RECYCLING WASTE AS BUILDING MATERIALS: AN INTERNET DATABASE

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Abstract

Environmental concern is expected to have serious implications for affect the construction industry in the years to come. The construction industry, including building materials production, is probably the greatest consumer of natural resources, using between 17 to 50 % of those available. Recycling wastes both from construction and other industries is one important alternative to reduce the impact of construction activities on the environment.

However there are some constraints in using recycled waste as building materials, due to lack of information, research and development technology. Market and technology differences between countries make some recycling technologies successful in some instances but not in others.

An methodology outline for guiding research and development of building materials from recycled waste is presented in this paper and its main steps are summarized.

Waste characterization is the first step of the study. The selection of possible applications for the waste must consider both the technical and market aspects. Laboratory research must be based on a scientific approach and performance concept. Durability evaluation is an important phase of the study and the service life of any new material will affect not only its economical feasibility but also its environmental impact.

A web site including a database about recycling waste as building material has been build and is available on the Internet. The database includes waste and some basic information about them, references and reports with researchers names. It is possible to everybody feed the database with new information. The address of the web site is http://www.recycle.pcc.usp.br.

Keywords: Recycling, methodology, database, Internet, sustainable development
1 Introduction

Environmental consciousness is considered as being one of the most important trends in the construction industry [1].

The construction industry, including building material production, is probably the greatest consumer of natural resources, using from 17 to 50 % of the extracted resources, as water, wood, minerals and fossil fuels [2]. These figures are probably greater in poorer countries. The consumption of natural rock for aggregates to make concrete, asphalt, and road base ranges between 1 to 7.7 tones/year/inhabitant [3]. One author estimate that building construction uses about 66 % of the virgin wood, a potentially sustainable material [4] but only 20 % of the tropical forests that supply most of hardwood are managed in a sustainable way [3]. Some of the materials consumed on a large scale are subject to shortage in the near future. These include copper and zinc, which have estimated reserves for about 60 years [5].

The construction industry is also one of the biggest waste generator in the economy. In developed countries like USA and Germany, the amount of waste generated by the construction industry is comparable to municipal solid waste generation [4]. In the big cities of poorer countries like São Paulo, the waste generated by construction and demolition activities is 2.3 times greater than the municipal solid waste [6]. Almost one third of this construction waste is illegally placed outside of landfill, polluting the environment, obstructing rivers, and promoting floods during the raining seasons. For each tonne of steel produced about 700 kg of waste are generated, including about 300 kg of blast furnace slag.

The construction industry also generates air pollution ranging from CO₂ during limestone burning to airborne particulate material during site operations.

Reducing the environmental impact of the construction industry is a complex situation and certainly will include the environmental motif “Reuse, Reduce and Recycle”. Re-using building components and reducing the consumption of energy and raw materials, including making the building more durable, will play an important role. But no matter how much the industry succeeds in reducing the natural materials consumption, making and maintaining buildings, roads, bridges will always consume large amount of materials and recycling waste produced by different industrial sectors seems to be vital.

2 Main recycling constraints

The construction industry has a long history on recycling. Recycling granulated blast furnace slag as a hydraulic binder, for example, started at the beginning of the 19th Century and in the beginning of the 20th Century the Portland slag cements were on the market and covered by standards [7]. Despite of the technical and environmental advantages of this kind of cement, it is not permitted to mix Portland cement with slag in some countries, like Argentina.

These differences in recycling policies between countries are not exception but a rule. Colliery spoil from coal extraction is recycled in China and the UK [3] but not in Brazil. This happens because recycling waste has some constraints.
2.1 Market differences

Differences in building materials market between countries or regions are frequently important. These differences can make one recycling technology economically viable in one region but not in other one. It occurs specially because the environmental impact of recycling is not considered at all in most of countries.

2.2 Lack of suitable research methodology

Standards and regulations, including those that are related to solid waste disposal and classification severely restrict recycling possibilities [9]. Most solid waste regulations are concerned about waste disposal and contain no rules that facilitate recycling. Standard leaching tests, for example, are developed to control groundwater contamination by a landfill, which can concentrate huge amount of dangerous waste. It clearly doesn’t apply to a waste widespread over a large area, like when a waste is recycled as building material. In addition, it does not take into account the decisive influence of the size, shape, water absorption, and evaporation that causes leaching in real materials as well as the influence of the environment.

The main problem here is probably the lack of a consolidated and widely accepted systematic methodology to guide research and development and environmental risk evaluation for recycling technology. On the other hand, technical standards for the building industry almost enforce the use of traditional materials and components. Technical Approval’s schemes, must also rely on a systematic methodology for environmental risk evaluation, could be a good solution to this problem. In addition, eco-label schemes can make good recycled products even more attractive to consumers.

2.3 Construction technologies

Differences between indigenous construction technologies also have a similar effect on the development of any recycling market.

