AS/NZS 1170.0:2002
(Incorporating Amendment Nos 1, 2, 3, 4 and 5)

AS/NZS 1170.0:2002

Australian/New Zealand Standard™

Structural design actions

Part 0: General principles

STANDARDS Australia

STANDARDS NEW ZEALAND PAEREWA AOTEAROA

This Joint Australian/New Zealand Standard was prepared by Joint Technical Committee BD-006, General design requirements and loading on structures. It was approved on behalf of the Council of Standards Australia on 29 March 2002 and on behalf of the Council of Standards New Zealand on 28 March 2002.
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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, in part, AS 1170.1—1989, *Minimum design loads on structures,* Part 1: *Dead and live loads*, and, in part, NZS 4203:1992, *Code of practice for general structural design and design loadings for buildings,* Volume 1: *Code of practice* and, in part, AS 2867—1986, *Farm structures—General requirements for structural design*.

This Standard incorporates Amendment No. 1 (January 2003), Amendment No. 2 (November 2003), Amendment No. 3 (April 2011), Amendment No. 4 (April 2005), and Amendment No. 5 (September 2011). The changes required by the Amendments are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

A4 This Standard is published as a joint Standard (as are also AS/NZS 1170.1 and AS/NZS 1170.2) and it is intended that it is suitable for use in New Zealand as well as Australia.

For Australia, this Standard will be referenced in the Building Code of Australia by way of BCA Amendment 11 to be published on 1 July 2002, thereby superseding in part the previous Edition, AS 1170.1—1989, which will be withdrawn 12 months from the date of publication of this edition. AS 1170.1—1989 may be used for structures not covered by the Building Code of Australia, until an Appendix is developed for inclusion in this Standard by amendment.

The objective of this Standard is to provide designers with general procedures and criteria for the structural design of structures. It outlines a design methodology that is applied in accordance with established engineering principles.

This Standard includes revised Clauses covering load combinations (referred to as combinations of actions) and general design and analysis clauses. It does not include values of actions (e.g. values of dead or live loads; referred to as permanent or imposed actions).

This Standard is Part 0 of the 1170 series, *Structural design actions*, which comprises the following parts, each of which has an accompanying Commentary published as a Supplement:

A4	AS/NZS 1170.0	General principles
	AS/NZS 1170.1	Permanent, imposed and other actions
	AS/NZS 1170.2	Wind actions
	AS/NZS 1170.3	Snow and ice actions
A4 A5	AS 1170.4	Earthquake actions in Australia
	NZS 1170.5	Earthquake actions – New Zealand

The Commentary to this Standard is AS/NZS 1170.0 Supp 1, *Structural design actions—General principles—Commentary* (*Supplement to* AS/NZS 1170.0:2002).

This Standard is based on the philosophy and principles set out in ISO 2394:1998, *General principles on reliability for structures*. ISO 2394 is written specifically as a guide for the preparation of national Standards covering the design of structures. It includes methods for establishing and calibrating reliability based limit states design Standards.

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.

A5 Statements expressed in mandatory terms in notes to tables are deemed to be requirements of this Standard. Notes to the text contain information and guidance and are not considered to be an integral part of the Standard.

CONTENTS

STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

Australian/New Zealand Standard
Structural design actions

Part 0: General principles

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard specifies general procedures and criteria for the structural design of a building or structure in limit states format. It covers limit states design, actions, combinations of actions, methods of analysis, robustness and confirmation of design.

The Standard is applicable to the structural design of whole buildings or structures and their elements.

This Standard covers the following actions:

(a) Permanent action (dead load).

(b) Imposed action (live load).

(c) Wind.

(d) Snow.

(e) Earthquake.

A3 (f) Static liquid pressure.

(g) Ground water.

(h) Rainwater ponding.

(i) Earth pressure.

NOTES:

1 Where this Standard does not give information required for design, special studies should be carried out. Guidance is given in Appendix A.

2 Where testing is used to determine data for design or to confirm a design, guidance on methods is given in Appendix B.

3 Normal design practice is that all likely actions be considered. Any actions considered in design that are not in the above list should be the subject of special studies, as they are not covered by this Standard.

4 Additional information on other actions such as movement effects, construction loads and accidental actions is given in the Commentary (see Preface).

5 Movement effects include actions on structures resulting from expansion or contraction of materials of construction (such as those due to creep, temperature or moisture content changes) and also those resulting from differential ground settlement. Serviceability may be particularly affected by such actions.

6 Guidance on criteria for serviceability is given in Appendix C, which have been found to be generally suitable for importance level 2 buildings. Structures of special importance or structures where more stringent criteria are appropriate may require the stated criteria to be tightened.

1.2 APPLICATION

This Standard may be used as a means for demonstrating compliance with the Requirements of Part B1 of the Building Code of Australia.

A3 This Standard is intended for citation by New Zealand's Department of Building and Housing as a document that contributes towards establishing compliance with Clause B1 'Structure' of the New Zealand Building Code (NZBC). Citation of the Standard means that compliance with the NZBC can be achieved by applying this Standard in conjunction with the appropriate material standards, provided that an engineer with relevant experience and skills in structural engineering is responsible for interpretation of the requirements.

1.3 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS
A3 1170 Minimum design loads on structures
1170.4 Part 4: Earthquake actions in Australia

AS/NZS
1170 Structural design actions
1170.1 Part 1: Permanent, imposed and other actions
1170.2 Part 2: Wind actions
A1 1170.3 Part 3: Snow and ice actions

Australian Building Codes Board
Building Code of Australia

A4 NZS
A5 1170 Structural design actions
1170.5 Part 5: Earthquake actions – New Zealand

1.4 DEFINITIONS

For the purpose of this Standard the definitions below apply.

1.4.1 Action

Set of concentrated or distributed forces acting on a structure (direct action), or deformation imposed on a structure or constrained within it (indirect action).

NOTE: The term load is also often used to describe direct actions.

1.4.2 Action effects (internal effects of actions, load effects)

Internal forces and bending moments due to actions (stress resultants).

1.4.3 Combination of actions

Set of design values used to confirm that the limit states are not exceeded under simultaneous influence of different actions.

1.4.4 Design action effect

The action effect computed from the design values of the actions or design loads.

1.4.5 Design capacity

The product of the capacity reduction factor and the nominal capacity.

1.4.6 Design situation

Set of conditions for which the design is required to demonstrate that relevant limit states are not exceeded.

1.4.7 Imposed action

A variable action resulting from the intended use or occupancy of the structure.

1.4.8 Limit states

States beyond which the structure no longer satisfies the design criteria.

NOTE: Limit states separate desired states (compliance) from undesired states (non-compliance).

1.4.9 Limit states, serviceability

States that correspond to conditions beyond which specified service criteria for a structure or structural element are no longer met.

NOTE: The criteria are based on the intended use and may include limits on deformation, vibratory response, degradation or other physical aspects.

1.4.10 Limit states, ultimate

States associated with collapse, or with other similar forms of structural failure.

NOTE: This generally corresponds to the maximum load-carrying resistance of a structure or structural element but, in some cases, to the maximum applicable strain or deformation.

1.4.11 Load

The value of a force appropriate to an action.

