

SANDBERG

REPORT 51794/G

**TESTING OF
THREecastLES LIMESTONE
(1st QUALITY)**

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MATERIALS TESTING

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TESTING OF

THREecastLES LIMESTONE

(1st QUALITY)

McKeon Stone Limited
Brockley Park
Stradbally Park
Co. Laois
Ireland

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

For the attention of Mr Niall Kavanagh

29 July 2014

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(1st QUALITY)

Reference: Instructions from Mr Niall Kavanagh of McKeon Stone Limited.

1. INTRODUCTION

We were instructed to undertake testing of natural stone, advised to be Threecastles limestone (1st quality), in order to establish petrographic and physical characteristics.

2. SAMPLES

Samples were received from McKeon Stone Limited at Sandberg laboratories on 27 June 2014 as follows.

Sandberg Reference	Specimen Size	Test
	Threecastles limestone (1st quality)	
G40564	1 no. 150 x 150 x 50mm	Petrographic examination
G40565	6 no. 50 x 50 x 50mm	Water absorption at atmospheric pressure
G40566	10 no. 180 x 70 x 30mm	Flexural strength (3-point), dry
G40567	10 no. 180 x 70 x 30mm	Frost resistance ; - Flexural strength (3-pt) - 56 cycles, dry

3. TEST METHODS AND RESULTS

3.1 Petrographic examination

A sample was subjected to petrographic examination in accordance with the methods described in BS 5930:1999¹, ISRM² and BS EN 12407:2011³.

The sample was first subjected to macroscopical and low power stereoscopic microscope examination supported by simple physical and chemical tests.

Record photographs of honed surfaces of the sample are presented in Table 1.

A representative portion from the sample was used to prepare a large area thin section which was examined using a Leica DM4500P high power petrological microscope employing plane polarised and cross polarised light at magnifications up to x1000.

The detailed petrographic examination results are given in Table 1 and can be summarised as follows ;

Threecastles limestone (1st quality)

Grey, very fine to coarse and very coarse grained bioclastic LIMESTONE, well compacted. The stone exhibited sparse stylolitic seams which ran parallel to subparallel to the principal surfaces imparting a faint bedding to the slab sample. Relict bioclastic debris and crystal aggregations, were up to 6mm and commonly less than 3mm across.

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
G40565	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.

¹ BS 5930:1999. Code of Practice for Site Investigation, Clause 44, Description and Classification of Rocks for engineering Purposes.

² Rock Characterisation Testing and Monitoring. International Society for Rock Mechanics (ISRM) Suggested methods. Petrographic Description of Rocks p.73, 1981 Edition.

³ BS EN 12407:2011. Natural Stone Test Methods - Petrographic Examination.

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
G40566	Unknown - dry	11.5 - 16.2	13.1

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

10.4

3.4 Frost resistance

Specimens were tested in accordance with BS EN 12371 : 2010 Technology Test (Test A) to 56 no. cycles.

On completion of the cycling period the specimens were tested for flexural strength in accordance with 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 4 of this report and may be summarised as follows.

Sandberg Reference	Orientation/Condition	Flexural Strength (3-pt) (MPa) Post-freeze/thaw 56 cycles	
		Range	Mean
G40567	Unknown - dry	11.0 - 14.2	12.7

Visual inspection of the test specimens (post-56 cycles) indicated a classification of '0' (intact).

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

Lowest Expected Value (MPa)

Unknown - dry

10.4

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 Limited
Brockley Park
Stradbally
Co. Laois
Ireland

for Sandberg LLP

For the attention of Mr Niall Kavanagh

D J Ellis
Partner

DJE/Geoman/ws

29 July 2014

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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 mark 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.

SAMPLE PHOTOGRAPHS



G40564 : Threecastles limestone. General view.



G40564 : Threecastles limestone. Close-up.

PETROGRAPHICAL EXAMINATION OF ROCK

BS 5930:1999, ISRM Method, BS EN 12407:2011

SAMPLE DETAILS			
Sample Reference	G40564	Client Reference/Site Mark:	-
Sample Type, Source and Sampling Location Details:	Threecastles limestone		
Condition on Receipt:	Dry	Sample Dimensions, mm :	150 x 150 x 50
Methods of Preparation of Specimens and Examination Procedures:	The sample was first subjected to macroscopical and low power stereomicroscopical examination supported by simple physical and chemical tests. A representative specimen from the sample was diamond-sawn and used to prepare a large area thin section which was examined under a Leica DM4500P high power petrological microscope employing magnifications up to x1000.		
Any Other Details:	A large area thin section 50mm x 50mm was prepared from a specimen taken perpendicular to the principal surfaces of the slab sample.		

