Study on the thermal spring-in behavior of composite beams

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ABSTRACT

In this investigation, the shaped composite beams ’ distortions usually occur after forming. The primary purpose of the paper is to derive a analytical model used as predicting the spring-in phenomenon caused by process-induced warpage for the L-shaped, U-shaped composite parts. The thermal deformation of composite material parts is influenced by the manufacturing parameters including material ’s coefficient of thermal expansion, stacking sequence, thickness, bending radius, design angle and so on. Afterward the commercial package of finite element method, ANSYS, was also applied to simulate the twisting phenomenon due to the structure length and stacking deviation by the three – dimensional model. The ANSYS was adopted in this research to acquire spring-in angle with fiber orientations and thickness defined by element coordinates. Subsequently, results of this research were compared with analytical solutions and experimental results. The thermoforming is employed to verify the feasibility and accuracy of this analytical model. The research is expected to provide engineers to the spring-in angle to revise machining parameters through understanding influences. Moreover, the concept of compensated angles is utilized to propose the correction factors of spring-in angle. The optimal angle design for L-shaped and U-shaped parts mold for correction of warpage deformation is suggested. Finally, MATLAB is used to integrate all procedures and develop a graphical user interface system to provide the forecast more efficiency.

Keywords : the composite beam、thermal warpage、spring-in、compensatory angle、finite element method

Table of Contents

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