REINFORCEMENT OF PLASTER OF PARIS (POP) FOR SUSPENDED CEILINGS APPLICATIONS USING KENAF BAST FIBRE

Abstract

Natural fibers as Green-Engineering materials have been used since the dawn of civilization by mankind for various engineering applications and material reinforcement. It has also been extensively used in packaging, building and construction industries (hard board, partition boards, particle board, pulp and paper, textile and geotextile applications). This research and development paper demonstrated and domesticated the applicability of kenaf blast fiber for Plaster of Paris (Pop) Reinforcement. Plaster of Paris is a brittle material with a low capacity for deformation under mechanical load (as a result of tensile stresses and chemical reactions in the material, which leads to cracking and instability). Kenaf plant as a natural fiber was naturally retted and modified using Control System Tank Retting (CSTR) method and modified with 10% Sodium Lauryl Sulfate (SLS) for 30 minutes. Extracted fibers were chopped and randomly distributed for Plaster of Paris (POP) Reinforcement. The properties of the modified material showed a significant increase in tensile strength and purity. The reinforced material was stable and the field trials of material indicated a good potential reinforcement for Plaster of Paris for suspended ceiling application at reduced cost

Keywords: Composites; kenaf Fibres; Plaster of Paris; Mechanical properties, Patterned Molds:

1. INTRODUCTION

This paper presents a study on utilization of modified kenaf blast fiber for reinforcement of plaster of Paris (POP) suspended Ceilings, Preliminary analysis of the constituent material of the plaster of Paris white cement (the binder) and modified kenaf blast fiber (the reinforcement) were conducted to confirm their mechanical and environmental suitability for suspended ceiling application. The reinforcing material is imbedded in the weaker material which provides the required strength and rigidity to the composite while the binder with mostly inadequate mechanical properties for structural load keeps the orientation of the reinforcement and transfers the external load to the reinforcement as indicated by Satish Pujari. *et. al.* (2014). Due to the light weight, high strength to weight ratio and other advantages, natural fiber based composites

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are becoming important composite materials in building and civil engineering fields, coupled with the global consciousness on health and environment which is compelling us to carry out research in the area of green engineering, commercialization of process and products that are feasible, economical and improve natural ecosystems while protecting human health and environment. We have much greater concern in selecting materials based on attributes like eco-friendliness, sustainability, biodegradability, recyclability, reusability, energy efficiency, renewability rather than depleting etc., which were not factored into making choice of materials earlier. We foresee emerging global demand for green materials as the future raw materials for industrial applications.

Plaster of Paris (POP) is a low mechanical integrity brittle material and under tensile stress and /or mechanical load lead to micro-macro deformation and cracking, which affect the mechanical performance and durability of POP materials. However, deformation and cracking could be minimized by appropriate fibre reinforcement.

2 MATERIALS AND METHOD

2.1 Materials used in this study include:

i. Retted, treated and bleached kenaf filament fibre (sponge-like material)

ii. Plaster of Paris (POP) cement

iii. Patterned Molds

v. Weighing Balance

vi. Water, trowel, Straight Edge and Range

2.2 Experimental procedures

2.2.1 Fiber extraction

Kenaf stems were harvested at FIIRO Experimental garden, followed by extraction and processing using controlled system tank retting (CSTR) method. (Akubueze *et al.*, 2015). This method is feasible in any season; the process allows greater control and produces more uniform quality fibers.

