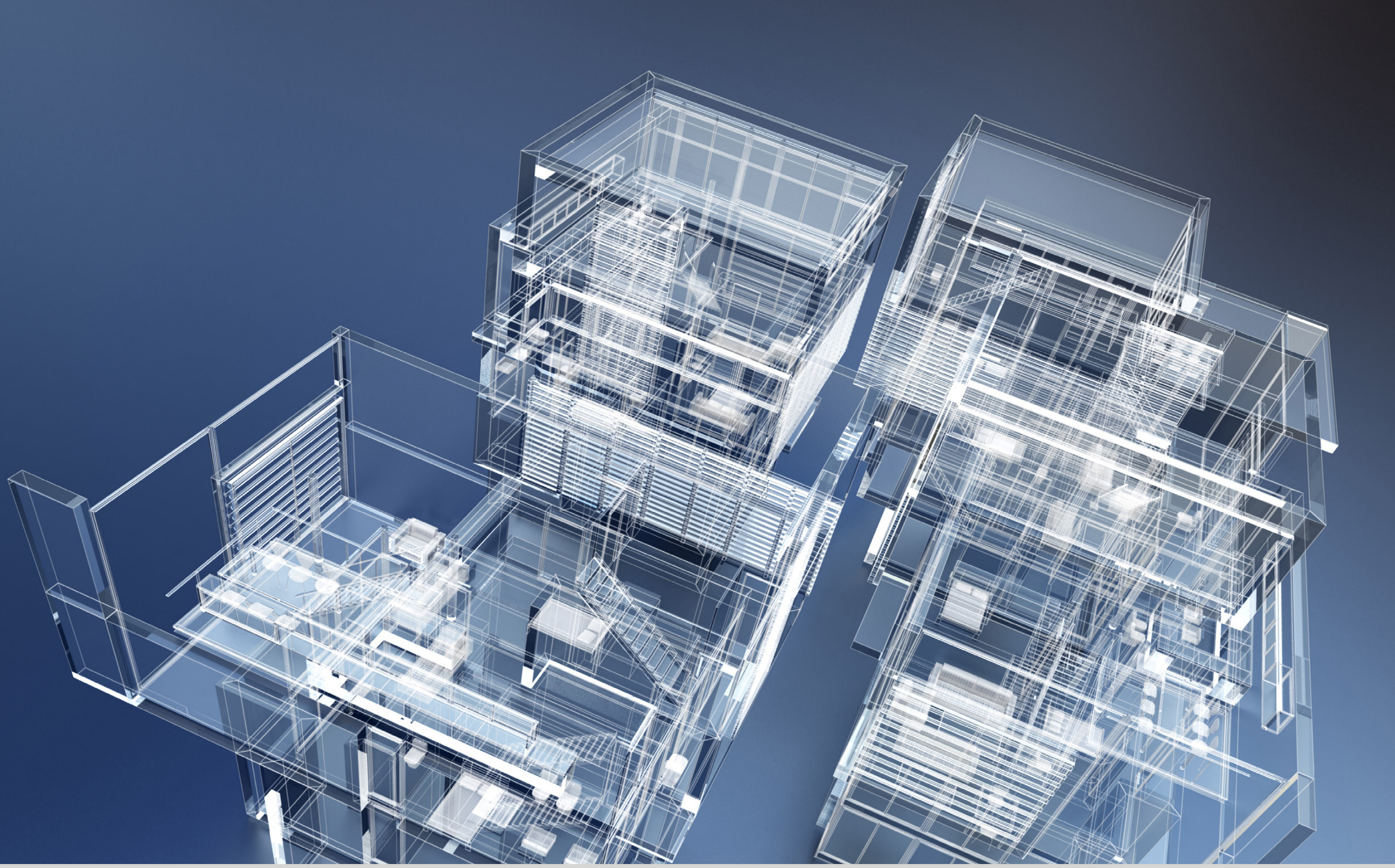
2 Building with Lightweight Construction



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Building with Lightweight Construction

Etex Australia offers a wide range of solutions for lightweight construction including metal framing, insulation, plasterboard linings, cement board linings, ceiling tiles, adhesives, jointing compounds, fire sealant and cornice.

Siniat wall and ceiling linings are available with a wide range of properties for different applications from impact resistant plasterboard to aesthetic ceiling linings that absorb sound.

Along with providing these solutions, Siniat offers a suite of Knowhow services to help bring your project to life from instant online calculators and system selectors to personal technical advice and all backed by a 10 year Siniat warranty.

Benefits of Lightweight Construction

When combined together, lightweight materials provide effective composite performance; the result is a vast range of combinations so the desired performance can be tailor made for construction. Lightweight construction is so called because it can achieve heavy weight performance while decreasing the weight and cost of the entire building.

A typical lightweight wall construction consists of either steel or timber framing, insulation and plasterboard or other lining board.

Siniat steel studs are an efficient way of providing framing for plasterboard and other lining materials.

Combine with Fletcher Insulation's acoustic and thermal insulation to enhance the performance of walls and ceilings.

2.1 Materials

Plasterboard

Plasterboard is made from a core of a naturally occurring mineral called gypsum, also known as calcium sulphate dihydrate or $CaSO_4.2H_2O$. The core is sandwiched between two layers of heavy duty recycled paper. The face paper is suitable for painting or wallpaper. Plasterboard has square profile cut ends and long recessed edges to enable easy jointing.

Etex Australia manufactures plasterboard to strict internal standards which meet or exceed the requirements of *AS/NZS 2588:2018, Gypsum Plasterboard.*

The Australian Standard for plasterboard installation is *AS/NZS 2589:2017, Gypsum linings – Application and finishing.*

Plasterboard is suitable for use as an interior wall and ceiling lining, and also for external ceilings when protected from the weather. For more information about the suitability of plasterboard, please refer to Section 2.2 Care and Use.

Environment Benefits

Plasterboard is an ideal product for sustainable construction. As a lightweight building material, plasterboard reduces transport costs and emissions as well as the total weight of buildings. Plasterboard is 100% recyclable, with low embodied energy, and made largely from a naturally occurring mineral – gypsum. The liner paper used to make plasterboard is biodegradable and made from recycled paper such as waste newspaper and cardboard.

The plasterboard manufacturing process operates under strict environmental guidelines:

- Efficient use of energy and water including heat recovery and storm water collection
- Effective collection and monitoring of dust.
- Ongoing waste and raw material usage reduction.
- Minimisation of plant impact on surroundings.

Since 2009, Etex Australia has introduced a number of initiatives to reduce carbon emissions which has also resulted in the first certified carbon neutral opt in program for plasterboard.

Combining plasterboard with lightweight framing such as timber or steel provides a vast array of system performances, which can be efficiently gauged to the precise needs of any project.

Lightweight steel framing is both strong and durable, and like plasterboard has the potential to be fully recycled at end of life.

For more information refer to:
siniat.com.au/sustainability

Fire Resistance

All plasterboard is naturally fire resistant. The core slows down the spread of fire by releasing chemically bound water when heated. This is a similar process to evaporation and aids cooling.

Fire Hazard Properties

The National Construction Code (NCC) regulates the fire hazard properties of coverings and lining materials in buildings according to NCC Volume One, Specification C1.10. Floor linings and coverings must have a high enough critical radiant flux to comply with NCC Volume One, Specification C1.10, while wall and ceiling linings must have a low enough group number. The group number indicates how quickly wall and ceiling linings spread fire, with Group 1 products ranked the slowest and Group 4 the fastest.

Table 1 Product Group Number

Product	Group Number	Average Specific Extinction Area (m^2/kg)
Curveshield	1	less than 250
Creason	1	less than 250
Createx	1	less than 250
Fireshield	1	less than 250
Intershield	1	less than 250
Mastashield	1	less than 250
Multishield	1	less than 250
Opal	1	less than 250
Permarock	1	less than 250
Shaftliner	1	less than 250
Soundshield	1	less than 250
Spangrid - Paper faced	1	less than 250
Spangrid – Protech ceiling panel	2	less than 250
Spanshield	1	less than 250
Trurock	1	less than 250
Trurock HD	1	less than 250
Watershield	1	less than 250

Fire Hazard Property Report

Down the Siniat Fire Hazard Property Report from our 'Certificates' web page by clicking on the link or by using your phone's camera on the QR code.

Combustibility

Plasterboard is considered to limit the spread of fire; therefore in accordance with NCC Volume One, Section C1.9 (e) (i), plasterboard may be used wherever non-combustible materials are required.

Thermal 'R' Value

The R-Value of plasterboard is a measure of its thermal insulation ability. Higher numbers indicate a better insulator. The values for plasterboard are:

- 10mm plasterboard = 0.059 m^2.K/W
- 13mm plasterboard = 0.076 m^2.K/W
- 16mm plasterboard = 0.094 m^2.K/W

Specific Heat Capacity

Specific heat capacity is the amount of heat energy required to raise the temperature of 1 kg of material by 1°C.

- Plasterboard is 1090 J/kg/K.

Dimensional Stability

Plasterboard is dimensionally stable when compared to other building materials. Two measures of dimensional stability are listed below:

- Thermal coefficient of linear expansion (α) = 16.7 x 10^{-6} m / °C, measured unrestrained over the temperature range of 3°C – 32°C
- Hygrometric coefficient of expansion = 6.5 x 10^{-6} / %RH, measured unrestrained over the Relative Humidity (RH) range of 10% – 90%.

Safety

Plasterboard is not classified as hazardous according to the criteria of Safe Work Australia. It is non-toxic and non-flammable.

Maintenance

Plasterboard is a product that is typically installed as a substrate for further decoration like painting, wall paper or tiles. As such, the requirements for maintenance of plasterboard are usually less compared to the decorative finish.

Where paint is used as the decorative finish, the paint manufacturer's recommendations should be followed for maintenance and cleaning. Similarly, if wall paper or tiles are used then recommendations from the manufacturer should be followed. This relates to the cleaning procedures and the suitable materials/ products that should be used.

Maintenance of plasterboard is likely to be necessary only as required. Otherwise, annual checks are recommended on wall and ceiling systems to assess whether maintenance is required for:

- Physical damage (dents, scratches)
- Structural damage (cracks, compression fractures)
- Fire or excessive heat damage
- Water damage (including moisture affected plasterboard and mould growth, etc)
- Re-painting (as and when desired)
- Cleaning (as and when desired)

If repairs are required, then they must be conducted in a way that maintains the installation requirements of *AS/NZS 2589:2017 Gypsum Linings – Application and Finishing, AS 2785-2020 Suspended Ceilings - Design and installation*, and for fire rated systems in accordance with Siniat technical literature.

OnBoard - Maintaining Plasterboard

Read Siniat OnBoard Technical Newsletter on Maintaining Plasterboard by clicking on the link or by using your phone's camera on the QR code.

Durability

The durability of Siniat plasterboard and its ability to perform as a wall or ceiling lining depends on several factors, some include:

- Ventilation of the building (and HVAC system) with the ability to control moisture and condensation
- Amount of humidity and air flow
- Decorative covering (paint, wall paper, tiles)
- Use of building wall wraps, roof sarking and vapour barriers
- Frequency and duration of wet and damp conditions (ie. water leaks)
- Mould growth
- Temperature range experienced
- Movement from substrate framing
- Allowance for framing movement (with control joints)
- Maintenance intervals.

Steel Framing

Siniat light-weight steel framing is an economical, durable and efficient way of providing the necessary support for a range of internal wall and ceiling linings as well as external cladding and brick veneer. Etex Australia manufactures a comprehensive range of steel framing components for a range of systems including:

- Non-load bearing steel stud wall framing
- Concealed and exposed ceiling framing with associated clips
- Steel stud ceilings
- Top hat and façade systems
- Jamb stud and associated brackets for openings in walls
- Acoustic studs
- Access panels, and
- Plaster finishing accessories.

Bluescope Steel is our supplier of large steel coils which are slit, then cold rolled to form the Siniat steel profiles in our manufacturing plant in Beenleigh, Queensland. The steel coils comply with:

- *AS/NZS 1365:1996 Tolerances for flat-rolled steel products*, and
- *AS 1397: 2011 Continuous hot-dip metallic coated steel sheet and strip - Coatings of zinc and zinc alloyed with aluminium and magnesium.*

Certification for systems in Blueprint have been based upon Siniat branded steel products. If other manufacturer's products have been used for the framing, it is the responsibility of that manufacturer to prove equivalent performance of the system and provide the associated certification.

Combustibility

Steel is considered to limit the spread of fire; therefore in accordance with NCC Volume One, Section C1.9 (e) (v), steel may be used wherever non-combustible materials are required.

Early Fire Hazard Indices

Ignitability Index (0-20)	Spread of Flame Index (0-10)	Heat Evolved Index (0-10)	Smoke Developed Index (1-10)
0	0	0	2

1. Zincalume steel
2. Test certificate FNE11602

Safety

Not classified as hazardous according to the criteria of Safe Work Australia. It is non-toxic and non-flammable.

Corrosion Protection

Siniat steel framing has a corrosion protection coating applied to the surface for enhanced durability. Etex Australia supplies Siniat branded products with the following corrosion protection:

- Zincalume® AM150 and AM125 (aluminium / zinc / magnesium) as per AS 1397 for wall studs, top and bottom tracks, wall noggings, furring channels, top cross rails, top hats and most accessories other than listed below.
- Galvaspan® Z350 (zinc) as per AS 1397 for Jamb Stud.
- Galvanised Z275 (zinc) as per AS1397 for ceiling hanging rods, and the following wall framing brackets: UB80, DB and JSCB.
- Zinc electroplated with clear passivate (Class 1 designation A trivalent chromate) for the following clips C24, C54, C60, C60DF, C60LDF, C61S, C66.

Table 2 Steel Grade and Corrosion Protection Coating

Profile	Grade	Ultimate Stress (MPa)	Yield Stress (MPa)	Coating
Studs, Head and Base Tracks, Nogging Tracks, Top Hats, Top Cross Rails	G300	340	300	AM150 / AM125
Furring Channel, Domestic Batten	G550	550	550	AM150
Jamb Stud	G450	480	450	Z350
Hanging rods and brackets: UB60, UB80, DB, JSCB	G250	320	250	Z275

Durability

The durability of Siniat steel products and their ability to perform the intended function for a particular application depends on the severity of exposure. There are many factors related to the severity of exposure, some include:

- Geographical location (ie: near breaking surf or near heavy industry)
- Location on a building
- Construction system the product is used in
- Use of building wall wraps, roof sarking and vapour barriers
- Type of external cladding / roof lining used
- Ventilation of the building (and HVAC system) with the ability to control moisture and condensation
- Amount of humidity and air flow
- Exposure to salt and chlorine laden air
- Frequency and duration of wet and damp conditions (ie. water leaks)
- Horizontal surfaces where water, dust or other contaminants like salt may pool
- The ability of the member to be cleaned by rainwater or hosing
- Maintenance intervals.

Siniat steel framing must be effectively separated from the external environment once installed. In addition, they must be installed to enable drying and prevent long periods of wetness. Extended exposure to high moisture may lead to some level of surface corrosion or staining, as such a regular inspection and maintenance schedule is recommended.

For applications not covered in this manual, additional corrosion protection coatings may need to be applied for certain applications or to prolong the intended service life. Siniat steel products do have industry leading factory applied corrosion protection, and they may be suited to other applications not listed in this section. Please consult a corrosion expert for advice.

Table 3 Suitability of Siniat Zincalume® Steel Products

Application		Geographical Location	
		Further than 300m from breaking surf and above 50m from calm salt water.	Between 100 – 300m from breaking surf, and between 10 – 50m from calm salt water.
Walls	Internal wall framing	✓	✓*
	Internal wall framing for a building with outer wall wrap	✓	✓*
	External wall framing (including top hats) behind external cladding	✓	✗
	External wall framing (including top-hats) behind wall wrap and external cladding	✓	✓
	Vertical top hats outside of outer wall wrap but under external cladding with a drained and vented cavity	✓	✓#
Ceilings	Ceiling framing under a concrete slab	✓	✓*
	Ceiling framing under a roof	✓	✗

* Based on full internal encapsulation with no uninhibited air flow from outside of the building envelope.
# Performance is expected to vary based on the type of external cladding used.

1. Table applicable to all Siniat Zincalume® coated steel products for a minimum expected life of 15 years under normal conditions (excluding indoor swimming pools and spas). Actual service life may increase or decrease depending the factors outlined in the section titled '*Durability*'.
2. All galvanised products must be used further than 300m from breaking surf and further than 50m from calm salt water.
3. Water must not be permitted to pool on surfaces and must be designed and installed to drain freely.
4. The outer wall wrap and roof sarking must be suited to the climate zone.
5. Foil backed insulation must be used under a metal roof to prevent condensation forming on the roof sheeting.
6. Regular recorded inspections must be conducted with any rectification measures actioned.
7. Fasteners/Anchors must have a suitable corrosion protection coating to match the application (ie: Class 1 or 2 for internal use, or Class 3 or greater for within 300m of breaking surf) or an applied coating for protection. Note that stainless steel screws are not recommended with Siniat steel framing.
8. Refer to 'Intensive Animal Farming and Industrial Buildings' and 'Indoor Swimming Pools and Spas' sections for further restrictions.

Corrosivity Zones

AS 4312-2019 Atmospheric corrosivity zones in Australia, classifies geographical zones within Australia based upon the theoretical first year atmospheric corrosion rate of mild steel open to exposure.

Actual corrosion rates depend on the severity of exposure, and these zones are a practical indication of the potential severity of the location to corrosion. This standard does not indicate which corrosion protection coatings must be used for certain locations.

As Siniat steel profiles must be effectively separated from the external environment once installed, the corrosivity zones are much less relevant. Refer to Table 3 for the use of Siniat products for the geographical location and intended application.

Intensive Animal Farming and Industrial Buildings

Certain micro environments have been found to be particularly corrosive such as intensive animal farming buildings. These buildings create an environment with high concentrations of sulphur and ammonia and as such are not suitable with Siniat steel products without the application of additional corrosion protection measures.

Industrial buildings and the like, and surrounding locations that are subject to heavy dust emissions, excessive heat, excessive moisture, corrosive chemicals or acids, fertilizer manufacturing and storage, near the combustion of fossil fuels are also micro environments which will require further advice before the use of Siniat steel products.

Please consult a corrosion expert for advice for these applications.

Indoor Swimming Pools and Spas

The overall design and maintenance plan of a facility affects the long term durability of the building products used in the construction. Other factors like humidity levels, ventilation, temperature, chemical cleaning treatment (chlorine) and proximity of the pool to walls and ceilings also affect durability. Although these factors are outside the control of Etex Australia (Siniat), they are critical to protecting steel framing from the corrosive atmosphere of an indoor swimming pool and spa.

Individual site conditions may require specific measures therefore consultants such as HVAC specialists, corrosion experts and building physicists are recommended.

Minimum requirements to use Siniat AM125, AM150 or Z275 coated steel products for concealed indoor swimming pool wall and ceiling framing:

- A slight negative pressure must be maintained in the pool room relative to the wall and ceiling spaces. This reduces the driving force of moisture into the wall or ceiling cavity where the framing is located.
- Ventilation systems must continuously circulate air and be vented to the outside only. The ceiling plenum must not be used for return air.
- Use a minimum of Class 3 corrosion resistant screws appropriate for the lining and also compatible with the steel framing. Please note that stainless steel screws are not recommended with Siniat steel framing.
- Vapour barriers between the wall and ceiling framing and the indoor pool room must be continuous and sealed at all joints and penetrations. Any following trades must re-seal any penetrations in the vapour barriers. The purpose of the vapour barrier is to prevent water vapour from the swimming pool or spa passing through the wall or ceiling lining into the cavity, where it may turn into condensation (liquid form).
- Allow wall and ceiling cavities to dry by using ventilation to the outside and vapour permeable membranes under any external claddings.
- Thermal insulation with vapour barrier must be installed under sheet roofing. This is to prevent condensation dripping onto the steel framing. Sarking must be installed under tiled roofs to reduce pressure fluctuations within the roof space which may draw air in from the pool area.
- Periodically inspect the steel framing for the appearance of rust and replace if detected or consult a corrosion specialist.

Zinc electroplated ceiling clips are not recommended for use in indoor swimming pools.

Dissimilar Metals

When dissimilar metals (active and noble metals) come into contact along with the presence of an electrolyte such as water they corrode via galvanic action. This is also known as galvanic corrosion or bi-metallic corrosion.

Copper, stainless steel, brass and lead are just some of the metals that can cause galvanic corrosion when in contact with Zincalume®, Galvaspan® or galvanised steel. Therefore, copper pipes, lead flashing and the like must not come in direct contact with Siniat steel products. Also any water flowing from lead flashing or copper pipes onto Siniat steel products shall be prevented.

Table 4 Compatibility of Siniat Steel

Coating / Metal	AM150 / AM125	Z275 Z350
Zinc (Z), Aluminium/Zinc (AZ), Aluminium/Zinc/ Magnesium (AM, ZAM)	Compatible	Compatible
Aluminium	Compatible	Compatible
Copper, Stainless Steel or Zinc Nickel coated steel	Not suitable	Not suitable

Termite Treated Timbers

Green timber and Copper Chrome Arsenic (CCA) treated timbers must not come into direct contact with Siniat steel products. Either they must be isolated or an alternative kiln dried timber treatment compatible with galvanised or Zincalume® corrosion protection must be used.

Thermal

Steel conducts heat so a thermal break is needed when steel studs are used to construct external walls. Refer to the NCC for more details.

Specific Heat Capacity

Steel is 490 J/kg/K.

Dimensional Stability

Thermal coefficient of linear expansion
(α) = 12 x 10^{-6} m / °C, measured unrestrained at a temperature of 25 °C

Maintenance

Maintenance can help extend the service life of steel framing and it is likely to be necessary only as required. Annual checks are recommended on wall, ceiling and facade systems to assess whether maintenance is required for:

- Physical damage
- Fire or excessive heat damage
- Corrosion
- Cleaning (as and when desired)

If repairs are required, then they must be conducted in a way that maintains the structural integrity of the original frame. Also, if new materials are introduced with any repairs then they must be compatible with the existing framing.

Timber

Unless otherwise stated, timber components used in the systems in this manual were designed using grade MGP10 timber.

