

Australian Standard[®]

Structural design actions

Part 4: Earthquake actions in Australia



This Australian Standard® was prepared by Committee BD-006, General Design Requirements and Loading on Structures. It was approved on behalf of the Council of Standards Australia on 22 May 2007.
This Standard was published on 9 October 2007.

The following are represented on Committee BD-006:

- Association of Consulting Engineers Australia
- Australian Building Codes Board
- Australian Steel Institute
- Cement Concrete and Aggregates Australia
- Concrete Masonry Association of Australia
- Department of Building and Housing (New Zealand)
- Engineers Australia
- Housing Industry Association
- Institution of Professional Engineers New Zealand
- James Cook University
- Master Builders Australia
- New Zealand Heavy Engineering Research Association
- Property Council of Australia
- Steel Reinforcement Institute of Australia
- Swinburne University of Technology
- Timber Development Association (NSW)
- University of Canterbury New Zealand
- University of Melbourne
- University of Newcastle

Additional Interests:

- Australian Defence Force Academy
- Australia Earthquake Engineering Society
- Australian Seismological Centre
- Building Research Association of New Zealand
- Environmental Systems and Services
- Geoscience Australia
- Institute of Geological and Nuclear Science
- New Zealand National Society for Earthquake Engineering
- Primary Industries and Resources South Australia
- Seismology Research Centre, Australia
- University of Adelaide

This Standard was issued in draft form for comment as DR 04303.

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 and through the public comment period.

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Standards may also be withdrawn.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.

Australian Standard[®]

Structural design actions

Part 4: Earthquake actions in Australia

Originated as AS 2121—1979.
Revised and redesignated as AS 1170.4—1993.
Second edition 2007.

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 8349 X

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee BD-006, General Design Requirements and Loading on Structures, to supersede AS 1170.4—1993, *Minimum design loads on structures*, Part 4: *Earthquake loads*.

After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this Standard as an Australian Standard rather than an Australian/New Zealand Standard.

The objective of this Standard is to provide designers of structures with earthquake actions and general detailing requirements for use in the design of structures subject to earthquakes.

This Standard is Part 4 of the 1170 series *Structural design actions*, which comprises the following parts, each of which has an accompanying Commentary* published as a Supplement:

AS

- 1170 Structural design actions
- 1170.4 Part 4: Earthquake actions (this Standard)

AS/NZS

- 1170.0 Part 0: General principles
- 1170.1 Part 1: Permanent, imposed and other actions
- 1170.2 Part 2: Wind actions
- 1170.3 Part 3: Snow and ice actions

NZS

- 1170.5 Part 5: Earthquake actions—New Zealand

This edition differs from AS 1170.4—1993 as follows:

- (a) Importance factors have been replaced with the annual probability of exceedance, to enable design to be set by the use of a single performance parameter. Values of hazard are determined using the return period factor determined from the annual probability of exceedance and the hazard factor for the site.
- (b) Combinations of actions are now given in the BCA and AS/NZS 1170.0.
- (c) Clauses on domestic structures have been simplified and moved to an Appendix.
- (d) Soil profile descriptors have been replaced with five (5) new site sub-soil classes.
- (e) Site factors and the effect of sub-soil conditions have been replaced with spectral shape factors in the form of response spectra that vary depending on the fundamental natural period of the structure.
- (f) The five (5) earthquake design categories have been simplified to three (3) new categories simply described as follows:
 - (i) I—a minimum static check.
 - (ii) II—static analysis.
 - (iii) III—dynamic analysis.
- (g) The option to allow no analysis or detailing for some structures has been removed (except for importance level 1 structures).

* The Commentary to this Standard, when published, will be AS 1170.4 Supp 1, *Structural design actions—Earthquake actions—Commentary* (Supplement to AS 1170.4—2007).

- (h) All requirements for the earthquake design categories are collected together in a single section (Section 5), with reference to the Sections on static and dynamic analysis.
- (i) The 50 m height limitation on ordinary moment-resisting frames has been removed but dynamic analysis is required above 50 m.
- (j) Due to new site sub-soil spectra, adjustments were needed to simple design rules throughout the Standard. The basic static and dynamic methods have not changed in this respect.
- (k) The equation for base shear has been aligned with international methods.
- (l) Structural response factor has been replaced by the combination of structural performance factor and structural ductility factor ($1/R_f$ to S_p/μ) and values modified for some structure types.
- (m) A new method has been introduced for the calculation of the fundamental natural period of the structure.
- (n) The clause on torsion effects has been simplified.
- (o) The clause on stability effects has been removed.
- (p) The requirement to design some structures for vertical components of earthquake action has been removed.
- (q) Scaling of results has been removed from the dynamic analysis.
- (r) The Section on structural alterations has been removed.
- (s) The clauses on parts and components have been simplified.
- (t) The ‘informative’ Appendices have been removed.

The Standard has been drafted to be applicable to the design of structures constructed of any material or combination thereof. Designers will need to refer to the appropriate material Standard(s) for guidance on detailing requirements additional to those contained in this Standard.

