



POLITECNICO DI TORINO

LABORATORIO MARMO

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

PROT. N. 6268

13.04.2007

REPORT N. 21/08/2007

DETERMINATION OF PHYSICAL AND MECHANICAL PROPERTIES
ON A SAMPLE OF A NATURAL STONE NAMED RHEIN
QUARZIT/SILBER GRÜN COMING FROM HINTERRHEIN,
SWITZERLAND

Il Coordinatore delle Prove:
(Dott. Paola Marini)

Visto:
~~Il Direttore~~
(Prof. Sergio Dequal)



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

Invoice to:

Graniti Conrad S.r.l. - Via Nazionale, 6 - 23020 - Piuro (SO) - Italy - P.I. 00123140147

De Giambattista Franco e F.lli S.r.l. - Via Boggia, 5 - 23020 - Gordona (SO) - Italy - P.I. 00057650145

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

Traditional name: Rhein Quarzit/Silber Grün

Petrographic name: paragneiss

Region of extraction: Hinterrhein, Switzerland

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

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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 sample is grey coloured , fine grained with schistose fabric.

Microscopic description:

The thin section show a clear anisotropy underlined by the orientation of the mica lamina and of the level of quartz.

The mineral present are:

Quartz (75%) in allotriomorphic grain whose dimensions vary from 0.05 to 1 mm;

White mica (10%) whose lamina reach the millimetre;

Piroxene (augite), garnet, K feldspar, plagioclase, titanite, rutilo and chlorite for the remaining 15 %.

The rock is a quartzitic paragneiss.

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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.

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	330,20	206,93	331,19	2650		0,8	
2	335,74	210,46	336,84	2650		0,9	
3	330,19	206,93	331,22	2650		0,8	
4	331,61	207,85	332,66	2650		0,8	
5	330,99	207,46	332,03	2650		0,8	
6	330,12	207,00	331,17	2650	2650	0,8	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.

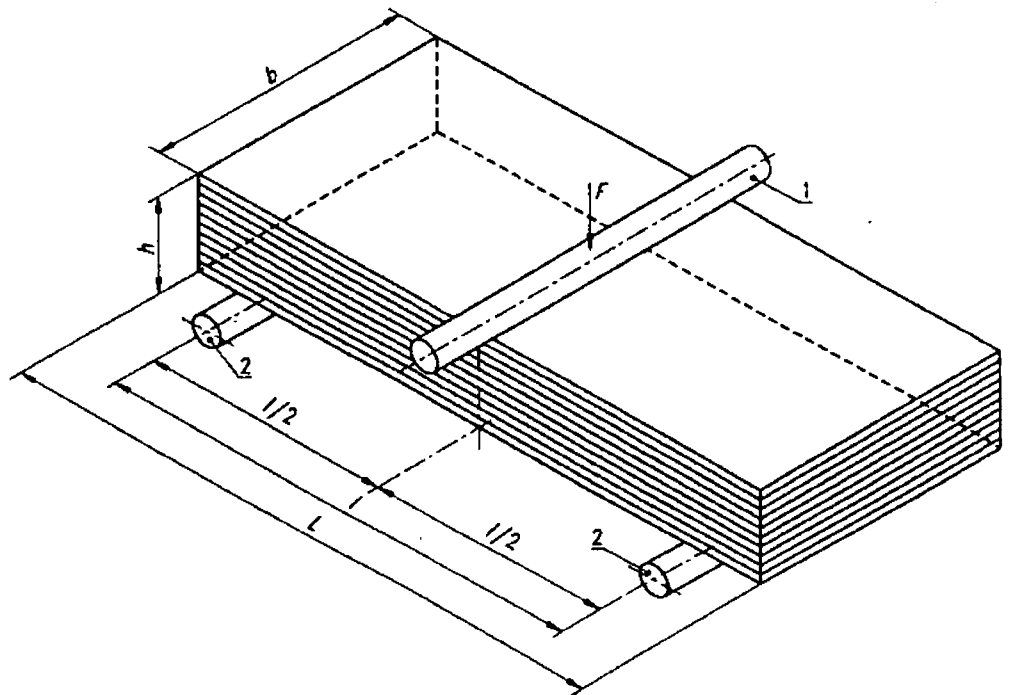
Specimen identification number	Mass of the dry specimen (g)	Mass of the saturated specimen in water (g)	Water absorption (% by mass)	
			individual values	average value
1	330,20	331,16	0,29	
2	335,74	336,73	0,29	
3	330,18	331,11	0,28	
4	331,62	332,57	0,29	
5	331,01	332,00	0,30	
6	330,12	331,00	0,27	0,3