MATERIAL DESCRIPTION:	Grey, very fine to coarse and very coarse grained bioclastic LIMESTONE, well compacted. The stone exhibited sparse stylolitic seams which ran parallel to subparallel to the principal surfaces imparting a faint bedding to the slab sample. Relict bioclastic debris and crystal aggregations, were up to 6mm and commonly less than 3mm across.
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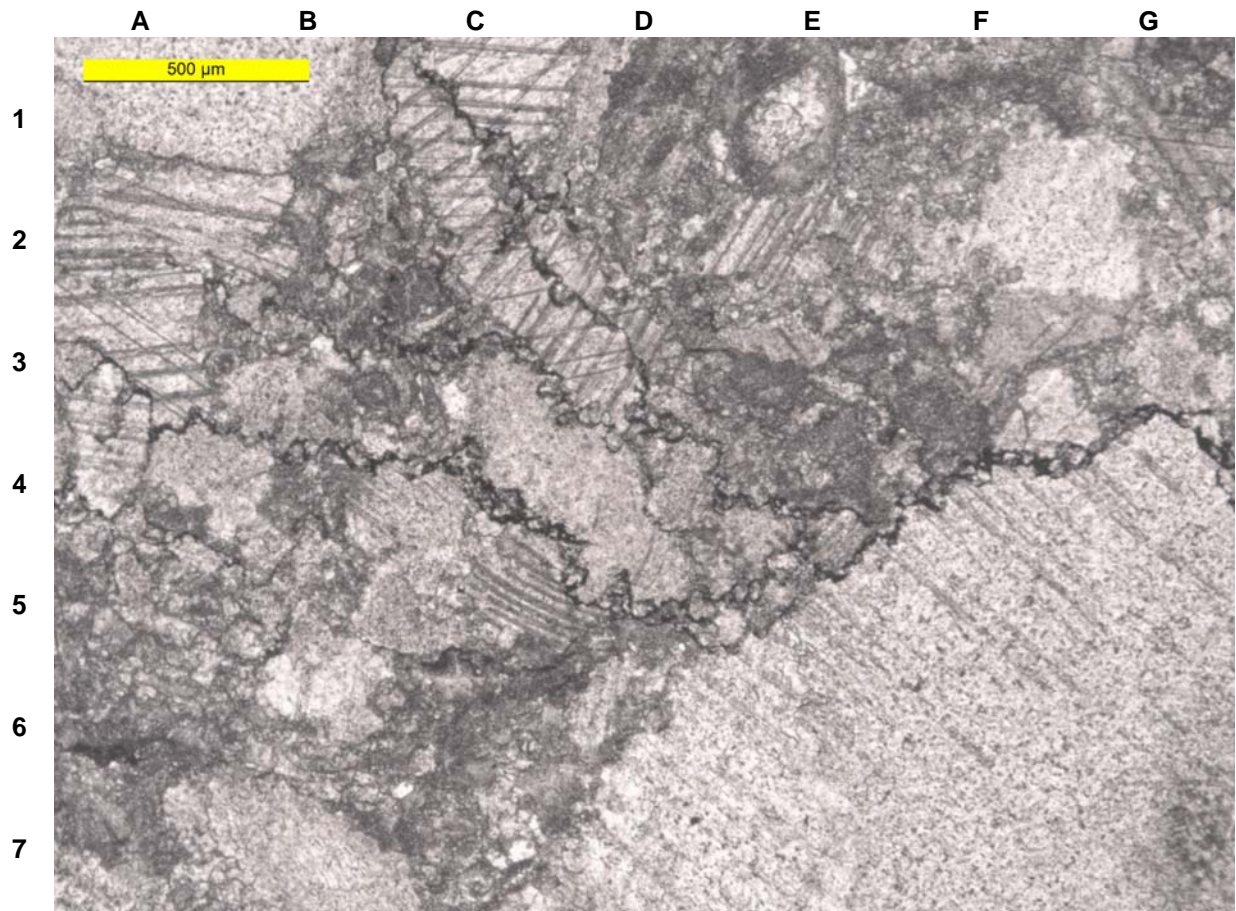
MATERIAL COMPOSITION:		PETROGRAPHICAL DETAILS ⁿ
COMPONENT	Volume % (estimated)	<p>The stone was mainly grain supported well compacted comprising relict bioclastic debris and intergranular sparry calcite and some micrite. The relict bioclastic debris was frequently replaced by sparry calcite and some micrite.</p> <p>Sparry calcite infilled intergranular voids, bioclast chambers or replaced bioclasts. Micrite was mainly intergranular infilling material.</p> <p>Stylolitic seams exhibited an extremely fine grained opaque material and were parallel to subparallel to the principal surfaces. Similar opaque material was sporadically present along grain boundaries and was possibly of a carbonaceous nature.</p> <p>Rare opaque grains up to 100µm across were also present, possibly pyrite.</p> <p>The stone was hard and robust (subjective estimate), well to very well compacted and slightly microporous with the microporosity mainly contributed by the micrite, crystal grain boundaries and stylolitic seams.</p>
Bioclastic debris	70	
Sparry calcite	20	
Micrite	10	
Carbonaceous material	<1	
Others (possible pyrite)	<<1	
TOTAL:	100	

UE = Undulatory Extinction. ND = Not Determined. NA = Not Applicable. NS = Not Supplied.

