Welsh Heather Blue

EN12326-1:2004						
Commercial document issued by:		Welsh Slate, Penrhyn Quarry, RE:R-ID-8.24/4a. 09/2005				
Location of the mine quarry:		Welsh Slate, Penrhyn Quarry, Bethesda LL57 4YG				
Date of sampling: December 2014		Date of testing: January – April 2015				
This document records the conformity of the product described below and is incomplete without the explanation of the meaning of the test results and the requirements of EN 12326-1:2004. the tests referred to and the criteria can be found in EN12326-1:2004						
Product description and commercial name		Penrhyn Heather Blue				Conformity
1. Dimensional tolerances						
Format		Rectangles				
Deviation from declared length		±2mm				Yes
Deviation from declared width		±2mm				Yes
Deviation from declared squareness		≤1%				Yes
Deviation from straightness of edges		<1%				Yes
Slate type for deviation from flatness		Very Smooth	Sm ooth	Normal	Textured	
Deviation from flatness		<1%				Yes
2. Thickness						
Slate type for packed thickness calculation			Capital	County	Celtic	
Nominal thickness and variation			5.5mm	7mm	9mm	Yes
3. Strength						
Characteristic MoR		Transverse	34MPa	Longitudinal	47MPa	Yes
Mean failure load		Transverse	1127N	Longitudinal	1587N	Yes
4. Water absorption		A1 – 0.17%				Yes
5. Freeze thaw						NR
6. Thermal cycle test		T1				Yes
7. Carbonate content		1.53%				Yes
8. Sulphur dioxide Exposure tests	≤20% carbonate	S1				Yes
	>20% carbonate					
9. Non-carbonate carbon content		1.1%				n/a
10. External fire exposure		Deemed to satisfy				Yes
11. Reaction to fire		Deemed to satisfy class A1				Yes
12. Release of dangerous substances		None in conditions of use as roofing or external cladding				Yes

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Date of sampling and testing		If more than on date is applicable to sampling or testing they should be indicated against the individual test results
Product description		Slate for roofing and external cladding or carbonate slate for roofing and external cladding
1. Dimensional Tolerances		
Length and width		Maximum deviation ± 5mm
Deviation from squareness		Maximum deviation 1% of the length
Deviation from straightness of edges		Slate length ≤500mm Permitted deviation ≤5mm
		Slate length >500mm Permitted deviation ≤1% of the length
Flatness: The limits of deviation from flatness is defined for four types of slate. The bevelled edges shall be applied to the convex face. Slates with deviation from flatness in excess of the limit may be used for special applications	Slate type	
	Very smooth	
	Smooth	
	Normal	
	Textured	
2. Thickness	The basic nominal thickness is determined as a function of the bending strength using the equations given in 3, local climate conditions and traditional construction techniques. The basic nominal thickness is increased in relation to the slate's performance in the appropriate sulfur dioxide test (if required) as shown in 7 and 8 below.	
3. Strength	Longitudinal and transverse bending strength and modulus of rupture; there is no limit for bending strength or modulus. However the basic nominal thickness is determined as a function of the bend strength using the equations given below, local climate conditions and tradition construction techniques.	

$$e_l = x\sqrt{\frac{l}{R_{cl}}}$$

$$e_t = x\sqrt{\frac{b}{R_{ct}}}$$

Where

e_l is the longitudinal thickness in millimeters(mm)

e_t is the transverse thickness, in millimeters (mm)

l is the length of slate, in millimeters (mm)

b is the width of the slate, in millimeters(mm)

R_{ct} is the characteristic transverse modulus of rupture in megapascals (MPa)

R_{cl} is the characteristic longitudinal modulus of rupture in megapascals (Mpa)

National factor x	Country	Transverse	Longitudinal	Country	Transverse	Longitudinal
	Belgium	1.35	1.35	Italy	1.2	1.2
	France	1.25	1.4	Spain	1.2	1.2
	Germany	1.2	1.2	UK	0.9	1.1

Those countries that have not declared a national value should select a value or a pair of values in relation to their countries climate and traditional construction techniques. It should not be less than the minimum value or pair of values given above.

e_l and e_t are determined by using the length/ and the width b of the slates. The maximum value determined is the basic individual thickness of the slate e_{bi}. The basic individual thickness is increased in relation to the slates performance in the appropriate sulfur dioxide test as shown in 7 and 8 below. For a significant difference between the longitudinal and transverse modulus of rupture the t-statistic is greater than 2.021

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4. Water absorption	The water absorption of slates shall not exceed 0.6% unless they can satisfy the requirements of the free-thaw test.
5. Freeze-thaw test	Slates with a water absorption greater than 0.6% shall show no significant reduction in bending strength using a one-sided Student's t-test at the 2.5% significant level (slates with a water absorption of 0.6% or less are not required to undergo a freeze-thaw test)
6. Thermal cycle test:	The following table explains the meaning of the test codes:

Code	Observation in the test	Conformity to the standard
T1	No changes in appearance. Surface oxidation of metallic minerals. Color changes that neither affect the structure nor form runs of discoloration.	Acceptable
T2	Oxidation or appearance changes of the metallic inclusions with runs of discoloration but without structural changes.	Acceptable
T3	Oxidation or appearance changes of metallic minerals which penetrate the slate and risk the formation of holes.	Acceptable subject to the note below

Note: Slates within code T3, which potentially may result in water penetration should only be used selectively with suitable methods of construction that avoid such penetration. Slates showing exfoliation splitting or other structural changes in this test are not acceptable.

