

TECHNICAL BULLETIN – TB010

FIXING OF MOISTURE AND THERMALLY SENSITIVE NATURAL STONE AND/OR 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 ashlar (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 reaction resin R class 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, $\geq 0.3 \leq 0.6$ mm 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.

There is also an effect where components in the adhesive (C Class in the main) penetrate into the stone and produce a physiochemical change in the properties of the matrix. This can appear as a change in gloss level or becoming rough to touch. Close examination of the tile surface may show crystal growths or changes in the stone surface texture. This is more problematic than a colour change.

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.

Seal coating of tiles

The practice of six side seal coating tiles with proprietary sealers is not a practice that ARDEX recommends to try and combat problems with moisture sensitive tiles. This is because the sealer unless tested and proven otherwise, can have a negative impact on tile adhesion. In particular this problem can be worse with C class adhesives, though it has also had an effect on R class adhesives. Sealing after fixing is at the discretion of the customer but should not be done beforehand.

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 to unstable	Low to high marking potential	ARDEX EG 15 ¹	ARDEX Abaflex Optima X18 +/-E90 X77 +/-E90 S28N + E90
2	Very high down to unstable	Low to high marking potential	NA	ARDEX EG15
3	Very high down to unstable	Low to high marking potential	NA	ARDEX WA100 Epoxy
4 (Internal only)	Very high to moderate	Low to high marking potential	NA	ARDEX S28N grey or white +/- E90
5 (Internal only)	Very high to moderate	Low to medium potential only	NA	ARDEX Quickbond +/- Abalastic

*Where the tile is semi or translucent a white adhesive is generally required. Note that epoxy resins have a yellowish hue due to the B components in the resin.

¹ Where EG15 is used the amount of filler powder should be reduced.

Specific Instructions

Option 1 – Involves sealing the stone prior to using high strength water based ceramic tile adhesives. This process is messy and fiddly but has been shown to be highly effective.

ARDEX EG15 liquid is mixed 2:1 Part A to Part B by volume with the Part C 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 this film remains wet or tacky, trowel the conventional adhesive such as **ARDEX Optima**, **ARDEX X77**, **ARDEX X18**, **ARDEX S28N + E90** or **ARDEX Abaflex** onto the substrate using the appropriate notched trowel and place the tile immediately on the wet cement based adhesive.

An **EG15** resin kit will cover approximately 4m² used this way.

Option 2 – Involves the use of a solvent free epoxy adhesive to bond the stone. The stone is bedded using **ARDEX EG15** mixed 2:1 Part A : Part B and add filler incrementally until a firm paste like consistency is obtained. This will normally be a lower filler mix ratio than when mixed as a grout. 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 the potential appearance of differential wet spotting on the tile face. This is an aesthetic consideration only and not a performance one.

Option 4 - Involves the use of a rapid setting rapid drying adhesive (F rated) 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 S28N +/- 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 (F rated) 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.

ALTERNATIVE METHODS WHICH REQUIRE INDIVIDUAL ASSESSMENT

Using a C Class adhesive

Where the tile is *known to be dimensionally stable, but questionably open to marking*, it is feasible to use a C class adhesive, preferably F rated, to bed the tile.

There are several qualifications to doing this however (note especially c & d).

- a) The tile shall be fully back buttered and then placed onto a notched adhesive bed on the substrate. There must be full coverage. We would recommend that on walls, only C2 rated adhesives are used in this way.
- b) No voids shall be left in the adhesive bed. Failure to do this can lead to shade striping or blotches, or any voids that fill with water afterwards can create striping as well.
- c) *The installer and client need to recognise that a colour shift to a darker shade is possible, and that this shading can be permanent. There is no guarantee also that the shading won't be variable across an area because of the variation in the tile properties.*
- d) *This method is not acceptable for tiles that display changes in surface texture such as loss of grind gloss or development of microcrystals on the surface.*
- e) This method shall not be used for manufactured tiles where the binder is a polyester resin.

Back coating the tile with epoxy and sand-seeding

In this case the back of the tile is coated with the mixed liquid epoxy resin (EG15), and then whilst wet the surface is broadcast with clean dry ARDEX Primer Sand to full coverage. After the resin dries, the excess sand is shaken / vacuumed off and the tile can be placed onto a standard C class adhesive bed.

This process requires a large area for the treated tiles to lie for up to 8-10 hours before the resin is sufficiently set before de-dusting. It is also messy in relation to creating areas of sand "overspray" and should not be used for heavy large format stone tiles on walls.

GROUTING OF NATURAL STONE

There is only one option 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):

Involves the use of a high-performance Epoxy Grout (non-water based) over interior wall and floor applications

ARDEX EG15 liquid is mixed 2:1 Part A to Part B by volume with the Part C filler powder at 6 to 8 parts.

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, porous/open matrix or matt surface.
- When using coarse grade filler component with EG15, exercise caution when grouting over soft or highly polished tiles. **ARDEX** recommends 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 or Ardex New Zealand 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

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