

# TECHNICAL BULLETIN – TB010

## FIXING OF MOISTURE AND THERMALLY SENSITIVE NATURAL STONE (AND MANUFACTURED TILES)

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### INTRODUCTION & SCOPE

Thin layer natural stone (and also man-made versions) tile finishes are becoming more popular and are used in many varying situations under a variety of climatic conditions within residential and commercial constructions.

In ancient times any stone that could be polished was referred to as marble and even in the industry today all limestone and dolomite rocks that can be polished are referred to generically as “marble”.

Today, the trades describe natural stone as either ‘marble’ or ‘granite’ despite the fact that the terms are in no way geologically accurate when describing the vast variety of new stone tiles that are reaching the modern market.

Examples of this practice include calling various calcium carbonate rocks such as limestone(s) tiles, marble, even though limestone is usually fine grained sedimentary rock whereas marble is a crystalline metamorphic rock. Another common so-called marble is composed of the unstable serpentine minerals, which are a green colour and produce ‘green marble’ which is actually Serpentinite.

Recently there has been a lot of so called ‘bluestone’ or ‘basalt’ sold which are not really basalts and have been found to be both moisture and thermally unstable. Finally, Ardex has seen large format ‘slate’ tiles from South American sources which are highly unstable.

In addition, the manufactured stone (typically a mix of natural stone aggregate in a resin or cement based binder matrix) may be described as an ‘agglomerate or conglomerate’ stone with no mention of the type of stone aggregate used. Where the binder is a resin, the type is also commonly not specified, but is often a polyester resin.

Many of these natural stones are sensitive to moisture, which can emanate in varying degrees, from either the substrate or from atmospheric conditions. This moisture can have a major effect on two properties of natural stones resulting in **colour variations** and/or **dimensional variations** like warping and shrinking.

Moisture in the normal tile adhesives used to bed these moisture sensitive stones can therefore cause undesirable (and often irreversible) discolouration or staining, and distortion (warping and curling) of the dimensional form of these stone tiles.

These dimensional changes are more evident with large physical tile sizes (X-Y axes) and low thickness (Z axis). For example, doubling the diagonal length of the tile face increases the potential dimensional changes by a factor of four. Thicker tiles such as the traditional ashlars (i.e. >25-30mm thick) are far less prone to warping.

In the case of resin based manufactured tiles, polyester resin is subject to alkaline based hydrolysis which causes cleavage of the ester bonds in the resin. This can result in breakdown of the adhesive bond at the tile rear face where chemical decomposition has occurred.

Another phenomenon that Ardex has seen is tiles that deform significantly when subjected to direct heating such as full sun exposure. This problem is worsened by dark coloured tiles which heat up rapidly.

### PRINCIPLES OF FIXING NATURAL STONE

In fixing sensitive natural stone the principle is simple – keep water away from the stone. With conventional tiling, this presents a problem since the vast majority of cement adhesives are mixed with water, while solvent-less adhesives such as 100% solids epoxies are more expensive.

The alternative is to protect the stone surfaces that will be exposed to the water based bonding materials and use conventional water based adhesives for the bedding process.



By this we do not mean the use of 'stone tile sealers, but the protection process actually becomes part of the adhesive bonding system.

While it is considered necessary to seal all surfaces that will be exposed to water (in this case topical stone sealers), care should be taken not to totally seal all surfaces, as stone must continue to breathe to retain its inherent properties, and must allow bonding with the selected adhesive system.

It is important that the moisture protection material and the tile adhesive are used in a manner that allows them to be compatible and achieve optimum bonding strength. The installation technique is therefore critical. For this reason the combination of an epoxy protective sealer and high end cement based adhesive is used.

A less desirable alternative is to use a rapid setting water based adhesive that minimises the time of exposure of the stone to water thus minimising the deleterious effects of the water. This approach is really only suitable for tiles with low to medium moisture related instability.

Thermal instability problems are not affected by the moisture properties of the adhesive, but a more critical factor is the adhesive's outright tensile strength and ability to absorb stress fatiguing due to cyclic movements. These properties require cement based adhesives with C2 and minimum S1 ratings, or alternatively high strength polymeric adhesives.

Where a manufactured tile has a polyester based matrix, the recommended adhesives are the polymeric adhesives such as the epoxies as they do not create alkaline based chemical attack.

Refer to Ardex Technical Bulletins TB001, TB144, TB148 and Ardex Technical papers TP001 and TP005 for more information on stone and large format tile fixing issues.

