Investigation of Mechanical and Physical Properties of Papyruses Reeds Reinforced Composites with Polyester

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Abstract. Composite materials are playing important part in engineering enforcement. They are utilized in vehicles, marine, aviation, sports and different other fields. This paper has studied the properties of papyruses reeds particles (PRP) reinforced polymer based composites. Composite materials specimens were fabricated with different weights of papyruses reeds PRP particles in polyester matrix. The effect of the different weights of (PRP) that reinforced polyester on the mechanical and physical properties was investigated. The results showed that composite material reinforced with 13% wt of papyruses reeds particles has maximum tensile strength of 57.556 MPa, while minimum tensile strength of 12.88 MPa was obtained at 18% wt of PRP. Hardness test showed that hardness increased with decreasing the weight of PRP. The maximum and minimum hardness values of 73.6 N/mm² and 67.2 N/mm² were obtained at 15% wt and 22% wt of PRP respectively. Furthermore, water gain percentage of composite materials was increased with increasing the PRP content at room temperature and reached the maximum percentage of 6.2 % after 6 weeks with 22% wt of PRP.

1. Introduction
Natural fibers are utilized for reinforcing material. These have convoluted structure, with crystalline cellulose micro fibril-reinforced amorphous lignin or/and hemi-cellulose
Natural fiber reinforced polymer composites are environment friend and low cost compared with synthetic fiber reinforced polymer composite. Natural fibers and the process of manufacturing them are easy. This make the researches to try locally available in expensive fibers and study possibility of using them as reinforcements. The low cost and high specific mechanical properties of natural fibers made them a good renewable and biodegradable alternative to the synthetic reinforcement glass fiber[1].Using natural fibers reinforcement in polymer matrix were studied by academic sector and the industry, because they have many significate advantages over synthetic fibers. Many types fibers are currently investigated for the use in plastic, they are environmentally friendly, fully biodegradable, abundantly available, renewable and cheap and have low density[2] Composites have light-weight, high strength-to- weight ratio and stiffness properties used to replace the conventional materials like metals, wood etc.. 60-80 percentage of component weight can be saved by replacing steel with composites and 20-50 weight percentage with aluminum component. Polymer matrix composites, are used widely because of their light weight, good mechanical properties [3]. Burning a large quantities of agriculture waste (natural fibers) is harmful to the environment because it is main source of air pollution in many countries.

matrix. Natural fibers are Consists of cellulose, hemi-cellulose, lignin, waxes and some water-soluble compounds. The main component of it are cellulose (60%-80%), hemi-cellulose (5%-20%), lignin and moisture (20%). Agriculture waste such as bagasse, rice straw and woof flour are very cheap, easily
available and renewable, so composite used these natural fibers are cheaper than traditional composites [4, 5]. Natural fibers are interest in their usage as natural fillers for many technology need materials with species combination of properties that cannot be find in the conventional metal alalys. They are extensively used in variety of engineering applications in many different fields such as aerospace oil, gas and process industries as per the strategic engineers piping manual[6]. Engineering applications require special combination of properties, especially in aerospace, underwater and transportation. The engineering demands of high technology industries, can be achieved by using composite materials which provide combination of properties such as high strength to weight ratio, light weight, high modulus to weight, high stiffness, good corrosion and chemical resistance which cannot be achieved by a single conventional materials[7]. The advantage of using composites with natural fiber reinforcements is increasing with time, low cost, ease of availability high weight etc. The important and exclusive properties of natural fiber composite are its renewability and biodegradability. These properties with low cost full the economic needs in industry[4, 5]. Including natural fiber reinforced composites are found in countries consumers products including boats, skin, agriculture machinery and cars. Major goal of natural fiber composites is to replace the need to glass fiber which is expensive, high density and independent or nonrenewable sources. Recently, can manufactures have been interested in incorporating natural fiber composite into interior and exterior parts [8]. Composites are of two composes: natural fiber and human being made or manufactured fiber. There are comprehensively two kinds of regular composites: creature based and plant based. Alongside these two there is one more compose that is mineral based natural filaments. Normally utilized creature based regular strands are fleece, hair, silk, chicken quill and so on. In plant based fibers hemp jute, sisal, bamboo, hemp, banana, flax and so on these a re used for reinforced composites. Such fibers are extricated from the nature without harming the condition [9]. The grouping of natural fibers is displayed in figure 1.

**Figure 1.** Grouping of natural fibers[9].

The main advantage of using (papyruses reeds) materials is that they are locally available and are very cheap. They are biodegradable and hence do not create disposal problems in the environment.

