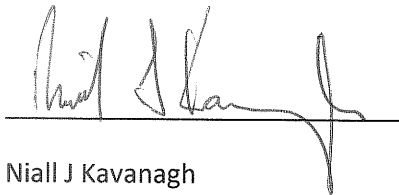


**Test Results on Irish Limestone performed in the Belgian Building Research Institute in December 2004 and January 2005.**

**Samples from McKeon Stone's , Threecastles quarry were identified by  
Reference 4295 and 4297**

**Samples from James Walsh's quarry were identified by  
Reference 4294 and 4296**



Niall J Kavanagh

Managing Director

Mc Keon Stone Ltd



WTCB-CSTC

# BELGIAN BUILDING RESEARCH INSTITUTE

INSTITUTION RECOGNISED BY APPLICATION OF THE DECREE-LAW OF JANUARY 1947

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VAT nr. : BE 407.695.057

Page : 1/12

LABORATORY : LMA  Materials for structural and finishing works	TEST REPORT DRAFT VERSION	Nr. DE, ATA, RE : DE 621 xA 761/2
		Nr. Laboratory : LMA 4294-4295-4296-4297
		Nr. Sample : N-2004-11-010

REQUESTED BY: G. COURTOIS NV  
Industriezone Zone 3 – ST Bernard – Nijverheidsstraat 34 Bus 1  
B-2620 HEMIKSEM

Contact persons: - Demander - Mr D. Van Dam  
- BBRI - Mr F. de Barquin

Tests carried out	References	Tests carried out	References
Apparent density and porosity	NBN EN 1936: 1999	Compressive strength	NBN EN 1926: 1999
Thermal expansion coefficient	prEN 14581: 2004	Flexural strength	NBN EN 12372: 1999
Dynamic elastic modulus	prEN 14146: 2003	Frost resistance	NBN EN 12371: 2002
		Abrasion resistance	EN 14157: 2004

Date and reference of the request : 10.12.2004  
Date of receipt of the samples : 06.03.2004  
Test date : 12.2004 – 01.2005  
Date of the report : 29.03.2005 (draft) – 09.2006

This report contains 12 pages, numbered from 1/12 to 12/12; it may only be reproduced in its entity.  
Each page of the original report has been stamped (in red) by the laboratory and initialled by the head of laboratory.  
The results and findings are only valid for the tested samples.

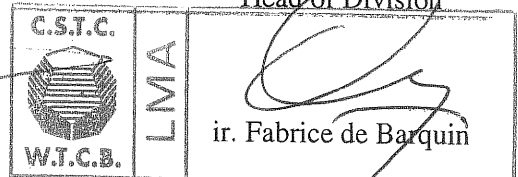
- No sample
- Sample(s) submitted to a destructive test
- Sample(s) to be removed from our laboratories 60 calendar days after sending the report, unless a written request is received by the demander of the test

In charge of the test

Deputy head of laboratory

Head of Division

*D. Nicaise*  
dr.sc. Dominique Nicaise



Technical assistance: - EW/IP

IP



## 1. SAMPLE

In the frame of the Belgian Technical Agreement (ATG) for natural stone, samples of blue limestone have been delivered to our laboratories. The test specimens were marked "JWQ" and "HRQ-TCQ" by the demander. The specimens were numbered in our laboratories. Dimensions and quantities of the test specimens used for each test are mentioned below.

LMA 4294	Erinstone – JWQ – type A
LMA 4295	Erinstone – HRQ-TCQ – type A
LMA 4296	Erinstone – JWQ – type B
LMA 4297	Erinstone – HRQ-TCQ – type B

## 2. TESTS AND RESULTS – TYPE A

### 2.1. APPARENT DENSITY AND OPEN POROSITY – NBN EN 1936

For each type, 6 test specimens with dimensions 7/7/7 cm have been used for this test.

After drying to a constant mass, six samples are weighed. Then they go into a vessel and under vacuum conditions they will absorb water that is add. After a certain time the samples are weighed wet (lightly wiped with a chammy) and under water.

