Multi-material topology optimization of laminated composite beams with eigenfrequency constraints

This paper describes a methodology for simultaneous topology and material optimization in optimal design of laminated composite beams with eigenfrequency constraints. The structural response is analyzed using beam finite elements. The beam sectional properties are evaluated using a finite element based cross section analysis tool which is able to account for effects stemming from material anisotropy and inhomogeneity in sections of arbitrary geometry. The optimization is performed within a multi-material topology optimization framework where the continuous design variables represent the volume fractions of different candidate materials at each point in the cross section. An approach based on the Kreisselmeier-Steinhauser function is proposed to deal with the non-differentiability issues typically encountered when dealing with eigenfrequency constraints. The framework is applied to the optimal design of a laminated composite cantilever beam with constant cross section. Solutions are presented for problems dealing with the maximization of the minimum eigenfrequency and maximization of the gap between consecutive eigenfrequencies with constraints on the weight and shear center position. The results suggest that the devised methodology is suitable for simultaneous optimization of the cross section topology and material properties in design of beams with eigenfrequency constraints.

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