



## TECHNICAL BULLETIN – TB148

# MECHANICAL FIXING OF STACK STONE CLADDING TILES TO WALL SUBSTRATES

JULY 2024

### INTRODUCTION & SCOPE

Technical Bulletin TB001 “Installation of Large Format and Heavy Stone Tiles” discusses the concerns of fixing heavy cladding tiles to wall substrates using adhesives only. The main issue is the capability of the wall substrate to support the weight of the tile finish and any associated applied surface preparation material (e.g. cement render). A table showing the maximum weight carrying capacity of various wall substrates was included in Technical Bulletin TB001 with a recommendation that additional mechanical fixing devices be used where these limits are exceeded and/or where the tiles are to be installed 3 metres (or higher) above ground level.

This bulletin provides some guidelines regarding the suitability of substrates to accept mechanical fixing devices and discusses a mechanical support system.

### TILE FINISHES

The cladding finishes applied to wall surfaces internally include ceramic and natural stone tiles in square and rectangular shapes. Most of these tiles are uniform in thickness and may have a weight per square metre less than the maximum given in TB001. However, the popular stack stone tiles, which are composed of narrow rectangular pieces of natural stone held together by a resin-based (e.g. epoxy) adhesive, may have considerable variations in thickness. These stack stones use variations in thickness as part of the attractiveness of the completed installation and frequently weigh in the order of 50 to 80kg per m<sup>2</sup>. The most common stack stone nominal sizes are 600 x 150 x (approx.) 25mm thick and 400 x 100 x (approx.) 20mm thick, and unlike ceramic tiles, they are usually installed with butt joints, i.e., no grout is used between the tiles. In addition, excess resin binder (usually epoxy) may prevent the tile adhesive from achieving full contact with the stone pieces, leading to weaker-than-normal bond strength when the adhesive is fixed to the wall substrate.

### WALL SUBSTRATES

The substrates to which these cladding tiles are fixed vary considerably. Substrates include concrete, concrete block, brick, and selected fibre cement sheeting, and even with these substrates, there can be issues when fixing external cladding systems.

#### Concrete

Concrete walls may be of cast construction (off-form) or tilt panel construction. These may have the residues of mould release agents remaining on the surface in addition to laitance and/or efflorescence deposits that will impair the adhesive fixing of the cladding tiles. Off-form concrete may also have an uneven surface where the formwork has not been fixed correctly, and rendering may be required to achieve a flat surface suitable for fixing the tiles. Surface preparation such as grinding, abrasive blasting or high-pressure water blasting may be required to achieve an open-pored textured substrate suitable for adhesive fixing of the cladding tiles.



### **Concrete block and brick**

Per the recommendations of AS3958, concrete block and brick should be rendered before the adhesive fixing of cladding tiles. In addition, the concrete block should be reinforced and core-filled, particularly when mechanical fixing is used in conjunction with the tile adhesives.

This recommendation ensures that all fixing bolts can grip to solid concrete, not just the thin block wall. This also applies to rendered brick walls, as too heavy a loading (or too shallow fixing into the block/brick) may cause the localised failure of the block/brick and lead to tiles falling. Some manufacturers supply masonry anchors for blockwork, but these have limited load-carrying capacity, so core filling is the preferred method.

Refer to Ardex Technical Bulletin TB230 for more information about block walls.

### **Fibre Cement Sheeting**

Fibre cement sheeting includes compressed and standard wall sheeting that may or may not have been primed at the factory before the sale. The standard (uncompressed) fibre cement sheeting is mostly used on internal walls (except specific external products) and is fixed to various framing systems such as timber or metal. We recommend that the fibre cement sheet manufacturer be consulted regarding each installation to ensure the frame spacing, sheet type, sheet thickness, and fasteners are appropriate for the job. For example, TB001 notes that the weight carrying capacity of a 6 mm fibre cement wallboard sheet fixed at 200mm centres is only 20 kg/m<sup>2</sup> compared to 32 kg/m<sup>2</sup> for a sheet fixed at 100mm centres.

We note that the James Hardies Villaboard Lining Installation Guide (Jan. 2012), page 17, table 9, lists the maximum tile thicknesses for different thicknesses of Villaboard sheeting fixed at two different stud intervals (600mm and 450mm centres). Tile thickness (together with density) guides the weight per square metre regardless of the individual tile size. Support angles are recommended when fixing tiles weighing more than 32kg per sqm and/or when exceeding a height limit to the tiling of 3 metres.

