Improving damping characteristics of epoxy by adding copper alloy wastes

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Abstract

Purpose – The purpose of this study is to get benefits from manufacturing harmful wastes is by using them as a reinforcement with epoxy matrix composite materials to improve the damping characteristics in applications such as machine bases, rockets, satellites, missiles, navigation equipment and aircraft as large structures, and electronics as such small structures. Vibration causes damaging strains in these components.

Design/methodology/approach – By adding machining chips with weight percentages of 5, 10, 15 and 20 Wt.%, with three different chip lengths added for each percentage (0.6, 0.8 and 1.18 mm), the three-point bending and damping characteristics tests are utilized to examine how manufacturing waste impacts the mechanical properties. Following that, the optimal lengths and the chip-to-epoxy ratio are determined. The chip dispersion and homogeneity are assessed using a field emission scanning electron microscope.

Findings – Waste copper alloys can be used to enhance the vibration-dampening properties of epoxy resin. The interface and bonding between the resin and the chip are crucial for enhancing the damping capabilities of epoxy. Controlling the flexural modulus by altering the chip size and quantity can change the damping characteristics because the two variables are inversely related. The critical chip size is 0.8 mm, below which smaller chips cannot evenly transfer, and disperse the vibration force to the epoxy matrix and larger chips may shatter and fracture.

Originality/value – The main source of problems in machine tools, aircraft and vehicle manufacturing is vibrations generated in the structures. These components suffer harmful strains due to vibration. Damping can be added to these structures to get over these problems. The distribution of energy stored as a result of oscillatory mobility is known as damping. To optimize the serving lifetime of a dynamic suit, this is one of the most important design elements. The use of composites in construction is a modern method of improving a structure's damping capacity. Additionally, it has been demonstrated that composites offer better stiffness, strength, fatigue resistance and corrosion resistance. This research aims to reduce the vibration effect by using copper alloy wastes as dampers.

Keywords Copper alloy wastes, Vibration damping, Epoxy resin, Chip

Paper type Research paper

1. Introduction

A manufacturing process that incorporates machining operations is required when producing mechanical parts. These are conventional machining techniques, which entail the application of a cutting tool. There will be a separation of material lost as chips or manufacturing waste as a result (Perez-Range *et al.*, 2020). As a result of this industrial waste, heavy metals like iron (Fe), copper (Cu) and zinc (Zn) accumulate in the soil (Ghori *et al.*, 2019). Due to their inability to degrade and their tendency to accumulate in nature, heavy metals have become a significant threat to the environment (Aslan *et al.*, 2019).

Recycling these metals' waste can increase economic worth while minimizing negative environmental effects (Zhai and Yuan, 2012). Numerous studies thus have investigated the reuse of metal chips in a variety of applications, including the use of steel scraps as reinforcement in metal matrix structures (Yao *et al.*, 2016) and the use of metal waste to sinter powder combinations to produce porous materials rather than using sand in the manufacturing of concrete (Alwaeli and Nadziakiewicz, 2012; Gecu and Karaaslan, 2020; Alaneme and Odoni, 2016; Abdulkader *et al.*, 2024).

One of the ways to get benefits from these harmful wastes is by using them as a reinforcement with epoxy matrix composite materials to improve the damping characteristics in applications such as machine bases (Piratelli-Filho and Levy-Neto, 2010), rockets, satellites, missiles, navigation equipment (Liang *et al.*, 2013) and aircraft as large structures and electronics as such a small structure (Kulkarni *et al.*, 2017).

The vibrations created in the structures are the principal cause of issues in machine tools, aviation and vehicle construction.

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