



FORMAN
BUILDING SYSTEMS

Suspended Ceilings



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Time allowance: 1 hour

CPD Points: 10

Online Quiz: 5

Introduction to Ceiling systems

- Ceiling Types
- Suspension Systems
- Ceiling Panel Types
- Surface Finishes
- Fire Performance
- Ceilings & Acoustics
- Absorption, Reflection & Transmission
- Summary of acoustic performance
- Green Star requirements



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Ceiling Types

- Direct Fixed
- Suspended Ceilings
- Discontinuous
- Tensioned



Direct Fixed

- More common in commercial applications where metal linear strips or corrugated metal sheets used



Moana Pool , Dunedin



Suspended Ceilings

- The suspension of ceiling components below structural members (floors or roof).
- Not part of the structural framework of a building.
- Commonly used to provide space for services
- Exposed or concealed Grid options





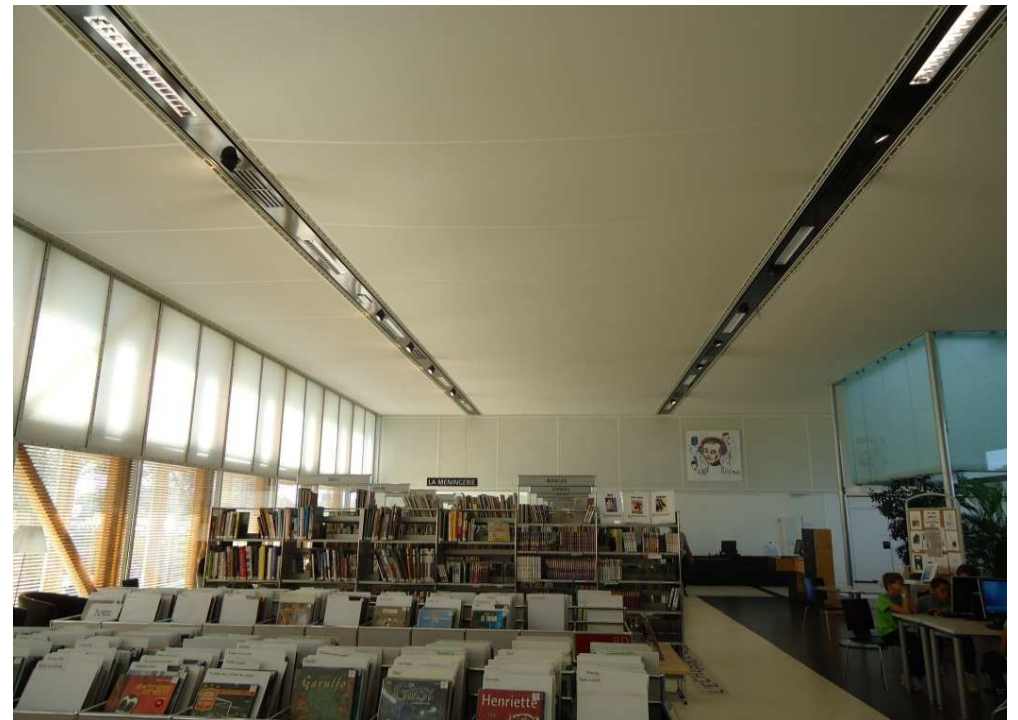
Discontinuous Ceilings

- A new trend which is modified from suspended ceilings



Tensioned Ceilings

- Fixed to channels around perimeter.
- Bungy and eyelets or springs



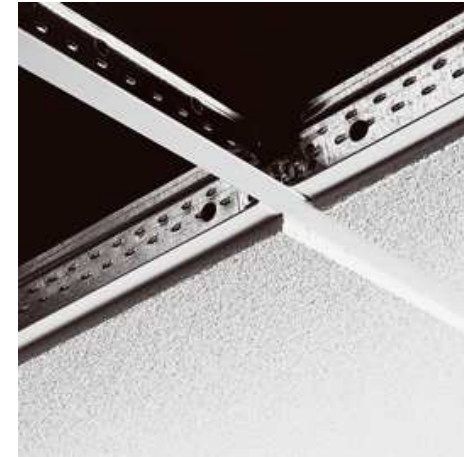


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Suspended grid types



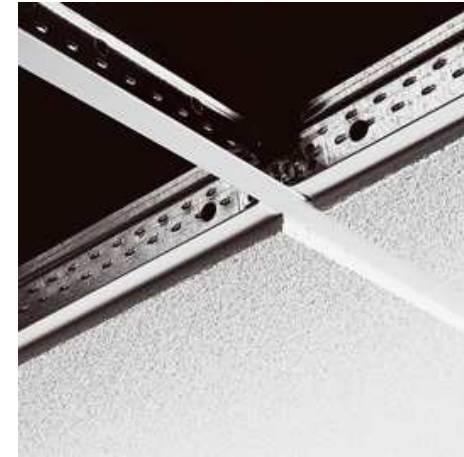
- Exposed Grid
- Semi-concealed Modules (K2C2)
- Concealed grid
- Rigid sheet concealed





Exposed Grid

- Most commonly roll formed steel grid with prefinished capping
- 15mm Suprafine
- 24mm Peakform
- 15mm Silhouette tophat
- Aluminium Options

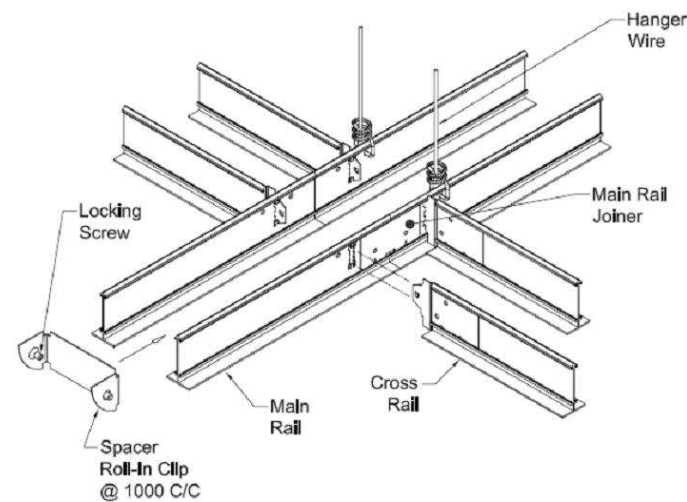




Semi concealed K2C2 Modules



- Large format module ceilings normally in aluminium grid
- Kerf edge 2 sides Cut edge 2 sides (K2C2)
- Tiles are 100% accessible