ARDEX will not recommend adhesive fixing tiles that disagree with the sheet supplier's published practices. So, no adhesive recommendation is provided for non-compliant sheets (e.g., Harditex, Exotec). In 2014, BGC Innova Stonesheet and James Hardie 'Easy Lap' were the only fibre-cement sheets intended to take external tiles.

Crucial to the carrying capacity is the framing that supports the fibre cement sheet wall linings, as the mechanical fixing devices must be fixed (screwed or bolted) through the sheet lining into the framing. Fixing to the sheet lining is unacceptable as the fixing screws/bolts may pull due to the weight of the tile finish. The framing must, therefore, be strong enough to support the weight of the sheet lining and the tile finish. Lightweight metal framing may not be suitable when heavy and large tiles are to be installed. Conversely, fibre-cement sheeting is not recommended for direct fastening to heavy steel sections that carry loads.

## **MECHANICAL FIXING**

Mechanical fixing systems commonly used for thick stone panels are considered unsuitable for these thinner cladding tiles. These fixing systems are frequently designed to be concealed, and the stone panels are usually sufficiently thick to be strong enough not to break around the fixing device.



Consideration of the thinner cladding tiles has led to the use of metal angles fixed horizontally across the face of the wall and at regular intervals up the wall. It is recommended these angles are made from stainless (304 or 316 grade) steel thick enough (2mm minimum) to support the weight of the stack stone tiles without distorting. Unprotected aluminium angles are not recommended as the aluminium may react with the cement in the tile adhesives and deteriorate over time. The angles are to be mechanically fixed into the wall substrate using suitable screws or bolts at frequent intervals. Care must be taken to ensure the fixing screws/bolts are in the framework of sheeted walls and that the heads of the screws/bolts do not protrude to such an extent as to prevent the tiles from being correctly set in position.

Examples of suitable masonry anchoring bolts are provided in specification manuals, such as those offered by Powers Fasteners or Ramset. The anchors best suited for use with the stone cladding support angles are the drilled-in types and are available in a range of sizes for fixing holes from 10mm to 32mm in diameter. As a guide, the hole should be drilled to 125% of the anchor length and set at intervals corresponding to 10 times the anchor diameter for maximum load capacity. Refer to the manufacturer's literature for full details.

Where the construction is framed, the interval between anchor locations will be decided by the framing locations, which can alter the actual load capacity of the tile supports.

These anchors are available with corrosion resistant coatings as well as being made from stainless steel. Anchors are available with Hex heads, countersunk heads, and mushroom heads. The anchor head must be large enough not to pull through the metal angle under load; a large washer may be required under the anchor head to prevent this from happening. The clamping (toggle) type anchors are not recommended for use when fixing the stack stone cladding as the substrates, such as hollow masonry block or fibre cement sheeting, for which these types of anchors are suited, are not suitable for the heavy stack stone cladding tiles. Fixing the support angles to these substrates may result in the anchor pulling through the substrate, and we recommend hollow masonry block or brick be core-filled before fixing the stack stone cladding tiles.

The size and weight of the cladding tiles will influence the vertical spacing of the angle. Heavier, larger stack stone pieces will have the angles at closer intervals than lighter pieces. For example, stack stones weighing approximately 65 kg/m<sup>2</sup> may have the angles placed at every third row first and then at every second row above two metres above ground level. Lighter, smaller tiles weighing only 35 kg/m<sup>2</sup> may have the angles at every fifth row first and then at every third or fourth above two metres.

The angle should be sufficient width to support a minimum of three-quarters of the tile thickness (measured on the thickest stack stone) so the metal edge is not showing in the tile finish. We noted previously that the stack stone tiles are normally fixed with no grout joints between the pieces. To install these stones, a rebate may need to be cut into the edge of the tile to allow the tile to sit on the angle without the metal showing; otherwise, the angled edge may be covered with a suitable flexible sealant used to fill the gap between the upper and lower rows of stack stone.

