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The Mechanical Performance of Pipe Based on Fiberglass Reinforced with Plastic Waste (FRPW) Composites

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Abstract. The project research present the mechanical performance of pipe based on fiberglass reinforced with plastic waste (FRPW) in plant application system. The use of FRPW able to reduce corrosion problem faced by oil and gas industry. In this study involved four types of combination ratio of fiberglass reinforced with plastic waste (FRPW) of 1.0: 0.5; 1.0:1.0; 1.0:1.5; and 1.0:2.0. The fabrication process started with grinding process of plastic waste into small size in the range of 0.1 mm. Fiberglass then reinforced with plastic waste by mixed with resin and hardener with ratio of 2: 1 and poured into the cylinder mould. There is a possibility fiberglass from 10-40% by weight result in substantial increase in elastic modulus, accompanied by an increase in strength with reduced ductility 1.0 of ratio. The tensile test showed clearly exhibited that 1.0 of plastic waste reinforced fiberglass with stand the higher maximum force value of 2.69 kN. For the bending test ratio of 1.0 of plastic waste withstand the higher bending strength at 5.29 kN. Ratio of 1.0 FRPW is more suitable for produced pipe in plant application system due to matrix-reinforcement bonding for each pipe sample after conducting tensile strength. The result obtained that ratio 1.0 of FRPW shown good matrix-reinforcement bonding.

1. Introduction

Plastics have substantial benefits in terms of their low weight, durability and lower cost relative to many other material types. These properties make manufactured polymers astoundingly helpful, and since we figured out how to make and control those, polymers have turned into a fundamental piece of our lives. Particularly finished the most recent 50 years plastics have immersed our reality and changed the way that we live [1]. Fiberglass can also be a less expensive alternative to other materials. Composite materials such as fiberglass reinforced plastics (CFRP) exhibit outstanding mechanical performance at low material densities, thus offering the potential of significant weight reduction in structural



lightweight components [2]. Fiberglass reinforced with plastic waste, FRPW can enhance mechanical properties. It additionally demonstrates that option of plastic to solid causes some lessening in mechanical properties for example, compressive strength, tensile strength, and flexural strength. Along these lines fiberglass reinforced with plastic waste, FRPW is best method to produce pipe in plant application system and also able to reduce corrosion problem.

The word “waste” projects a vision of a material with no value or useful purpose. However, technology is evolving that holds promise for using waste or recycled plastics to make an array of high performance composite products that are themselves potentially recyclable [3]. The plastic waste is now a serious environmental threat to modern civilization. The plastic waste are widely used in most of manufacture industry to refabricate the product that needed and also to reduce cost of production. The following products which is made from plastic waste can be used to reduce pollution. Approximately 50 per cent of plastics are used for single-use disposable applications, such as packaging, agricultural films and disposable consumer items, between 20 and 25% for long-term infrastructure such as pipes, cable coatings and structural materials, and the remainder for durable consumer applications with intermediate lifespan, such as in electronic goods, furniture, vehicles, and more [4]. Plastics are inexpensive, lightweight and durable materials, which can readily be moulded into a variety of products that find use in a wide range of applications. As a consequence, the production of plastics has increased markedly over the last 60 years.

2. Literature Review

The plastic waste is now a serious environmental threat to modern world. 50 percent of the plastic we use, we use just once and throw away. The amount of plastic waste consumed annually has been increase in weight. Studies demonstrate that regular corruption of plastic takes around 100 to 1000 years. The plastic wastes accounts for $10.62 \pm 5.12\%$ of the total stored wastes in the old landfill, among which, 69.13% is plastic bags include white PE plastic bags accounted for 11.34% colored PE plastic bags 29.77% and other plastic bags 28.02% and 30.87% plastics such as PP, PVC, PS and others [5]. Plastic waste is composed of several toxic chemicals, and therefore plastic pollutes soil, air and water. Since plastic is a non-biodegradable material, land-filling using plastic would mean preserving the harmful material forever. Figure 1 shows the source of plastic waste [6].