Concealed Grid

- Concealed mounting systems are not visible from below the ceiling.
- Softer ceilings prone to damage
- Best suited to metal systems to reduce subcontractor damage.
- Can incorporate services such as chilled ceilings



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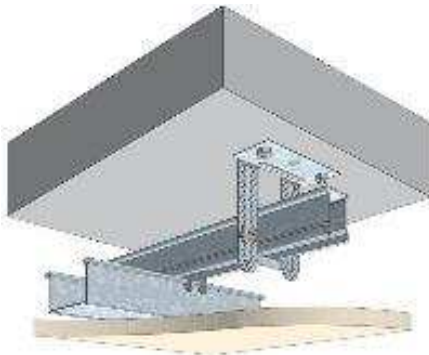
Concealed Grid





Rigid sheet concealed

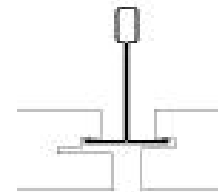
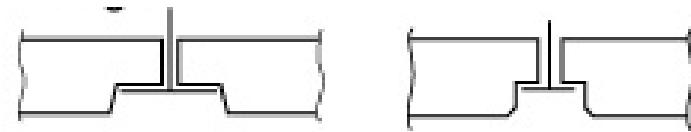
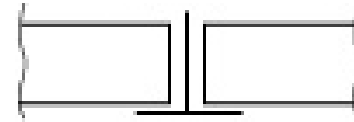
- Normally plasterboard or fibre cement sheets
- Sheets are fixed by screwing to metal furring channels which are supported by top cross rails and suspension components
- Spacings of all members to suit weights and suspension points





Ceiling Panel types

- Square edge
- Tegular edge (rebated)
- Vector edge
- K2C2 (kerf and cut)



Surface Finishes

A variety of finishes

- Water based paint finish
- Tissue (white or coloured)
- Tissue and paint
- Vinyl
- Powdercoat or enamel

Typical Brands

- Armstrong Fine Fissured, Dune , etc
- Eurocoustic Tonga/Minerval
- Eurocoustic Hermes, Armstrong Ultima
- Gibtone Gib Readytile
- Climateline , Fenta



Fire performance

AWTA PRODUCT TESTING

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TEST REPORT

CLIENT : Renhurst Ceiling Pty Ltd
48 Westgate Drive
Altona North Vic 3025
TEST NUMBER : 7-591310-CV
ISSUE DATE : 03/06/2013
PRINT DATE : 12/06/2013

SAMPLE DESCRIPTION Clients Ref: "Renhurst Rippletone Perforated Aluminium Ceiling Panel with Megasorber Soundmesh G8 Acoustic backing"
Nominal composition: Perforated aluminium panel with acoustic fabric

ISO 5660.1-2002 Reaction to Fire Tests - Heat Release, Smoke Production and Mass Loss Rate
Part 1: Heat Release Rate (Cone Calorimeter Method)

RESULTS:-

	Specimen 1	Specimen 2	Specimen 3	Mean
Average Heat Release Rate at 50kW/m2	FTI	FTI	FTI	kW/m2

Group Number Classification (In Accordance with New Zealand Building Code Verification Method C/VM2 Appendix A)

	Specimen 1	Specimen 2	Specimen 3	Mean
Average Specific Extinction Area (According to ISO 5660.2-2002)	5.8	14.3	8.4	9.7

Test orientation: Horizontal

	Specimen 1	Specimen 2	Specimen 3	Mean
Irradiance	50	50	50	50
Exhaust flow rate	24	24	24	24
Time to sustained flaming	FTI	FTI	FTI	180
Test duration	1800	1800	1800	1800

Heat release rate curve on the 9 attached sheets which form part of this report

	Specimen 1	Specimen 2	Specimen 3	Mean
Peak heat release after ignition	6.6	6.6	6.6	6.6
Average heat at 60s	105.7	106.5	106.0	106.1
Release rate at 180s	84.8	84.7	84.8	84.8
After ignition at 300s	19.8	20.5	20.0	20.1
Total heat released	20.9	21.8	21.2	21.3
Average effective heat of combustion	1.3	1.4	1.3	1.3

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APPROVED SIGNATORY

MANAGING DIRECTOR



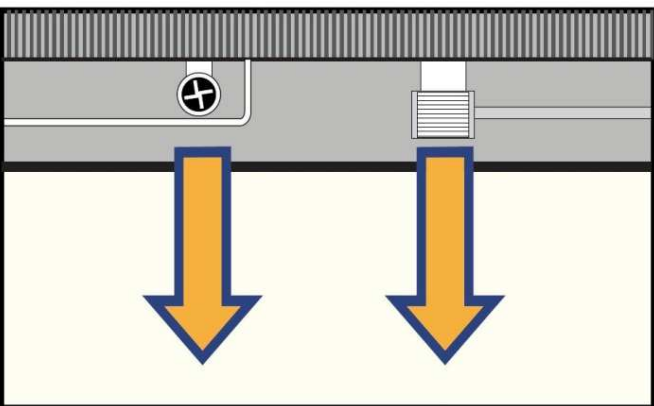
- Surface finish required to verified by independant test
- ISO5660 or ISO9705
- Group 1 to 4 depending on safe and protected paths , unsprinklered buildings , care facilities , public assembly

