TECHNICAL BULLETIN

ISSUES WITH FIXING SCHISTOSE AND SLATE LAYERED STACKED STONE TILES

INTRODUCTION & SCOPE

In the decade prior to the issue of this bulletin, a type of natural stone facing has come onto the market which is composed of typically 20-30mm wide by 15-30mm thick laths of cut rock. These laths are bonded together with an engineering type adhesive such as an epoxy, as determined suitable by the stone manufacturers.

Weight constraints

The size varies but a nominal set of dimensions are typically around 400mm x 100mm x 25mm, and depending on the rock bulk density the load weights on the walls can range from 40 to 90kg/m^2; (the rock density varies between 1800-2100kg/m^3 for the lower density types, but can be up to 2800-3000kg/m^3 for others). These loadings exceeds what DUNLOP considers to be a safe and sound recommendation for cladding weight on rendered surfaces when considered in load per square metre; (Note—the use of these stones tiles over external fibre-cement sheets with DUNLOP standard adhesives is not recommended).

Rock types constraints

The long term performance and durability of these cladding tiles is dependant on the minerals in the rock. Many are made from *sound rock bases* which have successfully been bonded with tile adhesives or combinations of adhesive and mechanical fixing.

These include tiles made from volcanic rocks such as;

- "Victorian Bluestone" - a trade name that could several rock types (but basalt *senso lato*)
- Quartzite (*senso stricto*),
- Slates (hard types)
- Some Sandstones and also
- Hard crystalline metamorphic rocks (Hornfels and Gneiss)
- Igneous rocks such as 'granites'; be they true *granitic* rocks like Granite, Granodiorite, Adamellite and Syenite, or unhelpful trade named as such e.g. Black Granite (which is actually Gabbro and not Granite at all) and
- Migmatites and Gneisses which are sold under a wide range of exotic names.

However, other tiles are not stable and the subject of this bulletin is cladding tiles made from rocks known as Schists and also 'Slates'.

COMPOSITION OF THE STONE

What is Schist? Schist is superficially similar to the well known rocks called Slates. Both rocks are of a type of metamorphic rock formed by intense pressure, but moderate heat. Schists are metamorphosed to a higher degree than Slates and this creates their notable features that can lead to problems.

The types we see in this country are predominantly imported from Asia and quarried from the great folded mountain belts associated with the Himalaya, China or Pakistan-India (although some are locally quarried as well).

To look at, these rocks, Schists are shiny, and range in colour from pale silvery grey, to shades of greenish grey, brown, dark grey and black. Slates are normally shades of grey, grey-green, grey-browns and grade into blacks. The colour is dependant on the basic mineralogy of the Schist or Slate, but the main mineral present is the platy and easily broken mineral

Mica. Mica has the property of separating along layers and creating thin leaves of material, in other words it has a natural in-built plane of weakness along which it fails. Micas are also relatively easily weathered and break down to clay which is very weak, and swells when wet. The rocks may also contain other minerals which can alter their properties.

In Schist and also Slate, the Mica plates are all strongly aligned in one direction which creates their closed book-like appearance in cross-section. This appearance is called a fabric, and the generic name is schistosity. This fabric is a plane of weakness and is the reason that Schists and Slates as well, can be split easily into sheets, and large tiles or shingles. The name of this splitting is cleavage and the planes of Mica grains are often called folia.

Two particularly problematic types of cladding tile seen recently by DUNLOP are:

a. A silvery greenish-grey, and has the mineralogy and rock fabric consistent with Schists composed mainly of white Mica, but also appears to contain greenish Chlorite and is also possibly Talc rich. The rock may also contain some dark grey Graphite. The highly developed schistosity of the rock means that it is inherently weak and can break up without significant stress. The possible presence of Talc or Graphite would make the surface difficult to bond to as the minerals are natural lubricants and can act as bond breakers.

b. A dark grey slate which has a weathered patina to a tan, rusty red-brown and chocolate

patchy colour. This Slate has been seen on several job sites and displays quite severe warping from moisture but also heat. When the tile is exposed to a water containing adhesive or rain it warps, and the diurnal variation from sun exposure also warps it. These movements have over time created de-bonding issues.

