be as follows:

- 10 years for wearing course,
- 20 years for road pavement (flexible) including base and subbase layers
- 40 years year for road pavement (rigid) including base and subbase layers.

Asphalt sealants may be considered to minimise urban heat island impacts and improve surface longevity.

# 11 Building services

Building services shall comply with Sections 11.1 to 11.4.

## 11.1 Electrical services and lighting

Electrical services shall comply with TS 04955.1.

Electrical installations in all car parks shall comply with AS/NZS 3000 and *Service and Installation Rules of New South Wales*. In addition, electrical installations at CCPs at TfNSW stations and interchanges shall comply with TS 03954.

Junction boxes for electrical service conduits shall be provided to facilitate drawing of electrical wiring.

Lighting at CCPs at TfNSW stations and interchanges shall comply with TS 04935.

Lighting for enclosed car parks shall comply with AS/NZS 1680.0.

Lighting for outdoor car parks shall comply with lighting subcategory PC1 in AS/NZS 1158.3.1:2020. Lighting of pedestrian crossings shall comply with lighting subcategory PCX in AS/NZS 1158.3.1:2020.

Lighting shall meet the requirements of AS 1428.1 and AS 1428.2.

Where possible light fittings shall be mounted for easy access and replacement. Light fittings shall not be mounted above parking spaces due to inability to access the fitting while vehicles are parked.

Light spill generated from car park lighting or by car headlights shall not adversely affect surrounding buildings or open spaces. The TAO or service provider shall demonstrate that light spill from car park is controlled as required by TS 04935.

## 11.2 Fire life safety services

Fire life safety services shall comply with TS 00008.1.

Physical barriers, for example, railings between split levels, shall not impede the efficacy of an emergency response (whether by access to the area, access to equipment, or use of the

equipment for example, hose spray). Fire services pumps shall be housed in secure dedicated rooms. All fire services block plans shall include information for location of relevant main distribution board isolation points and switches for any electric vehicle charging points or photovoltaic panels. Emergency services information package and tactical fire plans shall be prepared in accordance with fire brigade guidelines in *Fire safety guideline – Emergency services information package and tactical fire plans*.

### 11.2.1 Fire hydrants

Fire hydrants shall comply with AS 2419.1. Damage protection fixed bollards shall be installed where there is a risk of vehicles impacting hydrant systems within car parks. Fixed bollards shall comply with AS/NZS 2890.1. All hydrant outlets shall point towards the stair entry door when installed within the fire stairs at a height of 1000 mm finished floor level and at a 35 degree angle as noted in figure H.3(B) in AS 2419:2021.

### 11.2.2 Fire hose reels

Fire hose reels shall comply with AS 2441 and be located in weatherproof enclosures on roof levels where exposed to weather. These weatherproof enclosures shall be provided with an anti-climbing shroud.

### 11.2.3 Portable fire extinguishers

Portable fire extinguishers shall comply with AS 2444. Portable fire extinguishers shall be fitted within vandal proof enclosures.

### 11.2.4 Fire sprinklers

Where required by legislation sprinklers shall comply with AS 2118.1.

### 11.2.5 Smoke detection and occupant warning systems

Smoke detection and occupant warning systems shall be installed to comply with AS 1670.1 and any specific fire engineering report requirements. *The Environmental Planning and Assessment (Development Certification and Fire Safety) Regulation 2021* contains requirements related to fire engineering reports.

All panels associated with detection and occupant warning systems shall signal back to the fire brigade.

Smoke detection systems shall be installed in the following:

- tops of lift shafts that signal back to the main fire panel
- main switch rooms

- communication rooms
- battery rooms.

In addition, fire services pump rooms shall be provided with thermal detectors.

### 11.2.6 Smoke exhaust systems

Where required smoke exhaust systems shall comply with AS 1668.1 and any site specific fire engineered reports or methodologies.

## 11.3 Hydraulic services and equipment

Hydraulic services and equipment shall comply with AS/NZS 3500 (all parts), local water authorities (for example, Sydney Water) and local council requirements.

Installations shall meet the hydraulic requirements in TS 04955.1.

### 11.3.1 Onsite stormwater detention

The TAO or service provider shall identify requirements and constraints for incorporating OSD and advise TfNSW on approaches to incorporate OSD into the design.

OSD shall comply with *Onsite Stormwater Detention Policy* and planning approval.

Surface detention may be used, provided a clear path is provided to every car space and the water depth is no greater than 15 mm within the first 3 m of the car space as measured from the road or aisle, otherwise a tank or underground detention shall be required. Any ponding of water shall be drained within one hour. Access grates for OSD tanks shall be located above ground and in area clear from parking spaces, pedestrian and vehicular traffic SFAIRP.

All tank structures that are internal and integral with the carpark structure shall be waterproof. The use of approved concrete admixtures may be used to improve the waterproofing performance of tanks. Safe access for inspection and maintenance, including any confined space ventilation provisions, shall be provided.

All OSD tanks in flexible pavement areas shall have a pavement transition beam installed where the pavement transitions from flexible to rigid.

The TAO or service provider shall prepare a technical maintenance plan for future maintenance in accordance with TS 01506.1.

### 11.3.2 Stormwater drainage

The design of the stormwater drainage systems shall prevent overland flow of stormwater from entering the lower levels of the car park .Stormwater drainage systems shall be designed and constructed in accordance with:

- AS/NZS 3500 (all parts)
- AS 2150
- TS 03255.1
- TS 03256.1
- TS 03257.1
- TS 03258.1
- TS 03259.1
- TS 03260.1
- TS 03261.1
- TS 03262.1
- TS 02159.1
- local council regulations requiring on site detention.

