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POTENTIAL USE OF GYPSUM AS RECYCLABLE MATERIAL

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ABSTRACT
Gypsum has been increasingly used as a construction material, due to a number of advantages, such a fast-curing and improving the final surface roughness. Like any building material, it is important to deal with wastes resulting forms its production and final application. In general, those wastes are not properly disposed and eventually it may lead to soil and groundwater contamination due to the material's toxicity. The proper collection, segregation and storage of residues allow the recycling process and residues may regain come important original properties of gypsum, becoming adequate for reuse in the production chain. For instance, that recycled material may be used in the cement industry – as an addition to the clinker – or in the agriculture industry – improving soils which present calcium deficiency and high levels of aluminum. In conclusion, the recycling of gypsum is technically and economically practicable, representing a contribution to the sustainability of the construction industry.

KEYWORDS: gypsum, recycling, reuse, resolution, application.

1 - INTRODUCTION

1.1 - Production, use and history

The gypsum used in construction is a mineral which comes from the calcination of gypsum, hydrated calcium sulphates and gypsum as the raw material (Cavalcanti, 2011). Historically it can be said that the gypsum is one of the oldest construction materials used by man. Excavations in Syria and Turkey revealed that the use of this material dates from 8000 BC in the manufacture of flooring and containers. Such use has grown even more especially after the eighteenth century, when scientific knowledge about this material, was headed by Lavoisier. Since then study of this material has continued uninterrupted (Fiano & Pimentel, 2009). Various technologies have been developed enabling the use of gypsum in various ways, such as the Portland cement binder.

1.2 - The necessity of recycling

With population growth, modernization and progress of city construction grows the generation of waste (Construction and Demolition - CDW). The necessity of recycling policies and management of such waste is known, however this is still not a reality in many countries.

Of all the materials used in construction, one that is gaining momentum in recent years due to its ease, speed of execution, quality of workmanship, and low cost is the cast. However, this new technology adopted does not cooperate with the loss reduction, otherwise, they can reach up to 120% (Agopyan & John, 2000). The major factors that lead to too much waste being generated in the implementation phase is: the short time early picks, the other residues incorporated and principally to higher precursor of these problems, the labor disqualified. In general figures it is estimated that the wastage of gypsum in construction revolves around 45%, while the gypsum powder produced by the industry 30% (Pimentel & Harada, 2009). These wastes are commonly deposited in landfills or in more severe cases in unlicensed locations. The big problem is that the cast is a toxic material that releases Ca2 + and SO4- altering the alkalinity of the soil and contaminate groundwater (Harada & Pimentel, 2009).

However it can be said that the gypsum environmental issue is a paradox, whereas when comparing with other binders gypsum can be considered as a material of good performance in ecological viewpoint, since materials such as lime and Portland cement require calcination temperatures above 700 º C, the gypsum can be obtained at temperatures that are around 140 º C. While these binders release CO2 to the atmosphere, gypsum releases only water vapor.

The aim of this paper is to present and discuss the possibility of recycling and waste management of gypsum and present a material option that is economically and ecologically viable.

2 - BRAZILIAN CONAMA RESOLUTION NO. 307

On May 25, 2011, Brazilian Resolution No. 431 amending art. 3 of Resolution No 307 reclassifying the gypsum Class C - waste for which no technologies have been developed or economically feasible applications that allow recycling / recovery - Class B - recyclables to other destinations - enforcing several studies focused on the recycling of gypsum . This change came from the initiative of the Brazilian Association of Manufacturers of Sheet Drywall to that promoted studies that demonstrated their technical and economic feasibility.

3 - RECYCLING OF GYPSUM

The recycling of construction waste and demolition comes as a great environmental solution. Not only that, rationalization and training of the workforce are fundamental when it comes to preserving the environment. With gypsum it would be no different. Its use requires care ranging from the choice of material, training of workers, use of the product, as well as the phase of the generated waste storage, collection, segregation, transportation and disposal (John & Cincotto, 2010).

Because it is a quite powdery contaminant for recycled pellets, the construction site should be a place reserved only for the separation of the gypsum recycling and the site should be covered and dry. Therefore, space is required and training of manpower. The transportation of waste must comply with the rules established by the municipal environmental agency or cleaning service and carriers must be registered and have the correct documentation. Finally the waste is destined for areas Overflow Screening and licensed by the city to meet certain residues as in the case, gypsum.

An important element in the operation of the recycling of gypsum is the adoption of the culture of logistics auto-reverse: each chain segment (industry, distributor, gessaria, works, cement industry, etc) is responsible for forwarding the waste to the anterior segment. This concept of logistics makes the process more efficient and amplifies the scope of recycling, reaching even the smallest and most distant users of gypsum.
The recycling of gypsum requires in addition to grinding, removal of impurities and low temperature calcination. During the process of recycling waste gypsum, especially the "pure" regain the chemical characteristics of gypsum can be reused in the production chain (Cincotto & John, 2010).

4 - APPLICATIONS OF RECYCLED GYPSUM

There are today three fronts for the reuse of recycled gypsum that make it technically and economically feasible: in the cement industry, in agriculture, and in manufacturing of gypsum.

