

**SANDBERG**

**REPORT 61808/G**  
**TESTING OF**  
**IRISH BLUE LIMESTONE**  
**THREecastLES QUARRY**

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**TESTING OF**

**IRISH BLUE LIMESTONE**

**THREecastLES QUARRY**

McKeon Stone Ltd.  
Brockley Park  
Stradbally  
Co. Laois  
Ireland

This report comprises  
4 pages of text  
Table 1 of 1 sheet  
Table 2 of 1 sheet  
Table 3 of 1 sheet  
Table 4 of 2 sheets

For the attention of Mr Niall Kavanagh

2 March 2018

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## REPORT 61808/G

### TESTING OF

### IRISH BLUE LIMESTONE

### THREecastLES QUARRY

**Reference :** Instructions from Mr Niall Kavanagh of McKeon Stone Ltd.

#### 1. INTRODUCTION

We were instructed to undertake testing of natural stone, advised to be Irish Blue limestone, Threecastles Quarry, in order to establish physical, strength and performance characteristics.

#### 2. SAMPLES

Samples were received from McKeon Stone Ltd. in our laboratory on 12 February 2018 as follows;

Sandberg Reference	Specimen Size	Test
	<b>Irish Blue limestone Threecastles Quarry</b>	
G46848	6 no. 50 x 50 x 5mm	Density and porosity
G46849	6 no. 50 x 50 x 50mm	Water Absorption atmospheric
G46850	10 no. 300 x 100 x 50mm	Flexural strength (3-pt), dry
G46851	6 no. 200 x 200 x 30mm	Slip resistance - honed P36
G46852	6 no. 200 x 200 x 30mm	Slip resistance - bush-hammered

**3. TEST METHODS AND RESULTS**

**3.1 Density and Porosity**

Specimens were tested in accordance with BS EN 1936 : 2006.

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

Sandberg Reference	Apparent Density (kg/m <sup>3</sup> )		Open Porosity (%)	
	Range	Mean	Range	Mean
G46848	2680 - 2690	2690	0.4 - 0.4	0.4

**3.2 Water Absorption at Atmospheric Pressure**

Specimens were tested in accordance with BS EN 13755 : 2008.

Detailed test results are given in Table 2 of this report and are summarised as follows:

Sandberg Reference	Water Absorption (%)	
	Range	Mean
G46849	0.1 - 0.1	0.1

**3.3 Flexural Strength (3-point) Under Concentrated Load**

Specimens were tested in accordance with the method given in BS EN 12372 : 2006.

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

The detailed test results are given in Table 3 of this report and may be summarised as follows:

Sandberg Reference	Orientation / Condition	Flexural Strength (3-pt) (MPa)	
		Range	Mean
G46850	Unknown - dry	11.5 - 14.0	12.7

Statistical evaluation of the test results in accordance with the methods in BS EN 12372 : 2006 Annex A (normative) produced the following:

**Lowest Expected Value (MPa)**

Unknown - dry	10.9
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**3.4 Slip Resistance**

Specimens with honed P36 and bush-hammered surface finishes were tested for slip resistance in accordance with BS EN 1341 : 2012 using a portable skid resistance tester (pendulum tester).

Testing was carried out with a '55' rubber slider 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 8 and are summarised below.

Sandberg Reference		Average Slip Resistance Value (SRV) (55 rubber)	
		Dry	Wet
G46851	- honed P36	55	44
G46852	- bush-hammered	91	75

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 10µm R<sub>z</sub> to provide a moderate level of slip resistance and at least 20µm 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.

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<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.

McKeon Stone Ltd.  
Brockley Park  
Stradbally  
Co. Laois  
Ireland

for Sandberg LLP

For the attention of Mr Niall Kavanagh

David Ellis  
Partner

DJE/Geoman/pd

2 March 2018

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Materials, samples and test specimens are retained for a period of 2 months from the issue of the final report.

Tests reported on sheets not bearing the UKAS logo in this report/certificate are not included in the UKAS accreditation schedule for this laboratory.

