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Fabrication of Particle Boards From Rice Husk

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Abstract: *Globally, the construction industry is growing at a rapid pace as a consequence of increasing population and standard of living. High performance synthetic materials for construction such as glass fibre and carbon fibre reinforced composites are available today. However, these materials are mainly used for high-tech applications in aerospace and motor sports due to their high costs. Therefore, lightweight and high-strength wood and wood-based composite boards are still the preferred option for construction due to their reasonable costs. The growing shortage of wood has also led to the development of suitable alternative materials for construction. Rice husk particleboard is one such material, which is being considered as a potential substitute for wood and wood-based board products.The use of natural sponge particles (rice husks) as reinforcement for the production of particleboard was the thrust of this research work. These fibres being cheap and readily available with low energy demand during manufacturing are strong contenders for this work. Although number of research is carried out the suggested combination of rice husk, resin, catalyst, accelerator is not addressed so far. The particles, whose mass fraction was the variable were cut down into smaller sizes and mixed with resins and other binders. The resulting slurry was then poured into rectangular moulds, which were compacted until the composite became hard. Water absorbity, electrical conductivity tests were carried out on the samples. These tests confirmed the possible use of sponge particles as reinforcement in the production of particleboard. The developed particleboard composites can be used in density particleboards for general purpose requirements like panelling,Ceilings, partitioning, etc.*

Keywords: *Composite Boards, Rice Husk, Resins, Tests, Wood Products*

I. INTRODUCTION

The demand for wood in the forest industry has been growing, but the production of industrial wood from the natural forests continues to decline. The decline in forest resources in developing countries is due to the depletion of resources and in developed countries due to the withdrawal of forest areas from industrial production for other uses such as recreational areas. Also, there is a significant pressure on standing forest resources as a result of higher demand for wood in forest industry due to the increasing population and new application areas. Consequently, there is a need for alternative resources to substitute wood raw material.

Over dependency on natural solid wood for fuel, construction material and other wood works, and subsequently generation of wood wastes such as sawdust from wood processing, pose great challenges to environmental sustainability. However, production of particleboards which involves the utilization of the wood wastes and certain binder(s) now serve as an inexpensive and profitable alternative to the natural solid wood and environmental sustainability. Particleboard is a composite panel product consisting of wood particles such as sawdust, wood chips, sawmills shavings or other agricultural wastes that are bound together with a synthetic resin or other suitable binders under heat and pressure. It is an inexpensive alternative to solid wood paneling, and has emerged as a versatile substitute for wood in many applications. In building construction, particleboard find its application for decoration and acoustic purposes, AC duct covering, door panel inserts, wall panels, floor ceiling tiles, etc.

Sawdust is recommended for its relatively low specific weight and abundance as a cheap by-product. Agricultural wastes such as rice husk have been used for making particleboards. The utilization of these materials for particleboard production is significantly for reducing the demands for natural solid wood and improving environment.

Rice Husk

The reasons behind the use ofRice Husk (RH) in the construction industry are its high availability, low bulk density (90-150kg/m3), toughness, abrasive in nature, resistance to weathering and unique composition. The main components in RH are silica, cellulose and lignin. The composition of RH as a percentage of weight is shown in Table 1

Table 1. Components of Rice Husk

COMPOSITION	%Wt
SiO_2	**18.80-22.30**
Lignin	9-20
Cellulose	28-38
Protein	1.90-3.0
Fat	0.30-0.80
Other Nutreints	9.30-9.50

RH contains high concentration of silica in amorphous and crystalline (quartz) forms. The presence of amorphous silica determines the pozzolanic effect of RH. Pozzolanic effect exhibits cementitious properties that increase the rate at which the material gains strength. The extent of the strength development depends upon the chemical composition of alumina and silica in the material. The external surface of the husk contains high concentration of amorphous silica which decreases inwards and is practically non-existent within the husk.

