Structural Modeling and Analysis of FRP Composite Product Subsystems—A Systems Approach

This study derives a new mathematical model aimed to consider virtual design and manufacturing procedures for developing highly competitive, complex geometry composite products for various engineering applications. The fiber-reinforced polymer (FRP) composite industry faces several critical issues right from selection (of product, process, equipment, tooling, materials) to manufacturing the final products by meeting several design criteria and customer requirements. An attempt has been made in this article to identify different subsystems and other constituents of five main systems—resin system, reinforcement system, process equipment, tooling system, and product design of total composite product system. Intermediate processes, alternative designs, process sequence, technological changes, chemical reactions, and other performance affecting parameters have been discussed. Graph theoretical models, variable permanent adjacency matrix models, and permanent functions of these systems based on graph theory–matrix algebra–permanent function methodology are developed. Analytical tests for structural analysis of composite product system are derived to select optimum constituents in each of these five systems of composite product. Coefficient of similarity and dissimilarity are useful aid to take right decision between alternative solutions. Permanent function is a unique representation and to be used by composite industry for coding, evaluation, comparison, ranking, and optimum selection. Structural models are useful for basic understanding of complete composite product system, leading to right decisions for manufacturing and business strategies. Step-by-step procedure is developed to assist composite industry to implement the proposed method in a right way. Usefulness of the proposed methodology to composite industry is also presented. POLYM. COMPOS., 27: 681–699, 2006. © 2006 Society of Plastics Engineers