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Testing of Minas Natural Solutions S.L. Graphite Slate

for

Minas Natural Solutions S.L.

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Introduction

In accordance with the instructions we have carried out a series of tests on a slate sample in accordance with BS EN 12326-2 : 2001.

This report describes the test methods and presents the results of tests.

Details of Sample

A sample of 50 Graphite coloured slates each measured approximately 500 x 250mm, was received from yourselves on 3rd April 2023. The sample was identified by you as “Minas Natural Solutions S.L Graphite Slate”.

The sample was given our laboratory reference number E326.

Details of Testing

The following tests were conducted on the slate sample in accordance with BS EN 12326-2 : 2011.

3.1 Determination of the length and Width, Clause 5

3.2 Determination of the amount by which the edges deviate from a straight edge, Clause 6

3.3 Deviation of Rectangularity of Slates, Clause 7

3.4 Determination of Thickness, Clause 8

3.5 Determination of the Deviation from Flatness, Clause 9

3.6 Determination of the Modulus of Rupture and Characteristic Modulus of Rupture, Clause 10

3.7 Water Absorption, Clause 11

3.8 Determination of Calcium Carbonate and Non-Carbonate Carbon Content, by Catalytic Thermal Decomposition, Clause 13 (see Note 1)

Note 1 The test procedure was as describes in the standard except that an amount 0.5g from each powdered slate was added to 500ml of Hydrochloric acid. This was then filtered, washed and dried before 0.01g was analysed from each sample

3.9 Sulphur Dioxide Exposure Test for Slates with a Calcium Carbonate Content of less than 20%, Clause 14

3.10 Thermal Cycle Test, Clause 15

Test Results and Test Requirements

Length and Width

The length of the slate sample was 500mm.

The difference between the measured length and the nominal specified length (500mm) is 0mm (0%).

The width of the slate sample was 250mm.

The difference between the measured width and the nominal specified width (250mm) is 0mm (0%).

Test Requirement

The test requirement as stipulated in BS EN 12326-1 : 2014 is that rectangular slates shall not deviate from the manufacturers declared length and width by more than ± 5mm. The sample therefore meets the length and width requirements.

The amount by which the Edges Deviate from a Straight Edge

The maximum deviation of the edges of the slate Sd_1 and Sd_2

Sd_1 = 1.5mm

Sd_2 = 0.5mm

Test Requirement

In accordance with BS EN 12326-1, for slates less than or equal to 500mm in length the deviation shall not exceed 5mm. The sample therefore meets the requirement for the deviation from a straight edge.

Rectangularity of Slates

The deviation R_d of the slate edges from a rectangle is 0.3%.

Test Requirement

In accordance with BS EN 12326-1 rectangular slates which have not been shouldered shall not deviate from rectangularity in any corner by more than 1% of their length. The sample therefore meets the requirement for rectangularity.

Thickness of Individual Slates

Sample Ref	Measurement No. (mm)				Mean mm	Max Deviation %
	1	2	3	4		
E326	6.8	6.3	6.4	7.0	6.6	5.7

Requirements for Thickness

The variation of the individual thickness shall be within the declared range which shall not be greater than ± 35% of the nominal thickness. The sample therefore meets the individual thickness requirements.

Deviation from Flatness

The deviation from flatness was found to be 0.5%.

Requirement for the Deviation from Flatness

When tested in accordance with Clause 9 of BS EN 12326-2 : 2011 rectangular slates for normal use shall not deviate from flat by more than the percentage shown in the following table:

Table 1: Maximum deviation from flatness requirement

Slate Flatness*$_1$	Deviation as a percentage of length
Very Flat	< 0.9
Flat	< 1.0
Normal	< 1.5
Non-Flat	< 2.0
Slate for Special Situations	No Limit

*$_1$ As specified by the manufacturer

Since the deviation of the slate from flatness is 0.5%, the slate meets the requirements of a very flat slate.

Modulus of Rupture and Characteristic Modulus of Rupture

The results of the modulus of rupture tests are given in the following Tables 2 and 3.

