



Standard: EN 12407

PETROGRAPHIC ANALYSIS

Client:	Bettazza Graniti SA		
Project:	Natural stone testing - Tricolore		
Product:	Modular tiles of natural stone - SN EN 12057		
Quarry:	Boschetto, Cevio (TI), Svizzera		
Name of the stone:	Tricolore		
EN 12440 denomination:	--		
Sampling:	Carried out by the client	Date of testing:	07.09.2015
Delivery:	Carried out by the client on 13.07.2015	Technician:	Dott. Geol. B. Cecchin

1. Macroscopic description of the handsample

General description	Foliated, medium-to-fine-grained rock characterized by bands of different colours. The dominant colour of these macrolayers – which can vary in size from millimeters to centimeters – varies from white-grey, to green-grey, to dark purple matching different mineralogical associations of the rock. The rock has a gneissic structure and is characterized by closely-spaced levels of quartz and feldspars and thin levels of dark mica or green amphibole.
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2. Microscopic description of the sample**Orientation of the thin section:** parallel to lineation and perpendicular to foliation**2.1 Texture and structure**

General description	The granoblastic matrix of the rock is composed of different-sized grains of quartz and feldspars, in variable proportions. Frequent accessory minerals are: titanite, opaque minerals, and garnet. Schistosity is caused by the alignment of flakes of brown biotite or green amphiboles.
Microfractures:	Not present.

2.2 Mineralogical composition, grain size and microstructure

General description	The rock is characterized by several different minerals which can be grouped in three main associations. The first one is fine grained and is mainly composed of quartz and feldspars, with minor biotite. The second one – which corresponds to the dark purple band – has a slightly larger grain size and a higher content of biotite, frequently associated with garnet. The third association is similar to the first one, but it comprises amphiboles (instead of biotite), and a large quantity of accessory minerals such as titanite, epidote, and calcite. The three associations follow one another discontinuously and there are many contaminations. Frequent accessory minerals – such as opaque, titanite, apatite, garnet – can be found throughout the entire rock.
Weathering degree of the thin section	Slightly weathered.

2.3 Definizione petrografica proposta

Proposed petrographic definition	Protolite: sedimentary origin Facies: greenschist - amphibolite Rock name: banded gneiss
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Image A

Mineral association with quartz, feldspars, and minor biotite.

PPL image shows the typical aspect of a fine-to-medium grained paragneiss. The weak schistosity is due to few brown biotite flakes, locally replaced by chlorite.



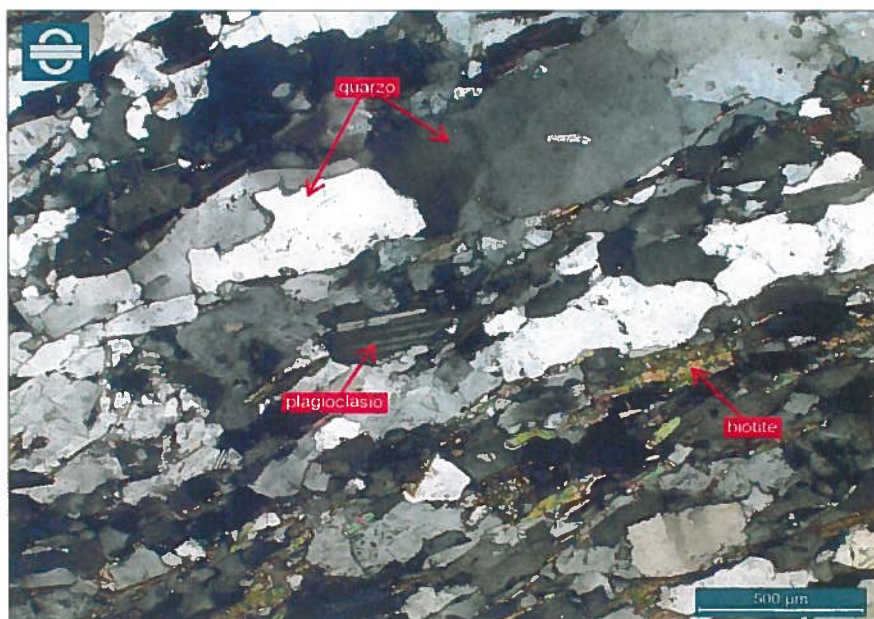
Magnification: 25x

Illumination: PPL

Image B

Mineral association with quartz, feldspars, and minor biotite, detail.

