

TECHNICAL BULLETIN

INSTALLATION OF LARGE FORMAT CERAMIC AND HEAVY STONE TILES

INTRODUCTION & SCOPE

The purpose of this technical bulletin is to raise awareness concerning the trend towards the use of Large Format Ceramic and/or Heavy Stone tiles (excluding thin sheet porcelain tiles) so that appropriate tile design, selection and application can take place with all factors taken into consideration.

WHAT IS A LARGE FORMAT OR HEAVY STONE TILE?

Due to fashion considerations, tile size has continued to grow requiring particular attention to fixing techniques that may not have been required with traditional tile sizes. Today tiles can now be defined as large format when one side is at least 400mm in length.

Typically, a large format tile is 400mm x 400mm although we are now seeing the trend towards tiles in the size range 300mm x 600mm to 600mm x 1000mm tiles, and even larger sizes have become available (1m-3m long). Rectangular shape tiles (400 x 100mm & 600 x 150mm) are also popular.

Heavy stone or ceramic tiles are defined as those that exceed 32 kg/m² in weight, although an often used guide when fixing with adhesive is a maximum weight of 4 kg per individual tile.

Some of the new, extra large stone tiles have more in common with fascia or facade cladding elements than traditional tiles, for example so called 'stacked stone' tiles which are commonly 400mm - 600mm long, 100mm - 150mm wide and 15mm - 30mm thick.

WHAT FACTORS SHOULD BE CONSIDERED WHEN FIXING OF A LARGE FORMAT TILE?

1. BACKGROUND

The first consideration is the capability of the **background** to support the weight of the tile.

Traditional ceramic tile sizes of up to 300mm x 300mm have not normally been an issue; however the trend towards adhesive fixing of large format ceramic and stone tiles quickly raises the total bonded load to above the wall substrate manufacturer's recommended load carrying capacity. The most contentious issue relates to the industry maximum capacity of 32 kg/m² loading of the most common backgrounds. Whilst this figure is quoted within the Tiling Industry both in Australia and overseas, there are no current Tiling Standards that validate this limit.

The limit has been established based on the success of in-practice applications within the building industry and takes into account the broad potential risk that is associated with system failure. The question of the ability of the adhesive to support a weight of a 32 kg/m² tile does not become an issue since the shear strength of selected DUNLOP adhesives is far greater than this limit, provided that suitable adhesion is established to both the tile and the substrate. Where destructive testing has taken place, we will generally see the destruction of the tile and/or cohesive failure of the substrate before seeing failure of the adhesive bond.

Another issue is the position of the substrate manufacturer with regards to application of tiles or cladding.

The three major Australian manufacturers of fibre-cement sheets have for example, stated that tiling over their general use external cladding boards is neither recommended nor warranted. They have a few types of specific sheets with strict guidelines.

A few cases in point;

- an installation of 85kg/m² stack stone applied directly over brick work on some columns, sheared the brick surface away,
- another installation of 60kg/m² stone tiles sheared the surface of so called 'blue board' fibre-cement sheets.

2. TILE PROPERTIES

Beyond the limitations posed by the background to sustain continuous loading under the environmental conditions imposed on it, the next consideration is that of the ability of the tile to sustain its own weight after exposure to the working environment.

A case in point is installation of sandstone tiles (dry weight of 48 kg/m²) to masonry walls, the limitations here being the ability of the masonry wall to support the weight of the sandstone and the cohesive strength of the sandstone to support itself. Porous tiles such as sandstone; will absorb water and become heavier which will result in delamination within the stone. In addition, the loading on the wall substrate may increase to be greater than the capacity of the wall to support the load.

3. ENVIRONMENT CONDITIONS

The service conditions and environment that the tiling system is exposed to can affect the integrity of natural stone tiles and their backgrounds and

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this should influence the choice of fixing method. The example here is sandstone for external cladding which has a higher risk factor simply because the cohesive strength of sandstone is reduced when it is wet, increasing the chance of delamination within the stone when the stone itself becomes too heavy. A similar situation applies to the backgrounds. For some types of backgrounds, such as fibre cement sheet or plasterboard, the surface strength reduces while it is wet, and consequently this reduces the maximum weight carrying capacity of the substrate.

