Seismic considerations
for suspended ceilings

ARCHITECTURAL SUPPORT SERVICES & TOOLS

Peter Wood
National Architectural and Specifications Manager
USG Boral

USG BORAL
INNOVATION INSPIRED BY YOU.™

Seismic compliance refers to the use of approved systems and designs that meet the seismic design requirements of a building project to provide life safety to occupants and maintain building function during and after an earthquake. Non-structural components often represent a high percentage of a project's capital investment. Failure of these components in an earthquake has the potential to cause harm, block egress and impede rescue efforts, and can disrupt the building's function. The basic objectives of seismic design for non-structural components are to provide life safety, minimise property loss and prevent functional loss.

DESIGN CONSIDERATIONS

AS/NZS 2785:2000 clause 3.2.2 (a) requires that dead, live, wind and earthquake loads are applied to the design of a suspended ceiling. In most cases, the following factors are required to establish the earthquake load and subsequent design:

- Soil condition/class
- Building construction materials
- Building usage
- Building importance
- Geographic location
- Location to fault lines (known) and hazard Z factor
- Weight of the ceiling
- Height of the ceiling from ground level
- Size of the ceiling
- Seismic Drift

By analysing these criteria for a construction project in conjunction with Australian standards, the seismic force is established, and from that the design requirements for the suspended ceiling(s). This is typically done by the project's structural engineer, but may require the involvement of qualified engineers more familiar with seismic design.

The three main Standards dealing with suspended ceilings in Australia are:

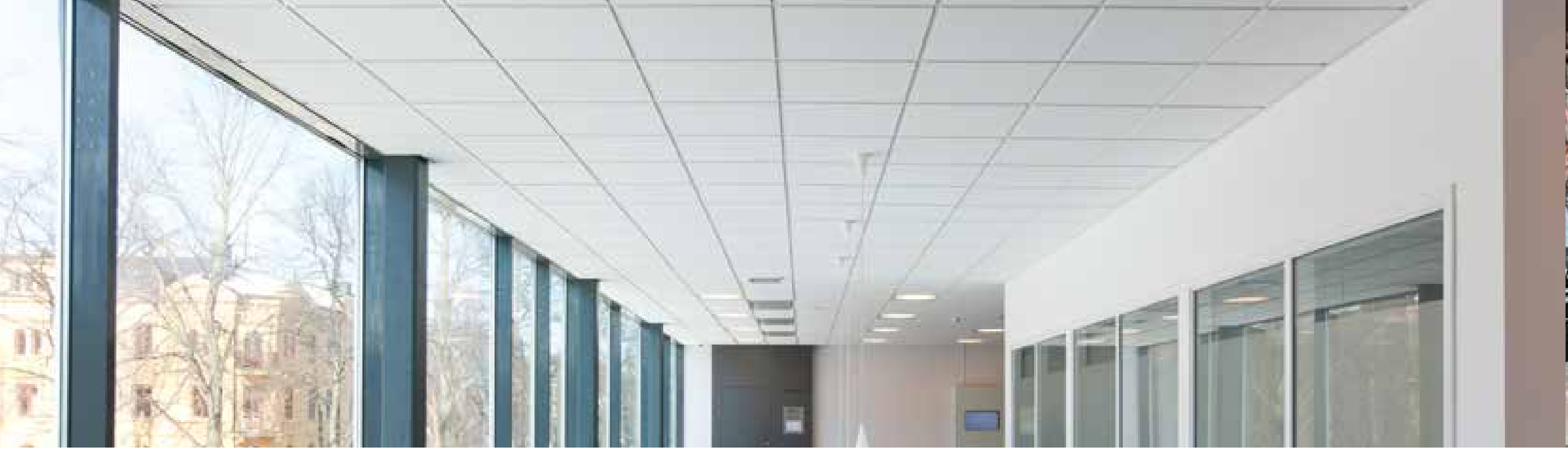
- AS1170.4:2007 - Structural Design Actions – Earthquake Actions in Australia
- AS/NZS 1170.0.2002 – Structural Design Actions – General Principals
- AS/NZS 2785:2000 – Suspended Ceilings, Design and Installation

COMMON MISCONCEPTIONS ABOUT SEISMIC CEILINGS

There is often confusion around how ceiling systems need to be installed in order to comply with AS1170.4:2007. Therefore it is important to have as much detail in a specification as possible in order to minimise errors on site during construction. It should be noted that there is no such thing as a 'one-size-fits-all' solution, as each project will differ considerably based on seismic requirements and design considerations.

