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Review of Machining on Composite and Connected Optimisation Techniques

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Abstract*:* This paper provides an associate comprehensive review of the literature, principally from the past decade, on optimization techniques of composite materials machining, each conventional and non-conventional process. Composite materials are regularly replacement conventional materials because of their wonderful corrosion resistance, higher strength to weight quantitative relation, however, the machining of composites may be a challenging method. Experimental trials all the same, researchers have also used numerous optimization techniques like Taguchi technique, Grey relation analysis, Response Surface technique, and fuzzy logic with analysis of variance etc., to spot the optimum parameters for the machining processes. Also, predictive modeling techniques like Artificial Neural Networks has also been used as optimization tools for studying the composite machining method. It had been found that Taguchi technique is that the most popular technique within the optimization studies.

Key words: Machining process, Composite, Optimization, Process parameter, Taguchi.

INTRODUCTION

Composite materials are created from two or more distinct constituents separated by a boundary referred to as interface and are usually classified as PMC, CMC, and MMC. Composites are wide used in engineering application like automotive, Aircraft and manufacture of spaceships and ocean vehicles' industries because high strength to weight ratio and high stiffness to weight ratio. As a consequence of the widening vary of applications of Composite; the machining of these materials has become a very important subject for analysis. [Pithili et.al, (2002),]. Machining composite materials could also be a rather advanced task because of their non-uniformity, anisotropy, and high abrasiveness of fibers, and it exhibits considerable problems in drilling technique like de-lamination, fibers pull-out, hole shrinkage and thermal degradation [Faraz A et al. (2009)]. The machinability of composites could be a drawback for the manufacturing industries due to the higher cost of producing as compared to that of metals, particularly high-performing fibers and a lack of high productivity producing methods. many optimization techniques that range from the normal design of experiments approach until the latest techniques such as Genetic algorithm, Artificial Neural Network, fuzzy logic etc., are used to optimize the machining parameters. And the techniques chosen were based on two factors i.e. the machining process and the nature of the optimization technique. during this paper, a review of the various composite machining processes and the optimization techniques over the past decade has been carried out to focus on the methods used based on the above-mentioned factors. The target of the paper is to throw light on the tools, techniques, processes and serve as a ready reference for researchers on the subject.

REVIEW BASED ON COMPOSITE MACHINING PROCESSES

Laser Machining

Ghosal, et.al. (2013) Investigated results on machining of Al/Al2O3-MMC by ytterbium fiber laser. The effects of the different parameters on the response characteristics are explained. Mathematical models for correlating the interactive and higher-order influences of various machining parameters such as laser power, modulation frequency, gas pressure, wait time, pulse width on the machining performance criteria e.g., metal removal rate and tapering phenomena have been developed for achieving controlled over fiber laser machining process.

ELECTRIC DISCHARGE MACHINING

Puhan, et.al. (2013) on Investigation on machinability characteristic of aluminum-silicon carbide composite on electrical discharge machine is carried out. The composites are prepared through powder metallurgy route. The influence of four machining parameters (discharge current, pulse duration, duty cycle, and flushing pressure) and two material parameters (weight fraction of silicon carbide in the composite and mesh size) on selected responses are studied. The responses considered, in this work, are material removal rate, tool wear rate, surface roughness and circularity. Gopalakannan, et.al. (2014) Carried out optimization of EDM process on MMC(material matrix composites) and performed an ANOVA and RSM(response surface methodology) model concluding that the pulse current was the most important factor affecting the MRR(material removal rate).

DRILLING

Latha, et al. (2011) allotted drilling tests on CNC drilling machine .The parameters thought-about for the drilling are spindle speed, feed rate and diameter of the drill bits. Multiple correlation analysis was used for the modeling of process parameters in drilling of GFRP composites. Taguchi's S/N magnitude relation analysis and desirability based approach were used for the optimization of method parameters for reducing the delamination in drilling of composites. The

results discovered that the issue feed rate and drill diameter were the foremost influential parameters that affected the delamination in drilling of composites. The interaction between the parameters additionally affected the delamination in drilling of composites. TV Rajamuruganet et al. (2013) established a relationship between the thrust force and drilling parameters (tool movement speed, tool feed rate, drill diameter and fiber orientation angle) in the drilling of GFRP Composites. Applied mathematics tools such as design of experiments (DOE), analysis of variance (ANOVA), and multivariate analysis were explored to develop the relationships.an ANOVA and RSM(response surface methodology) model concluding that the pulse current was the most important factor affecting the MRR(material removal rate).