Number test specimen	apparent density [kg/m <sup>3</sup> ]	porosity [v%]
4294/3	2681	0.55
4294/4	2680	0.59
4294/5	2682	0.51
4294/6	2686	0.35
4294/7	2671	0.91
4294/8	2680	0.57
<b>Mean value</b>	<b>2680</b>	<b>0.58</b>
<b>Standard deviation</b>	<b>5</b>	<b>0.18</b>





Number test specimen	apparent density [kg/m <sup>3</sup> ]	porosity [v%]
4295/3	2686	0.45
4295/4	2682	0.54
4295/5	2682	0.54
4295/6	2689	0.42
4295/7	2685	0.49
4295/8	2690	0.43
<b>Mean value</b>	<b>2686</b>	<b>0.48</b>
<b>Standard deviation</b>	<b>3</b>	<b>0.05</b>

### 2.2. THERMAL EXPANSION COEFFICIENT – PREN 14581

For each type, 2 test specimens with dimensions 5/2/25 cm have been used for this test.

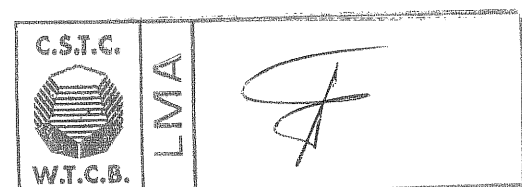
After drying to a constant mass, the length of the sample is measured, usually in one direction which is parallel to the plane of anisotropy. Subsequently the sample is brought up to at least two different temperatures and the length is measured each time the given temperature is reached and stabilized for a certain time. The linear thermal expansion coefficient is calculated from the difference in length at the two temperatures.

Number test specimen	$\alpha$ [mm/m.K]	$\alpha$ [mm/m.K]	Mean value
4294/53	0.0053	0.0052	<i>0.0052</i>
4294/54	0.0053	0.0054	<i>0.0053</i>
<b>Mean value</b>	<i>0.0053</i>	<i>0.0053</i>	<b>0.0053</b>

Number test specimen	$\alpha$ [mm/m.K]	$\alpha$ [mm/m.K]	Mean value
4295/53	0.0051	0.0051	<i>0.0051</i>
4295/54	0.0058	0.0058	<i>0.0058</i>
<b>Mean value</b>	<i>0.0055</i>	<i>0.0055</i>	<b>0.0055</b>

### 2.3. DYNAMIC MODULUS OF ELASTICITY – PREN 14146

For each type, 6 test specimens with dimensions 5/5/30 cm have been used for this test.





The dynamic modulus of elasticity of the stone is calculated from the fundamental resonance frequency that is measured with a specific device (type Grindo-Sonic). Vibrations are generated on the samples (prismatic or cylindrical) by a little stroke of a little hammer. The fundamental resonance frequency is then deduced from the received signal and the dynamic modulus of elasticity can be calculated.

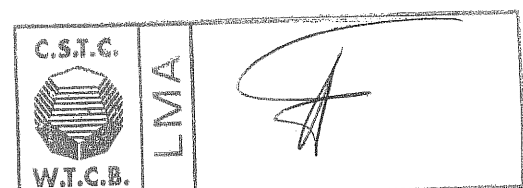
Number test specimen	resonance frequency [Hz]	apparent density [kg/m <sup>3</sup> ]	dynamic modulus of elasticity [GPa] or [kN/mm <sup>2</sup> ]
4294/47	2681.0	2473	65.76
4294/48	2758.5	2577	72.54
4294/49	2711.5	2522	68.60
4294/50	2717.0	2587	70.65
4294/51	2707.5	2547	69.07
4294/52	2757.0	2630	73.96
<b>Mean value</b>	<b>2722.1</b>	<b>2556</b>	<b>70.10</b>