*Australian Rainfall & Runoff – A Guide to Flood Estimation* shall be used as the basis of the drainage design and shall identify flood mitigation measure where appropriate, including all flood mitigation measure included in the stormwater and flood modelling.

The design shall accommodate:

- a 5% AEP (about 20-year ARI) design storm event for piped systems
- the 1% AEP (about 100-year ARI) design storm event to be conveyed in formalised overland flow paths.

Unless approved otherwise by the asset steward – delivery, the stormwater drainage system shall:

- utilise water sensitive urban design techniques and infiltration wherever possible
- provide ease of maintenance
- include water conservation principles
- limit the effect on the groundwater regime such that there is minimal adverse effect on the natural or built environment

- minimise the requirement for paved surfaces and piped drainage in accordance with sustainability principles
- provide a drainage system for all retaining structures and buildings
- retain and reuse the existing drainage system where possible
- not discharge into the rail corridor or track drainage system

The stormwater discharge points shall connect to suitable and approved stormwater discharge locations, ensuring the speed of discharge is appropriate and include energy dissipation structures designed in accordance with following guides for the particular scenarios;

- *Guide to Road Design Part 1 – Objectives of Road Design*
- *Guide to Road Design Part 3 – Geometric Design*
- *Guide to Road Design Part 4 – Intersections and Crossings: General*
- *Guide to Road Design Part 4A – Unsignalised and Signalised Intersections*
- *Guide to Road Design Part 4B – Roundabouts*
- *Guide to Road Design Part 4C – Interchanges*
- *Guide to Road Design Part 5 – Drainage – General and Hydrology Considerations*
- *Guide to Road Design Part 5A – Drainage: Road Surface, Networks, Basins and Subsurface*
- *Guide to Road Design Part 5B – Drainage – Open Channels, Culverts and Floodway Crossings*
- *Guide to Road Design Part 6 – Roadside Design, Safety and Barriers*
- *Guide to Road Design Part 6A – Paths for Walking and Cycling*
- *Guide to Road Design Part 6B – Roadside Environment*
- *Guide to Road Design Part 7 – New and Emerging Treatments*

In scenarios where the guides in the preceding bullet list are not applicable, the TAO may use alternative methods that shall be approved by the asset steward – delivery.

Where rip rap is used it shall be secured where possible in a rock mattress to minimise rocks being used as projectiles. The stormwater system shall:

- provide outlets and amplification when necessary to provide a drainage system as required to suit the new works and Local Council drainage network
- be designed with appropriate grades so that there is no ponding in finished road and paved areas

- be constructed to effectively drain pavement and other areas
- achieve minimum falls on external pavements footpaths (including asphalt or concrete or equivalent) of 1 in 50 (with 1 in 100 acceptable at landings) unless approved by the asset steward – delivery

Where it is reasonable to expect pedestrian traffic, grates shall be provided with heel guards in accordance with clause 9 of AS1428.2:1992.

Step irons shall be installed in all pits in accordance with TS 03254.1.

The stormwater drainage system components shall be:

- uPVC (unplasticized polyvinyl chloride), concrete or fibre reinforced underground piped drains to suit loads or any other equivalent materials as approved by the asset steward – delivery
- a minimum size for underground stormwater pipes of 225 mm diameter
- formed concrete or precast pits
- swale drains, dish drains, open channels, naturalised or concrete catch drains
- grates and frames in roadways in accordance with AS 3996
- grates and frames not in roadways equivalent to class C in accordance with AS 3996
- all lockable grates are to be hinged and lockable

The design of stormwater drainage systems shall consider impacts from rainfall and storm event increase due to climate change.

Written approval from the local authority for connection or increased flow of the proposed drainage system to the local authority's system shall be obtained by the TAO.

### 11.3.3 Subsoil drainage

Subsoil drainage shall be provided behind all retaining walls and under pavements and discharge to the surrounding stormwater drainage infrastructure.

The subsurface or subsoil drainage infrastructure for vehicle trafficable pavements shall be designed and constructed to comply with the typical cross sections and standard details contained in:

- TS 02716
- TS 02717
- TS 02718
- TS 02719
- TS 02720

- TS 02721
- TS 02738

The typical cross sections and standard details contained in the drawings in the preceding list are minimum requirements.

All subsoil or subsurface drainage lines shall be shown on the relevant civil stormwater drawings and include any subsoil drainage lines required to be coordinated with other consultant drawings.

### 11.3.4 Downpipes and gutters

Downpipes and gutters shall be robust, durable, easy to clean and easy to access for maintenance and replacement.

Downpipes shall not be embedded in structural columns, unless otherwise agreed in writing by the asset steward – delivery.

Rainwater heads, gutter, downpipes and pits shall be sized in accordance with table 3.3.4 of AS 3500.3–1990.

Rainwater heads, gutters and downpipes shall be constructed in 316L stainless steel.

Stormwater pits and grates located within the publicly accessible areas of car parks and along main paths of travel shall have heel proof grates.

### 11.3.5 Water supply for services

Water supply for services equipment shall comply with AS/NZS 3500 (all parts).

### 11.3.6 Onsite water recycling

Where onsite water recycling is proposed the system shall be appropriately located and protected from vandal access. Recycled water storage shall comply with the *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1)*.

### 11.3.7 Water quality treatment

Water quality treatment facilities, including oil separation shall be designed, constructed and operated in accordance with local council and TfNSW requirements and guidelines, including *Water sensitive urban design guideline*.

