**OPTIMIZATION OF MACHINING PARAMETERS IN TERMS OF THRUST FORCE AND CHIP FORMATION OF E-GLASS/EPOXY-CARBON NANOTUBE COMPOSITES**

**Sakine Kıratlı[[1]](#footnote-1)\***

**Engineering Faculty, Mechanical Engineering, Çankırı Karatekin University, Çankırı, Türkiye**

**0000-0001-6292-5605**

**Hüseyin Gökçe**

**Engineering Faculty, Mechanical Engineering, Çankırı Karatekin University, Çankırı, Türkiye**

**0000-0002-2113-1611**

**Mohammed Mudhafar Hussein Hussein**

**Engineering Faculty, Mechanical Engineering, Çankırı Karatekin University, Çankırı, Türkiye**

**0009-0003-5773-9375**

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| **ABSTRACT** Fiber-reinforced polymer composites have become interesting in industrial applications due to their functionality such as light weight, superior mechanical properties and versatile processing techniques [1, 2]. Especially glass fiber reinforced polymer composites have applications in aviation, sports, electronics, transportation and similar fields [3]. In recent years, nano- or micro-sized fillers have been added to matrices in order to improve the existing properties of composites [4]. Carbon nanotubes [5], graphene nanoplates [6], nanofibers [7] and nanoclays [8] are widely used to strengthen the matrix. In this study, the drilling performances of laminated composites containing multi-walled carbon nanotubes at different weight ratios were optimized with the Taguchi method in terms of thrust forces, which is a quality characteristic. Analysis of variance (ANOVA) was performed to determine significance levels. Material, drill bit, cutting speed and feed rate for each five levels were selected as control factors and an L25 vertical array experimental design was designed accordingly. A clamping mold was manufactured for the test samples with dimensions of 150 mm × 25 mm, and the samples placed in this clamping mold were connected to the bench table with a force gauge. Chip formation was examined by means of a digital microscope. It was determined that the carbon nanotube ratio was the most effective factor on the thrust forces with 69.03%, and as the carbon nanotube ratio increased, the thrust forces increased. The effectiveness rates were found to be 21.23% in feed rate, 2.17% in drill tip and 2.12% in cutting speed, respectively. It has been observed that chip formation is mostly affected by changes in feed amount and cutting speed. Although discrete chip formation is frequently observed, it has been observed that chips form in powder form, especially at low feed rate and high cutting speeds. Verification experiments were carried out under optimum conditions determined as a result of optimization. The results measured from these experiments were compared with the results calculated by the mathematical model. It was observed that the model could be used safely with a correlation value of 94.55%.**References:** [1] Mirabedini, A., Ang, A., Nikzad, M., Fox, B., Lau, K.T., & Hameed, N. (2020). Evolving strategies for producing multiscale graphene‐enhanced fiber‐reinforced polymer composites for smart structural applications. *Advanced Science*, 7(11), 1903501.[2] Zhao, F., Guo, W., Li, W., Mao, H., Yan, H., & Deng, J. (2022). A study on hot stamping formability of continuous glass fiber reinforced thermoplastic composites. *Polymers*, 14(22), 4935.[3] Dahiya, A.K., Bhuyan, B.K., & Kumar, S. (2023). Influence of process parameters on delamination of GFRP with abrasive water jet machining. *Materials Today: Proceedings*.[4] Rao, Y.S., Mohan, N.S., Shetty, N., & Shivamurthy, B. (2019). Drilling and structural property study of multi-layered fiber and fabric reinforced polymer composite-a review. *Materials and Manufacturing Processes*, 34(14), 1549-1579.[5] Jain, V., Jaiswal, S., Dasgupta, K., & Lahiri, D. (2022). Influence of carbon nanotube on interfacial and mechanical behavior of carbon fiber reinforced epoxy laminated composites. *Polymer Composites*, 43(9), 6344-6354.[6] Huang, K., Guo, H., Qin, Z., Cao, S., & Chen, Y. (2020). Flutter analysis of laminated composite quadrilateral plates reinforced with graphene nanoplatelets using the element-free IMLS-Ritz method. *Aerospace Science and Technology*, 103, 105915.[7] Ramezani, H., Kazemirad, S., Shokrieh, M.M., & Mardanshahi, A. (2021). Effects of adding carbon nanofibers on the reduction of matrix cracking in laminated composites: Experimental and analytical approaches. *Polymer Testing*, 94, 106988.[8] Ebrahimnezhad-Khaljiri, H., Eslami-Farsani, R., & Talebi, S. (2020). Investigating the high velocity impact behavior of the laminated composites of aluminum/jute fibers-epoxy containing nanoclay particles. *Fibers and Polymers*, 21, 2607-2613. |

# Keywords: Laminated composite, Taguchi method, drilling, thrust force, chip formation.

1. \* Corresponding author. *e-mail address:* *skiratli@karatekin.edu.tr* [↑](#footnote-ref-1)