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Characterization of Waste Plastic with Wood Particulate Composite

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Abstract: ***Recycled waste plastics and wood sawdust, which are available in abundant amount, can be used for producing a composite, a new material that reduces the waste plastic pollution, production costs and environmental damage. The new composite materials will be used for manufacturing floor tiles that are environmentally friendly, light but still technically qualified, and are expected to replace theceramic tiles that are relatively heavy. The possibilities of using recycled plastic wastes for the manufacturing of wood-plastic composites are examined. The samples were processed from the "light" fraction of construction plastic waste andwooden sawdust powder, and tested for tensile and un-notched impact strength and hardness properties. This paper presents an overview of themechanical properties and durability of recycled mixed plastic waste composites. This paperidentifies the research needs critical in the effective design and utilization of new compositematerials in civil engineering and construction.***
Keywords: Recycled plastic wastes, wood sawdust, wood-plastic composites.

I. INTRODUCTION

Modern life is unthinkable without plastic, but there's a catch. Some of the properties that make it so useful, like its low cost, light weight and durability, also make it hard to dispose of. To make things worse, millions of tonnes of this waste end up in the oceans. Birds, turtles and sea life get tangled in plastic bags and abandoned fishing equipment, or they die from eating plastic debris. Over time, larger pieces of plastic break down into tiny particles called micro plastic, which can form a sort of plastic soup. These particles can soak up chemical additives and endocrine disruptors, and when they are eaten and enter the food chain, they can end up on our plates.It's a large-scale problem, and it needs a global response.

Plastic recycling is an important tool in environ mentally friendly waste management because of the large amount of polymers used in many applications. Many plastic articles, in particular packaging, containers and other items, have a short life leading to waste materials that are slightly degraded and then with properties similar to those of the virgin materials. The melt reprocessing, necessary in the recycling operations of many polymers, can induce thermo mechanical degradation and then worsening of mechanical properties, aesthetic appearances, etc.

Recycled plastic pellets are essentially the middle line between waste plastic and the manufacturing of finished goods. Creating recycled plastic pellets is usually the final step in the recycling process before the material is distributed for the industrial production stage. Recycled plastic pellets are therefore one of the more popular choices for manufacturers.

Once waste plastic has been put through a plastic grinder and broken down, the smaller pieces are melted and compressed into recycled plastic pellets. These final recycled plastic pellets from RVK Enterprise are a high grade of enhanced, recycled material that is ready for remanufacturing.

The utilization of recycled plastic for the manufactureof recycled plastic pellet and wood particulate composites(WRPCs) has been studied by a number of authors [3, 4].Composites containing recycled plastics and wood sawdust particlesoffer interesting combinations of properties [5–7]. This resultis a strong impetus to expand the use of recycled plasticsin the manufacture of WRPCs. The use of recycled plastic andwood sawdust seems inevitable, and the present opportunitiesare promising [9].Comparisons of the stiffness/weight efficienciesrevealed that the stiffness of wood composites equals orexceeds that of most traditional materials of construction,including steel, aluminum, glass-fiber composites, andtalc-filled polyolefin, while retaining a major materialcost advantage [10]. However, a major issue in achievingtrue reinforcement for teak wood-recycled plastic composites is the inherentincompatibility between the hydrophilic fibers andthe hydrophobic polymers, which results in poor adhesionand, therefore, in poor ability to transfer stress from thematrix to the reinforcing fibers [11]. A more promising way to recover the economic value of this mixture could be the manufacturing of plastics lumber combining cellulosic reinforcement by blending techniques without

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separation. Cellulose materials offer several advantages, when combined with plastics, because of their low density, high modulus, and high strength.

In this work, we report the investigation on the effect of combining teak wood sawdust powder and recycled thermoplastic plastic reinforced compositematerials on the mechanical properties of the composites.

II. MATERIALS AND METHODS

A. *Materials*

The matrix material used in the fabrication of composite material was a mixture ofAraldite epoxy resin (LY556) and Hardener (HY951) mixed thoroughly in mass ratio (10:1).Two different fillers, namely recycled plastic pelletsand teak wood powder of averagesizes ranges from 75 - 105 mm were used as particulatereinforcements. The fillers were added in different mass percentages of matrix of epoxy resinto obtain different levels of reinforcement.The wooden Powderwas collected from wood sawdust in the woodshop, the main species of which were hardwoods with an apparent density of 0.2–0.3 g/cm3. Fibers were separated by sifting into different mesh particle sizes. For the fibers were dried in an oven at 150ºC for 2 hrs to ensure that their moisture content was less than 3%.