Confirmation of a reduction in the pollutants discharging from the site shall be undertaken utilising a MUSIC model or other method approved by TfNSW. The MUSIC model shall take into account all required bypass areas.

Where a GPT and or an oil separator is required, all water from the works shall pass through the device and be treated to ensure that water quality standards are met. The GPT shall be

located SFAIRP in area clear from parking spaces, pedestrian and vehicular traffic. A hardstand area shall be provided near the GPT for maintenance.

## 11.4 Mechanical services and equipment

Mechanical services and equipment in all car parks shall comply with AS 1668.1, AS 1668.2, AS 1668.4 and TS 04955.1.

## 11.5 Pedestrian footbridges and underpasses

Pedestrian footbridges or underpasses may be used to provide pedestrian connectivity between transport modes and car parks.

Physical security requirements for pedestrian footbridges and underpasses shall comply with TS 04992.

Pedestrian footbridges shall comply with TS 01715.

The following requirements should apply to pedestrian footbridges:

- footbridges should be located to contribute to the wider walking network
- footbridges should enable unimpeded public access
- footbridge physical requirements should be determined through pedestrian patronage modelling and emergency egress requirements
- pedestrian footbridges should have a minimum clear width of 3 m.

Pedestrian underpasses shall comply with TS 01713 requirements.

The following requirements shall apply to pedestrian underpasses :

- be located to contribute to the wider walking network
- have a minimum clear width of 3 m
- have a clear height of not less than 2.7 m between the FFL floor level and soffit or ceiling
- facilitate passive surveillance by means of direct line of sight between the entries of the underpass.

Pedestrian underpasses shall comply with TS 01713.

## 11.6 Fencing and gates

Fencing and gates shall comply with TS 02388 and TS 04992.

## 11.7 Signage and wayfinding

Requirements for mandatory signage are prescribed under the BCA, DSAPT and the *Disability (Access to Premises — Buildings) Standards 2010*.

Additionally, CCPs should be in accordance with *Wayfinding Planning Guide – Car parks*.

Design and placement of Safety signage shall comply with AS 1319.

Design and placement of regulatory and warning signage shall comply with AS/NZS 2890.1

Where required, parking control signage shall comply with AS 1742.11.

Vehicle height limitation signage shall be located at vehicle entry points. Unless approved by asset steward – operate or maintain vehicle height limitation signage shall specify a maximum vehicle height of 2.1 m.

Refer to TS 04992 for security requirements of design and placement of signage.

## 11.8 Operational technology

### 11.8.1 Electric vehicles and charging points

Where requirements for electrical vehicles are not specified in site specific SRS, charging points for electrical vehicles shall be provided at a rate of no less than 5% of total number of car park spaces provided within the car park. Unless agreed by the asset steward – delivery that future surface mounting of conduits is acceptable for the following:

- car parks with an asset life of 50 years or greater an additional 10% of the total number of car spaces shall be provided with cable conduits to allow for future installation of EV charging equipment and cabling
- for car parks with an asset life of under 50 years, additional future connection should be based on a site specific business case.

The TAO shall ensure that the switch room is functionally and spatially capable of accommodating additional distribution boards required for the potential expansion of EV charging services.

Charging points should be located near low voltage distribution boards from which they are powered.

The TAO or service provider shall determine specific parking and charging locations for electrical vehicles based on the following requirements:

- Charging points shall not be located within 12 m of fire-isolated exits or lifts.
- Maximum number of charging points in any one cluster shall be based on a risk assessment. Where a risk assessment has not been performed, the number of charging points in one cluster shall not be greater than 3. Each cluster of charging points shall be

separated by not less than 12 m and to be validated with project specific Fire Engineering Report.

Additional service provisions for future electrical vehicle charging shall be included at a rate of 15% of the total number of parking spaces. These additional provisions shall comprise spare power capacity and spare space capacity. Additional provisions shall include for an increase in switch room size and the compliance to AS/NZS 3000 requirements for two escape doors for rooms with switchboards larger than 800A or 3 m in length.

The car park design shall identify the location of future EV charging points and the cable tray routes for electrical cabling between relevant distribution boards and the designated car park spaces. Unless included in the project SRS, EV provisions shall not apply to extensions and additions to existing car parks.

### 11.8.2 Automated payment system

Opal card readers shall comply with TfNSW site specific SRS requirements and operational requirements.

Opal card readers and other access equipment required by TfNSW shall be installed in positions confirmed by TfNSW.

### 11.8.3 Barrier gates

Barrier gates (also known as boom gates) shall comply with the TfNSW site specific SRS.

Barrier gates and their applied coatings shall be robust, low maintenance, vandal and graffiti resistant in accordance with TS 04992.

Barrier gates shall be integrated with park and ride access system for access to parking.

### 11.8.4 Licence plate recognition system

The requirements for licence plate recognition systems shall comply with TfNSW site specific SRS.

### 11.8.5 Real time information

Car parks should provide real time parking availability guidance on car parking availability status.

### 11.8.6 Closed circuit television

CCTV shall comply with TfNSW site specific SRS and TS 04989.

### 11.8.7 Photovoltaic panels

The TAO or service provider shall identify opportunities early in the design process, to incorporate photovoltaic panels and energy storage units for new car parks. The TAO or service provider shall provide TfNSW a risk analysis and cost analysis, based on whole-of-life asset cycle, that demonstrates the impact of installing photovoltaic panels and energy storage units. Electrical switchboard areas should allow for positioning and spacing of potential future solar PV inverters or clearance areas for battery energy storage systems.

