SECTION 19

STRUCTURAL DESIGN

Table of Contents

Version	Date	Authors	Summary of Changes
P1	30/05/14	MHT	Preliminary Issue for review
2	19/8/14		Issue to web

9.0 STRUCTURAL DESIGN

9.1 Standards

The current version of Australian standards shall be used and complied with except where a higher standard is called for in this document. At a minimum, where relevant the following standards shall apply:

- Building Code of Australia (BCA)
- AS 1170 Structural Design Actions
- AS 3600 Concrete Structures
- AS 3700 Masonry Structures
- AS 4100 Steel Structures
- AS 1720 Timber Structures
- AS 2870 Residential Slabs and Footings - Construction
- AS 2159 Piling Design and Installation
- AS 1684 Residential Timber-Framed Construction
- AS 1418 Cranes (Including Hoists and Winches)
- AS 1657 Fixed Platforms, Walkways, Stairways and Ladders
- AS 3850 Tilt-up Concrete Construction
- AS 2327 Composite Structures
- AS 3798 Guidelines on Earthworks for Commercial and Residential Developments

9.2 Preamble

Durability & Flexibility

All University buildings shall be designed for the lifespan and durability parameters specified for each project. Where none have been specified, the following minimum requirements shall apply:

- Building Design Working Life – 50 years
- Building Importance Level – 2
- Annual Probability of Exceedance (ultimate) – 500 years
- Annual Probability of Exceedance (serviceability) – 20 years

All structural elements should have a high level of durability particularly with regard to resistance to:

- Deterioration and corrosion due to weathering and environmental effects
- Other factors which may increase long term maintenance
- Flexibility for potential changes in occupancy loadings.
- Provision for the installation of penetrations in floors and walls for future service penetrations.

At the commencement of each project, written agreement is to be sought from the University on the extent of flexibility for changes of occupancy and for the extent of provision for future penetrations in floors and walls proposed by the structural consultant.

Serviceability

The structural elements shall provide an appropriate level of serviceability for users. Vertical and lateral deflections shall not be visually or operationally perceivable to users under normal conditions of occupancy.

Design Loads
All structures shall be designed to withstand all applicable loadings with all appropriate factors of safety (load factors and load reduction factors) applied.

As a minimum the following information shall be noted in tabular form on the structural drawings approved for construction:

- Design superimposed dead loads
- Design live loads
- Special design live loads in localised areas such as compactus storage
- Design wind loads
- Design earthquake loads
- Design bearing pressures for foundation material
- Any other relevant loadings

Heavy Loadings
Areas of floor designed to support specific localised heavy loads e.g. from compactus storage or mechanical equipment shall be noted and shaded on the structural floor plans.

Load Bearing Walls & Columns
All buildings shall be 'future-proofed' as much as possible, to facilitate possible future changes to building usage, floor-plan layouts and loadings. For this reason the use of internal load bearing walls is to be avoided wherever possible. The extent of allowable load-bearing walls and internal columns shall be approved by the university early in the project. All load bearing walls are to be clearly noted on the structural drawings. The use of load bearing clay masonry walls (eg brickwork) is prohibited.

Dimensions and Member Sizes
The dimensions and sizes of all structural members shall be clearly noted on the drawings.

Generally
As a general principle, JCU requires the design of its new buildings to incorporate flexibility for future changes in internal layout or use. This requirement should be reflected in the design of the building structure. JCU does not seek to impose any structural design principles or methodologies on Consultants or Contractors, however it does require a structural design which combines both flexibility and economy.

Floor to Floor Heights
Floor to floor heights should be kept to a minimum whilst at the same time allowing sufficient space in ceilings for services distribution to maintaining a minimum ceiling height of 2.70m. Floor to floor height should match adjacent buildings where possible and if appropriate.

Location of Columns
Careful consideration must be given to the location of columns within the building. Columns within the body of a functional space should be avoided wherever possible. This applies in particular to Lecture Theatres and Seminar Rooms. Clear span slabs with no intermediate columns are desirable if budgetary constraints permit.

