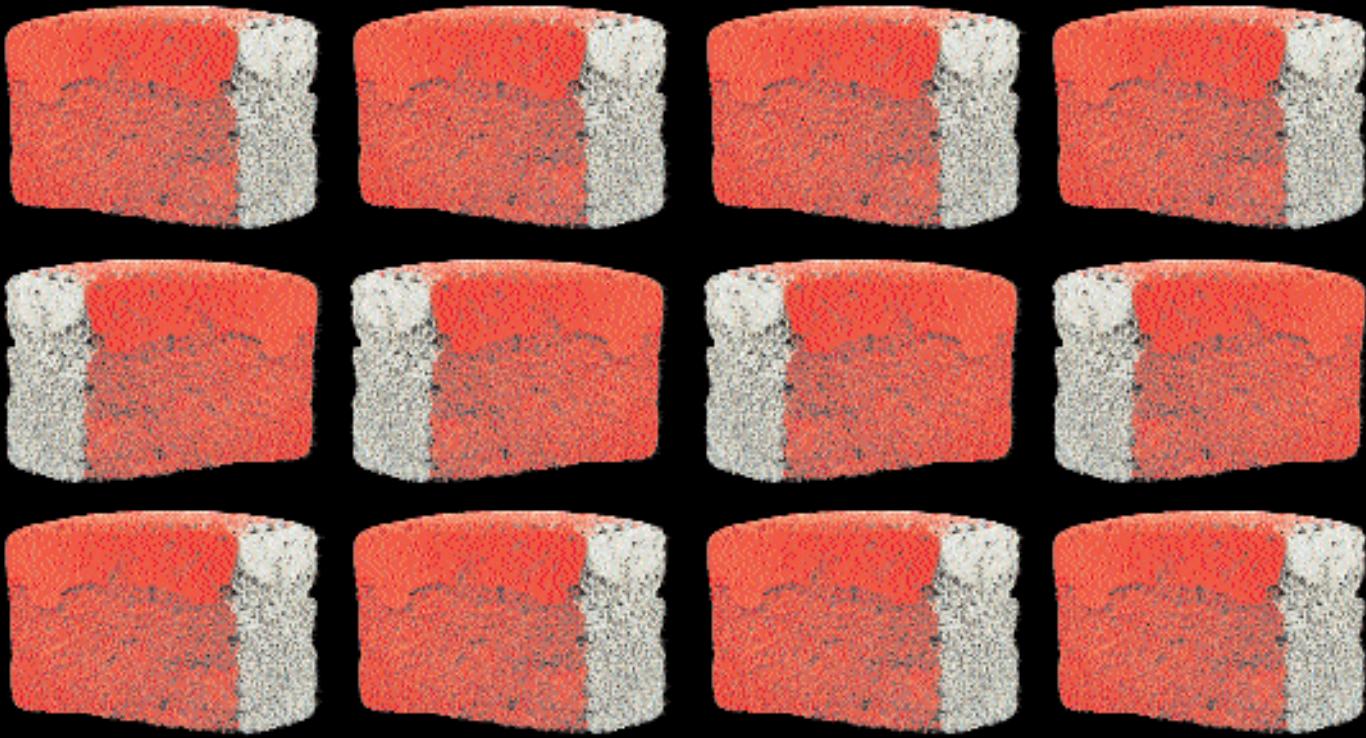


■ TECHNOLOGY

CIVIL ENGINEERING

# *Expanded* concrete

Researcher finds in aluminum slag a new ingredient for producing mortar







EDUARDO CESAR

Slag: 11,000 tons put to good use

**B**y bringing together concrete and aluminum slag, metallurgical engineer Edval Gonçalves de Araújo has obtained a new product that is going to lower the cost of materials used in the construction industry. It is a special kind of mortar called cellular concrete, which gives a useful purpose – and in an unprecedented way – to aluminum slag, a pollutant left over from the processing of this metal. In Brazil, this material amounts to over 11,000 tons a year. After it is processed, the aluminum slag acts as an expanding agent, which incorporates air into the mixture and can be used in the manufacturing of building blocks (bricks), pre-molded panels, subfloors and other kinds of surfaces. The two products used nowadays as expanding agents – aluminum powder and chemical substances called foaming agents – are very expensive and limit the use of cellular concrete. Production of the new material will start in six months, at a pilot plant in the town of Araçariguama, in the region of Sorocaba in the state of São Paulo.

The main advantage of the materials made of this new kind of cellular concrete over the conventional ones is the reduction in the quantity of raw material (sand, cement and lime) of up to 30%, which knocks down the

cost of building materials. This happens because the use of cellular concrete makes it possible to reduce the structural components of a building, such as the beams, columns and pillars, which also helps bring down the final price of the construction.

“The expanding agent works like yeast, in the preparation of the mortar”, explains Araújo, who is responsible for the development of the new product. He first discovered the possibility of using aluminum slag as an expanding agent while he was preparing his thesis for a doctorate in materials engineering, which he concluded in 1992 at the Nuclear and Energy Research Institute (Ipen). “In the course of the doctorate, I managed to make an aluminum powder from thin sheets of aluminum. I went after the possible applications for the product and saw that one of them was autoclaved cellular concrete”, says Araújo. “But the thin sheet market is a very closed one, as the suppliers of coils of thin sheets buy the residue as well (for recycling) from those who used them, I decided to look for another raw material, cheaper and available in greater quantities, but having a good potential for producing gases in the mixture, an essential condition for an expanding agent. After many studies and tests, I arrived at aluminum slag”.

