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Experimental Study of Effect of Rice Husk Ash on Building Thermal Insulation

Shailesh Singh Thakur[1], Dheeraj Lal Soni[2] and Pankaj Soni[3]

[1]Assistant Professor, Kalinga University, Atal Nagar Raipur
[2]Assistant Professor, Kalinga University, Atal Nagar Raipur
[3]Pro-Term Lecturer, Chhattisgarh Swami Vivekanand Technical Universiy, Bhilai
E-mail: [1]shailesh8484@gmail.com, [2]dlsbhilaisoni@gmail.com, [3]psbhilai24@gmail.com

Abstract—*In present century the different-different technology has been developed for human comfort but day by day atmospheric conditions also changes. Their fore the energy consumption may also be changed. Building consumes many more energy like heating and cooling. It is required to focus the building thermal insulation. Building designers can solve the problem of energy consumption by selection of appropriate thermal insulations. The main objective of this work is to study the ability of the rice husk ash as a mixing material for cement replacement in concrete. The mixing of rice husk ash in concrete improves the strength properties of concrete. It is an effort made to develop the concrete using rice husk ash as a source material and other mixture properties which gives tensile strength and compressive strength over the normal concrete.*

1. INTRODUCTION

It has been observed that the last 20 to 30 years the warmest surface temperature in recorded. In general, energy consumption can be examined under four main sectors such as industrial, building/residential, transportation and agriculture. In most countries, buildings are large consumers of energy with a substantial share of energy invested to heat or cool the space. After the burning of rice husk the produced ash fulfils the physical characteristic and chemical composition of mineral admixtures. The effect of cooling or heating in a building can be substantially reduced through the proper usage of building insulation material, thereby reducing the required air-conditioning size as well the annual energy cost. To obtain good quality of ash it is required suitable furnace as well as grinding method for burning and grinding rice husk. The optimized rice husk ash has been used in cement and concrete. Using it provides several advantages, such as improved strength and durability properties and environmental benefits related to the disposal of waste materials and to reduced carbon dioxide emissions.

Rice husk (hull), the hard protecting layer of rice grains, is an agricultural by-product generated by milling of paddy. It is used as fuel in the mills to generate steam for the parboiling process. About 25 % of its weight is converted into ash during the firing process and is known as rice husk ash (RHA). RHA is high in silica and hence a very good insulator. RHA is an excellent insulator, having low thermal conductivity, high melting point, low bulk density and high porosity.

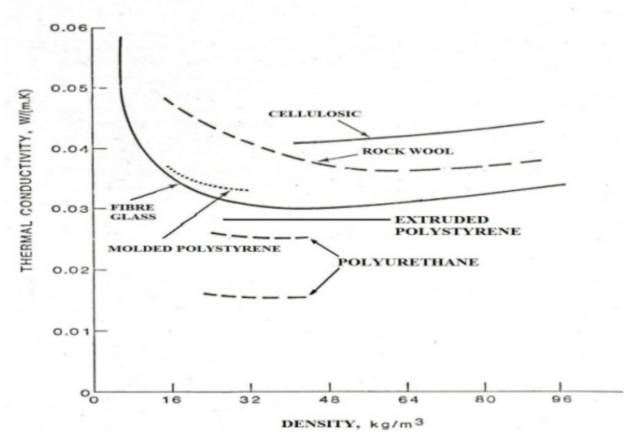
2. PROPERTIES OF RICE HUSK ASH:

Rice husk ash is having different physical and chemical properties. The product obtained from rice husk ash is identified by trade name silpoz which is much finer than cement.