Below are some examples of common misconceptions on seismic requirements and installation for suspended ceilings:

- Adding extra suspension hangers will render the ceiling seismic compliant
- Fixing the ceiling system at all four walls will stop movement and therefore failure in a seismic event
- Installing perimeter clips renders a ceiling system compliant in pretty much all circumstances
- Installing a ceiling system with moving wall angles will comply in any circumstance
- The heavier the steel used in the ceiling system, the stronger it is in a seismic event
- All grid systems are pretty much the same and the installation method of one system can be used on another
- The installation method recommended by one manufacturer can be used with an alternative system
- The installation method used on a previous project will function the same on another



BRACING LAYOUT OPTIONS

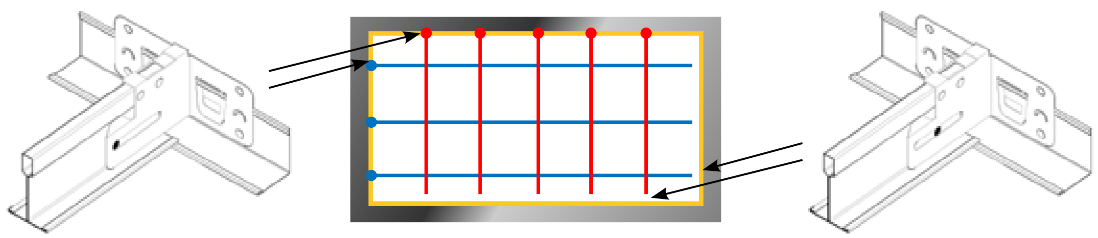
There are three different options for bracing the ceiling against lateral loading. The most common method of horizontal restraint is to fix the ceiling to the building structure on two sides of the perimeter (re option 1 and 2). If perimeter fixing is not sufficient or appropriate, the ceiling may be back-braced by fixing to the structure above.

OPTION 1 | Perimeter fixing on adjacent edges

Ceiling is fixed to the perimeter on two adjacent sides and a seismic sliding joint is used on the opposite sides. Lateral loads are transferred from the ceiling to the perimeter through the perimeter fixing.

Fixed end with screw in front of slot. End of tee must be in contact with perimeter Wall Angle.

Floating end with screw in centre of slot and not tightened. 10mm gap between end of tee and perimeter Wall Angle.



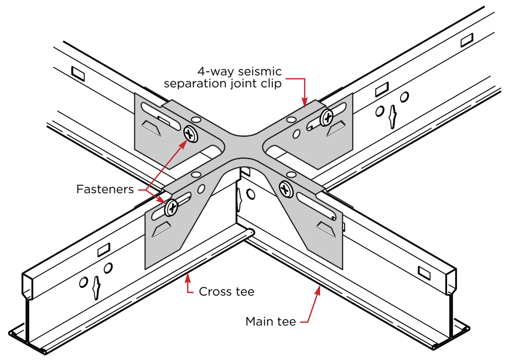
Legend

Main tee (fixed end)	Cross tee (fixed end)
Main tee (free end)	Cross tee (free end)
Perimeter trim	Surrounding Wall/Bulkhead

NOTE: The building engineer must confirm the two adjacent walls are capable of resisting the line loads of the ceiling.

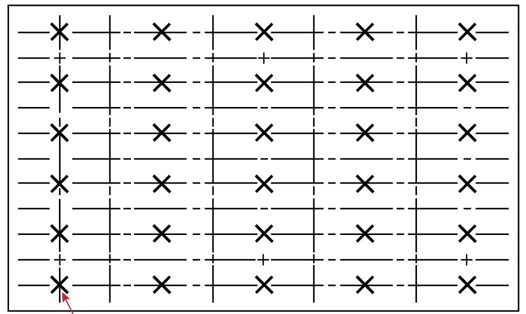
OPTION 2 | Perimeter fixing on more than two edges

The ceiling is split up into smaller sections using seismic joints. The ceiling can then be fixed to the perimeter on opposite sides. Lateral loads are transferred from the ceiling to the perimeter through perimeter fixings.



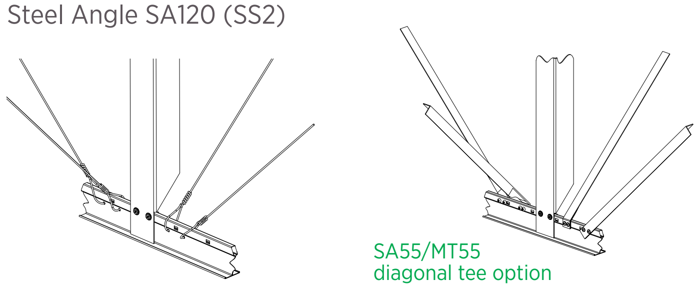
OPTION 3 | Back bracing

The ceiling is braced back to the structure above with compression struts and tension wire braces or diagonal tension/compression struts. A seismic sliding joint around the entire perimeter is required, as the ceiling may not be braced to both the structure above and the perimeter.

