Zukunft Bau

Short report

Title

Title: „Chemical prestressing of textile-reinforced concrete elements with expansive concrete“

Starting point

The aim of this research project was to develop thin concrete facade elements. For this purpose, chemical prestressing of textile-reinforced concrete was investigated. Chemical prestressing is introduced by the appropriate addition of expansive admixtures to the concrete mixture. Therefore, different concretes were analysed, considering in particular their prestressing behaviour on specimens with steel or textile reinforcement.

Description of the research project

In this research project the chemically prestressed thin concrete elements reinforced with carbon textile grids has to be developed. Initially, material investigations were carried out with different amounts of expansive admixtures, different superplasticizers and concrete mixtures. This resulted in a selection of two most promising compositions, which were used in the further work packages of the project, i.e. bond and load capacity analyses.

Investigations on the bond between concrete and steel reinforcement or textile reinforcement have shown that the addition of expansive admixtures to the concrete has no negative influence. Otherwise, it could be proven that the bond behaviour of chemically prestressed elements with textile reinforcement was improved.

Also the load-bearing behaviour was investigated within the scope of the project, firstly on beam specimens with internal steel reinforcement and then on two types of thin textile concrete slabs. In these experiments, it was shown that the stress that can be sustained until initial cracking occurs increases significantly in chemically prestressed elements. This was observed in both beam and slab specimens. In addition, the use of fibre-optic sensors made it possible to investigate the development of strain over time in the specimens and their deformation and crack behaviour during loading. The strain peaks and potential cracks identified by the optical sensors could be confirmed in their position by digital image correlation. Within the scope of this research project, the influence of a chemical prestress on the crack formation and post-cracking behaviour of specimens subjected to flexural loading was analysed and presented.

Furthermore, the creep behaviour of chemically prestressed elements was discussed. However, the results of the conducted experimental creep investigations could not confirm the findings reported in the literature.

Conclusions

The research project shows that chemically prestressed thin concrete elements with carbon textile reinforcement have many advantages in terms of load-bearing capacity and, in particular, serviceability. No additional mechanical prestressing devices or anchorages are required because the prestressing results from a controlled expansion of the concrete which is restrained by internal reinforcement. Especially for the precast industry, chemical prestressing would have economic advantages, as the production time of concrete elements could be shortened by the use of expansive admixtures.

Key data

Short title: Prestressing with expansive concrete

Researchers / Project leader:

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Overall cost: 309.305,67 € €

Share of federal grant: 177.641,67 €

Project duration: 24 months

FIGURES:

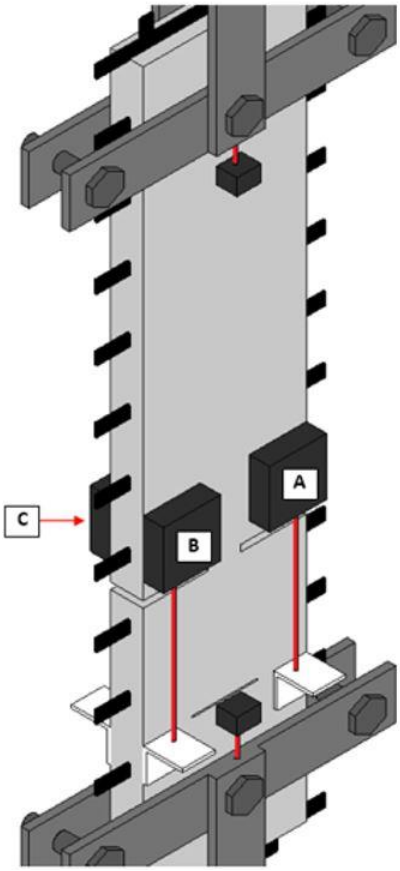

Fig. 1: Abb19_Auszug.jpg
Measurement concept for the test series and an example of a pull-out test