The stack stone tiles are not recommended to be installed onto overhanging wall substrates with no supporting base for the stone cladding. In this application, the total weight of the stone cladding will be on the wall. Framed wall construction may not be strong enough to support this loading, and we recommend that suitably qualified engineers be consulted before proceeding with this installation.



Stack stone cladding may use various stone types with variable strengths and weatherability. These, as well as mechanical load issues, need to be considered.

Ardex recommends that appropriately qualified and certified engineers determine the suitability of the sub-wall for tiling, the most appropriate metal angle supporting system, including dimensions and construction materials, and the anchor type, locations, and centres. Engineering and design issues must be resolved where it is intended to fix these stones to high walls.

## **TILE ADHESIVES**

Tile adhesives recommended for fixing the stack stone to the prepared substrates are generally the polymer fortified, C2 cement-based types or R1 reaction resin epoxies. These have high bond strength and resistance to all climatic conditions, including high temperatures and moisture penetration. Substrate preparation includes ensuring the surfaces are dry and free of all contaminants such as concrete curing agents, formwork release agents, paint over-spray, excess laitance and/or efflorescence, waxy or oily residues, and loose particles.

Porous substrates such as cement renders and fibre cement sheeting should always be primed with a compatible primer (e.g., Ardex Multiprime or Ardex P9) when using ARDEX cement-based adhesives and allowed to dry before adhesive fixing the stack stone.

The R-class epoxy construction type adhesives are recommended where greater performance is required.

For recommendations regarding specific adhesives, please consult Ardex Technical Services.

## **ENVIRONMENTAL ISSUES**

This engineering process must also consider the effects of seismic activity, wind loading, and weathering on the finishes of the stacked stone walls.

Where an installation is subject to seismic forces, the high-ground accelerations create significant loads on the cladding (commonly exceeding their design capabilities), which may result in the cladding de-bonding or tiles breaking free. Areas known to show seismic activity with recorded damaging earthquakes include:

NSW – Newcastle and the Southern Highlands around Canberra-Gunning,

Tasmania – Northeastern areas, the Bass Strait Islands, and areas in the central-west,

SA – Adelaide City and the Adelaide Hills,

WA – East of Perth centred on Meckering/Calingiri and the Kimberley-Pilbara regions.

Areas northwest of WA and NT can experience seismic effects from strong southern Indonesian earthquakes. Most of New Zealand can be subject to strong seismic activity outside Australia.

Large areas of the Australian coastal zone, especially north of Brisbane around the top of Australia to the north of Perth, are subject to cyclones and thus have strict wind load codes applied to construction. Where large areas of these heavy stone claddings are installed, this will increase the dead load on the construction, change the airflow characteristics, and may alter the wind load capacity of the wall.

Australian external walls, especially east-north-west facing, are subject to strong weathering due to heat and rain exposure. The thermal changes during the day, particularly in summer, can create differential stress and strains between the cladding and the substrate, and these need to be allowed for in the construction. Heavy tiles, without mechanical fixing, are more likely to be subject to movement-related bonding issues. Cladding made from inferior grades of dimension stone can also suffer from premature aging and failure of the stone itself due to weathering. Suspect rock types include schists and mudstone-argillites.

## DESIGN CONSIDERATIONS

ARDEX has encountered numerous situations where the wall design aesthetics have not considered the system's mechanical and technical properties or construction. In this situation, it may be necessary to re-design the cladding system to be appropriate for the type of tile that has been selected.