This Standard is not equivalent to ISO 3010:2001, *Basis for design of structures—Seismic actions on structures*, but is based on equivalent principles. ISO 3010 gives guidance on a general format and on detail for the drafting of national Standards on seismic actions. The principles of ISO 3010 have been adopted, including some of the detail, with modifications for the low seismicity in Australia. The most significant points are as follows*:

- (i) ISO 3010 is drafted as a guide for committees preparing Standards on seismic actions.
- (ii) Method and notation for presenting the mapped earthquake hazard data has not been adopted.
- (iii) Some notation and definitions have not been adopted.
- (iv) Details of the equivalent static method have been aligned.
- (v) Principles of the dynamic method have been aligned.

Particular acknowledgment should be given to those organizations listed as ‘additional interests’ for their contributions to the drafting of this Standard.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

* When published, the Commentary to this Standard will include additional information on the relationship of this Standard to ISO 3010:2001.

Statements expressed in mandatory terms in notes to tables and figures are deemed to be an integral part of this Standard.

Notes to the text contain information and guidance. They are not an integral part of the Standard.

CONTENTS

	<i>Page</i>
SECTION 1 SCOPE AND GENERAL	
1.1 SCOPE	6
1.2 NORMATIVE REFERENCES	6
1.3 DEFINITIONS	7
1.4 NOTATION AND UNITS	9
1.5 LEVELS, WEIGHTS AND FORCES OF THE STRUCTURE.....	11
SECTION 2 DESIGN PROCEDURE	
2.1 GENERAL	15
2.2 DESIGN PROCEDURE	15
SECTION 3 SITE HAZARD	
3.1 ANNUAL PROBABILITY OF EXCEEDANCE (P) AND PROBABILITY FACTOR (k_p).....	18
3.2 HAZARD FACTOR (Z)	18
SECTION 4 SITE SUB-SOIL CLASS	
4.1 DETERMINATION OF SITE SUB-SOIL CLASS	27
4.2 CLASS DEFINITIONS	28
SECTION 5 EARTHQUAKE DESIGN	
5.1 GENERAL	30
5.2 BASIC DESIGN PRINCIPLES	30
5.3 EARTHQUAKE DESIGN CATEGORY I (EDC I).....	31
5.4 EARTHQUAKE DESIGN CATEGORY II (EDC II)	31
5.5 EARTHQUAKE DESIGN CATEGORY III (EDC III).....	34
SECTION 6 EQUIVALENT STATIC ANALYSIS	
6.1 GENERAL	35
6.2 HORIZONTAL EQUIVALENT STATIC FORCES.....	35
6.3 VERTICAL DISTRIBUTION OF HORIZONTAL FORCES.....	36
6.4 SPECTRAL SHAPE FACTOR ($C_h(T)$)	37
6.5 DETERMINATION OF STRUCTURAL DUCTILITY (μ) AND STRUCTURAL PERFORMANCE FACTOR (S_p)	38
6.6 TORSIONAL EFFECTS	40
6.7 DRIFT DETERMINATION AND P -DELTA EFFECTS	40
SECTION 7 DYNAMIC ANALYSIS	
7.1 GENERAL	42
7.2 EARTHQUAKE ACTIONS	42
7.3 MATHEMATICAL MODEL	42
7.4 MODAL ANALYSIS	43
7.5 DRIFT DETERMINATION AND P -DELTA EFFECTS	43
SECTION 8 DESIGN OF PARTS AND COMPONENTS	
8.1 GENERAL REQUIREMENTS	44
8.2 METHOD USING DESIGN ACCELERATIONS	46
8.3 SIMPLE METHOD	46
APPENDIX A DOMESTIC STRUCTURES (HOUSING).....	48

STANDARDS AUSTRALIA

Australian Standard
Structural design actions

Part 4: Earthquake actions in Australia

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard sets out procedures for determining earthquake actions and detailing requirements for structures and components to be used in the design of structures. It also includes requirements for domestic structures.

Importance level 1 structures are not required to be designed for earthquake actions.

The following structures are outside the scope of this Standard:

- (a) High-risk structures.
- (b) Bridges.
- (c) Tanks containing liquids.
- (d) Civil structures including dams and bunds.
- (e) Offshore structures that are partly or fully immersed.
- (f) Soil-retaining structures.
- (g) Structures with first mode periods greater than 5 s.

This Standard does not consider the effect on a structure of related earthquake phenomena such as settlement, slides, subsidence, liquefaction or faulting.

NOTES:

- 1 For structures in New Zealand, see NZS 1170.5.
- 2 For earth-retaining structures, see AS 4678.

1.2 NORMATIVE REFERENCES

The following referenced documents are indispensable to the application of this Standard.

AS

1684	Residential timber-framed construction (all parts)
1720	Timber structures
1720.1	Part 1: Design methods
3600	Concrete structures
3700	Masonry structures
4100	Steel structures

AS/NZS

1170	Structural design actions
1170.0	Part 0: General principles
1170.1	Part 1: Permanent, imposed and other actions
1170.3	Part 3: Snow and ice actions



The remainder of this document
is available for purchase online at

➤ www.saiglobal.com/shop ◀

SAI Global also carries a wide range of publications from a wide variety of Standards Publishers:



Click on the logos to search the database online.