1.4.12 Permanent action

Action that is likely to act continuously and for which variations in magnitude with time are small compared with the mean value.

1.4.13 Proof testing

Application of test loads to a structure, sub-structure, member or connection, to ascertain the structural characteristics of that one item under test.

1.4.14 Prototype testing

Application of test loads to one or more samples of structures, sub-structures, members or connections to ascertain the structural characteristics of the population that the sample represents.

1.4.15 Reliability

Ability of a structure or structural element to fulfil the specified criteria, including the working life, for which it has been designed.

NOTE: Reliability covers structural safety and serviceability, and can be expressed in terms of probability.

1.4.16 Serviceability

Ability of a structure or structural element to perform adequately for normal use under all expected actions.

1.4.17 Shall

Indicates that a statement is mandatory.

1.4.18 Should

Indicates a recommendation (non-mandatory).

1.4.19 Structure

Organized combination of connected structural elements designed to provide some measure of resistance.

1.4.20 Structural element

Physically distinguishable part of a structure, for example, wall, column, beam, connection.

1.4.21 Structural robustness

Ability of a structure to withstand events like fire, explosion, impact or consequences of human errors, without being damaged to an extent disproportionate to the original cause.

1.4.22 Special study

A procedure for justifying departure from this Standard or for determining information not covered by this Standard.

NOTE: Special studies are outside the scope of this Standard.

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1.4.23 Design working life

Duration of the period during which a structure or a structural element, when designed, is assumed to perform for its intended purpose with expected maintenance but without major structural repair being necessary.

NOTE: In the context of this Standard, the design working life is a 'reference period' usually stated in years. It is a concept that can be used to select the probability of exceedance of different actions.

1.4.24 Environmental influences

Chemical, biological or physical influences on a structure, which may deteriorate the materials constituting the structure, and which in turn may affect its reliability in an unfavourable way.

1.5 NOTATION

Where non-dimensional ratios are involved, both the numerator and denominator are expressed in identical units.

The dimensional units for length and stress in all expressions or equations are to be taken as millimetres (mm) and megapascals (MPa) respectively, unless specifically noted otherwise.

Unless otherwise stated, the notation in this Standard has the following meanings:

E = action effect

E = earthquake action

E_{s} = serviceability earthquake action

E_{u} = ultimate earthquake action

E_{d} = design action effect

$E_{\mathrm{d,dst}}$ = design action effect of destabilizing actions

$E_{\mathrm{d,stb}}$ = design action effect of stabilizing actions

F_{e} = earth pressure action

$F_{\mathrm{e,u}}$ = ultimate earth pressure action

F_{ice} = ice action

F_{gw} = ground water action

$F_{l\mathrm{p}}$ = liquid pressure action

F_{pnd} = rainwater ponding action

F_{sn} = snow action

G = permanent action (self-weight or 'dead' action)

k_p = probability factor

k_t = factor to allow for variability of structural units

N = design working life of a building or structure, in years

P = the annual probability of exceedance

P_{ref} = reference probability of exceedance for safety

Q = imposed action (due to occupancy and use, 'live' action)

R = nominal capacity (based on the fifth percentile strength)

R_d = design capacity (equal to ϕR)

S_u = ultimate value of various actions appropriate for particular combinations

V_{sc} = coefficient of variation of structural characteristics

W = wind action

W_s = serviceability wind action

W_u = ultimate wind action

δ = values of the serviceability parameter determined on the basis of the design actions

δ_ℓ = limiting value of the serviceability parameter (the subscript 'ℓ' stands for limiting value)

ϕ = capacity reduction factor

ψ_c = combination factor for imposed action

A3 ψ_E = combination factor for earthquake actions

ψ_s = factor for determining frequent values (short-term) of actions

ψ_ℓ = factor for determining quasi-permanent values (long-term) of actions

SECTION 2 STRUCTURAL DESIGN PROCEDURE

2.1 GENERAL

Structural design shall be carried out using the procedure given in Clause 2.2 for ultimate limit states and Clause 2.3 for serviceability limit states.

2.2 ULTIMATE LIMIT STATES

Design for ultimate limit states shall be carried out by the following procedure:

A2 (a) Adopt the importance level for the building or structure and the associated annual probability of exceedance (P) for wind, snow and earthquake as follows:

   (i) For Australia—

      (A) structures covered by the Building Code of Australia—as given in the Building Code of Australia.

      (B) structures not covered by the Building Code of Australia and for which no design events are specified by the applicable legislation or by other Standards—as given in Appendix F.

   (ii) For New Zealand—as given in Section 3.

(b) Determine the permanent (G) and imposed (Q) loads in accordance with AS/NZS 1170.1.

(c) Determine the ultimate loads for wind (W) in accordance with AS/NZS 1170.2.

A4 (d) Determine the ultimate loads for earthquake (E_u) for Australia, in accordance with AS 1170.4 as modified by Appendix D of this Standard including the probability factor (k_p) and the changes to earthquake design category. For New Zealand determine the ultimate loads for earthquake (E_u), in accordance with NZS 1170.5.

A1 (e) Determine the ultimate loads for snow (F_{sn}) and ice (F_{ice}) in accordance with AS/NZS 1170.3.

(f) Where such actions are relevant, determine the ultimate loads for liquid pressure (F_{lp}) ground water (F_{gw}) rainwater ponding (F_{pnd}) and earth pressure loads ($F_{e,u}$) in accordance with AS/NZS 1170.1.

(g) Determine combinations of actions in accordance with Section 4.

(h) Analyse the structure and its parts for the relevant combinations in accordance with Section 5.

(i) Design and detail the structure in accordance with—

   (i) Section 6 for robustness; and

A4 (ii) for Australia, AS 1170.4 for earthquake, or

   (iii) for New Zealand, NZS 1170.5 for earthquake.

(j) Determine the design resistance using the applicable Standard or other document. The Building Code of Australia specifies the documents to be used within its jurisdiction.

(k) Confirm that the design resistance exceeds the appropriate action effects in accordance with Section 7.

2.3 SERVICEABILITY LIMIT STATES

Design for serviceability limit states shall be carried out by the following procedure as appropriate:

(a) Determine for the whole structure and for individual elements, the type of design serviceability conditions to be considered.

(b) Determine the design situation including the serviceability load event and serviceability limits for the design serviceability condition being considered (see Section 3 for New Zealand).

A2 NOTE: Guidelines for serviceability events and associated limits are given in Appendix C for loads associated with an appropriate annual probability of exceedance (P).

(c) Determine the permanent loads (G) and serviceability imposed loads (Q) in accordance with AS/NZS 1170.1.

(d) Determine serviceability loads for wind (W) in accordance with AS/NZS 1170.2.

A1 (e) Determine serviceability loads for snow (F_{sn}) and ice (F_{ice}) in accordance with AS/NZS 1170.3.

(f) Where such actions are relevant, determine serviceability loads for liquid pressure (F_{lp}) ground water (F_{gw}) rainwater ponding (F_{pnd}) and earth pressure ($F_{e,u}$) in accordance with AS/NZS 1170.1.

(g) Determine the applicable combinations corresponding to the selected design serviceability conditions in accordance with Section 4.

(h) Model the serviceability response of the structure and its parts for the relevant combinations for each serviceability condition using methods of analysis appropriate for the serviceability limit state in accordance with Section 5.

