

Australian/New Zealand Standard™

Suspended ceilings — Design and installation



AS/NZS 2785:2020

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- Association of Wall and Ceiling Industries of Australia
- Association of Wall and Ceiling Industries of New Zealand
- Australian Aluminium Council
- Business New Zealand
- Cement Concrete & Aggregates Australia
- Engineering New Zealand
- Engineers Australia
- Gypsum Board Manufacturers of Australasia
- New Zealand Institute of Architects

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Australian/New Zealand Standard™

Suspended ceilings — Design and installation

Originated as AS 2785—1985.
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Preface

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee BD-035, Ceiling Systems, to supersede AS/NZS 2785:2000.

The objective of this Standard is to provide the minimum requirements for the design, construction, installation, maintenance, and testing of internal and external non-trafficable suspended ceiling systems of dry construction with suspension systems for commercial and industrial applications. This Standard also applies to domestic structures designed in accordance with AS 1170.4 in Australia.

This Standard is based on limit states philosophy and covers aspects of the design and performance requirements, installation, workmanship, maintenance, and testing of suspended ceiling systems.

This edition incorporates the following major changes:

- (a) The word “load” has been replaced by the word “action” to be consistent with the terminology for structural design and the AS/NZS 1170 series of Standards.
- (b) The definitions have been substantially upgraded.
- (c) The word “fastener” has replaced the word “fixing”.
- (d) The concept of Seismic Grade (SG) of the ceiling has been introduced.
- (e) Design Producer’s Statement (PS) has been introduced.
- (f) Construction Monitoring (CM) has been introduced.
- (g) The concept of Specific Engineering Design (SED) has been introduced.
- (h) [Section 2](#), Design requirements, has been substantially revised including earthquake and wind design.
- (i) Restraint of luminaires has been added.
- (j) The design of fasteners into concrete has been revised.
- (k) The acoustic requirements have been modified.
- (l) Detailing, ceiling restraints and services interaction has been included in [Section 4](#).
- (m) Testing and verification methods have been upgraded in [Section 6](#).
- (n) The appendices have been upgraded.

In its deliberations, Committee BD-035 has considered the following documents:

ASTM C635, *Standard Specification for the Manufacture, Performance and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings*

ASTM C636, *Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels*

ASTM E580, *Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions*

ASTM E1264, *Standard Classification for Acoustical Ceiling Products*

EN 13964, *Suspended ceilings — Requirements and test methods*

Statements expressed in mandatory terms in notes to tables are deemed to be requirements of this Standard.

This Standard includes a commentary on some of the clauses. The commentary directly follows the relevant clause, is designated by “C” preceding the clause number and is printed in italics in a box. The commentary is for information and guidance and does not form part of the Standard.

The terms “normative” and “informative” have been used in Standards 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.

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Introduction

The needs of a client or owner for a given building may require more stringent requirements than those set out in the relevant earthquake and ceilings Standards. Early in the preliminary design phase of a building, designers should ascertain the client or owner's expectations of the building in the event of a severe earthquake. Should the designers be considering life safety or alternatively low-damage design, and whether a cost-benefit analysis of a more robust design is appropriate.

Commonly, clients/building owners have a different view on what earthquake design means for their building. They mistakenly assume that their building will survive a major earthquake without damage, which is not the intent of the earthquake Standards or design to this ceiling Standard. Non-structural parts and components, including ceilings, are equally important as the structure, and designers of ceilings must be involved in the discussion on whether they are designing for life safety or low-damage design. The failure of ceilings can cause harm to occupants and the public, prevent evacuation, and often result in an inoperative building. Designing of ceilings to this Standard is about life safety, accepting some damage, and hopefully preventing collapse. This Standard only provides the minimum requirements.



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NOTES

Australian/New Zealand Standard

Suspended ceilings — Design and installation

Section 1 Scope and general

1.1 Scope

This Standard sets out the minimum requirements for the design, construction, installation, maintenance, and testing of internal and external non-trafficable suspended ceiling systems of dry construction with suspension systems attached to a supporting structure. It is intended for use in commercial and industrial applications. This Standard also applies to domestic structures designed in accordance with AS 1170.4 in Australia.

1.2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document.

NOTE Documents referenced for informative purposes are listed in the Bibliography.

AS 1170.4, *Structural design actions, Part 4: Earthquake actions in Australia*

AS 1397, *Continuous hot-dip metallic coated steel sheet and strip — Coatings of zinc and zinc alloyed with aluminium and magnesium*

AS 1449, *Wrought alloy steels—Stainless and heat-resisting steel plate, sheet and strip*

AS 1530.4, *Methods for fire tests on building materials, components and structures, Part 4: Fire-resistance tests for elements of construction*

AS 1566, *Copper and copper alloys — Rolled flat products*

AS 1720.1, *Timber structures, Part 1: Design methods*

AS 1720.2, *Timber structures, Part 2: Timber properties*

AS 2841, *Galvanized steel wire strand*

AS 2848.1, *Aluminium and aluminium alloys — Compositions and designations, Part 1: Wrought products*

AS 3600, *Concrete Structures*

AS 3715, *Metal finishing — Thermoset powder coatings for architectural applications of aluminium and aluminium alloys*

AS 4100, *Steel Structures*

AS 5216, *Design of post-installed and cast-in fastenings in concrete*

AS 5637.1, *Determination of fire hazard properties, Part 1: Wall and ceiling linings*

AS ISO 354, *Acoustics — Measurement of sound absorption in a reverberation room*

AS ISO 717.2, *Acoustics — Rating of sound insulation in buildings and of building elements, Part 2: Impact sound insulation*

AS/NZS 1163, *Cold-formed structural steel hollow sections*

AS/NZS 1170.0, *Structural design actions, Part 0: General principles*

AS/NZS 1170.1, *Structural design actions, Part 1: Permanent, imposed and other actions*



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AS/NZS 1170.2, *Structural design actions, Part 2: Wind actions*

AS/NZS 1530.2, *Methods for fire tests on building materials, components and structures, Part 2: Test for flammability of materials*

AS/NZS 1530.3, *Methods for fire tests on building materials, components and structures, Part 3: Simultaneous determination of ignitability, flame propagation, heat release and smoke release*

