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Research topic:

Interactions between accelerators and clinker-efficient cements with several main constituents to improve the early strength of concrete

1 Aim of research

In order to further conserve resources, lower energy requirements and reduce greenhouse gas emissions, it is necessary to increase the use of cements with a significantly lower clinker content due to other main constituents. However, as the clinker content in cement decreases, the early strength of concrete decreases. This may require adjustments in the concrete processing industry and often makes the practical acceptance of clinker-efficient cements more difficult.

2 Working hypothesis

The early strength of concrete with Portland cement can be increased by additives that accelerate hardening, so-called hardening accelerators. In cements with several main constituents, they should strengthen the early reaction of alite and/or the aluminised clinker phases. This could indirectly lead to an earlier onset of conversion of the latent-hydraulic or pozzolanic main constituents. The reaction of other cement main constituents, such as blast furnace slag, could possibly be directly promoted by modern hardening accelerators.

3 Research objective

The aim of the research project was to generate basic knowledge on interactions between accelerators and cements with several main constituents. The extent to which cement performance can be improved by adding accelerators and thus the proportion of raw material and energy-intensive clinker can be utilised more efficiently or further reduced was systematically determined. The possibilities and limits of increasing the early strength of clinker-efficient cements were systematically determined by varying cement technology parameters in conjunction with the targeted use of different accelerator agents. The effects of reduced water/cement ratios and superplasticiser additives, which are necessary for workability and in some cases have a retarding effect, on the strength development of accelerated systems were analysed.

4 Summary of the research results

Hardening accelerators can increase the early compressive strength of clinker-efficient cements into the range of Portland cement or beyond. With decreasing clinker content in the cement, the early strength increasing effect of the accelerators decreased. The other cement main constituents (granulated blast furnace slag, calcined clay, limestone) did not significantly influence the specific effect of the respective accelerator. Consequently, the tested accelerators also interact primarily with the clinker in cements with several main constituents. The variation of the clinker did not significantly influence the effect of the accelerators with regard to the early compressive strength. Different water/cement ratios within the usual practical range did not significantly change the accelerator effect.

The findings were generally confirmed in concrete tests. The durability of concrete was not significantly affected by the accelerators used.

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