SECTION 4: STRUCTURAL & CIVIL

CONTENTS

4.1 INTRODUCTION

All structural design is to meet the requirements of this section of the University's Design Standards, all relevant Australian Standards and the Building Code of Australia (BCA).

At Concept Design stage, the structural consultant is to document and agree the structural design criteria with the University's Project Manager and the project architect. The design criteria should cover the following scope:

- Dead and Live Loads (loading diagrams may be required)
- Wind Loading;
- Seismic Design Criteria;
- Deflection Limits;
- Floor Vibration Limits;
- Durability;
- Fire Resistance; and
- Design for Future Flexibility.

4.2 STRUCTURAL DESIGN CRITERIA

4.2.1 Floor Loadings

Floor loadings shall be designed to the relevant Australian Standard, or the following table , whichever is the greater:

(a)	Minimum loading for all non-residential floors:	
	− general live load	4 kPa
	− demountable partitions	0.5 kPa
(b)	Compactus areas	10 kPa
(c)	Communication rooms	5 kPa
(d)	Air handling, refrigeration and boiler plant rooms	7 kPa
(e)	Open roof-top plant platforms	2.5 kPa or 5.0 kPa

In addition to the live load, a minimum superimposed dead load allowance of 0.3 kPa for ceiling and services shall be provided.

Some heavily loaded areas, such as archives and library shelving, or areas with heavy equipment will require computations to establish the floor loadings.

4.2.2 Floor Vibrations/Dynamics

All floors are to be designed to an appropriate footfall vibration criterion, to be determined by the structural engineer. As a minimum, no floor is to be designed with a response factor of less than 8. A response factor of 4 is to be considered for quiet offices.

Particular consideration is required in relation to laboratory and other specialist uses, in particular when used for balancing, microscopy and other sensitive laboratory equipment. The structural engineer shall determine the required footfall vibration limits based on the building's functional needs and future flexibility. At a minimum, laboratories intended for undergraduate teaching are to comply with ASHRAE Curve F (response factor =1.0) at the worst point on the floor. The performance of laboratories intended for research is to be agreed with the University Project Manager based on the equipment intended to be installed. At a minimum, 50% of the floor area of research laboratories is to comply with ASHRAE Curve VcA, (Response factor = 0.5) with the balance complying with Curve F.

The structural engineer is to provide the University with a plot of the floor performance so that sensitive equipment can be installed in the higher performing areas. Vibrations from plant and other equipment is to be addressed by isolation at source.

4.2.3 Durability

The design life for all structural elements is 50 years. Maintenance costs are to be minimised throughout. The structural materials and finishes selection is to ensure that no maintenance is required in the first 25 years of the building's life

4.2.4 Design for Future Flexibility

University buildings may be refurbished several times for differing purposes over their lifetime. Hence, the structure is to be designed with flexibility for future change in use in mind. A regular column grid is encouraged, and minimal internal structural walls. No floor is to be designed for less than the minimum load nominated above.

The structural engineer is to establish whether any specific allowances are to be made for future expansion either vertically or horizontally in conjunction with the University Project Manager.

4.2.5 Masonry

4.2.5.1 Brick Growth

- Masonry shall be designed to prevent the problems associated with brick growth.

4.2.5.2 Walls and Expansion Joints

- As the cost of building will be influenced by the structural system and external wall cladding, the method of facade proposed shall be discussed with the University's Project Manager at an early stage of the development of the design.
- Care shall be taken to ensure that there are sufficient control joints in all wall materials to avoid cracking due to shrinkage and expansion of the material, movement of the supporting structures under wind and other effects or unequal settlement.
- Any movement joints in the structure behind are to be carried through the cladding.
- Adequate weathering shall be provided for all copings, sills and at heads to openings.