(i) Determine the serviceability response using the applicable Standard or other document. The Building Code of Australia specifies the documents to be used within its jurisdiction.

(j) Confirm, in accordance with Section 7, that the modelled serviceability response does not exceed the appropriate limiting values for each of the serviceability conditions identified.

A3 (k) Serviceability limits applicable to earthquake loading in New Zealand are to conform with the requirements of NZS 1170.5.

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SECTION 3 ANNUAL PROBABILITY OF EXCEEDANCE (FOR STRUCTURES IN NEW ZEALAND ONLY)

3.1 GENERAL

This Section shall be used to determine the annual probability of exceedance of ultimate limit state loads for New Zealand. It does not form part of the Standard for use in Australia.

Structures of importance level 5 are outside the scope of this Standard and require the annual probability of load exceedance (design event) to be determined by a special study.

NOTE: For buildings within Australia, refer to the Building Code of Australia.

3.2 DESIGN REQUIREMENTS

A structure shall be designed and constructed in such a way that it will, during its design working life, with appropriate degrees of reliability sustain all actions and environmental influences likely to occur. In particular it shall be designed as follows:

(a) To withstand extreme or frequently repeated actions, or both, occurring during its construction and anticipated use (resistance, deformability and static equilibrium requirements; that is, for safety).

Specifically, for earthquake actions for ultimate limit states this shall mean—

(i) avoidance of collapse of the structural system;

(ii) avoidance of collapse or loss of support of parts of the structure representing a hazard to human life inside and outside the structure or parts required for life safety systems; and

(iii) avoidance of damage to non-structural systems necessary for the building evacuation procedures that renders them inoperative.

(b) So that it will not be damaged to an extent disproportionate to the original cause, by events like fire, explosion, impact or consequences of human error (robustness requirement).

(c) To perform adequately under all expected actions (serviceability requirement).

Structural design carried out using the procedures given in Clause 2.2 for ultimate limit states and Clause 2.3 for serviceability limit states is deemed to comply with this Clause.

A4 NOTE: The design should include consideration of appropriate maintenance and the effects of environmental influences.

3.3 IMPORTANCE LEVELS

The importance level of the structure shall be determined in accordance with its occupancy and use, as given in Tables 3.1 and 3.2. The Table describes, in general terms, five categories of structure and gives some examples of each. For those buildings not specifically mentioned, the designer will need to exercise judgement in assigning the appropriate level.

Structures that have multiple uses shall be assigned the highest importance level applicable for any of those uses. Where access to a structure is via another structure of a lower importance level, then the importance level of the access structure shall be designated the same as the structure itself.

A2 3.4 ANNUAL PROBABILITY OF EXCEEDANCE

3.4.1 Ultimate limit states

For ultimate limit states for structures of importance levels 1 to 4, the annual probability of exceedance (P) for wind, snow and earthquake loads shall be as given in Table 3.3.

The design working life of structures that are erected for a number of short periods of use and dismantled between each, is equal to the total of the periods of use.

3.4.2 Serviceability limit states

Serviceability limit states shall include—

A4 (a) SLS1—the structure and the non-structural components do not require repair after the SLS1 earthquake, snow or wind event; and

(b) SLS2—the structure maintains operational continuity after the SLS2 earthquake.

For serviceability limit states for structures of importance levels 2 to 4, the annual probability of exceedance (P) for wind, snow and earthquake loads shall be determined as given in Table 3.3.

NOTE: Guidelines for limits associated with serviceability events are given in Appendix C.

TABLE 3.1

CONSEQUENCES OF FAILURE FOR IMPORTANCE LEVELS

Consequences of failure	Description	Importance level	Comment
Low	**Low** consequence for loss of human life, *or* **small or moderate** economic, social or environmental consequences	1	Minor structures (failure not likely to endanger human life)
Ordinary	**Medium** consequence for loss of human life, *or* **considerable** economic, social or environmental consequences	2	Normal structures and structures not falling into other levels
High	**High** consequence for loss of human life, *or* **very great** economic, social or environmental consequences	3	Major structures (affecting crowds)
		4	Post-disaster structures (post disaster functions or dangerous activities)
Exceptional	Circumstances where reliability must be set on a case by case basis	5	Exceptional structures

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TABLE 3.2

IMPORTANCE LEVELS FOR BUILDING TYPES—NEW ZEALAND STRUCTURES

Importance level	Comment	Examples
1	Structures presenting a low degree of hazard to life and other property	Structures with a total floor area of <30 m^2 Farm buildings, isolated structures, towers in rural situations Fences, masts, walls, in-ground swimming pools
2	Normal structures and structures not in other importance levels	Buildings not included in Importance Levels 1, 3 or 4 Single family dwellings Car parking buildings
3	Structures that as a whole may contain people in crowds or contents of high value to the community or pose risks to people in crowds	Buildings and facilities as follows: (a) Where more than 300 people can congregate in one area (b) Day care facilities with a capacity greater than 150 (c) Primary school or secondary school facilities with a capacity greater than 250 (d) Colleges or adult education facilities with a capacity greater than 500 (e) Health care facilities with a capacity of 50 or more resident patients but not having surgery or emergency treatment facilities (f) Airport terminals, principal railway stations with a capacity greater than 250 (g) Correctional institutions (h) Multi-occupancy residential, commercial (including shops), industrial, office and retailing buildings designed to accommodate more than 5000 people and with a gross area greater than 10 000 m^2 (i) Public assembly buildings, theatres and cinemas of greater than 1000 m^2 Emergency medical and other emergency facilities not designated as post-disaster Power-generating facilities, water treatment and waste water treatment facilities and other public utilities not designated as post-disaster Buildings and facilities not designated as post-disaster containing hazardous materials capable of causing hazardous conditions that do not extend beyond the property boundaries
4	Structures with special post-disaster functions	Buildings and facilities designated as essential facilities Buildings and facilities with special post-disaster function Medical emergency or surgical facilities Emergency service facilities such as fire, police stations and emergency vehicle garages Utilities or emergency supplies or installations required as backup for buildings and facilities of Importance Level 4 Designated emergency shelters, designated emergency centres and ancillary facilities Buildings and facilities containing hazardous materials capable of causing hazardous conditions that extend beyond the property boundaries
5	Special structures (outside the scope of this Standard—acceptable probability of failure to be determined by special study)	Structures that have special functions or whose failure poses catastrophic risk to a large area (e.g. 100 km^2) or a large number of people (e.g., 100 000) Major dams, extreme hazard facilities

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TABLE 3.3
ANNUAL PROBABILITY OF EXCEEDANCE

Design working life	Importance level	Annual probability of exceedance for ultimate limit states			Annual probability of exceedance for serviceability limit states	
		Wind	Snow	Earthquake	SLS1	SLS2 Importance level 4 only
Construction equipment, e.g., props, scaffolding, braces and similar	2	1/100	1/50	1/100	1/25	
Less than 6 months	1	1/25	1/25	1/25	—	
	2	1/100	1/50	1/100	1/25	
	3	1/250	1/100	1/250	1/25	
	4	1/1000	1/250	1/1000	1/25	
5 years	1	1/25	1/25	1/25	—	—
	2	1/250	1/50	1/250	1/25	—
	3	1/500	1/100	1/500	1/25	—
	4	1/1000	1/250	1/1000	1/25	1/250
25 years	1	1/50	1/25	1/50	—	—
	2	1/250	1/50	1/250	1/25	—
	3	1/500	1/100	1/500	1/25	—
	4	1/1000	1/250	1/1000	1/25	1/250
50 years	1	1/100	1/50	1/100	—	—
	2	1/500	1/150	1/500	1/25	—
	3	1/1000	1/250	1/1000	1/25	—
	4	1/2500	1/500	1/2500	1/25	1/500
100 years or more	1	1/250	1/150	1/250	—	—
	2	1/1000	1/250	1/1000	1/25	—
	3	1/2500	1/500	1/2500	1/25	—
	4	*	*	*	1/25	*

* For importance level 4 structures with a design working life of 100 years or more, the design events are determined by a hazard analysis but need to have probabilities less than or equal to those for importance level 3.

