Tech
Spotlight

SCG LC3 Structural Cement

Low-carbon innovation driving green construction

by Chalermwut Snguanyat, Somchai Chitwarodom, Sakkarin Luangkamchorn, Oraya Assawanawachart, and Pawat Sukprasert

Through its Cement and Green Solutions business, SCG Cement Co., Ltd. (SCG), a building materials manufacturer in Thailand, is committed to advancing Thailand's construction industry toward a sustainable future as part of the Net Zero Roadmap 2050. Guided by the principles of a low-carbon economy and environmental responsibility, SCG is driving innovation across products, processes, and operations to achieve net-zero greenhouse gas emissions by 2050. One of the company's core strategies for achieving the net-zero target is the development of low-carbon products, particularly cement. This involves the use of alternative fuels such as biomass and refuse-derived fuels, as well as renewable energy sources like solar power. SCG has also focused on reducing clinker content in cement (Fig.1).

The company has implemented limestone cement, achieving a nearly 10% reduction in carbon dioxide (CO_2) emissions compared to ordinary portland cement (OPC). SCG has also developed cement that incorporates limestone-calcined clay technology, which currently reduces carbon emissions by over 30%, with the target to reach up to a 50% reduction compared to OPC. The company is scaling up production and promoting the adoption of limestone-calcined clay cement (LC3) across various applications.

SCG is the first company in Thailand to successfully develop and produce LC3, marking a step forward in the country's efforts to promote sustainable construction materials. LC3 is a blended cement that incorporates locally available materials to reduce environmental impact without compromising performance. The primary raw material, clay, is sourced from SCG's mineral reserves located in the central region of Thailand, ensuring consistent quality and a secure supply chain. This kaolinite-rich clay undergoes a thermal activation process known as calcination. It is fed into a rotary kiln (Fig. 2) and heated to a controlled temperature between 700 and 800°C (1292 and 1472°F). At this range, the kaolinite structure is transformed into a reactive form known as metakaolin. The calcined clay leaves the kiln with characteristic reddish and gray hues (Fig. 3), indicating successful activation.

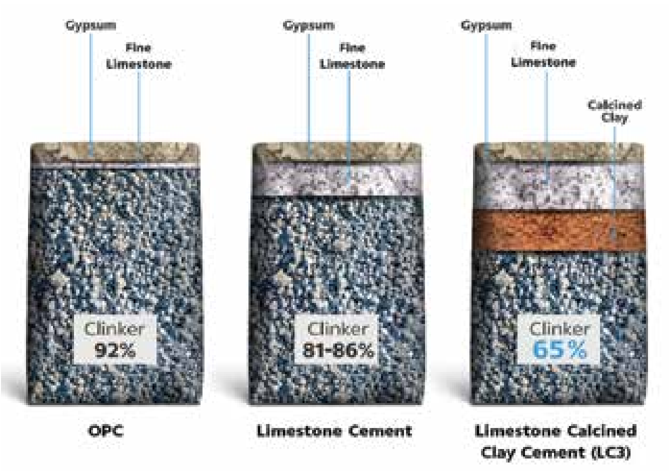

Fig. 1: Development of SCG Low Carbon Cement

Fig. 2: Rotary kiln used to calcine clay

Following the calcination process, the activated clay is cooled and finely ground with clinker, gypsum, and limestone. The grinding process is optimized to achieve a uniform particle size distribution, which is critical for the cement's performance and workability. The calcined clay functions as a pozzolanic material, reacting with calcium hydroxide released during cement hydration to form additional calcium silicate hydrates (C-S-H), which enhance the strength and durability of the cement matrix. Meanwhile, fine limestone interacts chemically with the alumina present in the clay, contributing to early strength gain through the formation of carboaluminate phases. The synergistic effect between calcined clay and limestone allows for a substantial reduction in clinker content—a major source of CO_2 emissions in traditional cement production.

The performance of concrete with LC3 has been extensively validated. Compared to OPC, LC3 offers equivalent mechanical properties, including compressive strength at 7 and 28 days (Fig. 4), elastic modulus, and creep behavior. It also provides enhanced durability with better resistance to chlorides (Fig. 5) and sulfate, as well as reduced shrinkage. Additionally, similar fresh properties such as workability retention (Fig. 6) and setting time (Fig. 7) can be

Fig. 3: Calcined clay after exiting the kiln is both reddish (left) and gray (right) in color

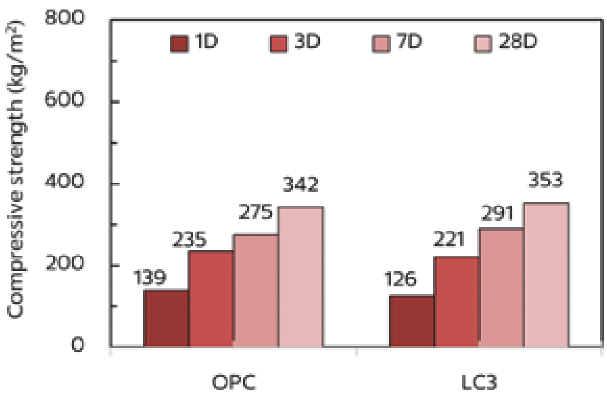

Fig. 4: Compressive strength of OPC and LC3 concrete with a water-binder ratio (*w/b*) of 0.60 and 20% fly ash replacement (Note: 1 kg/m² = 0.14 psi)