In the XPL image, it's possible to observe many optical properties of leucocratic minerals. Quartz shows undulatory extinction; a prismatic plagioclase grain with polysynthetic twinning is located in the center of the image.



Magnification: 40x

Illumination: XPL



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PETROGRAPHIC ANALYSIS

Client: Bettazza Graniti SA

Project: Natural stone testing - Tricolore

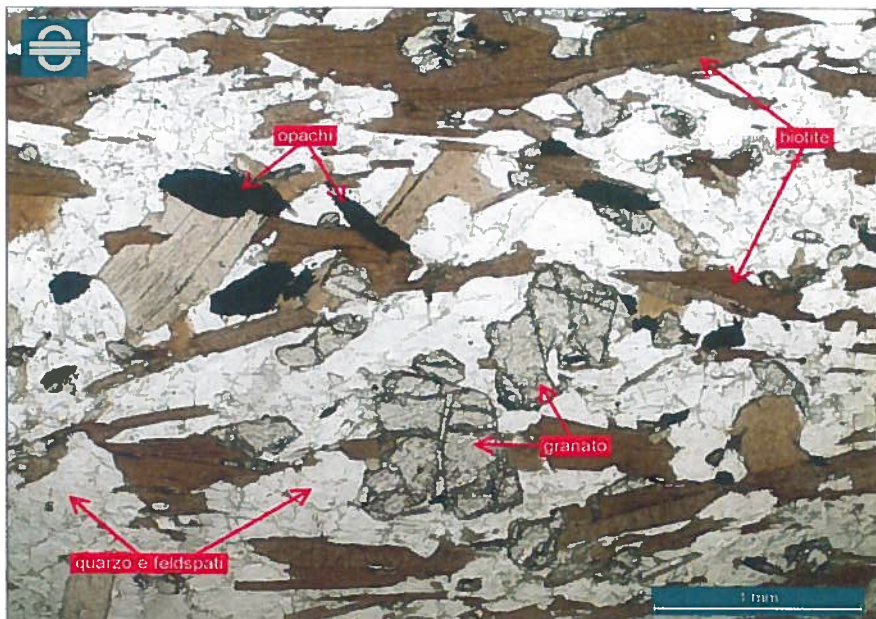
Product: Modular tiles of natural stone - SN EN 12057

Quarry: Tricolore

Image C

Mineral association with quartz, feldspars, biotite, and garnet.

In the dark purple bands, biotite is more abundant and larger in size. In the PPL image, numerous large flakes of biotite show strong reddish-brown pleochroism. Large crystals of garnets are easily recognizable by the high relief and rounded habit (at XPL they are always extinct).



