

# Chinese roofing slate – telling the good from the bad

Since Chinese slate was introduced to the UK market as a roofing material 10 years ago there have been rumours about its inability to survive the British climate. Are these true? According to **Barry Hunt**, of consultant STATS, who has been involved in the testing of a wide range of Chinese roofing slate, some is as good as any and some isn't.

**C**hinese roofing slate has had a hostile reception since its arrival on British shores in quantity 10 years ago. The reason it arrived at all, apart from the low price, was the range of colours available to feed a market demanding greater diversity. But no sooner had it arrived than whispers of problems emerged.

The slate was said not to last and quickly fell out of favour with the roofing market. Imports continued however chiefly for the home interiors market where durability is not a significant factor, as did the whispers.

But in the past two years there has been a push by the Chinese to get into the roofing market. And in the meantime, there have been some widely circulated reports about problems associated with low-cost Spanish imports of roofing slate and there has been an increased level of scepticism associated with imported slate in general. Is this fair? Is Chinese slate an inferior product?

STATS has now investigated a wide variety of Chinese slates for importers, merchants and users and the true story is somewhat complex. Some slate is eminently usable for high quality roofing

while other materials, sometimes visually indistinguishable from the good materials, would be lucky to last five years on a roof. To understand Chinese slate you have to begin at its source.

Few people will have heard of Hubei, Jianxi and Shaanxi, vast provinces in China each larger than the British Isles but with a nineteenth century infrastructure. The places are all remote and access is far from easy.

Some of the slate resources are quarries in the sense that they are holes in the ground, but there is only basic equipment and extraction relies on intensive labour. It is reported that some are no more than a collection of small holes worked by peasant farmers across a wide area.

The situation is changing, however. As China has steadily increased its exports, it has invested in new equipment, both for extraction and dressing. Improving rail links have also eased some of the transportation problems.

The level of extraction is at the root of many problems with Chinese slate. Most slates appear to be won close to the surface and are at the mercy of the geological factors where weathering can destroy the slate fabric.

However, as quarrying continues to develop, material is being taken from deeper locations less affected by weathering and the slate quality is improving. There is still one major hurdle to cross and that is control of the bed to ensure a uniform product.

All geological rock sequences vary. The question is: by how much across what dimension? Thus, nearly all good quality rock resources are mined from specific beds or veins of rock and from a well-defined area. A Welsh slate quarry for example may be working a hillside that is 100 per cent slate, but contains different zones of material that will split differently and have different levels of wastage.

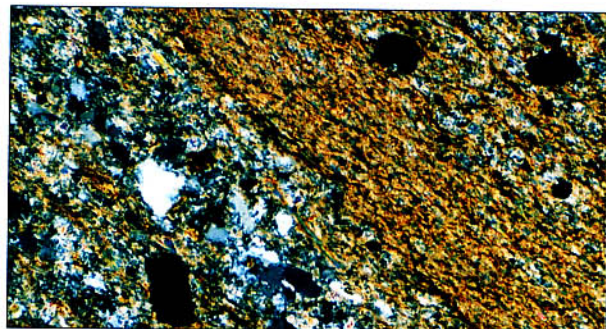
Some zones may be unworkable because of too many transverse joints or the presence of large quantities of nodules, pyrites and other potentially deleterious inclusions.

## Investigations so far

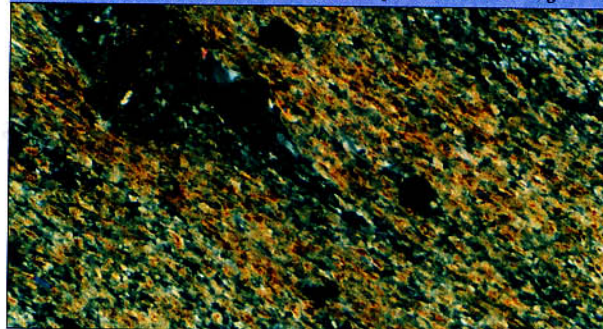
The investigations of Chinese slate so far confirm a problem with this aspect of extraction. However, some quarrying companies are now recognising the different grades of material and selling a range of products at different prices.



