Fabrication and Estimation of Rice Husk Green Composite

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Abstract. Composite materials form an important part of technical materials, from everyday products such as door frames to aircraft and space applications. The availability of natural fibres and the ease of production have prompted researchers to test inexpensive local fibres and examine their feasibility for reinforcement purposes and the extent to which these meet the specifications required for strong reinforced polymer composites. A lot of rice husk (RH) is believed to contain high silica fibre content. Depending on the size, the silica content and all impurities in the RH will vary. RHs mainly contain 15-20 wt. percent silica and various organic components are produced by thermal degradation. The low density and diversity of raw materials make silicon carbide easy to produce. In the current work, two different materials are considered for the production of composite materials, such as rice husk and polypropylene. These two available materials are considered as different components, and for each component, various parameters are evaluated to detect the usability of composite materials. In the research work, the proposed composite GUI production method was created using MATLAB, and different results were evaluated for different variables. According to the results, the RH mixture in PP has caused some changes in the various properties of the material, such as tensile strength, tensile modulus, fixture strength, porosity, and for different components, varied outcomes were obtained. According to application requirements, the composition of the material can be further considered. If good tensile strength is required, the minimum RH in the composition is considered. If a higher tensile modulus is required, the high RH composition of PP can be used for further consideration.

Keywords: Composite, rice husk, polypropylene, tensile strength, tensile modulus, fixture strength, porosity.

1. Introduction
The most important advantage of composite material production is that the specific characteristics of the component materials can be used to meet different requirements. Business and materials researchers are considering a more specific elaboration when defining a composition as a substance, which is
composed of content created by the physical combination of pre-existing constituent materials to create a novel material that has integral characteristics contrasted to the monolithic characteristics. This description distinguishes composite materials from different multiphase materials produced by batch processing, in which one or more phases are the product of phase change [1, 2]. Josh et al. [3] investigated the environmental efficiency of natural fiber composites and glass fiber reinforced mixtures during the life cycle, and noted that natural fiber composites have environmental advantages in the specific applications studied. Rana et al. [4] found that considering compatibilizer in jute fiber can improve its mechanical properties. The use of compatibilizers at 60% (weight) of the fiber load can increase the flexural strength to 100%, the flexural strength to 120%, and the impact strength to 175%. Shah and Lakkad [5] tried to match the mechanical properties of jute reinforcement and glass reinforcement, and the results showed that when jute fiber is used as a reinforcing material on the resin matrix, the mechanical properties are widely changed, and the reforming is relatively small instead of considering glass and other materials. Therefore, jute fibers can be considered as a reinforcing material, they have medium strength and modulus. Kenechi et al. [6] focused on using rice husk as a plastic composite reinforcement material. Synthetic plastic mixtures are becoming popular at a higher rate because the same factors are taken into account in all areas of life and business, which leads to cost inflation, environmental degradation and mainly petroleum by-products, which are non-renewable materials. Mahzan et al. [7] explores the potential characteristics of considering RH waste as the sound absorption content of rice husk-reinforced composite materials. At room temperature (25-30 °C), the RH is first washed and dried. Then dry RH is used as a binder and mixed with polyurethane (PU) foam to make a mixture reinforced with rice husks. Six individual samples were produced based on the percentage of rice husk. The resulting sound absorption coefficient indicates that the mixture produces a large output in the low frequency region. The research results also show that the composite material reinforced by rice husk has a better sound coefficient than other natural materials, which indicates a good marketing opportunity. In another study, Habib et al. [8] investigated the properties of rice husk ash (RHA) taking into account furnaces made of iron cement. The impact of milling is first checked on particle size and surface area, and then XRD interpretation is performed to verify the availability of amorphous silica in the ash. In addition, the effects of average particle size and RHA percentage on concrete workability, fresh density, and water-reducing agent content and compressive strength were also investigated. Although grinding RHA will reduce its average particle size (APS), it is not a key factor in surface conditioning. The solution of the above-mentioned problems provided the motivation for this research; therefore, the current work attempts to consider the rice husk as a possible reinforcement material for the manufacture of plastic composite materials by examining its characteristics, uses, applications and operations.

2. Research Methodology

Rice husk obtained locally. In order to recapture the dirt or dust and other foreign matter on the fibre, it was washed with ordinary water many times and exposed to the sun for three days to absorb all the surface moisture. The RH samples are connected to fibres of different lengths. The scale separation is achieved by sieving in a vibrating sieve system with 4, 3.35, 2.8, 2.36 and 2 mm sieves. Most RH content ranges from +2 to -2.36. For experiments, rice husk fibres of this size were chosen. The fibre length and diameter have an effect on the composite output. RH is a short fibre, and fibre length standardization is assumed to minimize the impact of asset composite variability because of the fibre length.