AS/NZS 1567, *Copper and copper alloys — Wrought rods, bars and sections*

AS/NZS 1573, *Copper and copper alloys — Wire for engineering purposes*

AS/NZS 1594, *Hot-rolled steel flat products*

AS/NZS 1595, *Cold-rolled, unalloyed, steel sheet and strip*

AS/NZS 1734, *Aluminium and aluminium alloys — Flat sheet, coiled sheet and plate*

AS/NZS 1865, *Aluminium and aluminium alloys — Drawn wire, rod, bar and strip*

AS/NZS 1866, *Aluminium and aluminium alloys — Extruded rod, bar, solid and hollow shapes*

AS/NZS 1867, *Aluminium and aluminium alloys — Drawn tubes*

AS/NZS 2499, *Acoustics — Measurements of sound insulation in buildings and of building elements — Laboratory measurement of room-to-room airborne sound insulation of a suspended ceiling with a plenum above it*

AS/NZS 2589, *Gypsum linings — Application and finishing*

AS/NZS 2728, *Prefinished/prepainted sheet metal products for interior/exterior building applications — Performance requirements*

AS/NZS 4506, *Metal finishing — Thermoset powder coatings*

AS/NZS 4534, *Zinc and zinc/aluminium-alloy coatings on steel wire*

AS/NZS 4600, *Cold-formed steel structures*

AS/NZS 4680, *Hot-dip galvanized (zinc) coatings on fabricated ferrous articles*

AS/NZS ISO 140-7, *Acoustics — Measurement of sound insulation in buildings and of building elements, Part 7: Field measurements of impact sound insulation of floors (ISO 140-7:1998, MOD)*

AS/NZS ISO 717.1, *Acoustics — Rating of sound insulation in buildings and of building elements, Part 1: Airborne sound insulation*

ISO 140-9, *Acoustics — Measurement of sound insulation in buildings and of building elements, Part 9: Laboratory measurement of room-to-room airborne sound insulation of a suspended ceiling with a plenum above it*

ISO 717, *Acoustics — Rating of sound insulation in buildings and of building elements*

ISO 5660-1, *Reaction-to-fire tests — Heat release, smoke production and mass loss rate — Part 1: Heat release rate (cone calorimeter method) and smoke production rate (dynamic measurement)*

ISO 5660-2, *Reaction-to-fire tests — Heat release, smoke production and mass loss rate, Part 2: Smoke production rate (dynamic measurement)*

ISO 9705-1, *Reaction to fire tests — Room corner test for wall and ceiling lining products — Part 1: Test method for a small room configuration*

ISO 10140-2, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 2: Measurement of airborne sound insulation*

ISO 10848, *Acoustics — Laboratory and field measurement of flanking transmission for airborne, impact and building service equipment sound between adjoining rooms*

ASTM C423, *Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method*

ASTM C635, *Standard Specification for the Manufacture, Performance and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings*

ASTM E336, *Standard Test Method for Measurement of Airborne Sound Attenuation between Rooms in Buildings*

ASTM E413, *Classification for rating sound insulation*

ASTM E492, *Standard Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine*

ASTM E1414, *Standard Test Method for Airborne Sound Attenuation between Rooms Sharing a Common Ceiling Plenum*

ASTM E3090 / E3090M, *17 Standard Test Methods for Strength Properties of Metal Ceiling Suspension Systems*

EN 13964, *Suspended ceilings. Requirements and test methods*

EN 1991-1, 4, *Eurocode 1. Actions on structures. General actions. Wind actions*

JIS G3302, *Galvanized cold rolled SGCC steels*

NZS 1170.5, *Structural design actions, Part 5: Earthquake actions — New Zealand*

NZS 3101, *Concrete structures standard*

NZS 3603, *Timber structures standard*

NZS 3604, *Timber-framed buildings*

NZS 4219, *Seismic performance of engineering systems in buildings*

NZS 4541, *Automatic fire sprinkler systems*

1.3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

1.3.1

access hatch

hinged or removable cover to allow access, from below the ceiling soffit, to services and the like within the ceiling plenum. It is not intended for human access on to the grid

Note 1 to entry: An access hatch should be taken into consideration when applying the design requirement in this Standard.

1.3.2

anchor fastener

manufactured device that connects a fixture to a base material. Previously called “fixings”

1.3.3

approved

approved by the building authority or approved by designer, or engineer as applicable

1.3.4**back brace****plenum brace**

system usually of diagonal and vertical members to brace the ceiling system to the structure above using tension and compression members

1.3.5**backing board****building board**

flat sheet of building board to which acoustic tile is attached using adhesive, screws, staples, or other suitable means (see [Figure 1.3\(A\)](#))

1.3.6**batten****furring channel**

ceiling grid members in a sheeted or flush ceiling, to which the building board is mechanically fixed

1.3.7**bow**

component of deviation in the horizontal plane of an element (see [Figure 1.3\(C\)](#))

1.3.8**brace**

member of a back brace or plenum brace which is usually inclined diagonally and which can be in tension and/or compression

Note 1 to entry: Wire braces are not capable of taking compression loads.

1.3.9**building authority****territorial authority**

body having statutory control over the design and construction of buildings or structures in the area in which the building or structure is to be erected including the ceilings

1.3.10**building board****backing board**

dry wall lining product supplied in rigid or semi-rigid sheet or panel form in a variety of materials for the lining of ceiling grid systems

1.3.11**Building Importance Level**

importance level of the building (including the ceilings) as set out in the National Construction Code (NCC) in Australia and the New Zealand Building Code (NZBC) in New Zealand

1.3.12**bulkhead**

vertical section of the ceiling greater than 150 mm in height separating two levels of horizontal ceilings or similar

Note 1 to entry: See [Appendix A](#).

