

A Global Approach

Michele Di Marino, Erik Pram Nielsen, Bi Zhuo Qin, Cementir Group, Italy, explain the benefits of linking applications and technologies with a global approach when it comes to white cement.

Introduction

White cement is regarded as a high-end and value-adding product, and its use varies from applications with aesthetic requirements to those with structural ones, for both renovation (decoration, repairs, and maintenance work) and new builds. Even totalling a global market of approximately 18 million t, however, white cement accounts for less than 1% of total cement consumption.

Cementir Group is the global leader in white cement, with a capacity of more than 3 million t, and production facilities strategically located across four continents. The management has identified the need to strengthen its leadership and further develop white cement as a key strategic pillar in the current 2017 – 2019 business plan, leveraging on its competitive position with its global presence and enjoying a diversified customer base in terms of size, business, culture, tradition, and technological levels. The group

aims to differentiate its value proposition on white cement globally, by redefining and developing solutions that will support the growth of clients' business through customised services, know-how sharing, and advisory and strategic partnering.

AALBORG WHITE® is ideally suited for the production of UHP(FR)C concrete, and has been proven for more than 30 yr. The application range served covers infrastructural applications, such as bridges and joint cast concretes, military applications, such as explosive/blast protection, and the rapidly growing market of residential applications in US, Europe, and Asia, such as rain-screens/cladding and high-performance facades.

Pursuing innovation: InWhite

The group sees the huge potential of a new strategic focus on applications in the market to which the customers are supplying their products. Here, the true potential for development of the business comes



UHPC bridge in Leiden, Netherlands.



UHPC façade panels in Nanjing Medical University, China.

through being upfront in developing innovative solutions to challenge existing products.

“Assessing mega trends in society, and specifically in the construction industry, as well as understanding the voice of the customer and the jobs to be done, Cementir wants to challenge the traditional way of looking at white cement as predominantly an aesthetic and architectural building material. There is an untapped potential to further develop our customers’ business with white cement that, as a global leader, we have to make available to our partners,” said Michele Di Marino, White Cement Commercial Development & Marketing Director, responsible for global commercial, business development, and innovation.

Cementir Group has established a global innovation engine for white cement, InWhite, with the purpose of generating a prioritised and actionable pipeline of high potential customer value proposition global initiatives, bringing new solutions for well-known applications, or completely new applications for white cement based products.

InWhite benefits from the group’s global knowledge on both well-established and emerging applications for white cement, as well as the technical expertise of its internationally acclaimed R&D centre, located at Aalborg, Denmark. It is aligned to the megatrends detected in society, such as customisation, circular economy, and high-energy efficient solutions.

Enhancing applications with emerging technologies

Some emerging and rapidly growing applications for AALBORG WHITE® cement are related to the chemistry and purity of the cement and the superior mechanical properties that can be achieved in concrete through advanced production technologies. Very high strength and durability can be achieved by manufacturing very thin panels and elements based on AALBORG WHITE cement. As an example, this principle can be applied to façade elements to achieve compact, high insulating panels featuring the following, among others:

- Low weight per m².
- A significant reduction in total wall thickness to allow for a more efficient use of the inside area of the building.
- Surfaces finished in one process to avoid the need for further treatments.
- Modular and build-up for reuse of materials.

New solutions based on high value and fast developing technologies like ultra high performance concrete (UHPC) and glass fiber reinforced concrete (GRC) have been identified and are in primary focus.

Ultra high performance concrete (UHPC)

The use of the term UHPC without any further clarification could become misleading. Many acronyms are used to categorise cement-based composites with very high compressive strength. Originally, the term UHPC was introduced to differentiate from high performance concrete (HPC), thereby introducing a compressive strength higher than 140 – 150 MPa. Most such concretes include fibres to add ductility, and are therefore usually characterised as UHPFRC (ultra high performance fibre reinforced concrete). The first of its kind, CRC®, was developed and patented by Hans Henrik Bache in Aalborg Portland’s Research and Quality Centre in 1986.

In real life, most UHPC or UHPFRC based products and commercially available premixes (both with and without fibers) have a compressive strength level of around 110 MPa or higher (Eurocode cylinder). Higher compressive strengths are rarely needed, as high tensile capacity, high durability, low water permeability, and high workability, etc. become more decisive parameters. Providing significantly higher strengths than this will result in the use of special aggregates that are not available locally, adding high costs to the production. Although UHPFRC, in its strict definition, may be required for some special applications, such as explosive protection, most applications will be well-covered by compressive strength levels of approximately 110 MPa or higher.

