

CODE OF PRACTICE

For Design, Installation and Seismic Restraint
of Suspended Ceilings

September 2024



The purpose of this Code of Practice is to assist the construction industry, building consent authorities, architects, engineers, builders, installers and specifiers to comply with the New Zealand Building Code.

ASSOCIATION OF WALL AND CEILING INDUSTRIES OF NEW ZEALAND INC. INTERIOR CONSTRUCTION PROFESSIONALS

AWCI represents Contractors, Manufacturers and Suppliers who operate within the residential and commercial interior fitout sector.

We are passionate about Interior Construction.

Interior Construction is now recognised as a specialised and exciting career choice with a variety of skills and experience required to create stunning interiors. When you use an AWCI member, you can rely that they are knowledgeable and experts in creating beautiful interior fitouts. Come and see the work that Interior Construction professionals can create for your residential or commercial building.

AWCINZ membership is open to any interested party.

For further information, please contact admin@awcinz.org.nz or go to www.awcinz.org.nz.

ACKNOWLEDGEMENT

This Code of Practice update was prepared by a project team comprising:

Richard Arkinstall	- AWCINZ
John Keen	-Interni Consulting
	-Rondo Building Services
Matt Bishop	-Brevity Engineering
Carla McDougall	-East Coast Suspended Ceilings

DOCUMENT HISTORY

This document may be updated from time to time. Refer to the website www.awcinz.org.nz for the most recent updates of this Code of Practice:

Version	Date
1 st published	October 2015
Reprinted	November 2015
2 nd published	September 2024

This Code of Practice is intended as a supplement to AS/NZS 2785:2020, the primary Standard for design and installation of suspended ceilings. The Code of Practice contains information in addition to AS/NZS 2785 that is more relevant to the New Zealand seismic environment and NZBC compliance for suspended ceilings as a non-structural element (NSE). Complex projects may require reference to the BIP NSE Code of Practice as well as Specific Engineering Design (SED).

Comments on this Code of Practice are welcome, please send all comments to admin@awcinz.org.nz.

Funding :

The production of this Code of Practice was generously funded by BRANZ and the Building & Construction Training Fund (BCTF) whose support is gratefully acknowledged.

Responsibility for the content lies solely with the Association of Wall and Ceiling Industries of New Zealand and does not necessarily reflect the opinion of BRANZ or BCTF. BCTF and BRANZ makes no representation or warranty regarding this Code of Practice. BCTF does not accept any liability for any loss or damage which may directly or indirectly result from any information, standard, opinion, representation or omission, whether negligent or otherwise, contained in this Code of Practice.



Foreword

FOREWORD FROM THE MINISTRY OF BUSINESS INNOVATION AND EMPLOYMENT (MBIE)

Damage to suspended ceilings from recent earthquakes has highlighted the need for correct design and installation of ceilings and other non-structural parts of buildings, such as partitions and building services. The failure of non-structural elements (NSE) in an earthquake can injure or kill people and can prevent the uninterrupted use of buildings after an earthquake.

This new Code of Practice focuses on seismic restraints and separations for suspended ceilings and on the roles and responsibilities of those involved to ensure that suspended ceilings are designed and installed correctly. The co-ordination with designers and contractors working on other non-structural elements is also highlighted.

NEW MBIE PRODUCT REQUIREMENTS

In December 2023 new building product information requirements (BPIRs) regulations came into effect to provide building product users with more consistent information about how building products contribute to compliance with the Building Code. They place obligations on New Zealand based manufacturers, importers, wholesalers, retailers and distributors of building products.

The Ministry congratulates the Association of Wall and Ceiling Industries on its initiative in producing this Code of Practice. It is encouraging to see industry groups creating their own guidance and codes of practice to complement Ministry guidance and Acceptable Solutions and Verification Methods. Note, however, that this Code of Practice is not part of the Ministry's Acceptable Solutions, Verification Methods or guidance documents.

Improving the compliance and performance of suspended ceilings will rely on greater awareness of responsibilities for design and installation from those involved in the construction industry. To this end, we hope that this Code of Practice will assist the industry with the procurement, design and installation of suspended ceilings, taking into consideration seismic actions, restraint, flexibility and interfaces with other building elements.

The regulations require a minimum level of information about building products to be made freely and publicly available. This will help NSE Seismic Designers, installers and consumers to choose the right products for the right application and install them in the correct way. It will also help BCA's with more efficient consenting as they will have the right information readily available to check that building products included in plans and specifications meet their applicable Building Code performance obligations.

Contents

1 Introduction	6	Plasterboard or other sheet-lined suspension systems	24
Possible reasons for failure of suspended ceilings	6	Specialty or feature ceilings	25
2 Background	8	Linear and metal	26
Past industry practice	8	Curved ceilings	27
The challenge for the industry	8	Floating cloud	28
Additional challenges	9	Ceilings below other ceilings	28
3 Seismic requirements	10	Wind loads	29
Identifying the seismic requirements of a ceiling design	10	- External air pressure	31
Building Importance Level	11	- Internal air pressure	31
Cost considerations	13	Bulkheads	32
4 Design	14	Ceiling components	35
The design process	14	Wall trims and perimeter channels	35
Roles and responsibilities of the parties involved in the design	14	Fixing clips	36
AWCI recommended project process	15	Main tees	37
Design co-ordination	16	Cross tees	37
Other trades in the plenum	16	Wall stud spanning	38
Seismic restraint of non-structural building components other than ceilings	16	7 Testing of product	39
Who does the design for other building components?	16	8 Generic seismic design guides	40
Co-ordination of design	16	9 Specific engineering design (SED)	41
Projects and consent exemptions	17	10 Generic details	42
5 Design documentation	18	Lateral force bracing	43
Compliance with NZBC and standards	18	Perimeter fixing	43
Seismic design	19	Perimeter restraint	43
Seismic forces	19	Fixed-end options	44
Limit state design	19	Non-fixed-end options	47
Producer Statements	19	Seismic separation joint details	48
Classification of parts (P1-P7)	20	Braced ceilings	50
6 Ceiling types and components	21	Tile clips	51
Ceiling fixing methods	21	Hangers	51
Ceiling systems	21	Hanger to structure fasteners	52
Two-way exposed	21	For timber structures	52
One-way exposed	22	For steel structures	52
Fully concealed (or two-way concealed)	23	For concrete structures	52
		Ceiling panel mounted services	53
		Grid configuration	53
		Grid below a plasterboard ceiling	53
		Services clearances and bridging	54
		Trapeze	55

11 Possible reasons for and consequences of failure	56	16 Acoustics	67
Swimming pool/sauna environments	57	Sound absorption (NRC)	67
12 Tendering	58	Sound transmission (STC, CAC)	67
Options for tendering	58	External sound transmission (STC)	68
Option 1: Where tender documents include full details of seismic restraints	58	17 Monitoring design and construction	69
Model tender qualification where seismic restraints are fully detailed	58	Producer statements	69
Option 2: Where seismic restraint design is required to be carried out by the tenderer	59	Design producer statement (PS1)	69
Model tender qualification where seismic restraints are not detailed in tender documents	59	Design review producer statement (PS2)	69
Option 3: Specific engineering design	59	Construction producer statement (PS3)	70
Model tender qualification where specific engineering design is required	60	Construction review producer statement (PS4)	70
General tender qualifications	60	Construction monitoring (CM) levels	70
Tender, consent and shop drawings	60	Level CM2	70
13 Installation	61	Level CM3	70
Site inspection	61	Level CM4	70
Material storage and handling	61	18 Summary of roles and responsibilities	71
Pre-installation checklist	61	Designer	71
Facilities for installation of suspended ceilings	61	Ceiling tenderer	71
Best-practice co-ordination with other ceiling services	62	Installer	71
Installation details to seismic design	62	Manufacturer	72
Aesthetics	62	Building Consent Authority	72
Specialty tools	62	Appendices	73
Quality assurance	62	A. Definitions, abbreviations and notations	73
Inspection	63	B. Relevant standards and associated documents	77
Refurbishment work	63	C. Tendering options guidelines	78
14 Partitions	64	D. Installer's producer statement (PS3) template	81
15 Fire and suspended ceilings	66	E. Example of a PS1 producer statement	82
Passive fire	66	F. Sample QA sheet	83
Early fire reaction	66	G. Design information list	84
		H. Compliance pathway	85
		I. Seismic Restraint of Suspended Ceilings Lined with Sheet Materials	86

Figures* and tables

Table 1: Building importance levels	11	Figure 25: Wind loads	31
Table 2: Importance Level & design actions	13	Figure 26: Bulkhead off solid underfloor	32
Table 3: Part category & design requirements	13	Figure 27: Bulkhead off solid underfloor with two ceilings at different heights	32
Figure 1: Change in relative cost of seismic requirements as complexity increases	13	Figure 28: Suspended ceiling and bulkhead, cantilevered top ceiling support	33
Figure 2: Recommended project process	15	Figure 29: Suspended ceiling and bulkhead	33
Table 4: Project steps & parties involved	17	Figure 30: Suspended ceiling and light trough bulkhead	34
Table 5: Project organisations definitions	17	Figure 31: Suspended ceiling to blind box detail	34
Table 6: Limit state definitions	19	Figure 32: L trims, various sizes, equal and unequal leg length	35
Table 7: Classification of building parts	20	Figure 33: Shadow trims, various sizes	35
Figure 3: Exposed grid and tile system in place	21	Figure 34: C channels, various sizes	35
Figure 4: Schematic diagram of two-way grid	21	Figure 35: Wall shims, used at edges of ceilings to accommodate sloped ceilings	35
Figure 5: Concealed edge	22	Figure 36: Perimeter clips	36
Figure 6: Tee grid visible in only one direction	22	Figure 37: Main tee joint clip	36
Figure 7: Schematic diagram of one-way exposed grid	22	Figure 38: Cross tee joint clip	36
Figure 8: Back-to-back L splines	23	Figure 39: Three-way cross joint clip for off-module connection	36
Figure 9: C and Z splines	23	Figure 40: Main tee, 24 mm face	37
Figure 10: Tee grid	23	Figure 41: Main tee, 15 mm face	37
Figure 11: Concealed grid	23	Figure 42: Cross tee, 24 mm face	37
Figure 12: Suspended sheeted or flush ceiling grid system	24	Figure 43: Cross tee, 15 mm face	37
Figure 13: Direct fix sheeted or flush ceiling system	24	Figure 44: Heavy gauge angle for spanning studs	38
Figure 14: Suspended T-grid for sheeted or flush ceilings	25	Figure 45: Continuous angle for spanning studs	38
Figure 15: Finished feature ceilings	25	Figure 46: Seismic layout concepts	42
Figure 16: Suspended linear or strip ceiling	26	Figure 47: Proprietary wall clip	43
Figure 17: Proprietary linear ceiling system	26	Figure 48: Proprietary wall clip in place	43
Figure 18: Curved ceiling schematic	27	Figure 49: Proprietary floating end bracket	43
Figure 19: Floating cloud ceilings	28	Figure 50: Pop rivet fixed end	44
Figure 20: Feature ceiling below another ceiling	28	Figure 51: Pop rivet with spacer block	44
Figure 21: Terrain Category 1	29	Figure 52: Seismic clip – main or cross tee	45
Figure 22: Terrain Category 2	29	Figure 53: Seismic clip – cross tee with spacer block, fixed end	45
Figure 23: Terrain Category 3	30		
Figure 24: Terrain Category 4	30		

Figure 54: Seismic clip – main or cross tee with spacer block and shadow wall angle, fixed end	46	Figure 76: Typical trapeze	55
Figure 55: Seismic clip – wall angle and wall angle with spacer block – floating end	47	Figure 77: Trapeze wire detail	55
Figure 56: Seismic channel – floating end	47	Figure 78: Lack of suspension points and service clearance	56
Figure 57: Small seismic joint, two directions, hidden joint	48	Figure 79: Unbraced partitions and service ducts	56
Figure 58: Small seismic joint, one direction, hidden joint	48	Figure 80: Sprinkler system supported from ceiling componentry rather than suspended from structure	56
Figure 59: Seismic joint clip – cross tee	48	Figure 81: The result of an unbraced ceiling	57
Figure 60: Large seismic joint with concave cover strip	49	Figure 82: Damage to ceiling tile from an unrestrained fire protection system	57
Figure 61: Large seismic joint with cover material at bottom of T-rail	49	Figure 83: Damage caused by unrestrained services	57
Figure 62: Large seismic joint with cover strip above T-rail	49	Figure 84: Lack of suspension points	57
Figure 63: Large seismic joint with compressible cover strip	49	Figure 85: Proprietary internal wall bracing connection (isolated from ceiling movement)	64
Figure 64: Lateral force bracing using 3-way solid struts	50	Figure 86: Generic internal wall bracing connection – wall terminates at ceiling	64
Figure 65: Lateral force bracing using splayed wires	50	Figure 87: Generic internal wall bracing connection – wall terminates above ceiling	65
Figure 66: Hanger wire minimum tie-off	51	Figure 88: Horizontal bracing – wall terminates at ceiling	65
Figure 67: Joining wires for deep plenums	51	Figure 89: Sound reflection	67
Figure 68: Timber attachment options	52	Figure 90: Sound transmission	68
Figure 69: Steel attachment options	52	Table 9: Producer statements likely to be required for NZBC compliance	69
Figure 70: Concrete attachment options	52	Figure 91: Load paths of sheeted ceilings	86
Figure 71: Transferring ceiling services load	53	Figure 92: Fixed -fixed perimeter restraint for sheeted ceilings	87
Figure 72: Common grid configurations	53		
Figure 73: Suspending a grid and tile ceiling below a plasterboard ceiling	53		
Table 8: Clearances form NZS 4219:2009	54		
Figure 74: Minimum clearance requirements for unrestrained to restrained services	54		
Figure 75: Bridging under ducts or services by other trades	54		

*Representative drawings are industry generic. Specific proprietary components or installation systems/assemblies shall be verified as suitable for the specific seismic design by a qualified engineer.

1

Introduction

Despite the requirements of various New Zealand standards,¹ the seismic compliance of ceilings has received scant attention in recent years. A series of major earthquakes in Christchurch in 2010 and 2011 and in Seddon in 2013, which also affected Wellington, highlighted a systemic problem.

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 others, ceilings were compromised by unrestrained or poorly restrained building services and partitions. Overseas, there are examples in Japan and California where injury and loss of life have occurred as a result of ceilings and/or building services they were supporting failing.

According to a University of Canterbury report,² well over half of the costs incurred in the Christchurch earthquakes were associated with non-structural elements such as ceilings, partitions and services. The Insurance Council of New Zealand reported to a Parliamentary Select Committee in May 2014 that the cost of non-structural element failures had resulted in many otherwise repairable buildings being demolished.³

Aside from the obvious concerns about the safety of building occupants and widespread non-compliance with the New Zealand Building Code (NZBC), 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.

More detailed information on non-structural elements can also be referenced in the document :

“BRANZ - Building Innovation Partnership (BIP) project *Code of Practice for the Seismic Performance of Non-Structural Elements* (BIP NSE CoP)”.

POSSIBLE REASONS FOR FAILURE OF SUSPENDED CEILINGS

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

- the seismic performance of the building
- unsuitable ceiling design for the particular structure
- the use of an unsuitable product/system
- installation not meeting the requirements of either the manufacturer, supplier or the NZBC
- ceiling hangers 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 live loads of a ceiling
- insufficient seismic gaps to allow for movement of the building structure
- partitions being connected to the ceiling system instead of 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.

This Code of Practice covers suspended ceilings only as a NSE and highlights the need for effective co-ordination of the ceiling support and restraint systems with seismic restraints for the specialist building services installations whose requirements are governed by separate Standards.

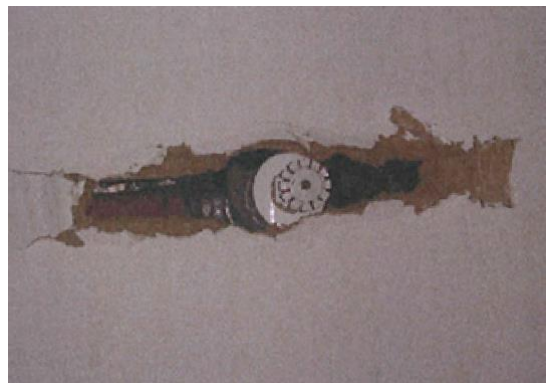
AWCINZ expects that the adoption of this Code of Practice – and the transition to fully compliant ceilings – will improve safety and reduce economic losses due to the failure of non-structural components.

- 1 Including NZS 1170.5:2004 *Structural design actions – Part 5: Earthquake actions – New Zealand*, AS/NZS 2785:2020 *Suspended ceilings – Design and installation*; NZS 4219:2009 *Seismic performance of engineering systems in buildings* and NZS 4541:2013 *Automatic fire sprinkler systems*.
- 2 Dhakal, R.P., MacRae, G.A. and Hogg, K. (2011). Performance of ceilings in the February 2011 Christchurch earthquake. *Bulletin of the New Zealand Society for Earthquake Engineering*, 44 (4): 379–389.
- 3 Submission to the Local Government and Environment Select Committee from the Insurance Council of New Zealand, 17 April 2014. <http://www.icnz.org.nz/wp-content/uploads/submission-buildings-earthquake-prone-buildings-amendment-bill-april2014.pdf>

EARTHQUAKE DAMAGE TO CEILINGS AND SERVICES



Damage caused by unrestrained services.



Damage from unrestrained fire protection system.



The result of an unbraced ceiling.



Plasterboard ceiling damage caused by interaction with structural circular columns.

2

Background

PAST INDUSTRY PRACTICE

In many cases, the design for seismic restraint of suspended ceilings has been an afterthought or not done at all. The scope of the seismic restraints and related engineering work required has also often not been known until the ceiling design has been completed. A typical approach has been as follows:

- Architects and engineers seldom provide all necessary technical information required to design the seismic restraints for a particular building at the time of tendering. Tenders are based on specifications and reflected ceiling plans. The suspended ceiling contractor works with the main contractor to agree aesthetic details such as edge trim, bulkheads, seismic breaks, trimming for light fittings and grilles and service tiles. Shop drawings are provided only where required to clarify details.
- Ceiling hangers are set out with hangers at the spacings required for the gravity support of the selected ceiling system. Often, they are cut or moved by other trades to allow building services to be installed, or services are installed without the clear spacing required under NZS 4219:2009.
- Product-specific seismic design and installation guides available from key industry manufacturers and suppliers offer a range of generic details, but they may not eliminate the need for the structural engineering design to achieve and demonstrate seismic compliance. A NSE Seismic Designer may inspect the work to decide where seismic restraints and braces can be fitted to achieve the required level of seismic design detail.

In addition, a market driven by the lowest tender price provides little incentive to properly address seismic restraints at budget and tender stage. A suspended ceiling contractor who allows for a seismically compliant

ceiling is unlikely to win against lower-priced competitors who 'tag out' seismic restraints, allow a nominal provisional sum or overlook the matter completely.

A persistent failure to address the matter as an early-stage design issue has resulted in non-conforming ceilings, avoidable rework, financial losses and disputes. Rectification of issues associated with ceilings that have inadequate seismic restraint costs ceiling contractors in terms of additional work required due to lack of co-ordination of non-structural components, disputes and potential litigation should the ceiling subsequently fail.

THE CHALLENGE FOR THE INDUSTRY

At the time of tender, a number of factors need to be known (for a comprehensive list, see Appendix G, page 84):

- Location of the building
- Building Importance Level
- Parts category (from NZS 1170.5:2004 section 8)
- Annual probability of exceedance (return period)
- A set of relevant working drawings
- Height of the ceiling seismic attachment from ground level
- Type of ceiling – grid & tile, sheeted, or specialty
- Seismic mass (including weights of linings, insulation and service load provisions)
- Wind load.

Regardless of past industry practice, it is not acceptable to treat seismic restraints and related structural engineering design, monitoring and certification as if they were optional. The industry must therefore revisit its practices in the procurement of buildings and in the methodology of all stages of design and construction to assure compliance with minimal added cost.

The industry needs to change the way it designs, procures, installs and certifies suspended ceilings and co-ordinates the seismic design details with other building elements.

The AWCINZ challenge to industry is to ensure that seismic design of suspended ceilings and building services is addressed in a co-ordinated manner, at the earliest possible stage of design, before tenders are called, which will reduce uncertainty, define the scope of work and allow tenderers to provide a firm price for the ceiling system. Leaving the seismic design details until later creates risk and uncertainty for all.

See Appendix G page 84 for a list of information normally required to enable a seismic design.

At time of tender, the information below may also be required:

- How the building structure has been designed to perform in an earthquake event.
- Type of ceiling – grid & tile, sheeted, or specialty
- How the ceiling supports and restraints may be co-ordinated with the structure.
- The space that will be available in the ceiling void for seismic restraints.
- How ceiling supports and restraints will be co-ordinated with the building services to be installed in the ceiling void for which detailed shop drawings have not yet been produced.
- The cost of engaging a qualified NSE Seismic Designer with specialist knowledge of suspended ceilings to design and certify the design of the seismic restraints for each area of ceiling.
- The type and extent of seismic restraints that will be required by the NSE Seismic Designer - ceilings, and consequently their cost.

- The cost of engaging the specialist NSE Seismic Designer to monitor installation work (if required), including the number of inspections required by the main contractor's construction program and to certify the completed installation.

This challenge cannot be met by the suspended ceilings industry alone. As there is no 'standard' building, there can be no 'standard' seismic restraints solution. Most buildings involve extensive specialist architectural, geological, structural and services engineering and require specific design input to address their site, location, form and function.

A cost-effective and compliant solution is possible with a co-ordinated approach to design and procurement.

Additional Challenges

Actual site conditions versus supplied information. On arrival at site and with a thorough review, conditions can differ to initial information supplied. This can include, (but not limited to):

- Dimensions of rooms
- Changes of angles of ceiling
- Wall position, or no walls
- Insufficient structure for fixing of hangers or braces
- Plenum services position interfering with hangers or braces
- Weight of services or insulation being supported by the ceiling
- Weight of substituted ceiling tiles or sheeted panel type
- Suspension systems steel gauge, finish and quality

These can have a crucial role in ensuring the structural integrity and seismic compliance of the suspended ceiling and can require a complete review of seismic calculations and subsequent design changes.

3

Seismic requirements

In order to make the process of achieving a compliant ceiling system understandable, it is important to understand the NZBC terminology and requirements.

Understanding the requirements allows designers to identify the extent to which a suspended ceiling is able to resist seismic forces and/or to remain intact in the event of an earthquake. It is conceivable that certain ceilings within a building will have a higher seismic requirement than other ceilings in that building.

Each step up in Importance Level reflects an incremental step in grid strength, the type and extent of seismic restraint, the requirement for specific engineering design where needed, and the involvement of independent NSE Seismic Designer /engineers.

There are a number of standards that are relevant to seismic restraints.

AS/NZS 2785:2020 *Suspended ceilings – Design and installation*

This standard sets out minimum requirements for the design, construction, installation, maintenance and testing of internal and external non-trafficable suspended ceiling systems of dry construction with suspension systems attached to a supporting structure, for use in commercial, and industrial applications. It includes earthquake design requirements for ultimate limit state (ULS) and serviceability limit state (SLS1 or SLS2) and when and where earthquake loads should be considered, by reference to NZS 1170.5:2004.

NZS 1170.5:2004 *Structural design actions – Part 5: Earthquake actions – New Zealand*

This standard provides procedures for the determination of earthquake actions on structures in New Zealand. It gives the requirements for verification procedures, site hazard determination, the evaluation of

structural characteristics, structural analysis for earthquake action effects, the determination and limits for deformations and the seismic design of parts of structures. It is to be applied in conjunction with AS/NZS 1170 parts 0, 1, 2 and 3 relevant material standards.

Technical Specification TS 1170.5 2024
At time of publication this was issued for industry comment. The engineering basis is different to NZS1170.5. It contains some important options including Ductility factors of 1.5 and 2.0 for suspended ceilings. Seismic design of suspended ceilings should use either NZS1170.5 OR TS1170.5 - do not use a mixture of both. Consult a seismic engineer for guidance.

NZS 4219:2009 *Seismic performance of engineering systems in buildings (services only)*

This standard sets out the criteria for the seismic performance of engineering systems related to a building's function. It covers the design, construction and installation of seismic restraints for these engineering systems. Buildings with importance level 5, large mass items, structures external to the building, lifts, building contents and fire sprinkler systems are excluded from this standard.

IDENTIFYING THE SEISMIC INFORMATION ELEMENTS FOR A CEILING DESIGN

The first step in establishing the seismic requirements of a ceiling (or ceilings) is to identify the geological, functional and engineering attributes, features or design factors that are relevant for the particular ceiling with regard to the requirements of the relevant New Zealand standards or project building other requirements.

See Appendix G page 84 for a list of information normally required to enable a seismic design.

The NSE Seismic Designer - ceilings will need to obtain or make conservative assumptions about the site subsoil category, building and ceiling risk category, building and ceiling ductility and period of vibration based on the information supplied.

BUILDING IMPORTANCE LEVEL

B1/VM1 (which references AS/NZS 1170.0:2002 Appendix 2) defines building importance levels as shown in Table 1 below. The building importance level (IL) shall be nominated on the design documentation.

Importance Level	Description of building type	Specific structure
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.	<ul style="list-style-type: none"> • Ancillary buildings not for human habitation • Minor storage facilities • Backcountry huts
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.	<ul style="list-style-type: none"> • All buildings and facilities except those listed in importance levels 1, 3, 4, and 5
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.	<ul style="list-style-type: none"> • Buildings where more than 300 people congregate in 1 area • Buildings with primary school, secondary school, or daycare facilities with a capacity greater than 250 • Buildings with tertiary or adult education facilities with a capacity greater than 500 • Health care facilities with a capacity of 50 or more residents but not having surgery or emergency treatment facilities • Jails and detention facilities • Any other building with a capacity of 5,000 or more people • Buildings for power generating facilities, water treatment for potable water, wastewater treatment facilities, and other public utilities facilities not included in importance level 4 • Buildings not included in importance level 4 or 5 containing sufficient quantities of highly toxic gas or explosive materials capable of causing acutely hazardous conditions that do not extend beyond property boundaries

Continued over page

From previous page

Table 1: Building importance levels.		
Importance Level	Description of building type	Specific structure
4	Buildings that are essential to post-disaster recovery or associated with hazardous facilities.	<ul style="list-style-type: none"> • Hospitals and other health care facilities having surgery or emergency treatment facilities • Fire, rescue, and police stations and emergency vehicle garages • Buildings intended to be used as emergency shelters • Buildings intended by the owner to contribute to emergency preparedness, or to be used for communication, and operation centres in an emergency, and other facilities required for emergency response • Power generating stations and other utilities required as emergency backup facilities for importance level 3 structures • Buildings housing highly toxic gas or explosive materials capable of causing acutely hazardous conditions that extend beyond property boundaries • Aviation control towers, air traffic control centres, and emergency aircraft hangars • Buildings having critical national defence functions • Water treatment facilities required to maintain water pressure for fire suppression • Ancillary buildings (including, but not limited to, communication towers, fuel storage tanks or other structures housing or supporting water or other fire suppression material or equipment) required for operation of importance level 4 structures during an emergency
5	Buildings whose failure poses catastrophic risk to a large area (e.g. 100 km ²) or a large number of people (e.g. 100,000).	<ul style="list-style-type: none"> • Major dams • Extremely hazardous facilities

Table 2: How Importance Level influences design requirements of ceiling systems	
Importance Level *	Recommended design actions
IL1	<ul style="list-style-type: none"> No SED or PS1 required. No PS4 required. Ceiling designer & PS3 acceptable.
IL 2	<ul style="list-style-type: none"> Typically, ceilings will not require SED or Producer Statements. However, this will be dependent on council or project requirements. Check requirements before Ceiling Designer proceeds.
IL 3	<ul style="list-style-type: none"> Most ceilings in IL3 projects will require SED and PSs. Some ceilings may be Ceiling Designer acceptable, depending on complexity.
IL 4	<ul style="list-style-type: none"> All ceilings in IL4 projects will require SED and PS, with few exceptions. Exceptions are likely to be specified in buildings or areas with lower importance level specifications.

*Refer Section 3, page 11 for IL full descriptions

Table 3: How Part category influences design requirements of ceiling systems	
Part Category *	Recommended design actions
P1/P2/P3/P4	Ceiling Designer of ceilings typically OK to confirm design specification. However, will normally require a PS1 in an IL3/4 building as well.
P5	SED required to determine what operational continuity limits are for the specific ceiling design. Unusual for ceilings outside of specialist rooms (eg. Hospital surgery rooms).
P6	SED recommended due to disproportionate risk. P6 ceilings should be specifically highlighted in design specification.
P7	No design required. Ceiling systems under 7.5kg total and under 3m height only.

*Refer Section 5, page 20 for Classification of Parts full descriptions

Additional information such as geotechnical reports or structural calculations for the building may allow for a more economical design, if these are available.

Seismic costs vs importance are set out in Figure 1.

Figure 1 demonstrates the incremental steps in the relative complexity and extent of engineering design and monitoring and consequentially the relative cost implications of the various Importance Level requirements.

COST CONSIDERATIONS

At the time of tendering, the actual requirements for each ceiling, having regard to its designated Importance Level and the requirements of the tender documents, should be checked.

While compliance with NZBC seismic requirements can add cost, it will also limit damage, reduce repair costs, reduce the length of time for re-occupancy after a seismic event and minimise health and safety risks for occupants.

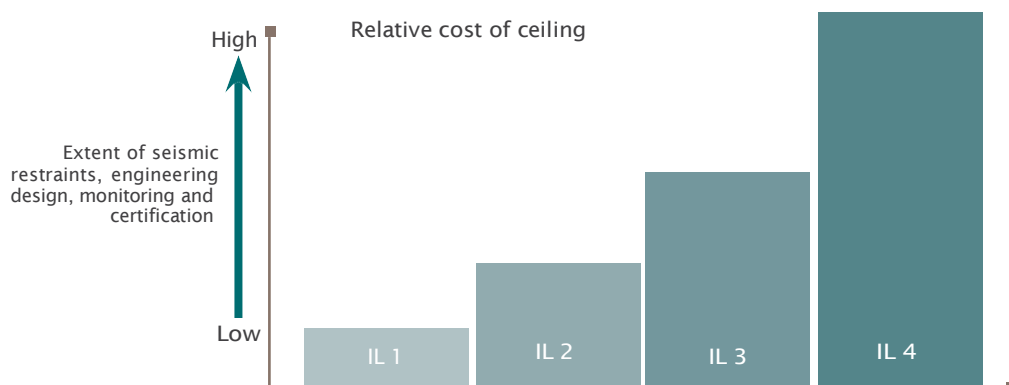


Figure 1: Change in relative cost of seismic requirements as complexity increases.

4

Design

THE DESIGN PROCESS

The opportunity to get the best design outcome is greatest early in the design process.

While the final product selection may not be known, the design parameters of all non-structural building elements should be outlined as early as possible so that all subcontractors are aware of the other trades.

The lead designer should be responsible for coordinating the design and installation of all subtrade equipment in the plenum and ceiling. The preferred approach, to ensure optimal coordination and productive use of resources, is for seismic design of non-structural components to be completed prior to the project going out to tender. Where a construction phase design process is used, the lead designer needs to specify the seismic restraint requirements in the tender documents.

Ideally, construction documents should be delivered with a generic seismic calculation or a PS1 for the suspended ceiling design. This would show that the ceiling has been designed to the minimum structural requirements.

DESIGN PRODUCER STATEMENT (PS1)

A PS1 is a statement of opinion that certain aspects of proposed building work will comply with the NZBC if the work is constructed according to the referenced documentation (for example, engineering design drawings and specifications).

The seismic design of suspended ceilings should be undertaken by a suitably qualified person* with experience in ceiling design. If a generic seismic design guide is used, the working sheets should be submitted with the ceiling design.

*This can be an engineer or a trained NSE Seismic Designer - ceilings/contractor.

CONSTRUCTION PRODUCER STATEMENT (PS3)

A PS3 is certification from the suspended ceiling contractor that the ceiling has been installed in accordance with the relevant design, New Zealand standards and/or building consent as applicable.

Lead designers, BCAs, owners and insurers should be aware of the limitations of manufacturers' generic guidelines and assumptions made, for example, the structure(s) that the bracing points a ceiling is fixed to must be adequate to take the load.