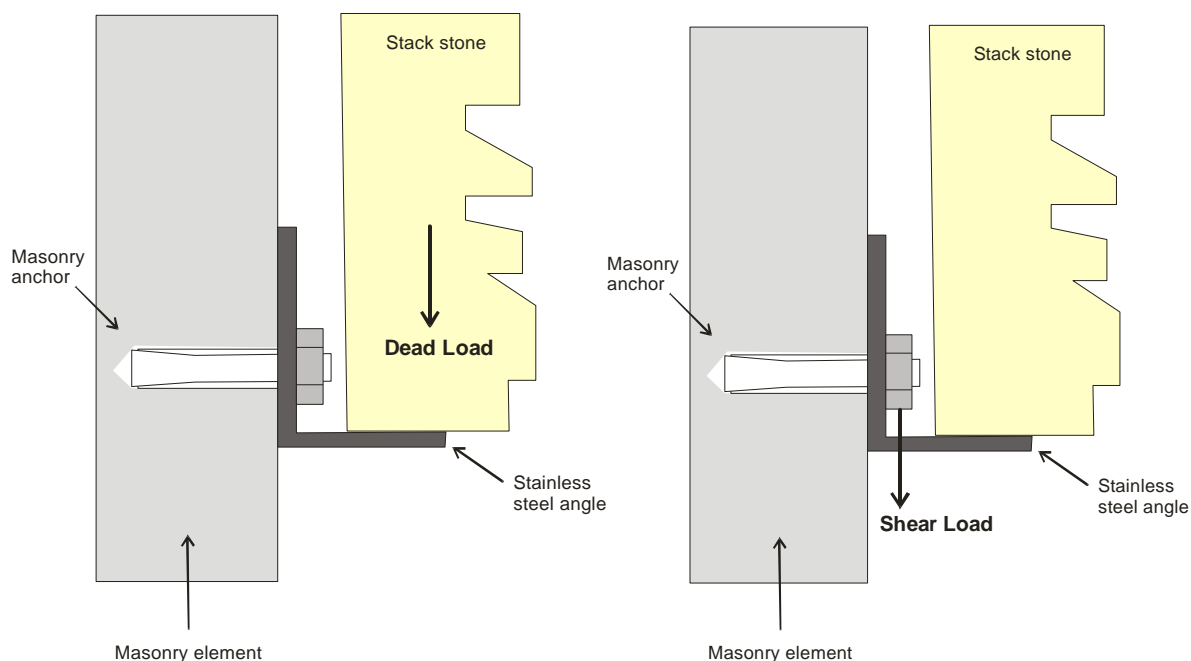
Another point that needs consideration is what waterproofing is required for lightweight cladding systems to prevent moisture from penetrating the sheet joints.

***The following schematic diagrams give some guidance to mechanical fixing.***

***They are not design diagrams and are not intended to be used for engineering purposes.***

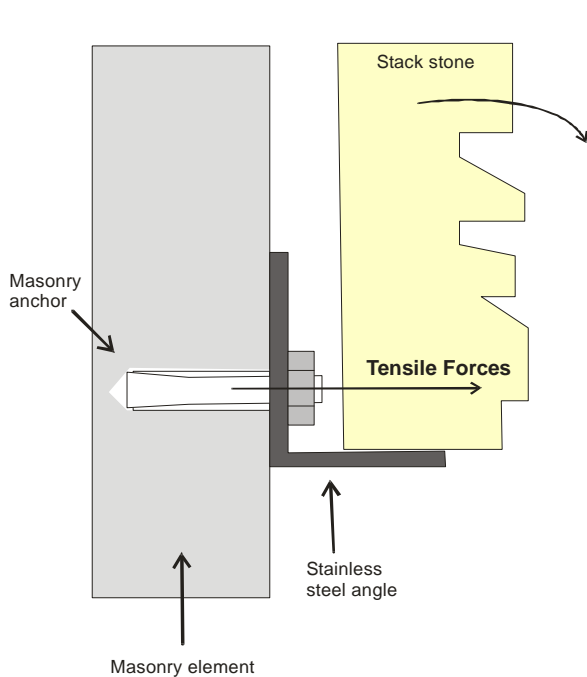
***All engineering and design drawings must be professionally drafted.***

Diagram 1 – The types of load cladding exerted on a wall and fastening system

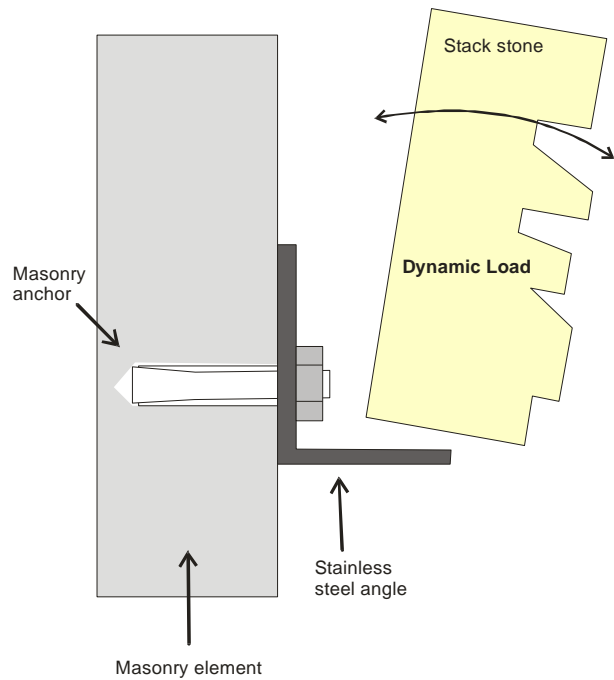


1a) Dead load from the cladding's weight.