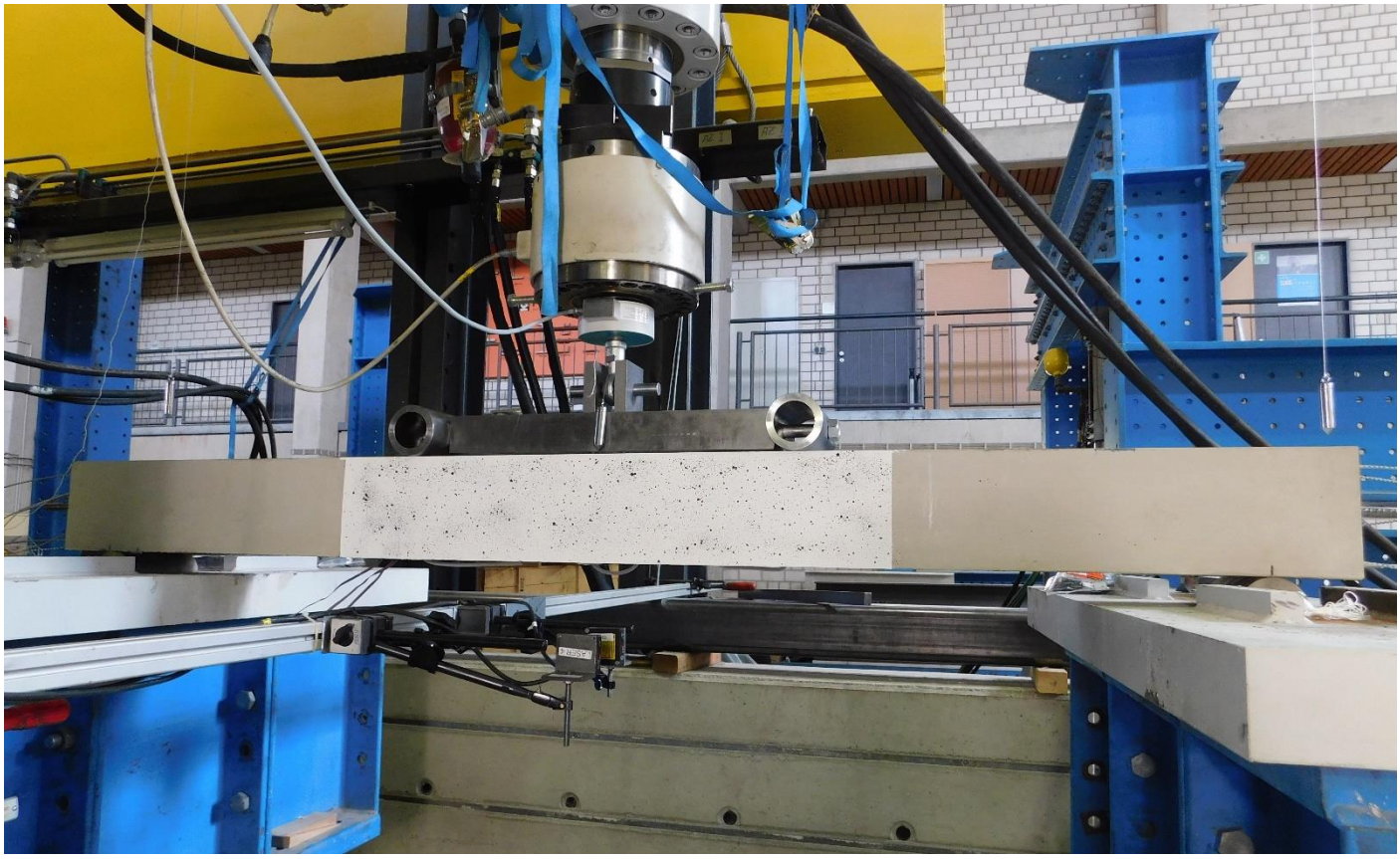

Fig. 2: Abb33_Balkenversuche1.jpg
Test setup for 4-point bending tests on steel-reinforced beams

