TECHNICAL BULLETIN

FIXING OF MOISTURE AND THERMALLY SENSITIVE NATURAL STONE AND MANUFACTURED TILES

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 using the name ‘marble’ for various Calcium Carbonate rocks such as limestone(s) and sometimes travetine 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.

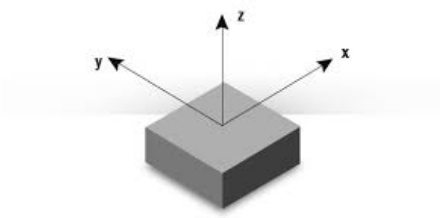
Finally, we have seen large format ‘slate’ tiles from South American sources which are highly unstable.

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.



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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 Dunlop 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.

TECHNICAL BULLETIN

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 at times 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.

CLASSES OF STABILITY

Deformation

Based on advice from our parent company Ardex GmbH and Ardex Australia test experience, we have 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 we use 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 movement values are shown in the table at the bottom of this page.

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.

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

TECHNICAL BULLETIN

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 adhesive options for bedding and bonding moisture sensitive natural (and/or manufactured) stone, is limited in the Dunlop range, and only tiles in the **low range** for movements can be bonded.

- DUNLOP TILE-ALL
- DUNLOP RAPIDFLEX
- DUNLOP SUPER TILESET
- DUNLOP FLOOR TILE ADHESIVE
- DUNLOP TRADE RESAFLEX
- DUNLOP UNIVERSAL TILE ADHESIVE
- DUNLOP WALL & FLOOR TILE ADHESIVE

These adhesives have to be used within their specified usage areas and service conditions.

Dunlop adhesives are intended for low moisture and thermal sensitivity tiles, and where the tiles are known or suspected to be moisture sensitive, then we advise to examine specialised adhesives in the Ardex range for stone tiles.

NOTES

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

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

Axes—These are the orientations for a tile sample. X-Y are equivalent to length and width, whilst Z is the thickness direction. For the purposes of testing X-Y are left-right and Z vertical.

Manufactured stone—These are tiles made in a factory where an aggregate such limestone chips are bonded together with cement or a polymer resin.

Metamorphic—One of the three main classes of rocks. Metamorphism a process where rocks are subjected to continual heat and pressure underground.

Polyester resin—A type of polymer resin made from poly-alcohols and poly-organic acids which react to form an ester. This is the sort of polymer resin used to make boats and car body parts. Alkalis such as lime from cement break the ester bonds leading to decomposition.

Sedimentary—One of the three main classes of rocks. Sedimentary rocks are composed of erosion products like sand or mud that are re-deposited. Limestone is a chemical sedimentary rock.

Solvent-less—A type of resin adhesive that contains no solvent to dissolve the polymer base for the adhesive. This is equivalent to 100% solids, which is a term used to describe epoxy resins.

Slate—A metamorphic rock composed of clay minerals, which are aligned in layer by the metamorphic process. These have been used for centuries as roof shingle and flag stones.