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Roofing Slate - Users Guide

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This is a guide for buying, grading, fixing & specifying roofing slate. It also provides a description of the relevant international standards that are designed to protect consumers from sub-standard slate quality and fixing practices. Slate must be installed in a manner consistent with the Australia Standards (AS 4597-1999).

Warning - there are some very dodgy slates being imported into Australia and sold under fabricated names and countries of origin. Sometimes even manufacturer crate labels are copied fraudulently. Buy slate from reputable sources, check crate QA labels and use only recognized slate specialists to fix the slate.

(1) Lifespan of Slate

The quality, performance and durability of roofing slate can vary enormously. The lifespan of slate in Australia may be as short as 10 years or longer than 150 years depending on the origin of the slate that is used and the quality of building design and workmanship.

The only slate that is known to perform 150 years or more under Australian conditions is Welsh Penrhyn – a slate that came to Australia as ballast in trading vessels the early 1800s.

The introduction of Spanish slate such as Cupa & Samaca has only occurred in the 15 – 20 years so less is known about how they perform on roofs under Australian conditions. Test results reveal they should last 75+ years – only time will tell.

Condensation in roofs is a major cause of slate and batten failure. Irrespective of slate quality, the performance of a slate roof is at the mercy of architects and builders – ventilation of the roof cavity is a critical determinant of longevity. Slate lying directly on boards or close to sarking is likely to have a shorter lifespan. A free flowing cushion of air under the slate is vital to avoid moisture build-up causing deterioration to the underside of the slate.

Quite often moisture build-up from condensation will rot out battens long before the slate is affected. Ultimately, slates too will perish from excessive condensation – it will just take longer because of their density and water resistance.

(2) Measuring Slate Performance Objectively

The top slate manufacturers in the world routinely test slate as part of their quality assurance programs – the ones that don't usually have something to hide.

There are a number of relevant tests for roofing slate that collectively indicate how well they will perform. There are many types of roofing slate available – the best slates have test results that validate their performance.

Each of the following tests has been designed to replicate the most common causes of failure.

Water Absorption Test – a slate should not increase in weight after repeated cycles of wetting (distilled water), boiling and drying. Levels of weight increase under 0.25% are optimal and under 0.3% acceptable. Slate is effectively impermeable to water but water trapped under the lapped zone can create failures on the under-surface of the slate.

Wetting & Drying Test – slates should not split, flake or delaminate after 15 cycles of soaking, cooling and drying in a ventilated oven. The best slates dry quickly. Water that adheres to the slate surface will dry slower and trap dirt and airborne biological matter which then holds moisture on the slate for longer predisposing the slate to premature degradation.

Acid Immersion Test – slates immersed in sulphuric acid baths for 240 hours should so no signs of swelling, softening, flaking or delamination along the edges and no gas formation or release.

Modulus of Rupture Test – this attempts to measure the flexural strength of slate to simulate foot traffic and hail on slate roofs. The test originated in the US and is based on the ability to withstand a 9000lb load on a 3/16" slate.

Flexure Test - These test methods cover determination of the breaking load, modulus of rupture and modulus of elasticity of slate by means of flexure tests

Weather Resistance Test – includes a depth of softening test and a chemical weathering test that measures slate disintegration that correlates with the durability of slate in actual weathering.

(3) Standards Protect Consumers

1. ASTM C406-06 – Standard Specification for Roofing Slate

The American Society for Testing & Materials (ASTM) was formed in 1898 but these days ASTM standards are truly international. ASTM C-406 is an extremely rigorous standard for roofing slate that has 3 grades – S1 (the top grade), S2 & S3. Slates that meet the S1 standard have a durability of 75 years or more. Penrhyn, Cupa and Glendyne slates are all S1 compliant.

The grades are based on physical tests:-

- flexure testing (ASTM C120- 06e1)
- water absorption (ASTM C121-06)
- weather resistance (ASTM C217-94)
- compressive strength (ASTM C170-90)

They also incorporate physical requirements:-

- minimum thickness 3/16" (4.76mm)
- free from broken corners
- curvature less than 1/8" (3.18mm)
- no "knots" or "knurls" that affects the smoothness of split
- freedom from "ribbons" i.e. rippled surfaces
- less than 1% broken or cracked slates
- maximum allowable deviation from face dimensions is 3mm from specification
- slates to be square & corners cut to be right angles.

