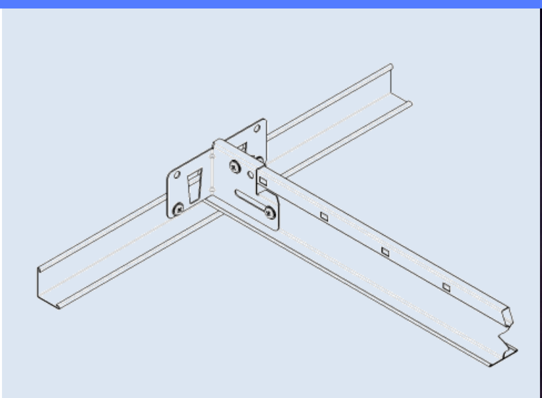
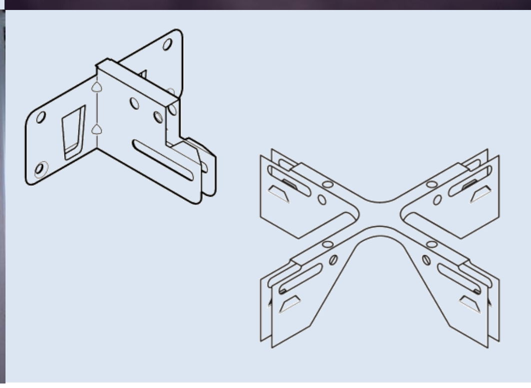
AS/NZS 2785 : 2000
NZS 1170.5 : 2004

September 2015

Generic Seismic Design

for DONN® Exposed Grid Suspended Ceilings





Seismic Design
- USG Boral Suspended Ceilings

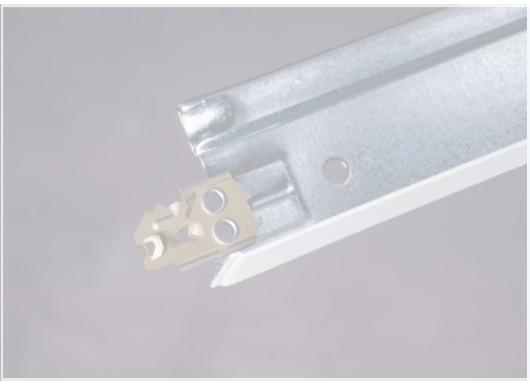
These generic designs are specifically for :
USG Boral DONN® Grid and USG Tile Suspension Systems

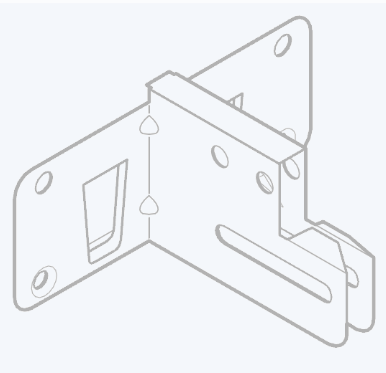
Earthquake forces need to be considered for all suspended ceilings in New Zealand and Australia, to comply with AS/NZS 2785:2000 – Suspended Ceilings, Design & Installation. Earthquake forces can act in the vertical and/or horizontal direction. The most common method of horizontal restraint is to fix the ceiling to the building structure around its perimeter. If perimeter fixing is not sufficient or appropriate, the ceiling may be back braced by fixing to the structure above.

Simple perimeter fixed or back-braced ceilings in low risk locations can be designed using this brochure which has been developed to comply with NZS1170.5 and AS/NZS2785. The ceiling installer must ensure that the ceiling is no larger than the maximum dimensions prescribed in the following tables, and complies with all of the Assumptions & Limitations stated in this brochure. For ceilings which fall outside the scope of these limitations, seismic design of the ceiling must be undertaken by a qualified structural engineer with experience in ceiling design, using USG Boral's Seismic Guidelines brochure.

It should be noted that ceilings in low risk locations are designed to withstand a serviceability level earthquake only (25 year return period), without incurring significant damage to ceiling components or allowing tiles to fall out. If a ceiling tee is rigidly perimeter fixed to the supporting structure at both ends, there is the possibility that the ceiling will be damaged by differential movement of the building. To avoid this, it is recommended that a 10-15mm gap is created between one end of each ceiling tee and the adjacent building structure. A similar isolation gap is also required around rigid objects that penetrate through the ceiling (eg. central columns).

USG has introduced the ACM7 Seismic Clip as an alternative option of creating this seismic isolation gap, while increasing the strength of the ceiling. Details are illustrated on page 10.





Standards and Building Codes

USG Boral uses the following Standards in its manufacturing, testing and marketing policies for compliance with the respective Building Codes of Australia and New Zealand

AS/NZS 2785	- Suspended Ceilings, Design and Installation
ASTM C635	- Standard Specification for the Manufacture, Performance and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
AS 1397	- Steel Sheet and Strip
AS1530.4	- Fire Resistance of Elements of Building Construction
AS/NZS 4600	- Cold Formed Steel Structures Code
AS 1170.4	- Earthquake Loads (Australia)
NZS 1170.5	- Earthquake Loads (New Zealand)
NZS 4219	- Specification for Seismic Resistance of Engineered Systems in Buildings
AS 2946	- Suspended Ceilings, Recessed Luminaires and Air Diffusers Interface
NZBC – B1/VM1	- NZ Building Code Verification Method B1/VM1 Clause 2
NZBC – B2 Durability	- DONN DX and DONN Centricitee will have a minimum serviceable life of 15 years when installed in a dry, non-corrosive, interior installation

ISO 9000 Quality Assurance

USG Boral Building Products NZ is a certified ISO 9001 – 2008 manufacturer
No. QEC 5044 by Telarc SAI

Telarc. REGISTERED TM
QUALITY
ISO 9001

NEW ZEALAND MADE

Seismic Design
- USG Boral Suspended Ceilings

Contents

SEISMIC DESIGN STATEMENT

Jacobs (formerly Sinclair Knight Merz [*SKM*]) has provided USG Boral with structural design services in respect of Clause B1 of the New Zealand Building Code to assist with the development of this USG Boral Generic Seismic Design brochure, dated September 2015.
The services provided by SKM have been undertaken in accordance with compliance documents issued by the Department of Building & Housing, Verification Method B1/VM1 as follows:

- Compression and tension testing of main tee and cross tee components was carried out by Materials & Testing Laboratories Limited in Auckland in 2007.
- Perimeter fixing connection tests were performed at USG Interiors Pacific Limited, Penrose, in 2011. An early sample of the testing was carried out under SKM's observation.
- SKM has analysed the results of these tests to determine the performance capability of the DONN DX® and DXT® systems under axial loads, in accordance with AS/NZS4600:2005, Section 8: Testing. In carrying out this analysis, SKM has relied upon, and presumed to be accurate, the results of this testing carried out by third parties.
- SKM has undertaken design calculations to determine the performance capability of the direct fixed, K-braced and seismic strut ceiling braces, in accordance with AS/NZS4600:2005. For the USG Compression Post, SKM has relied on and presumed to be accurate, the minimum compressive load capacity published in USG's USA Seismic Technical Guide for the post
- Design loads for seismic performance were determined in accordance with NZS1170.5:2004, as modified by the New Zealand Building Code, Clause B1 (Amdt 10, May 2011).

On the basis of the assumptions and limitations set out in this statement and elsewhere in this Generic Seismic Design brochure, SKM considers that suspended ceilings that are designed and constructed in accordance with this Generic Seismic Design brochure will meet the requirements of the relevant provisions of the New Zealand Building Code as at March 2012.

SKM's services have been provided in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose of assisting USG Boral to prepare this Generic Seismic Design brochure. Interpretation and application of this Generic Seismic Design guide for specific applications is outside the control of SKM and is the user's responsibility. Anyone using this guide must be well trained or qualified in the principles of seismic design of ceilings (e.g. a Chartered Professional Structural Engineer, or an approved USG Boral ceiling contractor and installer).

Jacobs Date: March 2012

SINCLAIR KNIGHT MERZ

Seismic Design
- USG Boral Suspended Ceilings

Assumption & Limitations	
Building in which ceiling is installed	■ Building must be located within New Zealand ■ Building must be no more than 40 metres tall ■ Building <u>must not be</u> Building Importance Level 4 having special requirements for "post disaster" functionality (eg. hospital, police station) – refer to AS/NZS 1170.0 for full definition ■ For perimeter fixed ceilings, a continuous nogging must be provided at the same level as the perimeter angle trim along all fixed edges of the ceiling (a continuous concrete or block masonry wall/beam is also acceptable) ■ The support structure (including nogging, associated wall/bulkhead, and building superstructure) must be strong and stiff enough to carry the seismic bracing loads from the ceiling without suffering any damage. This must be confirmed by a qualified structural engineer
Ceiling & Services	■ Main Tees must be either : DONN DX30D, DXL38D, DX38D, DXT30D, DXT38D ■ Cross Tees must be either : DONN DX30M, DX30D, DX38D, DXT30D, DXT38D ■ Rivet strengths allow for use with 6 and 10mm Teg Tabs, and no Teg Tabs (refer to Seismic Force Calculator) ■ End connections must be detailed as shown in this Design Guide. No substitution is permitted without specific engineering design ■ Maximum tee spacing must be 1200mm in any direction ■ Ceiling must be non-trafficable ■ Ceiling must be non-structural (ceiling system does not provide structural stability to the building e.g. acting as a ceiling diaphragm) ■ Install and fix all lay-in ceiling panels with correct hold-down clips in full conformance with USG Boral specifications. Where point accessibility is required, nominate unclipped panels with a visual marker eg. coloured sticker / board pin etc) ■ Ceiling weight must include ceiling tiles, suspension grid, lighting, any other services, and insulation if laid on the grid ■ Individual ceiling tiles must not weigh more than 10kg. All items weighing more than 10kg must be supported independently from the ceiling (including recessed or surface mounted luminaires, air conditioning cassettes etc) unless covered by specific engineering design (refer to page 6 for further guidance) ■ All interior partition walls must be supported independently from the ceiling (including independent horizontal restraint to top of wall), or their weight must be included in the ceiling seismic mass calculations, including specific consideration of the seismic load on each individual ceiling tee (obtain specific advice from a structural engineer) ■ All evacuation and life safety systems must be supported independently from the ceiling, and must be likely to remain functional even if the ceiling collapses ■ There must be no other reason why ceiling movement/damage or falling tiles would cause an unusually high level of hazard or damage (e.g. cause release of hazardous substances/organisms, damage to electrical reticulation). ■ Ceilings must be installed in accordance with: AS/NZS2785; USG Boral DONN Brand Grid Suspension Systems brochure*; USG Boral Fire Rated Exposed Grid Ceiling System brochure; and this document. *Note: Seismic Design may require heavier grid options than required for vertical loads ■ Perimeter fixing rivets must be aluminium. No substitution is permitted
Key Technical and Engineering Assumptions	■ AS/NZS2785:2000 has been interpreted in light of the more detailed guidance in NZS1170.5:2004, Section 8 "Requirements for Parts and Components". It is assumed that non-structural, non-trafficable suspended ceilings that satisfy the definition of a Category P.7 part in NZS1170.5, Table 8.1 are only required to satisfy **Serviceability Limit State** criteria. The generic ceilings specified on pages 7-23 of this brochure have not been designed to satisfy the requirements in AS/NZS2785, Section 3.3.4 during an ultimate limit state seismic event ■ For design of ceilings for **Ultimate Limit State** loads, refer to pages 24-25 for further detailed technical and engineering assumptions and guidance on specific engineering design ■ Annual probability of exceedance for design earthquake is 1/25 (for serviceability level earthquake) ■ The ceiling ductility is assumed to be $\mu = 1.0$ (for serviceability level earthquake)

Seismic Design
- USG Boral Suspended Ceilings

The following steps will guide you through to selecting the correct seismic restraint system based on this document's generic design criteria.
If all options are unable to provide the necessary restraint, specific engineering design will be required by a suitably qualified engineer.

Step 1 – From the flow chart on page 6 identify if the ceiling requires Serviceability Limit State or Ultimate Limit State design
For ULS design use the additional calculator tables on page 25. For SLS proceed to Step 2

Step 2 – Identify the building's Seismic Zone

Step 3 – Calculate the ceiling's total weight in kg/m² (Note : ceiling weight must include <u>all</u> products that the ceiling will be connected to or supporting. A design based on average weight in kg/m² will not be appropriate for situations where heavy loads (eg luminaires) are concentrated along an individual tee line and the perimeter fixings are rigid. Refer to page 7 for guidance.

Step 4 – Use the Seismic Force Calculator to establish the seismic force values for tees spaced at 1.2 and/or 0.6 metre centres

<u>Perimeter Fixing Option</u>

Step 5 – Confirm with the building engineer that perimeter and/or internal structure is adequate to resist earthquake line loads from the ceiling

Step 6 – Use two adjacent side fixing (unless building engineer confirms four sides are permissible)

Step 7 – Using the Main Tee, Cross Tee and Perimeter Fixing graphs, establish type of tee and fixing required. Use the lowest of the Maximum Allowable Tee lengths from the 3 graphs (Note: tee type may be greater than the type required for normal load carrying requirements [DONN Grid brochure]. Use the greater of the two)
If the ceiling layout is cross-nogged, use the lesser of the values from the Main Tee and Cross Tee graphs.
If Perimeter Fixing is possible, go to Step 11

If simple Perimeter Fixing is not possible due to actual length of tee greater than allowable length, or greater than perimeter fastener type from tables, consider providing a central expansion gap and creating smaller ceiling sections.

If Perimeter Fixing still does not provide the necessary restraint, proceed to Step 8 - Back Bracing.

Note: it is possible to be Perimeter Fixed in one direction and Back Braced in the other direction.

<u>Back Bracing Options</u>
The appropriate brace system (Direct Fix, K Brace, Seismic Strut) is determined from the Brace Design Tables on pages 16-23 for the relevant plenum depth.

