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A Homogenization Based Laminated Beam Theory

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A sequence of theories is developed for laminated (including sandwich) beams. An homogenization approach is used in conjunction with far-field stress and strain solutions resulting from constant, linear, . . . , n^{th} degree bending states; these solutions are called Fundamental Solutions. Based on the Fundamental Solutions, through-thickness stress and strain moments are used to obtain definitions of homogenized flexural and shear stiffness, homogenized transverse Poisson's ratio as well as a unique shear strain moment correction. All developed models adopt a form similar to that of Classical Timoshenko Beam Theory; however, the system parameters of the present and the Timoshenko model have different meanings. Numerical comparisons are made with 'exact' two-dimensional finite element results for a sequence of cantilever sandwich-beams. It is shown that all stress and strain components (in-plane, transverse and shear) are obtained with consistent and excellent accuracy which goes beyond the capability of conventional beam theories.

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