Ceilings and Acoustics

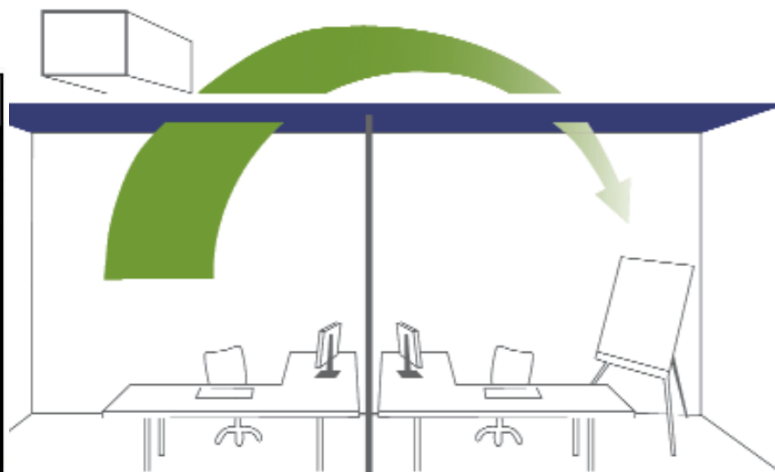
- Ceiling acoustics are measured in a number of ways:
- Absorption (NRC , αW)
- Reduction/ Transmission (CAC, DnCw)

Ceilings and Acoustics

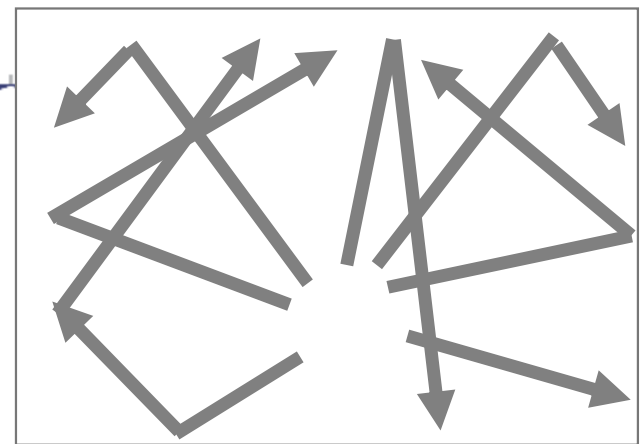
- Three concerns with ceiling acoustics:
 - Inter-storey or plenum noise breakout
 - Room to room transmission via ceiling plenum
 - Within room reverberation



