INT&RIOR SYSTEMS

Guiding Design • Informed Interiors

Seismic Design

Welcome

This eBook is brought to you by...

Hedda Oosterhoff

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Hedda is a member of the Acoustical Society of New Zealand (MASNZ), is on the Executive Committee of the AWCI (Association of Wall and Ceilings Industries) and is the Vice-Chair of the AS/NZS2785 (Suspended ceiling - Design and Installation) Revision Committee.

Joe Bain

This series is peer-reviewed by Dr Joseph Bain, PhD, BE(Hons), MIPENZ, CPEng, IntPE(NZ). Joe is Pilz/TUV Nord Certified Machinery Safety Expert and the co-founder and Chair of the New Zealand Society for Safety Engineering, a Technical Interest Group of IPENZ, and delivers the HSW legisation CPD courses for IPENZ. He is on the Leadership Team of HASANZ, the Health and Safety Association of New Zealand.

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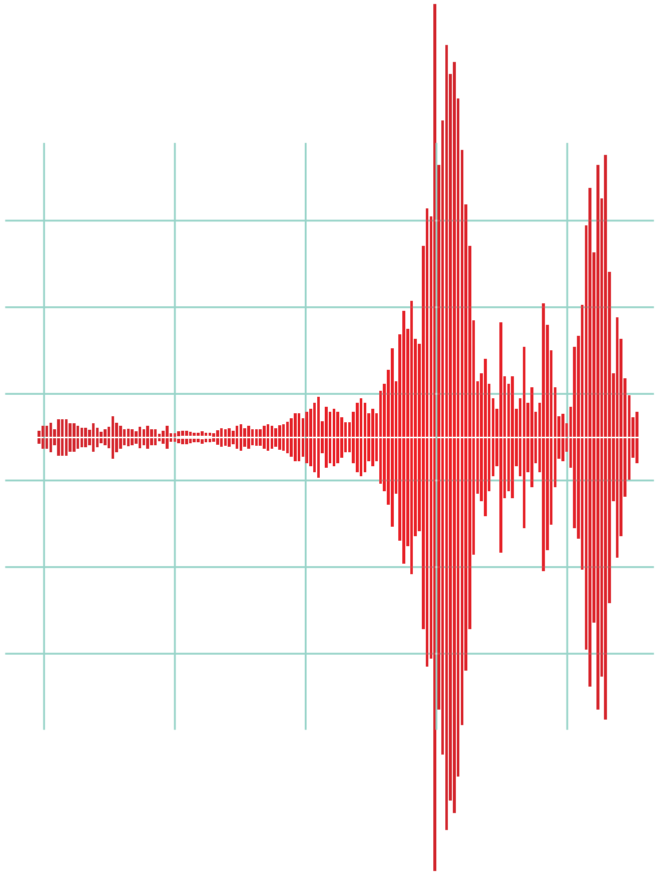

This eBook:

Guidelines and Standards

Earthquake Loads

Design Guides and Calculations

Details and Systems

NEW ZEALAND INSTITUTE OF ARCHITECTS INCORPORATED
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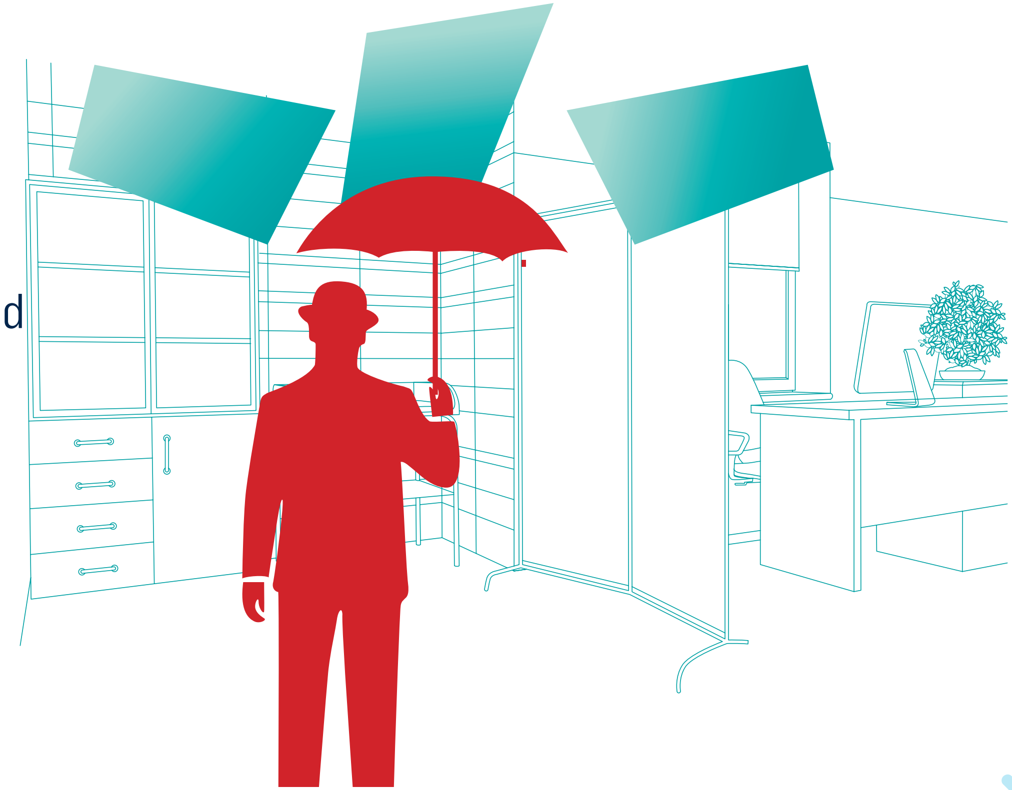
Relevant Design Standards

NZ1170.5: 2004 and 2016 Supplement

NZS 4219: 2009

AS/NZS 2785: 2000
- Suspended Ceilings, Design and Installation (will be updated and revised by the end of 2017)



Introduction

Guidelines for Architects and Designers

The industry is under increasing pressure to ensure seismic compliance on current and future construction projects.

While full compliance with seismic requirements will add cost, it will limit damage, reduce repair costs and reduce the time to re-occupy post event.

Because every building is different, there is no standard seismic restraint solution to address site, location, form and function. The scope of seismic restraint and related engineering work that will be required will not be known until the ceiling design is completed.

It is imperative that mechanical services, sprinkler systems, electrical and suspended ceiling design are all co-ordinated at appropriate stages in order to minimise the risk of failure.

Ceiling Failure

A series of major earthquakes in recent years have caused large amounts of damage and highlighted a systemic problem in the seismic design of suspended ceilings.

Many ceilings, partitions and building services within ceiling voids collapsed, causing damage in commercial and institutional buildings. In some cases, poorly restrained ceilings failed along with the building services they were supporting, and in other cases, ceilings were compromised by unrestrained or poorly restrained building services and partitions.

Aside from the obvious concerns about the safety of building occupants and widespread non-compliance with the Building Code, these avoidable losses are a significant burden on the New Zealand economy.

The industry is under increasing pressure to assure seismic compliance on current and future construction projects.

There are many reasons for possible failure of the suspended ceiling, including but not limited to:

- Unsuitable ceiling design
- The use of an unsuitable product/system
- Installation not meeting the requirements of either the manufacturer, supplier or the New Zealand Building Code
- Ceiling wires not installed correctly
- Services within the ceiling space, or connected to the ceiling grid, not installed to current codes
- Perimeter walls or bulkheads insufficient to receive the line loads of a ceiling
- Insufficient seismic gaps to allow for movement of the building structure
- Partitions being connected to the ceiling system
- Partitions not independently braced
- A lighter gauge of ceiling grid or non-tested system being installed outside its non-structural capability
- Interference from other non-structural building components in the plenum.
- Cross nogging
- Incorrect ceiling installation procedures

However, there are three main broad types of ceiling failure:

- Ceiling tiles popping out
- Progressive collapse where the whole grid collapses
- Failure resulting from interference of other non-structural elements in plenum
-

Seismic Theory

Part Categories   Building Importance Levels   Hazard Zones   Earthquake Loads

Seismic loading is the load that the suspended ceiling must be able to withstand. For non-specifically engineered designs (SED), it can be calculated using several factors to resist earthquake actions, as set out in NZS 1170.5:2004.

This section highlights critical design information that is required in order to achieve a compliant design:

- Part Categories
- Building Importance Level
- Installation location: Hazard Factor
- Size of ceiling

Amended NZS 1170.5

The New Zealand Seismic Design Actions Standard (NZS 1170.5) has been amended and changes came into effect in September 2016. This has significant implications on the design and installation of ALL suspended ceilings. Since NZS 1170.5 is the design actions standard cited by Verification Method 1 to clause B1 of the NZ Building Code, it must be adhered to in order for an installed ceiling to comply.

Before the amendment, seismic design requirements for ceilings were the source of confusion, namely around selecting the appropriate part category to apply. This was especially a problem with tile-and-grid suspended ceilings.

The previous version of the standard allowed 'parts' which weighed less than 10kg and which were less than 3m above floor level to be classified as part category P7, which only required design to a serviceability limit state (SLS) - design for no or minimal damage during a 1-in-25-year earthquake. Considering only the weight of individual components, rather than the total weight of the ceiling system, meant that ceilings were not designed for much larger ultimate limit state (ULS) events. Depending on the building importance level, ultimate limit state part categories can require design for up to a 1-in-2500 year event. It is obvious that selecting a Serviceability vs Ultimate limit state has a huge effect on the resulting seismic design.

The vagueness in the previous standard surrounding weight led some designers to treat all ceilings as P7 parts since individual components weighed less than 10kg while others considered the total weight of the ceiling system and designed for ultimate limit state events. A third group made a case-by-case assessment for each design, depending on the total weight per square meter of the ceiling components, the height above the floor and the location.

Supporting comments provided in the amended version of NZS 1170.5 resolves this confusion. The new standard lowers the weight threshold for ultimate limit state design to 7.5kg, and makes it clear that the total weight of the ceiling system needs to be considered - tiles, grid, luminaires and any other supported services. It is no longer possible to define ceilings as P7 simply because the weight of the individual components is below 7.5kg. Except for exceptionally small ceilings, they all now need to be designed for ultimate limit state events.

Given the performance of suspended ceilings in the Canterbury earthquakes, and reports that are emerging about the performance in the recent Hanmer Springs/Kaikoura quakes (especially in Wellington), these changes are very timely. Collapsing ceilings can injure occupants and interfere with evacuation and reoccupation of a building.

The most important requirement is to design all future ceilings for ultimate limit state events.

Standards Australia has recently begun work on a revision of AS/NZS 2785, the standard for suspended ceilings. At this stage it seems that the main area of revision is expected to be the seismic design requirements for ceilings, so clarification of the design requirements should be coming by the end of 2017.

Classification of Parts

Category	Criteria	Part risk factor R_p	Structure limit state	Examples
P.1	Represents a hazard to human life outside the structure.	1.0	ULS	• Cladding Panels • Glazing Systems • Verandahs • Signs of hoardings • Vessels containing a hazardous material
P.2 and P.3	Represents a hazard to human life within the structure.	1.0	ULS	• Vessels containing a hazardous material • Warehouse racking • Heavy partitions • Ceiling Systems
P.4	Required for the continuing function of the evacuation (after earthquake) and human life support systems within the structure.	1.0	ULS	• Emergency Lighting systems • Emergency stairs • Partitions adjacent to egress routes • Life Support systems
P.5	IL4 buildings: Required to maintain operational continuity and/or All buildings: Required to be operational/ functional for the building to be occupied.	1.0	SLS2	• Communication equipment in Fire, Ambulance and Fire stations • Operating facilities, essential lighting, reticulation facilities in major hospitals • Standby generators necessary for Code Compliance for occupation • Egress systems
P.6	Where the consequential damage caused by its failure is disproportionately great.	2.0	SLS1	• Water systems above perishable goods • Fire protection systems over water sensitive items
P.7	All other parts	1.0	SLS1	• Lightweigh partitions not adjacent to egress-ways • lighting systems with secondary (tethered) suspension

Building Importance Levels

The New Zealand Building Code AS/NZS 1170.0:2002 (Appendix 2) defines building importance levels as below. Design guides and calculators should only ever be used for a building with an importance level of 3 or below, if not, an engineer should be engaged. BCAs (Building Consent Authories) may request a PS1 or PS4 to verify that a design meets requirements. This must be designed and produced by a suitably competent engineer.

Importance Level	Building Type
1	Buildings posing low risk to human life or the environment or a low economic cost should the building fail. These are typically small non-habitable buildings, such as sheds, barns and the like that are not normally occupied, though they may have occupants from time to time.
2	Buildings posing normal risk to human life or the environment or a normal economic cost, should the building fail. These are typical residential, commercial and industrial buildings.
3	Buildings of a higher level of societal benefit or importance or with higher levels of risk-significant factors to building occupants. These buildings have increased performance requirements because they may house large numbers of people, vulnerable populations or occupants with other risk factors or fulfil a role of increased importance to the local community or to society in general.
4	Buildings that are essential to post-disaster recovery or associated with hazardous facilities.
5	Buildings whose failure poses catastrophic risk to a large area (eg. 100km^2) or a large number of people (eg. 100,000)

Annual Exceedance Levels

The ULS or SLS state of a ceiling determines the level of seismic activity that the ceiling must withstand. 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 seismic activity that is likely to occur.