Timber is a natural product and its dimensions vary with changes in surrounding moisture. Timber should be allowed to reach equilibrium with its surroundings before lining it with plasterboard. The equilibrium moisture content of timber is usually 10 -14%.

Cement Board

Where extreme water resistance is required, Permarock is a solid, engineered wall and ceiling lining made from inorganic aggregated cement with glass fibre mesh embedded in both the face and back. Available for both indoor and outdoor application, it is the ideal tile substrate and provides a solid and dry foundation for external rendered and painted facades.

Fibre Cement

Systems in Blueprint that include fibre cement were tested and evaluated using James Hardie™ fibre cement products.

James Hardie™ manufacturers fibre cement to the requirements of *AS/NZS 2908.2 Cellulose-Cement Products Flat Sheets.*

Table 5 Fibre Cement Internal Linings used in Fire Rated Systems

Product	Thickness (mm)	Weight (kg/m²)
Villaboard™	6	8.3
	9	12.4
	12	16.6

Table 6 Recommended Fibre Cement Cladding for External Wall Systems

Product	Thickness (mm)	Weight (kg/m²)
ExoTec™	9	16.3
	12	21.9
ExoTec Vero™	9	16.3
Hardie™ Fine Texture Cladding	8.5	12.5
Hardie™ Flex Sheet	4.5	6.5
	6	8.7
EasyLap™ Panel	8.5	12.5
Axon™ Cladding	9	12.5
Matrix™ Cladding	8	12.6
Stria™ Cladding	14	18.9
	16	21.6
Hardie™ Plank weatherboard	7.5	10 - 11.8
Linea™ weatherboard	16	21.1
Primeline™ weatherboard	9	13.2

For further information on James Hardie™ products please use the link below.

Insulation

Bulk insulation is one of the most cost effective and efficient methods of providing acoustic and thermal comfort and is generally included in light-weight construction systems.

Fletcher Insulation® provides a range of acoustic and energy efficient thermal solutions for the residential, commercial and industrial sectors. Fletcher Insulation® manufactures insulation to the requirements of *AS/NZS 4859.1, Materials used in the Thermal Insulation of Buildings*, and have been tested and certified to relevant Australian Standards ensuring compliance with the National Construction Code (NCC) of Australia.

With a history dating back over half a century, Fletcher Insulation® is a leading insulation manufacturer and distributor of insulation and building membranes in Australia. Supplying renowned brands such as Pink® Batts and Sisalation®, Fletcher Insulation® delivers leading insulation solutions designed for residential homes, commercial buildings as well as HVAC applications. With a national sales and distribution footprint to support our Australian manufacturing facilities, Fletcher Insulation® prides itself on providing first-class products backed by leading edge technical support. For more information contact Fletcher Insulation® directly on 1300 654 444 or visit www.insulation.com.au

Certification for systems in Blueprint have been based upon the insulation products from Fletcher Insulation® and are summarised in Table 7.

Table 7 Insulation used in Blueprint

Insulation
Pink® Partition 25mm 24kg/m³ R0.7
Pink® Partition 50mm 11kg/m³ R1.2
Pink® Partition 50mm 14kg/m³ R1.3
Pink® Partition 75mm 11kg/m³ R1.8
Pink® Partition 75mm 14kg/m³ R1.9
Pink® Partition 90mm 14kg/m³ R2.2
Pink® Partition 110mm 11kg/m³ R2.5
Pink® Batts Wall R1.5
Pink® Batts Wall R2.0
Pink® Batts Wall R2.0HD
Pink® Batts Ceiling R2.5
Polyester R1.5
Polyester Batts Ceiling R2.5

Glasswool insulation in system tables with a nominated R-Value have no restrictions on density or thickness. It is recommended to not compress insulation to less than 85% of its original designated thickness when insulation is used for acoustic performance only. Where insulation is utilised for thermal performance, no compression is permitted.

Insulation products nominated in system tables are the minimum required to meet the acoustic rating. Insulation with higher R-value may be required to meet the desired system R-value.

Fletcher insulation also offers a technical design service that can help predict the thermal and acoustic performance of systems.

Fletcher insulation has developed FletcherSpec™ Pro that is a thermal prediction calculator that can be used to determine the overall thermal performance of roof and walling systems and verifies performance against the NCC. Please click here for access to FletcherSpec™ Pro.

Fletcher Insulation® provides a comprehensive range of bulk insulation products including:

- Pink® Partition
- Pink® Batts: Wall
- Pink® Batts: Ceiling
- Pink® Batts: Floor
- Pink® Soundbreak™
- Pink® Building Blanket
- Pink® Partition HD Panels
- Permastop® Building Blanket
- Permatuff® Building Blanket
- Permastop® Tropic Building Blanket
- Pink® EmberGuard™ Building Blanket
- Polyester Batts: Wall
- Polyester Batts: Ceiling
- Polyester Batts: Underfloor
- Polyester Batts: Acoustic
- Polyester Acoustic Partition Blanket
- Fire Stop (Party Wall Batts)
- Pink® Thermal Slab
- Pink® NoiseSTOP™ with Durasorb® Facing
- Pink® SonoBatt Blanket

Wall Wraps and Roof Sarking

Where products are required for vapour control or airflow, the following products are recommended:

- Sisalation® Vapawrap™ Residential Wall Wrap
- Sisalation® Tuff Wrap™ Wall Wrap Standard (497)
- Sisalation® Tuff Wrap™ Wall Wrap Breather (497)
- Sisalation® Multipurpose EHD (456)
- HardieWrap™ Weather Barrier
- Sisalation® Vapawrap™ Vapour Permeable Metal Roof
- Sisalation® Metal Roof Medium Duty (433)
- Sisalation® Metal Roof Heavy Duty (453)

Fletcher Insulation can assist with condensation modelling and provide advice on the right products to use by climate zone to meet the needs of the NCC. Please contact Fletcher Insulation for assistance on 1300 654 444.

General Tapes for Building Blankets and Vapour Permeable Sarkings

Vapastop® 883 Tape is recommended for use with building blankets and foil faced sarking and wall membranes.

3M Seaming Tape is recommended for use with Sisalation Vapour Permeable membranes.

Thermal Break Strip

Thermal break tapes are required by the NCC to isolate steel wall and roof framing. The following thermal break products are recommended to isolate steel wall and roof framing:

- HardieBreak™ Thermal Strip
- Thermatape™ Thermal Break Strip

Refer to FletcherSpec™ Pro modelling software that can predict performance of thermal systems inclusive of thermal break. Please click here for access to Fletcher Spec™ Pro

Acoustic Pipe Wrapping

Soundlag 4525C (5 kg/m^2) acoustic pipe wrapping is recommended for the sound protection of ducts, rainwater or waste pipes.

Loaded Vinyl Barrier

Quadzero™ Loaded Vinyl Barrier is recommended where additional acoustic performance is required.

Fire Stopping

The following products are recommend for the fire protection of openings and service penetrations in Siniat plasterboard wall and ceiling systems.

- Siniat Bindex Fire and Acoustic Sealant
- Promat PROMASEAL® Retrofit Collars
- Promat PROMASEAL® Wall Collars FCW
- Promat PROMASTOP® UniCollar®
- Promat PROMASEAL® Conduit Collar
- Promat PROMASEAL® Flexiwrap
- Promat PROMASEAL® Bulkhead Batts
- Promat PROMASEAL® Supawrap Sleeve
- Promat PROMASEAL® Supawrap 40
- Promat PROMASEAL® Pillows
- Promat PROMASEAL® Fyrestrip
- Promat PROMASEAL® IBS Foam Strip™
- Promat PROMASEAL® A acrylic sealant
- Promat PROMASEAL® AG acrylic intumescent sealant
- Fire Stop (Party Wall Batts)

Fasteners and Anchors

Fasteners and anchors used to fix Siniat steel framing products and accessories must be compatible and also have equivalent corrosion protection for the service life of the entire system.

As Siniat steel profiles are roll formed using Zincalume®, Galvaspan® or galvanised corrosion protection coatings, they are particularly compatible with zinc coated fasteners. The zinc layer acts as a sacrificial anode which protects the steel from corrosion.

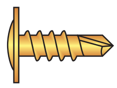
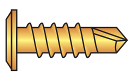
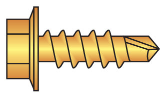
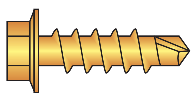
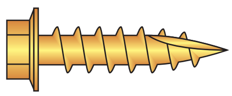
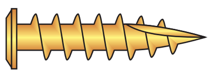
When using any fastener with Siniat steel profiles, it is essential that there is limited exposure to moisture during service. If the screws or studs come into contact with moisture, ensure that all moisture can dry out quickly beneath fastener heads or around washers (if used).

Please note that stainless steel screws are not recommended with Siniat steel framing, or alternatively seek expert advice on corrosion and compatibility prior to use.

Green timber and certain treated timbers such as Copper Chromium Arsenate (CCA) treated timbers are corrosive to steel fasteners, especially in combination with moisture.

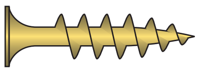
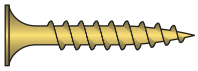
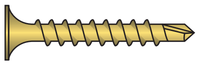
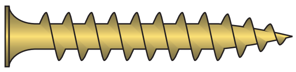
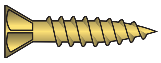
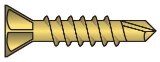
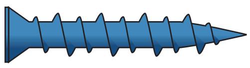
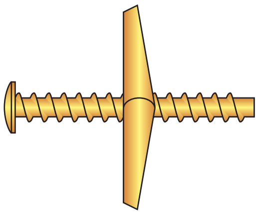
Consult the manufacturer for specific advice on the appropriate fasteners for the application and environmental conditions.

Table 8 Typical Steel Framing Fasteners Table

Typical Applications	Image	Features	Typical Sizes Available
			Screw gauge - Threads per inch x Length
Steel framing screw 0.75 - 2.50mm BMT. Recommended for Siniat 0.5 - 0.75mm BMT steel framing.		• Fine thread • Button head • Drill point	8 - 18 x 12mm 8 - 18 x 16mm 8 - 18 x 20mm 8 - 18 x 25mm 8 - 18 x 32mm
Steel framing screw 0.75 - 3.50mm BMT. Recommended for Siniat 1.15 - 1.5mm BMT steel framing.		• Fine thread • Wafer head • Drill point	10 - 16 x 16mm 10 - 16 x 22mm 10 - 16 x 30mm 10 - 16 x 40mm
Steel framing screw 0.75 - 3.50mm BMT. Recommended for Siniat 1.15 - 1.5mm BMT steel framing.		• Fine thread • Hex head • Drill point	10 - 16 x 16mm 10 - 16 x 25mm
Steel framing screw 1.00 - 4.50mm. Recommended for Siniat 1.15 - 1.5mm BMT steel framing.		• Fine thread • Hex head • Drill point	12 - 14 x 20mm 12 - 14 x 30mm 12 - 14 x 35mm 12 - 14 x 45mm 12 - 14 x 55mm 12 - 14 x 65mm 12 - 14 x 75mm
Steel framing to timber		• Coarse thread • Hex head • Type 17 point	10 - 12 x 25mm 12 - 11 x 25mm 12 - 11 x 40mm 12 - 11 x 50mm 12 - 11 x 65mm
Steel framing to timber		• Coarse thread • Wafer head • Type 17 point	10 - 12 x 25mm 10 - 12 x 35mm 10 - 12 x 45mm

1. Information in the table is supplied by ICCONS Pty Ltd, unless otherwise noted. Other fastener / anchor manufacturers product specifications may vary.
2. Refer to the manufacturer's technical literature for the correct in-situ applications, corrosion class and capacity information of a specific fastener or anchor.
3. Drawings are representative only.

Table 9 Typical Plasterboard and Fibre Cement Fasteners Table

Typical Applications	Image	Features	Typical Sizes Available Screw gauge - Threads per inch x Length
Plasterboard to timber		• Coarse thread • Bugle head • Needle point	6 - 9 x 25mm 6 - 9 x 32mm 6 - 9 x 41mm 8 - 9 x 45mm 8 - 9 x 50mm 8 - 9 x 75mm
Plasterboard to timber or steel up to 0.75mm BMT		• Fine thread • Bugle head • Needle point	6 - 18 x 20mm 6 - 18 x 25mm or 7 - 15 x 25mm 6 - 18 x 32mm or 7 - 15 x 32mm 6 - 18 x 35mm 6 - 18 x 41mm 6 - 18 x 45mm or 7 - 15 x 45mm 7 - 15 x 50mm 7 - 15 x 57mm 8 - 15 x 65mm 8 - 15 x 75mm 10 - 12 x 100mm
Plasterboard to steel 0.75mm to 2.30mm BMT		• Fine thread • Bugle head • Drill point	6 - 20 x 25mm 6 - 20 x 32mm 6 - 20 x 41mm 6 - 20 x 45mm 8 - 18 x 75mm (up to 2.50mm BMT)
Plasterboard laminating screw		• Coarse thread • Bugle head • Needle point	10 - 8 x 38mm 10 - 8 x 50mm
Fibre cement to steel up to 0.75mm BMT		• Self embed head • Needle point	8 -15 x 20mm 8 -15 x 30mm
Fibre cement to steel 0.75mm to 2.30mm BMT		• Fine thread • Self eambed head • Drill point	8 -15 x 20mm 8 -15 x 30mm
Plasterboard to masonry or concrete		• Tapcon thread • Countersunk head • Needle point	10 x 32mm 10 x 45mm 14 x 55mm 14 x 70mm
Hollow Wall Anchor (Spring Toggle)		• Fine thread • Pan head	1/8" x 50mm 1/8" x 75mm 3/16" x 50mm 3/16" x 75mm 3/16" x 100mm

1. Information in the table is supplied by ICCONS Pty Ltd, unless otherwise noted. Other fastener / anchor manufacturers product specifications may vary.
2. Refer to the manufacturer's technical literature for the correct in-situ applications, corrosion class and capacity information of a specific fastener or anchor.
3. Drawings are representative only.

Table 10 Fastener Corrosion Resistance Class

Minimum Fastener Corrosion Resistance Class	Atmosphere of Intended Use	Examples
1	General use in internal applications	• Offices
2	General use in other than external applications but where significant levels of condensation occur	• Warehouses or sport halls • Outdoor areas >50km from the coast* • When covered with coating system
3	External use in mild, moderate industrial or marine environments	• Dairies or food processing plants • Coastal areas with low salinity
4	External use in severe marine environment	• Indoor swimming pools • Outdoor areas <50m from bay shorelines or >300m to 1000m from surf*
5	Beachfront	• Outdoor areas <300m from surf

1. *Distances are approximate. Refer to AS4312 for more detail.
2. This is a general guide to minimum requirements only. Obtain specialist advice if in doubt.

Screw Anchors

Table 11 Screw Anchor Table

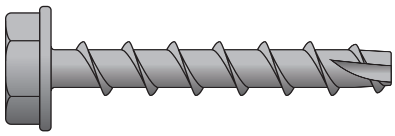
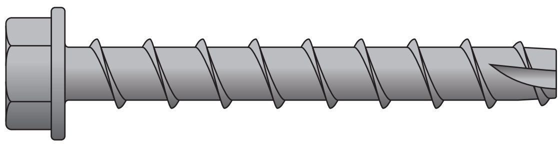
Typical Applications	Image	Features	Sizes Available Diameter x length
Siniat Screw Anchor for steel track or clips, into concrete or masonry		• Seismic C1 certified • Suitable for overhead applications • Hex head • Close to edge proximity compared to other anchors	6 x 45mm (SA6x45) 6 x 60mm (SA6x60)
Siniat Screw Anchor for Universal Bracket (UB80) and Dropper Bracket (DB), into concrete or masonry		• Seismic C1 certified • Suitable for overhead applications • Hex head • Close to edge proximity compared to other anchors	8 x 65mm (SA8x65)

Table 12 Properties

Anchor	SA6x45 and SA6x60	SA8x65
Head type	Hex-head SW13	Hex-head SW13
Corrosion protection	8 μm zinc coating	8 μm zinc coating
Nominal tensile strength f_{uk} (N/mm^2)	930	810
Yield strength f_{yk} (N/mm^2)	745	695
Stressed cross-section A_s (mm^2)	26.9	48.4

Table 13 Concrete Thickness and Anchor Placement

Anchor	SA6x45	SA6x60	SA8x65
Minimum concrete thickness (mm)	80	100	100
Minimum spacing S_{min} (mm)	35	35	50
Minimum edge distance C_{min} (mm)	35	35	40

Table 14 Static and Quasi-static Performance in Concrete

Design Resistance in Cracked Concrete (kN)		Static / Quasi-static Loads					
		Pull-out			Shear		
		SA6x45	SA6x60	SA8x65	SA6x45	SA6x60	SA8x65
Nominal embedment depth h_{nom} (mm)		40	55	60	40	55	60
Concrete Grade (MPa)	20	1.39	3.33	6.00	3.77	8.33	12.67
	25	1.54	3.70	6.66	4.22	8.33	12.67
	32	1.76	4.22	7.59	4.77	8.33	12.67
	40	1.96	4.70	8.46	5.33	8.33	12.67
	50	2.19	5.27	9.48	5.96	8.33	12.67

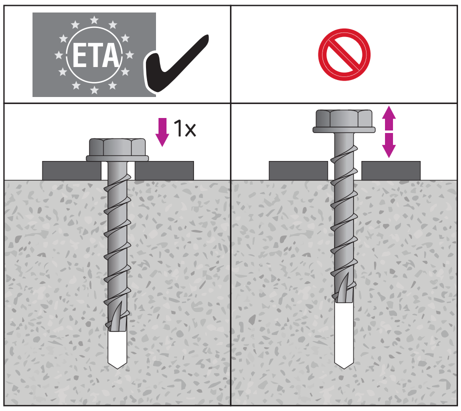
1. No edge distance and spacing influence, or reinforcement affects.
2. Interaction of both Pull-out and Shear to be considered as per AS5216-2018 Equation 8.2.1 (1) and 8.2.1 (2).

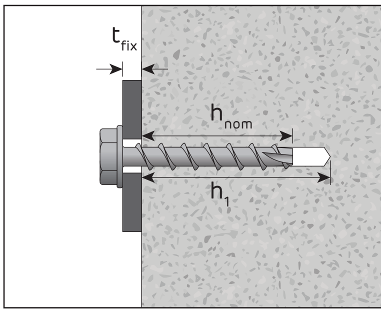
Table 15 Seismic C1 Performance in Concrete

Design Resistance in Cracked Concrete (kN)		Seismic C1 Loads					
		Pull-out			Shear		
		SA6x45	SA6x60	SA8x65	SA6x45	SA6x60	SA8x65
Nominal embedment depth h_{nom} (mm)		40	55	60	40	55	60
Concrete Grade (MPa)	20	1.39	2.22	6.00	1.60	1.67	3.97
	≥ 25	1.39	2.22	6.00	1.67	1.67	3.97

1. No edge distance and spacing influence, or reinforcement affects.
2. Interaction of both Pull-out and Shear to be considered as per AS5216-2018 Equation 8.2.1 (1) and 8.2.1 (2).
3. α_{gap} = 0.5

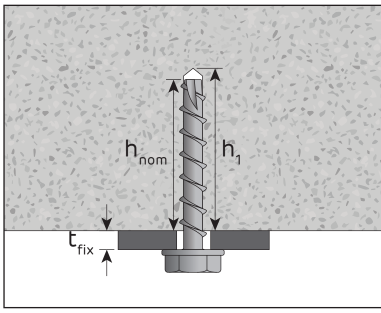
Screw Anchor Installation
SA6x45 and SA6x60





SA6x45	
h_1	50mm
h_{nom}	40mm
t_{fix}	5mm maximum
SA6x60	
h_1	65mm
h_{nom}	55mm
t_{fix}	5mm maximum

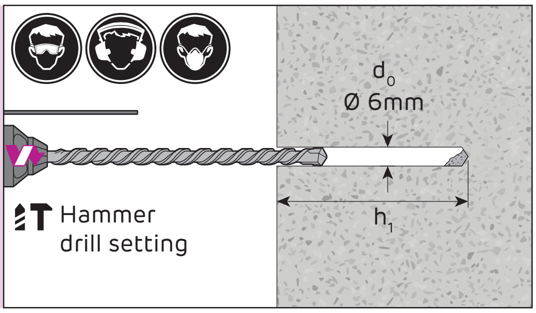
General Applications
Section



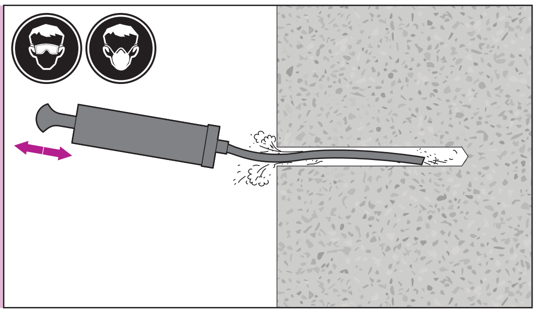
SA6x45	
h_1	48mm
h_{nom}	40mm
t_{fix}	5mm maximum
SA6x60	
h_1	63mm
h_{nom}	55mm
t_{fix}	5mm maximum

Overhead Applications
Section

1



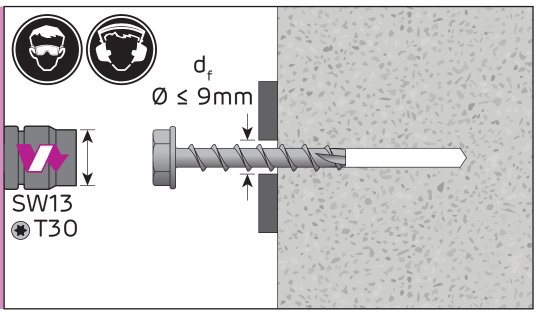
2



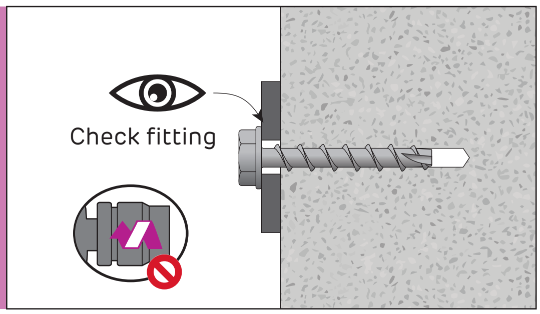
3

h_{nom}	Hilti Impact Driver / Wrench SID 2-A ½"	Hilti Impact Driver / Wrench SIW 6AT-A22 ½"	Hilti Impact Driver / Wrench SIW 22T-A ½"	Installation torque
40mm	✔	2 ✔	🚫	20 Nm
55mm	✔	3 ✔	🚫	25 Nm

