Design Checkers' Handbook for Buildings

STANDARDS AUSTRALIA

Handbook

Design Checkers' Handbook for Buildings

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DESIGN CHECKERS' HANDBOOK

For Checking The Structural Design Of Building Elements

Contents

Disclaimer

This handbook is published as a guide for the application of various structural design standards in the checking of structural calculations for commercial, residential and industrial buildings to meet the quality assurance requirements of Clause 4.4 of AS 3901. This handbook should not be used to replace design calculations performed by suitably qualified and experienced structural engineers. The publisher and the authors accept no liability for the incorrect use or inappropriate application of any of the contents of this handbook.

INTRODUCTION

Purpose of the Design Checkers' Handbook

This handbook is published as a guide for the application of various structural design standards in the checking of structural calculations for commercial, residential and industrial buildings to meet the quality assurance requirements of Clause 4.4 of AS 3901. This handbook should not be used to replace design calculations performed by suitably qualified and experienced structural engineers who must also ensure that any charts and checking guides are appropriate for the particular application.

The fundamental aim of this handbook is to foster safe and serviceable buildings. A further purpose is to bring about a reduction in litigation resulting from flawed building design, fewer consequential insurance claims and a reduction of professional indemnity insurance premiums.

These aims can be achieved through formal Quality Management Systems for Design and Design Checking. The designer and checker should possess typical design solutions for the most common situations. This enables them to "get a feel" for the approximate dimensions required for footings, columns, beams, slabs, timber and steel members.

Checklists and Design Checking Charts

This handbook provides checklists and design checking charts to assist in checking the structural design of buildings.

It may also be used as a "layman's guide" to understanding the limitations of practical building design.

The handbook may also form the basis of a formal Quality Management System for consulting structural engineers, architects and local authorities. It could form part of the Building Application and Building Approval documentation.

The format of each check sheet is consistent with the requirements of AS 3901-1987/ISO 9001-1987 "Quality Systems for Design/Development, Production, Installation and Servicing". The charts of "typical designs" are consistent with the requirements of the relevant Australian Standards as referred to in the Building Code of Australia. This makes the handbook relevant to most building designs throughout Australia, particularly for small to medium size structures in non-cyclonic areas.

How To Use The Handbook

There are two ways to use the Design Checker's Handbook:

* Architects and draughtsmen may select preliminary dimensions of the major building components using the Design Charts.
* Structural design engineers, checking engineers and local authorities may use it as the formal Design Control document, in conjunction with AS 3901. Clauses 4.4, 4.13 and 4.14 of AS 3901 provide for:
  - Planning
  - Organisation
  - Design Input
  - Design Output
  - Verification
  - Design Changes
  - Control of Nonconforming Product
  - Corrective Action

  For each Building Application, the checklists would be completed and signed by the designer, the "typical design" charts completed and signed by the checker and the whole handbook forwarded to the local authority for approval. Thereafter, the Handbook may be used as the control document to ensure that construction complies with the approved drawings.

Scope

The handbook is applicable to all Building Classes 1 to 10, as defined in the BCA (The Building Code of Australia), although many of the Design Checking Charts are more applicable to medium density residential buildings (Class 2, 3 or 4) and offices (Class 5).

The scope is limited to that work generally undertaken by architects and structural design engineers, and addresses the prevention of structural failures relating to strength and serviceability. Loads considered include dead loads, live loads, wind, fire and earthquake. Although not specifically included, provision can be made for snow loads.

The Design Checking Charts do not deal with the following matters which could have a bearing on structural design.

* Stability of the structure and its component parts
* General safety, head clearances, non-slip pavements, safe balustrading and child safety
* Waterproofing and damp proofing
* Light and ventilation
* Noise insulation
* Heat insulation
* Condensation
* Allowance for people with disabilities
* Allowance for services
* Vehicular access for parking

Additional contractural matters are not covered in the Handbook.

Background To Legal Requirements And Duty Of Care

The responsibilities which designers and checkers have under the law arises out of a "duty of care" This is a concept developed by common law, that is, the law which has evolved through decisions which have been brought down by the courts.

The concept of "duty of care" fulfils a fundamental element in the common law action of negligence which arises when -

* A duty of care is owed by the defendant to the person taking the action.
  For example, a duty is owed by a designer to building occupiers who may be injured because of faulty design.
* There is breach of this duty.
  For example, if the designer carries out work to a level below the standard acceptable to the courts.
* There are damages for which the cause is reasonably proximate to the defendant's conduct.
  For example, this will occur when a person is injured due to faulty design.

One of the purposes of this Handbook is to ensure that the quality of structural design is such that there will be no breach of the duty of care below the standard expected of the courts.

The "common law" standard, set by the courts, for the carrying our of design work will generally be achieved if:

* There is compliance with the essential requirements of legislation, particularly those of the BCA (The Building Code of Australia) as modified by each State's Building Regulations and those Australian Standards called up therein.