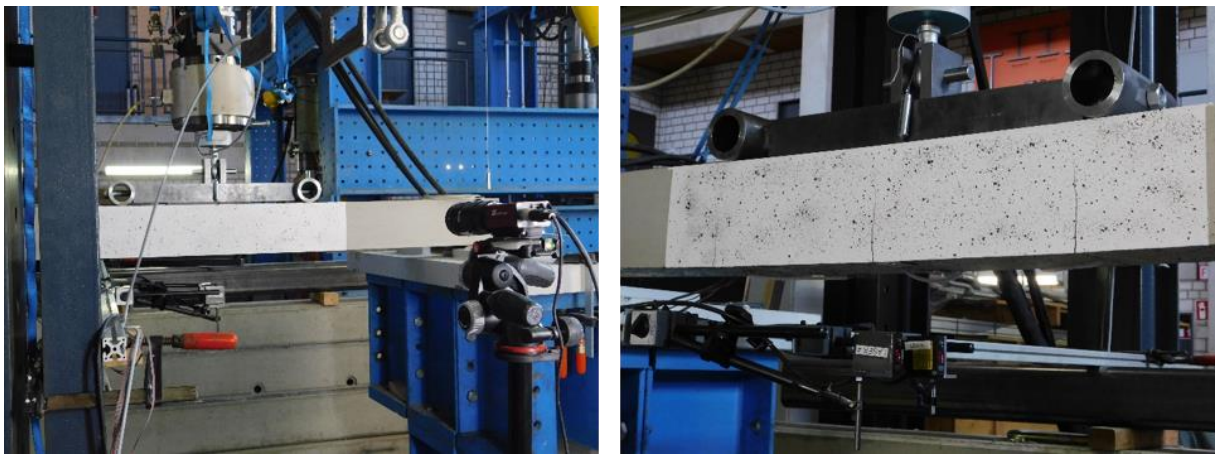

Fig. 3: Abb35_Balkenversuche2.png
Test setup for Digital Image Correlation (DIC), industrial camera with measurement area (left) and measurement area with typical crack pattern (right)

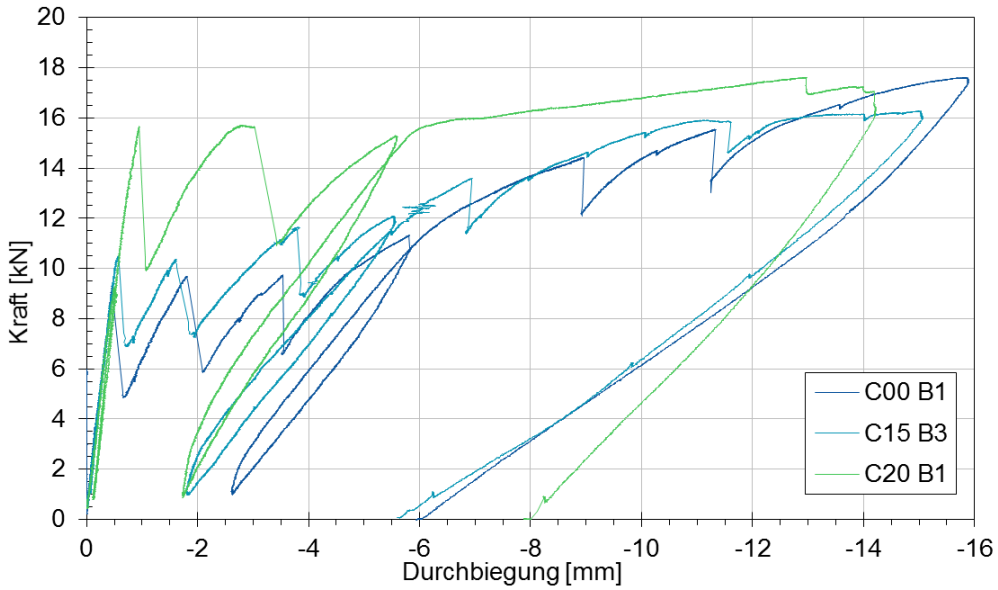

Fig. 4: Abb44_Balken_Vergleich.png
Force-deflection diagram for three selected beam specimens with different amounts of expansive admixtures