Number test specimen	resonance frequency [Hz]	apparent density [kg/m <sup>3</sup> ]	dynamic modulus of elasticity [GPa] or [kN/mm <sup>2</sup> ]
4295/47	2768.0	2663	75.49
4295/48	2788.0	2642	75.97
4295/49	2741.0	2653	73.74
4295/50	2782.0	2640	75.59
4295/51	2757.0	2662	74.85
4295/52	2776.0	2660	75.83
<b>Mean value</b>	<b>2768.7</b>	<b>2653</b>	<b>75.24</b>

#### 2.4. COMPRESSIVE STRENGTH – NBN EN 1926

For each type, 6 test specimens with dimensions 5/5/5 cm have been used for this test.

The samples, with rectified surfaces, are placed and centered on a platform of a press. The load of the press is continuously increased until rupture. This gives a value of compressive strength of the stone.





### 3. TESTS AND RESULTS – TYPE B

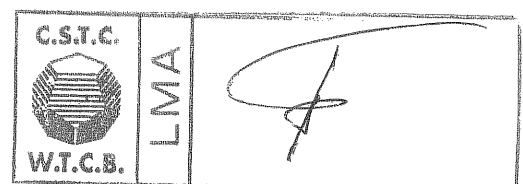
#### 3.1. ABRASION RESISTANCE – NBN EN 14157 – METHOD A (CAPON WIDE WHEEL)

For each type, 6 test specimens with dimensions 10/10/2 cm have been used for this test.

The test is carried out by abrading the face of the sample with a rotating wheel and an abrasive material. The abrasion wear is determined as the width of the indentation in the sample.

Number test specimen	abrasion [mm]
4296/35	20.4
4296/36	19.1
4296/37	19.5
4296/38	18.7
4296/39	20.0
4296/40	20.1
<b>Mean value</b>	<b>19.6</b>
<b>Standard deviation</b>	<b>0.65</b>

Number test specimen	abrasion [mm]
4297/35	18.1
4297/36	18.1
4297/37	18.1
4297/38	18.1
4297/39	19.2
4297/40	19.4
<b>Mean value</b>	<b>18.5</b>
<b>Standard deviation</b>	<b>0.65</b>





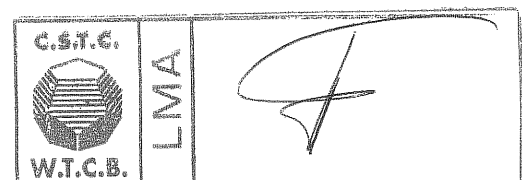
Number test specimen	compressive strength [N/mm <sup>2</sup> ]
4294/9	112
4294/10	110
4294/11	125
4294/12	114
4294/13	117
4294/14	116
<b>Mean value</b>	<b>116</b>
<b>Standard deviation</b>	<b>5</b>

Number test specimen	compressive strength [N/mm <sup>2</sup> ]
4295/15	146
4295/16	135
4295/17	151
4295/18	135
4295/19	128
4295/20	120
<b>Mean value</b>	<b>136</b>
<b>Standard deviation</b>	<b>12</b>

## 2.5. FLEXURAL STRENGTH – NBN EN 12372

For each type, 10 test specimens with dimensions 5/5/30 cm have been used for this test.

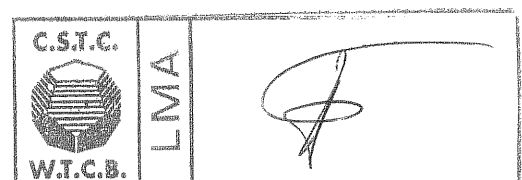
The samples, with standardized dimensions, are placed and centered on two bars. A concentrated load exerts pressure that is continuously increased, on the sample until rupture. This gives the value of flexural strength of the natural stone.