ULS = Specifically, for earthquake actions this shall mean avoidance of collapse of the structural system or parts of the structure representing a hazard to human life inside and outside the structure necessary for the building evacuation. Relates to the strength of the system

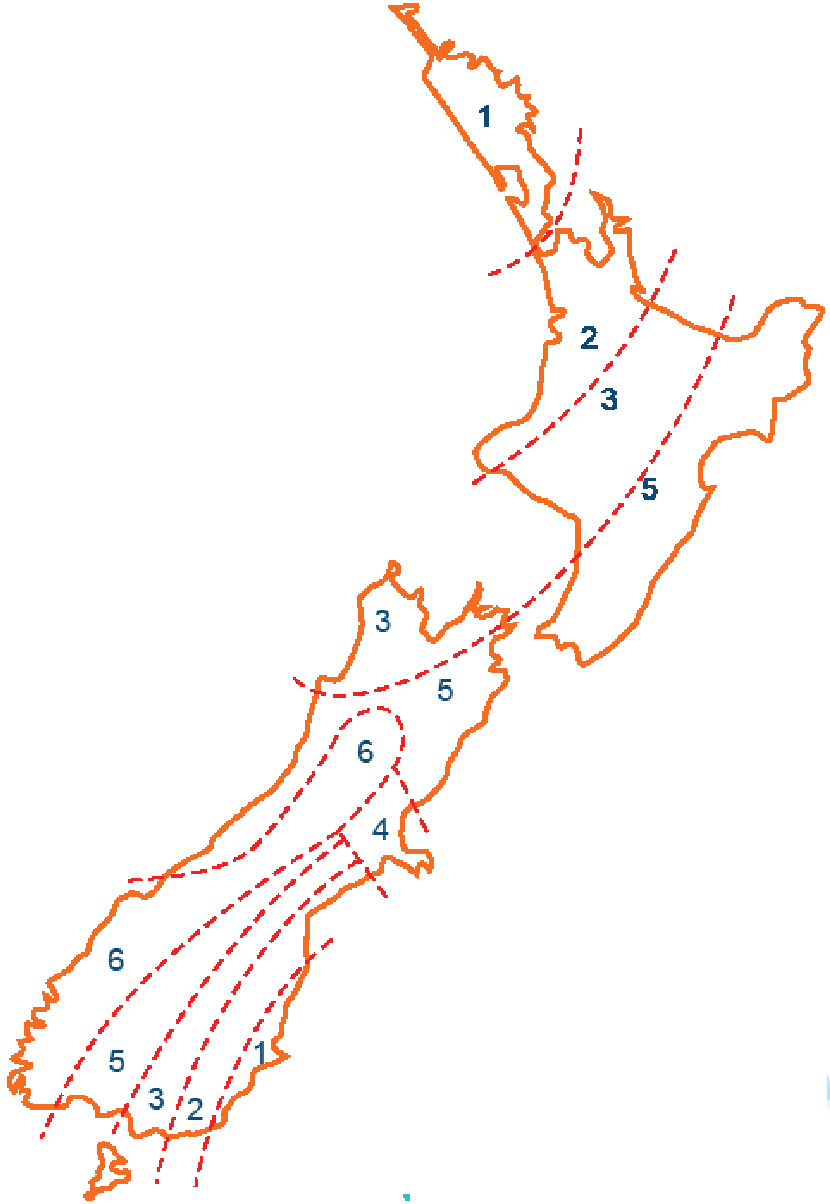
SLS - The structure and the non-structural components do not require repair after the seismic event. Relates to the flexibility of the system

Design Working Life	Importance Level	Annual Probability of exceedance for ultimate limit states (ULS) for EQs	Annual probability of exceedance for serviceability limit states (SLS2)
50 Years	1	1/100	No Consideration required
	2	1/500	1/100
	3	1/1000	1/250
	4	1/2500	1/500

(Please note that it is no longer acceptable to design for Serviceability Limit State 1)

Hazard Zones

Zone	Hazard Factor, Z	Localities
6	0.6	Arthurs Pass, Otira, Hanmer Springs, Milford Sound
5	0.46	Harihari, Hokitika, Fox Glacier, Franz Joseph, Kaikoura, Springs Junction, Masterton, Upper Hutt, Pahiatua, Woodville, Dannevirke, Waipawa, Waipukurau
5	0.4	Wainuiomata, Eastbourne, Wellington, Hutt Valley, Porirua, Paraparaumu, Waikanae, Otaki, Levin, Seddon, Ward, Cheviot, Wairoa, Gisborne, Napier, Hastings, Feilding, Palmerston North, Foxton, St Arnaud, Reefton, Greymouth, Te Anau, Mt Cook
4	0.396	Christchurch (Christchurch earthquake zone requires higher return period factor. The Z factor has been modified to account for this)
3	0.35	Queenstown, Arrowtown, Wanaka, Twizel, Murchison, Westport, Blenheim, Picton, Nelson, Motueka, Bulls, Marton,Taihape, Waiouru, Ohakune, Raetihi, Turangi, Taupo, Murupara, Ruatoria, Opotiki, Whakatane, Kawerau
1, 2	0.25	Other Localities

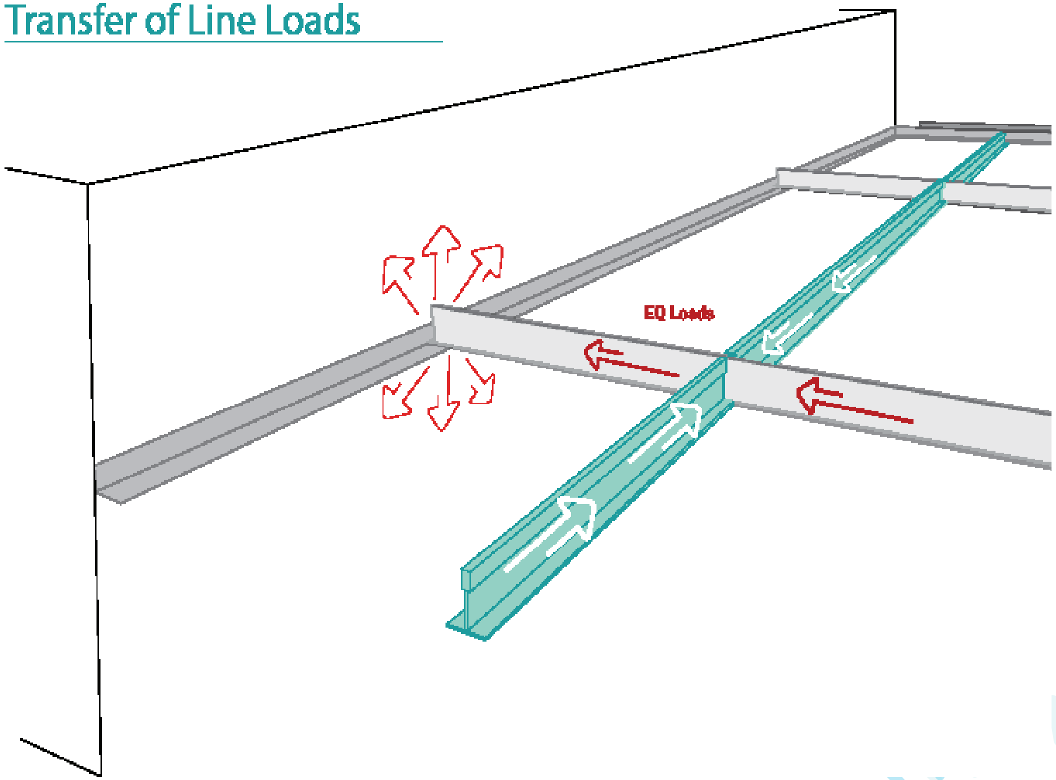


Earthquake Loads

Earthquake forces can act in vertical or horizontal directions and must be considered for all suspended ceilings in New Zealand and Australia to comply with AS/NZS 2785:2000 and NZS 1170.5:2004 (amended in 2016).

Post-Canterbury earthquake research has shown that allowance for relative motion between the ceiling and the structure must be provided. T&R Interior Systems and JSK Consulting Engineers have developed a system to accomodate floating edges (at least two edges of a square ceiling must be floating) as shown on the drawings in this guide. Floating edges must also be provided around rigid objects that pass through the ceiling (e.g. columns, wall partitions, sprinklers). Where vertical structure is required to take line-loads, the structural capacity of this must be sufficient to take the ceiling line loads.

Transfer of Line Loads



Seismic Design

Bracing Design   Fixed & Floating Edges   Services   Partition Walls

Seismic Bracing

There are two main types of seismic bracing for a ceiling:

- Edge Restraint
- Backbracing

Seismic bracing requirements for a suspended ceiling are a function of:

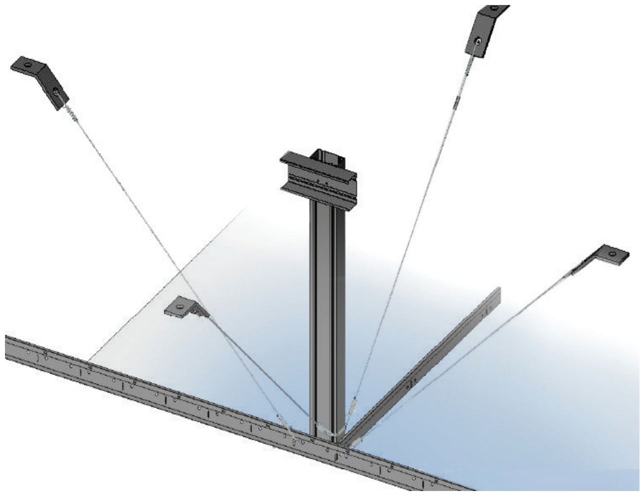
- Geographical Location
- The importance level of the building
- The height of the ceiling above the floor and the ground
- The mass of the ceiling grid
- The mass of the ceiling tiles
- The edge mounting arrangement

In New Zealand, seismic requirements for ceilings are based on:

- NZS 2785 - Suspended Ceilings, Design and Installation
- NZS 1170.5 - Earthquake Actions

In order to determine the type and amount of braces needed, the following are taken into consideration:

- Ceiling mass per square meter
- Bracing Post Calculation
- Ceiling height
- Plenum depth
- Ceiling area
- Maximum horizontal EQ load on tension cable and compression post



Ceiling Mass per Square Metre

Ceiling mass calculates the kg/m^2. It is the sum total of the grid mass, tile mass, luminaire mass as well as a distributed service load of 3kg/m^2. This distributed load is a requirement defined by AS/NZS 2785. Actual service loads must be used in design calculations.

Seismic Load

Seismic load calculations take into consideration the Hazard Factor of the particular location within New Zealand, the importance factor of the building and the height of the ceiling above the floor. These variables are used to calculate the horizontal design action.

Bracing

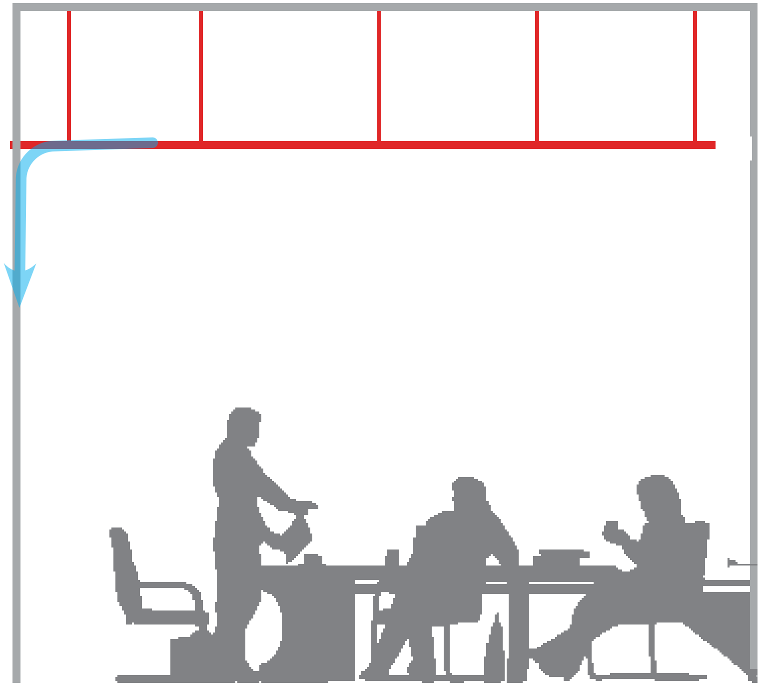
The bracing post calculation takes the plenum depth and uses this to calculate the maximum compressive load (kN) of each bracing post.

The bracing capacity depends on the maximum EQ Load on the tension cable and compression post. For the calculations, the smallest of these capacities is used.

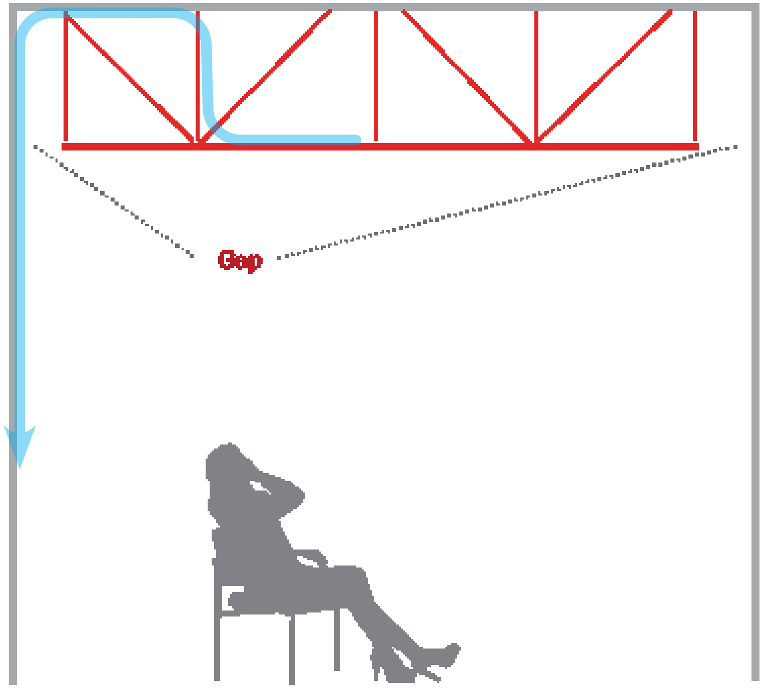
The Brace requirement calculation takes the earthquake forces, ceiling mass and ceiling area into consideration to provide a minimum number of braces required per area.