Some types of stone materials are subject to weathering. For example limestone or marbles suffer from acid rain and other fallout which dissolve or otherwise disrupt the stone tile matrix.

The durability performance of the system must also be considered in terms of whether the changes from extreme heat to cold or wet, or ageing over time creates stresses between the substrate and the cladding, in the cladding or in the substrate itself. An example would be differential movements between the cladding and the substrate creating shear strains, or even fatiguing of the components or adhesive.

4. OH&S AND PUBLIC SAFETY

The most obvious consideration, but one which needs re-emphasis is a risk assessment based on Occupational Health and Safety principles and consideration for potential catastrophic failure of the tiling system. Very weighty tiles may require particular considerations whereupon their application by the fixer can take place in a safe manner with suitable me-

chanical constraints engineered to ensure the safe placement of the tile. In addition, suitable engineered restraints may be required to secure the tile in place where the maximum design carrying capacity of the background or the limitations of the stone tile cohesive strength due to service or environmental conditions, is exceeded.

The application of large format and/or heavy stone tiles to external facades and ever increasing tiling heights has also required due diligence with respect to establishing application limits where total reliance on the adhesive to support the tile is a requirement. The location of tiles, in the event of catastrophic failure, becomes a critical consideration for all tile sizes. Best practice is achieved by limiting tiling heights both internally and externally to a 3 metre height limit, whilst evaluating the potential risk of failure to public safety. As a consequence, support for adhesive fixed tiles above 3 metres in height will only be considered by DUNLOP on a case by case basis.

Note: The practise of tiling ceilings or above open thoroughfares is not nominally recommended by DUNLOP Australia and this installation falls outside of the tiling applications discussed in AS3958.

5. MECHANICAL FIXING

Where mechanical fixing becomes a requirement, appropriate design considerations are required to ensure that all components are suitable for the service conditions and working life of the tiling system. Mechanical fixings can include epoxy bonded stainless steel pins, clamp fixings, head and sill capture of

stone, grooved stone edges with metal angle fixings and support or specialized proprietary systems. The use of an adhesive as a secondary support to primary mechanical fixing can result in an additional level of security that would enable the application of tiling that may not be acceptable if the adhesive was solely relied upon. Since the nature of large format ceramic and/or heavy stone tiles varies in material nature, thickness, shape and size, the selection of a suitable fixing method resides with the architectural engineer who has designed the total system.

6. SITE CONDITIONS.

The selection of a suitable DUNLOP adhesive is best done after consideration of the exposure conditions that the adhesive will endure; the background type, and the tile type. The provision of a consistent, structurally sound and suitably prepared dry substrate free of contaminants is critical to any successful application of tiles. Tilers must be able to recognise deficiencies in site conditions that may affect the bond of the adhesive to either the background or to the tile. Allowances must be made for full cure, settlement and shrinkage of the background with additional consideration of the potential structural shrinkage of concrete structures in high rise applications.

External façade tiling of some high rise applications may need to address the need for mechanical fixing of large format tiles applied lower than 3 metres above floor height, where high negative wind loadings become an issue, particularly at cor-

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ners. Another site issue is whether or not the site is in a seismic hazard, or mine subsidence area which can create dynamic loads on the cladding.

SPECIFIC EXAMPLES

The reference Table 2 (on page 5) depicts the limits of typical backgrounds that are used for the application of wall tiles, otherwise a suitable system for mechanical retention will be required in addition to the adhesive.

Special note: Tiling onto sand - cement renders

The weight limitation of fixing tiles/stone onto a mechanically prepared and roughened porous concrete surface (suitable for tiling) is 60 kg/m².

Whilst it may be assumed that a sand/cement render falls into the category of a masonry finish, it should be noted that a 15mm sand/cement render weighs approximately 33kg/m². Add the weight of typical tiling at 27 kg/m², then the combined weight loading of the background will approach the 60 kg/m² weight limit recommended for concrete surfaces.