Resin

Polyester is often referred to as fiber glass – which is not technically accurate. Fiber glass is reinforcement and polyester is the resin.The resin offers excellent mechanical properties, impact and water resistance. The glassfibre laminate made with this resin has excellent mechanical strength, good rigidity and outstanding durability. Unsaturated polyester resin is a thermoset, capable of being cured from a liquid or solid state when subject to the right conditions.Polyesters offer ease of handling, low cost, dimensional stability, as well as good mechanical, chemical-resistance and electrical properties. Polyester resins are the least expensive of the resin options, providing the most economical way to incorporate resin, filler and reinforcement.

For use in moulding, a polyester resin requires the addition of several ancillary products. These products are generally Catalysts and AcceleratorsResins can be formulated to the moulder's requirements ready simply for the addition of the catalyst prior to moulding. If given enough time an unsaturated polyester resin will set by itself. This rate of polymerisation is too slow for practical purposes and therefore catalysts and accelerators are used to achieve the polymerisation of the resin within a practical time period. Catalysts are added to the resin system shortly before use to initiate the polymerisation reaction. The catalyst does not take part in the chemical reaction but simply activates the process. An accelerator is added to the catalysed resin to enable the reaction to proceed at workshop temperature and/or at a greater rate.Great care is needed in the preparation of the resin mix prior to moulding. The resin and any additives must be carefully stirred to disperse all the components evenly before the catalyst is added. This stirring must be thorough and careful as any air introduced into the resin mix affects the quality of the final moulding. This is especially so when laminating with layers of reinforcing materials as air bubbles can be formed within the resultant laminate which can weaken the structure. It is also important to add the accelerator and catalyst in carefully measured amounts to control the polymerisation reaction to give the best material properties. Too much catalyst will cause too rapid a gelation time, whereas too little catalyst will result in under-cure.

Mould

Mild Steel was used for the construction of the moulds for the casting operation. The moulds were made having a rectangular cross-section measuring 250mm × 250mm with a height of 5mm.To produce the composite, the digital weighing balance was used to weigh the particle and Measuring jar is used to measure the resin. These are then thoroughly mixed manually by using stirrer. Thereafter, the mixture was then poured into a wooden mould measuring 250mm × 250mm x 5mm. This was later pressed using a heavier medium in four (4) uniform compacts. These however enabled the composite to take the shape of the mould cavity giving it a smooth surface free of voids and air holes. The mould was then carefully removed and the particleboard was carefully removed and allowed to dry naturally on free air.

II. LITERATURE REVIEW

Obam, Sylvester Ogah [1] discussed about the preparation of particle boards using saw dust, paper and starch, the authors suggested this as an alternative to asbestos ceiling boards. Paul A.P et.al [2] addressed a comparative study of the phenol formaldehyde and urea formaldehyde particleboards from wood waste for sustainable environment, and concluded that the property of the particleboards is a function of the percentage composition of the binder (resin) and the filler (sawdust). M. Sarkaret.al [3] conducted researchtoevaluate the properties of cement bonded particleboard made from rice husk and sawdust. Vo Chi Chinhet.al [4] discussed about fabrication of boards from agricultural wastes suitable for Nigerian country. Opara Patrick Nnamdi [5] studied about different low cost materials for construction and buildings and suggested that rice husk can be used because of its excellent properties. N. A. Amenaghawonet.al [6] addressed to optimise the production of particle boards from corn cobs and cassava stalks, two abundantly available and inexpensive agricultural residues in Nigeria.

III. FABRICATION OF MOULD

The mould for this process is made of mild steel material. Steel is any alloy of iron, consisting of 0.2% to 2.1% of carbon, as a hardening agent. Mild steel is selected since it is one of the most common of all metals and one of the least expensive steels used. It is weldable, very durable (although it rusts), it is relatively hard and is easily annealed. Having less than 2 % carbon it will magnetize well and being relatively inexpensive. Being a softer metal it is easily welded. Its inherent properties allow electrical current to flow easily through it without upsetting its structural integrity. Mild steel is very strong due to the low amount of carbon it contains. Mild steel has a high resistance to breakage. Mild steel, as opposed to higher carbon steels, is quite malleable, even when cold. This means it has high tensile and impact strength. Higher carbon steels usually shatter or crack under stress, while mild steel bends or deforms.

