USING ORNAMENTAL ROCK WASTE IN THE MANUFACTURE OF CEMENT BLOCKS FOR STRUCTURAL MASONRY

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Abstract:

The construction is an industry that despite generate large numbers of jobs has an aggravating factor in his performance and the amount of waste generated, but is an area considered highly detrimental to the environment, the proposal is incorporating new materials in construction. This study and evaluate the implementation of the waste generated in the cutting of ornamental production of cement bricks for structural masonry, as Brazil and a major producer of this with rocks and construction market expanding due to programs government incentives such as "My House, My life". This paper aimed to evaluate the app from the residues of rock ornamental, from the municipality of Cachoeiro Itapemirim, in the manufacture of cement blocks. Tests of simple compression and water absorption in blocks with and without addition of residues to a comparison between them and the standard for this type of block. According to the results of the average resistance of the blocks (traditional and with addition of residue), it appears that those with the addition of residue has higher average strength than those produced in a traditional way, but both do not meet the *minimum standard which is established by to 4.5 Mpa. When all dimensions are in accordance with established values and margins of tolerance.*

When the water absorption, it appears that the blocks produced with addition of ornamental rock waste has lower water absorption than those made by the traditional method, both of which meet the standard that specifies that the absorption should be less than 10%

Keywords: *Ornamental Rock, Civil Construction,* Structural Block

INTRODUCTION:

In 2011, Brazilian exports of ornamental and coating totaled $ 999.65 million, corresponding to a physical volume of marketed 2,188,929.59 t, or, in round numbers, $ 1 billion and 2.2 million t, Forward to the year 2010, there was a positive change of 4.22% in revenues due to the increase in the average price of the main export products, notably: Blocks of Marble, Slates, quartizos foliated, Plates Polished granite.

The municipality of Itapemirim, in the southern state of Espírito Santo (Figure 1), is one of the largest producers of ornamental stones in Brazil and is a pillar of its economy processing industry in ornamental stones. Like every major industry, especially the beneficiation of natural raw materials, also generates a large volume of solid waste due to its production process.

The demand for new materials in the construction market, due to the fact that the major breakthrough in the industry, the Federal Government data show that this sector employs more and more moves and what financial resources in the economy, due to be dynamic, in that shares may be verified by increasing government works. Only in the area of housing, the program "Minha Casa, Minha Vida" has transformed Brazil into a real construction site, in addition to major infrastructure such as ports, power plants and stadiums. It also contributes in the private sector, with construction for the new middle class, and this sector more competitive and requires companies to decrease their costs by reason of use of this alternative building materials, as proposed by this study.

Figure 1: Location of the municipality of Cachoeiro Itapemirim.

These wastes over time have become a serious environmental problem for today's society, because in most cases, are arranged in inappropriate places, causing possible damage to the environment through contamination of groundwater and river siltation, resulting from lung disease inhalation of airborne particles and more severe problems. Moreover, the construction industry despite being a major generator of waste in recent years has been highlighted also in the use of recyclable materials, such as waste rock ornamental suit seeking a clear methodology for determining the levels of incorporation of the constituents of materials.

The objective of this work is to take advantage, rationally, waste from this industrial process beneficiation of natural stones, which are widely available in the city of Itapemirim-ES, adding these wastes in the production of cement blocks for structural masonry (Figure 2) and comparative studies were made of compression strength, water absorption and moisture of these blocks with or without ornamental rock waste and to compare these values with those specified by the standards.

Figure 2: Hole Cement Blocks

MATERIALS AND METHODS:

For this work the cement blocks were supplied by a factory located in the city of Cachoeiro Itapemirim, seeking a review of the process of incorporation of this residue in their blocks. So were provided for the tests carried out in the Laboratory of Civil Engineering (LECIV) a number of blocks, called sample, this number was determined by virtue of the size of the batch manufactured by following the requirements of ABNT 6136 (2007) where for a lot of 10 000 blocks are required until six blocks for compression strength test and three for water absorption.

Once the blocks were received at the laboratory these were properly identified, total block has twenty-six and are called B blocks (Normal) and BR (Blocks with addition of residue) followed by their respective numbers.

Subsequent measurements were made of the dimensions of the blocks and may thus observe if there is a standardization of the manufacturing process were measured widths, heights and lengths, as well as wall thicknesses.

After the process of checking the dimensions of blocks, the sample was divided into two parts, the first contained thirteen blocks, initially classified as B, since they had no addition of waste, and other thirteen known BR because they residues in its composition. This quantitative ten blocks of each group were separated made for the compressive strength test and three other tests for water absorption and moisture.

The blocks were properly prepared and identified for the compression test following the requirements of the standard. The number of samples for the assay was determined according to ABNT 6136 (2007), were used in this case seven blocks. For this test the surfaces of the blocks were properly regularized with a mortar made for this purpose, so this surface should be completely smooth and without patches. The blocks were positioned trials of the press so that the load is applied in the same direction as your real effort centered correctly on the supports.

