

Validation of OpenFresco-based thermomechanical hybrid simulation to address an earthquake-fire coupled problem

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ABSTRACT

A new hybrid simulation platform for addressing thermomechanical coupled problems has been introduced into the Open-source Framework for Experimental Setup and Control (OpenFresco) [1]. This middleware resides between a numerical substructure (NS) and a physical substructure (PS) in a hybrid simulation and provides the means of communicating between the two. Whereas previously, this communication was restricted to mechanical loads, the new OpenFresco thermomechanical hybrid simulation (TMHS) capability additionally provides thermal degrees of freedom and temperature loads in the hybrid model. TMHS was implemented at the ETH Zürich IBK Structural Testing Laboratory. It provides a valuable resource for addressing mechanical-fire coupled problems, and in particular, earthquake-fire problems [2].

An experiment was conducted to demonstrate the capabilities for this combined hazard case. The hybrid model consisted of two elements. The NS was modeled in OpenSees [3] and remained “cold” for the test. The PS was tested in a universal testing machine, enclosed in a furnace. The hybrid model was first exposed to a ground motion excitation. This was followed by a fire curve. After completion of the fire curve and some cooling, a ground motion aftershock was applied to the hybrid model. The entire loading sequence was fully automated, so no user interaction was necessary except to open the doors of the furnace for the cooling phase. Demonstrating this successful investigation of the earthquake-fire coupled problem opens the possibilities for future investigations with more complex models and larger-scale tests.

REFERENCES

- [1] OpenFresco, (2014). Open Framework for Experimental Setup and Control. <http://openfresco.neesforge.nees.org>.
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- [3] OpenSees, (2014). Open System for Earthquake Engineering Simulation. <http://opensees.berkeley.edu>.