

Effect of Micronised Pumice Powder Addition on Shore-D Hardness Values of Medium Density Fiber Epoxy Composite

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Abstract—The present study explores the effect of MDF powder-reinforced filled pumice powder epoxy composites on their Shore - D properties, produced by using different weight percentage. The composites samples containing 10, 20, 30, 40, and 50wt% of pumice powder were fabricated by using hand lay-up technique. The specimens prepared were tested for hardness as per the ASTM D2240 standards. The outcomes of the study revealed that pumice powder amount in the composite increasing with an increased in Shore-D hardness values. It is noted that the weight percentage of 50% of pumice powder and 50% of MDF powder composite was produce the maximum hardness values.

Index Terms—Composites, Hardness, Shore-D, Pumice powder

I. INTRODUCTION

During recent years, interest in using eco-friendly materials in engineering has increased due to a growing environmental awareness. Based on this, many researcher are making studies for renewable, recyclable, sustainable, green, decomposable, or biodegradable materials to replace some of the traditional and synthetic engineering materials that are not environmentally friendly [1].

Natural fibers have several advantages over synthetic fibers such as glass and carbon fibers. The environment-related advantages include recyclability, renewability, biodegradability, CO² sequestration, and in terms of human health such as reduced dermal and respiratory irritation. In addition, the advantages associated with their usage in polymer composites include ease in processing, non-abrasion, low energy consumption, low density, and low costs [2,3]. Because of these reasons, natural fibers can be a potential substitute for the traditional man-made fibers.

However, these combinations of both natural and synthetic fibres within the same matrix could balance the benefits and limitations associated with each reinforcement material. Consequently, a balance between performance and cost could be achieved through proper material design [6]. Because of this reason, The incorporation of two or more types of fibre or filler into a single matrix has led to the development of hybrid composites. Previous studies have showed the loading filler and adding different amounts had a positive effect on the mechanical properties of natural fiber reinforced

composites [2-5]. These include pumice powder/pps composites, pumice particles/poly composite, pumice mineral/biocomposites, pumice powder/polypropylene pumice-reinforced/epoxy composites [7]. Koyuncu ve Ulay (2023), investigated the thermal and flammability behavior of walnut shell reinforced epoxy composites which the 50% pumice powder filler loading walnut shell particles the reinforced epoxy composites showed considerably higher and better thermal stability [8]. Koyuncu and Erkek (2022) reported that effects of particle size, pumice powder filling on the water absorption behavior, and elongation at break properties of walnut husk particles reinforced epoxy composite that results and findings of this study proved that can be successfully used to promote better interfacial adhesion between epoxy matrix and walnut husk particles, and pumice powder thus producing composites [9]. Koyuncu et al. (2023) analyzed the effect of pumice powder on mechanical, thermal, and water absorption properties of fiberboard composite. It was concluded that the pumice particles can be employed as an effective filler material to increase thermal stability, decrease water absorption, and improve mechanical proper [10].

Pumice, which mainly consists of silicon dioxide (SiO₂), is known as natural volcanic glassy rock. Pumice powder is cheaper than most of traditional particle fillers. Because of this reason, in this study, pumice was used pumice powder as a filler. In this study, the effect of pumice powder on Shore-D properties of composites was investigated.

II. METHOD

A. Materials

Medium-density fiberboard (MDF) was supplied by Van vocational school department of woodworking workshop. It is average particle size of 250 nm and average water content of 3.12%. Purpox® epoxy resin EFLR-0190 provided by Polikor Inc. (Turkey) was used as matrix material, a solvent-free resin with a transparent coating. The density of this resin was 1.00 to 1.10 g/cm³, the while the viscosity was 300-500 mPa.s. The epoxy resin and hardener were mixed at a weight ratio of 100:50 to produce the composite materials.

B. Fabrication of composite

MDF Powder, Epoxy / hardener and additives were pre-mixed in a horizontal mixer. The mixture slurry was poured into a metal mold, as per ASTM standard D3039 (2017) and ASTM standard D (790). The curing of the whole mixture in the chamber is done for 24-48 hours at room temperature. See Fig. 1.

