Limit states of small crack widths in sealing constructions made of reinforced concrete considering the demands on flow safety, usability and durability

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From the previous research report on improving the prediction quality of small crack widths for components made of reinforced concrete significant deficits where shown in predictive accuracy, especially at small crack widths.
The goal of this project was to examine whether the reliability in limiting the crack width by a probabilistic verification can be brought to a higher level, because there is a lack of predictive accuracy when using the deterministic proof.
Therefore statistical analysis were performed for four different models using the data base of recorded cracks made by the UPM Madrid. The aim was to estimate the influence of scattering material parameters on the prediction of crack widths. As a major influence the bond strength has been identified, which affects the calculated crack spacing. At the same time it was shown that the maximum crack spacing obviously is not sufficient as a measure for the initiation length of the strength that has to be transferred from concrete in to the steel, but the load transfer length is probably greater, which is particularly evident in the significantly better performance of the model by Windisch, whose model has a slightly different approach compared with commonly applied models.
For the crack width model in EC 2-1-1/NA and the model by Windisch relationships between computational and actually occurring crack width were created, which are required as a basis for the crack width limitation on a probabilistic basis.
The distribution functions were used for a verification of durability with deterministic crack width limits out of EC 2-1-1/NA for different durability criteria. In comparison, verifications with scattering limits were performed in order to verify an increase of the reliability level.
Especially for the verification of penetration of components with separating cracks by fluids hazardous to water it could be shown, that a significant increase in reliability is possible when scattering is taken into account. This was done for the fluid biodiesel, because real data from own experiments were available for this fluid. At the same time it was shown that the model out of EC 2-1-1 (with and without NA) even then does not have sufficient accuracy. The model by Windisch for this case however, can be recommended for the design of components, which are constructed according to the German Guideline „Betonbau beim Umgang mit wassergefährdenden Stoffen“ (in translation: concrete construction when dealing with substances hazardous to water).
It is recommended to establish a data set that is obtained on components with usual practice dimensions, because the data record, which is the base of the studies, contains a lot of "academic" specimen with dimensions, reinforcement ratio and concrete cover far away from the practice.
It is further recommended to rethink the model approach for crack width calculation. The crack spacing as a prelude to total the length of the strain differences appears inappropriate. The development of a new model must be accompanied by tests to be carried out analogously to the recommended data record on elements with usual practice dimensions.
For a more detailed assessment on a probabilistic basis data on the distribution of crack widths, in which the respective stability criterion is not met, is required, which during processing of the research project were not available. The preparation of such an appropriate data set for all stability criteria is recommended.