4.2.6 Roofing

4.2.6.1 Roofs

- Care shall be taken in the design and specification of roofs to avoid rain penetration in strong winds.
- Pitched roofs shall be used in preference to flat roof systems. The buildings users may, however, require some useable roof area for experimental or other purposes.
- All roof spaces shall have permanent, fixed, adequate access; be provided with catwalks and be sufficiently lit to enable the roof space to be traversed without danger 24 hours a day.
- The chemical reaction of aluminium in contact with other metals in an exposed situation shall be avoided.
- The method of proposed roof and facade access shall be discussed with the University's Project Manager at an early stage of the development of the design. Consideration must be given to installation of anchor points/static lines etc on the roof for harness attachments.

4.2.6.2 Guttering & Downpipes

Refer to section 5 of the Design Standards: Building Fabric, for guttering and downpipe requirements.

4.3 CIVIL

4.3.1 External Stormwater Drainage

The storm water network external to the building footprint shall be designed in accordance with AS 3500.3. The network shall be designed to convey, without surcharge, the 5% AEP (20-year ARI) plus 20% increase factor to allow for the potential effects of climate change. Appropriate overland flow paths shall be provided to prevent inundation of buildings in extreme events or in cases where the network becomes blocked.

Surface storm water shall be collected via various inlets within the surface such as grated pits, grated trench drains, side-entry pits and channels and conveyed within the underground piped drainage network to the existing trunk drainage systems or to the legal point of discharge as nominated by the responsible council.

Where the responsible council imposes restrictions on storm water discharge rates from the development, detention storage shall be provided to the satisfaction and approval of the council.

Grated pits and trench drains within hard pavements must be flush with their surroundings and ‘heel safe’ rated in pedestrian areas. All pit covers must be of strength class suitable to their location and must consider all loading scenarios including emergency vehicles or heavy cleaning equipment.

Water Sensitive Urban Design (WSUD) elements will be considered where possible in coordination with the Landscape Design and will typically include elements such as permeable pavement, bioretention cells and systems capable of capturing gross pollutants and sediment.

4.3.2 Vehicular Pavement

4.3.2.1 Flexible (Asphalt) Pavements

Design of light and medium duty pavements (design traffic in range of 10^3 to 10^5 ESA's) shall be designed in accordance with 'Austroads Technical Report AP-T36/06-Pavement Design for Light Traffic'.

Heavy duty pavements with design traffic > 10^5 ESA's pavement designs should be carried out in accordance with Austroads publication ‘Guide to Pavement Technology Part 2: Pavement Structural Design’ (2018).

Appropriate geotechnical investigations shall be carried out to determine performance criteria of the underlying subgrade material.

Subsoil drainage systems shall be provided where necessary to protect the pavement subgrade formation.

4.3.2.2 Rigid (Concrete Pavements)

Rigid pavements may be designed in accordance with the Cement and Concrete Association of Australia, (Third Edition Oct 2009), ‘Guide to Industrial Floors and Pavements - Design, Construction and Specification’.

4.4 CONSTRUCTION NOISE & VIBRATION

This section provides construction noise and vibration targets for occupied areas of the University. Where construction is undertaken on University land and requested by the University Project Manager, a Construction Noise and Vibration Management Plan is required to be submitted by the appointed contractor detailing:

- Construction equipment used;
- location/distances of construction equipment;
- timing and duration of construction works;
- predicted noise and vibration impacts; and
- mitigation and management methods to manage the noise and vibration impacts.

Wherever possible the noise and vibration impacts shall be reduced to comply with the targets set out in the following sections. Where the targets cannot be achieved, mitigation and management methods are to be applied to reduce the impacts as much as possible.

4.4.1 Noise

The targets for internal noise levels due to construction noise are shown in the table below. Where the target is exceeded, then management actions would need to be implemented.