Number test specimen	flexural strength [N/mm <sup>2</sup> ]
4294/31	18.6
4294/32	13.0
4294/33	22.1
4294/34	17.5
4294/35	21.0
4294/36	24.2
4294/37	16.8
4294/38	19.5
4294/39	18.1
4294/40	19.2
<b>Mean value</b>	<b>19.0</b>
<b>Standard deviation</b>	<b>3.1</b>

Number test specimen	flexural strength [N/mm <sup>2</sup> ]
4295/31	17.0
4295/32	14.2
4295/33	16.5
4295/34	16.7
4295/35	17.0
4295/36	17.3
4295/37	16.7
4295/38	16.7
4295/39	19.8
4295/40	16.2
<b>Mean value</b>	<b>16.8</b>
<b>Standard deviation</b>	<b>1.1</b>







### 3.2. COMPRESSIVE STRENGTH BEFORE FREEZE-THAW CYCLES – NBN EN 1926

For each type, 6 test specimens with dimensions 5/5/5 cm have been used for this test.

The samples, with rectified surfaces, are placed and centered on a platform of a press. The load of the press is continuously increased until rupture. This gives a value of compressive strength of the stone.

Number test specimen	compressive strength [N/mm <sup>2</sup> ]
4294/15	108.5
4294/16	113.4
4294/17	121.0
4294/18	95.1
4294/19	103.7
4294/20	106.6
<b>Mean value</b>	<b>108.0</b>
<b>Standard deviation</b>	<b>8.8</b>

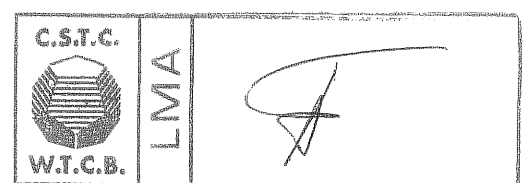
Number test specimen (*)	compressive strength [N/mm <sup>2</sup> ]
4295/15	146
4295/16	135
4295/17	151
4295/18	135
4295/19	128
4295/20	120
<b>Mean value</b>	<b>136</b>
<b>Standard deviation</b>	<b>12</b>

(\*) Due to a lack of samples, the results of §2.4 are here considered.

### 3.3. FLEXURAL STRENGTH BEFORE FREEZE-THAW CYCLES – NBN EN 12372

For each type, 10 test specimens with dimensions 5/5/30 cm have been used for this test.

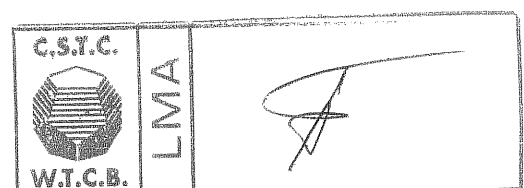
The samples, with standardized dimensions, are placed and centered on two bars. A concentrated load exerts pressure that is continuously increased, on the sample until rupture. This gives the value of flexural strength of the natural stone.





Number test specimen	flexural strength [N/mm <sup>2</sup> ]
4296/1	21.4
4296/2	19.5
4296/3	19.0
4296/4	19.2
4296/5	20.3
4296/6	17.9
4296/7	20.4
4296/8	16.4
4296/9	18.3
4296/10	20.0
<b>Mean value</b>	<b>19.2</b>
<b>Standard deviation</b>	<b>1.5</b>

Number test specimen	flexural strength [N/mm <sup>2</sup> ]
4297/1	18.5
4297/2	18.8
4297/3	19.0
4297/4	16.8
4297/5	18.2
4297/6	15.9
4297/7	18.6
4297/8	18.3
4297/9	19.5
4297/10	17.4
<b>Mean value</b>	<b>18.1</b>
<b>Standard deviation</b>	<b>1.1</b>





3.4. FROST RESISTANCE – NBN EN 12371

For each type, 10 test specimens with dimensions 5/5/30 cm and 6 test specimens with dimensions 7/7/7 cm have been used for this test.

The samples undergo 48 cycles of frost in air and thawing in water. After drying, the flexural / compressive strength is determined.

3.5. COMPRESSIVE STRENGTH AFTER FREEZE-THAW CYCLES – NBN EN 1926

For each type, 6 test specimens with dimensions 5/5/5 cm have been used for this test.

