

AS 5100.5 Supplement 1—2008

Bridge design—Concrete—Commentary (Supplement to AS 5100.5—2004)



This Australian Standard Supplement was prepared by Committee BD-090, Bridge Design. It was approved on behalf of the Council of Standards Australia on 23 May 2008. This Supplement was published on 21 August 2008.

The following are represented on Committee BD-090:

- Association of Consulting Engineers Australia
 - Australasian Railway Association
 - AUSTROADS
 - Bureau of Steel Manufacturers of Australia
 - Cement Concrete & Aggregates Australia—Cement
 - Engineers Australia
 - Queensland University of Technology
 - Steel Reinforcement Institute of Australia
 - University of Western Sydney
-

Standards Australia wishes to acknowledge the participation of the expert individuals that contributed to the development of this Standard through their representation on the Committee.

Keeping Standards up-to-date

Australian Standards® are living documents that reflect progress in science, technology and systems. To maintain their currency, all Standards are periodically reviewed, and new editions are published. Between editions, amendments may be issued.

Standards may also be withdrawn. It is important that readers assure themselves they are using a current Standard, which should include any amendments that may have been published since the Standard was published.

Detailed information about Australian Standards, drafts, amendments and new projects can be found by visiting **www.standards.org.au**

Standards Australia welcomes suggestions for improvements, and encourages readers to notify us immediately of any apparent inaccuracies or ambiguities. Contact us via email at **mail@standards.org.au**, or write to Standards Australia, GPO Box 476, Sydney, NSW 2001.

AS 5100.5 Supplement 1—2008

Bridge design—Concrete—Commentary (Supplement to AS 5100.5—2004)

Originated as HB 77.5 Supp 1—1996.
Revised and designated as AS 5100.5 Supp 1—2008.

COPYRIGHT

© Standards Australia

All rights are reserved. No part of this work may be reproduced or copied in any form or by any means, electronic or mechanical, including photocopying, without the written permission of the publisher.

Published by Standards Australia GPO Box 476, Sydney, NSW 2001, Australia
ISBN 0 7337 8871 8

PREFACE

This Commentary was prepared by the Standards Australia Committee BD-090, Bridge Design, to supersede HB 77.5 Supp 1, *Australian Bridge Design Code—Concrete—Commentary (Supplement to SAA HB 77.5—1996)*.

The objective of this Commentary is to provide users with background information and guidance to AS 5100.5.

The Standard and Commentary are intended for use by bridge design professionals with demonstrated engineering competence in their field.

In this Commentary, AS 5100.5—2004 is referred to as ‘the Standard’.

The clause numbers and titles used in this Commentary are the same as those in AS 5100.5, except that they are prefixed by the letter ‘C’. To avoid possible confusion between the Commentary and the Standard, a Commentary clause is referred to as ‘Clause C.....’ in accordance with Standards Australia policy.

