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TOPOLOGY OPTIMIZATION INVOLVING HIGH-CYCLE FATIGUE

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Abstract: The focus of this work is to develop a topology optimization method including high-cycle fatigue as a constraint. The fatigue model is based on a continuum approach, which uses the concept of a moving endurance surface being a function of the stress history and back stress evolution. The development of damage only occurs when the stress state lies outside the endurance surface. The added advantage of using such a model is that, non-proportional loading histories can be used for predicting fatigue quantities without involvement of any cycle-counting algorithms such as rainflow counting. Furthermore, an aggregation function, which approximates the maximum fatigue value, is derived and implemented. As the optimization workflow is sensitivity based, the fatigue sensitivities are determined using an adjoint sensitivity analysis. By using this fatigue model, the predicted damage has a history dependence, which is similar to elasto-plasticity and thus the adjoint solutions are solved stepwise. The sensitivities obtained from the adjoint sensitivity analysis are verified by comparing them to the sensitivities determined by global finite difference. The capabilities of the presented approach are tested on several numerical models where a typical optimization problem is to maximize the stiffness subject to high-cycle fatigue constraints.