7. Carbonate content.	There is no limit on carbonate content. However, the carbonate content determines which sulfur dioxide exposure test procedure should be carried out and, together with the strength, the minimum nominal thickness of the product. If the carbonate content is less than 20% then the sulfur dioxide exposure test procedure in EN 12326-2:2000, 15.1, applies. If the carbonate content is 20% or more, the sulfur dioxide exposure tests procedure in EN 12326-2:2000, 15.2 apply. The minimum thickness is calculated using the table below.

8. Minimal nominal thickness in relation to carbonate content and sulfur dioxide exposure code.

Carbonate content %	SO_2 exposure test code from EN 12326-2:2000, 15.1	Depth of softened layer from EN12326-2:2000, 15.2	Thickness adjustment
≤5.0	S1		None
	S2		e_{bi} +5%
	S3		e_{bi} ≥8.0 mm or switch to the test in EN 12326-2:2000, 15.2
>5.0 <20.0	S1		e_{bi} +5%
	S2		e_{bi} +10%
	S3		e_{bi} ≥8.0mm or switch to the test in EN 12326-2:2000, 15.2
≥20.0		0-0.7mm	e_{bi} + 0.5mm + $7t^2$

e_{bi} is the basic individual thickness obtained from 3 above in millimeters
t is the thickness of the softened layer obtained from EN 12326-2:2000, 15.2 in millimeters

9. Non-carbonate carbon content: The non-carbonate content shall be less than 2%

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BS EN 12326-1:2004 Testing Explained

BS EN 12326-1:2004 is the new European standard for slate and stone products for discontinues roofing or cladding. This replaces the old BS 680-2:1971.

Following is a brief explanation, explaining the tests and standards our slate reaches in order to conform to the new standard.

1. Dimensions

Tolerances are provided for the length, width, individual thickness, flatness, rectangularity and edge deviation, of the slate being tested.
The packed thickness for 100 slates must be calculated for every pallet to allow for the calculation of the average roofing slate thickness, with a reduction applied on the surface finish.

2. Flexural Strength

The slate test samples are supported on two bars and a third central bar is pushed down on the slate until failure occurs. The test is carried out both parallel and perpendicular to the long edge of the roofing slate. From the results gained a characteristic modulus of rupture is calculated (basically a ratio) and the larger of the two values is used for calculating the minimum individual thickness of the roofing slate.

4. Water Absorption

The slate is dried to a constant weight; it is then immersed in water. The absorption percentage is determined via the difference in mass. If the value obtained is less than 0.6%, the slate is classed as A1, whereas, if it is above 0.6% it is classed A2.

5. Freeze-Thaw Test

This test is only required on A2 classed slates. The slate is submitted to 100 cycles of freezing in air, followed by thawing in water, once this is complete the flexural strength test is repeated. If there is a significant change in results, the slate is deemed not suitable and does not pass the European standard.

Non-Carbonate Content

This test verifies the amount of graphite present in the slate, as well as oils and other organic matter. If the slate contains in excess of 2% graphite, it fails the test and does not pass the European standard.

Carbonate Content

These groups determine the thickness of the slate. The groups also determine the method of sulphur dioxide testing,

Sulphur Dioxide Exposure For Slate With Less Than 20% Carbonate

The slate is exposed to sulphur dioxide at two different concentrations for a duration of 21 days. Depending upon changes during the test, one of 3 codes will be given. The code is then used to apply a thickness adjustment, depending on the carbonate content of the slate.

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Sulphur Dioxide Exposure For Slates With More Than 20% Carbonate

The slate is subjected to surface scraping before and after exposure to sulphur dioxide vapor. After each exposure there is an increase in material removed, this carries on until the depth of softening is reached. A thickness adjustment is then applied to all slates, except for in the case where the softened layer is greater than 0.7mm.

Thermal Cycle Test

The slate is subjected to 20 cycles of immersion in water immediately followed by drying at 100 degrees Celsius, upon completion an inspection occurs for the presence of potentially harmful mineral components:
T1- for slate with colour changes that do not affect the structure and form runs of discoloration.
T2- for slates with colour runs that do not cause structural change.
T3- for slates where holes may be formed from the oxidization of inclusion.
If exfoliation, splitting or other structural changes occur, the roofing slate does not pass the test and is therefore not up to European standard.

Petrographic Examination

Geological appraisal that includes optical microscopy, x-ray diffraction and scanning electron microscopy. This examination determines the type of roofing slate and weather there is any presence of harmful or dangerous structures or minerals.