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Christian Doppler
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How to transform powder and water into concrete

Cement is amazing: just mixing calciend and ground rock powder with water and processing the resulting paste gives a mixture that hardens to artificial stone. Broader knowledge of the underlying physical and chemical processes leads to enhanced products.

What is at issue?

As the binding agent, cement is the key component of concrete. When mixed with aggregates and additives it enables the construction of houses, tunnels, bridges and many other structures. Schretter & Cie is a medium-sized enterprise in Tyrol, covering the entire production chain for cement. Limestone and marl are extracted locally in Vils and processed in the company's own facilities. A wide range of cements is produced: regular construction cement as well as special cements for pavements and ceilings, roads, tunnels and many more applications. Fundamental knowledge and advanced physical and chemical modelling are helping the company to develop better products and make more efficient use of the raw materials locally available.

The research question

The production of cement involves firing and grinding raw materials such as limestone and marl The process might seem simple but a varity of process parameters may be adjusted: raw materials can be mixed in different proportions, fired under different conditions, the

CD Laboratory for Performance-Based Optimization of Binder Composition and Concrete Manufacturing

Head
Univ.Prof. DI Dr Roman Lackner, University of Innsbruck

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Commercial partners
Doka GmbH, FCA-Holding GmbH, Schretter & Cie GmbH & Co KG

Three questions to ...

KR Dr. Reinhard Schretter
Managing Director of Schretter & Cie GmbH & Co KG

Why is basic research so important for innovation?
If our innovations were only based on current applications, we would not care about/ understand the scientific background. The systematic comparison of methods, wide-ranging experiments, or just extensive patent and literature reviews – they all provide the foundations for successful application. However, you have to keep in mind that both sides are important.

What are the biggest challenges in collaborating with universities?
The companies' time to market pressure poses a large challenge in basic scientific work. And there are obviously different expectations with regard to funding: the goals of company-driven research cannot be driven by funding possibilities only.

What do you like most about the CD Laboratory funding scheme?
The need to work together for a longer period is very positive and gives rise to wide-ranging systematic work without too much time pressure. An open and constructive dialogue is also beneficial for other topics. In addition, the companies' scientific work receives financial support, without the latter this scientific work may well not be possible.

binder may be mixed with modern additives such as polypropylene or steel fibres. Which of the maltitude of possibilities is the best? How do the differences affect processing, durability and mechanical properties? Can the available raw materials be used more efficiently without compromising product quality? To answer these questions the company must expand its knowledge base. It needs a detailed understanding of the physical and chemical properties of the components and of the various steps of processing.

Cooperation in the CD Laboratory

Schretter & Cie was attracted by Prof. Lackner's approach to material science. He is a material technologist considering "cement" and "concrete" analytically by establishing models that enable the company to develop new products. The properties of the individual components were characterized experimentally and fed into model of the processing steps. This enables optimization of the composition of the cement for each specific application, giving the favourite combination of ingredients.

Example: Efficient use of resources

Schretter & Cie operates its own quarries in Tyrol for limestone, marl and gypsum and aims to use its natural resources most efficiently. The primary goal is to save resources while maintaining raising quality, as well as making progress in other areas such as reducing CO2 emissions from the firing and grinding-process. Based on the physical and chemical descriptions and the process modelling, the company can now predict which measures could be helpful. The work within the CD-Lab has already led to the identification of promising approaches and paved the way for progress in process and material technology.

Example: Efficient tunneling

Portland quick cement is a special cement that hardens rapidly. It contains fibres and is produced by very few companies – including Schretter & Cie. The research related to a particular application in tunnel-building: tubbings are pre-fabricated cement segments used in the strengthening of tunnels. The demands on accuracy of fit are extremely high, with a margin of error of only a few millimetres. The logistics at a tunnel site requires tubbings to be delivered "just in time". They must harden quickly, while fitting as accurately as possible. However, their production is complicated by the use of strengthening fibres. Further development requires a detailed understanding of the various processing steps. As a result of the collaboration in the CD Laboratory the company now has deeper knowledge of the manufacture of particularly suitable concrete and can put the gained knowledge into engineering practice.

Scientific challenge

Cement and concrete represent an important topic in materials technology. Work aims at describing the properties of the materials and at understanding their chemical and physical behaviour at a fundamental level. Chemical reactions, such as cement hydration have to be described and the durability of structures investigated. A hybrid research approach is supplementing the experimental characterization of the material properties. The results are not only of interest to cement producers; the CD Laboratory's basic research output may also lead to applications in medicine, e.g. bone cement which is injected into bone sponge to stabilize highly porous bones or implants.

Added value for the company

The company has expanded its knowledge base on materials and processes. The new knowledge is contributing to the development of new products in a number of ways. The company now understands how to produce optimized Portland quick cement for use in tunneling and Schretter & Cie is achieving recognition for its research.

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