(Incorporating Amendment Nos 1 and 2)

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Australian Standards

for civil engineering students

Part 2: Structural engineering

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HB 2.2—2003 (Incorporating Amendment Nos 1 and 2)

Australian Standards for civil engineering students

Part 2: Structural engineering

Originated as part of HB 2—1982. Previous edition HB 2.2—2002. Eighth edition 2003. Reissued incorporating Amendment No. 1 (March 2003). Reissued incorporating Amendment No. 2 (July 2004).

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INTRODUCTION

This Handbook is the eighth edition (2003) of Part 2 of Australian Standards for civil engineering students. It was first published by Standards Australia in 1982 as a text book of abridged Standards suited to civil engineering subjects taught at tertiary level. The continuing intention is to make Standards more readily accessible to students and educational institutions.

Because of tightened copyright laws and the increased surveillance of copyright breaches, by 1981 the organization had become aware of a real need for a publication of this type. Lecturers from schools of civil engineering were asking for rights to copy and reproduce Standards, because purchase of Standards in their complete form was financially beyond most students. The Handbook was, therefore, designed to fill the requirements of both students and lecturers for a copy of commonly used parts of relevant Standards, at a reasonable cost.

This Handbook—

a) is re-issued incorporating Amendment No. 1 (March 2003), which corrects the editorial errors in some characters/symbols (such as f'_c , ρ , ζ , \leq , \pm , α , ε , °) on the following pages:

Introduction (this page), pages 6, 7, 11, 14, 15, 19, 27 to 32, 37, 38, 46 to 49, 51 to 53, 72, 78, 79, 84, 106, 112, 117, 118, 120, 121, 132, 526, 527, 545 to 547, 554 to 557, 560, 569 and 570;

and

b) incorporates Amendment No. 2 (July 2004). The changes required by this Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure, or part thereof affected.

This Handbook was prepared by Standards Australia in consultation with Schools and Departments of Civil Engineering and Building in Universities, Institutes of Technology and Colleges of Technical and Further Education in all States. It is not an Australian Standard but comprises extracts from selected Australian Standards considered relevant to undergraduate courses in civil engineering and advanced courses in building and building sciences. It is hoped that by this means, students will be better able to understand and use Standards when they enter the workforce.

Extracts in this part of the Handbook were selected to familiarize students with the nature and extent of structural engineering Standards and the type of constraints they imposed on persons working in the building industry. While extracts include portions of Standards that refer to frequently encountered situations, they do not contain all requirements that may be of critical importance to their assessment. In addition, while the Standards from which these extracts were taken were current editions at the time of publication of this Handbook, at any subsequent time the relevant Standards may have been amended or superseded.

For the foregoing reasons, this Handbook should only be used for educational purposes. Standards Australia does not accept any liability for any consequences that may result from the use of the Handbook for any purpose other than student instruction.

Views of teachers and students on this Handbook will be welcomed by Standards Australia, particularly on the inclusion of additional material or the deletion of other material in future revisions. Because this Handbook is comprised of 'extracts', it will be noted that, in some cases, Standards that are referred to are not necessarily included in the Handbook.

CONTENTS

Page

FOREWORD		4
CHAPTER 1	CONCRETE STRUCTURES	5
CHAPTER 2	STEEL STRUCTURES	135
CHAPTER 3	TIMBER STRUCTURES—DESIGN METHODS	269
CHAPTER 4	MASONRY STRUCTURES	405
CHAPTER 5	STRUCTURAL DESIGN ACTIONS	483
CHAPTER 6	RESIDENTIAL SLABS AND FOOTINGS—CONSTRUCTION	615

FOREWORD

Preparation and use of Standards

Australian Standards are issued by Standards Australia.

Within Standards Australia, the Construction Group produces Standards dealing with-

- (a) specifications for building materials;
- (b) methods of testing for the properties of construction materials;
- (c) rules for design and construction in the principal structural materials (usually called codes, and adopted by Governments in building regulations);
- (d) glossaries of terms; and
- (e) other matters related to building and civil engineering—such as standard fire tests and rules for demolition of old buildings.

Standards are revised and updated every few years in accordance with accepted good current practice, and experience in the use of the previous edition of the Standard.

Standards usually specify minimum requirements for the performance and safety of particular products or forms of construction. They are not intended to prevent or inhibit the development of new products or the application of good manufacturing design and construction techniques within the intent and spirit of the Standards.

The emphasis in modern Standards is on the required results (performance) rather than the methods or materials required to achieve these results (prescription).