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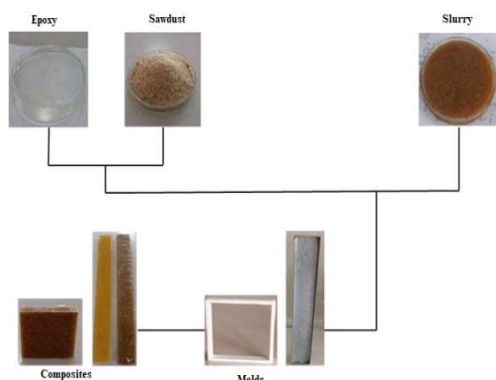


Fig. 1. Epoxy resin & MDF sawdust experimental and molding process.

C. Shore-D Tests

Shore D hardness values ASTM D 2240 (2010) on the shore D meter device (Stand: model Ld-J Loyka, China and Durometer LX-D model 0-100, China) with 5 kg load applied (Fig. 2). It was determined by taking 10 measurement. Technical specifications of the Shore- D device, Indentation geometry-material, with spherical cap, truncated cone, $R_0 = 1.25\text{mm}$, and $R = 0.1\text{m}$, Test Force: $N \leq F \leq 44.5\text{ N}$, Indentation Depth: $0\text{ mm} \leq h \leq 2.5\text{ mm}$.



Fig. 2. Shore-D test device.

III. RESULT AND DISCUSSION

As a result, it is critical to understand the properties of industrial pumice powder and characterize its uses in various industrial applications. This study looked into the effect of pumice powder reinforcement in composites and other industrial applications.

The results of the Shore - D hardness test are given in Table 1. Shore - D hardness value 67.4 and it is seen that it varies between 51.0 - 79.0.

TABLE I
THE RESULTS OF THE SHORE - D HARDNESS

Number of Measurements	Mean	Standard Deviation	Min.	Max.
10	67.4	1.01	55	79

Results composites of the determined shore-D hardness values of the is shown in Fig. 3. It is clear that the

composite as the percentage of pumice powder increased, the stiffness (shore- D) also increased, in the the case of unfilled composite. Increasing the amount of pumice had a positive influence, both on the stiffness value of composites Pumice powder treatment improved the dispersion of MDF flour in matrix. This result clearly shows the smallest area size and strong interface. The 50% weight filled pumice dust composite had better stiffness, compared to unfilled. This could be attributed, to both better dispersion of the MDF powder into the matrix with minimization of voids and stronger interfacial adhesion between matrix and MDF powder. Similar results have also been reported for Pumice effect onto polypropylene [11, 13, 14], and lightweight [13], concretes [12], and Fiberboard [10].

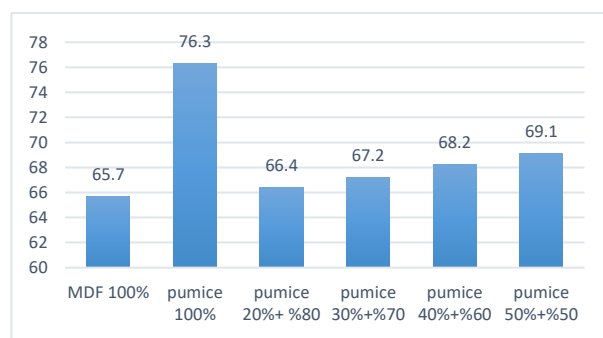


Fig. 3. Shore-D test curve of pure MDF and pumice powder, and MDF powder/Epoxy composites with different wt. % pumice powder.

V. CONCLUSION

In the study, it is understood that the addition of micronized pumice powder with an additive ratio of 10-50% has an effect on the hardness values of the new composite material consisting of MDF powder and epoxy resin. In order to improve this material by using alternative ratios in its components, mechanical and weathering tests under different ambient conditions can be recommended.

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