Recognising these Types Schist / Slate Cladding Tiles

As few people are trained petrologists, what features that can be used to identify these tiles:

- They are commonly a silver grey-green to metallic grey colour and have shiny slightly ripply surfaces along the cleavage plains.
- The surface of the cleavage plains are smooth, and can feel slippery to soapy or slightly greasy to touch
- They can commonly be scratched easily with a knife blade, and some can be scratched with fingernail.
- The cleavage is strongly developed and the layers can be easily broken away.
- Very strongly metamorphosed schists have large Mica crystals which can be flaked off.

Some slates have slightly shiny surfaces as well, but in general slates are harder and do not flake or split as easily.

Slates that may prove problematic are often those that a highly metallic silvery grey lustre or are black as these normally contain Graphite, but plain grey Slates can also be problematic.

Assessment of these Schistose Cladding Stones

The folia are effectively conduits for the penetration of water which would significantly increase the weight of the cladding stone units. Water penetration will increase the likelihood of breakdown by providing a lubricant along which the cleavage planes can part. Water, and in particularly salty or pool water will hasten weathering of the Chlorite and Mica to clay minerals. Mica also provides a flaky surface which is inherently weak and hard to bond to.

The stability of this rock is questionable in wet applications and would be more marginal in areas where wetting and drying occurs as this would lead to faster mechanical breakdown of the rock along the folia due to stresses resulting from shrinkage and expansion. Examples of these environments are pool water-line tiling and also water features with cascading water or artificial water falls.

Limitations and Recommendations

Schistose rock cladding

Due to the properties of this rock type, DUNLOP recommends the following limitations on installing highly Micaceous and easily split schistose stone tiles with DUNLOP tile adhesive:

DUNLOP warranty provisions exclude any failures resulting from delamination and break-down in the stone structure when exposed to its intended service environment.

Installers need to confirm that the types of rock the tiles are made from are physically sound, and that the minerals in them will not act as bond breakers, leading to de-bonding of the tile from the adhesive.

Slates and other natural rock types

DUNLOP has observed a number of rock stack stone tiles that are marketed as slates, but which are really Mudstone or Argillite. These tiles have displayed very unstable behaviour in terms of moisture and thermal stability which has resulted in a number of de-bonding episodes. There are two options, either do not use these tiles at all, or use a structural epoxy adhesive. In some cases there is no easy way to identify these tiles other than to test them.

The major issue with the other types of stone cladding tiles is the weight per square metre and in this case a combination of adhesive and mechanical fastening is required. The rear face of these stacked stones may not be flat, which can lead to problems with adhesive bed thickness and adhesive coverage. Ardex recommends that a deeper profile notch trowel is used, or if severely irregular then adhesive buttering of the stone may also be required. Note that whilst a thicker build of adhesive may be required, excessively high thickness can lead to shrinkage and drying issues.

Conclusion

DUNLOP does not recommend the use of any its ceramic tile adhesives for fixing the weak schistose or dimensionally unstable pseudo-slate stone cladding tiles discussed in this bulletin, on any types of substrate.

Sound types of rock used for stone cladding are acceptable, but installers need to observe the load weight restrictions.

The adhesives typically used for stone tiles on masonry surfaces are DUNLOP Tile All and DUNLOP Universal Tile Adhesive.

TECHNICAL BULLETIN

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.

ARDEX AUSTRALIA PTY LTD,

ABN 82 000 550 005

7/20 Powers Road, Seven Hills, NSW. 2147.

Figure 1. The attached photo is an example of an unstable stacked cladding stone, made by gluing together laths of Micaceous Schist. As can be seen some of the laminations are breaking along the cleavages. The epoxy adhesive was applied onto the cleavage which then breaks parallel to it.

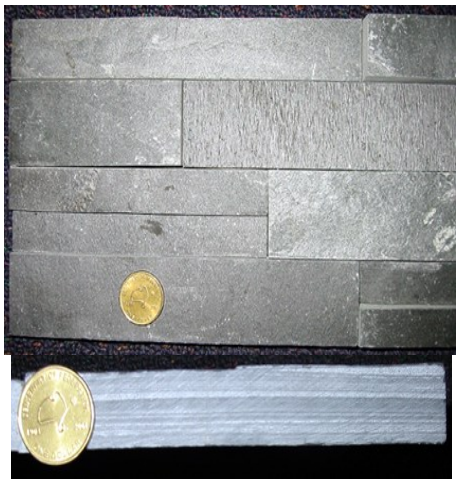

Figure 2. This cladding is a graphitic slate. As can be seen it has a dark grey and shiny surface due Mica and Graphite (Fig 2A). The laminations are strongly bonded and the tile is quite robust and hard (Fig 2B). Provided the adhesive is not 'bond broken' by the graphite content, this cladding would suitable for adhesive and mechanical fixing. The face of the tile is formed by cleavage plains, and the structural epoxy was applied across the cleavage/laminations.

