

**SANDBERG**

**REPORT 66577/G/1**

**TESTING OF  
VALENTIA STONE**

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**REPORT 66577/G/1**

**TESTING OF**

**VALENTIA STONE**

Carrig Conservation International Ltd.  
Unit 2, Atlantis Building  
Cumberland Street South  
Dublin  
D02 V588

For the attention of Mr Peter Cox

This report comprises  
6 pages of text  
Table 1 of 1 sheet  
Table 2 of 1 sheet  
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Table 5 of 1 sheet  
Table 6 of 4 sheets

17 December 2020

**REPORT 66577/G/1**

**TESTING OF**

**VALENTIA STONE**

**Reference :** Instructions from Mr Peter Cox of Carrig Conservation International Ltd.

**1. INTRODUCTION**

We were instructed to undertake testing of natural stone, advised to be Valentia stone, in order to establish physical, mechanical and durability characteristics.

The following sample information was not supplied ; name of the person or organization which carried out the sampling.

**2. SAMPLES**

Test specimens prepared ready for test were received from Carrig Conservation International Ltd. at Sandberg laboratories on 2 November 2020, as follows.

Sandberg Reference	Specimen Size	Test
	<b>Valentia stone</b>	
G50282	6 no. 50 x 50 x 50mm	Water absorption coefficient capillarity
G50283	10 no. 50 x 50 x 50mm	Compressive strength, dry (BS EN 1926)
G50284	10 no. 50 x 50 x 50mm	Frost resistance (56 cycles) - compressive strength, dry (BS EN 1926)
G50285	10 no. 50 x 50 x 50mm	Compressive strength, dry (BS EN 772-1)
G50287	6 no. 100 x 70 x 50mm	Abrasion resistance
G50288	6 no. 200 x 200 x 50mm	Slip resistance - honed
G50289	6 no. 200 x 200 x 50mm	Slip resistance - sawn
G50290	6 no. 200 x 200 x 50mm	Slip resistance - bush-hammered
G50291	6 no. 200 x 200 x 50mm	Slip resistance - riven

**3. TEST METHODS AND RESULTS**

**3.1 Water Absorption Coefficient of Capillarity**

Specimens were tested in accordance with BS EN 772-11 : 2011.

Detailed test results are given in Table 1 of this report and are summarised as follows:

Sandberg Reference	Water absorption coefficient of capillarity ( $\text{g}/\text{m}^2 \cdot \text{sec}^{0.5}$ )
G50282	0.59

**3.2 Compressive Strength**

Specimens were tested in accordance with the method given in BS EN 1926 : 2006.

Tests were carried out with the load applied in a perpendicular to bedding orientation and in an oven dried condition.

The detailed test results are given in Table 2 of this report and may be summarised as follows:

Sandberg Reference	Orientation / Condition	Compressive Strength (MPa)	
		Range	Mean
G50283	Perpendicular - dry	143.34 - 198.43	177 *

Statistical evaluation of the test results in accordance with the method in BS EN 1926 : 2006 Annex C (normative) produced the following:-

**Lowest Expected Value (MPa)**

Perpendicular - dry                          142 \*

\* To nearest 1 MPa

**3.3 Frost Resistance (56 Cycles) - Compressive Strength**

Ten specimens were tested in accordance with BS EN 12371 : 2010 to 56 no. cycles.

On completion of the cycling period the specimens were tested for compressive strength in accordance with BS EN 1926 : 2006.

The specimens were tested with the load applied in a perpendicular to bedding orientation and in an oven dried condition.



**3.5 Abrasion Resistance**

Specimens were tested in accordance with BS EN 14157 : 2017. The detailed test results are given in Table 5 of this report and may be summarised as follows.

Sandberg Reference	Individual Abrasion Value Range (mm)	Mean Abrasion Value (mm)
G50287	27 - 29.5	28

BRE IP10/00 (Flooring, paving and setts) proposes guidance on the interpretation of abrasion results performed to BS EN 1341 : 2001 Annex C.

The guidance does not take into account the cleaning and maintenance regime of a floor.