CONTENTS

	<i>Page</i>
SECTION C1 SCOPE AND GENERAL	
C1.1 SCOPE AND APPLICATION	7
C1.2 REFERENCED DOCUMENTS	8
C1.3 DEFINITIONS	8
C1.4 NOTATION.....	8
C1.5 USE OF ALTERNATIVE MATERIALS OR METHODS	8
C1.6 DESIGN	8
C1.7 MATERIALS AND CONSTRUCTION REQUIREMENT	9
SECTION C2 DESIGN REQUIREMENTS AND PROCEDURES	
C2.1 DESIGN REQUIREMENTS	10
C2.2 STRENGTH	10
C2.3 DURABILITY	11
C2.4 FIRE RESISTANCE.....	11
C2.5 FATIGUE	11
C2.6 DESIGN FOR STABILITY	13
C2.7 DEFLECTIONS OF BEAMS AND SLABS.....	13
C2.8 CRACKING	14
C2.9 VIBRATION	14
C2.10 DESIGN FOR STRENGTH AND SERVICEABILITY BY PROTOTYPE TESTING.....	14
C2.11 OTHER DESIGN REQUIREMENTS	14
SECTION C3 LOADS AND LOAD COMBINATIONS FOR STABILITY, STRENGTH AND SERVICEABILITY	
C3.1 LOADS AND OTHER ACTIONS.....	16
C3.2 LOAD COMBINATIONS	16
SECTION C4 DESIGN FOR DURABILITY	
C4.1 APPLICATION	17
C4.2 DESIGN FOR DURABILITY	18
C4.3 EXPOSURE CLASSIFICATION	20
C4.4 MEMBERS NOT CONTAINING MATERIAL REQUIRING PROTECTION	22
C4.5 EXPOSURE CLASSIFICATIONS A, B1, B2 AND C	22
C4.6 EXPOSURE CLASSIFICATION U	23
C4.7 ABRASION.....	24
C4.8 FREEZING AND THAWING	24
C4.9 CHEMICAL CONTENT IN CONCRETE.....	25
C4.10 COVER TO REINFORCING STEEL AND TENDONS	26
C4.11 PROVISIONS FOR STRAY CURRENT CORROSION	27
SECTION C5 DESIGN FOR FIRE RESISTANCE	30
SECTION C6 DESIGN PROPERTIES OF MATERIALS	
C6.1 PROPERTIES OF CONCRETE	31
C6.2 PROPERTIES OF REINFORCEMENT	44
C6.3 PROPERTIES OF TENDONS.....	46
C6.4 LOSS OF PRESTRESS IN TENDON	48

SECTION C7 METHODS OF STRUCTURAL ANALYSIS	
C7.1 GENERAL	54
C7.2 LINEAR ELASTIC ANALYSIS	54
C7.3 ELASTIC ANALYSIS OF FRAMES INCORPORATING SECONDARY BENDING MOMENTS	59
C7.4 RIGOROUS STRUCTURAL ANALYSIS	59
C7.5 PLASTIC METHODS OF ANALYSIS FOR SLABS	60
C7.6 PLASTIC METHODS OF ANALYSIS OF FRAMES.....	60
C7.7 SEISMIC ANALYSIS METHODS	61
SECTION C8 DESIGN OF BEAMS FOR STRENGTH AND SERVICEABILITY	
C8.1 STRENGTH OF BEAMS IN BENDING.....	64
C8.2 STRENGTH OF BEAMS IN SHEAR	68
C8.3 STRENGTH OF BEAMS IN TORSION	75
C8.4 LONGITUDINAL SHEAR IN BEAMS	78
C8.5 DEFLECTION OF BEAMS	80
C8.6 CRACK CONTROL OF BEAMS.....	82
C8.7 VIBRATION OF BEAMS.....	84
C8.8 PROPERTIES OF BEAMS	84
C8.9 SLENDERNESS LIMITS FOR BEAMS.....	84
SECTION C9 DESIGN OF SLABS FOR STRENGTH AND SERVICEABILITY	
C9.1 STRENGTH OF SLABS IN BENDING.....	87
C9.2 STRENGTH OF SLABS IN SHEAR.....	87
C9.3 DEFLECTION OF SLABS.....	88
C9.4 CRACK CONTROL OF SLABS.....	88
C9.5 VIBRATION OF SLABS	89
C9.6 MOMENT RESISTING WIDTH FOR ONE-WAY SLABS SUPPORTING CONCENTRATED LOADS	89
C9.7 LONGITUDINAL SHEAR IN SLABS	89
C9.8 FATIGUE OF SLABS.....	89
SECTION C10 DESIGN OF COLUMNS AND TENSION MEMBERS FOR STRENGTH AND SERVICEABILITY	
C10.1 GENERAL	91
C10.2 DESIGN PROCEDURES	91
C10.3 DESIGN OF SHORT COLUMNS.....	96
C10.4 DESIGN OF SLENDER COLUMNS.....	97
C10.5 SLENDERNESS.....	101
C10.6 STRENGTH OF COLUMNS IN COMBINED BENDING AND COMPRESSION	103
C10.7 REINFORCEMENT FOR COLUMNS.....	106
C10.8 DESIGN OF TENSION MEMBERS.....	108
SECTION C11 DESIGN OF WALLS	
C11.1 APPLICATION	111
C11.2 DESIGN PROCEDURES	111
C11.3 BRACING OF WALLS.....	111
C11.4 SIMPLIFIED DESIGN METHOD FOR BRACED WALLS SUBJECT TO VERTICAL IN-PLANE LOADS ONLY	111
C11.5 DESIGN OF WALLS FOR IN-PLANE HORIZONTAL FORCES	111
C11.6 REINFORCEMENT FOR WALLS	111