Figure 3. In case the stack is made from Quartz Mica Hornfels which has been epoxy glued parallel to the laminations. This rock is very hard and strong and does not easily fracture. When looked at carefully in hand specimen the quartz crystals can be seen glittering and the broken faces look 'sugary' in texture. As a tile, this type of rock is very durable, however the weight of this particular sample worked out to be 90kg/^{2} which is too high for adhesive only fixing and also too great for the substrate which de-bonded. Adhesive and mechanical fixing are required.

Figure 4. A final type of stacked stone which has given trouble since around 2009, is a layered mudstone which is marketed as slate. The surface is normal a brown and rusty colour as seen in Fig 4a. and side views show the fine grey laminations.

These tiles have been shown on a number of occasions to be both moisture and thermally unstable and warp in service, de-bonding off the walls.

The rear view, shows the other common problem with stackstone – contamination of the rear face with the epoxy layer bonding agent.

The last two images show actual installations in different states where these tiles had caused a problem with de-bonding after warping.

GLOSSARY

Adamellite, Granodiorite and Granite-Coarse grained plutonic igneous rocks composed of pale coloured Feldspar, Quartz and dark coloured Mica or Amphibole. These rocks form a series and are the true 'granitic rocks'.

Black Granite-This is a stone industry marketing name that does not correspond with a correct petrological rock type. These rocks can be any sort of dark grey (differing shades and hues) to black igneous or even some metamorphic rock types. Typical Black Granites are crystal containing or vesicular Basalts, Gabbros, Dolerite, Charnockites and some dark meta-volcanics.

Bulk rock density-Density is defined as mass per unit volume (weight ÷ volume) and expressed in kg/m^3. The density is controlled by the minerals that make up the rock and how they packed in the structure. The table below shows common rock density as specific gravity (S.G.) where and S.G. of 1 = 1000kg/m^3.

Andesite	2.5 - 2.8
Basalt	2.8 - 3.0
Diabase (Dolerite)	2.6 - 3.0
Diorite	2.8 - 3.0
Gabbro	2.7 - 3.3
Gneiss	2.6 - 2.9
Granite	2.6 - 2.7
Limestone	2.3 - 2.7
Marble	2.4 - 2.7
Mica schist	2.5 - 2.9
Quartzite	2.6 - 2.8
Sandstone	2.2 - 2.8
Slate	2.7 - 2.8

http://geology.about.com/cs/rock_types/a/aarockspecgrav.htm

Cleavage plane-these are the linear structures formed in Slates when the minerals align under heat and pressure. These rocks split along the cleavage planes. Cleavage is commonly called slaty cleavage because this is the fabric that defines the primary characteristic of this rock type.

Stack stone-This is a trade name for stone tiles made by bonding strips of cut rock together. The size range various from 150mm long to 500mm long.

Dead load-The weight of a rock creates a loading on the surface it is bonded to. The dead can be expressed as a force in N, a pressure in Pascals (Pa), or simply a weight per square metre. Rendered surfaces are normally considered to be able carry a dead load of 32kg/m^2 which is equivalent to 320N or 0.32kPa.

Igneous rocks-Formed from hardened molten rock (magma). Usually hard and strong, with the plutonic varieties coarsely crystalline, and volcanic often without visible crystals.

Live loading-This is the force exerted on a structure by dynamic forces such as wind or movements. This has to be added to the dead loads to work on the force applied to a walling system.

Mica-An alkali alumino-silicate mineral which has a platy flat structure. Black mica contains iron in the matrix.

Quarzite-A form of metamorphosed sandstone with a hard crystalline structure.

Sandstone-A rock type of sedimentary rock composed of sand grains held together with a matrix cement. Can be Quartz sand or other minerals.