## CLASSES OF STABILITY

### Deformation

Based on advice from Ardex GmbH and test experience, Ardex has a rating scale for the dimensional stability of tiles. This refers to the properties of the tiles to warp in the Z axis (vertical axis normal to thickness) creating tensile strain and compressive stress, rather than pure moisture/thermal movements in the plane of the tile face (X-Y directions). It should be noted that high in plane movements will create strains as well in both shear and tensile.

The performance of a tile can be measured purely as un-restrained movement (the tile is not bonded), and Ardex uses a method based on BS EN 14617-12:2005 Agglomerated stone-Test methods-Part 12: Determination of dimensional stability (but with a slightly different rating system). When this movement is found to be in the 'high' grouping, a second trial should be done with the tile bonded by the proposed adhesive, and this deformation also taken into account. Some tiles may prove to be unsuitable for bonding at all because their instability makes a long term bond problematic.

The following table gives Ardex's rating schedule for unstable tiles.

Table 1 – Dimensional Stability Classes

| Classification*       | Unrestrained Z axis movement in mm | Restrained (adhesive bonded) Z axis movement in mm |
|-----------------------|------------------------------------|----------------------------------------------------|
| Low instability       | <0.25mm                            | -                                                  |
| Moderate instability  | 0.26-0.4mm                         | -                                                  |
| High instability      | 0.41-0.7mm                         | <0.3mm                                             |
| Very high instability | >0.7mm                             | <0.3mm                                             |
| Unacceptable          | >0.7mm                             | >0.3mm                                             |

\*BS EN 14617-12:2005 uses <0.3mm A, ≥0.3≤0.6mm B and >0.6mm C for its classes of stability.

### Marking

A tile would be considered unstable where it displays any marking or staining which does not disappear after few weeks. However, it should be noted that for aesthetic reasons even short term marking may be considered unacceptable, and it is not always immediately obvious whether the marking will be short term or permanent.

Another problem which can occur is marking that occurs later where moisture penetrates behind the tile and lays in voids created by incomplete adhesive coverage. In this case a permanent pattern of notching marks can appear.

### Quick tests

A quick method of checking for moisture marking is to lay a piece of the tile on a damp towel and leaving it for a few hours to overnight. This will often reveal show-through issues, but will also give some indication of potential movement problems.

For some tiles, placement in the sun will also reveal instability with the tile actually warping upwards at the corner.

Where there are questions concerning grouts and silicones, the only way to check these is lay a test tile and use the products along the tile edges and see if marking develops over time. Adhesives can be checked in the same way.

### BEDDING OF NATURAL STONE

The options for bedding and bonding moisture sensitive natural (and/or manufactured) stone to prevent or minimise any water being absorbed by the stone are:-

Table 2 System Summary

| Adhesive System Option | Movement Stability Class | Marking Stability Class                                            | Protective sealant applied to back of stone tile | Adhesive(s) Recommendation (To substrate)               |
|------------------------|--------------------------|--------------------------------------------------------------------|--------------------------------------------------|---------------------------------------------------------|
| 1                      | Very high down           | Any except translucent due to Abapoxy colour                       | Ardex Abapoxy                                    | Ardex Abaflex/X18? Optima STS8+E90 X77 +/-E90 S16 + E90 |
| 2                      | Very high down           | Any except translucent due to Abapoxy colour                       | NA                                               | Ardex Abapoxy                                           |
| 3                      | Very high down           | Any (translucent tiles may require caution due to adhesive colour) | NA                                               | Ardex WA100 Epoxy                                       |
| 4 (Internal only)      | Moderate down            | Any (white for translucent)                                        | NA                                               | Ardex S16 grey or white +/-E90                          |
| 5 (Internal only)      | Moderate down            | Low susceptibility only                                            | NA                                               | Ardex Quickbond +/- Abalastic                           |

### Specific Instructions

Option 1 – Involves sealing the stone prior to using high strength water based ceramic tile adhesives.

**ARDEX Abapoxy liquid** is mixed 2:1 Part A to Part B by volume with the Part C Fine filler powder at 1.5 parts (adjust to suit application of a thin film that is stiff enough not to flow off the surface but is still easy to spread). This is painted on to the back of the stone/marble. While the Abapoxy remains wet or tacky, trowel the conventional adhesive such as **ARDEX Optima**, **ARDEX STS8 + E90**, **ARDEX X77**, **ARDEX S16 + E90** or **ARDEX Abaflex** onto the substrate using the appropriate notched trowel and place the tile immediately on the wet cement based adhesive.

A large **Abapoxy** resin kit will cover approximately 80m<sup>2</sup>.



