



POLITECNICO DI TORINO

LABORATORIO MARMO

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REPORT ON DETERMINATION OF PHYSICAL AND MECHANICAL PROPERTIES ON A SAMPLE OF A NATURAL STONE NAMED VALTURA FIORITO

The Scientific Coordinator:
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DETERMINATION OF PHYSICAL AND MECHANICAL PROPERTIES ON A SAMPLE OF A NATURAL STONE NAMED VALTURA FIORITO

Requested by: KAMEN d.d. PAZIN, 52000 PAZIN, Trg Slobode 2
HRVATSKA

Tested stone: (denomination in accordance with EN 12440):

Traditional name: Valtura Fiorito

Petrographic name: limestone

Region of extraction: Valtura (Istra, Republic of Croatia)

The following tests have been requested, also according to EN 1341, 1342 and 1343, 1469, 12057, 12058, CE marking standards for slabs, kerbs and setts of natural stone for external paving and for slabs for cladding, modular tiles, slabs for floors and stairs:

- petrographic examination, according to EN 12407;
- apparent density and open porosity, according to EN 1936;
- water absorption, according to EN 13755;
- flexural strength under concentrated load according to EN 12372;
- freeze-thaw resistance, according to EN 12371 and EN 12372;
- compressive strength, according to EN 1926;
- freeze-thaw resistance, according to EN 12371 and EN 1926;
- abrasion resistance, according to EN 1341, Annex C and EN 1342, Annex B;
- modulus of elasticity according to EN 14580;
- linear thermal expansion coefficient according to EN 14581;
- breaking load at dowel hole, according to EN 13364;
- resistance to salt crystallisation according to EN 12370.



TEST RESULTS

PETROGRAPHIC EXAMINATION

Test method:

The test has been performed according to EN 12407 – 2007 Natural stone test methods – Petrographic examination.

Macroscopic description:

The hand specimen appears fine grained and has an pale brownish colour with big fragments of fossils having a darker colour and other fragments having an ivory colour.

Microscopic description:

In thin section the rock appears almost completely made up by calcite.

The constituents are:

- micritic matrix (30 %);
- rounded grains (intraclasts) of sparitic calcite whose dimensions vary from 0.01 mm to 0.03 mm (40 %);
- Fragments of fossils (30 %) almost solely represented by big bivalvia, the dimensions of fragments vary from 1 mm to several centimetres.

The rock is a limestone (intrabiomicrite).



APPARENT DENSITY AND OPEN POROSITY

Test method:

The apparent density, real density and the total porosity have been determined according to EN 1936- 2006 Natural stone test methods - Determination of real density and apparent density and of total and open porosity.

All the specimens are in natural conditions with sawn surface finish.

APPARENT DENSITY AND OPEN POROSITY

Specimen identification number	Mass of the dry specimen (g)	Mass of the soaked specimen in water (g)	Mass of the soaked specimen in air (g)	Apparent density (kg/m ³)		Open porosity (% by volume)	
				individual values	average value	individual values	average value
1	302,22	190,15	313,19	2450		8,9	
2	304,12	191,34	315,20	2450		8,9	
3	291,19	183,19	306,74	2350		12,6	
4	301,89	189,97	313,50	2440		9,4	
5	308,16	193,88	317,75	2480		7,7	
6	308,54	194,1	317,97	2490	2440	7,6	9,2



WATER ABSORPTION

Test method:

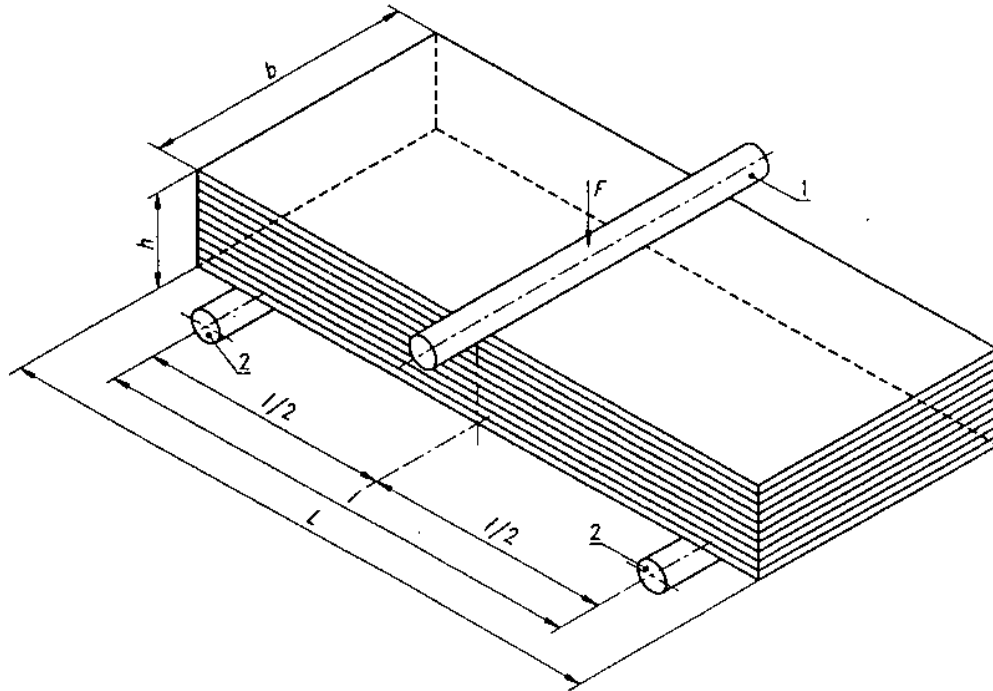
The water absorption has been determined according to EN 13755 - 2003 Natural stone test methods - Determination of water absorption at atmospheric pressure.