Plenum noise breakout



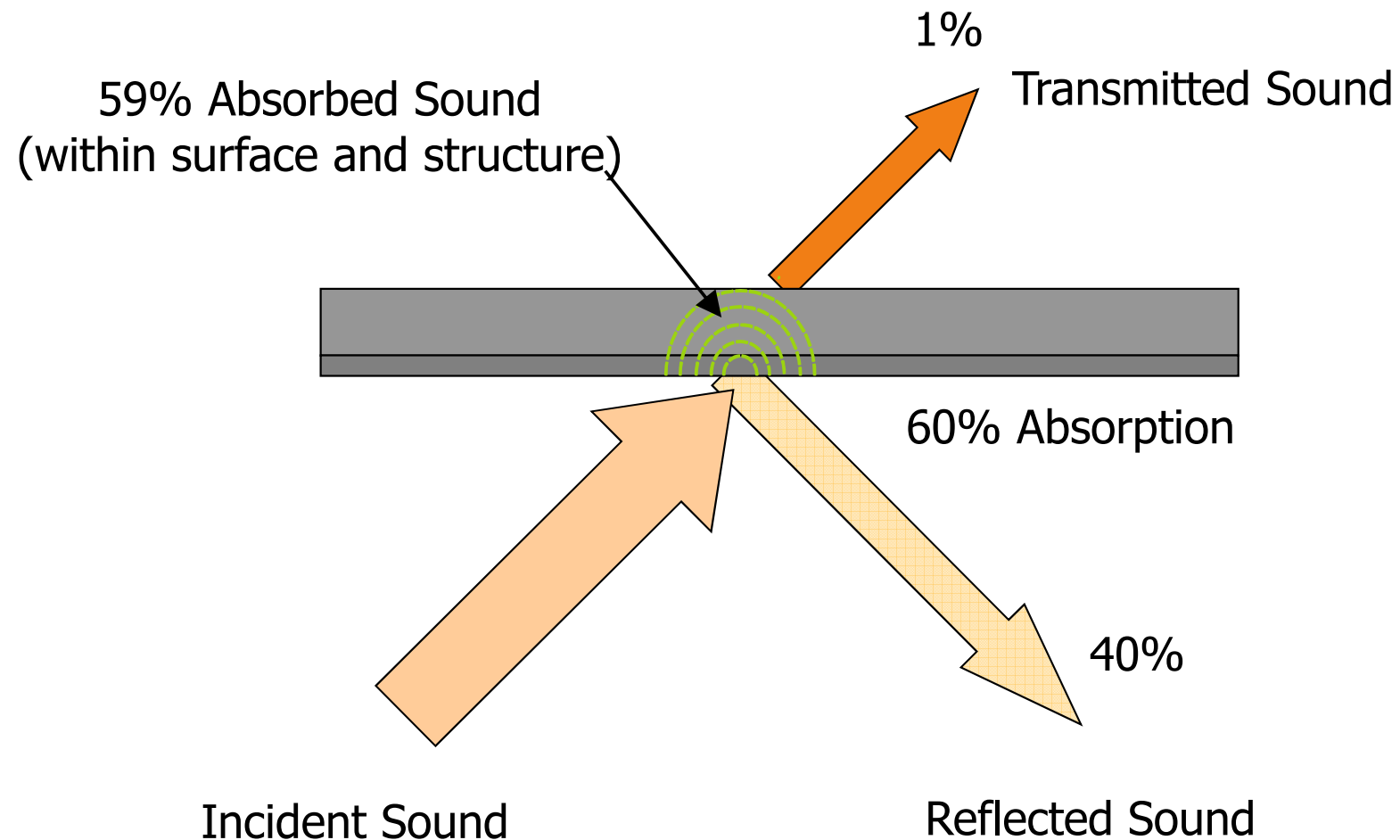
Room to room transmission



Within room Reverberation

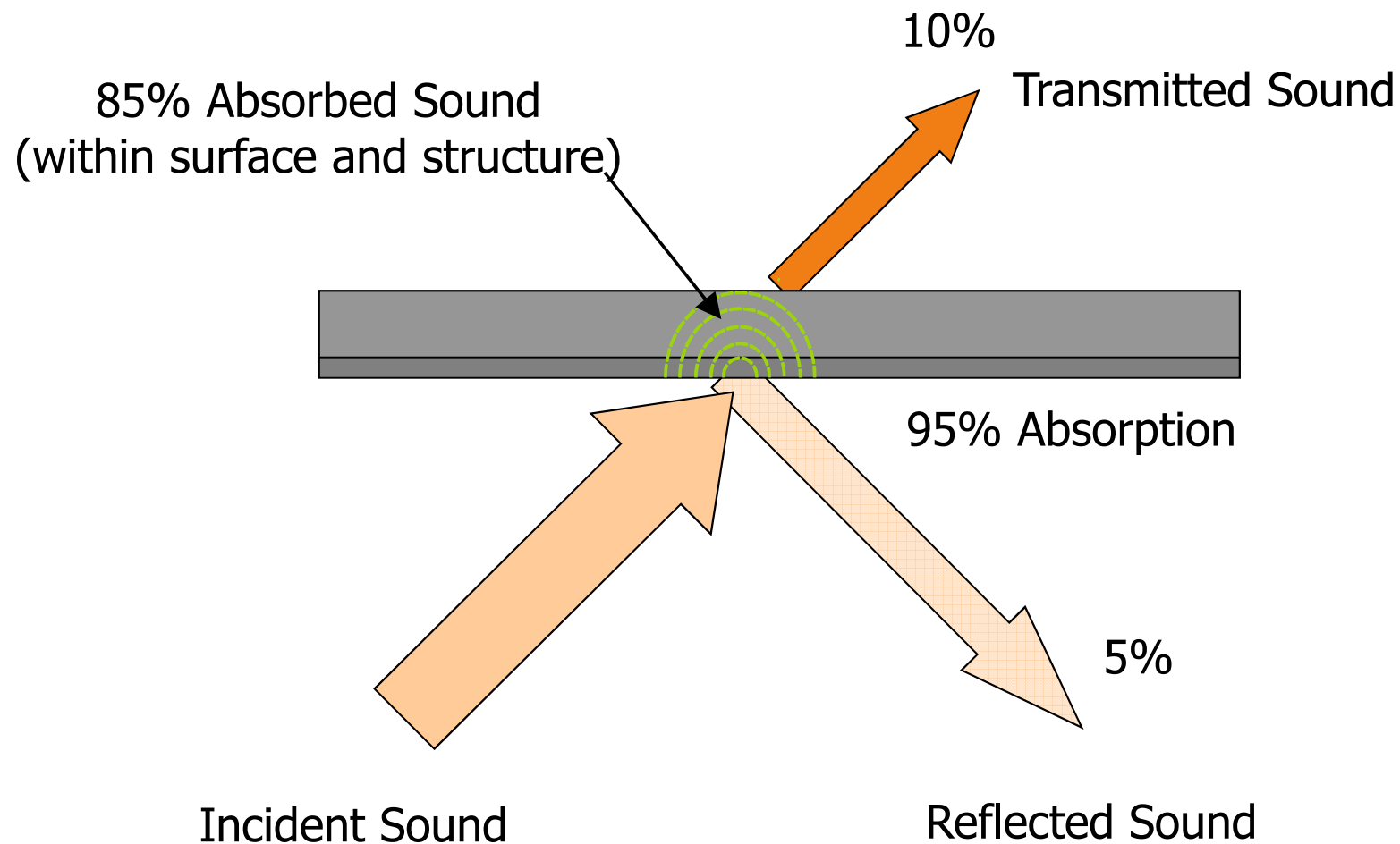
Absorption, Reflection & Transmission

RH99 Armstrong Fine Fissured



Absorption, Reflection & Transmission.....

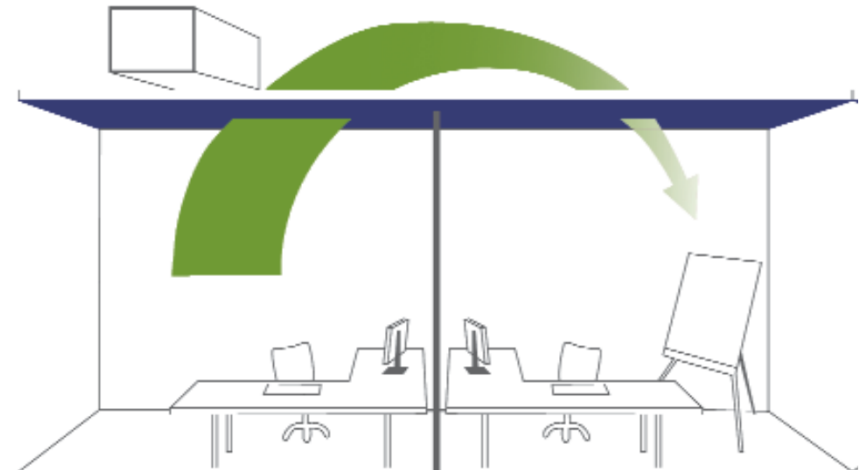
Eurocoustic /Parafon Soft Fibre





Room to room Attenuation (D_{ncw})

- Measured by CAC & D_{ncw}
- Double Pass attenuation
- Between adjacent spaces with a common ceiling plenum above;



Acoustic Performance Influences

Ceiling tile acoustic performance is influenced by

- Porosity
- Thickness
- Density

When product porosity increases

Sound Absorption increases

Sound Reduction reduces

When product thickness increases...