2.2.2 fiber modification

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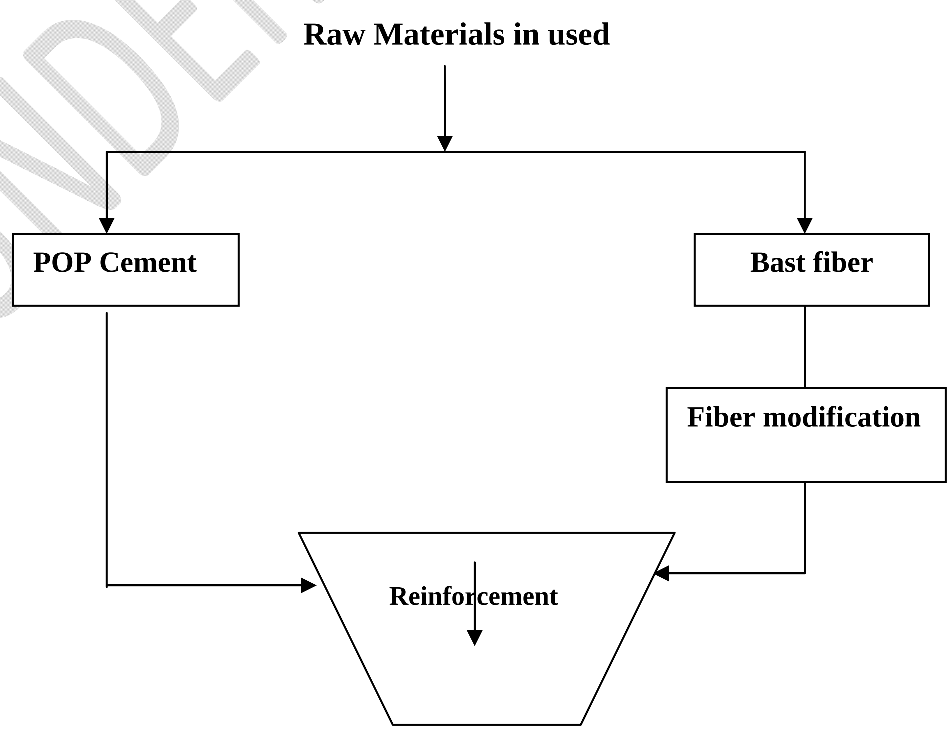
Chemical treatment of kenaf fiber samples was carried out using method of treatment applied by (M. Thiruchitrambalam *et al*., 2009). Kenaf fiber sample were treated with 10% Sodium Lauryl Sulfate (SLS) for 30 minutes and then washed with distilled water and dried.

2.2.3 Bleaching

The fiber bundles obtained were sampled and then bleached with H_2O_2. The fibre- liquor ratio was maintained at 1:50. Then the fiber was bleached with 10% peroxide concentration at 65-80^{0}C for 3hours. Finally, the bleached sample was washed thoroughly with distilled water and air dried.

2.2.4 Specimen preparation/processing

POP cement was mixed for 2-3minutes with a concentration of approximately 2:1 (w/v) to water. Fiber content was also set at 2-5% weight of the matrix and laid in the mold in a randomly orientated chopped form. Basically, the fibers provide increased stiffness and tenacity to the matrix in a similar way as iron rods helps to sustain concrete. POP cement was added to water to form a paste, which is the carrier for hardness. Immediate stirring for 2-5 minutes was carried out to get rid of lumps as the POP cement begins to set in contact with water. Heat is given off as an indication of chemical reaction (exothermic reaction). The matrix was poured gently into the Pattern mold of 8mm thickness to allow for escape of bubbles in the mixture. The hardening period was observed for 10-30minutes. Smoothening of molded samples was done with the help of a straight edged tool. And the de-molding was performed immediately after hardening of the materials.



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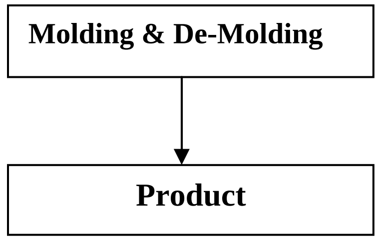

Fig.1. Process Flow Diagram

Fig 2: Extracted Kenaf Blast fiber

Fig 3: Extracted and Modified Kenaf Blast fiber

Fig 4: Fiber Sampling

Fig 5: Chemical Modification

Fig 6: Mechanical Testing (Tensile Strength)

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❖ **Plaster Of Paris (Pop) Kenaf Filament F ibre Reinforced Composite**