All the specimens are in natural conditions with sawn surface finish.

Specimens: 6 cubes having 50 mm edge.

Specimen identification number	Mass of the dry specimen (g)	Mass of the saturated specimen in water (g)	Water absorption (% by mass)	
			individual values	average value
1	304,45	312,17	2,54	
2	305,1	312,18	2,32	
3	299,72	308,65	2,98	
4	298,98	308,39	3,15	
5	306,05	313,54	2,45	
6	308,19	314,58	2,07	2,6

FLEXURAL STRENGTH UNDER CONCENTRATED LOAD ON SPECIMENS BOTH IN NATURAL CONDITIONS AND SUBJECTED TO FROST TEST



Test method:

The flexural strength has been determined according to EN 12372 - 2006 Natural stone test methods - Determination of flexural strength under concentrated load.

For the frost test ten specimens, previously saturated in water, have been submitted to 48 freezing and thawing cycles according to EN 12371 - 2001 Natural stone test methods - Determination of frost resistance.

All the specimens are in natural conditions with sawn surface finish.



Specimens in natural conditions

Specimen identification number	Length of span l (mm)	Height h (mm)	Width b (mm)	Total load at failure P (kN)	Flexural strength σ (MPa)	
					individual values	average value
1	125	24,6	49,9	2,06	12,8	
2	125	24,5	50,5	1,83	11,3	
3	125	24,4	49,8	2,01	12,7	
4	125	24,6	49,8	2,41	15,0	
5	125	24,5	51,1	1,71	10,5	
6	125	24,5	50,0	1,23	7,7	
7	125	24,6	50,1	1,81	11,2	
8	125	24,6	49,9	2,01	12,5	
9	125	24,5	49,6	1,73	10,9	
10	125	24,0	49,7	0,96	6,3	11,1

Specimens subjected to frost test

Specimen identification number	Length of span l (mm)	Height h (mm)	Width b (mm)	Total load at failure P (kN)	Flexural strength σ (MPa)	
					individual values	average value
11	125	24,9	50,4	1,29	7,7	
12	125	23,6	49,7	1,53	10,4	
13	125	24,5	49,9	1,34	8,4	
14	125	24,7	50,1	1,72	10,6	
15	125	24,6	49,8	1,39	8,6	
16	125	24,5	49,8	1,28	8,0	
17	125	23,6	49,8	1,41	9,5	
18	125	24,7	49,5	0,87	5,4	
19	125	24,6	49,9	1,30	8,1	
20	125	24,4	49,9	0,40	2,5	7,9



COMPRESSION STRENGTH ON SPECIMENS BOTH IN NATURAL CONDITIONS AND SUBJECTED TO FROST TEST

Test method:

The compression strength has been determined according to EN 1926 – 2006 Natural stone test methods - Determination of compressive strength.

For the frost test: five specimens, previously saturated in water, have been submitted to 48 freezing and thawing cycles according to EN 12371 -2001 Natural stone test methods - Determination of frost resistance.

Specimens in natural conditions

Specimen identification number	Area of the bearing surface (mm ²)	Total load at failure (kN)	Compressive strength	
			individual values (MPa)	average value (MPa)
1	4816	235	49	
2	4796	324	68	
3	4782	328	69	
4	4802	326	68	
5	4789	378	79	
6	4754	185	39	62

Specimens subjected to frost test

1	4823	252	52	
2	4816	313	65	
3	4789	297	62	
4	4768	231	48	
5	4789	257	54	
6	4782	219	46	55



DETERMINATION OF ABRASION RESISTANCE

Test method:

The abrasion resistance has been determined according to EN 1341 -2001 Slabs of natural stone for external paving – Requirements and test methods - Annex C and EN 1342 - 2001 Setts of natural stone for external paving – Requirements and test methods - Annex B and to EN 14157 - 2004 Natural stone test methods - Determination of abrasion resistance.

All the specimens are in natural conditions with sawn surface finish.

Specimen identification number	Groove length (mm)	Mean groove length (mm)
1	21,0	21,0
2	21,0	
3	21,0	
4	21,0	
5	21,0	
6	22,0	



MODULUS OF ELASTICITY

Test method:

The moduli of elasticity have been determined according to EN 14580 - 2005 Natural stone test methods - Determination of static elastic modulus.