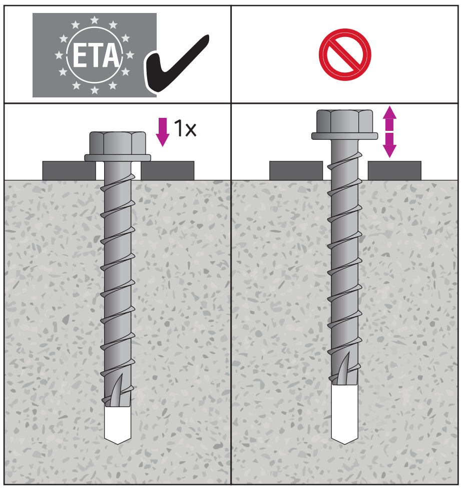
4

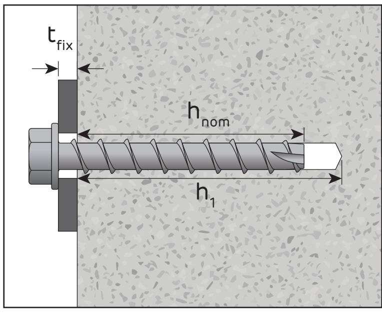


5



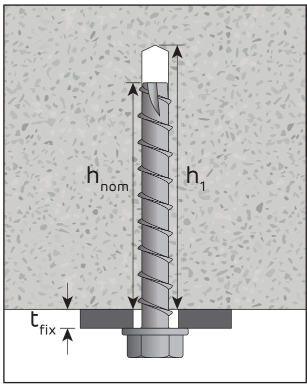
Siniat Screw Anchor Installation
SA8x65





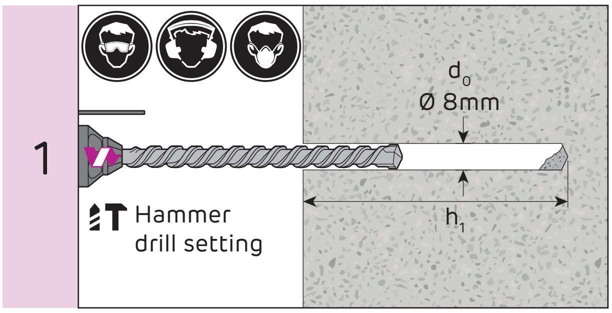
SA8x65	
h_1	70mm
h_{nom}	60mm
t_{fix}	5mm maximum

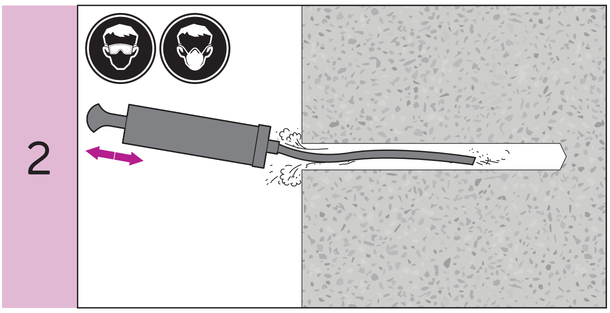
General Applications
Section



SA8x65	
h_1	70mm
h_{nom}	60mm
t_{fix}	5mm maximum

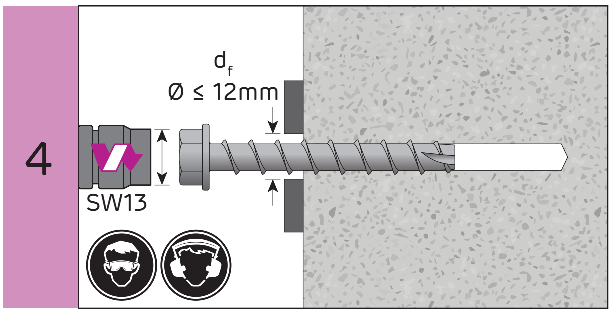
Overhead Applications
Section

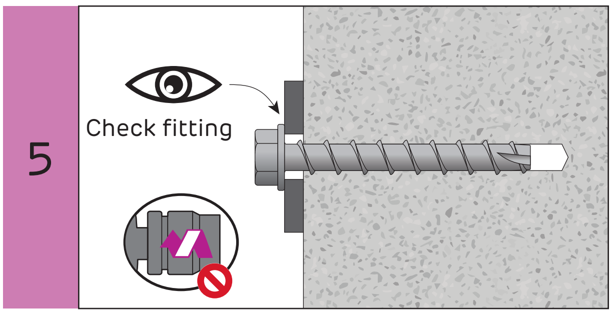




3

h_{nom}	Hilti Impact Driver / Wrench				
	SIW 22-A ½"	SIW 6AT-A22 ½"	SIW 22T-A ½"	SIW 22T-A ¾"	SIW 9-A22 ¾"
60mm	✔	✔	✔	✔	⊘





2.2 Care and Use

Storage, Delivery and Handling

Wall and ceiling linings must be kept dry and should be stacked clear of the floor using supports not more than 600mm apart as shown in Figure 1. If outdoor storage is unavoidable, linings and accessories should be fully protected from the weather. Plasterboard that has been exposed to direct sunlight, or has been fixed and left unpainted for long periods, may become discoloured. If this happens, it must be sealed with a solvent borne stain sealer undercoat as recommended by the paint manufacturer.

Plasterboard ceilings should not be left unpainted as they may absorb moisture from the atmosphere and sag. Plasterboard finishing compound must not be left unpainted as it becomes susceptible to moisture absorption and can develop shrinkage defects or become powdery and flake off if painting is attempted.

To reduce the possibility of damage to plasterboard, arrange delivery to site immediately before installation. During delivery, care should be taken not to damage the surface or edges the plasterboard sheets.

Exposure to excessive humidity during storage can result in plasterboard becoming damp and soft, and may appear defective. In this case allow the plasterboard to dry out and handle with care during installation.

To help protect plasterboard from absorbing humidity:

- Avoid open sources of water such as wet floors
- Wrap the plasterboard with plastic overnight when storing outside
- Provide ventilation
- Install soon after delivery
- Install during dry weather for best results.

Store Siniat steel products where they are not in constant contact with water or in wet environments for extended periods. Avoid exposure to airborne contaminants such as sea spray.

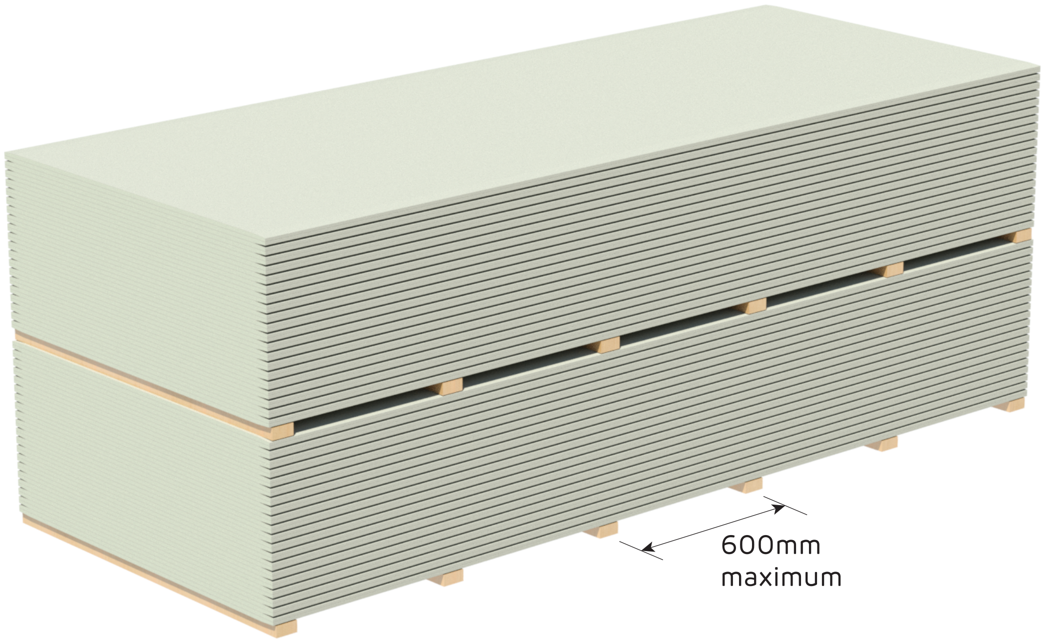


FIGURE 1 Correct Plasterboard Storage

Weather Protection

Siniat plasterboard must only be installed in a building that is weathertight. Particular care must be taken in areas of high humidity and coastal areas subject to salt spray. Complete all exterior doors, walls, windows and the roof before installing plasterboard. Prevent rain from entering buildings, avoid water on floors or other sources of open water and allow wet concrete or masonry to dry. These precautions will reduce excessive humidity that may be absorbed by timber or unpainted plasterboard and minimise defects caused by timber shrinkage or moist plasterboard.

Siniat plasterboard installed on the exterior side of external wall framing must be protected from the weather until moisture barriers and external cladding are installed. Protect plasterboard from water pooling at ground level.

Condensation and Ventilation

Condensation of water on a surface occurs when the temperature of a building element falls below the dew point temperature. Moisture from the air then condenses on the surface.

Condensation onto either the face or back of plasterboard and associated substrate framing must be avoided. Insufficient protection from condensation can result in plasterboard joint distortion, sagging, mould growth, fastener popping and corrosion on steel framing.

Many inter-related factors must be taken into account to control condensation. Good practice is to make use of wall and ceiling insulation, vapour barriers, and especially ventilation.

Siniat plasterboard and steel framing must only be installed in a well ventilated area. Ventilation is crucial to the longevity of all building materials as it controls the indoor air quality. Therefore appropriate ventilation must be considered for the spaces in walls, under floors and in particular under roofs and soffits.

Continuous ventilation in a wall or ceiling cavity near salt water may reduce the service life of any steel substrate framing. As such, vented wall and ceiling systems with only one opening are recommended. Fully ventilated building systems with multiple openings near salt water must be considered with caution.

To minimise the effects of condensation:

- Use **water**shield, **multi**shield, **tru**rock or **tru**rock hd to increase protection against moisture.
- Use moisture barriers, sarking, and insulation. However, it is important that the right type is selected for the construction type and that it is installed correctly. [Refer to the manufacturer's specifications]
- Use foil backed insulation under metal roofs which are susceptible to forming condensation.
- Install eave vents, gable vents and roof ventilators in the roof cavity.
- Remove humidity from bathrooms via an exhaust fan to the outside.
- Use a quality paint system to provide protection against paint peeling and condensation soaking into plasterboard and compounds.
- Ensure the building design controls condensation on the steel components so they are not constantly wet.

In hot and humid climates where the building is air-conditioned below the dew point of the outside air, the wall and ceiling framing members and internal linings should be fully protected by moisture barriers to separate them from the humid external air. The moisture barriers should be thermally insulated to maintain them at a temperature above the dew point.

Exposure to High Humidity

Plasterboard exposed to high humidity (above 90%) for an extended period, may affect the plasterboards integrity and therefore its ability to perform its intended function.

For rooms with intermittent periods of high humidity such as bathrooms or basements where plasterboard is installed, a source of ventilation is required to enable removal of excess moisture, such as an open window or exhaust fan.

Ceilings in rooms such as indoor swimming pools and communal showers are subject to long periods of high humidity (above 90%). The use of plasterboard on these ceilings is not guaranteed by Etex Australia. PermaRock Cement Board Indoor is recommended for these areas.

watershield, **multi**shield, **tru**rock or **tru**rock hd completely covered with a waterproof membrane complying with *AS/NZS 4858:2004 Wet Area Membranes* may be used for walls in rooms subject to long periods of high relative humidity. Vertical junctions and wall to floor junctions must also be waterproof, refer to Section 3.4 Internal Wet Areas using Plasterboard.

> In areas where high humidity is likely (ie: under concrete slabs with concrete block walls) consider closer framing intervals for ceiling linings to limit sag

Exposure to Water

Plasterboard that has become wet during its service life must be assessed for damage and then either repaired or replaced. Plasterboard exposed to water can be assessed by anyone familiar with plasterboard such as plasterer.

The Onboard referred to below may be used as a guide for determining if the plasterboard needs repair or replacement.

OnBoard 'Assessing Wet Plasterboard'

Read Siniat OnBoard Technical Newsletter on Assessing Wet Plasterboard by clicking on the link or by using your phone's camera on the QR code.

Exposure to Excessive Heat

Plasterboard is an ideal building material for normal ambient temperatures. It is not suitable for long periods at elevated temperatures such as installed near fireplace flues or chimneys. Fire resistant plasterboard is no exception. It is designed to slow down a fire, not to resist constant elevated temperatures.

The effect of high temperatures on plasterboard is to chemically dehydrate the core. This process generally begins at around 80°C but can occur at lower temperatures under certain conditions.

AS/NZS 2589:2017, Gypsum linings – Application and finishing, states that plasterboard must not be exposed to temperatures above 52°C for prolonged periods.

Heat generating appliances have installation instructions for the correct distances between plasterboard linings and heat sources. The *National Construction Code (NCC)* also has requirements for installation of heating appliances.

Glass or Stainless Steel Splashback

AS/NZS 5601.1-2013 General Gas Installations allows plasterboard to be used behind splashbacks near domestic gas burners as follows:

- Behind ceramic tiles any plasterboard may be used if the ceramic tiles are minimum 5mm thick
- If clearance to glass or stainless steel splashback is 200mm* or more, then any plasterboard may be used
- If clearance to glass splashback is less than 200mm* then 10mm plasterboard may be used if the glass is marked as 'toughened safety glass'
- Clearance to stainless steel splashback is less than 200mm* then 6mm fibre cement over 10mm plasterboard may be used if the steel is at least 0.4mm thick.

*Clearance is measured from the edge of the nearest burner to the splashback.

2.3 Building Requirements and Solutions

Siniat offers wall and ceilings systems using plasterboard to satisfy a variety of building requirements, including:

- Standard wall partition and ceiling types
- Fire protection
- Sound insulation
- Sound absorption
- Impact resistance
- Thermal insulation
- Wet areas and mould resistance
- X-ray shielding
- Improved indoor air quality solutions
- Aesthetic solutions

All systems in Blueprint have been designed to satisfy the requirements of the *National Construction Code (NCC)*.

System performance relies not only on selecting the correct nominated material components such as plasterboard, compounds, studs and insulation, but also on following the correct installation details such as stud spacing and fixing centres. Even small details like sealing gaps can have an effect on system performance.

Variations in construction or materials may reduce a system's fire and sound insulation rating, structural capacity or other aspects of performance. Where performance is compromised it can result in non-compliance. Non-compliance is costly to rectify and if not done the ultimate cost can be human life.

Control Joints

Control joints allow for building movement resulting from influences such as moisture migration, structural movement and foundation settlement. Cracks in plasterboard and plasterboard joints should be minimised by using control joints and the correct installation techniques.

According to *AS/NZS 2589:2017, Gypsum linings –Application and finishing*, control joints must be installed in plasterboard walls and ceilings at:

- Maximum 12 metre intervals
- Control joints in the structure
- Any change in the substrate material

Control joints are also recommended at the:

- Junction of a larger room and passageway
- Floor line in stairwells. Cover the gap with a moulding fastened to one edge.

Distance between control joints may need to be reduced to less than 12 metres due to conditions such as large temperature or humidity variations. Control joints used in plasterboard external ceilings must have 6 metre maximum intervals, and for tiled plasterboard walls must have 4.8 metre maximum intervals.

Ceilings in close proximity to roof tiles or metal sheeting may require control joints at much smaller intervals as they are exposed to larger rates of thermal expansion and higher humidity.

An internal or external corner, bulkhead or full height door or window may perform the function of a control joint.

Design Standards

Wall and ceiling system framing must be designed according to the relevant design standard:

- *AS 1684 Residential Timber Framed Construction*
- *AS 1720 Timber Structures*
- *AS/NZS 2785 Suspended Ceilings*
- *AS/NZS 4600 Cold Formed Steel Structures*
- *NASH Standard for Residential and Low-rise Steel Framing, Part 1 and Part 2*
- *AS/NZS 3700 Masonry Structures*

Siniat Frame Finder and Estimator

Use the Siniat Frame Finder and Estimator by clicking on the link or by using your phone's camera on the QR code.

Structural Frame Design for Lightweight Systems

Load Determination

To design the frame for a wall or ceiling system, first the loads acting on the system must be determined. The Australian and New Zealand 1170 series of standards must be referenced to define the loads that a structure is subjected to.

- *AS/NZS 1170.0 Structural Design Actions – General Principles*
- *AS/NZS 1170.1 Structural Design Actions – Permanent, imposed and other actions*
- *AS/NZS 1170.2 Structural Design Actions – Wind actions*
- *AS/NZS 1170.3 Structural Design Actions – Snow and ice actions*
- *AS 1170.4 Structural Design Actions – Earthquake actions in Australia*

An abridged version of the wind actions standard, specific to wind loads for certain Australian low-rise residential dwellings may also be used, and it is called AS 4055 Wind loads for housing.

There is also a joint Australian and New Zealand standard specific to suspended ceilings, *AS/NZS 2785 Suspended ceilings – design and installation*, which covers additional loads and load cases.

Common Loads on Wall and Ceiling Systems

The most common loads which may act on a wall or ceiling system include:

1. Dead loads (G): Weight of the wall or ceiling itself.
2. Live loads (Q): Shelf loads, Hand-rail loads, Impact loads, and any other variable loads.
3. Wind loads (W): External wind loads, and internal wind loads.
4. Services loads (U): A nominal service load specific to ceiling systems.
5. Earthquake loads (E): Forces acting on wall and ceiling systems due to an earthquake event.

Other load types do exist for particular situations, and the AS/NZS 1170 series should be referred to.

Wind Loads

External and internal wind loads for a building or dwelling on a specific site are determined using the relevant standards, either AS/NZS 1170.2 for larger buildings or AS 4055 for low-rise residential dwellings. Reference to these standards should be made as both contain limitations to the type and size of structures covered.

The calculation of wind pressures using the method prescribed in AS/NZS 1170.2 when used for a specific project is summarised below. As this is a guide only, it is recommended to refer to the standard or seek professional engineering advice when determining wind pressures for a specific building/dwelling.

To determine the wind pressures for a particular structure, the following items need to be determined:

1. Building Importance Level from the National Construction Code (NCC), Volume One, Section B1.2. This section of the NCC sets out the appropriate annual probability of exceedance limits for wind, snow and earthquake loads for the relevant importance level of the building. The building importance levels range from 1 (least important) to 4 (most important).

2. Determine the site wind speed,

$$V_{sit,\beta} = V_R\, M_d\, M_{z,cat}\, M_s\, M_t$$

where:

$V_{sit,\beta}$ is the site wind speed (metres per second) based upon the 8 cardinal directions.

V_R is the regional gust wind speed (metres per second) based upon the wind region [Refer to Figure 2] and the annual probability of exceedance.

M_d is the wind directional multipliers for the 8 cardinal directions. For simplicity the wind direction multiplier is usually taken is 1.

$M_{z,cat}$ is the terrain/height multiplier, and is a function of the Terrain Category surrounding the location, and the height of the building or particular building element above the ground. The terrain/height multiplier ranges from 0.75 to 1.32.

M_s is the shielding multiplier, and is usually taken as 1.

M_t is the topography multiplier, and should be checked as it also depends on the terrain surrounding the location. The topography multiplier is usually taken as 1 but it may also go higher than 1.

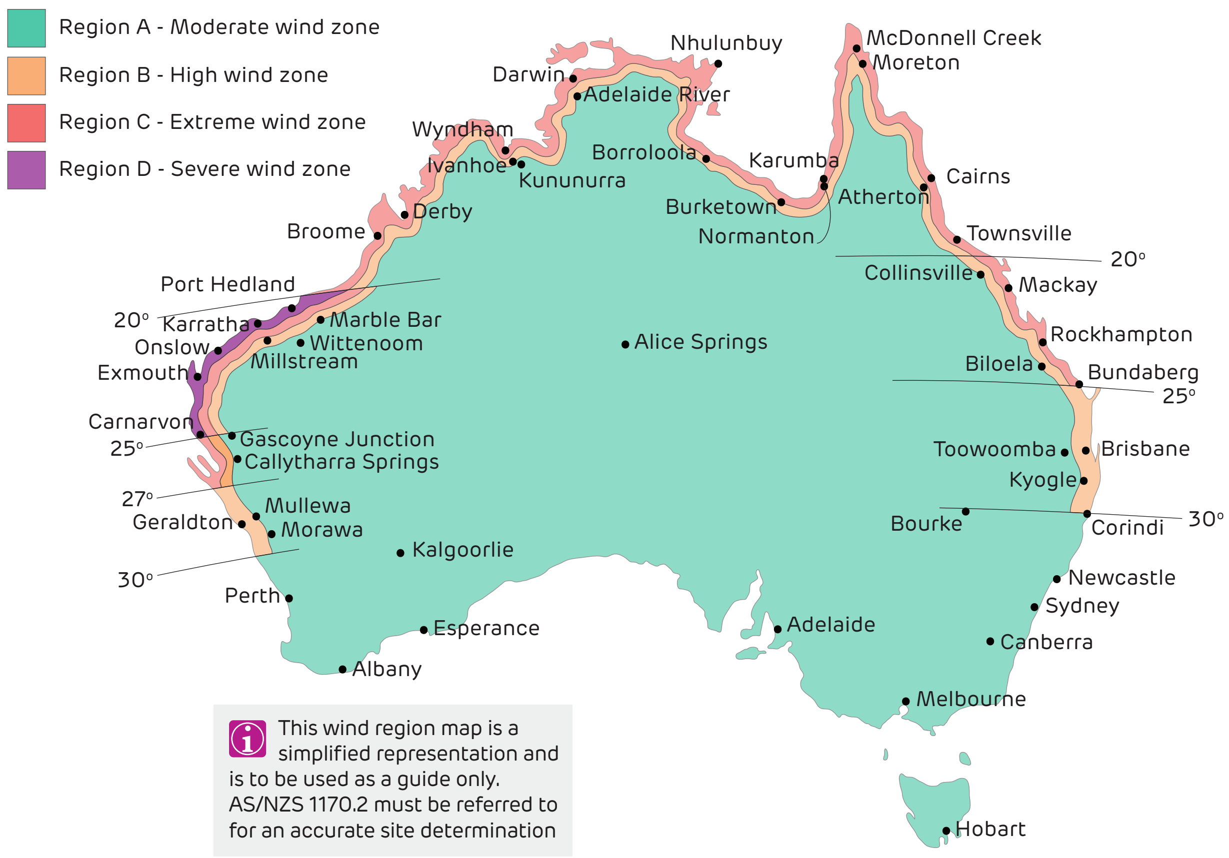


FIGURE 2 Australian Wind Regions

3. Determine the specific design pressure for the location of a building element.

$p = (0.5\ \rho_{air})\ [V_{des,\Theta}]^2\ C_{fig}\ C_{dyn}$

where:

p is the wind pressure, in pascals (Pa). As this is usually a large number it is simplified to kilo-pascals (kPa).