It is important to note that, for retrofit/refurbishment, the lead designer needs to provide sufficient information on the structural detail, including loading capacity, of the building.

While, in some cases, actual product systems are specified by the designer, they can also be specified on a performance basis, leaving the tenderer free to offer whichever system they feel is able to meet the requirements. Further, the design of non-structural building elements often occurs after the building consent has been granted.

The seismic bracing system for these non-structural building elements is thus typically the responsibility of the contractor and their subcontractors.

Figure 2 shows a recommended project process from design to completed installation of a suspended ceiling system. Some steps may not be relevant for all projects. Large projects, or individual Consent Authorities may require different processes.

See Section 17, p69 for detail on producer statements.

ROLES AND RESPONSIBILITIES OF THE PARTIES INVOLVED IN THE DESIGN

In most construction projects, there are many parties involved. All have different roles and

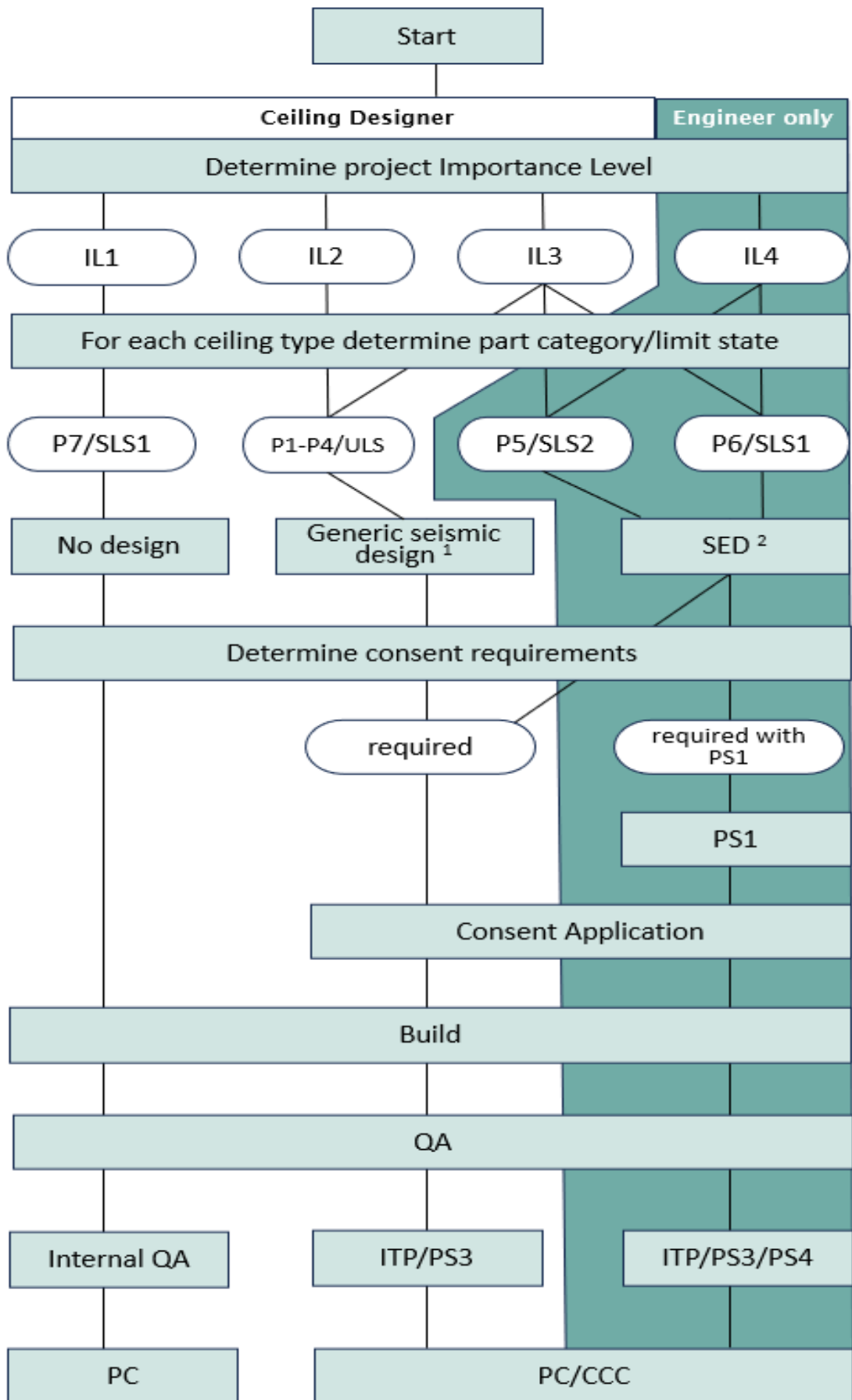


Figure 2: AWC recommended project process for NSE suspended ceilings.

¹ Refer Section 8 for detail

² Refer Section 9 for detail

Key:

ITP – Inspection & Test Plan

PC – Practical Completion

CCC – Code Compliance Certificate

responsibilities, and in many steps of the process, the roles and responsibilities of several parties will overlap.

Table 3 shows, in general, the main steps in construction projects, the main parties involved and the stages where input from each party may be required. Table 4 defines the key roles involved. For large, multi-discipline role projects, refer also the BIP CoP.

DESIGN CO-ORDINATION

Many view a suspended ceiling as a finished surface only and are unaware of the potential complexity of the design in the plenum. Consequently, they may not be aware of the possible true cost of a suspended ceiling system that has been designed to withstand earthquake actions.

Designers of other components in the plenum may have little regard to requirements of the ceiling support system.

The ceiling tenderer needs to establish what degree of co-ordination has taken place between the other suppliers of building components in the plenum in terms of their design, engineering calculations and installation processes.

Design co-ordination is possibly the single biggest issue facing suspended ceiling work. In general, the better co-ordination prior to issuing tender documents:

- the more accurate a costing can be achieved
- the better the installation process will be
- there will be fewer site variations
- there will be an overall lower total cost
- there will be fewer time delays during installation
- there will be fewer site conflicts.

OTHER TRADES IN THE PLENUM

Seismic restraint of non-structural building components other than ceilings

It is an NZBC requirement that non-structural building components must be properly restrained against earthquake actions to prevent them collapsing on people, cutting off exit routes from the building, being damaged or damaging other property.

The seismic design and compliance of building components in the plenum space are the responsibility of their respective designers, with the most common way of meeting the NZBC requirements being the use of Verification Method B1/VM1.

B1/VM1 cites New Zealand standard NZS 4219:2009, which contains prescriptive and specific engineering design options for restraining engineering systems, including items interrelated with suspended ceilings.

There are a wide range of non-structural building components that can be located in the plenum or below, including but not limited to:

- sprinkler systems
- air-conditioning ducts
- cabling ducts
- lighting systems, including their support
- ceiling-height partition walls
- bracing for ceiling-height partition walls
- full-height partition walls
- mechanical installations for access
- telecommunications cabling
- office equipment suspended from the ceiling system, for example, overhead projectors, security cameras, ceiling fans, alarm systems, air-conditioner cassettes, drop-down projector screens, signage, speakers and fire alarm systems.

Who does the design for other building components?

The layout of building components in the plenum needs to be coordinated so that any one component does not impede or interfere with another, for example:

- the need to allow 25 mm free movement around sprinkler droppers can be eliminated by using flexible hose droppers.
- careful consideration is required to ensure that elements such as light fittings and diffusers supported by the ceiling are independently supported unless under allowable weight limits – refer to relevant standards.

Co-ordination of design

Ideally, the lead designer should be responsible for co-ordinating non-structural building components in the plenum so that there are no conflicts.

Checklist to complete before tender shall include:

- bracing layout (including any minor repositioning tolerances due to other services)
- edge details
- services
- proof of co-ordination and location of services
- suspended ceiling plan overlaid with services and plenum
- suspension points identified that are clear of services
- unrestrained/restrained services
- maximum lateral displacement.

Table 4: Main steps and parties that may be involved.						
	Design	Compliance design	Tendering	Contract	Installation	Completion
Client	✓			✓		✓
Project manager	✓		✓	✓	✓	✓
Lead designer	✓	✓	✓		✓	✓
Ceiling Designer	✓	✓	✓		✓	✓
Engineer	✓	✓			✓	✓
Main contractor	✓	✓	✓	✓	✓	✓
Suspended ceiling contractor	✓	✓	✓	✓	✓	✓
Other trades	✓	✓	✓	✓	✓	✓
Supplier / manufacturer	✓	✓			✓	✓
Building consent authority		✓			✓	✓

For large, multi-discipline role projects, refer also the BIP CoP.

Table 5: Definitions.	
Client	The entity parties are contracted to.
Project manager	A person or company who will have an overview of the whole project, which may include co-ordination of the design team.
Lead designer	May be an architect, interior designer or engineer. The lead designer oversees the entire documentation process. Historically, this has been an architect, but more recently and depending on the nature of the project, other suitably qualified people have been taking on this role.
Ceiling designer	A person or company experienced with suspended ceiling systems and design guides and able to carry out or commission generic seismic restraint ceiling designs.
Engineer	A suitably qualified NSE Seismic Designer with experience in structural design of suspended ceilings.
Main contractor	The company that has contracted to build the entire project and is responsible for overseeing and co-ordinating all on-site trades and the construction programme.
Suspended ceiling contractor	The company that will be carrying out the installation and, in some circumstances, provide a seismic design if qualified to do so. Can be a NSE Seismic Designer - ceilings
Other trades	Other trades that may have non-structural building components being installed in the plenum such as air-conditioning ducts, fire protection systems or lighting fixtures.
Supplier/ manufacturer	The company supplying the building product for installation. Can also be a suitably qualified NSE Seismic Designer – ceilings and provide engineering services.
Building consent authority	Where required, the organisation that will grant a building consent, carry out inspections as necessary and, at completion, issue a Code Compliance Certificate.

Ceilings Exempt from Building Consents

Building Performance 1.2 Interior alterations to existing non-residential buildings.

Building work in connection with the interior of any existing non-residential building (for example, a shop, office, library, factory, warehouse, church, or school) if the building work:

(a). does not modify or affect the primary structure of the building; and

(b). does not modify or affect any specified system; and
(c). does not relate to a wall that is:
(i). a fire separation wall (also known as a firewall);

Issuing of a PS3 may or may not be a requirement.

See also:

Building Performance 1.1 General repair, maintenance and replacement.

<https://www.building.govt.nz/projects-and-consents>

5

Design documentation

The design and construction of a successful building requires the successful integration of a range of inputs, with one key factor being that the construction documentation must be well coordinated. Design documents provide the critical link between all parties in a building project so that everyone knows what is being built, where it is being put, when it will be done and how it is done. The better the documentation, the better the outcome will be.

With respect to suspended ceilings and all components and services in the plenum, design documentation should:

- clearly define design parameters and responsibilities from the outset and communicate these to all parties involved in the project.
- enable everyone to identify anything that may impact on their part of the project.
- give consistent information and specify critical datum point measurements – for suspended ceilings, the set-out point and design criteria may be critical.
- show where other components in the plenum will be located and their fixing points – 3D schematics would help to show any issues that may arise at the points of intersection
- specify the co-ordination of the installation sequencing.
- have evidence from the project structural engineer confirming the walls, bulkheads, roofing or other primary/secondary* structure will take the ceiling and bracing loads for both new and existing buildings.

The use of technology such as building information modelling (BIM) should also be considered.

COMPLIANCE WITH NZBC AND STANDARDS

NZBC clause B1 *Structure* requires that all building elements must have a low probability of failure when exposed to loads likely to be experienced

within their lifetime. Compliance with the NZBC can be achieved through Acceptable Solutions, Verification Methods or using Alternative Solutions. There are no published Acceptable Solutions for suspended ceilings, and therefore Verification Methods are almost always used.

Verification Method B1/VM1 provides a means for the design of structures to meet the performance requirements of NZBC clause B1 *Structure*. Within B1/VM1, there are numerous standards referenced that relate to suspended ceilings and engineering systems likely to be encountered in any building.

For engineering systems and non-structural building components, the most common Verification Methods for earthquake restraint are:

- NZS 4219:2009 *Seismic performance of engineering systems in buildings*
- NZS 1170.5:2004 *Structural design actions – Part 5: Earthquake actions – New Zealand* and the relevant product standard, for example,
- AS/NZS 2785:2020 *Suspended ceilings – Design and installation* or NZS 4541:2013 *Automatic fire sprinkler systems*
- AS/NZS 4600:2005 *Cold-formed steel structures*.

The Verification Method includes New Zealand-specific modifications to the referenced standards, which will need to be complied with as part of the design process.

Refer Appendix H, page 85 for Compliance Pathway.

*Primary structure: The core structural systems that support a building. Removing primary structure elements would result in global failure of the building. An example would be the main vertical columns holding the floor slab up.

Secondary structure: Structural elements that support other elements, but are not integral to the primary structure. Removing a secondary structure would result in failure of the elements attached to it only. An example would be a truss supporting mechanical services.

SEISMIC DESIGN

In addition to gravity forces, earthquake forces acting in vertical or horizontal directions must be considered for suspended ceilings in New Zealand to comply with AS/NZS 2785:2020 and NZS 1170.5:2004.

Seismic forces

Seismic forces are the actions developed during an earthquake and are determined in accordance with NZS 1170.5:2004 and applied in the limit state design of both structures and parts. Within the scope of NZS 1170.5:2004, ceilings are specified under 'parts'.

Limit state design

B1/VM1 provides a procedure and criteria to determine both ultimate limit state (ULS) and serviceability limit state (SLS) seismic actions. Most manufacturers provide a simplified conservative method of calculating the seismic forces, in accordance with the standards requirements.

ULS - The ultimate limit state is reached when the applied stresses actually exceed the strength of the structure or structural elements, causing it to fail or collapse. To be used if Parts Category P1, P2/3 and P4 are required.

SLS1 - The serviceability limit state is the point where a structure can no longer be used for its intended purpose but would still be structurally sound. SLS1 may be used for P7.

SLS2 - Is for parts or elements that are required for operational continuity of critical, post earthquake structures (typically IL4

structures). For example, a suspended ceiling in a surgery may be classified as SLS2.

Note: the same ceiling may fall under multiple Limit State categories, e.g. a ceiling may be required to meet both ULS and SLS2

The reliance on manufacturers' data will require intimate knowledge of the limitations in the data by the ceiling designer. In some instances, the generic data provided by the manufacturer can be used for ceiling systems depending on the size and complexity of the project. However, it should be noted that a Chartered Professional Engineer, registered in New Zealand (CPEng), will still need to be engaged for PS1 ceiling designs. Some manufacturer/suppliers can facilitate both functions.

PRODUCER STATEMENTS

A producer statement is a document prepared by a specialist confirming their professional opinion, based on stated reasonable grounds, that aspects of design of a building achieve compliance with the NZBC or that elements of construction have been completed in accordance with the approved building consent. The intent of a producer statement is evidence to the building consent authority that the design, installation (and monitoring work if required) complies.

Details on Producer Statement types and when they are required are referenced in Section 4, Figure 2 and Section 17.

Limit State	Definition	Description
SLS1	Service Limit State 1	A ceiling should be designed to experience no damage for earthquakes up to the Service Limit State earthquake. The only exception to this is minor cracking in plasterboard square stopped corners.
SLS2	Service Limit State 2	SLS2 is a special limit state for P5 part category ceilings. A ceiling designed to P5/SLS2 should remain operational after a Service Level State 2 earthquake.
ULS	Ultimate Limit State	A ceiling should be designed to not fail up to an Ultimate Limit State earthquake. That is, some damage should be expected, but the ceiling should remain intact to allow evacuation of the building.

CLASSIFICATION OF PARTS

The classification of building parts (Table 7) is a key step in the determination of the seismic actions, in accordance with NZS 1170.5:2004 section 8.

The majority of suspended ceilings will be categorised as P1, P2 or P3, as the ceiling system as a whole is likely to weigh more than 7.5 kg. Ceilings above main corridors and evacuation routes are likely to be P4, however as P1, P2, P3 and P4 all share the same structure limit state, ULS, it is recommended to design all ceilings to ULS limits.

The only exception is ceilings under 7.5 kg and lower than three metres, which can be designed as P7. For example, an average tile ceiling system weight is 4 kg/sqm, representing a ceiling area of only 1.875 sqm. P7 or SLS1 design is effectively limited to very small or very light ceilings.

P5 and P6 ceilings require Specific Engineering Design, as the failure modes or consequences are outside of the normal expectations. These ceiling types should be identified specifically on construction documentation, during contract due diligence care should be taken to identify any P5 or P6 ceiling specifications, or contract exclusions considered.

Ceiling tiles weighing more than 7.5kg or are higher than 3.0m above floor and cannot experience a loss of gravity ie restrained within a grid system, do not require individual tethering and therefore can use limit state SLS1, or ULS when the ceiling grid that supports the tiles is seismically designed.

Table 7: Classification of building parts.			
Building component	Criteria		Structure limit state
P1	Ceiling representing a hazard to life outside the structure	Ceilings weighing more than 7.5 kg or able to fall more than 3 metres	ULS
P2 and P3	Ceiling representing a hazard to human life inside the structure	Ceilings weighing more than 7.5 kg or able to fall more than 3 metres	ULS
P4	Ceiling necessary for the continuing function of the evacuation and life safety systems within the structure		ULS
P5	Ceiling required for the operational continuity of the structure	Only ceilings essential to the operational continuity of structures with importance level 4 will be classified as P5 – non-essential ceilings and ceilings within structures of other importance levels will be otherwise classified	SLS2
P6	Ceiling for which the consequential damage caused by its failure is disproportionately great		SLS1
P7	All other ceilings		SLS1

6

Ceiling types and components

This section looks at ceiling fixing methods, ceiling systems, bulkheads and ceiling components.

CEILING FIXING METHODS

There are two main ceiling fixing methods:

- Directly hung ceilings have main runners or tees directly suspended from the building structure.
- Indirectly hung ceilings are less common and have intermediate carrying channels directly suspended from the building structure.

CEILING SYSTEMS

Ceiling suspension systems come in a variety of forms, but the main common varieties are:

- grid and tile
- framework for plasterboard or other sheeted products
- specialty feature ceilings.

Two-way exposed

Main tee and cross tees exposed with lay-in acoustical panels. They are available as 24 mm, 15 mm or 38mm wide visible faces.

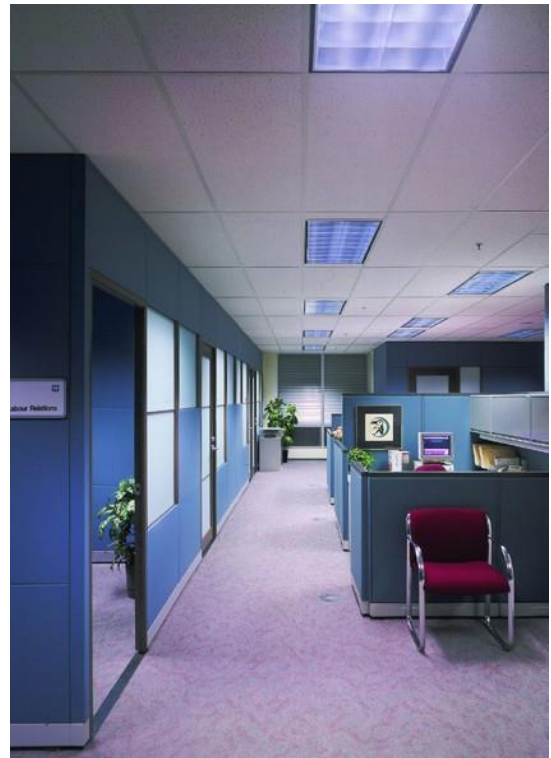


Figure 3: Exposed grid and tile system in place.

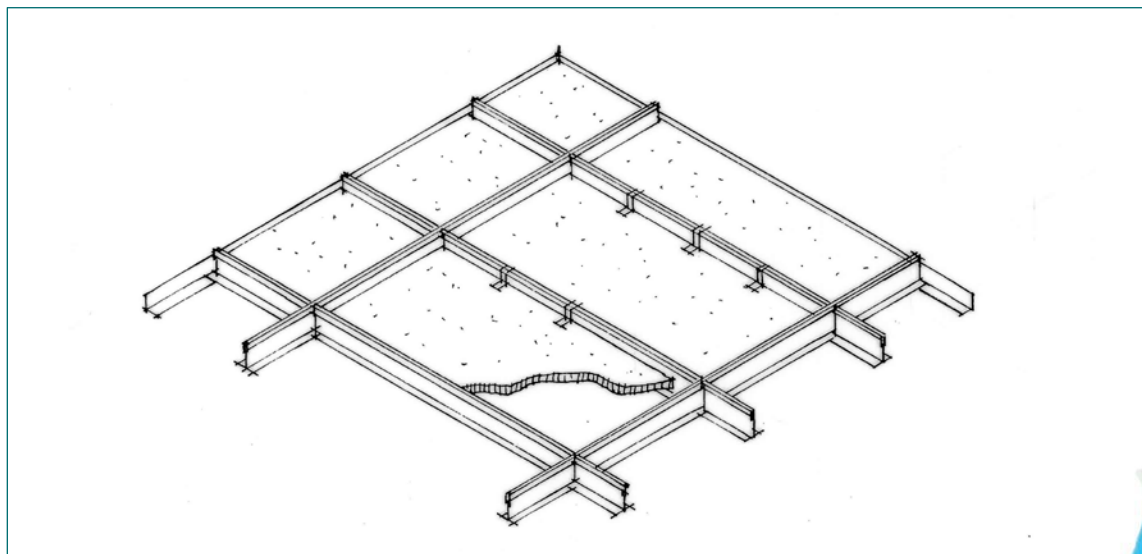


Figure 4: Schematic diagram of two-way grid.

One-way exposed

Main tee exposed, cross tees concealed by fully kerfed acoustical panel with splines.

NOTE: One-way systems are seldom used, not covered in manufacturer's generic design guides and would be subject to SED.

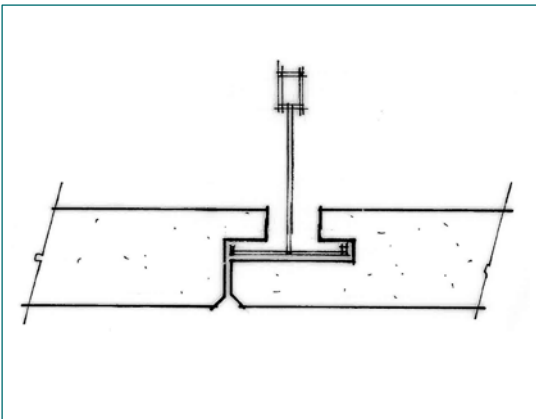


Figure 5: Concealed edge.

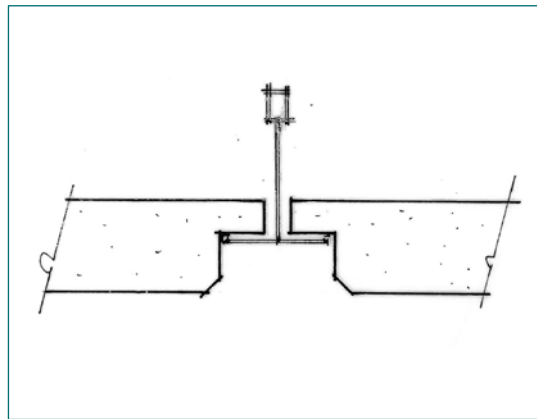


Figure 6: Tee grid visible in only one direction.

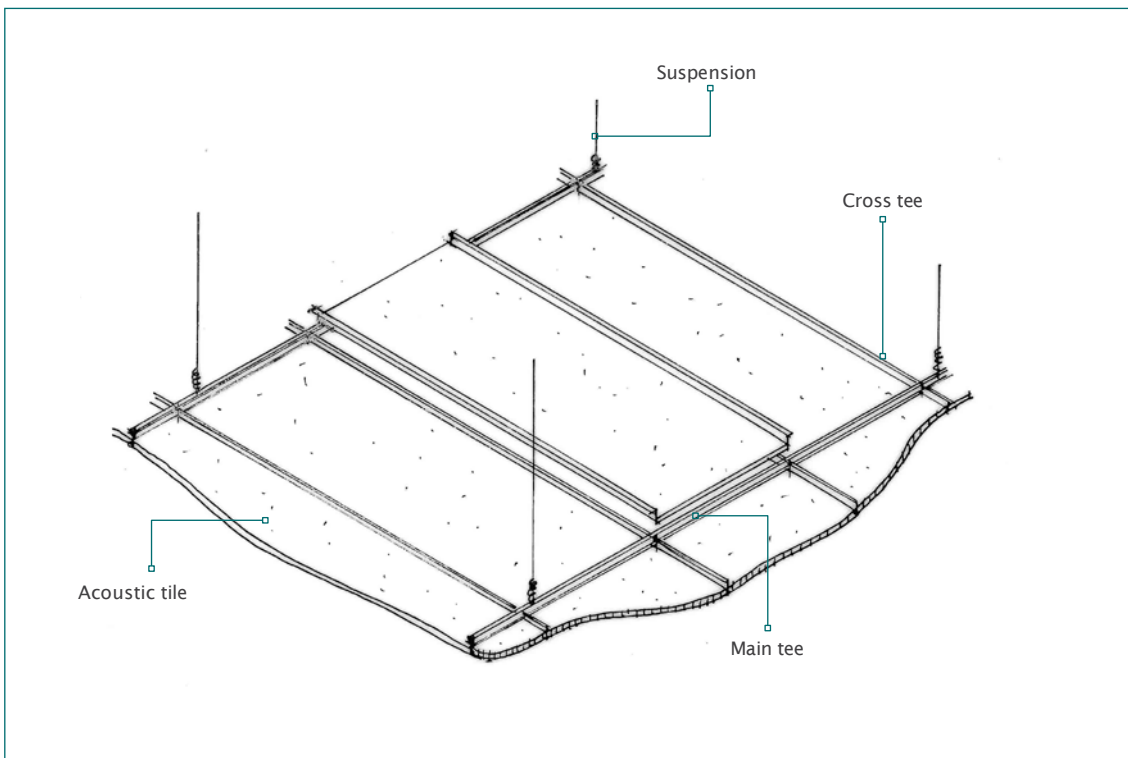


Figure 7: Schematic diagram of one-way exposed grid.

Fully concealed (or two way concealed)

For fully concealed grid systems, the main tee, cross tees and splines are concealed by fully kerfed acoustical tiles.

NOTE: Fully concealed systems are seldom used, not covered in manufacturer's generic design guides and would be subject to SED.

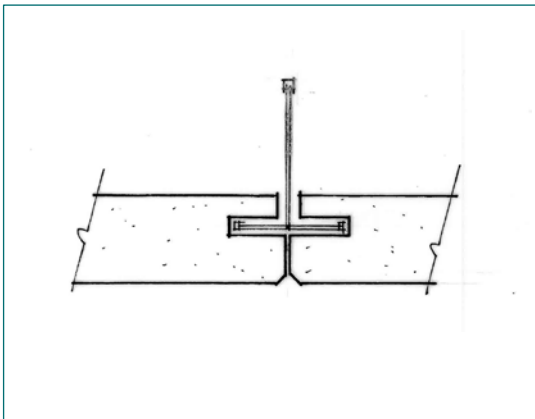


Figure 8: Back-to-back L splines.

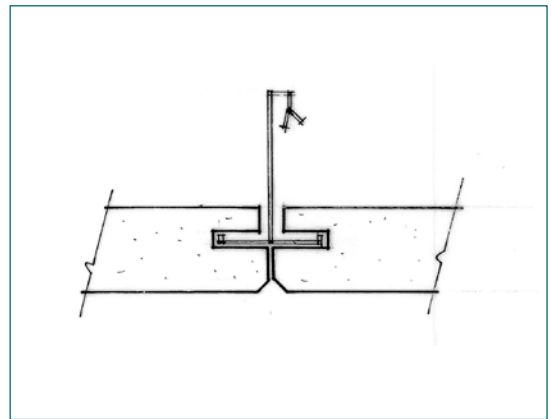


Figure 9: C and Z splines.

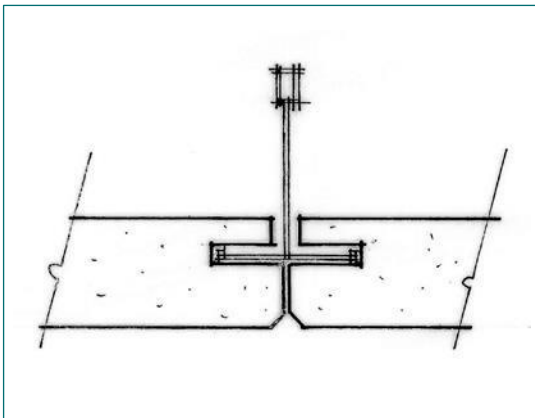


Figure 10: Tee grid.

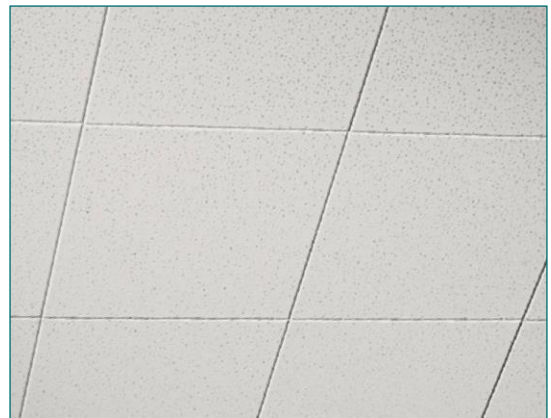


Figure 11: Concealed grid.

Plasterboard or other sheet-lined suspension systems

Steel framing systems expressly designed for attaching sheet linings such as plasterboard, fibrous plaster, fibre cement, plywood and MDF.

NOTE: for compliance with NZS4219 clearances between plenum services, (ref, Table 8, page 54), clearances shall be from the top of the suspension framing, not the back of the plasterboard/sheet lining.

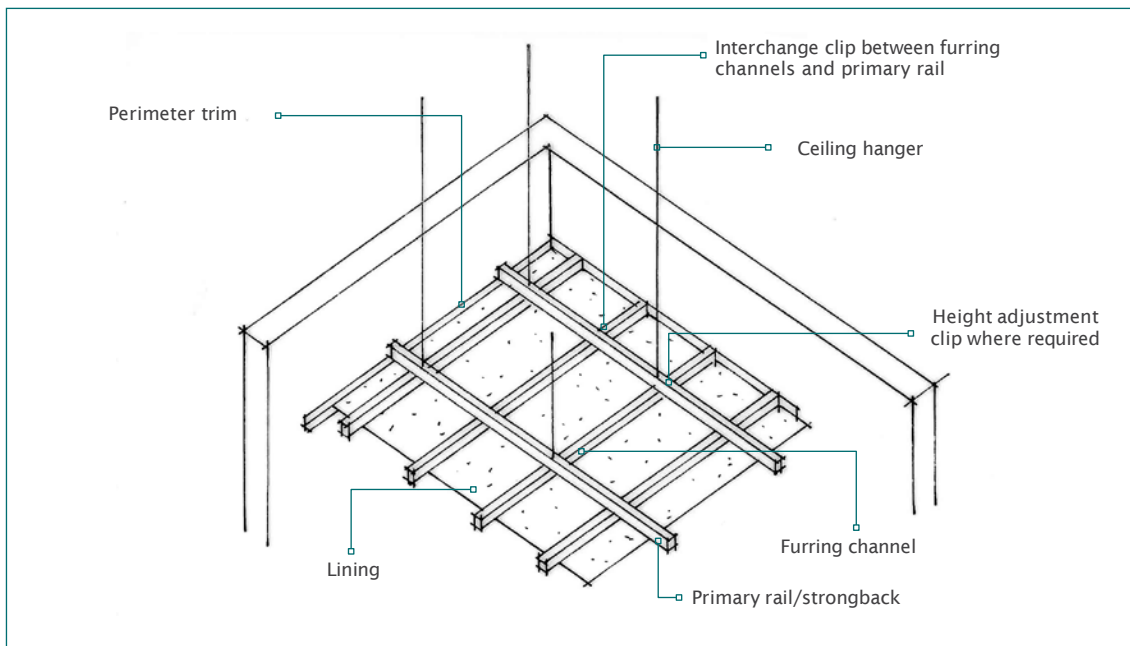


Figure 12: Suspended sheeted or flush ceiling grid system.