Design events for importance level 5 structures should be determined on a case by case basis.

SECTION 4 COMBINATIONS OF ACTIONS

4.1 GENERAL

The combinations of actions for use in design of structures shall be as given in this Standard. Other combinations may be required.

4.2 COMBINATIONS OF ACTIONS FOR ULTIMATE LIMIT STATES

4.2.1 Stability

The basic combinations for the ultimate limit states used in checking stability (see Clause 7.2.1) shall be as follows where the long-term and combination factors are given in Table 4.1:

(a) For combinations that produce net stabilizing effects ($E_{d,stb}$):

$E_{d,stb} = [0.9G]$ permanent action only (does not apply to prestressing forces)

(b) For combinations that produce net destabilizing effects ($E_{d,dst}$):

(i) $E_{d,dst} = [1.35G]$ permanent action only (does not apply to prestressing forces)

(ii) $E_{d,dst} = [1.2G, 1.5Q]$ permanent and imposed action

(iv) $E_{d,dst} = [1.2G, W_u, \psi_c Q]$ permanent, wind and imposed action

A3 (v) $E_{d,dst} = [G, E_u, \psi_E Q]$ permanent, earthquake and imposed action

(vi) $E_{d,dst} = [1.2G, S_u, \psi_c Q]$ permanent action, actions given in Clause 4.2.3 and imposed action

NOTE: Combination factors for prestressing forces are given in the appropriate materials design Standard.

4.2.2 Strength

The basic combinations for the ultimate limit states used in checking strength (see Clause 7.2.2) shall be as follows, where the long-term and combination factors are given in Table 4.1:

(a) $E_d = [1.35G]$ permanent action only (does not apply to prestressing forces)

(b) $E_d = [1.2G, 1.5Q]$ permanent and imposed action

(c) $E_d = [1.2G, 1.5\psi_\ell Q]$ permanent and long-term imposed action

(d) $E_d = [1.2G, W_u, \psi_c Q]$ permanent, wind and imposed action

(e) $E_d = [0.9G, W_u]$ permanent and wind action reversal

A3 (f) $E_d = [G, E_u, \psi_E Q]$ permanent, earthquake and imposed action

(g) $E_d = [1.2G, S_u, \psi_c Q]$ permanent action, actions given in Clause 4.2.3 and imposed action

A3 NOTES:

1 Combination factors for prestressing forces are given in the appropriate materials design Standard.

2 Refer to AS/NZS 1170.1, Clause 3.3.

A3 Where impact is a design consideration, and no other Standard sets the manner of calculation, the effect shall be considered as part of imposed action, that is substitute (Q + Impact) for Q in the relevant combinations.

TABLE 4.1

SHORT-TERM, LONG-TERM AND COMBINATION FACTORS

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Character of imposed action	Short-term factor (ψ_s)	Long-term factor (ψ_ℓ)	Combination factor (ψ_c)	Earthquake combination factor (ψ_E)
Distributed imposed actions, Q				
Floors				
Residential and domestic	0.7	0.4	0.4	0.3
Offices	0.7	0.4	0.4	0.3
Parking	0.7	0.4	0.4	0.3
Retail	0.7	0.4	0.4	0.3
Storage	1.0	0.6	0.6	0.6
Other	1.0	0.6	0.6	0.6
Roofs				
Roofs used for floor type activities (see AS/NZS 1170.1)	0.7	0.4	0.4	0.3
All other roofs	0.7	0.0	0.0	0.0
Concentrated imposed actions (including balustrades), Q				
Floors	1.0	0.6	as for distributed floor actions	0.3
Floors of domestic housing	1.0	0.4		0.3
Roofs used for floor type activities	1.0	0.6		0.3
All other roofs	1.0	0.0	0.0	0.0
Balustrades	1.0	0.0	0.0	0.0
Long-term installed machinery, tare weight	1.0	1.0	1.2	1.0

4.2.3 Combinations for snow, liquid pressure, rainwater ponding, ground water and earth pressure

Where appropriate to the design situation, the basic combinations shall be modified for the action of liquid pressure, ground water and earth pressure by the use of the following factored values:

A1 (a) $S_u = F_{sn}$ for snow determined in accordance with AS/NZS 1170.3.

(b) Where the liquid type and density is well defined and design liquid height cannot be exceeded—

  (i) $S_u = 1.2\ F_{lp}$ for static liquid pressure; and

  (ii) for self-weight of stored liquid, use the factor for permanent action

(c) Where liquid type or density is not well defined or design liquid height is not limited—

  (i) $S_u = 1.5\ F_{lp}$ for static liquid pressure; and

(ii) for self-weight of stored liquid, use the factor for imposed action.

(d) $S_u = 1.2\ F_{pnd}$ for rainwater ponding where the water level is as given in AS/NZS 1170.1.

(e) $S_u = 1.2\ F_{gw}$ for ground water where the ground water level is as given in AS/NZS 1170.1, otherwise $S_u = 1.5\ F_{gw}$.

(f) For earth pressures:

(i) $S_u = 1.0\ F_{e,u}$ when $F_{e,u}$ is determined using an ultimate limit states method.

(ii) $S_u = 1.5\ F_e$ when determined using other methods.

A1 | (g) $S_u = 1.2F_{ice}$ for ice determined in accordance with AS/NZS 1170.3.

4.2.4 Combinations of actions for fire

The combination of factored actions used when confirming the ultimate limit state for fire shall be as follows:

$[G$, thermal actions arising from the fire, $\psi_\ell Q]$

NOTE: Where it is appropriate to consider the stability of remaining walls that may collapse outwards after a fire event, other ultimate limit states criteria are given in Section 6.

4.3 COMBINATIONS OF ACTIONS FOR SERVICEABILITY LIMIT STATES

Combinations of actions for the serviceability limit states shall be those appropriate for the serviceability condition being considered. Appropriate combinations may include one or a number of the following using the short-term and long-term values given in Table 4.1:

(a) G

(b) $\psi_s Q$

(c) $\psi_\ell Q$

(d) W_s

(e) E_s

(f) Serviceability values of other actions, as appropriate.

4.4 CYCLIC ACTIONS

When checking structures or elements of structures for fatigue performance under repeated in-service cyclic actions, the level of repeated loading to be used shall be the actual load level expected for the design situation.