Step 8 – Round up the Seismic Force value calculated on page 7 (or 25) to the nearest 5, then select an allowable brace type from the corresponding row in the Brace Design Table

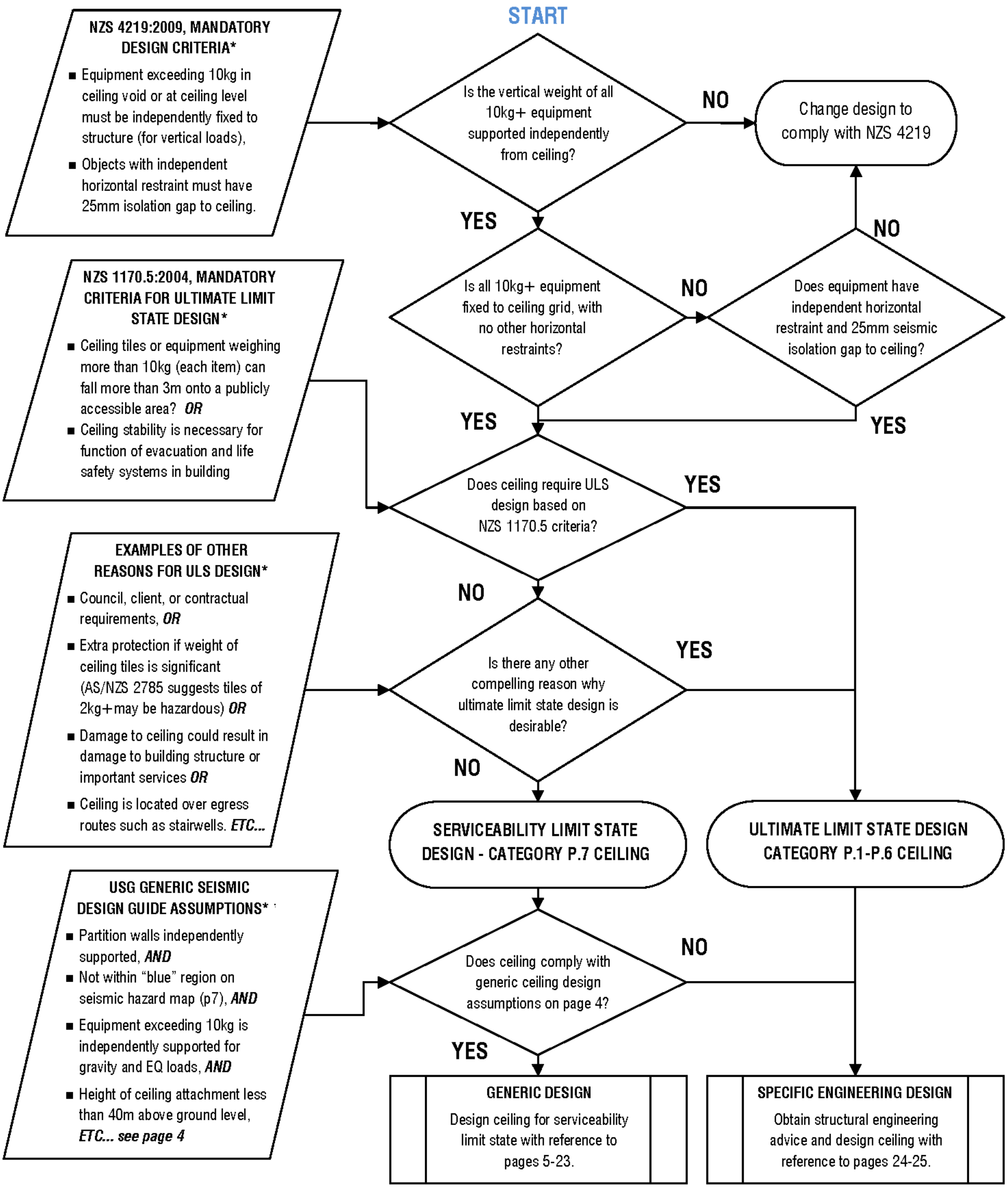
Step 9 – The selected brace type will determine the brace spacing and fasteners required to both construct the brace and attach to the structure and tees (note this may be different for Main Tee and Cross Tee directions

Step 10 – Allowable Main Tee and Cross Tee type will be determined from the Brace Design Tables

Step 11 – Transfer all details to the Project Summary pages 26-27

Seismic Design
- USG Boral Suspended Ceilings

Serviceability or Ultimate Limit State Design Flow Chart

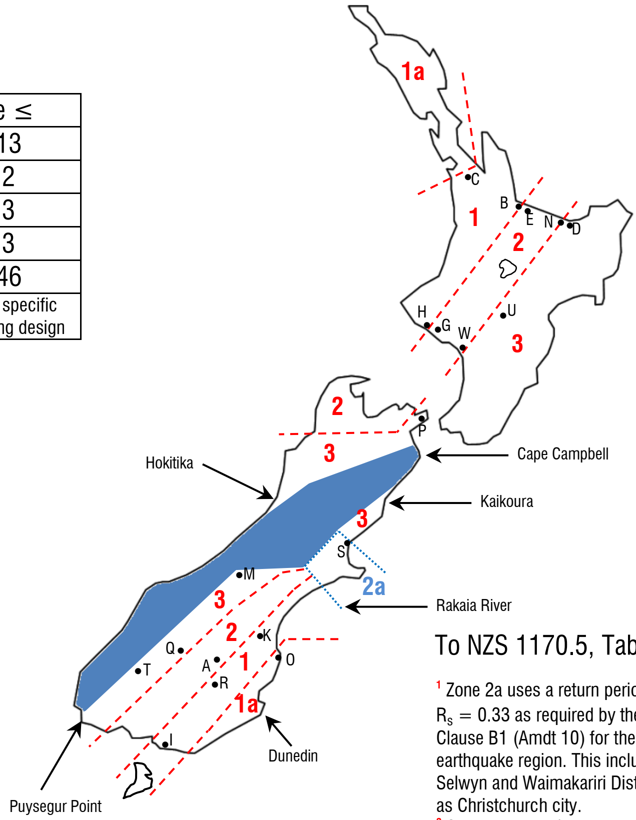


* The design criteria listed address the most common issues relevant to ceiling design only, and are not necessarily exhaustive. Ceiling designers must satisfy themselves that the design criteria in each respective standard have been satisfied for any given ceiling.

Seismic Design
- USG Boral Suspended Ceilings

Seismic Zones

ZONE	Z Value ≤
1a	0.13
1	0.2
2	0.3
2a[1]	0.3
3	0.46
(blue)	Zone for specific engineering design



To NZS 1170.5, Table 3.3

[1] Zone 2a uses a return period factor of R_s = 0.33 as required by the NZBC, Clause B1 (Amdt 10) for the Canterbury earthquake region. This includes the Selwyn and Waimakariri Districts as well as Christchurch city.

[2] Seismic Zones 1(including 1a), 2, & 3 are generally as defined in NZS 3604:2011

Location Key	
C	Mercer/Onewhero
B	Papamoa
E	Te Puke
N	Whakatane
D	Ohope
U	Waiouru
H	Hawera
G	Patea
W	Wanganui
P	Picton
S	Sefton
K	Kurow
O	Oamaru
R	Roxburgh
I	Invercargill
T	Te Anau
Q	Queenstown
A	Alexandra
M	Mt Cook

Ceiling Weight

Ceiling Panel ______]
DONN Grid ______] Dead Load

Lighting[4] ______]
Other[4] ______] Services Load

TOTAL[3] ______ kg/m²

Lighting Weight Calculation Details [4]

Size: ______ X ______ mm

Weight: ______ kg

Spacing Centres: ______ X ______ m

W ÷ SC = ______

[3] NZS1170.5 requires that the ceiling is designed for the actual mass of components that will be installed in the ceiling. If AS/NZS 2785:2000 is also specified, the ceiling must make allowance for a total Services Load of not less than 3kg/m²

[4] Where lighting or other loads greater than 10kg are concentrated along one or more tee lines, the ceiling components that provide horizontal seismic restraint must be designed for this higher intensity of loading.

Seismic Force Calculator

(Transfer values to Summary Page)

Ceiling Weight	
	kg/m²

x

Height[5] (metres)	ZONE FACTOR				
	1a	1	2	2a	3
0-3	0.8	1.2	1.8	2.3	2.7
3.1-6	1.0	1.6	2.4	3.1	3.6
6.1-9	1.3	2.0	2.9	3.9	5.0
9.1-12	1.5	2.4	3.5	4.6	6.0
12.1-20	1.5	2.4	3.5	4.6	7.3
20.1-40	1.5	2.4	3.5	4.6	8.5[6]

x

TEG TABS FACTOR[7]	
6mm with rivet	1.7
10mm with rivet	2.0
With ACM7 Clip (no rivet)	-
No Teg Tabs	-

Use this Factor ONLY for Perimeter Fixing graph

x

Tee Spacing	
1.2	m
0.6	m

=

SEISMIC FORCE

[5] For Perimeter Attachment – height of ceiling from ground level, or For Back Braced - height of structure where ceiling is attached, from ground level

[6] Provide rigid hangers to prevent uplift

[7] The Teg Tab Factor ONLY applies for calculation for Perimeter Fixing design table on page 9. Do not include in Seismic Force calculation for the Main or Cross tee tables, or for back braced designs

Seismic Design
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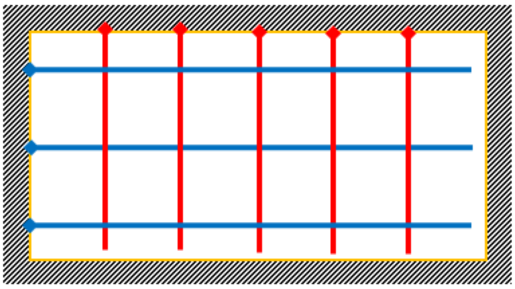
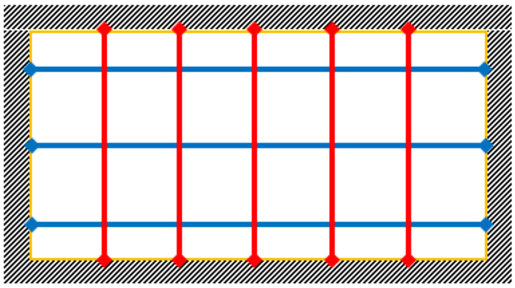
Perimeter Fixing Options

Fixed on two adjacent sides only ^



Fixed on all four sides #



Legend

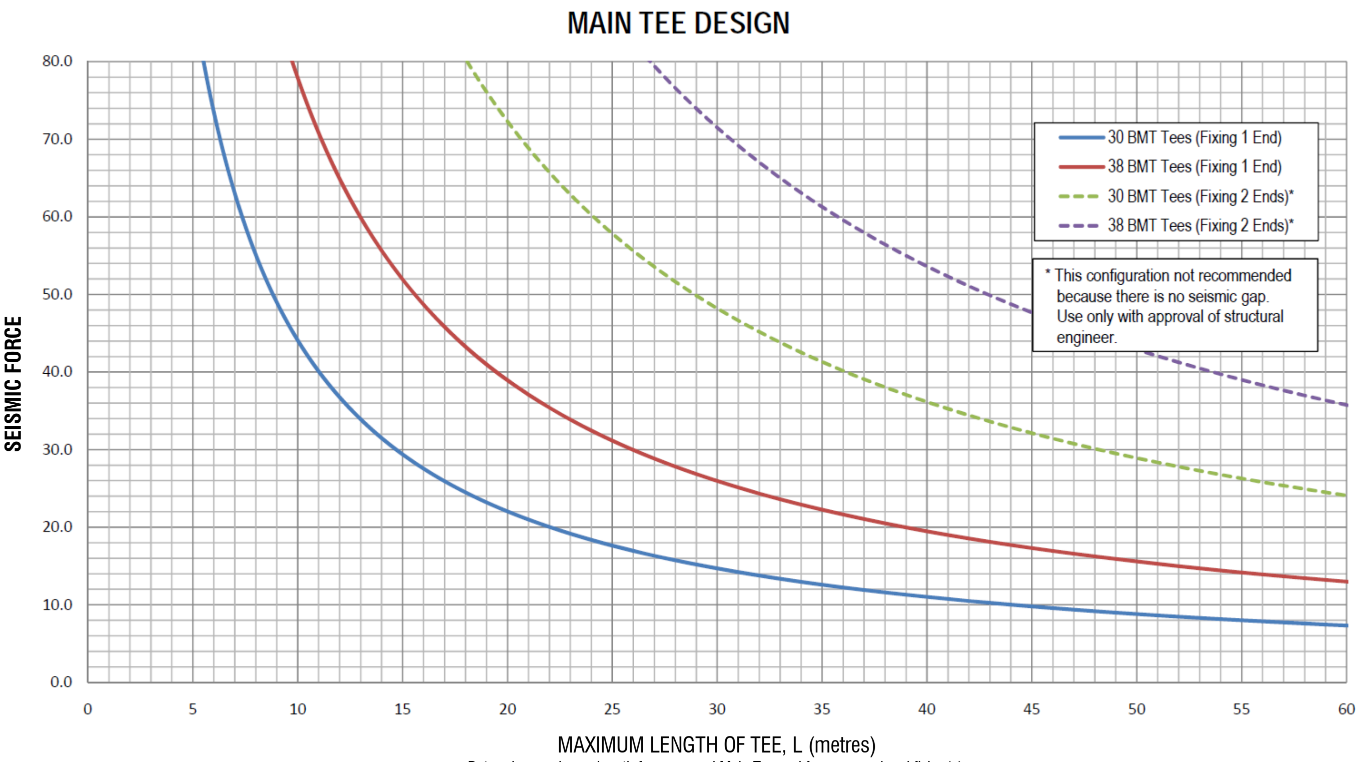
Main tee (fixed end)		Cross tee (fixed end)	
Main tee (free end)		Cross tee (free end)	
Perimeter trim		Surrounding wall/bulkhead	

^ Building engineer must confirm the two adjacent walls are capable of resisting the line loads of the ceiling

This installation configuration does not allow for any seismic gaps. **Use only with approval of the building structural engineer**.

