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TWO-SCALE PLATE MODEL WITH IN-PLANE PERIODIC MICROSTRUCTURES

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We develop a two-scale plate model with local heterogeneities characterized by in-plane periodic microstructures. The overall structure is replaced by an equivalent laminate at macro-scale, each of whose lamina has its own homogenized material properties, and its in-plane, bending and coupling responses of the composite plate can be characterized by the numerical material testing (NMT) based on the homogenization theory[1]. The NMT is realized by the finite element or iso-geometric analyses conducted on the three-dimensional unit cell models with in-plane periodicity only, and the data obtained from the NMT can be used to identify the material properties for all the laminae. Note here that the macro-scale plate is regarded as a laminated plate with several laminae, even if a laminated structure is not assumed for the microstructure.

Our first trial on this development focuses on the linearly elastic materials so that the in-plane, bending and coupling stiffness matrices in the conventional laminate model can be evaluated as macro-scale properties. Since the materials used for the unit cell can be nonlinear, the second stage of our presentation is devoted to the application of viscoelastic-plastic type material model to realize the rate- and/or time-dependent inelastic material response of plastics such as polycarbonate, which might exhibit finite deformations. For the nonlinear case, the parameters of the material model assigned to each macroscopic lamina have to be identified with an appropriate optimization method. In this study, we employ the method of particle swarm optimization or differential evolution with the help of the novel method of NMT conducted on a unit cell discretized with laminated plate elements.

Several numerical examples are presented to demonstrate the homogenization and localization capabilities of the proposed two-scale model and to confirm the performance of the employed material model for each macroscopic lamina.

REFERENCES

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