SECTION 5 METHODS OF ANALYSIS

5.1 GENERAL

The structural analysis used to determine action effects from loads shall be in accordance with the principles of structural mechanics.

5.2 STRUCTURAL MODELS

The structural model shall reflect the behaviour of the structure for the appropriate limit state being considered.

Structural models, parameters and properties shall be as given in the relevant Australian or New Zealand Standards for design of material for the appropriate limit states.

A3 Modelling shall be based on the following:

(a) Static or dynamic response, or both.

(b) Elastic or non-elastic (plastic) response, or both.

(c) Geometrically linear or geometrically non-linear response, or both.

(d) Time-independent or time-dependent behaviour, or both.

SECTION 6 STRUCTURAL ROBUSTNESS

6.1 GENERAL

General detailing of components of the structural force-resisting system and of other components shall be in accordance with this Section.

Structures shall be detailed such that all parts of the structure shall be tied together both in the horizontal and the vertical planes so that the structure can withstand an event without being damaged to an extent disproportionate to that event.

Clause 6.2 is deemed to satisfy this Clause.

6.2 LOAD PATHS

6.2.1 General

The design of the structure shall provide load paths to the foundations for forces generated by all types of actions from all parts of the structure, including structural and non-structural components. The minimum actions shall be as given in Clauses 6.2.2 to 6.2.5.

6.2.2 Minimum resistance

A3 The structure shall have a minimum lateral resistance equivalent to the following percentage of $(G + \psi_c Q)$ for each level, applied simultaneously at each level for a given direction:

(a) For structures over 15 m tall ....1%.

(b) For all other structures ....1.5%.

The height shall be the height of the top of the structure above the level where the structure is coupled with the ground for lateral resistance.

The direction of application of the lateral load shall be that which will produce the most critical action effect in the element under consideration, except that the application of this load in more than one direction simultaneously need not be considered in the design of any element.

6.2.3 Minimum lateral resistance of connections and ties

All parts of the structure shall be interconnected. Connections shall be capable of transmitting 5 percent of the value of $(G + \psi_c Q)$ for the connection under consideration.

6.2.4 Diaphragms

Floor and roof diaphragms shall be designed—

(a) to resist required horizontal forces; and

(b) to have ties or struts (where used) able to distribute the required wall anchorage forces.

6.2.5 Walls

A3 Walls shall be connected to the structure to provide horizontal resistance to face loads. The connection between the wall and the structure shall be capable of resisting the forces of 5% of G.

SECTION 7 CONFIRMATION METHODS

7.1 GENERAL

It shall be confirmed that all limit states are complied with by consideration of the relevant design situations and load cases, in accordance with Clauses 7.2 and 7.3.

NOTE: Appendix B gives guidance on testing as a means for confirmation.

7.2 ULTIMATE LIMIT STATES

7.2.1 Stability

When considering a limit state of static equilibrium or of gross displacements or deformations of the structure, it shall be confirmed that—

$$E_{\mathrm{d,stb}} + R_{\mathrm{d}} \geq E_{\mathrm{d,dst}} \qquad \ldots 7.1$$

where

$E_{\mathrm{d,stb}}$ = design action effect of stabilizing actions (see Clause 4.2)

R_{d} = design capacity (equal to ϕR)

$E_{\mathrm{d,dst}}$ = design action effect of destabilizing actions

7.2.2 Strength

When considering a limit state of collapse, rupture or excessive deformation of a structure, section, member or connection it shall be confirmed that—

$$R_{\mathrm{d}} \geq E_{\mathrm{d}} \qquad \ldots 7.2$$

where

R_{d} = design capacity (equal to ϕR)

E_{d} = design action effect (see Clause 4.2)

7.3 SERVICEABILITY LIMIT STATES

When considering a serviceability limit state, it shall be confirmed that—

$$\delta \leq \delta_{\ell} \qquad \ldots 7.3$$

where

δ = value of the serviceability parameter determined on the basis of the design actions (see Clause 4.3)

δ_{ℓ} = limiting value of the serviceability parameter.

NOTE: The limiting value of the serviceability parameter should be determined based on accepted information, unless specific limits are specified for the particular structure being designed. Guidance on acceptable serviceability limits for some typical situations are given in Appendix C.

APPENDIX A

SPECIAL STUDIES

(Informative)

Where changes are made to a part or all of the design processes detailed in Clauses 2.2 and 2.3 or new information or methods are introduced, they should be established by special studies.

NOTE: Generally, design situations to be considered are covered by the clauses in Sections 2 and 4. However, actions other than those specified in the Standard and design considerations specific to the structure being designed may require special studies to be carried out.

Special studies should be used for the following:

(a) To establish information or methods for design not given in this Standard, or to define more accurately the information or methods used, or where more accuracy is considered necessary.

NOTES:

1 For example, to determine a design parameter such as a wind pressure coefficient, to establish values for an action or to confirm a structure or population of structures.

2 Methods for performing tests and analysing test information are given in Appendix B.

(b) To evaluate loads for actions other than those specified in this Standard. Where they are considered a possibility, special studies should be used to determine values for the following actions:

(i) Foundation movements.

(ii) Dynamic effects.

(iii) Time-dependent movement of materials.

(iv) Differential axial shortening.

(v) Shrinkage and expansion of materials.

(vi) Temperature changes and gradients (including those caused by fire).

NOTE: Care is needed in determining material properties for use in these design-loading conditions.

Where a study is used to establish design values for an action, the factors for appropriate combinations should be determined as part of the study. The variability of the loads derived should be taken into account when determining the factors used in the combinations.

A special study should include appropriate documentation to show the source of all data. Any documentation should demonstrate that the study is appropriate in the context of the particular evaluation of structural performance and should include the following, where relevant:

(A) A complete report similar in scope to that set out in Appendix B.

(B) Reference to other national or international Standards.

(C) Comparison with other data.

(D) Analytical methods used.

APPENDIX B
USE OF TEST DATA FOR DESIGN
(Informative)

B1 GENERAL

B1.1 Scope

The use in design of data from observation and testing (experimental models) should be as given in this Appendix. Methods for testing and for evaluation of the results are given. More specific methods for each type of action can be found in the relevant Part of this series of Standards.

Testing may be carried out as part of a study, where—

(a) more accurate information is required for use in structural design;

(b) specific design parameters are not included in the relevant Standard; or

(c) the situation is sufficiently unusual to require that limit states be checked by methods other than calculation.

Specific methods for proof testing and prototype testing of structures or parts of structures are covered in Paragraphs B2 and B3. Checks on material properties or other control tests are not considered to be part of this Appendix.

Examples of information to be determined using this Appendix include—

(i) values for an action at a particular site (including reliability parameters);

(ii) design parameters (e.g., wind pressure factors);

(iii) structural response under loads; and

(iv) reliability of a structure or population of structures.

B1.2 Reliability

The use, in design, of data determined in this Appendix should be carried out in such a way that the structure, as designed or tested, has at least the same reliability with respect to all limit states, as structures for which the design is based on calculation only.

B1.3 Use of test data

The general design procedure should be in accordance with Section 2 of this Standard. Where test data is required for some part of the procedure, all variables relevant to that part of the procedure should be considered.