Table 2 Sample E326, Transverse Bending Tests BS EN 12326-2

Sample Ref	Ultimate Load P_i, N	Width b, mm	THICKNESS,e (mm)									Modulus of Rupture N/mm^2
			1	2	3	4	5	6	7	8	Av	3Pi.lt/2be^2
E326/1	763	125	5.8	5.7	5.4	5.5	5.5	5.5	5.6	5.8	5.6	52.6
E326/2	765	125	6.2	6.1	6.2	6.2	6.5	6.3	6.4	6.4	6.3	41.8
E326/3	552	124	5.4	5.1	4.9	5.1	5.2	5.2	5.1	5.0	5.1	45.8
E326/4	911	125	5.7	5.9	5.8	5.9	5.7	5.7	5.9	5.8	5.8	58.5
E326/5	832	123	6.0	6.0	6.1	6.2	6.4	6.4	6.4	6.3	6.2	47.1
E326/6	690	126	5.5	5.3	5.3	5.1	5.1	5.0	5.1	5.0	5.2	55.2
E326/7	775	127	5.7	5.8	5.9	5.8	5.5	5.6	5.7	5.6	5.7	50.7
E326/8	660	127	5.6	6.0	6.1	5.9	5.5	5.7	5.9	6.0	5.8	41.2
E326/9	743	126	6.2	6.3	6.2	6.2	6.4	6.2	6.2	6.2	6.2	40.9
E326/10	827	125	6.2	6.1	6.1	6.1	6.1	6.1	5.6	5.4	6.0	50.2
E326/11	674	126	5.8	5.8	6.1	6.1	5.1	5.0	5.0	5.9	5.6	46.1
E326/12	1267	127	7.2	7.4	7.5	7.6	7.4	7.4	7.4	7.4	7.4	49.0
E326/13	801	127	6.5	6.7	6.5	6.4	6.5	6.5	6.5	6.5	6.5	40.2
E326/14	1090	125	6.3	6.3	6.3	6.3	6.0	6.0	6.4	6.3	6.2	60.5
E326/15	845	127	5.9	5.8	6.1	6.2	6.3	6.3	6.1	5.8	6.1	48.9
E326/16	910	126	6.0	6.1	6.1	6.0	6.3	6.3	6.2	6.1	6.1	51.8
E326/17	929	126	5.6	5.6	5.7	5.6	5.7	5.7	5.7	5.6	5.7	62.4
E326/18	757	126	5.7	5.6	5.8	5.8	5.8	5.8	5.8	5.8	5.8	48.9
E326/19	576	127	5.1	5.4	5.3	5.5	5.3	5.2	5.2	5.1	5.3	44.2
E326/20	1054	126	6.6	6.7	6.7	6.6	6.3	6.5	6.5	6.5	6.6	52.6
Mean (N/mm^2)												**49.42**
Standard Dev												**6.39**
Characteristic Modulus of Rupture (N/mm^2)												**38.37**

Table 3 Sample E326, Longitudinal Bending Tests BS EN 12326-2

Sample Ref	Ultimate Load Pi, N	Width b, mm	THICKNESS,e (mm)									Modulus of Rupture N/mm^2
			1	2	3	4	5	6	7	8	Av	3Pi.lt/2be^2
E326/1	1027	126	6.4	6.4	6.1	6.0	6.0	5.9	5.9	5.9	6.1	59.6
E326/2	829	124	6.1	6.1	6.0	6.2	6.2	6.2	6.2	6.3	6.2	47.5
E326/3	945	127	5.8	5.8	5.8	5.7	5.9	5.9	5.5	5.5	5.7	61.0
E326/4	812	126	5.7	5.5	5.5	5.4	5.5	5.3	5.3	5.6	5.5	58.0
E326/5	885	126	5.5	5.5	5.5	5.5	6.0	6.3	6.2	6.2	5.8	55.7
E326/6	836	126	5.3	5.5	5.5	5.4	5.0	5.1	5.2	5.2	5.3	64.4
E326/7	424	126	4.9	5.1	5.1	5.2	5.2	5.4	5.6	5.5	5.3	33.0
E326/8	1025	125	5.8	5.9	5.9	6.0	5.7	5.8	5.7	5.6	5.8	65.8
E326/9	896	124	6.5	6.5	6.2	6.0	6.0	6.1	6.1	6.1	6.2	51.0
E326/10	645	126	5.0	5.1	5.2	5.3	5.1	5.1	5.1	5.1	5.1	52.6
E326/11	838	126	6.0	5.9	6.0	6.1	6.2	6.2	6.2	6.0	6.1	48.7
E326/12	1418	126	7.4	7.5	7.8	7.6	7.3	7.2	7.0	7.1	7.4	56.1
E326/13	1144	126	6.1	6.3	6.3	6.7	6.0	6.0	6.2	6.2	6.2	63.3
E326/14	886	125	6.0	5.9	5.9	6.1	5.9	5.9	5.9	6.0	6.0	54.1
E326/15	675	126	4.9	4.7	4.7	4.7	4.7	4.7	4.9	4.8	4.8	63.8
E326/16	1098	125	6.9	5.9	5.9	6.0	6.0	6.0	5.9	5.9	6.1	64.5
E326/17	1031	127	5.8	5.9	5.7	5.9	5.9	5.9	5.9	6.0	5.9	63.5
E326/18	998	125	5.8	5.8	5.8	5.6	5.6	5.7	5.7	5.7	5.7	66.1
E326/19	1003	125	6.4	5.9	6.2	5.9	5.9	6.0	6.0	6.1	6.1	59.2
E326/20	1234	126	6.0	6.4	6.6	6.8	6.9	6.9	6.7	6.5	6.6	60.7
Mean												**57.42**
Standard Dev												**8.08**
Characteristic Modulus of Rupture (N/mm^2)												**43.44**

