Optimal Multi-beam Laser Welding by State-constrained Semi-infinite Optimization

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Abstract

A semi-infinite optimization problem with a pointwise state constraint and an isoperimetric state constraint is investigated both theoretically and numerically. This problem arises from the modeling of a multi-beam laser welding process of aluminium alloys. Position, size and intensity of the auxiliary laser beams are described by a finite number of parameters. The main constraint is given by a quasi-stationary heat equation for the temperature field induced by the laser beams. Additionally, two state constraints play an important role. They either avoid melting under the auxiliary laser beams or restrict the opening displacement which can be the source of hot cracks. The aim of the optimization is the avoidance of that hot crack initiation.

Although necessary conditions can be developed, the complexity of these conditions clearly promote the approach “first discretize than optimize”. Numerical results that have been obtained this way will be presented. Moreover, the optimal solution can be verified experimentally.