The rice husk is finely ground and collected. The crushed rice husk produces various impurities such as dust, tiny particles and fine particles of grain. To get pure rice husk, it needs to be washed. After the water purification, the rice husks are dried directly in the sun for 10 hours. Then it is weighted according to the appropriate percentages (10, 20, 30 weight percentages). Then mix the polypropylene in the tube and stir well for five minutes. RH is slowly poured, stirring to make the components fully mixed. First apply a release agent (Vaseline) on the mould until the mixture is added to the mould to block the composite material from a viscous state into the mould when it is taken out. Finally, after the mixture
was inserted into the mould, it was left for 1 hour in the oven at 200 °C and then it is slowly left to cool down (Figure 1).

![Figure 1 Collection of the RH](image)

2.1. Design of Experiment
Taguchi techniques are mathematical techniques designed to retouch the efficiency of the produced products, and most presently also considered to engineering, biotechnology, marketing and advertisement. The Taguchi approach is used whenever interest parameter settings are appropriate, not just for the manufacturing processes. Table 1 shows the levels of process parameters. Experimental layout using L9 (3²) orthogonal array is shown in Table 2. In addition, Sequence of experiments with respect to % of rice husk and Polypropylene is shown in Table 3. Step by step processing of the sample preparation is shown in Figure 2.

| Process Parameters | Level 1 | Level 2 | Level 3 |
|--------------------|---------|---------|---------|
| % of Rice Husk     | 10      | 20      | 30      |
| Sieve Size         | 250     | 355     | 500     |

| L9 (3²) Experimental Trail | % RH | Sieve Size |
|----------------------------|------|------------|
| 1                          | 1    | 1          |
| 2                          | 1    | 2          |
| 3                          | 1    | 3          |
| 4                          | 2    | 1          |
| 5                          | 2    | 2          |
| 6                          | 2    | 3          |
| 7                          | 3    | 1          |
| 8                          | 3    | 2          |
| 9                          | 3    | 3          |

2.2. Sample Preparation
Composite in pieces of 300 mm X 200 mm X 5 mm were make-believe as per the ASTM standards (D790) for mechanical tests.
Die size = 300 x 200 x 5 mm = 300000 mm³
Volume of Die = 300cm³
Calculation of weights for 10 % Rice Husk and 90 % Polypropylene
90% of Polypropylene = 270000 mm³
Density of PP = 0.946 g/cc
Weight of PP = 270x0.946
Weight of PP = 255.42 grams
10% of Rice Husk = 30 cm³

| Experiment Number | % of Rice Husk | % of Polypropylene | Size of RH in microns | wt. of RH (grams) | Wt. of PP (grams) |
|-------------------|----------------|-------------------|----------------------|------------------|-----------------|
| 1                 | 10             | 90                | 250                  | 10.2             | 255.42          |
| 2                 | 10             | 90                | 355                  | 10.2             | 255.42          |
| 3                 | 10             | 90                | 500                  | 10.2             | 255.42          |
| 4                 | 20             | 80                | 250                  | 20.4             | 227.02          |
| 5                 | 20             | 80                | 355                  | 20.4             | 227.02          |
| 6                 | 20             | 80                | 500                  | 20.4             | 227.02          |
| 7                 | 30             | 70                | 250                  | 30.6             | 198.66          |
| 8                 | 30             | 70                | 355                  | 30.6             | 198.66          |
| 9                 | 30             | 70                | 500                  | 30.6             | 198.66          |

Figure 2 Step by step processing of the sample preparation

Volume of RH = 30 cm³
Density of RH = 0.34 g/cc
Weight of RH = 10.2 Grams
Calculation of weights for 20% Rice Husk and 80% Polypropylene
80% of Polypropylene = 240000 mm³
Density of PP = 0.946 g/cc
Weight of PP = 240x0.946
Weight of PP = 227.02 grams
20% of Rice Husk = 30 cm³
Volume of RH = 60 cm³
Density of RH = 0.34 g/cc
Weight of RH = 20.4 grams.
3. Results and Discussion

3.1. GUI Interface for proposed methodology

The proposed methodology is better validated using the simulation of the same for which MATLAB 15a is being considered and the GUI based snaps are shown as under (Table 4): In the show results the research methodology is better evaluated using the various parameters like Tensile strength, Flexure Strength, Tensile modulus, Porosity and also the variables like weights of PP and RH are considered as dynamic parameters which changes with the change in the composition of the PP and RH.

| Size of Rice Husk (µm) | % of PP | % RH | Curing Temp. (°C) | Compaction Pressure (ton) |
|------------------------|---------|------|-------------------|---------------------------|
| 250                    | 90      | 10   | 100               | 10                        |
| 250                    | 80      | 20   | 100               | 10                        |
| 300                    | 70      | 30   | 110               | 12                        |
| 300                    | 60      | 40   | 110               | 12                        |
| 300                    | 50      | 50   | 110               | 12                        |

In Figure 3, inputs are entered for the various parameters considered, and the GUI created on this basis estimates the results in various forms. Here the percentage of rice husk and polypropylene is 10/90, and the result showed tensile strength of 33 MPa, a flexural strength of 75 MPa, a tensile modulus of 1.18 GPa and a porosity of 36.6667%. In addition, when the percentage of rice husk and polypropylene is 20/80, the result is described as a tensile strength of 31 MPa, a flexural strength of 67 MPa, a tensile modulus of 1.30 GPa, and a porosity of 40%. Further, when the percentage of rice husk and polypropylene is 30/70, and the result is described as a tensile strength of 31 MPa, a flexural strength of 67 MPa, a tensile modulus of 1.30 GPa, and a porosity of 40%. These values are further calculated for different ratios of RH and PP, and these values are displayed with the help of graphics generated using the GUI. According to the estimated results, it is obvious that the RH content in the composite
material increases, the tensile strength, tensile modulus, flexural strength and porosity increase. As the RH content in the composite material increases, the tensile strength decreases, as shown in the figure below.