B. *Processing of fillers*

The fillers were obtained by grinding the respective raw materials to fine powders ofsize ranging in microns using a grinding machine. The grinding process increased surfaceroughness and contact area of the fillers, which favoured mechanical propertieswhere interlocking with thematrix materials.

C. *Mould preparation*

Mould was fabricated with a mallex sheet of 50×50 cm size and rubber block piece was pasted on the dimensions of 300 mm × 300 mm on four sides. The fabrication was carried out through the hand lay-up process technique. Before lay-up process the mould has been applied with a releasing agent to insure that the art will not adhere to the mould .The top and bottom plates are covered with mallex sheet and the fibers, using epoxy resin compressed to avoid the debris from entering into composite parts during curing.

D. *Preparation of Particulate filler composites*

The hardener (HY951) was added into the epoxy resin LY556 in mass ratio (1:10) and stirred well. Dried filler in different mass percentages of resin as required was mixed with the epoxy-hardener mixture. The mixture was stirred thoroughly for 8 - 10 minutes to form a homogenous suspension. Composite material was produced by pouring the resin filler mixture into a mould and curing at room temperature for 24 hours. Details of different combinations of composite materials are presented in Table 1.

To form laminated composites with three layers of lamina of glass fiber woven mats. The entrapped air bubbles (if any) are removed carefully with a sliding roller and the mould was closed for curing at a temperature of 30°C for 24 h at a constant load of 10 kg.

Table 1
Various combination of two different fillers particles reinforced composites.

Samples	Recycled plastic waste particle content in gms	Teak wood powder in gms	Epoxy resin + hardener in gms
I	0	80	220
II	20	60	220
III	40	40	220
IV	60	20	220
V	80	0	220

After curing, the composites are extracted from the mould plate. Fabricated samples are placed in dry place for improving solid gel strength of the samples. Again repeat the same process for all samples preparation of hybrid natural composites.

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E. Mechanical Testing

Tensile strength, tensile modulus was measured using Universal Testing Machine - UTM (Instron 5567). Tensile test specimen were made according to ASTM D 638M. A crosshead speed of 5 mm/min was used. All specimens were conditioned at a room temperature before testing. Hardness test specimen was made according to ASTM D618. Impact testspecimen was made according to ASTM D5628.

F. Results and Discussion

The bonding strength at the fiber matrix interface plays a major role in the mechanical behavior of composite materials. In polymer matrix composites the most important function of the matrix is to distribute the applied stress among the fibers. The applied stress must be transferred across the fiber/matrix interface, transverse, longitudinal, shear strength of a polymer matrix composite depend heavily on the interfacial bond strength. Thus bonding must be maximized if the full strength of reinforcing fiber is to be realized, making accurate characterization of interfacial bonding in composite materials.

G. Effect of wood flour on tensile properties

The effects of the wood flour (WF), 54 wt%, on the tensile properties of the composites are shown in Fig.2. As can be seen, the samples injection-molded from polymer blends (PBs) had higher strength and stiffness compared to the sample produced from the commercial LDPE. The loading of wood flour influenced the properties of the reference sample, both tensile strength (TS) and tensile modulus (TM), positively.

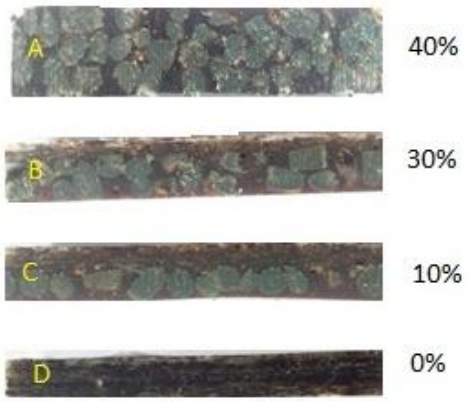

Fig.1 variouscombinations of two different fillers particles reinforced composites.

H. Tensiletest

The mechanical behavior of the composites prepared with the fabricated samples was tested in the Universal Tensile testing machine with testing load range of maximum 5 Ton with gear rotation speed of 1.25,1.5,2.5 mm/min. The experiments were conducted at normal room temperature .The test specimens were cut as per ASTM standards using cutting machining. The tensile strength was determined as per ASTM D 638 with standard gauge length of 50mm, with a cross head seed of 1.25 mm/min.