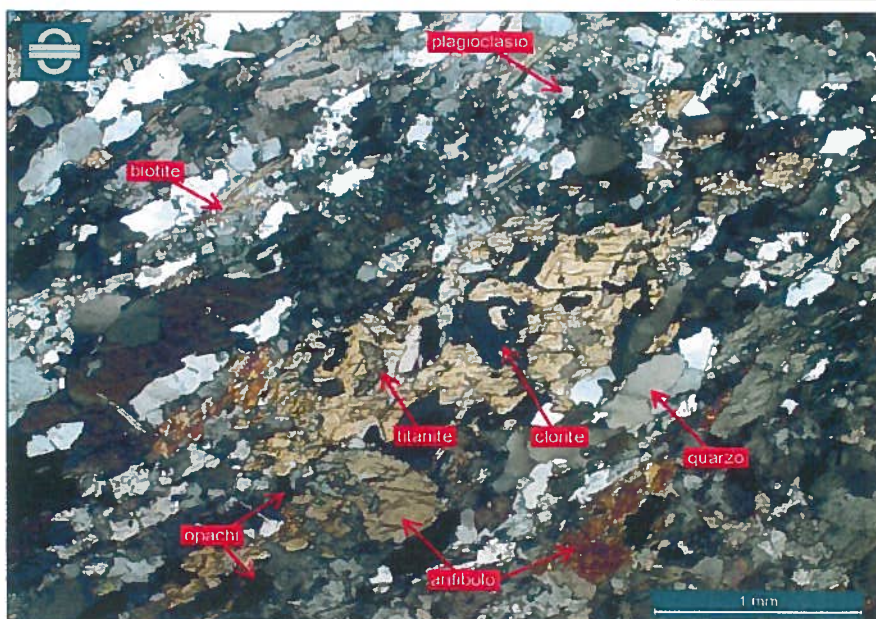
Magnification: 25x

Illumination: PPL

Image D

Mineral association with quartz, feldspars, and green amphibole.

Grey-green layers in the rock are characterized by the presence of green amphiboles instead of biotite. Amphiboles show prismatic habit and variable sizes. Accessory minerals such as titanite, epidote, and chlorite can also be seen.



Magnification: 25x

Illumination: XPL



Standard: EN 12407

PETROGRAPHIC ANALYSIS

Client: Bettazza Graniti SA

Project: Natural stone testing - Tricolore

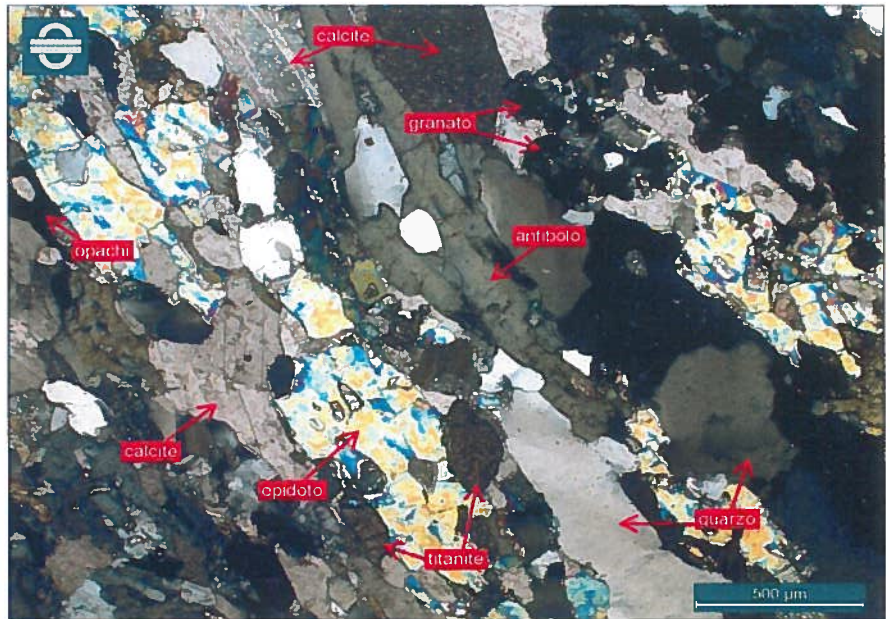
Product: Modular tiles of natural stone - SN EN 12057

Quarry: Tricolore

Image E

Mineral association with quartz, feldspars, and green amphibole, detail.

Numerous epidote crystals can be seen in this detailed image. Epidote is characterized by high relief and bright interference colours. Calcite grains are also recognizable by the distinguishing cleavage traces, twinning, and high interference colours. Few grains of extinct garnet are located at the top right corner of the image.