Sound Absorption increases

Sound Reduction increases

When product density increases...

Sound Absorption ...reduces

Sound Reduction ... increases

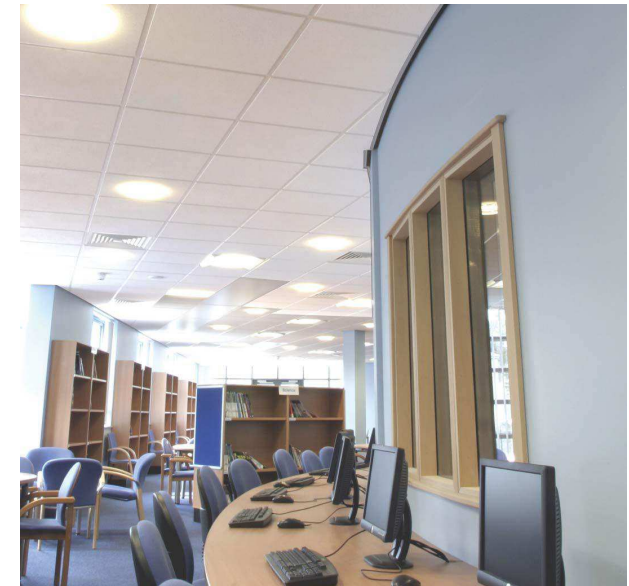
Mineral Fibre Tiles

Armstrong RH99 and RH100 mineral fibre tiles have medium porosity, and relatively high density...

- Good sound **absorption** and...
- High sound **reduction**.

Eurocoustic soft mineral fibre is very porous, relatively low in density, therefore have ...

- High sound **absorption** but ...
- Moderately low sound **reduction**.



Dune Max hard mineral fibre

Metal & Wood Veneer Tiles

- **Acoustic performance of metal , wood or plasterboard ceilings vary depending the perforation type, acoustic tissue and acoustic insulation above**
- **Perforated tiles with acoustic tissue may have medium to very high sound **absorption**, and **low sound reduction** without insulation behind and **high sound reduction** depending on the infill.**