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

**APPARENT DENSITY AND OPEN POROSITY**

BS EN 1936 : 2006

Rock Name	Iris Blue			Test By/Date	MB/21-2-18	
Rock Type	Limestone			Checked/Date	MMc/22-2-18	
Sandberg Sample Ref.	Oven Dried Mass in Air (g)	Density of Water (kg/m <sup>3</sup> )	Vacuum Saturated Mass in Air (g)	Vacuum Saturated Mass in Water (g)	Open Porosity (%)	Apparent Density (kg/m <sup>3</sup> )
G46848 a	353.09	998	353.65	222.34	0.4	2680
G46848 b	354.61	998	355.20	223.41	0.4	2690
G46848 c	357.71	998	358.27	224.86	0.4	2680
G46848 d	357.81	998	358.35	225.26	0.4	2680
G46848 e	356.87	998	357.38	224.91	0.4	2690
G46848 f	357.07	998	357.63	225.06	0.4	2690
Mean					0.4	2690

**WATER ABSORPTION AT ATMOSPHERIC PRESSURE**

BS EN 13755 : 2008

Rock Name	Irish Blue	Test By / Date	MB/23-2-18
Rock Type	Limestone	Checked / Date	LN/27-2-18
Sandberg Sample Ref.	Oven Dried Mass (g)	Saturated Surface Dried Mass (g)	Water Absorption (%)
G46849 a	351.26	351.75	0.1
G46849 b	355.34	355.80	0.1
G46849 c	354.91	355.37	0.1
G46849 d	354.66	355.13	0.1
G46849 e	351.16	351.59	0.1
G46849 f	352.40	352.84	0.1
Average			0.1



## FLEXURAL STRENGTH (UNDER CONCENTRATED LOAD)

BS EN 12372 : 2006

**Load Orientation<sup>1</sup> : Unknown**  
**Finish : Sawn**  
**Test Condition : Oven dried**

Rock Name	Irish Blue			Test By/Date	MB/20-2-18	
Rock Type	Limestone			Checked/Date	MMc/21-2-18	
Sandberg Sample Reference	Breaking Load (N)	Specimen Span (mm)	Specimen Width (mm)	Specimen Thickness (mm)	Flexural Strength (MPa)	Observations
G46850 a	8870	250	99.7	50.0	13.3	Normal Failure
G46850 b	8040	250	99.6	49.5	12.4	Normal Failure
G46850 c	7920	250	99.9	50.9	11.5	Normal Failure
G46850 d	9730	250	99.6	51.1	14.0	Normal Failure
G46850 e	8520	250	99.6	49.8	12.9	Normal Failure
G46850 f	9070	250	99.9	49.5	13.9	Normal Failure
G46850 g	8160	250	99.8	51.0	11.8	Normal Failure
G46850 h	8760	250	99.8	51.1	12.7	Normal Failure
G46850 j	8820	250	100.4	51.0	12.7	Normal Failure
G46850 k	7550	250	100.2	49.6	11.5	Normal Failure
Mean					12.7	
Std. Dev.					0.9	
Var. Coef.					0.1	

<sup>1</sup> With respect to bedding

Lowest Expected Value (MPa) : 10.9

Sandberg Reference	Material	Surface Finish	Orientation [along vein]	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
G46851 a	Irish Blue limestone	Honed P36	A	16.2	22	19	58	57	47	47
			180° to A	-	-	-	55		47	
G46851 b	Irish Blue limestone	Honed P36	A	15.6	-	-	55	56	48	48
			180° to A	-	-	-	57		48	
G46851 c	Irish Blue limestone	Honed P36	A	14.7	22	19	52	53	42	40
			180° to A	-	-	-	54		37	
G46851 d	Irish Blue limestone	Honed P36	A	16.7	-	-	52	53	43	42
			180° to A	-	-	-	53		41	
G46851 e	Irish Blue limestone	Honed P36	A	15.6	22	19	54	55	42	41
			180° to A	-	-	-	55		40	
G46851 f	Irish Blue limestone	Honed P36	A	13.6	-	-	52	54	42	44
			180° to A	-	-	-	56		45	

SRV dry (6 no. specimens): 55  
SRV wet (6 no. specimens): 44

Sandberg Reference	Material	Surface Finish	Orientation [along vein]	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
G46852 a	Irish Blue limestone	Bush-hammered	A	+50	22	19	93	93	71	71
			180° to A	-	-	-	92		70	
G46852 b	Irish Blue limestone	Bush-hammered	A	+50	22	19	91	93	78	78
			180° to A	-	-	-	94		78	
G46852 c	Irish Blue limestone	Bush-hammered	A	+50	22	19	92	93	73	77
			180° to A	-	-	-	94		80	
G46852 d	Irish Blue limestone	Bush-hammered	A	+50	22	19	89	91	77	75
			180° to A	-	-	-	92		72	
G 46852 e	Irish Blue limestone	Bush-hammered	A	+50	22	19	87	88	68	74
			180° to A	-	-	-	89		79	
G46852 f	Irish Blue limestone	Bush-hammered	A	+50	22	19	85	88	76	76
			180° to A	-	-	-	90		75	

SRV dry (6 no. specimens): 91  
SRV wet (6 no. specimens): 75

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Where our involvement consists exclusively of testing samples, the results and our conclusions relate only to the samples tested.

