MARKET ANALYSE AND DEMAND ESTIMATE OF CONSTRUCTION AND DEMOLITION WASTE: THE CASE STUDY OF THE MUNICIPALITY OF RIO DE JANEIRO

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ABSTRACT

The purpose of this work is to analyze the economic aspects of civil construction aggregates, such as market and competition study, as well as to estimate the supply and demand of these materials in the municipality of Rio de Janeiro.
Emphasis is given to recycled aggregates because the results obtained from the proposed analysis will later allow a feasibility study for the implementation of recycling plants of solid residues from construction and demolition (C&D) waste in the municipality of Rio de Janeiro.
The use of recycled aggregates has been an alternative seldom used for solving housing and infrastructure problems. As a major aggregate consumer on account of the construction of popular houses and infrastructure works, the public administration could adopt policies to promote recycled aggregate consumption.
In relation to the C&D waste reception, the recycling centres have as competitor the municipal landfills. According to the Brazilian state-of-art, the land fills need large amounts of inert material to cover the landfill cells. The inert landfills are also competitors of recycling centres in relation to reception of C&D waste. There are in the Municipality of Rio de Janeiro plain areas to where the city is expanding, that may be elevated.

Key words: Municipality of Rio de Janeiro, Construction and Demolition waste.

INTRODUCTION

Only eleven (0.2%) of the 5,507 Brazilian municipalities have C&D waste recycling centres. Thirteen centres (seven in operation, one restarting its operation and five have shut down) are stationary plants and recycle part of the C&D waste produced in local communities. It can, therefore, be concluded that a large part of this waste is not recycled in Brazil. Nonetheless, this situation is changing.
Since the publication of CONAMA (Brazilian Environmental Protection Agency) Resolution no. 307 in 2002, all Brazilian local governments are obliged to prepare and

adopt strategies for sustainable management of C&D waste. In the justifications for this resolution, mention was made of the feasibility of the production and use of C&D waste materials. However, there has been relatively little research in Brazil to prove the technical and economic viability of C&D waste recycling centres.

With the objective of changing this situation and increasing the amount of recycling plants in the country, the present study was carried out with the objective of analyzing the economic aspects of civil construction aggregates, such as market and competition study, as well as to estimate the supply and demand of these materials in the municipality of Rio de Janeiro. Emphasis is given to recycled aggregates because the results obtained from the proposed analysis will later allow a feasibility study for the implementation of recycling plants of solid residues from construction and demolition (C&D waste) in the municipality of Rio de Janeiro.

METHODOLOGY

Initially, general data of the municipality of Rio de Janeiro will be presented. For the analyze of the economic aspects of civil construction aggregates, in special in relation to recycled aggregates, the following items will be detailed:

- Market and competition analysis;
- Demand estimate; and
- Supply estimate.

Collection of data necessary for the completion of this work was done mainly through bibliographic research and consults with material and equipment suppliers, businessmen of mining and recycling industry, aggregate producers unions, among other countess professionals. Most of the data were collected between January and November 2003.

THE MUNICIPALITY OF RIO DE JANEIRO

Rio de Janeiro is the second largest city of Brazil. The population is around six million inhabitants and 100% urban. There are 1,802,347 domiciles in an area of 1,261 km² (IBGE, 2000).

The urban infrastructure is reasonable with regard to the water supply, street lighting and sewer system. 345,257 domiciles (around 20% of the total of domiciles) are located in slums. Ninety-five percent of the domiciles are attended by the water supply net and 69% have sewage nets (IPP, 2001).

The Rio de Janeiro Municipal Urban Cleaning Company provides public cleaning and waste management services. These services supply around 96% of the commercial and residential units in Rio de Janeiro (IPP, 2001). The population of the metropolitan region is around 12.5 million inhabitants over an area of 10,222 km² (IBGE, 2000).

MARKET ANALYSIS

In Brazil aggregates resources for the construction industry are plentiful. The major Brazilian consumer centers, in general, are located in regions with good quality reserves. In

national terms, large volumes of sand and crushed stone are produced; however, their sales value is low. Transportation costs account for about 2/3 of the products final price (DNPM, 2003).

According to Sindipedras (2004), the consumption in Brazil is estimated around 1.5 tons per inhabitant/year. In the developed countries this consumption responds to approximately 7.0 and 10.0 tons per inhabitant/year. The population of Brazil is around 178,116,860 inhabitants (IBGE, 2000), so the total consumption of aggregates corresponds to 267 millions tonnes (about 170 millions m³). The segmentation of the aggregate market for civil construction in Brazil is described in Table 1.