Columns located on the centre line of the building generally impose constraints on the layout of the floors, particularly those levels incorporating Academic Offices. It is the general policy of GU to locate Academic Offices along the external walls of the building to provide maximum natural light to these spaces, with all offices of generally equal size. This often results in a central corridor, and this must not be obstructed by columns.

9.3 Geotechnical Investigation

General

A geotechnical investigation and report shall be mandatory for all new buildings. The structural consultant shall provide the geotechnical investigation brief on behalf of the University.

At the commencement of any new project, any existing geotechnical investigations within the vicinity of the project shall be sourced by the University and reviewed by the consultant prior to briefing for the new investigation. If an existing investigation is deemed suitable for use on the project, then the extent of the new investigation may be reduced as seen fit by the consultant eg to provide confirmation of the existing investigation findings.

Notwithstanding this, it remains the structural consultant's responsibility to ensure that the resultant geotechnical investigations and reports are adequate and correct, and that the foundations can be accurately designed to suit the actual conditions. It is not acceptable for foundations to be redesigned during construction as a result of an inadequate or poorly briefed geotechnical investigation. The investigation shall be comprehensive and shall take account of all factors which could affect the design and serviceability of the building. As a mimimum, a new geotechnical investigation should include the following:

- 2 x Boreholes to a minimum depth of 2.5m;
- Dynamic Cone Penetrometer tests beside each borehole;
- Borelogs identifying the types of material encountered;
- Identification of depths of any existing fill;
- Identification of depths of any water table;
- Relevant laboratory testing such as grading, shrink-swell, plasticity index, linear shrinkage and CBR as determined necessary;
- AS2870 Site Classification (regardless of structure type);
- Discussion and recommendations on suitable foundation types;
- Bearing capacities for high-level footings;
- End bearing and side friction capacities for piled foundations;
- Discussion and recommendations on short and long-term settlements;
- Recommendations and design parameters for retaining walls and graded embankments.

On receipt of the geotechnical report, the structural consultant shall review the report and confirm that the information contained therein is adequate for design of the foundations. If the information is not adequate, then the consultant shall make this known immediately. Where required, additional investigation and/or reporting and/or recommendations shall be requested from geotechnical organisation.

Flood Levels & Water Tables

The geotechnical investigation shall address all issues relating to the effects of a flood on building foundations, and shall also identify any existing or potential water tables. The report shall make appropriate foundation design recommendations in order to negate such effects.

9.4 Design Loads for Floors

General
Superimposed dead loads and live loads and load combinations for floors shall generally be in accordance with AS 1170.1 for the proposed use or uses of the building. All other expected loadings which cannot be derived from AS1170 (eg equipment loadings) shall be obtained from the relevant organisations. Flexibility for future changes in occupancy and floor loads should also be considered at the commencement of the project in consultation with the University.

Floor and Roof Loadings
All floor and roof loadings shall be determined for each specific zone and use within the structure, however the following minimum live loadings shall apply:

- Office areas – 4.0kPa
- Internal stairs, landings & foyers – 4.0kPa
- Plant rooms – 5.0kPa
- Basements – 5.0kPa
- Non-trafficable Roofs – 0.25kPa

Compactus Storage
Provision shall be made for compactus storage as follows:

- The floors shall be designed for the specific compactus locations nominated in the brief,
- The floors shall be designed for additional possible compactus locations in all general office and administration areas in locations to be agreed with JCU,
- The size of the compactus shelving and the weight of materials to be stored shall be confirmed with JCU.

Library Stack Areas
The design live load for library stack areas shall be derived from the shelving manufacturer's specifications, but in no case less than 6kPa up to a maximum shelf height of 2.3m. For heights greater than 2.3m the load shall be determined specifically.

Special Use Areas
Design floor loads for special use areas shall be determined by the structural consultant in consultation with the University.