1b) Shear load exerted on the fastener by the cladding. Fasteners with too low a load rating may bend or shear off.

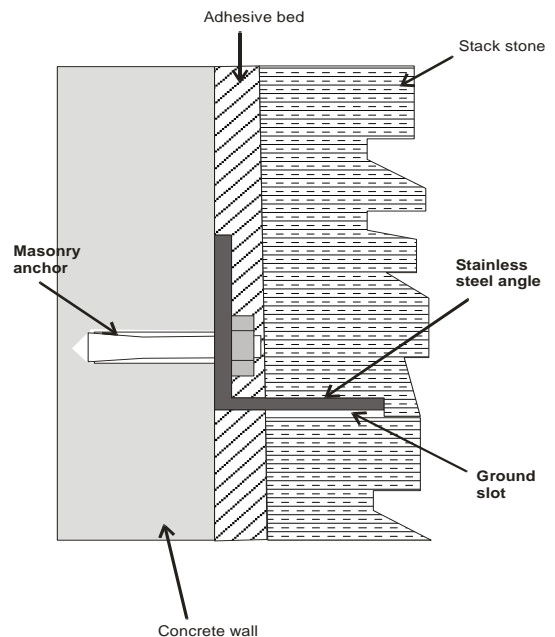


1c) Tensile loads on the fastener (pull out load on the fastener). Well anchored fasteners can remove a cone shaped piece of the substrate which fails before the fastener pulls out.



1d) Dynamic loads created by movements in the cladding (i.e. seismic, wind loading, differential movement or simple impacts)

Diagram 2.  
Suggested method of using L brackets and mechanical anchors for fixing to solid concrete walls.





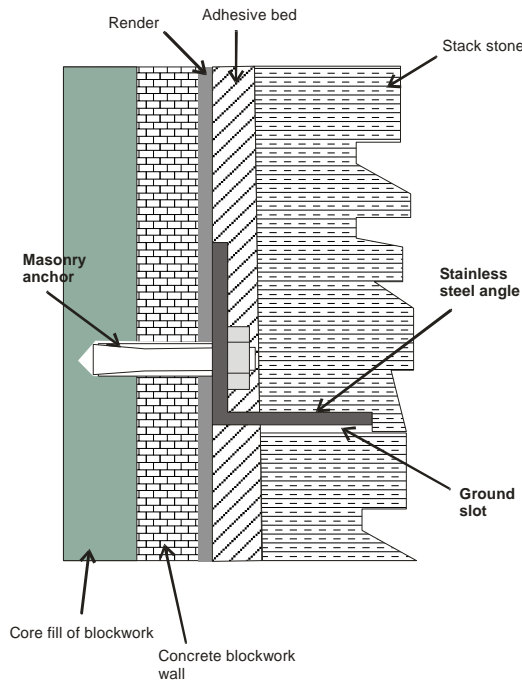


Diagram 3.

Suggested method of using L brackets and mechanical anchors for fixing to rendered filled block work and rendered brick walls

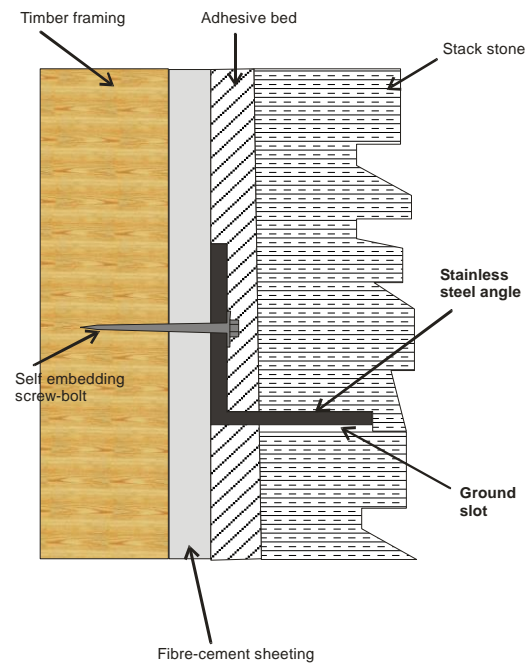


Diagram 4.