Fig 7: Experimental Products

3.0 Results and Discussion

TABLE 1 Fiber Properties

PARAMETERS	Unmodified kenaf fiber	Modified kenaf fiber
Moisture content (wt. %)	12.5	10.5
Fibre Density (g/cm^3)	1.21	1.04
Ash Content (wt. %)	2.35	1.90

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Cellulose (wt. %)	60.0	67.4
Hemicelluloses (wt. %)	25.5	22.3
Lignin (wt. %)	14.5	10.3
Tensile Strength (Mpa)	475.0	520.0
Elongation @Break (%)	1.5	1.8
Young's Modulus (GPa)	25	27
Lustre	Low	Moderate
Colour	Dark brown	Light brown

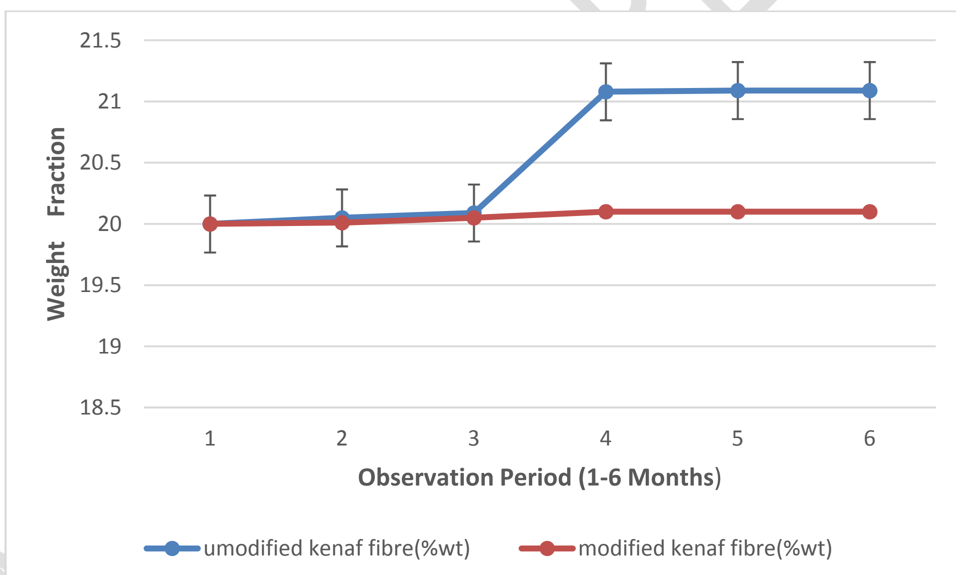

Fig 8: Effect of Moisture Movement and Environmental Stability of Reinforced Material

The tensile strength, the moisture movement and environmental stability of the material were investigated. From table 1. There is a drastic change in the fiber properties as a result of chemical modification, with significant increase in mechanical integrity, reduction in lignin content and improvement in fiber purity which was also reported by Ishak M.R. *et. al*., (2010), that the higher

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cellulose content, smaller fiber diameter and long fibers significantly increases mechanical properties. Figure 8 shows the moisture movement of the reinforced samples under six (6) months period of investigation and observation. The unmodified and modified samples were environmentally stable within three (3) months of observation, and immediately after three months we noticed sharp and significant increase in the moisture movement of unmodified sample while the modified sample showed stability within the six (6) months period of investigation. Increase in moisture moment could lead to strength loss, volumetric instability, fast deterioration of the materials and internal expansion by extension leading to cracking of material. In principle, visible cracking will arise when the tensile stresses go beyond or exceed the tensile strength of the material.

4 CONCLUSIONS

Eco-friendly products remain one of the critical focus of the 21st century. The industrial prospect of kenaf fiber as a natural fiber is in line with the growing eco-consciousness in material selection. Global markets are in transition to bio-based biodegradable materials. The utilization of kenaf fibers in an industrial arena offers a lot of benefit with the short life cycle of the fiber plant (130-150days of the plant maturity), satisfactory mechanical properties and ease of exploit for commercial purpose. In a nutshell, the reinforced Plaster of Paris with kenaf blast fiber showed good stability and good mechanical anchoring of the fiber to the matrix (plaster of Paris)

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