The graph shown above (Figure 4) is the depiction of the tensile strength for the different compositions considered for the polypropylene and rice husk. The PP and RH are considered in three different compositions as 90/10, 80/20, 70/30, 60/40 and 50/50 where the 90, 80, 70, 60 and 50 shows the constituent of PP and rest is of the RH. In addition, figure 5 showed that highest porosity was attained by 50/50 (PP/RH) composition followed by 60/40 composition.

In the current work, two different materials are considered for the production of composite materials, such as rice husk and polypropylene. These two available materials are considered as different composition, and for each composition, various parameters are evaluated to detect usability of the composite. In the research work, the proposed composite GUI production method was created using MATLAB, and different results were evaluated for different variables. According to the results, it is shown that mixing RH in PP will cause some changes in the various properties of the material, such as tensile strength, tensile modulus, flexural strength, porosity, and for different composition. According to the application requirements, the composition of the material can be further considered. If good tensile strength is required, the minimum RH of the composition should be considered. In the case of higher tensile modulus requirements, the high RH composition of PP can be used for further consideration. The composition discussed in the work is made of PP and RH with different compositions, which have properties such as tensile strength, tensile modulus, flexural strength, and porosity.
Table 5 Summarization table for output variables

| % of PP | % of RH | Wt. PP (g) | Wt. RH (g) | Tensile Strength (MPa) | Flexure Strength (MPa) | Tensile Modulus (GPa) | Porosity (%) | Tensile Strength | Flexure Strength | Ref. |
|---------|---------|------------|------------|------------------------|------------------------|-----------------------|--------------|-----------------|----------------|------|
| 90      | 10      | 255.42     | 10.2       | 33 (29)                | 75 (65.4)              | 1.18                  | 36.67        | Tensile Strength increases by 8.7%, F.S increases by 12.80% (Best Sample) | [ 9, 10 ] |
| 80      | 20      | 227.04     | 20.4       | 31 (32.3) @ (85,15)   | 67 (69.3)              | 1.30                  | 40           | Tensile Strength decreases by 4.19%, F.S decreases by 3.43% | [ 9, 11 ] |
| 70      | 30      | 198.66     | 30.6       | 29 (26.6)              | 59 (54.3)              | 1.58                  | 43.33        | Tensile Strength increases by 8.2%, F.S Increases by 7.9% | [ 9, 10 ] |
| 60      | 40      | 170.28     | 40.8       | 27 (27.3) @ (65,35)   | 51 (48.2)              | 1.84                  | 46.67        | Tensile Strength decreases by 1.17%, F.S increases by 5.4% | [ 9, 11 ] |
| 50      | 50      | 141.9      | 51         | 25 (24.6)              | 43 (44.7)              | 2.10                  | 50           | Tensile Strength decreases by 1.5%, F.S decreases by 4.0% | [ 9, 10 ] |
| 90      | 10      | 255.42     | 10.2       | 33 (29)                | 75 (65.4)              | 1.18                  | 36.67        | Tensile Strength increases by 8.7%, F.S Increases by 12.80% (Best Sample) | [ 9, 10 ] |

With the increase of the RH composition in the composite material, the tensile strength shows a moderate degradation change. Therefore, the tensile strength is the reason for the hardness of the composite material. Therefore, the composite material that requires hardness should maintain a lower RH content. Similarly, the flexural strength increases with the increase of the RH content in the composition, which is responsible for the deformation resistance of the composite material and has its own application fields (Table 5). The tensile modulus and porosity increase as the RH content in the composition that contributes to elasticity and absorption increases. The composite material can be well used in applications that require highly elastic materials and have good absorption capacity.

4. Conclusion
In the current work, two different materials are considered for the production of the composite material such as rice husk and polypropylene, both available materials are considered in different composition and for each of the compositions several parameters were evaluated to detect the usability of the compound. The best samples were obtained with samples of 90% PP and 10% rice husk. The tensile strength was found to be increased by 8.7% compared to the previous study, and the flexural strength increased by 12.80%. In the 90% PP and 10% rice husk samples, the porosity and tensile modulus are the smallest.

5. Future Scope
In the current work, the main consideration is to evaluate and determine various parameters. These parameters define the strength of materials considering PP and RH in various compositions.
- The work done can be further considered for real-time application in industry.
- Other tests can also be performed by XRD and SEM.
- Other thermal properties can also be tested.
- On the basis of the application the material can be selected for further research.
- The resulting composite material can be further applied to practical applications and can be verified through various tests to identify the quality of the composite material.

Conflict of interest
None.

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