Cutting Chinese slate (above) and (below) Pre-holing of slate using drills. Note the curvature to some slates in the pile on the left.



Magnified photos of (above) a Chinese flooring slate: sandstone interbedded with siltstone and mudstone; (below) a Chinese roofing slate, in the geological sense, in which minerals run parallel to the cleavage





Crates of Chinese slates (above) and loaded at the railway station (below)



(above) Many slates bleach during acid tests — Wang Wei Green

Flexural strength can vary considerably resulting from the presence of jointing which may be highly erratic. The joints may be mineralised; typically this has been by silica that does not appear to have a significant adverse effect on durability. The presence of a 'grain' or secondary splitting direction is often difficult to determine and also causes some erratic results. Flexural strength also

appears to be no problem. However, random testing using acid may identify a significant proportion to be carbonate-rich and potentially at risk from the acidic atmospheric conditions now experienced by most industrialised nations.

Slate containing carbonates are subjected to the acid resistance test of BS 680 Specification for roofing slates often dissolve into a grey sludge after 24 hours. To

varies as a result of the slate dressing which can lead to stress fractures.

Possibly the most damning indictment of variation in Chinese slate is the content of carbonate minerals, especially calcite (CaCO<sub>3</sub>).

In some batches, all the tests will be passed and there

pass the test they should remain physically unchanged after 10 days of immersion.

#### Problems after extraction

Once the slate is extracted there are still problems to overcome concerning, splitting, trimming and holing. In China, slates are split into all thicknesses and are rarely sorted accordingly — a batch of slates advised to be in the 5-7mm range may easily have many slates as thin as 2mm or as thick as 10mm. Trimming is often crude and edges may not be neat, often with considerable edge delaminations and corners not at right angles.

The presence of large nodules, or knots, curved slates and variations in thickness across the slate are not perceived as problems by the Chinese as such slates would be used without question by them. Part of the American market is not so strict on dimensional variation and flaws either, as many roofs are designed to serve a decorative function rather than be part of the weather-resisting barrier.

Additionally, some of the Chinese slates can be too brittle and holing by traditional means can lead to large cratering. These problems can mean that considerable sorting on the site may be required and a considerable wastage may occur — 10 per cent has been cited when 1-2 per cent should be the norm for a good quality slate. This wastage and time involved in sorting may offset any price saving.

Most damaging of all to the Chinese slate industry has been the assertion that the slate is not true slate as defined in the geological sense (see 'The origin of slate' panel). This is not true for the current

### Table showing the performance of some Chinese slates tested by STATS

Some of the slates shown below have been tested several times for different companies while other slates not shown have either now stopped production or were not tested after they failed the acid drop test. Part of the variation in the results, especially with flexural strength (modulus of rupture) appears to be related to slate production rather than purely geological factors.