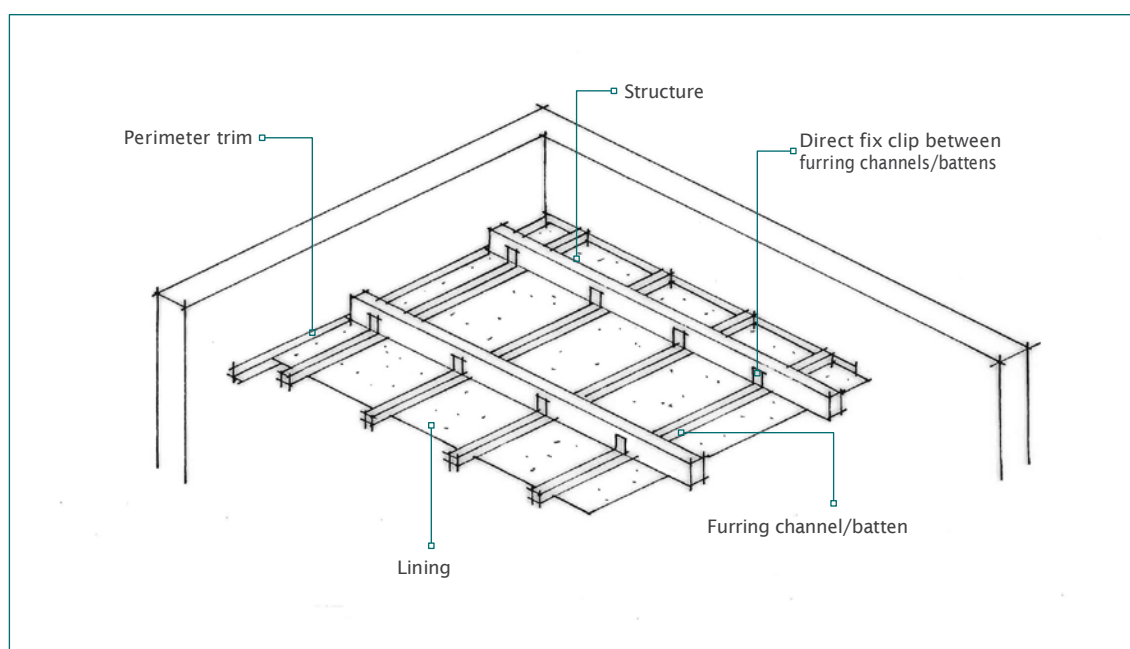


Figure 13: Direct fix sheeted or flush ceiling system.

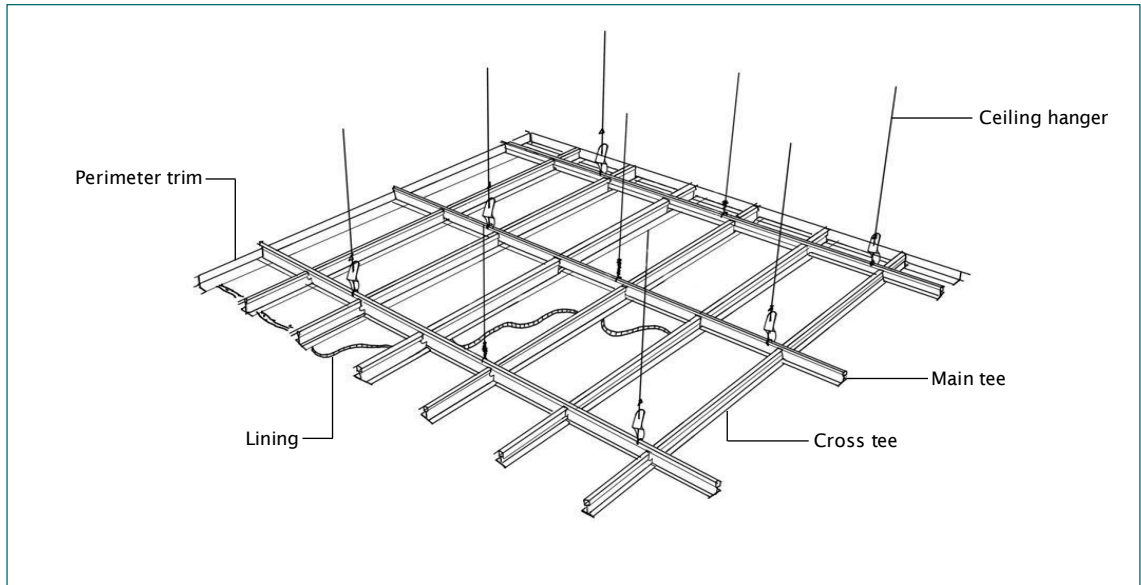


Figure 14: Suspended T-grid for sheeted or flush ceiling

Specialty or feature ceilings

These allow the designer to create custom design far beyond the usual limits of standard

ceilings. Specialty ceilings give the ability for unique innovative installations.



Figure 15: Finished feature ceilings. NOTE: Due to their uniqueness, feature ceilings are likely to require SED.

Linear and metal

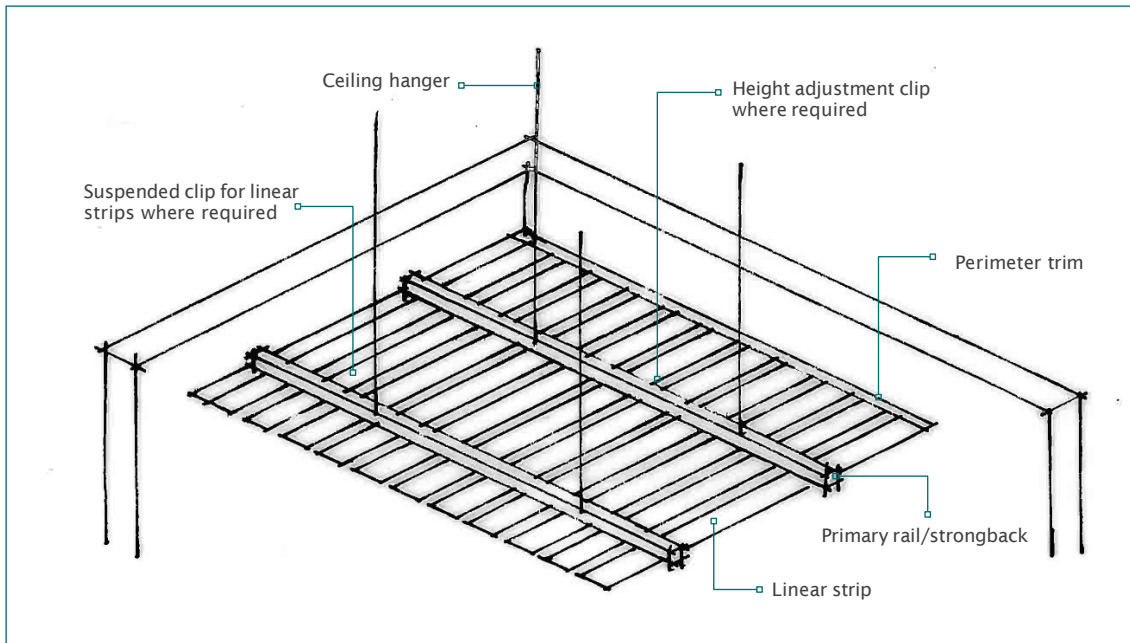


Figure 16: Suspended linear or strip ceiling system.



Figure 17: Proprietary linear ceiling system.

Curved ceilings

May be curved in one, two or three dimensions.
Panels may be formed or flat and flexible to conform to the curve of the ceiling.

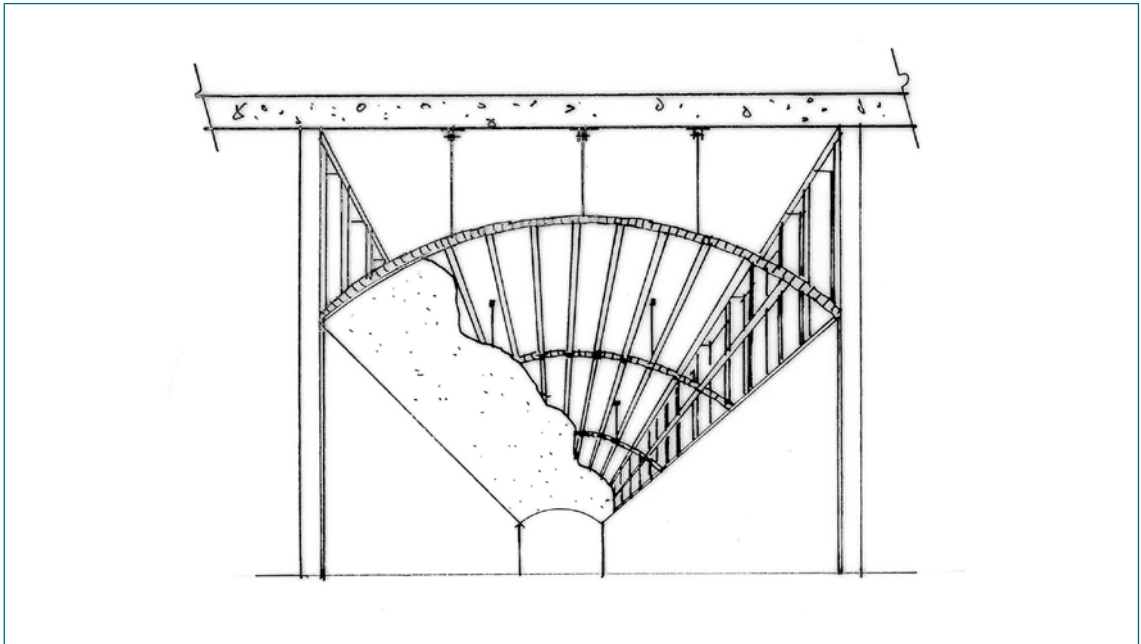
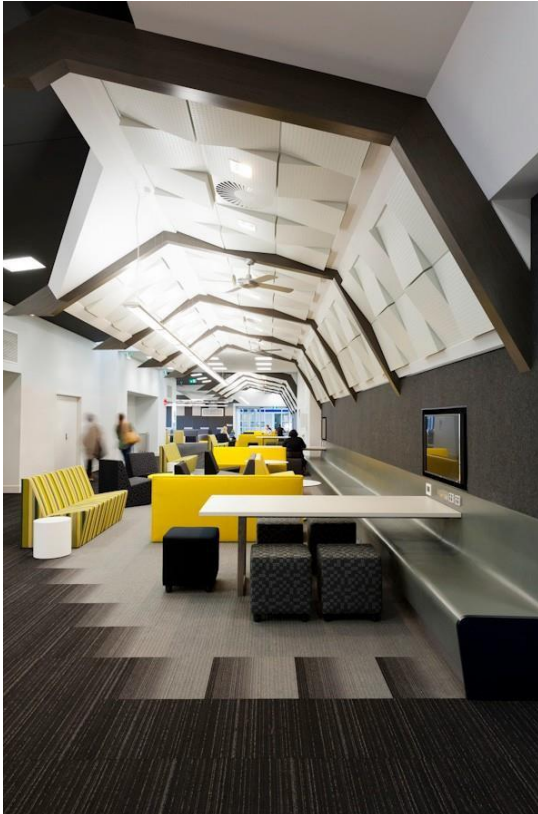


Figure 18: Curved ceiling schematic.

Floating cloud



Ceilings below other ceilings



Figure 20: Feature ceiling below another ceiling.



Figure 19: Floating cloud ceilings.

Diaphragm Ceilings

Diaphragm ceilings are not covered by this document or AS/NZS 2785:2020 as they are typically residential and become a structural element to SED.

Wind loads

Wind loads should be considered with all ceilings.

Wind loads can be affected by the terrain the building is situated on, and its proximity to other terrain elements, including buildings and other natural objects.

The NZBC has four specific Terrain Categories.

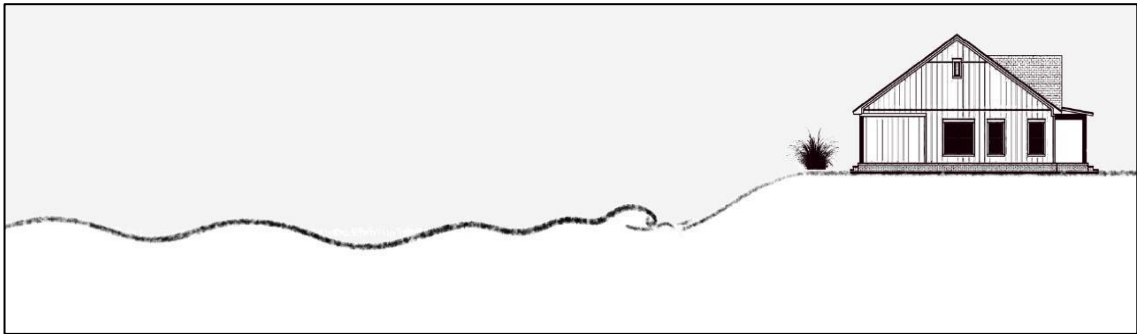


Figure 21: Terrain Category 1

Terrain Category 1 is an open area, undulating ground and has no close buildings or other objects. This means it is the most exposed to wind conditions.

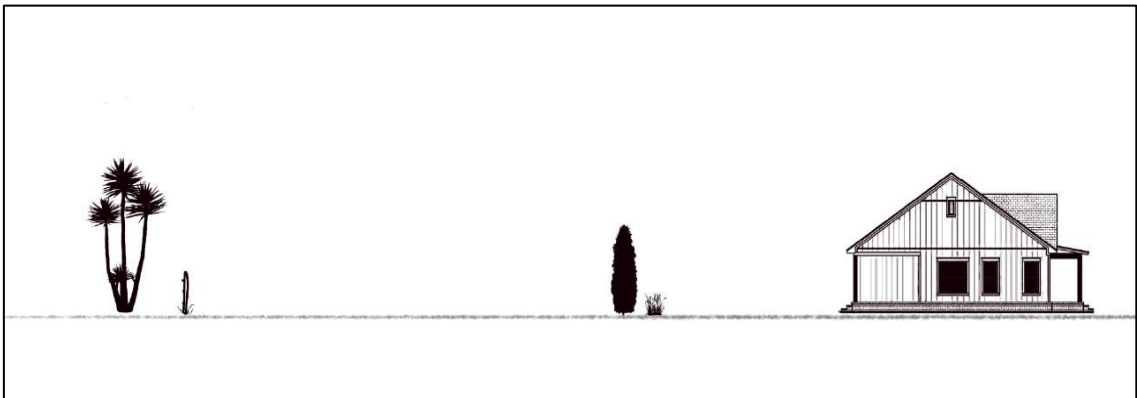


Figure 22: Terrain Category 2

Terrain Category 2 is an open area, flat ground and has no close buildings, but may have other objects nearby. This means it is still exposed but may have broken or irregular wind conditions.



Figure 23: Terrain Category 3

Terrain Category 3 is a non-open area, flat ground and has buildings or objects nearby. This means it is less exposed but will have broken or irregular wind conditions.



Figure 24 Terrain Category 4

Terrain Category 4 is a non-open area, flat ground and has buildings or objects in close proximity. This means it is less exposed and can have irregular wind conditions on different parts of the building.

Wind loads

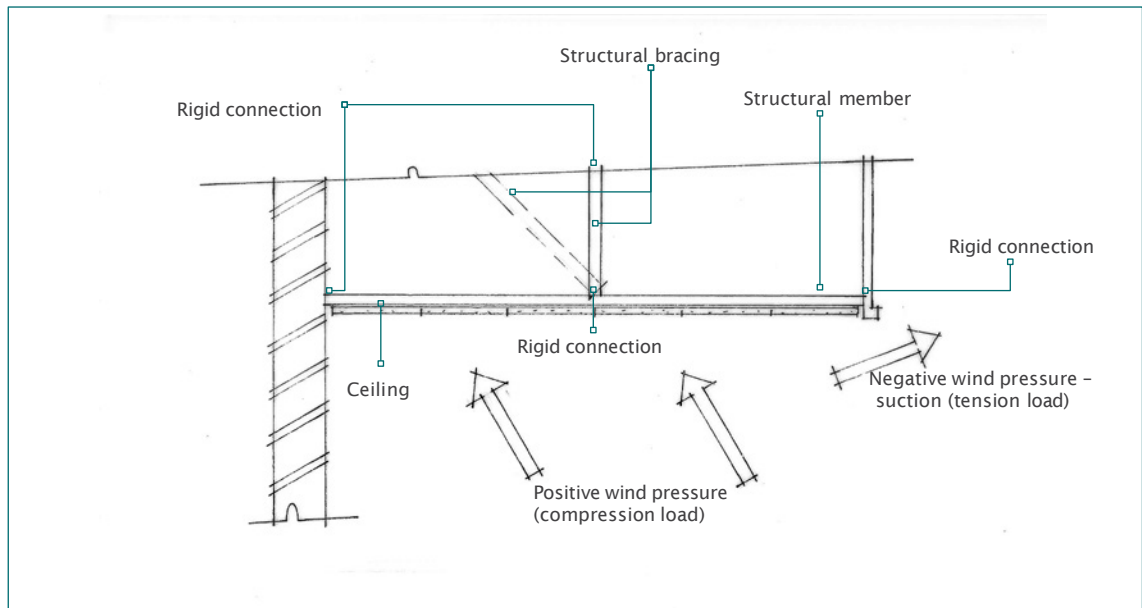


Figure 25: Wind loads.

External air pressures

Ceilings subject to exterior wind pressures will require rigid struts to resist both positive and negative air pressures. See Figure 25 above. Air grilles may also be fitted as with internal ceilings if acceptable for the environmental conditions entering the plenum area. Exclusion of insect/birds etc must also be a consideration.

Internal air pressures

Grid and tile ceilings subject to wind uplift should be clipped to resist lifting or tile "flutter". Additionally, air grilles can be fitted in the area to balance air pressure differentials on both sides of the ceiling. If required, "breathable" cloth may be installed over the grilles to maintain air quality. Sheeted ceilings may require vertical struts to resist upward pressure. Air grilles can also be fitted as with grid and tile ceilings.

BULKHEADS

Bulkheads are typically used to create boxed-in areas to conceal structural elements/services or to separate ceilings of differing heights.

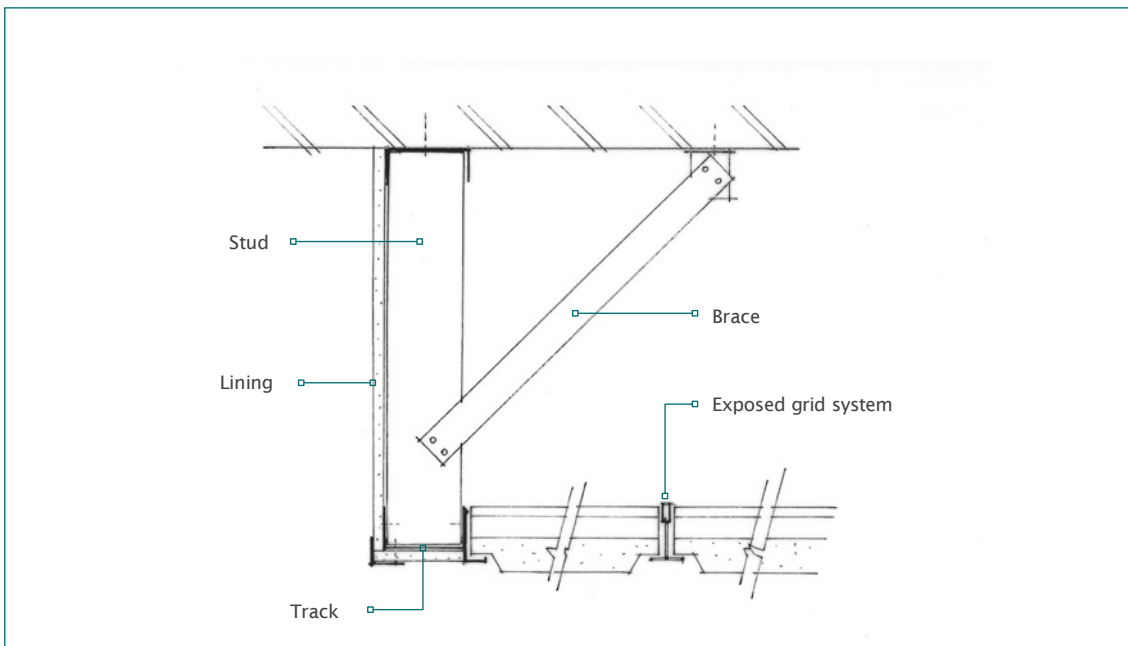


Figure 26: Bulkhead off solid underfloor.

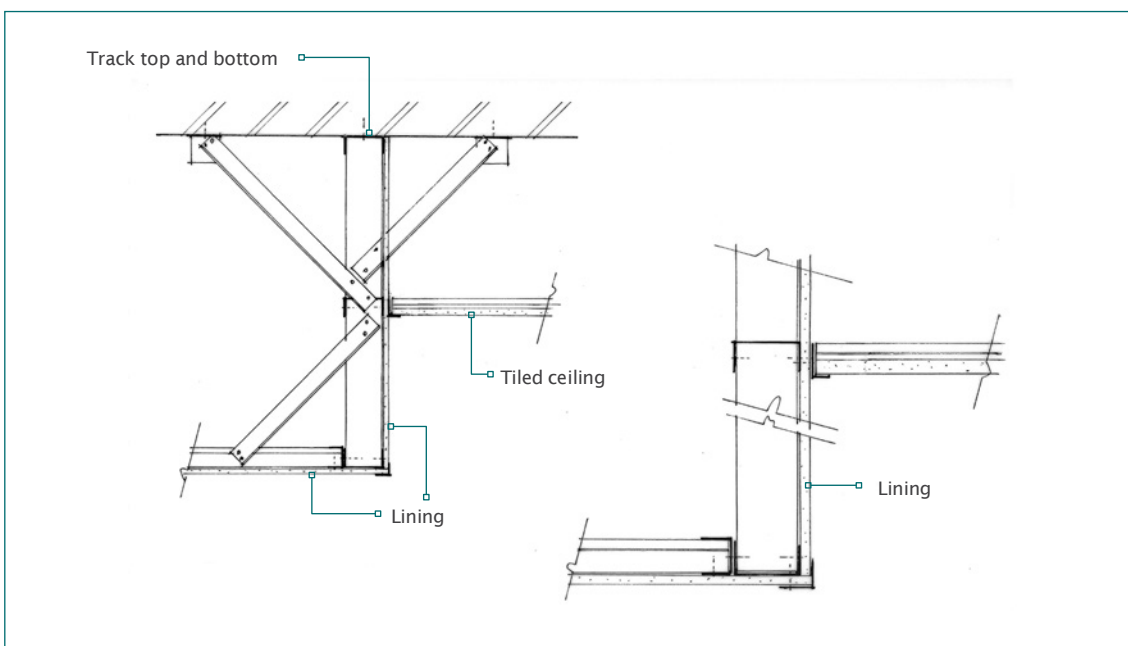


Figure 27: Bulkhead off solid underfloor with two ceilings at different heights.

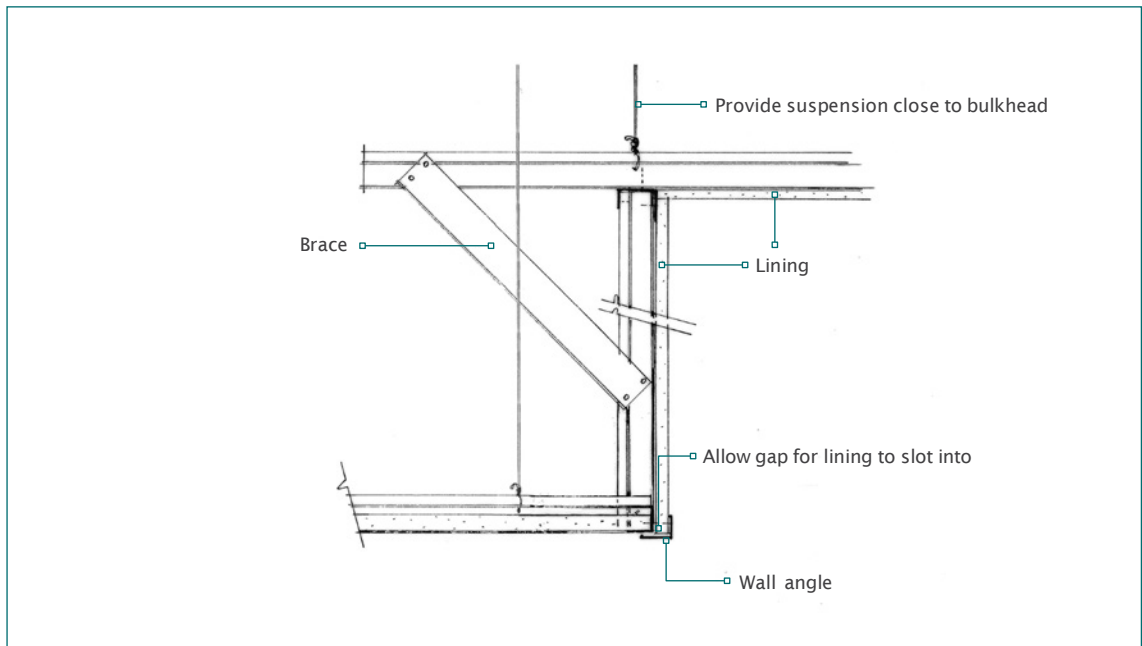


Figure 28: Suspended ceiling and bulkhead, cantilevered top ceiling support.

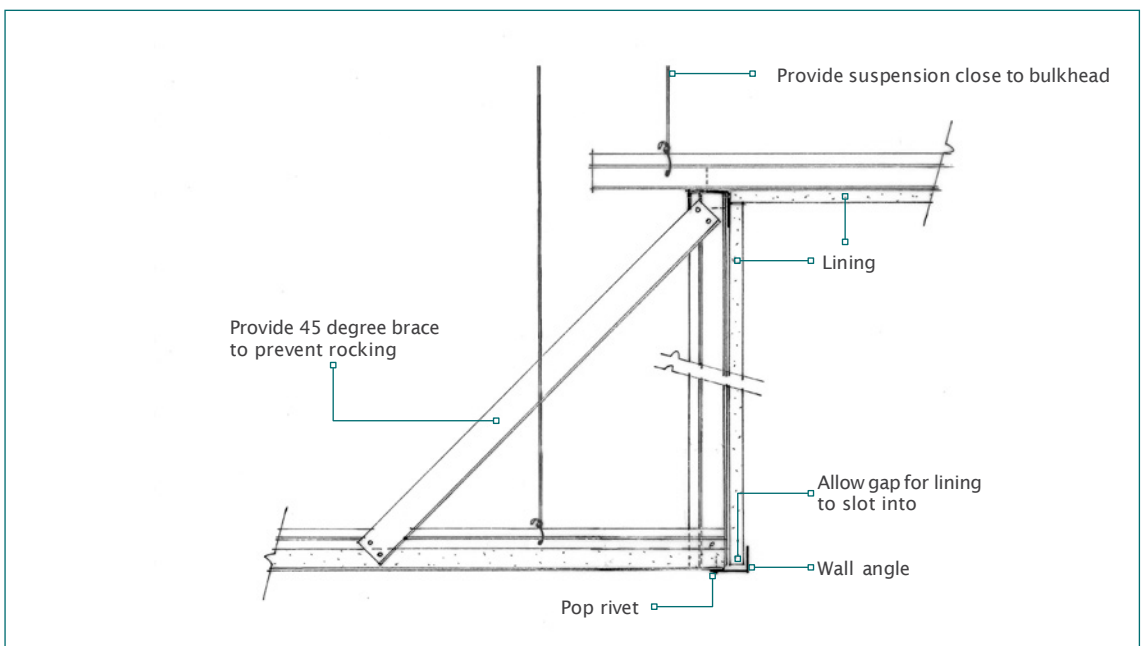


Figure 29: Suspended ceiling and bulkhead.

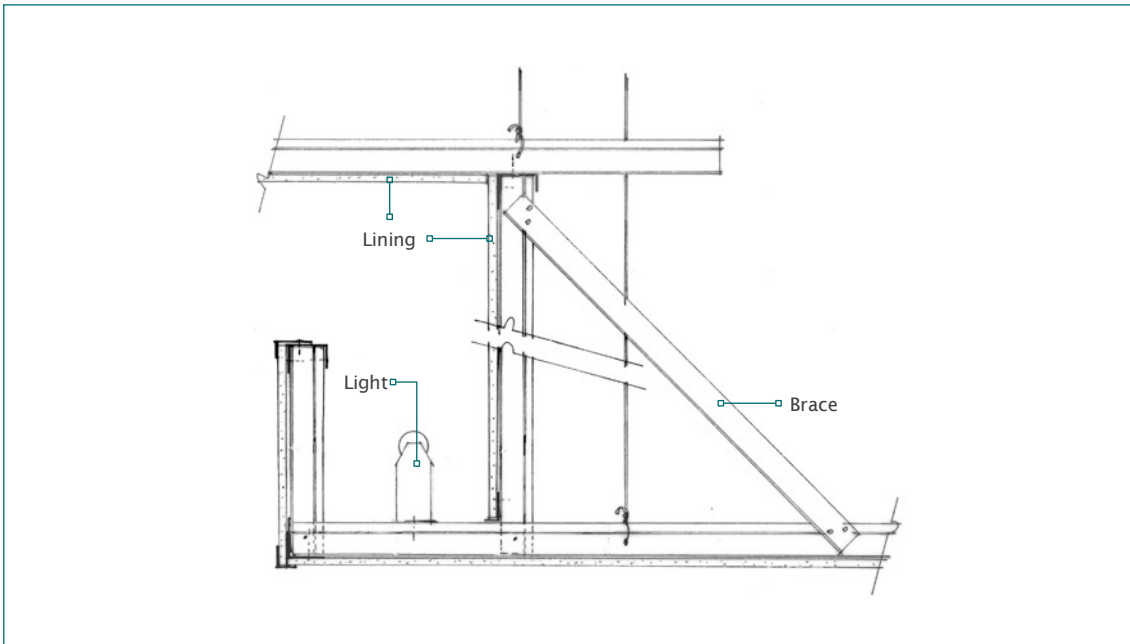


Figure 30: Suspended ceiling and light trough bulkhead.

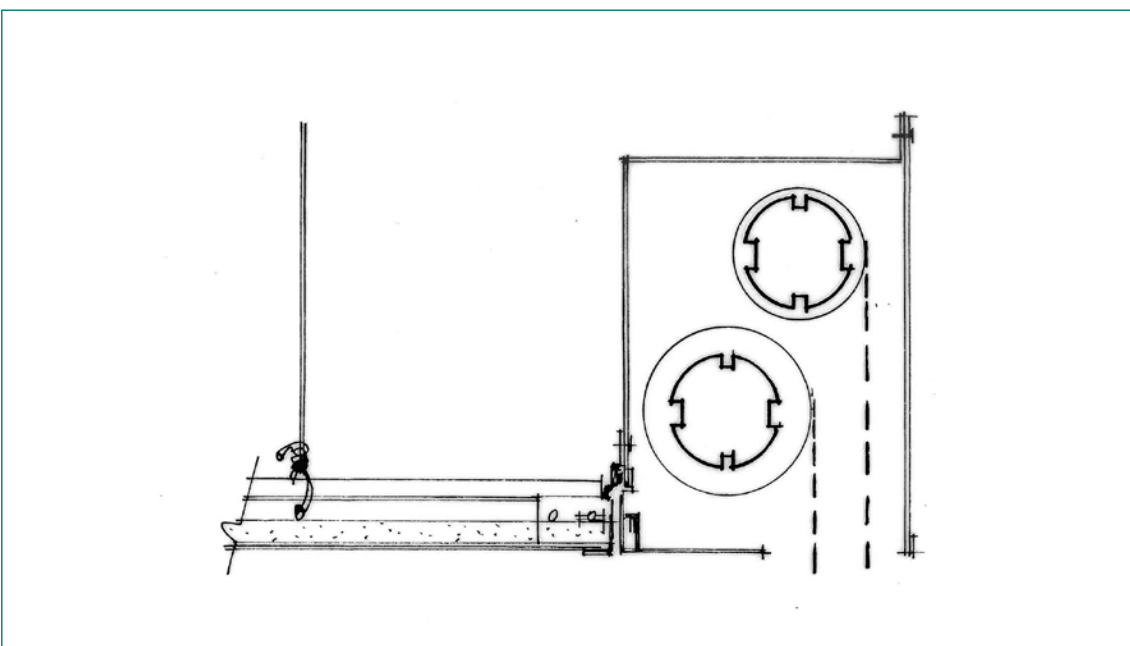


Figure 31: Suspended ceiling to blind box detail.