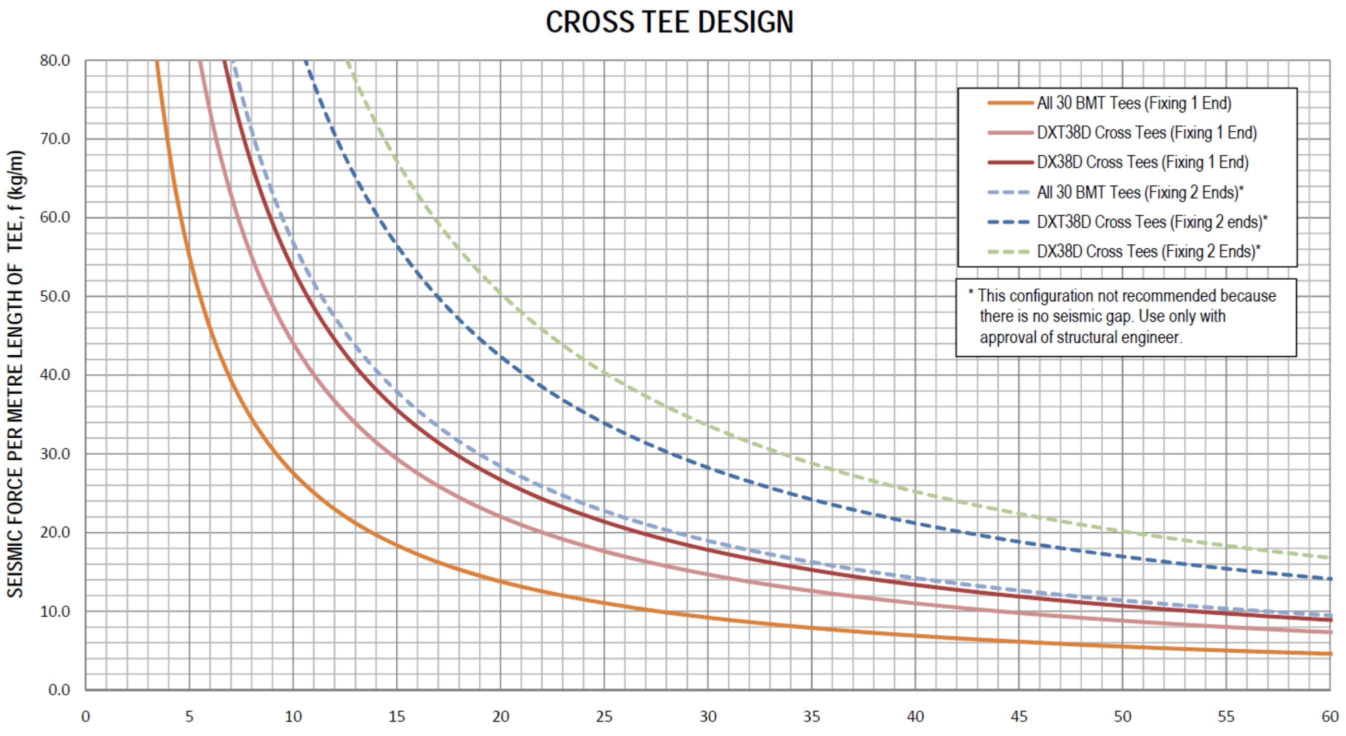
To establish the correct tee to use, locate the intersection point of the Seismic Force value from page 7 (SLS), or 25 (ULS) and the actual length of the tee in the building. Select the tee line on the graph <u>above</u> the intersection point. Repeat for Cross Tee and Perimeter Fixing graphs. If the intersection point is above allowable tee or perimeter fixing types, or the building engineer confirms that the perimeter walls are not line load bearing, then back bracing will be required (pages 16-23).

DONN Main Tee



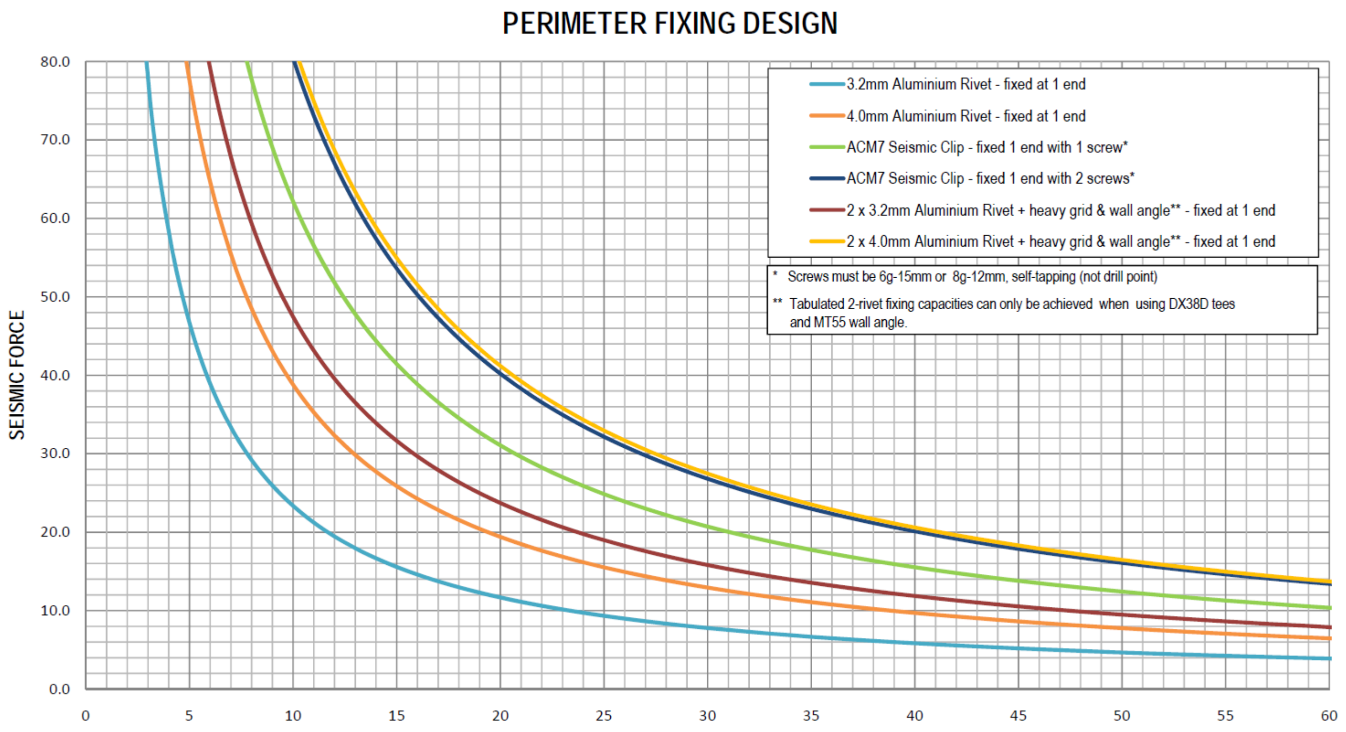
Determine maximum length for proposed Main Tee and for proposed end fixing(s).
Maximum allowable ceiling length is the lowest of these two values

DONN Cross Tees



Determine maximum length for proposed Cross Tee and for proposed end fixing(s).
Maximum allowable ceiling length is the lowest of these two values

Fixings

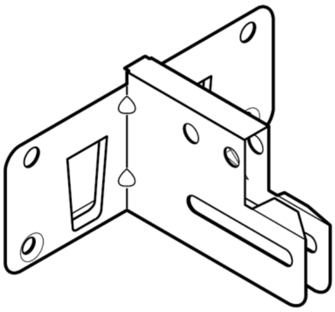


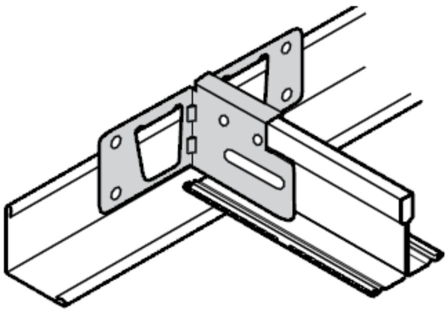
Determine maximum length for proposed end fixing(s).
Maximum allowable ceiling length is the lowest of this or the Main Tee or Cross Tee lengths

ACM7 Seismic Clip Information

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.

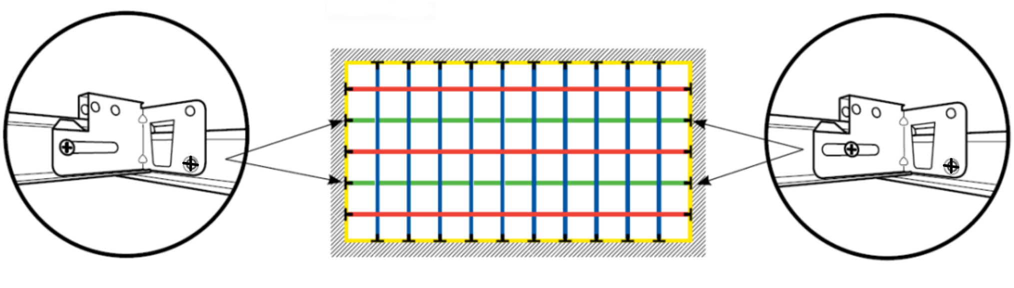




- It has been tested in New Zealand to provide engineered solutions for perimeter seismic restraint under both tension and compression.
- The design provides support on both sides of the tee web and around the bulb of the tee
- This clip also provides two return wings which connect to the Wall Angle 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 3 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 an earthquake event, depending on the severity, and may need to be replaced afterwards)

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

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



USG BORAL

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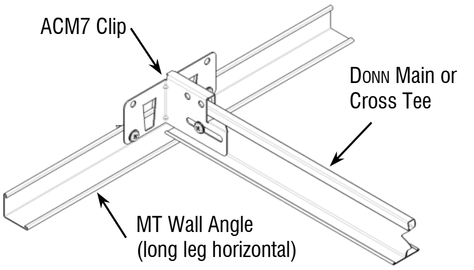
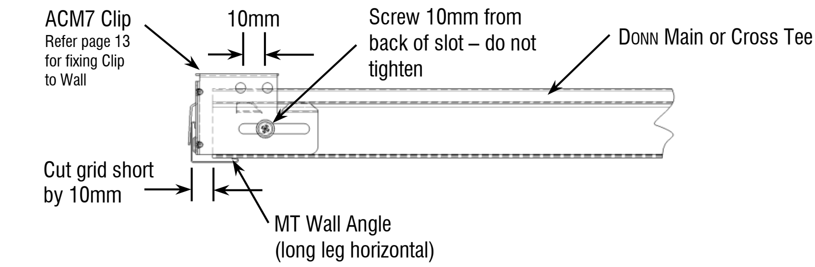
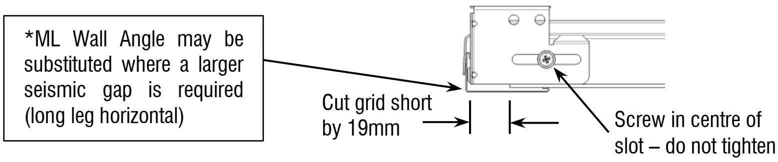
Non-fixed (free) End Options

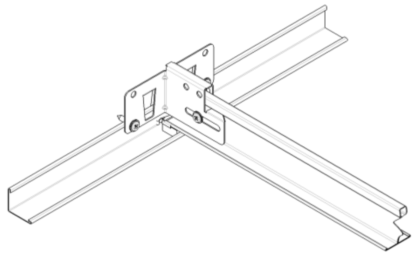
ACM7 Seismic Clip – MT* Wall Angle — PA1

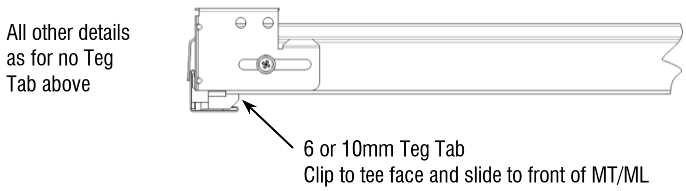




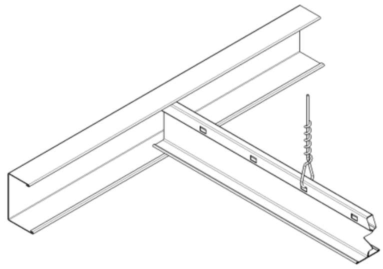


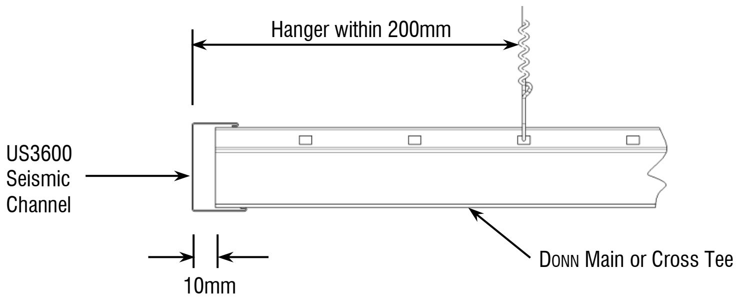
ACM7 Seismic Clip – MT* Wall Angle with Teg Tab — PA2





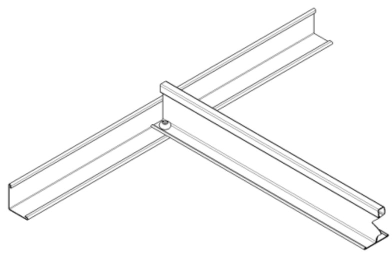
US45-3600 Seismic Channel — PA3

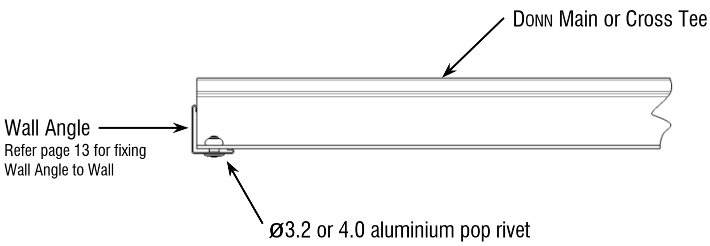




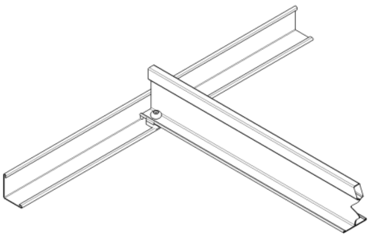
Fixed End Options

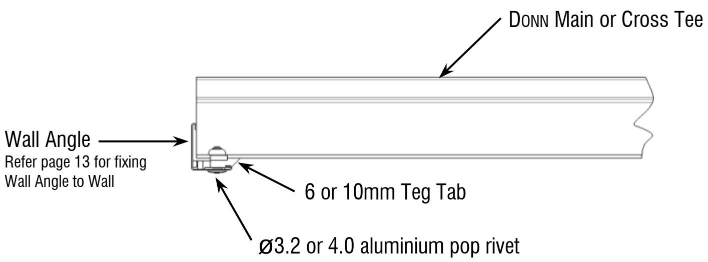
Pop Rivet — PA4





Pop Rivet with Teg Tab — PA5





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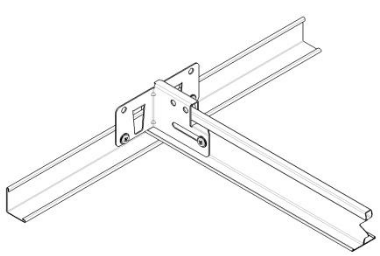
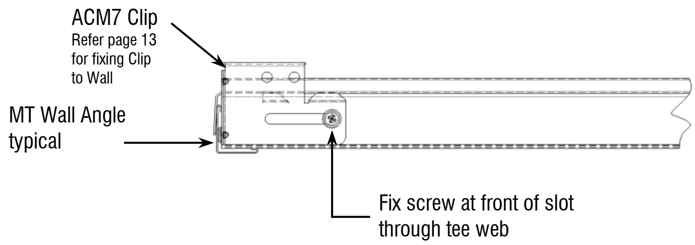
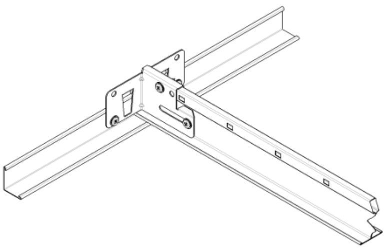
Fixed End Options con't

