



INGENIERIE EUROPE

GROUPE



GINGER CEBTP

Bayonne, 23 July 2010

**PIEDRA DEL ALTO ARAGON
22373 FISCAL (HUESCA)**

NATURAL STONE TESTS

File No. SBA3.9.0125/05

This document contains 10 pages

This document shall not be used for commercial or advertising purposes other than in its full unabridged form without prior authorisation. The results obtained cannot be generalised without substantiation of the representativeness of the samples and of the tests. The samples are not retained after delivery of the test report unless the client has specifically so requested.



Agence de BAYONNE

ZA Saint Frédéric - Rue de Chalibardon

64100 BAYONNE

Téléphone : 05 59 55 88 10

Télécopie : 05 59 55 58 30

Email : cebtp.bayonne@gingergroupe.com

CONTENTS



1 – INTRODUCTION	P3
2 – TEST PROGRAMME	P3
4 – TEST RESULTS	P4

1 – INTRODUCTION

GINGER-CEBTP, CEE of Bayonne, France carried out natural stone tests at the request and on behalf of PIEDRA DEL ALTO ARAGON, 22373 FISCAL.

The samples were taken by the client and delivered to our laboratory in BAYONNE (64100), France.

2 – TEST PROGRAMME

The tests were carried out as per our commercial quote SBA3.9.0149 of 19/10/2009 and consisted of the following :

- Petrographic examination for stone characterisation ;
- Determination of the density and porosity as per the standard NF EN 1936 ;
- Compression strength measurement as per the standard NF EN 1926 ;
- Flexural strength measurement as per the standard NF EN 12372 ;
- Determination of the water absorption by capillarity as per the standard NF EN 1925 ;
- Mohs hardness measurement;
- Slip resistance measurement (pendulum tester) as per the standard NF EN 14157 ;
- Wear test (metal disc) as per the standard NF EN 14157;
- Freeze/thaw test (144 cycles) as per the standard NF EN 12371.

3 – TEST RESULTS

3.1 – Petrographic examination

The examination shows the samples to be a lithic arenite – calcarenite.

3.2 – Determination of density and open porosity

The tests were carried out as per the standard *NF EN 1936*.

	Cubic test specimens 75 x 73 x 70					
Reference no.	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
MVA (kg /m ³)	2688	2689	2687	2687	2674	2686
Open porosity (%)	0.3	0.3	0.3	0.3	0.5	0.4

Average density = 2685 kg/m³
Average open porosity = 0.35%

3.3 – Compression test

The tests were carried out on cubic test specimens 70 x 70 x 70 mm, as per the standard NF EN 1926.

Reference no. of test specimen	Mass (g)	Compressive stress (MPa)
1	1007	143.8
2	1039	174.7
3	1026	142.0
4	1024	147.9
5	1022	130.6
6	1014	162.5
7	1022	154.9
8	1013	150.2
9	1030	146.5
10	1039	141.2
Average Rc		149.4

3.4 – Flexural strength measurement as per the standard NF EN 12372

The tests were carried out on test specimens 300 x 50 x 50 mm, as per the standard NF EN 12372.

Reference no. of test specimen	Mass (g)	Compressive stress (MPa)
1	2081	24.1
2	2125	24.7
3	2126	16.8*
4	2124	25.9
5	2126	28.3
6	2127	26.5
7	2078	23.5
8	2109	16.2*
9	2135	24.7
10	2123	25.9
Average Rf		23.7

* Rupture plane located at a distance of more than 15% of the distance between supports.

3.5 - Determination of water absorption by capillarity

The water absorption by capillarity test was carried out as per the standard *NF EN 1925*.

Cubic test specimens 70 x 70 x 70 mm						
Reference no.	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
$\frac{C}{g/m^2 \cdot s^{0.5}}$	115	135	148	121	140	133

$$\text{Average} = 132 \text{ g/m}^2 \cdot \text{s}^{0.5}$$

3.6 - Mohs hardness measurement

Test specimens D 145 x 97 x 21 mm						
Reference no.	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
Mohs hardness	5 1/2	5 1/2	6	5 1/2	6	6

According to the Mohs hardness scale, glass (5 1/2) and orthoclase (6) do not produce more than one scratch on the specimens tested (test adapted according to the standard *EN 101* on ceramic tiles).

