Thermo–Mechanical Setup for Real-Time Multiphysics Hybrid Simulation

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Abstract

Hybrid simulation combines the flexibility and cost-effectiveness of computer simulation with the realism of experimental testing in order to obtain the response of a system subjected to dynamic excitation by combining loading-rate-sensitive numerical and physical substructures. The key advantage is that only the critical components of a structure that are difficult to model numerically are sub-structured for testing in the laboratory, while the remainder of the structure with more predictable behavior is computer simulated using finite-element analysis software.

Conducting a thermo-mechanical experiment involves more than one simultaneously occurring physical field. Applying forces/displacements concurrently with thermal loading conflicts the overall response of the tested system. The need to provide a testing framework where realistic operating conditions of the tested specimen can be reproduced motivated the development of a versatile thermo-mechanical (TM) virtualization platform. The virtualization platform consists of a TM test rig (TM-TR), which combines a mechanical and a thermal transfer system that allows us applying mechanical and thermal loads to the tested specimen.

The goal of this project is to conduct thermo-mechanical real-time hybrid testing with a powerRibs composite plate for validation and calibration of high-fidelity multi-axial constitutive material models. The powerRibs technology is an innovative reinforcement solution where a natural flax fiber grid is added to one side of thin-walled shell element. Concurrently with a buckling load, a thermal loading condition was applied to the provided plate, heating up the specimen till 90°C with the infrared (IR) lamp. The two clamps of the TM-TR can vary from free to fixed.

Keywords: Real-time hybrid simulation, Thermo-mechanical testing, Multiphysics response, Composite plate

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