Current prices for the civil construction aggregates have had little chance since 1994, and the average prices per aggregate type (prices without transport) are detailed in Table 2. The costs with transport are estimated to be around 0.22 R$/(m³.km).

Table 1.: Segmentation of the market for aggregates used by civil construction in Brazil.

Aggregate	Market	
Gravel	70 % for the mixture with cement	35% concrete
		15% pre-cast components
		10% retail (construction material shops) and ultimate consumers
		10% rock filling, basement for railways and contention of slopes
	30% for the mixture with asphalt bituminous	Street pavements, bases and sub bases for highway construction
Sand	50% for the production of concrete and pre-cast components	
	50% for the production of mortar	

Source: DNPM (2003)

Table 2.: Aggregates in the Metropolitan Region of Rio de Janeiro (Sindibrita, 2004).

Aggregates	Aggregate grading (diameter in mm)	Prices (excl. taxes)		Prices (incl.taxes[1])	
		(US $/m³)	(US $/t)	(US $/m³)	(US $/t)
Sand	< 4.8	4.67	2.75	6.00	3.53
Stone powder	< 4.8	4.67	3.00	6.00	3.85
Gravel 0, 1, 2, 3	from 4.8 to 76.0	5.72	3.94	7.33	5.06
Gravel mixed	from 4.8 to 50.0	4.67	2.67	6.00	3.41

Both aggregate prices and the number of new construction projects have been low for a long time. Consequently, there is currently a large supply of aggregates. Even the most optimistic forecasts do not believe in price rise. So in order to attract and fix clients, the prices of the recycled aggregates must be lower than the natural aggregates.

[1] It was considered a simple company a tributary load around 22%.

The estimates for the consumption of aggregates in the Metropolitan Region of Rio de Janeiro are of 11.3 million tons per year, for the next ten years. These estimates can be increased by 50% if we take into account the demands of the Pan-American Games (Nunes, 2004). In a scenario considering that 30% of the current market of sand and crushed stone could be replaced by recycled aggregates, there would be in the metropolitan region of Rio de Janeiro a minimum market of 3.4 million tons per year of recycled aggregates in the next ten years.

Due to the low, long-time stable price of aggregates in Brazil and to the reduced number of civil works, there is a large offer of aggregates today in the country. Therefore, in order to attract and maintain clients, the price of recycled aggregates must be lower than that of conventional aggregates.

COMPETITION ANALYZE

Regarding C&D waste reception, recycling plants have sanitary landfills as competitors, which, according to the engineering techniques applied, need large quantities of inert material to cover the landfills cells. The material is also necessary to build accesses and maneuver areas for the dump trucks that used to carry the city garbage.

Nevertheless, landfill operating companies and municipal urban cleaning companies should evaluate if there is a waste of secondary raw material (C&D waste) and a mistakenly acceleration towards the end of useful life of sanitary landfills.

It must be noticed that, in general, landfill operating companies (in municipalities where landfill operation has been outsourced) charge by received ton. The more C&D waste they accept, the higher the invoices.

Inert landfills are also competitors for recycling plants on C&D waste reception. In the municipality of Rio de Janeiro there are low-lying areas (in the East region) with the possibility of increasing their elevation and the city are expanding towards them. According to municipal authorities, this increase would provide benefits to the city (such as lower risks of flooding and improvement of the bearing capacity of soils).

According to this estimate, the municipality of Rio de Janeiro would have a C&D waste landfill availability of about 155 million tons, taking into account these low-lying areas only (East region) (Nunes, 2004).

Concerning this landfilling capacity, it is important to notice that a percentage of these areas are environmentally protected. Additionally, the city hall should conduct an environmental impact study before granting licenses to inert landfills, considering that, without proper control, there is a risk of illegally dumping of industrial and domestic waste in the landfills along with C&D waste. This could create serious environmental problems in the involved regions.

DEMAND AND SUPPLY ESTIMATE

In 2000, it was estimated that for the metropolitan region of Rio de Janeiro there was a deficit of 391 thousand residential units and 520 thousand residential units without

adequate basic infrastructure. In 2004, these numbers were likely to remain the same or be even higher.

The estimative for production and collection of C&D waste in some Brazilian municipalities are presented in Table 1. In 2004 the Rio de Janeiro Municipal Urban Cleaning Company has estimated that it collected 1,000 ton/day (0.17 kg/inhab.day) of C&D waste, an amount below the average in seven other surveyed municipalities (0.51 kg/inhab.day).