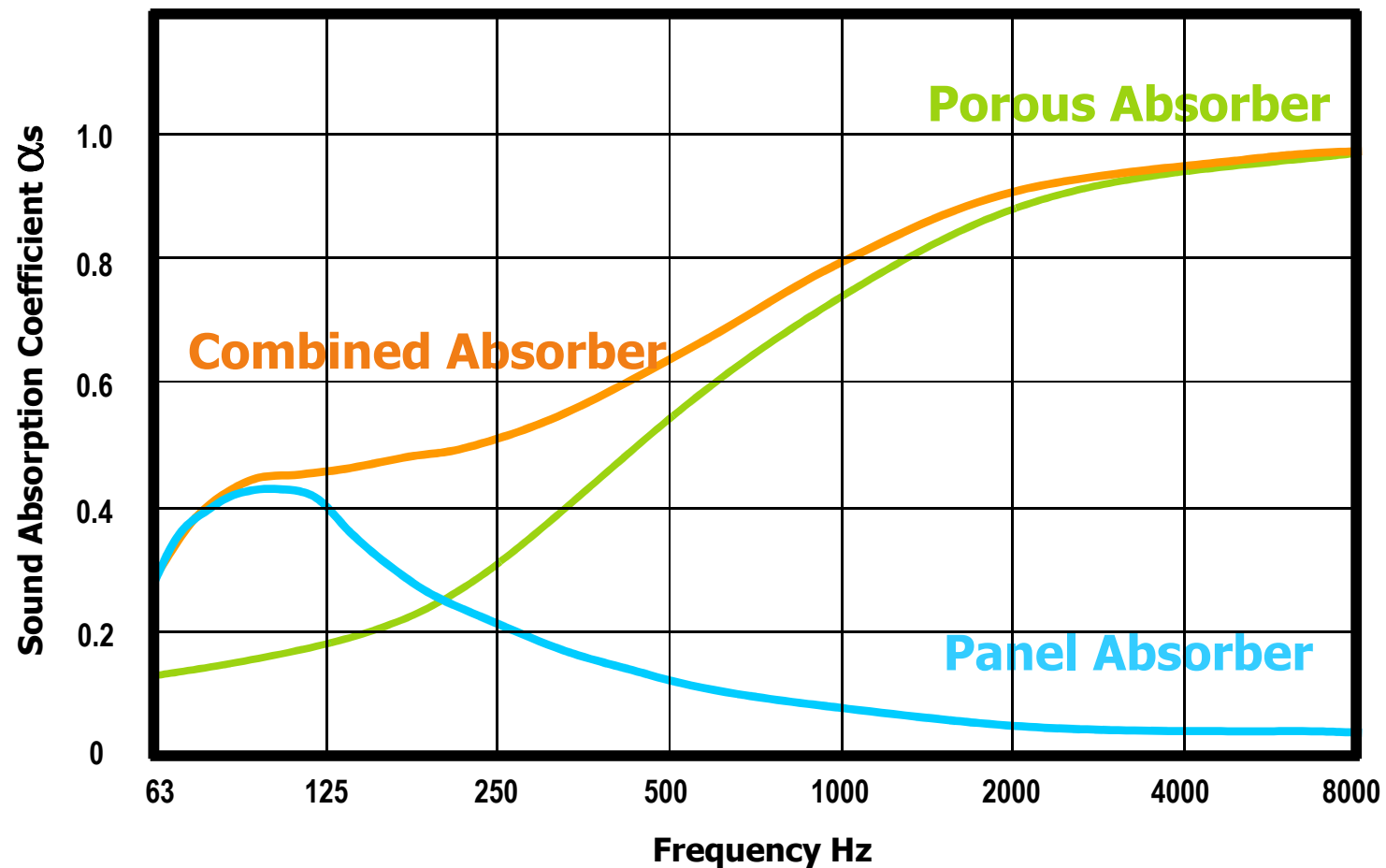
Boral Echostop perforated plasterboard



Lindner Metal Acoustic Tiles
BNZ Harbour Quays Wellington

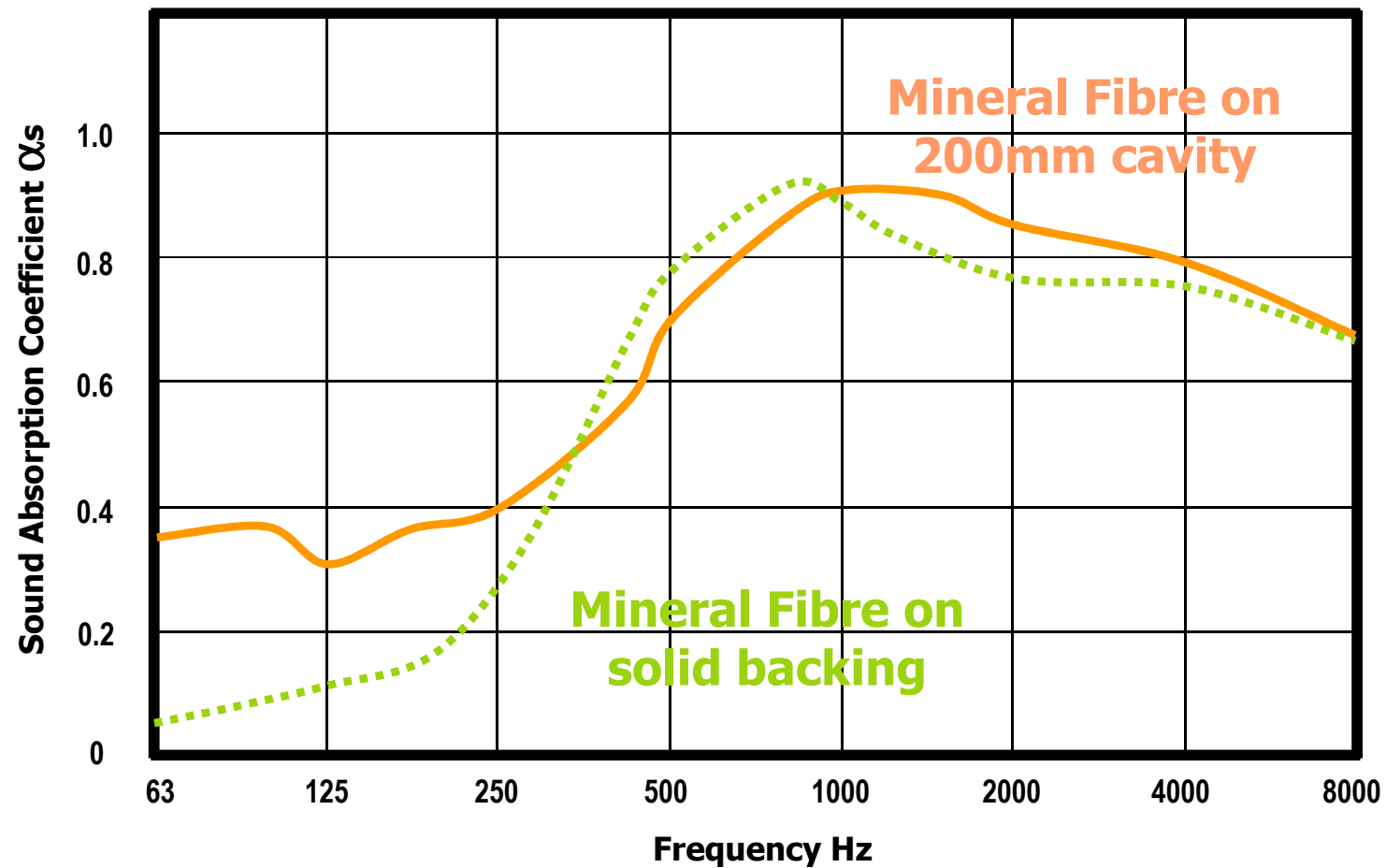


Absorption is frequency dependent





And the depth of void is important





Predicting Acoustic performance

- By using measured properties of various materials we can predict the acoustic performance of a room
- **Reverberation Time (RT)** can be predicted using various methods
- The widely used method is the **Sabine equation**.
 - Despite several assumptions that limit it's accuracy, the Sabine Equation is widely used for its simplicity and as people cannot differentiate between fractions of seconds or tenths of decibels.
 - It makes a link between the amount of absorption in and the volume of a room and the reverberation time.

$$T = \frac{0.16 V}{A}$$

...

Where...

