Uncertain processes and numerical monitoring of structures

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Abstract

A structure is subjected to numerous alterations and modifications during its lifetime. These modifications result from:

- the sequence of different states during construction;
- changes in material, e.g. the change of material behavior due to physical or chemical processes;
- structural alteration resulting from refurbishing, bonding of prestressing elements by grouting the duct, strengthening, etc.;
- changes in load, described by a load process.

The special modification of structures comprises cross-section modifications, modifications of structural members, and modifications of support conditions. The change of prestressing forces may also be understood as modification of structures. The entirety of the modifications of structures constitutes the process of modifications.

Numerical monitoring of a structure during its lifetime close to reality requires considering the complete load and modification processes simultaneously. Both processes run discontinuously. They cause time dependent, discontinuous result values. The parameters of the load and modification process are usually uncertain parameters. Due to their predominantly informal and lexical uncertainty, they are described as fuzzy processes, respectively fuzzy functions.
Taking account of this uncertainty in the numerical simulation of the load and modification process requires a fuzzy structural analysis in the time domain. The fuzzy variables and the fuzzy functions are mapped on the fuzzy result variables with the aid of a crisp or uncertain analysis algorithm.

The time dependent state of the structure during the load and modification process is evaluated by different newly defined uncertain time dependent indicators. These indicators enable the assessment of the benefit of the structure's modification. The numerical simulation is based on an optimization procedure. This procedure searches for special points in the input space of the fuzzy variables. Each point of the input space represents a deterministic parameter data set, which is introduced in a deterministic fundamental solution.

In the paper the geometrically and physically nonlinear analysis of plane reinforced concrete, prestressed concrete, textile strengthened, and steel bar structures as well as folded plate structures is chosen as deterministic fundamental solution. The algorithms are demonstrated by way of examples.