3.7 - Slip resistance measurement

The tests were carried out using a test pendulum.

Test principle

This test assesses the appearance of the roughness of a surface by the friction of a rubber pad on this surface at low speed.

Its aim is to measure the friction coefficient which, by definition, is the average divided by 100 of a certain number of readings taken on the pendulum dial.

The contact surface and the pad are copiously wetted before the test.

Test specimens D 145 x 95 x 20 mm						
Reference number	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
Number of readings	66	61	68	64	69	70

$$\text{Average friction coefficient} = 0.66$$

3.8 - Wear test using a metal disc

The tests are carried out as per the NF EN 14157 standard (method A).

The length of each imprint formed by a steel disc (\varnothing 200 mm \pm 1 mm, width 70 mm \pm 1 mm) rotating for 60 s at a speed of 75 rpm on the facing of the samples is determined.

White aluminium oxide (corundum F 80) flows between the disc and the sample.
A counterweight presses the sample against the disc.

Two imprints are made on each sample. Only the maximum individual value reached is noted.

	Test specimens D 100 x 70 mm					
Reference no.	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
Imprint length (mm)	20.5	19.5	21.0	21.5	19.0	19.0

Average value = 20.0 mm

3.9 – Frost resistance as per the NF EN 12371 – May 2003 standard

3.9.1 - Procedure

The prisms received were subjected to cycles of freezing in air / thawing in water which respected the cycles and exposure temperatures required under the standard.

The test carried out was the identification test (Test B): 7 prisms were placed in the cold chamber. The temperature was taken inside one of the specimens, the regulation of the chamber being slaved to this measurement. Each cycle consists of 6 h of freezing in air, followed by 6 h of thawing in water.

According to the NF EN 12371 standard (part 7.3.2.4), the test is continued until at least 2 test specimens are considered to be altered according to one of the following criteria:

- Visual examination

The visible alterations during examination are expressed according to a scale of evolution ranging from 0 to 5 (crumbling, cracking, flaking, splitting and breaking). The alteration threshold is reached for a score of **3**.

- Apparent volume

The change in the apparent volume is measured by hydrostatic weighs. The reduction in the apparent volume must be less than 1%. This reduction indicates a loss of material.

- Dynamic elasticity modulus

The reduction in dynamic elasticity modulus is determined using the fundamental resonance frequency (NF EN 14146). It indicates the appearance of nonvisible cracks. The alteration threshold is reached for a reduction of **30%** of this modulus.

3.9.2 - Results

Petrography:	Lithic arenite – Calcarenite	Delivery date:	12/01/2010
Trade name:	NC	Preparation date:	19/03/2010
Place of extraction:	Fiscal-Broto, Huesca, Aragon, Spain	Start of test:	22/03/2010
Supplier:	Piedra Del Alto Aragon	Number of specimens:	7
Sample taken by:	Piedra Del Alto Aragon	Test supervisor:	PA/JN

Samples			1	2	3	4	5	6	7
Length	L	mm	301.0	301.0	301.0	301.0	301.0	301.0	301.0
Base 1		mm	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Base 2		mm	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Mass of saturated specimen after immersion in water and before freezing	M_{s0}	g	2121.8	2125.0	2118.8	2108.9	2110.5	2144.0	2078.2
Apparent volume of the specimen before freezing	V_{b0}	ml	790.9	791.9	789.3	785.5	786.5	798.1	775.1
True wet density		kg/m ³	2682.8	2683.4	2684.4	2684.8	2683.4	2686.4	2681.2

Date:	22/03/2010								
Number of cycles:	0								
Visual examination			0	0	0	0	0	0	0
Apparent volume of the specimen before freezing	V_{b0}	ml	790.9	791.9	789.3	785.5	786.5	798.1	775.1
Dynamic elasticity modulus of the wet specimen at n cycles	E_0	MPa	70426.7	69849.1	69446.7	70430.0	70228.4	71586.1	70783.1