Modulus of Rupture and Characteristic Modulus of rupture Requirements

There is no limit for the modulus of rupture of slates, as indicated in BS EB 12326-1 : 2014.

Water Absorption

The results of the water absorption test are given in Table 4 below:

Table 4 : Water Absorption Test Results

Specimen		Thickness (mm)					Water Absorption %
		1	2	3	4	Mean	
E326/	A	7.7	7.9	7.1	7.6	7.6	0.45
	B	6.9	6.9	7.1	7.3	7.1	0.42
	C	4.6	4.4	5.0	4.8	4.7	0.29
	D	4.5	4.2	4.4	4.8	4.5	0.47
	E	6.5	6.2	6.3	6.4	6.4	0.33
Mean							0.39

Water Absorption Requirements

In accordance with BS EN 12326-1 : 2014 the slate shall conform to code W_1 or code W_2 as follows:

Water Absorption %	Code
≤ 0.6	W_1 (≤ 0.6)
>0.6 and tested to clause 5.6	W_1 (> 0.6)
>0.6 and not tested to clause 5.6	W_2

The slate sample therefore was found to meet code W1 (≤ 0.6%) requirements.

Non Carbonate Carbon Content

The non-carbonate carbon was found to be 0.2%.

Requirement for the Non-Carbonate Carbon Content

In accordance with BS EN 12326-1 : 2014 the non-carbonate carbon content of the slate when tested to Clause 13 of BS EN 12326-2 shall be less than 2%.

Apparent Calcium Carbonate Content

The mean calcium carbonate content was 0.0%.

Requirement for the Apparent Calcium Carbonate Content

In accordance with BS EN 12326-1, the carbonate content of the slate when tested to Clause 13 of BS EN 12326-2 shall conform to the appropriate classification according to Table 1 (BS EN 12326-1).

Sulphur Dioxide Exposure Test

After the exposure period to solutions A and B of sulphur dioxide the test specimens did not show any significant visual signs of splitting, swelling or cracking. No softening or surface flakes were detected. The slate was given code S_1.

Requirement for the Sulphur Dioxide Test

In accordance with BS EN 12326-1 the slate shall be allocated a code S_1, S_2 or S_3 that is dependent on the apparent calcium carbonate content. In this case, the carbonate content of the slate was less than 5%, therefore the requirement for S_1 code has been met.

Thermal Cycle Test

After 20 cycles of water immersion and drying, there were no significant signs of alterations in the condition of the specimens. There was no obvious evidence of localised oxidation of surface minerals except in one localised area in one specimen, the specimens did not show any signs of surface disruption. The sample was given code T1.

Requirement for the Thermal Cycle Test

When tested to Clause 16 of BS EN 12326-2:2011 the following observations apply:

ode	Observation in test
T1	No changes in appearance. Surface oxidation of metallic minerals. Colour changes that neither affect the structure nor form runs of discolouration
T2	Oxidation or appearance changes of the metallic inclusions with runs of discolouration but without structural changes
T3	Oxidation or appearance changes of metallic minerals which penetrate the slate and risk the formation of holes

Conclusions

Based on the test results given in this report and the test requirements stipulated in BS EN 12326-1 :2014, the slate sample identified as " Minas Natural Solutions S.L, Graphite Slate" was found to comply with the following:

i. Length, width and deviation from specified length and width
ii. The amount by which the edges deviate from a straight edge
iii. Rectangularity
iv. Thickness
v. Deviation from flatness
vi. Water absorption, Code W1
vii. Non carbonate carbon content
viii. Sulphur dioxide exposure, Code S1
ix. Thermal cycle, Code T1

Quality Statement

We confirm that in preparing this report we have exercised all reasonable skill and care.

Any information relating to the sample received for testing has been supplied by the client unless otherwise specified.

This report does not provide 'product approval' status but shows only the results of the material or sample tested.

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