SECTION C12 DESIGN OF NON-FLEXURAL MEMBERS, END ZONES AND BEARING SURFACES

C12.1 DESIGN OF NON-FLEXURAL MEMBERS.....	113
C12.2 PRESTRESSING ANCHORAGE ZONES	117
C12.3 BEARING SURFACES.....	120

SECTION C13 STRESS DEVELOPMENT AND SPLICING OF REINFORCEMENT AND TENDONS

C13.1 STRESS DEVELOPMENT IN REINFORCEMENT.....	122
C13.2 SPLICING OF REINFORCEMENT.....	126
C13.3 STRESS DEVELOPMENT IN TENDONS	127
C13.4 COUPLING OF TENDONS	128

SECTION C14 JOINTS, EMBEDDED ITEMS FIXING AND CONNECTIONS

C14.1 DESIGN OF JOINTS	129
C14.2 EMBEDDED ITEMS	130
C14.3 REQUIREMENTS FOR FIXINGS.....	130
C14.4 CONNECTIONS	131

SECTION C15 PLAIN CONCRETE MEMBERS

C15.1 APPLICATION	132
C15.2 DESIGN	132
C15.3 STRENGTH IN BENDING.....	132
C15.4 STRENGTH IN SHEAR.....	132
C15.5 STRENGTH IN AXIAL COMPRESSION	132
C15.6 STRENGTH IN COMBINED BENDING AND COMPRESSION.....	132
C15.7 REINFORCEMENT AND EMBEDDED ITEMS.....	132

SECTION C16 MATERIAL AND CONSTRUCTION REQUIREMENTS

C16.1 MATERIAL AND CONSTRUCTION REQUIREMENTS FOR CONCRETE AND GROUT	133
C16.2 MATERIAL AND CONSTRUCTION REQUIREMENTS FOR REINFORCING STEEL	136
C16.3 MATERIAL AND CONSTRUCTION REQUIREMENTS FOR PRESTRESSING DUCTS, ANCHORAGES AND TENDONS	138
C16.4 CONSTRUCTION REQUIREMENTS FOR JOINTS AND EMBEDDED ITEMS	141
C16.5 TOLERANCES FOR STRUCTURES AND MEMBERS	141
C16.6 FORMWORK.....	143

SECTION C17 TESTING OF MEMBERS AND STRUCTURES

C17.1 GENERAL	145
C17.2 TESTING OF MEMBERS.....	145
C17.3 PROOF TESTING.....	145
C17.4 PROTOTYPE TESTING	146
C17.5 QUALITY CONTROL	147
C17.6 TESTING FOR STRENGTH OF HARDENED CONCRETE IN PLACE.....	147

APPENDICES

CA REFERENCED DOCUMENTS	150
CB DESIGN OF SEGMENTAL CONCRETE BRIDGES	151
CC BEAM STABILITY DURING ERECTION	153
CD SUSPENSION REINFORCEMENT DESIGN PROCEDURES	154
CE COMPOSITE CONCRETE MEMBERS DESIGN PROCEDURES.....	155

	<i>Page</i>
CF BOX GIRDERS.....	156
CG END ZONES FOR PRESTRESSING ANCHORAGES	157
CH STANDARD PRECAST PRESTRESSED CONCRETE GIRDER.....	158
CI REFERENCES	159

STANDARDS AUSTRALIA

Australian Standard

Bridge design—Concrete—Commentary (Supplement to AS 5100.5—2004)

SECTION C1 SCOPE AND GENERAL

C1.1 SCOPE AND APPLICATION

C1.1.1 Scope

The Standard sets out minimum provisions and criteria. Design engineers should always consider whether or not these will be sufficient for their particular structure, both from the point of view whether the given criteria are stringent enough and whether or not other considerations, not mentioned therein, need to be taken into account.