Ceiling Installation Configuration

There are two ways of approaching the design of the ceiling to wall junction: fixed or floating. If the ceiling is fixed to the perimeter wall, line loads on the grids are transferred out these walls during seismic movement and this acts as seismic restraint. However, due to the nature of this layout, maximum spans are limited . When the ceiling is floating, the ceiling moves with the structure above and is not affected by the wall movement. Back bracing ensures that the ceiling doesn't experience too much lateral and vertical movement. This is ideal for larger ceilings.



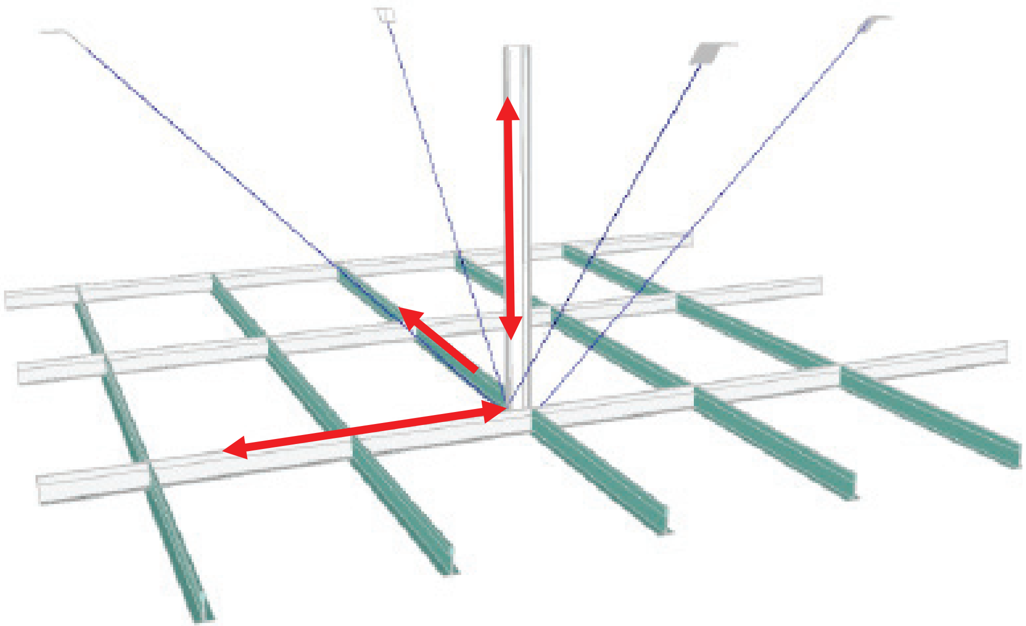
Fixed-edge configuration

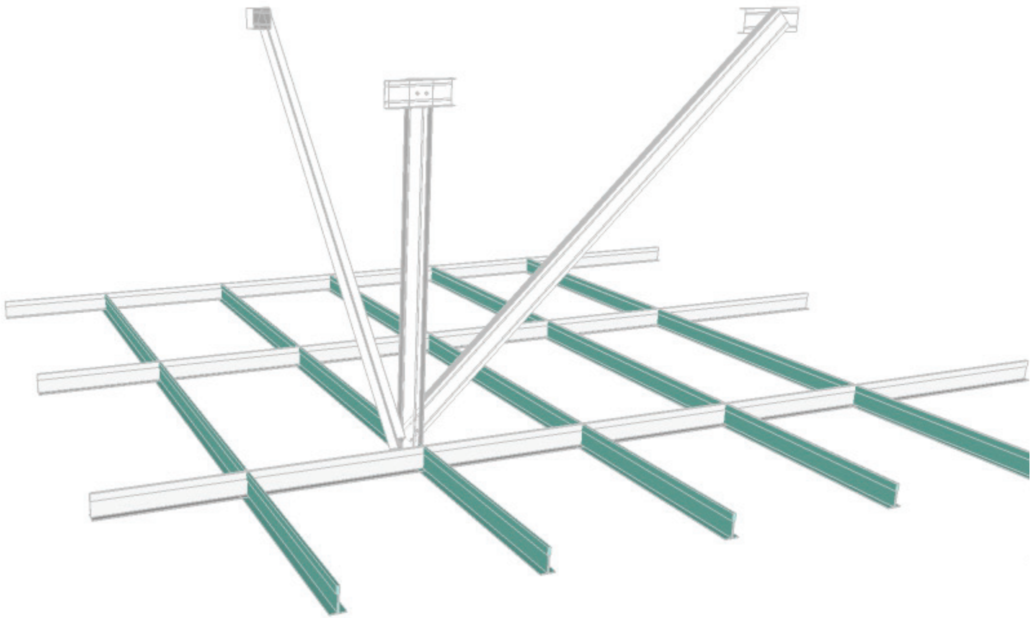


Floating-edge configuration

Back Bracing

Back Bracing consists of a compression post and wires/studs to prevent horizontal and vertical movement of the grid.

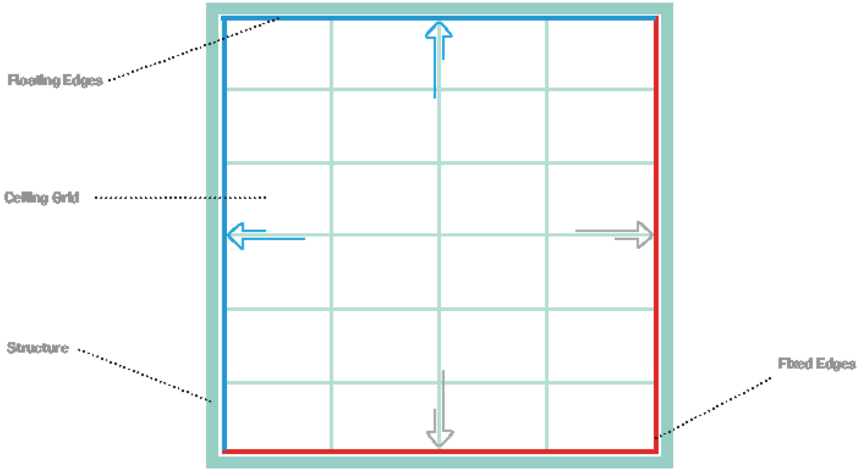


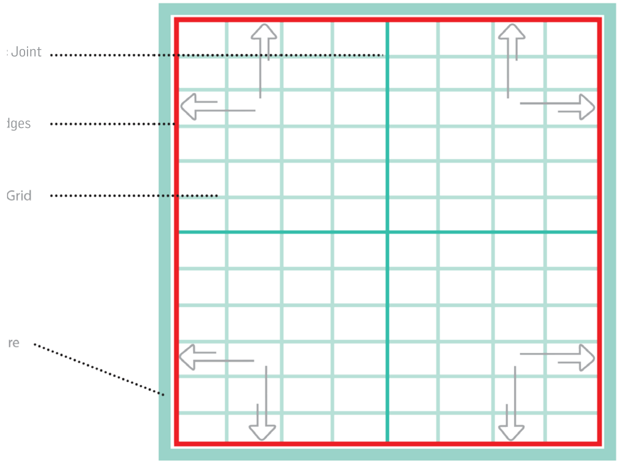


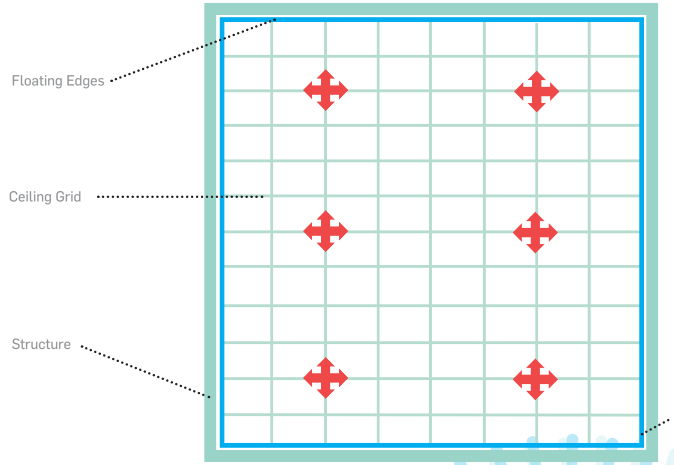
Edge Configurations

There are three fundamental seismic layout concepts:

- Perimeter connecting on two adjacent walls and two walls floating
- Perimeter fixed on all four sides with 'seismic separation' to allow for movement
- Floating on all sides, fixed/braced to the structure above

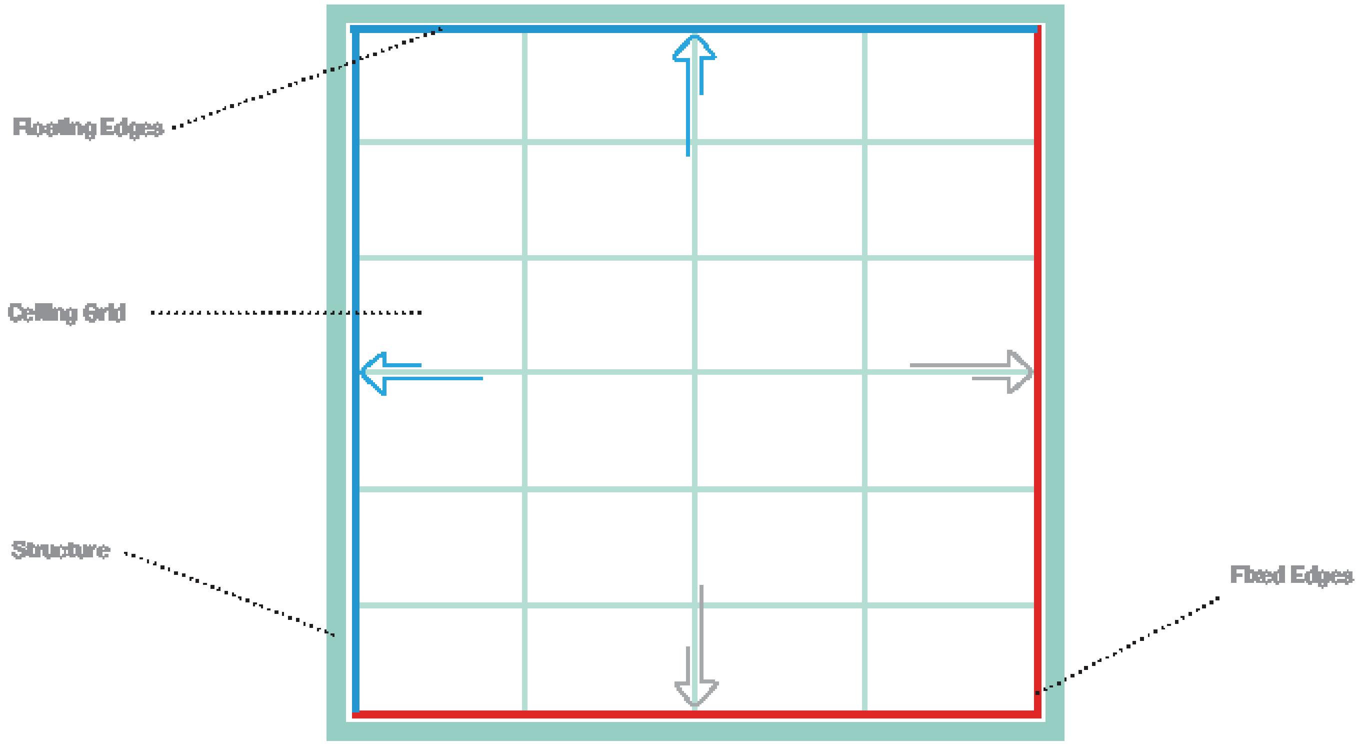






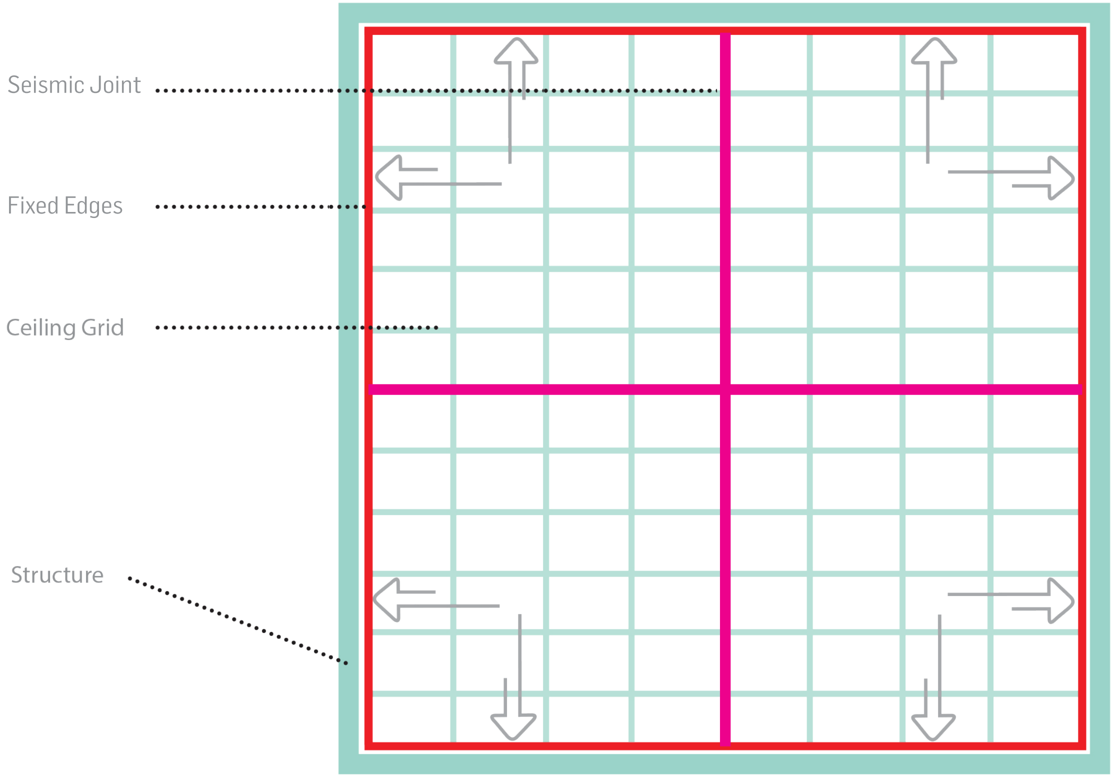
Fix Two; Float Two

The T&R Seismic System for small and medium ceilings - where no back bracing is required - relies on two perimeter walls to add support and brace the ceiling, but allows movement on the opposite side to prevent the grid pulling apart or crushing under compression. Opposing sides are never fixed.