The unknown coefficients or quantities to be evaluated from the test data should be clearly indicated and the supporting test information provided.

The evaluation of the data should be based on statistical methods consistent with the aim of Paragraph B1.2. The statistical approach used in the evaluation of the test data should be described.

Separate account should be taken of those variables or conditions that are not covered by the test procedures.

B1.4 Modelling

The test arrangement should be modelled taking into account the circumstances affecting the real situation being modelled. The differences between reality and the testing conditions should be accounted for by a suitably determined modification factor.

Apparatus should be appropriately calibrated.

The testing procedure and any analysis methods to be used should be established and documented.

B1.5 Report

The test report should include the following:

(a) Scope of information required from the test data.

(b) Description of conditions that could influence the behaviour under consideration.

(c) Details of the testing arrangement and measurement methods.

(d) Details of the testing procedure (including the methods established for analysis).

(e) Environmental conditions of the test.

(f) Materials tested (including number of samples, all relevant properties of samples, e.g., nature and size of characteristics in timber).

(g) Measurements of relevant properties.

(h) Results (including modes of failure if relevant).

(i) Evaluation of the data and conclusions.

(j) Any unusual aspects of the testing.

(k) The name and location of the testing laboratory or testing organization.

(l) The number of this Australian/New Zealand Standard, i.e. AS/NZS 1170.0.

B2 PROOF TESTING

B2.1 General

This test method establishes the ability of the particular unit under test to satisfy the limit state that the test is designed to evaluate. The relevant parts of Paragraph B1 should be followed.

B2.2 Test load

The target test load should be equal to the design action effect for the relevant limit state.

NOTE: The design action effect may need to be factored to account for the effect of duration of load on the strength and serviceability of the structure.

B2.3 Criteria for acceptance

The criteria for acceptance should be as follows:

(a) *Strength limit state* The item should be deemed to comply with the strength limit state if it is able to sustain the target test load for that limit state for at least 15 min. It should then be inspected to determine the nature and extent of any damage incurred during the test. The effects of the damage should be considered and, if necessary, appropriate repairs to the damaged parts carried out.

NOTE: For materials with time-dependent properties, the load should be removed within a reasonably short period of time after completion of the test. For example, reduce the design load by 25 percent within 15 min, and 50 percent within the following hour. Further guidance should be given in the relevant materials Standards.

(b) *Serviceability limit state* The maximum deformations of the item should be within the specified serviceability limits when subjected to the target test load for that limit state. Where the residual deflection exceeds 30 percent of the deflection at the target test load, the item should either be reloaded to the target test load to ensure that it has not sustained serious permanent damage, or other measures should be taken to determine the level of damage.

B3 PROTOTYPE TESTING

B3.1 General

This test method establishes the ability of a population of items to satisfy the limit state that the test is designed to evaluate. The method is not applicable to the testing of structural models, nor to the establishment of general design criteria or data.

Sampling should be carried out so that samples are representative of the population they are drawn from.

The test load should be applied at as constant a rate as practicable. Load-deflection curves should be plotted during each test on each unit. Deflections should be measured appropriate to the material being tested and should include values before the commencement of the test, after the test load has been applied and after removal of the test load.

B3.2 Design capacity of specific products and assemblies

The design capacity of a specific product or a specific assembly may be established by prototype testing of that product or assembly. The design capacity should not exceed the minimum value of the test results divided by the appropriate value of k_t as given in Paragraph B3.4.

B3.3 Units for testing

The units used in testing should be manufactured using the materials and methods that will be used in production. Where the units are sampled from a defined population they should be a representative sample. If the materials or methods of production change then the results of the testing may not be applicable to the new production without further investigation.

B3.4 Test load

The target test load should be equal to the design action effect for the relevant limit state determined in accordance with this Standard, multiplied by the appropriate factor k_t, given in Table B1 to allow for variability of structural units.

Other appropriate factors should be applied depending on the materials from which the unit is manufactured, including factors covering the effect of time-dependent properties. See materials design Standards for appropriate values.

The distribution and duration of forces applied during the test should represent those forces to which the unit is deemed to be subjected. For a short-term test, the test load should be applied at a uniform rate such that the test duration is not less than 5 min.

The coefficient of variation of structural characteristics of the parent population of the production units (V_{sc}) should be established taking into account variation due to fabrication and material.

TABLE B1

VALUES OF k_t TO ALLOW FOR VARIABILITY OF STRUCTURAL UNITS

Number of units to be tested	Coefficient of variation of structural characteristics (V_{sc}), percent						
	5	10	15	20	25	30	40
1	1.20	1.46	1.79	2.21	2.75	3.45	5.2
2	1.17	1.38	1.64	1.96	2.36	2.86	3.9
3	1.15	1.33	1.56	1.83	2.16	2.56	3.3
4	1.15	1.30	1.50	1.74	2.03	2.37	2.9
5	1.13	1.28	1.46	1.67	1.93	2.23	2.7
10	1.10	1.21	1.34	1.49	1.66	1.85	2.1

NOTE: For values between those listed in the Table, interpolation may be used. Extrapolation is not permitted.

B3.5 Criteria for acceptance

The criteria for acceptance are as follows:

(a) *Strength limit state* The unit is deemed to comply with the strength limit state if it is able to resist the target test load for that limit state.

(b) *Serviceability limit state* When subjected to the target test load for the serviceability limit state, the maximum deformation of the unit (or other serviceability criteria) should be within the serviceability limits specified. After the completion of the test, the residual deflection or deformation of any part of the unit should not exceed 5 percent of the acceptable amount under short-term loading or such other limit as may be specified.

APPENDIX C

GUIDELINES FOR SERVICEABILITY LIMIT STATES

(Informative)

This Appendix gives guidelines for the serviceability limit states resulting from deformation of complete structures and members of structures under load.

Except where absolute limits are required, it is generally best to deal with deflection design in terms of the individual loads being applied (for example, it is usually preferable to deal with the effects of permanent loads separately from the deflection effects of transient or short-term loads). Unlikely combinations of actions need not be considered and total deflection usually only needs to be considered where absolute clearance limits must be maintained.

Guidance on limits for the design of members for serviceability is given in Table C1. This Table identifies deflection limits related to actions with an annual probability of exceedance A2 of 1/25 (i.e., $P = 0.04$) beyond which serviceability problems have been observed. Such boundaries for acceptance are imprecise and should be treated as a guide only. These limits are not applicable in all situations.

Table C1 is arranged into building elements that could be affected by the structure. For each element several possible control phenomena are prescribed, each of which detail—

(a) the serviceability parameter for which the control is intended;

(b) the action that is to be applied to the structure; and

(c) the acceptable response of the element to that action.

Different deflection limits may apply depending on the phenomenon controlled, and the most stringent appropriate limit should control the design. The environment of the observer influences the tolerance of people to sensory deflection. Where a lot of movement is occurring, the stated sensory limits can often be exceeded without complaint.

Further information is given in the commentary to this Standard.

A2 For farm structures of low human occupancy, serviceability criteria should be as follows:

(i) Deflection criteria may be relaxed provided that, taking note of appropriate use of the structure, deflections do not—

 (A) weaken or damage the structure, cladding or lining material and their fixings; or

 (B) produce unacceptable cracking.