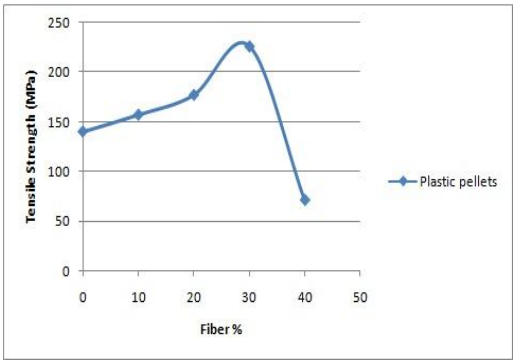

Fig: 2 Variation of tensile strength for different plastic pellets percentage.

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Thus wood sawdust particles increases exposed on the bonding of the recycled plastic pellets surface resulting in better mechanical interlocking and epoxy resin matrix interfacial bond and, resulting in increased mechanical properties. Besides, the increase in tensile strength up to 30% fiber content is due to adequate strength adding of the recycled plasticpellets by the matrix and reasonable amount of plastic pellets to bear applied load. The decrease in strength and modulus at pellets content, of 40% probably resulted from poor bonding strength, also the epoxy resin content is not sufficient to wet all the plastic particle surfaces, leading to poor interfacial adhesion [13].

I. Impact Tests

Impact strength of the composite specimens was carried out in impact testing machine according to ASTM D 256 standard. The specimen size was 65.5*12.7*3 mm.The izod impact test is a standardized high strain rate test which determines the amount of energy absorbed by a material during fracture. This absorbed energy is a measure of a given material's toughness and acts as a tool to study temperature-dependent ductile-brittle transition.

When compared to other different composite, 30% plastic pellets of compositehave high impact strength. The gradually increase in impact strength up to 30% pellets content composite materials and then decrease in 40% pellets composite which shows in fig 3. The decrease in strength and modulus at pellets content, of 40% probably resulted from poor bonding strength of materials.

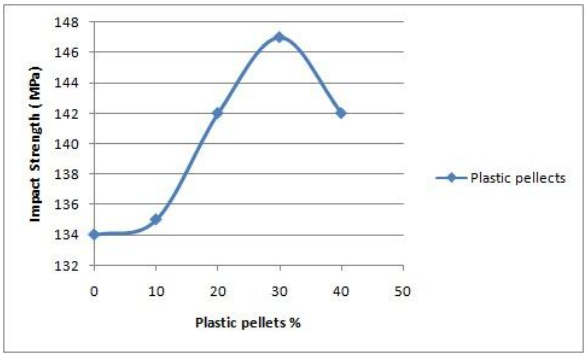

Fig: 3 Variation of impact strength for different plastic pellets percentage.

J. Hardness Test

The hardness is measured from an indentation produced in the composite by applying a constant load on a specific indenter in contact with the surface of the composite for fixed time. This test was carried out in hardness testing machine as per standard ASTM D 2240.

The results of various hardness strength of different percentage of recycled plastic pellets content of composite materials as shown in fig 4. If increasing the plastic pellets in composite which leads to increase in brittle strength from ductile properties.

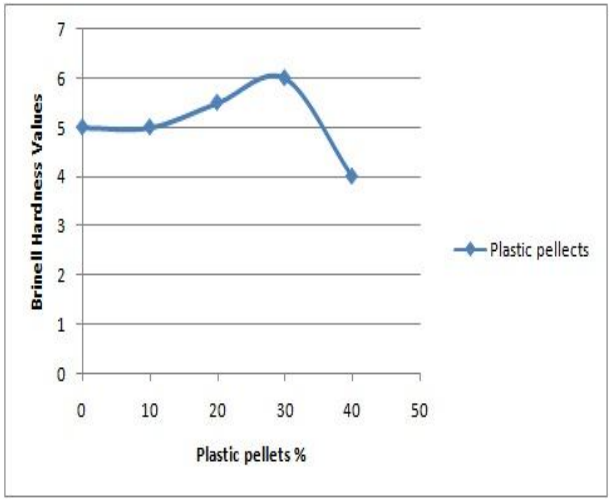

Fig: 4 Variation of hardness strength for different plastic pellets percentage.

