BRANZ FACTS

SEISMICALLY RESILIENT NON-STRUCTURAL ELEMENTS #1

Compliance and standards

Building work in New Zealand is governed by the Building Act 2004, the Building Regulations 1992 and the Building Code, which is contained within Schedule 1 of the Building Regulations. Collectively, these are known as building controls

THE BUILDING CODE sets out the performance standards that all building work must meet. These requirements are described in several clauses, such as B1 *Structure*, B2 *Durability*, C6 *Structural stability*, E2 *External moisture* and many others. Acceptable Solutions (AS) and Verification Methods (VM) provide ways to comply with the performance requirements of a particular clause of the Building Code.

For engineering systems, the most common way to meet the requirements of clause B1 Structure is to use Verification Method B1/VM1. This cites NZS 4219:2009 Seismic performance of engineering systems in buildings, which contains prescriptive and specific engineering design options for restraining a variety of engineering systems. This is subject to B1/VM1 clause 13.0 Specified modifications applicable to the Canterbury earthquake region.

Building Code requirements

New Zealand Building Code clause B1 *Structure* requires all building elements to have a low probability of failure when exposed to loads likely to be experienced within the building's usable life.

Several Building Code supporting documents help to meet this requirement. Which one to use depends on the restraint requirements of the building element in question.

The restraint of building elements not covered by NZS 4219:2009 should be designed in accordance with two standards taken together. The first is NZS 1170.5:2004 *Structural design actions – Part 5: Earthquake actions – New Zealand*. The second is either:

- the appropriate materials standard (such as NZS 3404:1997 *Steel structures standard*) or
- the specific system standard (such as AS/NZS 2785:2000 *Suspended ceilings – Design and installation* for dry suspended ceilings and NZS 4541:2013 *Automatic fire sprinkler systems* for fire sprinkler system pipework).

Scope of NZS 4219:2009

The objective of NZS 4219:2009 is to safeguard people from injury and to minimise damage by preventing failure of engineering systems when subject to earthquake actions.

To do this, the standard provides requirements for designing engineering systems in buildings to achieve seismic performance. The criteria for seismic performance relates to a building's function and covers restraint systems, flexibility to cater for differential movement and clearance to avoid adverse interactions resulting from differential movement.

The standard applies to:

- all engineering systems necessary to ensure compliance with the Building Code
- all engineering systems essential for the normal operation of the building
- building compliance schedule items.

The provisions of NZS 4219:2009 may be used for services in new or existing buildings and for the purpose of retrofitting engineering systems into existing buildings.

Exclusions

The following building elements are excluded from the scope of NZS 4219:2009:

- Fire sprinkler system pipework. (Fire hydrants are not excluded from NZS 4219:2009, although the complying standard is NZS 4510:2008 *Fire hydrant systems for buildings*. NZS 4541:2013 *Automatic fire sprinkler systems* notes that sprinkler components such as valves, fire pumps and diesel storage tanks can be designed using NZS 4219:2009.)
- Suspended ceilings.
- Lifts (including guide rails) and escalators.
- Engineering systems in buildings of importance level 5.
- Items that are independently supported on the ground outside the building.
- Individual components with a mass exceeding 20% of the combined mass of the component and the building structure and with a period greater than 0.2 seconds.
- Building contents, such as portable appliances, and other items not attached to the building structure (see NZS 4104:1994 *Seismic restraint of building contents*).

Verification of the supporting structure for gravity and seismic actions is also outside the scope of NZS 4219:2009.

Design pathways in NZS 4219:2009

NZS 4219:2009 provides two pathways to design a seismically resilient engineering system – specific design and non-specific design.

Specific design

The specific design pathway (sections 1, 2, 4 and 5 and Appendices A, B and C of NZS 4219:2009) allows experienced structural engineers to design the installation using standard structural engineering rationale and calculations, based on AS/NZS 1170 *Structural design actions* and the relevant materials standards. This pathway is intended to be a Verification Method that provides a means to comply with the requirements of Building Code clauses B1, G10, G12 and G14.

Examples where NZS 4219:2009 stipulates specific design include:

- components connected to the building structure at more than one level without flexible joints or connections
- wall-mounted components
- floor-mounted components without a single definable centre of gravity
- brittle components
- pipes with a diameter larger than 200 mm
- steam and gas piping that requires restraint
- individual components weighing more than 25 kg that are within or supported by a suspended ceiling
- piping sytems that cross seismic gaps.

Non-specific design

The non-specific design process (sections 1, 2, 3 and 5 and Appendices A, B and C of NZS 4219:2009) allows building systems designers who don't have a detailed knowledge of seismic engineering to use a range of ready-made solutions for standard situations. This is, in effect, a self-contained Acceptable Solution that provides a means to comply with Building Code clauses B1, G10, G12 and G14.

A non-specific design is not a generic solution, and the non-specific design process must be repeated for each building and engineering system being considered. It may be possible, however, to develop non-project-specific solutions for commonly used components, adapt them to a particular project and verify the suitability of solutions by engaging a seismic specialist.

