Numerical verification of stability for large strain thermo-elasto-plasticity

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This research addresses the numerical verification of stability in thermo-elasto-plastic materials undergoing large strains. The notion of stability is often associated with the stability of a structure, however, in this paper the attention is paid to the stability of a material at a point. The stability condition derived for a general model formulated in the thermodynamically consistent format is presented in [3]. From a mathematical point of view the stability analysis reduces to a minimization problem of a function dependent on a direction in Euclidean space. Various numerical methods can be employed to solve this problem, such as a search method within the discretized direction space [2] or a multi-start algorithm incorporating a gradient-based method [1].

In the paper the attention is paid to the development of an efficient numerical treatment incorporated into simulations performed using the finite element method. First, methods available in the literature are implemented, tested and analyzed with regard to their applicability to the stability analysis of thermo-elasto-plastic material. Second, a hybrid approach is developed combining different methods and enabling the verification of stability at integration points in complex samples subjected to non-uniform deformation as shown in Fig. 1.

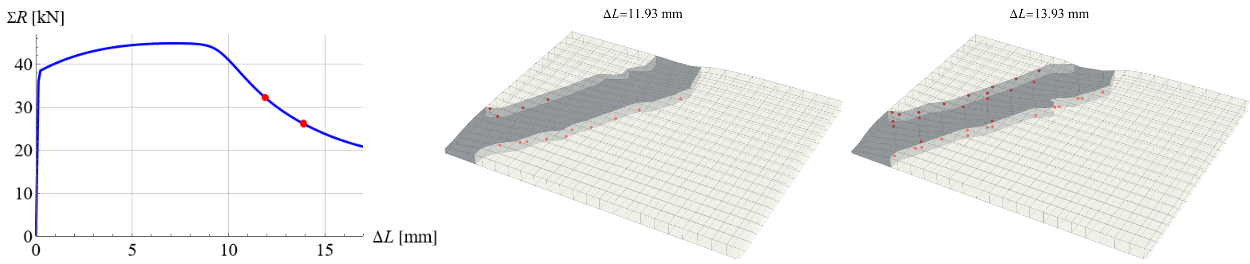

Figure 1: Sum of reactions vs enforced displacement for a tensile plate with a thermo-elasto-plastic material model (on the left) and deformed meshes with plastic zone shown in gray and Gauss points with stability lost marked as red points at load steps ΔL=11.93 mm (in the middle) and ΔL=13.93 mm (on the right).

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