All Sides Fixed with Seismic Separation Joints

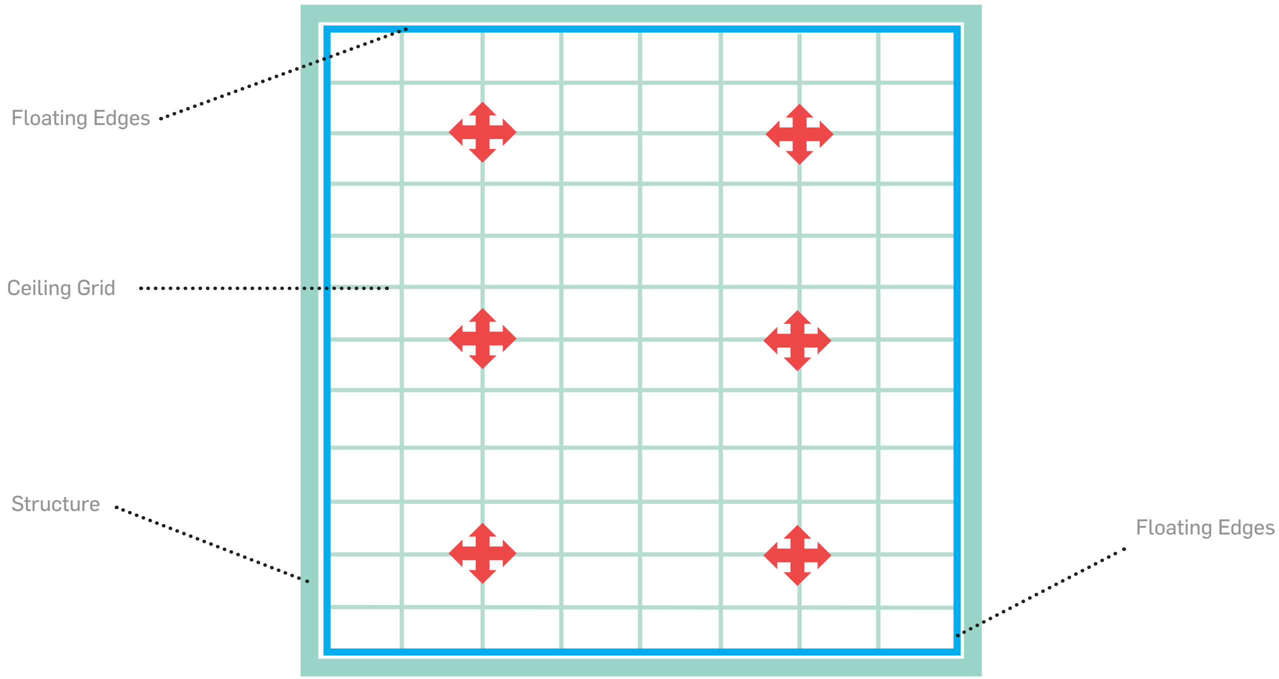
This can be used where the ceiling length and width are **less than twice** the maximum length for tee spans for the edge fixing method. The seismic joint effectively creates a floating edge which means that the four sections require no back bracing, whereas the complete ceiling with floating edges would. Again, opposing sides are never fixed.



All Sides Floating

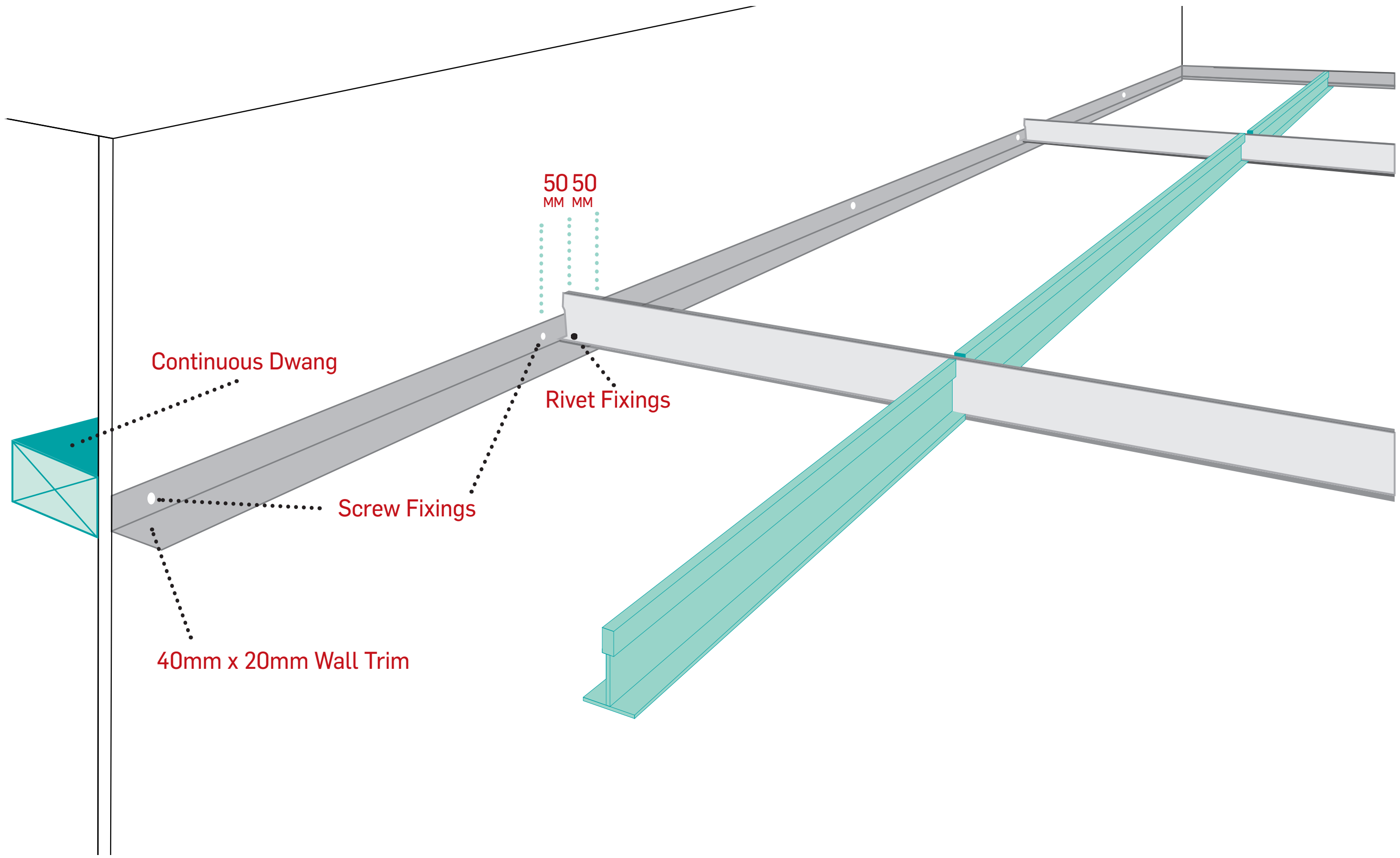
On larger ceilings where back bracing is required, the T&R Seismic systems is for all sides to be floating. Because the ceiling is not attached to the perimeter walls at any point, it moves with the structure above.

Testing has shown that where sides are fixed, the forces are transferred to the perimeter walls first and foremost, and it is only when these fixings reach capacity (and fail) that the back-bracing starts having any effect. Therefore, when back bracing is required, perimeter fixing is detrimental. Although there are some cases where perimeter walls will not cause sufficient forces on the grid to cause damage when edges are fixed, this can only be calculated by an engineer taking into account deflections of the walls. Therefore, the T&R Seismic System does not recommend fixing sides where back bracing is required, but where necessary, this should be checked by an Engineer.



Fixed Edge

When using fixed edges, the tee is attached to the wall trim by a rivet. The perimeter walls must have a continuous dwang at ceiling height to take the transfer of line loads. There must be screw fixings 50mm either side of the termination of the tees. The wall trim is also screwed to the wall between every tee in order to provide sufficient structural stability for the line load transfer.



Floating Edge

As no line loads are being transferred to the wall, additional structure is not necessary within it. The tees stop short of the wall to provide seismic clearance. A nominal 20mm is recommended but may be increased for specific design requirements. A 'Z-rail', notched at 600 centers, locks over the tees and is attached to the grid with a rivet and is suspended independently. This allows the ceiling to move with the structure above. The wall trim is structurally unnecessary but provides an aesthetic cover.

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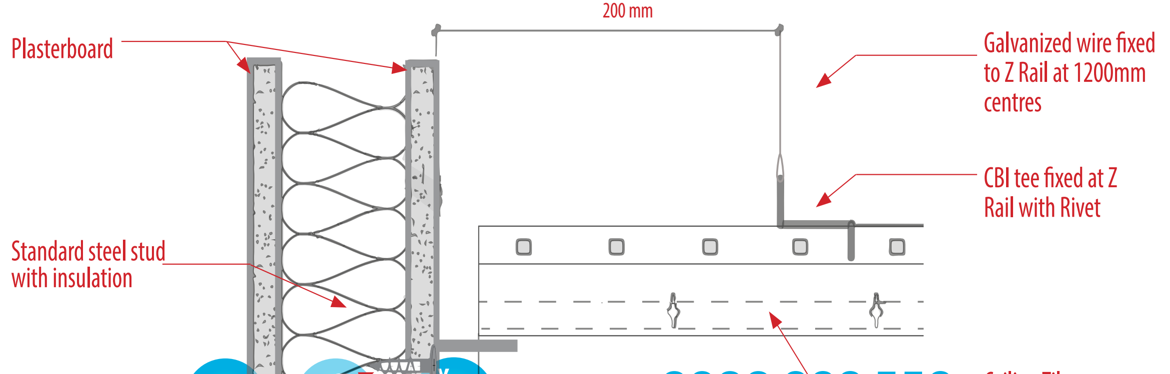
T & R Seismic Detail

Floating Edge

January 2016

Alternative Floating Edge Section



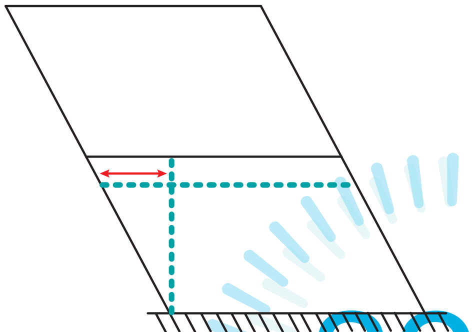
T&R Z Rail at the perimeter. Note that tees stop short of the vertical structure

T & R Seismic System specifies a nominal 20mm Seismic Space between termination of tee and the wall.

The expected deflection at ceiling height = The seismic spacing required

This should be discussed with a structural engineer.

The deflection between the floor and structural deck above suspended ceiling in section.

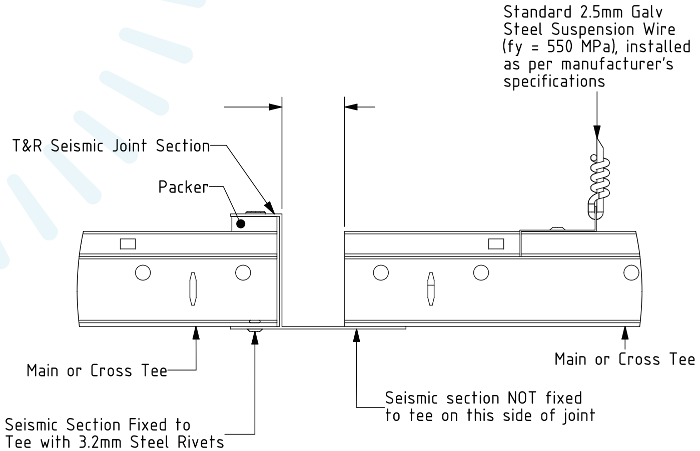


Seismic Joints

ASCE 7-10 - Minimum Design Loads for Buildings and other Structures specifies that "ceilings larger the 2500 ft^2 (232 m^2) shall be broken up into smaller areas by seismic joints unless sufficient clearance is provided to accommodate lateral displacement". Since the T&R Seismic Design philosophy treats ceilings as units for seismic purposes and bracing prevents relative motion between sections anyway, the clearance for movement around the ceiling edges is sufficient to accomodate lateral displacement in most cases.

There are designs where seismic joints are required: namely, where a seismic joint exists in the structure above the suspended ceiling.

