Structural Optimization and Reconstruction Developments for Large Scale and Non-linear Modeling Events

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The current work presents three topics on latest industrial solutions and workflows.

Initially, we demonstrate topology and sizing designing for non-linear optimization consider transient events including inertia, material non-linearities as well as geometrical non-linearities for large deformations and contacts. To the best of our knowledge, this is the first work that shows results for non-linear topology and sizing of shell thicknesses using adjoint sensitivities for the three types of non-linearities for transient events including inertia.

Secondly, several advances have been done for the Abaqus Multi-Grid (AMG)-based iterative solver addressing large scale simulations with high performance and high accuracy. The AMG solution is implemented for both the primal systems of the structural equations as well as for the adjoint systems for the sensitivities. The presented AMG solution allows for realistic simulation and thereby, realistic optimization as unstructured and arbitrary meshes can be simulated including modelling of contact (penalty & augmented Lagrange method), gasket elements, pre-tension sections, tie constraints, MPC, kinematic couplings and rigid bodies, symmetry and periodicity boundary conditions, as well as a large number of boundary conditions.

Thirdly, we will demonstrate a one-click generation of smoothed CAD reconstructed geometries using efficient and robust CAD-reconstruction methods solving one of the main obstacles in embedding topology optimization and other non-parametric optimization methods in the product design process. Various strategies for CAD-reconstructions and for new CAD-features of industry based topology optimizations solutions will be presented in detail. Some of the new CAD reconstruction tools are focusing on free-form optimized structures for additive manufacturing whereas others are focused on more classic and traditionally manufactured methods like milling but still with a high degree of geometrical complexity matching the topology optimization results. The present solution combines classical CAD-solids and surfacing features in a single application that to the author's knowledge is the first dedicated workbench to CAD-reconstructed non-parametric optimization results.

For all above three topics several industrial design applications will be shown.