1.3.13**camber**

component of deviation in the vertical plane of an element (see [Figure 1.3\(C\)](#))

1.3.14**ceiling contractor****installer**

person or company that will carry out the installation and in some circumstances the design of the suspended ceilings

1.3.15**ceiling hanger
hanger**

ceiling system suspension component used to support the ceiling system from the structure above. A ceiling hanger can be either in tension or compression

1.3.16**ceiling plank**

like a ceiling tile, but with the dimension ratio generally greater than 2 to 1

1.3.17**ceiling supplier**

company that manufactures or supplies the ceiling system to the ceiling contractor for installation. They may also take responsibility to provide the technical data for the design of the ceiling including wind and earthquake

1.3.18**ceiling suspension system**

assembly of ceiling components for suspending ceiling systems. It does not include timber systems that form part of AS/NZS 2589 and timber building Standards

1.3.19**ceiling system**

components that together form the basis of a ceiling, including the grid members and suspension system and infill material, as appropriate. A ceiling system may be direct fixed or suspended

1.3.19.1**cell ceiling system**

egg-crate-like structure with open areas to the plenum but with a closed appearance at low angle viewing

1.3.19.2**concealed grid ceiling system**

suspended ceiling system in which the supporting system is not exposed to view

1.3.19.3**compression post
strut**

member of a back brace or plenum brace to resist tension and/or compression actions

1.3.19.4**linear ceiling system
strip ceiling system**

ceiling whose soffit has the appearance of continuous strips of infill materials

1.3.19.5**luminous ceiling system**

ceiling of translucent material with lamps in the ceiling void to light the space below

1.3.19.6**non-trafficable ceiling system**

ceiling system where access by personnel onto the ceiling system for any purpose is strictly prohibited. This Standard applies only to non-trafficable ceilings

1.3.19.7**one-way exposed grid ceiling system**

ceiling whose soffit has the supporting grid members visible in one direction

1.3.19.8**open ceiling system**

suspended ceiling formed of louvres, battens, open cells, or similar ceiling components

1.3.19.9**sheeted or flush ceiling system**

ceiling lined with building board where the joints between the board are either exposed, set or concealed with cover strips, beads, or the like, such that the supporting grid members are not visible

1.3.19.10**strip ceiling system****linear ceiling system**

ceiling whose soffit has the appearance of continuous strips of infill materials

1.3.19.11**two-way exposed grid ceiling system**

ceiling whose soffit has the supporting grid members visible in two directions

1.3.20**ceiling tile**

infill unit that is fitted within or to the ceiling grid system to form a soffit

1.3.21**competent person**

person who has acquired through education, training, qualifications, or experience (or a combination of these) the knowledge and skill that enables that person to perform the required task correctly and safely

1.3.22**concealed spline**

ceiling member inserted into the kerfs of adjacent ceiling tiles to form a concealed mechanical joint and to prevent tile sag

1.3.23**cross runner or cross tee**

secondary member that is connected to the main runner or main tee to form an exposed or concealed grid system (see [Figure 1.3\(A\)](#) and [Figure 1.3\(B\)](#))

1.3.24**designer****Lead Designer**

person responsible for the ceiling design who may be an architect, interior designer or engineer, or a competent person to take on this role, or it may be several persons carrying out various parts of the design for the overall design of the ceiling

1.3.25**direct fix ceiling**

ceiling system whose soffit is near the structural soffit, and generally is directly fixed to the structural soffit by stiff connection

1.3.26**ductility**

ability of a member or connection to sustain its load-carrying capacity, without rupture, within the inelastic range

Note 1 to entry: Ductile materials and ductile connections will deform but should not break even when subjected to design actions beyond those required by the Standards. This behaviour is essential when designing ceilings systems for ultimate limit state actions.

1.3.27**engineer**

competent person who has qualified as an engineer and who can design the structural aspects of the ceiling particularly for seismic and wind actions, and any Specific Engineering Design (SED) where required

Note 1 to entry: In Australia and New Zealand the engineer will be required to be qualified, chartered and registered (in some areas).

1.3.28**fastener****anchor**

manufactured device that connects a fixture to a base material. Previously called “fixings”

1.3.29**fire resistance level (Australia)****FRL****fire resistance rating (New Zealand)****FRR**

nominal grading period, in minutes, that is determined by subjecting a specimen to the standard fire time temperature test while measuring —

- (a) structural adequacy;
- (b) integrity; and
- (c) insulation.

1.3.30**fire resistance rating (New Zealand)****FRR****fire resistance level (Australia)****FRL**

nominal grading period, in minutes, that is determined by subjecting a specimen to the standard fire time temperature test while measuring —

- (a) structural adequacy;
- (b) integrity; and
- (c) insulation.

1.3.31**fixing****top fasteners**

means or device by which suspension hangers are secured to the building structure above

1.3.32**furring channel****batten**

ceiling grid members in a sheeted or flush ceiling, to which the building board is mechanically fixed

1.3.33**grid**

system of interconnecting members usually at right angles supporting the ceiling

1.3.34**hanger****ceiling hanger**

ceiling system suspension component used to support the ceiling system from the structure above. A ceiling hanger can be either in tension or compression

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1.3.35**installer****ceiling contractor**

person or company that will carry out the installation and in some circumstances the design of the suspended ceilings

1.3.36**kerf**

preformed groove in the edge of a ceiling infill unit

1.3.37**Lead Designer****designer**

person responsible for the ceiling design who may be an architect, interior designer or engineer, or a competent person to take on this role, or it may be several persons carrying out various parts of the design for the overall design of the ceiling

1.3.38**limit state**

state beyond which the structure or component including ceilings no longer satisfies the design performance requirements

1.3.38.1**serviceability limit state**

limit state that corresponds to conditions beyond which specified service requirements for a structure or structural element or ceilings are no longer met

1.3.38.2**stability limit state**

limit state corresponding to the loss of static equilibrium of a structure or part of a structure considered as a rigid body

1.3.38.3**ultimate limit state**

limit state corresponding to collapse or other similar forms of structural failure

1.3.39**linear slot**

section of the ceiling where a slot interrupts the tiles or building board generally filled with luminaires, air conditioning registers or similar

1.3.40**lipping**

misalignment between abutting edges of separate members whereby their surfaces are not in the same plane (i.e. not flush)

Note 1 to entry: Lipping is usually due to inaccuracies in the cutting of kerfs, incorrect installation of the suspension system or deviations of the substructure.

