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Contribution to the management system of the laboratory of construction materials of the civil construction course of CEFET-RJ

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ABSTRACT
The construction industry accounts for 15 to 50% of the consumption of natural resources extracted on the planet (FINESTRA, 2009). As a result, many of these raw materials are currently in short supply. The production of building materials also contributes significantly to the pollution of the planet, with the release of gases and dust into the atmosphere. In addition, construction is the largest producer of waste in the entire society. In Brazil, most of this waste goes to inadequate deposits (often clandestine), which contributes significantly to the degradation of the ecosystem (PORTAL COMPET, 2006).
This project rethought the use of the laboratory of building materials, characterizing the useful space – its functionality, the activities carried out there, limitations – as well as the materials used. From a diagnostic study carried out, criteria were established for a better management of the same and possibilities were studied regarding the reduction of the amount of materials and inputs used in the classes, prioritizing the reuse and/or recycling of all or most of them.
In addition, it is expected that this research will stimulate students of technical courses in civil construction (buildings and roads) to understand the role of environmental management – both in the academic environment and on a construction site. Thus, when inserted in the labor market, they become multipliers and promote a gradual change from the current and expensive methods used today.

Keywords: Construction, Management, Solid Waste, Reuse, Sustainability, Innovation.

1 INTRODUCTION

The data on the environmental degradation caused by human activity on the planet are increasingly alarming and the consequences are visible: from the increase in the temperature of the planet to the extinction of fauna and flora due to the loss of its natural habitat [BRASIL ESCOLA, 2002].

The impacts exerted by man are of two types: first, the consumption of natural resources at a faster rate than that at which they can be renewed by the ecological system; second, by generating waste products in larger quantities than can be integrated into the natural nutrient cycle. In addition to the use of non-renewable raw materials, such as iron ore, which are threatened by large-scale extraction [PINTO, 2007].

The construction industry is one of the largest extractors of natural resources. Many of these are scarce today, such as the world's copper reserves - expected lifespan of 60 years (INDUSTRY AND ENVIRONMENT, 1996). Civil Construction is also responsible for much of the terrestrial pollution due to the processes employed in the production of its construction materials. For example,

for every ton of quicklime, 785 kg of CO2 is produced. Studies reveal that it is the largest and main national producer of waste, having, only in São Paulo, the volume of debris generated in the order of 2500 trucks per day [VANDERLEY, 2001].

The classrooms of the Technical Course of Buildings of CEFET / RJ have been addressing for some years the importance of rethinking the methods used in the Civil Construction industry. Students have been presented with the importance of opting for sustainable development, that is, a development capable of meeting the needs of the current generation, without compromising the ability to meet the needs of future generations [WWF-BRASIL, 2008].

It is understood by the students' own discussions in the classroom and conducting research that, in order to reverse this situation, it is necessary that each one be responsible for the way they relate to the environment, especially for the generation of waste and garbage itself.

The Construction Materials laboratory is one of the most important for the technical education of Buildings. In that space, under the guidance of the professor, students become familiar with the properties and utilities of cement, mortars and concrete, materials of paramount importance for civil construction in Brazil and in the world.

In this way, knowing the way the construction industry has contributed on a large scale to the degradation of our planet and, understanding that with the Laboratory of Construction Materials within CEFET / RJ seeks to reproduce a situation of reality, it is verified that it is necessary to research and adopt environmental management measures in accordance with the new ecological standards of production, prioritizing in the best possible way the reduction of the amount of materials used, the reuse of possible waste and, finally, the possibility of recycling them.

Therefore, the present research work has as main objectives:

- Identify the current proposals for a sustainable development in Civil Construction, such as reuse of waste, recycling of materials, proposals for replacement of certain materials used in construction, but that are already scarce on the planet;
- Study the possibility of adopting an environmental management in the Laboratory of Civil Construction Materials.
- Propose solutions so that the impact caused by the activity of the Construction Materials Laboratory can be reduced, as well as propose a better use of this space.
- Through the results obtained with this research, encourage the students of CEFET themselves, especially of the Technical Course of Buildings to opt more and more for projects that aim at the well-being of people and the environment.

