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Determination of Physical and Mechanical Properties of Quarries Dos Bocas Mouths and Mine Copeto for High Resistance Concretes

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Abstract

The importance of the use, the type and the correct quality of the aggregate (aggregate) cannot be underestimated. Thin and coarse aggregates occupy about 60% to 80% of the volume of the concrete (70% to 85% of the mass) and strongly influence the properties both in the fresh and hardened state, in the proportions of the mixture and the economy of the concrete. Due to the great importance of the quality of the materials that must be used for high strength concretes, this research has been conducted to determine if the aggregates of the Dos Bocas and Copeto quarries meet the requirements outlined in the standards MOP-001 - F- 2002 for high resistance concretes. The bulk material was taken from the Dos Bocas quarry located in Puerto Cayo, Province of Manabí, and the fine aggregate was obtained from the Copeto Mine that is located in the Santo Domingo sector, Santo Domingo de los Tsáchilas Province. The tests executed in the Laboratory of Soil Mechanics, consisted in determining the quality index of the aggregate, calculating the maximum percentage of mass wear, determination of minimum and maximum percentages that pass through the standard sieves, volumetric mass, absorption and surface moisture. For a better understanding and interpretation of the results obtained from the different tests. We proceeded to graphically represent each of them for the two types of aggregates, allowing us to compare the property of each material with its respective specification, as mentioned in the Technical Specifications of the Ministry of Public Works MOP-001 - F- 2002.

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1. Introduction

Some time ago it was said that the aggregates were inert elements within the concrete since they did not intervene directly within the chemical and physical reactions. At present it is established that this material being the highest percentage (approximately 60% -80% of the volume)) of participation has within the cubic unit of concrete, its properties and diverse characteristics influence in all the properties, the influence of the aggregates in the properties of the concrete have important effects, not only in the finish and final quality, but also on the form of work and consistency in plastic state, as well as the durability and resistance of hardened concrete [2]. In some countries, studies have been carried out to determine the physical-chemical properties of debris samples materials to be used in concrete [3].

100% of the concrete produced in Mexico uses aggregates that can be obtained from two sources: in deposits of natural origin (rivers, beaches, etc.) and as rock crushing products [1]. The need to have a quality concrete makes it indispensable to know its components in detail, since both the resistance and the durability depend on the physical and chemical properties of them, especially the aggregates. However, one of the problems that engineers and builders usually encounter when using concrete is the lack of verification of the characteristics of the stone aggregates they use, which frequently leads to different results than expected [1].

Some important physical properties of the aggregates are the shape and texture of the particles, the porosity, the absorption, the density, the adhesion, the resistance, etc. Also important is the granulometry of the aggregates, and the maximum size of the aggregate (for the gravel), both in the behavior of the concrete in its plastic state, as well as in its hardened state.

The characterization tests belong to the field of quality control that is carried out during production, and properties are assessed which, when fluctuating, modify the properties in the fresh state of the concrete. Their frequency is very high, they are carried out throughout the work, and their results are obtained quickly (from a few minutes to a few hours). These tests give us a quick tool to make the necessary corrections to maintain the final quality of the concrete over time. Among them, you can indicate granulometric analysis, dust content, humidity, etc. [4].

The influence of the characteristics of the aggregates in the concrete are these: type of aggregate, shape, and texture, size distribution, fine content # 300, # 75 μm, absorption, humidity can be consulted in studies carried out in Cement Institute Argentine Port St. Martin [4]. In the case of rigid pavements, the mixtures of the Hydraulic Concrete must be designed to guarantee satisfactory durability within the requirements of the Pavement [5]. In addition to considering the behavior of the subgrade in case they have expansive properties [6].

The term "benefit of aggregates" is used to describe the improvement in the quality of the aggregates through the removal of harmful substances. Some of the processes that are used are sieving, crushing, and separation of particles in heavy media [7]. In the majorities of the provinces of Ecuador, quarries and mines are sectored for different uses, whether for concrete, asphalt mixtures, granular materials, etc. But for the use of concrete in general, especially for those with high resistances, the aggregates must comply with some standards. So that their use in engineering is optimal: they must be clean, durable particles, with an adequate distribution of the sizes of the particles, modulus of fineness, absorption and humidity, resistance to wear by impact, volumetric mass, among others [8].

2. Research Methods

In order to carry out this research, the field work was carried out, which consisted of taking samples of materials from two different sectors, these being the Dos Boca quarry. It is located in Puerto Cayo in the province of Manabí in the case of coarse material and of the Copeto mine located in Santo Domingo, province of Santo Domingo de Tsáchilas for fine material.

Subsequently, the laboratory work was carried out, which consisted in the execution of the following tests: granulometric analysis, which allows determining the particle size of the aggregates for both fine and course material, this test was carried out taking into account the parameters under the ASTM C 33 standard [9].