1.3.41**main runner****main tee**

primary rail or member in an exposed grid ceiling system (i.e. the suspension is fixed directly to the member)

1.3.42**main tee****main runner**

primary rail or member in an exposed grid ceiling system (i.e. the suspension is fixed directly to the member)

1.3.43**metal pan tile**

metal ceiling component with formed edges that act as part of a ceiling soffit

1.3.44**nogging**

horizontal bracing piece used to give rigidity between two adjacent vertical members of a steel or timber stud partition and to which the ceiling system may be attached

1.3.45**perimeter trim**

any component fitted around the outer edges of the ceiling to provide an aesthetic finish, particularly at the ceiling-to-wall joint. It may also provide structural support to the outer edges of the ceiling and may allow for seismic movement. See also wall angle ([1.3.63](#))

1.3.46**plenum brace****back brace**

system usually of diagonal and vertical members to brace the ceiling system to the structure above using tension and compression members

1.3.47**primary channel****primary rail****strong back**

primary support member suspended from the structural soffit, to which the secondary ceiling grid members are connected

1.3.48**primary rail****primary channel****strong back**

primary support member suspended from the structural soffit, to which the secondary ceiling grid members are connected

1.3.49**principal contractor****project manager**

person or company engaged by the client for the owner of the building to execute the contract works and authorized to have management or control of the workplace and who will oversee the whole project and which may include the coordination of the design team including the ceilings

1.3.50**project manager****principal contractor**

person or company engaged by the client for the owner of the building to execute the contract works and authorized to have management or control of the workplace and who will oversee the whole project and which may include the coordination of the design team including the ceilings

1.3.51**resistance to incipient spread of fire (Australia)****RISF**

in relation to a ceiling membrane, means the ability of the membrane to insulate the space between the ceiling and roof, or ceiling and floor above, so as to limit the temperature rise of materials in this space to a level which will not permit the rapid and general spread of fire throughout the space

1.3.52**seismic or wind clip**

clip designed to restrain or allow for movement as required under seismic or wind actions

1.3.53**sliding lock**

concealed ceiling grid member that can be slid into a position to allow access through a concealed grid ceiling system

1.3.54**soffit****1.3.54.1****ceiling soffit**

surface of a ceiling system exposed to general view

1.3.54.2**structural soffit**

underside of the structure, from which, the ceiling system may be suspended and/or braced

1.3.55**strong back****primary channel****primary rail**

primary support member suspended from the structural soffit, to which the secondary ceiling grid members are connected

1.3.56**strut****compression post**

member of a back brace or plenum brace to resist tension and/or compression actions

1.3.57**suspended ceiling**

ceiling system hung at a distance from the floor or roof above. It does not include nailed timber conforming with AS/NZS 2589 and timber building Standards

1.3.58**territorial authority****building authority**

body having statutory control over the design and construction of buildings or structures in the area in which the building or structure is to be erected including the ceilings

1.3.59**tether**

lightweight metal cable or metal cord fixed to the service and also fixed to the structure above such that in the event of a failure of the ceiling, the tether can support the weight of the service

1.3.60**tie**

member of a back brace or brace which carries tension forces

1.3.61**top fasteners****fixing**

means or device by which suspension hangers are secured to the building structure above

1.3.62**twist**

angle of rotation measured in a transverse plane between the two end cross-sections of an element or component (see [Figure 1.3\(C\)](#))

1.3.63**wall angle**

edge angle of a ceiling system that is attached to a wall (see [Figures 1.3\(A\) and \(B\)](#)). The wall angle may also provide support for the infill unit or ceiling components that are located at the periphery of the ceiling. It may also allow for seismic and/or wind actions. See also perimeter trim ([1.3.45](#))

1.4 Notation

The symbols used in this Standard are listed in [Table 1.4](#).

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

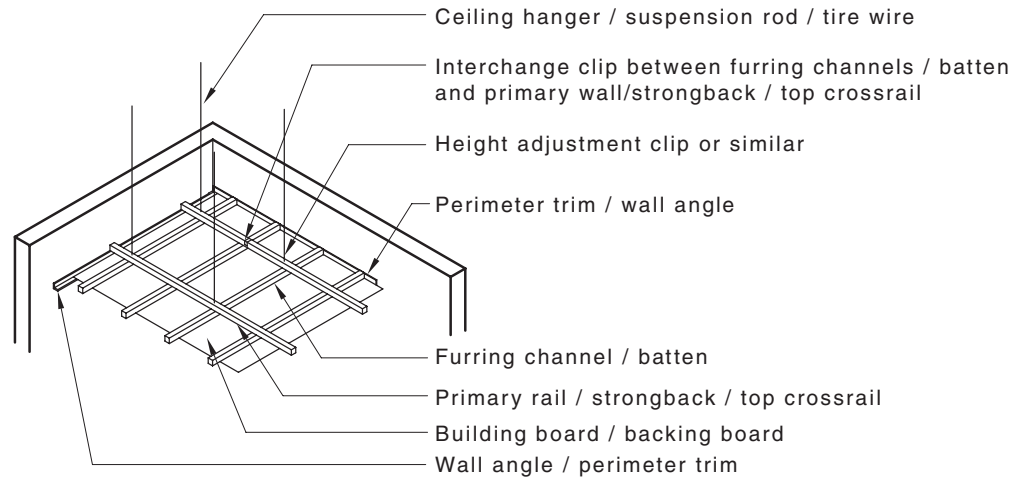
The dimensional units for length and stress in all expressions or equations are to be taken as millimetres (mm) and megapascals (MPa) respectively unless specifically noted otherwise.

