NEW TYPE OF WOOD-POLYMER COMPOSITES

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Household waste is generated in residential areas, including workplaces. The accumulated solid household waste is transported to specially designated locations using specialized vehicles. When solid household waste remains stationary for an extended period at permanent storage sites, biological changes occur under external influences, leading to the decomposition of the organic components of the waste. During the chemical and biochemical transformation process of decomposition reactions, various by-products are released, which disperse into the air through the wind and spread across residential areas. At the same time, soil, water, and the atmosphere become contaminated.

It is well known that the disposal of solid household waste is a major global issue, and different approaches are taken to solve it in various regions. In Japan, after waste is collected at designated locations and placed in waste containers, it is sent to waste incineration plants. The energy generated from incineration is used to heat water until it turns into steam. The steam's energy is then directed to special units, where its mechanical energy is converted into electrical energy. This entire process takes place without causing any negative impact on the environment. Additionally, in developing industrial countries, research is being conducted on efficiently utilizing such waste to produce composite materials. As a continuation of these studies, we have also conducted research on obtaining wood-polymer composites using local wood species.

The use of plastic and wood waste for composite production is a promising solution to reducing the amount of waste in landfills. It is worth noting that landfills contain various types of wood waste, such as branches, leaves, and twigs, which, due to their chemical composition and surface morphology, significantly affect the properties of wood-polymer composites (WPCs). Thus, this study examines the impact of different types and compositions of wood waste on the mechanical and physical properties of WPCs processed under natural weathering conditions. The ultimate goal of this study was to explore the effects of wood waste types and compositions under natural weather conditions to develop environmentally friendly WPCs from plastic and wood waste accumulated in landfills. The new findings are beneficial for the construction and infrastructure sectors, particularly for exterior applications such as decking, fencing, cladding, roofing, walls, and paneling, which require resistance to natural weathering. Moreover, the research results are expected to increase interest in utilizing waste materials to develop WPC products, thereby helping to reduce landfill waste.

For the study, waste materials were selected from a landfill located in the Tashkent region, including plastic bags, wooden branches, twigs, and leaves. Before processing, the plastic bags were washed with a liquid detergent solution and rinsed three times with water. Then, they were shredded into 0.5–1.5 cm pieces using a cutting mill and converted into granules using an extruder at temperatures ranging from 200 to 225°C. The material was then processed using a hot press.

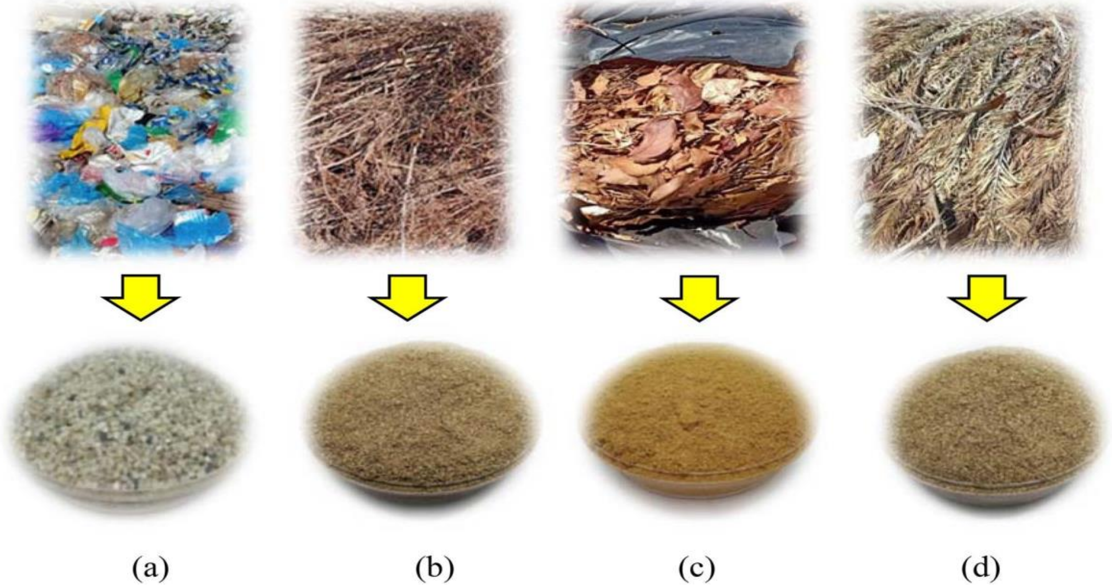

Figure 1. a) Plastic waste, b) Wooden twigs, c) Leaves, and d) Other tree leaf waste.

Processes for Obtaining Wood-Polymer Composites. The raw materials prepared for the experiment were mixed together in a co-rotating twin-screw extruder with wood waste flour and pigment. The extrusion temperature was adjusted to 165-185°C, and the screw rotation speed was set at 60 rpm until full mixing was achieved. Then, the extruded mass was prepared for pressing before leaving the extruder. For this, it was preheated in a hydraulic compression machine at a temperature of 300°C-350°C under a pressure of 3.55 MPa for 5-7 minutes, followed by shaping under a pressure of 6.90 MPa for 15 minutes. The WPC samples were then cooled under a pressure of 6.90 MPa for 15 minutes. Finally, WPC panels were prepared as samples for testing mechanical and physical properties.

