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Drilling parameter analysis of hybrid composites (Al/B4C/graphite) using grey relational and Taguchi techniques

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Abstract

Application of composite materials has been increasing worldwide especially in production industries. In drilling operation, standard of hole is the basic demand in numerous applications. The choice of optimized drilling parameters is extremely vital for good hole quality. Our objective is to optimize the parameters involved in drilling of aluminium /boron carbide/ graphite hybrid composite materials to get good quality holes. A series of drilling experiments are conducted in CNC machining centre on the hybrid composite specimen slabs of size 100mm×100mm×10mm, made-up by stir casting technique. Our work is to analyse the consequences of drilling parameters like spindle speed, feed and drill tool diameter on thrust force, torque, surface roughness and roundness error. The experimental results are collected individually on L27 orthogonal array and analysed by Signal – Noise (S/N) quantitative relation and grey rational analysis with an objective to optimize the drilling parameters to reveal the dominant factors that have an effect on the responses mentioned.

Introduction

Aluminum Hybrid Composites (AHCs) see a category of light mass with high-performance aluminium reinforced material systems. Good strength like tenuity, high strength with low weight quantitative relation, smart resistance to corrosion and better properties at high temperature are the most important benefits of aluminium composites over metallic element and non – metallic elemental materials [1].

The reinforcement in Aluminium Hybrid Composites might be a type of continuous or broken fibres or particulates. Properties of Aluminium Hybrid Composites will be custom-made to the necessity of various modern utilizations by making acceptable blending of matrix material and reinforcements and also by using different processing techniques. [2].

Generally, for the metal matrix composites to be hybrid, there should be more than one reinforcement material in the metal matrix [3]. Al/SiC/Gr is one such hybrid composites, in which, the silicon carbide and graphite are used to strengthen the base metal. Graphite particles also increase the wear resistance of the material, which make it useful for applications in automotive sectors.

On the other hand, these materials are having a drawback of poor machinability and so machining / drilling of these materials become a challenging task for the field operators [4]. On account of the application of hybrid composites, the parameters for machining or drilling must be optimized to improve the quality of production [5].

The base metal picked for the study is Al 6061, various ingredients of Al6061 is given in Table 1. The strengthening materials used for reinforcement in this specimen is 5% of boron carbide powders and 5% of graphite powder which was made by stir casting methodology since stir casting is the most effortless and least expensive methodology for producing the metal matrix hybrid composites [6].

Drilling operation is one of the standard manufacturing processes primarily followed for making variety of products using hybrid aluminium composites. Fulfilment of these products for their corresponding applications are based on the standard of the drilled hole surface and its precision. Geometry of the twist drill and the drilling factors like drill feed and the spindle speed, governing the quality of the drilled surface [7]. Wrong choice of twist drill and the factors of drilling lead to overheat of the tool, increasing wear rate of the tool and excessive drilling force, that cause poor standard of the drilled holes and damage the inner surface of the drilled holes [8].

Generally, multi objective functions, including all the factors, can be analysed successfully using GRA technique [9] by converting multi attributes of the drilling into

a single value known as grey relational grade. On the basis of this grade, the ideal parameters can be achieved. In Taguchi analysis, S/N ratios are used to determine the influence of various factors affecting the responses.

Our objective in this experimental study is to determine the impact of drilling factors affecting the standard and precision of the drilled hole while drilling Al/B4C/Gr hybrid composites and also to find the ideal parameters of drilling using GRA and Taguchi techniques.

Section snippets

Specimen preparation

Various ingredients of the base metal Al6061 is given in Table 1. Al6061 homogeneously mixed with 5% weight proportion of boron carbide and 5% of graphite powders with the help of stir casting process is the hybrid material chosen for our investigation. The sample of the material is cast into square blocks of size 10cm×10cm×1cm. %.

Drilling experiments

For our experimental investigations, to determine the extent of the impact of drilling variables, we have chosen three different parameters of drilling, viz

Results and discussion

The experimental results and normalised values of all the responses are given in Table 3. The experimental results for the thrust force, drilling torque, surface roughness and roundness error are listed in Table 3. Basically, thrust force, drilling torque, surface roughness and roundness error belong to the “smaller-the-better” methodology and the equation (2) is utilized for data pre-processing. Once normalizing the experimental values, the grey relational coefficients are calculated with the

Conclusion

To drill holes effectively in Al/B4C/Graphite composite materials, the analysis to determine the ideal drilling variables is carried out and the conclusions at the end of our investigations are listed here.

The required 5% B4C and 5% Graphite reinforced Al6061 hybrid MMC specimens were prepared with the help of mechanical stirring type casting technique.

Drilling trials were organized as per Taguchi's L27 array in the VMC by changing the drilling variables like tool diameter, drilling speed and

CRediT authorship contribution statement

S. Senthil babu: Conceptualization, Methodology, Writing – original draft, Investigation, Validation. **C. Dhanasekaran:** Supervision.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References (11)

A.S. Mali *et al.*

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K. Siva Prasad *et al.*

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Mater. Today:. Proc. (2021)

J.U. Prakash *et al.*
Multi-objective drilling parameter optimization of hybrid metal matrix composites using grey relational analysis
Mater. Today:. Proc. (2021)

A.A. Daniel *et al.*

N.L. Khanh *et al.*
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