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Optimization of incremental sheet metal forming process using grey relational analysis (Article)

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Abstract

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The incremental sheet forming (ISF) process has features that are adaptable to a great variety of applications and demands without relying on dies and punches. However, some features of incremental sheet forming part quality can be unsatisfactory if the forming process parameters are not adequately chosen. In this paper, a Taguchi-based Grey optimization of the incremental sheet forming process is presented for the purpose of determining a combination of optimal process parameters that will result in a high part quality with many favorable characteristics, such as the wall angle, the surface roughness, and the springback. Signal-to-noise ratio (S/N) and Taguchi's L18 orthogonal array design were the basis for obtaining the objective function. The impact of individual factors on the final output was determined with Analysis of variance (ANOVA). The study supplied the optimal process parameters. Indeed, the vertical step depth with contribution value of 68.5% followed by the tool diameter with 9.7% contribution, and number of sheets with 6.1% contribution were found to be the most influential parameters on the three responses taken together. Consequently, the other two parameters (spindle speed and feed rate) were deemed non-significant with contribution of 2.9% and 1%, respectively. In addition, the graphs and response tables that resulted from ANOVA and Taguchi analysis together form an efficient and effective method of finding optimal levels for each design parameter. With optimized parameters, the ideal value of wall angle and the minimum values of springback and surface roughness are produced. Finally, confirmation testing, using suggested optimal conditions, showed a GRG value with 27.4% improvement. It can thus be concluded that the use of the multi objective optimization of wall angle, surface roughness and springback in the proposed Grey-Taguchi method is suitable for optimizing the ISF process and is additionally effective for use in other metal forming processes. © BEIESP.

Author keywords

Grey-relational | Incremental sheet forming | Metal forming | Multi-objective | Optimization | Taguchi

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