SHAPE OPTIMIZATION OF HEAT RESISTANT STRUCTURES

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The design and protection of structures exposed to significant heat transfer rates is studied in this work. This problem corresponds to a structure exposed to a fire or near an extremely hot environment. The classical optimal layout of a structural material is modified to include constraints associated to thermal considerations. The problem is formulated as a standard topology optimization problem, where the shape of the structure is represented by a material property [1,2], but also contains the distribution of fire protective material that will not stiffen but insulate the structure. A three-phase layout problem is thus suggested that includes an insulating material, the structural material, and an unspecified distribution of heat sources. The heat sources are used to approximate very crudely a fire burning in the available space adjacent to the structure and the insulating material. This problem is represented with a three-phase SIMP (Simplified Material with Penalization) model [3,4]. Various thermal constraints on the structure are possible and presented. The model is very simple but already yields interesting layouts that differ significantly from layouts found from solving the structural problem without heat transfer considerations.

References

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