Naturally these weight loadings of the sand/cement render are reliant on the bond and cohesive strength of the render, in that correct background preparation, water/cement ratios, correct mix design, and best practice installation procedures are employed.

Where the background is suitable for wet areas, the same load limits apply when DUNLOP approved waterproofing membranes are used.

When selecting the weight (kg/m²) limit for the nominated background, in comparison to the maximum tile

weight, the lowest value must always be selected.

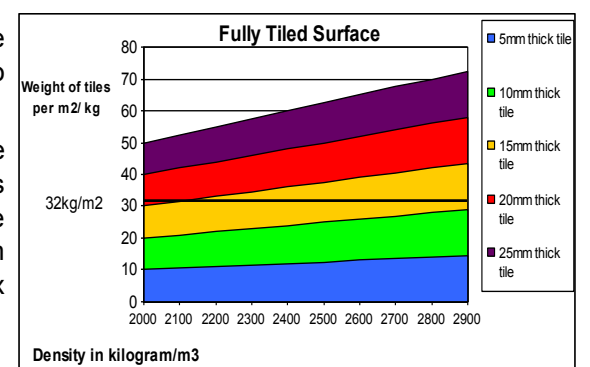
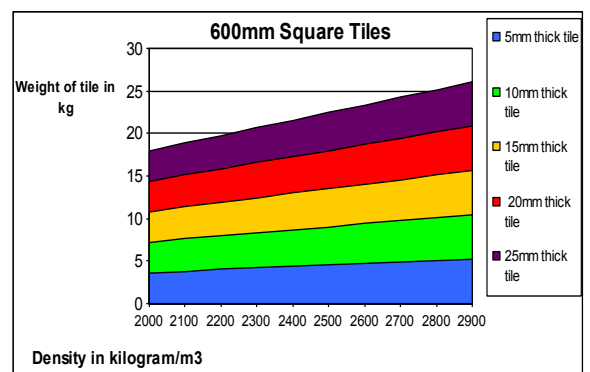
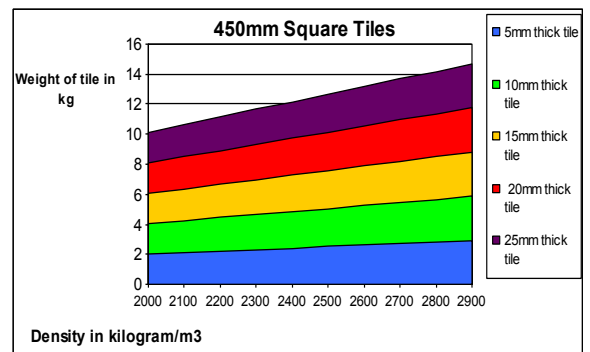
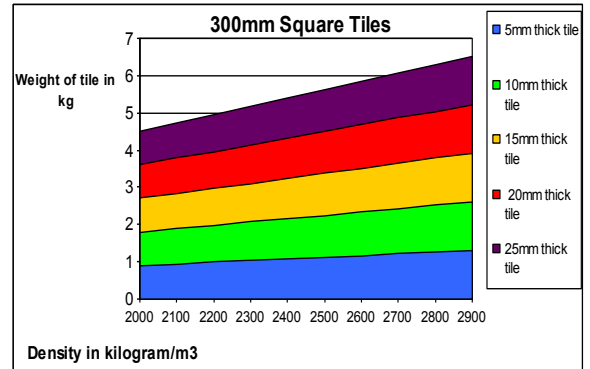
Example 1: A 12.5 kg/m² rated background would not be suitable to support a tile of dimensions 400mm x 400mm that weighed 26 kg/m² but would be suitable if a lighter ceramic tile whose dimension was 600mm x 600mm, but only weighed 11.1kg/m² was used. The 400mm x 400mm tile would require mechanical fastening in addition to the adhesive to reduce the dead load stress that is applied to the background.

Example 2: A background that was rated for 32 kg/m² would be suitable for the 400mm x 400mm tile that weighed 26 kg/m² however the individual tile may weigh 4.2 kg and exceed the 4 kg single tile limit. Consequently the tile may require some mechanical fastening, in addition to the adhesive, to hold the weight of the tile.

