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GEOTECHNICAL AND CHEMICAL STUDY AND ANALYSIS OF THE MARBLE QUARRY IN THE ALENTEJO AREA, PORTUGAL

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Abstract:
This work is a part of an economic project where the knowledge of the surface layers morphology and composed phases identification is essential for the control of any industrial process.

In order to improve and increase the production, the quality and the quantity of a marble industry chain. A detailed study of the filling materials of the quarry aimed of this work has been carried out using a different, innovative, and economic methodology.
With the intention to determine the nature, composition, and quality of the marble in the quarry of the Alentejo area, we proceed to many physical, mechanical tests, structural and chemical analysis.

This work will be divided into two major parts which concern: i) the geotechnical study and ii) the structural and chemical analysis of the marble collect in the quarry.

Geological observation and geotechnical study [1, 2] allowed us to determine the geological nature (color, size shape, and hardness),physical (mass, porosity, density and saturation coefficient) and mechanical properties (strength, impact and wear resistance tests).
Chemical part [3, 4], consists in the determination of the constitution of the material including phases and elemental composition. Hence, the characterization of the material will be carried out using X-ray diffraction, X-ray fluorescence (XRF), and Energy dispersive Spectrometer (EDS). When, morphology, distribution of the formed phases and structural defects will be determined by mean of the electronic scanning microscope.

This work is a part of the project "Quality Control of Ornamental Stone Blocks" with the reference ALT20-03-0247- FEDER-017659 BRO.

Keywords: marble, geotechnical parameter (physical and mechanical), Instrumentation, phase analysis, X-ray diffraction, Elemental analysis, X-ray fluorescence, EDS, Microstructure

1. INTRODUCTION

In the old time, like in the new, the ornamental rocks have occupied an important place in the construction and the decoration.

The term ornamental rock refers to rocks that can be polished and used in civil construction as floors, walls, sinks, tables, etc. In contrary, unpolished rocks used for decorative purposes are called semi-ornamental and are normally included in the concept. This wide field of applications requires an extremely wide range of products with excellent quality and quantity for the production processes in order to meet the market demand and standard.

In Portugal, this activity is one of the oldest national economic activities, offering the country the opportunity to be one of the main producers of ornamental stones in the world *[5]*.

With this in mind, we have taken an interest in this activity by providing the scientific knowledge that allows an effective and rational management of the proposed specifications. Hence, our study will be based in two major parts: first is the geological observation and geotechnical study, the second is chemical analysis.

A third part could be added to our work in order to determinate the real quantity of the marble in the quarry; using geophysical test that consists in the measurement of the electric resistance.

2. GEOLOGICAL OBSERVATION AND GEOTECHNICAL STUDY:

The production of ornamental rocks must go through three important phases, i) extraction ii) primary processing and iii) final processing [*6, 7]*.

2.1 Extraction

This procedure consists in the extracting of useful or economically usable materials from rock masses or deposits. The product of the extraction is the block of edges roughly rectangular, of variable dimensions.

2.2 Primary processing

Results from the cutting of the blocks to obtain sheets, bands or fragments, with very close dimensions to those which will have in the final products.

2.3 Final processing

In this stage of the production cycle, the marble take its final shape, size and appearance. It can be subdivided into three processes that the ornamental product undergoes: i) polishing, ii) cutting and iii) finishing.

3. GEOLOGICAL OBSERVATION AND SAMPLING:

The key to the success of this work is correct and quality sampling. In our case, numerous samples were taken in the quarry, at different positions and depths, to ensure not only the good quality of the material, but also to identify any irregularities. Heterogeneity, micro-cracking or any significant variation in mineralogical composition from one area to another was taken into account. The first observation on the field gives us a quick and general appreciation of our marble.

Macroscopic observations show that the material is essentially constituted by grains of quartz within a black mica and feldspath matrix. However, the chemical composition of each constituent need to be accurately determined.

On the other hand, the marble present a homogeneous appearance without any cracks or irregularities. However, a small variation in color in some areas from white to light pink has been noted.

Based on the Mohs hardness *[8]*; we could appreciate the hardness of our marble. Indeed, our marble could be scratched with a knife or a glass which places its hardness, according to this scale between 5 and 6.

4. GEOTECHNICAL PROCESSING

Many data need to be considerate to qualifier the ornamental rock because in the industry we need to inform the customer on the recommended uses and the maximum limit. So why a serious study needed to be carried, so that we can determinate the different physical and mechanical parameter [*9]*.

This step is very important in order to set the specifics characteristic of the marble, because in general all types shear the same physiological propriety.

The geotechnical study will be devised in tow step, the first is the physical identification and the second is the mechanical identification *[10]*.

The identification of the physical propriety will be based essentially, in the determination of

the mass m, porosity e, density d and the saturation coefficient Sr . (europienne Norme NF EN 1097) *[11]*.

The identification of the physical propriety will be based essentially, in the determination of strength, impact resistance test, usury (Wear), and the resistance to external factors.

These steps allow us to know the rheology and the comportment of our materiel in face of the meteorological effect like water, wind and glace *[12]*.

5. CHEMICAL ANALYSES

Knowledge of chemical composition of marble constituents, morphology and sizing of parts, surface layers, etc. is essential for any industrial process. It is therefore important to know and (or) control these different parameters in order to validate the methods and processes.

The laboratory test is able to characterize any type of morphology and various associated parameters (size, roughness, etc.). Different stages are planned.

Using wavelenght dispersive X-ray (WD-X-ray) fluorescence (WDXRF) *[13]*, we can obtain basic informations about the composition of the marble.

By mean of electronic scanning microscope *[14]*, we will determine the microstructure of the marble. Numerous sections and thin slides (of 30 μm) of the material have been prepared, in order to analyze and characterize the different phases, morphology, grain size, distribution, porosity….

Finally, Energy dispersive Spectrometer EDS *[15]*, will be used to determine the elemental analysis or chemical characterization in some interesting area in our samples (mica, quartz, feldspath..).

6. CONCLUSION:

The ornamental stone industry is one of the important and big sources of income in Portugal. Its importance is not only in the huge role in the economy but also from the architectural and decoration point of view. The resistance and solidity of these materials to various external elements and the ease of the handling in sculpture is also a critical factor. From all investigation techniques, test and observation, either geological, geotechnical or chemical, we will have a global and detailed look in our materiel. Better appreciation and recommendation in the good way to use the marble and the better domain for a best exploitation and income are expected.

Our results will allow us to make a technical sheet to identify the different mechanical

physical and mineralogical characteristics. These later are qualified as strong and weak point that could affect the quality of the final produce.

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