The die for moulding process can be cut from the large sheet of mild steel. To do so, first the sheet of mild steel of desired thickness is selected. From the selected sheet the required dimension of about 250mm X 250 mm is cut using steel cutting tool. Two pieces of the dimensions 250mm X 250 mm is cut using steel cutting tool. The pieces, which are cut are polished for good surface finish. The good surface finish need to be obtained to avoid rough surface. A poor surface finished mould results in poor surface of the final material obtained. The mould plate obtained is shown in Fig 1

Figure 1 Mild steel Mould

IV. FABRICATION OF SPACER

The spacer is placed between the two mild steel plates of the mould. The thickness of the spacer determines the thickness of the board to be obtained. By varying the thickness of the spacer, the thickness of the final product (i.e.) the rick husk board can also be increased. The material used for manufacture is also mild steel. The reason for choosing mild steel is as mentioned earlier it is cheap, readily available, cheap and has high ductility. The process involved in manufacturing of spacer includes,

1. Cutting and polishing
2. Welding

Spacer can be manufactured by cutting for pieces of mild steel bars of required length and welding it in a rectangular shape. The length and breadth of the spacer must be same as that of the mould whereas the thickness of the spacer can be varied according to the requirement. First, four pieces of mild steel bars of required length (i.e.) 250mm are cut from the mild steel plate using steel cutting tool. Then the four pieces which are obtained are polished for good surface finish. As mentioned earlier, good surface finish is required for good surface finish in the final product. The thickness of spacer can be varied according to the needs. Here the thickness of about 5mm is selected.

V. COMPONENETS REQUIRED FOR FABRICATION

Mould

The mould is made of mild steel material. The size of the mould is 250mm X 250mm. The mould is shown in Fig. 2

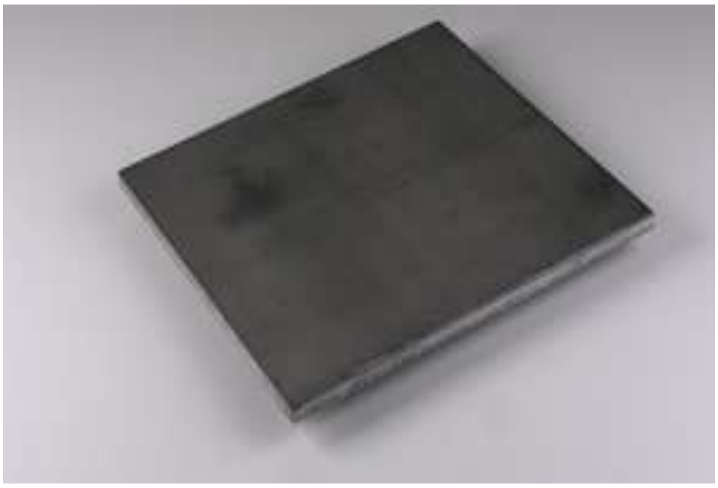

Figure 2 Mould

Spacer

The material used for manufacturing of spacer is mild steel. The thickness of the spacer is 5mm. The thickness can be varied based on the requirement. The spacer is shown in Fig. 3

Figure 3 Spacer

8.3. Poly Ester

Poly ester resin is used since it has very good binding properties. Resin of about 200ml is used for each board to be obtained in the size of 250mm x 250mm x 5mm.

Rice Husk

Rice husk is used as a composite in this process. It is used since it is highly available and has low bulk density. The proposition of rice husk varies from 15% - 25% depending upon the requirement. Rice husk is powdered using the ball mill before they are used in the process. The powdered rice husk is shown in Fig 4.

Figure 4 Powdered Rice Husk

Catalyst

A catalyst does not take part in a chemical reaction but is used to speed the reaction. The catalyst used in this process is methylene ethane ketone per oxide. It is colourless and odourless. Care must be taken as it should not have direct contact with our skin. The catalyst used is shown in Fig 5.