CEILING COMPONENTS

Wall trims and perimeter channels

Trims and channels are available in varying profiles to match the grid.

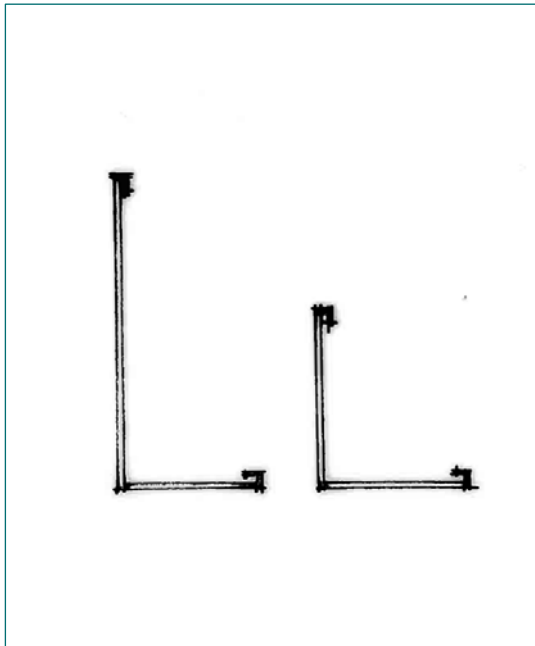


Figure 32: L trims, various sizes, equal and unequal leg length.

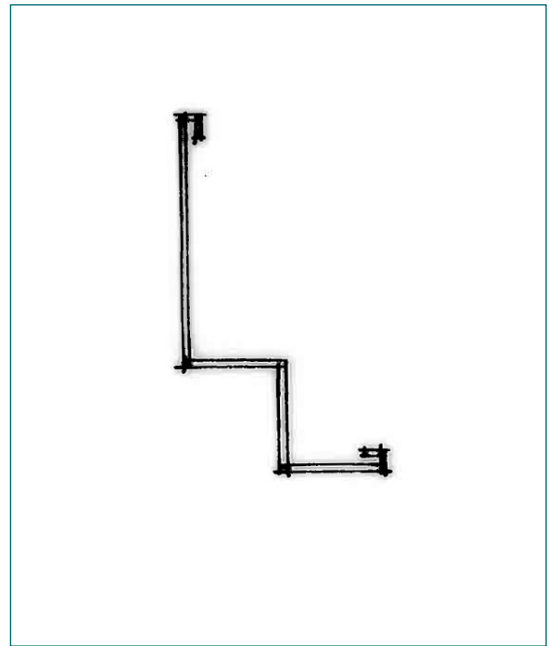


Figure 33: Shadow trims, various sizes.

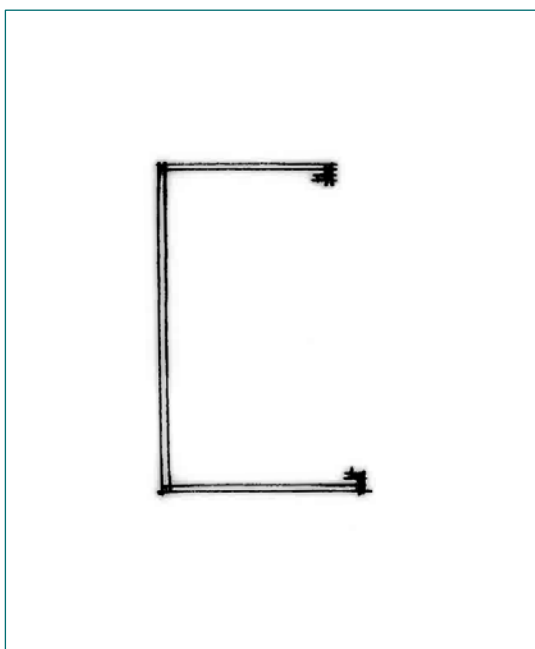


Figure 34: C channels, various sizes.

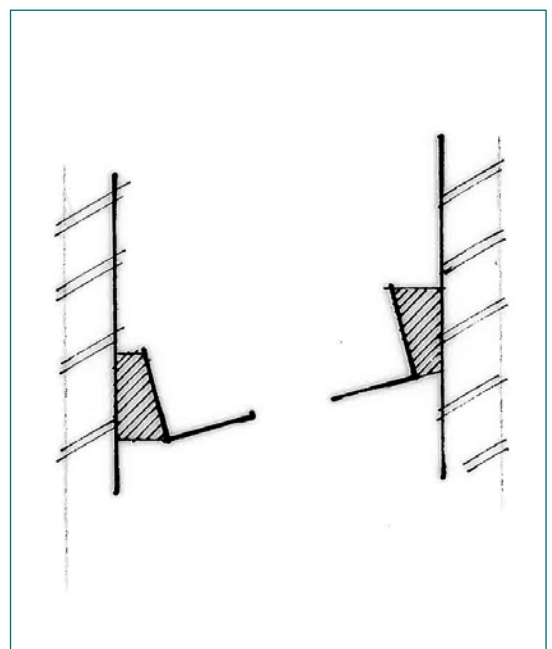


Figure 35: Wall shims, used at edges of ceilings to accommodate sloped ceilings, or bent angles.

Fixing clips

Providing connection options that allow some expansion movement within a perimeter-attached suspended ceiling.

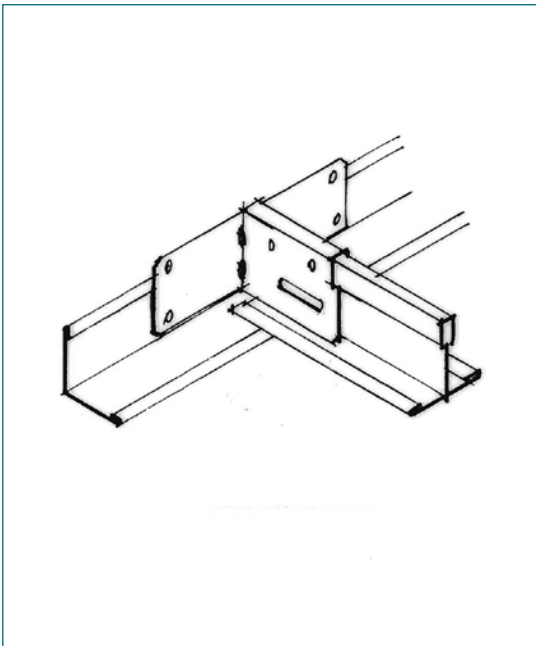


Figure 36: Perimeter clips.

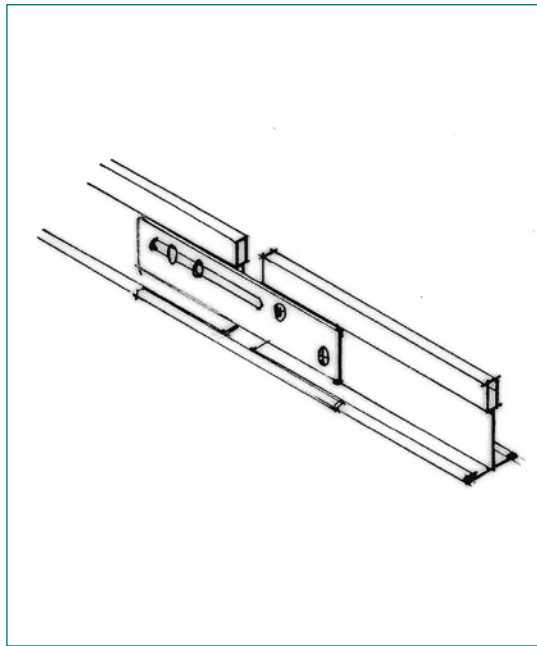


Figure 37: Main tee joint clip.

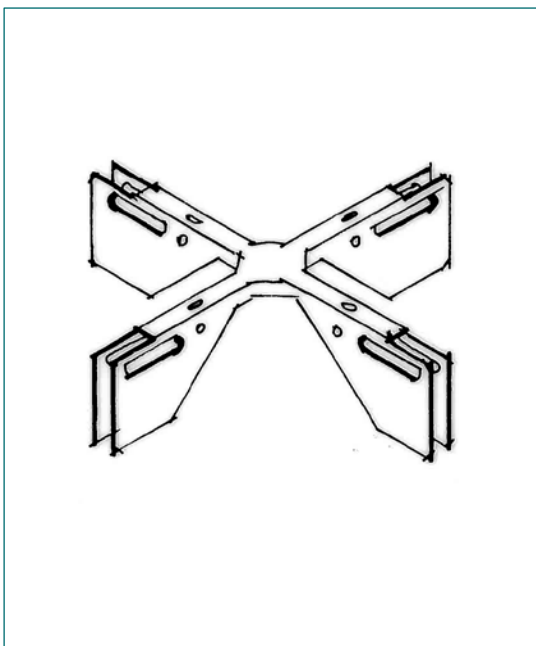


Figure 38: Cross tee joint clip.

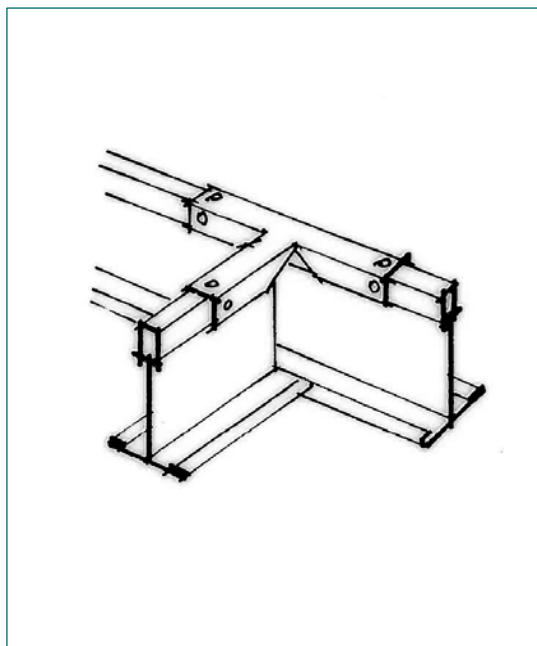


Figure 39: Three-way cross joint clip for off-module connection.

Main tees

Standard length is 3600 mm. Other non-standard sizes may be project specified and manufactured to order. Available with a 24 mm

15 mm or 38mm visible face. Imperial sizes for refurbishment are also available, subject to minimum order quantities.

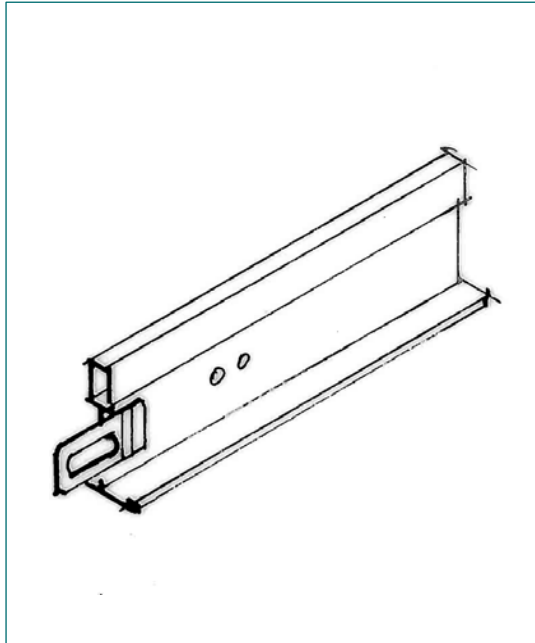


Figure 40: Main tee, 24 mm face.

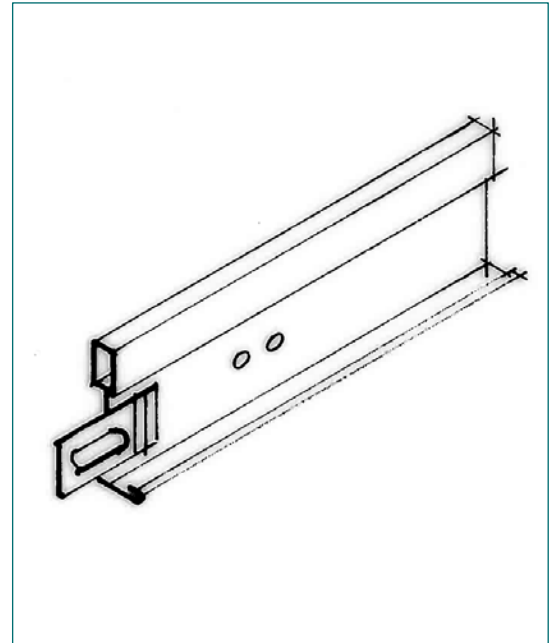


Figure 41: Main tee, 15 mm face.

Cross tees

Standard lengths are 1200 mm and 600 mm. Other non-standard sizes may be project specified and manufactured to order. Available

with a 24 mm, 15 mm or 38mm visible face. Imperial sizes for refurbishment are also available, subject to minimum order quantities.

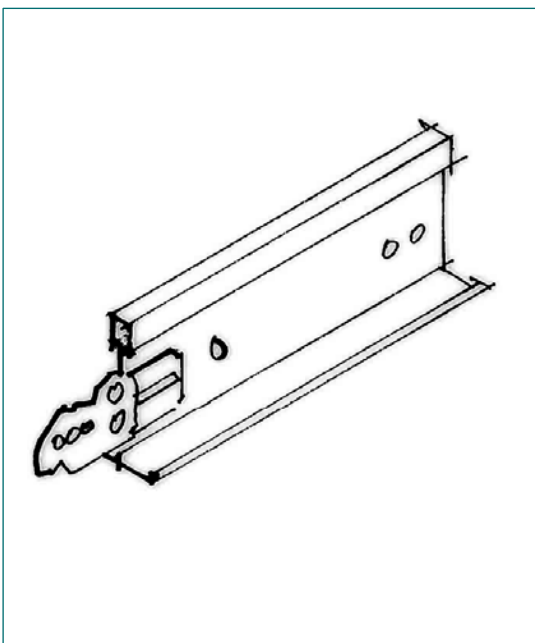


Figure 42: Cross tee, 24 mm face.

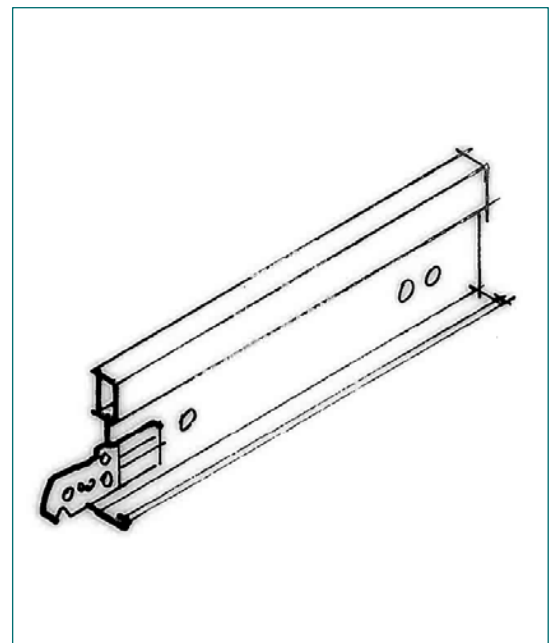


Figure 43: Cross tee, 15 mm face.

Wall stud spanning

Perimeter trims require a solid nog behind for seismic perimeter attachment. Where this is not confirmed, such as in existing structures, a heavy gauge angle can be used to span multi studs to provide a solid line for attaching perimeter trims, seismic clips etc. Angle specification will be required from a ceiling seismic engineer subject to the calculated seismic lateral loads.

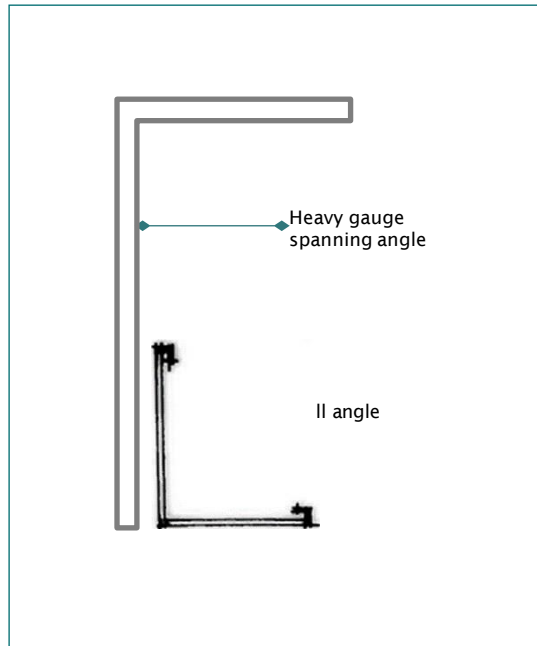


Figure 44: Heavy gauge angle for spanning studs

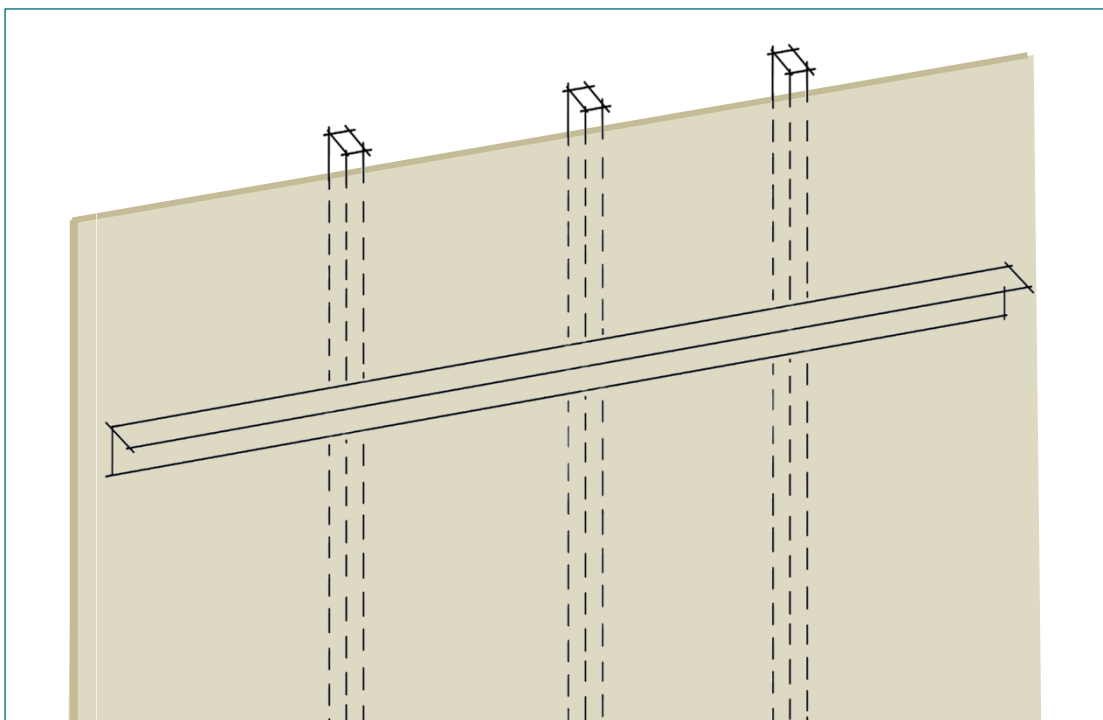


Figure 45: Continuous angle for spanning studs

7

Testing of product

The relevant standards to prove compliance for New Zealand conditions include, but are not limited to:

- AS 1397-2011 *Continuous hot-dip metallic coated steel sheet and strip – Coatings of zinc and zinc alloyed with aluminium and magnesium*
- AS/NZS 4600:2018 *Cold-formed steel structures.*
- AS/NZS 2785:2020 *Suspended ceilings – Design and installation*

A minimum of 10 standard production samples shall be tested to ensure a fair representation of what variability products achieve. Minimum failure values shall apply (not the average). Variability factors shall be applied (AS/NZS 4600:2018 Table 6.2.2.) subject to the actual number of samples tested.

Imported steel for local manufacturing, or fully manufactured products imported shall be verified by the importer that the steel type, gauge, and finish are to specification as ordered and comply with the relevant Standards, prior to market supply. Proof of quality assurance documentation or similar ISO quality Certification of the supplier shall be essential.

NOTE: Inferior steel or incorrect steel type/gauge may result in failure of the componentry and non-compliance of the New Zealand Building Code and cited Standards.

To confirm compliance, involvement may require the expertise of suitably qualified engineers familiar with the structural capacities of light gauge steel components. Additionally, reference to the BIP NSE CoP may also be appropriate.

8

Generic seismic design guides

Some global suspended ceiling manufacturers provide generic seismic design guides/wizards that calculate the seismic design detail requirements for many common non-SED ceiling installation situations. Additionally, there are now engineering originated electronic seismic design calculators that provide independent similar outputs. These can be used for initial design and tendering and can be validated with detailed PS1 documentation if required.

If a manufacturer's generic seismic design guide is used, the working sheets must be submitted with the PS3. Manufacturers and engineers generic seismic design guides are only to be used for a design when an SED is not required.

Being generic, they can be conservative, and there can be limitations on how they are used, and outputs/solutions provided.

Example: Service Limit State 2 (SLS2) designs are excluded from most calculators. Unless a seismic design is completed by a Professional Engineer, the liability for a design will rest with the ceiling designer even if they use a supplier's guideline or calculator.

To utilise generic seismic design guides, a NSE Seismic Designer - ceilings should be trained by the suppliers to ensure they are fully competent before full reliance is used to submit on suitable projects.

Some manufacturer/suppliers may also be able to provide full engineering services in addition to their generic design guides.

Manufacturers' design guides for lined plasterboard ceilings or bulkheads may now be available. Check manufacturers' or suppliers' websites for the most up-to-date information.

However, plasterboard (and other rigid sheeted linings) do not perform like grid and tile ceilings during seismic movement. Provided :

- The suspension framing is designed and installed correctly to support the intended load, and
 - the linings are attached to the suspension systems by the manufacturer or suppliers' installation requirements, and
 - perimeter walls are capable of taking the lateral line loads,
- then perimeter gaps, particularly for square stopped plasterboard, may not be necessary. Slight crushing can be expected under SLS1 limitations.

Large areas of plasterboard ceilings require control joints at no greater than 12 metre centres, in both directions, thus providing natural seismic movement joints where the perimeter areas are rigidly fixed to perimeter walls. (Note: perimeter walls shall be checked to ensure they are capable of taking the horizontal line loads of the ceiling).

Should there be an area entirely within control joints on all sides, then back bracing restraint will be required in those areas.

9

Specific engineering design (SED)

Projects that are more complex than those that can be designed from the manufacturers' generic seismic design guides are classified as specific engineering design (SED).

Reasons why a project would be classified as SED include (but are not limited to):

- complexity of the ceiling
- size of the ceiling
- ceiling type (see Appendix I for details on sheeted type ceilings)
- building importance level
- floor to ceiling height
- ceiling to structure (plenum) height
- other building components in the plenum
- design working life (annual probability of exceedance).

The lead designer will need to decide if an SED is required or whether manufacturers' generic design guides are appropriate.

Where this is not clearly identified, it can be up to the NSE Seismic Designer - ceilings/installer to notify if they believe a SED is required.

A Chartered Professional Engineer (CPEng) must be engaged to carry out all specific engineering designs.

Some manufacturer/suppliers may also be able to provide full SED services in addition to their generic design guides.

10

Generic details

The following drawings show some generic details that can be used for seismic restraint and separation of ceilings. NOTE: These drawings are illustrative only and do not represent actual project seismic restraint requirements

Manufacturers might have their own proprietary systems that may have different ways of achieving the same outcome. Examples below are primarily for grid and tile ceilings, but examples 2 & 4 two directions, can be used for sheeted ceilings. See Appendix I, page 86.

There are five fundamental seismic layout concepts (Figure 46):

1. Perimeter fixing on two adjacent walls and two walls floating.
2. Perimeter fixing on three or four sides with 'seismic separation' breaks to allow for movement.
3. Back bracing to the structure, one or two directions.
4. Perimeter fixing with central section(s) back braced with seismic breaks.
5. Perimeter fixed all 4 sides (not shown) – for the design of full sheet type ceilings, refer to Appendix I, page 86

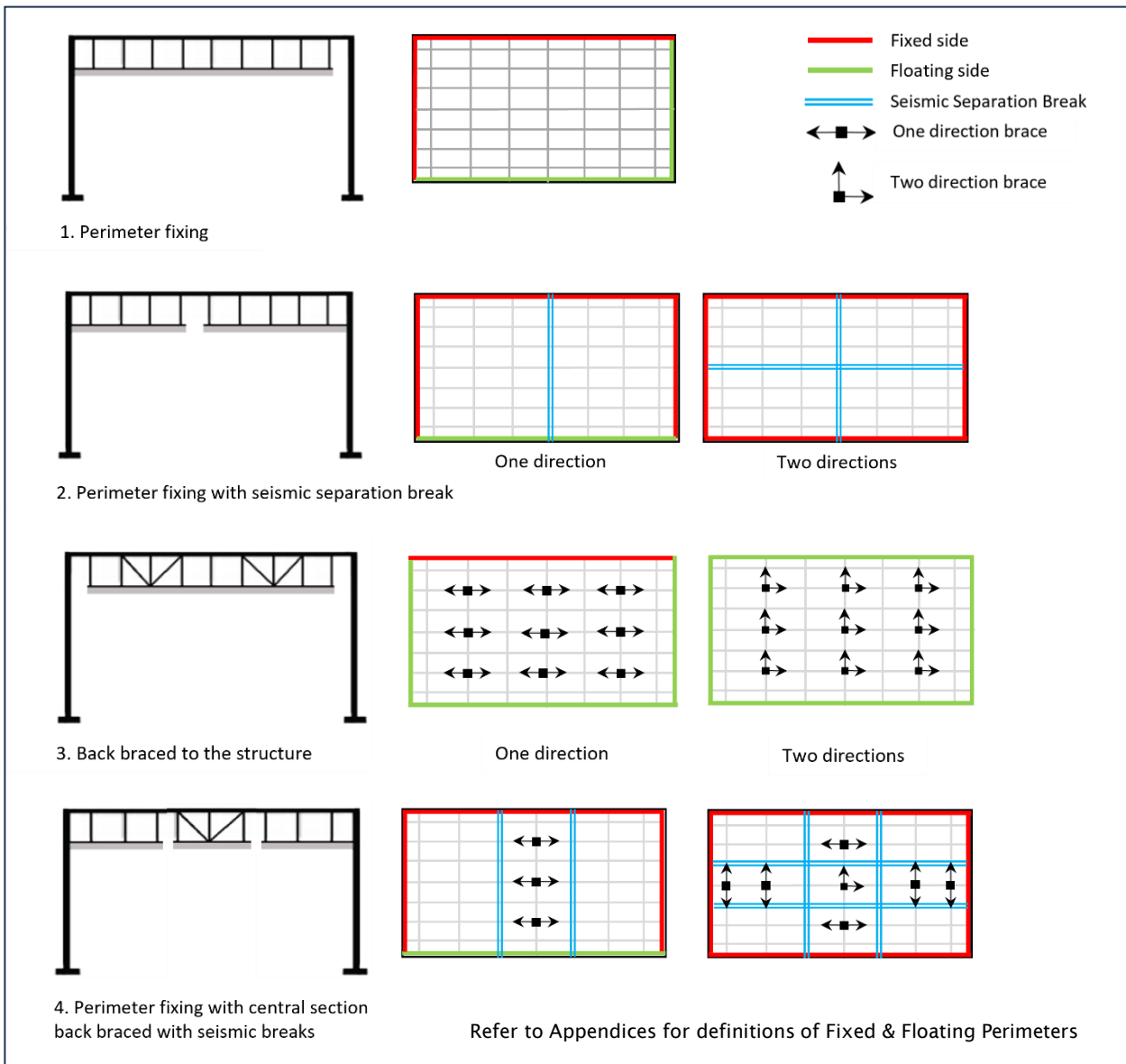


Figure 46: Seismic layout concepts.

LATERAL FORCE BRACING

Lateral force bracing can be provided by perimeter restraint, K-bracing or use of vertical struts (compression posts) and supporting bracing for exposed grid systems.

Lateral force bracing can be calculated from the generic design guides or subject to SED.

Perimeter fixing

Perimeter fixing of ceilings may be restricted by the room size, which will depend upon, but not be limited to:

- the seismic forces to be accommodated.
- the capacity of the ceiling grid and perimeter fixing components to transfer load.
- the capacity of the perimeter fixings to accommodate lateral movement.
- the capacity of the perimeter walls to transfer loads.

Perimeter fixing can be either fixed or free/sliding. The determination of whether the perimeter fixing is free or sliding will depend upon not only the above factors but many other factors as well. A minimum of two adjoining sides will be fixed, and in some instances, all four sides may be fixed.

Vertical restraint is usually provided by the self-weight of the suspended ceiling in the downward direction. Rigid hangers or compression type struts may be required depending on seismic zone, wind loading, floor to ceiling height and plenum height.

PERIMETER RESTRAINT

Generally, one end of the ceiling grid shall be attached to the wall moulding or wall, and the other end shall have a clearance from the wall and be free to slide, with the required gap to be determined by the seismic design.

Fixed-end options

The grid shall be attached at two adjacent walls (pop rivets or other approved method). There must be solid blocking in the wall or a solid wall capable of taking the lateral force of the ceiling.

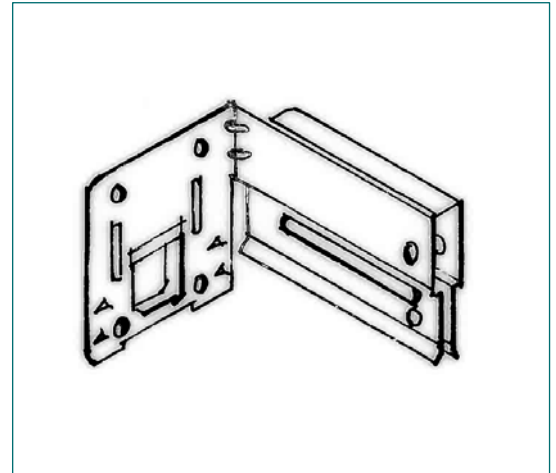


Figure 47: Proprietary wall clip.

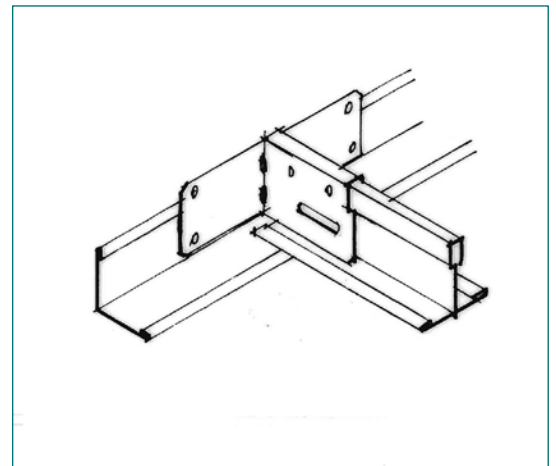


Figure 48: Proprietary wall clip in place.

