

Calcined clays: new products and applications

The production of calcined clays on an industrial level is one of the latest technological developments deployed by Cementos Argos at one of its cement plants. This article presents a part of the results obtained when developing and manufacturing Green Cement, a low-carbon product based on this innovative production technology. Furthermore, the environmental declaration of this product confirms the product's important benefits in terms of CO₂ emissions reduction.

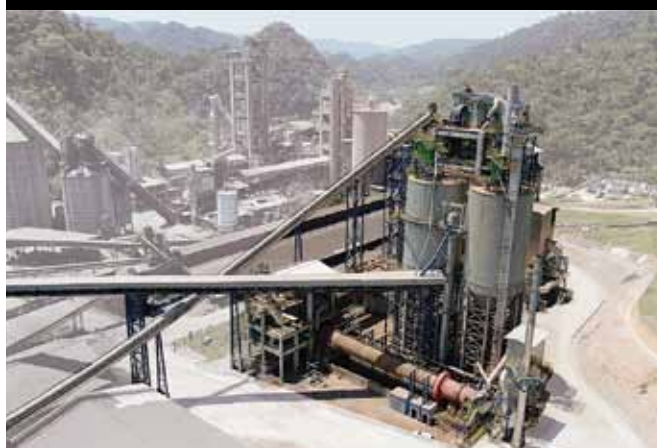
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The global cement industry has been focussing its attention on several challenges and strategies to achieve a more sustainable utilisation of the necessary natural resources for producing cement and to lower the amount of CO₂ emissions that are released into the atmosphere as a result. In this regard, the construction industry will inevitably undergo a profound transformation in the coming years, enabling it to offer customers a portfolio of carbon-neutral solutions by 2050 at the latest.¹

With this purpose in mind, and to address the challenge facing the sector over the coming years, Cementos Argos has been developing various new products, including the Green Solutions – Conscious Innovation² portfolio. These include low-carbon, embodied energy services and products that facilitate the

optimisation and reuse of valuable resources and non-renewable materials at different stages of construction, as well as products and construction solutions that provide people with health and wellbeing. Each of these solutions is the result of having integrated high standards of sustainability, innovation and cutting-edge technologies within Argos' business model, thereby reaffirming the company's intention to continue being a key partner

The production line for calcined clays being deployed at Cementos Argos' Rioclaro plant, Colombia



for its clients and that each of these solutions help to effectively build a greener future.

Consequently, cement production at the Rioclaro plant in Antioquia, Colombia, has evolved significantly. This is due to the fact that the technology associated with calcined clay (CC) is being used as a supplementary cementitious material (SCM). This allows it to produce a cement whose manufacturing process reduces not only 40 per cent of CO₂ emissions but also energy consumption by 20 per cent, compared to the average data reported in the Portland Cement Association's (PCA) Environmental Product Declarations for Portland Cement Type I on the US market.³

It also maintains intact its product performance standards. This is Argos' new Green Cement.

Green Cement – characteristics and performance features

There is substantial worldwide availability

Figure 1: average mechanical strength levels obtained with Green Cement in standard mortar⁴ and its comparison with the values specified in the Colombian standard