2. **Methodology**

Papyruses reeds fibers was collected from agro-land Dujail-Iraq, the leaves were separated from stems, washed and dried, the powder was papered by using milling technicians then sieved to 0.6 mm.
The composites with papyruses reeds loading at different weight percentage (13, 15, 18, 20, 22) % were fabricated using hand layup method with size mould of 127 mm (length, L) × 25 mm (width, W) × 3 mm (thickness, T). Initially, polyester resin and hardener were blended with proportion 200: 2 and blended neatly to shape the matrix. Then, fibers were diffusion into mold and enveloped with the matrix. The composites were compacted until thickness of 3 mm was completed. left for 72 hours at room temperature (25-30°C). Finally, the samples of composite were cut on a standard basis ASTM D3039.

2.1. Diffusion Test

The basic purpose of the hydrolysis study of polymers and their compositions in water, is to identify the effect of water. The importance of these mechanisms depends largely on the type of material, temperature and immersion time. To understand this phenomenon, there are two important factors, the first is The existence of the interface, and a channel for the passage of the other solutions through it, and the second The ability to interact with molecules of solutions chemically or physically with the material, the phase, or the minutes, and this should be taken into consideration due to the hardness.

2.2. Preparation of sample

The samples was cut in Dimensions (1*1) cm and immersing in water at room temperature, during the soaking period, the sample mass is recorded every week.

The percent of water gain in each specimen is defined as [10].

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M\% = \frac{Mt-M_{\text{solid}}}{M_{\text{solid}}} \times 100
\]  

(1)

where M% is the percent of the water gain in the samples, Mt is the mass of the sample at time t, and M solid is the mass of solid calculated (dry specimens) before they are immersed, at ambient temperature.

3. Results and Discussions

Figure 2 showed the results of tensile strength with the increase in weight ratio of papyruses reeds, the tensile strength of pure polyester is higher than reinforced composites accept the specimen with 0.6 gm weight of papyruses reeds, which has 57.556 MPa, higher than pure polyester specimen which has 53.956 MPa. There was not much difference in tensile strength value from 18% to 22% wt of papyruses specimens. The highest tensile strength is 57.556 MPa for 13% wt of papyruses reeds and the lowest tensile strength is 12.886 MPa for 18% wt specimen.
Figure 2. Tensile strength MPa verses wt percent % of (papyrus reeds particles).

Figure 3 showed the results of hardness test with the increase in weight ratio of papyruses reeds particles, this fig showed that the hardness of pure polyester is higher than the reinforced composites 78.6 N/mm² then it decreased till 13% wt of papyruses specimen which showed 63 N/mm², after that the hardness increased at 15% wt of papyruses specimen which is showed the maximum hardness of composite 73.6 N/mm². The hardness decreased at 18%wt 68 N/mm², after that there was not much difference in hardness from 18% to 13% wt of papyruses specimens.

3.1. Effect of time and weight of fiber when immersing specimens with water
Figure 4 illustrates water absorption percentages of papyruses reeds Reinforced Composites with polyester specimens through immersion in water at an ambient temperature. Obviously increase The PRP content increased water absorption percentage of composite materials at the room temperature, this is similar with results of Naguib. H. M. et.al (2015) [5].
For the first week of immersion appeared increase in the level of water gain of the composites materials for all different weight, Four week later appeared gradual increase in the water gain, and the samples finally reached the maximum water gain percentage 6.2 % after 6 week with 22% wt of PRP. Prove that increasing the period of soaking increases the absorption of water, Generally polymer reinforced with fiber absorbs more water because the hydrophilic nature of the papyruses reeds (due to the existence of a polar group).

![Figure 4. Weight gain% versus time at different weight percent of (PRP) in water.](image)

The composite water may penetrate through the cutting/ interfacial side of the specimens, that allowed hydrogen bonding to occur between the free hydroxyl group of the cellulose molecules with water molecule. During three days, the water caused the fiber cell wall to swell and due to the fiber to expand until the cell wall becomes saturated with water.

**4. Conclusion**

In this work, papyruses reeds Fiber Reinforced Composites with Polyester were prepared by addition (13,15,18,20,22) % weight of papyruses reeds to the polyester resin, the effect of this on the physical and mechanical properties of the prepared composites was studied.

The following conclusions of Practical experiments for research on mechanical and physical behaviour of particles PR reinforced polyester composites:

1- Tensile strength of the reinforced composite material increases with 13%wt of PRP , it was 57.556 Mpa

2- Hardness test showed that with increasing of the weight of papyruses reeds decrease hardness, the hardness of pure polyester is higher than the reinforced composites. The hardness for 13% wt was 63N/mm²

3- Water absorption percentage of composite materials was increase with The PRP content increased and the period of soaking, at the room temperature, and the maximum percentage 6.2 % after 6 weeks with 22% wt of PRP.

**Nomenclature**

wt.% Weight Percentage.

PRP Papyruses Reeds Particles.
M% percent of the water gain.
Mt the mass of the sample at time t.
M_{\text{solid}} the mass of solid.

**Acknowledgments**

Authors wishing to acknowledge assistance or encouragement from colleagues, special work by technical staff or financial support from organizations should do so in an unnumbered Acknowledgments section immediately following the last numbered section of the paper.

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