ρ_{air} is the density of air, taken as 1.2 kg/m³

$V_{des,\Theta}$ is the maximum value of $V_{sit,\beta}$ in the range of ± 45° from the buildings 4 orthogonal directions.

C_{fig} is an aerodynamic shape factor for the building element in question. C_{fig} can be relevant for external ($C_{fig,e}$), internal ($C_{fig,i}$), and a combination of external and internal wind pressures ($C_{fig,net}$). For a detailed explanation of the aerodynamic shape factor, see the relevant wind sections below.

C_{dyn} is a dynamic response factor and is related to the effects of fluctuating forces and resonant response of wind sensitive buildings. It analyses the along wind and cross wind response of a building during wind events. Generally taken as 1, but it may go higher than 1. Specialist wind engineering expertise may be required for certain buildings.

External Wind Pressures for Enclosed Rectangular Buildings

External wind pressures apply to cladding elements and structural elements directly supporting cladding like top hat framing. For a specific building element the external aerodynamic shape factor can be calculated by:

$C_{fig,e} = C_{p,e}\ K_a\ K_L\ K_p$

where:

$C_{fig,e}$ is the aerodynamic shape factor for external wind pressures.

$C_{p,e}$ is the external pressure coefficients for the outer surface of a building. There are different external pressure coefficients for windward walls, leeward walls, side walls and roofs.

K_a is an area reduction factor based upon the tributary area (m2) that a building element structurally supports. Generally taken as 1 for light-weight systems as the tributary area is rather small compared to larger structural members supporting the main structure.

K_L is a local pressure factor for wind pressures applied to cladding and members that support the cladding including all relevant fasteners. This factor

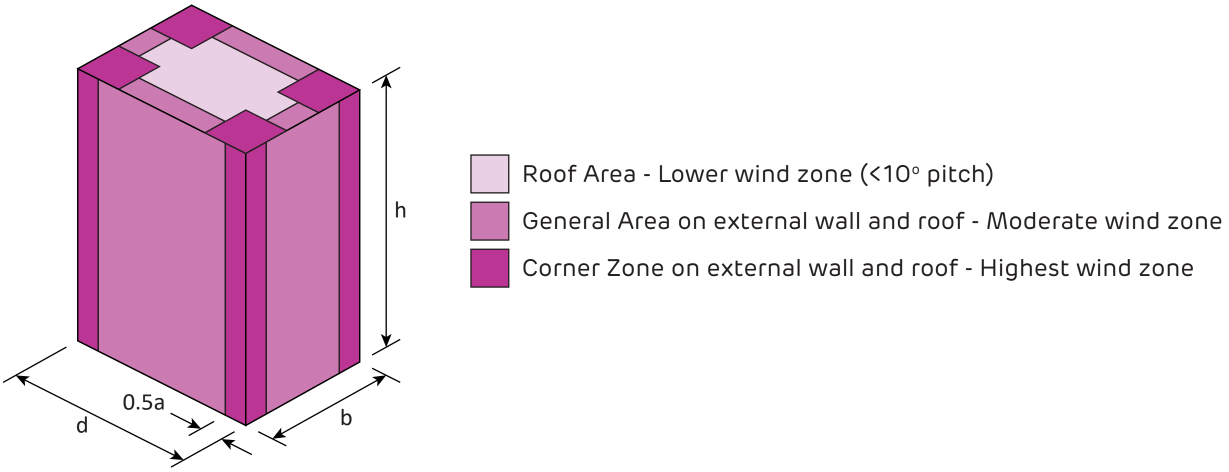


FIGURE 3 **Typical Simplified Wind Zones on a Building**
Combination external plus internal wind pressures (for stud framing)
Simplified to 2 zones

is dependent on the geometric properties of the building including height (h), breadth (b) and depth (d) [Refer to Figure 3], where depending on the location of the building the local pressure factor may be in the range of 1 up to 3. (a) is the minimum of 0.2b, 0.2d or h.

Internal Wind Pressures For Enclosed Rectangular Buildings

Internal wind pressures apply to internal wall and ceiling systems, and they are a function of the external wind pressures (site wind speed) and the size of any potential openings in the external surfaces. Potential openings include doors, windows and vents, which may be left open or may fail during a wind high event.

In regions C and D [Refer to Figure 2] the internal wind pressure must also contend with the potential effects of airborne debris during high wind events. An assessment should be made for each case; therefore professional advice will be required.

For a specific building element inside a building, the internal aerodynamic shape factor can be calculated by:

$C_{fig,i} = C_{p,i}$

where:

$C_{fig,i}$ is the aerodynamic shape factor for internal wind pressures.

$C_{p,i}$ is the internal pressure coefficient for the spaces inside a building. When there are no potential openings in any external surface greater than 0.5% of the total surface area, then the internal pressure coefficients are generally taken as the values shown in Figure 4.

For cases where the potential openings in any external surface can be greater than 0.5%, then the internal wind pressures gradually increase right up to the external pressures if the opening is large enough. Advice should be sought from Siniat or a professional engineer should this case occur for your project.

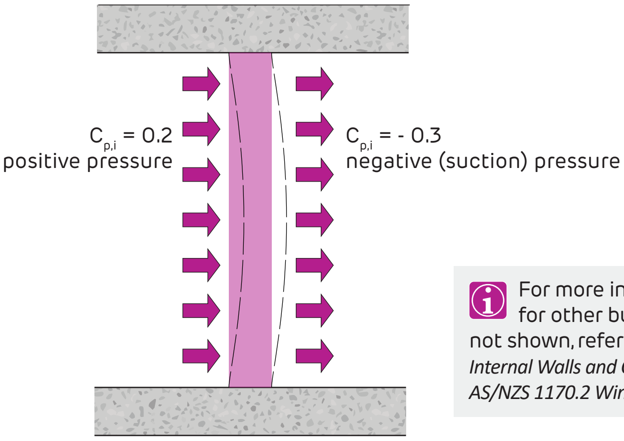
Implementing a sufficient building management plan for high wind events when a building is operational, is a possible way to reduce the potential size of external openings, and thus keeping the internal wind pressures to more economical levels.

For some applications it is also common in the drywall industry to use nominal internal wind pressures of
W_{ult} = 0.375 kPa, and W_{ser} = 0.25 kPa with either a maximum deflection of height/240 for flexible linings (i.e.: plasterboard) or height/360 for brittle linings (i.e.: fibre cement, masonry) for walls, and span/200 for suspended ceilings or span/360 for horizontal stud or top hat ceilings. If a project determines that this design criteria is acceptable, then the nominated wall height and ceiling span tables may be used to select the appropriate frame.

Note that these nominal pressures should not be confused with NCC Volume One, Specification C1.8 which is a robustness criteria for lightweight fire rated walls, such as fire rated plasterboard walls, and should not be confused with site specific internal wind pressures.

Siniat Internal Wind Load Calculator

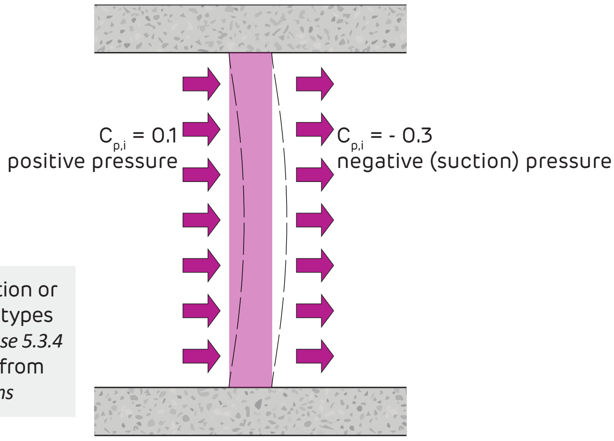
Use the Siniat Internal Wind Load Calculator by clicking on the link or by using your phone's camera on the QR code.



Case 1: Internal Wall $C_{p,i\ net}$ = 0.5

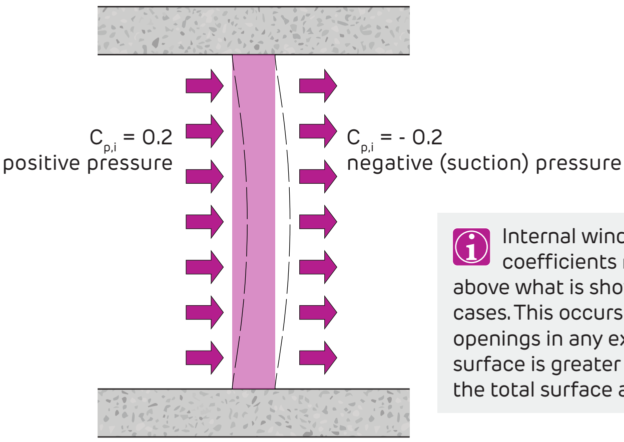
1. Apartment buildings and the like with 2 or 3 walls permeable, and other walls impermeable
2. Single leaf internal wall
3. Effectively sealed wall
4. Adjacent to an external wall.

For more information or for other building types not shown, refer to *Clause 5.3.4 Internal Walls and Ceilings* from *AS/NZS 1170.2 Wind Actions*



Case 2: Internal Wall $C_{p,i\ net}$ = 0.4

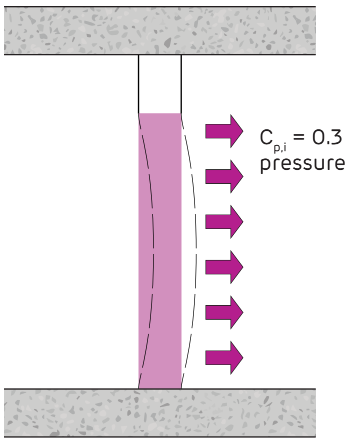
1. Apartment buildings and the like with 2 or 3 walls permeable, and other walls impermeable
2. Single leaf internal wall
3. Effectively sealed wall
4. Other internal walls that provide an effective seal between spaces.



Case 3: Internal Wall $C_{p,i\ net}$ = 0.4

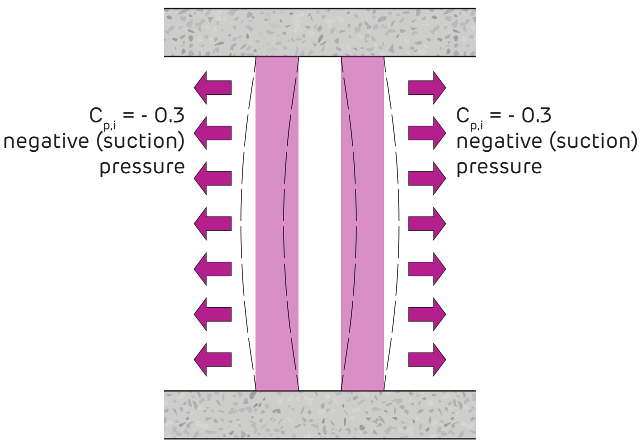
1. Air-conditioned Hospitals, Offices and Shopping Centres (except loading docks) that are effectively sealed where the external walls have non-opening windows
2. Single leaf internal wall
3. Effectively sealed wall
4. Adjacent to an external wall, or other internal walls that provide an effective seal between spaces.

Internal wind pressure coefficients may go above what is shown in these cases. This occurs when openings in any external surface is greater than 0.5% of the total surface area.



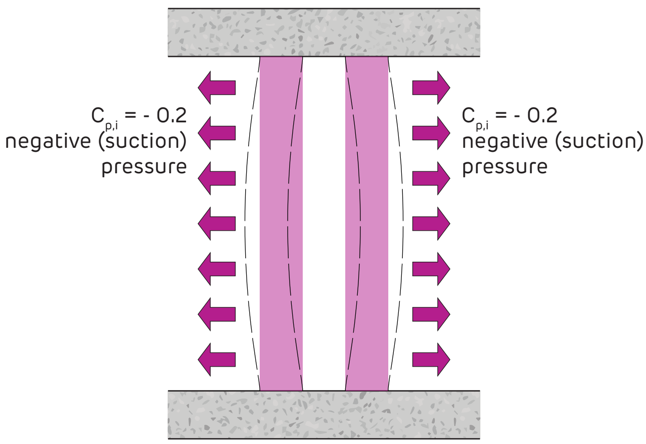
Case 4: Internal Wall $C_{p,i\ net}$ = 0.3

1. Single leaf internal wall
2. Wall with no permanent effective seal



Case 5: Internal Wall $C_{p,i\ net}$ = 0.3

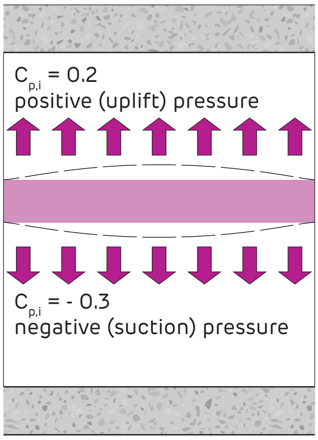
1. Apartment buildings and the like with 2 or 3 walls permeable, and other walls impermeable
2. Double leaf internal wall
3. Effectively sealed wall
4. Adjacent to an external wall.



Case 6: Internal Wall $C_{p,i\ net}$ = 0.2

1. Air-conditioned Hospitals, Offices and Shopping Centres (except loading docks) that are effectively sealed where the external walls have non-opening windows
2. Double leaf internal wall
3. Effectively sealed wall
4. Adjacent to an external wall.

FIGURE 4 Typical Simplified Wind Pressure Coefficients for Internal Wall Frame Design
Region A and B only - No potential openings in any external surface greater than 0.5% of the total surface area
Section view

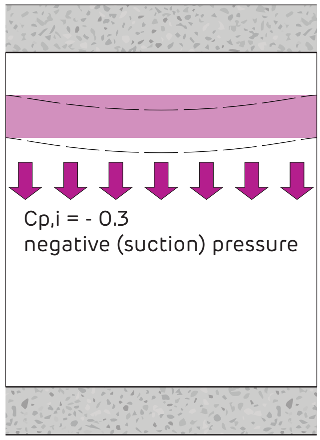


Case 1: Internal Ceiling $C_{p,i}$ = - 0.3 (suction) and $C_{p,i}$ = 0.2 (uplift)

1. Apartment buildings and the like with 2 or 3 walls permeable, and other walls impermeable
2. Internal ceiling adjacent to an external walls
3. Effectively sealed ceiling with an impermeable roof.

> For more information or for other building types not shown, refer to *Clause 5.3.4 Internal Walls and Ceilings* from *AS/NZS 1170.2 Wind Actions*

> Internal wind pressure coefficients may go above what is shown in these cases. This occurs when openings in any external surface is greater than 0.5% of the total surface area.



Case 2: Internal Ceiling $C_{p,i}$ = - 0.3 (suction)

1. Air-conditioned Hospitals, Offices and Shopping Centres (except loading docks) that are effectively sealed where the external walls have non-opening windows
2. Internal ceiling
3. Effectively sealed ceiling with an impermeable roof.

FIGURE 5 Typical Simplified Wind Pressure Coefficients for Internal Ceiling Frame Design
Region A and B only - No potential openings in any external surface greater than 0.5% of the total surface area
Section view

Table 16 Internal Wind Pressures $C_{p,i}$ =0.3

$C_{p,i}$ = Internal wind pressure coefficient

Building Importance Level 2																														
Region	A															B														
Ultimate Wind Speed V500 (m/s)	45															57														
Serviceability Wind Speed V25 (m/s)	37															39														
Terrain Category	1			1.5			2			2.5			3			1			1.5			2			2.5			3		
Height above ground (z)	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50
$M_{z,cat}$	1.12	1.21	1.25	1.06	1.15	1.22	1.00	1.10	1.18	0.92	1.04	1.13	0.83	0.97	1.07	1.12	1.21	1.25	1.06	1.15	1.22	1.00	1.10	1.18	0.92	1.04	1.13	0.83	0.97	1.07
Ultimate Wind Pressure (kPa)	0.46	0.53	0.57	0.41	0.48	0.54	0.36	0.44	0.51	0.31	0.39	0.47	0.25	0.34	0.42	0.73	0.86	0.91	0.66	0.77	0.87	0.58	0.71	0.81	0.49	0.63	0.75	0.40	0.55	0.67
Serviceability Wind Pressure (kPa)	0.31	0.36	0.39	0.28	0.33	0.37	0.25	0.30	0.34	0.21	0.27	0.31	0.17	0.23	0.28	0.34	0.40	0.43	0.31	0.36	0.41	0.27	0.33	0.38	0.23	0.30	0.35	0.19	0.26	0.31

Building Importance Level 3																														
Region	A															B														
Ultimate Wind Speed V1000 (m/s)	46															60														
Serviceability Wind Speed V25 (m/s)	37															39														
Terrain Category	1			1.5			2			2.5			3			1			1.5			2			2.5			3		
Height above ground (z)	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50
$M_{z,cat}$	1.12	1.21	1.25	1.06	1.15	1.22	1.00	1.10	1.18	0.92	1.04	1.13	0.83	0.97	1.07	1.12	1.21	1.25	1.06	1.15	1.22	1.00	1.10	1.18	0.92	1.04	1.13	0.83	0.97	1.07
Ultimate Wind Pressure (kPa)	0.48	0.56	0.60	0.43	0.50	0.57	0.38	0.46	0.53	0.32	0.41	0.49	0.26	0.36	0.44	0.81	0.95	1.01	0.73	0.86	0.96	0.65	0.78	0.90	0.54	0.70	0.83	0.45	0.61	0.74
Serviceability Wind Pressure (kPa)	0.31	0.36	0.39	0.28	0.33	0.37	0.25	0.30	0.34	0.21	0.27	0.31	0.17	0.23	0.28	0.34	0.40	0.43	0.31	0.36	0.41	0.27	0.33	0.38	0.23	0.30	0.35	0.19	0.26	0.31

Building Importance Level 4																														
Region	A															B														
Ultimate Wind Speed V2000 (m/s)	48															63														
Serviceability Wind Speed V25 (m/s)	37															39														
Terrain Category	1			1.5			2			2.5			3			1			1.5			2			2.5			3		
Height above ground (z)	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50
$M_{z,cat}$	1.12	1.21	1.25	1.06	1.15	1.22	1.00	1.10	1.18	0.92	1.04	1.13	0.83	0.97	1.07	1.12	1.21	1.25	1.06	1.15	1.22	1.00	1.10	1.18	0.92	1.04	1.13	0.83	0.97	1.07
Ultimate Wind Pressure (kPa)	0.52	0.61	0.65	0.47	0.55	0.62	0.41	0.50	0.58	0.35	0.45	0.53	0.29	0.39	0.47	0.90	1.05	1.12	0.80	0.94	1.06	0.71	0.86	0.99	0.60	0.77	0.91	0.49	0.67	0.82
Serviceability Wind Pressure (kPa)	0.31	0.36	0.39	0.28	0.33	0.37	0.25	0.30	0.34	0.21	0.27	0.31	0.17	0.23	0.28	0.34	0.40	0.43	0.31	0.36	0.41	0.27	0.33	0.38	0.23	0.30	0.35	0.19	0.26	0.31

Table 17 Internal Wind Pressures $C_{p,i}$ =0.4

$C_{p,i}$ = Internal wind pressure coefficient

Building Importance Level 2																														
Region	A															B														
Ultimate Wind Speed V500 (m/s)	45															57														
Serviceability Wind Speed V25 (m/s)	37															39														
Terrain Category	1			1.5			2			2.5			3			1			1.5			2			2.5			3		
Height above ground (z)	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50
$M_{z,cat}$	1.12	1.21	1.25	1.06	1.15	1.22	1.00	1.10	1.18	0.92	1.04	1.13	0.83	0.97	1.07	1.12	1.21	1.25	1.06	1.15	1.22	1.00	1.10	1.18	0.92	1.04	1.13	0.83	0.97	1.07
Ultimate Wind Pressure (kPa)	0.61	0.71	0.76	0.55	0.64	0.72	0.49	0.59	0.68	0.41	0.53	0.62	0.33	0.46	0.56	0.98	1.14	1.22	0.88	1.03	1.16	0.78	0.94	1.09	0.65	0.84	1.00	0.54	0.73	0.89
Serviceability Wind Pressure (kPa)	0.41	0.48	0.51	0.37	0.43	0.49	0.33	0.40	0.46	0.28	0.36	0.42	0.23	0.31	0.38	0.46	0.53	0.57	0.41	0.48	0.54	0.37	0.44	0.51	0.31	0.39	0.47	0.25	0.34	0.42

Building Importance Level 3																														
Region	A															B														
Ultimate Wind Speed V1000 (m/s)	46															60														
Serviceability Wind Speed V25 (m/s)	37															39														
Terrain Category	1			1.5			2			2.5			3			1			1.5			2			2.5			3		
Height above ground (z)	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50
$M_{z,cat}$	1.12	1.21	1.25	1.06	1.15	1.22	1.00	1.10	1.18	0.92	1.04	1.13	0.83	0.97	1.07	1.12	1.21	1.25	1.06	1.15	1.22	1.00	1.10	1.18	0.92	1.04	1.13	0.83	0.97	1.07
Ultimate Wind Pressure (kPa)	0.64	0.74	0.79	0.57	0.67	0.76	0.51	0.61	0.71	0.43	0.55	0.65	0.35	0.48	0.58	1.08	1.26	1.35	0.97	1.14	1.29	0.86	1.05	1.20	0.72	0.93	1.10	0.60	0.81	0.99
Serviceability Wind Pressure (kPa)	0.41	0.48	0.51	0.37	0.43	0.49	0.33	0.40	0.46	0.28	0.36	0.42	0.23	0.31	0.38	0.46	0.53	0.57	0.41	0.48	0.54	0.37	0.44	0.51	0.31	0.39	0.47	0.25	0.34	0.42

