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Prediction and Optimization of Machining Induced Residual Stresses in End Milling of AISI 1045 Steel

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Abstract : Extensive experimentation and numerical investigation are performed to predict the machining-induced residual stresses in the end milling of AISI 1045 steel, and an optimization code has been developed using the particle swarm optimization technique. Experiments were conducted using a single factor at a time and design of experiments approach. Regression analysis was done, and a mathematical model of the cutting process was developed, thus predicting the machining-induced residual stress with reasonable accuracy. The mathematical model served as the objective function to be optimized using particle swarm optimization. The relationship between the different cutting parameters and the output variables, force, and residual stresses has been studied. The combined effect of the process parameters, speed, feed, and depth of cut was examined, and it is understood that 85% of the variation of these variables can be attributed to these machining parameters under research. A 3D finite element model is developed to predict the cutting forces and the machining-induced residual stresses in end milling operation. The results were validated experimentally and against the Johnson-cook model available in the literature.

Keywords : residual stresses, end milling, 1045 steel, optimization
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