The guidance values presented are as follows :

<u>Abrasion resistance value</u>	<u>Suggested usage</u>
<23	Intensive use (e.g. shopping malls)
23 - 30	Moderate (e.g. office buildings)
>30	Individual (e.g. houses)

**3.6 Slip Resistance**

Specimens with honed, sawn, bush-hammered and riven surface finishes were tested for slip resistance in accordance with BS EN 14231 : 2003 using a portable skid resistance tester (pendulum tester).

Testing was carried out in dry and wet conditions.

Surface roughness measurements were also carried out using a Surtronic Duo roughness meter whilst the slip resistance measurements were being made.

Detailed results of the slip resistance test are given in Table 6 and are summarised below.

Sandberg Reference		Average Slip Resistance Value (SRV) (55 rubber)	
		Dry	Wet
G50288	- honed	70	50
G52089	- sawn	75	55
G50290	- bush-hammered	76	65
G50291	- riven	72	52

The TRL pendulum tester has a range of readings from 0 to 150, high values indicate good slip resistance. Guidance on the interpretation of results is suggested by the UK Slip Resistance Group<sup>1</sup>. These are generally accepted limits and are given below.

<u>Pendulum Test Value</u>	<u>Slip Potential</u>
0 - 24	High
25 - 35	Moderate
36+	Low

The surface roughness measurements are a guide to slip resistance particularly in borderline regions. It is recognised that the roughness of the floor surface can give an improvement in slip resistance in wet conditions.

Surfaces contaminated with pure water generally require a surface roughness of at least 10 µm R<sub>z</sub> to provide a moderate level of slip resistance and at least 20 µm R<sub>z</sub> to indicate low slip potential. More viscous contaminants require higher surface roughness<sup>2</sup>.

The slip resistance results relate to the samples in their as-received condition. It should be noted that the slip resistance of surfaces in service can be altered by various factors such as abrasion, polishing and contamination. Overall assessment of the potential for slip should take into account conditions of use and the environment, in addition to test results.

<sup>1</sup> The assessment of Floor Slip Resistance. The UK Slip Resistance Group, Issue 3, 2005.

<sup>2</sup> Roughness measurements should not be solely relied upon to evaluate the potential slip resistance of a floor.

4. **REMARKS**

These results conclude the requested programme of testing. Please do not hesitate to contact us if we can be of any further assistance in this matter.


Carrig Conservation International Ltd.  
Unit 2, Atlantis Building  
Cumberland Street South  
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D02 V588

For the attention of Mr Peter Cox

DJE/Geoman

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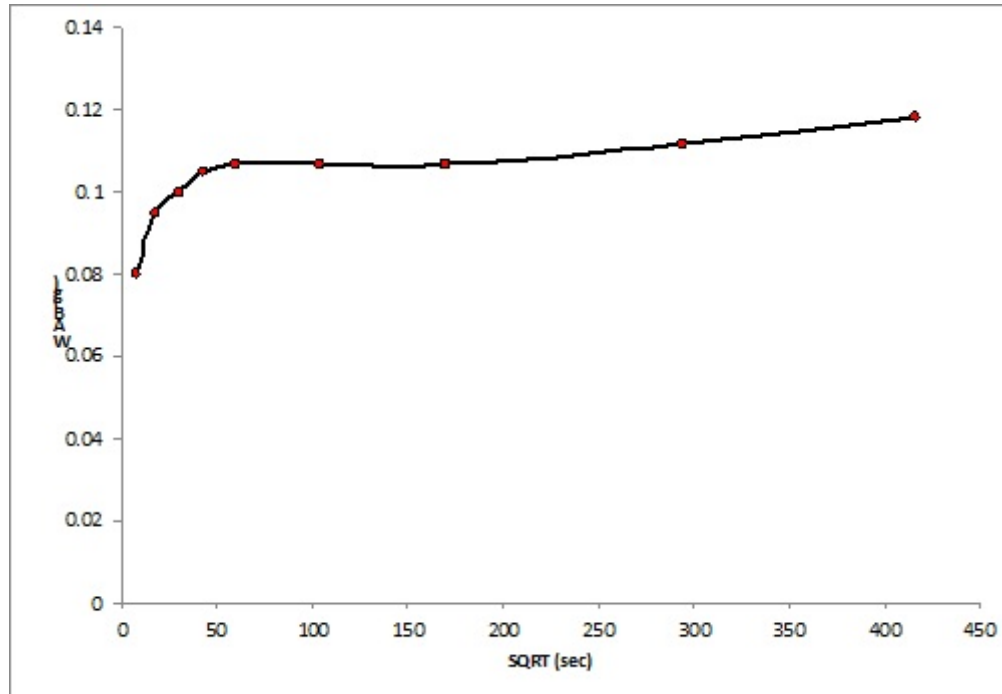
for Sandberg LLP

