# Portland cement is produced from industrial residues

**With recyclable raw material and less emission of pollutants, Portland cement manufacturing industry reduces environmental impacts**

*Written by: Carolina Golenia*

The large amount of polluting gases released into the atmosphere on a daily basis is worrying, and civil construction is recognized worldwide as one of the main agents of environmental contamination today. Data from the United States Geological Survey (USGS) and the US Energy Information Administration (EIA) point out that cement manufacturing accounts for about 9.3% of Brazil's CO2 emissions from fossil fuels burning.

Alternative Portland cement can be produced from rice husk ash, steel slag, crushed bricks, building materials and demolition debris – Photo by: Carolina Golenia

Due to the ever-growing population rates and the increased industrialization of developing countries, it is estimated that cement production will show significant growth over the coming decades. According to the National Union of Cement Industry (SNIC), the per capita consumption of cement in Brazil increased from 177 to 311 kilograms per inhabitant between 1990 and 2010. In addition, in its manufacturing process, the plants emit sulfur dioxide, Nitrogen oxides, carbon oxides, aldehydes, gaseous hydrocarbons, silicate dusts and other pollutants.

One of the alternatives found by a research group in materials science of the Nucleus Oriented for the Innovation in Edification (Norie) to reduce this kind of polluting emission is the production of cement from industrial waste. Ana Paula Kirchheim, professor of Civil Engineering at UFRGS and responsible for the project, explains that "for each ton of cement produced, 0.8 to 1 ton of carbon dioxide is emitted into the environment. For example: for every ton of limestone that is used in cement production, 44% is pure CO2. In addition, the extraction of raw material ends up being quite high."

The goal of the researchers is to use industrial waste instead of consuming more raw material, re-using this waste in the production of cement that is more sustainable. To make the conventional Portland cement, raw material (limestone) extraction, burning, and grinding are necessary. The alternative cement, on the other hand, requires only the activation of the residues by means of a chemical process. Among the residues that may be used are rice husk ashes, steel slag, crushed bricks, building materials and demolition debris. It is important to note that the waste must be composed of aluminum, silicon, a combination of the two (called aluminosilicate) or calcium.

The research follows three steps: the residues are analized and classified, the cement is produced and applied, and finally the results are assessed. Also, through a life cycle assessment, the feasibility of the use of the material in an ecological environment is tested, and compared to its resistance and durability in relation to the ordinary Portland cement. "As we are beginning, we focus on non-structural elements, such as prefabricated pieces, but the alternative Portland cement is in the course to be apllied to other elements in the future," remarks the researcher.

"We are looking for waste from the south region – Rio Grande do Sul and Santa Catarina – that do not have a noble use. The heavy ash is abundant here," says Ana Paula. Waste from thermoelectric plants can be reused, as well as those produced by Petrobrás in the chemical processes of petroleum refining. "We work with a very interesting waste from Alpoa [durable goods company of Porto Alegre], which is a leftover of the galvanization of aluminum." On a large scale, the manufacture of this alternative cement can provide a number of benefits, such as reduction in emissions of polluting gases, production of new and more-resistant-to-chemical-attacks materials, as well as the

possibility of small-scale production of blocks and structural materials by poor communities, the cheap, simplified process giving them with the autonomy to build their own homes. In addition, alternative cement can aid the increased demand for Portland cement, which is far too large than its production, so avoiding the importation of this material and generation of more pollutants.

The project has partnerships with other Brazilian universities, such as the University of São Paulo (USP), the Federal University of Paraíba (UFPB), the Federal University of Pará (UFPA), the University of Vale dos Sinos (Unisinos) and The Southern Faculty of Passo Fundo (Imed). In addition, it has international support from the University of Sheffield, in England; of the Polytechnic University of Catalonia (UPC), in Barcelona; and the University of California, in Berkeley.

In 2013, the project won the Santander Universities award, with Eugênio da Costa's dissertation thesis. Da Costa used waste from Alpoa to replace the bauxite for the production of alternative cement. According to Ana Paula, the award opened the research new doors, bringing new confidence to researchers and attracting more students to this area. "In addition, two foreign teachers have joined us because they have won a scholarship: one from Spain and one from England. They give talks, supervise students, and this partnership ends up internationalizing the research," notes the teacher.
Despite this visibility, Ana Paula points out that a major difficulty faced during the research is the lack of infrastructure, forcing the samples to be sent to other laboratories within UFRGS, to São Paulo, or even to places as far as England.
In future projects, Ana Paula says that the team is seeking new materials for the production of cement, and after gaining a good experience in production, the project enters its second phase, which is that of the application. A Twitter account (@cimentos_norie) was opened to publicize the progress of the studies.

**Dissertation thesis**

Title: Aproveitamento do resíduo de anodização do alumínio na produção do cimento sulfoaluminato de cálcio belítico
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Text in Portuguese available at: http://www.ufrgs.br/secom/ciencia/cimento-alternativo-e-produzido-a-partir-de-residuos-industriais/

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Directions