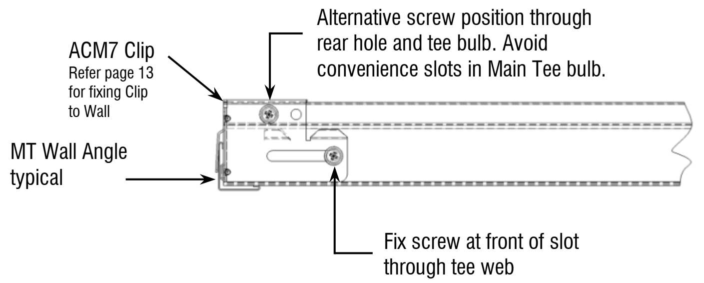
ACM7 Seismic Clip – DX30M Cross Tee — PA6



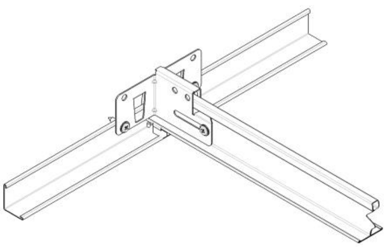


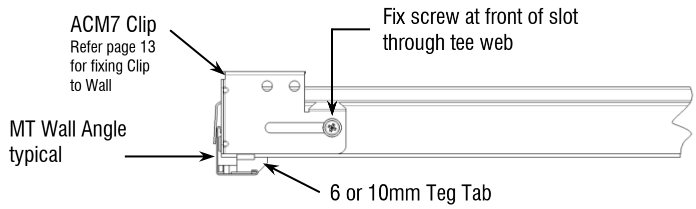
ACM7 Seismic Clip – DX/DXT30D, DX/DXT38D, Main or Cross Tee — PA7



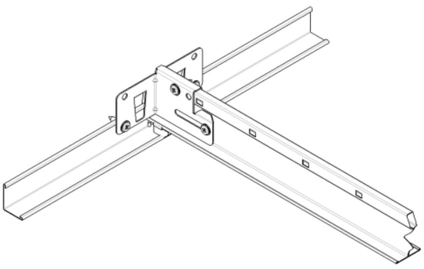


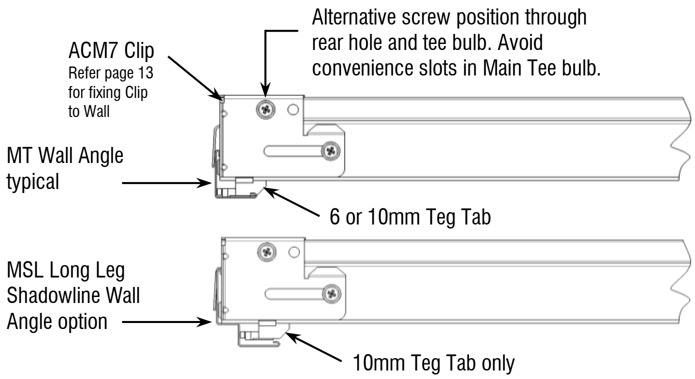
ACM7 Seismic Clip – DX30M Cross Tee with Teg Tab — PA8





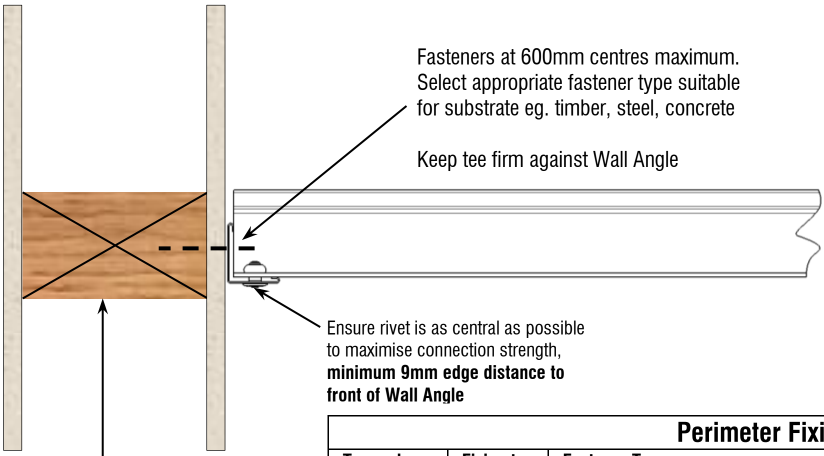
ACM7 Seismic Clip – DX/DXT30D, DX/DXT38D, Main or Cross Tee with Teg Tab — PA9





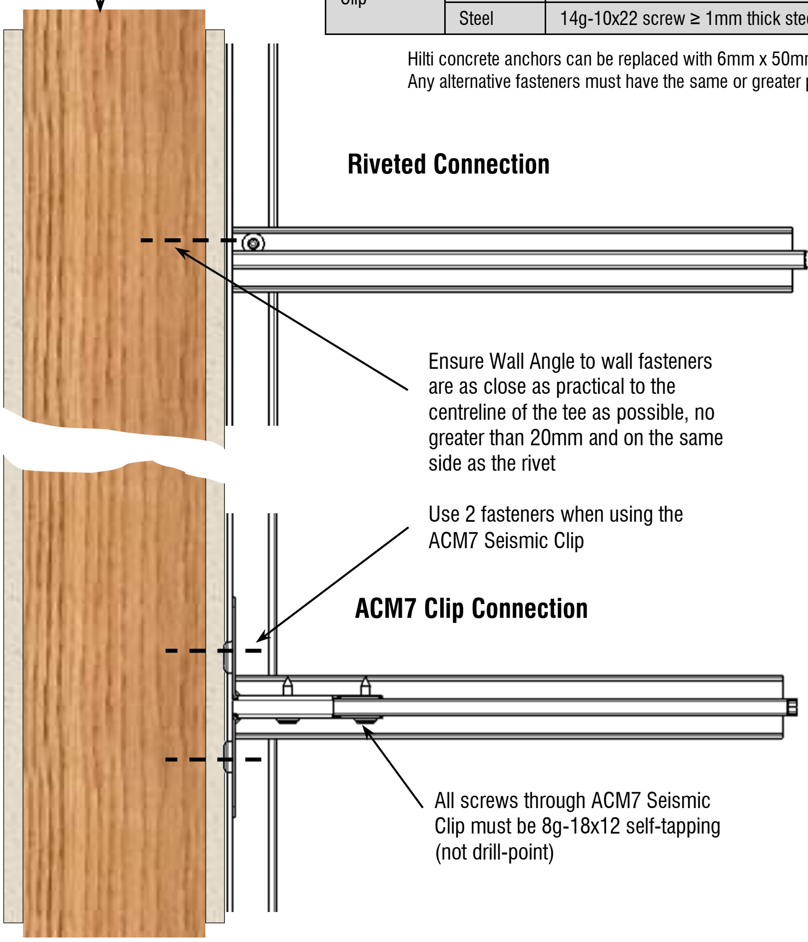
Seismic Design
- USG Boral Suspended Ceilings

Fixing to Building Structure



Perimeter Fixing				
Tee end Fastener (from Graph page 9)	**Fixing to Substrate**	**Fastener Type**	**Number of Fasteners**	**Minimum Edge Distance in Substrate (mm)**
Ø3.2 alu rivet	Concrete	6 x 30 Hilti HUD-1 Universal Anchor (No. 10 screw)	1	30
	Timber	No.8 x 51mm roundhead screw	1	20
	Steel	14g-10x22 screw ≥ 1mm thick steel	1	20
Ø4 alu rivet	Concrete	6 x 30 Hilti HUD-1 Universal Anchor (No. 12 screw)	1	40
	Timber	No.8 x 51mm roundhead screw	1	20
	Steel	14g-10x22 screw ≥ 1mm thick steel	1	20
ACM7 Clip	Concrete	6 x 30 Hilti HUD-1 Universal Anchor (No. 12 screw)	2	40
	Timber	No.8 x 51mm roundhead screw	2	20
	Steel	14g-10x22 screw ≥ 1mm thick steel	2	20

Hilti concrete anchors can be replaced with 6mm x 50mm Shure Drive, or 7mm dia. Ramplug with No. 9 screw. Any alternative fasteners must have the same or greater published performance criteria to listed options.

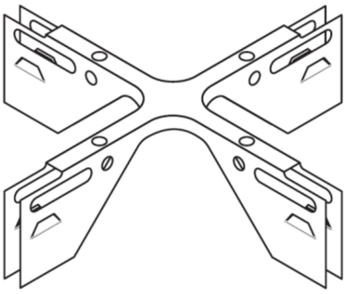


Note:
The support structure, including line of solid fixing as illustrated, must be strong and stiff enough to carry the seismic bracing loads from the ceiling without suffering any damage (refer to Assumptions on page 4)

Seismic Design
- USG Boral Suspended Ceilings

DH4 Seismic Separation Joint Clip

The DONN DH4 Seismic Separation Joint Clip is engineered to provide a robust connection option to allow an expansion movement area within a perimeter attached suspended ceiling

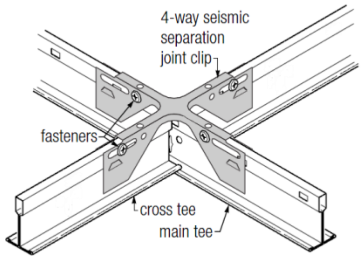


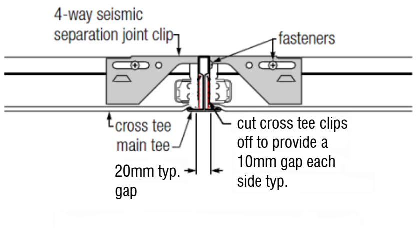
- Attaches over DONN Main Tee/Cross Tee joint
- Fastener holes and slots enable a variety of connection options
- Maintains squareness and strength of suspension system
- Permits ± 10mm of seismic gap control
- Flush design does not interfere with suspension or light fixtures
- Can only be used with 38mm high tees

Construction

A one-piece, multi-directional fastener with a slot that secures the tee while allowing separation-joint movement. This clip sits on top of bulb, avoiding interference with light fixtures and ceilings panels.

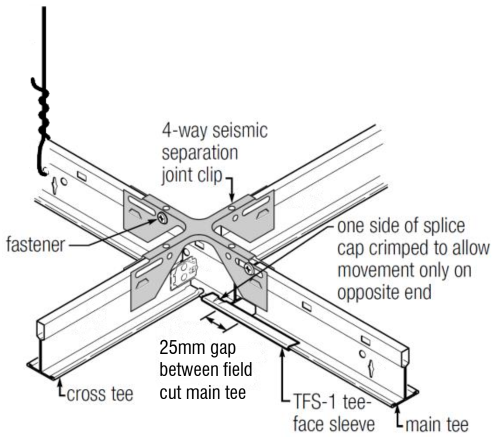
Cross Tee Direction

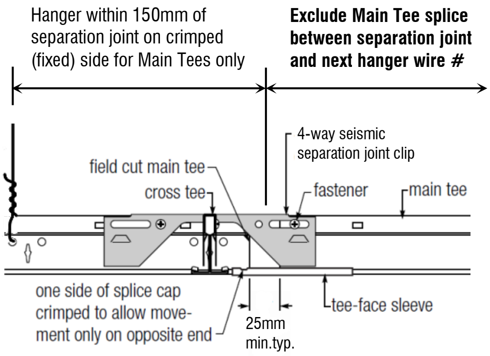




Do not tighten slot fasteners to allow for movement

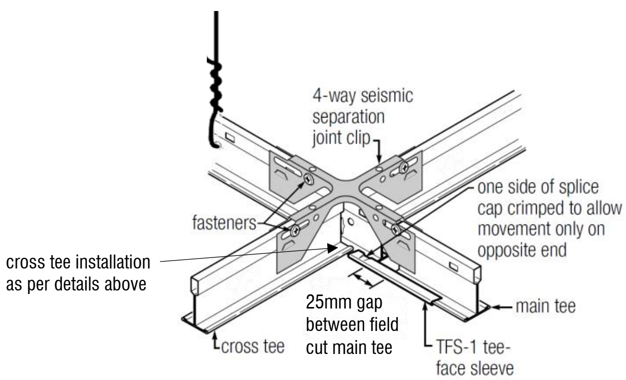
Main Tee Direction





When setting out the ceiling for a Main Tee separation joint, install the Main Tees joint splices no closer than 1200mm to the separation joint

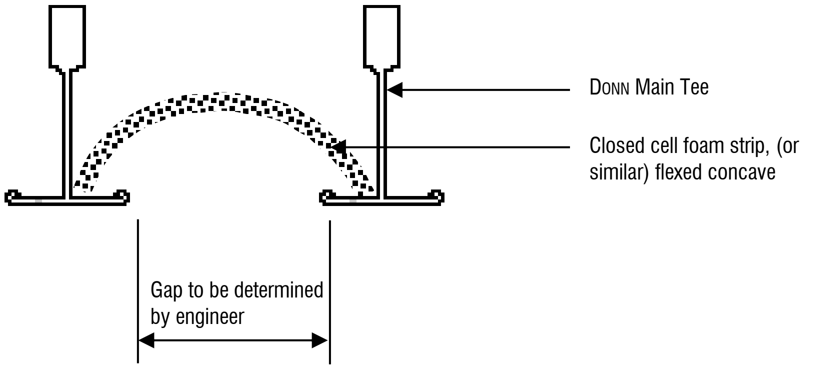
Adjacent Separation Joints



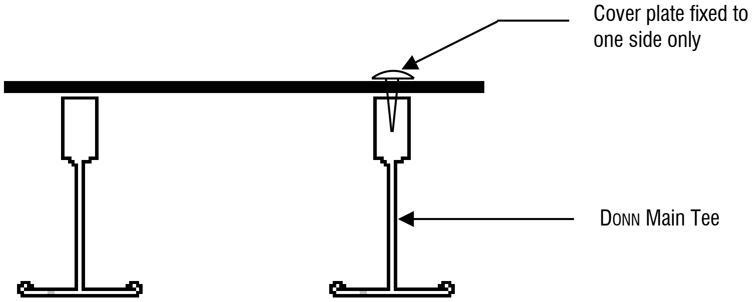
Seismic Design
- USG Boral Suspended Ceilings

If the seismic gap requirements are greater than the DH4 Seismic Separation Joint Clip permits, then an alternative design detail is required. Some general concept details are illustrated below.