The samples, with rectified surfaces, are placed and centered on a platform of a press. The load of the press is continuously increased until rupture. This gives the value of compressive strength of the stone.

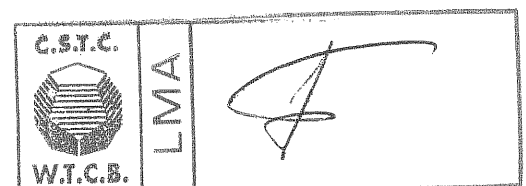
Number test specimen	compressive strength [N/mm <sup>2</sup> ]
4296/28	118.3
4296/29	117.9
4296/30	122.0
4296/31	114.7
4296/32	117.0
4296/33	124.1
<b>Mean value</b>	<b>119.0</b>
<b>Standard deviation</b>	<b>3.4</b>

Mean value compressive strength "before freeze-thaw cycles: 108 N/mm<sup>2</sup>

Mean value compressive strength "after freeze-thaw cycles: 119 N/mm<sup>2</sup>

The variation in compressive strength after freeze-thaw cycles for "JWQ" is + 10.14 %

Number test specimen	compressive strength [N/mm <sup>2</sup> ]
4297/28	119.0
4297/29	135.5
4297/30	132.3
4297/31	123.8
4297/32	130.0
4297/33	131.0
<b>Mean value</b>	<b>128.6</b>
<b>Standard deviation</b>	<b>6.1</b>





Mean value compressive strength "before freeze-thaw cycles: 136 N/mm<sup>2</sup>  
Mean value compressive strength "after freeze-thaw cycles: 129 N/mm<sup>2</sup>  
The variation in compressive strength after freeze-thaw cycles for "HRQ-TCQ" is - 5.39 %

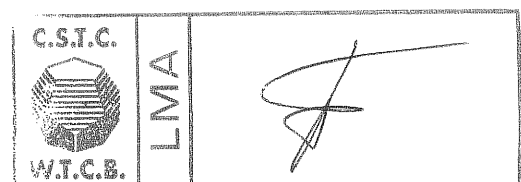
### 3.6. FLEXURAL STRENGTH AFTER FREEZE-THAW CYCLES – NBN EN 12372

For each type, 10 test specimens with dimensions 5/5/30 cm have been used for this test.

The samples, with standardized dimensions, are placed and centered on a two bars. A concentrated load exerts pressure that is continuously increased, on the sample until rupture. This gives the value of flexural strength of the natural stone.

Number test specimen	flexural strength [N/mm <sup>2</sup> ]
4296/11	15.5
4296/12	15.9
4296/13	16.8
4296/14	17.9
4296/15	16.3
4296/16	15.8
4296/17	16.5
4296/18	16.0
4296/19	16.7
4296/20	16.9
<b>Mean value</b>	<b>16.4</b>
<b>Standard deviation</b>	<b>0.7</b>

Mean value flexural strength "before freeze-thaw cycles: 19.2 N/mm<sup>2</sup>  
Mean value flexural strength "after freeze-thaw cycles: 16.4 N/mm<sup>2</sup>  
The variation in flexural strength after freeze-thaw cycles for "JWQ" is - 14.63 %





Number test specimen	flexural strength [N/mm <sup>2</sup> ]
4297/11	13.3
4297/12	14.7
4297/13	13.8
4297/14	16.9
4297/15	14.9
4297/16	17.0
4297/17	16.5
4297/18	15.6
4297/19	15.0
4297/20	16.1
<b>Mean value</b>	<b>15.4</b>
<b>Standard deviation</b>	<b>1.3</b>

Mean value flexural strength "before freeze-thaw cycles: 18.1 N/mm<sup>2</sup>

Mean value flexural strength "after freeze-thaw cycles: 15.4 N/mm<sup>2</sup>

The variation in flexural strength after freeze-thaw cycles for "HRQ-TCQ" is - 15.03 %