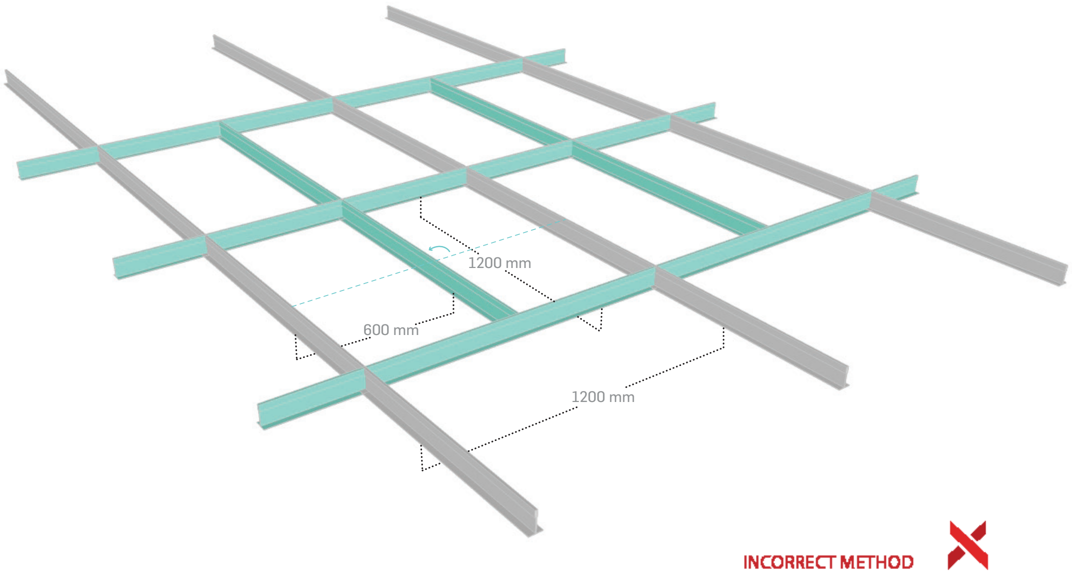
They can also be used where the ceiling length and width are **less than twice** the maximum length for tee spans for the edge fixing method. The seismic joint effectively creates a floating edge which means that the four sections require no back bracing, whereas the complete ceiling with floating edges would.



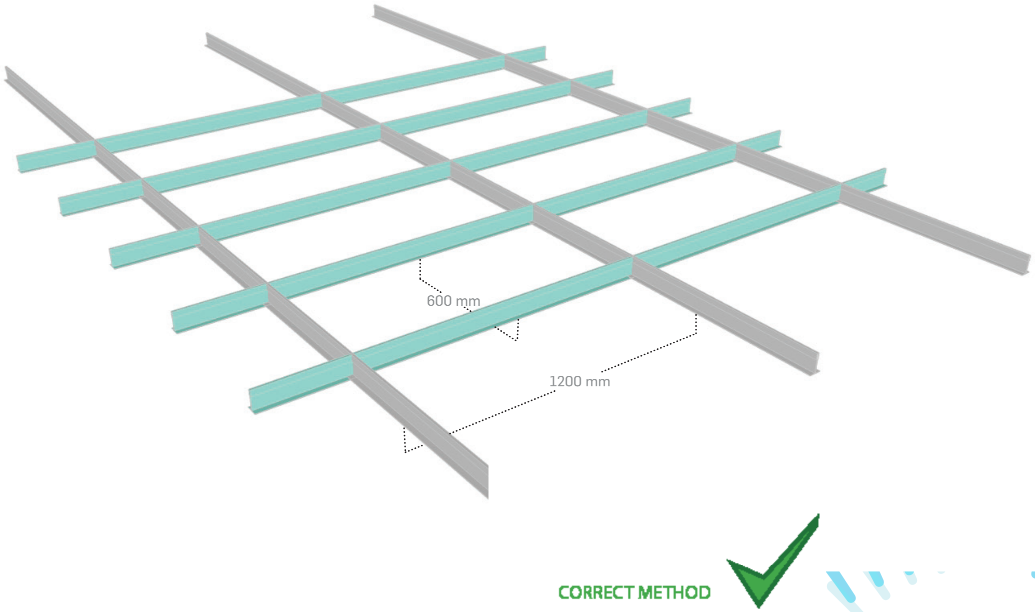
Cross Nogging

Cross Nogging is a common practice in the ceiling industry. This method rotates the orientation of the grid in order to allow the long edge of the ceiling tiles to run in the same directions as the purlins. However, cross nogging is very detrimental to the strength of the grid. It should be avoided at all costs and will not work with the T&R Seismic System.

Cross Nogging



Correct Nogging



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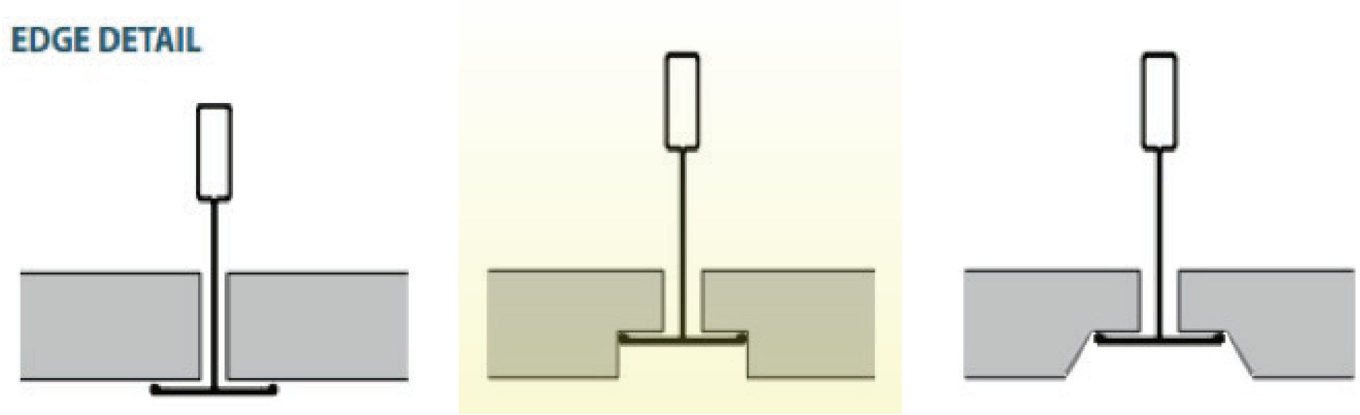
Diaphragm

Testing has shown that the level of seismic strength can be increased by using square edge reveal tiles (as per the center diagram below). Because the tile locks around the grid, it increases stiffness of the diaphragm. This is more effective than a standard Square Edge tile.

Due to the shape of the bevelled edge tiles, they are more likely to pop out of the grid during seismic activity.

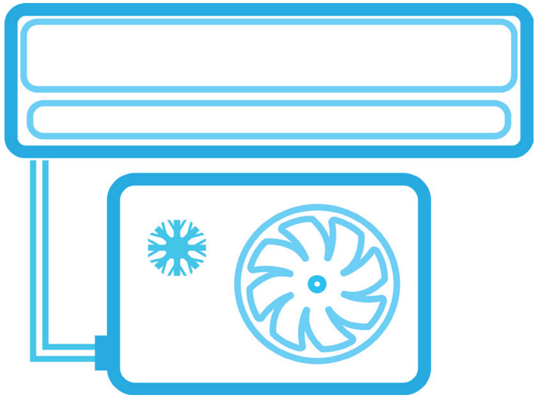


Square Edge

Square Edge Reveal (Rebated tiles)

Bevelled Edge

Services



The Building Code requires that all non-structural building components must be properly restrained against seismic movement to prevent them collapsing on people, cutting off exit routes from the building, being damaged, or damaging other property.

It is critical that all building components in the plenum do not impede or interfere with one another and in most cases, it is not possible to support these elements with the grid. Additional structure will be required. Refer to NZS4219 for further details.

Any services that are supported independently and that penetrate through the ceiling grid must be provided with sufficient clearance for relative movement. This is especially true for sprinkler heads. Sprinkler head penetrations shall have a 50mm oversize ring, sleeve or adapter through a ceiling tile to allow free movement of at least 25mm in all horizontal directions if NZS4219 is being used as the verification method. Flexible dropper design that can accommodate 25mm free movement shall be permitted as an alternative.

Failure to provide adequate clearance could result in the ceiling collapsing during a seismic event. During the Canterbury Earthquakes, ceiling failures caused by services in the plenum were overwhelming. Separation of components is required by code and allows for relative movements between services and ceiling during an earthquake

Clearances

Bracing layout and services should be co-ordinated. Services within the ceiling can be either braced or unbraced. Different clearances are required between braced and unbraced services.

NZS 4219: 2009 is the standard specifically concerned with the seismic restraint of mechanical systems in buildings.

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 floor)	50	50
NOTE - Ceiling hangers and braces are considered to be restrained components for the purposes of this table		

C5.2.1 Flexible connections within the service may allow penetration clearances to be reduced.

Partition Walls

When partition walls or glazing lines are attached to the suspended ceiling, the horizontal deflection of these elements during a seismic event can cause the ceiling to collapse.

Partition walls and glazing lines need to be independently braced at all times. At a minimum of 40kg/m^2, these walls have the weight to create catastrophic failure when horizontal deflection occurs.

Partitions under ceilings should be braced through the ceiling with sufficient seismic gaps to allow for calculated ceiling movement. There are proprietary and generic methods to permit partition bracing.

The TRACKLOK™ system allows for horizontal deflection of the wall of up to 40mm each way, while allowing for inter-story drift of 70mm.

CBI Grid

Components

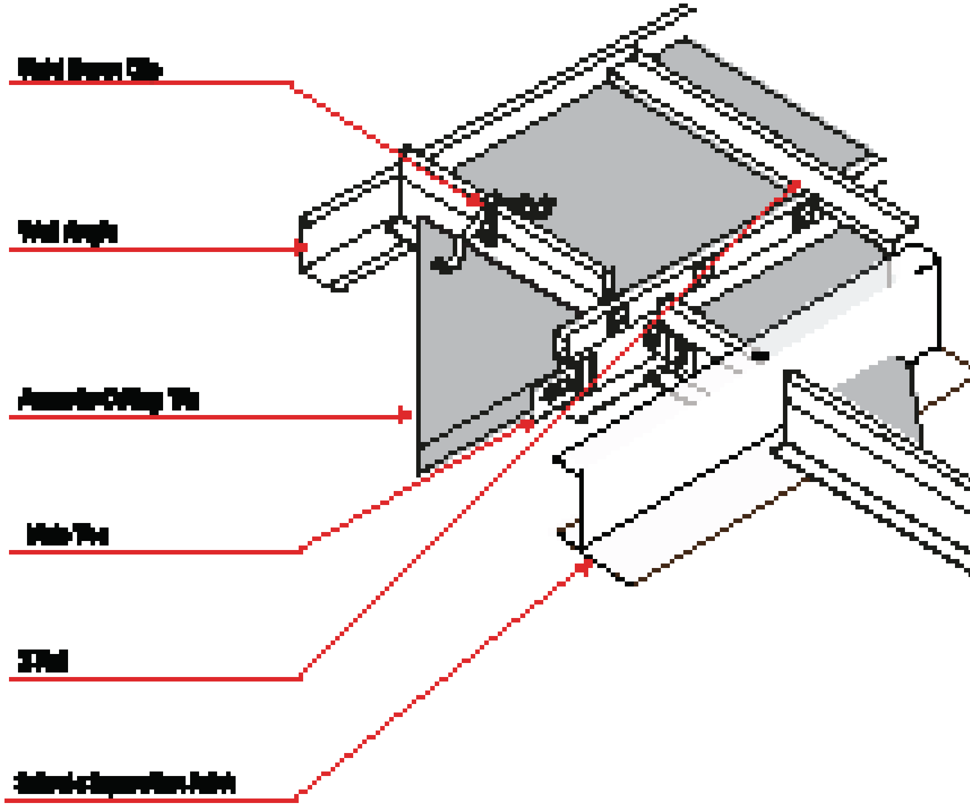
Qualities

Components

15 & 24 mm Two Way Exposed CBI Grid
All calculations in the brochure are based on 24mm CBI Grid

Main Tee The Main Tee is manufactured from hot dipped galvanised steel in a double web, balanced tee design, in 3700mm lengths. It is finished with a pre-painted steel cap. The main tee is conveniently punched at 100mm centres and includes suspension points in both the bulb and web. Main tees extend from wall to wall and are the primary ceiling support. End splices allow for greater lengths. Slots along the runner side allow cross tee to connect. Hold down clips are available as required.

Cross Tee The Cross Tees are manufactured in the same configuration in 1200mm and 600mm lengths. Lay on edge detail for neatness of installation coupled with resistance to twist. They connect between main tees using interlocking tabs. The high tensile clips ensure a positive locking system for quick installation



Wall angle L-shaped pieces that fasten to the wall and support the ends of the main runners and cross tees.

Z Rail A seismic support that suspends and supports the edge of the grid without relying on the perimeter.

