Abstract

In the current process of updating Eurocode 2 (EC2) at European level, alternative models were proposed for the design against punching without punching shear reinforcement and one-way shear without shear reinforcement, the derivation of which was based on the *Critical Shear Crack Theory* (CSCT). In Germany, when developing the previous models, the empirical coefficient was derived using test results. This was based on a target value of 1.0 for the 5 %-quantile value of the ratio of the experimental failure load to the theoretical load in the case of punching or shear failure. In the course of this research project, the failure probabilities for the proposed design models were determined semi-probabilistically. For this purpose, the reliability index β was determined using up to four different calculation methods (*Mean Value First Order Second Moment Method, First Order Reliability Method, First Order Second Moment Method* und *Monte Carlo Simulation*). The reliability index β is a measure for the failure probability p_f; the larger the reliability index, the smaller p_f. The target value for the calibrations in the ultimate limit state was set at $\beta = 3.8$ in accordance with DIN EN 1990. This refers to the minimum value for the reliability class RC 2, which corresponds to the consequence class CC 2 for a reference period of 50 years.

The sensitivity analyses carried out have shown that the safety level for the considered design equations essentially depends on the model uncertainty. While the statistical characterization of the concrete strength and the effective depth still play a minor role, the influence of the other basic variables of the limit state function is very small. The statistical characterization of the model uncertainties was based on the evaluation of experimental databases. For the remaining random variables, the mean values and the scattering were determined according to the specifications in *Probabilistic Model Code*.

Comparable results were obtained for all the investigated limit state functions with a *First Order Reliability Method*, a *First Order Second Moment Method* (Level II method with approximation of the limit state function in the design point) and with a *Monte Carlo Method* (Level III method). In this respect, the safety index determined using a *Mean Value First Order Second Moment Method* (approximation of the limit state function based on the mean value) was, in each case, approx. 25 % below the other results. Therefore, it was excluded for further safety level evaluations.

In the parametric studies for the design approaches in the draft of the new EC2, the reliability indices obtained were approximately $\beta \approx 4.0$ for punching shear without punching shear reinforcement and $\beta \approx 3.8$ for one-way shear without shear reinforcement. Thus, the safety level required in EN 1990 is attained, except for concrete compressive strengths above approximately 40 MPa.