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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 σ (MPa)		
					individual values	average value	st. deviation
1	125	26,4	50,2	3,62	19,4		
2	125	26,4	50,4	3,64	19,4		
3	125	26,7	50,5	3,57	18,6		
4	125	26,8	50,3	4,25	22,1		
5	125	26,5	50,5	4,16	22,0		
6	125	26,4	50,1	3,61	19,4		
7	125	26,7	50,3	4,20	22,0		
8	125	26,8	50,3	3,62	18,8		
9	125	26,4	50,3	4,12	22,0		
10	125	26,5	50,4	3,86	20,4	20,4	1,5

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	st. deviation
11	125	26,2	50,5	3,71	20,1		
12	125	26,0	50,0	4,09	22,7		
13	125	26,2	50,4	3,43	18,6		
14	125	26,6	50,4	3,63	19,1		
15	125	26,5	50,6	3,44	18,2		
16	125	26,6	50,6	3,53	18,5		
17	125	26,6	50,3	3,48	18,3		
18	125	26,6	50,4	4,00	21,0		
19	125	26,9	50,6	4,07	20,8		
20	125	26,8	50,1	4,15	21,6	19,9	1,6

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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 ²)	Total load at failure		Compressive strength	
		(kN)	individual values (MPa)	average value (MPa)	st, deviation (MPa)
1	4956	539	109		
2	4942	927	188		
3	4886	956	196		
4	4921	880	179		
5	4914	754	154		
6	4921	975	198	170	34

Specimens subjected to frost test

1	4928	741	150		
2	4942	859	174		
3	4956	785	158		
4	4970	838	169		
5	4907	861	176		
6	4977	898	180	168	11

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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	15,5	
3	15,5	
4	15,5	
5	15,5	
6	15,0	



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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	71		65	
2	68		68	
3	65		66	
4	70		66	
5	69		64	
6	72	69	69	66

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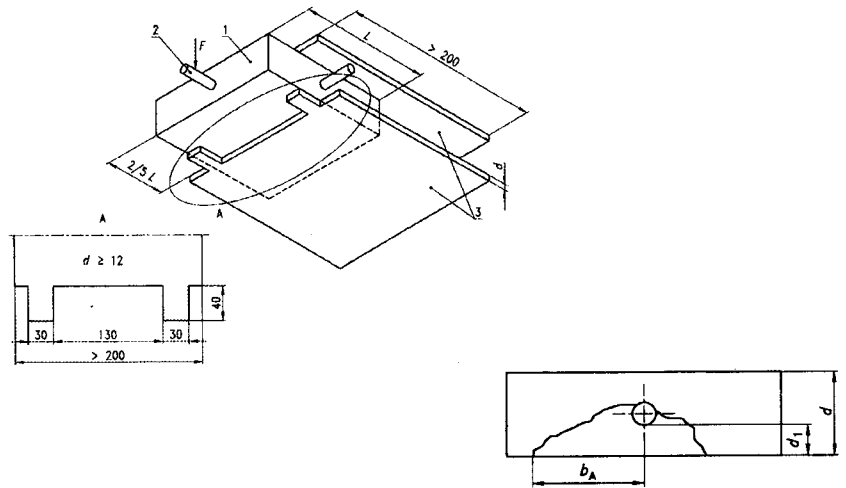


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DETERMINATION OF THE BREAKING LOAD AT DOWEL-HOLE

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

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	3030	53	10
	2	30,0	3020	53	10
2	1	30,0	2010	52	9
	2	30,0	2020	52	9
	3	30,0	3140	40	11
3	1	30,0	3160	40	11
	2	30,0	2300	47	9
	3	30,0	2600	48	10
4	1	30,0	2280	47	9
	2	30,0	2640	48	11
Mean value			2620	48	10

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SUMMARY OF THE RESULTS (average values)

Table with 2 columns: Property Name and Value. Rows include Petrographic name (paragneiss), Apparent density (2650 kg/m³), Open porosity (0.8 % by volume), Water absorption (0.3 % by mass), Flexural strength in natural conditions (20.4 MPa), Flexural strength after frost test (19.9 MPa), Compression strength in natural conditions (170 MPa), Compression strength after frost test (168 MPa), Abrasion resistance (groove length) (15.5 mm), Slip resistance value - sand blasted (dry) (69 (SRV)), Slip resistance value - sand blasted (wet) (66 (SRV -USRV)), Breaking load at dowel-hole (2620 N), and Breaking load at dowel-hole, maximum fracture distance (48 m).

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