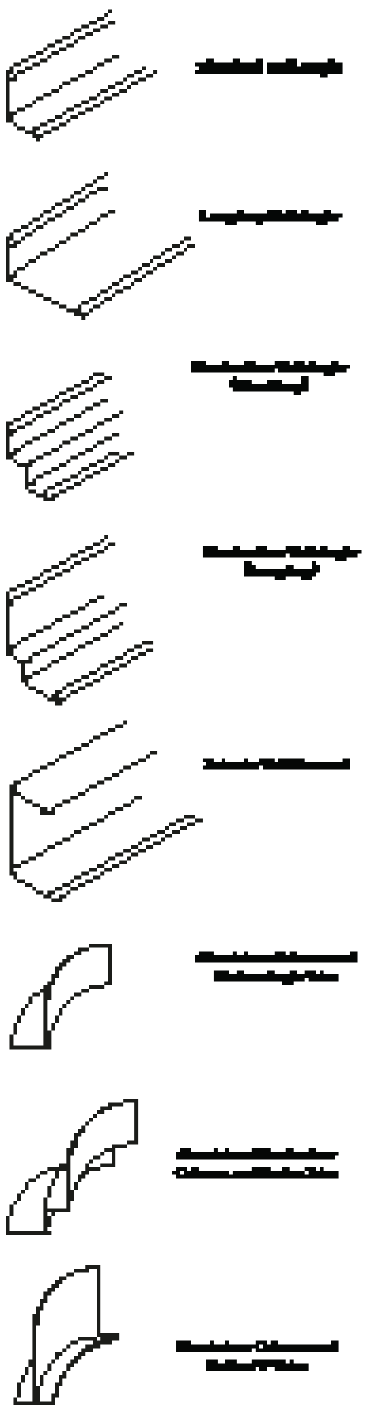
Border Cut panels around the perimeter of the room. They should be greater than half of a tile to maintain balance and add visual appeal.

CBI Qualities

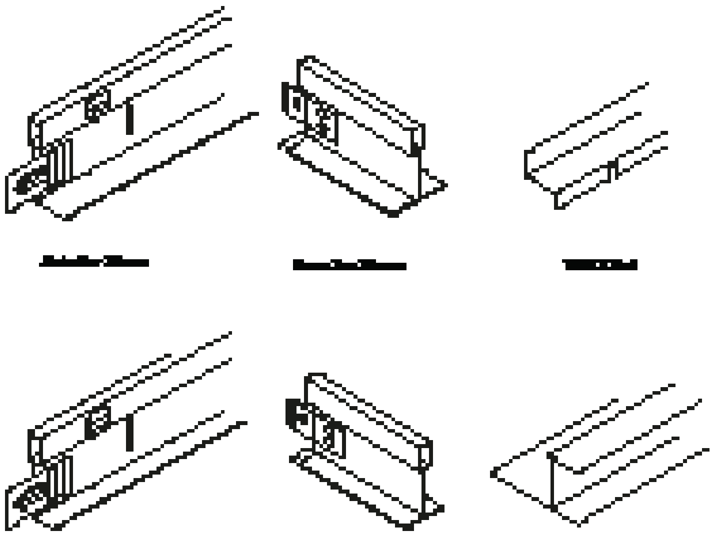
- Heavy-duty configuration with a 38mm web height to both Main & Cross Tees
- Main Tees punches at 100centres with first punch at 50mm
- Convenient punch out to both Web and Bulb for ease of suspension
- Seismically tested and proven to meet current NZ Standards
- High quality Italian design and manufacture
- 30-year system Warranty
- PS1 and PS4 are available from our Consulting Engineer as required
- Site specific ceilings will be designed to both ultimate and serviceability limit states to meet current NZ standards