A handwritten signature in black ink, appearing to read 'D J Ellis', is written over a horizontal line. The signature is slanted upwards to the right.

D J Ellis  
Partner

17 December 2020





G50282 (perpendicular)

Coefficient of water absorption by capillarity :  $0.59 \text{ g/m}^2\text{s}^{0.5}$

**DETERMINATION OF WATER ABSORPTION COEFFICIENT OF CAPILLARITY**  
BS EN 772-11:2011

Table
1

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## COMPRESSIVE STRENGTH

BS EN 1926 : 2006

**Load Orientation<sup>1</sup> : Perpendicular**  
**Test Condition : Oven dried**

Rock Name	Valentia				Test By/Date	MB / 10.11.20	
Rock Type	Slate				Checked/Date	MMc / 11.11.20	
Sandberg Sample Reference	Breaking Load (N)	Specimen Height (mm)	Mean Lateral Dimension (mm)	Mean Lateral Dimension (mm)	Cross Section Area (mm <sup>2</sup> )	Compressive Strength (MPa)	Observations
G50283 a	489800	49.1	50.4	49.7	2505	195.53	Normal failure
G50283 b	380000	49.0	52.5	50.5	2651	143.34	Normal failure
G50283 c	441800	50.0	50.7	50.5	2570	171.91	Normal failure
G50283 d	416800	49.9	50.3	49.8	2505	166.39	Normal failure
G50283 e	456800	49.7	50.4	49.3	2485	183.82	Normal failure
G50283 f	423700	48.8	50.4	49.7	2505	169.14	Normal failure
G50283 g	486800	49.4	50.4	50.1	2525	192.79	Normal failure
G50283 h	504000	49.6	50.4	50.4	2540	198.43	Normal failure
G50283 j	406300	49.7	50.5	49.5	2500	162.52	Normal failure
G50283 k	467100	49.8	50.3	49.4	2485	187.97	Normal failure
Mean						177 *	
Std. Dev.						17 *	
Var. Coef.						0.1	

<sup>1</sup> Relative to bedding

Lowest Expected Value (MPa) : 142 \*

\* To nearest 1 MPa

## COMPRESSIVE STRENGTH

Post-56 cycles of freeze/thaw to BS EN 12371:2010  
BS EN 1926 : 2006

**Load Orientation<sup>1</sup> : Perpendicular**  
**Test Condition : Oven dried**

Rock Name	Valentia				Test By/Date	MB / 10.12.20	
Rock Type	Slate				Checked/Date	MMc / 11.12.20	
Sandberg Sample Reference	Breaking Load (N)	Specimen Height (mm)	Mean Lateral Dimension (mm)	Mean Lateral Dimension (mm)	Cross Section Area (mm <sup>2</sup> )	Compressive Strength (MPa)	Observations
G50284 a	501000	49.6	50.0	50.7	2535	197.63	Normal failure
G50284 b	573700	49.8	50.1	50.0	2505	229.02	Normal failure
G50284 c	580200	49.5	49.0	50.3	2465	235.38	Normal failure
G50284 d	587600	49.3	50.5	50.7	2560	229.53	Normal failure
G50284 e	495700	49.0	50.7	50.4	2555	194.01	Normal failure
G50284 f	573500	49.9	50.1	49.5	2480	231.25	Normal failure
G50284 g	608000	49.8	50.4	50.0	2520	241.27	Normal failure
G50284 h	640900	49.2	50.9	50.0	2545	251.83	Normal failure
G50284 j	605400	50.1	50.0	49.8	2490	243.13	Normal failure
G50284 k	622100	49.8	50.1	50.1	2510	247.85	Normal failure
Mean						230 *	
Std. Dev.						20 *	
Var. Coef.						0.09	