Suggested method of using L brackets and screws bolts for fixing to timber framed walls

Diagram 5

This is a typical layout for a mechanical fixing system on a masonry wall. This example shows the closer bracket spacing for the heavier weight range.

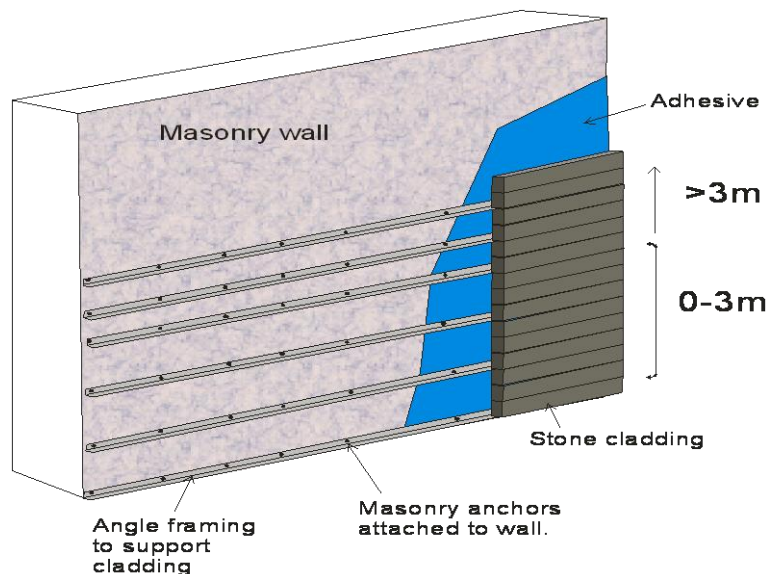


Diagram 6

This is a detail for bracketing at the base of a wall or overhanging area. The bracket must extend past the maximum thickness of the

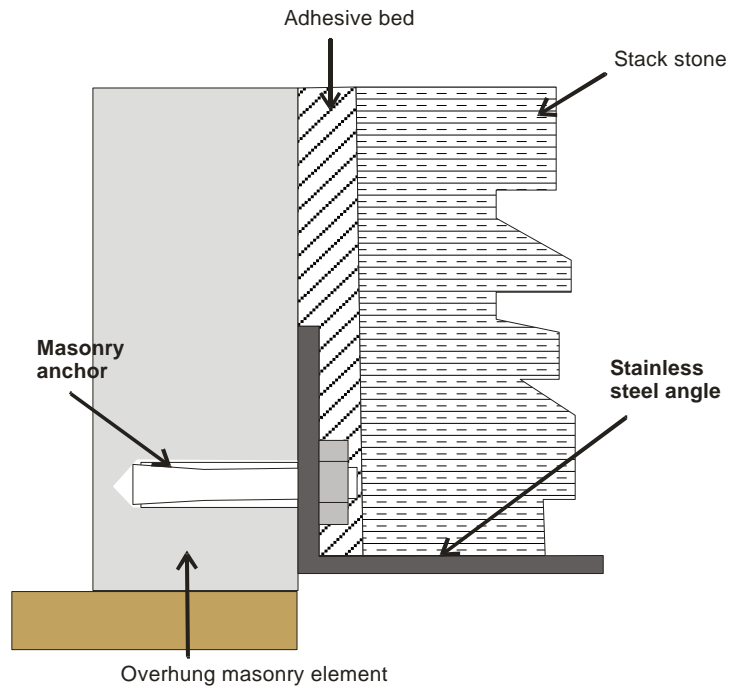


Diagram 7

This is a typical layout for a mechanical fixing system on a timber-framed internal wall. It shows the closer bracket spacing for the lighter weight range.