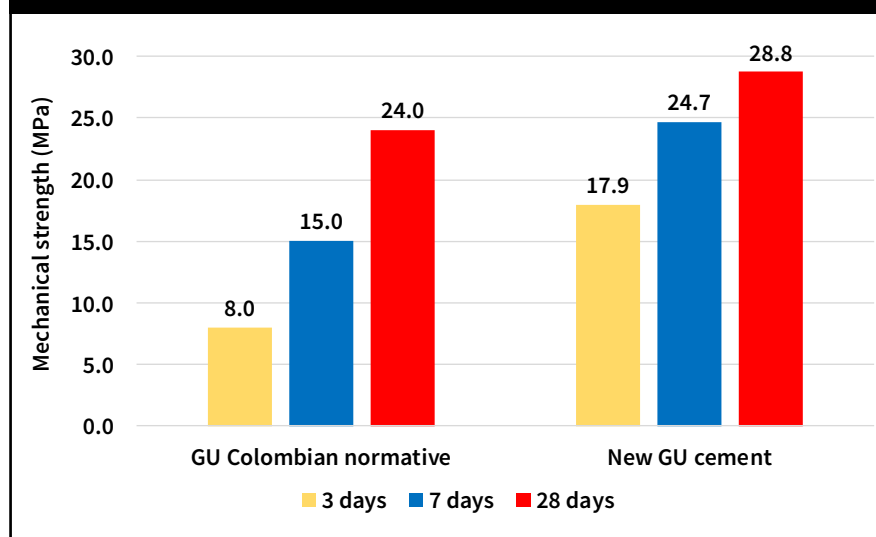
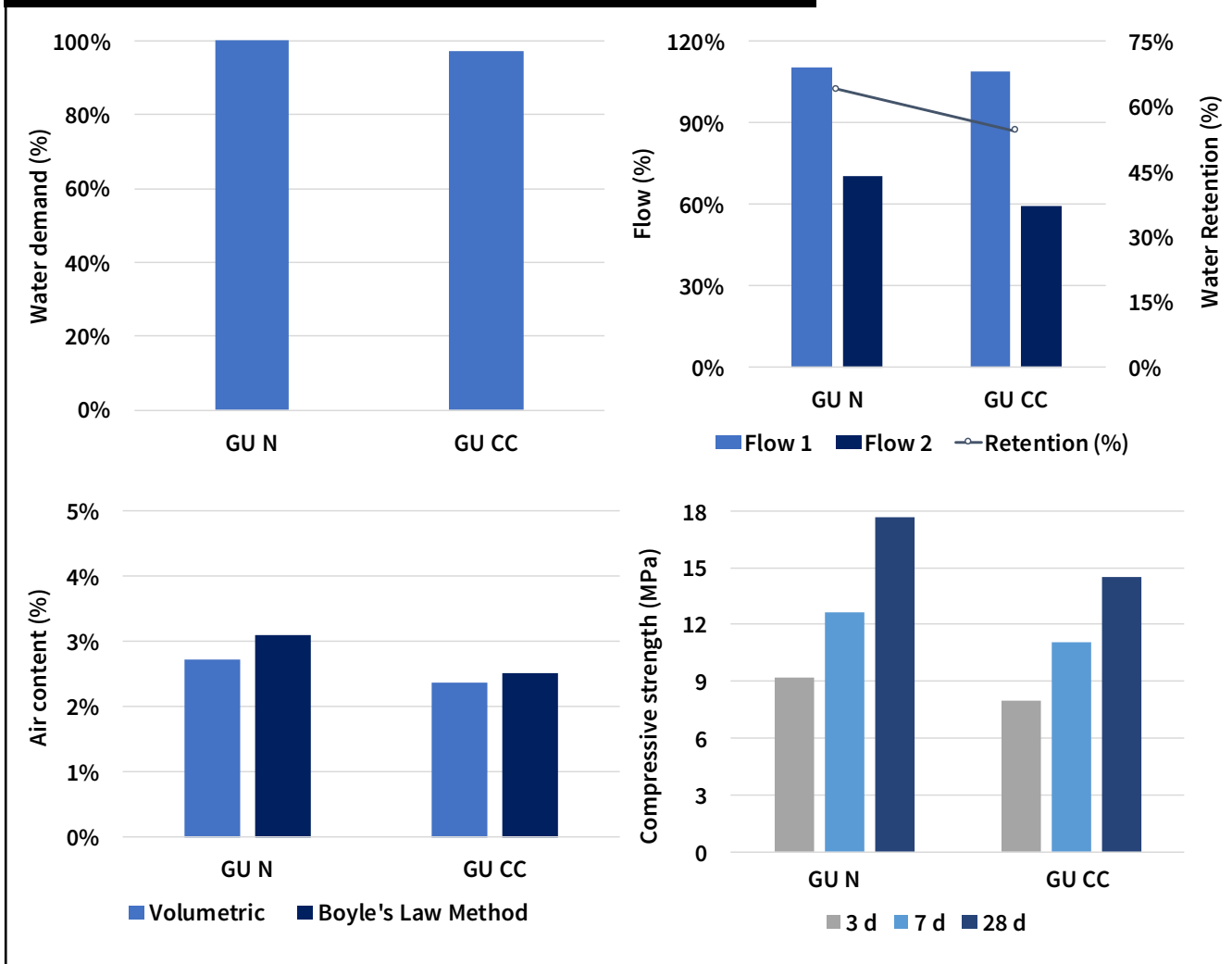


Figure 2: comparison between the main physical and mechanical characteristics of Green Cement (GU CC) with respect to a typical General Use cement (GU N) used for masonry



of clays capable of being thermally activated, which is why this SCM is now offering the greatest potential for the cement industry.