<sup>1</sup> Relative to bedding

Lowest Expected Value (MPa) : 190 \*

Visual inspection classification (post-56 cycles) : '0' (specimen intact)

\* To nearest 1 MPa

## COMPRESSIVE STRENGTH

BS EN 772-1:2011+A1:2015

**Load Orientation<sup>1</sup> : Perpendicular**  
**Test Condition : Oven dried @ 70°C**

Rock Name	Valentia				Test By/Date	MB / 10.11.20	
Rock Type	Slate				Checked/Date	MMc / 11.11.20	
Sandberg Sample Reference	Breaking Load (N)	Specimen Height (mm)	Mean Lateral Dimension (mm)	Mean Lateral Dimension (mm)	Cross Section Area (mm <sup>2</sup> )	Compressive Strength (MPa)	Observations
G50285 a	475400	49.0	49.4	50.4	2490	190.92	Normal failure
G50285 b	483800	48.9	50.8	50.4	2560	188.98	Normal failure
G50285 c	405000	49.1	50.5	50.2	2535	159.76	Normal failure
G50285 d	471200	48.8	50.5	50.5	2550	184.78	Normal failure
G50285 e	492100	48.9	51.1	50.6	2586	190.29	Normal failure
G50285 f	478800	49.7	50.5	49.1	2480	193.06	Normal failure
G50285 g	419600	49.8	50.0	50.2	2510	167.17	Normal failure
G50285 h	484800	49.8	50.2	50.0	2510	193.15	Normal failure
G50285 j	438100	49.0	52.6	50.4	2651	165.26	Normal failure
G50285 k	380900	50.0	50.0	49.8	2490	152.97	Normal failure
Mean						179 *	
Std. Dev.						16 *	
Var. Coef.						0.1	

<sup>1</sup> Relative to bedding

Lowest Expected Value (MPa) using BS EN 1926 : 2006 Annex C (normative) : 148 \*

\* To nearest 1 MPa

## ABRASION RESISTANCE

BS EN 14157 : 2017

Rock Name	Valentia	Test by/Date Checked by/Date	HO / 17.11.20 MB / 17.11.20
Rock Type	Slate	Surface finish	Honed
Sandberg Sample Reference	Individual abrasion value (mm)	Mean abrasion value (mm)	
G50287 a	27	28	
G50287 b	27.5		
G50287 c	28.5		
G50287 d	28		
G50287 e	27.5		
G50287 f	29.5		

Sandberg Reference	Material	Surface Finish	Orientation	Surface Roughness $R_z, \mu\text{m}$	Ambient Temperature $^{\circ}\text{C}$		Slip Resistance Value (SRV)			
							Dry		Wet	
					Dry	Wet	Mean [5 readings]	Mean	Mean [5 readings]	Mean
G50288 a	Valentia slate	Honed	A	13.3	20	20	66	68	50	54
			180° to A	-	-	-	69		57	
G50288 b	Valentia slate	Honed	A	13.7	17	20	69	69	51	49
			180° to A	-	-	-	69		46	
G50288 c	Valentia slate	Honed	A	12.9	18	20	68	69	45	48
			180° to A	-	-	-	70		50	
G50288 d	Valentia slate	Honed	A	13.9	18	20	70	70	51	46
			180° to A	-	-	-	65		40	
G50288 e	Valentia slate	Honed	A	13.7	19	20	70	70	55	53
			180° to A	-	-	-	70		51	
G50288 f	Valentia slate	Honed	A	14.5	19	20	70	72	46	48
			180° to A	-	-	-	73		50	