| Slate type                 | BS tests to BS 680: 1971 |                    |                   | US tests to ASTM C406-96                           |                                                                                        |                                                                                       | Sodium sulphate resistance % loss | Abrasion resistance ASTM C241 | Slip/skid resistance TRRL method            |
|----------------------------|--------------------------|--------------------|-------------------|----------------------------------------------------|----------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|-----------------------------------|-------------------------------|---------------------------------------------|
|                            | Water absorption %       | Wet/dry resistance | Acid resistance   | Modulus of rupture (MPa*)                          | Water absorption (%)                                                                   | Depth of softening (mm)                                                               |                                   |                               |                                             |
| Tin Wei Black              | 0.18                     | pass               | pass              | 78/58 (46-92)                                      | 0.15                                                                                   | 0                                                                                     | —                                 | —                             | —                                           |
| Wang Wei Black             | 0.17                     | pass               | pass              | 56/53 (24-86)                                      | 0.20                                                                                   | 0                                                                                     | —                                 | —                             | —                                           |
| Wang Wei Green             | 0.20                     | pass               | fail <sup>1</sup> | 50/50 (40-57)                                      | 0.20                                                                                   | 0                                                                                     | —                                 | —                             | —                                           |
| Wei Lung Grey Black        | 0.29                     | pass               | pass              | 59/54 (45-71)                                      | 0.35                                                                                   | 0                                                                                     | —                                 | —                             | —                                           |
| Yin Long                   | 0.26                     | pass               | pass              | 66/60 (39-91)                                      | 0.25                                                                                   | 0                                                                                     | —                                 | —                             | —                                           |
| Wei Chun                   | 0.38                     | pass               | pass              | 38/53 (34-61)                                      | 0.40                                                                                   | 0                                                                                     | —                                 | —                             | —                                           |
| HST 1105                   | 0.36                     | fail               | fail <sup>2</sup> | —                                                  | —                                                                                      | —                                                                                     | —                                 | —                             | —                                           |
| Beijing Green <sup>#</sup> | 0.80                     | fail               | fail              | —                                                  | —                                                                                      | —                                                                                     | 0                                 | 4                             | 36                                          |
| Sheng Li <sup>#</sup>      | 0.99                     | pass               | pass              | —                                                  | —                                                                                      | —                                                                                     | 0                                 | 9                             | 47                                          |
| Bamboo <sup>#</sup>        | 1.96                     | fail               | fail              | —                                                  | —                                                                                      | —                                                                                     | 1 <sup>^</sup>                    | 11                            | 43                                          |
| Test Criteria              | Pass if ≤0.3             | —                  | —                 | Pass if ≥0.62 across the grain (first value shown) | Grade S <sub>1</sub> ≤0.25<br>Grade S <sub>2</sub> ≤0.35<br>Grade S <sub>3</sub> ≤0.45 | Grade S <sub>1</sub> ≤0.05<br>Grade S <sub>2</sub> ≤0.2<br>Grade S <sub>3</sub> ≤0.36 | —                                 | 8 or more                     | >35 considered acceptable by European draft |

#### Key to table

Shaded zones denote failure; lightly shaded zones were considered borderline

\* First value across the grain, second value with the grain. Values in parentheses are the range  
<sup>^</sup> Serious delamination occurred

<sup>#</sup> Geologically these were not true slates  
<sup>1</sup> One specimen delaminated  
<sup>2</sup> Two specimens dissolved

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roofing slate imports, but is justified for much of the material sought by the cladding and floor tiling market.

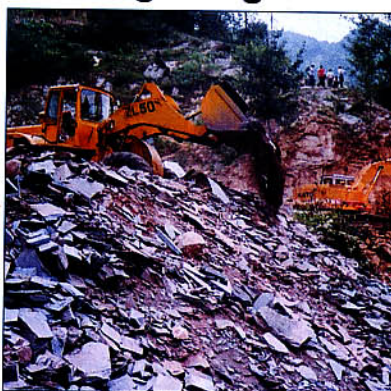
Many of the stones finding their way into private residences and the occasional supermarket are found to be thinly bedded or laminated sandstones, siltstones and mudstones in addition to slate. The fissility of these rocks between the thin beds and laminations means they can be split to the thinness of roofing slates.

Weathering of iron-rich bands has usually imparted the wide variation in colour often observed in these materials, but these bands are also their principal weakness. The iron-rich bands are often highly microporous and susceptible to rapid water infiltration. If used externally the stone may delaminate if frozen.

Those stones that are susceptible to such potential deterioration may be sealed prior to use and if carried out correctly, this may considerably enhance their life.

### Test results

The table on the previous page shows results of testing Chinese slates used for both roofing and tiling purposes. It is clear that the last three slates, which were



Chinese slate quarry location

used for tiling, are quite different to those used for roofing and no comparisons should be drawn.

The tiles underwent the roofing slate standard testing as currently there are no British Standard tests for these types of materials and the testing regime must be considered extremely harsh. Some of the tiles fared reasonably well and were certainly adequate for flooring purposes.