Building Importance Level 4																														
Region	A															B														
Ultimate Wind Speed V2000 (m/s)	48															63														
Serviceability Wind Speed V25 (m/s)	37															39														
Terrain Category	1			1.5			2			2.5			3			1			1.5			2			2.5			3		
Height above ground (z)	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50
$M_{z,cat}$	1.12	1.21	1.25	1.06	1.15	1.22	1.00	1.10	1.18	0.92	1.04	1.13	0.83	0.97	1.07	1.12	1.21	1.25	1.06	1.15	1.22	1.00	1.10	1.18	0.92	1.04	1.13	0.83	0.97	1.07
Ultimate Wind Pressure (kPa)	0.69	0.81	0.86	0.62	0.73	0.82	0.55	0.67	0.77	0.46	0.60	0.71	0.38	0.52	0.63	1.19	1.39	1.49	1.07	1.26	1.42	0.95	1.15	1.33	0.80	1.03	1.22	0.66	0.90	1.09
Serviceability Wind Pressure (kPa)	0.41	0.48	0.51	0.37	0.43	0.49	0.33	0.40	0.46	0.28	0.36	0.42	0.23	0.31	0.38	0.46	0.53	0.57	0.41	0.48	0.54	0.37	0.44	0.51	0.31	0.39	0.47	0.25	0.34	0.42

Table 18 Internal Wind Pressures $C_{p,i}$ =0.5

$C_{p,i}$ = Internal wind pressure coefficient

Building Importance Level 2																														
Region	A															B														
Ultimate Wind Speed V500 (m/s)	45															57														
Serviceability Wind Speed V25 (m/s)	37															39														
Terrain Category	1			1.5			2			2.5			3			1			1.5			2			2.5			3		
Height above ground (z)	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50
$M_{z,cat}$	1.12	1.21	1.25	1.06	1.15	1.22	1.00	1.10	1.18	0.92	1.04	1.13	0.83	0.97	1.07	1.12	1.21	1.25	1.06	1.15	1.22	1.00	1.10	1.18	0.92	1.04	1.13	0.83	0.97	1.07
Ultimate Wind Pressure (kPa)	0.76	0.89	0.95	0.68	0.80	0.90	0.61	0.74	0.85	0.51	0.66	0.78	0.42	0.57	0.70	1.22	1.43	1.52	1.10	1.29	1.45	0.97	1.18	1.36	0.82	1.05	1.24	0.67	0.92	1.12
Serviceability Wind Pressure (kPa)	0.52	0.60	0.64	0.46	0.54	0.61	0.41	0.50	0.57	0.34	0.44	0.52	0.28	0.39	0.47	0.57	0.67	0.71	0.51	0.60	0.68	0.46	0.55	0.64	0.38	0.49	0.58	0.31	0.43	0.52

Building Importance Level 3																														
Region	A															B														
Ultimate Wind Speed V1000 (m/s)	46															60														
Serviceability Wind Speed V25 (m/s)	37															39														
Terrain Category	1			1.5			2			2.5			3			1			1.5			2			2.5			3		
Height above ground (z)	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50
$M_{z,cat}$	1.12	1.21	1.25	1.06	1.15	1.22	1.00	1.10	1.18	0.92	1.04	1.13	0.83	0.97	1.07	1.12	1.21	1.25	1.06	1.15	1.22	1.00	1.10	1.18	0.92	1.04	1.13	0.83	0.97	1.07
Ultimate Wind Pressure (kPa)	0.80	0.93	0.99	0.71	0.84	0.94	0.63	0.77	0.88	0.53	0.69	0.81	0.44	0.60	0.73	1.35	1.58	1.69	1.21	1.43	1.61	1.08	1.31	1.50	0.90	1.17	1.38	0.74	1.02	1.24
Serviceability Wind Pressure (kPa)	0.52	0.60	0.64	0.46	0.54	0.61	0.41	0.50	0.57	0.34	0.44	0.52	0.28	0.39	0.47	0.57	0.67	0.71	0.51	0.60	0.68	0.46	0.55	0.64	0.38	0.49	0.58	0.31	0.43	0.52

Building Importance Level 4																														
Region	A															B														
Ultimate Wind Speed V2000 (m/s)	48															63														
Serviceability Wind Speed V25 (m/s)	37															39														
Terrain Category	1			1.5			2			2.5			3			1			1.5			2			2.5			3		
Height above ground (z)	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50	10	25	50
$M_{z,cat}$	1.12	1.21	1.25	1.06	1.15	1.22	1.00	1.10	1.18	0.92	1.04	1.13	0.83	0.97	1.07	1.12	1.21	1.25	1.06	1.15	1.22	1.00	1.10	1.18	0.92	1.04	1.13	0.83	0.97	1.07
Ultimate Wind Pressure (kPa)	0.87	1.01	1.08	0.78	0.91	1.03	0.69	0.84	0.96	0.58	0.75	0.88	0.48	0.65	0.79	1.49	1.74	1.86	1.34	1.57	1.77	1.19	1.44	1.66	1.00	1.29	1.52	0.82	1.12	1.36
Serviceability Wind Pressure (kPa)	0.52	0.60	0.64	0.46	0.54	0.61	0.41	0.50	0.57	0.34	0.44	0.52	0.28	0.39	0.47	0.57	0.67	0.71	0.51	0.60	0.68	0.46	0.55	0.64	0.38	0.49	0.58	0.31	0.43	0.52

Combination External Plus Internal Wind Pressures

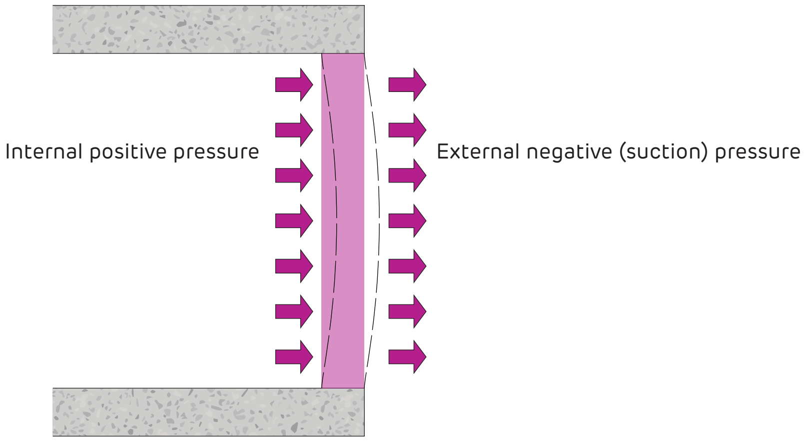
$C_{fig,net} = (C_{fig,i} + C_{fig,e})\ K_C$

where:

$C_{fig,net}$ is the combination net pressure coefficient of $C_{fig,i}$ acting with $C_{fig,e}$ [Refer to Figure 6]. When calculating the combined internal with external wind pressure actions, $C_{p,i}$ is taken as 0.2 for side walls and leeward walls, and either – 0.3 when the building has all walls equally permeable or – 0.2 when the building is effectively sealed having non-openable windows.

K_C is a combination factor. It allows for a concession to the overall net wind pressure when considering the combination of external and internal wind pressures acting together in the same direction. When considering the combined effects of internal and external wind pressures, then K_C can be taken as 0.9, otherwise for all other cases K_C must be taken as 1.

As an alternative to determining the site specific wind pressures from AS/NZS 1170.2, a project may employ the services of a specialist wind engineering consultancy to determine the wind pressures associated with a specific building on a specific site. They are usually engaged to provide cost savings for large projects.



External Wall $C_{fig,net} = C_{fig,i}$ **acting with** $C_{fig,e}$

1. Combination factor K_c can be taken as 0.9

FIGURE 6 Example of internal and external wind pressures acting in the same direction
Total wind pressure ($C_{fig,net}$) acting on the external wall stud framing
Section view

Seismic Actions

Seismic actions for buildings and building elements are determined using *AS/NZS 1170.4 Earthquake Actions in Australia*. Seismic actions accelerate an object causing a corresponding load to be exerted. The load also results in displacement of the object which must be accounted for in structural design.

The forces generated on buildings and their respective elements must have a clear path to return the load to the buildings foundation. Displacements of building elements under the nominated load from the standard must also be allowed to occur without major structural failure or collapse. Some damage is expected to occur though depending on the magnitude of an actual earthquake event.

Lightweight walls, ceilings and their connections are considered architectural (non-structural) parts and components. The methods prescribed in AS/NZS 1170.4 to determine the seismic actions and design the architectural parts and components for a specific project are summarised below. As this is a simplified guide only, it is recommended to refer to the standard or seek professional engineering advice when determining the seismic actions for a specific building or building element.

To determine the seismic actions applied to lightweight walls and ceilings, the following items need to be determined:

1. Building Importance Level from the National Construction Code (NCC), Volume One, Section B1.2. This section of the NCC sets out the appropriate annual probability of exceedance limits for wind, snow and earthquake loads for the relevant importance level of the building. The building importance levels range from 1 (least important) to 4 (most important).

2. Determine the probability factor k_p from AS/NZS 1170.4 Clause 3.1. This is an amplification factor based on the annual probability of an earthquake event and is affected by the building importance level.

3. Determine the hazard factor Z from AS/NZS 1170.4 Clause 3.2. This factor is also an amplification factor related to the geographic location in Australia and the potential hazard that location presents.

4. Check the multiplication of the probability factor k_p and the hazard factor Z are not below the minimum outlined in AS/NZS 1170.4 Table 3.3.

5. Determine the site sub-soil class from Section 4. There are 5 classifications of sub-soil from strong rock to very soft soil. This is usually determined by geotechnical testing.

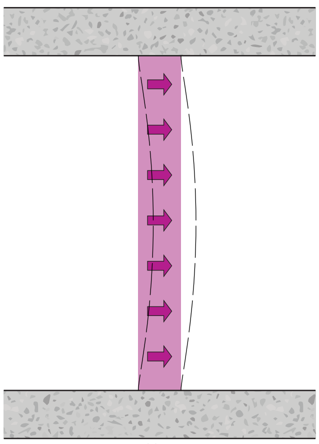
6. Determine the earthquake design category (EDC) from Table 2.1. The earthquake design categories are either I, II or III.

7. Design the lightweight wall or ceiling and their associated connections in accordance with Section 5 *Earthquake Design* and Section 8 *Design of Parts and Components.*

Earthquake Design Category I

The design of category I buildings and elements is limited to structures with a height of 12m maximum. Structures and components are designed using an equivalent lateral (horizontal) static load of 10% of the seismic weight acting at the centre of mass of the item being designed.

Vertical actions and pounding are not considered for this category except where any vertical actions arises from the structural analysis.


Case 1: Wall

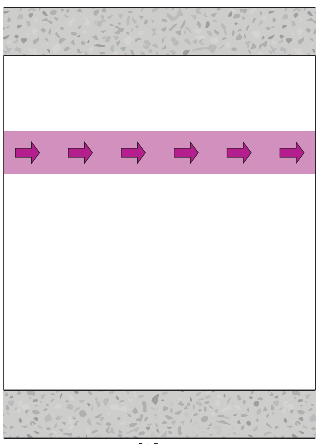

Case 2: Ceiling

FIGURE 7 Typical Seismic Actions for Lightweight Walls and Ceilings
Section view

Earthquake Design Category II

The design of architectural parts and components for category II is typically conducted in accordance with Section 8 of AS/NZS 1170.4.

Architectural parts and components along with their associated connections to the main structure, are typically designed for the earthquake forces determined via the Simple Method in Clause 8.2 or the Design Accelerations Method in Clause 8.3. They are also required to accommodate the anticipated inter-storey drift.

The inter-storey drift at the ultimate limit state is calculated from an equivalent static method of the building outlined in Section 6 and shall not exceed 1.5% of the storey height.

Earthquake Design Category III

Similar to category II, the architectural parts and components for category III are designed in accordance with Section 8 of AS/NZS 1170.4.

Also similar to category II, the architectural parts and components and their associated connections to the main structure are typically designed for the earthquake forces determined via the Simple Method in Section 8.2 or the Design Accelerations Method in Section 8.3. They are also required to accommodate the design inter-storey drift.

The inter-storey drift at the ultimate limit state calculated from a dynamic analysis of the building outlined in Section 7 and shall not exceed 1.5% of the storey height.

Forces on Components

The horizontal earthquake forces on the architectural parts and components are applied at the centre of gravity of the component. They must also be considered in any horizontal direction.

Fixings like the Siniat Screw Anchor range used to fix external walls and walls enclosing stairs, stair shafts, lifts and exit paths to the structure, must be designed for 150% of the anticipated seismic force determined via the Simple or Design Accelerations Methods.

Inter-Storey Drift

Inter-storey drift refers to the horizontal displacement between floors of a building under seismic load. AS/NZS 1170.4 determines the loads to be applied at each floor via an equivalent static method for category II buildings, or a dynamic analysis for category III buildings.

An accurate inter-storey drift displacement can be identified via structural analysis of the building under the loads applied at each floor, or simply limited to a maximum of 1.5% of the storey height.

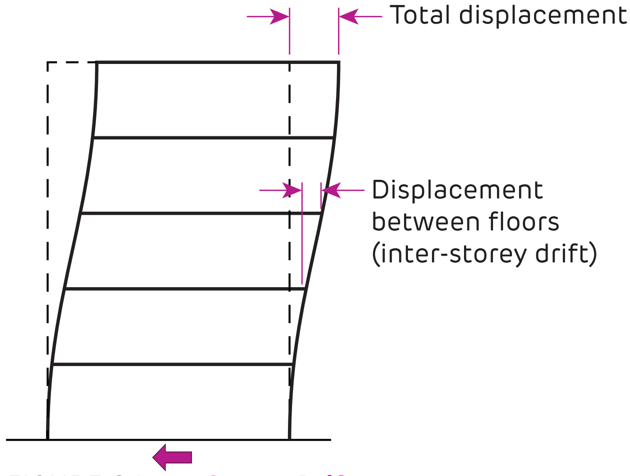


FIGURE 8 Inter-Storey Drift
Section

Simple Method

The horizontal force on the architectural parts and components using the simple method is determined using the equation:

$F_c = W_c\, k_p\, Z\, Ch(0)\, a_x\, I_c\, a_c / R_c$ but > $0.05\, W_c$

where:

W_c is the seismic weight of the component.

k_p is the probability factor from Clause 3.1.

Z is the hazard factor from Clause 3.2.

Ch(0) is the bracketed value of the spectral shape factor for the period of zero seconds from Clause 6.4.

a_x is a height amplification factor to account for the height of the element above the ground

I_c is the component importance factor which is taken as 1.5 for critical for life safety components

a_c is the component amplification factor taken as 1 for light-weight walls and ceilings.

R_c = component ductility factor typically taken as 2.5 for light-weight walls and ceilings, and 1 for connections of those lightweight walls and ceilings.

Design Accelerations Method

$F_c = a_{floor}\, I_c\, a_c / R_c \le 0.5\, W_c$

where:

a_{floor} is the effective floor acceleration at the level where the component in situated, and calculated using the equivalent static method of Section 6 or the dynamic analysis of Section 7. a_{floor} must not be $< k_p\, Z\, C_h\,(0)$.

All other factors in the equation are the same for the Simple Method.

Structural Analysis

Once all the loads on the walls and/or ceilings have been derived, an analysis is conducted using various load cases to determine the strength and stiffness requirements for the frame and lining.

Walls: Common load cases to satisfy the Ultimate Limit State (Strength):

Case 1: 1.35G
Case 2: 1.2G + W_{ult}
Case 3: 1.2G + 1.5Q_{impact}
Case 4: 1.2G + 1.5$Q_{handrail}$
Case 5: 1.2G + 1.5$Q_{basin\ /\ monitor\ arm}$
Case 6: 1.2G + 1.5Q_{shelf}
Case 7: 1.2G + 0.6Q_{shelf} + W_{ult}
Case 8: 1.2G + 0.6Q_{shelf} + Q_{impact}
Case 9: G + 0.6Q_{shelf} + E_{ult}

Walls: Common load cases to satisfy the Serviceability Limit State (Stiffness):

Case 1: G + W_{ser}, deflection limited to height/240 for flexible linings (i.e.: plasterboard)
Case 2: G + W_{ser}, deflection limited to height/250 for expressed jointed fibre cement
Case 3: G + W_{ser}, deflection limited to height/360 for brittle linings (i.e.: rendered fibre cement, tiled walls, masonry veneer, AAC walls)
Case 4: G + Q_{impact}, deflection limited to height/200 or 12mm maximum
Case 5: G + $Q_{handrail}$, deflection limited to height/480
Case 6: G + Qbasin / monitor arm, deflection limited to height/360
Case 7: G + Q_{shelf} + W_{ser}, deflection limited to height/360
Case 8: G + Q_{shelf}, deflection limited to height/480
Case 9: G + 0.6Q_{shelf} + E_{ser}, deflection limited to height/360

Ceilings: Common load cases to satisfy the Ultimate Limit State:

Case 1: 1.4G + 1.7U
Case 2: 1.2G + 1.2U + W_{ult}
Case 3: 0.9G + W_{ult} (uplift)
Case 4: G + U + E_{ult}

Ceilings: Common load cases to satisfy the Serviceability Limit State:

Case 1: G + U, deflection limited to span/500 for suspended concealed, horizontal stud, and top-hat frame ceilings.

Case 2: G + U + W_{ser}, deflection limited to span/200 for suspended ceilings (top cross rail, furring channel, batten)

Case 3: G + U + W_{ser}, deflection limited to span/360 or 12mm maximum, for stud ceilings and top hat ceilings.

Case 4: G + E_{ser}

where:

G is the dead load
Q is the live load
W_{ult} is the ultimate limit state wind load
W_{ser} is the serviceability limit state wind load
U is a nominal service load specific to ceiling systems equal to 3 kg/m^2
E_{ult} is the ultimate limit state earthquake load
E_{ser} is the serviceability limit state earthquake load

After the structural analysis is complete, the frame is designed using the relevant framing design standard [Refer to the Design Standards section], and the most appropriate frame and lining is selected to satisfy the predicted loads during the service life of the wall or ceiling system.

Fire Resistance

Fire Definitions

Fire Resistance Level

Fire systems are rated to withstand a fire under test conditions for a certain period of time. This time is known as the Fire Resistance Level (FRL) and consists of the three criteria listed below:

- Structural Adequacy
- Integrity
- Insulation

Figure 9 below shows an FRL of 60/60/60. This means that if a building element were exposed to a standard fire test, it would not be expected to fail for 60 minutes in each of the three criteria. The NCC specifies FRLs for building elements such as walls, columns, roofs and floors. These FRLs can be many combinations of the three criteria,
e.g. 90/-/-, 90/60/30 or -/60/60. A dash in the FRL means there is no requirement for that criterion.

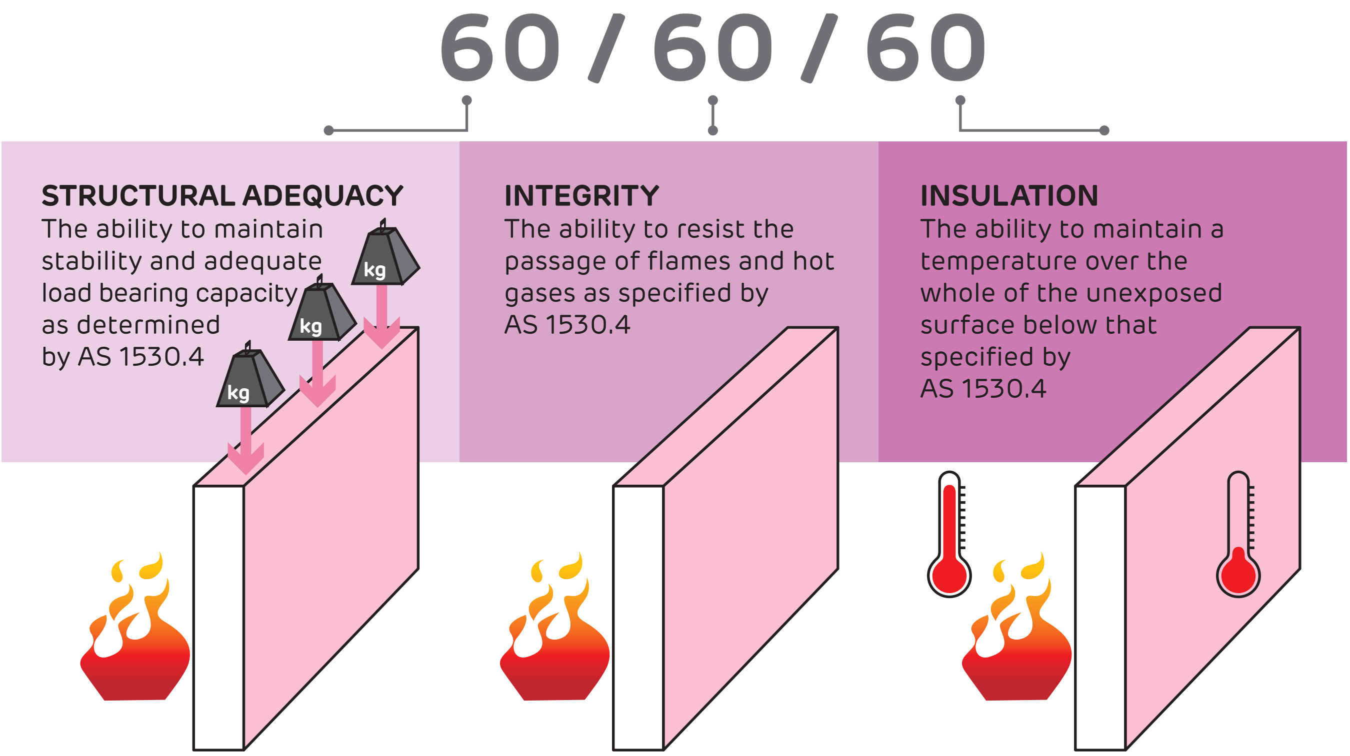


FIGURE 9 **Fire Resistance Level**

> Fire testing is carried out in accordance with AS 1530.4 *Methods for fire tests on building materials, components and structures.* All fire rated plasterboard systems in this manual have been the subject of a report by an accredited testing authority.

