Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 8, No.2, August : 2024

MANUFACTURING PARTICLE BOARD (WOOD) FROM COMPOSITION OF RICE HUSK AND CORN HUSK

S. LINGAMAIAH, Teaching Faculty Department of Mechanical Engineering Sri Krishnadevaraya University College of Engineering & Technology Sri Krishnadevaraya University, Anantapuramu,515003, AP, India. E-Mail: lingamaiahs.me@skucet.ac.in,
Dr. U. Jawahar Surendra Teaching Faculty Department of Mechanical Engineering Sri Krishnadevaraya University College of Engineering & Technology Sri Krishnadevaraya University, Anantapuramu,515003, AP, India. E-Mail ujsurendra@gmail.com

ABSTRACT
The pursuit of sustainable materials, this study explores a novel approach to particle board manufacturing using abundant agricultural by-products: rice and corn husks. Through a blend of innovation and resourcefulness, these humble remnants are transformed into durable and eco-friendly particle boards, offering a compelling alternative to traditional wood-based products.
The manufacturing process involves the careful collection and processing of rice and corn husks, followed by blending with eco-friendly adhesives to form panels. Mechanical properties, dimensional stability, and environmental impact assessments are conducted to ensure the viability and compliance of the resulting particle boards.
*The Furniture industry is entirely on wood as its core elements and there by contributes to large scale deforestation. The experiment here provides a feasible and particle solution to this problem. And present "**Rice husk and Corn husk**" as a potential substitute for wood – based board materials and is serve the environment on **"Replacing the non – renewable resources and waste management"***
Regarding the particle boards, the following Physical and Mechanical properties were evaluated
- COMPRESSIVE TEST
- WATER ABSORPTION TEST

Keywords:
Sustainable manufacturing, Particle board, Agricultural by-products, Innovation, Eco-friendly materials.

1. INTRODUCTION:

Particle board, also known as chipboard, is a versatile and economical engineered wood product widely used in construction and furniture manufacturing. It is made from wood particles, such as sawdust, wood chips, and shavings, which are bonded together using synthetic resins under heat and pressure.
The production process begins with the raw materials being sorted and cleaned to remove impurities. The wood particles are then mixed with resin, usually urea-formaldehyde or phenol-formaldehyde, to form a thick, sticky mixture. This mixture is spread onto a flat surface and compressed under high pressure to form a dense panel. Heat is then applied to cure the resin, resulting in a rigid and stable board.
Particle board comes in various grades and densities, depending on the intended application. Standard grades are used for general-purpose construction, while higher-density boards are suitable for applications requiring greater strength and durability. The surface of particle board can be smooth or textured, depending on the manufacturing process and intended use.
One of the main advantages of particle board is its affordability. It is typically less expensive than solid wood or other engineered wood products, making it a cost-effective choice for budget-conscious projects. Additionally, particle board is easy to work with and can be cut, drilled, and shaped using standard woodworking tools.

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 8, No.2, August : 2024

Despite its affordability, particle board offers good dimensional stability and uniformity, making it suitable for a wide range of applications. It is commonly used in the construction of interior walls, floors, and ceilings, as well as in the manufacture of furniture, cabinets, and shelving.
However, particle board does have some limitations. It is not as strong or durable as solid wood or plywood and may not hold up well to moisture or heavy loads. Additionally, because it is made from wood particles and synthetic resins, particle board can emit formaldehyde and other volatile organic compounds (VOCs), which may pose health risks if not properly ventilated.

2.EXPERIMENTAL PROCEDURE:

The methods of Manufacturing of Particle Board the Following Steps:

2.1 Collecting of Rice husk & Corn husk

Rice husk is a waste product of rice milling that is collected after the raw grain has been milled to remove the husks. Rice husk is made of hard materials like silica and lignin, and contains about 30–50% organic carbon. It has a moisture content of about 14–15%. Rice husk is used for energy production, such as combustion and gasification. Combustion is the process of burning carbon in the rice husk, which emits CO and generates heat energy. Rice husk is also used in agriculture, such as as compost. Bio-degradation of agricultural waste into compost and incorporation into soil may enhance the nutrient recycling and maintain soil fertility.

Rice husk and its derivatives, including ash, biochar, hydro char, and activated carbon, have applications in agriculture and other industries, such as: fuel and other energy resources, construction materials, pharmacy, medicine, and nanobiotechnology.