Occupational health and safety concerns limit wall tiling to a maximum height of 3 metres where only the adhesive is relied upon to hold the tile in place.

The exceptions to this are internal applications of glass mosaics where individual tile elements have a maximum size of 25mm x 25mm x 4mm.

Please contact DUNLOP technical advice for external tiling above 3 metres.



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A typical 400mm x 400mm fully vitrified tile or ceramic tile would be limited to a thickness of about 10mm to

be within the 32 kg per m² limit. Care should be taken when assessing agglomerate and natural stone tiles as

the bulk density of stone tiles can range from 2300kg/m³ to 3200kg/m³ depending upon the composition.

BACKGROUND	Maximum Weight Capacity
Concrete*: Mechanically prepared to provide a roughened porous solid surface.	60 kg/m ²
Sand/Cement Render*: Applied to solid open porous roughened concrete, brick, or masonry surface.	32 kg/m ²
Paper-faced plasterboard generic Gyprock plasterboard	32 kg/m ² Remove wallpaper, vinyl and paint finishes.
Gyprock Aquachek Sheet fixing @ 200mm centres Waterproof membrane -Yes	12.5 kg/m ²
Gyprock Aquachek Sheet fixing @ 100mm centres Waterproof membrane - Yes	32 kg/m ²
Fibre Cement Wallboard# Sheet fixing @ 200mm centres	20 kg/m ²
Fibre Cement Wallboard# Sheet fixing @ 100mm centres	32 kg/m ²
Gypsum Plaster	20 kg/m ²
Masonry and blockwork May require rendering prior to the installation of tiling - refer to AS 3958.1 – 2007, Section 4.5 refer to sand/cement render.	32 kg/m ²
Hebel Block Walls/Hebel Wall Panels	32kg/m ² max. Internal walls only. No additional mechanical fixings to be used.

Notes:

*Maximum weight capacities of backgrounds are based on concrete and sand/cement render mixed and applied according to the relevant standard.

Refer to fibre-cement manufacturer's position with regards to application of tiles onto fibre-cement boards in external environments.

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CONCLUSION

Taking all these factors into consideration, the responsibility of selecting the appropriate tiling system will reside with the project engineer to evaluate the interaction of building elements with the proposed fixing system. The engineer must take into consideration the service environment, site conditions, background loadings, tile weights, fixing methods, issues in respect of Occupational Health and Safety for the intended end use of the project, and the overall "Risk Management" assessment.

Reference should be made to other DUNLOP or ARDEX Technical bulletins that are associated with the issue of large format and/or heavy stone tiles to be fixed to wall surfaces. These include a summary of the uses of fibre cement sheeting as intended by the sheet manufacturer, considerations when tiling over existing walls tiles and guides to estimating dead loads that are to be imposed on wall substrates.

Always refer to the product data sheets for specific usage details.

NOTES

The information contained herein is to the best of our knowledge true and accurate.

No warranty is implied or given as to its completeness or accuracy in describing the performance or suitability of the product application.

Users are asked to check that the literature in their possession is the latest issue.

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GLOSSARY OF TERMS

Dead Load—The load created by the weight of a tile without any other factors taken into account.

Fatiguing—The progressive degradation in the performance of a building element as the result of cyclic loading, such as wind loading, vibration, hot-cold or heat-rain cycling

Live Load—The load imposed on a substrate by outside forces such as wind or vibrations.

Load Carrying Capacity (weight or load limit)—The amount of live and dead load a substrate can withstand before failure may be expected.

Seismic Hazards—Refers to areas where building design has to take earthquake risks into consideration.

Shear Strain/Stress—Forces applied to the tile or substrate at an angle less than 90 degrees. Typically shear is considered to apply at angles less than 45 degree to the horizontal axis.

Wind Loading—External facades and walls mainly in coastal areas of Australia, normally have to be designed to withstand certain wind loading pressures. This information can be found in AS1170 and AS4055. Refer to the relevant standard for requirements in the area you are working in.