Table 1.4 — Notation

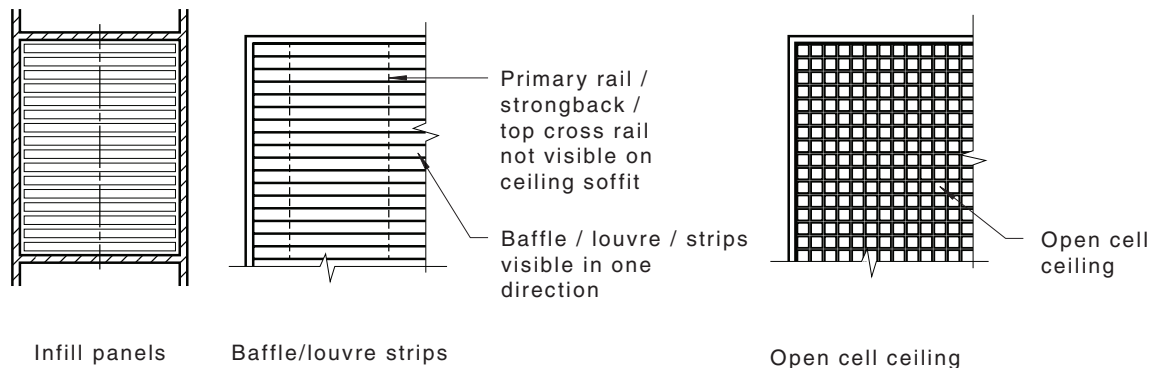
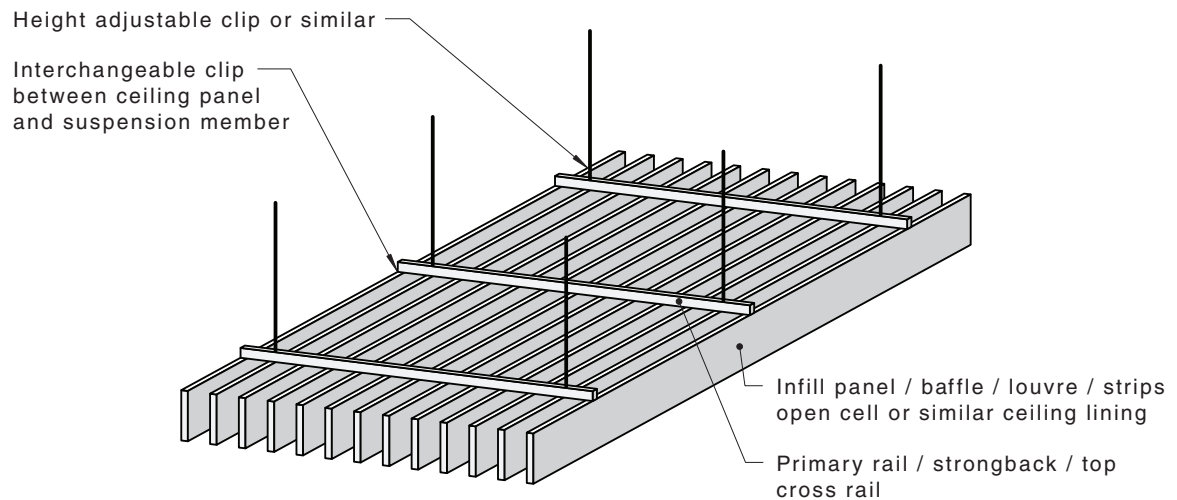
Symbol	Description	Reference
C_H	Ceiling height, i.e. the distance from ceiling to floor below (m)	Clause B.7
C_{tr}	Spectrum adaption value	Clause 2.6.2.2.2
$D_{n,c,w}$	Weighted suspended ceiling normalized level difference	Clause 2.6.2.2.1
E	Earthquake actions	Clause 2.2.2
E_d	Imposed lateral load	Clause 2.2.2
F_B	Design action applied to the bulkhead	Appendix A
F_c	Horizontal design earthquake action, determined in accordance with AS 1170.4 or NZS 1170.5	Clause B.8
		Clause B.9
		Appendix A
H_{sl}	inter-storey height of level l , measured from the centre-line of floor (m)	Clause B.7
F_w	Horizontal design action applied to the partition	Clause B.8
G	Permanent action (self-weight or “dead” action)	Clause 2.2.2
g	Gravity (9.8 m/s ²)	Clause 4.3.3.5
k_{du}	Ultimate limit state drift deflection	Clause B.7
k_m	Material variance for steel elements as per AS/NZS 4600	Clause 6.2.2.2
k_t	Reduction factor for steel elements as per AS/NZS 4600	Clause 6.2.2.2
l	Distance from the top fastener to the mass centroid of the ceiling (m)	Clause 4.3.3.5
L_g	Length of run of ceiling grid, perpendicular to the line of partition (m)	Clause B.8
		Appendix A
$L_{n,w}$	Weighted normalized impact sound pressure level	Clause 2.6.2.3
P	Annual probability of exceedance	Clause 2.4.3
P_H	Ceiling plenum height (m)	Clause B.7
Q	Imposed live actions (due to occupancy and use, “live” action)	Clause 2.2.2
R_{min}	Minimum of the tested values	Clause 6.3.5

Table 1.4 (continued)

Symbol	Description	Reference
R_w	Weighted sound reduction index	Clause 2.6.2.2.2
S_u^*	Design ultimate value	Clause G.2.9
S_{gm}	Spacing of the grid member abutting the partition or bulkhead (m)	Clause B.8 Appendix A
SSH	Equal to the inter-storey height less the slab thickness (m)	Clause B.7
T_p	Fundamental period of the part (s)	Clause 4.3.3.5
V_{sc}	Coefficient of variation of structural characteristic	Clause 6.3.5
W	Wind actions	Clause 2.2.2
α_w	Weighted sound absorption coefficient	Clause 2.6.2.1



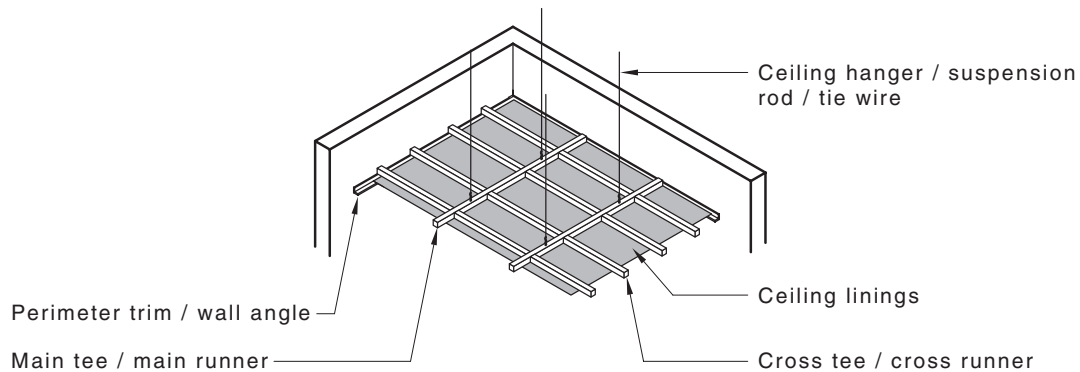
(a) Suspended sheeted or flush ceiling grid system