The artificial pozzolan obtained after the thermal activation processing of the Rioclaro clays produces an extraordinary level of pozzolanic activity.

In addition to this, cement manufacturers are able to control their capacity and quality.

Physical and mechanical product performance

Based on the mechanical performance results shown in Figure 1, Argos can safely state that this new CC cement not only meets, but even visibly exceeds, the mechanical specifications of the current Colombian cement standard NTC 121⁴, which are also shown in Figure 1. However, the true technological headway made at the Rioclaro plant using this new technology is the reduced amount of clinker required to manufacture this new

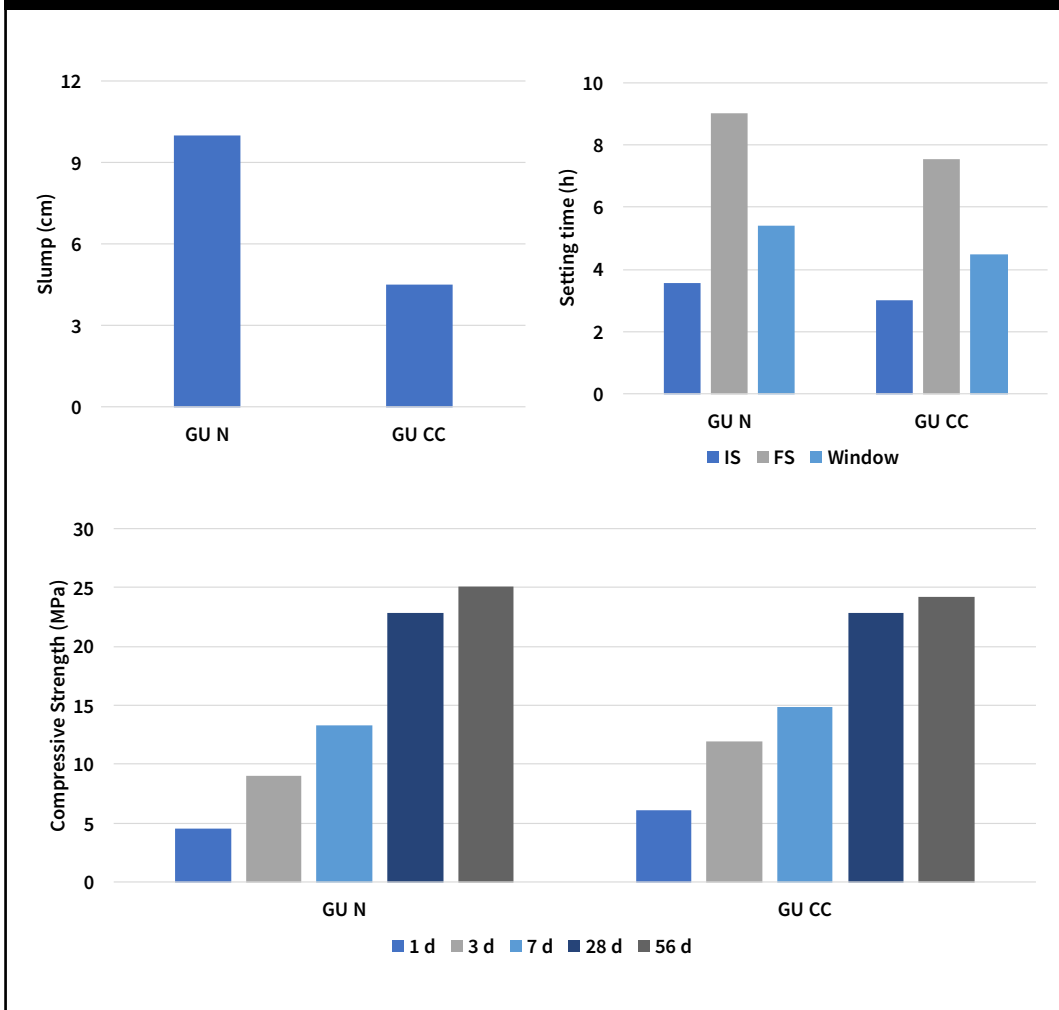
“These levels of mechanical performance for Green Cement mean, in short, that the pozzolanic properties of this calcined material are true, correct and considerable.”

general use cement.⁴ By comparing its clinker content with that contained in the cement traditionally manufactured at this plant, it can be concluded that the 12 per cent reduction in clinker content has been achieved through the industrial production of CC as a pozzolanic addition. These levels of mechanical performance for Green Cement mean, in short, that the pozzolanic properties of this calcined material are true, correct and considerable.