Slabs
Floor slabs shall be designed for the following general criteria:

- The most economical construction method to suit the project eg flat slabs, drop panels, slab and beams, post-tensioned etc;
- The use of large spans with reduced intermediate supports;
- Reduced extent of beams and beam depth to accommodate ductwork and other services suspended below the slab without unnecessarily increasing the floor to floor height.
- Flexibility of future use with due consideration to long-term deflections;
- Provision of known penetrations for current usage, and for future penetrations up to 1200mm square in selected areas;
- Provision of future core holes up to 200mm diameter possibly adjacent to columns;

Approval must be obtained from the University prior to the adoption of a post tensioned or precast concrete system for floor slab and beam construction. Where post tensioned slabs are installed, the structural drawings shall clearly note the following on all post-tensioning plans:

- The contractor shall undertake an as-built survey of the location of all tendons in three dimensions just prior to pouring concrete;
- The contractor shall produce an as-built drawing which clearly sets out the tendon locations in three dimensions relative to a permanent lateral datum and relative to the slab soffit;
- The contractor shall clearly and permanently mark the tendon run locations on the underside of the slab.

Slab construction and expansion joints shall be incorporated in the design, and shall be positioned to minimise movement and cracking in slabs, and to avoid unsightly gaps in floors and walls resulting from any movement of the structure.

All internal floor slabs on ground shall be detailed on moisture barrier equivalent to a 300 micron thick 'Fortecon' polythene membrane, and turned up around the perimeter and turned down into footings, with all joints lapped and sealed.

9.5 Reinforced Concrete Members

Durability

All reinforced concrete members shall be designed to satisfy the durability requirements set out in Section 4 of AS 3600. The durability parameters shall be determined for each concrete component of each project, however the following minimum requirements shall apply:

- Surfaces of members in interior environments – Exposure Classification = A2, f'c = 25MPa
- Surfaces of members in above-ground exterior environments - Exposure Classification = B1, f'c = 32MPa
- Vehicle pavements in any location – f'c = 32MPa

Control of Shrinkage Cracking

Control of cracking in reinforced concrete members shall satisfy all of the requirements set out in Sections 8, 9, 10 & 11 of AS 3600 for to a moderate level. The crack control parameters shall be determined for each concrete component of each project, however the following minimum requirements shall apply:

- Slabs – Moderate degree of crack control
- Walls - Moderate degree of crack control

Slip Joints

The design shall incorporate adequate slip joints between suspended concrete slabs and beams, and the tops of any masonry walls which are not rigidly connected to the slabs or beams with reinforcing bars.

Concrete Walls

Any walls 12m in length or more must have a full height movement control joint. Where possible the joint should be located immediately adjacent window or door openings and must be weatherproof.

Structural Walls
The use of concrete or masonry walls should be kept to minimum to ensure flexibility for future internal modifications or alterations. Such walls should be limited to lift shafts, fire stairs and plant rooms wherever possible. Walls required for bracing purposes should be carefully located so as not to impact severely on flexibility.

9.6 Structural Steelwork

Detailing
All structural steelwork shall be designed to permit ease of fabrication, transportation and erection. Wherever possible, members shall be kept to a maximum length and size which does not require any special permit for standard truck transportation.

Where members such as beams and struts are required to fit between fixed receiving members such as walls, they shall not be detailed with fixed end plates at each end. Wherever possible such members shall have cleated connections at least at one end to allow for ease of installation and adjustment.

Corrosion Protection
All external steelwork and connections and/or those exposed to the weather shall be hot dip galvanised in their entirety. All other members shall be coated with a suitable paint system specified by the structural consultant in conjunction with the architect.

Design shall proceed on the basis that cutting and welding on-site is not permitted. All cutting and welding shall be carried out in the steel fabricators shop during fabrication, prior to galvanising or painting.

9.7 Timber Framing

Permanent structural timber framing shall not be used on any project.