(ii) Deflection criteria for flat or near-flat roofs should take into account the possibility of ponding of rainwater.

The design should make adequate provision for any hazards affecting the life of the farm structure that may arise from its use (e.g., typical movement of animals in farm structures designed for animals).

TABLE C1
SUGGESTED SERVICEABILITY LIMIT STATE CRITERIA

A3

Element	Phenomenon controlled	Serviceability parameter	Applied action	Element response (see Notes 1 and 2)
Roof cladding				
Metal roof cladding	Indentation	Residual deformation	Q = 1 kN	Span/600 but <0.5 mm
	De-coupling	Mid-span deflection	$[G, \psi_s Q]$	Span/120
Concrete or ceramic roof cladding	Cracking	Mid-span deflection	$[G, \psi_s Q]$	Span/400
Roof-supporting elements				
Roof members (trusses, rafters, etc.)	Sag	Mid-span deflection	$[G, \psi_l Q]$	Span/300
Roof elements supporting brittle claddings	Cracking	Mid-span deflection	$[G, \psi_s Q]$ or $[W_s]$	Span/400
Ceiling and ceiling supports				
Ceilings with matt or gloss paint finish	Ripple	Mid-span deflection	G	Span/500 (see Note 3)
Ceilings with textured finish	Ripple	Mid-span deflection	G	Span/300
Suspended ceilings	Ripple	Mid-span deflection	G	Span/360
Ceiling support framing	Sag	Mid-span deflection	G	Span/360
Ceilings with plaster finish	Cracking	Mid-span deflection	$[G, \psi_s Q]$ or $[W_s]$	Span/200
Wall elements				
Columns	Side sway	Deflection at top	W_s	Height/500
Portal frames (frame racking action)	Roof damage	Deflection at top	$[W_s]$ or $[E_s]$	Spacing/200 (Note 4)
Lintel beams (vertical sag)	Doors/windows jam	Mid-span deflection	W_s	Span/240 but <12 mm (see Note 5)
Walls—General (face loaded)	Discerned movement	Mid-height deflection	W_s	Height/150
	Impact: soft body (neighbours notice)	Mid-height deflection	Q = 0.7 kN	Height/200 but <12 mm (see Note 6)
	Supported elements rattle	Mid-height deflection	W_s	Height/1000
Walls—Specific claddings (see Note 7):				
Brittle cladding (ceramic) face loaded	Cracking	Mid-height deflection	W_s	Height/500
Masonry walls (in plane)	Noticeable cracking	Deflection at top	$[W_s]$ or $[E_s]$	Height/600
Masonry walls (face loading)	Noticeable cracking	Deflection at top	$[W_s]$ or $[E_s]$	Height/400
Plaster/gypsum walls (in plane)	Lining damage	Mid-height deflection	W_s	Height/300
Plaster/gypsum walls (face loading)	Lining damage	Mid-height deflection	$[W_s]$ or $[E_s]$	Height/200
Movable partitions (soft body impact)	System damage	Deflection at top	Q = 0.7 kN	Height/160
Glazing systems	Bowing	Mid-span deflection	W_s	Span/400
Windows, facades, curtain walls	Facade damage	Mid-span deflection	$[W_s]$ or $[E_s]$	Span/250
Fixed glazing systems	Glass damage	Deflection	$[W_s]$ or $[E_s]$	2 × glass clearance (see Note 3)
Floors and floor supports				
Beams where line-of-sight is along invert	Sag	Mid-span deflection	$[G, \psi_l Q]$	Span/500 (see Notes 8, 9)
Beams where line-of-sight is across soffit	Sag	Mid-span deflection	$[G, \psi_l Q]$	Span/250
Flooring	Ripple	Mid-span deflection	$[G, \psi_l Q]$	Span/300
Floor joists/beams	Sag	Mid-span deflection	$[G, \psi_l Q]$	Span/300
Floors	Vibration	Static midspan deflection	Q = 1.0 kN	less than 1 to 2 mm (see Note 10)
Normal floor systems	Noticeable sag	Mid-span deflection	$[G, \psi_l Q]$	Span/400
Specialist floor systems	Noticeable sag	Mid-span deflection	$[G, \psi_l Q]$	Span/600
Floors—Side-sway (acceleration)	Sway	Acceleration at floor	W_s (P=5)	<0.01g (see Note 11)
Floors—Supporting masonry walls	Wall cracking	Mid-span deflection	$[G, \psi_l Q]$	Span/500
Floors—Supporting plaster lined walls	Cracks in lining	Mid-span deflection	$[G, \psi_l Q]$	Span/300
Floors supporting existing masonry walls—Underpinning floors	Wall cracking	Mid-span deflection	$[G, \psi_l Q]$	Span/750
Floors—For access for working by operators and maintenance	Sag	Midspan deflection	Q = 1 kN	Span/250
Handrails—Post and rail system	Side sway	Mid-span system deflection	Q = 1.5 kN/m	Height/60 + Span/240

NOTES:

1 Long-term creep, when present, needs to be included in assessing the long-term deflection of members that are prone to creep. In such cases, the long-term factored occupancy load, $G + \psi_\ell Q$, should be considered for the creep component and the difference between the short-term and long-term factored occupancy load, $(\psi_s - \psi_\ell)Q$ added to account for the incremental short-term deflection.

2 The span or height ratios used in the deflection criteria are the clear spacing between points of support.

3 The deflection limits for ceilings or floors are strongly influenced by the surface finish. Glass is an extreme example where the reflective surfaces amplify apparent bowing as the reflected images move with the surface distortions. Observers are often disturbed by such movements. Ripple effects appear more pronounced when the surface is flat (and has a reflective gloss finish). Textured surfaces tend to disguise ripple effects. Surfaces that extend over a wide expanse reveal both ripple and sag effects when light is reflected from the surface. Where the texture of the surface is unknown, the more stringent criteria of highly reflective surfaces will be conservative.

4 The limiting deflection for portal frame knee deflections is related to the behaviour of the cladding between the 'free portal' and a more rigid plane (typically the end wall of a structure). The deflection limit of such portals is based on the bay spacing and ability of the cladding to withstand in-plane shear distortion.

5 Problems with visually sensed deflections are frequently dependent on the presence of a visual cue for the observer to gauge linearity. Deflection limits are therefore a function of the line of sight of the observer.

6 Walls and partitions require stiffness control to minimise disturbance of elements or people often on the reverse side of the wall or partition (e.g., neighbours beyond inter-tenancy walls). The response of the wall to soft-body impact is greatly influenced by the nature and characteristics of the impacting body. The deflection criteria stated (height/200 from a concentrated load of 0.7 kN at mid-height) has been simplified for ease of application by designers. It is based upon a running person falling against a wall. Internal partitions may be subjected to differential pressures, which result from wind. A net coefficient of 0.5 may be considered appropriate when used in conjunction with the serviceability wind pressures.

7 Often different wall claddings have different tolerances to movement. Some of these have been specifically listed.

8 Where members are pre-cambered, the pre-camber present can be deducted from assessments of sag. Where construction progresses in stages, the incremental permanent action only needs to be considered for sag.

