
Analysis of Bending Curve and Intelligent Design of Carbon Fiber Composite Fishing Rod Based on VFIFE

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Abstract

The analysis of force response in carbon fiber composite fishing rods faces challenges due to their complex material properties and strong geometric nonlinearities. Deformation performance is the most critical metric for evaluating the quality of fishing rods. Traditional fishing rod design relies heavily on experience, resulting in low efficiency and high costs. To achieve standardization and intelligence in fishing rod design, the following research was conducted. Carbon fiber composite fishing rods are fabricated by rolling multiple layers of carbon fiber cloth with varying fiber orientations onto a conical mold. Given the complexity of their geometric models, Grasshopper was utilized for precise modeling of the fishing rods to obtain accurate material properties. Since the deformation of fishing rods involves strong geometric nonlinearities, the application of conventional finite element methods can easily lead to ill-conditioned matrices and convergence issues. Therefore, the vector form intrinsic finite element method was adopted to simulate the bending curves of carbon fiber composite fishing rods. The proposed numerical computation method was validated through experiments on the bending curves of fishing rods. The geometric modeling and bending curve calculation procedures for fishing rods were integrated to form a unified program for fishing rod modeling and bending curve computation. This integrated program was used to generate bending curve data in batches. A prediction model for the bending curves of fishing rods based on BP neural networks was developed. The trained neural network model can replace complex modeling and calculation procedures, providing fast and accurate bending curves. The trained neural network model was used as the fitness function in a genetic algorithm, with NSGA-II employed for multi-objective optimization. Based on the target bending curve of the fishing rod, the shape parameters of the carbon fiber cloth can be reverse-searched, with material-saving solutions considered. This study provides a set of efficient, accurate, and intelligent methods for the design of carbon fiber composite fishing rods, offering strong practical guidance and economic significance for the production of these products.

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