CBI Grid and Related Components

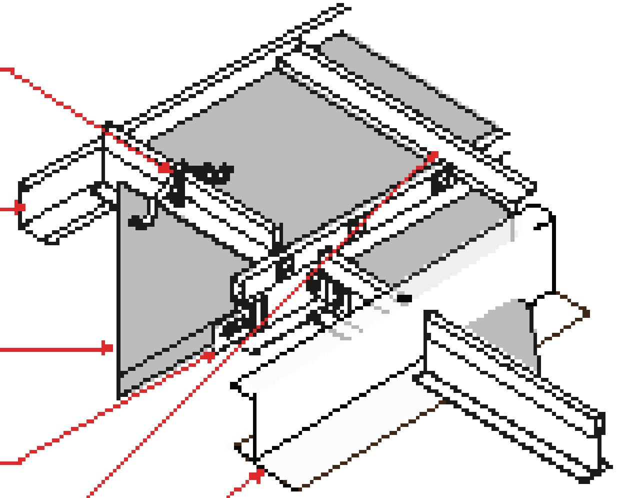
Wall and Column Trims



Support Members + Main Tees + Cross Tees

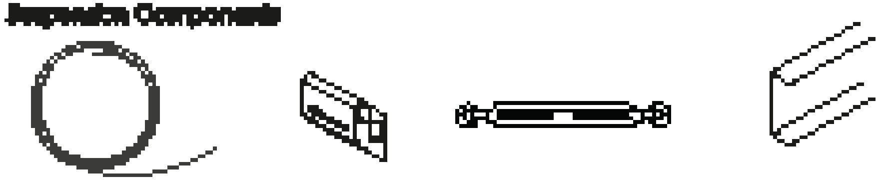


Ceiling Tile Edge Details

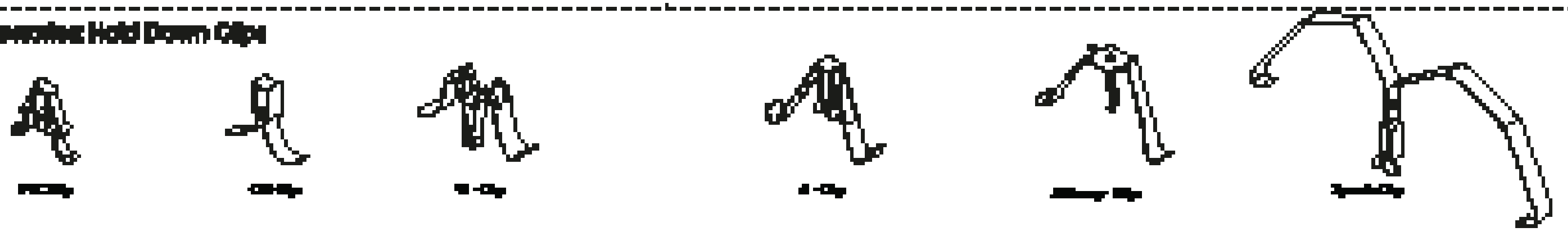


Eye Screws

Suspension Components



Accessories: Hold Down Clips



Detail Drawings

Fixed Edge

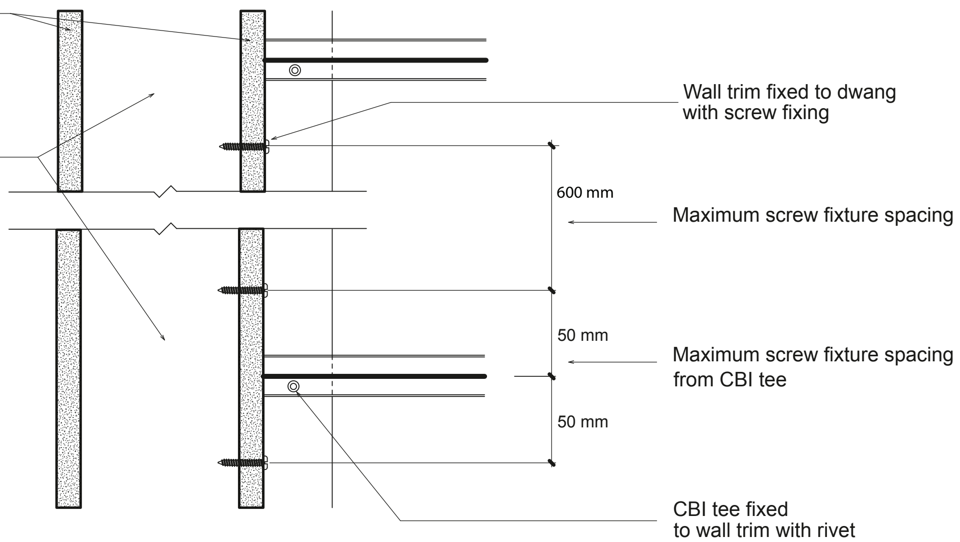
Floating Edge

Bulk Head

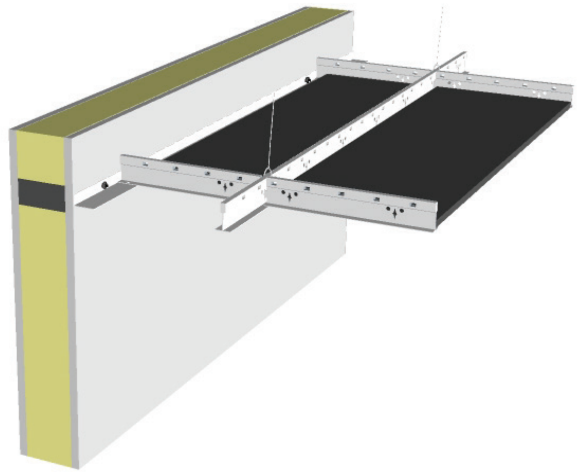
Bracing

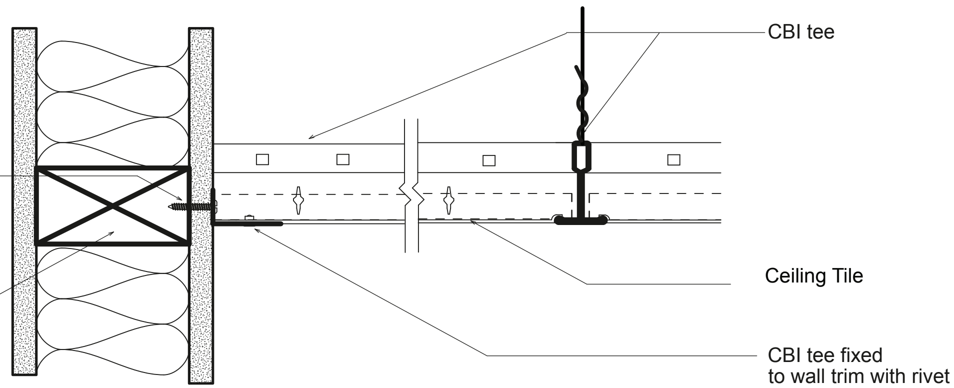
Wall Partitioning

Fixed Edge

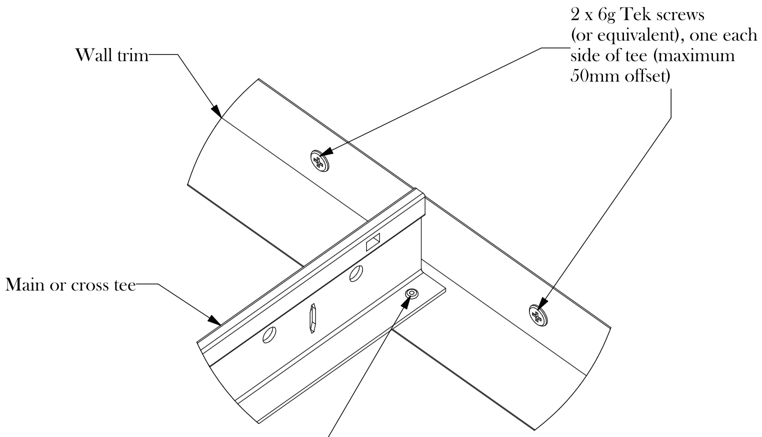


Fixed Edge Plan

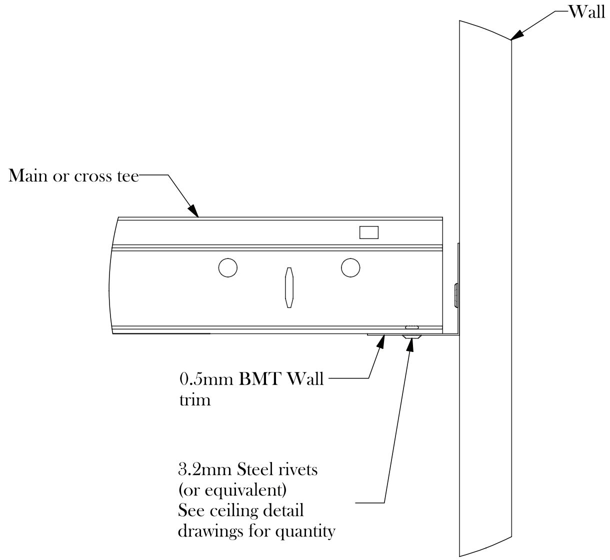




Fixed Edge Section



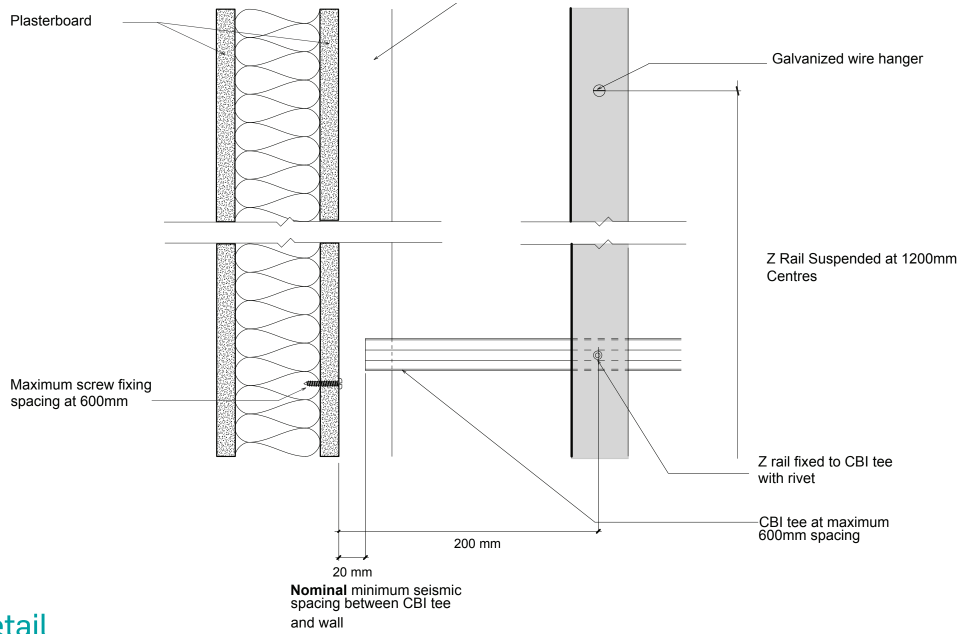
Fixed Edge Isometric



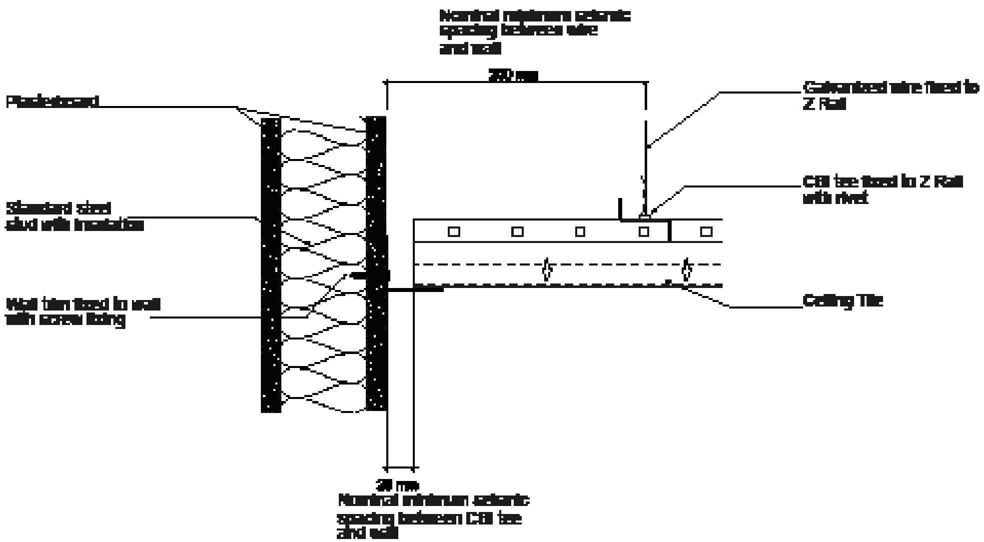
Fixed Edge Detail

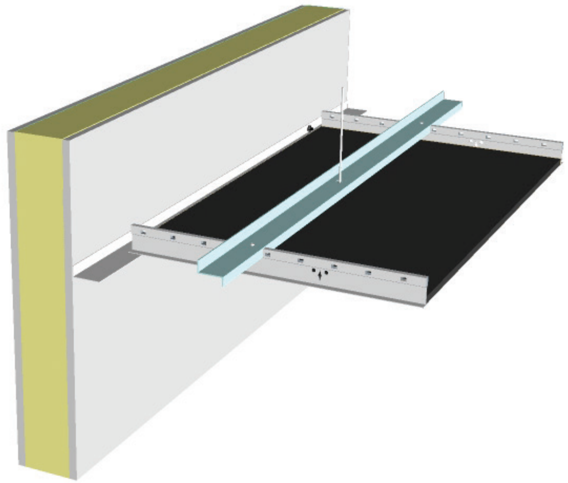
Note: Walls are to be fitted with a continuous dwang at ceiling height on walls where edge fixing is required, as per T&R seismic design guide.