Examples where NZS 4219:2009 allows non-specific design include typical:

- pipe bracing
- duct bracing
- fan coil unit bracing
- cable tray bracing
- floor-mounted components
- light fitting details.

Quality and building controls

The design of seismically resilient building services is a specialist design process often outside the engineering capability of building services contractors. In some circumstances, it requires structural engineering knowledge, and contractors will need to engage a building services seismic specialist to undertake seismic design, inspection and certification.

The building services seismic specialist should always be a suitably qualified and competent seismic design professional, such as a chartered professional engineer.

Design

Where a building services seismic specialist undertakes the seismic design, they should provide seismic design submissions and a design producer statement (PS1).

Where a building services contractor prepares the designs and they are reviewed and certified by a services seismic specialist, the contractor should provide a PS1. The seismic specialist should provide a design review producer statement (PS2).

Where the contractor prepares pre-engineered (non-project-specific) and pre-reviewed details, the seismic specialist should provide a PS2 that is specific to the project.

Design details and producer statements should be submitted to the relevant project manager/contract administrator, as well as the building consent authority if this is a condition of the building consent.

Installation

As NZS 4219:2009 is a performance-based standard, it is not possible to inspect an installation for compliance with NZS 4219:2009 itself. It is only possible to inspect an installation for compliance with a design undertaken in accordance with NZS 4219:2009. It is important for construction monitoring to be undertaken by the person responsible for or with detailed knowledge of the design.

The building services contractor should provide a construction producer statement (PS3) certifying that the installation has been completed in accordance with the seismic specialist's design.

The seismic specialist should provide an agreed level of construction monitoring as appropriate to the complexity and criticality of the works. They should provide a construction review producer statement (PS4) certifying that the works have been completed in accordance with the relevant requirements of the building consent.

Table 1.1 summarises the producer statements that should be provided during construction.

Table 1.1 Responsibilities for construction-stage producer statements.			
Producer statement		**Provided by**	**Comment**
PS1	Design	Seismic specialist or building services contractor	Certifies that the proposed works, if constructed as designed, will comply with the requirements of the Building Code.
PS2	Design review	Seismic specialist	Where a PS1 is provided by the contractor, the seismic specialist should provide a corresponding PS2 to certify that the proposed works, if correctly constructed, will comply with the requirements of the Building Code.
PS3	Construction	Building services contractor	Certifies that the works have been completed in accordance with the seismic specialist's design documentation.
PS4	Construction review	Seismic specialist	Certifies that construction monitoring and information provided by the contractor indicates that works have been completed in accordance with the seismic specialist's design documentation.

Further information

The following resources are relevant to the seismic resilience of non-structural systems in New Zealand buildings.

Compliance with the New Zealand Building Code

- Clause B1 *Structure* Verification Method B1/VM1
- Clause G10 *Piped services* Acceptable Solution G10/AS1
- Clause G12 *Water supplies* Acceptable Solution G12/AS1
- Clause G14 *Industrial liquid waste* Verification Method G14/VM1

Related standards

- AS/NZS 1664.1:1997 *Aluminium structures – Limit state design*
- AS/NZS 2785:2000 *Suspended ceilings – Design and installation*
- AS/NZS 3679.1:2010 *Structural steel – Hot-rolled bars and sections*
- AS/NZS 4600:2005 *Cold-formed steel structures*
- AS/NZS 4673:2001 *Cold-formed stainless steel structures*
- AS/NZS 5601:2010 *Gas installations*
- NZS 1170.5:2004 *Structural design actions – Part 5: Earthquake actions – New Zealand*
- NZS 3101.1&2:2006 *Concrete structures standard*
- NZS 3404 Parts 1 and 2:1997 *Steel structures standard*
- NZS 3501:1976 *Specification for copper tubes for water, gas, and sanitation*
- NZS 3603:1993 *Timber structures standard*
- NZS 4104:1994 *Seismic restraint of building contents*
- NZS 4219:2009 *Seismic performance of engineering systems in buildings*
- NZS 4230:2004 *Design of reinforced concrete masonry structures*
- NZS 4332:1997 *Non-domestic passenger and goods lifts*
- NZS 4510:2008 *Fire hydrant systems for buildings*
- NZS 4541:2013 *Automatic fire sprinkler systems*

Other useful sources of information

- ACI 318-11 *Building Code Requirements for Structural Concrete and Commentary*
- ACI 355.2-07 *Qualification of Post-installed Mechanical Anchors in Concrete and Commentary*
- ETAG 001:2012 *Metal Anchors for use in Concrete – Annex E Assessment of Metal Anchors under Seismic Action*
- *ASHRAE Handbook* – www.ashrae.org/resources--publications/handbook
- *A Practical Guide to Seismic Restraint*, Tauby, Lloyd, Nice and Tunnissen, 1999
- ASCE 7-05 *Minimum Design Loads for Buildings and Other Structures*, ASCE, 2005
- *Seismic Process Guide for Mechanical Services Subcontractors*, Climate Control Companies Association, 2014
- *Code of Practice for Design, Installation and Seismic Restraint of Suspended Ceilings*, Association of Wall and Ceiling Industries of New Zealand (AWCI), 2015

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