SRV dry (6 no. specimens) : 70

SRV wet (6 no. specimens) : 50

Sandberg Reference	Material	Surface Finish	Orientation	Surface Roughness $R_z, \mu\text{m}$	Ambient Temperature $^{\circ}\text{C}$		Slip Resistance Value (SRV)			
					Dry	Wet	Dry		Wet	
							Mean [5 readings]	Mean	Mean [5 readings]	Mean
G50289 a	Valentia slate	Sawn	A*	31.2	18	20	75	76	50	53
			180° to A*	-	-	-	77		55	
G50289 b	Valentia slate	Sawn	A*	33.0	18	20	75	75	53	54
			180° to A*	-	-	-	75		54	
G50289 c	Valentia slate	Sawn	A*	31.0	18	20	75	77	54	55
			180° to A*	-	-	-	78		55	
G50289 d	Valentia slate	Sawn	A*	32.9	18	20	75	75	55	54
			180° to A*	-	-	-	75		53	
G50289 e	Valentia slate	Sawn	A**	35.7	18	20	68	71	55	60
			180° to A**	-	-	-	74		65	
G50289 f	Valentia slate	Sawn	A*	31.6	18	20	75	75	55	55
			180° to A*	-	-	-	75		55	

\* Across saw plane

\*\* With saw plane

SRV dry (6 no. specimens) : 75

SRV wet (6 no. specimens) : 55

## SLIP RESISTANCE TESTING - RUBBER SLIDER TYPE : 55

BS EN 14231 : 2003 and UK SRG Issue 5 : 2016

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Sandberg Reference	Material	Surface Finish	Orientation	Surface Roughness R <sub>z</sub> , μm	Ambient Temperature °C		Slip Resistance Value (SRV)			
							Dry		Wet	
					Dry	Wet	Mean [5 readings]	Mean	Mean [5 readings]	Mean
G50290 a	Valentia slate	Bush-hammered	A	40.1	19	19	77	77	65	65
			180° to A	-	-	-	77		65	
G50290 b	Valentia slate	Bush-hammered	A	43.2	19	19	85	78	81	66
			180° to A	-	-	-	70		50	
G50290 c	Valentia slate	Bush-hammered	A	35.5	19	19	75	75	66	64
			180° to A	-	-	-	75		62	
G50290 d	Valentia slate	Bush-hammered	A	44.7	19	19	75	75	66	66
			180° to A	-	-	-	75		66	
G50290 e	Valentia slate	Bush-hammered	A	33.8	19	19	75	75	69	64
			180° to A	-	-	-	75		59	
G50290 f	Valentia slate	Bush-hammered	A	45.3	19	19	67	74	50	63
			180° to A	-	-	-	80		76	

SRV dry (6 no. specimens) : 76

SRV wet (6 no. specimens) : 65

## SLIP RESISTANCE TESTING - RUBBER SLIDER TYPE : 55

BS EN 14231 : 2003 and UK SRG Issue 5 : 2016

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Sandberg Reference	Material	Surface Finish	Orientation	Surface Roughness $R_{z, \mu m}$	Ambient Temperature $^{\circ}C$		Slip Resistance Value (SRV)			
					Dry	Wet	Dry		Wet	
							Mean [5 readings]	Mean	Mean [5 readings]	Mean
G50291 a	Valentia slate	Riven	A	31.3	18	19	74	75	54	52
			180° to A	-	-	-	75		49	
G50291 b	Valentia slate	Riven	A	32.1	18	19	64	73	44	55
			180° to A	-	-	-	81		68	
G50291 c	Valentia slate	Riven	A	29.5	18	19	68	77	52	58
			180° to A	-	-	-	85		64	
G50291 d	Valentia slate	Riven	A	22.6	18	19	73	68	54	49
			180° to A	-	-	-	63		43	
G50291 e	Valentia slate	Riven	A	32.3	18	19	65	70	44	49
			180° to A	-	-	-	74		54	
G50291 f	Valentia slate	Riven	A	31.4	18	19	69	70	48	49
			180° to A	-	-	-	70		49	

SRV dry (6 no. specimens) : 72

SRV wet (6 no. specimens) : 52

## SLIP RESISTANCE TESTING - RUBBER SLIDER TYPE : 55

BS EN 14231 : 2003 and UK SRG Issue 5 : 2016

Test By/Date

MR / 5-12.11.20

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