

Effects of processing parameters for vacuum-bagging-only method on shape conformation of laminated composites

ABSTRACT

Complex composite structures manufactured using a low-pressure vacuum bag-only (VBO) method are more susceptible to defects than flat laminates because of the presence of complex compaction conditions at corners. This study investigates the contribution of multivariate processing parameters such as bagging techniques, curing profiles, and laminate structures on laminates' shape conformation. Nine sets of laminates were produced with a concave corner and another nine sets with a convex corner, both with a 45° inclined structure. Three-way analysis of variance (ANOVA) was performed to quantify thickness variation and spring effect of laminated composites. The analysis for concave and convex corners showed that the bagging techniques is the main factor in controlling the laminate thickness for complex shape applications. The modified (single) vacuum-bag-only (MSVB) technique appeared to be superior when compared to other bagging techniques, exhibiting the least coefficients of variation of 0.015 and 0.016 in composites with concave and convex corners, respectively. Curing profiles and their interaction with bagging techniques showed no statistical significance in the contribution toward laminate thickness variation. The spring effect of laminated composites was investigated by calculating the coefficient of determination (R^2) relative to that of the mold. The specimens exhibited a good agreement with R^2 values ranging from 0.9824 to 0.9946, with no major data offset. This study provides guidelines to reduce thickness variations and spring effect in laminated composites with complex shapes by the optimum selection of processing parameters for prepreg processing.

Keyword: Processing parameters; Vacuum-bag-only method; Curing profiles; Laminated composite; Thickness variation; Spring effect; Taguchi orthogonal array; Analysis of variance