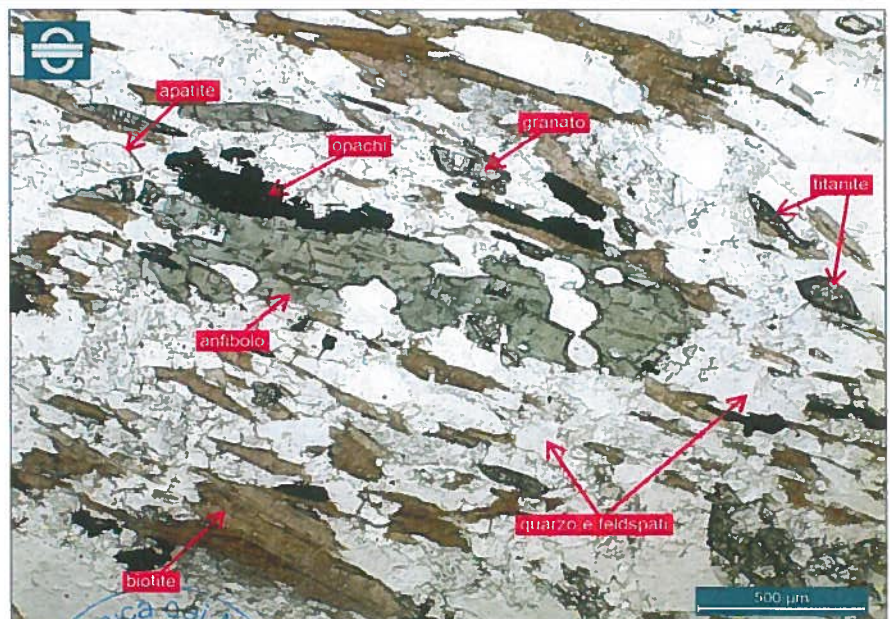


Magnification: 40x

Illumination: XPL

Image F

Example of a transition/mixed zone characterized by the contemporary presence of both amphibole, biotite and garnet. Several accessory minerals can also be seen, such as: titanite, apatite, and opaque minerals.



Magnification: 40x

Illumination: PPL

Grancia, 16.09.2015

General Manager: Dott. M. Di Tommaso

IMM section: physical and mechanical testing on rocks

(Method statement: RO-10)

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Standard: SN EN 1925, SN EN 12057



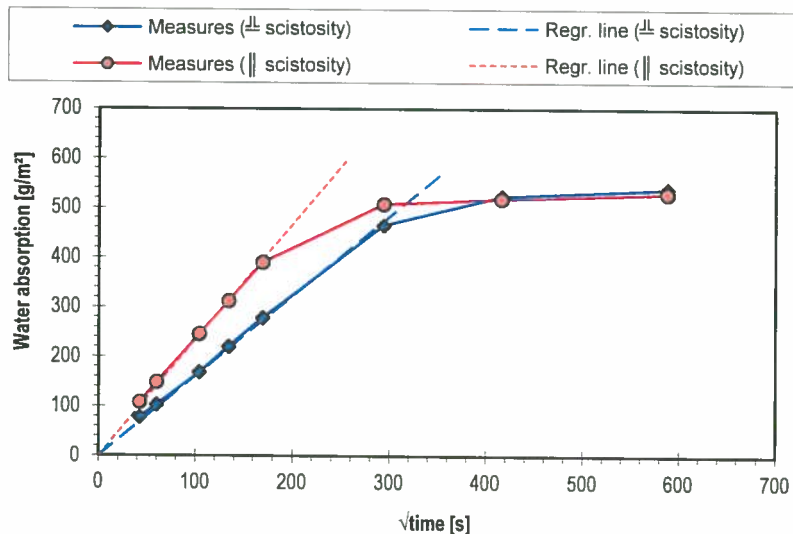
WATER ABSORPTION COEFFICIENT BY CAPILLARITY

Client: Bettazza Graniti SA
Project: Natural stone testing - Tricolore
Product: Modular tiles of natural stone
Quarry: Boschetto, Cevio (TI), Svizzera

Name of the stone: Tricolore
EN 12440 denomination: --
Petrographic description: Banded gneiss

Sampling: Carried out by the client
Delivery: 13.07.2015
Date of testing: 21.07.2015 ÷ 24.07.2015
Nominal sizes: Prisms: L = 70 mm; W = 70 mm; H = 70 mm
Technician: Geol. B. Cecchin

Orientation	Perpendicular to schistosity		Parallel to schistosity	
	Δm [g]	Absorp. [g/m ²]	Δm [g]	Absorp. [g/m ²]
Time				
0.5 h	0.4	77.6	0.5	108.2
1 h	0.5	102.8	0.7	148.4
3 h	0.8	168.7	1.2	245.3
5 h	1.1	220.1	1.6	312.3
8 h	1.4	278.4	1.9	390.3
24 h	2.3	465.3	2.5	508.3
48 h	2.6	523.9	2.6	518.6
96 h	2.7	539.5	2.6	529.4