To increase the possibility of using this new cement in all typical applications across the construction sector, Argos studied its physical and mechanical performance in the case of masonry applications (see Figure 2). Here, the company was able to confirm that Green Cement can be used when preparing mortar for bonding bricks and blocks, or for plastering or rendering interior and exterior walls and architectural finishes.

In this sense, special emphasis was placed on studying the workability of different mortars and their water retention properties. Figure 2 shows that the physical parameters in terms of the amounts of water required and retained, as well as the air content of Green Cement, do not vary significantly with respect to those obtained with the General Use cement that has traditionally been manufactured at Rioclaro. For this reason, the workability of this cement was amply demonstrated, thereby facilitating its application and final finishing.

Figure 3: comparison between the main physical and mechanical characteristics of concrete dosed with Green Cement (GU CC) compared to the use of traditional cement (GU N)



penetration⁵ and in water permeability⁶ for all those kinds of concrete prepared with Green Cement compared with the types of concrete for which General Use cement has traditionally been used. This level of performance is undoubtedly a consequence of reduced porosity due to having introduced an SCM in the Green Cement whose action is synergistic, and therefore stimulates the hydration of the Portland clinker contained in the cement.

These results also show the enormous advantage of Green Cement when, to adequately dose the concrete, aggregates that are potentially reactive to the cement's alkali content are used. It is a fact that the expansion

Likewise, the physical and mechanical performance of Green Cement was studied with regard to dosing traditional concrete (3000-4000psi) (see Figure 3). Here, the R&D staff at Cementos Argos sought to study the feasibility of being able to translate all the environmental strengths of this new product to the final product used in construction, which is concrete. In this way, the company could evolve towards greener types of concrete that should facilitate the construction of more sustainable projects.

Figure 3 shows the comparative performance results of a concrete with the same dosage, but with two different cements, Green Cement and a typical General Use one. In this case, in terms of physical parameters such as setting times and levels of mechanical performance, there were no significant differences between the two. When using this type of cement, it should be noted that the water required for ensuring the desired consistency of concrete may be somewhat higher. However, this increase in the

amount of water required for obtaining the final product is not necessarily associated with a loss of mechanical resistance, since CC also needs water to generate the insoluble hydrates characteristic of its pozzolanic activity.

Product durability

Based on the results obtained from the different tests carried out (see Figure 4) it can safely be concluded that, broadly-speaking, CC provides important benefits in terms of durability for concrete dosed using this technology.