The fineness modulus was calculated, according to ASTM C 125 [10], for this purpose a series of sieves is used, the larger the fineness module, the thicker the aggregate. The volumetric mass of an aggregate was determined under the parameters of the ASTM C 29 standard [11]. To evaluate the relative specific mass or specific gravity, the relative test methods of the fine and coarse aggregates described in the ASTM C 127 standard [12] were used, here it is also possible to obtain the absorption of the aggregates to control the water total of the concrete. The internal structure of an aggregate particle is formed in a solid and empty way that may or may not contain water [8].

To determine the wear of the material, the abrasion test was performed with the Los Angeles machine, this test is essential especially when the concrete is subject to delegates, such as floors for heavy services (industrial) or rigid pavements, it was executed in based on ASTM C 131 [13].

3. Results and Analysis

3.1 Soil laboratory results

To know the graduation of the course material of the Dos Bocas quarry. The granulometry tests are presented, according to the ASTM C 33 standard [9], tabulated in table 1 the percentages that pass through each of the sieves are shown with their respective standard, noting that the opening of the screen comprises from 3" to No 200 which are the smallest openings

Table 1
Granulometric analysis of the coarse aggregate, Dos Bocas quarry

Sieve		Peso retenido	Percentage detained (%)	Percentage passing through the mesh (%)	Specification	
Sieve opening (")	mm	Partial			Lower limit	Upper limit
3	76,20					
2 1/2	63,50					
2	50,80				100	100
1 1/2	38,10			100,00		
1	25,40	123,00	2,66	97,34	95	100
3/4	19,10	1289,00	27,84	69,51		
1/2	12,30	1670,00	36,07	33,44	25	60
3/8		908,00	19,61	13,83		
No 4	4,76	391,40	8,45	5,38	0	10
No 8	2,360	159,00	3,43	1,94	0	5
No 50	0,300					
No 200	0,074					
Pass the No200		90,00	1,94	1,94		
TOTAL		4630,40				

In figure 1, the results of the granulometric analysis are shown, noting that the curve of the percentages that pass the sieves of the specification of the coarse aggregate coming from the quarry Dos Boca is within the upper and lower belt.

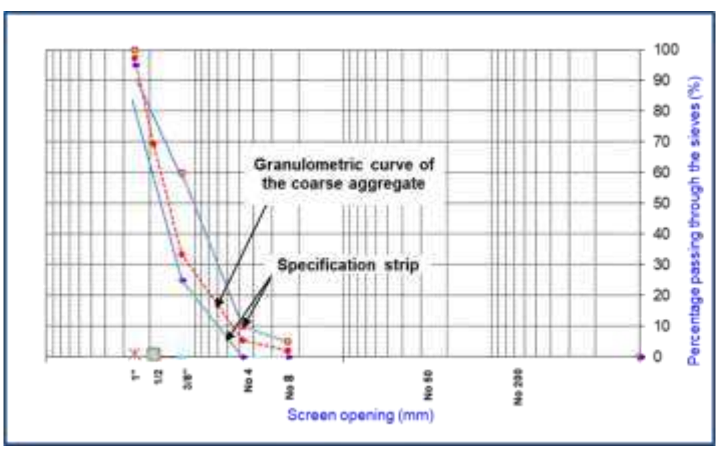

Figure 1. Curve granulometry of the coarse aggregate, Dos Bocas quarry
In table 2, the results of the granulometric analysis of the fine aggregate from the Copeto Mine are presented

Table 2
Granulometric analysis of the fine aggregate, Copeto mine

Sieve		Retained weight	Percentage withheld (%)	Percentage passing through the mesh (%)	Specification	
Sieve opening (")	mm	Partial			Lower limit	Upper limit
3/4"						
1/2"						
3/8"				100,00		
No 4	4,76	125,00	11,23	88,77	95	100
No 8	2,36	133,00	11,95	76,82	80	100
No 16	1,18	155,00	13,92	62,90	50	85
No 30	0,60	216,40	19,44	43,46	25	60
No 50	0,30	235,90	21,19	22,27	10	30
No 100	0,15	202,40	18,18	4,09	2	10
No 200	0,07	36,50	3,28			
Pass the No200		9,00				
TOTAL		1113,20				

In figure 2, it is shown that the percentages that pass the sieves No. 4 and No. 8 are outside the strip granulometry with a tendency to thick, while in the sieves No.16, No.30, No.50, and No.100 comply with the requirement established by the MOP-001-F-2002 standard regarding the distribution of particles.

