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Random field modelling of local strength in randomly arranged unidirectional FRP plate under transverse tensile loading

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In this paper, random field modelling of the local strength in a unidirectional fiber reinforced plastic (FRP) plate under a tensile load toward the transverse direction is discussed.

Composite materials have been widely used in industry due to their superior specific stiffness and strength. Apparent material properties of those materials are strongly influenced by their microstructure. Furthermore, some microscopic features cannot be perfectly controlled, and microscopic randomness should be considered in apparent material property estimation for the safe design of composite structures.

For this problem, stochastic homogenization [1][2], multiscale stochastic stress analysis [3] and random field modelling [4] for composite materials have been noted. Estimation of the uncertainty propagation through the different scales and identification of the microscopic random field will play a very important role for numerical analysis of composite structure considering multiscale randomness / uncertainties. In particular, random dispersion of the apparent strength will be one of disadvantages of composites, and it should be precisely estimated for more reliable design.

In view of the above, numerical analyses are performed for evaluating the local strength in microscale of the FRP plate, and distribution of the local strength is identified. The numerical model is constructed from a SEM image, and the random field of local strength at each location is modelled by the moving window technique. The estimated random fields obtained from the analysis considering different boundary conditions are also compared in terms of their statistical characteristics, and validity of the results is discussed.

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