T = reverberation time in seconds

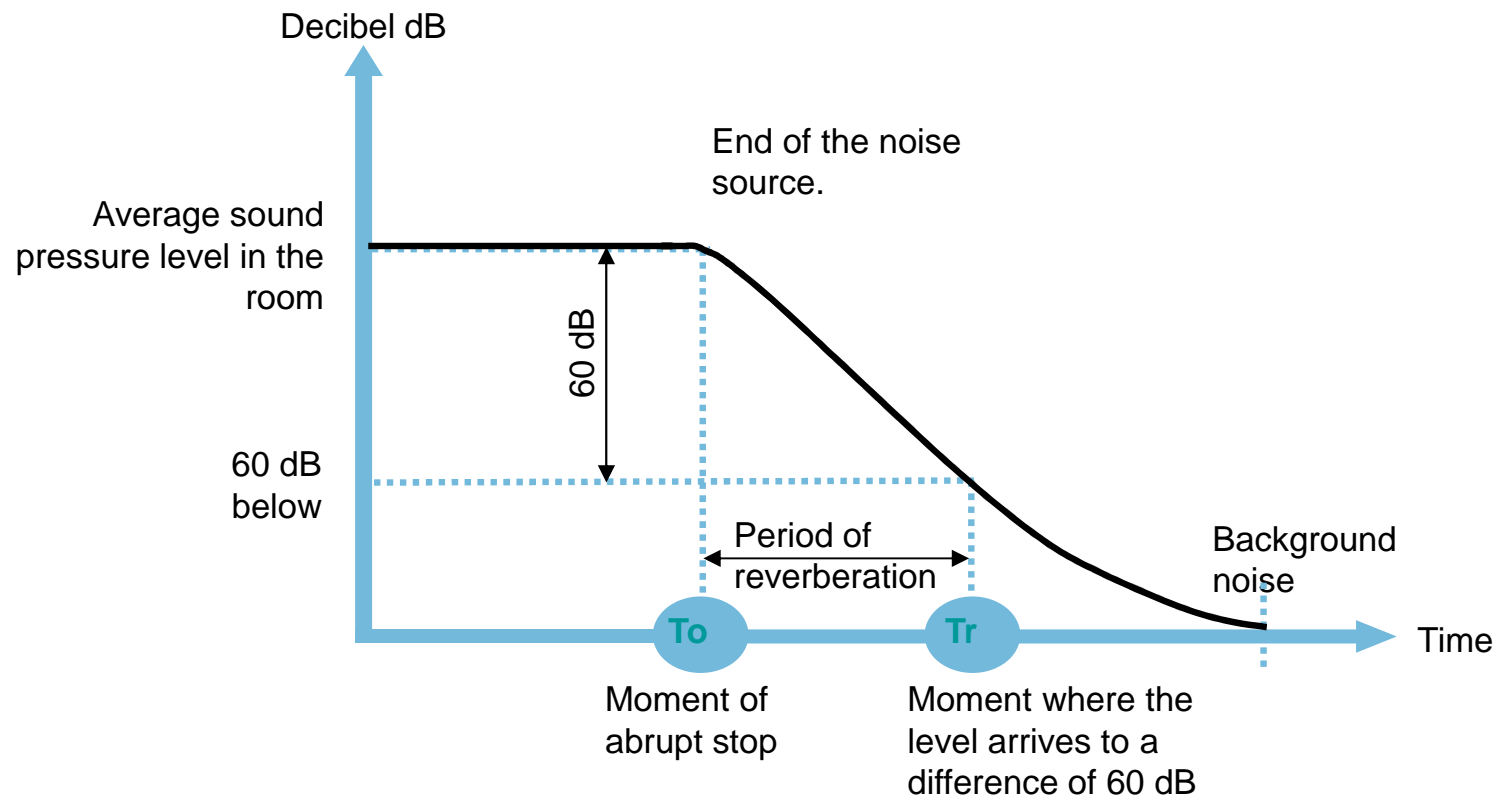
V = volume of the room in m³

and...

A = total absorption within the room

Applying absorption results

The **Reverberation Time (RT)** is the time in seconds for the reverberant sound in an enclosure to decay 60dB after the noise source is stopped...





Affect of Absorbers

A typical cellular office (50m³) ...

Concrete

RT= 0.97 sec



Plasterboard

RT= 0.60 sec



**Wet Felt Mineral Fibre
(RH99 Dune Max)**

RT= 0.44 sec



**Soft Mineral Fibre
(Eurocoustic
Attrium)**

RT= 0.29 sec



Note: Different room sizes and finishes to those assumed for this example will result in different reverberation times.



A typical primary school classroom (100m³) ...

Concrete

RT= 1.20 sec



Plasterboard

RT= 1.10 sec



**Wet Felt Mineral Fibre
(RH99 Dune Max)**

RT= 0.52 sec



**Soft Mineral Fibre
(Eurocoustic
Attrium)**

RT= 0.34 sec

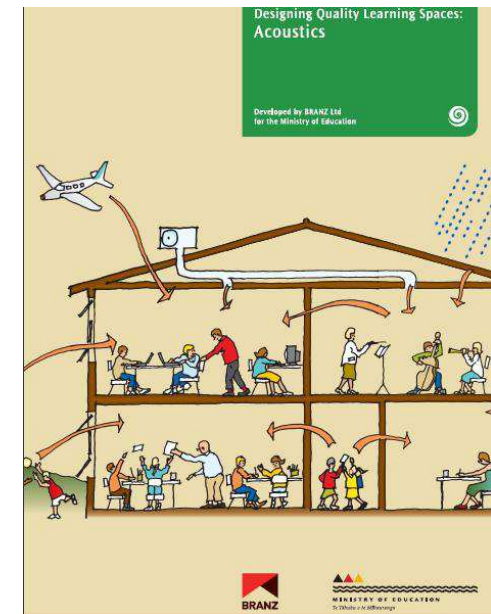


Note: Different room sizes and finishes to those assumed for this example will result in different reverberation times.



