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Evaluation of structural und mathematical hot spots within the numerical simulation of polymere components

In proof of stability und service ability for plastic constructions computer-aided calculations e.g. via finite element method (FEM) are applied increasingly frequent. FEM is a numeric procedure permitting modeling and calculation of structures and construction elements, which cannot or were insufficient described via analytical simulation techniques. In terms of plastic constructions this is due to material specific features on the one hand (e.g. visco-elastic behavior) and den characteristic production processes/methods on the other hand (e.g. rotationally symmetric constructions) which provides nearly each geometry.

During the numerical calculation of plastic shell structures locally and highly elevated values are occuring within the design stresses at so-called imperfections (e.g. singularities, apertures, point supports), which have to be estimated. This increase of stresses is based on the choosen calculation method and is not appearing in reality. The "phenomena" of unrealistic peak stresses within FEM calculations at imperfections is sufficiently known to mechanical design engineers. Currently there is a lack of consistent technical rule to evaluate these prominent regions.

In the context of the research project at hand, the imperfections to study are classified into four paramount groups. For each group, experienced mechanical design engineers provided often occurring instances in construction practice, for which validation computations have been implemented via different commercial calculation programs. Such an approach ensures the comparability of the obtained results und reflects the big amount of simulation technologies utilized in practice. The results have been checked for plausibility und compared to each other. Adequate representive calculation instances and results have been compiled und documented. These enable the derivation of a profound approach for handling structural and mathematic imperfections. Occurring set of problems for handling with different commercial calculation tools have been cataloged und indicated suggestions for the implementation of the complex of problems as described.

Developing a best practice for evaluation of structural and mathematical imperfections within the numerical simulation of shell-shaped plastic components, five different assessment procedures for chosen representative examples have been investigated. Thereby, independent of material and imperfection classification one procedure turned out to be the preferred approach for derivate a near universal valid calculation rule. The suggested methodology „integrative method" has been verified and refined on chosen instances and serves the subsequent user for a simple handling of computation results. Furthermore it induces an improved measurability by a third party. The designed proposal for solution provides a clear approach for to-be handling of specified difficulties in a uniform and established way. Also against the background of theoretical FEM basics (energy analysis and basis for weighted residual methods), the prioritized method of integration is plausible.

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