Structures supporting PV panels shall not facilitate unlawful climbing or access to roof structures.

Where PV panels are to be installed, the design shall incorporate maintenance walkways to allow for ease of access, replacement and inspection.

Where PV panels are installed, they shall be metered using an Embedded Network Manager (a service provider accredited by the Australian Energy Market Operator) approved by TfNSW.

# 12 Surveillance

Car parks shall be configured to provide natural surveillance.

Car parks shall be configured so that vehicles are parked in grid like rows to facilitate good sightlines.

Sightlines shall provide safe interaction of pedestrian and vehicle movement.

Surveillance measures shall comply with TS 04992.

# 13 Car park type specific requirements

Sections 13.1 to 13.4 contain specific requirements applicable to types of car park.

## 13.1 At grade car parks

At grade car parks shall also comply with the following requirements:

- not be designed as thoroughfares
- have bitumen ground surfaces (or gravel if approved by AMB)
- include kerbs with runoff gaps to allow water to entre planting areas
- include wheel stops combined with kerbless swales where applicable
- have integrated low scale planting to improve aesthetics and shading
- tree planting that does not decrease visual surveillance or increase opportunities for vandal or criminal activities

- be designed to minimise urban heat island impacts
- be designed to incorporate water sensitive urban design approaches
- have clear boundaries to increase natural surveillance
- have drainage designed to avoid flooding in a 1:20 storm event.

## 13.2 Multi-storey car parks

Multi-storey car parks shall also comply with the following requirements:

- have natural ventilation through open or semi open decks where practicable
- have fire services
- have vehicular noise mitigation measures where multi-storey carparks are constructed adjacent to residential land, whether built upon or not

## 13.3 Underground car parks

Underground car parks shall also comply with the following requirements:

- provide protection against water ingress in accordance with BS 8102
- provide subsurface and above ground drainage systems
- provide mechanical services in accordance with AS 1668.2
- provide fire services
- provide noise mitigation for mechanical services
- provide vertical transport
- provide fuel inceptor system
- provide special structural requirements including vibration and earthquake resistance.

## 13.4 Temporary car parks

Temporary car parks shall also comply with the following requirements:

- have bitumen surfaces for parking hardstand (or gravel if approved by AMB)
- clear visual surveillance of the car park and surrounding environment to reduce opportunity for vandal or criminal activities
- parking hardstands adequately drained to prevent water ponding on surfaces.

# 14 Project documentation

The TAO or service provider shall provide all necessary documentation including temporary works documentation and supporting calculations to facilitate the timely and accurate design and construction of the car park. Project documentation shall comply with TS 01508.

The TAO or service provider shall provide TfNSW with as-built drawings for all works undertaken.

# Appendix A Urban setting and contextual considerations

## A.1 Urban context

Good design is underpinned by the way in which a building or structure responds to, and integrates with, its context. The context include a list of characteristics which describe the typical urban and environmental conditions, which should be considered when designing a car park that responds to its context. Table 2 lists examples of urban context categories across NSW, ranked from low density to high density.

**Table 2 – CCP urban context category**

| Category | Characteristics and densities | Example |
|---|---|---|
| Rural | Very low density of built form<br>Few adjacent buildings<br>Abundance of open space<br>Rural character<br>Likely long life – longer last miles<br>Typically elevated environmental considerations and constraints to be considered | Dubbo |
| Greenfield or brownfield sites | Low density surrounding context with planned densification<br>Low-rise scale<br>Prevalence of open, undeveloped space (greenfield and brownfield) | Edmondson Park<br>Leppington<br>Luddenham Park<br>Marsden Park |
| New suburban centres | Medium density, typically with a focus on residential<br>Split between locally based customers and customers who have travelled to the transport hub using personal transport | Kellyville<br>Tallawong |
| Established town centres | Compact medium density<br>Constrained<br>Limited access<br>Heritage considerations<br>Mixed use including main street<br>Mid-rise context (5 to 7 levels) | Waterloo South<br>Rouse Hill<br>Maroubra Junction<br>Kingsford |
| Inner city | Mature and developed sites<br>Complex settings<br>Multiple heritage considerations<br>Fully mixed use, focus on commercial<br>High-rise context (more than 7 levels)<br>Highly constrained access<br>Secondary CBD<br>Potential for below ground | Bondi Junction<br>Hornsby<br>Green Square |

Regardless of the urban context categories in Table 2 sites have their own unique opportunities and challenges. Sites need to be assessed on a case-by-case basis, in order to understand the unique parameters and opportunities to ensure appropriate design responses that are sensitive to site contexts and aligned with relevant statutory planning requirements.

## A.2 Life cycle

The expected usage of the core car park building elements during their life will influence the design methodology employed for CCPs. Car park buildings that are constructed to remain in place for the duration of their functioning life may be designed to be tailored to suit sites with more complex constraints, such as irregular or sloped sites. Alternatively, car park buildings that are constructed with the intention of future disassembly and re-assembly in a new location would need to suit multiple sites over the course of their life cycles. These designs are therefore more efficient when applied to regular shaped, flatter sites, where fewer bespoke building elements are required.