The above values are the mean value of 6 measurements

Water absorption coefficient by capillarity, perpendicular to schistosity: $C1 = 1.6 \text{ g/m}^2 \cdot \sqrt{s}$

Water absorption coefficient by capillarity, parallel to schistosity: $C2 = 2.3 \text{ g/m}^2 \cdot \sqrt{s}$

Notes:

Grancia, 16.09.2015

General Manager: **Dott. M. Di Tommaso**

Settore IMM: prove su pietre naturali



(Procedura interna: PN-09)



Standard: SN EN 13755, SN EN 12057



WATER ABSORPTION AT ATMOSPHERIC PRESSURE

Client: Bettazza Graniti SA

Project: Natural stone testing - Tricolore

Product: Modular tiles of natural stone

Quarry: Boschetto, Cevio (TI), Svizzera

Name of the stone: Tricolore

EN 12440 denomination: --

Petrographic description: Banded gneiss

Sampling: Carried out by the client

Delivery: 13.07.2015

Date of testing: 28.07.2015 ÷ 04.08.2015

Nominal sizes: Prisms: L = 70 mm; W = 70 mm; H = 70 mm

Technician: Geol. B. Cecchin

Id.	Dry mass m_d [g]	Wet mass m_s [g]	Water absorption A_b [%]
1	981.3	984.4	0.3
2	982.0	984.8	0.3
3	992.2	995.1	0.3
4	987.3	990.3	0.3
5	1001.8	1005.1	0.3
6	987.6	990.4	0.3

Mean and STD: 0.3 ± 0.02 %

Notes:

Grancia, 16.09.2015

General Manager: Dott. M. Di Tommaso

Settore IMM: prove su pietre naturali

(Procedura interna: PN-08)



Standard: SN EN 1936, SN EN 12057



APPARENT DENSITY AND OPEN POROSITY

Client: Bettazza Graniti SA

Project: Natural stone testing - Tricolore

Product: Modular tiles of natural stone

Quarry: Boschetto, Cevio (TI), Svizzera

Name of the stone: Tricolore

EN 12440 denomination: --

Petrographic description: Banded gneiss

Sampling: Carried out by the client

Delivery: 13.07.2015

Date of testing: 28.07.2015

Nominal sizes: Prisms: L = 70 mm; W = 70 mm; H = 70 mm

Technician: Geol. B. Cecchin

Apparent density and open porosity					
Id.	Wet mass in water m_h [g]	Wet mass in air m_s [g]	Dry mass m_d [g]	Apparent density ρ_b [t/m ³]	Open porosity p_o [%]
7	637.9	988.4	985.4	2.806	0.9%
8	641.3	994.0	990.9	2.805	0.9%
9	652.5	1006.8	1003.6	2.828	0.9%
10	650.5	1006.3	1003.2	2.815	0.9%
11	631.7	980.2	977.1	2.799	0.9%
12	638.8	990.4	987.3	2.803	0.9%
Mean and STD				2.809 ± 0.010	0.9 ± 0.02 %

Notes:

Grancia, 16.09.2015

General Manager: Dott. M. Di Tommaso

Settore IMM: prove su pietre naturali



(Procedura interna: PN-10)



Standard: SN EN 14231, SN EN 12057

SLIP RESISTANCE

Client: Bettazza Graniti SA
Project: Natural stone testing - Tricolore
Product: Modular tiles of natural stone
Quarry: Boschetto, Cevio (TI), Svizzera

Name of the stone: Tricolore
EN 12440 denomination: --
Petrographic description: Banded gneiss

Sampling: Carried out by the client
Delivery: 13.07.2015
Date of testing: 08.09.2015
Nominal sizes: Prisms: L = 150 mm; W = 100 mm; H = 20 mm
Reference stone: Quartz-dolerite type TRL
Rubber slider width: 76 mm
Test length: 126 mm
Calculation of results: SRV mean value of 5 measurements in two opposite directions
Technician: Geol. B. Cecchin

