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A Benchmark for Fluid-Structure Interaction in Hybrid Manufacturing: Simulation with preCICE in OpenFOAM

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Fluid-structure interaction (FSI) occurs in various hybrid manufacturing processes, such as mold filling of fiber composite sandwich components with an integrated foam core in the RTM process [1], simultaneous molding and filling of novel fiber-metal laminates, or insert deformation during over-molding. Process simulation methods provide important tools to reliably design hybrid manufacturing processes, although simulating FSI during such processes is challenging due to the shifting and deforming interface between fluid and solid and the varying spatial domain.

In this contribution, a benchmark test is presented to verify and evaluate different simulation approaches for FSI in hybrid manufacturing processes. The test involves the interaction of a deformable circular metal blank with the cylindrical squeezing flow of a highly viscous fluid. Compression force, blank deformation, and flow front propagation are used to compare different numerical approaches with experimental results.

The simulations highlighted in this work are carried out by coupling the fluid simulation in OpenFOAM to a structural simulation in Calculix using the coupling library preCICE. The flow of the highly viscous fluid is modeled using a two-phase volume of fluid approach with a dynamic mesh and passes the resulting hydrodynamic forces to preCICE as input to the structural simulation of the deformable metal blank, which returns displacements at the interface in each increment. The approach for the proposed benchmark test is compared in terms of accuracy and computation time with different simulation approaches from other works such as e.g. Coupled Eulerian-Lagrangian (CEL).

REFERENCES

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