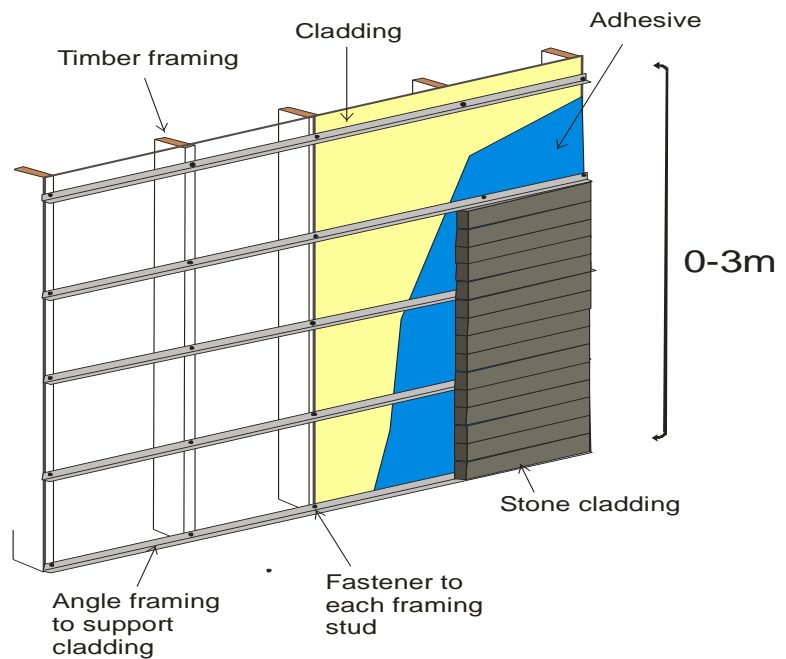
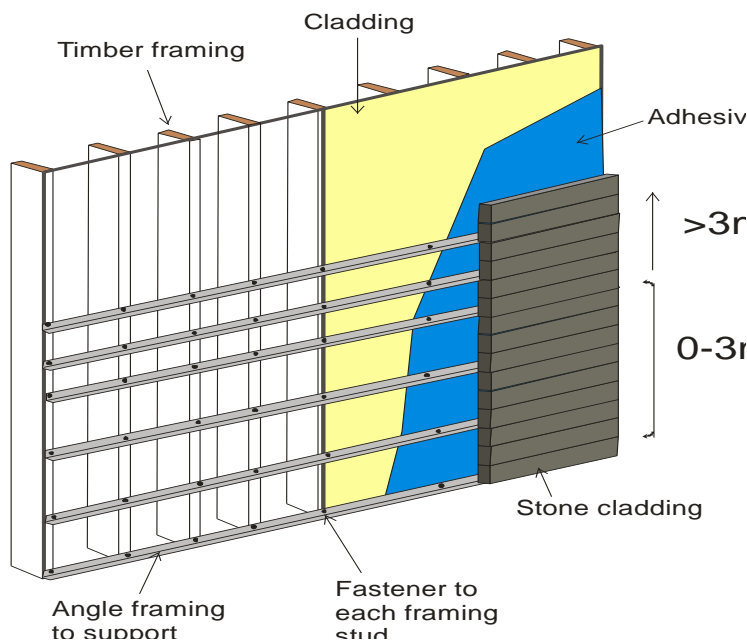




Diagram 8

This is a typical layout for a mechanical fixing system on a timber-framed internal wall. In this example, the closer bracket spacing is shown for the heavier weight range.



## References

Ardex Australia – TB001 Installation of Large Format and Heavy Stone Tiles

Ardex Australia – TB099 Differential Movement and Tiling Finishes

ASTM C1242-05 Standard Guide for Selection and Installation of Dimension Stone Anchoring Systems

Australian Stone Advisory Association – Natural Stone Design Manual -2010

<http://www.asaa.com.au>

Power Fasteners 2012 – Buyers guide. Construction site 2012.

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Ramset 2012 – Specifiers Resource Book (online PDF docs, requires login).

Ramset undated – Anchoring Principles - Mechanical Anchoring  
<http://www.ramset.com.au/Document/Resources>

**IMPORTANT**

This Technical Bulletin provides guideline information only and is not intended to be interpreted as a general specification for the application/installation of the products described. Since each project potentially differs in exposure/condition, specific recommendations may vary from the information contained herein. For recommendations for specific applications/installations, contact your nearest Ardex Australia Office.

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