	Id.	1÷6	1÷6							
	Surface finish	C60	C120							
Dry test	Specimen 1	78	75							
	Specimen 2	79	78							
	Specimen 3	80	74							
	Specimen 4	81	73							
	Specimen 5	77	74							
	Specimen 6	82	74							
	Mean	80	74							
Wet test	Specimen 1	60	56							
	Specimen 2	64	56							
	Specimen 3	62	57							
	Specimen 4	68	53							
	Specimen 5	63	58							
	Specimen 6	65	56							
	Mean	64	56							

Notes:

Grancia, 16.09.2015 General Manager: Dott. M. Di Tommaso

Settore IMM: prove su pietre naturali

(Procedura interna: PN-07)



Standard: SN EN 12372, SN EN 12057



FLEXURAL STRENGTH

Client: Bettazza Graniti SA
Project: Natural stone testing - Tricolore
Product: Modular tiles of natural stone
Quarry: Boschetto, Cevio (TI), Svizzera

Name of the stone: Tricolore
EN 12440 denomination: --
Petrographic description: Banded gneiss

Sampling: Carried out by the client
Delivery: 13.07.2015
Date of testing: 20.08.2015
Nominal sizes: Prisms: L = 300 mm; W = 100 mm; H = 50 mm
Test setup: Center-point loading
Load direction: Perpendicular to schistosity
Load rate: 0.250 MPa/s
Supports spacing: 250 mm
Technician: Geol. B. Cecchin

Initial Type Test					
Id.	L / W / H [mm]	M [g]	ρ [t/m ³]	F [kN]	R _t [MPa]
1	300.0/100.2/51.2	4278.3	2.780	14.85	21.2
2	300.0/100.3/51.6	4360.1	2.811	12.84	18.1
4	301.0/100.2/51.5	4364.9	2.813	13.41	19.0
5	301.5/100.2/51.4	4381.2	2.821	15.33	21.7
7	301.0/100.2/51.1	4348.8	2.824	16.11	23.1
8	301.0/100.2/51.5	4417.3	2.841	12.86	18.1
9	301.0/100.2/50.9	4283.4	2.792	14.66	21.2
10	301.0/100.2/50.6	4254.7	2.790	15.03	22.0
11	301.2/100.2/51.9	4370.2	2.789	14.81	20.6
12	301.0/100.1/51.6	4331.2	2.788	13.83	19.5

Type Test	Mean and STD	Strength: $R_{ti, m} = 20.4 \pm 1.7$ MPa	Density: $\rho_{i, m} = 2.805 \pm 0.020$ t/m ³
	Lower expected values	Strength: $R_{ti, min} = 17.1$ MPa	

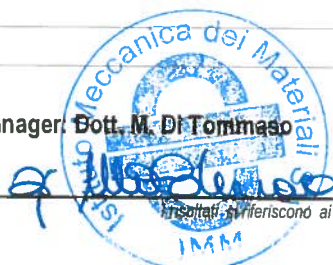
Notes:

Grancia, 16.09.2015

General Manager: Dott. M. Di Tommaso

Settore IMM: prove su pietre naturali

(Procedure interne: PN-04, PN-05)





Standard: SN EN 12372, SN EN 12371, SN EN 12057



FROST RESISTANCE BY FLEXURAL STRENGTH

Client:	Bettazza Graniti SA
Project:	Natural stone testing - Tricolore
Product:	Modular tiles of natural stone
Quarry:	Boschetto, Cevio (TI), Svizzera
Name of the stone:	Tricolore
EN 12440 denomination:	--
Petrographic description:	Banded gneiss
Sampling:	Carried out by the client
Delivery:	13.07.2015
Number of cycles:	56 cycles (21.08.2015 ÷ 11.11.2015)
Date of testing:	18.11.2015
Nominal sizes:	Prisms: L = 300 mm; W = 100 mm; H = 50 mm
Test setup:	Center-point loading
Load direction:	Perpendicular to schistosity
Load rate:	0.250 MPa/s
Supports spacing:	250 mm
Technician:	Geol. B. Cecchin