Corn husk is the outer shell of the sweetcorn plant when the cobs have grown and are ready to be harvested. The processing of corn produces many by-products, such as corn gluten meal, corn husk, and corn steep liquor, which are rich in protein, oil, carbohydrates, and other nutrients. Yes, rice husk is an agricultural waste. It's produced in large quantities and is a major by-product of the rice milling and agro - based biomass industry. Rice husk is also called rice hull, and it's the coating on a seed or grain of rice. It's formed from hard materials, including silica and lignin, to protect the seed during the growing season. Each kg of milled white rice results in roughly 0.28 kg of rice husk as a by-product of rice production during milling. Rice husk is abundant in rice producing countries like China, India, Bangladesh, Brazil, US, Cambodia, and Vietnam. For example, India generates a huge amount of husk (approximately 24 million tons) as primarily agricultural wastes.

The handling of rice husk waste is mostly by burning, and the smoke from burning is toxic, so it has a poor impact on environmental health.

Fig: collecting husk

2.2 GRAIN CLEANING:

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 8, No.2, August : 2024
After threshing, grains (or shells, in the case of groundnuts) are contaminated by impurities (earth, small pebbles, plant and insect waste, seed cases, etc.). These impurities hinder drying operations and make them longer and more costly. After drying, especially by traditional methods such as open-air drying, the grain may still be contaminated by impurities.

These impurities lower the quality of the product and are also a focal point for potential infestation during storage. "Cleaning" means the phase or phases of the post-harvest system during which the impurities mixed with the grain mass are eliminated. This operation, which may be accompanied by a sorting of the products according to quality, is indispensable before storage, marketing or further processing of the products. It is also necessary as an operation preliminary to artificial drying of the products in dryers. Indeed, it would be not only costly but also superfluous to waste time, effort and money on drying the impurities along with the grain.

2.3 GRINDING

The grinding process of rice husk and corn husk involves reducing the size of the husks into smaller particles or powders, making them suitable for various applications.

Preparation: Before grinding, the husks may undergo preliminary cleaning and drying processes to remove impurities and reduce moisture content, facilitating efficient grinding.

Grinding Equipment: Specialized grinding equipment such as hammer mills, pulverizers, or mills equipped with blades or hammers are commonly used. These machines are designed to break down the tough husk material into finer particles.

Grinding Operation: The husks are fed into the grinding equipment, where they undergo mechanical forces that crush, shear, or impact the material. The grinding action breaks down the husks into smaller pieces or powders.

Particle Size Control: Depending on the desired application, the grinding process may include sieving or classification steps to control the particle size distribution of the ground husk material.

2.4 SELECTING FOR SUITABLE ADHESIVE:

Enhanced Flexibility:

Adhesive preparation reduces the risk of breakage and ensures that particle board can be shaped without splintering.

Improved performances:

Proper bending increases the lifespan of the material and guarantees structural integrity in applications.

Professional finish:

Applying bending techniques enable the creation of complex shapes, enhancing the visual appeal of the final product.

Example: Synthetic resin or Natural binders, soy-based binders, urea – formaldehyde resin etc.…,

BOARD FORMATION:

The project involves the creation of a wooden mould measuring 14mm x 14mm x 1.3mm and a wooden compressor designed to compress slurry into particle board. Both components are vital to the project's success. Following construction, rigorous testing procedures are implemented to reduce the risk of errors and ensure optimal performance. Testing includes verifying dimensional accuracy, assessing material quality, conducting pressure tests for the compressor, evaluating durability and longevity, and testing functionality and compatibility. These tests aim to identify and address any potential issues before full-scale production, thereby minimizing risks and ensuring the efficiency and effectiveness of the particle board manufacturing process.