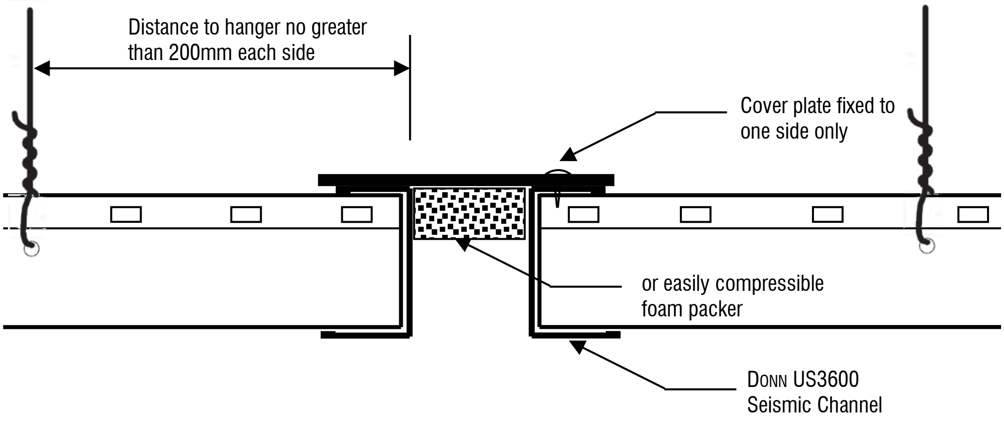
Option 1



Option 2



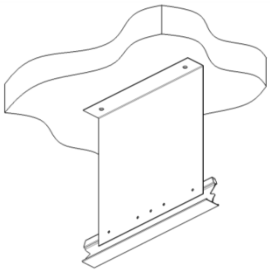
Alternate Direction Option

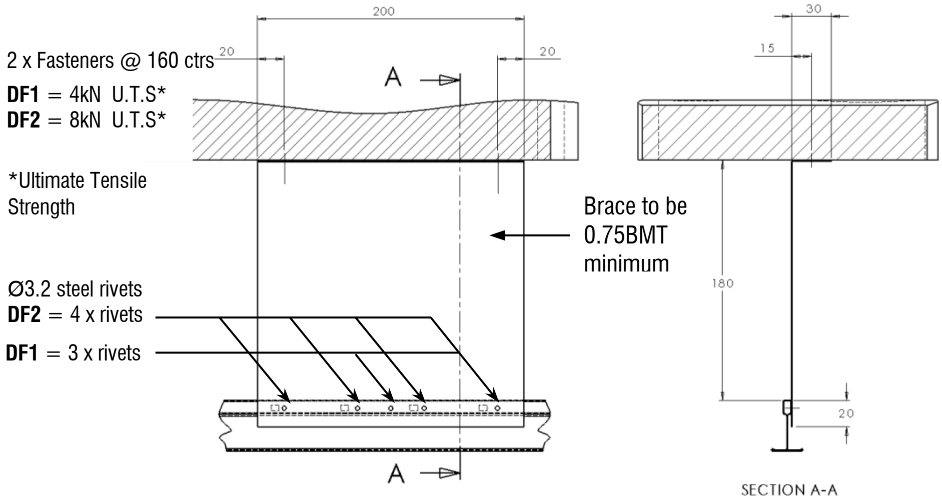


Seismic Design
- USG Boral Suspended Ceilings

If Seismic Force values exceed allowable tee lengths for perimeter fixing, then back bracing is the next option. Select the appropriate brace type from the following tables depending on the plenum depth.
Installation details for the various brace types are on the following pages. Back braced ceilings <u>must not be perimeter fixed</u> as well.
Braces are to be positioned as equally as practical across the ceiling. The first brace position shall be no more than half the maximum brace spacing from the perimeter eg. if brace spacing is 10.8m, then the first brace must be no more than 5.4m from the perimeter.

Direct Fix (DF)





Allowable Tee Type Key	
Main Tee	
1	DX30D
2	DX38D
3	DXL38D
4	DXT30D
5	DXT38D
Cross Tee	
6	DX30M
7	DX30D
8	DX38D
9	DXT30D
10	DXT38D

For Direct Fix Specification, see panel opposite on page 17

DIRECT FIX BRACE

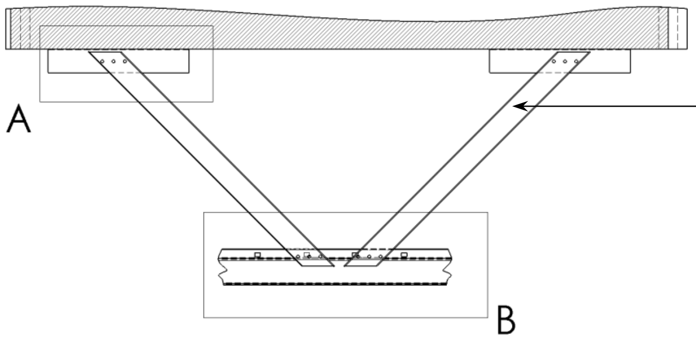
Seismic Force	Brace Type (min.)	Allowable Area per Brace m²	Max. Brace Spacing (M)	Allowable Tee Type 1	2	3	4	5	6	7	8	9	10
60#	DF2	20.6	8.6		•	•					•		
	DF1	10.3	4.3	•	•	•	•	•	•	•	•	•	•
55	DF2	22.8	9.5		•	•					•		
	DF1	11.7	4.9	•	•	•	•	•	•	•	•	•	•
50	DF2	25.4	10.6		•	•					•		
	DF1	12.9	5.4	•	•	•	•	•	•	•	•	•	•
45	DF2	28.3	11.8		•	•					•		
	DF1	14.4	6.0	•	•	•	•	•	•	•	•	•	•
40	DF2	31.9	13.3		•	•					•		
	DF1	21.6	9.0	•	•	•	•	•			•		•
	DF1	15.8	6.6	•	•	•	•	•	•	•	•	•	•
35	DF2	36.0	15.0		•	•					•		
	DF1	24.7	10.3	•	•	•	•	•			•		•
	DF1	18.7	7.8	•	•	•	•	•	•	•	•	•	•
30	DF2	42.2	17.6		•	•					•		
	DF1	28.8	12.0	•	•	•	•	•			•		•
	DF1	21.3	8.9	•	•	•	•	•	•	•	•	•	•
25	DF2	51.1	21.3		•	•					•		
	DF1	34.5	14.4	•	•	•	•	•			•		•
	DF1	26.1	10.9	•	•	•	•	•	•	•	•	•	•
20	DF2	63.8	26.6		•	•					•		
	DF1	43.2	18.0	•	•	•	•	•			•		•
	DF1	32.4	13.5	•	•	•	•	•	•	•	•	•	•
15	DF2	85.2	35.5		•	•					•		
	DF1	57.6	24.0	•	•	•	•	•			•		•
	DF1	43.6	18.2	•	•	•	•	•	•	•	•	•	•
10	DF2	128.1	53.4		•	•					•		
	DF1	86.6	36.1	•	•	•	•	•			•		•
	DF1	65.7	27.4	•	•	•	•	•	•	•	•	•	•
5	DF1	173.2	72.2	•	•	•	•	•			•		•
	DF1	131.7	54.9	•	•	•	•	•	•	•	•	•	•

Higher Seismic Force values may be available. Please contact USG Boral.

USG BORAL

Seismic Design
- USG Boral Suspended Ceilings

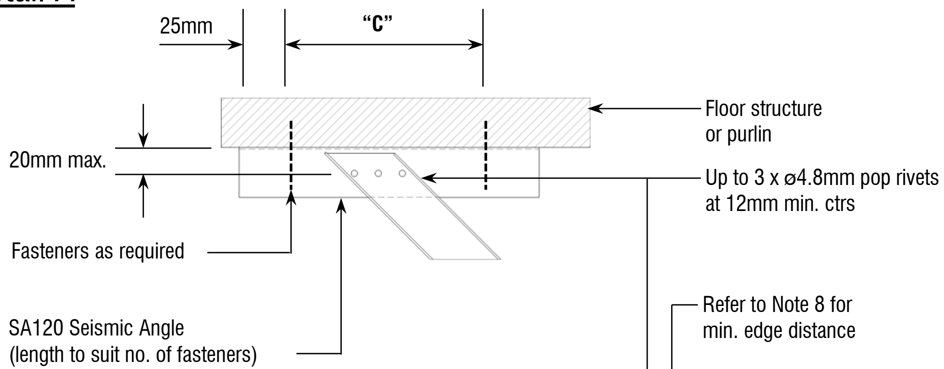
K Brace



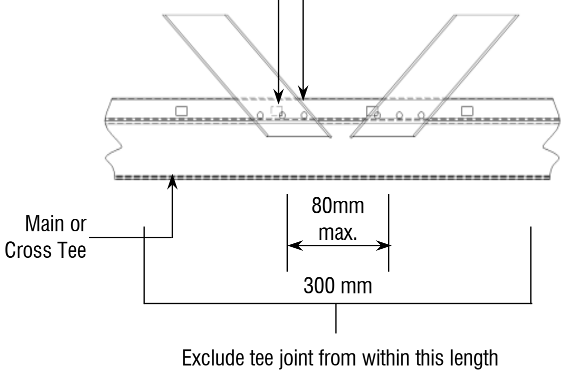
K BRACE TYPE KEY	
KB1	SA55/MT55 Wall Angle
KB2	SA120 Seismic Angle
KB3	DJ38 Strongback C Channel
KB4	WT64 x 30 x 0.75 Track
KB5	WT92 x 30 x 0.75 Track

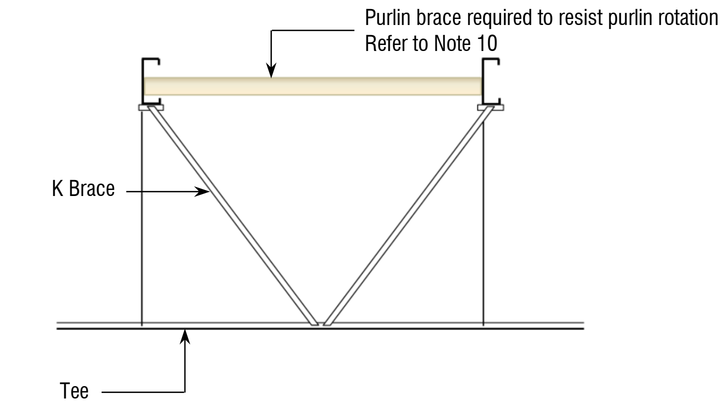
Substrate	"C" centres
Concrete	70mm
Timber No. 8	40mm
No.10	50mm
Steel	25mm min.

Detail A



Detail B



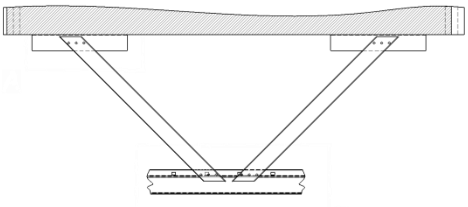


Direct Fix and K Bracing Construction Specification Clauses

1. Bracing must be provided in the Main tee direction and Cross tee direction when perimeter fixing is not adequate.
2. Design tables permit K Braces/Seismic Struts to be installed along tee lines that are up to 2.4 metres apart (max.) relying on diaphragm action of the ceiling tiles to support unbraced tee lines in between. This spacing must not be exceeded without specific engineering design. For optimum seismic performance, it is recommended that every tee line be braced. K braces must be evenly distributed around the ceiling area, with a minimum of two braces in each direction for any ceiling.
3. Install and fix all lay-in ceiling panels with correct hold-down clips in full conformance with USG specifications. Where point accessibility is required, nominate unclipped panels with a visual marker eg. coloured sticker / board pin etc)
4. Plenum depths greater than 1300mm may require more than 10mm separation gap to perimeter. Refer to building designer for required gaps.
5. Suspended ceiling hanger wires and/or bracing shall not be located within 150mm of a/c ducting.
6. Angled braces must be fixed at 40-45° to the plane of the ceiling grid system and in line with either the Main or Cross Tees
7. Tee joints shall not occur within ±150mm of bracing points
8. All screw and rivet fasteners must have a minimum edge distance and spacing of 3x nominal fastener diameter. When fixing to the bulb of a ceiling tee, ensure fixing is vertically centred on the bulb and has 3x fastener diameter edge distance to any holes in the Main Tee bulb.
9. Back braced tees <u>must not be perimeter fixed</u> as well.
10. Obtain information from the building engineer that the superstructure is able to resist earthquake loads from ceiling braces. This is especially critical when fixing to steel purlins.