2. NF P32.301 & P32.302 - French Norm or Standard for Roofing Slate

These are French standards for roofing slate widely regarded as being the toughest most stringent standards for roofing slate in the world. This is because they only test slates randomly sampled by independent representatives of the testing house rather than having company selected slates sent for testing. In addition, sampling may take place at any time in any place. This means the test results are genuinely statistically significant. The standards incorporate all the tests outlined above.

It would be highly unlikely to achieve continual compliance with these standards unless a company had one hellishly good quality assurance program backing its products. Cupa slates are NF: P32.301& P32.302 compliant.

3. BS680 Part 2 1971 – British Standards for Roofing Slate

These are superseded British standards that were applied to samples submitted (rather than randomly sampled) for the following tests:-

- water absorption test
- wetting & drying test
- acid immersion test

This standard was criticized because it did not address iron pyrite content - some types of which are reactive and cause slate to rust out causing roof failures. For what it is worth, all slates distributed by Bellstone were BS680 compliant.

4. BS EN 12326-1 2004 – European Standards for Roofing Slate
This European standard came into force in May, 2006 and replaces BS680 Part 2 1971. These standards were set by member countries of the EU and are a compromise and because of this some feel they are not particularly useful to the consumer, because the bar has allegedly been set “too low”. However, any standard is better than none so our suggestion is to use it.

Its contents include:

- Symbols and abbreviations
- Origin and petrography
- Thickness
- Bending strength
- Grain Water absorption
- Freeze–thaw resistance (only for code A2 from Table 2)
- Thermal cycle test
- Carbonate content
- Sulphur dioxide exposure test
- Non-carbonate carbon content
- Defects
- Dimensions
- Release of dangerous substances
- Number of slates required for type tests and factory production control
- Evaluation of conformity
- Testing frequency
- Type of tests
- Factory production control
- Procedures in case of non-conformity and/or complaint
- Marking, labeling and packaging

(4) Quality Assurance – ISO 90001:2000

Quality assurance (QA) is a management process that addresses the critical control points in delivering slate for mountain to market. Quality management is documented and compliance with all the steps along the

way to deliver product to specification is audited to ensure 100% compliance. Independent auditors are used to ensure company integrity.

Slate is not just about good raw material it is also about how diligently a company processes the slate and the care it takes in checking quality.

ISO 90001:2000 is generally regarded as the most rigorous QA standard in the world. Welsh Slate, Cupa, Samaca & Glendyne have ISO accreditation.

Buying slate from companies without independently audited quality assurance programs is a risk not worth taking.

(5) Slater / Fixing Skills

Slater is a term of respect for a roofer or roofing contractor that bestows reverence for the enormous skill levels that are required to “fix” or lay a slate roof. Achieving a uniform roof surface with every slate lying flat with no “kickers” is an enormous challenge especially on roofs with steep pitches.

Many slaters working in Australia are of British or European descent – some 2nd and 3rd generation.

Choosing an experienced slater is vital. If in doubt ask to see their last job or better still get independent, professional advice.

(6) Grading Slates - Flatter Roofs

The best slaters will carefully grade every slate before it goes on the roof. They grade slate thickness into three groups (thin, medium & thick) using the thinner slates at the top of the roof and thicker slates near the eaves. Usually only a small percentage of slates are bowed or twisted; these are set aside for “cuts” on hips, valleys and verges.

A professionally fixed roof using graded slates will have a wonderful harmony from one slate to the next and will contain no “kickers” – bowed slates that sit up and ruin the uniformity of the roof line.

(7) Headlaps – Hidden Hurdles

Headlap is a technical term that relates to how slates are lapped and fixed on a roof. In Australia, the usual headlap for a roof with a pitch of 40

degrees is 75mm. This means that 15.4 slates per covered metre will be required if 500x300mm slates are used and 18.5 slates per covered metre if 500x250mm slates are used.

Flatter roofs e.g. 30 degrees, require bigger slates and headlaps. The reverse is true for roof pitches greater than 45 degrees.

If lower headlaps are used, fewer slates are required to do the job which either increases roofing margins and/or lowers cost but this may not be good practice. Headlaps are specified by architects for all new buildings. If you are re-roofing an old building make sure that the quotes for work clearly state the headlap to be used.

Welsh Slate has a headlap calculator based on a spreadsheet format; contact us if you would like a free copy.

(8) Copper Nails are for Keeps!

Hundreds of nails are used to fix slate to roof battens. Sometimes the longevity of a roof can be determined by the quality of nails used. If nails corrode in salt or polluted air slates can slide off a roof long before their lifetime performance has been met. Falling slates are dangerous and both nails and slates are costly to replace.

