

Substitution or partial replacement of tests by Finite Element simulations in concrete- and composite construction – Requirements, evaluating criteria and limits

In Structural Engineering traditionally tests are widely used for the derivation of calculating methods. This experimental approach leads often to high development costs for new products, since to identify realistic structural resistances relatively large and complex test setups are required. As examples from the realm of concrete structures tests on punching and shear resistance of twin-head anchors, the load-bearing capacity of consoles, the load-bearing capacity of overlap connections or the structural ductility of composite structures are to be named.

The development of realistic material laws and efficient numerical algorithms and the availability of cheaper Computers with high computing and Storage capacities enable the numerical simulation of the nonlinear fracture behaviour of specimens by the Finite Element Method. This computational approach has the advantage that it is often less expensive than an experimental study, and thereby a wider range of influencing Parameters can be examined. The disadvantage is that e.g. for reinforced concrete currently not all of the fracture mechanisms can be simulated with the same accuracy. For example, the shear and punching failure can only partially be modelled. Therefore, in practice usually a combined experimental and numerical approach is chosen in such cases.

Rules and criteria for evaluating the required accuracy of numerical methods for the extrapolation of the structural resistance in experimentally not tested application areas or as a substitute or partial replacement of tests do not exist. Therefore, for standard or expert committees it is often difficult to decide whether numerical studies submitted and therefrom derived design values reach the required level of safety, or whether the complex Computer simulations disregard fundamental influences. Shall tests on specimens partially be replaced by Finite Element simulations, also the numerics demand requirements for the experimental setup, the material characteristics and the measured variables. Thus, not every attempt is suitable to calibrate numerical models.