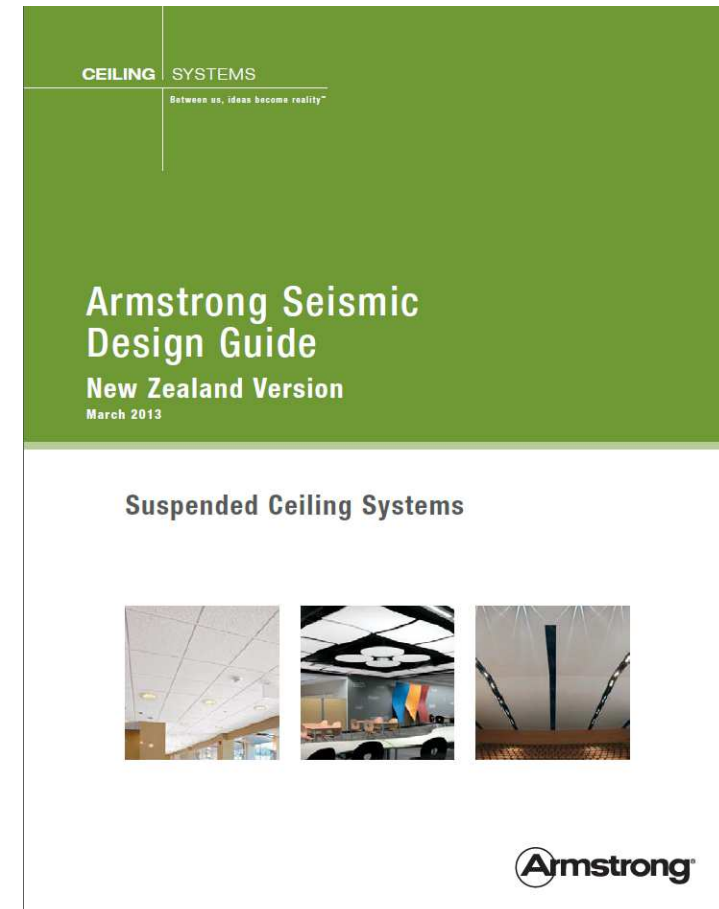
RT Calculations for Schools

- According to AS2107-1987 the ideal outcome measured as RT (Reverberation Time) is 0.4-0.7 seconds.



Armstrong Seismic Design Guide – RX system

- As a result of the Christchurch earthquakes much work has been done on seismic design.
- Four revisions in 2 years .



Armstrong Grid Seismic Design Guide

- Simple calculation steps to determine bracing options and requirements

JOB NAME: _____ JOB NUMBER: _____

Bracing Option Layouts 1 & 2 (Perimeter Fixing)

GRID AND CONNECTION TYPE
 Enter the values below and multiply them together to calculate the maximum force in the main and cross tees. This calculation is only required for option 1 or 2 bracing.

Seismic Force, $F_p =$	X	Tee Spacing (m)	X	Tee Length* (m)	=	Total Force $F_t =$
	X	Main Tee	X	Main Tee	=	Main Tee
	X	Cross Tee	X	Cross Tee	=	Cross Tee

*Tee Length - Option 1 (Fixed on one side) = Length from wall to wall.
 Option 2 (Fixed on two sides with seismic gap in middle) = Maximum length from wall to seismic gap.

GRID AND CONNECTION TYPE
 Choose a grid type from the options below so that the force on the grid is less than the grid capacity, i.e. $F_t \leq F_g$. If none of the grid types work a different bracing option will need to be used.

Grid Type	Tee	Allowable Force, $F_g =$	OK?
Suprafine XL 15mm	Main Tee	100	
	Cross Tee	60	
Prelude XL 24mm	Main Tee	100	
	Cross Tee	60	

Fixed Connection Type	Allowable Force, $F_c =$	OK?
3.2Φ Alum Rivet	70	
4.0Φ Alum Rivet	100	
BERC2 Clip	60	

* In the Maximum Total Force, $F_t \leq F_c$, Allowable Force?

FREE CONNECTION TYPE (CIRCLE ONE)

BERC2 Clip	Seismic Channel	None
------------	-----------------	------

CALCULATE THE MAXIMUM ALLOWABLE LENGTH OF MAIN AND CROSS TEES

Allowable Force (Tees and Connections)*	÷	Tee Spacing (m)	÷	Seismic Force, $F_p =$	=	Maximum Allowable Length (m)
Main Tee	÷		÷		=	Main Tee
Cross Tee	÷		÷		=	Cross Tee

*Minimum allowable force from chosen grid connection and tee type above.

Seismic Design Guide – Armstrong Grid

Suspended Ceiling Seismic Design Form

Seismic Gap Options and other Armstrong Details

From Armstrong Seismic design booklet

- BERC2 Clip
- Seismic Joint Clip – Main Tee
- Seismic Joint Clip – Cross Tee

Seismic Joint Clip – Main Beam

PRODUCT DESCRIPTION

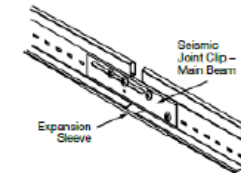
MATERIALS

A. General: Commercial-quality cold rolled hot dipped galvanized steel, chemically cleansed.

B. Components:

- Seismic Joint Clip, stamped, unfinished, single piece unit with slots and screw holes
- Expansion Sleeve, stamped, exposed face prefinished in baked polyester paint

Note: Not suitable for use with vector panels.



Bucket #	Description	Dimension	Color/Finish
■ SJMR15	Seismic Joint Clip – Main Beam for 24mm grid	100mm x 25mm nominal	Unpainted
■ ES4	100mm Expansion Sleeve For Prelude 24mm Main Beam	100mm x 24mm nominal	White
■ SJMR9	Seismic Joint Clip – Main Beam for 19mm grid	100mm x 25mm nominal	Unpainted
■ ES49	100mm Expansion Sleeve For Supratino 19mm Main Beam	100mm x 19mm nominal	White

Seismic Joint Clip – Cross Tee

PRODUCT DESCRIPTION

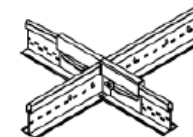
MATERIALS

A. General: Commercial-quality cold rolled hot dipped galvanized steel, chemically cleansed.

B. Components:

Seismic Joint Clip, stamped, unfinished, two piece unit with slots

Note: Not suitable for use with vector panels.



Item#	Description	Dimension	Color/Finish
■ SJCG	Seismic Joint Clip 2 pcs required / joint	125mm x 38mm nominal	Unpainted

- New proprietary components



GreenStar Compliance for ceilings

- Primary concerns are volatile organic compounds , recycled content , acoustic performance ,lighting levels
- Other concerns are damage over time

