WAYS TO REDUCE HYDRATION AND CRACKING OF CONCRETE IN THE PRODUCTION OF SPECIAL REINFORCED CONCRETE PRODUCTS

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Abstract
The article presents the results of an experimental study of the ways to reduce the dehydration of the concrete mixture and the formation of cracks in reinforced concrete products during their manufacture.

Key words: Concrete, reinforced concrete, water demand, cracks, fly ash, shrinkage

Introduction

Reinforced concrete as a structural material is much younger than metal, wood and even plastics. The history of the development of this material is barely 150 years old. Despite such a relatively short period, reinforced concrete "conquered" the whole world and became the most common building material. The volume of production of concrete and reinforced concrete is so great that it ranks second in human activity after water. But cheap, durable and affordable reinforced concrete turned out to be an extremely difficult material for designers. The joint work of two materials with different properties (concrete and steel) turned out to be difficult to understand and create an effective calculation theory. That is why up to the present time they attach and, obviously, will attach exceptional importance to experimental research for a long time to come. Without an experiment, one cannot reveal the mechanism of destruction of a structure, the formation of cracks in it, one cannot comprehend the distribution of forces in sections, and much more.

Methods

It is known that cracks periodically appear during the manufacture of products in reinforced concrete plants, with intensive dehydration of freshly molded concrete.
One of the most effective ways to reduce the dehydration of the concrete mixture and concrete cracking is the introduction of fly ash into the concrete mixture.
The introduction of mineral additives can have a beneficial effect on many properties of concrete. This is due either to a physical effect, which is that fine particles usually have a finer particle size distribution than Portland cement, or to reactions of active hydraulic constituents. Mineral additives can affect the composition of the concrete mix, the rheological properties of plastic concrete, the degree of hydration of Portland cement, the strength and permeability of hardened concrete, the resistance to cracking during

heat treatment, the reduction of the impact of various alkalis on silica, as well as the resistance to sulfate aggression.

For a given concrete consistency, a reduction in water demand can lead to an overall improvement in its technological properties.

The granulometric characteristics of large and small aggregates and cement particles affect the volume of voids and the water demand of the concrete mixture. The introduction of fine particles of mineral additives, usually having a size of 1-20 microns, should increase the effect of Portland cement grains on reducing porosity in the concrete mixture, which reduces the need for water to obtain concrete of a given consistency. It has been found that replacing 30% of cement with fly ash reduces water demand by about 7% at constant slump. When using three types of fly ash with different particle sizes, a decrease in water demand by 5-10% was noted in solutions of equal consistency with the addition of 33, 67 or 133% fly ash by weight of cement.

Not all mineral supplements reduce water demand. For example, many researchers have found that the use of coarse fly ash or fly ash with high loss on ignition (typically 10% or more) increases rather than reduces water demand. It is now known that this only occurs when significant amounts of cellular coke particles are present in the fly ash, typically large in size (100 μm). Similarly, some types of high calcium fly ash can contain significant amounts of C_3A, resulting in an increase in water demand due to the loss of consistency caused by the rapid formation of calcium hydroaluminate or hydrosulphoaluminate. For mineral additives having extremely small particle sizes or high surface area, the amount of water required for normal consistency increases almost in direct proportion to the cement content in the mass.

The presence of fly ash or ground blast furnace slag between the aggregate particles helps to reduce laitance separation. A significant reduction in the number of dewatering channels in concrete helps to reduce delamination and improves its finishing characteristics.

Obviously, with the introduction of fly ash, it is possible to improve the quality of lean concretes or concretes made with aggregates that have an insufficient amount of fine fractions. Non-drained concrete containing fly ash admixture must be adequately protected under conditions conducive to shrinkage cracking in the ductile concrete mix. [1].

Another important property of plastic concrete mass - workability - depends mainly on water-holding capacity, controlled by the volume of dough in concrete. The advantage of replacing cement in concrete with an equal weight of low density mineral admixtures is the ultimate increase in dough content. For example, it can be calculated that with an equal mass, the volume of fly ash with a density of 2.4 t/m3 will exceed the volume of Portland cement by about 30%.

A change in the fly ash content of concrete based on strength data at 28 days requires replacement of cement at a ratio greater than 1:1 by weight (additional fly ash replacing the fine aggregate fraction). In this regard, there is an even greater increase in the content of the test in relation to the content of aggregates. The effect of mineral additives on Portland cement is usually manifested in slowing down its setting. This is especially true for low calcium fly ash with a high carbon content.

High-calcium ash usually has a low carbon content and a high content of reactive constituents (both crystalline and non-crystalline) and sometimes behaves in the opposite way. However, not all types of high-calcium fly ash accelerate setting. Therefore, before using unknown types of fly ash, it is necessary to study the effect of this fly ash on the setting time of concrete, for which appropriate control should be ensured using setting regulators.

The ash is characterized by sufficient activity, which, when tested in accordance with the standard, is 8-9 MPA, the normal density is 25%, the setting time meets the requirements of the standard. The introduction of fly ash instead of 20-30% of cement does not lead to a decrease in the strength of steamed concrete in all periods of hardening.

An experimental reinforced concrete slab covering the trench furnace was made. The concrete in these products is homogeneous, less dehydrated, has good workability during concreting, and also has relatively low evaporation of moisture from the concrete surface, which is especially important for areas with a dry hot climate [2]. However, the complete absence of cracks in the products was not achieved. To find ways to eliminate them, further research was required on plastic shrinkage, which is one of the main causes of early cracking of concrete. In the initial period of hardening in concrete, due to its intensive dehydration under the influence of capillary forces, plastic shrinkage occurs, which significantly disrupts the structure of the hardening concrete and further reduces its basic physical and mechanical properties and durability.

Plastic shrinkage in a dry hot climate is several times higher than similar deformations of concrete hardening under normal conditions. In our experiments for heavy concrete of class B15, this value reached the indicated values and amounted to 4 hours.

Results and Discussion

The analysis of the obtained results made it possible to reveal that plastic shrinkage at any time (within 4 hours) can be stopped by starting an effective moisture treatment of molded concrete. With a sudden cessation of moisture care, plastic shrinkage immediately begins to intensively manifest itself, reaching significant values and the greater, the earlier the care of hardened concrete was stopped.

Plastic shrinkage of concrete in the structures resulted in the appearance of more cracks 1.5 hours after the completion of concreting, mainly along the reinforcement. The width of their disclosure reached 1.5-2.0 mm or more. Reducing the plastic shrinkage of concrete is possible with moist care of freshly laid hardening concrete using solar caps.

Thus, it can be recommended that the minimum duration of initial maintenance of freshly cast concrete should be at least 6 hours.

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