

Free and Hanseatic City of Bremen
Official Institute for the Analysis of Materials
(MPA Bremen)

Certificate of Analysis No. M 20899-00

Analysis Sheets: eight; **Annex:** None

Applicant: Sociedade Alemã para Cooperação Técnica
(GTZ) Ltda. - Dag - Hammarskjöld - Weg 1-5 - 65760
Eschborn / **Application dated:** October/04/2000-----

Application Content: Natural Stone Analysis-----

We performed the following analyses: -----

- Determination of water absorption under atmospheric pressure and pressure, as well as the calculation of the saturation values in accordance with DIN 52103 (08.88) standard, procedures A, D, and S. -----
- Determination of dry density, in accordance with DIN 52102 (08.88) standard, proceeding RE. ---
- Determination of resistance to pressure, according to DIN 52105 (08.88) standard. -----
- Determination of flexural strength, according to DIN 52112 (08.88) standard. -----
- Evidence of the strength capacity required against a freezing and de-freezing change, according to DIN 52104 standard, part 1, proceeding B (11.82). -----

Subject: Minas Gerais, Brazil, Industrial Environmental Protection Project - evidence *CA*---

1. Analysis Material (test material) -----

Received on: November/02/2000-----

Ten compact, agglomerated, crystalline yellow/ocher-colored blocks, with practically different-size rectangular planes, and a remarkable foliation. The fractures present mica scales. The rock is classified as Quartzite on a first sight. The upper, lower, and side faces have a rough brittleness. -----

The firm Cooperativa de Minas Gerais, Belo Horizonte, Brazil was appointed to withdrawn the analysis material, according to the "CA" breaking code adopted in Brazil. The transportation to MPA Bremen was made by delivery. The marking of samples, as well as the weight are in table 1 to follow. -----

Examined material: It was destroyed in part. -----

Table 1: Details of the Examination Material. -----

Type of Examined Material	Marking ¹⁾	Weight in Kg
Block	CA 08/1, Sep. 12, Quartzite, w= 39.0 kg, Brazil	39.0
Block	CA 08/2, Sep. 12, Quartzite, w= 23.0 kg, Brazil	23.0
Block	CA 08/3, Sep. 12, Quartzite, w= 18.0 kg, Brazil	18.0
Block	CA 08/4, Sep. 12, Quartzite, w= 37.0 kg, Brazil	37.0
Block	CA 08/5, Sep. 12, Quartzite, w= 22.0 kg, Brazil	22.0

Block	CA 08/6, Sep. 12, Quartzite, w= 25.0 kg, Brazil	25.0
Block	CA 08/7, Sep. 12, Quartzite, w= 24.0 kg, Brazil	24.0
Block	CA 08/8, Sep. 12, Quartzite, w= 28.0 kg, Brazil	28.0
Block	CA 08/9, Sep. 12, Quartzite, w= 22.0 kg, Brazil	22.0
Block	CA 08/10, Sep. 12, Quartzite, w= 39.0 kg, Brazil	39.0

1) Marking is in accordance with the notations on package labels. -----

2. Examination Results-----

Remark: The results of the following examinations refer only to the samples mentioned in item 1 of this examination certificate with the sample material showing a "CH" marking. -----

2.1. Water Absorption and Saturation Value, according to DIN 52103 standard. -----

The water absorption determination was performed on the ten blocks of the material examined. The blocks cutting was performed with a saw, and the material sample was wet. -----

The examination is consistent with item 6 of DIN 52103 (8.88) standard, proceeding A (DIN 52103-A test), under atmospheric pressure, and proceeding D (DIN 52103-D test), an examination performed under 150-bar pressure. Results are shown in tables 2 and 3 to follow. -----

From values found saturation values (S) (DIN 52103-8 test) were computed, water absorption under atmospheric pressure, divided by the water

absorption under 150-bar pressure. Such values are listed in table 4. -----

The water absorption examinations were performed between November 22 and 25, 2000. -----

Table 2: Water Absorption under Atmospheric Pressure-----

Test No.	Dry weight mg	Volume V	Water absorption		
			g W ₃	Weight (%) W _{m.a.}	Volume (%) W _{v.a}
1	1018.4	388.1	3.9	0.38	1.00
2	980.8	372.8	3.1	0.32	0.83
3	934.6	356.4	4.0	0.43	1.12
4	980.2	375.4	5.9	0.60	1.57
5	677.3	259.4	4.2	0.62	1.62
6	1009.8	384.7	4.0	0.40	1.04
7	957.6	365.4	4.3	0.45	1.18
8	946.9	360.6	3.6	0.38	1.00
9	963.3	369.2	6.1	0.63	1.65
10	1044.3	400.2	6.6	0.63	1.65
Average	-----			0.48	1.27