9 Floor sag may result in furniture that rocks or is not firmly seated or drainage surfaces that do not function adequately. Specialist floors are those upon which trolleys may move, sensitive equipment may be installed or special activities (e.g. bowls, etc.) may be undertaken. More restrictive deflection limits may be appropriate is such cases.

10 Floor vibration problems are very complex. Problem floors usually have low levels of elastic damping present. The limiting criteria stated (between 1 and 2 mm under a 1 kN point load) should give a guide as to whether the floor may have vibration problems. When the criterion is not satisfied, a more detailed examination of the dynamic behaviour of the floor may be merited. Where a floor system may be used for group rhythmic activity, such as marching, dancing, concerts, jumping exercises or gymnastics, and has a fundamental frequency of vibration less than 8 Hz, then a specific study of the resonant response should be considered, to demonstrate that the building remains functional.

A3 11 The criteria of 0.01g relates to a frequency range of 0.05 to 1 Hz. It is a first test to determine if further investigation is required. The sensitivity of people to motion in tall buildings varies widely and further research is being conducted.

A3

APPENDIX D

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APPENDIX E

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APPENDIX F

ANNUAL PROBABILITY OF EXCEEDANCE (FOR AUSTRALIAN USE ONLY—STRUCTURES FOR WHICH DESIGN EVENTS ARE NOT GIVEN ELSEWHERE)

(Normative)

F1 GENERAL

This Appendix specifies minimum design events for safety (ultimate limit states design), in terms of annual probability of exceedance for wind, snow and earthquake, for the design of structures in Australia that are not covered either by the Building Code of Australia or by other Standards (such as that for transmission line structures). This Appendix does not apply to structures in New Zealand; for those structures, Section 3 of this Standard applies.

NOTE: Structures covered by this Appendix may include industrial structures, mining and oil and gas structures, and communication structures.

F2 IMPORTANCE LEVELS

The importance level of a structure shall be determined in accordance with Table F1.

Structures that have multiple uses shall be assigned the highest importance level applicable for any of those uses. Where an adjacent structure provides access to another structure with a higher importance level, then the structure providing access shall be designated the same importance level as the structure to which it provides access.

NOTE: Structures that have very low frequency fundamental modes of vibration should be considered for special study of their earthquake design event and structural response (e.g. very long conveyors).

TABLE F1

STRUCTURE TYPES FOR IMPORTANCE LEVELS

Consequences of failure	Description	Importance level	Comment
Low	**Low** consequence for loss of human life, *or* **small or moderate** economic, social *or* environmental consequences	1	Minor structures (failure not likely to endanger human life)
Ordinary	**Medium** consequence for loss of human life, *or* **considerable** economic, social *or* environmental consequences	2	Normal structures and structures not falling into other levels
High	**High** consequence for loss of human life, *or* **very great** economic, social or environmental consequences	3	Major structures (affecting crowds)
		4	Post-disaster structures (post-disaster functions or dangerous activities)
Exceptional	Circumstances where reliability must be set on a case by case basis	5	Exceptional structures

F3 DESIGN EVENTS

A2
A5

Design events (in terms of annual probability of exceedance) shall be as given in Table F2 for use in determining the actions affecting the structure. Structures whose failure might result in loss of human life shall not be designed for less than a 25 year life.

Importance Level 4 structures shall not be designed for less than a 25 year life. For importance Level 4 structures with design working life of 100 years or more, the design events shall be determined by a risk analysis but shall have probabilities less than or equal to those for importance Level 3.

The design working life of structures that are erected for a number of short periods of use, and dismantled between each, is equal to the total of the periods of use.

NOTE: The design life for normal structures is generally taken as 50 years. For further guidance on the use of Table F2 see AS/NZS 1170.0 Supp 1, *Structural design actions—General principles—Commentary (Supplement to AS/NZS 1170.0:2002.)*

A2 A4 A5

TABLE F2

ANNUAL PROBABILITY OF EXCEEDANCE OF THE DESIGN EVENTS FOR ULTIMATE LIMIT STATES

Design working life	Importance level	Design events for safety in terms of annual probability of exceedance		
		Wind	**Snow**	**Earthquake (see Note 1)**
Construction equipment (e.g. props, scaffolding, braces and similar)	2	1/100	1/50	Not required (see Note 3)
5 years or less (only for structures whose failure presents no risk to human life, see Note 2)	1 2 3	1/25 1/50 1/100	1/25 1/50 1/100	Not required (see Note 3)
25 years	1 2 3 4	1/100 1/200 1/500 1/1000	1/25 1/50 1/100 1/250	Not required (see Note 3) 1/250 1/500 1/1000
50 years	1	1/100 (non-cyclonic)	1/100	1/250
	1	1/200 (cyclonic)		
	2	1/500	1/150	1/500
	3	1/1000	1/200	1/1000
	4	1/2500	1/500	1/2500
100 years or more	1 2 3 4	1/500 1/1000 1/2500 (see Paragraph F3)	1/200 1/250 1/500 (see Paragraph F3)	1/250 1/1000 1/2500 (see Paragraph F3)

NOTES:

1 Design for earthquake is not required for structures for primary produce with low human occupancy.

2 For a design working life (L) between 5 and 100 years that is not listed in Table F2, the annual probability of exceedence ($1/R$) for wind and earthquake events is calculated as r/L, where the lifetime risk (r) is given in the following table:

Importance level	Risk of exceedance of design load (r)
1	0.20 to 0.25
2	0.10 to 0.125
3	0.04 to 0.05
4	0.020 to 0.025

3 Earthquake loads for these annual probabilities are low and design for robustness or other actions will provide sufficient resistance.

4 Structures in wind Regions C and D (i.e. cyclonic regions, as defined in AS/NZS 1170.2) that are erected and remain erected, only during the period of May to October, may be designed for regional wind speeds given in AS/NZS 1170.2, for Region A, or alternatively from a specific analysis of non-cyclonic wind events for the site. A structure not designed for cyclonic wind speeds shall not remain erected during the months of November to April inclusive.

AMENDMENT CONTROL SHEET

AS/NZS 1170.0:2002

Amendment No. 1 (2003)

REVISED TEXT

SUMMARY: This Amendment applies to the Clauses 1.3, 2.2, 2.3 and 4.2.3, and Appendix E.

Published on 8 January 2003.

Amendment No. 2 (2003)

REVISED TEXT

SUMMARY: This Amendment applies to the Clauses 1.4, 2.2 and 2.3, Section 3, and Appendices C and F (new).

Published on 28 November 2003.

Amendment No. 3 (2011)

REVISED TEXT

SUMMARY: This Amendment applies to Clauses 1.1, 1.2, 1.3, 1.5, 2.3, 4.2.1, 4.2.2, 5.2, 6.2.2 and 6.2.5, Table 4.1 and Appendices C and D.

Published on 11 April 2011.

Amendment No. 4 (2005)

CORRECTION

SUMMARY: This Amendment applies to the Preface and Clauses 1.3, 2.2, 3.2, 3.4.2, Table 3.3 and Table F2.

Published on 28 April 2005.

Amendment No. 5 (2011)

REVISED TEXT

SUMMARY: This Amendment applies to the Preface, Clause 1.3 and Appendix F.

Published on 22 September 2011.

NOTES

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