

# Rice Hull

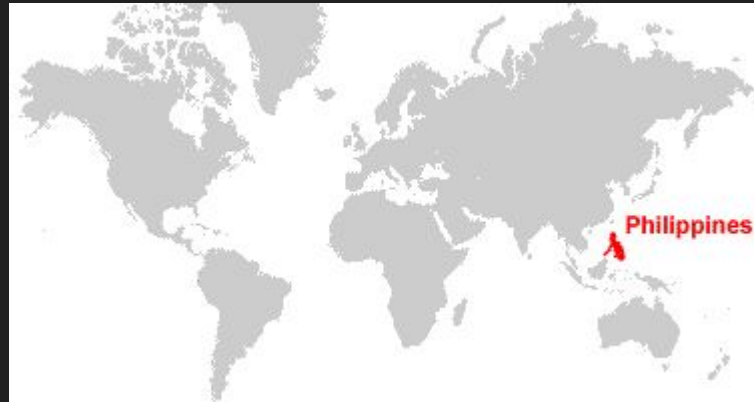
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# Objective

- To research a material not covered in class that has significant use in countries outside of the U.S.
- Learn about the uses, properties, standards, and background of this certain material.
- Material: Rice Hull
- Country: Philippines



# Introduction

- Rice hull is the protective covering around rice grains as they grow which are then removed by milling.
- The husks can then be reused as a building material instead of going to waste.
- Used as an indigenous material and produced abundantly in the Philippines and many parts of Southeast Asia.
- Renewable material with environmental benefits since it is a byproduct.
- Has favorable material properties.

# Background of Material

- Rice hull has been utilized as building material for a very long time.
- The Philippines produces an abundant amount of rice hulls making it an environmental and extremely low cost by-product to use as a building material.
- Damage to structures in the Philippines due to termites and earthquakes is solved with the use of rice hull.
  - Bamboo and wood structures being used last no longer than around five years.

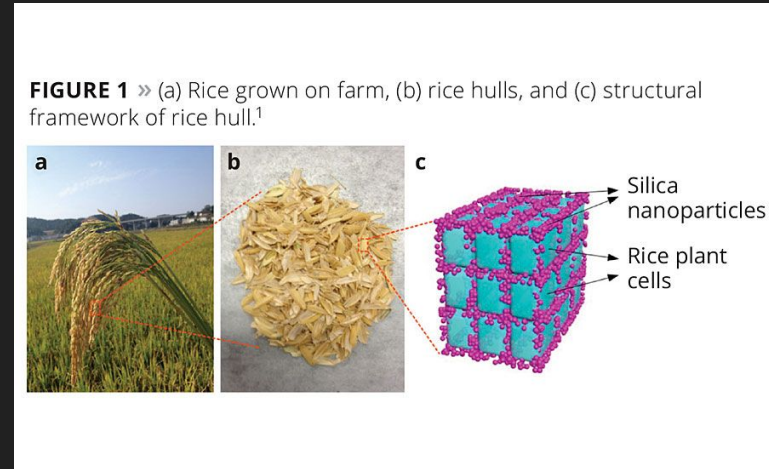
# House made of Rice Hull and Clay

- Provides strong and durable structure
- Good insulation
  - Stays cool in heat and warm in cold



# Properties of Rice Hull

- Does not flame or smolder easily
- Resistant to moisture penetration and fungal decomposition
- Does not transfer heat well
- No gas emitted
- Not corrosive with respect to certain metals



# Construction Uses and Practices

- Building Material
  - Rice Hulls as aggregate combined with clay as a binder to make blocks
  - High stiffness and strength
- Used as insulator
  - Resistant to moisture and fungus
  - Does not flame or decompose easily
- Rice Hull Ash (RHA) can be used with concrete as a supplementary siliceous material.



Figure 1: Rice Hull Blocks

# Rice Hull Ash (RHA)

- Partial replacement of cement in concrete.
- Advantages:
  - Less expensive
  - More environmental (byproduct and cement production).
  - Concrete keeps same compressive strength
  - Same density
  - More resistant to sulfate
  - More durable
- Disadvantage:
  - Less workability (water reducer needed)

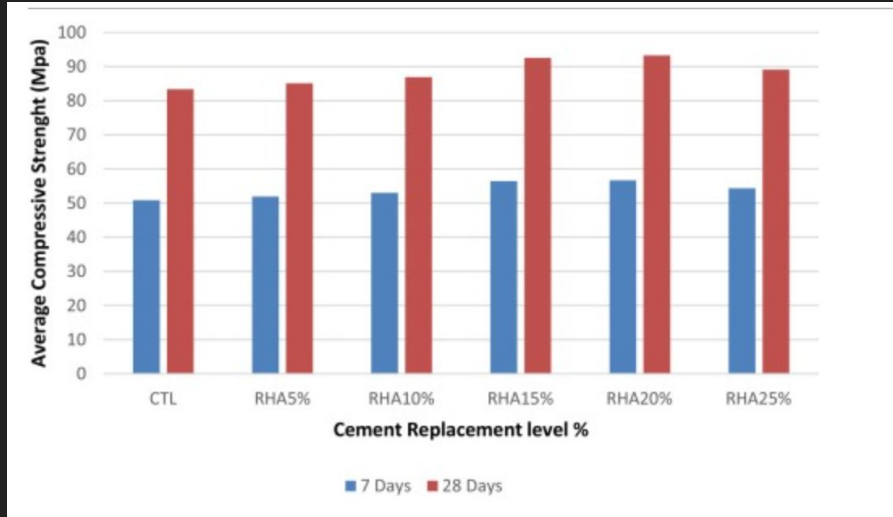


[1]