* Critical elements of the design which are not covered (or incorrectly covered) by existing legislation, but which may have a bearing on the building's safety and adequacy, are dealt with by "state of the art" practices.

Establishment Of Priorities

To ensure that the standard of their "duty of care" is satisfactory, designers and design checkers should establish task priorities. These priorities are to ensure that time is effectively used to reduce major faults and failures in buildings.

Priorities should be set in respect to:

* The building as a whole
* Each element of the building

The particular Quality Management Plan for the design of any particular building should be based on the ranking of the building. The sample Quality Procedures which follow give guidelines for the establishment of priorities.

Checklists

Each section of the Handbook includes a three page Design Control and Design Verification Checklist which may be used as part of the Project Quality Plans for any particular building. The importance of correctly maintaining records cannot be emphasised strongly enough.

Design Checking Charts

Design Checking Charts provide for quick checking of critical elements. Although the charts vary for each element, the principles remain the same.

* All charts are based on the requirements of Australian Standards.

* The charts are plotted for the most commonly occurring loads:
  eg. Charts for suspended concrete slabs are plotted for a combination of floor live load of 2.0 kPa, roof live load of 0.25 kPa, roof and partition dead loads of 2.0 kPa for one, two or three storeys.

* Once the load case is known, enter the charts with the dimensions of the loaded area. Then read off the required member dimensions, reinforcement etc.

* The plotted solution is generally conservative, using simplified rules provided within the appropriate standard.

Provided the loads and support conditions have been properly assessed and the detailing meets all of the requirements of the Australian Standard, any member that complies with the Design Checking Chart will most likely be of adequate size. In this case compliance can be noted on the Checklist.

If the design does not comply with the appropriate, Design Checking Chart then further more detailed checking is required to determine whether:

* a more sophisticated design has been adopted, or
* the loads are different from those assumed in the Design Checking Charts, or
* the design is inadequate, requiring rectification.

Imporant Note:

These charts should only be used for checking or for preliminary sizing of members.

They do not replace the need for comprehensive and detailed design by a suitably qualified and experienced structural engineer in accordance with the appropriate Australian Standards.

Limit States

The design checker must identify the limit states of building elements that may lead to either structural failure or building fault. AS 1170 sets out the load combinations and load factors for structural design.

Possible modes of failure of major building elements should be noted with the Structural Design - Priority Ranking. The limits states which must be considered include:

(a) Structural failure arising from forces that include

* Live and dead loads
* Wind
* Foundation movements
* Earthquake
* Snow
* Temperature changes,moisture changes, chemical changes and creep
* Impact from trains, vehicles, boats, aeroplanes
* Explosions from leaking gas, chemicals, explosives
* Combinations of the above

Modes of failure that may arise from the action of such forces include-

* Ultimate limit state (collapse)-
  - Compression
  - Tension
  - Shear
  - Direct bending
  - Bending with shear
  - Buckling - axial or bending
  - Overturning or loss of stability
  - Formation of mechanism
  - Loss of bond or anchorage
  - Progressive collapse
  - Loss of material strength due to fire
  - Combinations of the above including effects of forces in three dimensions

* Serviceability limit states-
  - Deflection
  - Cracking
  - Vibration
  - Dynamic vibration
  - Fatigue
  - Weather penetration
  - Durability deterioration from:
    - Metal corrosion
    - Reaction between dissimilar metals
    - Abrasion
    - Loss of protective coating or cover
    - Sunlight
    - Corrosive atmosphere or liquids

(b) Fire Safety considerations of the BCA (The Building Code of Australia) that include-

* Loss of required fire-resistance level (FRL) as defined in the BCA because of reduction in
  - Structural adequacy
  - Integrity
  - Insulation

Faults may occur-

- within a structural element itself
- at the interface with adjoining elements

* Factors considered under Australian Standard 1530
  - Combustibility
  - Flammability
  - Ignitability

* Fire separation (compartmentation) both horizontally and vertically by floors and walls as required by Section C2 of the BCA.

* Safety of heating appliances

* Appropriate performance of fire fighting equipment including smoke and fire alarms emergency lighting and signs, lifts, hydrants and hose reels and sprinklers.

* Bush fire protection in accordance with AS 3959

(c) General safety considerations that include-

* Head clearances
* Correct going and rises for steps
* Provision for non slip surfaces in pedestrian areas
* Balustrading complying with Section D2.16 of the BCA
* Child safety, including swimming pool isolation.

(d) Waterproofing and damp proofing of-

* External doors, floors and roofs
* Internal wet areas

(e) Light and Ventilation

(f) Noise and insulation

(g) Heat insulation

(h) Condensation

(i) Allowance for people with disabilities as outlined in Section D2.4 of the ADCM (Australian Domestic Construction Manual), including-

* Pedestrian access to the dwelling - ramp
* Gradients, landings, kerbs, widths of doorways
* Vehicular access and parking

(j) Correct functioning of all services including-

* Air conditioning
* Water supply
* Sewerage
* Storm water drainage
* Electrical
* Telephones and other cable communications

(k) Vehicular access and parking

Quality Assurance Documents

Set out below are extracts from sample quality assurance documents which are based on the requirements of AS 3901. These extracts could form the basis of an acceptable Design Control element complying with AS 3901 Clause 4.4 for the quality management system of a typical small to medium sized design office.

