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Abstract

Estimates of the effective stiffness of a composite containing multiple types of inclusions are needed for the design and study of functionally graded systems in engineering and physiology. While excellent estimates and tight bounds exist for composite systems containing specific classes and distributions of identical inclusions, these are not easily generalized to complex systems with multiple types of inclusions. For example, three-point parameters are known for only a few inclusion shapes and orientations. The best estimate available for a composite containing multiple classes of inclusions arises from the Kanaun-Jeulin approach. However, this method is analogous to a generalized Benveniste approach, and therefore suffers from the same limitations: while excellent for low volume fractions of inclusions, the Kanaun-Jeullin and Benveniste estimates lie outside of three-point bounds at higher volume fractions. Here, we present an estimate for composites containing multiple classes of aligned ellipsoidal inclusions that lies within known three-point bounds at relatively higher volume fractions of inclusions