Natural Weathering Test. The natural weathering tests were conducted in the Gazalkent district, near the Chirchiq River, at a field house where the samples were placed around a pond. The WPC samples were exposed directly to natural weathering conditions in the climate of the river vicinity. The samples were tested for six months during the rainy season, from July 2024 to December 2024. During the experiment, the average relative humidity was 82.03% RH, the total precipitation over 117 days amounted to 2366.8 mm, and the temperature ranged from 22.8°C to 34.8°C. The samples were evaluated after 2, 4, and 6 months of exposure.

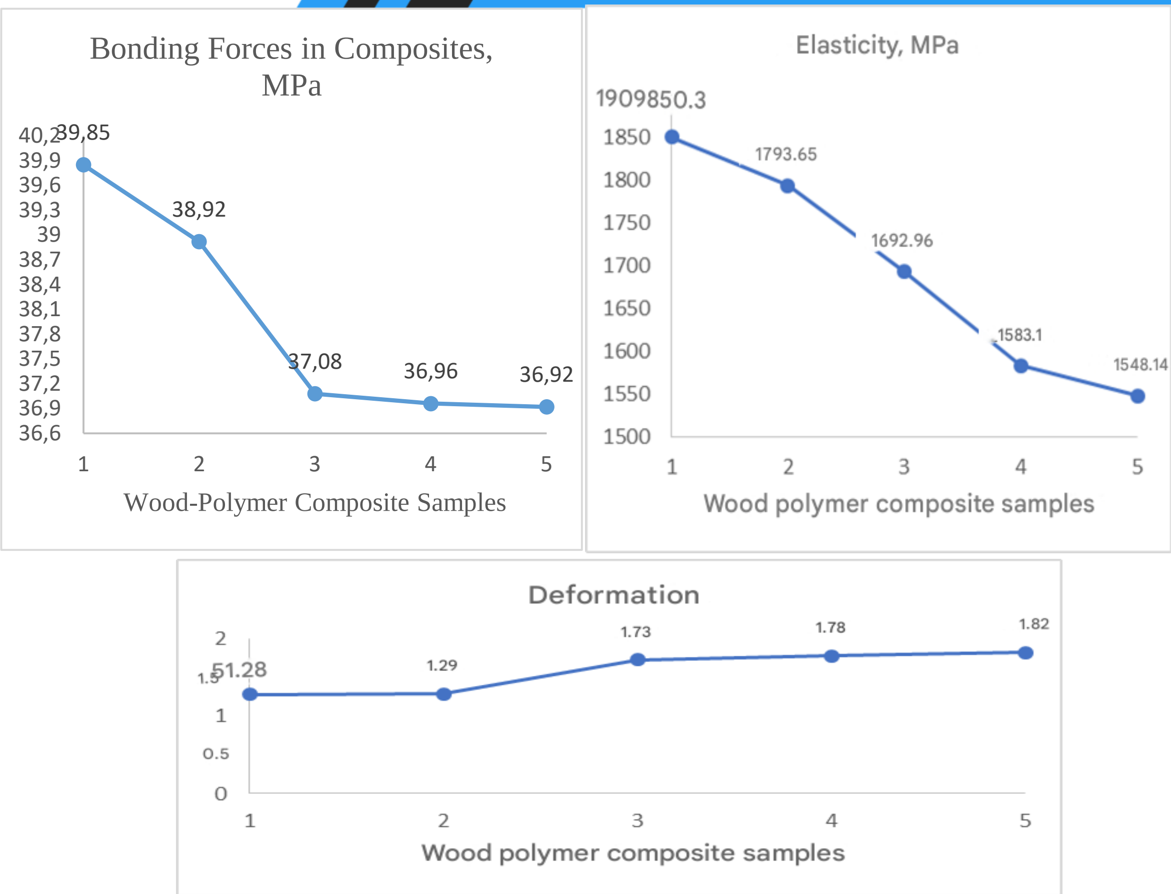

Figure 1. Physical and Mechanical Properties of Wood-Polymer Composites

The results of the tests on valence forces, elasticity modulus, and deformation properties of all composites can be seen in Figure 1. The results indicate that the physical and mechanical properties mentioned above are higher in samples with a greater amount of walnut wood waste flour. The maximum tensile strength was observed in sample-1. The addition of 6% MAPPS improved interfacial adhesion. Moreover, as the MAPPS content increased, the material's hardness also increased. Consequently, due to the weak boundary between the matrix and additives, the deformation values decreased. Taking the above into account, it can be seen from the table that in samples with lower MAPPS content, the valence forces increased, whereas the elasticity modulus decreased. On the other hand, as the amount of walnut wood waste flour increased, the elastic modulus also increased. As a result, when the MAPPS content was increased from 2% to 6%, the elasticity modulus and valence forces of all four types of wood composites also increased. MAPPS ensured a stronger boundary between the polymer matrix and the additives.

Conclusion: This study demonstrated that exposure time, as well as different types and compositions of wood waste, significantly affected the physical and mechanical properties of WPC materials. Although all properties of WPCs deteriorated with increased exposure to natural weather conditions, the hardness of WPCs increased as the amount of wood waste in all wood types increased. Raising the wood waste content in wood-polymer composites from 30% to 60% increased the percentage loss of MOR, MOE, SWS, and hardness properties due to microcracks on the WPC surface. Based on the results of this study, wood-polymer composites based on branches and twigs are recommended for the production of WPC materials for construction and building products. Additionally, it was concluded that solid household waste could be used as a raw material in WPC production. Recycling waste is a promising solution to reducing the accumulation of various types of waste in landfills.

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