- Chemical Composition Ratios
  - $\text{SiO}_2$ : 78–86
  - $\text{Al}_2\text{O}_3$ : 1–2.0
  - $\text{Fe}_2\text{O}_3$ : 16–1.85
  - $\text{CaO}$ : 55–4.81
  - $\text{MgO}$ : 35–4.5
  - $\text{SO}_3$ : 24–1.18
  - $\text{Na}_2\text{O}$ : 1–1.14
  - $\text{K}_2\text{O}$ : 54–3.68



# Graphical Information



[2]

Mix plan	7 days	28 days	S.S,D
Control	50.84	83.36	2530
RHA 5%	51.92	85.12	2511
RHA 10%	53	86.9	2478
RHA 15%	56.43	92.51	2463
RHA 20%	56.67	93.28	2451
RHA 25%	54.35	89.1	2437

Table 1 and 2: Concrete Compressive Strength with RHA

# Known ASTM Standards for Rice Hull

- From the Rice Hull House Source:
- Insulation Material
- Design Density Test: Density of 9.807 lb/cu.ft
- ASTM E 970: Critical Radiant Flux Test
  - Average CRF was 0.29 W/sq.cm
  - Coefficient of variation was 0.05. - Passed standard test
- ASTM C 739, Section 14: Smoldering combustion test
  - 3 samples showed weight loss of 0.07%, 0.03%, 0.03% - Passed
- ASTM C 739, Section 9: Corrosiveness test
  - Passed



# Rice Hull House Insulation Project

- Houses indistinguishable from normal homes using rice hulls as the only insulator.
- Project hopes to develop communities of these houses to reduce costs and energy consumption.
- Rice Hull classifies as Class A or Class I insulation Material.
- Reduces energy needs for heating and cooling by 24%.
- Environmental and affordable since a byproduct is being recycled.



Figure 2: Rice Hull insulation construction

[3]



Figure 3: Rice Hull insulated House

# Other Possible Uses

- Rice hulls are useable in horse and animal feeding. While it is not a great source of fiber and it can be sharp on their mouths, it can be used as long as it is not over 10% of the full diet.
- Usage in cardboard and particle boards. Using rice hull makes it less attractive to termites which is a very important factor for boards in some areas where they are very common.
- These hulls can also be used as a substitute for anything that needs a similar type of material to wood shavings, and wood fiber.

# Tangible Factors

- Some locations we came across through our research :
  - Many parts of Southeast Asia
  - Majority in the Philippines
  - Thailand
- These locations have very similar weather as well as similar soil conditions.
- These conditions work very well when the strengths of rice hull are used in some of these areas.

# Intangible Factors

- One drawback that prevents the advancement of rice hulls from having more common usage is that it produces a large quantity of smoke when it is combusted.
- One way that this has been controlled over the years is by using gasification, which uses a gasifier to minimize the amount of dark, black smoke that is produced.
- Rice hull, also known as rice husk, is a viable cheap option but it is not as abundant as we would need in order to have it as a main source. This is because it is only 20% of a grain of rice and after it is obtained, only 20% of that is left when it is burnt and boiled.

# Case Study

Where ? - Pichit Thailand

Who ? - AT Biopower

What Occurred ? - AT Biopower purchased rice hull as well as a couple systems including one that controls the ash, and denseveyors that are used to minimize the amount of dust created.

Outcome - This system was able to assist the company with their needs by limiting the excess dust, maximizing their value, and also making it able to withstand the high temperatures.



Figure 4 : Denseveyor

# Conclusion

- Abundantly available in the Philippines due to the massive amount of rice produced within the country.
- Indigenous material.
- Has many uses due to its favorable properties.
- Properties:
  - High strength and Stiffness
  - Resistant to corrosion, heat, fungus, and moisture
  - Good insulation
- Uses:
  - Building material
  - Aggregate
  - Insulator
  - RHA cement
- Environmental and cost effective.



# References

- [1] Rice Husk Ash in Concrete: Uses, Pros & Cons & Its Effect on Properties of Concrete, from <https://gharpedia.com/blog/rice-husk-ash-in-concrete-pros-cons/>
- [2] Rice husk ash as a partial replacement of cement in high strength concrete containing micro silica: Evaluating durability and mechanical properties, from <https://www.sciencedirect.com/science/article/pii/S2214509516300924>
- [3] The Rice Hull House, from <http://www.esrla.com/pdf/ricehullhouse.pdf>
- [4] Case Study from, [Ground Rice Hulls Ash | Macawber Engineering, Inc.](#)
- [5] Husk-to-Home: A Sustainable Building Material for the Philippines, from [https://cfpub.epa.gov/ncer\\_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/10834](https://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/10834)

Thank You!

Any Questions?