One thing that the testing highlights is the problem with the currently available standards. Some of the slates pass the British Standard test criteria but then fail the American Standard criteria and vice versa. The most appropriate currently available procedure is petrographic examination, which will be included in the new European Standard. Petrographic examination is the description of mineralogy and fabric as observed down the microscope and can identify most potentially problematic features of stones.

So is there a good Chinese slate? The answer is yes. Some are excellent and bear comparison with the best Welsh and Spanish slate. Naturally, these slates cost more than other Chinese slates and may be of similar price to any other slate on the market of reasonable quality.

At the cheaper end of the market expect problems and try to minimise them to save time, effort and money. (See panel left entitled 'The first step to spotting a potentially usable Chinese slate.' for a simple guide to identifying a slate that gives the minimum of fuss).

The hand-over last year of Hong Kong from the UK to China may help the Chinese to become more familiar with European business practices, the methods of using slate and the standards generally expected.

A small amount of well-placed investment in more equipment and better transport links and a better understanding of the European market's requirements may help prices to drop and quality to improve. This could create an industry which could become the world market leader.

This poses the final question: how long will that take? The answer is not long. China is already the world's second largest slate exporter.

### The origin of 'slate'

The word slate comes from Old English *slat* (or *sclat*) and through it from a French verb *esclater* (now *eclater*), meaning 'to split' or 'to shiver to pieces'. This description of any stone able to be split has been maintained by masonry practices and hijacked by the sciences.

The majority of stones that split easily are found to be metamorphosed sediments of extremely fine grain size and so geologists took the word *slate* to describe these rocks. Unfortunately they did not realise the wider implications to the stone industry and arguments still continue over the definition of *slate*.

British Standards are helpful and make a clear distinction between *slate* as a geological material and as a roofing material. In BS 6100 *Glossary of building and civil engineering terms*, the following definitions are found:

520 1207, **slate**: rock derived from argillaceous sediments or volcanic ash by metamorphism, characterised by cleavage planes independent of original stratification 132 4301, **roofing slate**: piece of slate or other laminated stone, split and dressed for use in roofing.

It must be remembered that not every stone that can be split and dressed will necessarily make good roofing slate.

### The first step to spotting a potentially usable Chinese slate

Testing to recognised standards must always be carried out, but only when one is satisfied that a source is likely to be consistent and of reasonable quality. There are however a number of simple tests that you can quickly carry out yourself on a random selection as follows:

- Apply drops of mild acid to the surface of the slates, if they fizz then the carbonate content may be very high and long-term durability suspect. Geologists favour a 5 per cent solution of hydrochloric acid; as an alternative some toilet descalers make good substitutes, but check the ingredients first for the presence of the acid.
- Firmly tap slates of 4-5mm thickness over the knee, low quality slate will usually break. A hammer can deliver too sharp a blow but the standard slaters 'ring' will usually indicate a slate without flaws (NB unweathered 'tight' joints will not necessarily be detected by this subjective traditional technique). Always check how the slate holes, it may need to be drilled.
- A flat, non-flexible board with two raised edges forming a right angle is immensely useful in checking both flatness and squareness.
- Look for spots of rust which may be the result of decomposition of iron-sulphur minerals such as pyrites (Fool's Gold) which appear as lustrous metallic flecks of yellow and silver appearance when fresh. If such minerals are present, spot them with the acid; iron-sulphur minerals with associated carbonate can be extremely bad news.
- If you are offered existing test results it is unlikely that they truly represent the variation in quality of the slate resource. If the results come attached to a survey, then make sure that the materials to be purchased can be guaranteed to be from the same bed/vein as at the moment this is unlikely.

When a choice has been made it may take more than just the British Standard tests to determine whether or not the slate is going to last. Strength testing should also be carried out and, most importantly, petrographic analysis which is the microscopical analysis of the slate fabric and constituent minerals<sup>10</sup>.

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