

# Structural analysis enhanced BIM models for integrated simulation with Isogeometric B-Rep Analysis to simulate different stages of construction

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## Abstract

In the design process of structures it became apparent that the tight integration of numerical simulation techniques into CAD is a key for a fluent and successful workflow. It allows to directly analyze the structures performance on basis of the chosen geometries. This can be especially interesting if different stages of the construction process are taken into account. From a structural point of view it is then very important to consider the history of each respective structural component to finally simulate correctly the behavior of the complete model. Many important physical properties which occur in each respective stage, as e.g. elastic and plastic deformations, simulated and measured damage, etc. can be imported back and handled within the CAD model. This simplifies the modeling procedure and can produce more accurate simulations. The enhancement by the analysis information within the design is one of the major impacts in the scope of Building Information Modeling (BIM) and accessible throughout the entire life cycle of the structures.

The Isogeometric B-Rep Analysis (IBRA) [2], as extension to the Isogeometric Analysis (IGA), uses the B-Rep described CAD models, including trimmed multipatch surfaces. It has beneficial properties to a staged analysis. With special interfaces, the gap between CAD and solver can be closed [1] and the solutions can be directly included in the design process. Within this contribution the required data structure is presented together with the CAD data enhancement procedure and necessary isogeometric element formulations.

The structural analysis enhanced BIM process will be demonstrated by some examples. The possible integration of different types of solution techniques throughout the staging process will be shown, with a special focus on brittle structures including historic damage models.

## References

- [1] Teschemacher T, Bauer AM, Oberbichler T, Breitenberger M, Rossi R, Wüchner R, Bletzinger K.-U., Realization of CAD-integrated shell simulation based on isogeometric B-Rep analysis. *Advanced Modeling and Simulation in Engineering Sciences*. 2018; 5(1):276.
- [2] Breitenberger M, Apostolatos A, Philipp B, Wüchner R, Bletzinger K.-U., Analysis in computer aided design: Nonlinear isogeometric B-Rep analysis of shell structures. *Computer Methods in Applied Mechanics and Engineering*. 2015; 284(284):401–457.