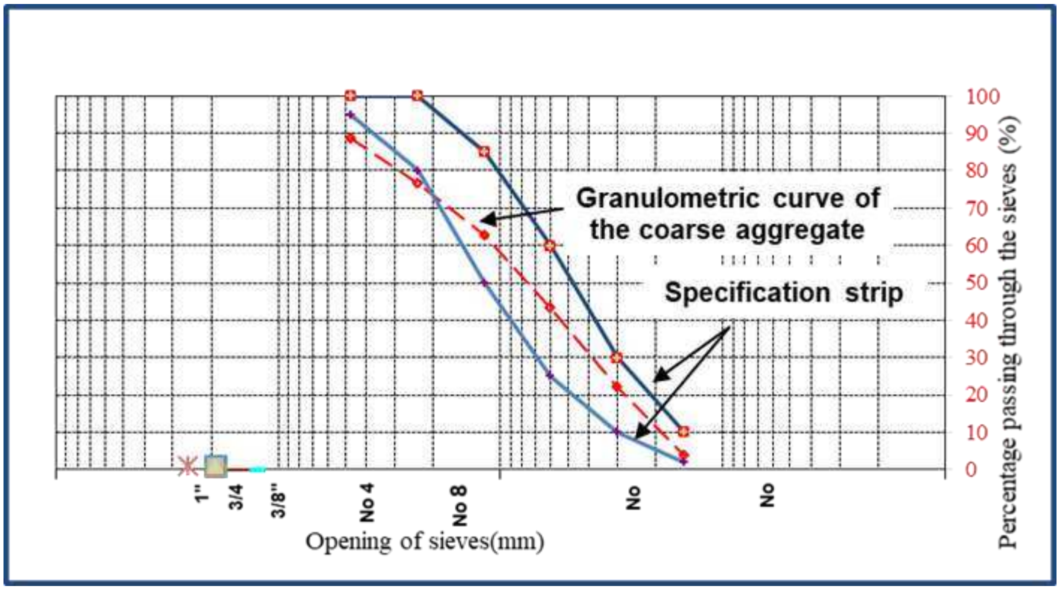

Figure 2. Fine particle size curve of the fine aggregate, Copeto mine

Table 3 shows the results of fineness modulus of the fine aggregate from the Copeto Mine. The ASTM standard incorporates the regulations of the fine aggregate. It establishes that the sand must have a fineness modulus of not less than 2.3 nor greater than 3.1, obtaining in the analysis a value 3.0 as indicated in the table.

Table 3
Fine aggregate fineness module, Copeto Mine

Sieve		Retained weight	Percentage withheld (%)	Cumulative withholding (%)	Percentage that passes the mesh (%)
Sieve opening (")	mm	Partial			
3"					
2 1/2"					
2"					
1 1/2"					
1"					
3/4"					
1/2"					
3/8"					100,00
No 4	4,76	125,00	11,23	11,23	88,77
No 8	2,36	133,00	11,95	23,18	76,82
No 16	1,18	155,00	13,92	37,10	62,90
No 30	0,60	216,40	19,44	56,54	43,46
No 50	0,30	235,90	21,19	77,73	22,27
No 100	0,15	202,40	18,18	95,91	4,09
No 200	0,07	36,50	3,28		
Pass the No200		9,00			
TOTAL		1113,20			

Fineness module:	3,0

In table 4, the results of the mass wear of the coarse aggregate are shown by the abrasion test with the Los Angeles machine, which was at 21.40%, complying with what was specified by MOP-001-F-2002 where Indicates that it must be less than 40%

Table 4
Wear of coarse material, Quarry Dos Bocas

Abrasion wear		Specification
Initial mass (Gr)	5000	<40 %
Final mass (Gr)	3930	
Loss or wear (%)	21,4	

Table 5 shows the results of the specific gravity test of coarse and fine material from the Dos Bocas and Mina Copeto quarries respectively, which do not have a specification to be accepted or rejected but are essential for the theoretical design of concrete.

Table 5
Specific gravity test results

Result of the specific gravity test (gr/cm^3)		
Characteristic	Thick material	Fine Material
Gravedad Específica de la Masa	2,917	2633
Gravedad Específica SSS	3,006	2,728
Gravedad Específica Aparente	3,202	2,909
% de Absorción	3,05	3,61

In table 6, the results of the tests of loose and compacted unit weights of the coarse and fine material of the quarries under study are presented. In the case of the use of aggregates for concrete, these parameters are used to execute the calculation of the concrete design and determine the appropriate dosage.

Table 6
Soil and Compacted Unitary Weights of coarse and fine aggregates

Results of the unit weight test (g/cm^3)		
Properties	Thick material	Fine Material
Peso Unitario suelto	1,619	1,328
Peso Unitario compactado	1,680	1,455

These results allowed us to assess the physical and mechanical properties of the coarse aggregates of the Dos Bocas and fines quarry at the Copeto mine. Demonstrating according to the MOP-001 - F-2002 standards that can be used for high strength concrete, but for this purpose must perform a concrete design taking into account the parameters already presented in the investigation and performing a correct control on site.

4. Conclusion

Through the results of the Laboratory, it was determined that the coarse aggregates obtained from the Cantera Dos boca. It is located in Puerto Cayo in the Province of Manabí and the fine aggregate of the Copeto mine located in Santo Domingo of the Santo Domingo de Tsáchilas Province comply with the conditions specifications in MOP-001 - F-2002 to be used for the manufacture of high resistance concretes.

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