Resistance to Incipient Spread of Fire (RISF)

Resistance to the Incipient Spread of Fire (RISF) is the ability of a ceiling to limit the temperature rise in the ceiling cavity [Figure 10]. The RISF is a requirement of the NCC in specific applications. They are appropriate where the ceiling is the primary fire barrier that limits fire spread via the ceiling space. The RISF for Siniat fire rated ceilings are stated in the system tables.

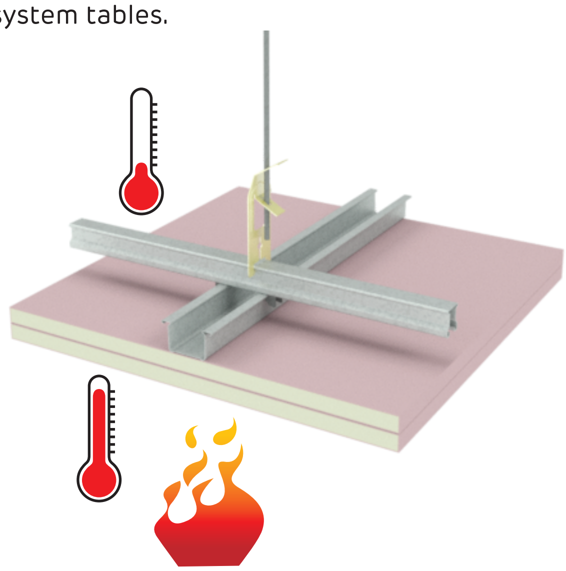


FIGURE 10 Resistance to Incipient Spread of Fire

Load Bearing or Non-load Bearing ?

If a building element is load bearing then it must have a Structural Adequacy component to the FRL, for example 60/60/60. The definition of load bearing from the NCC states that a structure is 'intended to resist vertical forces additional to those due to its own weight'. Therefore walls such as those holding up a floor or roof above are load bearing. While (in general) walls that span between concrete slabs and are not holding up the slab, are considered non-load bearing.

The NCC 'deemed to satisfy' provisions, specify FRLs based on whether the building element is load bearing or not [Refer to NCC Volume One, Specification C1.1]. For example, walls separating sole occupancy units in a Class 2 building of Type A construction (residential high rise) need an FRL of -/60/60 if they are non-load bearing and 90/90/90 if they are load bearing. Residential high rise buildings are usually slab to slab construction in which case the concrete columns are load bearing but the plasterboard infill walls are not.

If an FRL with Structural Adequacy is specified (e.g. 90/90/90) where there is no additional vertical load, a building element without Structural Adequacy may be used (e.g. -/90/90) [Refer to NCC Volume One, Schedule 5 Clause 6 Non-load bearing elements].

Standard Fire Test

AS 1503.4 Methods for fire tests on buildings materials, components and structures prescribes the heating conditions, test procedures and criteria for the determining the fire resistance level of building elements.

Completed wall or ceiling specimens are usually loaded onto one face of a fire furnace and then subjected to a standardised time - temperature curve [Figure 11] to determine its performance under fire conditions.

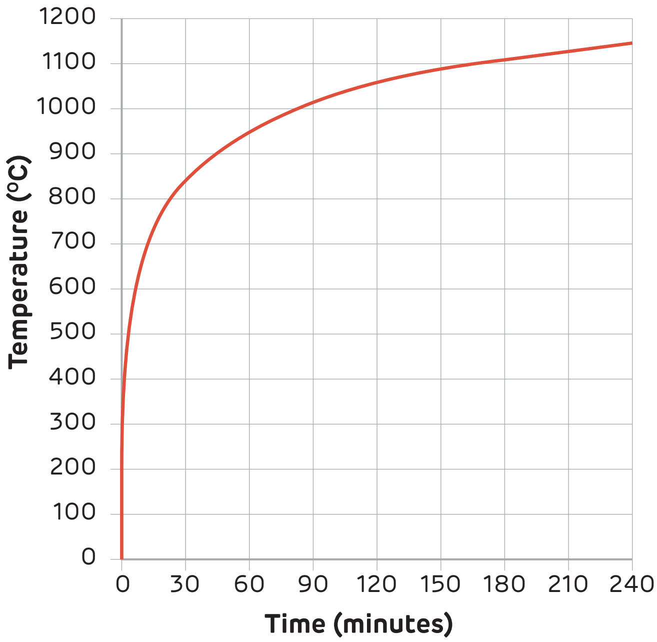


FIGURE 11 Standard Fire Test
Time - Temperature curve

Plasterboard to Resist Fire

Siniat recommends the installation of **fire**shield, **multi**shield, **tru**rock or **tru**rock hd for wall and ceiling systems to control the spread of fire.

These specially formulated products contain additives that improve the natural fire resisting properties of the plasterboard.

Acceptable Variations to Fire Rated Systems

Fire rated systems must be built according to the installation instructions in this manual. However, there are some variations allowed that will not degrade the performance of the system:

- Increasing plasterboard thickness
- Increasing cavity width
- Increasing stud size or metal thickness
- Adding steel, timber or plywood noggings to support fixtures or service
- Decreasing stud spacing
- Decreasing fastener spacing
- Substituting 13mm **fire**shield with 13mm **multi**shield, 13mm **tru**rock or 13mm **tru**rock hd
- Substituting 16mm **fire**shield with 16mm **multi**shield or 16mm **tru**rock
- Substituting **masta**shield with **water**shield
- Adding additional linings to a system
- Adding tiles up to 32kg/m² per side.

Modifications to Fire Rated Systems

Fire rated systems are often modified by the installation of:

- Fire rated inspection hatches
- Fire rated power points
- Fire rated light fittings
- Fire rated doors
- Fire dampers
- Electrical cables
- Metal or plastic pipes
- Other fire rated penetrations.

It is the responsibility of the manufacturer of these components to ensure that the fire and acoustic properties of the plasterboard system are maintained.

Some modifications are detailed in this manual, many include the use of **bindex** fire and acoustic sealant. Any modification not covered in this manual must be according to the relevant manufacturer's instructions.

Construction Details

Construction details in Siniat literature show common situations for installers and designers with guidance on how systems are installed. Siniat does not exclude other construction details for situations not covered by our technical literature. The approved construction details in Siniat technical literature should be used as guides to create site-specific details using the same principles.

Construction details without a specific FRL noted may be used with all systems within that section; the number of layers can vary as well as the framing configuration, e.g. single stud, Acoustic Stud and double stud.

Smoke Walls

The purpose of a smoke wall is to prevent smoke passing from one side of a wall to the other. A smoke wall must be built from non-combustible materials like steel studs.

Doors and windows used in smoke walls must comply with requirements in the NCC Volume One, Specification C2.5. Ducts through the smoke wall must use a smoke damper, unless the duct is part of the smoke handling system and is required to function during a fire.

Class 9A Healthcare Buildings, Class 2 and 3 Residential Buildings

Smoke walls in Class 9a, 2 and 3 buildings must extend up to:

- The floor above, or
- A non-combustible roof covering, or
- A ceiling having an RISF of 60 minutes.

Class 9C Aged Care Buildings

Plasterboard used for smoke walls in Class 9c buildings must have a thickness of at least 13mm. Smoke walls in Class 9c buildings may also be lined on one side only and must extend up to:

- The floor above, or
- A non-combustible roof covering, or
- A jointed plasterboard ceiling with a minimum thickness of 13mm with all penetrations sealed.

Table 19 Fire Resistance Level Requirements for Class 2 and 3 Buildings - Type A

Construction	Element		Load Bearing FRL	Non-Load Bearing FRL
Type A without sprinkler	Internal Walls	Between or bounding SOU's, corridor walls and public lobbies	90/90/90	- /60/60
		Lift, stair and service shaft walls	90/90/90	- /90/90
		Lower storey car park	90/90/90 and be of masonry or concrete	n/a
		Other load bearing internal walls, beams, trusses and columns	90/ - / - *	n/a
		Other internal walls inside a SOU	90/ - / -	-
		All internal walls required to have an FRL with respect to integrity and insulation, must extend to the floor above, or to a ceiling directly below the roof with RISF 60 minutes, or to the underside of the roof covering if it is non-combustible.		
	External Walls where the distance to the fire source feature is	< 1.5m	90/90/90	- /90/90
		1.5m to < 3m	90/60/60	- /60/60
		≥ 3m	90/60/30	- / - / -
	Floors		90/90/90	n/a
	Roofs		-	n/a
Type A with sprinkler system for a building with rise in storeys of ≤ 3, or 4 if the lowest storey is for car parking	Internal Walls	Between or bounding SOU's, corridor walls and public lobbies	60/60/60	- / - / - if lined with 13mm plasterboard
		Lift, stair and service shaft walls	60/60/60	- / - / - if lined with 13mm plasterboard
		Lower storey car park	90/90/90 and be of masonry or concrete	n/a
		Other load bearing internal walls, beams, trusses and columns	90/ - / - *	n/a
		Other internal walls inside a SOU	90/ - / -	-
		All internal walls must extend to the floor above, or to a ceiling with RISF 60 minutes, or to the underside of the roof covering if it is non-combustible.		
	External Walls where the distance to the fire source feature is	< 1.5m	90/90/90 from outside 60/60/60 from inside	- /90/90
		1.5m to < 3m	90/60/60 from outside 60/60/60 from inside	- /60/60
		≥ 3m	90/60/30 from outside 60/60/30 from inside	- / - / -
	Floors		60/60/60	n/a
	Roofs		-	n/a

1. This table is a summary only and is not intended as a substitute for the NCC as it does not consider all building classes, requirements, applications or certain concessions which may apply. [Refer to the NCC for the full details of fire resistance level requirements]
2. 'Service shaft walls' include ventilation, pipe, garbage and the like shafts not used for the discharge of hot products of combustion
3. SOU = Sole Occupancy Unit
4. '-' indicates there is no requirement for that criterion.
5. * concessions apply. May be reduced to FRL 60/60/60 for top floor only of buildings with effective height ≤ 25m.

Table 20 Fire Resistance Level Requirements for Class 2 and 3 Buildings - Type B

Construction	Element		Load Bearing FRL	Non-Load Bearing FRL
Type B without sprinkler	Internal Walls	Between or bounding SOU's, corridor walls and public lobbies	60/60/60	- /60/60
		Lift, stair and service shaft walls	90/90/90	- /90/90
		Other load bearing walls and columns	60/ - / -	
		Other internal walls inside a SOU	90/ - / -	- / - /-
		All internal walls required to have an FRL with respect to integrity and insulation, except a wall that bounds a SOU in the topmost storey and there is only one unit in that storey, must extend to the floor above, or to a ceiling with RISF 60 minutes, or to the underside of the roof covering if it is non-combustible.		
	External Walls where the distance to the fire source feature is	< 1.5m	90/90/90	- /90/90
		1.5m to < 3m	90/60/30	- /60/30
		3m to < 9m	90/30/30	- / - / -
		9m to < 18m	90/30/ -	- / - / -
		≥ 18m	- / - / -	- / - / -
	Floors		30/30/30, or 13mm fire grade plasterboard or ceiling with RISF 60 minutes.	n/a
	Roof		-	n/a
Type B with sprinkler system	Internal Walls	Between or bounding SOU's, corridor walls and public lobbies	60/60/60	- / - / - if lined with 13mm plasterboard
		Lift, stair and service shaft walls	60/60/60	- / - / - if lined with 13mm plasterboard
		Other load bearing walls and columns	60/ - / -	n/a
		Other internal walls inside a SOU	90/ - / -	- / - / -
		All internal walls must extend to the floor above, or to a ceiling with RISF 60 minutes, or to the underside of the roof covering if it is non-combustible.		
	External Walls where the distance to the fire source feature is	< 1.5m	90/90/90 from outside 60/60/60 from inside	- /90/90
		1.5m to < 3m	90/60/30 from outside 60/60/30 from inside	- /60/30
		3m to < 9m	90/30/30 from outside 60/30/30 from inside	- / - / -
		9m to < 18m	90/30/ - from outside 60/30/ - from inside	- / - / -
		≥ 18m	- / - / -	- / - / -
	Floors		30/30/30, or 13mm fire grade plasterboard or ceiling with RISF 60 minutes.	n/a
	Roof		-	n/a

1. This table is a summary only and is not intended as a substitute for the NCC as it does not consider all building classes, requirements, applications or certain concessions which may apply. [Refer to the NCC for the full details of fire resistance level requirements]
2. 'Service shaft walls' include ventilation, pipe, garbage and the like shafts not used for the discharge of hot products of combustion
3. SOU = Sole Occupancy Unit
4. '-' indicates there is no requirement for that criterion.

Table 21 Fire Resistance Level Requirements for Class 2 and 3 Buildings - Type C

Construction	Element		Load Bearing FRL	Non-Load Bearing FRL
Type C without sprinkler	Internal Walls	Between or bounding SOU's, corridor walls and public lobbies	60/60/60	-/60/60
		Bounding stairs	60/60/60	-/60/60
		Other load bearing walls and columns	60/ - / -	
		Other internal walls inside a SOU	30/ - / - or covered with 13mm fire grade plasterboard	- / - / -
		All internal walls must extend to the floor above, or to a ceiling with RISF 60 minutes, or to the underside of the roof covering if it is non-combustible.		
	External Walls where the distance to the fire source feature is	< 1.5m	90/90/90 from outside	- / - / -
		≥ 1.5m	- / - / -	- / - / -
	Floors		30/30/30, or 13mm fire grade plasterboard	n/a
	Roof		-	n/a

1. This table is a summary only and is not intended as a substitute for the NCC as it does not consider all building classes, requirements, applications or certain concessions which may apply. [Refer to the NCC for the full details of fire resistance level requirements]
2. 'Service shaft walls' include ventilation, pipe, garbage and the like shafts not used for the discharge of hot products of combustion
3. SOU = Sole Occupancy Unit
4. '-' indicates there is no requirement for that criterion.

Acoustics

Sound Waves

Sound waves create small pressure fluctuations in a transmission medium like air or water. The sound pressure is measured in decibels (dB) using a specific logarithmic scale. Decibel is the unit of measurement used when describing the sound level in a room.

Sound waves also known as vibrations, and are measured in hertz (Hz) which is the number of vibrations per second. The length of a sound wave varies – low pitch sounds have a long wavelength whereas high pitch sounds have a shorter wavelength. Accordingly low pitches (long wavelengths) have a low frequency and high pitches (short wavelength) have a high frequency.

Perception of Sound

People with normal hearing can perceive sounds between 20 Hz and 20,000 Hz, however the ear is at its most sensitive in the frequencies between 250 and 3150 Hz, also known as the consonant frequency range and where the most important information is contained for speech.

Voice communication is essential for humans and understanding what is said involves much more than the meaning of the words. Tone of voice and rhetoric are also important elements in understanding.

The perception of sound is subjective and contextual, what is perceived as good sound by one person can be very different to another person's view. Physiological factors, taste, culture, habit, mood and environment can all affect our perception of what constitutes positive and negative sound.

Sound Strategies

It is important that the acoustics of a space match the function of that space; and that everyone that resides or works in that space experiences good acoustic comfort.

In order to modify the sound experienced in a room, there are a number of strategies that can be employed:

- Block the sound from entering the room
- Absorb the sound inside the room
- Spread the sound around the room
- Redirect the sound away from and within the room
- Emphasise the sound in parts of the room
- Mask the sound in the room

The following pages look at the principles and definitions of sound insulation – a strategy for blocking sound, i.e. preventing it from entering a room, and sound absorption and diffusion – strategies for dealing with the sound inside a room.

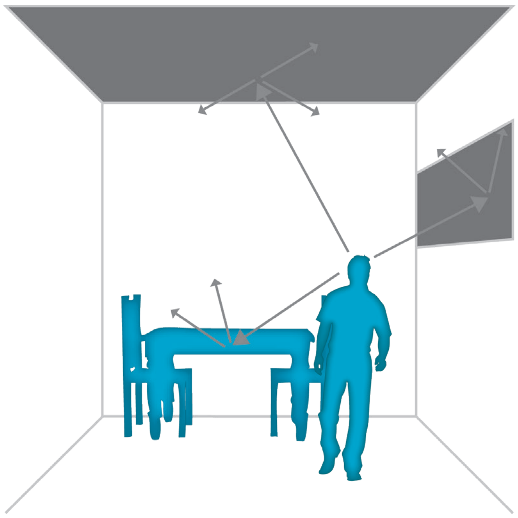


FIGURE 12 Sound Absorption and Diffusion

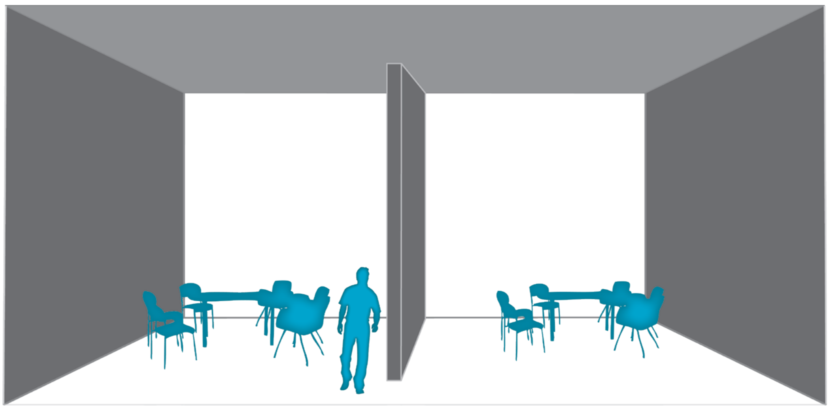


FIGURE 13 Sound Insulation

Sound Insulation

Acoustic Terms and Definitions

R_W (Weighted Sound Reduction Index)

Rw describes the airborne sound insulating power of a building element. It is a laboratory measured value that can apply to walls, ceiling/floors, ceiling/roofs, doors or windows. The higher the number, the greater the sound insulating power of the building element.

For example, an increase in the Rw of a wall by 10 points will reduce the perceived loudness of sound passing through the wall by about half. Table 21 shows how the sound insulating effectiveness of walls depends on their Rw values.

R_W+C_{tr} (R_W Plus Spectrum Adaptation Term)

Rw + Ctr is equal to Rw with the addition of a low frequency sound correction, Ctr. The use of Rw + Ctr has been adopted due to the increase in low frequency sound sources such as surround sound systems, traffic and aircraft noise, drums and bass guitars. Two walls can have the same Rw rating but have different resistance to low frequency sound, thus a different Rw + Ctr.

D_{nTw} and D_{nTw}+C_{tr} (Measured On-Site)

These values are the equivalent of Rw and Rw + Ctr, but are measured on-site. Rw is the value measured in an acoustic laboratory, while DnTw is the value measured on-site.

An on-site measured value of DnTw + Ctr is permitted to be 5 points lower than the Rw + Ctr value. Where the NCC may call for an Rw + Ctr ≥ 50, the same requirement may be satisfied by measuring DnTw + Ctr ≥ 45 on-site.

$L_{n,w}$ (Impact Sound Insulation Rating)

$L_{n,w}$ describes how easily impact sound travels through a floor. Impact sound is generated by sources such as dryers, washing machines and heeled shoes on a wooden floor.

Unlike R_W values, better performing floors have lower values. Therefore when specified, Ln,w values are maximums while Rw values are minimums. For example, the NCC requires some floors to have $L_{n,w} \leq 62$.

Impact Sound Insulation

Walls that have Impact Sound Insulation are defined in the NCC as walls that do not have any rigid mechanical connection between two separate leaves except at the periphery.

Systems in this manual that satisfy this NCC requirement are staggered stud plasterboard walls with no noggings, and walls that use resilient mounts.

Impact sound insulation with discontinuous construction

Discontinuous Construction is defined in the NCC as walls that have a gap of at least 20mm between two separate leaves, and:

- for masonry, where wall ties are required to connect leaves, the ties are of the resilient type, and
- for other than masonry, there is no mechanical linkage between leaves except at the periphery.

Double stud plasterboard walls are classed as 'discontinuous'.

Ceiling Attenuation Class (CAC)

Ceiling Attenuation Class (CAC) indicates the ceiling's ability to reduce airborne sound transmission via the ceiling cavity when the dividing wall does not extend past the ceiling to the underside of the floor or roof.

In this manual CAC is expressed as Rw and Rw + Ctr ratings. These represent the sound reduction from one room to the next via the two ceilings and the cavity above the ceiling.

The noise in the source room can pass through the wall and through the ceiling cavity. To compensate for the additional noise level in the receiving room, when sound isolation is important, Siniat recommends using wall and CAC ceiling systems that both have an Rw rating 3 points higher than the requirement.

According to the NCC Volume One, Part F5.5, where a wall required to have sound insulation has a floor or roof above, the wall must continue to the underside of the floor or roof above, or a ceiling that provides the sound insulation required for the wall.

Table 22 Effect of Various Walls on Sound Insulation Performance

R_W	Effect of Different Values of R_W on Sound Insulation Performance
25	Normal speech can be heard easily
30	Loud speech can be heard easily
35	Loud speech can be heard but not understood
42	Loud speech heard as murmur
45	Must strain to hear loud speech
48	Loud speech can be barely heard
53	Loud speech cannot be heard
63	Music heard faintly, bass notes 'thump'
70	Loud music still heard very faintly

Sound Insulation Requirements

Performance requirements of the NCC relating to sound insulation shown in table 22 can be satisfied in a number of ways that include the following:

1. Deemed-to-Satisfy Construction

Construct a wall or ceiling system that complies with the deemed-to-satisfy provisions of the NCC Volume One, Specification F5.2 (2). This section of the NCC details generic systems that satisfy the NCC sound insulation requirements. However, more efficient solutions can be found in this manual.

2. Laboratory Test

Many of the systems in this manual were tested in an acoustic laboratory according to AS 1191:2002. Acoustic testing laboratories are designed to ensure that flanking paths do not occur. Tested systems are constructed with extreme care to achieve optimum performance. For these reasons, on-site performance may be different to laboratory performance.

