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On the modelling of finite thermo-viscoplasticity with application to thermal buckling

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Experiments have shown that aerothermodynamical loads induced by high enthalpy flow on thin metallic panels in combination with unavoidable constrains for the movement of the structure might lead to undesirably localized plastic deformation and buckling phenomena. An important part of the structural model is the description of the material behaviour. This requires a fully thermomechanical coupled viscoplastic model including large deformations.

Therefore a realistic description of the highly temperature- and rate-dependent material behaviour of the structure must be considered. Besides thermal conduction, the temperature dependence of the mechanical material behavior as well as the deformation dependence in conduction and capacity terms have to be included in the thermomechanical coupling. For that an extended thermomechanical model is used which takes non-linear thermal evolution into account [1]. This is achieved by defining a heat capacity which is nonlinear dependent on the temperature. By including aspects of Vladimirov [2] to this thermo-viscoelastic model, it is extended to a thermodynamically consistent model of finite thermo-viscoplasticity with non-linear kinematic and isotropic hardening for large deformations. The Helmholtz energy includes nonlinear functions of the temperature and the isothermal energy, which decomposes into an elastic, a kinematic and an isotropic hardening part.

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