Specimen identification number	Static elastic modulus (MPa)	Mean value (MPa)
1	48490	
2	49962	
3	48697	
4	47938	
5	47048	
6	47788	48321



DETERMINATION OF LINEAR THERMAL EXPANSION COEFFICIENT

Test method

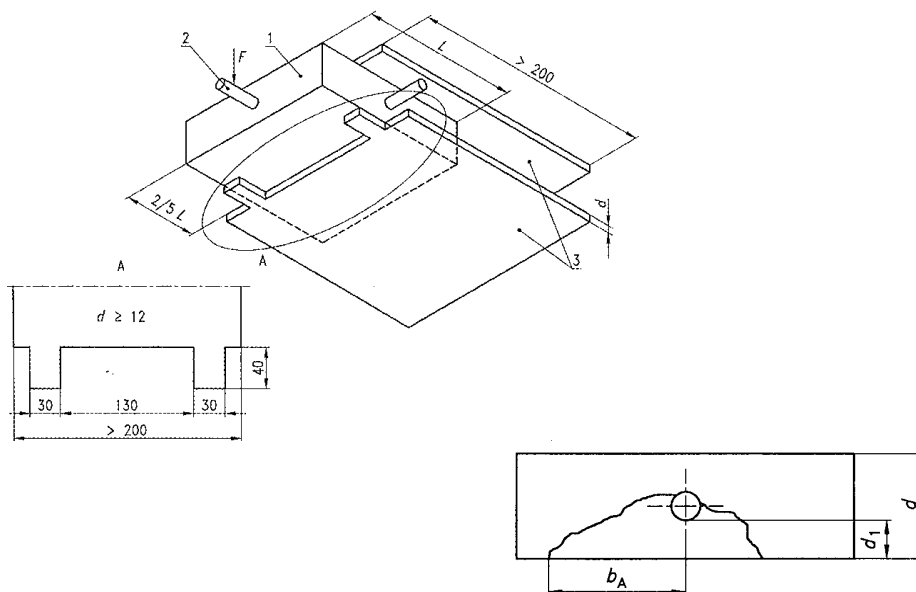
The test has been performed according to EN 14581 – 2004 Natural stone test methods - Determination of linear thermal expansion coefficient

Specimen identification number	Linear expansion coefficient ($10^{-6} \cdot ^\circ\text{C}^{-1}$) after the first heating cycle	Linear expansion coefficient ($10^{-6} \cdot ^\circ\text{C}^{-1}$) after the second heating cycle
1	3	3
2	3	3
Mean values	3	3

DETERMINATION OF THE BREAKING LOAD AT DOWEL-HOLE

Test method

The test has been performed according to the EN 13364 - 2001 Natural stone test methods - Determination of the breaking load at dowel hole.



Dimensions in millimetres

Specimen identification number	Hole identification number	Specimen thickness (mm)	Breaking load (N)	Maximum distance from the centre of the hole to the edge of the fracture (b_A)(mm)	Distance from the hole to the face in the direction of the force (d_1)(mm)
1	1	30,0	2350	35	11
	2	30,0	2630	41	10
	3	30,0	1730	57	10
	4	30,0	890	34	9
2	1	30,0	1710	31	10
	2	30,0	2550	54	12
	3	30,0	1310	32	8
	4	30,0	1670	40	9
3	1	30,0	1370	42	9
	2	30,0	1640	56	9
	3	30,0	1500	36	10
	4	30,0	2200	43	11
Mean values			1796	42	10

DETERMINATION OF RESISTANCE TO SALT CRYSTALLISATION

Test method:

The test has been performed according to EN 12370 - 1999 Natural stone test methods - Determination of resistance to salt crystallisation.

Specimen identification number	Initial mass of the dry specimen (g)	Initial mass of the dry specimen re-weighed with label (g)	Final mass of the dry specimen weighed with label (g)	Relative mass difference (%)
1	155,24	155,95	153,42	-1,6
2	152,11	152,96	144,40	-5,6
3	154,06	154,51	149,59	-3,2
4	156,13	156,80	154,35	-1,6
5	152,21	152,85	145,68	-4,7
6	153,04	153,69	143,86	-6,4
Average value				-3,86



Photograph of the specimens after the crystallization test: the reference specimen is in the centre.

The test has produced strong alterations with detachments.



SUMMARY OF THE RESULTS
(average values)

Petrographic name:.....	limestone (intrabiomicrite)
Apparent density:.....	2440 kg/m ³
Open porosity	9.2 % by volume
Water absorption	2.58 % by mass
Flexural strength in natural conditions	11.1 MPa
Flexural strength after frost test.....	7.9 MPa
Compression strength in natural conditions	62 MPa
Compression strength after frost test	55 MPa
Abrasion resistance (groove length)	21,0 (mm)
Static modulus of elasticity	48321 MPa
Linear expansion coefficient	$3-3 * 10^{-6} * ^\circ\text{C}^{-1}$
Breaking load at dowel-hole.....	1796 N
Breaking load at dowel-hole, maximum fracture distance	42 mm
Resistance to salt crystallisation	- 3.86 % (mass difference)