DESIGN OF FUNCTIONALLY GRADIENT PARTS FOR FREEZE-FORM EXTRUSION FABRICATION PROCESS

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ABSTRACT
Being able to design and fabricate parts made of Functionally Gradient Materials (FGMs) with optimum properties is of prime importance. Very limited research has been carried out thus far regarding the optimization of composition of different constituent materials throughout the part. In this paper, a technique is introduced to maximize the stiffness of parts made of FGM by determining the material composition for each small element inside the part. Furthermore, a manufacturing procedure, using Freeze-form Extrusion Fabrication process, is explained to build the designed part, and its constraints along with their effects on results are discussed. As an example, a two dimensional cantilever beam made of two materials is considered and a Sequential Approximate Optimization method is used to determine the optimum composition of materials for the beam so that the global stiffness is maximized. The only applied force on the beam is a nodal force acting at the tip. One of the constituent materials is stiffer and heavier than the other material. The optimization constraint is the total mass of the beam predetermined by the engineer. The problem is how to distribute materials throughout the beam so as to have the maximum stiffness. The results show a considerable increase in the stiffness of the beams after optimization as compared to the beams with uniformly distributed materials.