TURNING

Ahmet Yardimeden (2014) suggested to Influence of cutting parameters and insert radius on the cutting force and surface roughness of GFRP material during machining was investigated. For measuring main cutting force, a three component piezoelectric crystal type of dynamometer was used. Cutting force and surface roughness were experimentally measured through longitudinal axes of the GFRP material. Through this study, it was observed that high cutting speeds and low feed rates provide the best surface quality in the turning process of GFRP composite materials. M. Nataraj, et al. (2016) study to evaluate the machining characteristics of hybrid metal matrix composite, and a mathematical model was developed to predict the responses, namely, surface finish, the intensity of vibration and work-tool interface temperature for known cutting condition while turning was performed in computer numerical control lathe. The design of experiments approach was used to conduct the trials; response surface methodology was employed to formulate a mathematical model.

MILLING

Chenwei Shan, et al. (2013) Suggested that milling force prediction model for milling of the composite using the carbide ball end tools is built by orthogonal experiment. The experiment results show that: the reliability of this prediction model is quite high, and the effect of milling speed on milling force is not very obvious, but the milling force increases with the increment of feed per tooth, milling depth and milling width.

RESPONSE SURFACE METHODOLOGY

The objective is to optimize a response which is influenced by several independent variables with the help of various statistical and mathematical techniques. Erol Kilickap (2010) find out the mathematical model for correlating the interactive and higher order influences of drilling parameters on the delamination factor in drilling composites using response surface methodology. The purpose of this article is to investigate the influence of drilling parameters, such as cutting speed, feed, and point angle on delamination produced when drilling composite. Venkatesan, et.al. (2014) suggested that optimum cutting force and surface roughness in machining of Al Alloy Hybrid Composite find out by using RSM.

ARTIFICIAL NEURAL NETWORK

ANN is a computational tool, based on the properties of biological neural systems that can compute values from inputs and are capable of machine learning as well as pattern recognition. Neuro-Fuzzy is a combination of Artificial Neural Networks and Fuzzy Logic. Krishnamoorthy, et al. (2011) study with respect to spindle speed in rpm, drill size in mm and feed in mm/min. Delamination is one of the major defects to be dealt with. Experiments are carried out using computer numerical control machine and the results are applied to an artificial neural network (ANN) for the prediction of delamination factor at the exit plane of the CFRP material. It is found that ANN model predicts the delamination for any given set of machining parameters with a maximum error of 0.81% and minimum error of 0.03%.K. Palanikumar, et al. (2013) suggested that use of the artificial neural network (ANN) for the prediction of surface roughness in drilling glass fiber reinforced plastic (GFRP) composites. The experiments are carried out on computer numeric control machining center. The results indicated that the well-trained ANN model could able to predict the surface roughness in the drilling of GFRP composites.

TAGUCHI METHODOLOGY

Taguchi's Orthogonal Array methodology gives a much-condensed variance for the experiment with

Optimum settings of control parameters. Vinod, et al. (2014) carried out as per the Taguchi experimental design and an L9 orthogonal array was used to study the influence of various combinations of process parameters on hole quality. Analysis of variance (ANOVA) test was conducted to determine the significance of each process parameter on drilling. Parida (2015) examined the surface roughness of carbon fiber reinforced plastic composite on the basis of cutting parameters like depth of cut, speed, and feed rate. The surface quality was found to relate closely to the cutting speed, feed rate, and depth of cut. The Taguchi method was adopted during this study to analyze the influence of surface roughness by cutting parameters. Further, analysis of variance was accustomed analyze the influence of method parameters and their interaction effects throughout machining.

GREY RELATIONAL ANALYSIS

Grey Relational Analysis uses a specific concept of information and based on the calculated grey relational coefficients it provides solution to system in which the information is either incomplete. The model is unsure. Shunmugesh K, et al. (2014) used gray relative Analysis (GRA) approach for study and optimization of the machining parameters Tool condition, a variety of flutes, cutting speed and feed rate on milling of GFRP so as to reduce surface de-lamination, machining forces, cutting force and surface roughness. For this study; GFRP was invented by hand lay-up with thirty-third fiber and sixty-six general purpose resin. Experiments were designed and allotted as per orthogonal array and parameters were optimized using Grey Relational Grade (GRG). Gopalakannan, et.al (2013) used Taguchi based Grey analysis to optimize EDM parameters on machining of aluminum Hybrid Metal Matrix composite. The Pulse current, Voltage, and Pulse on time are primary factors

that affect the quality of Aluminium hybrid metal matrix composite, while Pulse off time is considered as a secondary factor.

CONCLUSION

In this paper, the recent trends of varied optimization techniques and machining processes with composite materials are reviewed to provide a summary of the ongoing analysis work and facilitate additional analysis within the area. A review of the papers over the last decade shows that each conventional and un-conventional machining method were used for machining composites and also found that Taguchi methodology was principally preferred followed by fuzzy logic and Artificial Neural Networks.

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