ⁿ Details mainly relate to components or features of possible engineering significance.

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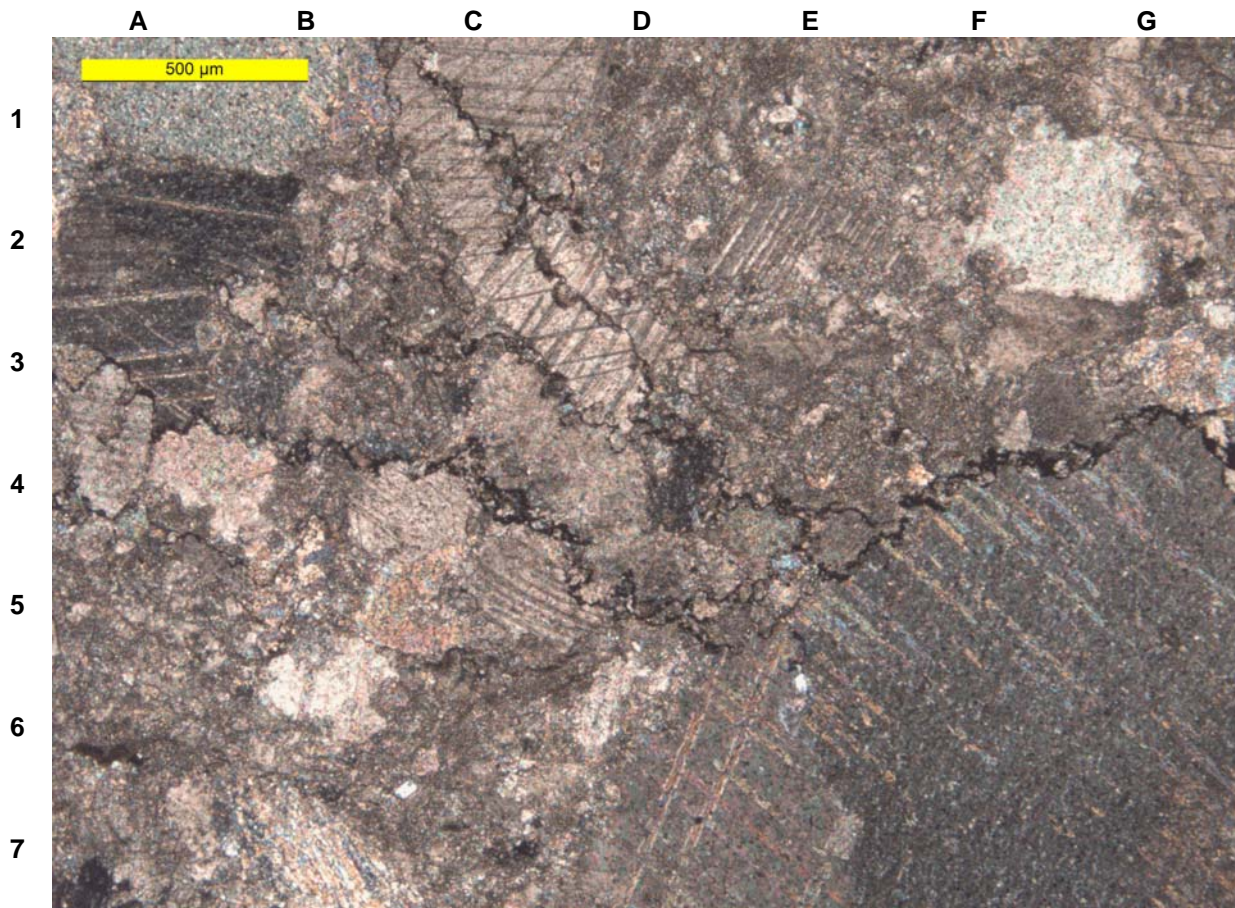
PETROGRAPHICAL EXAMINATION OF STONE - PHOTOMICROGRAPH