Initial Type Test					
Id.	L / W / H [mm]	M [g]	ρ [t/m ³]	F [kN]	R_t [MPa]
1	300.0/100.2/51.2	4278.3	2.780	14.85	21.2
2	300.0/100.3/51.6	4360.1	2.811	12.84	18.1
4	301.0/100.2/51.5	4364.9	2.813	13.41	19.0
5	301.5/100.2/51.4	4381.2	2.821	15.33	21.7
7	301.0/100.2/51.1	4348.8	2.824	16.11	23.1
8	301.0/100.2/51.5	4417.3	2.841	12.86	18.1
9	301.0/100.2/50.9	4283.4	2.792	14.66	21.2
10	301.0/100.2/50.6	4254.7	2.790	15.03	22.0
11	301.2/100.2/51.9	4370.2	2.789	14.81	20.6
12	301.0/100.1/51.6	4331.2	2.788	13.83	19.5

Test after freeze/thaw cycles (56 cycles)					
Id.	L / W / H [mm]	M [g]	ρ [t/m ³]	F [kN]	R_t [MPa]
1	300.0/100.1/51.4	4379.0	2.838	12.88	18.3
2	300.0/100.2/51.4	4327.0	2.804	15.21	21.6
4	300.0/100.4/51.2	4288.0	2.780	14.47	20.6
5	300.0/100.6/51.7	4342.0	2.781	15.01	20.9
6	300.0/100.4/51.6	4341.0	2.792	14.66	20.6
7	300.0/100.1/51.1	4350.0	2.837	12.87	18.5
8	300.0/100.5/51.3	4387.0	2.836	14.35	20.4
9	300.0/100.5/51.2	4407.0	2.857	11.67	16.6
10	300.0/100.1/51.0	4334.0	2.832	13.85	20.0
11	300.0/100.1/51.4	4362.0	2.828	12.53	17.8

Type Test	Mean and STD	Strength: $R_{t, m} = 20.4 \pm 1.7$ MPa	Density: $\rho_{t, m} = 2.805 \pm 0.020$ t/m ³
	Lower expected values	Strength: $R_{t, min} = 17.1$ MPa	
After freeze/thaw	Mean and STD	Strength: $R_{t, m} = 19.5 \pm 1.6$ MPa	Density: $\rho_{t, m} = 2.818 \pm 0.027$ t/m ³
	Lower expected values	Strength: $R_{t, min} = 16.3$ MPa	$\Delta R_{t, min} = -4.4\%$

Notes:

Grancia, 20.11.2015

General Manager: Dott. M. Di Tommaso

Settore IMM: prove su pietre naturali

(Procedure interne: PN-04, PN-05)



Standard: SN EN 12372, SN EN 12057



FLEXURAL STRENGTH

Client: Bettazza Graniti SA
Project: Natural stone testing - Tricolore
Product: Modular tiles of natural stone
Quarry: Boschetto, Cevio (TI), Svizzera

Name of the stone: Tricolore
EN 12440 denomination: --
Petrographic description: Banded gneiss

Sampling: Carried out by the client
Delivery: 13.07.2015
Date of testing: 20.08.2015
Nominal sizes: Prisms: L = 300 mm; W = 100 mm; H = 50 mm
Test setup: Center-point loading
Load direction: Perpendicular to the edge of schistosity plans
Load rate: 0.250 MPa/s
Supports spacing: 250 mm
Technician: Geol. B. Cecchin

Initial Type Test					
Id.	L / W / H [mm]	M [g]	ρ [t/m ³]	F [kN]	R _t [MPa]
1	300.3/100.4/50.1	4226.2	2.796	12.63	18.8
2	300.5/100.1/50.1	4274.6	2.839	12.78	19.1
3	301.0/100.3/50.6	4316.6	2.826	12.16	17.8
4	300.2/100.0/50.2	4236.8	2.810	12.65	18.8
5	301.4/100.2/49.6	4197.6	2.802	11.70	17.8
6	301.5/101.1/50.2	4296.9	2.808	13.68	20.1
13	301.5/100.5/50.4	4314.7	2.828	13.19	19.4
9	301.5/100.5/50.3	4295.7	2.821	12.05	17.8
10	300.0/100.4/50.7	4276.5	2.803	13.25	19.3
12	300.5/100.8/50.4	4274.3	2.802	12.89	18.9