3. On-site Testing

Conduct on-site acoustic testing on a wall or ceiling system. This is a 'verification method' accepted by the NCC to confirm the performance requirements are met. Also the effectiveness of the complete installed system
can be verified by on-site acoustic testing.

4. Certification by an Acoustic Consultant

An acoustic consultant can certify that the construction on a particular site meets the NCC requirements. This certification includes the effectiveness of penetrations and flanking paths. It usually involves some level of
on-site testing.

5. Acoustic Opinion

Acoustic consultants can provide acoustic opinions on the sound insulation rating of building elements. An acoustic opinion may provide sufficient evidence of compliance depending on the type and size of building. Check with the building certifier prior to construction.

Higher Acoustic Requirements

Where performance is critical or noise is higher than normal, accredited acoustic engineers should be consulted. Their role is to ensure that design and construction will meet any specific requirements.

All acoustic ratings in this manual are either test results or professional opinions based on test information. Acoustic opinions in this manual were provided by professional acoustic consulting engineers.

Acoustic predictions for systems not published in Siniat technical literature can often be generated by acoustic modelling software. Contact Siniat Technical Services for an acoustic prediction based on the Siniat product range.

The Association of Australian Acoustical Consultants (AAAC) offer detailed guidance on acceptable acoustic performance. They have published their own star rating system. Ratings range from 2 to 6 stars and are based on field testing by an AAAC consultant to verify that they have been achieved. More information about AAAC Star Ratings for apartments and townhouses is available at www.aaac.org.au

Acoustic Testing and Actual Performance

Attention to detail during construction is important for achieving good sound insulation, as performance may be is determined by the weakest link in the system. Performance of installed acoustic systems may fall short of laboratory measured results. Acoustic measurements in a typical laboratory test represent the maximum performance that can be achieved.

Actual site conditions are usually less than ideal and sound flanking paths normally exist around the perimeter of the system. Flanking paths may be minimised by sealing the perimeter with sealant and by installing services using acoustically rated details.

Table 23 Sound Insulation Requirements For Sole Occupancy Units (SOU)

	Airborne Sound Insulation	Impact Sound Insulation
Building Class 1 – NSW, Vic, Qld, Tas, WA, SA and ACT		
Walls separating a bathroom, toilet, laundry or kitchen and a habitable room (other than a kitchen) in adjoining SOUs.	Rw + Ctr ≥ 50	✓Discontinuous
Walls separating SOUs in all other cases.	Rw + Ctr ≥ 50	
Walls or ceilings separating a duct, soil, waste or water supply pipe or storm water pipe from a habitable room.	Rw + Ctr ≥ 40	
Walls or ceilings separating a duct, soil, waste or water supply pipe or storm water pipe from a kitchen, bathroom or other non-habitable room.	Rw + Ctr ≥ 25	
Building Class 2 & 3 – NSW, Vic, Qld, Tas, WA, SA and ACT		
Walls separating habitable rooms in adjoining SOUs.	Rw + Ctr ≥ 50	
Walls separating kitchens, toilets, bathrooms and laundries in adjoining SOUs.	Rw + Ctr ≥ 50	
Walls between a bathroom, toilet, laundry or kitchen and a habitable room (other than a kitchen) in adjoining SOUs.	Rw + Ctr ≥ 50	✓Discontinuous
Walls between an SOU and a public corridor, public lobby, stairway or the like or parts of a different classification.	Rw ≥ 50	
Walls between an SOU and a plant room or lift shaft.	Rw ≥ 50	✓Discontinuous
Walls or ceilings separating a duct, soil, waste or water supply pipe or storm water pipe from a habitable room.	Rw + Ctr ≥ 40	
Walls or ceilings separating a duct, soil, waste or water supply pipe or storm water pipe from a kitchen or other non-habitable room.	Rw + Ctr ≥ 25	
Floors between SOUs and between an SOU and a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification.	Rw + Ctr ≥ 50	Ln,w ≤ 62
Building Class 1, 2 and 3 – Northern Territory		
Walls separating a bathroom, toilet, laundry or kitchen and a habitable room (other than a kitchen) in adjoining SOUs.	Rw ≥ 50	Impact sound resistant
Walls separating SOUs in all other cases.	Rw ≥ 45	
Walls or ceilings separating a soil or waste pipe from a habitable room.	Rw ≥ 45	
Walls or ceilings separating a soil or waste pipe from a kitchen, bathroom or other non-habitable room.	Rw ≥ 30	
Floors between SOUs.	Rw ≥ 45	
Building Class 9c – All Australian States and Territories		
Walls separating SOUs from a kitchen or laundry.	Rw ≥ 45	✓Discontinuous for other than masonry
Walls and floors separating SOUs and walls separating SOUs from a bathroom, toilet, plant room or utilities room.	Rw ≥ 45	
Walls or ceilings separating a duct, soil, waste or water supply pipe or storm water pipe from a habitable room.	Rw + Ctr ≥ 40*	
Walls or ceilings separating a duct, soil, waste or water supply pipe or storm water pipe from a kitchen or other non-habitable room.	Rw + Ctr ≥ 25#	

This table is a summary only and is not intended as a substitute for the NCC. [Refer to the NCC for the full details of sound insulation requirements]
* For Building Class 9c in Northern Territory, Rw ≥ 45
# For Building Class 9c in Northern Territory, Rw ≥ 30

Habitable Room

A habitable room means a room used for normal domestic activities and:

- includes a bedroom, living room, lounge room, music room, television room, kitchen, dining room, sewing room, study, playroom, family room, home theatre and sunroom; but
- excludes a bathroom, laundry, water closet, pantry, walk-in wardrobe, corridor, hallway, lobby, photographic darkroom, clothes-drying room, and other spaces of a specialised nature occupied neither frequently nor for extended periods.

Sound Insulation Performance of Wall and Ceiling Systems

Sound insulation ratings for single steel stud walls are based on 600mm stud spacing and the thinnest BMT.

Sound insulation performance listed in systems tables may vary due to decreased stud spacing and increased steel stud thickness (BMT) to the tested systems. Sound insulation performance may also vary due to any additional linings on battens or on separate stud walls.

The sound insulation rating of a basic wall or ceiling system can be upgraded by using a combination of:

- **sound**shield or **tru**rock
- Additional plasterboard layers
- Insulation in the cavity
- Resilient mounts
- **acoustic** stud
- Larger size studs
- Double stud walls
- Staggered stud walls
- Larger cavity size.

soundshield for Superior Noise Control

Siniat recommends the installation of **sound**shield wall and ceiling systems to minimise noise from aircraft, traffic and neighbours.

soundshield is a plasterboard with enhanced sound insulation qualities. **sound**shield has a super high-density* core which helps to resist the transmission of noise into rooms.

*The denser the plasterboard, the better it will resist sound transfer.

Sound Absorption

Sound absorption is the ability of a material to reduce the amount of sound energy reflecting back into the same space.

As a general rule heavy objects with smooth surfaces such as concrete, reflect sound and light objects with porous surfaces such as fabric, absorb sound.

Sound absorbers can be materials like Fletcher Insulation's glasswool products or they can be a ceiling made from perforated panels like Siniat **Crea**tex or Siniat **Crea**son with a cavity behind.

Sound Absorption Coefficients

If a material is 100% reflective then its sound absorption coefficient α is 0, and if it is 100% non-reflective, then α is 1.

The same material can have different sound absorption coefficients at different frequencies.

The sound absorption coefficient of a material or system is measured in a reverberation chamber in an acoustic test laboratory. The measured sound absorption coefficient at a one-third octave band frequency such as 100 Hz, 125 Hz and 160 Hz is called α_S. For each octave band frequencies such as 125 Hz, 250 Hz and 500 Hz, the average of the measured α_S of three consecutive one third octave band frequencies is rounded to the nearest multiple of 0.05, which is then called the practical sound absorption coefficient, α_P.

Noise Reduction Coefficient (NRC)

A single number sound absorption rating obtained from an arithmetic average of sound absorption coefficients, α_S, at 250 Hz, 500 Hz, 1000 Hz and 2000 Hz rounded to the nearest multiple of 0.05.

The higher the NRC, the better the sound absorption of a material or system in the normal frequency range of human speech.

Weighted Sound Absorption Coefficient (α_W)

Designing room acoustics based on NRC can be misleading and result in poor acoustic performance in practice. That's because NRC is an average value that can mask high and low values at different frequencies.

A more sophisticated way to measure acoustic performance is to calculate a weighted sound absorption coefficient (α_W). An α_W value is calculated by comparing the sound absorption coefficients α_P at 250 Hz, 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz to a standard curve [*Refer AS ISO 11654:2002*].

The α_W rating is more commonly used in Europe than NRC; it gives a better picture of a material's performance across all of the frequencies important to human hearing, as the α_W figure is reduced by any low performance frequencies with respect to the reference curve. In other words, any weak points in the material's acoustic performance are uncovered by an α_W value.

Table 24 Sound Absorption Coefficients

Frequency	α_S	α_P
100	0.45	
125	0.58	0.55
160	0.67	
200	0.76	
250	0.82	0.85
315	0.92	
400	0.95	
500	0.94	0.90
630	0.85	
800	0.82	
1000	0.80	0.80
1250	0.79	
1600	0.75	
2000	0.65	0.65
2500	0.61	
3150	0.55	
4000	0.60	0.60
5000	0.70	
Average	0.73	
NRC	0.80	
α_W	0.70	

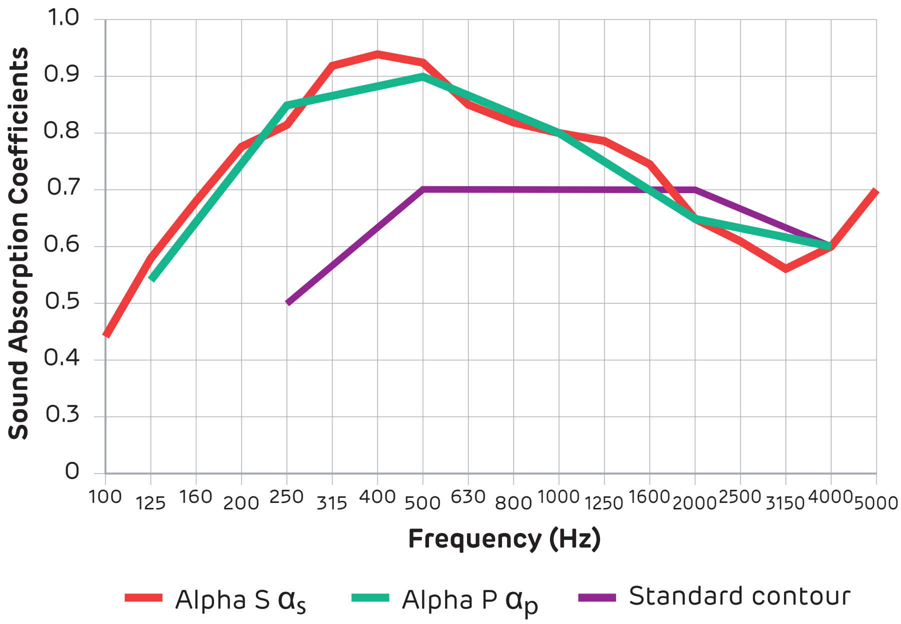


FIGURE 14 Sound Absorption Profile Comparing NRC with α_W

Sound Reflection and Diffusion

Sound reflection in multiple scattered directions is called sound diffusion. Sound diffusion is helpful to spread sound evenly inside a closed space and in combination with sound absorption, helps avoid echoes and uneven reverberation time distribution throughout the room. This creates a uniform and favourable acoustics environment.

Siniat Createx or Siniat Creason assist sound diffusion via irregular sound reflection due to the perforations in the products.

Reverberation Time (RT)

In an enclosed space, sound gets reflected from hard, smooth surfaces creating reverberation, the persistence of sound even after its source has stopped. Sounds reflected from multiple surfaces increase the noise level in a room.

The time required for the reverberated noise level to decay by 60dB is called reverberation time, represented by RT (or RT60) measured in seconds.

Spaces without sound absorbing materials such as large, unfurnished rooms have long reverberation times while spaces with lots of sound absorbers such as cinemas have short reverberation times.

Reverberation Time Requirements

Reverberation time requirements are dependent on the function of a room. Long reverberation times make a space acoustically 'live', while short reverberation times reduce noise and if too short can deaden the sound.
To enhance speech intelligibility it is important to have a suitable reverberation time across the frequency range.

AS/NZS 2107:2016 provides recommended design sound levels and reverberation times for building interiors [Refer to Table 25].

Table 25 AS/NZS 2107:2000 Reverberation Time Requirements

Application	Recommended Reverberation Time (seconds)
Primary school classroom	0.4 ~ 0.5
Secondary school classroom	0.5 ~ 0.6
Libraries, open plan offices, medical consulting rooms, hospital corridors & lobbies	0.4 ~ 0.6
Call centres	0.1 ~ 0.4
Meeting rooms, office corridors & lobbies, assembly halls, private offices	0.6 ~ 0.8
Hospital wards, laboratories, waiting rooms & reception areas	0.4 ~ 0.7
Speech auditoriums, lecture theatres, conference & convention centres, drama theatres	0.7 ~ 1.0

Siniat Reverberation Time Calculator

Siniat offers an easy to use online reverberation time calculator. It includes reverberation time requirements in accordance with AS/NZS 2107:2016 and estimates the amount and type of sound absorbers required.

Siniat Reverberation Time Calculator

Use Siniat Reverberation Time Calculator by clicking on the link or by using your phone's camera on the QR code.

Choosing the Right Siniat Sound Absorption Systems

- Sound absorption systems can be selected from the range of premium acoustic solutions from Siniat, including our Createx and Creason perforated plasterboards. There are several options which cover a range of design and performance requirements like absorption ratings (w or NRC), or sound attenuation ratings (CAC).
- Two products or systems with similar NRC or µw ratings might perform differently in practice. The sound absorption of a product or system at different frequencies must be considered while also evaluating reverberation time and other acoustics characteristics, such as sound diffusion, reflection, attenuation, etc.
- The sound absorption performance of cavity or resonance absorbers such as Siniat **Crea**tex and Siniat **Crea**son can vary depending on the perforation type, perforation ratio, depth of ceiling cavity and the type and thickness of insulation material used in the cavity.
- The placement of sound absorbing materials must take into account the occupants and activity to ensure that sound is absorbed, reflected and spread in the required manner. It is often common practice to only use sound absorbing materials on the ceiling, however in narrow or large rooms with high ceilings, placement of sound absorbers on the walls may be necessary to achieve the right acoustic environment.

For Sound Absorption Performance

Siniat recommends the installation of **Crea**tex and **Crea**son perforated acoustic linings to create a comfortable acoustic environment and enhance audibility.

Createx and **Crea**son are available in a range of perforation patterns and have the added benefit of air-cleaning technology.

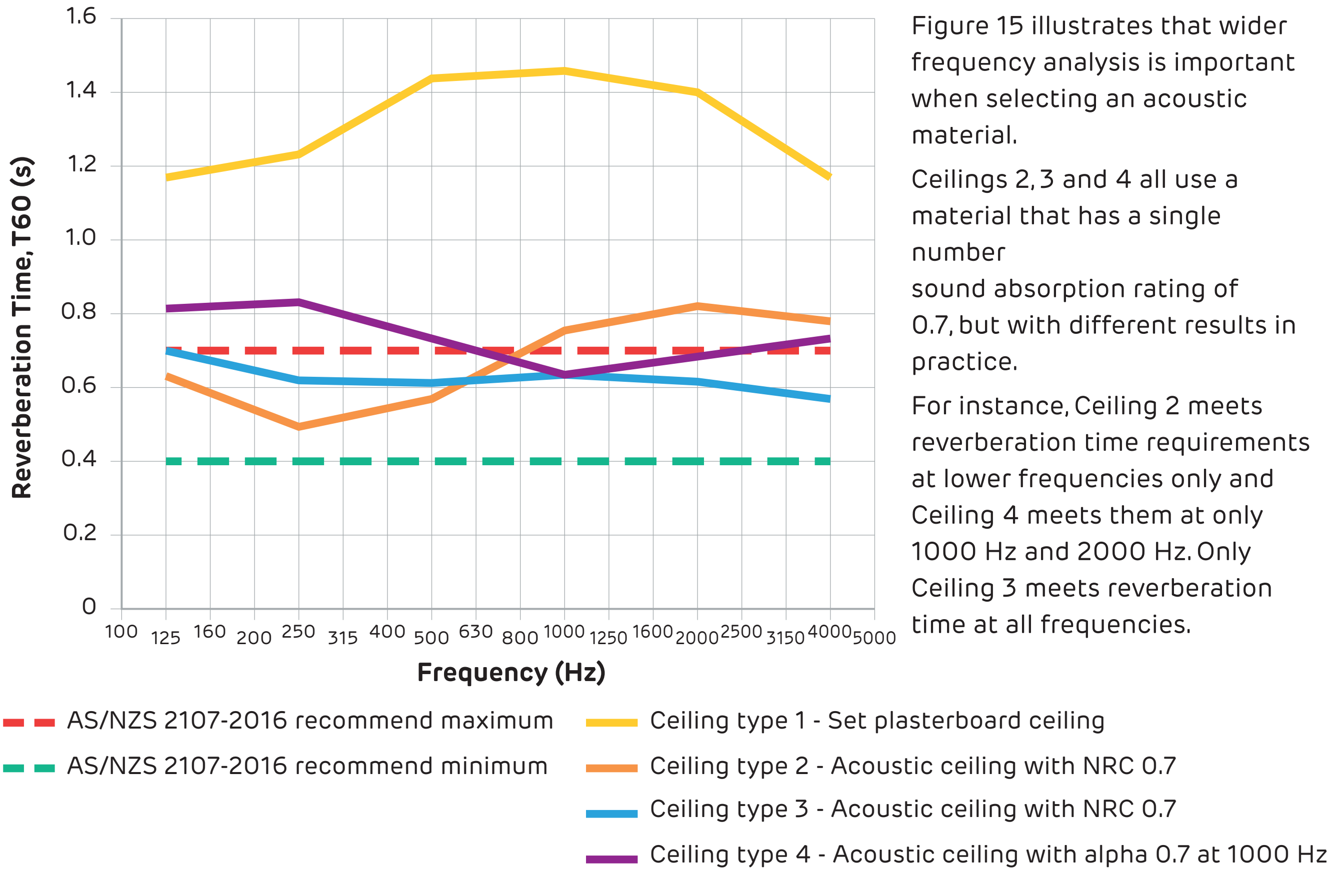


Figure 15 illustrates that wider frequency analysis is important when selecting an acoustic material.

Ceilings 2, 3 and 4 all use a material that has a single number
sound absorption rating of 0.7, but with different results in practice.

For instance, Ceiling 2 meets reverberation time requirements at lower frequencies only and Ceiling 4 meets them at only 1000 Hz and 2000 Hz. Only Ceiling 3 meets reverberation time at all frequencies.

FIGURE 15 Reverberation Time Comparison
Calculated using Siniat Reverberation Time Calculator for 10m long x 7.5m wide x 4m high reception room in a hospital for hard and smooth surfaced walls, sparsely occupied and lightly furnished.

Thermal Performance

The Importance of Total R-Value for Energy Efficiency

Energy efficient construction requires a building envelope that resists the transfer of heat. This thermal resistance is measured as an R-Value (m^2K/W).

Total R-Value is one of the most important indicators of the thermal performance of a building element. The higher the Total R-Value, the better the thermal insulation, i.e. the longer it takes the heat to get into the building (in summer) or out of the building (in winter).

Total R-Value is defined in the National Construction Code (NCC 2019 Volume One) as the sum of the R-Values of individual component layers in a composite element. This includes any building material, insulating material, airspace, thermal bridging and associated surface resistances.

Definition of R-Value

R-Value is the thermal resistance of a component determined by dividing its thickness by its thermal conductivity. Total R-value is the sum of the components with thermal resistance and surfaces in the system.

Total R-Value along the insulation pathway
$R_T = R_{Si} + R_1 + R_2 + ... + R_n + R_{Se}$

Where R_{Si} is the thermal resistance of the internal surface and R_{Se} is the thermal resistance of the external surface; both depend on temperature, speed of air flow and the emissivity of the surface. R_n is the thermal resistance of n^{th} layer parallel to the heat flow direction.

The Total R-Value formula above does not take into account the effects of thermal bridging and hence by itself does not comply with NCC 2019 Volume One for Class 2 to 9 buildings. However, it still complies with NCC 2019 Volume Two for Class 1 and 10 buildings and Section J of NCC 2009 Volume One.

Winter vs Summer

The R-Value of an individual component may vary in different temperatures, as its thermal conductivity depends on the mean temperature of the material. The higher the mean temperature (i.e. in summer) the higher the thermal conductivity and hence a lower R-Value.

In a solid material, such as concrete or plasterboard, the effect of temperature on thermal conductivity is marginal, but in a thermal insulating material like glasswool, the effect can be greater. The surface thermal resistances, R_{Si} and R_{Se} in the above formula may also vary in winter and summer.

The effect of temperature and the direction of heat flow on R-Value of an air space, such as the cavity in a wall or roof, are even more significant. Therefore, the Total R-Value of a building system may vary in winter (heat flow outwards) and summer (heat flow inwards).

Total System U-Value

Construction systems can also be evaluated by the thermal transmittance value, or U-Value (W/m^2K). This is the inverse of the thermal resistance R-Value. In this case, the lower the number, the better the thermal insulation performance.

Reflective Air Space

Heat transfer may happen by conduction (transfer via contact of materials, such as heat transfer in solids), convection (transfer via physical movement of material, like heat transfer in liquids and gases) and radiation (transfer without any material via electromagnetic waves, such as solar radiation). Reflective surfaces such as aluminium foil can effectively block the heat transfer via radiation, and hence increase the total R-Value of a building element.

However it's important to be cautious while using the reflective surface's contribution towards the Total R-Value. A very basic principle is that the reflective surface must always face a free air cavity.