## A.3 Facades

The follow are examples of multi-storey facade design approaches:

- No facade – this approach seeks to minimise material usage and provides only what is required to achieve compliance. None of the benefits of a facade are realised in this option.
- Demount and reuse – the facade systems in this approach can be easily demounted and reused (typically in another car park). These systems span between floor to floor and they can also be modular and prefabricated. All connection details between the structure and the facade are reversible.
- Demount and repurpose – the facade systems in this approach can be easily demounted and repurposed as facades on other buildings or can be recycled as raw materials for other construction projects. These systems are not restricted to floor to floor heights and can be modular and prefabricated. All connection details between the structure and the facade are reversible.
- Adaptable facade – this approach uses prefabricated facade modules with reversible cassette fixings where modules can be plugged in and unplugged to respond to the program needs of the building.
- Temporary facade – temporary facades can be used when car parks require a temporary change to non-car park associated uses. These systems are lightweight and can be easily installed and removed with temporary fixing mechanisms.

# Appendix B Examples of car park strategies

## B.1 Precast kit of parts

### B.1.1 Overview

Precast kit of parts make use of a standardised range of precast concrete structural elements, including planks, columns and beams. Bespoke or unique elements are kept to a minimum to maximise material and manufacturing efficiency and to enable streamlined assembly and disassembly.

Manufacture of the modular precast components occurs offsite, minimising onsite trades. Formwork used to produce precast elements can be retained stored in the manufacturing facilities, allowing the production of additional components for future expansion of the structure. The production of additional components can be undertaken on demand, avoiding the excessive manufacture of parts which may become redundant if future expansion is not undertaken.

The precast modular elements are also designed to be disassembled through the use of standardised mechanical connection details. Portions of the structure can be disassembled incrementally in response to a reduction in parking demand.

### B.1.2 Strategic focus

The precast kit of parts approach is best suited to the strategy in Section C.2 but can also be applied to the strategies in Sections C.1, C.5 and C.6.

### B.1.3 Structural and facade considerations

Precast kits of parts are best suited to sites with the adequate adjacent space to enable future scale change, both horizontally and vertically. These systems are best suited to scenarios where there are limited constraints such as adjoining buildings, and therefore most likely to be implemented in less dense sites with less complex conditions. To achieve maximum efficiency, the use of standardised components should be maximised. Use of a kit of parts option is best suited to flat sites with minimal complexities.

Facade considerations include the following:

- lightweight facade systems are highly recommended to ensure easy disassembly
- perforated facades can be used in these car parks for natural ventilation
- facades should also be designed to conceal views of services from public areas
- net positive facades (especially green facades) should be designed to allow for easy removal.

Applicable facade design approaches include the following:

- no facade
- demount and reuse
- demount and repurpose
- net positive facade.

The key challenges and opportunities for the precast kits of parts are captured in the following design challenges:

- Challenge 1 – monolithic wearing surface versus de-mountability. A monolithic car park surface is desirable to provide a consistent uninterrupted contact surface, with appropriate abrasion resistance and the ability to be finished appropriately for both vehicle and pedestrian traffic and to facilitate the application of line markings and on floor wayfinding. However monolithic construction is not inherently demountable or seamlessly expandable.
- Challenge 2 – modular jointed construction vs waterproofing and fire proofing joints are integral to a prefabricated modular strategy, however are generally undesirable as they increase potential for noise when trafficked and act as weak links in the water and fire proofing systems.

The following strategies are proposed to address the design challenges listed in the preceding bullet list:

- Challenge 1 – provide a concrete topping to the precast planks. The topping is sacrificial and should be removed and recycled in locations to be demounted. The topping also acts as a structural diaphragm and allows a more robust connection between the planks and precast beams.
- Challenge 2 – no concrete topping for ease of deconstruction. Planks are mechanically connected to the precast beams. Planks are prestressed together with unbonded strands to limit relative movements across plank interfaces and seal joints for water and fire proofing. Planks and joints are finished with a flexible movement tolerant resin.

Additional challenges and opportunities include the following:

- Reversible mechanical connections vs concrete construction. Precast concrete structures are typically stitched together onsite using wet joints (in situ concrete or grout). Mechanical reversible connections need to be carefully designed to ensure they can be delivered by subcontractors within the tolerances of the rest of the structure and are both intuitive and robust.
- Permanent finished appearance versus readiness for expansion or contraction.
- Discrete concealment of mechanical joints.

### B.1.4 Services considerations

The greatest mechanical and electrical service efficiencies are achieved when any service is run parallel to precast structural elements. Service considerations should be made at design stage to allow for future expansion, contraction or deletion of services within a relocated structure.

Mechanical services include the following:

- consider width limitations for natural ventilation
- if mechanical ventilation is being used, ventilation system may need to be upsized when expanding for more car park spaces.

Electrical services include the following:

- modularity and flexibility with power distribution arrangement should be considered during the initial design for future decommissioning and commissioning
- disassembly and reuse of electrical systems is possible if the system is designed to allow for modular installation
- installation has to be certified by a license electrician every time it is recommissioned
- changes in power demand to the building may trigger upgrades to incoming power supply to the building
- spare space to be maintained within internal reticulation systems such as cable trays and local distribution boards and so on.

## B.2 Re-deployable prefabricated steel cassettes

### B.2.1 Overview

Re-deployable prefabricated steel cassette options presents re-deployable prefabricated steel cassette systems which can be fully disassembled, transported to a new location and reassembled as a car park.

The structure, facade and services are designed to allow the whole structure to be de-mounted, transported be reassembled in a new location for use as a car park. This option is best suited to sites where a short-term solution is required, such as undeveloped areas which are about to undergo significant development.

### B.2.2 Strategic focus

The structural approach presented in this option is best suited to the strategy in Section C.3.