Fig. 5: Abb57_PlattenNachAusschalen.png
Slabs after formwork removal with details of fixing joint for the transport and vertical storage

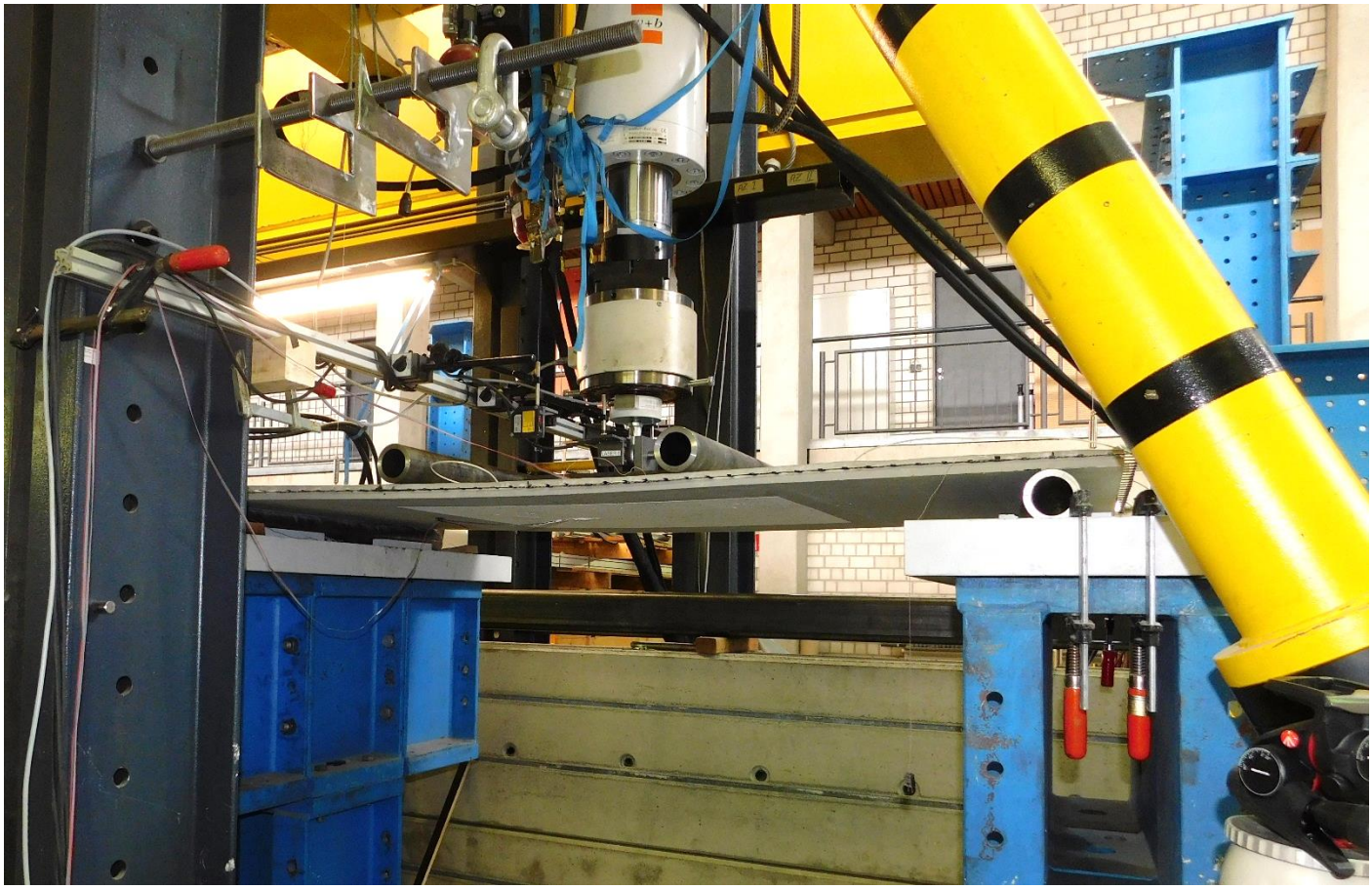

Fig. 6: Abb61_Plattenversuche.jpg
Test setup for the 4-point bending tests of the textile-reinforced slabs