2 METHODOLOGY

In order for the objectives previously described to be achieved, it was necessary to carry out a bibliographic review, at which time there was contact with published works, mainly in the area of environmental management, and documentation related to the management of the Laboratories of the Civil Construction Course of CEFET-RJ.

Next, we tried to survey elements for the diagnosis of the functioning of the Laboratory of Building Materials: its physical space, its limitations, its uses, the activities developed there, which users, the routine of conservation and maintenance. To this end, the following series of questions and measures was elaborated:

a) Identify and classify each waste produced in the Construction Materials Laboratory; Find out how it has been discarded or packaged;
b) What is the percentage of waste reused in the Building Materials Laboratory?
c) What percentage of waste can be reused or recycled? Is this recycling feasible? What is the fate of this new product?
d) Is there any way to improve the activities carried out in this laboratory in order to avoid waste?
e) How is cement stored at the construction site of CEFET/RJ? Does it respect the previous guidelines?
f) What is the percentage of cement loss due to poor packaging?
g) What can be done to prevent the loss of this material?
h) How are aggregates stored in the construction sites of CEFET/RJ?

Are they free from impurities?

i) Does the laboratory suffer the consequences of the flooding that occurs in CEFET/RJ due to the overflow of the Maracanã River?
j) In the procedures carried out in the Laboratory of Building Materials, can recycled rainwater be used? Is there a need to be distilled water? Can the water to be distilled be that of rain?
k) Survey of all tests performed in the laboratory.
l) Specimens are produced every six months by the tests in the Laboratory. Once dried and evaluated, they lose their usefulness and go to waste. What to do?
m) Would it be possible to recycle part of the specimens in CEFET/RJ? Could this activity be carried out by the students themselves as one of the tests of the Building Materials Laboratory? Would the specimens be taken to some industry to be crushed there?

3 RESULTS

3.1 LEGAL BASIS

CONAMA RESOLUTION No. 307, of July 5, 2002, which provides for the creation of guidelines, criteria and procedures for the management of construction waste in the Municipalities and the Federal District, served as a basis for the study of the actions necessary to minimize environmental impacts and to identify the types of waste produced in the Laboratory of Construction Materials.

This legislation defines Civil Construction Waste (CCR): "*are those from constructions, renovations, repairs and demolitions of civil construction works, and those resulting from the preparation and excavation of land, such as: bricks, ceramic blocks, concrete in general, soils, rocks, metals, resins, glues, paints, wood and plywood, linings, mortar, plaster, tiles, asphalt pavement, glass, plastics, pipes, electrical wiring, etc., commonly called construction debris." [CONAMA RESOLUTION, 2002].*

In addition, it is defined as Class A CCR"*waste that is reusable or recyclable as aggregates, such as:*

(a) the construction, demolition, refurbishment and repair of pavement and other infrastructure works, including soil from earthworks;

b) construction, demolition, renovations and repairs of buildings: ceramic components (bricks, blocks, tiles, cladding plates etc.), mortar and concrete;

c) manufacturing process and/or demolition of precast concrete parts (blocks, tubes, curbs, etc.) produced on construction sites;

3.2 TESTS CARRIED OUT IN THE DISCIPLINES OF BUILDING MATERIALS I AND II

In the Laboratory of Construction Materials, currently, the tests indicated in table 3.1 are performed. It should be noted that all are performed by up to 5 groups of students.