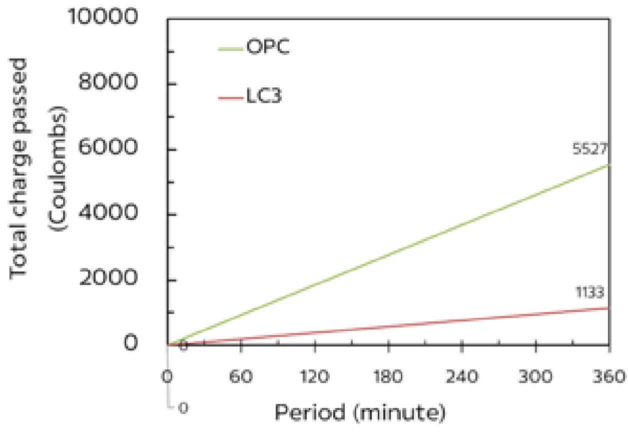

Fig. 5: Rapid chloride permeability test results for OPC and LC3 concrete with *w/b* of 0.60 and 20% fly ash replacement

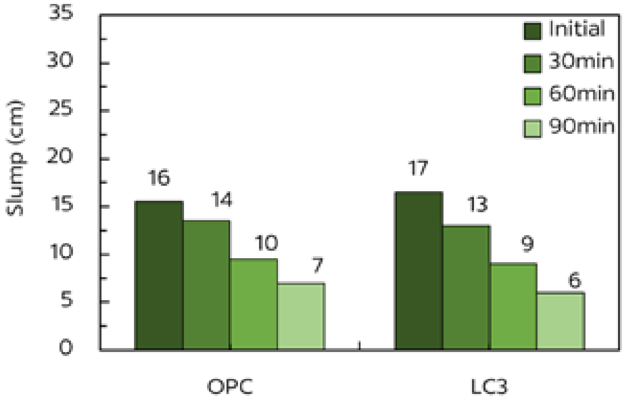

Fig. 6: Workability retention of OPC and LC3 concrete with *w/b* of 0.60 and 20% fly ash replacement (Note: 1 cm = 0.4 in.)

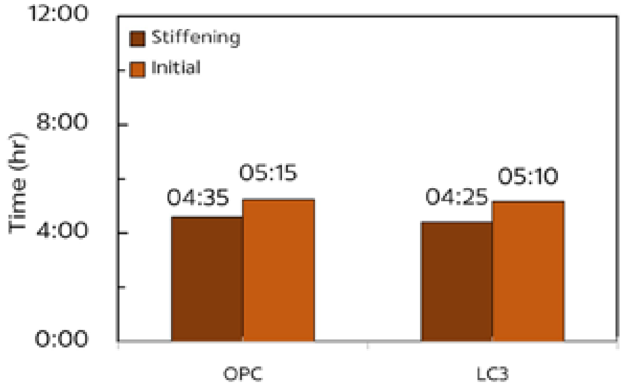

Fig. 7: Setting time of OPC and LC3 concrete with *w/b* of 0.60 and 20% fly ash replacement

Fig. 8: Installation of a decorative façade made of LC3 concrete

Fig. 9: Fibers used in LC3 concrete and casting fiber-reinforced LC3 concrete

achieved with appropriate use of concrete admixtures. Consequently, the use of LC3 from SCG can lead to a concrete carbon emission reduction of more than 30%. Since 2024, LC3 has been used in various non-structural concrete applications, including walkways, toppings, and decorative façades, as well as in structural applications like concrete pavements. Figure 8 shows the installation of a decorative façade produced by the LC3. The combination of LC3 concrete and synthetic fibers was also used as topping in a SCG concrete laboratory workshop, which can further reduce the carbon footprint of the structure with OPC concrete and crack-controlling steel reinforcement (Fig. 9). Starting this year, SCG plans to expand its use in structural components, such as beams and columns for low-rise housing, to bolster customer confidence in this new low-carbon cement and promote decarbonization within the concrete and construction industry.

LC3 cement's natural earth tone sets it apart from conventional gray cement (SCG defines the color "clay"). While this color difference may be noticeable, it is considered advantageous in architectural design, especially in projects that emphasize a natural and earthy aesthetic.

Concrete containing LC3 was selected for the walls and interior of Harudot Khaoyai by Nana Coffee Roasters due to its performance and color. This café is the first project in Thailand and the Association of Southeast Asian Nations (ASEAN) region to use LC3 for concrete finishing applications (Fig. 10). The walls have thickness ranging from 70 to 100 mm (2.75 to 4 in.), with a total concrete volume of 115 m^3 (150 yd^3), using 38 tonnes (42 tons) of LC3.

LC3 attracted attention from the designer for its use in sustainable design. Global construction is shifting toward green construction, and cement manufacturers need to focus on researching and developing low-carbon cement to align with this trend. In the future, LC3 will be further applied for both decorative cement and structural use.

Selected for reader interest by the editors.

Fig. 10: Application of LC3 concrete in the construction of Harudot Khaoyai by Nana Coffee Roasters in Thailand

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