

QUARRY FINES GENERATION – A CASE STUDY

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ABSTRACT

Fines fractions generated by the production of crushed stone quarries are considered as one of the main tailings of the mining activity. The estimated production in the State of São Paulo is around 1.200.000 ton/year [Fujimura et al.,1996], generated by comminution processes. This tailing may result in a series of environmental impacts, besides causing a waste of raw material. In this paper, our goal is to study the generation of stone quarry fines in order to minimize wastes, as well as to present a case study in a quarry located in São Paulo Metropolitan Area (SPMA).

INTRODUCTION

Definition

Stone quarry fines are materials derived from rock (granitic, gneissic, basaltic or calcareous) comminution processes and are considered as side materials when they do not have a commercial value. When they possess such value they are evaluated as a sub-product or co-product generated mainly by quaternary and/or tertiary crushing.

Estimated production

According to Mendes (1999), in a crushing facility for granitic and gneissic rocks, the generated amount varies from 5 to 10% of the total production; for basaltic rocks, this value may reach 15%. However, studies conducted in this paper reveal other results, where these numbers are increased up to 21% of the total production

According to Fujimura et al. (1996), the estimated production of such fines is around 1.200.000 tons a year in São Paulo. This percentage increases due to the fact that quarries generate unquestionable higher amounts of fines due to their equipment

When these fines are considered as a sub-product acting as a fine aggregate used in civil engineering works such as in pre-modelled blocks or for paving ways.

Sieve Size

According to Fujimura et al. (1996), stone quarry fines are classified as materials below the 4.8 mm fraction (equivalent to sieve number 4 from the Tyler series), though this value varies from quarry to quarry due to the kinds of equipment and nature of the rock. Field studies and visits made to some of the quarries located in SPMA show that this value may vary from 6.0 to 5.0 mm.

Environmental aspects

According to the Instituto Brasileiro de Mineração-IBRAM (1992), environmental impacts are connected in all steps of a project, from its conception, the mining lan until mine decomissioning .

It is important to make a distinction between environmental impact and environmental effect. Sanches (1989) defines impact as a change in human health and welfare, including the ecosystem. Effect would be an alteration on these behaviours. Other factors that cause changes and are defined as effects are: erosion processes, pollution dispersion, relocation of people as well as ground topographic changes and hydrography. These effects would cause environmental impacts such as: visual and water quality impacts.

The benefaction and extraction technology of the mining industry inevitably generates such fines or rock dust. Their stockpile is a problem when there is not an adequate destination for them.

The consequences in which the fines can be directly involved are:

- deposal of tailings pile (rock dust) on ground surfaces of the quarry that might have another use;
- alteration to the landscape caused by visual impact ;

- alteration to the hydraulic regime and to draining canals, since fines may be deposited in the pipes, causing obstruction;
- dust generation in stone crushing operations as well as in disposing of pile formation.

However, there might be interference in social, economical and cultural aspects in a society. This would be a clear example in quarries located in areas near habitation centres. The piles generated by such fines can be characterised as a cause of visual impact.

According to Nicholson (1996), it is clear that the visual impact caused by mineral extraction should be handled in order to allow mitigation measures to the enterprise.

Another extremely important factor is that fines piles are subject to rain action that causes their carrying, which may lead to river and mainly to obstructions in draining pipes.

It was observed, in a typical stone crushing facility, the presence of a decantation tank to direct fines with size minus 0.075 mm, watering this fraction in a lake as shown in Figure 1.

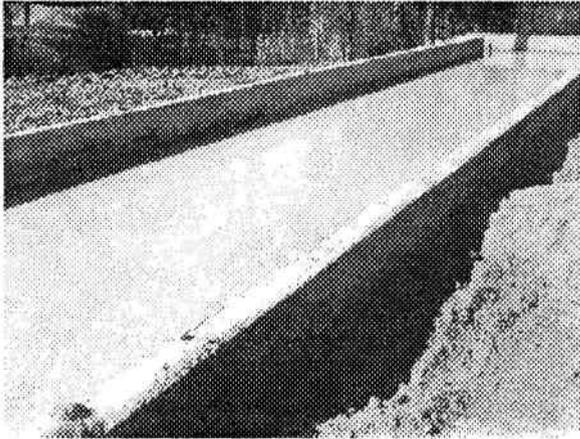


Fig. 1 - Fines decantation tank

Therefore, must emphasise the importance of an adequate destination to the materials decanted in artificial lakes, causing several environmental impacts besides the waste of raw material (see figure 2) and loss of potentially useful areas.

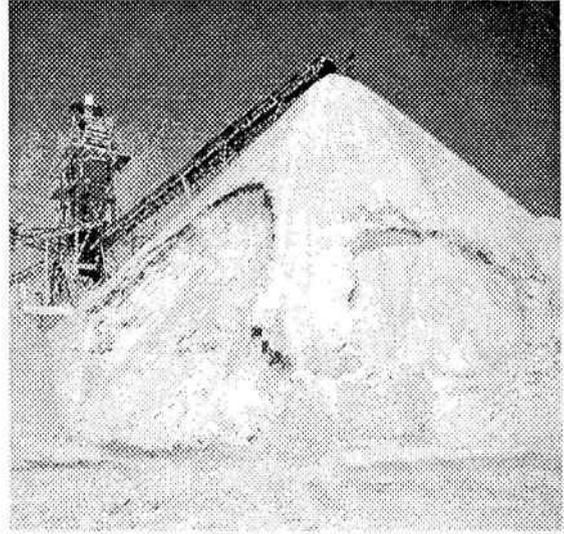


Fig. 2 - Fines pile generated by comminution processes

EXPERIMENTAL PROCEDURE

The work carried out in this project involves a case study in the city of Barueri, in SPMA.

