Validation Experiments for Unsteady Thermal Fluid Structure Interaction

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ABSTRACT

Over the last years, multi-physics simulations have become increasingly complex. For these to be useful for their actual purpose of predicting otherwise unknown physical behavior, the overall numerical method needs to be thoroughly validated. While for simple problems experimental data is available, this is not true for most complex problems.

The particular multi-physics situation considered here is unsteady thermal fluid structure interaction between air and steel. Specific applications are cooling of gas-turbine blades and in particular gas quenching, where after a steel forging process, the hot steel is locally cooled using high pressured air. Since the steel undergoes phase transition, nonlinear macroscopic models are used. In the air, the flow is typically turbulent, making turbulence modelling necessary. This combination makes it questionable that the numerical method can give a quantitative prediction, unless it can be validated.

We thus present a serious of experiments for the purpose of validating a code for unsteady thermal fluid structure interaction that consist of steel in simple geometric forms being put into a wind tunnel [2]. These are then used to validate our fast coupling solver, which consists of a time adaptive second order method in time with linear extrapolation in time of starting values for the Dirichlet-Neumann coupling iteration [1].

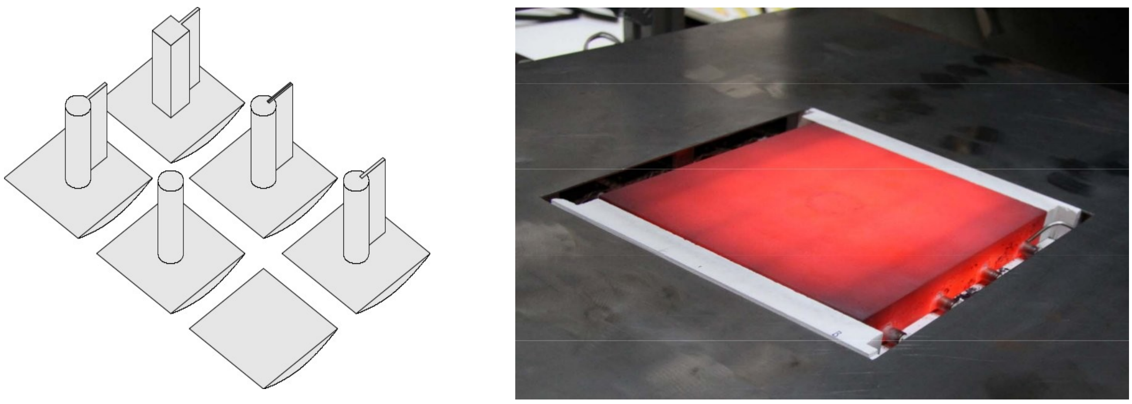

Figure 1: Sketch of experimental designs (left) and heated plate in wind tunnel (right).

REFERENCES

[1] P. Birken, T. Gleim, D. Kuhl, A. Meister, "Fast Solvers for Unsteady Thermal Fluid Structure Interaction", *Int. J. Numer. Meth. Fluids*, submitted

[2] M. Weiland, M. Berth, P. Birken, S. Carstens, D. Kuhl, A. Meister, O. Wünsch: *Experimental investigations of thermal fluid structure interaction*, Proceedings of the 1st International Conference on Thermo-Mechanically Graded Materials, pp. 127-133