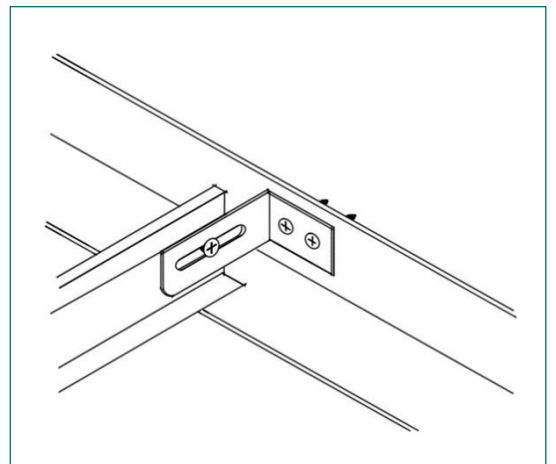


Figure 49: Proprietary floating end bracket

Fixed-end options

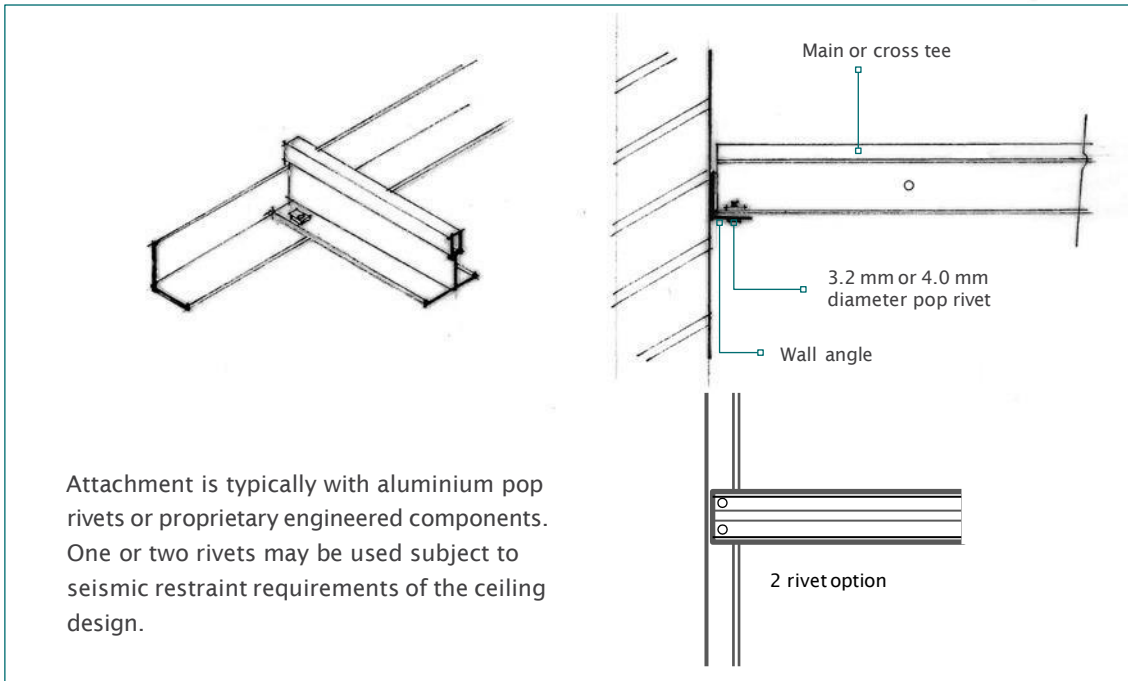


Figure 50: Pop rivet.

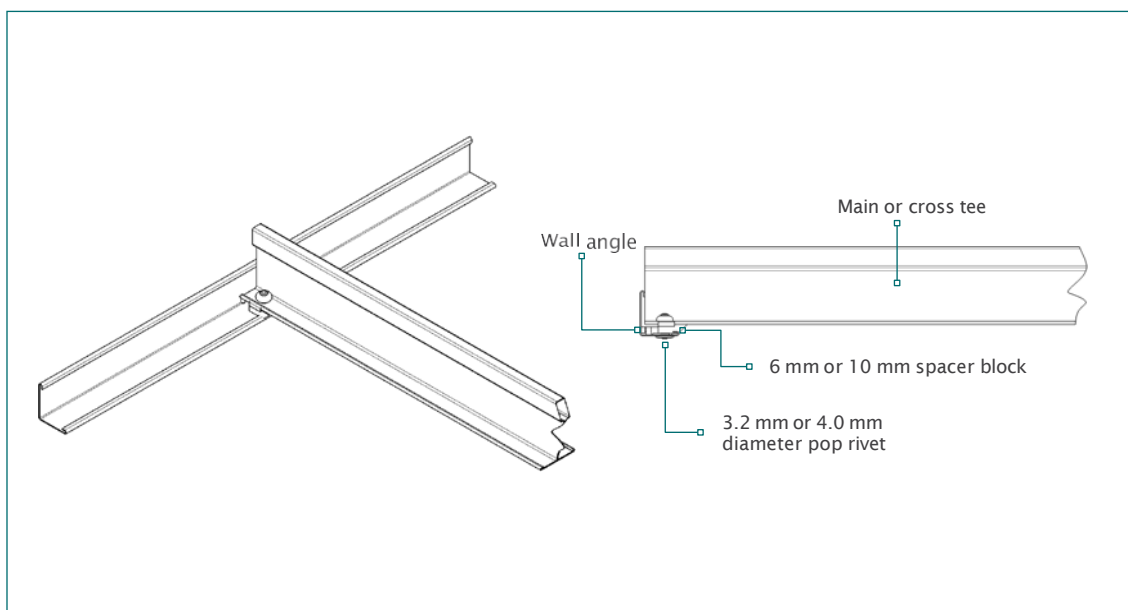


Figure 51: Pop rivet with spacer block (used with rebated tiles).

NOTE: Do not use grid crimping method for rebated edge tile perimeter solution. This significantly weakens the grid.

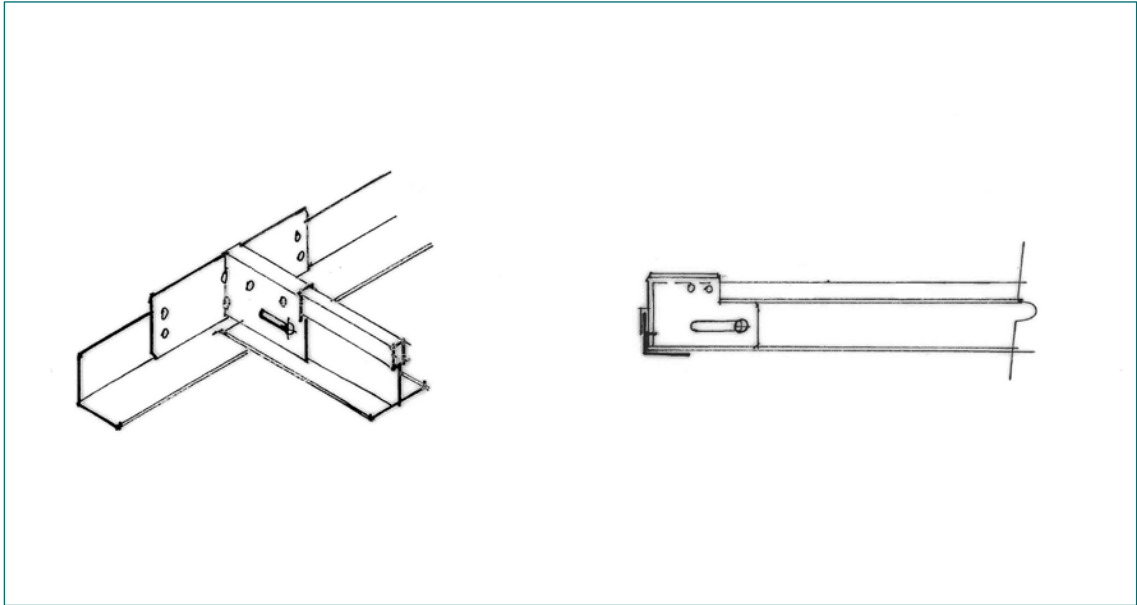


Figure 52: Seismic clip – main or cross tee, fixed end.

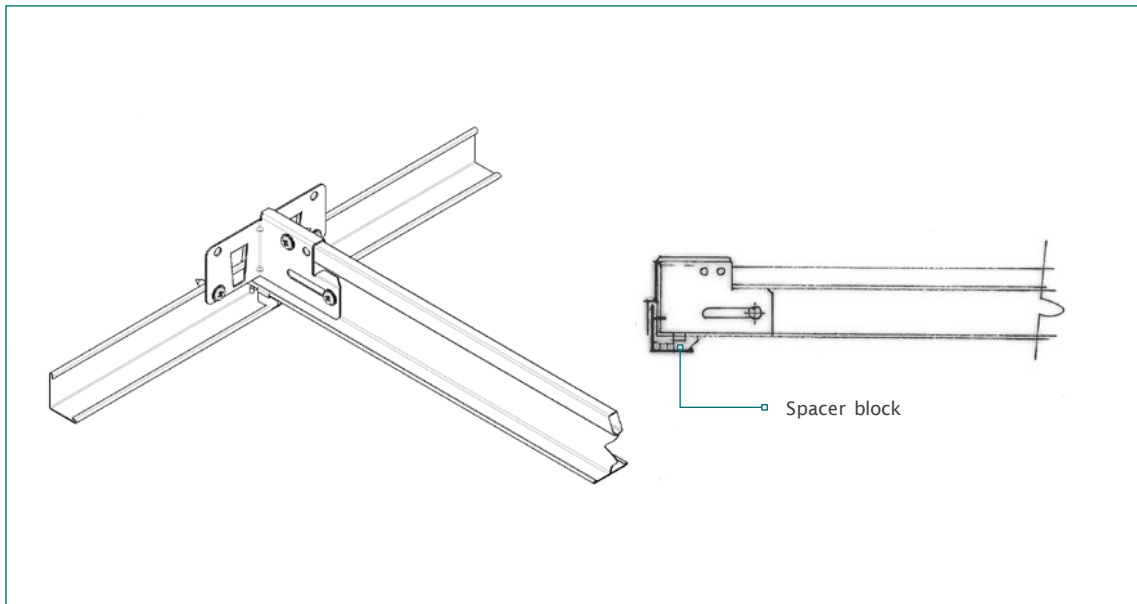


Figure 53: Seismic clip – cross tee with spacer block, fixed end.

NOTE: Do not use grid crimping method for rebated edge tile perimeter solution. This significantly weakens the grid.

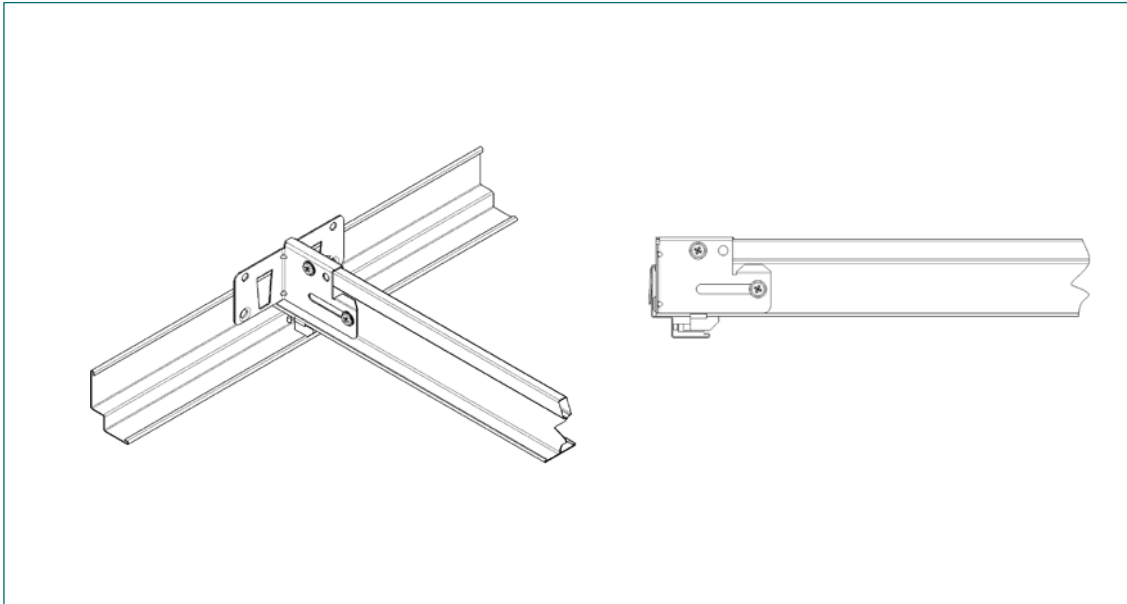


Figure 54: Seismic clip – main or cross tee with spacer block and shadow wall angle, fixed end.

Non-fixed-end options

Opposite ends to fixed components must be left to move freely but shall be restrained sufficiently to not allow the grid or tiles to collapse, typically achieved with a channel wall moulding, proprietary components, or specific design.

There must be solid blocking in the wall or a solid wall capable of taking the lateral force of the ceiling.

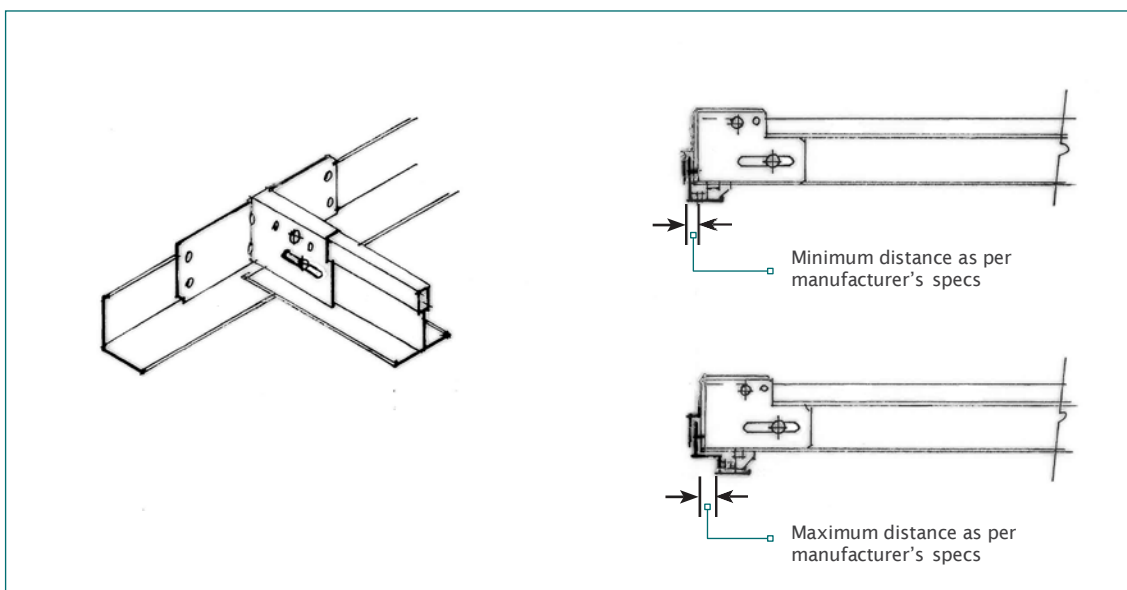


Figure 55: Seismic clip – wall angle and wall angle with spacer block, floating end.

Non-fixed-end options

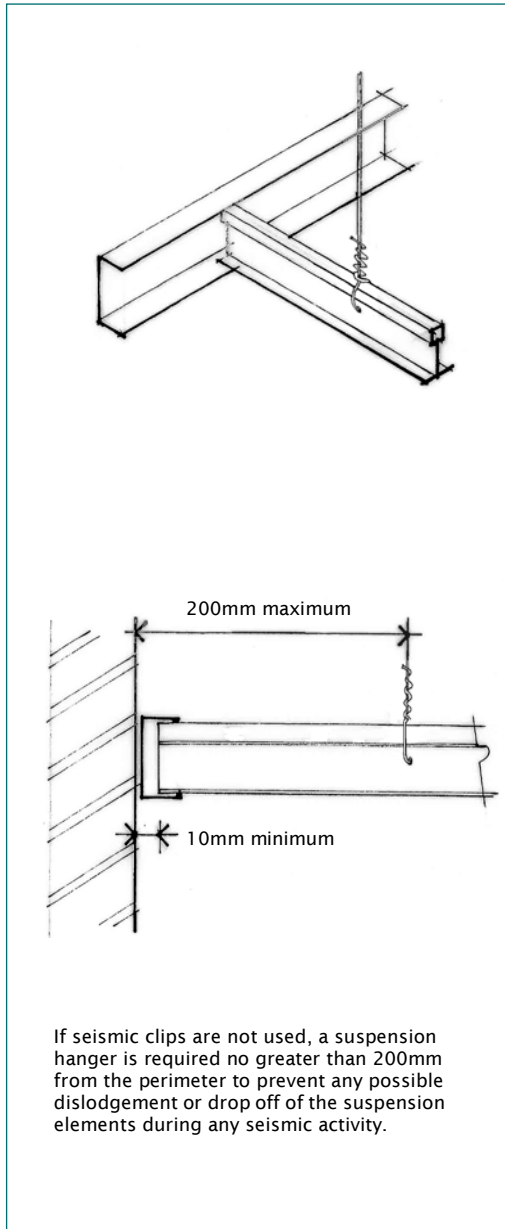


Figure 56: Seismic channel, floating end.

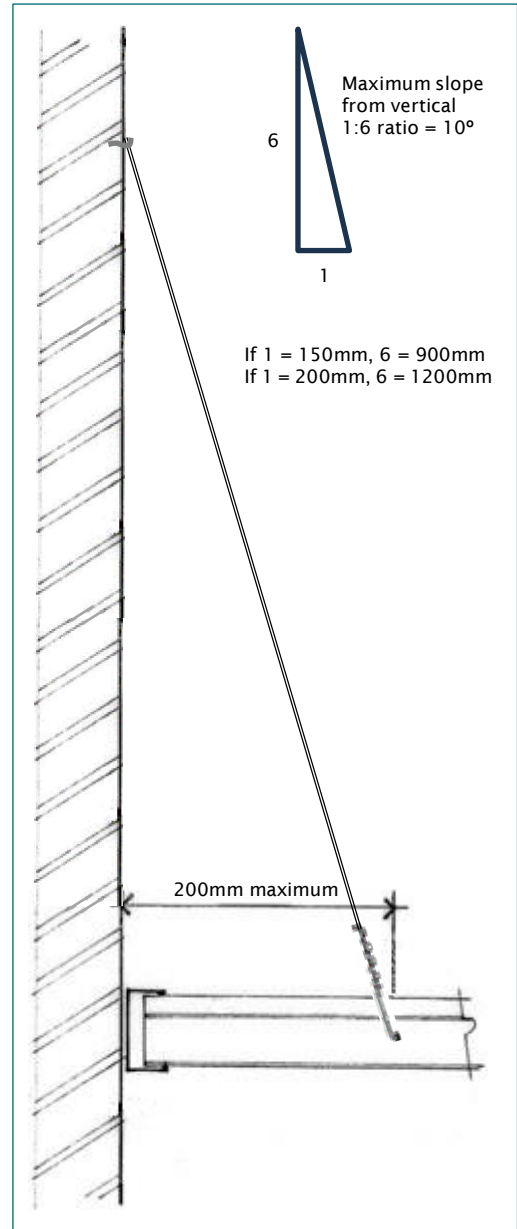


Figure 57: Off-plumb hanger attached to wall.

SEISMIC SEPARATION JOINT DETAILS

Seismic separation joints can provide solutions when:

- perimeter fixing is allowable, but grid allowable length is less than the actual ceiling length.

It is possible to use seismic joints in just one direction.

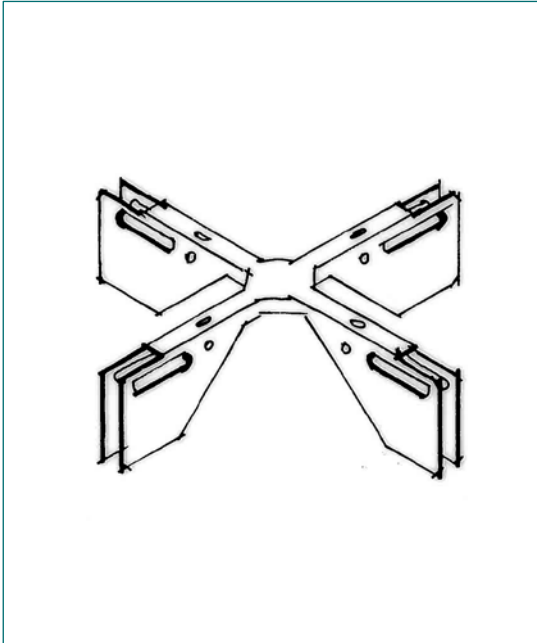


Figure 57: Small seismic joint, two directions, hidden joint. Can also be used to strengthen across Main Tee/Cross Tee joint.

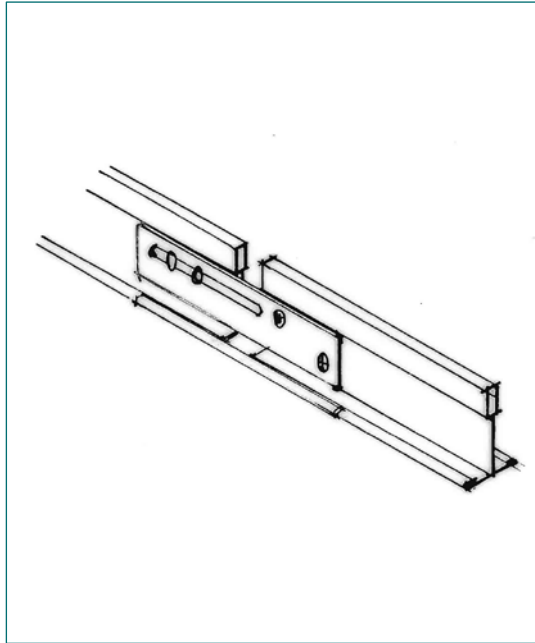


Figure 58: Small seismic joint, one direction, hidden joint.

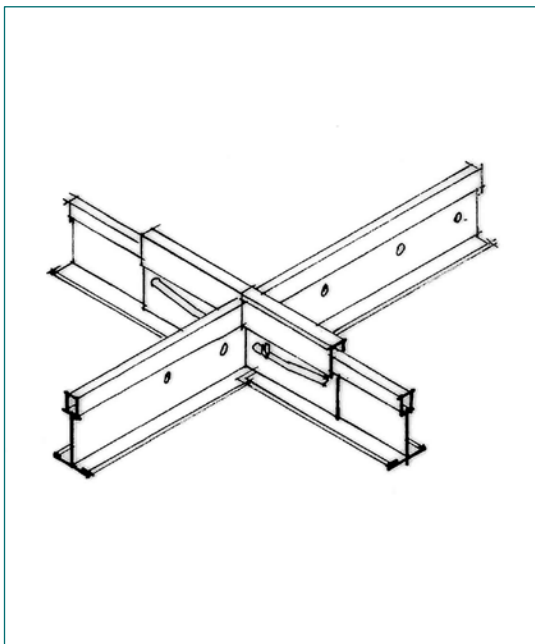


Figure 59: Seismic joint clip – cross tee.

NOTE: Where tees are cut to provide a seismic gap, a suspension must be provided no greater than 150mm from the joint on the fixed side.

Seismic separation joints can be either large (usually greater than 20 mm) or small, and they can be visible or hidden within the ceiling system.

Some custom options are shown below. Rigid infill strips that cannot compress during seismic activity are not to be used eg ceiling tile off-cuts.

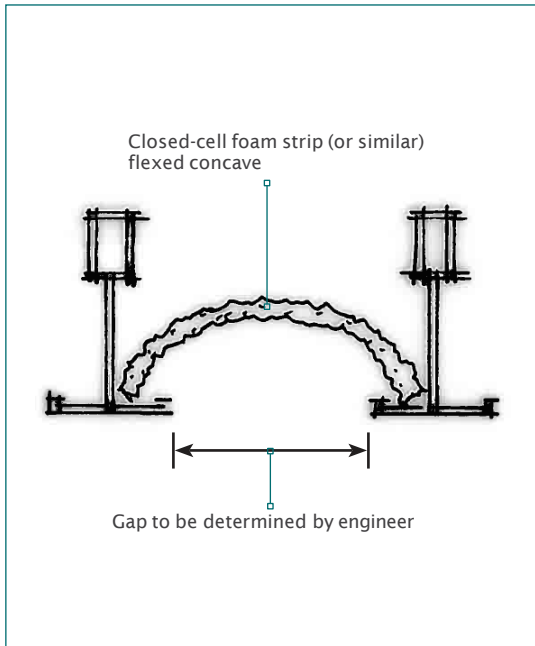


Figure 60: Large seismic joint with concave cover strip.

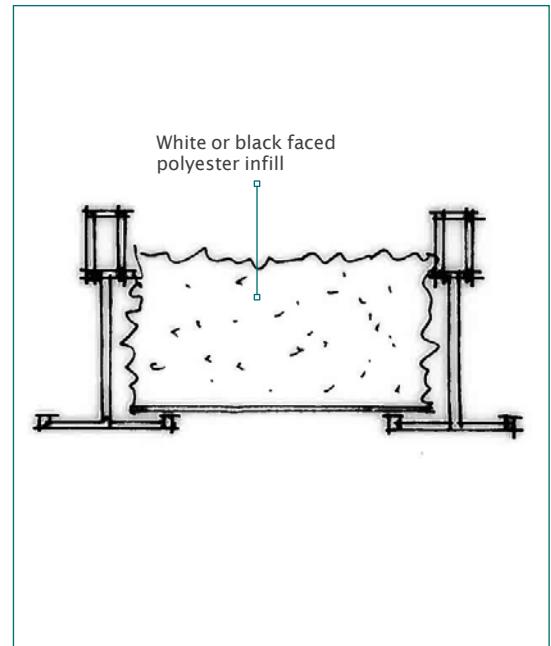


Figure 61: Large seismic joint with cover material at bottom of T-rail.

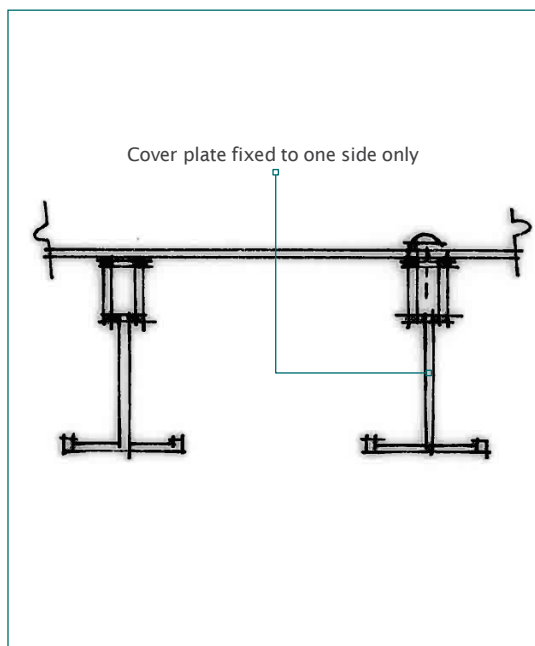


Figure 62: Large seismic joint with cover strip above T-rail.

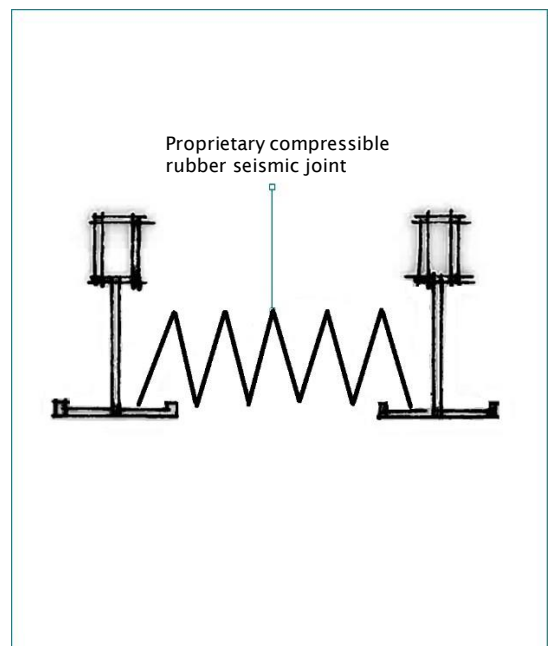


Figure 63: Large seismic joint with compressible cover strip.

BRACED CEILINGS

Bracing of ceilings is a solution for 'large' rooms where fixed/float and seismic breaks do not provide a restraint solution, or open areas where there are limited partition walls to restrain the ceiling grid. (Ref Figure 46)

The bracing is generally installed on a uniform and regular grid pattern, the spacing of which will depend upon, but not be limited to:

- the seismic forces to be accommodated.
- the capacity of the ceiling grid and bracing systems to transfer load.
- the density of the services located within the ceiling plenum space.

Seismic braces shall be attached to the grid and to the structure in such a manner that they can support a design load as calculated.

Support braces are to be within 50 mm of the connection of the vertical strut to the suspended ceiling.

Vertical struts must be positively attached to the suspension systems and the structure above.

The vertical struts may be angles, metal studs or a proprietary compression post.

Proprietary engineered components to join grid systems to bracing elements are available.

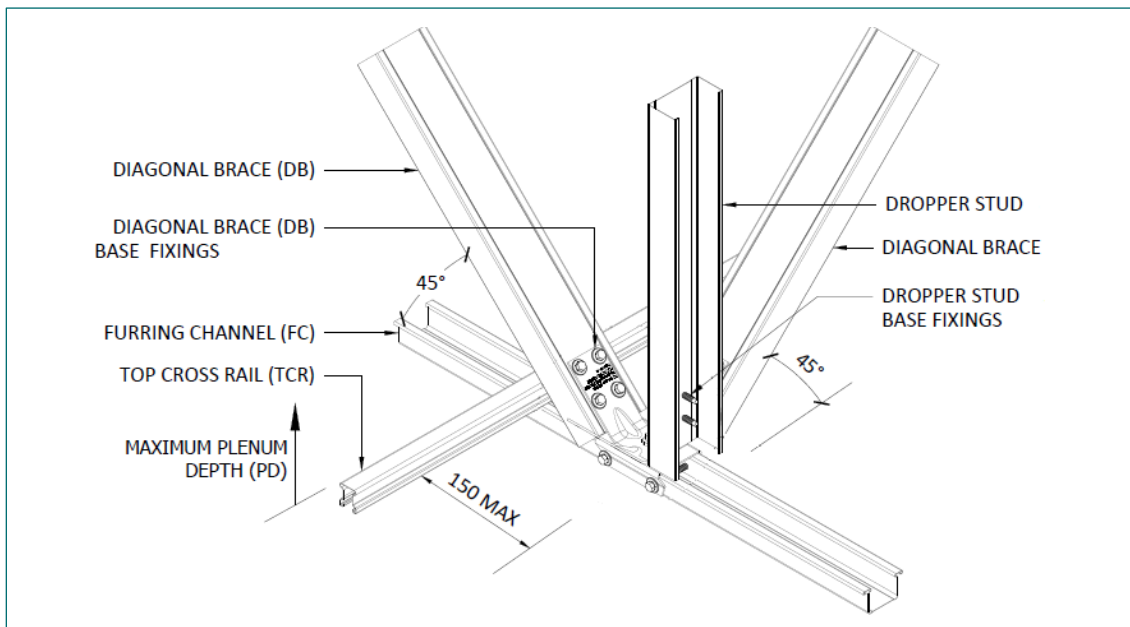


Figure 64: Lateral force bracing using 3-way solid struts.

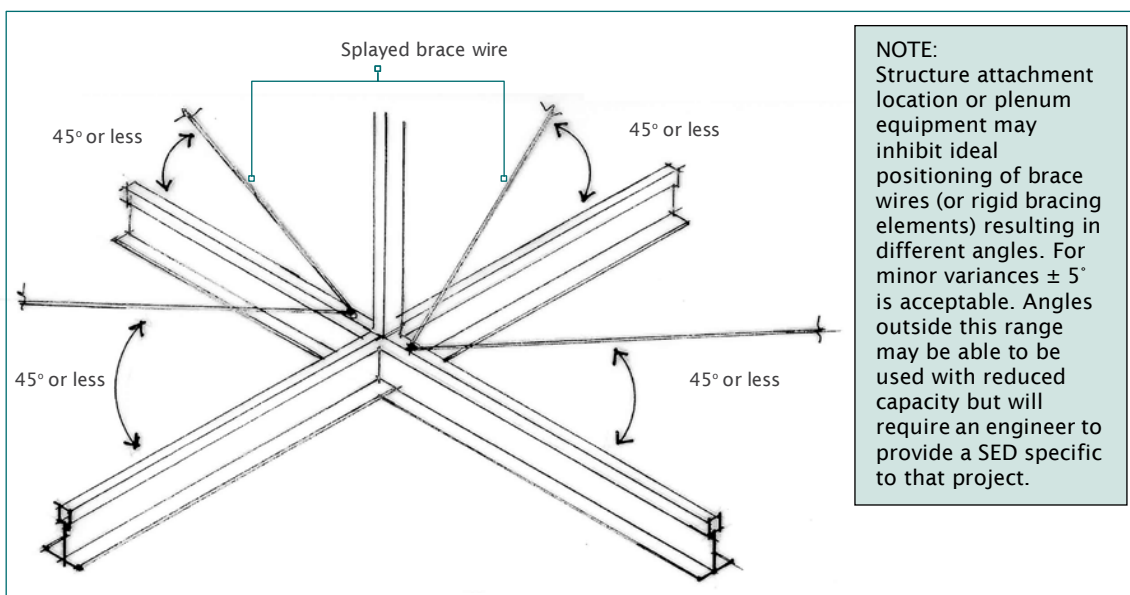


Figure 65: Lateral force bracing using splayed wires.