1. Factors influencing thermal insulation selection

1) Thermal characteristics: Thermal resistance is a measure of the effectiveness of thermal insulation to retard heat flow. A high thermal resistance to the flow of heat and thus a high R-value (or low thermal conductivity value) is desirable. Also there should be continuity/thermal bridging of thermal insulation around walls/roof with minimum framing requirement. The thermal storage benefits from massive walls is yet another feature. The coefficient of thermal expansion (or contraction) is required for design of expansion and contraction joints in the insulation system. Other properties include thermal diffusivity, specific heat, thermal shock resistance and emittance.
2) Combustibility : The property of the insulating material to resist combustibility and its potential contribution to a fire hazard determined by its flash point temperature, flame point temperature, self-ignition temperature, burning rate, rate of flame travel, heat contribution, explosion index, auto-internal heating, toxicity of products of combustion, smoke density, melting point temperature, etc.
3) Mechanical properties: Strength in compression, tension, shear, impact, flexure, abrasion resistance, resistance to vibration is desirable for insulations used in load bearing roofs and floors. Other desirable properties depending on application include density, hardness, resilience, resistance to settling, permanence, reuse value, dimensional stability and uniformity, etc.

4) Moisture related properties: Includes capillarity, hygroscopicity, water migration, water permeability and absorption, shrinkage-wet to dry.
5) Cost: The cost of insulation (cost per R-value), the cost of workmanship/labor, the impact on air-conditioning equipment size and initial cost, and, the impact on energy/operating cost.
6) Ease of construction: The impact on workmanship requirements, ease/speed of construction and ease of operation, maintenance and replacement.
7) Building codes requirements (safety and health issues) : Includes fire resistance capabilities, health hazards (toxic or irritating fumes), Structural stability (load bearing vs. non load bearing, compressive strength), etc.
8) Durability: The change in R-value over time, the effects of water and moisture, dimensional stability, settling over time, strength, effect of chemicals and other corroding agents, biological agents (dry rot and fungal growths).
9) Acoustical performance: The ability of insulation for sound absorption and insulation.
10) Air tightness: Includes vapor/infiltration barrier, sealed penetrations, no cracks and good weather stripping.



2. Economic Thickness of Building Insulation

The cost of installed insulation increases with thickness. This increment cost is in terms of labor as well as material. The life cycle costing (LCC) spreads the initial cost of the insulation over the number of years the insulation is expected to be in service. Since insulation is often applied in multiple layers (Figure 3) and more insulation does not necessarily imply the better, the optimum economic thickness of insulation is defined as the thickness of insulation for which the cost of the added increment of insulation is just balanced by the increased energy savings over the useful life of the building project. As thickness increases, the average slope of the curves increases with the number of layers because the labor and material costs increase at a more rapid rate. Insulation lowers the energy demand by reducing the size and capital cost of the air-conditioning equipment required for an installation. The point A on the total cost curve corresponds to the economic insulation thickness.

3. Physical properties of Rice husk ash:

Sr. No.	Particulars	Properties
1	Colour	Gray
2	Odour	Odourless
3	Specific gravity	2.3
4	Appearance	Fine
5	Shape texture	Irregular

4. Chemical properties of Rice husk ash:

Sr. No.	Particulars	Proportion
1	Iron oxide	0.1%
2	Sodium oxide	0.1-0.8%
3	Silicon dioxide	85.6%
4	Aluminum oxide	0.2%
5	Iron oxide	0.1%
6	Magnesium oxide	0.5%

5. Experimental work:

The primary air of experimental work is to study the properties of rice husk ash.

Objective:

1) Effect of compressive strength of concrete.
2) Effect of density.
3) Effect of hardness.
4) Effect of water absorption
5) Effect of water vapour transmission.
6) Effect of Water vapour Permeance.

Mix design of concrete:

Sr. No.	Particulars	Quantity
1	Rice husk ash	2 kg
2	Cement	1 kg
3	Plaster of Paris	500 gm
4	Lime	500 gm
5	Fabrocrette	200 ml

6. Test result and discussion:

1) Water Vapour Absorption

Specimen	Water absorption as a percentage by Volume	Water absorption per unit surface Area (Cm^3/m^2)
1	48.4578	4301.556
2	43.23252	3596.922
3	54.1218	4167.31
4	52.56127	4480.278
5	62.92431	5382.732

6	67.72637	5573.224

2) Water Vapour Transmission Rate:

Weight change of specimen with beaker in humidity chamber operation.

