



# POLITECNICO DI TORINO

LABORATORIO MARMO

Dipartimento di Ingegneria del Territorio, dell'Ambiente e delle Geotecnologie

PROT. N. 6267

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REPORT N. 20/08/2007

DETERMINATION OF PHYSICAL AND MECHANICAL PROPERTIES  
ON A SAMPLE OF A NATURAL STONE NAMED VERDE SPLUGA  
COMING FROM ISOLA, SONDRIO, ITALY

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Il Coordinatore delle Prove:  
(Dott. Paola Marini)

Visto:  
Il Direttore  
(Prof. Sergio Dequal)



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PROPERTIES ON A SAMPLE OF A NATURAL STONE NAMED  
VERDE SPLUGA COMING FROM ISOLA, SONDRIO, ITALY

**Requested by:** Graniti Conrad S.r.l. - Via Nazionale, 6 - 23020 - Piuro (SO) - Italy

**Invoice to:** Soc. Cavatori Beola e Quarzite Valle Spluga S.r.l. - fraz. Isola - 23024  
Madesimo (SO) - Italy - P.I: 00427470141

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

Traditional name: Verde Spluga

Petrographic name: gneiss

Region of extraction: Isola (Sondrio, Italy)

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:

- 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;
- slip resistance, according to EN 1341 Annex D and EN 1342, Annex C and to EN 14231 for the following surface finished:
  - sand blasted
- breaking load at dowel hole, according to EN 13364;

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## TEST RESULTS

### APPARENT DENSITY AND OPEN POROSITY

#### Test method:

The apparent density and the open 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 <sup>3</sup> )		Open porosity (% by volume)	
				individual values	average value	individual values	average value
1	336,21	210,50	337,17	2650		0,8	
2	335,85	210,32	336,83	2650		0,8	
3	337,68	211,44	338,75	2650		0,8	
4	334,64	209,60	335,68	2650		0,8	
5	336,82	211,08	337,85	2650		0,8	
6	336,61	210,86	337,55	2650	2650	0,7	0,8



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## 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	336,21	337,05	0,25	
2	335,86	336,73	0,26	
3	337,71	338,60	0,26	
4	334,65	335,50	0,25	
5	336,84	337,71	0,26	
6	336,61	337,46	0,25	0,3

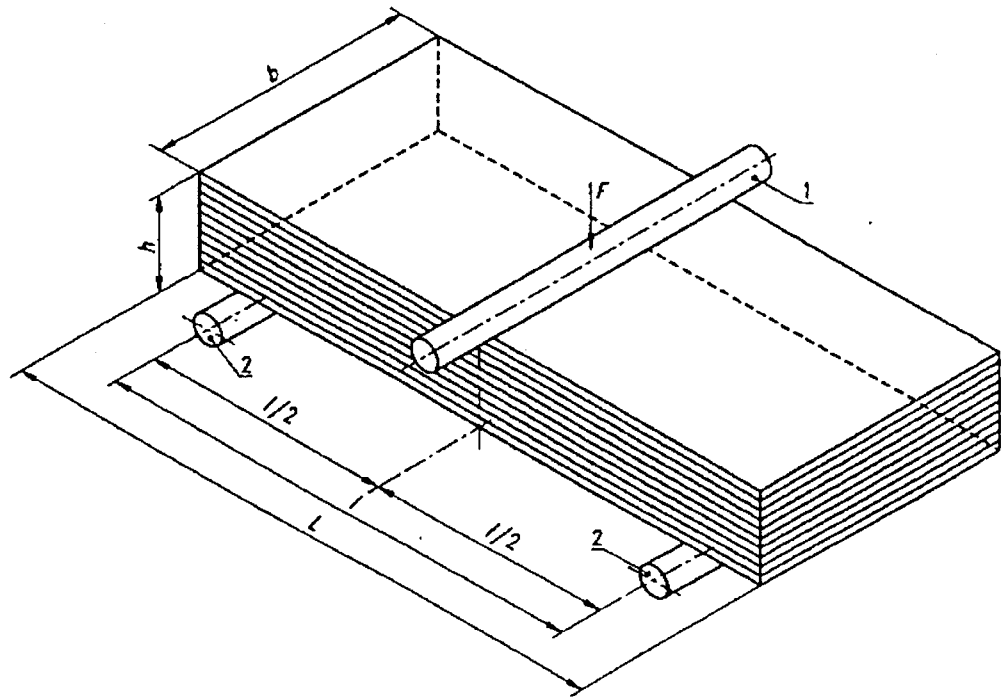
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## FLEXURAL STRENGTH UNDER CONCENTRATED LOAD ON SPECIMENS BOTH IN NATURAL CONDITIONS AND SUBJECTED TO FROST TEST



### 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.

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**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 $\sigma$ (MPa)		
					individual values	average value	st. deviation
1	125	24,7	50,5	4,59	27,9		
2	125	25,0	50,5	4,77	28,3		
3	125	25,1	50,6	4,56	26,8		
4	125	25,2	50,2	4,83	28,4		
5	125	24,9	50,2	4,40	26,5		
6	125	24,8	50,3	4,28	25,9		
7	125	24,9	50,1	4,71	28,4		
8	125	25,2	50,3	4,92	28,9		
9	125	25,3	50,3	4,93	28,7		
10	125	25,1	50,4	4,34	25,6	27,6	1,2

