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Experiencing FUTURECEM™

Cementir Group is broadening horizons with its sustainable FUTURECEM™ solutions...

Cementir Group, with its mantra 'Building a sustainable future,' regards sustainable growth as both a responsibility and a requirement for producers to continue operating in the cement industry. Cementir Group's business model strikes the balance between the creation of economic value, the protection and conservation of the environment and a sense of responsibility towards people and communities. Cementir Group has based this journey toward sustainability on four pillars: usage of alternative fuels; wind energy production; energy recycling and green cement innovations.

Introducing FUTURECEM™

Regarding green cement innovations, the Cementir Group has a long record in the development of more CO_2 friendly types of cement and concrete. This is centred at its Research and Quality Centre in Aalborg, Denmark. There, its researchers have been studying different alternative cement and concrete compositions in cooperation with stakeholders from the whole value chain of construction, as well as leading universities and research institutions.

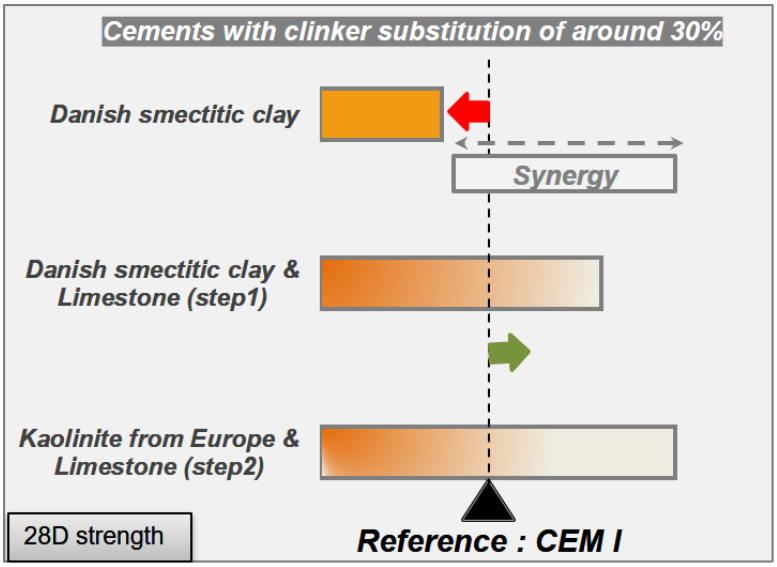
FUTURECEM™ technology is the result of this extensive applied research, which also covers raw materials assessment, manufacturing technology and concrete technology. FUTURECEM™technology relies simply on the synergy between calcined clay and limestone filler, which allows replacement of clinker of more than 40%, depending on the type of clay, all while maintaining the same performance as a pure Portland cement.

FUTURECEM™ technology is both green and sustainable, since clay and limestone are raw materials available in large quantities on a global scale. This is an essential driver in an era when the supplementary cementitious materials currently used for cement/concrete production, such as fly ash and blast-furnace slag, are both limited in quantity. On a global scale, fly ash and blast-furnace slag production is far too small to reduce clinker content to the amount that is technically feasible. In Europe and the US a fly ash shortage is beginning to be felt as coal-fired power plants are being shut down, while blast-furnace slag is almost fully used, with no plans to increase steel production in these regions.

The story so far...

FUTURECEM™ dates back almost 20 years, to when researchers at the Cementir Group Research and Quality Centre discovered the synergy between certain types of calcined clay and limestone. This was not published but was brought back to attention when increased focus on sustainable development and climate change made the development of new, lower CO_2 cements more interesting.

This led to the original FUTURECEM™ project from 2008 to 2011, in which the basic technology was developed. In this project, it was surprisingly found that not only kaolinite clay could be used, but also the kinds of smectitic clays known as bentonites, which are found in abundance in Denmark. To protect the development, a patent application was



Right: The synergy between calcined clay and limestone compared to reference CEM I in standard mortar.