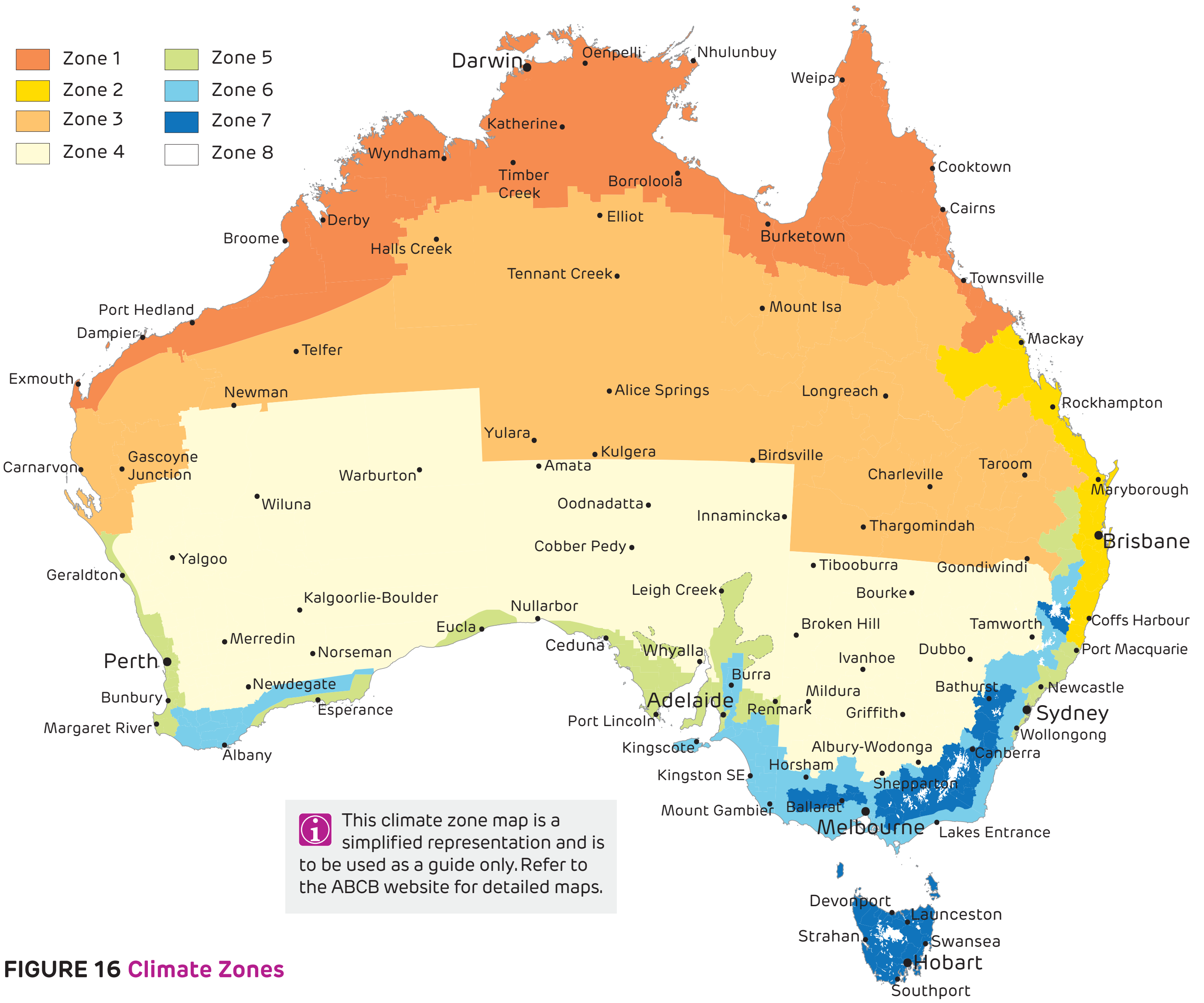
The reflectivity of sarking and wall membranes varies and this will impact on the contributing R-value.

Calculating Thermal Performance

Fletcher insulation has developed FletcherSpec™ Pro that is a thermal prediction calculator that can be used to determine thermal performance of roof and wall systems inclusive of the type of wall membrane and impact of air space. It can also verify performance against the NCC. Please click here for access to FletcherSpec™ Pro.

For Thermal Performance

Siniat recommends Fletcher Insulation to provide a cost-effective, thermal and acoustic solutions for energy-efficient construction.



This climate zone map is a simplified representation and is to be used as a guide only. Refer to the ABCB website for detailed maps.

FIGURE 16 **Climate Zones**

Climate Zones

Australia has a diverse climate ranging from hot summers to cold winters, with varying degrees of humidity levels and rainfall. Depending on the location, buildings will need specific consideration for the climate experienced, performance expected and the construction systems used.

The National Construction Code (NCC) therefore defines 8 climate zones, each with their own specific performance requirements for heating, cooling and energy efficiency for buildings. These climate zones have different performance attributes that impact products used, ie: Vapour permeable membranes is climate zone specific.

A high resolution version of the climate zone map, as well as state based versions are available by following the link below to the Australian Buildings Codes Board (ABCB) website.

Thermal Requirements

In an effort to reduce greenhouse gas emissions, new buildings have provisions to limit the amount of energy required to operate them. These building provisions are contained in the NCC and are applicable to houses and most building types.

There are several ways to satisfy the performance requirements of the NCC, including deemed-to-satisfy provisions or alternative means including verification methods.

The deemed-to-satisfy provisions have been summarised in the following tables. Please note, almost all states also have their own specific requirements that must be followed. Refer to the NCC for the complete details.

NCC 2019 Deemed-to-Satisfy Thermal Requirements - Class 1 and 10

Table 26 Roof Minimum Total R-Value - Class 1 and 10

Climate Zone		1	2 Altitude < 300m	2 Altitude ≥ 300m	3	4 and 5	6 and 7	8
Direction of heat flow		Down	Down	Down and Up	Down and Up	Up	Up	Up
Upper surface solar absorptance value	≤ 0.4	3.1	4.1	4.1	4.1	4.1	4.6	6.3
	> 0.4 to ≤ 0.6	4.1	4.6	4.6	4.6	4.6	5.1	6.3
	> 0.6	5.1	5.1	5.1	5.1	5.1	5.1	6.3

1. This table is a summary only and is not intended to be a substitute for the NCC. Tables do not consider all building classes, requirements, state government provisions, and concessions which may apply. Refer to the NCC for the full details.
2. In climate zones 1 to 5, the total R-Value can be reduced by 0.5 when the insulation is laid on the ceiling and the roof space is ventilated. Refer to NCC Volume Two, Section 3.12.1.2 Roofs.
3. Refer to roof sheeting / tile manufacturer for accurate solar absorptance values.
4. A thermal break of minimum R-Value 0.2 is required when metal sheet roofing is directly fixed to metal roof framing and does not have a ceiling lining or has a ceiling lining fixed directly to metal purlins, metal rafters or metal battens. Refer to NCC Volume Two, Section 3.12.1.2 (c)

Table 27 External Wall Minimum Total R-Value - Class 1 and 10

Climate Zone	1 to 5	6 and 7	8
Total R-Value	2.8 or 2.4 with certain external wall shading	2.8	3.8

1. This table is a summary only and is not intended to be a substitute for the NCC. Tables do not consider all building classes, requirements, state government provisions, and concessions which may apply. Refer to the NCC for the full details.
2. Thermal breaks are required for steel frame external walls that have either no internal wall lining or when the internal wall lining is directly fixed to the steel frame, and there is light-weight cladding or metal sheeting also directly fixed the outer side of the steel stud frame. The thermal break must have a minimum R-Value of 0.2.

Table 28 Suspended Floor (without in-slab heating) Minimum Total R-Value - Class 1 and 10

Climate Zone	1	2	3	4	5	6	7	8
Direction of heat flow	Up			Down				
Total R-Value	1.5	1.0	1.5	2.25	1.0	2.25	2.75	3.25

1. This table is a summary only and is not intended to be a substitute for the NCC. Tables do not consider all building classes, requirements, state government provisions, and concessions which may apply. Refer to the NCC for the full details.

NCC 2019 Deemed-to-Satisfy Thermal Requirements - Class 2 to 9

For Class 2 to 9 buildings, the required Total R-Value and Total System U-Value must allow for thermal bridging.

Table 29 Roof and Ceiling Minimum Total R-Value - Class 2 to 9

Climate Zone	1	2	3	4	5	6	7	8
Direction of heat flow	Down	Down	Down	Down	Down	Down	Up	Up
Total R-Value	3.7	3.7	3.7	3.7	3.7	3.2	3.7	4.8

1. This table is a summary only and is not intended to be a substitute for the NCC. Tables do not consider all building classes, requirements, state government provisions, and concessions which may apply. Refer to the NCC for the full details.
2. The required Total R-Value must include allowance for thermal bridging.
3. In climate zones 1 to 7, the solar absorptance of the upper surface of a roof must not be more than 0.45.
4. Refer to roof sheeting / tile manufacturer for accurate solar absorptance values.
5. A thermal break of minimum R-Value 0.2 is required when metal sheet roofing is directly fixed to metal roof framing and does not have a ceiling lining or has a ceiling lining fixed directly to metal purlins, metal rafters or metal battens. Refer to NCC Volume One, Section J0.4 Roof thermal breaks.

Table 30 Walls and Glazing Maximum Total System U-Value - Class 2 to 9

Climate Zone	1	2	3	4	5	6	7	8
Building Class 2 common area, Class 5, 6, 7, 8, 9b or 9a other than a ward area	U2.0							
Building Class 3, 9c, or 9a ward area	U1.1	U2.0	U1.1	U1.1	U2.0	U1.1	U1.1	U0.9

1. This table is a summary only and is not intended to be a substitute for the NCC. Tables do not consider all building classes, requirements, state government provisions, and concessions which may apply. Refer to the NCC for the full details.
2. Total System U-Value of display glazing must not be greater than U5.8.

Table 31 Wall-glazing Construction Minimum Total R-Value - Class 2 to 9

Climate Zone		1	2	3	4	5	6	7	8
Wall is < 80% of the area of the wall-glazing construction		1.0							
Wall is ≥ 80% of the area of the wall-glazing construction	Building Class 2 common area, Class 5, 6, 7, 8, 9b or 9a other than a ward area	2.4	1.4						
	Building Class 3, 9c, or 9a ward area	3.3	1.4	3.3	2.8	1.4	2.8	2.8	3.8

1. This table is a summary only and is not intended to be a substitute for the NCC. Tables do not consider all building classes, requirements, state government provisions, and concessions which may apply. Refer to the NCC for the full details.
2. Maximum solar admittance of wall-glazing construction must also be calculated. Refer to NCC Volume One, Section J1.5

Table 32 Floors Minimum Total R-Value - Class 2 to 9

Climate Zone	1	2	3	4	5	6	7	8
Direction of heat flow	Up	Up and Down		Down				
Floor without an in-slab heating or cooling system	2.0	2.0		2.0				3.5
Floor with an in-slab heating or cooling system	3.25	3.25		3.25				4.75

1. This tables is a summary only and is not intended to be a substitute for the NCC. Tables do not consider all building classes, requirements, state government provisions, and concessions which may apply. Refer to the NCC for the full details.

Wet Areas

The NCC requires wet area construction to protect the occupants from dangerous or unhealthy conditions, and to protect the building from damage. Acceptable construction for wet areas is detailed in the NCC and Australian Standard AS 3740:2010, Waterproofing of Domestic Wet Areas.

watershield, **multi**shield, **tru**rock and **tru**rock hd are all water resistant plasterboards. The installation of these products in accordance with Section 3.4 of this manual complies with the requirements for wet areas from AS 3740 and the NCC.

multishield, **tru**rock and **tru**rock hd are water resistant plasterboards that are also fire resistant and can be substituted for **fire**shield in all systems.

watershield, **multi**shield, **tru**rock and **tru**rock hd are manufactured to high internal standards that meet or exceed the requirements for water resistant gypsum board within Australian Standard AS 2588:2018, Gypsum Plasterboard.

watershield, **multi**shield, **tru**rock and **tru**rock hd are water resistant, however they are not waterproof. Direct contact with water over time must be avoided and if plasterboard has been water damaged, it must be replaced.

Precautions against condensation listed in Section 2.2 'Condensation and Ventilation' must be followed.

Water Resistant Plasterboard for Wet Areas

Siniat recommends the installation of **water**shield to resist moisture in wet areas like showers, bathrooms and laundries. For areas that require a fire rating as well as water resistance Siniat recommends **multi**shield, **tru**rock and **tru**rock hd.

watershield, **multi**shield, **tru**rock and **tru**rock hd are ideal substrates for tiles as they are dimensionally stable.

Impact Resistance

Areas subject to wear and tear need special consideration to reduce damage and maintenance costs. High traffic and wear areas are commonly found in:

- Shopping centres
- Educational facilities
- Hotels
- Airports
- Correctional centres
- Hospitals
- Garages
- Gymnasiums
- Corridors
- Rumpus rooms.

Testing of Impact Resistant Linings

trurock and **tru**rock hd have been tested for three types of impact resistance

- Soft body representing a person impacting a wall
- Large hard body representing intentional damage
- Small hard body representing incidental damage; every day wear and tear.

Soft Body Impact

The soft body test involves swinging a sand filled bag into a test wall with studs at 600mm centres and simulates the kind of loads applied to a wall system by the human body.

Soft body impact was tested in accordance with NCC Volume One, C1.8, meeting the impact requirements for fire rated walls and fire isolated exits.

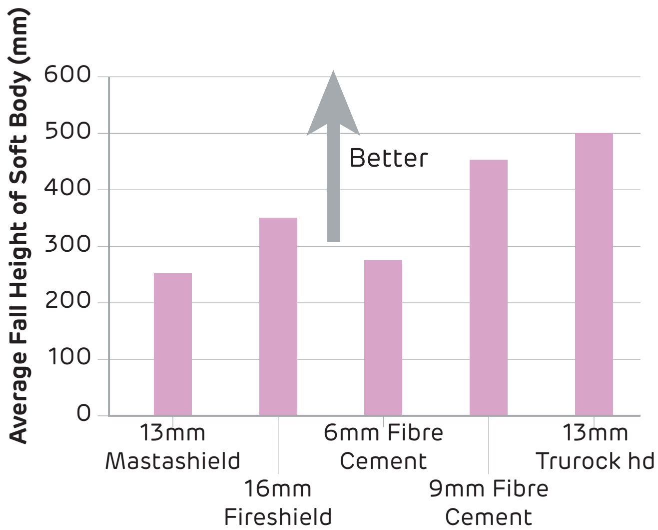


FIGURE 17 Soft Body Impact Testing

Large Hard Body Impact - 5kg Steel Ball

Hard body tests were carried out by dropping a steel ball from different heights and measuring the depth of the indentation caused by the impact. Hard body tests simulate loads such as a trolley or swinging a heavy suitcase.

Large hard body impact resistance was tested with a 5 kg spherical steel weight, swung from a height of 300mm. It has about the same energy as a cricket ball travelling at 60 km/h. This impact simulates a reasonable kick with a steel capped boot which makes a hole in standard 13mm plasterboard.

The number of impacts it took to penetrate the lining was recorded. Penetration was defined by the ability of a 10mm diameter probe to pass through the lining when applied with 2.5 kg of force.

13mm standard plasterboard was penetrated after 1 impact, 13mm **tru**rock withstood a further 3 hits before being penetrated on the 4th impact. 13mm **tru**rock hd was penetrated on the 10th impact.

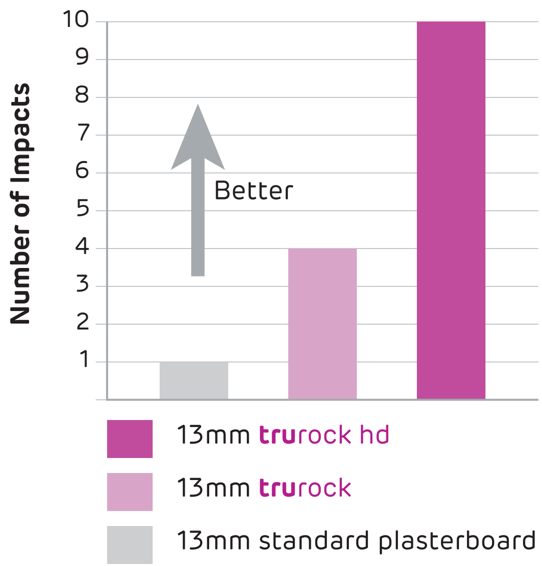


FIGURE 18 Large Hard Body Impact Testing

Small Hard Body Impact - 510g Steel Ball

Small hard body impact resistance was tested with a 50mm steel ball weighing 510 grams, dropped onto 400mm square plasterboard samples. The samples were placed on a 300mm square aluminium support sitting on concrete:

- Standard 13mm plasterboard was completely penetrated at a drop height of 2.4m while **tru**rock only sustained a dent 2mm deep
- At a 1.6m drop height, 13mm standard plasterboard suffered an impact more than 4mm deep, while **tru**rock showed only a minor dent 1mm deep.

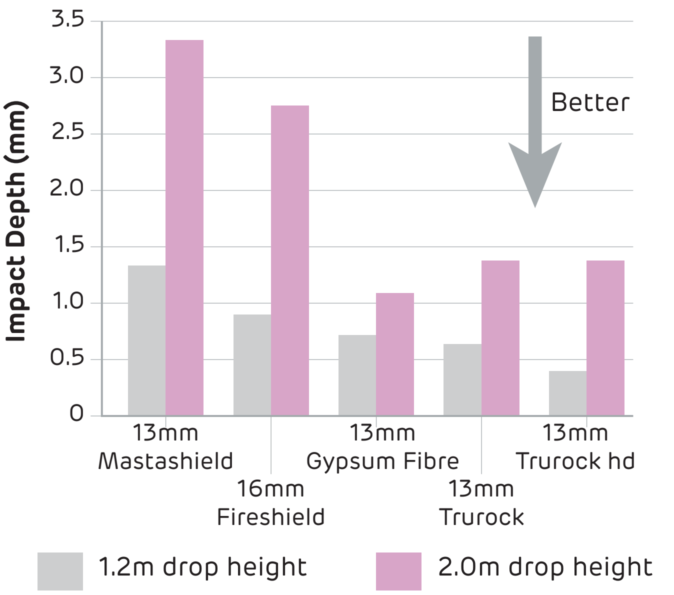


FIGURE 19 **Small Hard Body Impact Testing**
1.2m and 2.0m drop heights

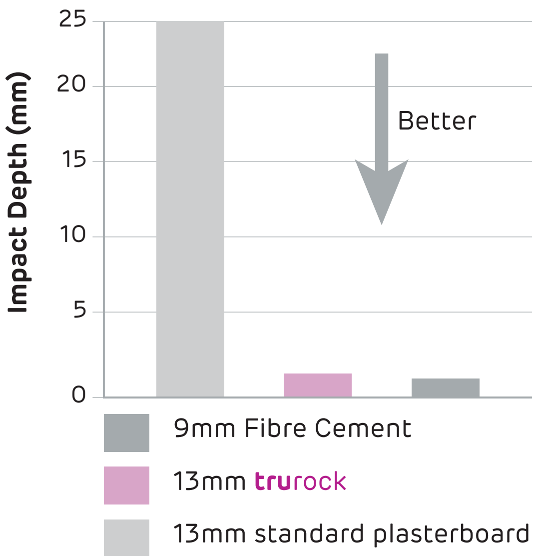


FIGURE 20 **Small Hard Body Impact Testing**
2.4m drop height

Benefits of Trurock

- High resistance to marks, scores, dents and holes
- Twice as tough and hard as standard 13mm plasterboard.

13mm **tru**rock can substitute 13mm **fire**shield in any system and maintain the fire and acoustic performance. 16mm **tru**rock can also substitute 16mm **fire**shield.

trurock is not intended to safeguard against damage from deliberate attack with heavy tools or in areas where heavy moving machinery may contact the walls (e.g. unprotected forklift operating areas).

Impact Resistance

Siniat recommends the installation of **tru**rock with a high density core and heavy duty face and back paper, to minimise wear and tear in high traffic areas.

trurock hd is an impact resistant plasterboard reinforced with a continuous fibreglass mesh embedded in a high density core.

X-Ray Resistance

Medical X-ray diagnostic rooms require the use of protective barriers to shield operators and occupants of adjacent areas against unacceptable levels of X-ray radiation.

The level of shielding required depends on:

- X-ray workload and frequency of use
- Direction of X-ray beam, voltage of X-ray tube, number of exposures and X-ray current
- Occupancy and usage of areas adjacent to X-ray suites
- Position of the X-ray unit and the controls in the room
- The dimensions of the room housing the equipment.

Protection usually takes the form of X-ray absorbing sheet material on the walls of the room in which equipment is operated, together with suitably shielded windows and doors. X-ray shielding may also be required on the floors and ceilings of X-ray facilities in multi-storey buildings.

Every Australian State and Territory has individual requirements for radiation shielding of diagnostic medical facilities. A Health Physicist or Radiation Consultant will be typically be involved in projects to ensure that the local requirements for radiation shielding are fulfilled, according to the regulations of the State or Commonwealth.

The advantages of using GIB **x-block**® Shielding systems are:

- Lead free and environmentally friendly
- Easy to install and joint as standard plasterboard
- Enhances other important performance requirements such as noise control and fire ratings
- Eliminates the need for backing joints with lead strips.

X-ray Resistance Energy Levels

X-ray radiation is measured in kilovolts peak (kVp). Depending on the type of radiation equipment used in the room, diagnostic facilities will have different requirements for shielding:

- CT 120-140 kVp
- General radiographic rooms 60-90 kVp
- Dental 60-80 kVp
- Mammography 25-35 kVp

Other facilities such as nuclear medicine suites may use higher energy X-rays or different types of radiation and additional shielding may be necessary. The level and quality of radiation differs between applications, therefore a Health Physicist must always be involved in determining the shielding requirements for X-ray diagnostic facilities.

GIB **X-Block**®
For Radiation Shielding

Siniat recommends the use of GIB **x-block**® systems to provide X-ray radiation protection in medical X-ray diagnostic rooms within medical facilities and dental clinics.

GIB **x-block**® is a lead-free plasterboard system with high levels of barium sulphate which provides an effective radiation barrier. It eliminates the need for costly and complex installation procedures usually associated with installing lead based lining solutions.

GIB **x-block**® systems use GIB **x-block**® Jointing Compound, a compound specifically designed to give lead equivalent joints on walls and ceilings using GIB **x-block**® plasterboard.