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Coupled Sensitivity and Design Optimization for Thermo-Structural Systems

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Thermo-structural systems coupled with heat conduction and structural mechanics exist in many industrial engineering. The thermal responses of such systems, e.g. thermal deformation, stresses, and buckling are commonly the predominant factors in the system design. Hence it is imperative to incorporate the heat conduction and structural mechanics in the design phase. This paper presented a systematical methodology for the design optimization of thermo-structural systems using the coupled sensitivity analysis and mathematical programming techniques which takes the heat conduction and structural mechanics into account simultaneously. Detailed attentions are paid to the coupled sensitivity effects of the two disciplines by employing the direct and the adjoint methods for the static thermal stress, the qusi-static thermal stresses and the thermal buckling problems. The design optimization is solved with the sensitivity information. Numerical examples reveal the necessity of the coupled sensitivity analysis and effectiveness of design optimization. The implemented software system includes the size and the shape design variables, and then can be applied to the design optimization for the plane, axi-symmetric, and thin-walled shell elements for complex structures.

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