Sensitive Area	Internal Construction Noise Level Target, dB(A) $L_{eq,15min}$
Teaching spaces	45
Lecture theatres	40
Open office spaces	45
Private offices	40
Meeting rooms / conference rooms	40
Computer laboratories (non-teaching)	50
Other laboratories (non-teaching)	50
Libraries	
General areas	50
Reading areas	45
Common rooms	45
Public spaces	50
Cafes	50

4.4.2 Vibration

The targets for vibration due to construction works are based upon the NSW document *Assessing Vibration: A Technical Guideline* (the NSW Guideline) and reproduced in the table below. As per the NSW Guideline, management actions should be implemented if the Vibration Dose Values (VDVs) are exceeded, specifically:

- Management actions should be implemented where the Preferred levels are exceeded, and levels up to the Maximum levels are permissible as long as reasonable and feasible actions have been taken; and

- Where the Maximum levels are exceeded, negotiation must be undertaken with the University's Project Manager.

Table 1 Construction vibration targets as Vibration Dose Values (VDV)

Location	Preferred VDV	Maximum VDV
	$m/s^{1.75}$	$m/s^{1.75}$
Particularly sensitive spaces	0.1	0.2
Offices, schools, educational institutions, places of worship	0.4	0.8
Workshops	0.8	1.6

The use of VDVs require the assessment of vibration levels over an extended period, which is not always practical. Therefore, it may be easier for the vibration targets to be converted to a Peak Particle Velocity (PPV) level, which allows for the assessment of vibration based on short-term measurements.

Table 2 presents PPV construction vibration targets based on Annex A of AS 2670.2 and the NSW document *Assessing Vibration: A Technical Guideline*. Note that the PPV targets in 2 are relatively conservative as they are based on continuous (rather than impulsive) vibration and are based on conservative assumptions with regard to crest factor and orientation of the occupant with respect to the vibration.

Table 2 PPV construction vibration targets

Location	Preferred PPV	Maximum PPV
	mm/s	mm/s
Particularly sensitive spaces (e.g. Alice Hoy Optometry)	0.14	0.28
Offices, schools, educational institutions, places of worship	0.56	1.1
Workshops	1.1	2.2

To assist with the assessment of risk from construction vibration, Table 3 presents typical safe working distances for potential key construction plant that may be expected on site based on prior experience. Note that the distances may need to be increased for areas with vibration-sensitive equipment.

Table 3 Recommended safe working distances for key vibration-intensive plant

Plant	Rating	Typical safe working distance for occupant comfort
		m
Vibratory roller	< 7t	≥ 35
	7t – 12t	≥ 50
	≥ 13t	≥ 75
Rock saw		≥ 35

Plant	Rating	Typical safe working distance for occupant comfort
Bulldozer ripping rock	D8 type	≥ 35
Rock-breaking	Small hammer 300 kg: 5-12t excavator	≥ 20
	Medium hammer 900 kg: 12-18t excavator	≥ 35
	Large hammer 1600 kg: 18-34t excavator	≥ 70
Impact piling	≤ 800mm	≥ 100
Bored piling	≤ 800mm	≥ 20
Jackhammer	Handheld	Avoid contact with structure

Contractors carrying out work on University sites must also ensure construction vibration levels do not cause damage to structures. This generally only becomes a concern at levels well above those which may annoyance to building occupants. Guidance on acceptable vibration levels for preventing damage to structures, including heritage-listed structures, is given by German Standard DIN 4150-3:1999 *Structural Vibration – Part 3: Effects of vibration on structures*.

4.4.3 Management & Mitigation Measures

Appropriate management and mitigation measures will vary from project to project. However, consideration should be given to the following:

- Decanting of spaces that may be significantly affected. This will require discussion with and approval from the University's Project Manager;
- The timing of works and whether potentially annoying works can be undertaken at times when sensitive uses are less sensitive or unoccupied;
- The provision of respite periods to affected sensitive users;
- The use of less noise- and or vibration-intensive plant;
- The installation of temporary mitigation measures to reduce noise levels such as hoarding or glazing upgrades to affected uses;
- The location of noisy activities, including compounds, away from sensitive areas.
- The use of existing shielding features to reduce noise levels;
- Minimising the use of tonal reversing beepers through the use of alternative non-tonal alarms or the design of access routes to remove the need for reversing; and
- The enforcement of good on-site practice to reduce noise levels associated with shouting, swearing, and the use of horns as signalling devices.