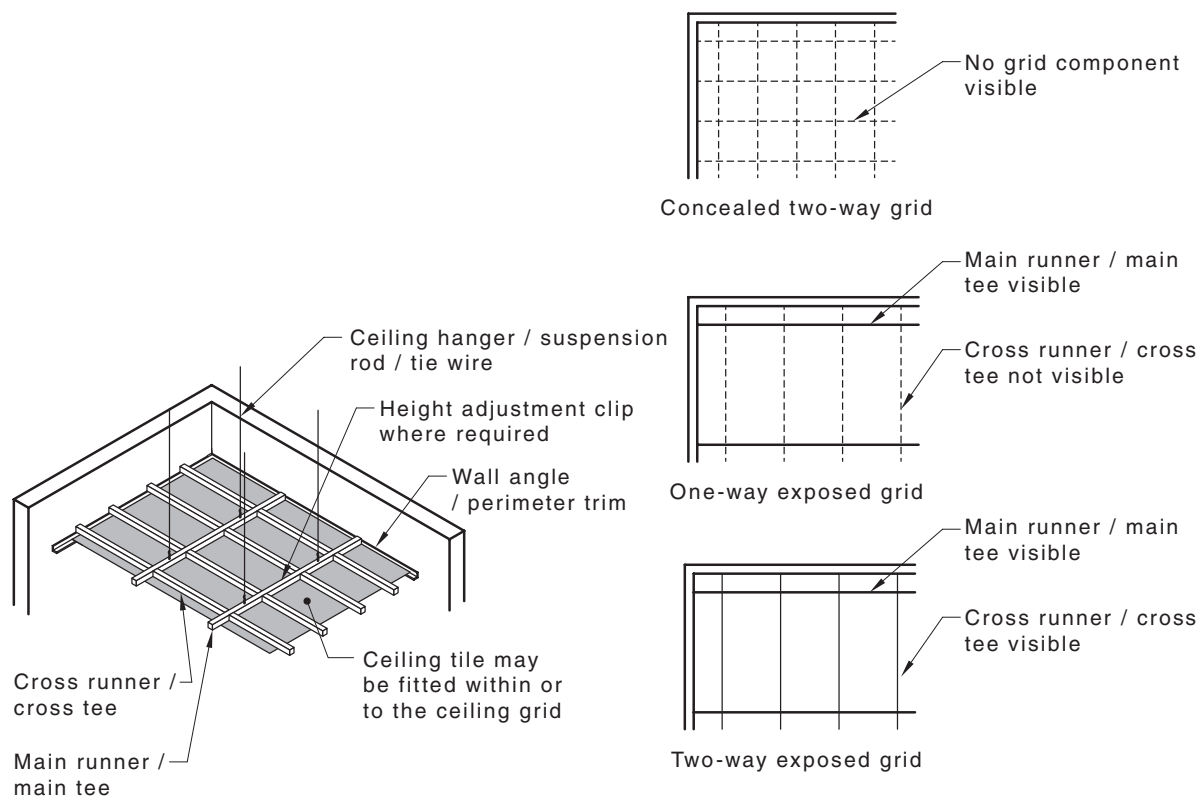
(b) Suspended linear or strip ceiling system

NOTE May require Specific Engineering Design for ceiling diaphragm action under seismic actions

Figure 1.3(A) — Ceiling systems



(a) Direct fix sheeted or flush ceiling systems



(b) Suspended exposed grid ceiling system

NOTE Where required the ceiling tile may be stiffened using a backing board or similar.