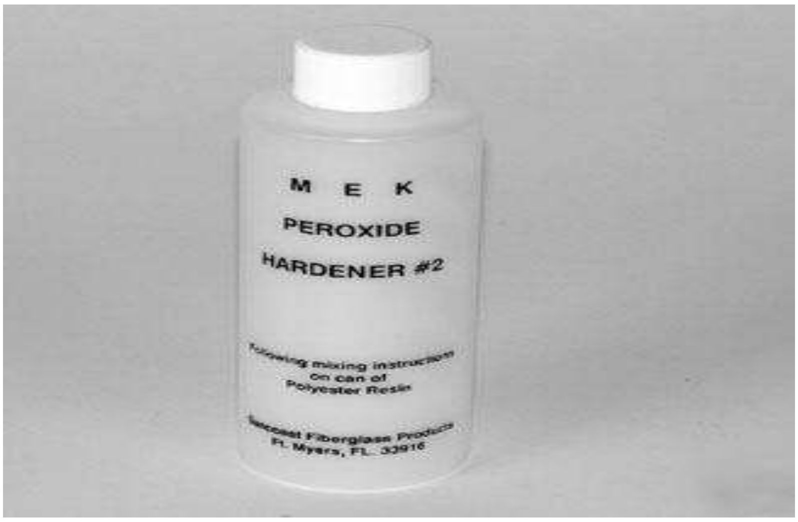

Figure 5 Catalyst

Accelerator

The accelerator used in this process is cobalt accelerator. The colour of the accelerator used is violet. The accelerator which is used in this process is shown in Fig 6.

Figure 6 Accelerator

VI. MANUFACTURING OF PARTICLE BOARDS

The experimental procedure for manufacturing of particleboards from rice husk is quite simple as shown in the Fig. 7

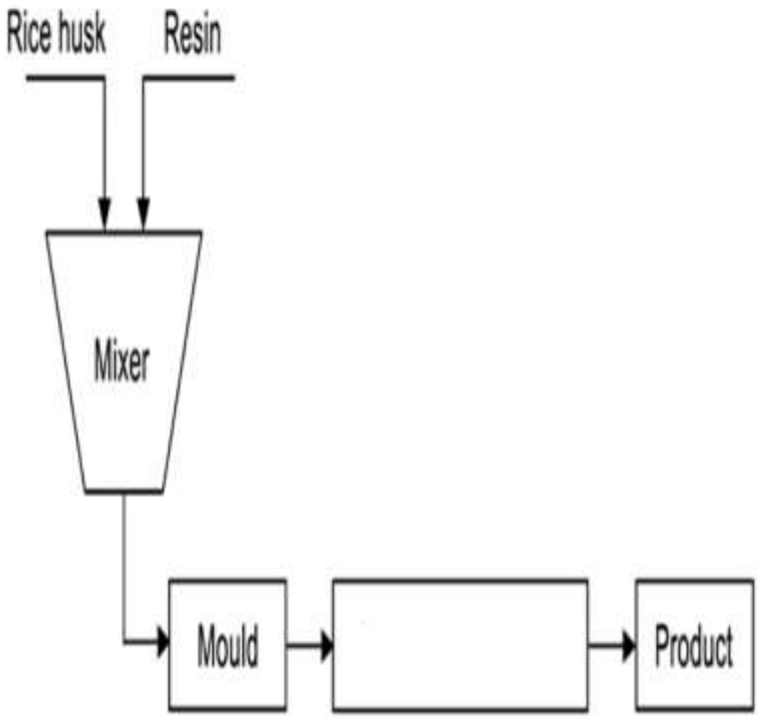

Figure 7 Methodology

The first step in preparation of particleboards from rice husk is grinding the rice husk in to particle size. The rice husk are ground by using ball milling machine. Fine particles of rice husk are obtained by ball milling. Then, the obtained fine particles are screened using sieving machine using the fine sieve. Sieving is done to obtain rice husk particles of uniform size. It is done to avoid swelling of rice husk. Now, Polyester resin of about 200ml is measured using measuring jar and it is poured in to a container, which is cleaned well before use. Then, about 20% of rice husk (i.e.) 20g are weighed in an electronic weighing machine. The measured rice husk are added slowly in to the container containing the resin with constant stirring.