4.5 UNDERGROUND INFRASTRUCTURE

This section provides details of minimum requirements for the design and construction of underground infrastructure including interface points with Utility Service Providers (USP's).

The requirements outlined in this section fit between Section 6 of the Design Standards: Hydraulic Services and the connection point to USP owned assets.

4.5.1 Standards & Regulations

All underground infrastructure works shall meet all the requirements of national and local authorities and shall be in accordance with the following in so far as they apply to the work:

- Building Code of Australia and Building Permit conditions;
- SAA National Plumbing and Drainage Code AS 3500;
- AS 3500 Plumbing and Drainage;
- WorkCover for the relevant state (e.g. WorkCover QLD, SA, NSW etc.);
- Worksafe at Federal Level;
- OHS regulations;
- Environment Protection Authority for relevant state;
- EnergySafe Victoria;
- Gas Installation Code SA5601.1;
- Water Services Association of Australia Codes;
  - WSA 03-2011-3.1 Water Supply Code of Australia Melbourne Retail Water Agencies (MRWA) Edition Version 2
  - WSA 02-2014-3.1 Gravity Sewerage Code of Australia Melbourne Retail Water Agencies (MRWA) Edition Version 2
  - WSA 01-2004 Polyethylene Pipeline Code Version 3.1
  - WSA 05-2013 Conduit Inspection Reporting Code of Australia Version 3.1
  - These codes are updated periodically, the latest versions must be used and can be obtained by visiting the Water Services of Australia website https://www.wsaa.asn.au/shop/category/1
- AS 1289 Methods of testing soils for engineering purposes;
- AS 1379 Specification and supply of concrete;
- AS 1906 Retroreflective materials and devices for road traffic control purposes;
- AS 2566.1 Structural Design of Buried Flexible Pipe;
- AS 2566.2 Installation of Buried Flexible Pipe;
- AS 2685 Safe Working in Confined Space; and
- AS 4020 Products for use in contact with water intended for human consumption with regard to their effect on the quality of water.

4.5.2 Investigation & Design

a) Designs are to be undertaken by personnel competent and experienced in the design of underground infrastructure;

b) The Designer(s) must visit site, identify the location and depth of other UoM and Utility services and locate all property and fire service connections;

c) The Designer(s) must liaise with all affected utility providers to determine their requirements for interface points, access, maintenance and metering; and

d) The location of all pits, tanks and pumping stations shall be designed to allow convenient access for operations, maintenance and repairs.

4.5.3 Construction

Prior to commencing construction, the contractor must provide a copy of the following documents to the University's Project Manager for approval;

i. All contractual documentation outlined in the construction contract (i.e. security, insurances etc)

ii. Tree Protection Plan

iii. Traffic Management Plans

iv. Construction Management Plan

v. Safety Management Plan including all safe work method statements

vi. Inspection and Test Plan (ITP)

vii. Reinstatement and Landscape Plan

4.5.4 Commissioning & Acceptance Testing

a) A commissioning and test plan must be submitted to the University's Project Manager for approval;

b) Draft Operating Manuals must be submitted four weeks prior to practical completion. Any training of University personnel must be undertaken prior to practical completion being awarded;

c) Final Operating Manuals must be submitted within four weeks of practical completion.

d) As-constructed drawing shall conform to the University's CAD standard requirements (refer to the Design Standards web page);

e) Any CCTV required by the inspection test plan must be submitted to the University's Project Manager; and

f) Any guarantees and warranty information must be submitted.

4.5.6 Certification of Completed Work

The contractor shall issue upon practical completion of the works all Utility certifications and any other necessary Certificate(s) of Compliance nominating the works carried out on the project and submit the certificate(s) to the University's Project Manager.

4.6 DESIGN CHANGE AUTHORISATION

All requests for changes to the requirements of the Design Standards must be made on the Modification Request Form. No design work is to proceed on the basis of the proposed modification until the modification request has been approved in writing.