2.4 Lack of information

Lack of reliable information about both successful and unsuccessful recycling technologies and expertise also plays an important role. Most waste producers have little association with the building industry and for this reason, they are not able to foresee possible applications. If they do succeed in detecting an application, they often take a long time seeking researchers with proper experience in develop new building material from recycled waste. Lack of information also affects research activities. The lack of knowledge about potentially recyclable waste can partially explain the concentration of research on blast furnace slag and fly ash. A web-site can contribute to widespread information about waste and recycling waste as building materials.

2.5 Recycling strategy

A poor recycling strategy can also contribute to keep some waste out of the recycling process. Most industries try to sell waste as waste, and as such, the consumer of the waste have to have the knowledge of recycling. This strategy works for some simple recycling technologies that are easy to develop or for those tremendously profitable. However, in most cases no potential consumer wants to bear the risk of financially supporting the research and development of a recycling technology for a product that belongs to someone else. The high cost of waste deposition and possible
profits of recycling can however persuade a waste producer to invest in research and development.

3 Recycling research and development methodology

A recycling research and development project is always a comprehensive and multi-disciplinary study. A proposed outline of a methodology is presented.

3.1 Waste characterization

The first step in any research and development project must be the characterization of the waste, including any production parameter and a comprehensive physical and chemical analysis which considers it’s variability with the time and environmental risk.

3.2 Selection of possible application

The next and the single most important step is selection of possible applications must consider both the technical and market aspects. From the technical point of view there is frequently more than one possibility for recycling. The selection of the most suitable alternative depends upon market evaluation, which must be based on a comprehensive knowledge of both the construction market and construction technology as well as a good estimation of the economic feasibility of each alternative.

Developing a cheap material may not lead to success in the market. For example, blast furnace slag activated with lime or sodium hydroxide was on the European and even North American market until the end of the 1940’s. Even though this cement was cheaper than Ordinary Portland Cement, it vanished from the market because of it’s poor performance regarding frost resistance and low initial strength [7]. Finding an application where the new product has a better performance than any other alternative already in the market is the most important thing.

Economical feasibility must be evaluated by comparing the cost of waste disposal in an authorized landfill against the cost of recycling.

3.3 Product research and development

It starts with very basic research and goes on to a complete performance evaluation, which includes durability and environmental impact. Development of the process of production, including the appropriate quality control tests, must also be covered.

The research must be conducted on a scientific basis in order to ensure complete knowledge about the new material properties. The evaluation of the new product must be carried on by considering its fitness for the purpose. It could be based on CIB W 60 [10] methodology and ISO 624 1.

Indoor air quality must be carefully considered when studying wastes containing volatile organic components. The use of standards developed specifically for traditional but similar material or components is not adequate and can give the wrong results. Tests must elucidate the main degradation factors, degradation mechanisms and the effect of these processes on the performance.

Not all recycling is environment friendly and therefore environmental impact has to be evaluated on cradle-to-grave basis.
3.4 Technology transfer
Unfortunately, few research programs dealing with recycling have been designed to facilitate the transfer of developed technology to the market and for this reason, most of them never reach the production stage.

Technology transfer must be planned from the very first phase of the research. Successful joint research and development projects will include a research institution, the waste producer and a company that expects to manufacture the new material. Of course, selecting the appropriate application for the waste is also critical.

Wide dissemination of research results to building entrepreneurs and consumers is also helpful to create good expectations in the market before the product is actually ready to be sold.

After the development is completed is important that the researchers give continued support to the producer to ensure the product get a technical approval and the proper environmental certificates.

4 Diffusion information using an Internet database
As mentioned previously, dissemination of information on potentially recyclable waste, research expertise and any research results could not only help other researchers but the society in general.

It has been the aim of this research programme to develop a database that is accessible through Internet by a plain Web connection. This database include:

1. Internet data sources and web-sites;
2. Potentially recyclable waste as building materials and their main characteristics
3. Waste recycling alternatives, both proved or possible;
4. References of papers and reports;
5. Researchers names, including the addresses if available.

The database is a relational one, built over a SQL server. It is fully indexed using a controlled vocabulary, making it easy and reliable in any search. It is possible feed the database with new information which will be available at the web site as soon as its consistency is checked.

The web site also includes short reports and texts and its address is http://www.recycle.pcc.usp.br.

5 Final remarks
Environmental concern is expected to deeply affect the construction industry in the years to come. Recycling wastes both from construction and from other industries is one important alternative to reduce the impact on the environment.

There are many constraints which make it difficult to develop a waste into a new material. These constraints include lack of information, lack of research methodology, poor recycling strategies from waste producers as well as differences in market and construction technologies between countries.
The development of a new product through waste recycling must include product characterization, careful evaluation of the market and technical acceptance of the recycling option, a scientific based research that includes the evaluation of the environmental impact of the recycling, as well as technology transfer.

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7 References