Figure 1.3(B) — Ceiling systems

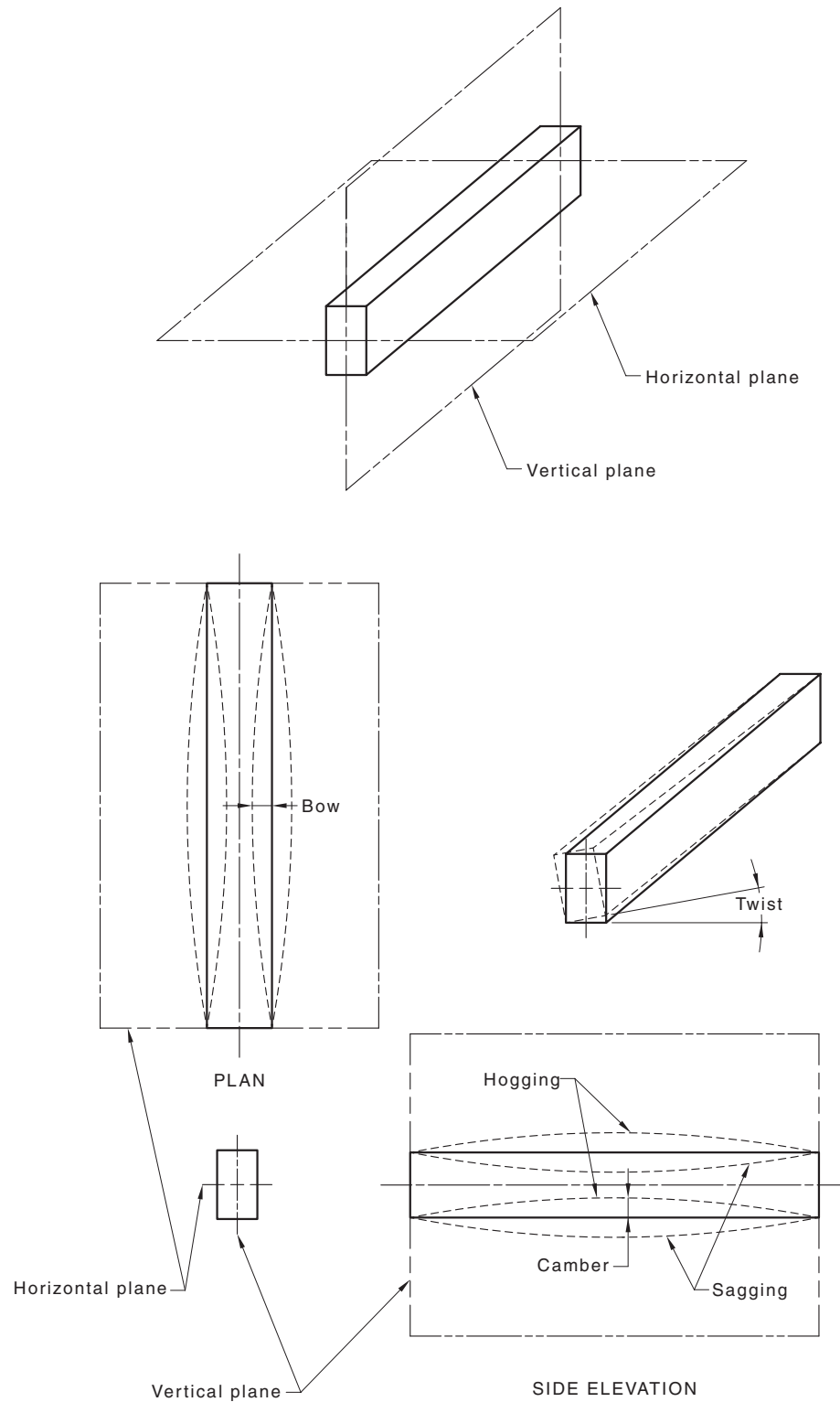


Figure 1.3(C) — Diagrams showing camber, bow and twist

Section 2 Design requirements

2.1 Design

2.1.1 Aim

The aim of the design for the ceiling is to provide a ceiling system that satisfies the ultimate and serviceability limit states, while simultaneously satisfying other objectives such as aesthetics, economy and ease of construction.

2.1.2 Requirements

The ceiling system, including its connections and abutments to the structure, shall sustain all reasonably expected design actions.

NOTE 1 Design actions should be determined by referring to the applicable procedures specified in the Building Code relevant to the locality of the construction.

Unless specified otherwise:

- (a) *In Australia*, the Importance Level of the ceiling shall not be less than that of the building or structure.
- (b) *In New Zealand*, the Design Working Life shall not be less than that of the building or structure.

NOTE 2 Refer to the New Zealand Building Code (NZBC) for durability requirements.

The service life of the ceiling can be different to the Design Working Life of the structure to which it is fitted, and unless otherwise stated, can be taken to be the warranty period.

NOTE 3 The Building Importance Level (Australia) and Design Working Life (New Zealand) of a structure is used to determine the design actions for the ceiling. Designers of ceilings should ascertain the specific design parameters for the structure from the designer of the structure.

2.1.3 General design considerations

The design process shall consider all aspects of the ceiling systems, including the capacity of the primary structure to provide the necessary support to the ceiling and the function of the building.

The design of suspended ceilings, including assessment of wind and seismic actions, should be undertaken by a competent person with experience in ceiling design for all actions. If a supplier's generic seismic and/or wind design guide is used, it should be submitted with the tender showing how it conforms with the project requirements.

The design of the ceiling shall ensure all items interacting with the ceiling do not compromise the ceiling design.

The ceiling system design specification shall be verified as being able to resist seismic and wind actions by the provision of specific test data. For seismic actions, the design shall include details and locations of any bracing, fixed and free joints, seismic clips to join secondary framing if necessary, together with all fasteners that will meet the requirements for seismic design.

The ceiling system layout shall be designed such that the primary rails or main runners are orientated perpendicular to the primary structural elements (i.e. roof purlins in the case of steel roofs).

NOTE For specific test data, see [Section 6](#).

2.1.4 Ductility

When designing ceiling systems for seismic actions, ductility factors shall be in accordance with [Table 2.1.4](#) and AS 1170.4 or NZS 1170.5 as appropriate.

Table 2.1.4 — Ductility factors

Action being considered	In Australia (RC)	In New Zealand (μ_p)
Section or member capacity checks	≤ 2.5	1.0 ^a
Connection checks, including: Fixings to the primary structure Fastenings used within the ceiling grid (i.e. screwed or riveted splice connections) Perimeter connections Component connections (i.e. main tee to main tee)	1.0	1.0
^a Refer to NZS 1170.5 for ductility factors applicable for serviceability limit states (SLS).		

2.2 Actions

2.2.1 General

The design of a ceiling for ultimate and serviceability limit states shall consider all action effects applicable for the ceiling system.

2.2.2 Requirements

The following apply, as a minimum:

- (a) Permanent (G), imposed (Q), wind (W) and earthquake (E) actions shall be determined in accordance with AS/NZS 1170.1, AS/NZS 1170.2, AS 1170.4 and NZS 1170.5, as applicable.
- (b) Load combinations shall be considered in accordance with AS/NZS 1170.0 as applicable.
- (c) Allowance shall be made for an additional imposed live action (Q) of not less than 0.03 kPa (3 kg/m²) in all ceilings, to account for incidental loading. This action shall be included in the earthquake mass, and shall be additional to all permanent actions including insulation, light fittings and the like. Pattern loading need not be considered with this action, unless applicable.
- (d) All ceiling hangers shall be designed to withstand worst-case scenarios and combinations potentially resulting from positive and negative actions.

NOTE See provisions within [Clause 2.2.3](#) and [Clause 2.3.4](#).

- (e) Where access hatches are present, an imposed point action (Q) equal to 0.2 kN (20 kg) shall be applied, in addition to all other actions, to the members providing direct support to the access hatch. The point action shall be positioned for worst case.

Access hatches shall not be used for personnel to enter the ceiling plenum space. Maintenance and other personnel shall be supported independent of the ceiling system.

- (f) Where bulkheads are present they shall be designed for the following additional design actions, as a minimum:
 - (i) An imposed lateral live action (Q) of 0.25 kPa, in conjunction with an imposed vertical live action (Q) of 0.15 kPa.



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- (ii) An imposed lateral design action (E_d) as determined in accordance with [Clause 2.3](#), where the ceiling is laterally restrained by the bulkhead.