- Option 2 – Involves the use of a solvent free epoxy adhesive to bond the stone  
The stone is bedded using **Ardex Abapoxy** mixed 2:1 Part A : Part B and add Coarse Filler incrementally until a non-slump consistency is obtained. Spread the adhesive onto the substrate using an appropriate notched trowel and bed the stone.  
Note: This is best as a thin bed adhesive 2-3mm thick as the epoxy becomes less viscous when setting due to the exothermic reaction (generates heat) and slumping can occur especially if full coverage is not achieved.
- Option 3 - Involves use of high strength, white two part epoxy stone adhesive (non water based) that exhibits superior adhesive bond strength.  
For external applications, the stone is bedded using **ARDEX WA 100 mixed** in the ratio of 1:1 (Part A : Part B) by weight or by volume with a suitable notched trowel to achieve a minimum of 90% coverage on the back of the tile  
Or,  
Spot bonding on internal walls using a minimum of five (5) spots applied evenly across the back, one in each corner and the one in the middle to ensure a total of 10% coverage is achieved with the five spots (5).  
Note: Where there is a potential for a highly porous tile to be saturated in service, it may be preferable to achieve full adhesive coverage to avoid potential the appearance of differential wet spotting on the tile face. This is an aesthetic consideration only and not performance one.
- Option 4 - Involves the use of a rapid setting rapid drying adhesive to minimise the warping, curling and water staining effects of the water on the stone. *Limited to low/medium dimensionally sensitive stone and is suitable only for use in dry internal situations.*  
Mix **ARDEX S16 and ARDEX S16W +/-ARDEX E90** in accordance with the Product Data Sheet and trowel the adhesive onto the substrate using the appropriate notched trowel
- Option 5 - Involves the use of a rapid setting adhesive to minimise the deleterious warping and curling effects of the water on the stone. *Limited to low/medium dimensionally sensitive stones and can be used for internal installations. External applications require test areas.*  
Mix **ARDEX Quick Bond +/-Abalastic** in accordance with the Product Data Sheet and trowel the adhesive onto the substrate using the appropriate notched trowel.

For Options 1-3 testing of the tiles is recommended to eliminate those deemed to be in the unacceptable group. This can be a simple site test to observe for marking or warping using a straight edge.

For Options 4 & 5 it is necessary to test the dimensional stability of the stone, either formally in the laboratory or on site test areas. The site testing should be similar to the suggestion for Options 1-3 above.

All testing for tiles to be used on the project should be done prior to commencement of the installation of the stone. At a minimum Ardex recommends that the installer conducts a site trial to check for problems.

Suitability for any Option should be determined on a project by project basis and written specifications or recommendations with a warranty will only be issued after samples of the stone from the project are tested and verified by ARDEX Research & Development Laboratories in Sydney.

#### **GROUTING OF NATURAL STONE**

The options for grouting moisture sensitive natural stone to prevent or minimise any water being absorbed by the stone and thereby preventing any possible surface discolouration around the edge (picture framing) are:

- Option 1 – Involves the use of a high performance Epoxy Grout (non water based) over interior wall and floor applications  
**ARDEX Abapoxy liquid** is mixed 2:1 Part A to Part B by volume with the Part C Fine filler powder at 8 or 9 parts.

Option 2 – Involves the use of a rapid drying and hardening cement based grouts for stone and marble for internal wall and floor applications.

Mix **ARDEX MG** in a clean container whilst stirring thoroughly to give a lump free, paste like, creamy mortar. 5kg of **ARDEX MG** requires approximately 1.5 litres of water.

Use **ARDEX ST** flexible neutral cure sealant for internal/external wall and floor tiles in movement and connecting joints.

The use of ARDEX WA grout is potentially problematic as it is not a 100% solids system and can potentially develop picture framing in some tiles. For this reason is also not recommended for fixing sensitive stone tiles.

**PRECAUTIONS:**

- Despite the above grouts being suitable for natural stone tiles, edge discoloration could still occur in some low density stone tiles and other stone tiles due to grout having an adverse reaction with sealants and contaminants left over during the processing of these tiles, hence, **ARDEX** strongly recommends application of a test area before proceeding further.
- Prior to grouting it is advisable to check ease of cleaning with tiles that have a textured or matt surface.
- When using coarse grade filler component with **Abapoxy**, exercise caution when grouting over soft or highly polished tiles. **ARDEX** recommend a trial application.

**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.

**DISCLAIMER**

The information presented in this Technical Bulletin 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 a product for a particular application. Users are asked to check that the literature in their possession is the latest issue.

**REASON FOR REVISION - ISSUER**

Modifications to the text. Inclusion of references to BS EN 14617-12:2005. Comments about Ardex WA epoxy

**DOCUMENT REVIEW REQUIRED**

24 months from issue.

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