In spite of developing question, plastics are basic to present day life. Plastics made conceivable the improvement of PCs, mobile phones, and the greater part of the lifesaving advances of present day solution. Lightweight and useful for protection, plastics help spare non-renewable energy sources utilized as a part of warming and in transportation. Maybe most essential, economical plastics raised the way of life and made material wealth all the more promptly accessible [7]. The plastic waste are widely used in most of manufacture industry to refabricate the product that needed. Plastic waste also applications like protection, during their service life, plastic materials spare in excess of 140 times the vitality required for their generation. They are likewise champion with regards to ensuring merchandise and sustenance, subsequently decreasing breakage and waste. Due to the interesting properties of plastic materials, they are utilized as a part of an extensive variety of use areas, for example, packaging, building and construction, automotive and aeronautics, electrical and electronic to help us to live and build a more sustainable world [8].

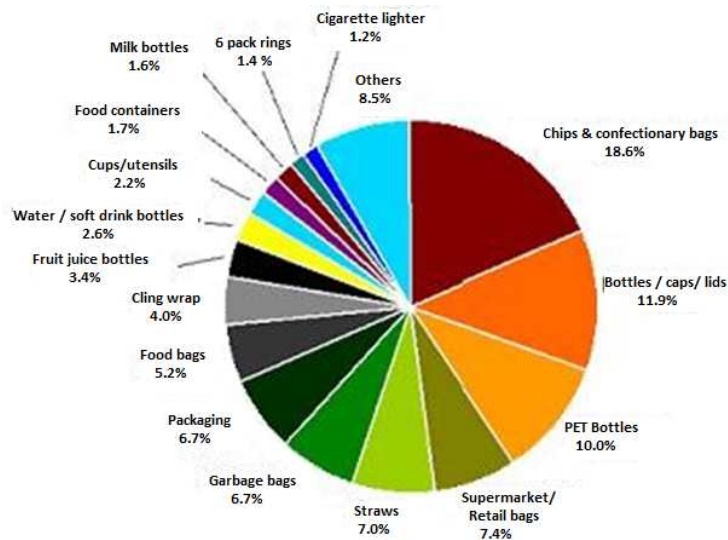


Figure 1: The source of plastic waste [6]

3. Methodology

3.1. The preparation of samples

The preparation of samples was involved grinding process of plastic waste with size in the range of 1 – 3mm. The plastic waste was provided by Kim Hoe Thye Industries Sdn. Bhd. The plastic waste were mixed with the epoxy and hardener within three minutes. The mixture was spread thoroughly on the fiberglass. Next another layer of fiberglass was again spread thoroughly on the existing fiberglass by using paint roller. Four samples were prepared to produce pipe from fiberglass reinforced by different ratio of plastic waste which is the ratio of 1:0.5, 1:1.0, 1:1.5 and 1:2.0 as shown in Table 1 and Figure 2.

Table 1. Samples with different ratio of plastic waste

Samples	Plastic waste	Fiberglass	Ratio of epoxy resin and hardener
A	0.5	1.0	3:1
B	1.0	1.0	3:1
C	1.5	1.0	3:1
D	2.0	1.0	3:1



Figure 2: Pipe samples by different ratio of fiberglass reinforced plastic waste (FRPW); (a) 1:0.5, (b) 1:1.0, (c) 1:1.5, (d) 1:2.0

4. Results and discussions

4.1. Tensile strength test

Figure 3 exhibited the graph of force versus time for different ratio of fiberglass reinforced plastic waste (FRPW). It is clearly exhibited that 1.0 of plastic waste reinforced fiberglass withstand the higher maximum force at 2.79 kN, followed by 2.0 of plastic waste reinforced fiberglass at 2.26 kN, the ratio of 1.5 of plastic waste can sustain at 1.20 kN and 0.5 ratio which can hold up to 1.55 kN.