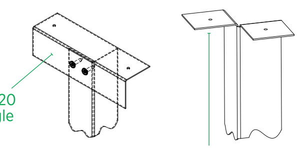


Steel Track (SS1 and SS3)

Steel Angle SA120 (SS2)



Strut top fixing options



SPECIFYING A COMPLIANT CEILING SYSTEM

When specifying a ceiling system which needs to be installed to withstand a seismic event, ensure you specify an exposed or concealed ceiling grid system which has been tested and designed to meet the requirements AS1170.4:2007 (USG Boral DONN® Grid or USG Boral Drywall Grid systems meet these requirements).

Exposed mineral fibre ceilings which use USG Boral DONN® Grid and ceiling tiles may be covered by a USG Boral warranty of up to 30 years[1]. There are several factors to consider when designing and specifying a ceiling system which complies with AS1170.4:2007 as well as achieving desired aesthetics, acoustic performance and fire ratings. It is important to understand how the ceiling will need to be restrained when designing the layout of the ceilings and walls. In many cases, the perimeter fix and float method is the most cost-efficient solution, so designing the wall systems with this in mind may reduce cost and installation time.

Recommendations:

- Ideally the wall systems should be built up to and fixed to the underside of the structure, and designed to withstand the lateral force of the ceiling system. This will allow the perimeter fix and float method to be used and may reduce material and labour costs, as well as minimising potential issues regarding services in the plenum.
- Use a purpose-made system for transitions from plasterboard to mineral fibre ceilings to maintain seismic performance.
- If recessed continuous LED lighting or similar continuous services are going to be used within a ceiling system, the grid system may need to be modified with a Yoke bracket or similar in order to 'bridge' over the light or service. Contact USG Boral if you require more information.
- Avoid excessively heavy lining materials for ceilings, as this will increase the seismic force of the ceiling and may require excessive plenum bracing.
- For plasterboard ceilings consider using lightweight plasterboard (e.g. USG Boral Sheetrock®) to reduce the seismic force of the ceiling system.

1. For more information on USG Boral DONN® Grid and ceiling tile warranty visit www.usgboral.com/en_au/legal.html

USG BORAL SEISMIC CEILING SYSTEMS

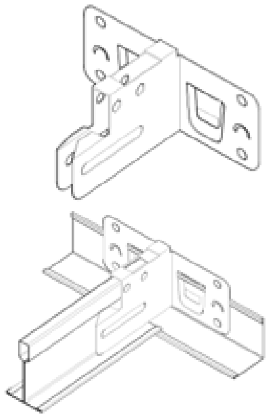
To assist the designer and contractor, USG Boral provides a seismic ceiling design service that provides seismic solutions for many common building types. There are several ways in which we can assist with your next project.

- Specify USG Boral ceiling systems and note that the ceiling system must be designed by USG Boral prior to installation. We will work with the contractor to ensure they understand how the ceiling system needs to be installed.
- Contact USG Boral for a preliminary design advice to ensure the ceiling system can be designed to your requirements as well as to AS1170.4:2007.
- Arrange a project-specific preliminary seismic design report from USG Boral.

The USG ACM7 seismic clip is designed and engineered to provide a more robust perimeter restraint than traditional L-shaped clips.

It features a saddle that fits securely over DONN® tee bulbs (38 and 32mm height tees only) and fastens to the tee web and to the wall.

- It has been tested in New Zealand to provide engineered solutions for perimeter seismic restraint under both tension and compression.
- The design provides support on both sides of the tee web and around the bulb of the tee.



- This clip also provides two return wings which connect to the Wall Angle on each side of the tee with screws and friction fit tabs.
- Either wing can be snipped off to fit corners and other tight junctions (Note: this configuration is not suitable for resisting seismic loads at fixed end of tees).
- It can be adjusted to accommodate tees that intersect the wall at an angle other than 90°.
- Pre-punched holes and slot provide options for secure restraint for fixed perimeter junctions.
- A non-tightened screw is used in the centre of the slot for floating (or free) ends.
- Use of the ACM7 clip at both ends (fixed at one, floating at the other) can increase the strength and allowable length of a ceiling tee by more than three times, compared to single end fixing using a ø3.2 aluminium rivet. (Note that the ACM7 clips are likely to experience some degree of tearing during earthquake event, depending on the severity, and may need to be replaced afterwards).

PRODUCT INFORMATION

See USGBoral.com for the most up-to-date product information.

SALES ENQUIRIES

1800 003 377

TECHNICAL ASSISTANCE

TecASSIST™ 1800 811 222

UB1087-ARC 05/17

USG BORAL
INNOVATION INSPIRED BY YOU.™