Important Note: These clauses form only a framework on which a functional Quality Assurance System could be built. Each design office must customise the system, and add to it their own design procedures and work instructions necessary for them to effectively assure the quality of their design and checking work. This element must be used in conjunction with the other nineteen elements which are required for quality management systems complying with AS 3901.

QUALITY POLICY - DESIGN CONTROL

AS 3901 Clause 4.4 Refer to Procedure No 4

This policy shall apply to all design work undertaken by the Company, or by consultants on the Company's behalf, in the course of executing any "design only" or "design and construct" projects covered by the Quality System. Details shall be set out in Quality Procedures.

Any design work undertaken by external consultants on behalf of the Company, shall be controlled by the Consultant's Quality Assurance System and shall comply with AS 3901. The Project Manager shall prepare a Design Brief which shall be forwarded to the Consultant together with any supporting documentation. A copy of this Design Brief shall be forwarded to the Quality Manager for filing. Before commencement of the work, the Project Manager shall obtain from the Consultant a certification that the design work will be undertaken within a Quality Management System complying with AS 3901. If the Consultant does not have a suitable system complying with AS 3901, the work shall be subject to verification by the Company.

The Quality Procedures Manual shall specify the details of the design inputs, design outputs, design verification and design changes.

The Project Manager shall have the responsibility and authority to carry out the necessary design and development **planning**. The planning shall make provision for design changes and updates. The Project Manager shall have the responsibility and authority to initiate the routine design and detailing work and the required verification. AS 3901 Clause 4.4.2

The Project Manager shall have the responsibility and authority to **assign work** to the Designer, Design Checker and other personnel as required. AS 3901 Clause 4.4.2.1

The Designer shall **liaise** with other staff and regulatory authorities, as required, to ensure that all design information is supplied as described in the Procedures. AS 3901 Clause 4.4.2.2

Design input information, such as purchaser's specification, shall be clearly stated in a design brief. AS 3901 Clause 4.4.3

Design output information shall take the form of drawings, material lists, specifications etc. It shall be controlled by reference to Design Check Sheets to ensure that it meets the input requirements, is functional and meets the regulatory requirements (Building Code of Australia and referenced Australian Standards). AS 3901 Clause 4.4.4

Design verification of all parts of the design shall be carried out by a Design Checker, who shall have the appropriate degree of independence as described in the Procedures. The Design Checker shall record the verification on the appropriate drawings and Design Control and Design Verification Sheets which shall be retained in the permanent records. AS 3901 Clause 4.4.5

Design changes, whether initiated by the Purchaser or initiated internally, shall be documented as set out in the policy and procedure on Document Control. All drawings and specifications shall be treated as "Controlled Documents". AS 3901 Clause 4.5

QUALITY PROCEDURE - DESIGN CONTROL

AS 3901 Clause 4.4

1 PURPOSE

The purpose of this procedure is to describe the means of controlling and verifying any design work carried out by the Company (or on the Company's behalf) to ensure that the specified requirements are met.

2 SCOPE

This procedure shall apply to all design work undertaken by the Company or by consultants on the Company's behalf in the course of executing any "design only" or "design and construct project" project covered by the Quality System.

3 REFERENCES

AS 3901
"Quality Systems for Design/Development, Production, Installation and Servicing"
Standards Australia

AS 1057
"Quality Assurance and Quality Control - Glossary of Terms"
Standards Australia

4 GLOSSARY

Quality Policy Manual	A document setting out the quality policy, organisation, procedures and practices of the Company
Quality Procedures	A series of documents setting out the procedures to be undertaken to assure the quality of design and construction work undertaken by the Company
Document	Any relevant item associated with the Quality Management System or the particular Project including Quality Policy Manual, Quality Procedures Manual, Project Quality Plan, Drawings, Specifications, Site Instructions.

5 DESIGN CONTROL FOR DESIGN BY COMPANY STAFF

5.1 Design Brief

The Project Manager shall prepare a Design Brief and attach it to a standard form setting out the Structural Design Priority Ranking. This, together with any supporting documentation, shall be forwarded to the Designer who shall assume responsibility for design. A copy of the relevant documents shall be forwarded to the Quality Manager for filing.

5.2 Planning and Design Priorities

The Project Manager shall have the responsibility and authority to carry out the necessary design and development planning. To initiate the design and planning of such new products, the General Manager shall issue a memo to all relevant personnel. This authority and responsibility may be delegated to the Project Manager.

The Project Manager shall determine and record the appropriate priorities and ranking as set out using the following pages.