Photomicrograph Details			
Sandberg Sample Ref:	G40564	Client Ref/Site Mark:	Threecastles limestone
Microscope Light:	Plane polarised	Objective Magnification:	x5
Photomicrograph Description			
<p>General view of the stone structure. In the field of view there is relict bioclastic debris (e.g. B/7, B-C/4-5, etc.) and sparry calcite (e.g. C/1-2, A/2, etc.) exhibiting rhombic cleavage. Stylolitic seams are the sutured black lines.</p>			

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PETROGRAPHICAL EXAMINATION OF STONE - PHOTOMICROGRAPH



Photomicrograph Details			
Sandberg Sample Ref:	G40564	Client Ref/Site Mark:	Threecastles limestone
Microscope Light:	Cross polarised	Objective Magnification:	x5
Photomicrograph Description			
<p>General view of the stone structure. In the field of view there is relict bioclastic debris (e.g. B/7, B-C/4-5, etc.) and sparry calcite (e.g. C/1-2, A/2, etc.) exhibiting rhombic cleavage. Stylolitic seams are the sutured black lines.</p>			

WATER ABSORPTION AT ATMOSPHERIC PRESSURE

BS EN 13755 : 2008

Rock Name	Threecastles (1 st quality)	Test By / Date	HO / 07.07.14
Rock Type	Limestone	Checked / Date	MB / 07.07.14
Sandberg Sample Ref.	Oven Dried Mass (g)	Saturated Surface Dried Mass (g)	Water Absorption (%)
G40565 a	334.68	335.09	0.1
G40565 b	333.91	334.29	0.1
G40565 c	333.55	333.94	0.1
G40565 d	334.84	335.22	0.1
G40565 e	333.64	334.00	0.1
G40565 f	335.61	336.03	0.1
Average			0.1

FLEXURAL STRENGTH (UNDER CONCENTRATED LOAD)

BS EN 12372 : 2006

Load Orientation¹ : Unknown
Finish : Sawn
Test Condition : Oven dried

Rock Name	Threecastles (1 st quality)			Test By/Date	MB / 08.07.14	
Rock Type	Limestone			Checked/Date	LN / 08.07.14	
Sandberg Sample Reference	Breaking Load (N)	Specimen Span (mm)	Specimen Width (mm)	Specimen Thickness (mm)	Flexural Strength (MPa)	Observations
G40566 a	10180	250	99.8	53.2	13.5	Normal Failure
G40566 b	9140	250	99.9	54.0	11.8	Normal Failure
G40566 c	10530	250	100.0	51.7	14.8	Normal Failure
G40566 d	10580	250	100.0	53.2	14.0	Normal Failure
G40566 e	9340	250	100.0	53.0	12.5	Normal Failure
G40566 f	9260	250	99.5	52.7	12.6	Normal Failure
G40566 g	12450	250	99.7	53.7	16.2	Normal Failure
G40566 h	9100	250	99.9	53.2	12.1	Normal Failure
G40566 j	8100	250	100.0	51.3	11.5	Normal Failure
G40566 k	8520	250	99.8	51.1	12.3	Normal Failure
Mean					13.1	
Std. Dev.					1.5	
Var. Coef.					0.1	

¹ With respect to bedding

Lowest Expected Value (MPa) : 10.4

FLEXURAL STRENGTH (UNDER CONCENTRATED LOAD)

BS EN 12372 : 2006

After 56 Cycles of Freeze-Thaw to BS EN 12371 : 2010

Load Orientation¹ : Unknown

Finish : Sawn

Test Condition : Oven dried

Rock Name	Threecastles (1 st quality)			Test By/Date	MB / 24.07.14	
Rock Type	Limestone			Checked/Date	CW / 25.07.14	
Sandberg Sample Reference	Breaking Load (N)	Specimen Span (mm)	Specimen Width (mm)	Specimen Thickness (mm)	Flexural Strength (MPa)	Observations
G40567 a	9150	250	99.8	52.8	12.3	Normal Failure
G40567 b	9290	250	99.9	54.7	11.7	Normal Failure
G40567 c	10850	250	99.8	53.6	14.2	Normal Failure
G40567 d	9080	250	99.9	53.8	11.8	Normal Failure
G40567 e	8050	250	99.8	52.5	11.0	Normal Failure
G40567 f	10180	250	100.1	52.1	14.0	Normal Failure
G40567 g	9470	250	99.8	54.3	12.1	Normal Failure
G40567 h	10700	250	100.0	53.9	13.8	Normal Failure
G40567 j	10590	250	100.0	53.2	14.0	Normal Failure
G40567 k	8880	250	99.9	52.8	12.0	Normal Failure
Mean					12.7	
Std. Dev.					1.2	
Var. Coef.					0.1	

¹ With respect to bedding

Lowest Expected Value (MPa) : 10.4

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