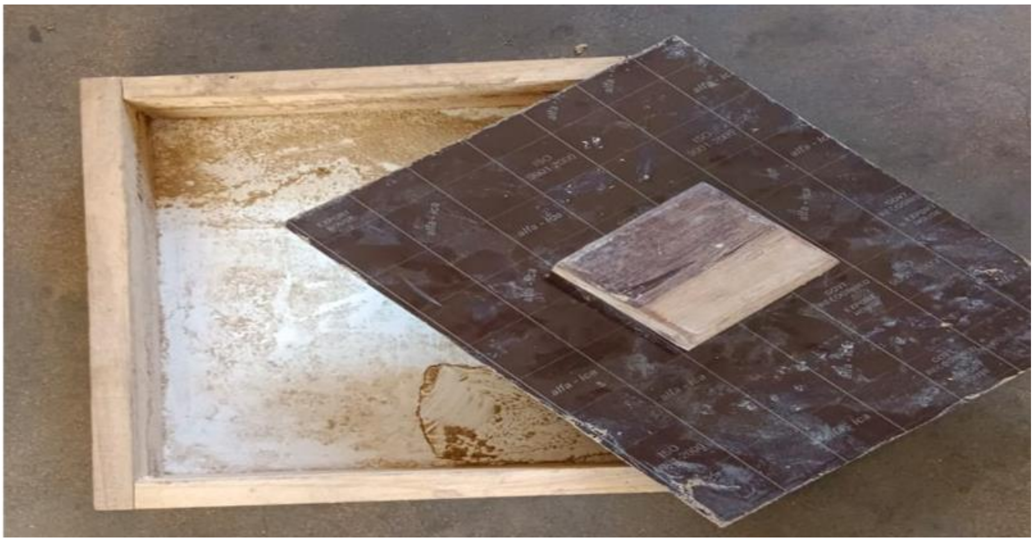

Fig: 2 Mold

MIXING:

The mixing of rice husk and corn husk with synthetic glue serves as a key process in the production of composite materials, such as particle board or fiberboard. Rice husk and corn husk are agricultural waste materials abundant in some regions. When combined with a binding agent like synthetic glue, they form a strong and durable composite material suitable for various applications in construction and furniture making.

The process involves thoroughly blending the rice husk and corn husk fibers with the synthetic glue to ensure even distribution and adhesion of the adhesive to the fibers. The mixture is typically formed into mats or sheets under pressure and heat, allowing the glue to cure and bond the fibers together, forming a solid and cohesive structure. The composition of rice husk is 50% and corn husk is 40% and synthetic resin is 10%

FORMING:

HYDRAULIC PRESS: Hydraulic presses are commonly used for forming particle board panels. These presses consist of large stationary bed and a movable platen that applies pressure to the particle board mixture. Hydraulic cylinders provide the force necessary to compress the mixture and shape into the panels.

DRYING:

MICROWAVE DRYING: Utilizes microwave radiation to heat and evaporate moisture. After the desired pressure and temperature condition have been reached, the formed particle board panel are cooled to set the binder and solidify the material. Cooling may be achieved through natural air cooling or by using cooling systems integrated into the forming equipment. The formed particle boards.

TEST PERFORMED:

COMPRESSIVE TEST:

- Note the dimensions and weight of the particle board using scale and weighing machine
- Clean the testing surface of compression testing machine
- Place the specimen in the machine in such a way that the load is applied on the opposite sides of the cube
- Align the specimen centrally on base plate of the machine
- Apply the load at the rate of 113.76N/s till the specimen fails
- Record the load at which the specimen sample fails
- Repeat the steps 2-3 time.

Observations and calculation:

Specimen sample numbers	Sample 1	Sample 2

Mass(kg)	0.5	0.54
Dimensions (mm)	14 * 14 * 1.3	14 * 14 * 1.3
Compressive strength (kg/cm2)	12.19	11.26

The average compressive strength of the particle board = 12.19 + 11.26/2
= 11.725MPa

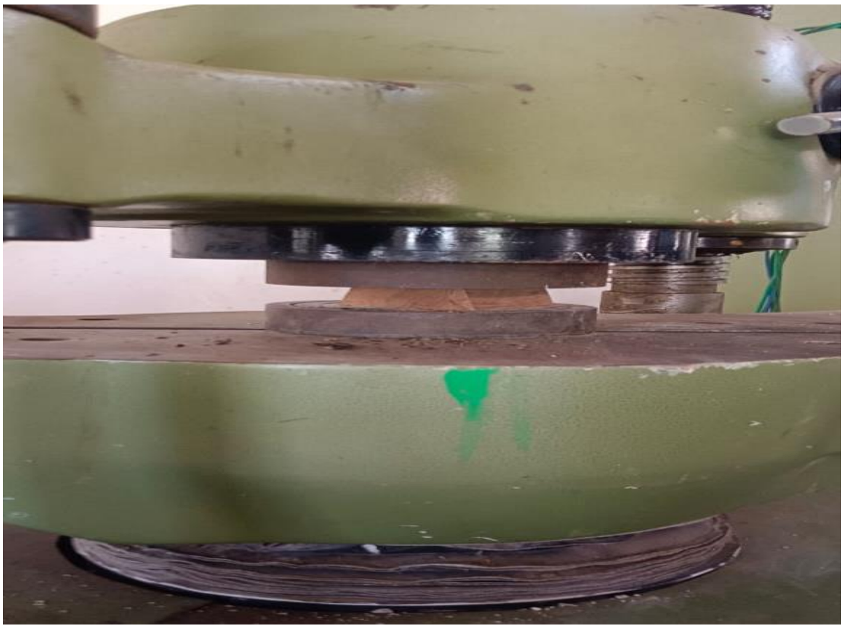

Fig : 3 compressive test

WATER ABSORPTION TEST:

- A small sample from the product is taken and weighed. It is then subjected to water absorption test. In this test, using a dripper, water is allowed to fall drop by drop on the sample for 12 hours and then for the next 12 hours the hence soaked sample is allowed to dry. The percentage of water absorbed is measured and calculated. Should not exceed 40% because the specimen is fail.
- Percentage of water absorbed= (final weight- initial weight)/ initial weight *100

OBSERVATION TABLE:

S.NO	INITIAL WEIGHT	FINAL WEIGHT	% OF WATER ABSORPTION
1	25.7g	27.4g	6.614%

ADVANTAGDES:

- The major advantage of selecting particle board is that it is a cost-effective option against plywood or medium density fiber boards.
- To control the deforestation
- To reduces the waste management
- Due to its lightweight property, particle board can be easily transported and handled
- Particle board has more screw holding capacity as compared to MDF (medium density fiber board), so it is widely used to make furniture which can be assembled using screws.
- It requires minimal maintenance and is easy to clean.

APPLICATION:

Particle board, also known as chipboard, has many applications, including:

➢Furniture: Chairs, tables, and kitchen cabinets

➢Flooring: Underlayment, structural sub-flooring, and stair treads
➢Walls: Wall panels, door core, and veneer substrates
➢Decking: Manufactured home decking
➢Other: Shelving, storage containers

CONCLUSION:

Particle board, a versatile engineered wood product, offers cost-effective and environmentally friendly alternatives to traditional wood boards. Composed of wood particles bonded together with resin, it boasts excellent dimensional stability and uniform strength. Its smooth surface allows for easy finishing and painting, making it suitable for various applications in furniture, cabinetry, and construction. However, it's susceptible to moisture damage and may emit formaldehyde, posing health concerns. Overall, particle board's affordability, ease of use, and eco-friendly nature make it a popular choice in the woodworking industry, though its limitations necessitate careful consideration in specific applications and environments.

FUTURE SCOPE:

The pared strength of the binder can be increased. Using more advanced Adhesive, the strength of the product can be increased manifolds. Also, with further research on the same, more practicable results can be obtained and the product can be marketed.

REFERENCES:

❖ Biological, physical and mechanical properties of particleboard from waste tea leaves [1997] - M. K. Yalinkilic, Y. Imamura, M. Takahashi, H. Kalaycioglu, G. Nemli, Z.Demirci, T. Ozdemir

❖ Characterization and utilization of vine prunings as a wood substitute [2002] - G. A. Ntalos, A. H. Grigoriou

❖ Suitability of kiwi (Actinidia sinensis Planch.) prunings for particle board manufacturing [2003] - G. Nemli, H. Kirci, B. Serdar, N. Ay

❖ Bamboo chips as an alternative lignocellulosic raw material for particle board manufacture [2004] N. Papadopoulos, C. A. S. Hill, A. Gkaraveli, G. A. Ntalos, S. P. Karartergiou

❖ Manufacture and properties of binderless particleboard from bagasse [2005] R. Widyorini, J. Xu, K. Umemura, S. Kawai

❖ Some of the properties of particleboard made from paulownia [2005] - H. Kalaycioglu, I. Deniz, S. Hiziroglu

❖ Properties of Medium Density Fiberboard (MDF) made from wet and dry stored bagasse [2006] H. Z. Hosseinabadi, M. Faezpour, A. J. Latibari, A. Enayati

❖ Application of liquefied wood as a new particle board adhesive system [2010] - M. Kunaver, S. Medved, N. Cuk, E. Jasiukaityte, I. Poljansek, T. Strnad

❖ Characterization of raw materials and manufactured binderless particleboard from palm biomass [2011]
- R. Hashim, W. N. A. W. nadhari, O. Sulaiman, F. Kawamura, S. Hiziroglu,

❖ M. Sato, T. Sugimoto, T. G. Seng, R. Tanaka • Producing particle board using of mixture of bagasse and industrial wood [2011] - T. Tabarsa

❖ Development of eco-friendly particle board composites using rice husk particles and gum arabic [2013]
- Y. Suleiman, V. S. Aigboidion, L. Shuaibu, M. Shangalo

❖ Assessing the potential of particle board production from food waste [2017] - S. vakalis, A. Sotiropoulos, K. Moustakas, D. Malamis, M. Loizidou