The water absorption test was conducted in accordance with ABNT 12118, were used drying to a temperature of 110 °C. Initially, the blocks were weighed and their values were recorded (column before the gases), then were taken to the greenhouse temperature of 110 ° C for a period of 24 hours, after this period were removed and weighed again (after column oven), assuming a period of no more than 10 minutes out of the oven. After this procedure the blocks were brought again to an oven for one peroxide for 2 hours and cooled after being withdrawn naturally (in contact with air) at ambient temperature to immerse the blocks in water at a temperature of 23 ° C, for a period of 24 hours. Subsequent to this period of soaking the blocks were removed and weighed again (wet column). With this data was calculated the water absorption of the blocks, following Equation (A). To obtain the moisture of the blocks equation was used (B).

$$AW(\%) = \left(\frac{m_{damp} - m_{after\mathrm{drying}}}{m_{after\mathrm{drying}}} \right) * 100 \qquad \text{(A)}$$

$$m(\%) = \frac{m_{\mathrm{before\,drying}} - m_{after\mathrm{drying}}}{m_{damp} - m_{after\mathrm{drying}}} \qquad \text{(B)}$$

RESULTS:

According to ABNT 6136 (2007), the concrete hollow blocks shall meet the standard dimensions, allowing up tolerances of ± 2mm in width and ± 3 mm for height and length. Blocks provided for the tests fall within the designation M-15 with nominal dimensions of 15 x 20 x 40 (cm) were measured for this block dimensions provided to whether they fit on the requirements of the standard (Table I).

Table I: Dimensions of the blocks tested.

Standard Dimensions (mm)			
Name	**Width**	**Height**	**Length**
B4	138	193	388
B5	139	189	392
B6	139	193	389
B7	138	190	390
B8	139	190	390
B9	139	190	388
B10	138	189	390
BR4	138	188	390
BR5	139	190	391
BR6	139	191	388
BR7	139	190	390
BR8	138	188	388
BR9	138	193	390
BR10	138	189	390

The results of compression tests of blocks without residue (Table II) and with addition of residue (Table III), below.

Table II: Results compression of traditional concrete blocks.

NO RESIDUE				
Number of Blocks	**Strenght (tf)**	**Strenght (N)**	**Area (mm^2)**	**Resistence (Mpa)**
B4	17,00	166713,05	53544,00	3,11
B5	17,76	174166,10	54488,00	3,20
B6	26,27	257620,70	54071,00	4,76
B7	19,49	191131,61	53820,00	3,55
B8	23,06	226141,35	54210,00	4,17
B9	28,24	276939,80	53932,00	5,13
B10	19,07	187012,82	53820,00	3,47
AVERAGE	21,56	211389,35	53983,57	**3,92**

Table III: Results of compression blocks with addition of cement residue.

WITH RESIDUE				
Number of Blocks	**Strenght (tf)**	**Strenght (N)**	**Area (mm^2)**	**Resistence (Mpa)**
BR4	23,54	230848,54	53430,00	4,32
BR5	19,87	194858,14	54349,00	3,59
BR6	24,16	236928,66	53932,00	4,39
BR7	22,62	221826,42	54210,00	4,09
BR8	18,94	185737,95	53544,00	3,47
BR9	23,85	233888,60	53820,00	4,35
BR10	21,05	206429,98	53430,00	3,86
AVERAGE	22,00	215788,33	53816,43	**4,01**

The results of the water absorption and moisture below in Table IV.

Table IV: Results of water absorption and moisture blocks with and without residue.

NO RESIDUE						WITH RESIDUE					
Block	**Mass (Kg) (before drying)**	**Mass (Kg) (after drying)**	**Mass (Kg) (Damp)**	**AW (%)**	**m (%)**	**Block**	**Mass (Kg) (before drying)**	**Mass (Kg) (after drying)**	**Mass (Kg) (Damp)**	**AW (%)**	**m (%)**
B1	11,35	11,15	11,95	7,17	25,00	BR1	11,25	11,10	11,90	7,21	18,75
B2	11,50	11,00	11,80	7,27	62,50	BR2	10,80	10,65	11,50	7,98	17,65
B3	11,60	11,40	12,20	7,02	25,00	BR3	11,50	11,35	12,15	7,05	18,75
AVERAGE	11,48	11,18	11,98	**7,15**	**37,50**	**AVERAGE**	11,18	11,03	11,85	**7,40**	**18,37**

CONCLUSION:

According to the results of the average resistance of the blocks (traditional and with addition of residue), it appears that those with the addition of residue has higher average strength than those produced in a traditional manner. According to ABNT 6136 (2007), the blocks can be classified into four different classes (Table V).

Table V - Minimum compressive strength of the blocks.

Class	**Minimum Resistance (Mpa)**
A	≥6
B	≥4
C	≥3
D	≥2

Since class A structural works above or below ground level, B and C structural works above the ground and D bricks. Thereby classify the material without residue as Class C waste material and class B, both being structural works above the ground, being able also to be bricks.

As for its dimensions are all in conformity with the established values and margins of tolerance.

As regards the water absorption shows that the blocks produced with addition of ornamental rock waste has lower water absorption than those made by the traditional method, both of which meet the standard that specifies that the absorption should be less than 10%.

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