TILE CLIPS

Tile clips can help retain tiles in a ceiling against vertical movement in a seismic event, wind pressure and if required under specific engineering design (SED).

Refer to manufacturers' or engineers' recommendations.

HANGERS

The requirements for hangers are as follows:

- Hanger and perimeter wires must be plumb within 1 in 6 unless counter-sloping wires are provided.
- Suspension hangers shall be spaced at 1200 mm centres maximum or as specified in the seismic design, no greater than 600mm from fixed perimeters and 200mm from floating perimeters without proprietary clips, and 150mm from Main Tee splice joint.
- Shot-fired fasteners into concrete are not to be used in general, but some exceptions may permit their use. (SED required)
- When using concrete anchors, they shall be installed in accordance with the manufacturer's recommendations, taking due care to maintain minimum edge distances, spacing and embedment depth.
- Post installed anchors into concrete must be in accordance with NZS 3101:2006.
- Cast-in anchors often present alignment problems for suspended ceilings.
- Fixings into aerated concrete or lightweight concrete requires special attention and shall only be made in accordance with the manufacturer's recommendations.
- Refer to specific values in AS/NZS 2785:2020 clause 2.3.4 (a) of 50 kg plus factors to allow for variability in Table 6.2.2 in AS/NZS 4600:2005.
- Wires shall not attach to or bend around interfering material or equipment. A bridging system or similar device shall be used where obstructions preclude direct suspension. The bridge type and suspensions shall be engineered for the spans as required. Refer to AS/NZS4219:2009 Table 15, or Table 8 page 54
- All wire ties are to be minimum three tight turns around itself within 75 mm (see Figures 66 & 67), 2.5 mm diameter hanger wire spaced 1200 mm on centre maximum.

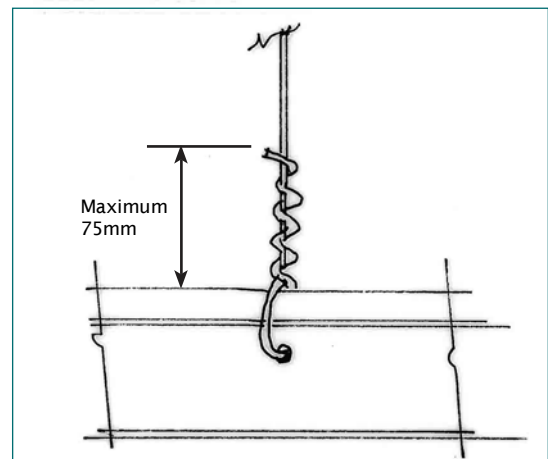


Figure 66: Hanger wire minimum tie-off.

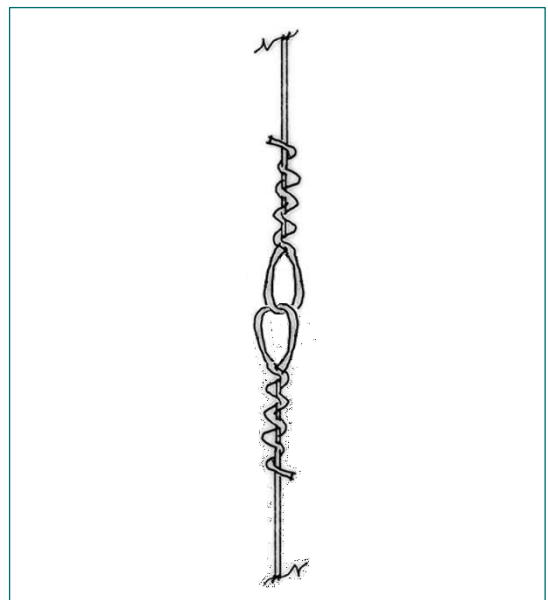


Figure 67: Joining wires for deep plenums.

- For deeper plenums, hanger wires may be joined together using the same method ensuring three tight turns for each wire.
- Use of solid hangers for shallow suspension may interfere with horizontal seismic movement for fixed and float ceilings depending on number of fasteners used. Consult a seismic engineer for advice.

HANGER TO STRUCTURE FASTENERS

For gravity loads, use fasteners appropriate for the type of structure material the hanger is attached to and calculated gravity load.

For timber structures

Timber eye screws, driven into the bottom of joists, purlins, beams.

Flat plates or brackets are also used.

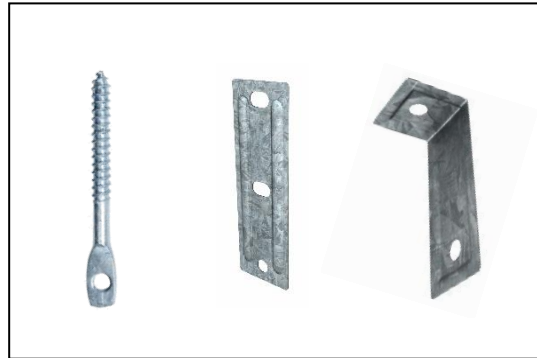


Figure 68: Timber attachment options

For steel structures

Purlin eye screws. Use of a rubber washer type reduces the likelihood of loosening due to vibration. Purlin eye screws shall be installed no greater than 25mm from the purlin web.

Flat plates or brackets are also used screwed to the web of a purlin.

Shot fired fasteners may be used into non-fire rated steel structures.

If the steel is intumescent coated for fire rating, then a timber packer must be mechanically attached which will allow for fastener use as above for timber.

NOTE: Check for any items that may be hidden within the purlin, particularly electrical cabling.

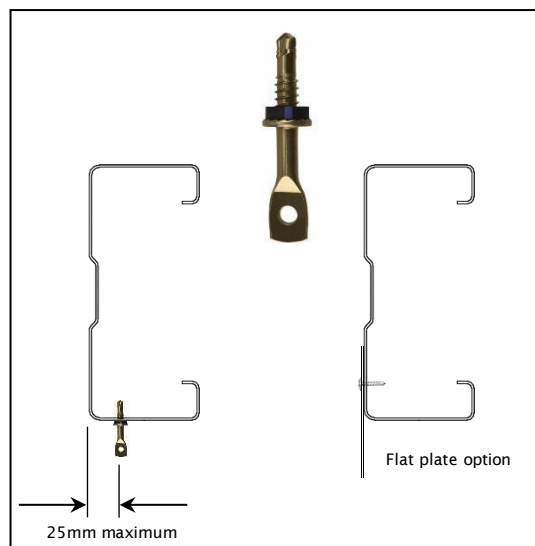


Figure 69: Steel attachment options

For concrete structures

Concrete anchor type will depend on floor style, thickness and age of concrete being attached to. Typical industry types are masonry sleeve anchors, screw and metal deck eye screws.

Concrete anchors for hangers must comply with the current cited Standard NZS 3101:2006, Amendment 3 2017. Manufacturers advice may be sought to identify suitable solutions that meet these design requirements, and the project engineer is to be consulted as to suitability.

NOTE: Current requirements based on the European Standard are under review, including new fastener type options more suitable for the suspended ceiling industry.

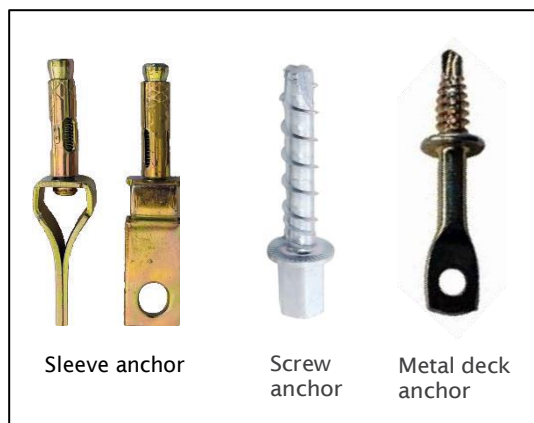


Figure 70: Concrete attachment options

CEILING PANEL MOUNTED SERVICES

Maximum allowable point loading by ceiling services is generally limited by manufacturers to lightweight fittings. Where this exceeds maximums, provision shall be made to support the service by transferring its load back to the grid suspension. Typically, this can be by using simple supports spanning onto the grid, or by using a rigid panel or strip (eg MDF or ply) fully across the back. If the item is greater than 7.5 kg, then independent support is required.

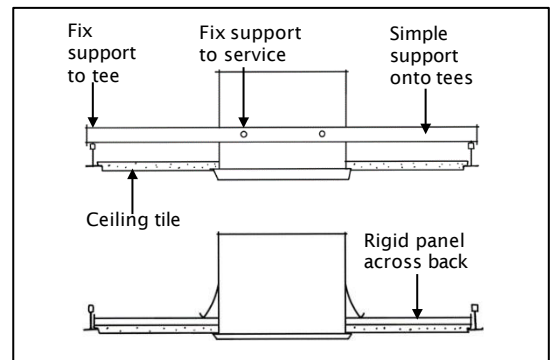


Figure 71: Transferring ceiling services load.

GRID CONFIGURATION

For exposed grid systems, the most common layout is a 1200 x 600mm module. This is achieved with **Main Tees** at 1200mm centres and **Cross Tees** at 600mm centres. This is the strongest seismic layout.

Main Tee —
Cross Tee —

An alternative layout called cross noggling is sometimes used to reorientate the direction of a 1200 x 600 module, for either installation or aesthetic reasons. This layout is less strong than the standard method described above and should be avoided if at all possible. If it must be used, then it will require an engineer to calculate seismic design specific to that project.

Other layouts and sizes are also possible – refer to grid suppliers for specific options, as these will usually require SED.

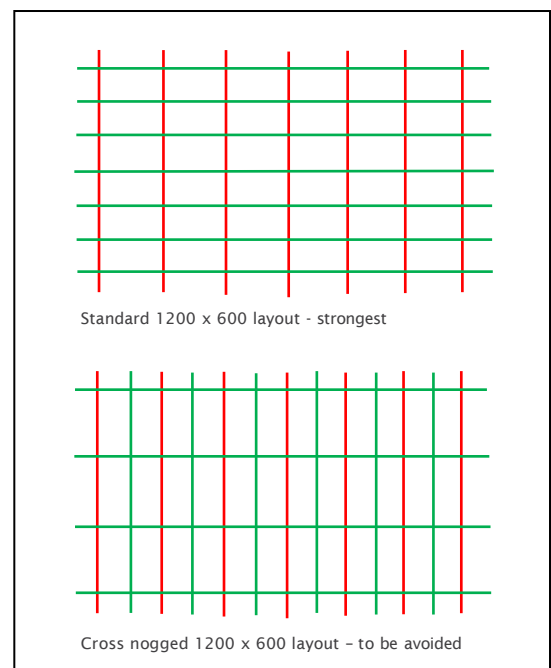


Figure 72: Common grid configurations

GRID BELOW A PLASTERBOARD CEILING

Grid and tile ceilings can be required to be suspended below plasterboard ceilings, usually for acoustic noise reduction. Use a heavy gauge spanning angle to attach to the PB ceiling to enable grid suspension.

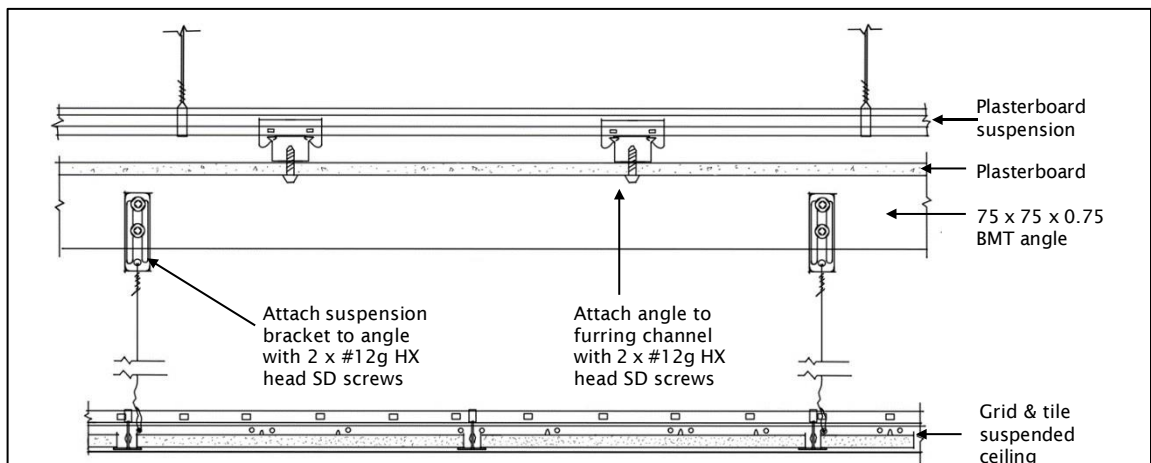


Figure 73: Suspending a grid and tile ceiling below a plasterboard ceiling

SERVICE CLEARANCES AND BRIDGING

Services are required to comply with NZS 4219:2009, which specifies seismic clearances between adjacent building services components as well as between building services components and other non-structural components, for example, including ceilings.

Bridging is required when hanger points cannot be accessed because of obstruction by services. Details shown in Figure 75 are a guide for ceiling supports around and next to services.

Best practice is to co-ordinate services to allow access to hanger points.

Condition being considered	Minimum clearance (mm)	
	Horizontal	Vertical
Unrestrained component to unrestrained component	250	50
Unrestrained component to restrained component	150	50
Restrained component to restrained component	50	50
Penetration through structure (such as walls and floors)	50	50

NOTE: Ceiling hangers and braces are considered to be restrained components for the purposes of this table.

Table 8: Clearances (from NZS 4219:2009 - Table 15)

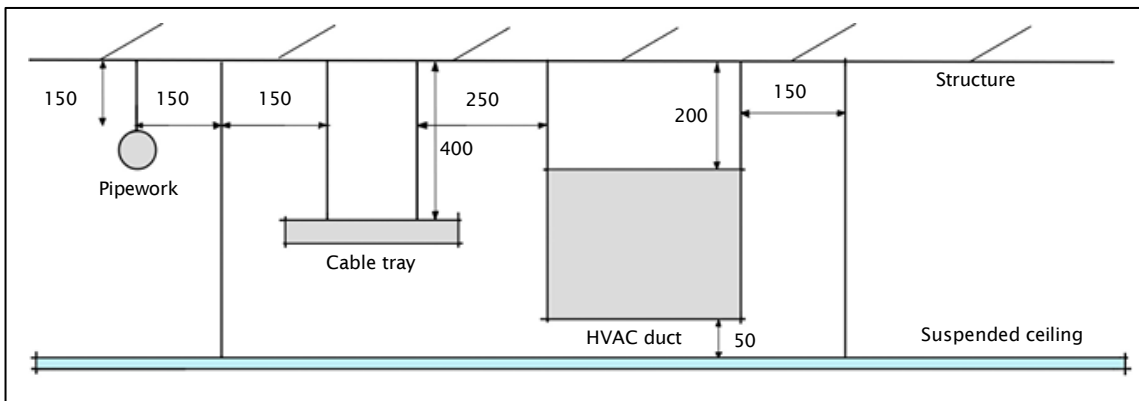


Figure 74: Minimum clearance requirements for unrestrained services to restrained ceiling.

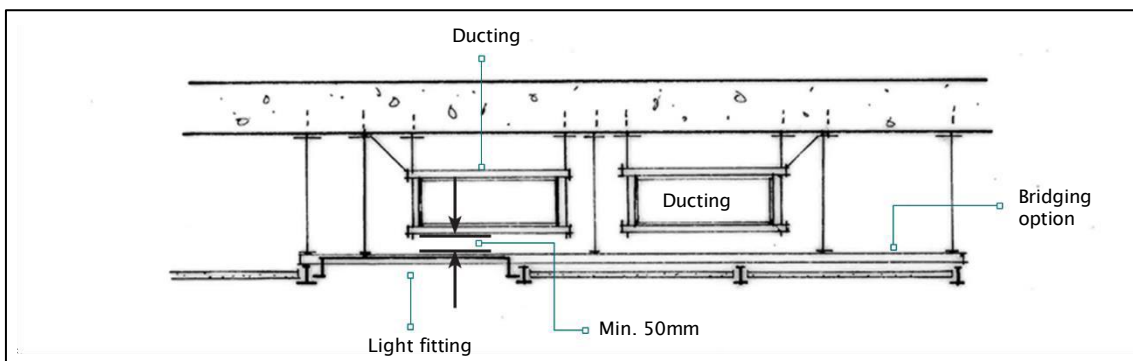


Figure 75: Bridging under ducts or services by other trades.

TRAPEZE

An opposing angle wire suspension system can be used where hanger points cannot be accessed because of obstruction by services or are greater than 1200mm suspension hanger centres. eg purlins at 1800mm centres.

Where the plenum depth is too shallow to use trapezing to pick up required suspension point, then use the bridging method to span between structures to provide a suspension point.

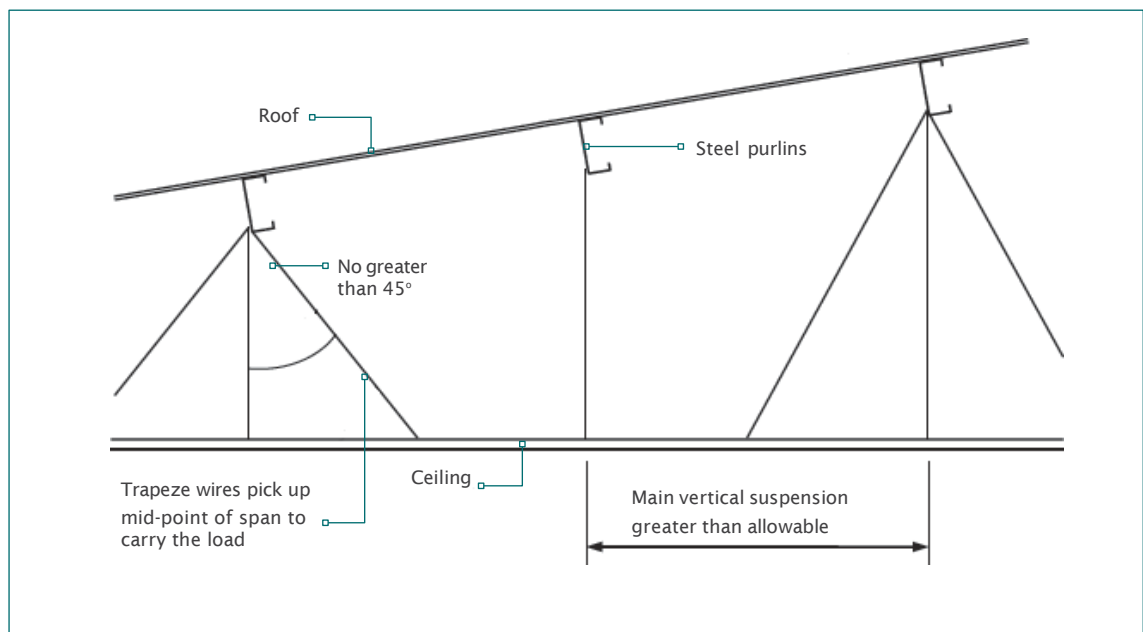


Figure 76: Typical trapeze.

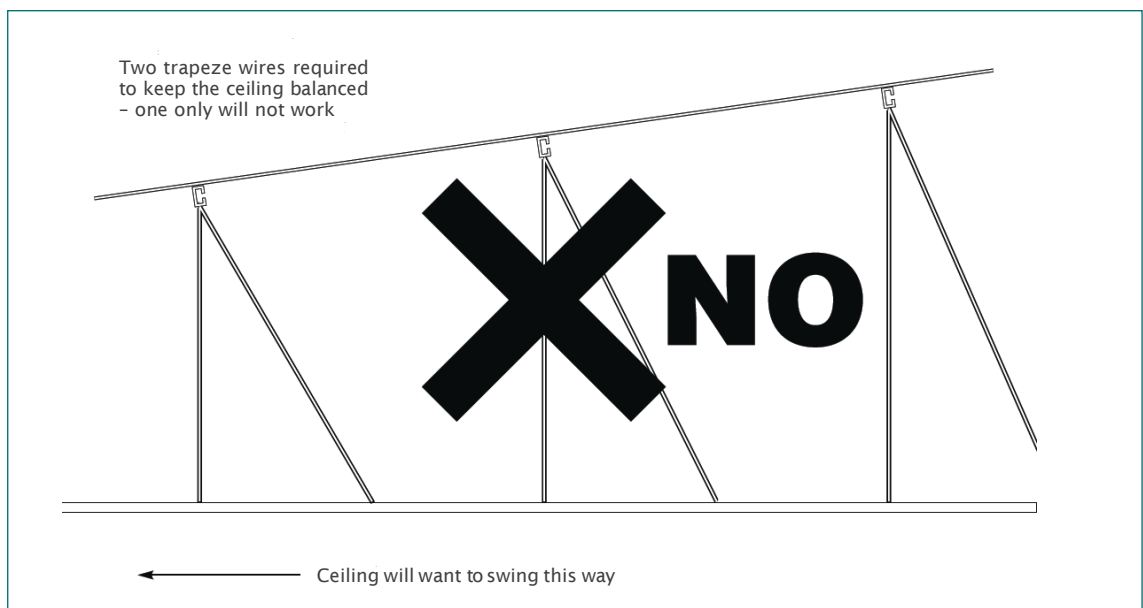


Figure 77: Trapeze wire detail.

11

Possible reasons for and consequences of failure

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 NZBC
- ceiling wires not installed correctly
- services within the ceiling space or connected to the ceiling grid not complying with current codes
- perimeter hangers or bulkheads having insufficient strength to receive the line loads of a ceiling
- insufficient seismic gaps to allow for movement of the building structure or other non-structural elements
- partitions being connected to the ceiling system but not independently braced
- a lighter gauge of ceiling grid or non-tested system being installed outside its structural capability
- interference from other non-structural building components in the plenum.
- incompatibility of material-to-material contact resulting in premature corrosion.



Figure 78: Lack of suspension points and service clearance.



Figure 79: Unbraced partitions and service ducts.



Figure 80: Sprinkler system supported from ceiling componentry rather than suspended from the building structure.



Figure 81: The result of an unbraced ceiling.

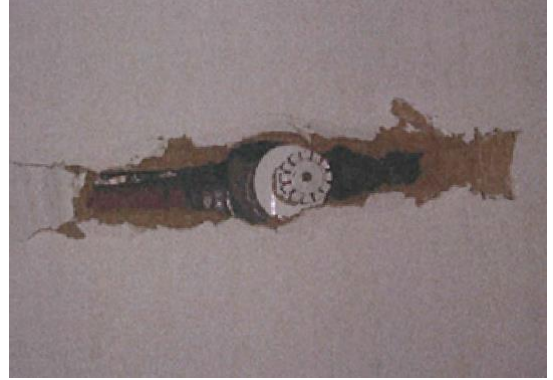


Figure 82: Damage to ceiling tile from an unrestrained fire protection system.



Figure 83: Damage caused by unrestrained services.



Figure 84: Lack of suspension points.



Swimming Pool/Sauna Environments

These areas provide a harsh environment. Selection of metal fixing and framing components is important in indoor pool environments. Galvanic corrosion and stress fracture failure of parts can occur, therefore extra care shall be taken during installation. Aluminium and stainless steel products may be used in indoor swimming pool environments,

however, joining of stainless steel to aluminium is to be avoided where possible as this type of connection may lead to galvanic corrosion and failure of the fixing.

Isolation between aluminium and stainless steel is often achieved with nylon or rubber components.

Aluminium brackets and components shall be protected against galvanic corrosion. This can be achieved by either powder coating or anodising (Marine Grade 25 micron minimum).

12

Tendering

Suspended ceiling contractors tendering for suspended ceilings must consider and make due allowance for the cost implications of the seismic restraints and seismic design that will be required and clearly identify the provisions that have been made.

OPTIONS FOR TENDERING

The need for ceilings to be seismically resistant is not new. However, there is a new awareness of the need to be able to demonstrate that installed ceilings have been properly seismically restrained.

A suspended ceiling contractor shall check at the time of tendering the actual requirements for each ceiling of the tender documents. The tender documents should include structural engineering information required for tender options 2 and 3, including annual probability of exceedance, building importance level, building component category, SLS/ULS, provisions for load transfer to structure, requirements for producer statement and any confirmation that services loads will be restrained in accordance with NZS 4219:2009.

In the interests of ensuring true competition in the marketplace, each company must determine its own commercial terms, including but not limited to the prices charged, the risks accepted and the wording of its tenders. Therefore, any AWCINZ recommendations regarding tendering methodologies are advisory only and are intended to raise awareness of the issues that should be considered in determining a tender price. Suspended ceiling contractors should also be mindful that qualified (or tagged) tenders may be treated as non-compliant and may not be considered. The options developed by AWCINZ in its tendering protocol are designed to assist tenderers to:

- submit offers based on consistent information
- reduce the number of tags
- reduce the number of on-site variations
- reduce the number of on-site work conflicts with other trades
- give a more accurate costing
- reduce the number of variables in the tender.

There are three main options for responding to tenders. The response will depend on the level of information available at the time of tender.

OPTION 1: WHERE TENDER DOCUMENTS INCLUDE FULL DETAILS OF SEISMIC RESTRAINTS

This option is preferred to encourage fully conforming and untagged tenders and to assure fully compliant ceiling installations. Prepare the tender to include the following qualifications.

Model tender qualification where seismic restraints are fully detailed

We have allowed for the seismic restraints as detailed on the understanding that they have been fully designed and detailed in the tender documents to conform with the requirements of AS/NZS 2785:2020 and NZS 1170.5:2004. The suspended ceiling contractor will be responsible only for the installation of the restraints as detailed and for the provision of the associated construction producer statement (PS3) to confirm that the ceiling has been constructed in accordance with the design.

Any additional bracing or modification to the ceiling system to achieve the required level of seismic bracing or to co-ordinate with structural elements or building services shall be a variation

We have not allowed for any engineering design, design producer statements (PS1, PS2), installation review by engineer (PS4) or for any additional work that may be required to co-ordinate the ceiling supports and restraints with

other services and their associated restraint systems and spatial requirements.

OPTION 2: WHERE SEISMIC RESTRAINT DESIGN IS REQUIRED TO BE CARRIED OUT BY THE TENDERER

Unless seismic restraints have been fully designed and detailed in tender documents, it is unlikely that the documents supplied to the suspended ceiling contractor will have enough information to determine the seismic restraints requirements and their interface with the structural elements and building services.

As the nature and cost of seismic details will not be known until completion of design by the NSE seismic designer - ceilings, this methodology will require the inclusion of provisional sum allowances in

Ideally, the provisional sum allowances, based on the nominated building seismic Importance Level and any additional bracing requirements over and above the minimum required to comply with the NZBC will be specified in tender documents. Where this is not done, the suspended ceiling contractor should nominate a provisional sum allowance in the tender and include that allowance in its tender price.

This option encourages fully conforming tenders generally limited to IL1-IL2 buildings and some IL3 buildings (refer Figure 2 flowchart). Option 2 tenders should identify the proposed bracing concept, the applicable manufacturer's generic design guide and any underlying design assumptions.⁶ Any ceilings outside the scope of manufacturers' generic design guides should be nominated in the tender and identified for specific engineering design and a provisional sum allowed for engineer-designed bracing as Option 3.

Model tender qualification where seismic restraints are not detailed in tender documents

As the seismic restraints have not been fully designed, we have allowed a provisional sum of \$[state amount included in tender price] based on manufacturers generic design guide and project information supplied.

[OR, where a provisional sum is nominated in the tender documents]

We have allowed the specified provisional sum of \$[state amount included in tender price].

The provisional sum shall cover all costs associated with specialist engineering design and issue of associated design producer statements (PS1), any design review statement (PS2), the supply and installation of seismic bracing and engineering monitoring and provision of engineer producer statements (PS4) that may be required for the actual seismic restraints.

OPTION 3: SPECIFIC ENGINEERING DESIGN

Specific engineering design is required where Option 1 does not apply and Option 2 does not apply to some or all ceilings.

Unless full engineering data has been provided within the tender documents, such design must be carried out post-tender when full structural and building performance data is available. Where the scope of seismic bracing cannot be accurately ascertained at tender, a provisional sum⁷ should be nominated for the added cost of bracing.

Model tender qualification where specific engineering design is required

We have allowed for ceilings to be constructed in accordance with the specific engineering design supplied.

The main contractor shall, without charge to the ceiling contractor:

- provide suitable fixing points and all secondary steelwork, purlin blockings and so on for fixing of ceiling hangers and bracing
- provide continuous nogs to allow solid fixings wherever ceilings abut partitions and bulkheads
- ensure that all in-ceiling services are installed strictly in accordance with NZS 4219:2009 including that all components and services over 7.5 kg are restrained from gravity and earthquake forces with proper clearances from ceiling and supports in accordance with NZS 4219:2009
- co-ordinate the required bracing with structure and in-ceiling services.

Any requirement for additional steelwork to modify proposed bracing or support requirements due to a lack of structural fixings and support or for co-ordination with in-ceiling services is a variation.

GENERAL TENDER QUALIFICATIONS

- A suspended ceiling design, or Producer statements where specified, shall be provided for the entire design and/or the completed ceiling installation. Any additional or interim producer statements for separate areas or completion stages shall be a variation.
- Drawings shall comprise as a minimum reflected ceiling plans marked up to show the position and type of seismic bracing and seismic control provisions.
- Drawings submitted for approval shall, unless approved in writing, be deemed approved within 10 working days of submittal.

TENDER, CONSENT AND SHOP DRAWINGS

Several types of drawings can be produced for a project. The contract type will determine what will be produced and by whom:

- Tender documents can give performance requirements for the suspended ceiling or can be more detailed, depending on the nature of the design methodology.

- They must contain at least some minimum physical information as well as the finished aesthetic. Usually produced by the lead designer.
- Consent drawings must show how the proposed system meets the requirements of the NZBC and the relevant clauses (B1 *Structure* and B2 *Durability*). Usually produced by the lead designer.
- Shop drawings generally show all detail so that all components can be priced accurately.

Ceiling design defines the seismic restraint types and locations, engineering calculations, inspections for construction monitoring (if required) and certification. The development of shop drawings for seismic restraints requires:

- co-ordination of the designer's reflected ceiling plans with structural and architectural features and partitions
- co-ordination of ceilings with building services installed within the ceiling void attached to or suspended above or adjacent to the ceiling and other architectural features
- co-ordination of ceiling and above-ceiling services restraints and seismic clearances providing support and bracing of building services and other components over 7.5 kg supported by the ceiling system.

This may require attendance on co-ordination meetings and discussions with relevant services and partitioning trades as early as practicable to establish methodologies for key co-ordination issues.

Design details and appropriate producer statements may be required in the consent application and project specification.

6 Unless otherwise stated in the ceiling contractor's tender, underlying assumptions include building importance level of 3 or less (AS/NZS 1170.0:2002 Table 3.2), relevant geographic location (NZS 1170.5:2004 Table 3.3), annual probability of exceedance 1/25 (AS/NZS 1170.0:2002 Table 3.3) and adequate space and fixing provisions for installation of compliant seismic restraints.

The main contractor or the client's NSE Seismic Designer -ceilings should verify tenderers' stated assumptions post-tender when full engineering data is available, and any required additional bracing should be a variation.

7 A provisional sum (not being an estimate) for seismic bracing should identify the ceiling areas requiring specific engineering design to cover the cost of specialist engineering design, design producer statements (PS1), supply and installation of seismic bracing and engineer producer statements (PS4) for the actual seismic restraints. Unless otherwise stated, such provisional sum would be additional to the tender price.