Case Study

A case study of a quarry located in the city of Barueri, in the Big Sao Paulo is presented. The quarry is composed by a granitic rock massif belonging to Brita Brás Mining of the Lafarge Aggregates Group.

Fines can be produced by rock dismounting processes using explosives, but they are mainly generated in stone crushing, classified as a rough phase of mineral comminution.

As shown by Bartalini (1999), if there is an excessive amount of fines in the feeding, product distribution will be proportionally affected.

However, a parameter for control of the regime for the creation of a representative sample has been set: the openings of APF (closed position opening) stone crushers. The parameters for stone crushing operations used in this case study are shown in Table I.

Table I. Parameters for operation of stone crushing processes

Types of stone crushers	APF Openings (mm)
Primary (jaw)	≅ 178
Secondary (cone)	50
Tertiary (cone)	19.5
Quaternary (a) cone	13
Quaternary (b) cone	12

According to Faço (1994), there is a return of the material to the same crusher through the closed circuit.

RESULTS AND DISCUSSION

Primary stone crushing is done with a jaw crusher that breaks the material into a granulometric fraction between 10 to 6 ½ in and it is piled in stockpile.

The crushing is done by compression of the material among the jaws and the way in which particles are broken depends on nature, that is, on rock lithology and the force applied to them.

According to Bartalini (1999), the energy applied to the particles exceeds the one required for fractionating and as a consequence, it produces multiple fractions, with a large amount of particles of different sizes.

On the next step there is the secondary crushing where a cone crusher is used to reduce the material to the 50mm fraction, followed by sub-divisions into 4 fractions. The fraction larger than 50 mm will be fed into the tertiary crusher. As for the fraction passing through 50mm but retained in 27 mm, the final product could be crushed rock number 3 and part of this fraction could be directed to tertiary and quaternary crushers. On this stage, a larger production of fines was observed.

Fines are generated since rock dismounting until tertiary and mainly, quaternary (a) and (b) crushing processes. The cone crusher is used on the secondary, tertiary and quaternary crushings.

The dismissed fraction in the tertiary crusher and the fraction in 27 mm are directed to a two-deck screen.

The fraction above 27 mm returns to both quaternary crushers (a) and (b) for the final recrushing processes.

The material (above 27 mm) passes through a crusher in an APF between 11 and 15 mm. The products generated in this stage are: crushed aggregate size number 1 (-22mm +10mm), and number 2 (-10mm +5mm) destined to civil construction market and to stone dust (-5mm +0mm).

The production of fines with material below 5 mm is around 21% of the total production of this crushing facility.

Belt conveyors do the transportation from crushers to screens with approximately 2000-m rug in 22 transporters of different sizes, each for its specification.

The cone crusher is mainly used in secondary and tertiary crushings. According to Bartalini (1999), the important thing to product and capacity is the output opening in closed position (APF). It is largely utilized in the recrushing circuit, as shown in Fig. 3.

The fraction produced below 4.8 mm is around 7.000 m³ a month. This varies according to the enterprise.

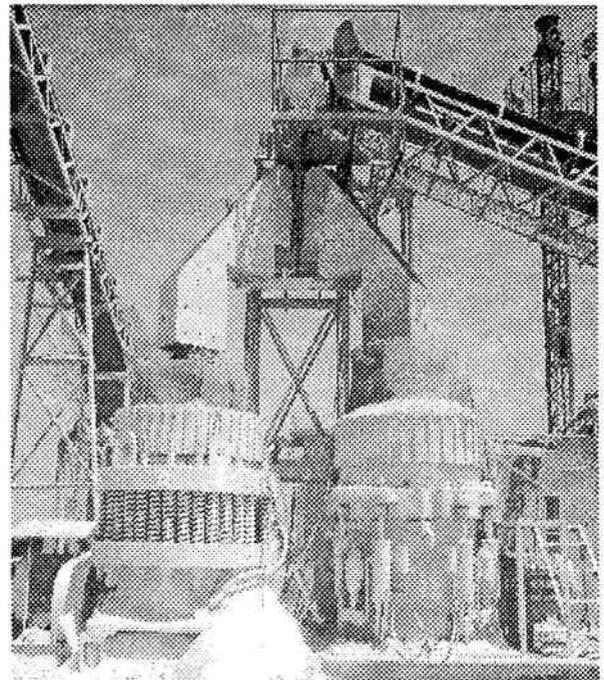


Fig. 3 - Cone crushers in quaternary operation (a) and (b)

Although they are materials with over 10% minus 200 mesh content, these fines can be useful to the civil construction industry in engineering works.

According to the sampling processes, the material retained in the sifting done before it passes through the tertiary crusher with 22 mm will affect the passing flow in 5 mm. Thus, when the latter is bypassed for classification in the intermediate screen. It might be rejected for the process of production (specification material of - 9mm +0mm).

Thus ever gauged retained in sieve 11 mm, to be classified later as material below 5 mm (stone dust), this being considered as fine.

It was observed that this material may be a (by - product) or even a product for the civil construction industry, depending on market acceptance. However, it is a fact the possibility that the enterprise plant can work with the production of materials of different size ranges, producing more or less quantity of fines according to their use and demand. This problem can be solved with the usage of specialist software programs.

CONCLUSIONS

The experiences here presented reflect only the generation of stone dust from granitic rock crushing processes.

It is important to emphasise that there was no study done about naturally produced fines, only about fines produced by comminution processes.

Thus we hope to re-appraise this raw material through non-trivial or consecrated usage.

Therefore, the paper tried to demonstrate the importance of this matter, either by the environmental or by the economical aspects that such utilisation will allow to the mining enterprise.

This material can be used to procdution of concrete in substitute natural sand.

However, it is important to mention that this study is still being carried on for a Masters degree research and this is only a partial conclusion.

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