Date:	29/03/2010								
Number of cycles:	14								
Visual examination			0	0	0	0	0	0	0
Apparent volume of the specimen at n cycles	V_{bn}	ml	790.4	791.8	789.1	785.4	786.4	798	774.9
Variation in the apparent volume of the specimen	ΔV_b	%	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Dynamic elasticity modulus of the wet specimen at n cycles	E_n	MPa							
Dynamic elasticity modulus variation	ΔE	%							

Date:	06/04/2010								
Number of cycles:	28								
Visual examination			0	0	0	0	0	0	0
Apparent volume of the specimen at n cycles	V_{bn}	ml	791.2	792.1	789.4	785.6	786.9	798.2	775.2
Variation in the apparent volume of the specimen	ΔV_b	%	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
Dynamic elasticity modulus of the wet specimen at n cycles	E_n	MPa	69815.6	68896.4	69380.9	68424.6	69043.5	69481.4	69807.9
Dynamic elasticity modulus variation	ΔE	%	0.9	1.4	0.1	2.8	1.7	2.9	1.4

Petrography:	Lithic arenite – Calcarenite	Delivery date:	12/01/2010
Trade name:	NC	Preparation date:	19/03/2010
Place of extraction:	Fiscal-Broto, Huesca, Aragon, Spain	Start of test:	22/03/2010
Supplier:	Piedra Del Alto Aragon	Number of specimens:	7
Sample taken by:	Piedra Del Alto Aragon	Test supervisor:	PA/JN

Samples			1	2	3	4	5	6	7
Date:	16/04/2010								
Number of cycles:	42								
Visual examination			0	0	0	0	0	0	0
Apparent volume of the specimen at n cycles	V_{bn}	ml	791	792.1	789.3	785.3	786.7	798.3	775.1
Variation in the apparent volume of the specimen	ΔV_b	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dynamic elasticity modulus of the specimen at n cycles	E_n	MPa							
Dynamic elasticity modulus variation	ΔE	%							

Date:	27/04/2010								
Number of cycles:	56								
Visual examination			0	0	0	0	0	0	0
Apparent volume of the specimen at n cycles	V_{bn}	ml	790.6	791.8	789.2	785.4	786.4	797.8	775
Variation in the apparent volume of the specimen	ΔV_b	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dynamic elasticity modulus of the wet specimen at n cycles	E_n	MPa	69141.7	68896.4	67731.3	68310.5	68961.5	69119.9	69363.9
Dynamic elasticity modulus variation	ΔE	%	1.8	1.4	2.5	3.0	1.8	3.4	2.0

Date:	07/05/2010								
Number of cycles:	70								
Visual examination			1	1	1	1	1	1	1
Apparent volume of the specimen at n cycles	V_{bn}	ml	791.1	792.2	790	785.6	786.9	798.5	774.3
Variation in the apparent volume of the specimen	ΔV_b	%	0.0	0.0	-0.1	0.0	-0.1	-0.1	0.1
Dynamic elasticity modulus of the wet specimen at n cycles	E_n	MPa							
Dynamic elasticity modulus variation	ΔE	%							

Date:	17/05/2010								
Number of cycles:	88								
Visual examination			1	2	1	2	1	1	1
Apparent volume of the specimen at n cycles	V_{bn}	ml	790.2	791.7	789.2	785.4	786.6	798.1	774.9
Variation in the apparent volume of the specimen	ΔV_b	%	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Dynamic elasticity modulus of the wet specimen at n cycles	E_n	MPa	69272.9	68716.4	67650.2	68375.7	68879.7	67391.8	69363.9
Dynamic elasticity modulus variation	ΔE	%	1.6	1.6	2.6	2.9	1.9	5.9	2.0