Table 3: Water absorption under 150-bar Pressure---

Test No.	Dry weight mg	Volume V	Water absorption		
			g W _d	Weight (%) W _{m.d}	Volume (%) W _{v.s.}
1	1018.4	388.1	3.9	0.38	1.00
2	980.8	372.8	3.3	0.34	0.88
3	934.6	356.4	4.1	0.44	1.15
4	980.2	375.4	6.0	0.61	1.60
5	677.3	259.4	4.3	0.63	1.66
6	1009.8	384.7	4.0	0.40	1.04
7	957.6	365.4	4.3	0.45	1.18

8	946.9	360.6	3.6	0.38	1.00
9	963.3	369.2	6.1	0.63	1.65
10	1044.3	400.2	6.6	0.63	1.65
Average		-----		0.49	1.28

Table 4: Saturation S Value-----

Test No.	Water absorption in g		Saturation value S
	Wa	Wd	
1	3.9	3.9	1.00
2	3.1	3.3	0.94
3	4.0	4.1	0.98
4	5.9	6.0	0.98
5	4.2	4.3	0.98
6	4.0	4.0	1.00
7	4.3	4.3	1.00
8	3.6	3.6	1.00
9	6.1	6.1	1.00
10	6.6	6.6	1.00
Average	----		0.99

2.2. Dry, Gross State Density (according to DIN 52102) -----

The determination of the dry, gross state density is in accordance with DIN 52102 (08.88), proceeding RE on samples, which had already their water absorption determined. The weight was determined after drying, up to a 110° C weight constant. An ascending force (proceeding A) was applied for volume determination. -----

Water was the liquid used in the test. -----

Results are listed in table 5. -----

Test period: November 20 through 25, 2000. -----

Table 5: Dry, Gross Density-----

Test Number	Volume in cm ³	Dry and gross density in g/cm ³
1	388.1	2.62
2	372.8	2.63
3	356.4	2.62
4	375.4	2.61
5	259.4	2.61
6	384.7	2.62
7	365.4	2.62
8	360.6	2.63
9	369.2	2.61
10	400.2	2.61
Average	-----	2.62

2.3. Resistance to Pressure-----

Ten cubic, wet blocks with around 7-cm corners were saw-cut from the sample delivered for analysis. The cuttings were performed on five blocks with the pressure axis parallel to the foliation and on other five blocks transversal to the pressure axis. The upper and lower planes were cut in parallel. The determination of resistance to pressure was performed after sufficient drying, according to DIN 52105 (8.88) standard. -----

Results are listed in table 6-----

Table 6: Resistance to Pressure-----

Test No.	Measurements in mm			Resistance to pressure B _o N/mm ²	Fracture image description
	Length	Width	Height ²⁾		
Pressure force parallel to foliation					
1	70.4	70.5	70.1	60.4	
2	70.4	70.2	70.0	87.0	
3	70.3	70.3	70.3	76.9	Conical
4	70.1	70.1	70.3	61.1	Fracture
5	70.3	70.5	70.1	121.1	
Average	-----			81.3	-
Pressure force transversal to foliation					
1	70.3	70.1	70.1	217.1	
2	70.2	70.7	70.0	171.3	
3	70.2	70.4	70.3	307.6	Conical
4	70.5	70.4	70.3	66.5	Fracture
5	70.8	70.3	70.1	79.4	
	Average			168.4	----

2) Height after cutting of the pressure planes. ---

2.4. Flexural Strength-----

Ten blocks for examination for determination of flexural strength were taken from the material delivered. Cuts were performed towards the load direction for five samples parallel to foliation and transversal to foliation in the five remaining samples. After sufficient drying, the force flow proceeded at a 250-mm distance between the supports, as the load center (proceeding A), according to DIN 52112 (08.88) standard. -----

Results are on table 7-----

Test date: November/22/2000-----

Table 7: Flexural Strength-----

Sample No.	Measurements in mm			Resistance to flexion N/mm ²	Fractured image description
	Length	Width	Height		
Force induction parallel to foliation					
1	301,0	50.8	50.0	9.38	Straight Fracture on medium third of sample
2	300.5	50.3	50.3	11.52	
3	299.1	50.5	50.3	9.53	
4	300.0	50.0	50.1	6.76	
5	300.0	50.1	50.1	2.90	
Average	-----			8.02	-----
Force induction transversal to foliation					
1	299.8	50.1	50.1	9.46	Straight fracture on third average of sample
2	300.9	50.1	50.1	12.45	
3	299.9	50.2	50.2	9.16	
4	302.0	50.1	50.2	6.03	
5	299.7	50.1	50.2	4.37	
Average	-----			8.29	----