Table 3.1 – Tests carried out in the disciplines of Construction Materials I and II in the Technical Courses of Buildings and Roads [CEFET-RJ, 2009]

Essay No	Norm	Test Name
1		Determination of the moisture content of fine aggregate
2	NBR 8492	Solid soil-cement brick - Determination of compressive strength and water absorption
3	NBR NM 52: 2003	Fine aggregate - Determination of specific mass, apparent specific mass
4	NBR NM 45: 2006	Aggregates - Determination of unit mass and volume of voids
5	NBR NM 248: 2003	Aggregates : Determination of particle size composition
6	NBR 11579	Portland cement - Determination of fineness by means of sieve 75 µm (n° 200)
7	NBR NM 43: 2003	Portland cement - Determination of normal consistency paste
8	NBR NM 65: 2003	Portland Cement - Determination of Grip Time
9	NBR 7222	Mortar and concrete - Determination of diametral compressive tensile strength of cylindrical specimens
10	NBR NM 67: 1998	Concrete - Determination of consistency by lowering the cone trunk
11	NBR 5738	Concrete - Procedure for molding and curing specimens
12	NBR 5739	Concrete - Compression tests of cylindrical specimens

3.3 IDENTIFICATION AND QUANTIFICATION OF WASTE GENERATED

Table 3.2 provides the types of residues generated by the tests.

Table 3.2 – Types of waste generated in the tests of the Laboratory of Construction Materials.

Essay No	Waste generated
1	Dry sand
2	Saturated brick
3	Sand in hygroscopic moisture
4	Saturated sand
5	Dry sand
6	Cement in hygroscopic humidity
7	Cylindrical specimens of hardened portland cement paste
8	Cylindrical specimens of hardened portland cement paste
9	Hardened mortar specimen shards
10	Fresh concrete at the time of testing and then hardened
11	Hardened concrete specimen
12	Hardened concrete specimen shards

Therefore, according to the data collected, there are as residues coming from the Laboratory of Construction Materials, basically: cement, sand, gravel, mortar and concrete, in different states.

The quantitative evaluation of the residues of the present work is a conservative prediction, that is, it considers the greater load of residues that could be generated if all classes had a homogeneous behavior. However, it may be in dissonance with the reality practiced in the Civil Construction Course, given that the tests, although carried out according to the standards determined by the Technical Standard, may undergo pedagogical adaptations – thus changing the quantities generated.

Thus, table 3.3 was elaborated, which shows the quantities of waste according to its typology, per academic semester.

Table 3.3 – Estimated amounts of solid waste generated in the tests of the Laboratory of Construction Materials.

Test n°	Number of groups per class	Number of classes per	Waste generated	Quant	unid
1	6	3	dry sand	16,2	kg
2	6	3	saturated brick	31,6	kg
3	6	3	Sand in hygroscopic moisture	25,2	kg
4	6	3	saturated sand	9,0	kg
5	6	3	dry sand	18	kg
6	6	3	Cement in hygroscopic moisture	0,9	kg
7	6	3	Cylindrical specimens of hardened portland cement paste	7,6	kg
8	6	3	Cylindrical specimens of hardened portland cement paste	7,6	kg
9	6	3	Shards of hardened mortar test piece	8,5	kg
10	6	3	Fresh concrete at the time of the test and then hardened	1,4	kg
11	6	3	Hardened concrete specimen	-	-
12	6	3	Shards of hardened concrete specimen	228,9	kg
TOTAL				354,94	kg

The following are some of the assumptions used in the calculations in Table 3.3:

- Trial 1: three capsules of 30g for each team;
- Test 2: one solid brick per group;
- Test 10: one test for every 6 groups;

3.4 CONSERVATION AND MAINTENANCE ASPECTS

The aggregates (sand and gravel) used in the Laboratory tests are stored in silos with wood buffering. This reduces the undesirable effects of high humidity, dust, leaks and animal waste.

Cement is not properly stored. With the constant use of the classes the cement bag is usually packed in plastic bags and on countertop, but this does not prevent that, over time, the humidity causes chemical reactions causing the cement to quickly lose its ideal characteristics of use.