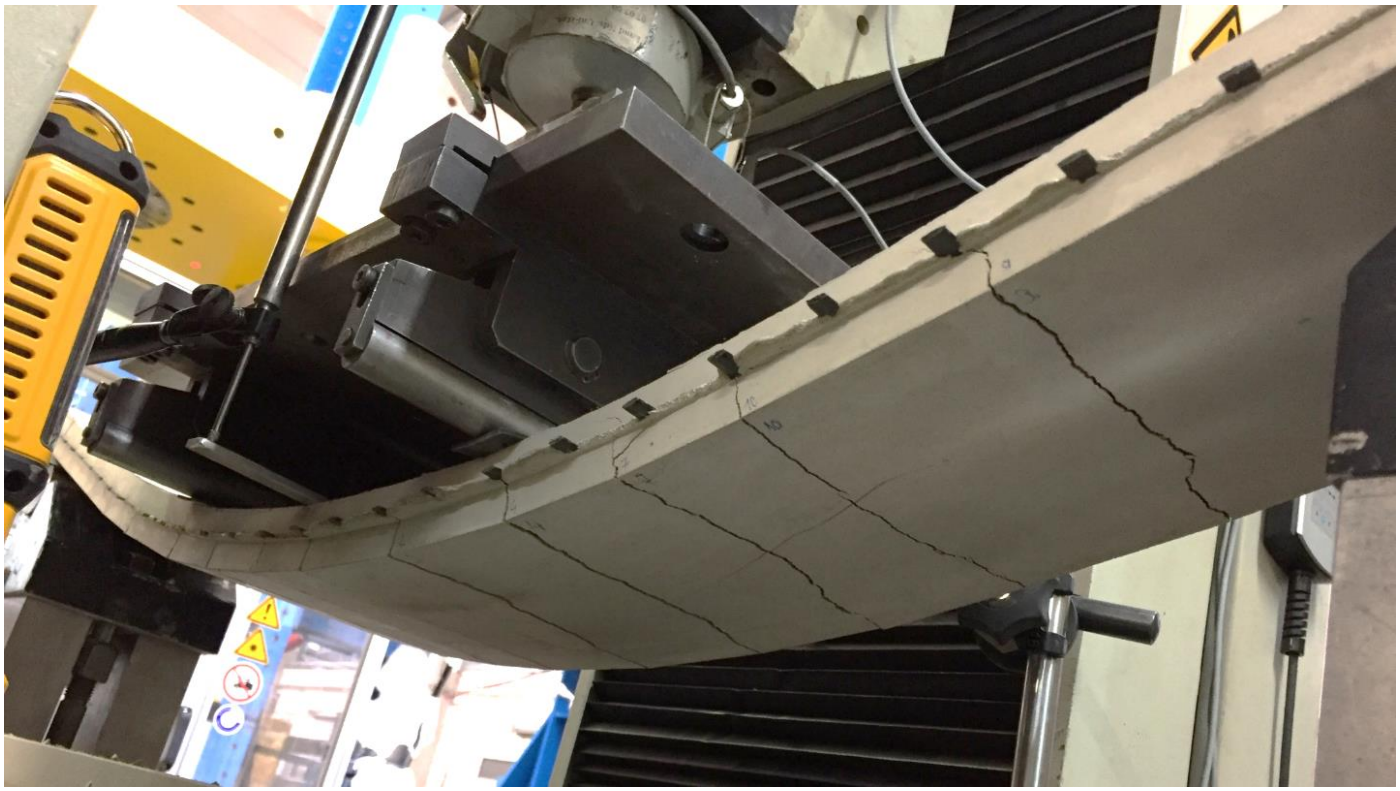

Fig 7: Abb52_KleinePlatten_Versuche.jpg
Deflection of a thin slab with textile reinforcement in 4-point bending test