The mixture is stirred well using glass rod (or) wooden stirrer. Then about 1.5 ml of accelerator is added to the mixture and the mixture is stirred well. The mixture is stirred until it is uniformly mixed. The catalyst (which has no reaction chemically with the mixture, but speeds up the reaction) of about 1.5 ml is added to the mixture and is stirred well. The mixture itself will settle without the addition of catalyst but takes very long time to get harden. So catalyst is added to speed up the reaction, which reduces the time taken for making the board.

Once the catalyst is added and the mixture is stirred well, it is poured in to the mould (die with spacer) measuring 250mm x 250mm x5mm. The mixture is allowed to flow on its own inside the mould. Then a slight pressure is applied on mould my manual pressing (or) by placing weights above the mould. The mixture inside the mould is allowed to settle down in the mould. The settling time for the mixture inside the mould is be around 10 hours. After 10 hours of settling time the mould is carefully removed and the board is obtained. The step by step procedure is explained with the following figures


Figure 8 Mixing Rice Husk and Resin**Figure 9 Mixing the Accelerator**


Figure 10 Mixing the CatalystFigure 11Pouring the mixture into the Mould

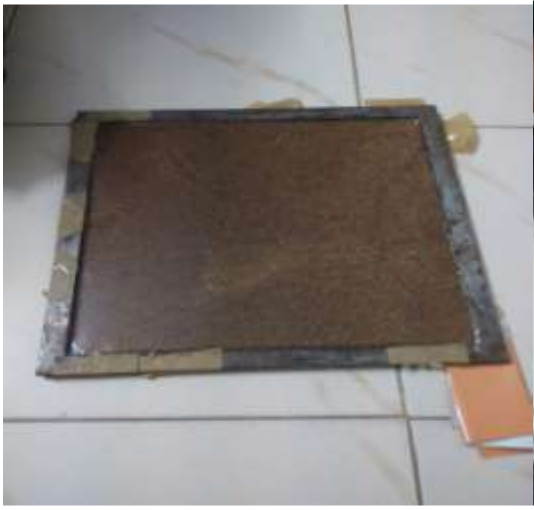


Figure 12 Settled Mixture in the MouldFigure13 Pressure Applied above the Mould

VII. TESTING OF PARTICLE BOARD

The particle boards were prepared with 20% of Rice Husk and 25% of Rice husk using the above procedure and the electrical conductivity test and water absobtivity tests were conducted

Electrical Conductivity Test

Electrical conductivity is a physical property that indicates how well a given material conducts electricity. The test was performed to check the electrical conductivity of the material.. The electrical circuit used to check the electrical conductivity is shown in Fig 8.1

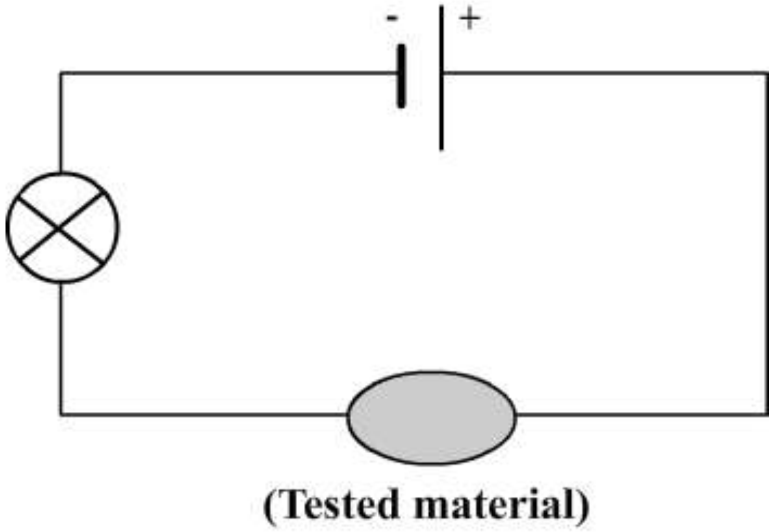

Figure 14 Circuit for Electrical Test

The negative terminal of a battery is connected directly to the blub. A wire from the positive terminal of the battery is connected to the rice husk board. Another wire is connected between rice husk board and the bulb. If the board conducts electricity the bulb must glow. On conducting the experiment the bulb failed to glow, which proves that the rice husk board does not conduct electricity. This property of non conducting nature makes it useable for switch boards, electrical circuits etc.