The provisions have been formulated on the basis of typical bridge structures. Design engineers are alerted to the fact that they should exercise engineering judgement when applying them to other structures. For example it may be appropriate to use the criteria for concrete properties for the concrete in a tunnel but the criteria for fire resistance may not be used, as the type of fire, fire load and structure behaviour under fire may be quite different.

In the preparation of a Standard such as this, a certain level of knowledge and competence is assumed. It was assumed that the predominant users of the Standard would be professionally qualified civil or structural engineers experienced in the design of concrete bridge structures, or equally qualified but less experienced persons working under their guidance. It is intended that the Standard be applied and interpreted primarily by such persons. It should be noted that the Standard is neither: a textbook, a design handbook nor a Guide to good practice. Users should consult other references for this type of information.

C1.1.2 Application

The lower limit on the characteristic compressive strength of concrete has been imposed because strengths less than this are not considered suitable for structural use. The upper limit has been imposed taking into account test data available on the behaviour of members made using higher strength concrete. It should be noted that within the Standard, concrete properties and design equations vary depending on the strength adopted.

Concretes made from naturally occurring Australian coarse aggregates have surface-dry densities falling in the range 2100 kg/m³ to 2800 kg/m³. Lightweight structural concretes in Australia generally use naturally occurring sands combined with manufactured lightweight coarse aggregates, for which the surface-dry density is seldom less than 1800 kg/m³. Density limits have been set accordingly.

The reinforcing steel Standard AS/NZS 4671 refers to three ductility classes of which two Class L and N are commonly available in Australia. The third, Class E, is formulated to meet the requirements for earthquake design in New Zealand and is normally not available in Australia. Thus provisions are given for only the two former classes.

The provisions of the Standard may be used for the design of structures with unbonded tendons, provided the design engineer recognizes the inherent differences in the behaviour of these structures and those with bonded tendons under both serviceability and ultimate limit states.

C1.2 REFERENCED DOCUMENTS

The Standards listed in Appendix A are subject to revision from time to time. A check should be made with Standards Australia (see its website www.standards.org.au) as to the currency of any Standard referenced in the text.

C1.3 DEFINITIONS

Technical definitions are provided in Clause 1.3 of the Standard. Some technical definitions that are applicable to only one Section are given in the Section in which they are relevant.

C1.4 NOTATION

The basis of the notation is generally in accordance with ISO 3898, *Bases for Design of Structures—Notations—General Symbols*. Standards Australia's policy is to use ISO recommendations on notation, wherever practicable, in structural design Standards such as AS/NZS 1170, AS 2327, AS 3600, AS 4100 and AS/NZS 4600.

The notation used in the Standard is consistent with AS 3600. This may result in some of the notation having a different definition to that of other parts of AS 5100.

C1.5 USE OF ALTERNATIVE MATERIALS OR METHODS

C1.5.1 General

(No Commentary)

C1.5.2 Use of other materials or methods

Where alternative materials or methods are to be used, the design engineer is required to seek approval from the appropriate authority.

C1.5.3 Existing structures

The evaluation of an existing structure from drawings should be undertaken with caution as the size and condition of the members and materials together with the properties of the materials may be significantly different to those indicated in the drawings. Actual bridge details and condition should be clarified by field inspection (see AS 5100.7 (Ref. 1)).

C1.5.4 Lightweight structural concrete

Lightweight structural concrete should be limited to material made with lightweight coarse and normal weight fine aggregates.

If lightweight structural concrete is to be used, due account should be taken of the variation of concrete properties from normal weight concrete and the effect on serviceability limit states.

C1.6 DESIGN

The information applicable to most members may be shown in only one of the drawings, usually the first sheet, or cited in the project specification as appropriate.

C1.6.1 Design data

The relevant requirements from AS 5100.2 should be included in the drawings.

C1.6.2 Design details

The class of formwork required for the specified surface finish should be as required by the authority. If the class of formwork is not specified, reference should be made to AS 3610.

Where a casting procedure has been assumed in the design process, that casting procedure should be shown in the drawings.