**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 $\sigma$ (MPa)		
					individual values	average value	st. deviation
11	125	25,0	50,3	5,06	30,2		
12	125	24,9	50,5	4,53	27,1		
13	125	24,8	50,3	4,62	28,0		
14	125	25,0	50,2	4,84	28,9		
15	125	24,9	50,4	4,41	26,5		
16	125	24,8	50,3	4,44	26,9		
17	125	25,0	50,3	4,40	26,2		
18	125	25,0	50,2	4,35	26,0		
19	125	25,0	50,4	4,70	28,0		
20	125	24,9	50,7	4,34	25,9	27,4	1,4

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

### Test method:

The compression strength has been determined according to UNI 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 <sup>2</sup> )	Total load at failure		Compressive strength	
		(kN)	individual values (MPa)	average value (MPa)	st, deviation (MPa)
1	4928	884	179		
2	4907	809	165		
3	4921	726	148		
4	4893	885	181		
5	4935	933	189		
6	4914	942	192	176	17

### Specimens subjected to frost test

1	4984	999	200		
2	4956	1070	216		
3	4935	1091	221		
4	4956	1075	217		
5	4914	1138	232		
6	4963	929	187	212	16

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## 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	15,5	15,5
2	15,0	
3	15,5	
4	15,5	
5	15,5	
6	16,0	





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## DETERMINATION OF SLIP RESISTANCE VALUE BY MEANS OF THE PENDULUM TESTER

### Test method:

The slip resistance value (SRV) on dry specimens has been determined according to EN 14231- 2003 Natural stone test methods - Determination of the slip resistance by means of the pendulum tester.

The slip resistance value measured on wet specimens has been determined following EN 1341: 2001 "Slabs of natural stone for external paving – Requirements and test methods" Annex D, EN 1342: 2001 "Setts of natural stone for external paving – Requirements and test methods" Annex C and EN 14231- 2003 Natural stone test methods - Determination of the slip resistance by means of the pendulum tester.

For this reason for CE marking, concerning the specimens in wet conditions, the USRV (unpolished slip resistance value) requested by EN 1341 and 1342 is the same value of the SRV requested by EN 12057 and 12058.

### Specimen surface: SAND BLASTED

Specimen identification number	SRV specimens in dry conditions	Mean SRV dry conditions	SRV - USRV specimens in wet conditions	Mean USRV wet conditions
1	85		60	
2	79		63	
3	82		57	
4	91		64	
5	87		67	
6	89	86	66	63

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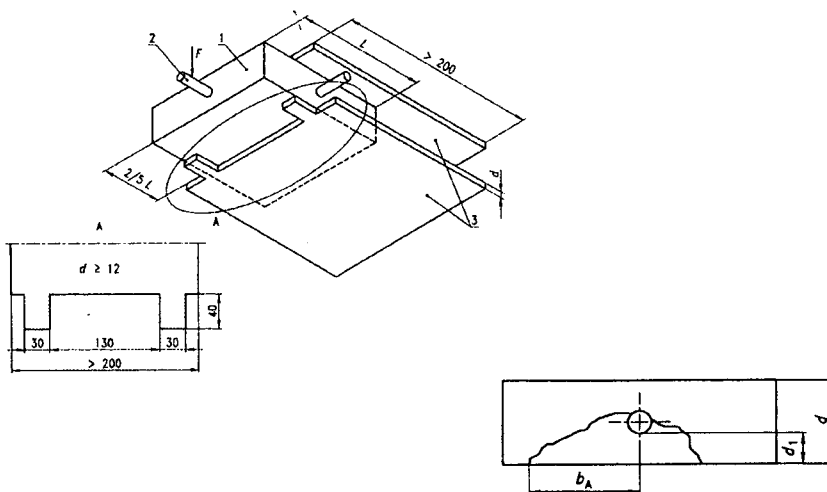


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DETERMINATION OF THE BREAKING LOAD AT DOWEL-HOLE

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

Table with 6 columns: 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). It contains 12 rows of test data and a final row for the mean value.

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Handwritten signature of Paola Marini

Visto: Direttore (Prof. Sergio Dequal)

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SUMMARY OF THE RESULTS (average values)

Apparent density: .....	2650 kg/m <sup>3</sup>
Open porosity .....	0.8 % by volume
Water absorption .....	0.3 % by mass
Flexural strength in natural conditions.....	27.6 MPa
Flexural strength after frost test .....	27.4 MPa
Compression strength in natural conditions .....	176 MPa
Compression strength after frost test .....	212 MPa
Abrasion resistance (groove length).....	15.5 mm
Slip resistance value - sand blasted (dry).....	86 (SRV)
Slip resistance value - sand blasted (wet).....	63 (SRV -USRV)
Breaking load at dowel-hole .....	3228 N
Breaking load at dowel-hole, maximum fracture distance.....	69 m

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