Water Apsorptivity Test

Two samples were taken from each mass fraction, weighed, and soaked in water for 24 hours . Thereafter, they were removed from water, cleaned, dried, and re-weighed. The obtained data were recorded against each mass fraction. The percentage water absorptivity was also calculated and recorded against each mass fraction. The percentage water absorptivity was calculated

Percentage of Water Absorptivity = (Final Weight – Initial Weight) / Initial Weight × 100

For 20% of rice husk,
Initial weight = 38g
Final weight =39g
Percentage = (39-38)/38 × 100 = 2.63 %

For 25% of rice husk,
Initial weight = 30 g
Final weight =32g
Percentage = (32-30)/30 × 100 =6.67%

The results shows that the percentage of water absorptivity increases as the percentage of rice husk in the board increases. If the rice husk needed to be increased for manufacturing stronger boards then the water absorption need to be sacrificed.

VIII. APPLICATIONS

The rice boards can be used as an substitute for false ceiling boards. The normal false ceiling boards costs around Rs 200 per square feet ,but the rice husk boards costs less than Rs. 40 per square feet.From environmental point of view, the normal false ceiling boards are made of thermocol, which is non bio degradable and is hazards to nature. Here only rice husk is used in making boards. Rice husk is easily degradable and it creates an eco-friendly environment. Due to the non-conducting nature of the rice husk boards it can be used in electrical circuits. It can be used in manufacture of switch boards, circuit boards, switches etc. They can also be used in making partitions in shelves, cabinets as an substitute for wood and concrete which is costlier as compares to rice husk boards.It also has an advantage that the waste rice husk is being converted in to some useful product and it has no harm towards the human and environment.

IX. CONCLUSION

In this project, we fabricated a ceiling board from rice husk using suitable binders. The main advantage of the project is that, it is eco friendly and it is very cheap compared to boards manufactured from other materials. It also helps to convert the waste rice husk in to useful boards. The boards manufactured are electrical resistant and therefore can be used in electrical circuits.The manufacturing process is quite simple and cost efficient. It does not require any skilled labour, which makes the manufacturing even more cheaper.

REFERENCES

[1]. Obam, Sylvester Ogah, Properties of saw-dust, paper and starch composite ceiling board,American Journal Of Scientific And Industrial Research 2012, 3(5), 300-304.

[2]. Paul A.P Mamza, Emmanuel C. Ezeh, E.C. Gimba, David EbukaArthur.Comparative Study of Phenol Formaldehyde And Urea Formaldehyde Particleboards From Wood Waste For Sustainable EnvironmentInternational Journal Of Scientific & Technology Research,
3(9), 2014, 53-61.

[3]. M. Sarkar, M. Asaduzzaman, A. K. Das, M. O. Hannan and M. I. Shams ,Mechanical properties and dimensional stability of cement bonded particleboardfrom rice husk and sawdust,Bangladesh Journal Of Scientific And Industrial Research, 47(3),2012, 273-278.

[4]. Vo Chi Chinh1, Hoang An Quoc, Manufacturing Heatproof Ceiling from Agricultural Wastes, Journal of Engineering Technology& Education,10(2),2013, 111-117.

[5]. Opara Patrick Nnamdi, Low Cost Materials For Building And Construction a Case Study Of Rice Husk, Journal of Sustainable Development and Environmental Protection1(1),2011,87-93.

[6]. N. A. Amenaghawon*1, W. Osayuki-Aguebor1, C. O. Okieimen1,Production of particle boards from corn cobs and cassava stalks: Optimisation of mechanical properties using response surface methodology, Journal of Materials and Environmental 7 (4),2016, 1236-1244.