Revealing the cause for high air content in concrete

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A study carried out in Aalto University showed that the effectiveness of the mixing process has a great significance when newer plasticizing additives are used.

Lately, high air contents of concrete have been occasionally observed in Finland. Problems with the compression strength of weather-resistant concrete structures were discovered in the summer of 2016; for example, a railway bridge in Kemijärvi had to be demolished shortly after it had been cast. It was found out that one significant cause of the strength problems was increased air content in the concrete.

In order to improve frost resistance, the air content of concrete is increased to about six per cent in the concrete manufacturing. In some situations, the air content of concrete was measured to be significantly higher, and in some construction sites, it has increased to over ten per cent. Actors in the Finnish concrete sector wanted to find the cause for the problem and asked for help from the Aalto University Department of Civil Engineering.

"We carried out a large number of laboratory tests in early 2017, in which the aim was to determine the impacts of the properties of concrete and the additives on the stability of the air content in the concrete after the mixing process," explains Jouni Punkki, Professor of Practice in concrete technology, who was in charge of the Robust Air study.

"In the laboratory tests, we simulated a practical situation where the

mixing of the concrete is continued in a concrete truck at the construction site. The measurements made during the tests showed that the air content was substantially higher when the concrete was mixed 30 or 60 minutes after the primary mixing process at the station."

The results show that new types of polycarboxylate-based plasticizers require the concrete to be mixed effectively, which means that the mixing process needs to be long enough. If the mixing process is not effective enough, the additives, i.e. air-entraining agents, only have a partial impact during the mixing process and the formation of the air may continue as the concrete is mixed in the concrete truck at the construction site. The risk of an increased air content depends on the properties of the concrete, such as its workability. Higher workability makes the concrete easier to handle, but it simultaneously increases the risk of increased air content significantly when compared to stiffer concretes. It was also discovered that there are differences between additives.

"Problems can be avoided if more attention is paid to the concrete manufacturing process. In the future, the additives should also be developed so that a maximum proportion of the required air content can already be created during the main mixing process. There should also be a closer look at the current quality control procedures and the regulations concerning the frost resistance of concrete," Punkki says, listing some of the measures that should be taken.

Provided by Aalto University

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