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III. CONCLUSION

The mechanical properties of recycled plastic pellets and wood saw dust particulate composite have been investigated in this research. This results obtained reveal that the highest tensile, impact strength and hardness was obtained at 30% of recycled plastic pellets particle content.Besides, the increase in tensile strength up to 30% fiber content is due to adequate adding of the pellets by the matrix materials and reasonable amount of plastic pellets to bear applied load. The decrease in strength and modulus at pellets content, of 40% probably resulted from poor bonding strength, also the epoxy resin content is not sufficient to wet all the plastic particle surfaces, leading to poor interfacial adhesion. It was shown that recycled plastic waste pellets and wood fibers were very effective in the improvement of composite modulus, and the stiffness of the composites from secondary material was significantly higher compared to the reference; the hardness was comparable with the reference.

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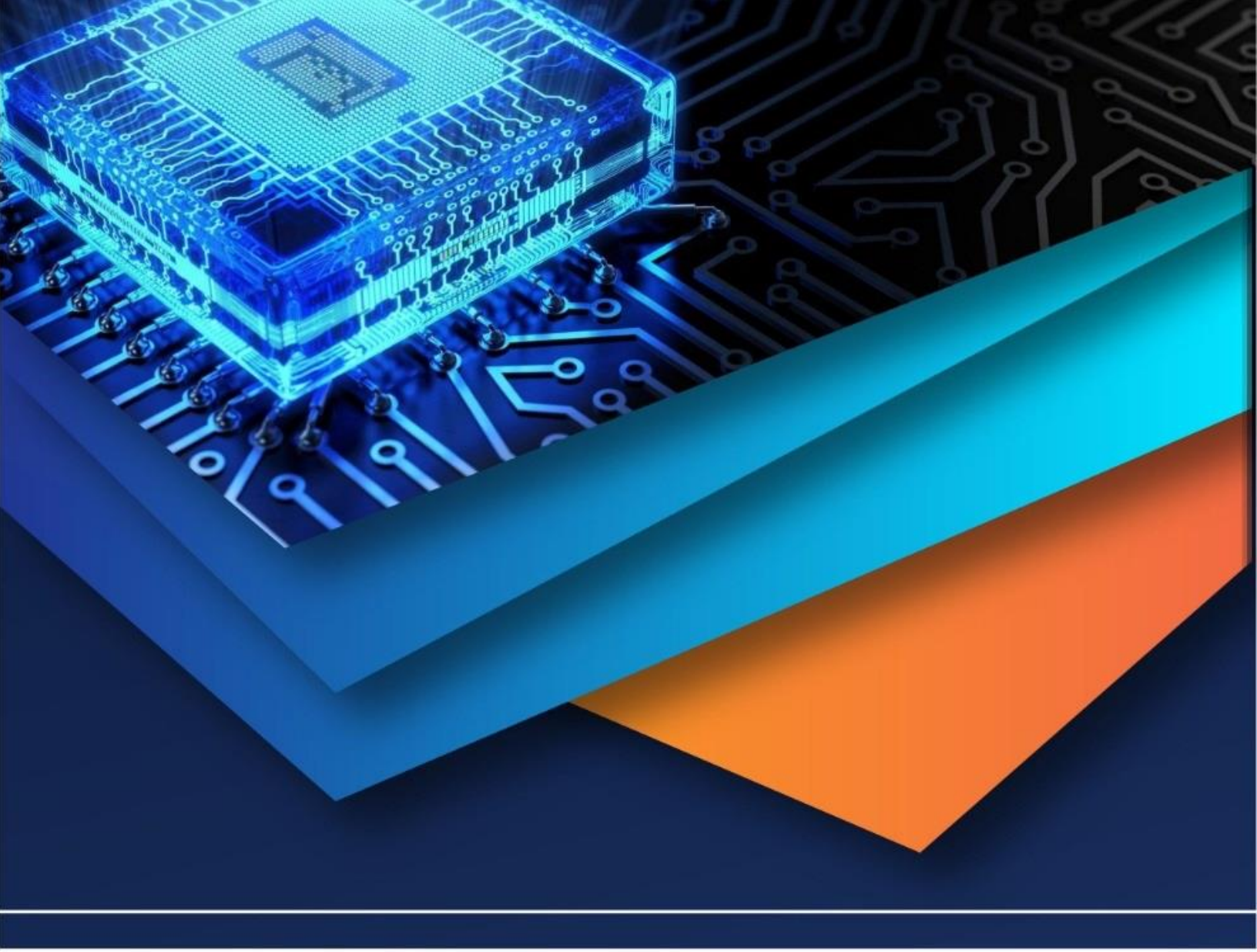

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