Floating Edge

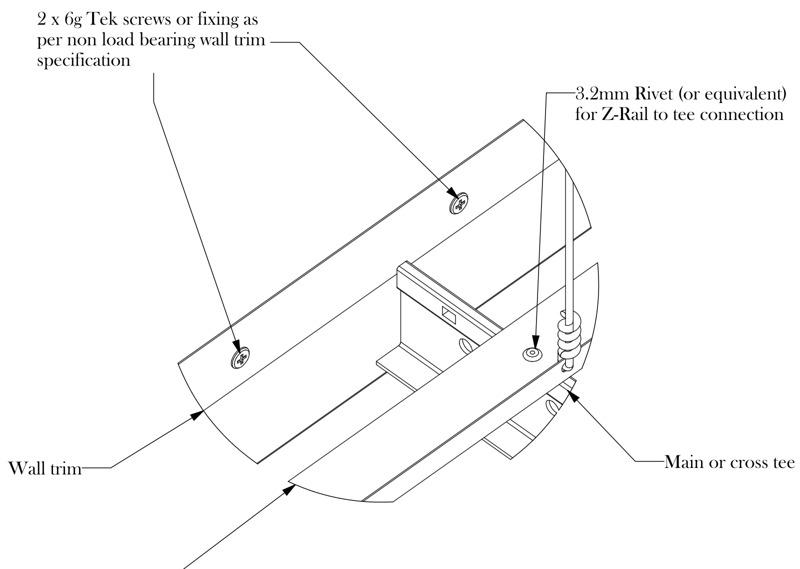


Floating Edge Plan Detail

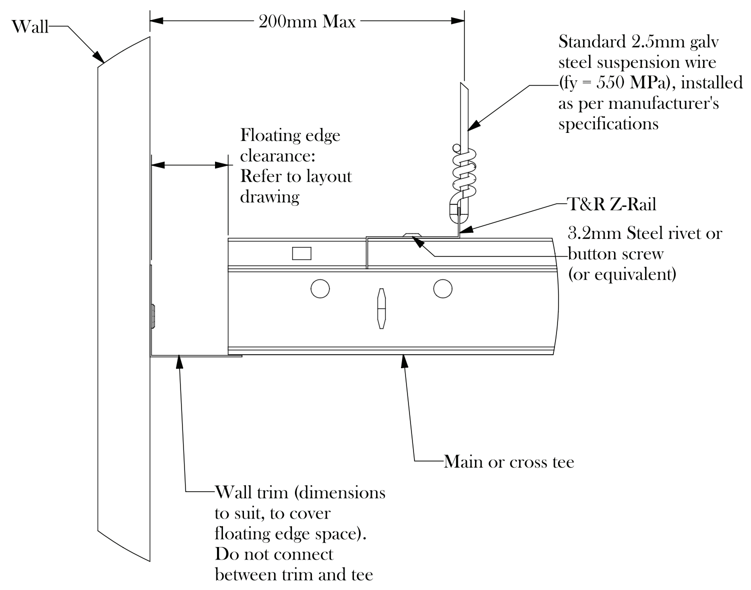




Floating Edge Secti

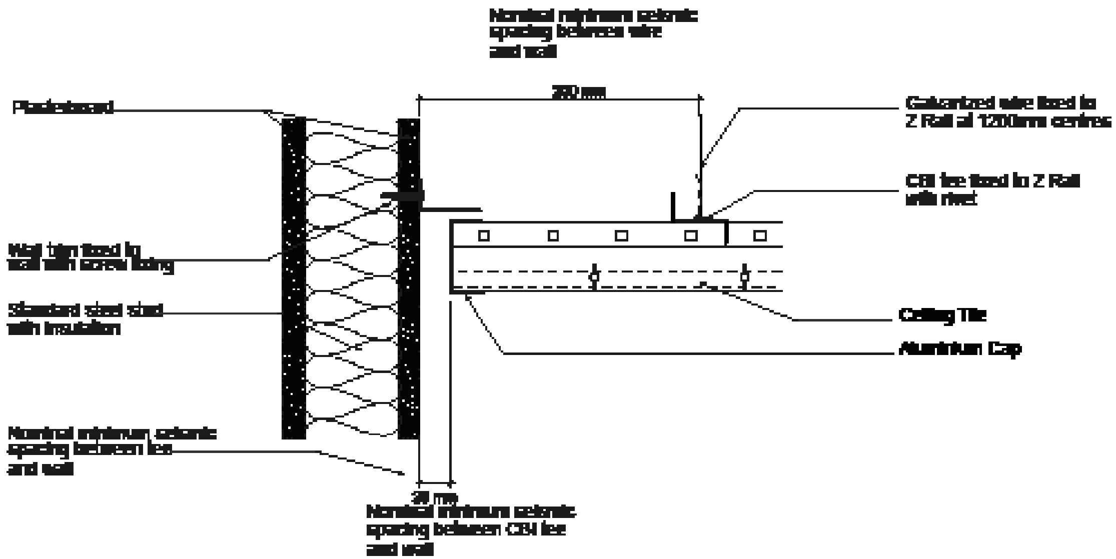


Floating Edge Isometric



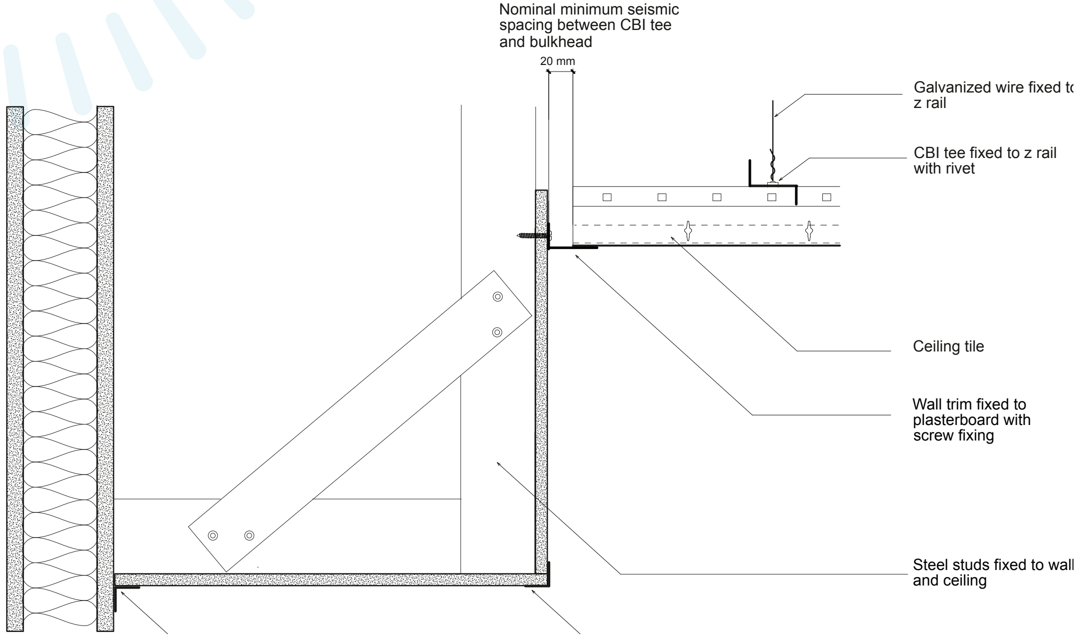
Floating Edge Detail

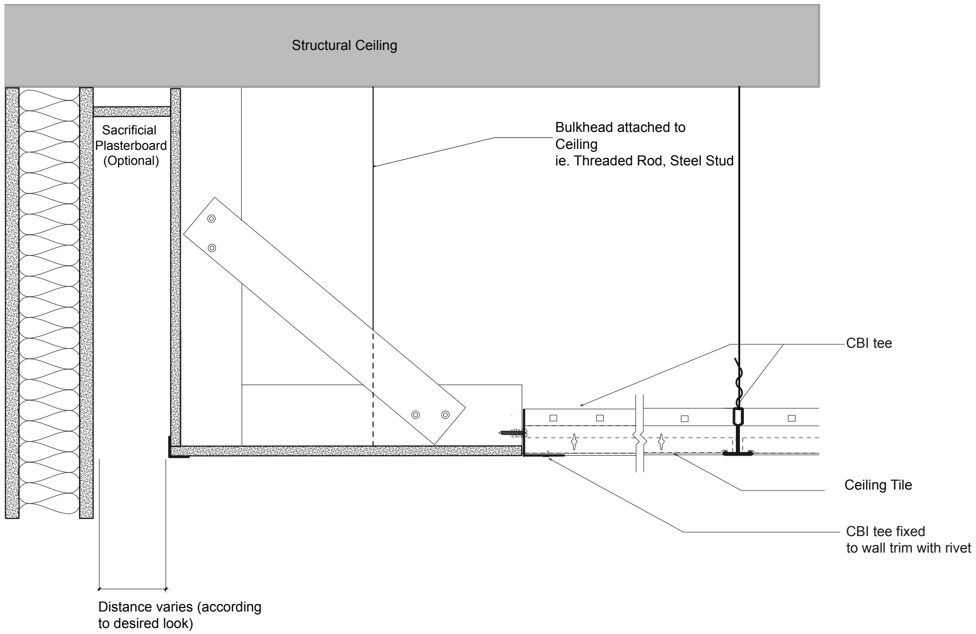
Alternative Floating Edge Detail

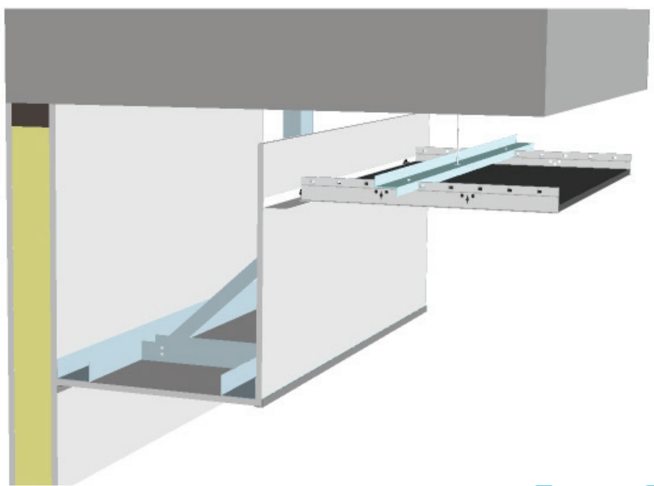


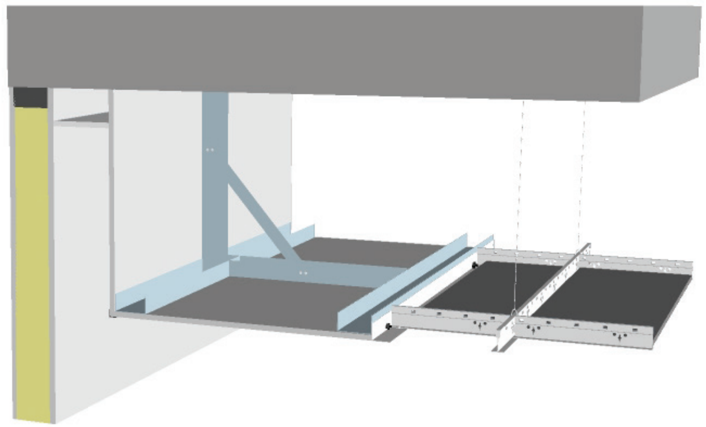
Alternative Floating Edge Section

Bulk Head Details

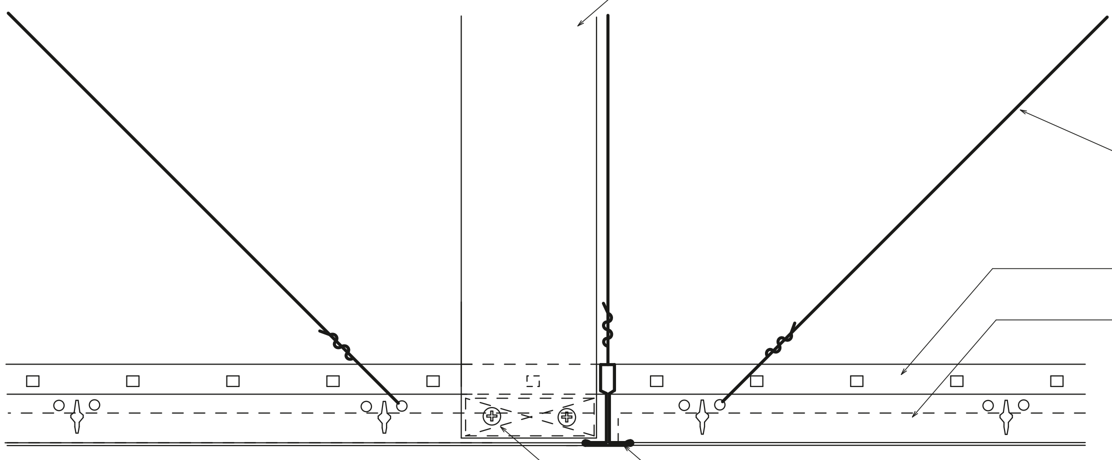




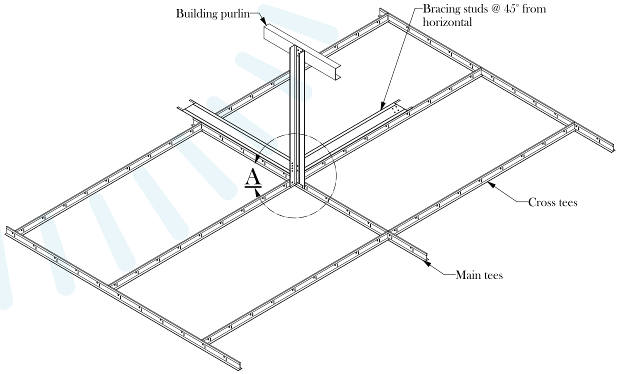




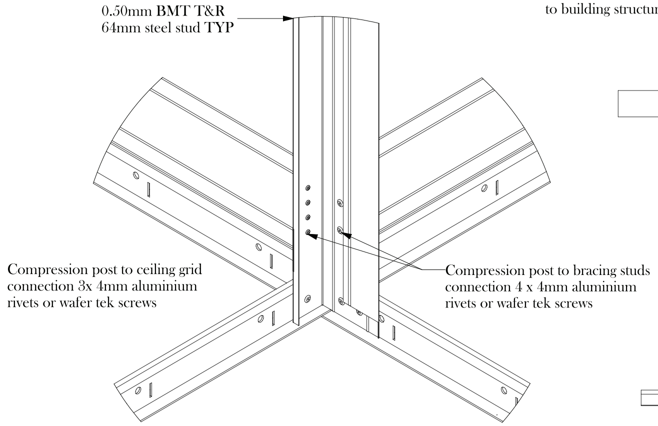
Back Bracing



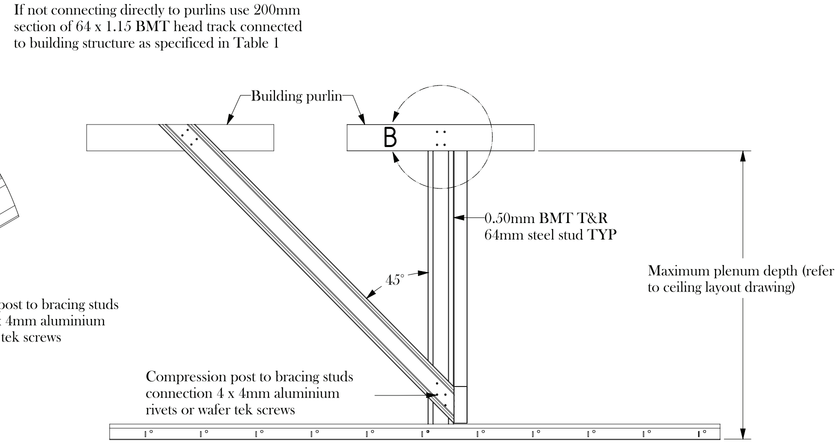
Standard Bracing Detail 1



SYSTEM ISOMETRIC VIEW



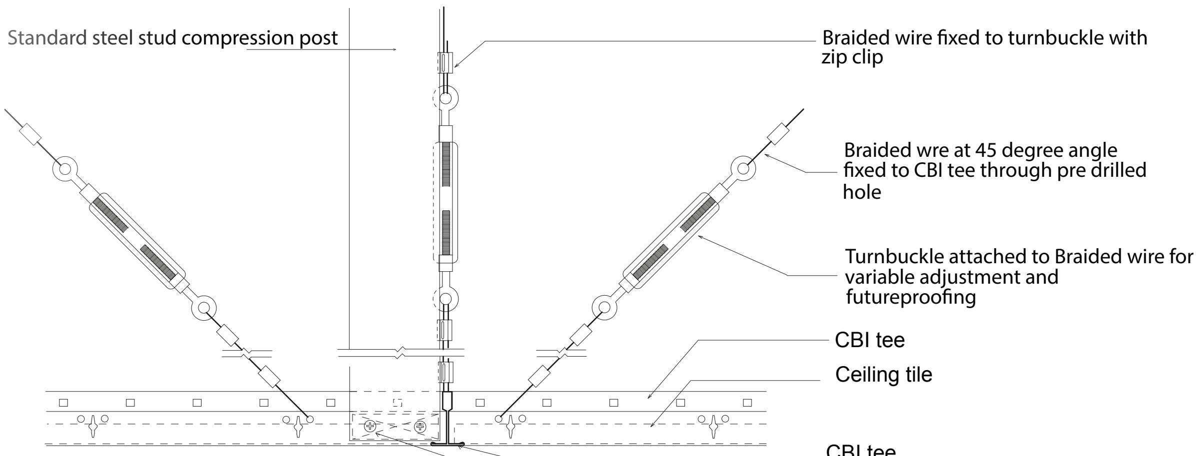
TEE CONNECTION
DETAIL A



REAR VIEW

Standard Stud Bracing

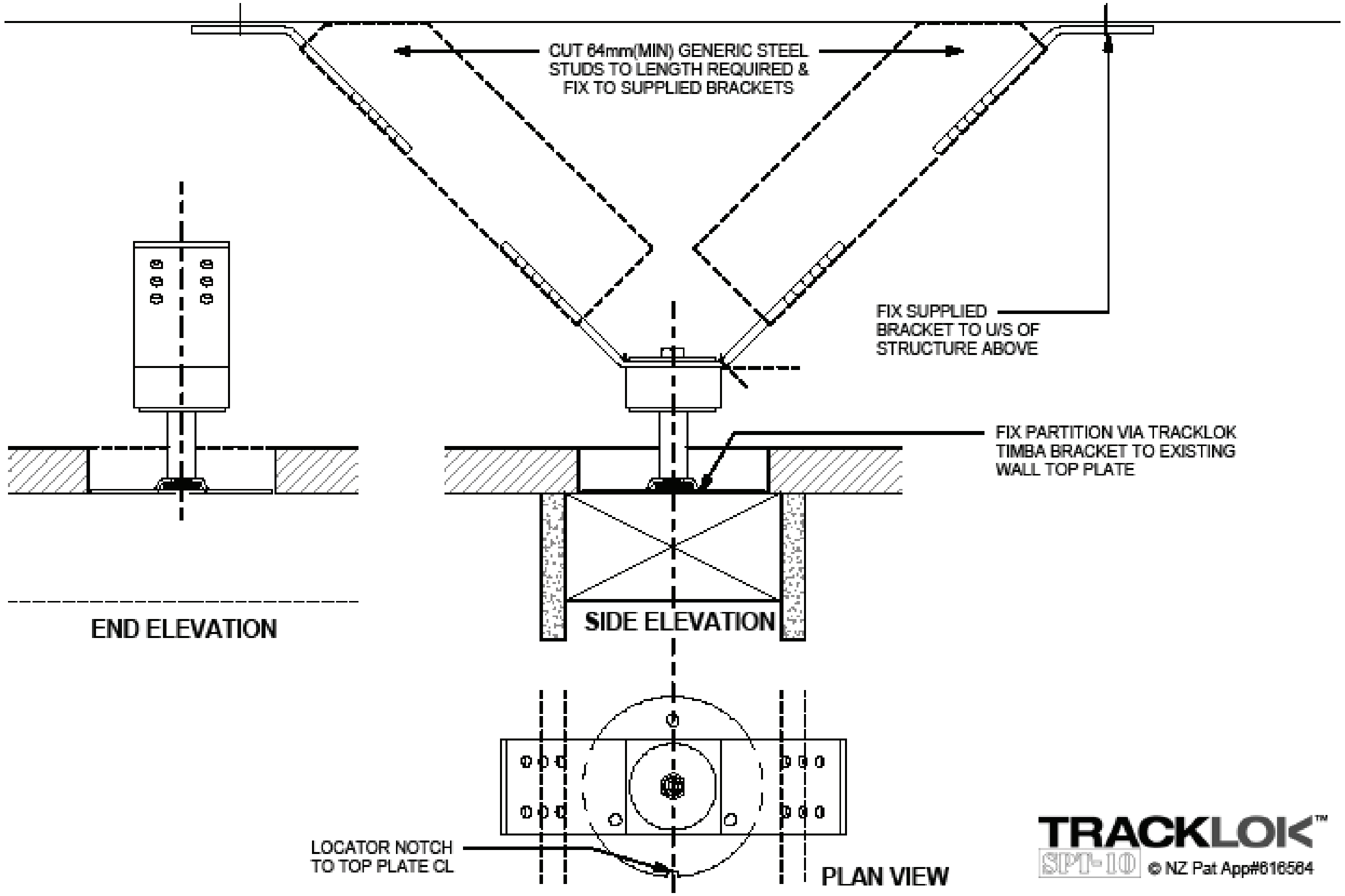
Adding turnbuckles to the wires future proofs the bracing if there is ever-large seismic activity. This allows the building maintainer to tighten the tension/compression wires to maintain structural integrity for the next shake.



Bracing Detail 3

Wall Partitioning

TRACKLOK Wall Partitioning Seismic Bracing



Design Calculations

Usage Notes

T&R Interior Systems have developed an online seismic calculator for suspended ceilings.

It can be found here:
http://www.tris.co.nz/index/home/Seismic_Calculator

Thiis calculator allows a designer to calculate required bracing for suspended ceilings. The calculations are based on conservative assumptions. Reduced seismic bracing designs for individual sites may be possible if a suitably qualified Chartered Professional Engineer carries out a site-specific design. This guide should not be used as a calculation template for a PS-1; specific seismic design should be carried out for these cases.

This guide has been prepared by by JSK Consulting Engineers for T&R Interior Systems with the usual care and thoroughness of the consulting profession. Interpretation and application of this guide is outside the control of JSK and therefore is the users' responsibility. This guide does not constitute a producer statement or engineer's certification, and is not for use with trafficable ceilings or ceilings which support partition walls or any other service load.

Allowance for relative motion between the ceiling and structure must be provided by floating edges. If the perimeter bracing method is used then two perpendicular edges must be fixed with the remaining two floating. If back bracing to the upper structure is used, then all edges must be floating. Floating edges must also be provided around rigid or separately braced items that pass through the ceiling. The amount of clearance should be checked by an engineer on a case-by-case basis.

Consult a Structural Engineer for the expected earthquake deflections of the structure.

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Step Two - Seismic Weight

Calculate the total seismic weight based on the ceiling and service weights.

Enter or select the corresponding values in the column on the right and sum all the component weights to get a total seismic weight. This value will be used in the following steps this worksheet.

Grid Mass	Main Tee @ 1200 | Cross Tee @ 600	1.1
Tile Mass	Show Common Tiles	
Services	Luminaires	1.5
	Insulation	
	Other (min 3 kg/m²)	3
	Total Seismic Weight Sw	kg/m²

‹ Previous | Next ›

T	Limit State Type	ULS
Sw	Seismic Weight	
Sf	Seismic Force	SLS = ULS =
Lmt	Limiting Main Tee Length (max)	SLS = ULS =
Lct	Limiting Cross Tee Length (max)	SLS = ULS =
Ab	Area per Brace	
#	Number of braces	
MT	Max Tee Space	

http://www.tris.co.nz/index/home/Seismic_Calculator

T&R Interior Systems Ltd.
2017