Multi-material topology optimization of laminated composite beam cross sections

This paper presents a novel framework for simultaneous optimization of topology and laminate properties in structural design of laminated composite beam cross sections. The structural response of the beam is evaluated using a beam finite element model comprising a cross section analysis tool which is suitable for the analysis of anisotropic and inhomogeneous sections of arbitrary geometry. The optimization framework is based on a multi-material topology optimization model in which the design variables represent the amount of the given materials in the cross section. Existing material interpolation, penalization, and filtering schemes have been extended to accommodate any number of anisotropic materials. The methodology is applied to the optimal design of several laminated composite beams with different cross sections. Solutions are presented for a minimum compliance (maximum stiffness) problem with constraints on the weight, and the shear and mass center positions. The practical applicability of the method is illustrated by performing optimal design of an idealized wind turbine blade subjected to static loading of aerodynamic nature. The numerical results suggest that the proposed framework is suitable for simultaneous optimization of cross section topology and identification of optimal laminate properties in structural design of laminated composite beams.