It was observed that in certain tests, such as the granulometric composition of aggregate (test No. 5) and the fineness of cement (test No. 6), which use, respectively, fine aggregates and cement, students discard these materials after their use.

A worrying factor regarding the storage of materials and conservation of the equipment of the Laboratories of the Civil Construction Course was the flooding with rainwater from floods of the Maracanã River. Even after the works carried out in CEFET/RJ, the floods of the referred river

continue to generate disturbances, because the rainwater has returned through the sewage facilities, sporadically flooding the floor of the Laboratory.

It was not possible to obtain a definitive answer to the question of using water captured from rainfall in relation to the tests due to the lack of time available for the creation and preparation of tests and tests.

The mortar and concrete specimens are produced every six months in the laboratory and discarded after evaluation.

4 DISCUSSION

According to the classification established by the Federal Legislation, all waste generated in the tests carried out is Class A, therefore, reusable and / or recyclable. In this sense, table 4.1 presents the results of the study of the potential for short-term reuse of the waste listed in table 3.3, in the Laboratory of Construction Materials itself.

Table 4.1 – Study of the potential for short-term reuse of the CCRs produced in the Construction Materials Laboratory of the Civil Construction Course of CEFET-RJ.

Essay No	Waste generated	Potential for short-term reuse in the Laboratory
1	Dry sand	Yes
2	Saturated brick	Yes
3	Sand in hygroscopic moisture	Yes
4	Saturated sand	Yes
5	Dry sand	Yes
6	Cement in hygroscopic humidity	Yes
7	Cylindrical specimens of hardened portland cement paste	No
8	Cylindrical specimens of hardened portland cement paste	No
9	Hardened mortar specimen	No
10	Fresh concrete at the time of testing and then hardened	No
11	Hardened concrete specimen	-
12	Hardened concrete specimen shards	No

If, after performing tests 5 and 6, for example, the waste was disposed of in suitable places, where it could be reused in the future, and if the storage of the materials was correct – avoiding that the same test had to be redone due to the poor condition of a certain component – it would be possible to considerably reduce the amount of waste discarded by the Laboratory.

For tests 1, 2, 3 and 4, the simple air drying already enables the reuse of these materials.

Thus, it is estimated that approximately 71% of the waste does not currently have potential for reuse, being disposed in the garbage. In relation to the procedure adopted today, the percentage of

reduction of CCR would be 29%, which will generate savings for the institution and reduce the impact on the environment, either by reducing solid waste or by reducing CO2 emissions into the atmosphere.

Throughout this research, options for reuse or recycling of waste from trials 7 to 12 were sought. However, although there are Technical Standards that deal with the recycling of these CCRs (crushing to be reused as aggregates), no innovative or advantageous way has been found for the school to reuse and/or recycle this waste.

Regarding the proposal to capture rainwater for use in the trials, it proved to be unfeasible. The rainwater, previously filtered, can even be used for sanitary discharges and fire reserves, among others, but does not reach the necessary characteristics for the preparation of mortars and concrete according to the Technical Standard. [CIOCHI, LUIZ – TO USE RAINWATER IN BUILDINGS; 2003].

5 CONCLUSIONS

The reuse of almost 30% of the inputs currently used in the tests of the disciplines of Construction Materials I and II proved not only feasible, through adequate treatment, but also necessary, to reduce the costs of acquisition of the same and reduce the environmental impact previously generated by them. They are simple precautions such as outdoor drying for the absolute majority of them (99%) and moisture-free packaging for the remaining 1%. With this, the results obtained are free of possible misconceptions due to the necessary materials not being in their technical conditions and aesthetic ideas.

Steps should be made with the Institution in order to eliminate the problem of flooding of the facilities of the Laboratory of Construction Materials to preserve the materials, equipment and the healthiness of the laboratory environment.

Ways of recycling mortar and concrete waste in the pedagogical environment should be sought by future research that will follow this work.

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