DESIGN RIGHT

# Seismic restraint of building services

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Poorly restrained or unrestrained building services can cause havoc during earthquakes, leaving buildings unusable afterwards. Prevent this by following the guidance on properly restraining building services.

**RECENT EARTHQUAKES** have highlighted the potentially devastating consequences of inadequately restrained building services such as water reticulation, electricity supply, communications, heating, ventilation and air conditioning (HVAC) and fire sprinkler systems.

Flooding may result from ruptured pipework, a fire may break out due to electrical equipment shorting and components may collapse onto people causing injury or block exit routes. The damage is likely to cause ongoing lost productivity.

### *Seismic restraint is mandatory*

The New Zealand Building Code clause B1 *Structure* requires that both structural and non-structural building elements remain stable under imposed loads such as those caused by earthquakes.

It cites NZS 4219:2009 *Seismic performance of engineering systems in buildings*, which sets out design options for the seismic restraint of non-structural engineering systems. These are defined as permanently installed systems to provide water, gas, steam, electrical and communications services, environmental control and active fire-fighting or fire-suppression systems in a building.

### *Some building elements left out*

NZS 4219:2009 doesn't cover some building elements, such as lifts, fire sprinklers and suspended ceiling systems.

For these, the design should be in accordance with two standards taken together – NZS 1170.5:2004 *Structural design actions – Part 5: Earthquake actions – New Zealand* and either:

- the appropriate materials standard (such as NZS 3404:1997 *Steel structures standard)* or
- a specific system standard (such as AS/NZS 2785:2000 *Suspended ceilings – Design and installation* for suspended ceilings).

### *Good seismic design principles*

Good seismic design of engineering systems includes incorporation of:

- fixings to provide seismic restraint
- adequate clearances
- flexible connections.

#### *Fixings to restrain*

Fixings should provide restraint and transfer seismic loads to the building structure through a continuous load path that matches or exceeds the earthquake load demand of the building.

They include bolts, welds, anchors, brackets, cleats and gusset plates that connect components to each other, to the elements of a restraint system and to the supporting structure.

#### *Adequate clearances*

NZS 4219:2009 Table 15 sets out minimum clearances between building services and adjacent components based on whether the respective components are restrained or unrestrained.

#### *Flexible connections*

Flexible connections allow independent movement under seismic displacement. They should be used:

- at seismic joints between adjacent buildings
- at seismic joints in base-isolated buildings.

For example, flexible connections should be used to connect pipes to anchored equipment.

Vertical pipes should have enough flexibility to accommodate the relative horizontal movement between floors or fixing locations.

**Table 1**

## NZS 4219:2009 TABLE 15 – CLEARANCES

| CONDITION BEING CONSIDERED | MINIMUM CLEARANCE (MM) | |
|---|---|---|
| | HORIZONTAL | VERTICAL |
| Unrestrained component to unrestrained component | 250 | 50 |
| Unrestrained component to restrained component | 150 | 50 |
| Restrained component to restrained component | 50 | 50 |
| Penetration through structure (such as walls and floors) | 50 | 50 |

**Note** – Ceiling hangers and braces are considered to be restrained components for the purposes of this table.

### *Some restraints non-specific design*

Generally seismic design is required to be project-specific, which means the design must be considered specifically for every different building and engineering system.

However, NZS 4219:2009 allows ducting and piping system restraints to be designed using a non-specific design pathway if the installation meets the criteria in the standard. This means that, for some commonly used components, it is possible to develop non-project-specific solutions and adapt them for a specific project. Solutions must be verified by a seismic specialist.

Typical details where NZS 4219:2009 allows non-specific design include:

- light fittings
- fan coil unit bracings details
- cable tray bracing
- duct bracing.

When conduit, cables and cable trays cross a structural separation or seismic gap, they must be specifically designed.

### *Suspended ceilings*

Many suspended ceiling systems were damaged during the Christchurch earthquakes. Problems included dislodged and broken ceiling tiles, failed grid connections and perimeter angles and impact damage between ceiling components and adjacent services.

AS/NZS 2785:2000 provides specific and non-specific design pathways for suspended ceilings. Non-specific design guidance is usually provided by suspended ceiling manufacturers with prescriptive solutions for particular ceiling systems. Where ceilings are more complex, specific design is required.

A proposed code of practice for design, installation and seismic restraint of suspended ceilings is being developed by the Association of Wall and Ceiling Industries of New Zealand. They expect to release it later in 2015.

### *Use a seismic specialist*

Seismic design is an integral part of building design. It requires an integrated design and coordination between building designers, structural engineers and building services engineers from the earliest stages of the building project.

The design of non-structural systems such as building services should be carried out or supervised by a suitably qualified, competent seismic design professional who can undertake the design, inspection and sign-off for each component.

**For more** See the soon to be released BRANZ seismic resilience resource at www.seismicresilience.org.nz.