Seismic Design
- USG Boral Suspended Ceilings

K Brace



K BRACE TYPE KEY	
KB1	SA55/MT55 Wall Angle
KB2	SA120 Seismic Angle
KB3	DJ38 Strongback C Channel

Allowable Tee Type Key	
Main Tee	
1	DX30D
2	DX38D
3	DXL38D
4	DXT30D
5	DXT38D
Cross Tee	
6	DX30M
7	DX30D
8	DX38D
9	DXT30D
10	DXT38D

Design tables are based on braces being installed along tee lines that are 2.4m apart (max.).
Refer to Notes on page 17.
Braces are to be positioned as equally as practical across the ceiling. The first brace position shall be no more than half the maximum brace spacing from the perimeter eg. if brace spacing is 10.8m, then the first brace must be no more than 5.4m from the perimeter.

Plenum Depth 0.19 – 0.5 metres — **K BRACE**

Seismic Force	Brace Type (min.)	Allowable Area per Brace (m²)	Max. Brace Spacing (M)	Allowable Tee Type 1	2	3	4	5	6	7	8	9	10
60#	KB3	20.6	8.6		•	•					•		
	KB2	18.0	7.5		•	•					•		
	KB2	10.3	4.3	•	•	•	•	•	•	•	•	•	•
55	KB3	22.8	9.5		•	•					•		
	KB2	19.4	8.1		•	•					•		
	KB2	11.7	4.9	•	•	•	•	•	•	•	•	•	•
50	KB3	25.4	10.6		•	•					•		
	KB2	21.6	9.0		•	•					•		
	KB2	12.9	5.4	•	•	•	•	•	•	•	•	•	•
45	KB3	28.3	11.8		•	•					•		
	KB2	24.0	10.0		•	•					•		
	KB2	14.4	6.0	•	•	•	•	•	•	•	•	•	•
40	KB3	31.9	13.3		•	•					•		
	KB2	26.8	11.2		•	•					•		
	KB2	15.8	6.6	•	•	•	•	•	•	•	•	•	•
35	KB3	36.0	15.0		•	•					•		
	KB2	18.7	7.8	•	•	•	•	•	•	•	•	•	•
	KB1	5.7	2.4	•	•	•	•	•	•	•	•	•	•
30	KB2	36.0	15.0		•	•					•		
	KB2	21.3	8.9	•	•	•	•	•	•	•	•	•	•
	KB1	6.7	2.8	•	•	•	•	•	•	•	•	•	•
25	KB2	43.2	18.0		•	•					•		
	KB2	26.1	10.9	•	•	•	•	•	•	•	•	•	•
	KB1	8.1	3.4	•	•	•	•	•	•	•	•	•	•
20	KB2	54.0	22.5		•	•					•		
	KB2	32.4	13.5	•	•	•	•	•	•	•	•	•	•
	KB1	10.3	4.3	•	•	•	•	•	•	•	•	•	•
15	KB2	72.0	30.0		•	•					•		
	KB2	43.6	18.2	•	•	•	•	•	•	•	•	•	•
	KB1	13.6	5.7	•	•	•	•	•	•	•	•	•	•
10	KB2	108.2	45.1		•	•					•		
	KB2	65.7	27.4	•	•	•	•	•	•	•	•	•	•
	KB1	20.6	8.6	•	•	•	•	•	•	•	•	•	•
5	KB2	131.7	54.9	•	•	•	•	•	•	•	•	•	•
	KB1	41.5	17.3	•	•	•	•	•	•	•	•	•	•

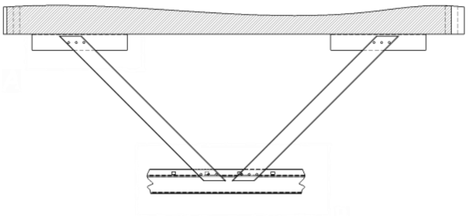
Higher Seismic Force values may be available. Please contact USG Boral.

FASTENER TYPES

	K Brace Types
To Structure	**KB1**
Concrete	2 x M6 Dynabolt (25mm embedment min.)
Timber	2 x No. 8 screw (30mm embedment min.)
Steel	3 x 14g -10 TPI-22mm long screws
To Brace & Tee	2 x ø 3.2 aluminium rivet
To Structure	**KB2**
Concrete	2 x M6 Dynabolt (25mm embedment min.)
Timber	4 x No. 10 screw (30mm embedment min.)
Steel	3 x 14g -10 TPI-22mm long screws
To Brace & Tee	3 x ø 4.0 aluminium rivet
To Structure	**KB3**
Concrete	2 x M6 Dynabolt (25mm embedment min.)
Timber	4 x No. 10 screw (30mm embedment min.)
Steel	3 x 14g -10 TPI-22mm long screws
To Brace & Tee	3 x ø 4.8 aluminium rivet

Seismic Design
- USG Boral Suspended Ceilings

K Brace



K BRACE TYPE KEY	
KB1	SA55/MT55 Wall Angle
KB2	SA120 Seismic Angle
KB4	WT64 x 30 x 0.75 Track

Allowable Tee Type Key	
Main Tee	
1	DX30D
2	DX38D
3	DXL38D
4	DXT30D
5	DXT38D
Cross Tee	
6	DX30M
7	DX30D
8	DX38D
9	DXT30D
10	DXT38D

Design tables are based on braces being installed along tee lines that are 2.4m apart (max.).
Refer to Notes on page 17.
Braces are to be positioned as equally as practical across the ceiling. The first brace position shall be no more than half the maximum brace spacing from the perimeter eg. if brace spacing is 10.8m, then the first brace must be no more than 5.4m from the perimeter.

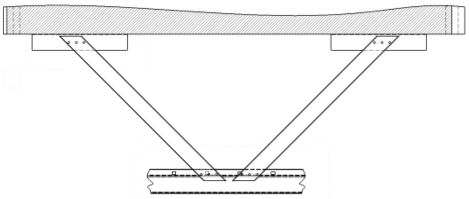
Plenum Depth 0.51 – 0.8 metres				**K BRACE**									
Seismic Force	Brace Type (min.)	Allowable Area per Brace (m²)	Max. Brace Spacing (M)	Allowable Tee Type									
				1	2	3	4	5	6	7	8	9	10
60#	**KB4**	20.6	8.6		•	•					•		
	KB2	17.0	7.1	•	•	•	•	•			•		•
	KB2	10.3	4.3	•	•	•	•	•	•	•	•	•	•
55	**KB4**	22.8	9.5		•	•					•		
	KB2	18.4	7.7	•	•	•	•	•			•		•
	KB2	11.7	4.9	•	•	•	•	•	•	•	•	•	•
50	**KB4**	25.4	10.6		•	•					•		
	KB2	20.4	8.5	•	•	•	•	•			•		•
	KB2	12.9	5.4	•	•	•	•	•	•	•	•	•	•
45	**KB4**	28.3	11.8		•	•					•		
	KB2	22.5	9.4	•	•	•	•	•			•		•
	KB2	14.4	6.0	•	•	•	•	•	•	•	•	•	•
40	**KB4**	31.9	13.3		•	•					•		
	KB2	25.4	10.6	•	•	•	•	•			•		•
	KB2	15.8	6.6	•	•	•	•	•	•	•	•	•	•
35	**KB4**	36.0	15.0		•	•					•		
	KB2	29.0	12.1	•	•	•	•	•			•		•
	KB2	18.7	7.8	•	•	•	•	•	•	•	•	•	•
30	**KB4**	42.2	17.6		•	•					•		
	KB2	34.0	14.2	•	•	•	•	•			•		•
	KB2	21.3	8.9	•	•	•	•	•	•	•	•	•	•
25	**KB4**	51.1	21.3		•	•					•		
	KB2	40.8	17.0	•	•	•	•	•			•		•
	KB2	26.1	10.9	•	•	•	•	•	•	•	•	•	•
20	**KB2**	51.1	21.3	•	•	•	•	•			•		•
	KB2	32.4	13.5	•	•	•	•	•	•	•	•	•	•
	KB1	8.6	3.6	•	•	•	•	•	•	•	•	•	•
15	**KB2**	68.1	28.4	•	•	•	•	•			•		•
	KB2	43.6	18.2	•	•	•	•	•	•	•	•	•	•
	KB1	11.5	4.8	•	•	•	•	•	•	•	•	•	•
10	**KB2**	65.7	27.4	•	•	•	•	•	•	•	•	•	•
	KB1	17.5	7.3	•	•	•	•	•	•	•	•	•	•
5	**KB2**	131.7	54.9	•	•	•	•	•	•	•	•	•	•
	KB1	35.0	14.6	•	•	•	•	•	•	•	•	•	•

Higher Seismic Force values may be available. Please contact USG Boral.

FASTENER TYPES	
	K Brace Types
To Structure	**KB1**
Concrete	2 x M6 Dynabolt (25mm embedment min.)
Timber	2 x No. 8 screw (30mm embedment min.)
Steel	3 x 14g -10 TPI-22mm long screws
To Brace & Tee	2 x ø 3.2 aluminium rivet
To Structure	**KB2**
Concrete	2 x M6 Dynabolt (25mm embedment min.)
Timber	4 x No. 10 screw (30mm embedment min.)
Steel	3 x 14g -10 TPI-22mm long screws
To Brace & Tee	3 x ø 4.0 aluminium rivet
To Structure	**KB4**
Concrete	2 x M6 Dynabolt (25mm embedment min.)
Timber	4 x No. 10 screw (30mm embedment min.)
Steel	3 x 14g -10 TPI-22mm long screws
To Brace & Tee	3 x ø 4.8 aluminium rivet

Seismic Design
- USG Boral Suspended Ceilings

K Brace



K BRACE TYPE KEY	
KB2	SA120 Seismic Angle
KB4	WT64 x 30 x 0.75 Track
KB5	WT92 x 30 x 0.75 Track

Allowable Tee Type Key	
Main Tee	
1	DX30D
2	DX38D
3	DXL38D
4	DXT30D
5	DXT38D
Cross Tee	
6	DX30M
7	DX30D
8	DX38D
9	DXT30D
10	DXT38D

Design tables are based on braces being installed along tee lines that are 2.4m apart (max.).
Refer to Notes on page 17.
Braces are to be positioned as equally as practical across the ceiling. The first brace position shall be no more than half the maximum brace spacing from the perimeter eg. if brace spacing is 10.8m, then the first brace must be no more than 5.4m from the perimeter.

FASTENER TYPES	
	K Brace Types
To Structure	**KB2**
Concrete	2 x M6 Dynabolt (25mm embedment min.)
Timber	4 x No. 10 screw (30mm embedment min.)
Steel	3 x 14g -10 TPI-22mm long screws
To Brace & Tee	3 x ø 4.0 aluminium rivet
To Structure	**KB4**
Concrete	2 x M6 Dynabolt (25mm embedment min.)
Timber	4 x No. 10 screw (30mm embedment min.)
Steel	3 x 14g -10 TPI-22mm long screws
To Brace & Tee	3 x ø 4.8 aluminium rivet
To Structure	**KB5**
Concrete	2 x M6 Dynabolt (25mm embedment min.)
Timber	4 x No. 10 screw (30mm embedment min.)
Steel	3 x 14g -10 TPI-22mm long screws
To Brace & Tee	3 x ø 4.8 aluminium rivet

Plenum Depth 0.81 – 1.25 metres				K BRACE									
Seismic Force	Brace Type (min.)	Allowable Area per Brace (m²)	Max. Brace Spacing (M)	Allowable Tee Type									
				1	2	3	4	5	6	7	8	9	10
60#	**KB5**	20.6	8.6		•	•					•		
	KB2	14.8	6.2	•	•	•	•	•			•		•
	KB2	10.3	4.3	•	•	•	•	•	•	•	•	•	•
55	**KB5**	22.8	9.5		•	•					•		
	KB2	16.3	6.8	•	•	•	•	•			•		•
	KB2	11.7	4.9	•	•	•	•	•	•	•	•	•	•
50	**KB5**	25.4	10.6		•	•					•		
	KB2	18.0	7.5	•	•	•	•	•			•		•
	KB2	12.9	5.4	•	•	•	•	•	•	•	•	•	•
45	**KB4**	25.4	10.6		•	•					•		
	KB2	19.9	8.3	•	•	•	•	•			•		•
	KB2	14.4	6.0	•	•	•	•	•	•	•	•	•	•
40	**KB4**	28.8	12.0		•	•					•		
	KB2	22.5	9.4	•	•	•	•	•			•		•
	KB2	15.8	6.6	•	•	•	•	•	•	•	•	•	•
35	**KB4**	32.8	13.7		•	•					•		
	KB2	25.6	10.7	•	•	•	•	•			•		•
	KB2	18.7	7.8	•	•	•	•	•	•	•	•	•	•
30	**KB4**	38.4	16.0		•	•					•		
	KB2	30.0	12.5	•	•	•	•	•			•		•
	KB2	21.3	8.9	•	•	•	•	•	•	•	•	•	•
25	**KB4**	46.0	19.2		•	•					•		
	KB2	36.0	15.0	•	•	•	•	•			•		•
	KB2	26.1	10.9	•	•	•	•	•	•	•	•	•	•
20	**KB4**	57.8	24.1		•	•					•		
	KB2	45.1	18.8	•	•	•	•	•			•		•
	KB2	32.4	13.5	•	•	•	•	•	•	•	•	•	•
15	**KB2**	60.2	25.1	•	•	•	•	•			•		•
	KB2	43.6	18.2	•	•	•	•	•	•	•	•	•	•
10	**KB2**	90.4	37.7	•	•	•	•	•			•		•
	KB2	65.7	27.4	•	•	•	•	•	•	•	•	•	•
5	**KB2**	181.2	75.5	•	•	•	•	•			•		•
	KB2	131.7	54.9	•	•	•	•	•	•	•	•	•	•

