

SECTION 19

STRUCTURAL DESIGN

TABLE OF CONTENTS

19.0	STRUCTURAL DESIGN	2
19.1	Design Process Requirements	2
19.1.1	Approvals Required during Design	2
19.1.2	Site Infrastructure Connection Approvals	2
19.1.3	Schematic Design (SD) Report / Design Review	2
19.1.4	Developed Design (DD) Report / Design Review	2
19.1.5	Construction Contract Document Requirements	3
19.1.6	Handover Requirements	3
19.2	Specific Design Requirements	4
19.3	Standards	5
19.4	Geotechnical Investigation	6
19.5	Design Loads for Floors	7
19.6	Reinforced Concrete Members	8
19.7	Structural Steelwork	9
19.8	Timber Framing	9

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	05/05/15	Manager, Infrastructure Services	Rewritten with FortisEM and cross referenced with other sections
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19.0 STRUCTURAL DESIGN

This document is a section of the James Cook University (JCU) Design Guidelines and is not to be read in isolation. Consultants and Contractors are required to comply with all sections of the JCU Design Guidelines.

19.1 Design Process Requirements

The consultant shall be held responsible / liable for ensuring that all works necessary for the complete installation and successful operation are included in the design and specifications. Specific deliverables are required at the end of each project stage, namely:

19.1.1 Approvals Required during Design

Approval shall be obtained from the JCU Estate Directorate, Deputy Director, Planning and Development in SD for the:

- Buildings lifespan and durability parameters as noted in 19.2
- Extent of provision for future penetrations in floors and walls,
- Extent of allowable load-bearing walls and internal columns,
- Proposed use of load bearing clay masonry walls (e.g. brickwork),
- Use of Compactus Storage systems, and the
- Proposed adoption of a post tensioned or precast concrete system for floor slab and beam construction.

19.1.2 Site Infrastructure Connection Approvals

Not Applicable for this section.

19.1.3 Schematic Design (SD) Report / Design Review

Report Content in addition to requirements of Section 30:

- Structural drawings, dimensions and sizes of all structural members shall be clearly noted on the drawings, with information shown in tabular format:
 - Layout drawings showing any interfaces with existing services and structures including proposed services corridor/trenches.
 - Design superimposed dead loads
 - Design live loads
 - Design wind loads
 - Design earthquake loads
 - Design bearing pressures for foundation material
 - Special design live loads in localised areas such as compactus storage or mechanical equipment
 - Any other relevant loadings

19.1.4 Developed Design (DD) Report / Design Review

Report Content in addition to requirements of Section 30:

Following commissioning, undertake a witness inspection of the installation, ensure that the Consulting Engineer and JCU Manager, Asset Strategy and Maintenance (or representative) are present.

Provide a signed out and complete defects lists to the JCU Project Manager at least 2 weeks prior to practical completion.

19.2 Specific Design Requirements

JCU owns, operates and maintains all infrastructure services and all academic buildings on and within the campuses. The RPEQ consulting engineer shall take a long term (whole of life) investment and maintenance decision strategy when designing the systems.

All 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

Any deviation from these requirements shall be approved by the JCU Estate Directorate, Deputy Director, Planning and Development at the early briefing stages of the project, or when a change is proposed.

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 JCU Estate Directorate, Deputy Director, Planning and Development 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.

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.

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

All structural designs to take cognisance of additional support requirements given in Section 22 Ecological Sustainable Designs.

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 Deputy Director – Planning and Development in early briefing stages of the project. All load bearing walls are to be clearly noted on the structural drawings. The use of load bearing clay masonry walls (e.g. brickwork) is prohibited unless approved by the Deputy Director – Planning and Development in early briefing stages of the project,

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 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.

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 JCU 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.

19.3 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

19.4 Geotechnical Investigation

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

At the commencement of any new project, any existing geotechnical investigations within the vicinity of the project shall be sourced by the JCU Project Manager 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 e.g. 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 minimum, 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.

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.

19.5 Design Loads for Floors

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 (e.g. 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 JCU Estate Directorate, Deputy Director, Planning and Development.

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

No provision shall be made for compactus storage unless directed by the JCU Estate Directorate, Deputy Director, Planning and Development in the early stages of the project, the size of the compactus shelving and the weight of materials to be stored shall be confirmed with JCU Project Manager.

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.

Design floor loads for special use areas shall be determined by the structural consultant in consultation with the JCU Project Manager.

Floor slabs shall be designed for the following general criteria:

- The most economical construction method to suit the project e.g. 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 JCU Estate Directorate, Deputy Director, Planning and Development 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.

19.6 Reinforced Concrete Members

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, $f'c = 25\text{MPa}$
- Surfaces of members in above-ground exterior environments - Exposure Classification = B1, $f'c = 32\text{MPa}$
- Vehicle pavements in any location – $f'c = 32\text{MPa}$

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

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.

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

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.

19.7 Structural Steelwork

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.

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 in accordance with the requirements of Section 16 of these Design Guidelines.

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.

19.8 Timber Framing

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