In the course of his post-doctoral studies, now on the recycling of aluminum, at the Polytechnic School of the University of São Paulo (USP), the researcher got in touch with Siporex, a company located in Ribeirão Pires, in the São Paulo metropolitan region. It is one of the two Brazilian industrial concerns that specialize in making autoclaved cellular concrete. Araújo’s intention was to test aluminum powder recycled from thin sheets, and, at a second moment, slag used as an expanding agent. “That was how, in the light of the good results, we decided to put a project forward to FAPESP”, the researcher explains.

Starting in 2001, the project was funded under the Small Business Innovation Research Program (PIPE), and it should go on to 2004. This is the deadline for the first factory specialized in Brazil in the production of expanding agents based on aluminum slag to start commercial production. The pilot plant will be working at Recicla, a company from Araçariguama in the São Paulo state. A good deal of the R\$ 400,000 of the financed funds is being used in building the plant, which in its initial stage will have the capacity to produce 90 tons a month of the slag-based expanding agent.

Siporex went into partnership with Recicla, which, in compensation, is going in with the land for the pilot plant, the slag and the labor. It is a company that recycles the slag made by several producers of aluminum, such as Alcoa and Companhia Brasileira de Alumínio (CBA), the two largest in Brazil, and Metalur – of which it is a subsidiary. The estimate is that around 11,300 tons a year of primary slag are generated. This amount is equivalent to 1% of the production of aluminum, which came to 1.13 million tons in 2001, according to figures from the Brazilian Aluminum Association (Abal).

When the expanding agent is added to the mortar, it has the function of making it porous, reducing the density of the products manufactured. This expanding effect happens because, as it reacts to the alkaline medium of common mortar (cement, lime and sand), hydrogen (H<sub>2</sub>) and methane (CH<sub>4</sub>) gases are released, forming bubbles that are incorporated into the material. In spite of being 30% less dense than conventional mortar, cellular concrete can

meet all the requirements for resistance to compression, according to the application for which it is intended. Building blocks made of cellular concrete with slag have the same required resistance to compression as the common blocks.

As a result of its high price, the use of cellular concrete in Brazil is still minimal. While the square meter of this material costs R\$ 14.00, ordinary bricks is sold at R\$ 6.00, and hollow concrete blocks R\$ 8.00. The high price is due to the costs of the currently used expanding agents. Aluminum powder and the foaming agent cost, respectively, US\$ 5 and US\$ 4.50 the kilo – and for this reason are little used in Brazil. “The slag-based expanding agent will replace these two products and be ten times cheaper than they are”, Araújo guarantees. The estimated price for one kilo of the slag-based expanding agent is R\$ 1.50.

**Environmental benefits** - Besides its low cost, the expanding agent made of aluminum slag can show other benefits, when compared with its rivals, aluminum powder and the foaming agent. The first of these is environmental. “Our intention is to put to use in the production of light concrete a highly pollutant waste”, Edval Araújo explains. Aluminum slag is usually disposed of in an inappropriate way, mainly by secondary recyclers (recycling the primary slag of aluminum scrap), as, for example, those who remove the aluminum from foundry slag. They throw the slag into lakes, rivers and onto fields, causing serious damage to the environment.

## THE PROJECT

*Development of an Aluminum Slag Based Expanding Agent for the Production of Autoclaved or Molded in loco Cellular Concrete*

### MODALITIES

Small Business Innovation Research Program (PIPE)  
Support for Intellectual Property Program (PAPI)

### COORDINATOR

EDVAL GONÇALVES DE ARAÚJO – Siporex

### INVESTMENTS

R\$ 396,490.80 (PIPE)  
and R\$ 6,000.00 (PAPI)

Both the aluminum slag classified as primary, coming from the production of aluminum, or the secondary variety, can be used in making the expanding agent, although the former is more advantageous, for having lower levels of salts, which are not desirable in the process. Another important attraction of the expanding agent made using aluminum slag is that there is no need for specific equipment, such as an autoclave or a foam generator, to produce the special mortar.

According to Araújo, the pilot plant will cover some 40 square meters, and will be made up of a grinding center, a centrifugal fan, a cyclone type classifier (a sort of sieve) and a storage silo. “If the expanding agent proves to be reasonable for use in, for example, rich mortar – used to fill the gap between brick walls and beams or cement slabs –, the demand from the market will be much greater than the productive capacity of the pilot plant (90 tons a month)”, Araújo explains. “If all works out well, we already have plans to expand production to 500 tons a month”, the engineer says. In this case, additional investments in the order of US\$ 2 million will be needed.

**Patent under way** - There is only one patent in the world relating to the transformation of aluminum slag into an expanding agent for autoclaved cellular cement, but there is no commercial production. The patent was granted in 1976 to a Russian researcher, resident in the United States. “Until today, nobody has developed the product to be applied in cellular cement or to be used as an additive to mortar”.

Because of its unprecedented nature, the new product is at the stage of being patented. “In January 2002, we started the process, by means of FAPESP’s Patents and Technology Licensing Nucleus (Nuplitech). The patent is for the process of manufacture, which is different from the one done by the Russian researcher, and for the various products created with the expanding agent”, says he. The patent requesters are FAPESP, the researcher and Siporex. A good partnership, which not only creates new products for the building industry, but also brings recognition for Araújo’s work and introduces the company to the field of technological innovation. •