Contents of Part 2

Part 2 contains extracts from Standards related to structural engineering design and construction in the commonly used materials.

This edition of Part 2 of the Handbook includes extracts from the following Standards:

AS	
1170	Minimum design loads on structures
1170.4—1993	Part 4: Earthquake loads
1720	Timber structures
1720.1—1997	Part 1: Design methods
2870—1996	Residential slabs and footings—Construction
3600—2001	Concrete structures
3700—2001	Masonry structures
4100—1998	Steel structures
AS/NZS	
1170	Structural design actions
1170.0:2002	Part 0: General principle
1170.1:2002	Part 1: Permanent, imposed and other actions
1170.2:2002	Part 2: Wind actions

Where included Standards have been amended, the amendments have been incorporeated in the extracts.

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CHAPTER 1

CONCRETE STRUCTURES

This Chapter consists of edited extracts from AS 3600—2001, *Concrete structures*. The Standard deals with the design and construction of plain, reinforced and prestressed concrete structures and members, but does not apply to special structures such as mass concrete dams or non-structural elements such as precast concrete pipes.

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STANDARDS AUSTRALIA

Australian Standard Concrete structures

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE AND APPLICATION

1.1.1 Scope

This Standard sets out minimum requirements for the design and construction of concrete structures and members that contain reinforcing steel, or tendons, or both. It also sets out minimum requirements for plain concrete members.

This Standard will be referenced in the Building Code of Australia by way of BCA Amendment No. 9 to be published by 1 July 2001, thereby superseding the previous edition, AS 3600—1994, which will be withdrawn 12 months from the date of publication of this edition.

1.1.2 Application

This Standard is intended to apply to concrete structures made of concrete—

- (a) with a characteristic compressive strength at 28 days (f'_c) in the range of 20 MPa to 65 MPa; and
- (b) with a saturated surface-dry density in the range 1800 kg/m^3 to 2800 kg/m^3 .

The Standard also applies to reinforcing steels complying with-

- (a) AS 1302, or having a yield strength (f_{sy}) of 500 MPa and Ductility Class N in accordance with AS/NZS 4671. These reinforcing materials may be used, without restriction, in all applications referred to in this Standard; and
- (b) AS 1303 or AS 1304, or having a yield strength (f_{sy}) of 500 MPa and Ductility Class L in accordance with AS/NZS 4671. These reinforcing materials shall not be used in any situation where the reinforcement is expected to undergo large deformation under strength limit state conditions.

NOTE: The use of Ductility Class L reinforcement is further limited by other clauses within this Standard.

(c) Prestressing tendons complying with AS 1310, AS 1311, or AS 1313, as appropriate.

For concrete road bridges and for concrete railway bridges, HB77.5 and HB77.8, respectively, shall be used where applicable.

The general principles of concrete design and construction embodied in this Standard may be applied to concrete other than that specified above, or to concrete structures or members not specifically mentioned herein.

This Standard is not intended to apply to the design of mass concrete structures. It is also not intended that the requirements of this Standard should take precedence over those of other Australian Standards.

NOTES:

1 It is intended that the design of a structure or member, to which this Standard applies, be carried out by, or under the supervision of, a suitably experienced and competent person.

2 Consideration is being given to extending the application of the Standard to structures in which the characteristic compressive strength of concrete (f'_c) is greater than 65 MPa. However, before such an extension could be incorporated, current research data indicates that some requirements of the Standard would need to be more stringent than those presently given and others appropriately modified.

1.2 REFERENCED DOCUMENTS

The documents referred to in this Standard are listed in Appendix C.

1.3 USE OF ALTERNATIVE MATERIALS OR METHODS

1.3.1 General

Provided that the requirements of Section 2 are met, this Standard shall not be interpreted so as to prevent the use of materials or methods of design or construction not specifically referred to herein.

NOTE: Where the intended use is subject to the control of a Building Authority, approval for the use of alternative materials or methods will need to be obtained from the Authority.

1.3.2 Existing structures

Where the strength or serviceability of an existing structure is to be evaluated, the general principles of this Standard may be applied. (See also Appendix B.)

1.4 DESIGN

1.4.1 Design data

The following design data shall be shown in the drawings:

- (a) Reference number and date of issue of applicable design Standards.
- (b) Live loads used in design.
- (c) Exposure classification for durability.
- (d) Fire-resistance rating, if applicable.
- (e) Class and, where appropriate, grade designation of concrete.
- (f) Grade, Ductility Class and type of reinforcement and grade and type of tendons.
- (g) The appropriate earthquake design category, acceleration coefficient and site factor determined from AS 1170.4.