The ratio of 1.0 plastic waste gives higher tensile performance due to the composition of plastic waste is optimum and more consistent compared to other fillers and reinforcements. Generally, the addition of fiberglass from 10-40% by weight result in substantial increase in elastic modulus, accompanied by an increase in strength with reduced ductility [9]. Tensile properties of a composite material are mainly depending on fiber strength, modulus, fillers, fiber length and orientation, fiber-matrix interfacial bonding and fiber content [10]. Previous researcher was observed that the presence of 5% maleic anhydride polypropylene copolymer in fiberglass reinforced polypropylene composites results in an increase of tensile and flexural strength by 41% and 45%, respectively [11].

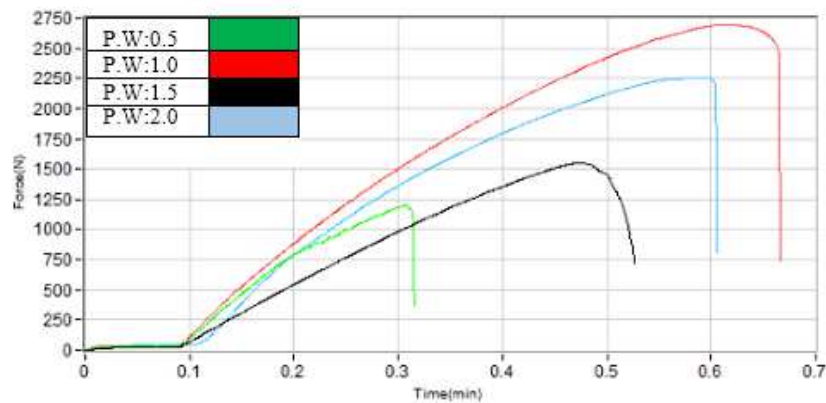


Figure 3: Tensile test results at different ratio of Fiberglass Reinforced Plastic Waste (FRPW)

4.2. Bending Test

The preparation of samples was involved Figure 4 exhibited the bending strength test for different ratio of Fiberglass Reinforced Plastic Waste (FRPW).

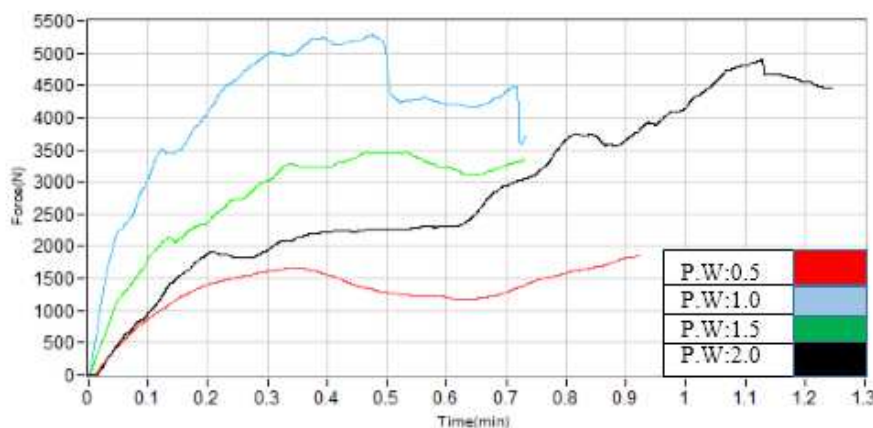


Figure 4: Bending test at different ratio of Fiberglass Reinforced Plastic Waste (FRPW)

It is shown that 1.0 of plastic waste reinforced fiberglass withstand the higher maximum force value of 5.29 kN, followed by 2.0 of waste plastic reinforced fiberglass with value of 4.89 kN, then 1.5 of waste plastic reinforced fiberglass with value of 3.45 kN and lastly 0.5 of waste plastic reinforced fiberglass which can hold up till value of 1.85 kN. It was expected that fibrous fraction of FRPW would have a significant reinforcing effect and lead to a higher improvement on flexural behavior. Fiber reinforcing has several advantages to enhance the mechanical properties [12]. Plastic waste matrix itself has relatively less strength and hence this research work will focus on the enhancement of mechanical properties preferentially flexural strength and compressive strength through glass fiber reinforcement and binder pitch [13].

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