In order to better adapt its terminology to the markets it is serving, as well as the expected development within them, Aalborg Portland chose to use the terms UHPC and UHPFRC for high performance

concretes with compressive strength above 110 MPa, with special performance properties, such as low permeability, high chemical and aesthetic durability, high tensile capacity, and high fire resistance.

As an industrial example, and parting from the technology developed in the 1980s in Aalborg's laboratories, since 1995 Hi-Con Group has developed an innovative market for stairs, balconies, and other structural components, using AALBORG WHITE. The technology is being further transferred into UHP(FR) C bridges, and complex, low-weight and high energy efficient structural prefabricated façade elements.

A global tendency that has been observed, and is aligned with the earlier mentioned megatrends in society, is the development of new market possibilities during recent years based on advanced aesthetic UHPC based cladding/rain-screen systems and integrated prefabricated façade panels. In terms of volume, these types of application are expected to lead the growth of global consumption of UHPC.

Each application in the market defines a specific set of requirements to be fulfilled by the concrete. Cementir's aim is to guide and support using optimised concrete binder technologies suited for the applications that have emerged over the last 3 – 5 yr among customers, as well as the ones still to be developed. The Research & Quality Centre in Aalborg, Denmark, is intensively designing, testing, and documenting new binder formulations to meet the requirements and challenges revealed through the company's global reach and strong customer relations. This, together with the evaluation of strategic partnerships, represents some of first steps towards a further global spread on the use of UHPC and UHPFRC exploiting AALBORG WHITE.

The global market of UHPC (and UHPFRC) is expected to experience yearly growth rates above 10% over a period of 3 – 5 yr, and this will be concentrated in regions such as Asia, Europe Middle East, and US, which mirror Cementir Group's global production and commercial footprint for white cement.

The following details interesting cases from different geographical locations, which provide a preview of the future applications of AALBORG WHITE-based UHP(FR)C.

Catherina Bridge, Leiden, Netherlands

The Catherina Bridge in Leiden, Netherlands, is officially the longest bridge in ultra high performance concrete in the Netherlands. The bridge is 36 m long and has a maximum cross section thickness of 275 mm.

The bridge was completed in 2016 by contractor Pieters Bouwtechniek, and architect DP6, Leiden. The bridge elements were designed and manufactured by Hi-Con Nederland B.V.

CRC i3®, a third generation of the original CRC (Compact Reinforced Concrete) from 1986, based on AALBORG WHITE, was used for the bridge sections. This version includes larger aggregates and exhibits even lower shrinkage and enhanced stiffness. CRC JointCast®



UHPC staircase in Per Aarsleff office building, Denmark.

with AALBORG WHITE was used for jointing the bridge sections.

UHPC staircase in Viby J, Denmark

A UHPC staircase adorns the office building of Per Aarsleff in Viby J, Denmark. The staircase is constructed as a helical staircase, with a step-height of 173 mm and step-width of 1250 mm, built based on 25 UHPC elements.

The office building was completed in 2016 by contractor A. Enggaard A/S and Architema A/S. The staircase was designed and manufactured by Hi-Con Denmark with AALBORG WHITE.

CRC i2®, a second generation of the original CRC (Compact Reinforced Concrete) from 1986, based on AALBORG WHITE, was used for the staircase. This version exhibits, among others, enhanced workability using the latest available technology within chemical admixtures. CRC JointCast was used for mounting the staircase.

UHPC claddings in Nanjing City, China

A teaching and research complex in Nanjing Medical University was completed in 2014 in Nanjing City, Jiangsu Province, China. The conceptual design of this project was carried out by British architect studio, BDP (Building Design Partnership), with detailed design

by the local Chinese architecture institute, JSARCHI (Jiangsu Provincial Architectural D&R institute). The total facade area of the project was 32 000 m², of which white UHPC panels cover 22 000 m².

The UHPC facade panels are manufactured by OmegaZeta in Nanjing, China, using AALBORG WHITE, produced at Cementir's plant in Anqing, Anhui, China. The large size of the panels, which are up to 2.2 m × 3.0 m (full size), are an important feature of this project. Aesthetically, the building appears much more magnificent and majestic, and, at the same time, it reduces installation time and complexity.

Conclusion

Cementir Group, within its innovation path on white cement, is strategically linking applications and technologies to generate customer value proposition with a global reach, by exploiting AALBORG WHITE cement's high potential. UHPC is, among other technologies, in focus due to its range of possible applications and expected market development, as well as matching megatrends in society and their impact in the building industry. 🌐