1.4.2 Design details

The drawings or specification for concrete members and structures shall include, as appropriate, the following:

- (a) The shape and size of each member.
- (b) The finish and method of control for unformed surfaces.
- (c) Class of formwork in accordance with AS 3610 for the surface finish specified.
- (d) The size, quantity and location of all reinforcement, tendons and structural fixings and the cover to each.
- (e) Any required properties of the concrete.
- (f) The curing procedure.
- (g) The force required in each tendon, the maximum jacking force to be applied and the order in which tendons are to be stressed.

- (h) The location and details of planned construction or movement joints, connections and splices, and the method to be used for their protection.
- (i) The minimum period of time before stripping of forms and removal of shores.
- (j) Any constraint on construction assumed in the design.
- (k) Any other requirements.

1.5 CONSTRUCTION

All concrete structures, designed in accordance with this Standard, shall be constructed to ensure that all the requirements of the design as contained in the drawings and specifications are achieved.

1.6 DEFINITIONS

1.6.1 General

The definitions below apply to this Standard. Definitions peculiar to a particular Clause or Section are given in that clause or section and referred to below.

1.6.2 Administrative definitions

1.6.2.1 Approved

Except as may be otherwise stated, approved by the relevant Authority.

1.6.2.2 Building authority or other relevant regulatory authority

A body having statutory powers to control the design and erection of the structure in the area in which the structure is to be erected.

1.6.2.3 Drawings

The drawings forming part of the documents setting out the work to be executed.

1.6.2.4 Specification

The specification forming part of the documents setting out the work to be executed.

1.6.3 Technical definitions

1.6.3.1 Action

Any agent, such as imposed load, foundation movement or temperature gradient, which may act on a structure.

1.6.3.2 Action effects

The forces and moments, deformations, cracks and other effects, which are produced in a structure or in its component members by an action.

1.6.3.3 Average ambient temperature

The mean value of the daily maximum and minimum ambient temperatures at a site, averaged over the relevant period (i.e. $(\Sigma T_{max.} + \Sigma T_{min.})/(2 \times number of days))$.

1.6.3.4 Cement

Portland or blended cement complying with AS 3972, or a mixture of either of these with one or more supplementary cementitious materials complying with AS 3582.

1.6.3.5 Characteristic strength

That value of the material strength, as assessed by standard test, which is exceeded by 95% of the material.

1.6.3.6 *Composite concrete member*

A member consisting of concrete components constructed separately but structurally connected so that the member responds as a unit to applied actions.

1.6.3.7 Concrete

A mixture of cement, aggregates, and water, with or without the addition of chemical admixtures.

1.6.3.8 Construction joint

A joint, including a joint between precast segments, that is located in a part of a structure for convenience of construction and made so that the load-carrying capacity and serviceability of the structure will be unimpaired by the inclusion of the joint.

1.6.3.9 Cover

The distance between the outside of the reinforcing steel or tendons and the nearest permanent surface of the member excluding any surface finish.

NOTE: Unless otherwise noted, the tolerances on position of reinforcement and tendons given in Clause 19.5.3 apply.

1.6.3.10 *Creep factor*

The ratio of creep strain to elastic strain under conditions of constant stress.

1.6.3.11 Critical tensile zone

A region of a beam or slab where the design bending moment at the serviceability limit state $(M^*_{s,1})$, calculated with short-term load factor $\psi_s = 1.0$, equals or exceeds the critical moment for flexural cracking (M_{crit}) , which is calculated assuming a flexural ensile strength of concrete equal to 3.0 MPa.

1.6.3.12 *Direct loading*

Loading on a structure that includes the self-weight of its component elements and externally applied loads.

1.6.3.13 Ductility Class

A designation relating to the ductility of reinforcement, ('L' designates 'low', 'N' designates 'normal').

1.6.3.14 *Effective depth*

The distance from the extreme compressive fibre of the concrete to the resultant tensile force in the reinforcing steel and tendons in that zone which will be tensile at the ultimate strength condition in pure bending.

1.6.3.15 Effective span

The lesser of $(L_n + D)$ and L.

1.6.3.16 Exposure classification

See Clause 4.3.

1.6.3.17 *Fire-resistance level*

See Clause 5.2.

1.6.3.18 Fire-resistance period

See Clause 5.2

1.6.3.19 Fire-separating function

See Clause 5.2.