2.5. Freezing/Defreezing Examination-----

For determination of resistance to freezing/defreezing, samples with around 5-cm wet, cubic corners were sawed. For determination of resistance to pressure after performance of freezing/defreezing, the samples were prepared in accordance with item 2.1 of the examination certificate. Examination was performed in accordance with process B of DIN 52104 standard, part I (11.82) (test DIN 52104-B) aqueous samples

saturation according to item 6.1.1.1 (aqueous deposit for strong humidification) under atmospheric pressure and performance of freezing under water, according to item 6.2.2 of the above-mentioned standard. -----

Sample dimensions, the result of water absorption, the behavior of samples during examination, weight loss, and resistance to pressure after freezing are shown in tables 8 through 11. 10 different freezing/defreezing tests were performed. The determination of water absorption occurred on July 14 through 17, 2000. The freezing/defreezing performance took place on July 17 through August 18, 2000. -----

Table 8: Dimensions and Water absorption before the Test. -----

Test No.	Dimensions in mm			Weight Relation in g		Water absorption	
	Length	Width	Height	Dry	Wet ³⁾	in g	in Weight (%)
1	50.0	50.1	50.1	327.940	329.178	1.238	0.38
2	49.8	50.0	50.1	326.275	327.152	0.877	0.27
3	50.0	50.4	50.4	329.460	330.785	1.325	0.40
4	50.0	50.3	50.3	326.194	328.395	2.201	0.67
5	50.0	50.4	50.2	327.603	329.647	2.044	0.62
Average	-----						0.4%

3) Weight after water saturation-----

4) Water absorption in relation to the dry weight--

Table 9: Samples Degradation during Test-----

Quantity of changes during freezing/defreezing	Behavior of samples during freezing/defreezing				
	1	2	3	4	5
	Low erosion on corners				
5	Low erosion on corners				
10	Low erosion on corners				

Table 10: Weight Loss after Freezing/Defreezing----

Sample No.	Weight relation in g ⁵⁾		Splintering / weight loss ⁶⁾	
Average	327.940	327.815	0.125	0.04
	326.275	326.144	0.131	0.04
	329.460	329.324	0.136	0.04
	326.194	326.013	0.181	0.06
	327.603	327.433	0.170	0.05
Average	-----			0.05

5) Weight loss in relation to the initial dry weight-----

6) After drying to the weight constant at 110° C---

Table 11: Resistance to Pressure after Freezing / Defreezing-----

Sample No.	Measurements in mm			Resistance to pressure N/mm ²	Fracture image description
	Length	Width	Height ⁷⁾		
Force induction parallel to foliation					
1	50.0	50.1	50.1	133.3	Conical Fracture
4	50.0	50.3	50.3	137.6	
Average	-----			-----	-----
Average ⁹⁾	-----			81.3	-----
Force induction transversal to foliation					
2	49.8	50.0	50.1	142.2	Conical Fracture
3	50.0	50.4	50.4	137.3	
5	50.0	50.4	50.2	138.1	
Average	-----			139.2	----
Average ⁸⁾	-----			168.4	-----

7) Height after cutting of the pressure planes. ---
 8) Average resistance to pressure of samples
 without freezing/defreezing, transversal foliation
 (see items 2 and 3). -----

9) Average resistance to pressure of samples,
 without freezing/defreezing, parallel to foliation
 (see items 2 and 3). -----

The result of freezing examination shows sufficient
 capacity to resistance against changes in freezing
 / defreezing. Freezing testing shows no changes in
 texture. Results of resistance to pressure, after
 the freezing/defreezing tests situate in dispersion
 of resistance to pressure, which were obtained from
 samples not submitted to the freezing / defreezing
 testing. -----

Bremen, December 20, 2000

Paul-Feller-Strasse 1

Official Materials Testing Institute

In Charge of Section 2 - Constructions-----

(*Certified Engineer A. Meyer*) -----

Special Group 2.1 - Mechanical-Technical Tests-----

(*I.A.G. Bukowski*) -----

We attest to the true performance of tests-----

Bremen, December 22, 2000 (*Buchard*)-----