## B.2.3 Structural and facade considerations

The greatest efficiencies are achieved if the site conditions for re-deployable prefabricated steel cassettes are very similar between the initial location and the future relocation. For example, if the car park is initially constructed in a rectilinear arrangement on a flat site, relocation to a similarly flat site with minimal adjacency considerations is optimal.

Facade considerations include the following:

- Lightweight facade systems are highly recommended to ensure easy de-mountability. Perforated facades can be used in these car parks for natural ventilation.
- Facades should also be designed to conceal views of services from public areas.
- If net positive facades (especially green facades) are used, they should be designed to allow for easy deconstruction.

Applicable facade design approaches include the following:

- no facade
- demount and reuse
- demount and repurpose
- net positive facade.

The key challenges and opportunities for the re-deployable prefabricated steel cassettes are captured by the following:

- Challenge 1 – monolithic wearing surface versus de-mountability (similar to the precast kits of parts option in Section B.1.3).
- Challenge 2 – modular jointed construction versus waterproofing and fire proofing (similar to the precast kits of parts option in Section B.1.3).

The following strategies are proposed address the challenges listed in the preceding bullet list.:

- Challenge 1 – no concrete topping for ease of deconstruction. Cassettes are bolted together along their span to limit relative movements across cassette interfaces and joints between cassettes are sealed for water and fire proofing Cassettes and joints are finished with a flexible movement tolerant resin. The resin finish is sacrificial at joints to allow disassembly.
- Challenge 2 – provide an additional concrete topping to the precast planks. The topping is unbonded over the cassettes reinforced concrete topping and is sacrificial: it should be broken away (to be recycled) prior to disassembly and a new topping reinstated once the structure is re-erected.

Additional challenges and opportunities include the following:

- Fire protection versus redeployment of electric vehicles preclude the use of the ESA/M method to justify inherent fire resistance of the steelwork alone, requiring the minimum Floor Reduced Level to be achieved with additional protection (for example, intumescent paint, concrete encasement, fire rated plasterboard or vermiculite spray).

### B.2.4 Services considerations

The greatest mechanical and electrical service efficiencies are achieved when any service is run parallel to precast structural elements. Penetrations through structural members should be minimised. Penetrations through precast concrete members should be avoided.

Mechanical services include the following:

- design for largest penetrations – limits services flexibility (could increase services cost)
- consider fall required for services – will be difficult to achieve
- prefer middle third for reticulation through web
- possible notching primary beam either ends.

Electrical services include the following:

- Modularity and flexibility with power distribution arrangement should be considered during the initial design for future decommissioning and commissioning.
- Disassembly and reuse of electrical systems is possible if the system is designed to allow for modular installation.
- Installation has to be certified by a license electrician every time it is recommissioned.
- Reuse in different location will need consideration for incoming power infrastructure. Limited to use of available power infrastructure onsite or new incoming power infrastructure to be installed. Generator back up system should be considered.

## B.3 Steel and precast kits of parts

### B.3.1 Overview

Steel and precast kits of parts enable the initial car park structure to be disassembled, transported to a new location and reassembled in an adaptive manner to enable alternative uses.

The range of new uses which the reassembled structure can support are limited by the constraints of the original structure, with the exception of the columns which can be substituted for taller members during the reassembly.

## B.3.2 Strategic focus

The structural approach presented in this option is best suited to the strategy in Section C.4 but can also be applied to the strategy in Section .

## B.3.3 Structural and facade considerations

Steel and precast kits of parts present an opportunity to disassemble and reuse the structure for a new program, however it is likely the most constrained opportunity in terms of site considerations. Similar to re-deployable prefabricated steel cassettes, the greatest efficiencies are achieved if the site conditions for are very similar between the initial location and the future re-location.

Facade considerations include the following:

- lightweight facade systems are highly recommended for these car parks to ensure easy de-mountability
- perforated facades can be used in these car parks for natural ventilation
- facade systems should not be restricted to floor-to-floor heights to increase flexibility for future alternative uses.
- facades should also be designed to conceal views of services from public areas.

Applicable facade design approaches include the following:

- no facade
- demount and reuse
- demount and repurpose
- adaptable facade
- temporary facade
- net positive facade.

The key challenges and opportunities for steel and precast kits of parts:

- Challenge 1 – monolithic wearing surface vs de-mountability (similar to the precast kits of parts option in Section ).
- Challenge 2 – modular jointed construction vs waterproofing and fire proofing (similar to the precast kits of parts option in Section B.1.3).

The following strategies are proposed to address the challenges listed in the preceding bullet list:

- Challenge 1 – no concrete topping for ease of deconstruction. Planks are post tensioned together across their width to limit relative movements across plank interfaces and tongue and groove joints between planks are sealed for water and fire proofing. The resin finish is sacrificial at joints to allow disassembly.
- Challenge 2 – provide an additional concrete topping to the precast planks. The topping is unbonded over the planks RC topping and is sacrificial and it should be broken away (to be recycled) prior to disassembly and a new topping reinstated once the structure is re-erected.

Additional challenges and opportunities include the following:

- Fire protection versus redeployment. Electric vehicles preclude the use of the ESA/M method to justify inherent fire resistance of the steelwork alone, requiring the minimum Floor Reduced Level to be achieved with additional protection (for example, intumescent paint, concrete encasement, fire rated plasterboard or vermiculite spray). Consideration should be given to the following challenges:
  - Challenge 1 – intumescent paint touched up after structure is re-erected.
  - Challenge 2 – fire rated plasterboard preassembled on cassettes where possible such as secondary beams.
- Procurement – the proposed structural system is an assembly of conventional components (for example, steel frames, precast planks), omitting the conventional concrete topping would introduce a complexity to be worked through early engagement with specialised contractors. Similarly, early engagement is key in ensuring successful future relocation strategies, including deconstruction, temporary storage, transport and re-erection, noting the structure will need to be recertified in the new location.