The best nails are copper, they cost a little more especially when copper prices are so high but if their initial cost is written off against their longevity, they are a better investment than cheaper alternatives. Ask to have the type of nails to be used specified when seeking quotes for work.

Roofing nails or clouts should be a minimum thickness of 2.8mm and 30mm long; the nail should be long enough to penetrate the batten by a minimum of 15mm (AS2334).

(9) Oregon Battens Last Longer

Oregon is the timber of choice for use as battens under slate roofs. While pine may be popular for many short lived roofs it is essential that the timber used under slate has the ability to match its lifespan.

Battens should be a minimum of 50x25mm thick for 450mm rafter spacings and 500x38mm if rafters are spaced 600mm apart.

(10) Patination Oil Prevents Slate Discolouration

New lead is commonly used on slate roofs for ridge capping and flashing around chimneys. Rain reacts with the lead to form an unattractive, lead carbonate stain that is white in colour. Over time, white leach marks gravitate down the slates and persist for many years.

These stains are unsightly and can be easily prevented by coating lead with patination oil that forms a semi permeable membrane on the lead.

If lead is used on a new roof, it is essential to have it treated with patination oil prior to, or immediately after fixing.

(11) Re-using Old Welsh Slate

Good quality Welsh Slate can often be re-used after over 100 years on a roof. The percentage of salvage will be dependent on a number of factors some of which are below.

Slates need to be carefully removed, ideally with a slate ripper, avoiding damage to the nail holes.

Slates for re-use need an initial visual examination of the fabric of the slate. Particular attention should be paid to ensure that there is no excessive spalling to the nail holes and that there is no sign of delamination to the slate.

The slate should still “ring true” when struck, if there is a dull thud then the slate is no good.

Check that the existing holes are at the correct gauge to maintain the specified headlap. If the existing holes are enlarged then re-holing will be necessary and will only be possible if the new holes can be positioned no more than 30mm from the edge of the slate. In some cases the slates will have been re-fixed already during their lifetime and there may be multiple nail holes in the slate which would make its re-use almost impossible.

If re-holing of the slates is necessary the existing holes should never be below the new holes as this could compromise the weather tightness of the roof.

Begin by sorting re-usable slates into batches of slate of the same thickness. Lay the thickest slates at the eave and the thinnest up to the ridge.

(12) Sarking - Waterproofing & Insulation

Sarking is a term originating from the UK that was used to describe boards that slate was fixed to - as in "sarking boards". These days, sarking has a more general definition e.g. "The foil sheet used in roofs to assist with preventing water intrusion; generally in high winds" or "A layer of boarding and/or a layer of waterproofing material fixed underneath the roof tiles".

Sarking may also combine insulation properties with its function as a waterproofing material. There are various product names and grades for sarking materials commercially available in Australia.

According to Australian Standards, sarking should be used on all roofs exposed to wind velocity in excess of 47m/sec (AS4200.2). Sarking prevents roof damage caused from droplets of water being driven up under the slate at high velocity. The application of sarking will depend on roof pitch, rainfall and wind velocity. Most architects and builders recommend sarking be used under slate providing it is (1) not too close to the slate under-surface (sometimes cross battens are used to create a larger air cushion) and (2) it is not stretched too tightly and allowed to sag slightly so that droplets of moisture fall between, rather than on the rafters.

(13) Roof Ventilation Vital

Good ventilation is essential for slate. Moisture build-up under the slate will cause it to fret, crumble or de-laminate. We have 120 year old Welsh slate at our warehouse that has been removed from a well ventilated roof and the slate is still sound and "rings true". This slate has years of working life ahead of it. By comparison a similar aged Welsh slate laid on boards with no under-surface air movement is badly decayed and shows signs of delamination. We keep both as a demonstration of the importance of ventilation.

(14) Slate & Minimum Roof Pitch

The Australian Standards makes no recommendation for the minimum roof pitch for slate. It has references to roof pitches as low as 17.5 degrees in relation to sarking requirements (Table 3). One would have to assume that slates fixed on roofs with less than 20 degree pitches would need to be in very benign climates with big headlaps. In such circumstances an under-surface membrane / sarking would be a critical design factor.

Welsh Slate's brochure on Roofing Slate (downloadable from http://bellstone.com.au/brochures.htm) indicates a minimum rafter pitch of 20 degrees.

Our suggestion is not to contemplate using slates on roofs with a pitch less than 20 degrees and then only for big format slates e.g. 500x300mm. At low roof pitches, a building will be vulnerable to high rainfall, high winds or a maritime location that combines both.