Durability of autoclaved aerated concrete slabs under realistic conditions" - Brief summary

The research project is taking place in the context of a series of investigations whose starting point was formed by trials on the creep resistance behaviour of autoclaved aerated concrete slabs with low gross density. In these trials, which were carried out around the year 2000, disproportionately large creep deformations occurred. Effects due to carbonation were discussed as their possible cause.

The objective of this research project was to put the knowledge gained in previous projects under laboratory conditions in the context of realistic conditions. For this purpose, specimens were left outside both for over 40 months to 58 months and exposed to a 1% CO_2 atmosphere for 28 days or 56 days. Compressive and tensile splitting strengths, as well as the level of carbonation of the specimens were investigated. Shrinkage tests were also carried out in the delivery condition, as well as XRD analyses in order to determine the phase composition.

The three types of shrinkage strain development identified in the preceding project were able to be observed in the results of the shrinkage investigations. With the exception of the samples examined from a manufac-turing plant, the measured values of the shrinkage strain approximated asymptotically a limit value. Some of them thereby went through an interim maximum.

After the outdoor storage, the compressive and tensile splitting strengths were determined on small specimens, and the compressive strength was determined on whole slabs. Again with one exception, it was shown that there was no significant reduction in the strengths. Instead, a slight increase in the test values over time was observed in some cases. The slabs investigated from a manufacturing plant on the other hand showed a halving of the compressive strength after 18 months outdoor storage.

The investigations on the carbonation level showed a carbonation of the small specimens as well as of the complete slabs. In the case of the complete slabs, a gradient could be determined running from the outside to the inside. The slabs investigated from a manufacturing plant showed after outdoor storage a complete breakdown of the Tobermorite with an increased Vaterite content. The carbonation level was similarly high as that caused by rapid carbonation.

Based on the results of this research project and its predecessor projects, it can be assumed that there is a risk of loss of compressive strength caused by carbonation for the slabs examined from a manufacturing plant under all storage conditions investigated. Otherwise the risk is estimated to be rather low. A residual risk may exist however particularly in the case of low gross density classes if greatly increased CO_2 stresses occur (e.g. champagne-pressing houses and similar), and further factors such as high humidity or permanent stress may become relevant. Special attention must therefore be paid to the use of slabs of autoclaved aerated concrete in components which due to their use are exposed to a greatly increased CO_2 concentration.

In the course of the research projects, various testing procedures were also discussed, by means of which possible remaining application risks can be identified and prevented at an early stage. It was found that under the general conditions applied, rapid carbonation does not constitute any meaningful time-lapse trial. For target-oriented testing at elevated CO_2 stresses, extensive modifications of the test conditions (CO_2 content, air humidity, temperature and length of the trials) would first be required.

On the basis of the available results, shrinkage tests along the lines of DIN EN 680 appear to be the most suitable as a first indication of a potential carbonation risk. In variance from DIN EN 680, the criterion used should not be the conventional reference value of the drying shrinkage $\varepsilon_{cs,ref}$, but the maximum shrinkage stress in the delivery condition (e.g. 0.4‰ after 28 days). The course of the shrinkage deformation (asymptotic approximation to a limit value) should also be taken into account in the assessment. In the previous projects, it was shown that problems in the creep behaviour over time can occur particularly in the case of slabs of a low gross density class, so that in case of doubt, long-term testing could also be advisable.