Petrography:	Lithic arenite – Calcarenite	Delivery date:	12/01/2010
Trade name:	NC	Preparation date:	19/03/2010
Place of extraction:	Fiscal-Broto, Huesca, Aragon, Spain	Start of test:	22/03/2010
Supplier:	Piedra Del Alto Aragon	Number of specimens:	7
Sample taken by:	Piedra Del Alto Aragon	Test supervisor:	PA/JN

Samples			1	2	3	4	5	6	7
Date:			27/05/2010						
Number of cycles:			98						
Visual examination			1	2	1	2	1	1	1
Apparent volume of the specimen at n cycles	V_{bn}	ml	790.5	791.8	788.9	785.1	786.3	797.6	774.7
Variation in the apparent volume of the specimen	ΔV_b	%	0.1	0.0	0.1	0.1	0.0	0.1	0.1
Dynamic elasticity modulus of the wet specimen at n cycles	E_n	MPa							
Dynamic elasticity modulus variation	ΔE	%							

Date:			03/06/2010						
Number of cycles:			112						
Visual examination			1	2	1	2	1	1	1
Apparent volume of the specimen at n cycles	V_{bn}	ml	790.1	791.5	788.9	784.8	786.2	797.6	774.6
Variation in the apparent volume of the specimen	ΔV_b	%	0.1	0.1	0.1	0.1	0.0	0.1	0.1
Dynamic elasticity modulus of the wet specimen at n cycles	E_n	MPa	68112.5	68292.0	67083.5	68147.5	67982.3	68906.8	68676.0
Dynamic elasticity modulus variation	ΔE	%	3.3	2.2	3.4	3.2	3.2	3.7	3.0

Date:			16/06/2010						
Number of cycles:			126						
Visual examination			1	2	1	2	1	1	1
Apparent volume of the specimen at n cycles	V_{bn}	ml	790.5	791.5	789.1	784.8	786.4	797.5	774.8
Variation in the apparent volume of the specimen	ΔV_b	%	0.1	0.1	0.0	0.1	0.0	0.1	0.0
Dynamic elasticity modulus of the wet specimen at n cycles	E_n	MPa							
Dynamic elasticity modulus variation	ΔE	%							

Date:			28/06/2010						
Number of cycles:			144						
Visual examination			1	2	1	2	1	1	1
Apparent volume of the specimen at n cycles	V_{bn}	ml	790	791.3	788.8	784.5	785.6	797.2	773.9
Variation in the apparent volume of the specimen	ΔV_b	%	0.1	0.1	0.1	0.1	0.1	0.1	0.2
Dynamic elasticity modulus of the wet specimen at n cycles	E_n	MPa	67803.6	67950.1	66599.6	68163.8	67966.1	68710.4	68414.8
Dynamic elasticity modulus variation	ΔE	%	3.7	2.7	4.1	3.2	3.2	4.0	3.3

3.9.3 – Remarks

- Results

After 144 freeze/thaw cycles, the variation in the apparent volume was stable and relatively uniform between the specimens.

From 70 freeze/thaw cycles, the corners and edges were observed to round off, which does not affect the physical integrity of the specimens, and corresponds to a score of 1 in the scoring scale.

At the 88th cycle, specimens no. 2 and 4 each lost a fragment of area less than 10 mm². They therefore have a score of 2.

Up to the 144th cycle there was no further change in the defects observed on the specimens. The scores are the same as at the 88th cycle.

The dynamic elasticity modulus variation, after 144 freeze/thaw cycles remained low, stable and relatively uniform between the specimens. The reduction was between 2.7% and 4.1%.

- **Special surface finish of the specimens:** sawn surfaces.

- Remarks

According to standard *NF EN 12371*, no alteration threshold was exceeded by the specimens. The freeze/thaw tests are terminated when 2 specimens in the same series are considered to be altered. Therefore, the stone series tested is considered to be resistant to 144 freeze/thaw cycles.

Signed in BAYONNE, on 23/07/10

Contracts Manager
CEE BAYONNE

B. BOUFFAUT

Agency Manager
CEE BAYONNE

A. BARRIERE