The results presented in Figure 4 show a very important decrease in chloride ion

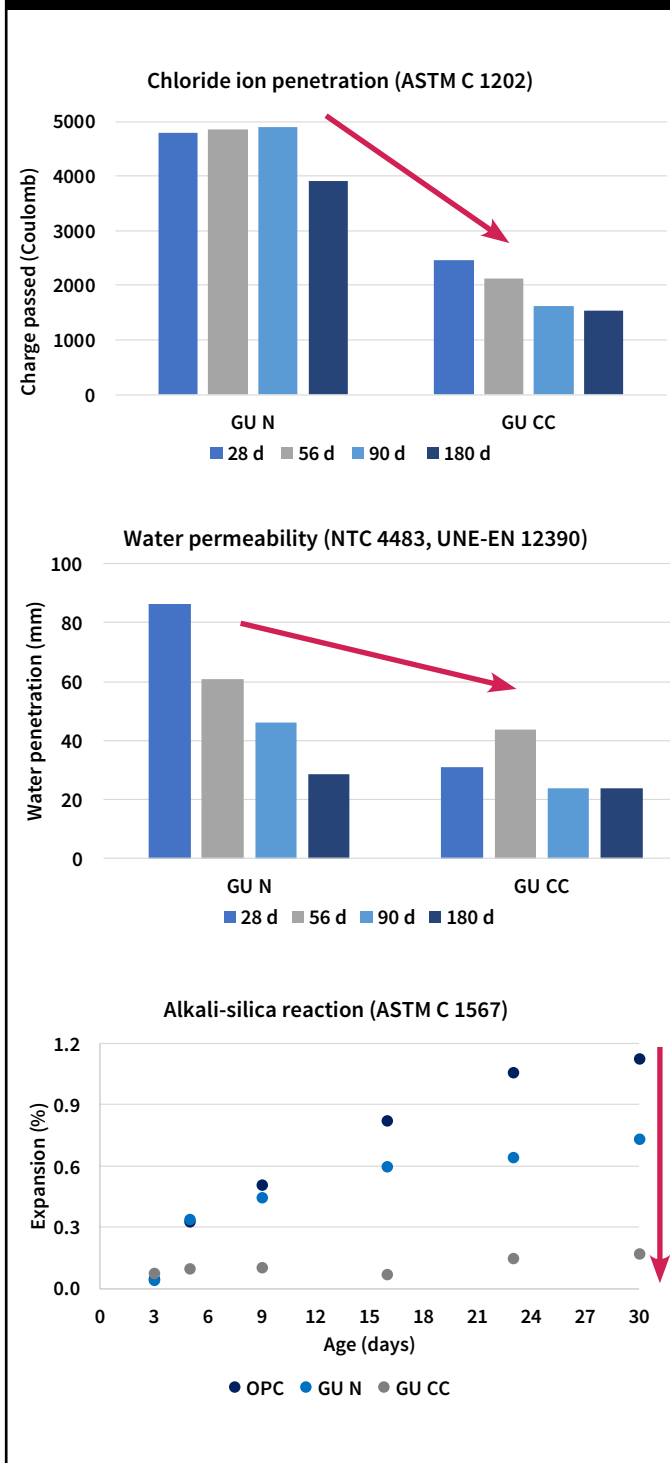
phenomena present in concrete is reduced due to this aggressive chemical attack, as shown in Figure 4.⁷ Consequently, once again, CC substantial pozzolanic activity is reaffirmed.

Environmental product declaration

The percentage reductions of CO₂ emissions and energy consumption with respect to the Green Cement production process are based on a comparison of the impacts of Global Warming Potential (GWP) and Non-Renewable Primary Energy (NRPR E) consumption for the Environmental Self-Declaration of a product developed

Table 1: summary of the Environmental Product Declaration		
Environmental impact	Green Cement	Average PC Type I
Global warming potential (kg CO ₂ eq/t cement)	535	922
Non-renewable primary energy (NRPR E) consumption (MJ LHV/t cement)	3.160	4.080

Figure 4: comparison between the main durability properties of concrete dosed with Green Cement (GU CC) compared to the use of traditional cement (GU N)



by Argos for General Use grey cement manufactured using calcined clays at Rioclaro. To perform this comparison, the average Environmental Product Declaration for Portland cement³ as defined by the ASTM C219 standard⁸ and specified in the ASTM C150⁹, ASTM C1157¹⁰, AASHTO M 85¹¹ or CSA A3001¹² standards, as produced in the US were used (see Table 1).

Both the Environmental Self-Declaration drawn up by Argos for Green

is calculated based on figures reported by the PCA industry-average Environmental Product Declaration, thereby representing a specific climate-driven initiative on the part of Argos.

For Cementos Argos, the production of this type of cement at the Rioclaro plant is the culmination of several years of research, thanks to which it has been possible to obtain a product offering the best possible technical characteristics in

Cement, as well as the Environmental Declaration prepared by the PCA for the average cement corresponding to the US cement industry and its respective indicators, were calculated using the tool for drawing up Environmental Product Declarations (EPD), facilitated by the Global Cement and Concrete Association (GCCA). This has been developed and verified by international entities and allows for EPDs to be drawn up with a “cradle-to-gate” scope under the EN 15804¹³ and ISO 21930¹⁴ standards.

Conclusions

Green Cement can be considered as both an eco- and environmentally-friendly cement, since its production results in a 40 per cent reduction in CO₂ emissions. This

both its fresh and hardened state for any type of construction application.

In this sense, Green Cement, given the optimal dosage of its components, produces important benefits in terms of durability for the finished product against different aggressive chemical attacks to which it may be exposed. ■

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