Left: A FUTURECEM™ road bridge in Lolland, Denmark. **Source:** Torben Eskerod.

submitted.[1] This has since led to FUTURECEM™ to be patented in USA, Canada, Mexico, Europe, India, China and Australia. The patent is currently pending in Brazil.

The next step was the SCM project 2011-2014, which aimed to develop production technology for calcined clay and further developing the technology. The first test batches were produced and used in real concrete production, including a demo wall at the Aalborg Portland cement plant in Denmark.

From 2014-2019, the Cementir Group participated together with research institutions and a range of stakeholders from the construction industry in the Danish project Green Concrete II (Green Transformation of Cement and Concrete Production) with the aim of testing FUTURECEM™ in a wide range of actual ready-mix concrete applications.

Within this project, FUTURECEM™ has been tested at full-scale in construction parts for infrastructure as well as in an indoor floor and wall in the new concrete laboratory at the Danish Technological Institute (DTU). Such demonstrations show that FUTURECEM™ can be implemented in the concrete industry, while maintaining conventional production and execution technologies. Furthermore, similar performance to conventional concrete in terms of workability, strengths and other key parameters were achieved.

In order to evaluate durability in aggressive environments, a number of long-term exposure sites have been established. These will document FUTURECEM™-based concrete exposed to sea water or highway traffic. Furthermore, investigations at the Technical University of Denmark, the Danish Technological Institute and the Cementir Group Research and Quality Centre have shown that concrete based on FUTURECEM™ technology is resistant to corrosion by chloride from sea water and salt, shows good carbonation resistance and resistance to alkali-silica reaction as well as no degradation by sulphate attack.

Moving forward

Similar developments are taking place in other areas of the world. It has been estimated that if the existing types of cement are replaced by the green types of cement and concrete, global CO_2 emissions could be reduced by 400Mt/yr.[2] This is the same as the annual CO_2 emissions of the whole of France. Furthermore, increased use of limestone and calcined clay has

Left: A FUTURECEM™ rail bridge in Lolland, Denmark. **Source:** Torben Eskerod.

Right: A view of part of the Aalborg Portland cement plant in Aalborg, Denmark, where the Cementir Research and Quality Centre is based.

been suggested in a recent road map for global low-CO_2 transition of the cement industry.[3]

However, when working with concrete today, cement and concrete compositions are based on threshold value requirements as defined by norms and standards. In practice, implementing innovative solutions is difficult, indeed it is sometimes impossible, within the framework of today's legislation. In the short term, limestone-calcined clay cement needs to be accepted in the national adaptations of the European cement standard. Therefore the European cement standard EN 197-1 must be updated to accept up to 50% clinker replacement by limestone-calcined clay. In the longer run, building codes and standards should support the green transition, for instance by boosting performance-based design approaches in which composition thresholds are not a limitation.

Beyond cement

FUTURECEM™ is not only for the production of sustainable cement, but is also a sustainable binder as well as additive for concrete addition. As a sustainable binder, it powers new innovative solutions like Aalborg Extreme® Light 120. This is an Ultra High Performance Concrete (UHPC) based on AALBORG WHITE® cement, which is ready to be used (just add water), has reduced shrinkage and is self-compacting for the manufacture of thin/slim concrete products with high mechanical and durability performance and good aesthetics.

As a supplementary cementitious material, it can be used as a substitute for fly ash and blast-furnace slag, (which, as mentioned above, are in short supply), with very similar performance and higher sustainability.

Below: The new DTU Headquarters, built partly with FUTURECEM™. **Source:** Torben Eskerod.

References

1. European Patent Application EP 09160271.4, Filed 14 May 2009.

2. Scrivener, K. L.; John, V. M.; Gartner, E.M. *'Eco-efficient cements. Potential, economically viable solutions for a low-CO_2, cement based materials industry,'* United Nations Environment Programme, Paris 2016.

3. International Energy Agency and Cement Sustainability Initiative, *'Technology Roadmap. Low-Carbon Transition in the Cement Industry,'* 2018.