13

Installation

SITE CONDITIONS

Internal ceiling installation work is not to commence until the building is effectively watertight or in accordance with suppliers specifications, and the work of all wet trades has been completed and dried, unless specifically designed for this situation.

External ceiling work can commence once the construction above the ceiling is completed.

MATERIAL STORAGE AND HANDLING

Ceiling tile faces are the visible finished face, so ensure hands are clean and grease-free or wear white gloves when handling the tiles. PPE should also be used when handling metal products to avoid any potential injuries, eg gloves, glasses etc.

When materials are stored on site, they must be laid flat and protected from water or impact damage.

PRE-INSTALLATION CHECKLIST

Before commencing work, the installer needs to confirm with the project manager the installation parameters:

- Where will materials be stored? Is it safe and secure? Is it clean? Will the materials sustain any damage?
- Will the installer have clear access to do their work, or will other trades be working in the same space at the same time?
- Will the installer be able to complete their work in one continuous time period with no interference from other trades, i.e. can they safely leave work incomplete or must they secure it at the end of each day?
- Will the installer be able to complete their work on consecutive days?
- Will scaffolding/elevating work platforms be available for the installer's use, or do they need to provide their own?
- Will lighting and power be supplied?
- Who is responsible for clearing waste materials, and where are these to be deposited?
- Will the space be fully closed in and protected from external weather before installation commences?

- Has the set-out point for all subtrades in the plenum been determined?

FACILITIES FOR INSTALLATION OF SUSPENDED CEILINGS

Unless otherwise agreed, a suspended ceiling contractor is entitled to assume that a builder/client will provide the following upon request and free of charge:

- Suitable fixing points and adequate space for the gravity hangers and seismic restraints for the suspended ceiling system.
- All secondary structure, framing, purlin blockings and the like in suitable positions to attach ceiling hangers and braces.
- Continuous nogs to provide for solid fixing to partitions and bulkheads where ceilings abut.
- All partitions appropriately braced independent of the ceiling grid by the partition installer to avoid lateral force on the ceiling grid.
- All in-ceiling services installed strictly in accordance with NZS 4219:2009.
- All components and services over 7.5 kg to be supported by the ceiling system shall be restrained by the relevant installer from gravity and earthquake forces, and producer statements shall be provided.
- Installers of components and services will certify the actual weight of any services under 7.5 kg that are to be supported by the ceiling grid.
- Building services installed with proper clearances from ceiling and supports in accordance with NZS 4219:2009.
- In-ceiling services designed with due allowance for the gravity supports and seismic bracing that will be required.

Any requirement to provide additional steelwork or to modify the planned bracing or support requirements due to a lack of reasonable provision for gravity fixings and support for the ceiling and associated bracing, or to overcome clashes with in-ceiling services, will be treated as a variation.

BEST-PRACTICE CO-ORDINATION WITH OTHER CEILING SERVICES

The installer should view all drawings relating to the plenum before commencing installation work. They need to be aware of other trade work to be installed in the void, wall/ceiling junctions, movement joints, seismic restraints or lack thereof.

A meeting should be held with the project manager and all other trades to ensure that access, timing, conflicts and so on of all work in the plenum is co-ordinated. Any conflicts that arise must be brought to the attention of the project manager and resolved before any further work is installed. It is the responsibility of the installer to visually inspect all aspects of the project before commencing. If there are any issues arising, they should be resolved fully via the project manager before commencing any work.

INSTALLATION DETAILS TO SEISMIC DESIGN

The lead designer or engineer is responsible for a complying workable design. However, the installer must not carry out any installation if it is immediately obvious that there is either a conflict with another building component or there is a deficiency in the design. If such a situation arises, the installer must resolve this with the engineer and project manager before proceeding any further.

AESTHETICS

There are many design details that can influence the finished aesthetic of a ceiling design, both from a design and a good workmanship perspective. These include:

- construction tolerances
- consistent shadow gaps
- accurate 90 degree angles
- wall angle alignment
- large wall angles (>25 mm) often show waves
- level = 1 in 360 maximum.

Installers must be trained either by the supplier and/or their installation company on the appropriate health and safety issues.

SPECIALTY TOOLS

Installers must be trained either by the supplier and/or their installation company on how to deal with the proprietary fittings for different types of systems, but the minimum range of tools that they must know how to use are:

- laser levelling systems
- aviation snips
- drill
- pop rivet gun
- hole punch
- hole saw
- screws
- grid clips.

QUALITY ASSURANCE

The two key principles of quality assurance (QA) are that products are:

- fit for purpose – the product is suitable for the intended purpose
- right first time – foreseeable mistakes are to be eliminated.

Though outside the scope of this Code of Practice, QA includes management of the quality of raw materials, assemblies, products and components, services related to production as well as management, production and inspection processes.

Site variations can be minimised by carrying out some pre-installation processes such as:

- checking that the correct product and the correct volume has arrived
- co-ordinating installation processes with other trades to remove any conflicts
- reviewing installation drawings for layout and fixings of all other building components in the plenum.

Any quality control programme shall include:

- inspection of material and workmanship
- conformance to plans/construction documents
- special inspections
- a thorough inspection throughout and on completion of the project.

Job sheets shall be signed by all parties involved to show that the installation has been completed as designed and specified (see Appendix F, page 83 for a sample QA sheet).

INSPECTION

An inspection of ceiling framing prior to installation of tiles or panels shall include checking for compliance with the manufacturer's recommendations and in particular:

- spacing of support hangers – typically 1200 mm maximum but reduced around the perimeter to 400–600 mm typically
- angle of hanger support – no more than 1 in 6 from vertical
- fixing of support hangers – screwed to purlin webs, never hooked over purlin lips, never pop riveted, never fixed to other plenum services
- perimeter fixing – solid wall or bulkheads
- perimeter fixing – perimeter brackets fixed where necessary
- adequate support of ceilings beneath large service ducts or group of closely spaced services (bridging members may be needed), and the ceiling system shall not be suspended from any building services such as ducts
- support around access hatches – ensure support members are not cut unless additional trimmers and hangers are provided, note manufacturers' recommendations around additional trimmers to support openings and ensure the opening will not adversely affect the ceiling's performance in an earthquake
- support of lighting – ensure lighting is fixed into or supported independently as per the intended design, and note the manufacturer's recommendations around additional trimmers and/or hangers to support lighting
- downlights or other services shall not rely on the ceiling panel for support – they shall be installed in rigid infill, for example, MDF board, supported on the ceiling grid, or the load shall be transferred back to the ceiling structural components
- bulkheads shall be attached to the structural soffit, independent of the ceiling, unless specifically designed otherwise
- wind uplift – provide back bracing of ceilings to all external areas and where necessary to internal installations.

Seismic-specific detail check to include:

- seismic brackets to two adjacent walls and sliding joint to the other two walls where specified – ensure screws are fixed in the correct locations in the brackets, as in some systems, the screw location is the principal difference between a sliding and fixed connection
- back bracing is located as specified and constructed to the specific bracing details
- seismic joint clips are installed on main tee connections where recommended by the manufacturer or ceiling seismic designer
- seismic joint clips are installed on cross tee connections where recommended by the manufacturer or ceiling seismic designer.

REFURBISHMENT WORK

For any refurbishment project, work must not commence before the primary support structure has been inspected and verified by a suitably qualified person as being structurally sound for a suspended ceiling to be hung from and/or attached to walls. An inspection should also include any other non-structural building components already in the proposed plenum or any new such components to be installed at the same time.

When extending, modifying or refurbishing existing ceilings, if available, the same components as existing shall be used to ensure a consistent finish.

Note that subsequent changes in the compliance requirements of the NZBC may require more extensive work to be carried out than a replacement of comparable component or assembly, for instance, there may have been an increase in the seismic capability required. In such instances, a seismic design will be needed to ensure compliance with the newer requirement.

See Ceilings Exempt from Building Consents page 17.

Replacement of ceiling tiles with similar weight tiles does not normally require consent or additional seismic bracing.

14

Partitions

Partitions that are tied to the ceiling shall be laterally braced to the building structure. The bracing shall be independent of any ceiling splay bracing system, and the ceiling must not be perimeter fixed.

project-specific seismic gaps must be allowed for any through penetrations in the ceiling.

Here are some examples of partitions that are supported independently of ceilings.

Partitions are not to be braced to the ceiling unless they have been designed to do so, and

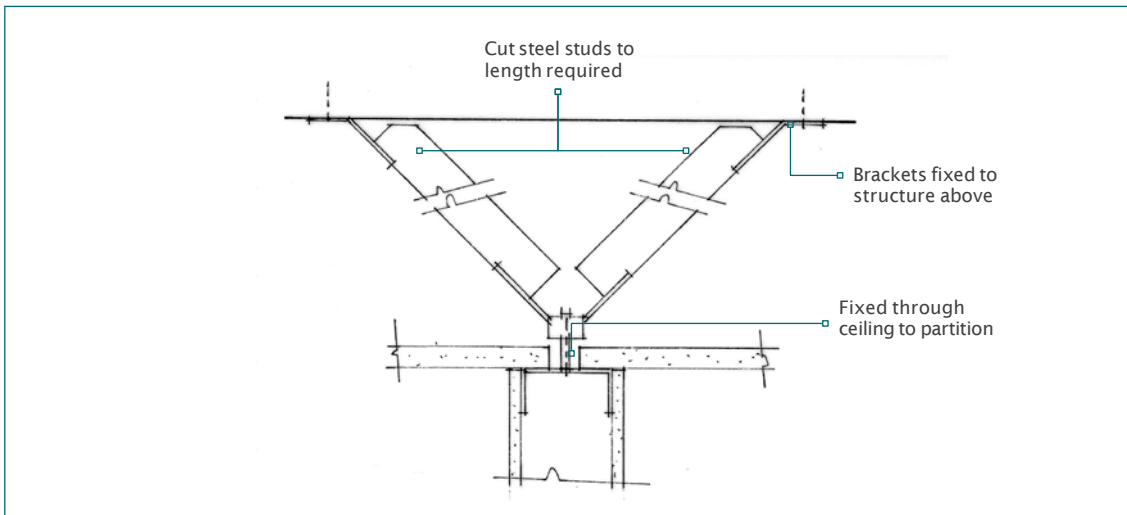


Figure 85: Proprietary internal wall bracing connection (isolated from ceiling movement).

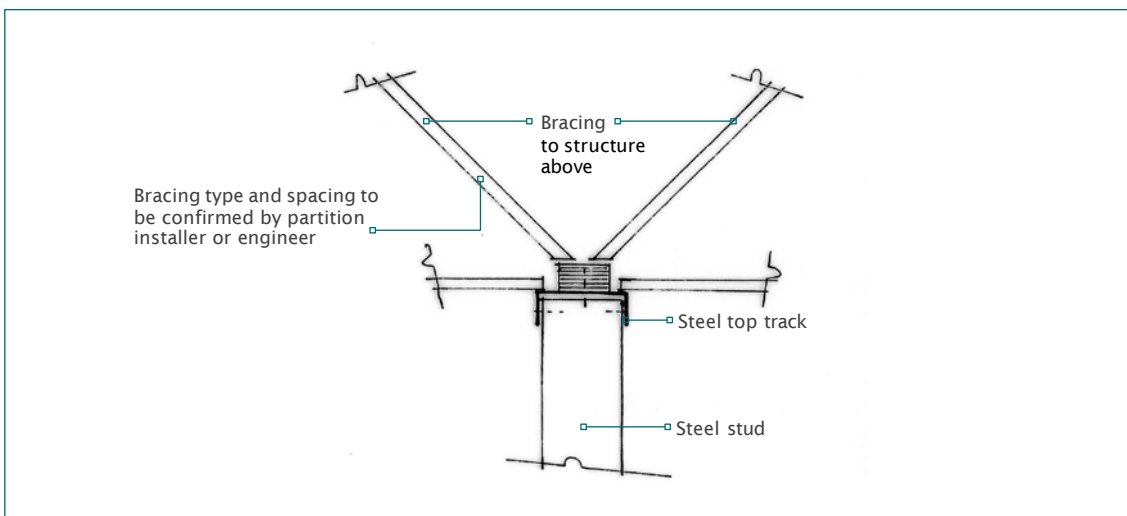


Figure 86: Generic internal wall bracing connection - wall terminates at ceiling.

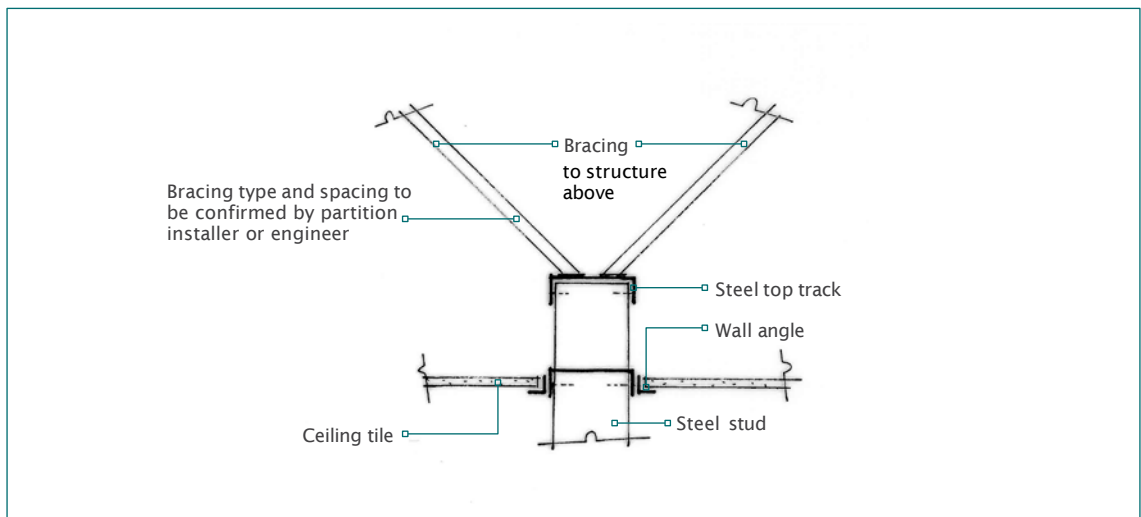


Figure 87: Generic internal wall bracing connection – wall terminates above ceiling.

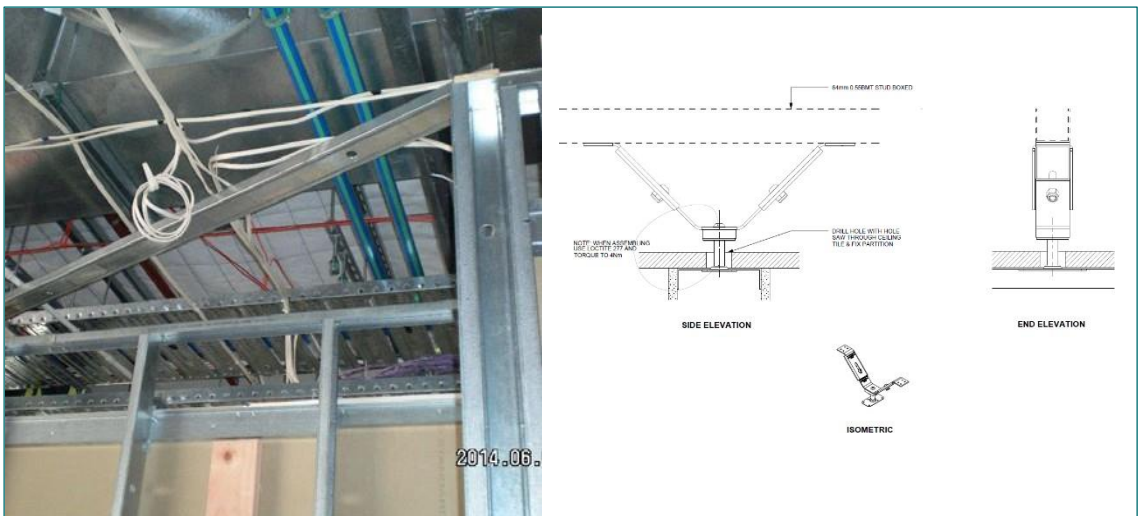


Figure 88: Horizontal bracing – wall terminates at ceiling.

15

Fire and suspended ceilings

The fire design of suspended ceilings is outside the scope of this Code of Practice. The following information is intended to highlight some features of fire-rated ceilings.

Suspended fire-rated ceilings may require specific engineering design for seismic restraint.

Consult manufacturers/suppliers for detailed information.

A fire-rated ceiling helps prevent fire and/or heat from reaching a floor or roof above a room that is on fire. This allows time for evacuation of the floors above and protects against property damage.

A fire-rated ceiling system is part of a total fire-rated assembly, which includes approved beams, joists and floor or roof assemblies.

The fire resistance rating (FRR) of a building assembly (walls, floor/ceilings and so on) refers to the period of time the assembly will serve as a barrier to the spread of a fully developed blaze. It also refers to how long the assembly can function structurally after it is exposed to a fire of standard intensity as defined in AS 1530.4:2014.

The designation for a system to resist the passage of fire is represented by three performance measurements and normally expressed as 60/60/60, 30/30/30 and so on. It can also be expressed as -/60/60 etc where Structural Adequacy is not a requirement.

The numbers indicate minutes, which, in order of expression, represent:

- **structural adequacy** – failure occurs when the specimen collapses under load
- **integrity** – failure occurs when the specimen develops cracks or openings through which flames or hot gases can pass

- **insulation** – failure occurs when the average temperature of the unexposed surface of the specimen increases by more than 140°C above the initial temperature or the temperature at any point of the unexposed surface increases by more than 180°C above the initial temperature.

PASSIVE FIRE

Penetrations through fire-rated ceilings need to be protected to the same rating as the ceiling and adequately restrained so that, in the event of seismic movement, the fire rating is not compromised.

This is dictated by the specification and can be determined by a fire engineer or manufacturers' product literature as to the type of treatment required.

The individual who penetrates the passive fire protection is responsible for ensuring that the integrity of the passive fire protection is maintained and/or reinstated after work is completed.

EARLY FIRE REACTION

How an interior surface finish reacts when exposed to a fire is detailed in the NZBC C3 section. This tabulates the finish rating as Group Numbers. The Material Group Number is a numeric representation of the performance achieved during the test and is used as a standardised benchmark for the assessment of surface finish performance. The Group Number requirements are repeated within the Acceptable Solutions C/AS2 relevant to each building occupancy risk group. 1-S is the best rating, down to 4.

NOTE: The Group Number rating method (to ISO 5660 or ISO 9705) has replaced the previous Standard AS/NZS 1530.3 test method, which is no longer acceptable.

16

Acoustics

The acoustic design of suspended ceilings is outside the scope of this Code of Practice. The following information is intended to highlight some features of acoustic-rated ceilings.

Acoustic ceiling systems are designed to deal with sound 'pollution' – unwanted sound either from noise within the room or from noise travelling into or out of the room.

SOUND ABSORPTION (NRC)

When sound is reflected by a surface, it loses part of its energy. This energy loss is called sound absorption or the sound absorption capability of that surface. The single number rating of how much sound an acoustic product absorbs is called the noise reduction coefficient (NRC).

The NRC is expressed as a number between 0.00 and 1.00. The higher the number, the better the surface acts as an absorber. As a guideline, an NRC of 0.70 or greater is recommended for open-plan offices. Ministry of Education DQLS require 0.85 or higher of the ceiling including ceiling mounted services

SOUND TRANSMISSION (STC, CAC)

When sound travels from its source through the walls, floors and ceilings of adjoining rooms, this is called sound transmission. The rating system that evaluates the effectiveness of assemblies to isolate airborne sound transmission is called the sound transmission class (STC). The ceiling attenuation class (CAC) is a related rating system specifically for sound transmission through the ceiling and plenum. A CAC of 40–44 is recommended for closed-plan offices.

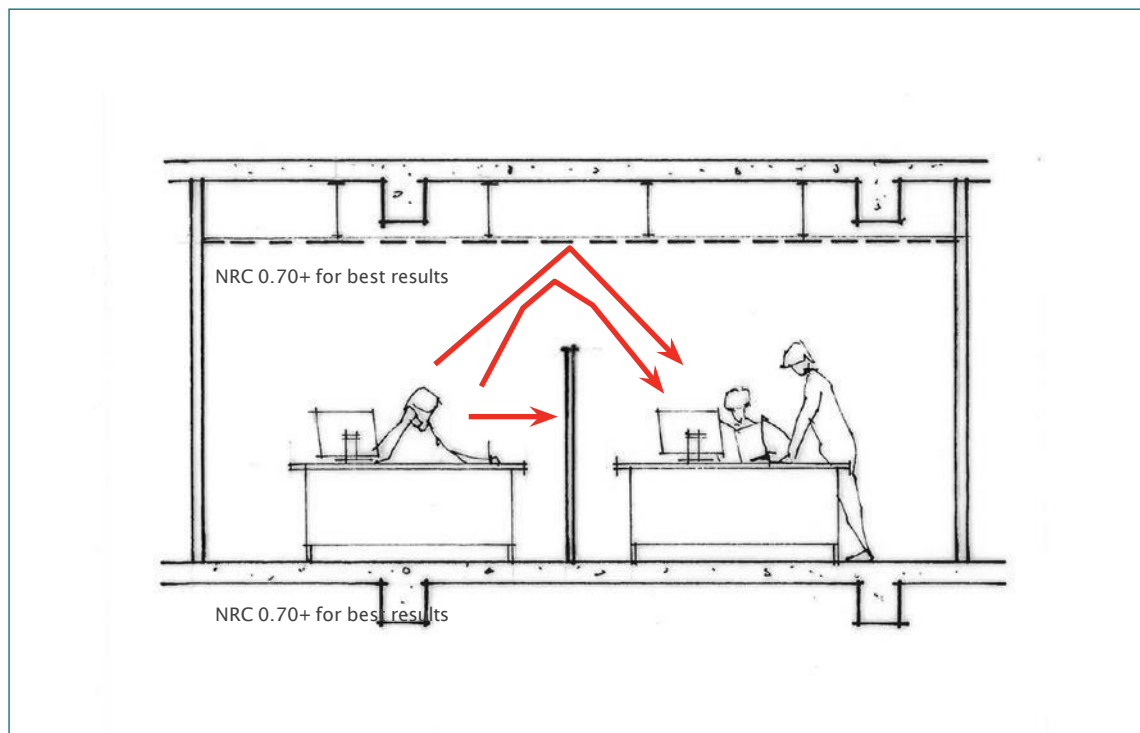


Figure 75: Sound reflection.

All materials absorb, reflect and dampen sound vibrations to some extent. Truly acoustic materials absorb sound to a measurable degree, with a minimum NRC of 0.50.

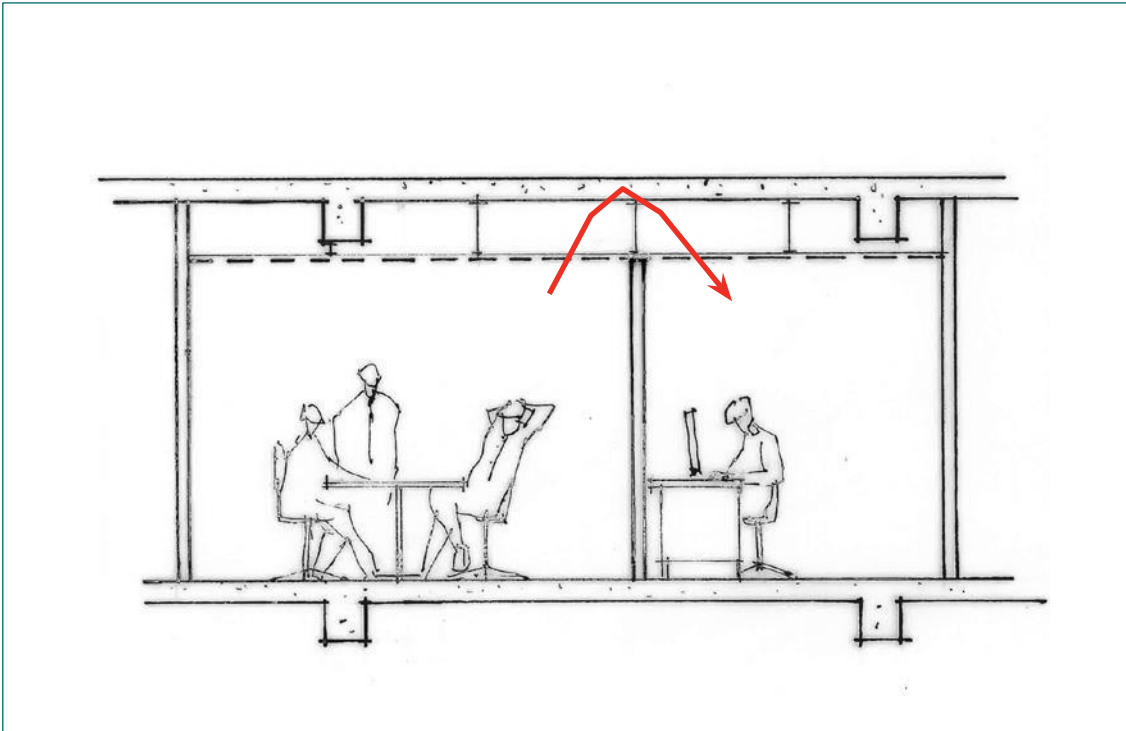


Figure 76: Sound transmission.

EXTERNAL SOUND TRANSMISSION (STC)

Typically, rain, aircraft, rail, motorway etc can affect room acoustics and clarity of communication. Depending on roof type construction materials, this can be an issue. Use of mass loaded barriers of high-density material (with a weight of 10 kg/m² or more) will help reduce the passage of external noise, such as:

- Plasterboard
- Other solid sheeting materials like fibre cement, particle board etc.
- Ceiling tiles with a high CAC rating (usually plaster-backed or high density)

A typical STC value reduction will be a little less than half a CAC value. STC values will vary more due to type of material and how they are attached to the building structure.

17

Monitoring design and construction

Monitoring design and construction is a key part of the process but is often neglected. Producer statements, although not statutory documents, are commonly required by contractors. The IPENZ construction monitoring levels are also used to monitor design and construction.

PRODUCER STATEMENTS

A producer statement⁹ is a document prepared by a specialist confirming their professional opinion, based on stated reasonable grounds, that aspects of design of a building achieve compliance with the NZBC or that elements of construction have been completed in accordance with the approved building consent. The intent of a producer statement is evidence to the building consent authority that the design, installation and monitoring work complies.

Design producer statement (PS1)

A PS1 is a statement of opinion that certain aspects of proposed building work will comply with the NZBC if the work is constructed according to the referenced documentation (for example, engineering design drawings and specifications).

Where a PS1 is required for seismic design that is undertaken, a structural specialist provides structural design details and calculations and issues a PS1 certificate accordingly.

Design review producer statement (PS2)

A PS2 is a statement of opinion, based on a review of design documents that have been prepared by others, that the aspects of proposed building work reviewed will comply with the NZBC.

An independent engineering review by a suitably experienced Chartered Professional Engineer (CPEng) may be required:

- where the suspended ceiling subcontractor or suspended ceiling system supplier prepares designs and details for review and certification by an external structural specialist and provides a PS1, or
- where the suspended ceiling contractor prepares pre-engineered (non-project-specific) and pre-reviewed generic details from the suspended ceiling system supplier.

Table 9: Producer statements likely to be required for NZBC compliance.

Compliance type	Producer Statement type			
	PS1	PS2	PS3	PS4
Specific engineering design and design producer statement required	If specified			
Design review by independent NSE Seismic Designer - ceilings required		If specified		
Construction producer statement required			Yes	
Monitoring of installation by qualified independent NSE Seismic Designer - ceilings required and issue of PS4 certification				If specified

Construction producer statement (PS3)

A PS3 is certification from the suspended ceiling contractor that the ceiling has been installed in accordance with the relevant design, New Zealand standards and/or building consent as applicable.

The suspended ceiling contractor should take care to ensure that the wording of the PS3 certification accurately reflects the scope of work that has been carried out.

A PS3 template example is shown in Appendix D and available to members on the AWCi website.

Construction review producer statement (PS4)

A PS4 is a statement of opinion, based on reasonable and stated grounds that may include the records of construction monitoring and information supplied by the contractor, that certain aspects of building work have been completed according to the building consent and amendments.

Where required for the seismic design of the ceiling or by the tender documents, a structural specialist should provide the level of construction monitoring they consider appropriate and issue a PS4.

CONSTRUCTION MONITORING (CM) LEVELS

The construction monitoring (CM) levels¹⁰ and guidelines below are based on IPENZ Engineering Practice Guideline – Construction Monitoring Services.

Level CM2

- CM2 is an appropriate level for smaller routine projects such as a small office fit out. Representative samples of key design elements such as seismic braces and connection details are required to be inspected to ensure the correct materials and construction methods have been used. The compliance of the finished work is then dependent upon the installer completing the work to at least the same standard as the representative sample reviewed.
- Be available to provide the constructor with technical interpretation of the plans and specification.

This is considered appropriate for building importance level 1 or 2 buildings being undertaken by an experienced and competent suspended ceiling contractor and where a higher than normal risk of non-compliance is acceptable.

Level CM3

- For CM3 random sampling of important work procedures is required. For example, the review of typical shop or office fit-outs like those found at Commercial Bay in Auckland is appropriate at CM3. Sampling of at least 33% of each design feature is recommended ensuring these samples are spaced throughout different areas in the build to ensure there is a consistent quality of work.
- Be available to provide the constructor with technical interpretation of plans and specifications.

This is considered appropriate for building importance level 3 buildings being undertaken by an experienced constructor when a normal risk of non-compliance is acceptable or for building importance level 1 or 2 buildings where the suspended ceiling contractor is not experienced in seismic restraints installations.

Level CM4

- The required sampling steps up from random to frequent in CM4. This level of service is appropriate for projects such as Auckland Town Centre or the Canterbury University's new engineering block. To ensure work methods and materials meet this level of compliance, sampling 66% of each design feature across as much of the project as possible is recommended.

This is considered appropriate for all building importance level 4 buildings where a lower-than-normal risk of non-compliance is required and building importance level 3 buildings where the services trade contractor is not experienced in seismic restraint installations.

⁹ See Engineering NZ Guidelines on Producer Statements, 2021 – <https://www.engineeringnz.org/engineerools/engineering-tools/documents/producer-statements/>

¹⁰ CM1 (monitor outputs from another party's quality assurance programme) and CM5 (full-time on-site monitoring) have not been included as they are not relevant to the construction monitoring required to be carried out by a structural specialist.

18

Summary of roles and responsibilities

As with any construction project, there are many parties involved. All have different roles and responsibilities, and in many steps of the process, the roles and responsibilities of several parties will overlap.

In general, the greater the collaboration and the earlier communication between all parties commences, the greater the chances of a successful project with fewer contract variations, omissions or parties ending up out of pocket.

DESIGNER

The seismic design of suspended ceilings must be undertaken by a suitably qualified person.

The designer's responsibilities are to:

- identify the seismic requirements of the ceiling
- design the ceiling
- design appropriate seismic restraints
- issue or obtain a PS1 to certify the design if required
- commission a PS2 if required
- issue or obtain a PS4 if contracted to do so.

The lead designer may be an architect, interior designer, engineer, or specialist NSE Seismic Designer - ceilings familiar with seismic requirements and industry seismic calculators. The lead designer oversees the entire documentation process as a whole and must be aware of all the components in the plenum and how they interact and ensure that all parties are aware of

Each component in the plenum may also have its own specialist designer. Ideally, the lead designer will co-ordinate all other non-structural building components in the plenum so that there are no conflicts. They may need to modify the design to co-ordinate and overcome clashes with other components and the related fixings and bracing designed by their structural specialists.

CEILING TENDERER

The ceiling tenderer is the contractor who supplies and installs the suspended ceiling.

The tenderer's responsibilities are to:

- ensure all ceiling details 'work'
- verify the seismic requirements of the ceiling (as identified by the designer or based on the information provided)
- identify a provisional sum allowance for seismic restraints (as applicable)
- review co-ordination with other trades.

INSTALLER

The installation of suspended ceilings shall be undertaken by a suitably qualified person with experience in ceiling installation. A suitably qualified person will hold a National Certificate in Specialist Interiors (Installation) and/or be a certified tradesperson or under the supervision of a suitably qualified installer or a certified business member of AWCINZ.