Type Test	Mean and STD	Strength: $R_{ti, m} = 18.8 \pm 0.8$ MPa	Density: $\rho_{i, m} = 2.814 \pm 0.014$ t/m ³
	Lower expected values	Strength: $R_{ti, min} = 17.2$ MPa	

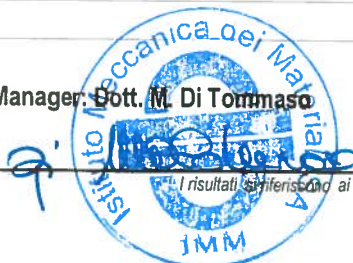
Notes:

Grancia, 16.09.2015

General Manager: Dott. M. Di Tommaso

Settore IMM: prove su pietre naturali

(Procedure interne: PN-04, PN-05)





Standard: SN EN 12372, SN EN 12057



FLEXURAL STRENGTH

Client: Bettazza Graniti SA
Project: Natural stone testing - Tricolore
Product: Modular tiles of natural stone
Quarry: Boschetto, Cevio (TI), Svizzera

Name of the stone: Tricolore
EN 12440 denomination: --
Petrographic description: Banded gneiss

Sampling: Carried out by the client
Delivery: 13.07.2015
Date of testing: 20.08.2015
Nominal sizes: Prisms: L = 300 mm; W = 100 mm; H = 50 mm
Test setup: Center-point loading
Load direction: Parallel to schistosity
Load rate: 0.250 MPa/s
Supports spacing: 250 mm
Technician: Geol. B. Cecchin

Initial Type Test					
Id.	L / W / H [mm]	M [g]	ρ [t/m ³]	F [kN]	R_t [MPa]
1	300.0/100.2/50.2	4216.0	2.794	3.58	5.3
2	300.2/100.0/50.3	4223.9	2.797	3.88	5.8
4	300.0/100.2/50.2	4222.6	2.797	2.87	4.3
5	300.1/100.0/50.2	4216.0	2.797	2.41	3.6
6	301.0/100.1/51.1	4294.8	2.791	2.60	3.7
7	300.5/100.4/50.3	4232.3	2.792	3.46	5.1
8	300.5/99.7/51.0	4273.6	2.796	3.09	4.5
9	300.4/100.2/50.2	4218.3	2.789	3.15	4.7
10	300.5/100.4/50.2	4222.5	2.789	2.19	3.2
12	300.5/100.2/51.1	4292.9	2.792	2.75	3.9

Type Test	Mean and STD	Strength: $R_{ti, m} = 4.4 \pm 0.8$ MPa	Density: $\rho_{i, m} = 2.793 \pm 0.003$ t/m ³
	Lower expected values	Strength: $R_{ti, min} = 2.9$ MPa	

Notes:

Grancia, 16.09.2015

General Manager, Dott. M. Di Tommaso

Settore IMM: prove su pietre naturali

(Procedure interne: PN-04, PN-05)



Standard: EN 14157:2005; EN 12057:2005

ABRASION RESISTANCE

Client: Bettazza Graniti SA

Project: Certification of natural stone - Tricolore

Product: Natural stone products - Modular Tiles for flooring and stairs

EN 12440 denomination: --

Name of the stone: Tricolore

Petrographic description: Banded Gneiss

Quarry: Boschetto, Cevio (TI), Switzerland

Sampling: Carried out by client

Delivery: 31.07.2015

Date of testing: 17.08.2015

Nominal Sizes: Prisms: L = 150 mm; W = 100 mm; H = 20 mm

Test Method: Wide Wheel

Abrasive: Corindone according with FEPA 42 F:1984

Test Orientation: Parallel to schistosity

Tested Surface condition: Dry Surface

Calibration Value: 20.5 mm

Technician: F. Protti

Id.	Groove [mm]
B1	20.0
B2	18.5
B3	19.5
B4	18.5
B5	18.0
B6	17.5

Mean and standard deviation: 18.5 ± 1.0 mm

Higher expected value (Eh): 20.5 mm

Notes:

Crevoladossola, 18.08.2015

General Manager

Sector CSL: natural stone test methods



(Procedura interna: PN-20)

The results obtained are referred only to the tested samples. Only the paper document printed and signed has legal value.