2.2.3 Other actions

Any action, which may affect the strength, serviceability or stability of a ceiling system including, but not limited to, the following, shall be considered:

- (a) Temperature changes and gradients.
- (b) Construction actions.
- (c) Creep and shrinkage.
- (d) Vibration.
- (e) Mechanical fastener — Pull-out, pull through and over torquing of fasteners.

NOTE Elements that hang below the ceiling such as TV screens and monitors and operating theatre lights may result in significant actions (for example, bending moments) if attached directly to the ceiling system and will require independent consideration.

2.3 Ultimate limit state

2.3.1 General

A ceiling system has adequate strength, provided the ceiling system can resist the most critical design action effect.

The ultimate limit state is reached when the ceiling system or part thereof ruptures, becomes unstable, or loses equilibrium.

2.3.2 Design criteria

The ceiling system and its suspension system shall be designed for the ultimate limit state conditions.

NOTE Refer to the National Construction Code (NCC) or the New Zealand Building Code (NZBC) as applicable.

2.3.3 Combinations of actions for ultimate limit state

The combinations of actions for the ultimate limit state shall be as nominated in AS/NZS 1170.0. (See [Table 2.3.3](#).)

Table 2.3.3 — Short-term, long term and combination factors

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 action (Q)				
Ceilings	1	0	0	0
Concentrated imposed actions (Q)				
Ceilings	1	0	0	0

C2.3.3 A ceiling installed to the underside of a floor used as a storage facility would have the combination factors specified in Table 4.1 of AS/NZS 1170.0.

2.3.4 Fasteners and hangers

All fasteners to the primary structure, including their fixing brackets and hangers shall be designed for the greater of —

- (a) 0.50 kN (50 kg) downwards; or
- (b) the vertical actions determined in accordance with [Clause 2.2.2\(d\)](#) with an additional allowance of 50 % of the vertical actions on the basis that an adjacent hanger can fail and the vertical action is redistributed to the two adjoining hangers.

2.3.5 Wind actions and internal pressures

Internal pressures shall be determined in accordance with AS/NZS 1170.2, as applicable.

Differential pressure on the ceiling system may be relieved by provision of adequate venting.

Provisions shall be made for the restraining of the ceiling system and for the anchoring of the panels, tiles or other materials of the ceiling proper against the design action effects of any internal pressure that is likely to be encountered. This is to include both positive (uplift) and negative (downward) pressures, as applicable.

NOTE 1 For further details in relation to wind actions on external ceilings, see [Appendix E](#).

NOTE 2 It is recommended that advice from a competent person be sought for wind actions on ceilings.

2.3.6 Earthquake

2.3.6.1 General

In Australia, earthquake actions shall be determined in accordance with AS 1170.4. Vertical actions arising from earthquakes need not be considered unless otherwise determined by a special study or where required by AS 1170.4.

In New Zealand, earthquake actions shall be determined in accordance with NZS 1170.5. Horizontal and vertical actions arising from earthquakes shall be considered in accordance with that Standard.

2.3.6.2 Requirements

The mass of the ceiling (G) considered under earthquake actions shall include, but shall not be limited to, the following:

- (a) The mass of the ceiling tile or ceiling coverings and grid system (G).
- (b) Partitions connected to the underside of the ceiling (G) (see Notes 1 and 2).
- (c) Recessed or surface-mounted luminaires (G) or similar.
- (d) Services such as air conditioning registers (G) that are attached to and supported and/or restrained by the ceiling.
- (e) Insulation (G).

The design earthquake action shall be applied through the centre of mass of the ceiling which can be taken as either the centre of the ceiling tile or lining boards.

Ceiling systems shall be designed to resist earthquake actions without —

- (i) causing suspension components to dislodge;

- (ii) the ceiling impacting the building structure, services, or non-structural components, including allowance for inter-storey drift of the structure;
- (iii) allowing parts weighing 7.5 kg or more to dislodge and fall more than 3 m.

NOTE 1 Unless specified otherwise, the imposed live action (Q) for potential future fixings and fittings should not be less than 25 kg per metre per shelf, for a shelf width up to 300 mm. For shelving greater than 300 mm wide, the imposed load should be proportioned upwards according to the shelf width in millimetres divided by 300. Where the ceiling is to provide lateral restraint to the partition, the ceiling should be specifically designed for the following actions that include, as a minimum: the mass of the partition, fixtures and fitting attached to the partition and an allowance for potential for future fixings and fittings.

NOTE 2 It is recommended that partitions not be restrained by the ceiling system because of the difficulty in assessing seismic action taken by the ceiling system. Usually the ceiling system is of lightweight construction and of limited structural strength and may not be capable of resisting such actions.

2.3.6.3 Ultimate inter-storey drift deflections

The ceiling system shall accommodate the expected ultimate limit state differential deflections between itself and the primary structure or other building elements. Some damage to the ceiling system at the ultimate limit state is allowable, however, collapse or loss of stability shall not occur.

For the purposes of determining the differential deflections, the following shall be used:

- (a) *In Australia*, the maximum ultimate limit state inter-storey drift deflection shall be taken as 1.5 % of the storey height, unless a lower value is determined by analysis or by special study or as provided in the tender information.
- (b) *In New Zealand*, the maximum ultimate limit state inter-storey drift deflection shall be taken as 2.5 % of the storey height, unless a lower value is determined by analysis or by special study or as provided in the tender information.

Ceiling systems may be supported wall to wall, as in corridors, and not suspended from the plenum. The support at the ends of the ceiling system needs to be sufficient to allow for all sway movements due to seismic actions and not be dislodged.

2.4 Serviceability limit state

2.4.1 General

A ceiling system is serviceable if the probability of loss of serviceability of the system or the components is acceptably low and the ceiling maintains its intended performance level throughout its intended life. (See [Clause 2.4.4](#).)

2.4.2 Method

The ceiling system shall be designed for the serviceability limit state conditions.

NOTE Refer to the National Construction Code (NCC) or the New Zealand Building Code (NZBC) as applicable.

2.4.3 Combinations of actions for serviceability limit state

The combinations of actions for serviceability limit state shall be as given in AS/NZS 1170.0. Additionally, the following load combination shall be assessed:

$$[G, (\Psi_c) Q]$$

Short-term and long-term factors, for the serviceability limit state, are given in [Table 2.3.3](#).