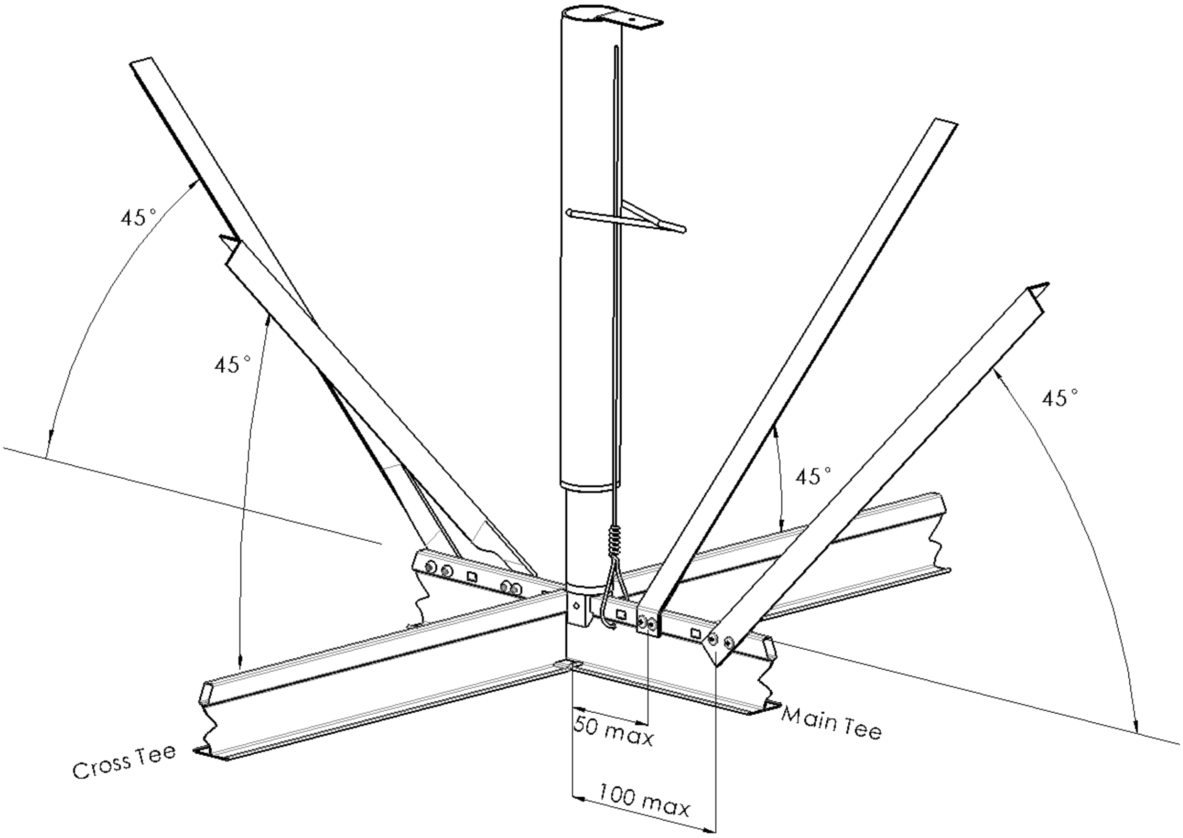
Higher Seismic Force values may be available. Please contact USG Boral.

USG BORAL

Seismic Design
- USG Boral Suspended Ceilings

Seismic Strut Brace

Seismic struts are an efficient method of providing two-way bracing for ceilings with deeper plenums. Ceilings with very high seismic loads may require vertical struts to resist upward movement.
Following are solutions using dedicated proprietary products (USG Compression Post) and alternative standard USG Boral steel roll formed sections. Substitutions are not permitted as bracing values have been based on USG Boral specific sections and steel type.
Vertical struts require support bracing similar to K bracing, in both directions and are attached to the Main Tee only.
Struts are to be positioned as per the 3 Steps on page 23. The first strut position shall be no more than 2.0m from the perimeter.



Seismic Strut Construction Specification Clauses

1. Vertical struts must be fixed to the Main Tee only, and within 50mm of the Main Tee/Cross Tee joint.
2. Design tables permit Seismic Struts to be installed along tee lines that are up to 2.4 metres apart max. (3.6m in some situations – ref. Strut Tables) relying on diaphragm action of the ceiling tiles to support unbraced tee lines in between. This spacing must not be exceeded without specific engineering design. For optimum seismic performance, it is recommended that every tee line be braced. Seismic struts must be evenly distributed around the ceiling area, with a minimum of two braces on any ceiling.
3. Strut bracing is to be fixed to the Main Tee only, with the Cross Tee direction bracing within 50mm of the joint and all bracing within 100mm of the joint.
4. Plenum depths greater than 1300mm may require more than a 10mm separation gap to perimeter. Refer to building designer for required gaps.
5. Suspended ceiling hanger wires, vertical struts and/or bracing shall not be located within 150mm of a/c ducting.
6. Diagonal wires to be minimum of ø2.5 galvanised wire, secured using at least three complete turns and through tee web holes only, NOT the bulb slots. Ensure wire position is not directly below the bulb slot.
7. Angled braces must be fixed no greater than 45° to the plane of the ceiling grid system, and may be less (not less than 30°) to accommodate fixing to irregular structure, typically due to purlin spacing, and must be parallel to the Main and Cross Tees.
8. Tee joints shall not occur within ±150mm of strut/bracing points.
9. All screw and rivet fasteners must have a minimum edge distance and spacing of 3x nominal fastener diameter. When fixing to the bulb of a ceiling tee, ensure fixing is vertically centred on the bulb and has 3x fastener diameter edge distance to any holes in the Main Tee bulb.
10. Vertical seismic strut braced ceilings must not be perimeter fixed as well.
11. Install and fix all lay-in ceiling panels with correct hold-down clips in full conformance with USG specifications. Where point accessibility is required, nominate unclipped panels with a visual marker eg. coloured sticker, board pin, etc.

Seismic Design
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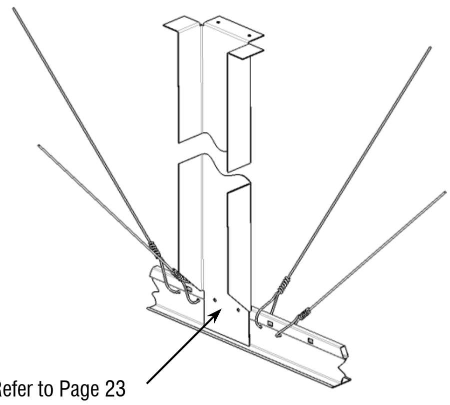
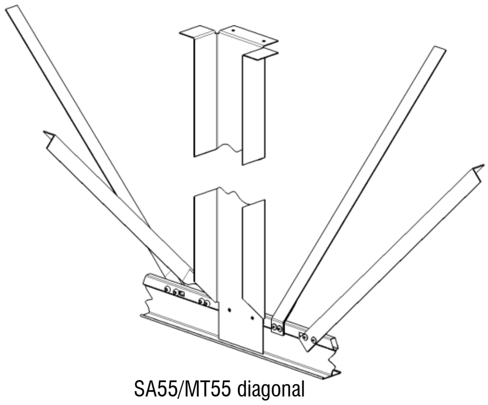
Seismic Strut Options

SEISMIC STRUT TYPE KEY		Diagonal Tie
SS1	WT64 x 30 x 0.55 BMT Track	Ø2.5 wire
SS2	SA120 Seismic Angle	Ø2.5 wire
SS3	WT92 x 30 x 0.75 BMT Track	Ø2.5 wire
SS4	USG Compression Post	SA55/MT55

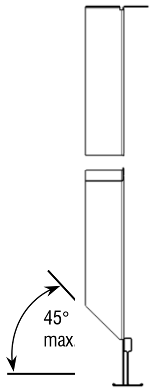
Steel Track (**SS1** and **SS3**)



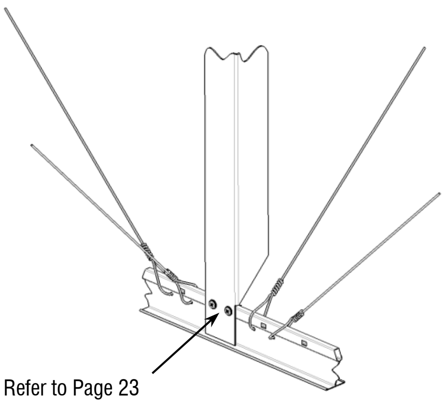
Refer to Page 23
for rivet fixings



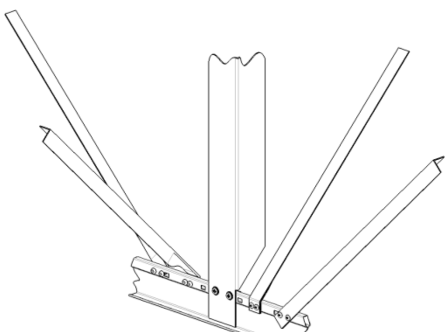
SA55/MT55 diagonal
tie option



Steel Angle SA120 (**SS2**)

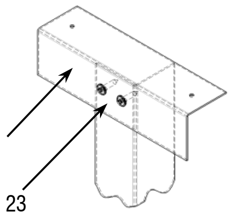


Refer to Page 23
for rivet fixings



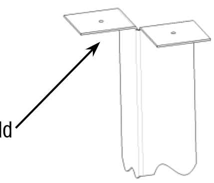
SA55/MT55 diagonal
tie option

Strut top fixing options



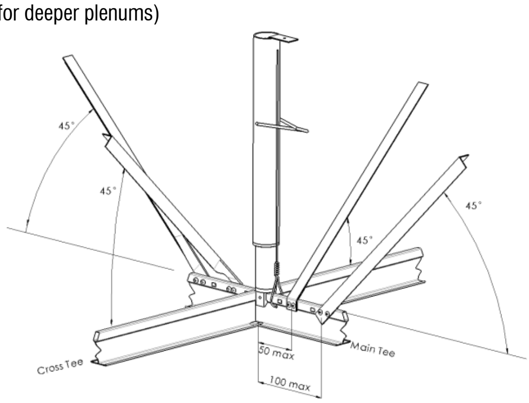
SA120 Angle

Refer to Page 23
for rivet fixings



Cut and fold
legs back

USG Compression Post VSA 48/84 (**SS4**)
(other sizes available for deeper plenums)



NOTES:
1. Refer to Seismic Strut Construction Specification clauses and bracing layout requirements on page 21.
2. For SA55/MT55 strut brace, fix to underside of structure as for K Brace details on page 17.
3. For wire strut brace fix to structure with M4.5 Setlok eyebolt or similar. Wires must be taut, and ends securely wound off with 4 tight 360° turns

Seismic Design
- USG Boral Suspended Ceilings

SEISMIC STRUT TYPE KEY		Diagonal Tie
SS1	WT64 x 30 x 0.55 BMT Track	Ø2.5 wire
SS2	SA120 Seismic Angle	Ø2.5 wire
SS3	WT92 x 30 x 0.75 BMT Track	Ø2.5 wire
SS4	USG Compression Post	SA55/MT55

Allowable Tee Type Key	
Main Tee	
1	DX30D
2	DX38D
3	DXL38D
4	DXT30D
5	DXT38D
Cross Tee	
6	DX30M
7	DX30D
8	DX38D
9	DXT30D
10	DXT38D

Step 1. Provide perimeter struts no more than 2.0m from the edge of the ceiling at 2.4m max. centres (3.6m allowable for some options – ref table). Perimeter struts must be located as close as practical at the intersection of a Main Tee/Cross Tee joint, no greater than 50mm. **Step 2.** Subdivide the ceiling into Zones which have a max. length & width from the table. These Zones would normally be square, but may also be rectangular if the Zone side(s) is less than the max. allowable length. Eg. if Zone length/width is 4.2 x 4.2, then 4.2 x 3.6 is OK. **Step 3**. Provide struts all around the perimeter of each Zone in the ceiling, at 2.4m max centres (3.6m if allowable from table)

FASTENER TYPES

	Strut Types
To Structure	**SS1**
Concrete	2 x M6 Dynabolt (25mm embedment min.)
Timber	2 x No. 8 screw (30mm embedment min.)
Steel	3 x 14g -10 TPI-22mm long screws
Strut to Tee	2 x ø 3.2 aluminium rivet
SB/MT to Tee	2 x ø 3.2 aluminium rivet
To Structure	**SS2**
Concrete	2 x M6 Dynabolt (25mm embedment min.)
Timber	2 x No. 8 screw (30mm embedment min.)
Steel	3 x 14g -10 TPI-22mm long screws
Strut to Tee	2 x ø 3.2 aluminium rivet
SB/MT to Tee	2 x ø 3.2 aluminium rivet
To Structure	**SS3**
Concrete	2 x M6 Dynabolt (25mm embedment min.)
Timber	2 x No. 8 screw (30mm embedment min.)
Steel	3 x 14g -10 TPI-22mm long screws
Strut to Tee	2 x ø 3.2 aluminium rivet
SB/MT to Tee	2 x ø 3.2 aluminium rivet
To Structure	**SS4**
Concrete	1 x M6 Dynabolt (25mm embedment min.)
Timber	1 x No. 8 screw (30mm embedment min.)
Steel	1 x 14g -10 TPI-22mm long screws
Strut to Tee	1 x No. 8 x 16mm screw
SB/MT to Tee	3 x ø 4.8 aluminium rivet

Plenum Depth 1.21 – 1.55 metres				SEISMIC STRUT									
Seismic Force	Strut Type (min.)	Max. Perimeter Spacing (m)	Zone length /width (m)	Allowable Tee Type									
				1	2	3	4	5	6	7	8	9	10
60#	SS4	2.4	8.4		•	•					•		
	SS4	2.4	4.2	•	•	•	•	•	•	•	•	•	•
55	SS4	2.4	9.0		•	•					•		
	SS4	2.4	4.8	•	•	•	•	•	•	•	•	•	•
50	SS4	2.4	10.2		•	•					•		
	SS4	2.4	5.4	•	•	•	•	•	•	•	•	•	•
	SS3	2.4	3.0	•	•	•	•	•	•	•	•	•	•
45	SS4	3.6	7.8		•	•					•		
	SS4	2.4	6.0	•	•	•	•	•	•	•	•	•	•
	SS3	2.4	3.0	•	•	•	•	•	•	•	•	•	•
40	SS4	3.6	8.4		•	•					•		
	SS4	2.4	6.6	•	•	•	•	•	•	•	•	•	•
	SS3	2.4	3.6	•	•	•	•	•	•	•	•	•	•
	SS2	2.4	3.0	•	•	•	•	•	•	•	•	•	•
35	SS4	3.6	9.6		•	•					•		
	SS4	2.4	7.8	•	•	•	•	•	•	•	•	•	•
	SS3	2.4	4.2	•	•	•	•	•	•	•	•	•	•
	SS2	2.4	3.6	•	•	•	•	•	•	•	•	•	•
30	SS4	3.6	11.4		•	•					•		
	SS4	2.4	8.4	•	•	•	•	•	•	•	•	•	•
	SS3	2.4	4.8	•	•	•	•	•	•	•	•	•	•
	SS2	2.4	4.2	•	•	•	•	•	•	•	•	•	•
25	SS4	3.6	7.2	•	•	•	•	•	•	•	•	•	•
	SS3	2.4	6.0	•	•	•	•	•	•	•	•	•	•
	SS2	2.4	4.8	•	•	•	•	•	•	•	•	•	•
	SS1	2.4	2.4	•	•	•	•	•	•	•	•	•	•
20	SS4	3.6	9.0	•	•	•	•	•	•	•	•	•	•
	SS3	2.4	7.2	•	•	•	•	•	•	•	•	•	•
	SS2	2.4	6.6	•	•	•	•	•	•	•	•	•	•
	SS1	2.4	3.0	•	•	•	•	•	•	•	•	•	•
15	SS3	2.4	10.2	•	•	•	•	•	•	•	•	•	•
	SS2	2.4	8.4	•	•	•	•	•	•	•	•	•	•
	SS1	2.4	4.2	•	•	•	•	•	•	•	•	•	•
10	SS3	3.6	10.2	•	•	•	•	•	•	•	•	•	•
	SS2	3.6	8.4	•	•	•	•	•	•	•	•	•	•
	SS1	2.4	6.0	•	•	•	•	•	•	•	•	•	•
5	SS3	3.6	19.8	•	•	•	•	•	•	•	•	•	•
	SS2	3.6	17.4	•	•	•	•	•	•	•	•	•	•
	SS1	3.6	8.4	•	•	•	•	•	•	•	•	•	•

Higher Seismic Force values may be available. Please contact USG Boral.