The installer's responsibilities are to:

- prepare shop drawings (if applicable)
- submit shop drawings (if applicable)
- obtain design approvals (if required)
- install the ceiling in accordance with the approved shop drawings or seismic design details.
- inspect seismic restraints for conformance with approved design
- issue a PS3 to certify that the installation has been completed in accordance with the design.

Before commencing any work, the installer shall visually inspect the site and raise any issues arising with the project manager. The installer shall also hold a meeting with the project manager and all other trades with components in the plenum and supported by the ceiling to co-ordinate installation scheduling, location of their components and all fixing points.

MANUFACTURERS

The manufacturer/suppliers' responsibilities are to:

- provide the materials, equipment etc needed by the various contractors, and specialists.
- Ensure that the materials supplied are of the same quality as claimed in the approvals and specifications.
- adhere to set delivery schedules and timelines.
- provide complete documentation including material safety data sheets, approvals, certifications, etc. when required.
- Provide Building Product Information (BPIRs) as required under the regulations that came into effect in December 2023.
- Manufacturer/suppliers may also provide services as detailed in Tables 4 and 5.

BUILDING CONSENT AUTHORITY

Registered building consent authorities perform building consenting functions under the Building Act 2004.

The BCA's responsibilities are to:

- grant building consents for NZBC compliance of building work, including building elements that form part of the seismic ceiling designs.
- inspect building work to ensure it is consistent with the plans and specifications that received consent.
- issue a code compliance certificate for the completed building work.

Appendices

A. DEFINITIONS, ABBREVIATIONS AND NOTATIONS

Acceptable Solution

A prescriptive design solution comprising step-by-step instructions that, if followed, is deemed to comply with the NZBC. Acceptable Solutions and Verification Methods are published by the Ministry of Business, Innovation and Employment and often cite other documents such as New Zealand standards. Designers and builders are not obliged to use Acceptable Solutions and may put forward their own Alternative Solution proposal.

Alternative Solution

A design solution that differs totally or partially from Acceptable Solutions or Verification Methods yet complies with the performance requirements of the NZBC. These are stand-alone solutions put forward and substantiated by the building consent applicant and considered and approved on their individual merits by a building consent authority.

annual exceedance probability

The chance or probability of a natural hazard event (usually a rainfall or flooding event) occurring. Typically defines an earthquake that is likely to occur during the lifetime of the structure.

brace (see also K-brace, knee brace)

Component used to restrain the ceiling. Usually attached to the structure above.

bridge

A horizontal bar supported by hangers/wires to span under ducting or services.

Building Code clauses

B1 - Structure

B2 - Durability

C3 - Fire affecting areas beyond the source

G3 - Food preparation and prevention of contamination

Building Importance Level

Refer Table 1, page 11.

ceiling attenuation class (CAC) (see also STC)

Similar to STC, this rating system is specifically for sound transmission through a ceiling and plenum.

Chartered Professional Engineer (CPEng)

A statutory title under the Chartered Professional Engineers of New Zealand Act 2002, which established a register of professional engineers whose competence is up to date.

concealed

Term usually associated with suspension systems where the ceiling tile fully covers the suspension framing. Sometimes also used to describe a plasterboard lined ceiling.

contract variation, site variation

An amendment to a contract that changes the original terms or conditions of the contract.

cross tees, cross runners, cross T-bars

A cross member that interlocks with a main beam.

designer

The person who designs the suspended ceiling.

diffuser

A circular or rectangular metal grille used for the passage of air from a ducted system.

earthquake action, return period

An estimate of the likelihood of an event, such as an earthquake. Also known as a recurrence interval.

engineer

Person qualified as an engineer. May not be chartered.

essential service buildings

Any building designed to be used by public agencies such as a fire station, Police station, emergency operations centre or emergency communications centre.

face load

A force applied at right angles to a building plane.

grid

The main beams and cross tees of the suspension system.

hanger wire, suspension wire

2.5 mm annealed wire used as the primary support for the grid system.

hanger

A type of suspension for the ceiling. It may be wire, rod or a rigid style of brace to resist vertical movement.

K-brace (see also brace)

A type of brace for the ceiling. It may be wire or a rigid style of brace to resist horizontal movement in one direction.

knee brace (see also brace)

A type of brace, typically used above a partition. It is normally a rigid style of brace to resist horizontal movement in one direction.

lateral force bracing

The bracing method used to prevent or to restrict lateral movement during a seismic event.

linear ceiling

Long lengths of a material, usually light metal, that form the ceiling.

main tee, main beam, main runner, carrying tee, carrying runner

The primary suspension member supported by hanger wires.

main contractor

Head builder, usually appoints subcontractors for specialist building work.

movement joint

Area of connections designed to allow for movement.

noise reduction coefficient (NRC)

The amount of sound an acoustic product absorbs.

NSE Seismic Designer - ceilings

Can be a specialist designer, engineer, or suitably qualified ceiling contractor

one-way grid

Tile edge design conceals the grid in one direction.

perimeter clips

Proprietary angle bracket attached directly to the wall trim, which allows for movement in the event of seismic activity and interlocks properly with the ends of a grid system.

perimeter wires

Hanger wires placed within 200 mm of the surrounding walls.

plenum

The space between the underside of the structure above and the suspended ceiling system.

project manager

A person who will be on site and have an overview of the whole project.

provisional sum

An allowance that is inserted into tender documents.

return period

See annual probability of exceedance.

reverberation

When a sound wave continues to reflect around a room after the sound at source has died out.

seismic clip

Proprietary clip designed to either restrain or allow for movement.

seismic joint

Area specified to allow for anticipated movement.

seismic restraint

Components used to resist seismic movement.

seismic strut

Vertical rigid component to resist upward movement, usually supported by diagonal braces.

serviceability limit state (SLS) (see also ULS)

The point where a structure can no longer be used for its intended purpose but would still be structurally sound.

set-out point

The specified starting point used to lay out the ceiling.

sheeted ceiling

Where a suspended ceiling is sheet lined and finished. (Not a grid and tile ceiling)

slack wire

A safety wire that is not tight or taut.

soil type

Ranges from hard rock to soft soil. The ground motion of an earthquake is affected by the soil profile through which the vibrations travel.

sound absorption

The energy lost by a sound when it strikes and is partially reflected off a surface.

sound transmission class (STC)

A rating system that evaluates the effectiveness of assemblies to isolate airborne sound.

specific engineering design (SED)

Seismic restraint design specific to a project, typically outside the scope of seismic design guides.

splay wires

Wires installed at an angle rather than perpendicular to the grid.

spreader bar, spacer bar, stabiliser bar

A bar with notches to prevent the suspension system from separating.

strut

A rigid style of brace to resist horizontal and vertical movement.

suitably qualified person

Person qualified to carry out work.

suspension wire

A wire rod, typically 2.5 mm diameter.

T-rail

An exposed grid.

tag(s), tagged

Design and specification changes that often have a cost implication.

tenderer

A person or company that puts forward an estimate of cost.

tight turns

Installation requirement for suspension wire.

trapeze

An opposing angled wire suspension system.

two-way grid

Grid can be seen in both directions.

ultimate limit state (ULS) (see also SLS)

Reached when the applied stresses exceed the strength of the structure or structural elements.

Verification Method

A prescriptive design solution comprising a calculation or test procedure, which provides an approved way of complying with the NZBC. Verification Methods (along with Acceptable Solutions) are published by the Ministry of Business, Innovation and Employment and often quote other documents such as New Zealand standards. Designers are not obliged to use the Verification Methods and may put forward their own Alternative Solution proposal.

vertical struts, compression posts, seismic posts, seismic struts

The rigid vertical member used in the bracing of the suspension system. Common materials are angles, metal studs or proprietary products.

wall trim, wall moulding

A light-gauge metal wall trim or channel fastened to the perimeter wall or partition to support the perimeter ends of an acoustical ceiling grid.

wet trades

Trades involved with installing products that give off moisture, for example, plastering.

B. RELEVANT STANDARDS AND ASSOCIATED DOCUMENTS

Standards

AS/NZS 1170.1:2002 *Structural design actions – Part 1: Permanent, imposed and other actions*

NZS 1170.5:2004 *Structural design actions – Part 5: Earthquake actions – New Zealand*

Provides procedures for the determination of earthquake actions on structures in New Zealand. It gives the requirements for verification procedures, site hazard determination, the evaluation of structural characteristics, structural analysis for earthquake action effects, the determination and limits for deformations and the seismic loads on parts of structures. It is to be applied in conjunction with AS/NZS 1170 parts 0, 1, 2 and 3 and relevant material standards. Appendices cover aspects of ultimate limit state design and the requirements for material-specific structural design standards that are able to be used in conjunction with NZS 1170.5:2004.

NZS 1170.5 Supplement 1: 2004 *Structural design actions – Part 5: Earthquake actions – New Zealand commentary*

Provides background to the various provisions in NZS 1170.5:2004, suggests approaches that may satisfy the intent of the standard and, if appropriate, describes differences between this and previous editions of the standard. References are provided for further reading, and these are given at the end of each section of the commentary.

ISO 5660-1:2015 *Reaction to fire (cone calorimeter method, heat release, smoke production and mass loss rate)*

ISO 9705-1:2016 *Reaction to fire (room corner test for wall and ceiling lining products)*

AS/NZS 2785:2020 *Suspended ceilings – Design and installation*

Sets out minimum requirements for the design, construction, installation, maintenance and testing of internal and external non-trafficable suspended ceiling systems of dry construction with suspension systems attached to a supporting structure, for use in commercial, industrial and residential applications.

AS 2946-1991 *Suspended ceilings, recessed luminaires and air diffusers – Interface requirements for physical compatibility*

NZS 3404:2009 *Steel structures standard*

NZS 4219:2009 *Seismic performance of engineering systems in buildings*

NZS 4541:2013 *Automatic fire sprinkler systems*

AS/NZS 4600:2005 *Cold-formed steel structures*

Sets out minimum requirements for the design of structural members cold formed to shape from carbon or low-alloy steel sheet, strip, plate or bar not more than 25 mm in thickness and used for load-carrying purposes in buildings.

AS 1397-2011 *Continuous hot-dip metallic coated steel sheet and strip – Coatings of zinc and zinc alloyed with aluminium and magnesium*

ISO 6308:1980 *Gypsum plasterboard – Specification*

ASTM C423-09 *Test method for sound absorption and sound absorption coefficients by the reverberation room method*

ASTM E1414-11 *Standard test method for airborne sound attenuation between rooms sharing a common ceiling plenum (two-room method)*

AS ISO 354-2006 *Acoustics - Measurement of sound absorption in a reverberation room*

Other documents

Acceptable Solutions and Verification Methods for NZBC clause B1 *Structure* (www.building.govt.nz/UserFiles/File/Publications/Building/Compliance-documents/B1-structure-1st-edition-amendment-21)

NZBC clause B2 *Durability* (www.building.govt.nz/UserFiles/File/Publications/Building/Compliance-documents/B2-durability-2nd-edition-amendment-8.pdf)

Codewords Issue 54 – December 2012 – Seismic resistance for engineering systems and non-structural elements (www.building.govt.nz/codewords-issue-054#seismic)

Engineering NZ Practice Note 1, V3
Guidelines on Producer Statements, January 2014
(<https://www.engineeringnz.org/engineer-tools/engineering-documents/practice-notes-and-guidelines/>)

C. TENDERING OPTIONS GUIDELINES

AWCINZ has developed a guideline and protocol to assist in the tendering process. It lists different design methodologies that will give different outcomes. It will assist tenderers to:

- submit offers based on consistent information
- reduce the number of tags
- reduce the number of on-site variations
- reduce the number of on-site work conflicts with other trades
- give a more accurate costing
- reduce the number of variables in the tender.

It is reproduced on the following page or download at www.awci.org.nz/suspended-ceilings/.

AWCI TENDERING PROTOCOL FOR GRID SUSPENDED CEILING INSTALLATIONS

1. All installed suspended ceilings must comply with AS/NZS 2785:2020 and the seismic restraint requirements of NZS 1170.5:2004.
2. AWCINZ members are encouraged to submit tenders for grid suspended ceilings based on this AWCI Tendering Protocol to assure compliance.
3. Options for the design of seismic restraints for Grid Suspended Ceilings include:

Option 1: Full design of ceiling seismic restraints system by NSE Seismic Designer - ceilings tender documents

Full seismic restraints design incorporated in building consent documentation and tender documents.

This option is preferred to encourage fully conforming and untagged tenders, and to assure fully compliant ceiling installations.

Option 2: Generic Design Guides

New Zealand manufacturer/supplier/engineering Generic Design Guide/calculators provide seismic bracing installation details for basic ceilings within product limitations and structural performance assumptions, for subcontractor design and pricing.

This option encourages fully conforming tenders generally limited to perimeter restrained or fixed / float seismic restraint designs of SLS or ULS categories. While some engineering software will allow for braced or plenum restrained designs to be designed, generally coordination with other plenum services may require Specific Engineering Design.

Option 2 tenders should identify the proposed bracing concept, the applicable Generic Design Guide/calculators,¹ and any underlying design assumptions².

Any ceilings outside the scope of Generic Design Guides (eg, generally requiring bracing or services coordination or complex architectural feature ceilings) should be nominated in the tender and identified for specific engineering design, and a Provisional Sum allowed for chartered engineer-designed bracing as Option 3.

- ² Unless otherwise stated in the ceiling contractor's tender underlying assumptions include building importance level of 3 or less (AS/NZS 1170.0:2002 Table 3.2), relevant geographic location (NZS 1170.5:2004 Table 3.3), annual probability of exceedance 1/25 (AS/NZS 1170.0:2002 Table 3.3), and adequate space and fixing provisions for installation of compliant seismic restraints. The main contractor or the client's NSE Seismic Designer - ceilings should verify tenderers' stated assumptions post-tender when full engineering data is available, and any required additional bracing should be a variation.

¹ **Armstrong:** Armstrong Seismic Design Guide – New Zealand Version; Seismic Installations and Armstrong Ceiling Systems

Rondo: Generic Seismic Installation for DONN® Exposed Grid Suspended Ceilings; Seismic design Guidelines – Suspended ceilings

Brevity: Penguin Seismic Calculator

T & R Seismic Calculator

Option 3: Specific engineering design

Specific engineering design (required where Option 1 does not apply, and Option 2 does not apply to some or all ceilings).

Unless full engineering data has been provided within the tender documents such design must be carried out post-tender when full structural and building performance data is available. Where the scope of seismic bracing cannot be accurately ascertained at tender a Provisional Sum³ should be nominated for the added cost of bracing.

A Provisional Sum (not being an estimate) for seismic bracing should identify the ceiling areas requiring specific engineering design, to cover the cost of specialist engineering design, design producer statements (PS1), supply and installation of seismic bracing, and engineer producer statements (PS4) for the actual seismic restraints. Unless otherwise stated such Provisional Sum would be additional to the tender price.

General

Minimum ceiling design information requirements for Options 2 and 3 include return period, building importance level, building classification, SLS/ULS, provisions for load transfer to structure, requirements for producer statement, any confirmation that services loads will be restrained in accordance with AS/NZS 4219.

Producer statements, where specified, shall be provided for the entire design and/or the completed ceiling installation. Any additional or interim producer statements for separate areas or completion stages shall be a variation.

Shop drawings shall comprise as a minimum reflected ceiling plans marked up to show the position and type of seismic bracing and seismic control provisions, including tolerances for clash of other plenum services.

Shop drawings submitted for approval shall unless approved in writing be deemed approved within 10 working days of submittal.

Coordination of structure and services with ceiling fixings and bracing

The main contractor shall, without charge to the ceiling contractor:

- Provide suitable fixing points and all secondary steelwork, purlin blockings, etc. for fixing of ceiling hangers and bracing.
- Provide continuous nogs to allow solid fixings wherever ceilings abut partitions and bulkheads.
- Ensure that all in-ceiling services are installed strictly in accordance with AS/NZS 4219 including all components and services over 7.5kg are restrained from gravity and earthquake forces with proper clearances from ceiling and supports in accordance with AS/NZS 4219.
- Co-ordinate the required bracing with structure and in-ceiling services.

Any requirement for additional steelwork, to modify proposed bracing or support requirements due to a lack of structural fixings and support or for coordination with in-ceiling services would be a variation.

D. INSTALLER'S PRODUCER STATEMENT (PS3) TEMPLATE

The PS3 below is an example of what some building consenting authorities may require from the installer.

You should attach the seismic design summary sheet(s) if you are using industry generic design guide/calculators.

Producer statement construction (PS3)
Suspended Ceilings

Company logo here

All sections of this form must be completed
To be completed by the person confirming compliance with the consented plans

Name: _____
Company: _____

Member of  AWCI

Building Consent No: _____
Site address: _____

NZBC clauses:

B1 Structure	<input type="checkbox"/>
B2 Durability	<input type="checkbox"/>
C3 Fire C/VM2	<input type="checkbox"/>
_____	<input type="checkbox"/>
_____	<input type="checkbox"/>

Installation description:

I have sighted the above building consent and confirm that installation complies with:

- Contract documents
- NZBC Clauses as noted
- AS/NZS 2785:2020 Suspended Ceilings, design and installation
- NZS 1170.5 Section 8
- Manufacturers requirements

I understand the Council will rely upon this Producer Statement for the purposes of establishing compliance with the above building consent.



Signature: _____ Date: _____
Role in project: _____
Address: _____ Postcode: _____
Business No: _____
Mobile No: _____ Email: _____

E. EXAMPLE OF A PS1 PRODUCER STATEMENT

The PS1 front page below is an example of what some building consenting authorities may require from the design engineer.

The PS1 documentation should also contain all relevant detail information pertaining to the design.

PRODUCER STATEMENT – PS1 DESIGN

BUILDING CODE CLAUSE(S): B1
ISSUED BY: Engineering Design Firm Ltd
(Engineering Design Firm)
TO: Developer Ltd
(Owner/Developer)
TO BE SUPPLIED TO: Auckland Council
(Building Consent Authority)
IN RESPECT OF: Design of non-structural building elements - Ceilings
(Description of Building Work)
AT: 123 Queen St, Auckland Central, Auckland
(Address, Town/City)
LEGAL DESCRIPTION: Lot 1, DP 12345

JOB NUMBER: 12345678

We have been engaged by the owner/developer referred to above to provide *(Extent of Engagement):* N/A in respect of the requirements of the Clause(s) of the Building Code specified above for Choose one as specified in the Schedule, of the proposed building work.

The design carried out by us has been prepared in accordance with:

- Compliance documents issued by the Ministry of Business, Innovation & Employment *(Verification method/acceptable solution)* B1 / VM1
- Alternative solution as per the attached Schedule.

The proposed building work covered by this producer statement is described on the drawings specified in the Schedule, together with the specification, and other documents set out in the Schedule.

On behalf of the Engineering Design Firm, and subject to:

- Site verification of the following design assumptions: Grid, braces and connections installed to design
- All proprietary products meeting their performance specification requirements;

I believe on reasonable grounds that:

- the building, if constructed in accordance with the drawings, specifications, and other documents provided or listed in the Schedule, will comply with the relevant provisions of the Building Code and that;
- the persons who have undertaken the design have the necessary competency to do so.

I recommend the Choose level of construction monitoring.

I, *(Name of Engineering Design Professional)* John Hancock
 CPEng number 123456
 and hold the following qualifications BE Hons

The Engineering Design Firm holds a current policy of Professional Indemnity Insurance no less than \$200,000
 The Engineering Design Firm Choose a member of ACE New Zealand.

SIGNED BY *(Name of Engineering Design Professional):* John Hancock
(Signature below):

ON BEHALF OF *(Engineering Design Firm):* Engineering Design Firm Ltd
 Date: 1 March 2024

Note: This statement has been prepared solely for the Building Consent Authority named above and shall not be relied upon by any other person or entity. Any liability in relation to this statement accrues to the Engineering Design Firm only. As a condition of reliance on this statement, the Building Consent Authority accepts that the total maximum amount of liability of any kind arising from this statement and all other statements provided to the Building Consent Authority in relation to this building work, whether in tort or otherwise, is limited to the sum of \$200,000.

This form is to accompany Form 2 of the Building (Forms) Regulations 2004 for the application of a Building Consent.

Job Number _____
 PRODUCER STATEMENT PS1

Page 1 of 3

November 2021

F. SAMPLE QA SHEET

Below is a sample of a QA sheet that should be completed at the completion of every notifiable

stage of the installation contract and for every different area of project work.

Construction Quality Control

Job number: _____

Contract name: _____ Date: _____

Main contractor: _____

Subcontractor: _____

Trade: _____

Work area/room no: _____

Work completed by: _____

Drawings ref: _____

Grid type: _____

Two way: Screw fix: Tile type:

	Inspection OK		Comments
	Sub foreman	Site foreman	
Grid alignment			
Grid seismic bracing			
Suspension to specification			
Bulkheads parallel and straight			
Wall channel alignment			
Service penetrations			
Service tiles issued			
Release HOLD for tile installation			
Tile installation			
Final Inspection			
Clean up work area and rubbish to bin			

Final approvals:

Subcontractor foreman: _____ Date: _____

Site foreman QA check: _____ Date: _____

G. DESIGN INFORMATION LIST

Considerations when designing and installing suspended ceilings can include, but not limited to:

REQUIRED INFORMATION	ENGINEER	DESIGNER	INSTALLER
seismic design criteria and seismic design intent	✓	✓	
risk factors	✓		
accelerations and movements of the primary building structure during an earthquake	✓		
minimum clearances between hangers/ plenum braces for ceilings and services	✓	✓	✓
building location	✓	✓	✓
estimated maximum number of occupants	✓	✓	
ceiling type and manufacturer	✓	✓	✓
weight of ceiling	✓	✓	
plenum depth	✓	✓	✓
weight of services	✓	✓	
perimeter wall suitability to take line loads	✓	✓	✓
NZS 1170.5:2004 section 8 parts category	✓	✓	
building importance level	✓	✓	
annual probability of exceedance (return period)	✓	✓	
design working life	✓		
ductility of parts and systems	✓	✓	
site hazard factor (Z)	✓	✓	
site subsoil class	✓	✓	
full set of drawings including reflected ceiling plan and services locations	✓	✓	✓
wind loads	✓	✓	
inter-storey drift of the structure	✓	✓	
ceiling height from ground and floor	✓	✓	✓
total height of building	✓	✓	
location of any seismic ceiling gaps	✓	✓	✓
where recessed luminaires are to be used, they shall be shown on the reflected ceiling plans	✓	✓	✓
adequate support of ceilings beneath large service ducts	✓	✓	✓
access hatches	✓	✓	✓
bulkheads	✓	✓	✓
skylights	✓	✓	✓
internal partitions.	✓	✓	✓

H. COMPLIANCE PATHWAY

Deemed to comply with NZBC through B1/VM1 Verification Method

Clause A2 - Interpretation states a building element includes: "any structural or non-structural component and assembly incorporated into or associated with a building. Included are fixtures, services, drains, permanent mechanical installations for access, glazing, partitions, ceilings and temporary supports."

Clause B1 - Structure of the Building Regulations 1992, version as at 15 November 2021 requires that: "Buildings, building elements and sitework shall withstand the combination of loads that they are likely to experience during construction or alteration and throughout their lives."

Note: The scope of this engineering method is limited to loads experienced throughout the building element life, and does not cover construction or alteration loads.

The deemed to comply Acceptable Solutions and Verification Methods for NZBC Building code clause B1 Structure (1st edition, Amendment 20) does not state an acceptable solution for Ceilings generally, or Suspended Grid and Tile ceilings specifically. Hence, the Verification Method B1/VM1 General will be applied.

Verification Method B1/VM1 General requires: "For any particular building or building design, the Verification Method shall consist of AS/NZS 1170 used in conjunction with the relevant cited material standards as modified by this Verification Method."

Grid and Tile ceilings experience self-weight and imposed loads, earthquake actions, and wind actions. The grid is the primary structural system and is constructed of connected cold formed steel sections. Therefore, this method calculates actions and capacity to the following standards:

AS/NZS 1170.0:2002 - Amendments 1-5
AS/NZS 1170.2:2021 - Amendment 1
NZS 1170.5:2004 - Amendment 1
AS/NZS 4600:2018

I - Seismic Restraint of Suspended Ceilings Lined with Sheet Materials

The “ceilings Standard”, AS/NZS 2785:2020 - Suspended Ceilings – Design and Installation, gives typical examples of seismic restraint based primarily on methodologies for grid-and-tile ceilings. In particular, the “fixed-float” perimeter fixed method aims to reduce one of the primary failure modes for grid-and-tile ceilings, compression or tension failure of the grid at the ceiling perimeter and has been researched comprehensively ¹.

For suspended sheet material ceilings, such as suspended gypsum plasterboard ceilings, the use of the “fixed-float” method is not directly applicable. There is a much smaller body of research on suspended sheet material ceilings, however recent studies show that a “fully fixed” design method performs as well, if not better than a “fixed-float” design method under seismic loading ^{2,3}.

Importantly, a “fixed-float” method for sheet material ceilings introduces issues, such as noise attenuation, air tightness, hygiene, and fire-resistance, as the floating edge doesn’t meet these performance requirements.

Sheet material ceilings do not behave like grid-and-tile ceilings. In a sheet material ceiling, the plasterboard acting horizontally has more strength than the suspension system, and therefore takes most of the load. For example, a typical riveted primary suspension connection has 1-1.5 kN per metre of capacity, but a taped and stopped sheet material joint has 4 - 6 kN per metre of capacity ⁴. The seismic loads transfer through the stiffer connection, meaning the sheet material connection transfers most of these loads. Further, a “floating” square-stopped sheet material connection acts as a fixed connection, regardless of the suspension system's connection to the boundary walls.

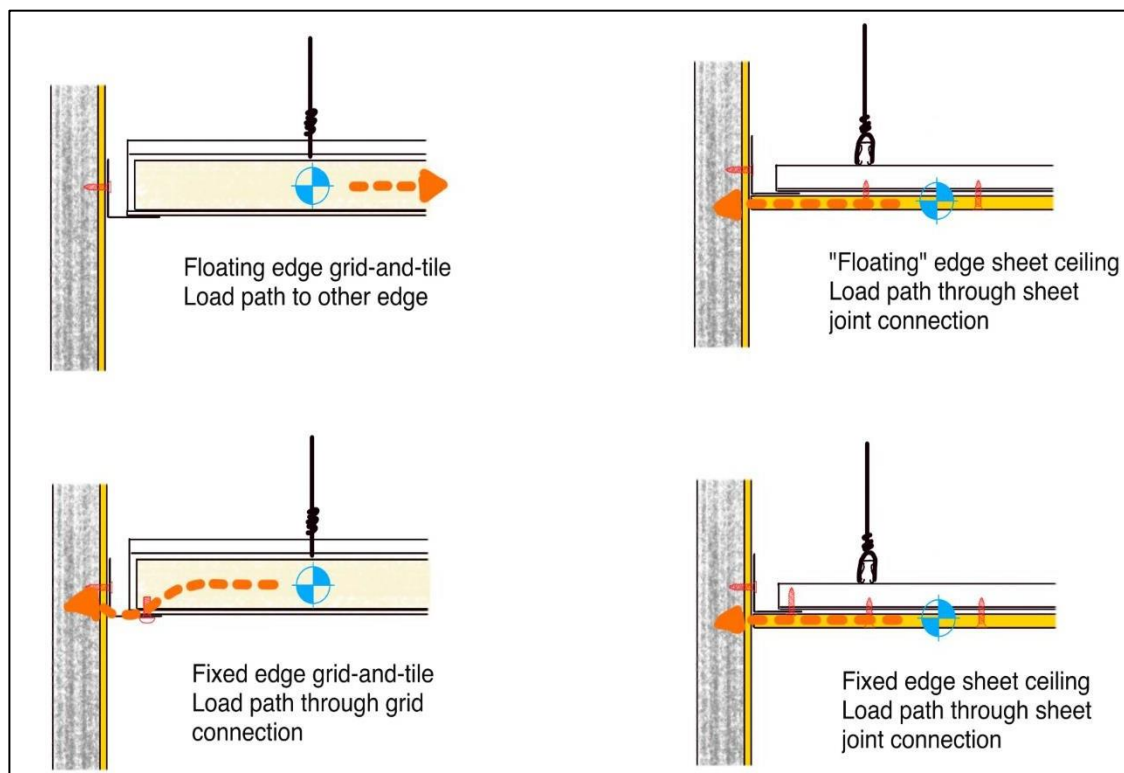


Figure 91: Fixed/float load path for suspended grid-and-tile versus suspended sheet material ceiling.

¹<http://dx.doi.org/10.26021/2844>

²https://www.researchgate.net/publication/344351010_Seismic_Performance_of_Plasterboard_Suspended_Ceilings_under_Shaking-Table_Generated_Motions

³https://www.researchgate.net/publication/269159475_Evaluation_of_Non_Structural_Partition_Walls_and_Suspended_Ceiling_Systems_through_a_Shake_Table_Study

⁴ Refer manufacturer’s test details for specific capacity values.

A typical example for “fixed-fixed” perimeter restraint for sheet material lined suspended ceilings to supplement Figure 46 of this Code, or section 4.3.3 of AS/NZS 2785 is shown below (Figure 92). This typical example can be used without the need for specific engineering design (SED), provided the following conditions are met:

The ceiling:

- installed in a IL1 or IL2 building,
- boundary walls can accept and transfer these forces, are connected to the same floor and roof structure, and are fixed to wall structure on all sides that are of comparable height, material, mass, rigidity and fundamental frequency.
- incorporates ceiling lining(s) not exceeding 22 kg/m² in mass,
- does not exceed 144 m² in area and 12 m in length or width,
- suspension system is not braced to the structure above.
- suspension framing is designed and installed to manufacturers guidelines,
- sheet material linings are installed to the suspension system in accordance with the lining manufacturer or supplier’s installation instructions,
- perimeter connection, including tape and compound qualification and details, can transfer both shear and tension seismic forces to boundary walls,
- has no complex interactions with structural components (eg structural columns passing through the ceiling),
- is level, with no height variations along the ceiling plane.
- has no large openings, its position is limited to the middle 1/3 of the length and width of the ceiling. The dimension in any direction does not exceed 1/3 of the smaller of length or width.

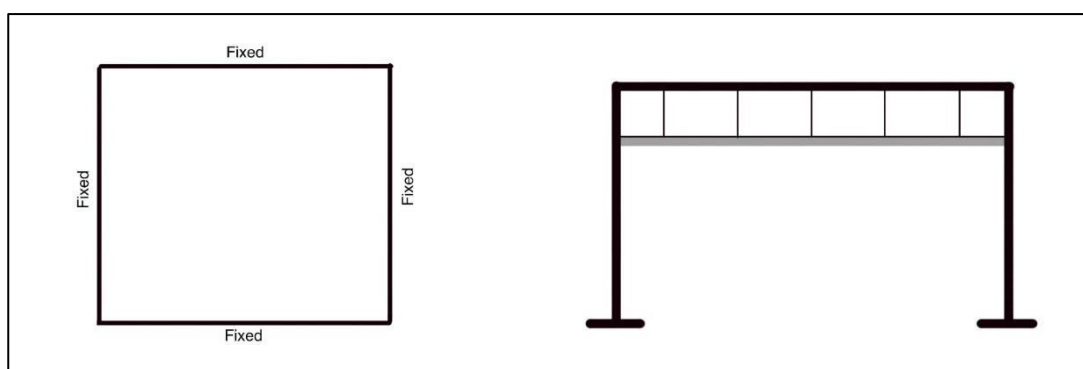
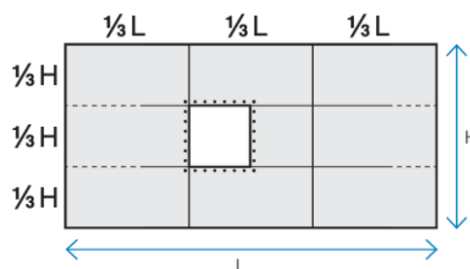


Figure 92: A typical example for “fixed-fixed” perimeter restraint for sheet material lined suspended ceilings.

Outside these parameters SED is required and can consider fully fixed or free edge options as required. Back-bracing of the suspension system will be required when free joints or walls cannot be relied upon to transfer seismic forces.

Large areas of gypsum plasterboard ceilings commonly require control joints at 12 m centres. These relief joints can be designed to provide natural seismic movement joints when remaining ceiling edges are fixed to boundary walls. Ref Figure 46, details 2 & 4, Two directions.