Assuming hypothetically that 20% of the weight of the garbage that the municipal company has removed from streets (the public waste) would be part of the C&D waste illicitly dumped, the C&D waste collection *per capita* would rise from 0.15 to 0.27 kg/inhab.day, but this would still be below the average collection in the surveyed municipalities (table 3).

Table 3.: Estimative for production and collection of C&D waste in some Brazilian municipalities (Nunes, 2004).

Municipalities	Estimative of C&D waste (em toneladas por dia)		Year-Base	Population (IBGE, 2000)	Production per inhabitant (kg/inha.day)	Collection per inhabitant (kg/inha.day)
	Produced	Collected				
Rio de Janeiro	n.a.	1,000	2003	5,857,904	n.a.	0.17
Salvador	n.a.	2,746	2000	2,443,107	n.a.	1.12
São Paulo	16,000	3,360	2001	10,434,252	1.53	0.32
Ribeirão Preto	1,000	250	2003	504,923	1.98	0.50
São José dos Campos	733	n.a.	1995	539,313	1.36	n.a.
Piracicaba	620	n.a.	2003	329,158	1.88	n.a.
Vinhedo	n.a.	11	2003	47,215	n.a.	0.23
Guarulhos	n.a.	n.a.	-	1,072,717	n.a.	n.a.
Ribeirão Pires	n.a.	n.a.	-	104,508	n.a.	n.a.
São José do Rio Preto	687	n.a.	1996	358,523	1.92	n.a.
Santo André	1,013	n.a.	1996	649,331	1.56	n.a.
Belo Horizonte	n.a.	2,220	2000	2,238,526	n.a.	0.99
Londrina	1,280	n.a.	2003	447,065	2.86	n.a.
Brasília	n.a.	n.a.	-	2,051,146	n.a.	n.a.
Macaé	-	35	2003	132,461	n.a.	0.26
Florianópolis	636	n.a.	2001	285,281	2.23	n.a.
Averages					1.92	0.51

n.a.: not available

However, there is a significant difference between the generated quantity and the collected quantity, because illicit dumps often end up incorporating themselves into the city landscape or the C&D waste eventually get reused in the works that generate them.
Adding to the quantity of C&D waste collected by the municipal cleaning company the quantity produced for use in new buildings and renovations (considering for both works the value less optimistic as the C&D waste generation rate, of 150 kg/m²), the result is an estimate of the amount of C&D waste generated in the municipality of Rio de Janeiro of 2,877 tons/day, corresponding to 0.59 kg/inhab.day or 180 kg/inhab.year. These amounts do not include material proceeding from demolitions due to lack of more information (Nunes, 2004).
The rate of 180 kg/inhab.year is below the estimate made by Pinto (1999), the median of some Brazilian cities (500 kg/inhab.year), as well as the average of eight of the municipalities studied in the Table 1 (1.92 kg/inhab.day, what means 701 kg/inhab.year).
Adding the inert mineral fractions (concrete, stone, aggregate and ceramic) of 2,877 tons/day, it is possible to conclude that there is a potential for 2,712 tons/day (one million tons per year) of inert mineral material to be processed and sold in the municipality of Rio de Janeiro.
Considering the hypothesis that there was no C&D waste recycling in the municipality of Rio de Janeiro, and that all the inert fraction of C&D waste generated was destinated to landfilling the East Region of Rio de Janeiro, it would take about 155 years to exhaust the capacity of inert material reception of these regions.

CONCLUSIONS / RECOMMENDATIONS

In Brazil the resources for aggregates for civil construction are abundant, with good quality and close to the urban consumer centres. Both the prices o the aggregates and the number of new construction projects have been low for a long time. So, for attracting and establishing clients, the prices of the recycled aggregates must be lower than the natural aggregates.
In relation to the C&D waste reception, the recycling centres have as competitor the landfills. According to the Brazilian state-of-art, the land fills need large amounts of inert material to cover the landfill cells. The material is also necessary to build the accesses and the maneuver areas for the waste collecting trucks in the landfills.
The inert landfills are also competitors of recycling centres in relation to reception of C&D waste. There are in the Municipality of Rio de Janeiro plain areas to where the city is expanding, that may be elevated.
For the Metropolitan Region of Rio de Janeiro was estimated in 2000 a deficit of around 400 thousand residential units and 520 thousand other residential units have not adequate basic infrastructure. The public government authorities are large consumers of aggregates, for example through the building of social houses and infra-structure projects and street maintenance services. So the public authorities can incentive the consumption of recycled aggregates.
Incentives for the use of processed C&D waste could also be obtained through tax reduction and financing with low interest rates for the processing and sale of recycled

materials, executing civil works with these materials and building private recycling plants, for instance.

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