## B.3.4 Services considerations

Mechanical and electrical services will need to be designed once the use of the reused structure has been established.

Some points to consider include the following:

- Mechanical services:
  - reuse of services is possible if within design life and recommissioned
  - facade and internal partitions to be considered
  - design for services zone or ceiling void for future use to ensure there is adequate room for flexibility

- consider predetermined soft spots in slab for future risers through building
- plant can be located on roof top as long as there is a path of reticulation to rooms
- additional floor to floor height should be considered for future services zone.

- Electrical services:
  - modularity and flexibility with power distribution arrangement should be considered during the initial design for future decommissioning and commissioning
  - disassembly and reuse of electrical systems is possible if the system is designed to allow for modular installation
  - installation requires certification a licensed electrician every time it is recommissioned
  - reuse in different location will need consideration for incoming power infrastructure and load capacity requirements
  - limited to use of available power infrastructure onsite or new incoming power infrastructure to be installed
  - changes in power demand to the building shall trigger upgrades to incoming power supply to the building and internal power infrastructure
  - spare space to be maintained within Internal reticulation systems such as cable trays and local distribution boards and so on.

# B.4 Timber-concrete composite

## B.4.1 Overview

Timber-concrete composite embeds flexibility in the base build design allowing adaptive reuse of the structure to facilitate a change of use. The option to change the building use enables the building to maintain relevance as demand changes over time.

The structural grid, member sizing, floor to floor heights, access and servicing strategies are specified and designed to support predetermined uses. One example may be the transition from a car park on day one, to a mix of retail, day care and commercial uses in the future.

## B.4.2 Strategic focus

The structural approach presented in this option is best suited to the strategy in Section C.5..

## B.4.3 Structural and facade considerations

Timber-concrete composite is fairly flexible in terms of the locations where it can be implemented. When considering future adaptation, it is important to understand the future needs and requirements to ensure that they are not compromised by the site conditions. Fixing to

timber composite slabs, fixing of speed humps, crash barriers and so forth on the relatively thin concrete topping of the composite slabs should be carefully considered in the design phase. Cast-in connectors engaging both the concrete and cross laminated timber might be considered. Strategically locating the fixings on the band beams or providing additional in situ bands within the slabs might be a strategy where pullout forces are significant.

Facade considerations include the following:

- lightweight facade systems are highly recommended for these car parks to ensure easy de-mountability
- facade systems should not be restricted to floor-to-floor heights to increase flexibility for future alternative uses
- if perforated systems are used, care should be taken to protect the timber structure from direct weather exposure
- facades should also be designed to conceal views of services from public areas.

Applicable facade design approaches include the following:

- demount and reuse
- demount and repurpose
- adaptable facade
- temporary facade
- net positive facade.

The key challenges and opportunities for timber-concrete composite are as follows:

- In situ concrete curing cycles vs speed of erection. Both the precast shell beams and CLT slabs act as "formwork' greatly reducing or eliminating propping during construction and removing stripping of formwork from the construction critical path. Delayed early strength associated with high SCM concrete mixes is less likely to impact the construction program, although adequate early strength is still required for band pre-stressing.
- Use of precast columns, prefabricated reinforcement or PT cages within the shell beams, simple mesh reinforcement for the topping and preinstalled screws in the CLT slab all contribute to speeding up construction.
- Timber or concrete bond compositely vs deconstruction. The CLT slab and in situ topping rely on a large number of steel screws for composite action, preventing easy disassembly and material separation at end of life. Saw cutting the composite slabs into re-useable composite planks could be considered as an alternative to breaking away the topping and removing the screws for recycling and reusing or recycling the CLT.

- Prototyping and building permit approval. A prototype is likely to be required to demonstrate to the relevant building authorities adequate performance of the structural system. This can also serve as a calibration exercise for the builder to fine tune the methodology ahead of full scale construction.
- Procurement – early engagement with a specialist contractor and the supply chain is critical to the success of timber projects. Local or overseas procurement, requirements for prototyping, approval processes including fire approvals should all be considered early and factored in the design and construction program.

# B.5 Other options

## B.5.1 Optimised post-tensioned concrete structures

In this option the use of optimised in situ PT concrete with high Portland cement replacement is proposed to reduce volume of material and associated embodied carbon.

The use of PT concrete can be considered in all settings, with the right architectural and urban design considerations, specifically relating to the built form scale, articulation and facade treatments.

The adaptive reuse of post-tensioned concrete structures may be limited due to higher structural constraints due to complexities and limitations of modification of existing structures.

## B.5.2 Precast T beams structures

This option is designed to enable concurrent uses. The structure is not demountable, however the structural grid, member sizing, floor to floor heights, access, and servicing strategies are specified and designed to support predetermined concurrent uses.

# Appendix C Design strategies

## C.1 Better than business as usual

A better than business as usual strategy looks to incrementally build upon previous design strategies. A means of incremental improvement may include the following considerations:

- better accommodation of future transport trends, for example greater than a 5% EV accommodation
- de-materialisation optimising structures for minimum material use
- higher embodied carbon and sustainability targets, for example greater than 25% SCM for concrete
- better integrated end-of-life strategies.