4.1 - Cement industry

The cement industry uses gypsum for adding to the clinker, ranging from 3% to 5% by weight of the material. This addition made in the clinker grinding step, aims to increase the length of the handle and constitutes a mandatory addition to all types of cement. Without it the time would takes a few minutes, which would hamper their use.
Because it is a mandatory addition and defined percentage, this demand will be proportional to the domestic production of cement. Analyzing the figures for production from 2005 to 2011 (Snic, 2012), it appears that there was a growth of over 60% culminating in a production of over 64 million tons in 2011, featuring a consistent demand and significance that shows how an outlet for this waste is recycled.

4.2 - Agricultural sector

In the agricultural sector, gypsum is used as a correction of soil acidity and improving characteristics. In Brazil, the Cerrado soils especially benefit from this use, primarily by the occurrence of Indian summer - dry period during the rainy season, with days of intense heat and sunshine, with a minimum duration of 4 days (Agritempo, 2012).
When applied to soil, the gypsum penetrates to below the topsoil layer, increasing the concentrations of calcium and magnesium and reducing the toxicity of aluminum, improving the conditions of soil for root development. This effect can be observed in the agricultural year of application of gypsum.
Better distribution occurrs with deep roots in the soil, it allows a better utilization of the available water, which are characteristic particularly important during the Indian summer. Besides water, there is more efficient absorption of nutrients as well (Figures 1 and 2).

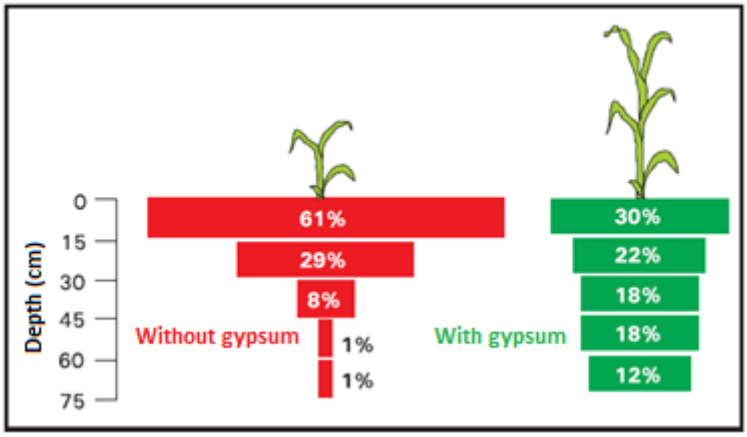

Figure 1 - Relative distribution of maize roots in the profile of a clayey Oxisol without implementation and application of gypsum (Souza, 2005)

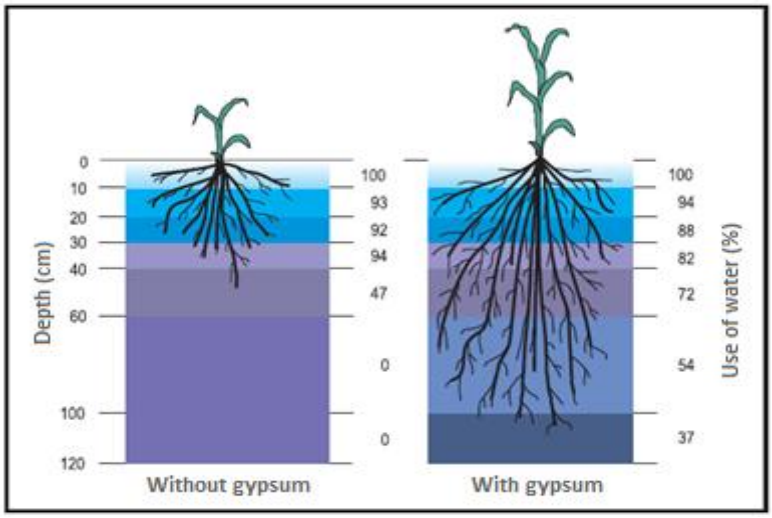

Figure 2 - Use the blade on available water in the profile of a clayey Oxisol by corn, Indian summer after a 25-day, at the launch of spikes, for treatments with and without application of gypsum application (Souza, 2005)

The gypsum must be applied to the soil where: aluminum saturation is greater than 20% or calcium content is less than 0.5 cmol / dm ³. To calculate the required amount of gypsum, one must know the clay content and the type of crop to be grown - annual or perennial. The effects provided by the residual effect of gypsum have at least five years and may extend to 15 years, depending on the soil, eliminating reapplying during this period (Souza, 2005).

4.3 - Manufacturing industry of gypsum

Finally, you can reincorporate waste, to some extent, in their own production processes in the manufacturing industry of the cast, this process can be done within the work itself. This is an alternative that is still rarely explored in practice.

5 - CONCLUSION

It can be concluded that:

• Recycling of gypsum is technically and economically feasible, presenting three options currently proven useful for recycled waste.

• The demand for this material is consistent, significant and growing, with a greater demand found in the cement industry.

• Increased network of strategically located and spread of auto-reverse logistics factors are necessary for the process of recycling of gypsum and catalyst of their success, scope and effectiveness.
• It is noteworthy that training of manpower and awareness of builders and companies to allocate resources and spaces, appropriately is important. These materials are not transported to the preceding parts of logistics.

• Since this is a very recent subject, more studies are expected on recycling of waste, potentially revealing new applications and more efficient techniques, so that in the near future recycling of gypsum is common practice in construction.

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