Seismic Design
- USG Boral Suspended Ceilings

Technical Assumptions	The following assumptions apply to all calculations in this design guide: ▪ Refer to page 4 for important design assumptions and limitations ▪ It is assumed that the period of the ceiling is less than 0.75 seconds for assessment of the spectral shape co-efficient for design of parts (conservative) ▪ The following maximum building periods have been assumed for evaluation of the near fault factor which have been applied uniformly throughout Zone 3 only: T=2.0 sec for heights up to 12m, T=3.0 sec for heights up to 20m, T=4.0 sec for heights up to 40m (when designing ceilings for serviceability limit state loads, note that the period will be for a building with stiffness corresponding to serviceability limit state).
Specific Engineering Design	The seismic force calculated on page 7 is a non-standard unit used for ease of calculation. To convert "seismic force" into kg/m length of tee (eg. for use in specific engineering design), follow these steps: 1. Multiply the factors in the height/zone table by 0.1729 (note: this figure represents $C_h(0)_{max}\ Z_{min}$ = 1.33 x 0.13). The maximum allowable length of tee (or brace spacing) obtained from the design graphs must also be multiplied by 0.1729 in order to balance the design equation. 2. Ignore the Teg Tab factor when calculating the "seismic force" on the perimeter fixings (i.e. multiply by a Teg Tab factor equal to 1.0 only). If a 6mm Teg Tab will be used with a rivet, divide the design strength of the riveted connection by 1.7. If a 10mm Teg Tab will be used with a rivet, divide the design strength of the riveted connection by 2.0 (note: design strength is typically expressed as a maximum allowable length of tee in this brochure).
Ultimate Limit State Design	▪ As stated on page 2, this generic design guide is primarily intended for low risk ceilings where it is appropriate to design for serviceability limit state (SLS) loads only. Some ceilings will need to be designed to maintain their integrity under Ultimate Limit State (ULS) loads, as illustrated in the flow chart on page 6. ▪ The following alternative seismic force calculator (page 25) must be used for Ultimate Limit State design. The designer must select the appropriate Importance Level for the building (with reference to AS/NZS1170.0), the appropriate part classification for the ceiling (with reference to NZS 1170.5:2004, Table 8.1), and the appropriate ductility factor (with reference to NZS 1170.5, relevant materials standards, and current technical literature). ▪ **If the result of Zone Factor x ULS Design Factor x Ceiling Ductility Factor on Page 25 is greater than 21, use 21.** This reflects the horizontal seismic force limit of 3.6g in NZS1170.5, equation 8.5(1). ▪ Design Working Life of the building structure is assumed to be 50 years for ULS design, based on the normal minimum requirements of the New Zealand Building Code. Specific Engineering Design is required for consideration of a longer or shorter design working life. ▪ Anyone using this ULS design guide must be well trained or qualified in the principles of seismic design of ceilings (eg. a Charted Professional Structural Engineer or an approved USG Boral ceiling contractor and installer).

Seismic Design
- USG Boral Suspended Ceilings

Ceiling Weight	
	kg/m²

(From page 7)

x

Height [1] (metres)	ZONE FACTOR[5]				
	1a	1	2	2a	3
0-3	0.8	1.2	1.8	2.3	2.7
3.1-6	1.0	1.6	2.4	3.1	3.6
6.1-9	1.3	2.0	2.9	3.9	5.0
9.1-12	1.5	2.4	3.5	4.6	6.0
12.1-20	1.5	2.4	3.5	4.6	7.3
20.1-40	1.5	2.4	3.5	4.6	8.5[2]

x

TEG TABS FACTOR[3]	
6mm with rivet	1.7
10mm with rivet	2.0
With ACM7 Clip (no rivet)	-
No Teg Tabs	-

Use this Factor ONLY for Perimeter Fixing graph

[1] For Perimeter Attachment – height of ceiling from ground level, or For Back Braced - height of structure where ceiling is attached, from ground level

[2] If the result of the Zone Factor x ULS Design Factor x Ceiling Ductility Factor is greater than 8, provide rigid hangers to prevent uplift

[3] The Teg Tabs Factor only applies to design of Perimeter Fixings. Do not include in Seismic Force for design of ceiling tees or for braced ceilings

x

Category Classification
(NZS1170.5, Section 8, Table 8.1)

- P.1 - Part representing a hazard to life outside the structure
- P.2 – Part representing a hazard to a crowd of greater than 100 people within the structure
- P.3 – Part representing a hazard to individual life within the structure
- P.4 - Part necessary for the continuing function of the evacuation and life safety systems within the structure
- P.5 – Part required for operational continuity of the structure
- P.6 – Part for which the consequential damage caused by its failure are disproportionately high
- P.7 – All other parts

Ceiling Category	Building Importance Level (APE#)	Earthquake Zone (see page 7)	ULS DESIGN FACTOR[5]
P.7	1 & 2 & 3 (1/25)	1a & 1 & 2 & 2a & 3	1.0
P.6	1 & 2 & 3 (1/25)	1a & 1 & 2 & 2a & 3	2.0
P.5	4 (1/500)	SPECIFIC ENGINEERING DESIGN	
P.4 & P.2 & P.1	2 (1/500)	1a & 1 & 2 & 3	4.0
		2a	3.1
	3 (1/1000)	1a & 1 & 2 & 3	5.2
		2a	4.0
P.3	2 (1/500)	1a & 1 & 2 & 3	3.6
		2a	2.8
	3 (1/1000)	1a & 1 & 2 & 3	4.7
		2a	3.6

Annual **P**robability of **E**xceedance

x

Ductility (μ)[4]	CEILING DUCTILITY FACTOR[5]
1.0	1.0
1.25	0.85
2.0	0.55

[4] A ductility of 1.0 must be assumed, except on the advice of a Chartered professional structural engineer for a specific ceiling

x

Tee Spacing	
1.2	m
0.6	m

[5] **If the result of Zone Factor x ULS Design Factor x Ceiling Ductility Factor is greater than 21 before multiplying the Tee Spacing, use 21.** This reflects the horizontal seismic force limit of 3.6g in NZS1170.5, equation 8.5(1).

=

SEISMIC FORCE

Seismic Design - USG Boral Suspended Ceilings

Summary

Project Name: Project No. : Ceiling Level: floor

Location: ____________________ Seismic Zone: _____

Seismic Force Calculator Details

	Ceiling Weight kg/m²:		Ceiling Height Factor:		Teg Tab Factor: (N/A)		ULS Design Factor:		Ductility Factor:		Tee Spacing:		SEISMIC FORCE :
Tees & Braces	__________	x	__________			x	__________	x	_______	x	1.2	=	____________
											0.6	=	____________
Perimeter Fixings	__________	x	__________	x	_____	x	__________	x	_______	x	1.2	=	____________
											0.6	=	____________

Suspension and Wall Angles

(circle required type & spacing) *Note: When using DX38D, use MT55 Wall Angle option for when perimeter fixing with rivets, not MT45*

Main Tee type DX38D / DX30D / DXL38D / DXT38D / DXT30D @ 0.6 / 1.2 m centres

Cross Tee type DX38D / DX30D / DX30M / DXT38D / DXT30D @ 0.6 / 1.2 m centres

Wall Angle type MT55 / MT45 / ML45 / US45 / MSL45 / MXT45

Wall Angle fastener(s) ____
(see page 13) ____

Perimeter Fixing Options

(tick/circle required type)

☐ **Main Tee** - Fixed on one end only

Max. allowable tee length (tee) _______m

Max. allowable tee length (fixing) _______m

Actual tee length _______m

☐ Fixed on both ends (confirmed with building engineer)

Max. allowable tee length (tee) _______m

Max. allowable tee length (fixing) _______m

Actual tee length _______m

Fixed end fasteners PA __ ø3.2 alu rivet / ø4.0 alu rivet / ACM7 Seismic Clip

Free end fixing PA __ ACM7 Seismic Clip / Hanger ≤ 200mm / Other / N/A____________________

☐ **Cross Tee** - Fixed on one end only

Max. allowable tee length (tee) _______m

Max. allowable tee length (fixing) _______m

Actual tee length _______m

☐ Fixed on both ends (confirmed with building engineer)

Max. allowable tee length (tee) _______m

Max. allowable tee length (fixing) _______m

Actual tee length _______m

Fixed end fasteners PA __ ø3.2 alu rivet / ø4.0 alu rivet / ACM7 Seismic Clip

Free end fixing PA __ ACM7 Seismic Clip / Hanger ≤ 200mm / Other / N/A____________________

Teg Tab none / 6mm / 10mm ☐ with rivets ☐ without rivets

Seismic Expansion Gap Options

(circle required type)

Main Tee direction DH4 / Other ____

Cross Tee direction DH4 / Other ____

Installation Company: Name: Signed: Date:

Seismic Design - USG Boral Suspended Ceilings

Summary

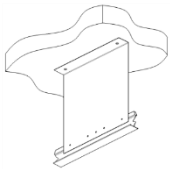
Project Name: Project No. : Ceiling Level: floor

Location: ____________________ Seismic Zone: _____

Back Bracing Options

Plenum Depth ___________m

Direct Fix

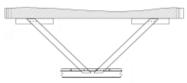


(tick required type)

☐ **DF1**
Fastener Type to Structure ___________________ Fastener Type Brace to Tee 3 x ø3.2 steel rivets

☐ **DF2**
Fastener Type to Structure ___________________ Fastener Type Brace toTee 4 x ø3.2 steel rivets

K Brace



(tick required type)

☐ **KB1** SA55/MT55
Fastener Type to Structure ___________________ Fastener Type Brace toTee __ x ø____ alum rivets

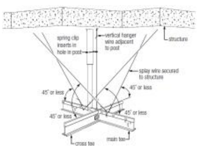
☐ **KB2** SA120 Seismic Angle
Fastener Type to Structure ___________________ Fastener Type Brace toTee __ x ø____ alum rivets

☐ **KB3** DJ38 Strongback C Channel
Fastener Type to Structure ___________________ Fastener Type Brace toTee __ x ø____ alum rivets

☐ **KB4** WT64 x 30 x 0.75 BMT track
Fastener Type to Structure ___________________ Fastener Type Brace toTee __ x ø____ alum rivets

☐ **KB5** WT92 x 30 x 0.75 BMT track
Fastener Type to Structure ___________________ Fastener Type Brace toTee __ x ø____ alum rivets

Seismic Strut



(tick required type)

☐ **SS1 WT64 x 30 x 0.55 track** + Ø2.5 wire brace
Fastener Type to Structure ___________________ Fastener Type Brace to Tee __ x ø____ alum rivets

☐ **SS2 SA120 Seismic Angle** + Ø2.5 wire brace or SA55/MT55 brace
Fastener Type to Structure ___________________ Fastener Type Brace to Tee __ x ø____ alum rivets

☐ **SS3 WT92 x 30 x 0.75 track** + Ø2.5 wire brace or SA55/MT55 brace
Fastener Type to Structure ___________________ Fastener Type Brace to Tee __ x ø____ alum rivets

☐ **SS4 USG Comp. Post VSA 48/84** + SA55/MT55 brace
Fastener Type to Structure ___________________ Fastener Type Brace to Tee __ x ø____ alum rivets

Brace Spacing (maximum)

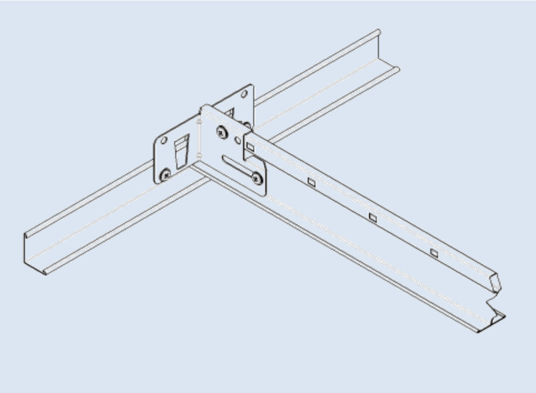
Along Main Tee ____________m Between braced Main Tees ________m Total # of MT braces ____

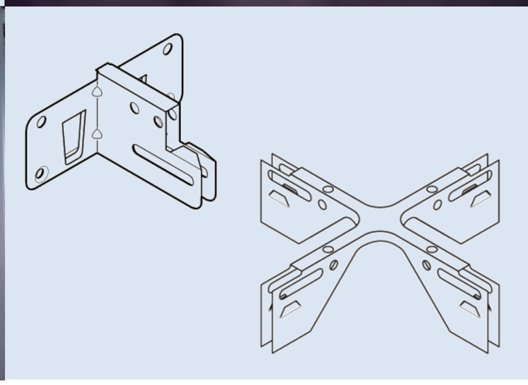
Along Cross Tees __________m Between braced Cross Tees _______m Total # of CT braces ____

☐ Bracing layout attached

Installation Company: Name: Signed: Date:

Seismic Design
- USG Boral Suspended Ceilings





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