## C.2 Expandable and contractible structures

An expandable or contractible strategy is a solution which enables a car park to respond to changing demand over time. A kit of parts approach is suggested which would allow a car park structure to change in scale over time, through the removal or addition of structural modules. This approach should include the following considerations:

- Where a structure is reduced in scale, there is scope to give back a portion of the site to facilitate a new land use.
- Given that a kit of parts produces more generic structures it may be more challenging to achieve a bespoke appearance. Therefore, this solution is limited in its ability to respond to site context, both in form and aesthetics.
- It is important to clearly articulate the design life of the kit of parts.
- There are a range of proprietary solutions available which could be considered if adopting this approach.
- De-mountable elements could be stored for future use or repurposed on another site.

## C.3 Design for disassembly, relocation and reuse as a car park

Design for disassembly, relocation and reuse as a car park system enables the car parking structure to be disassembled, transported to a new location and reassembled. It is envisaged that this approach may suit sites where an increased parking demand is shorter term. For example, in the interim period where a new train station has been constructed, but the surrounding residential development has not yet been built.. A kit of parts design is suggested

to simplify and enable disassembly, transportation and reassembly. As a building type, a car park is exceptionally well suited for design for disassembly given that the spatial unit of a parking space remains the same when reassembled, even if the building geometry changes. This approach should include the following considerations:

- Given the generic kit of parts may be more challenging to achieve a bespoke appearance a solution is limited in its ability to respond to site context, both in form and aesthetics.
- A staged approach can be considered allowing partial disassembly of the structure.
- This option is best suited to sites with similar conditions to avoid the need for bespoke parts.
- Clearly articulate the design life of the kit of parts.

## C.4 Design for disassembly, relocation and re-purpose for a different program

Similar in approach to Section C.3, where the car park is designed to be disassembled and relocated. In this case, the approach enables new functions to occur when the building is re-assembled. A number of design features should be implemented to enable and support the future use change, such as the ability to increase the floor to floor height, provision for increased level of servicing and an upgraded facade. This option recognises that car parking demand is decreasing in some areas and seeks to reuse the building materials in others where demand is increasing.

In addition to considerations listed in Section C.3, this approach should include the following considerations:

- undertaking thorough analysis of functional requirements and code requirements when implementing a use change
- planning implications triggered by use class change to be considered
- space proofing required to accommodate future service reticulation and plant areas
- future change of use which may likely necessitate facade upgrade, considering minimal or de-mountable facade under initial car parking use
- future compliance assessment and certification to be undertaken when car parks are disassembled and repurposed for a different use.

## C.5 Design for future adaptive reuse

This scenario envisages a car parking structure which has inherent flexibility to enable future adaptation and use change. Potential new uses beyond the initial use as a car park are wide ranging and should be considered when designing the base build. It is important to note that the

building requirements for alternative uses are highly varied and should be understood to ensure that the building has the inherent flexibility to enable the intended future use. This scenario can be an effective method to future proof the structure and limit the need for demolition when car parking demand changes.

This approach should include the following considerations:

- Necessity to provide greater floor to floor heights than typically required for a car park to facilitate future use.
- Thorough analysis of functional requirements and code requirements when implementing a use change.
- Diminished suitability for disassembly, given the increased engineering to accommodate future demand. Planning and land use zoning implications triggered by use class change would need to be considered.
- Partial removal of slabs to achieve a floor plate depth that better suits future program.
- Space proofing required to accommodate future service reticulation and plant areas.
- De-mountable car ramps.
- Future program change that will likely necessitate facade upgrade, consider minimal or de-mountable facade under initial car parking use.
- When sections of the car parks are repurposed for a different program, these altered spaces will need to be assessed for compliance and will require new building certification for their adaptive reuse.

## C.6 Design for concurrent programs

This strategy is an approach which enables additional and alternative functions to occur in the building, in addition to car parking. It is designed to maximise the usability of the structure, responding to periods of reduced demand a range of time frames: daily, weekly, annually. For maximum efficiency, the alternative uses should be able to occur within the building, with minimal need for variation to the parking structure.

Ground and roof levels are highlighted as particular areas where alternative uses may be accommodated with minimal adjustment to the base building design. Alternative use considerations include the following:

- weekend markets
- rooftop sports facilities
- day care
- public recreation space for use in evenings, for example a gym

- car maintenance or washing areas
- ground level retail
- primary, secondary or tertiary educational at ground and roof levels.

This approach should include the following considerations:

- building requirements to enable successful alternative use of space, including but not limited to area, floor to floor height, access to natural light, security, provision of amenity and thermal and ventilation
- the impact on the efficiency of the remaining car parking.
- changing between functions will have an operational impact, which may require resourcing
- potential implications on BCA, building classification, and fire safety measure requirements.

## C.7 Net positive

A net positive strategy goes beyond achieving net zero carbon emissions to create an environmental benefit by removing additional carbon dioxide from the atmosphere. This includes reducing material use and specifying low carbon materials, eliminating fossil fuel use from construction and transport, sourcing renewable energy for operation and offsetting more carbon than that released from the use of materials and construction.

This approach should include the following considerations:

- Low carbon embodied materials such as concrete, steel or timber to reduce use and minimise carbon. Long design life captures longer life of embodied carbon, reducing whole-of-life carbon impact.
- Low carbon construction process.
- Procurement and transport, all electric construction.
- Low carbon operations – electricity, lighting, ventilation, more stairs, less lifts and renewable.
- Oversizing of photovoltaic to cater for future demand.