Specimen	Original weight in gm	weight in gm (after 24 hr.)	weight in gm (after 48 hr.)	weight in gm (after 72 hr.)
1	239.58	242.08	243.79	245.55
2	233.65	236.65	238.53	240.51
3	198.95	202.01	204.21	206.43
4	247.45	250.73	252.78	254.82
5	267.59	270.40	272.34	274.36
6	260.55	262.64	264.11	265.64

3) Water Vapour Transmission Rate (μg/m²s)

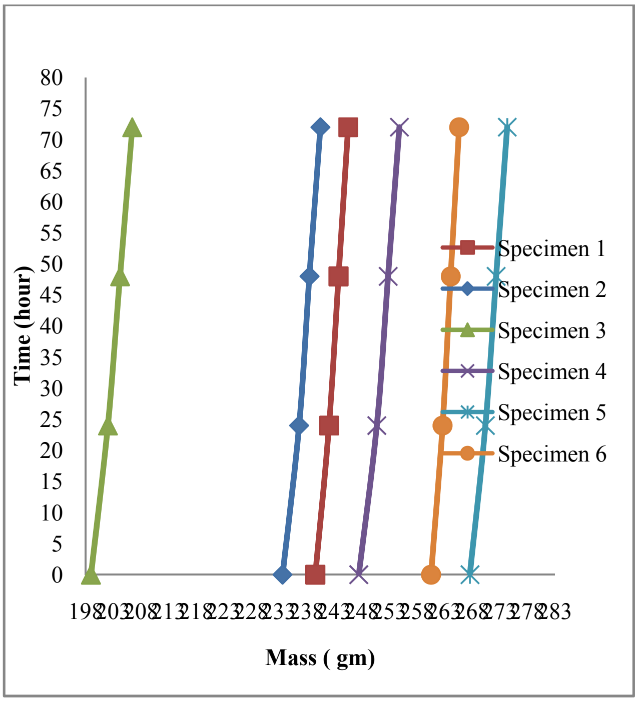
Temperature	After 24 hr.	After 48 hr.	After 72 hr.
SPECIMEN wt. in (gm)	**WVT**	**WVT**	**WVT**
SPECIMEN 1	8282.32	5665.316	5830.753
SPECIMEN 2	10059.07	6303.684	6638.98
SPECIMEN 3	10198.6	7332.348	7399.006
SPECIMEN 4	10866.4	6791.502	6758.373
SPECIMEN 5	9337.304	6446.395	6712.225
SPECIMEN 6	97007.81	4928.944	5130.126

4) Water vapour Permeance (ng/pa.s.m²)

Temperature	After 24 hr.	After 48 hr.	After 72 hr.
SPECIMEN wt. in (gm)			
SPECIMEN 1	15.03143	10.28188	10.58213
SPECIMEN 2	18.25603	11.44044	12.04897
SPECIMEN 3	18.50926	13.30735	13.42832
SPECIMEN 4	19.72124	12.32577	12.26565
SPECIMEN 5	16.94611	11.69945	12.1819
SPECIMEN 6	12.71836	8.945452	9.310574

5) Water vapour Permeability (ng/pa.s.m)

Temperature	After 24 hr.	After 48 hr.	After 72 hr.
SPECIMEN wt. in (gm)			
SPECIMEN 1	0.6734	0.4606	0.474
SPECIMEN 2	0.8105	0.5079	0.5349
SPECIMEN 3	0.6644	0.4777	0.482
SPECIMEN 4	0.874	0.5462	0.5436
SPECIMEN 5	0.749	0.5171	0.5384
SPECIMEN 6	0.517	0.4016	0.418



7. Conclusions

The effect of rice husk ash on building thermal insulation contribute in reducing the required air-conditioning system size as well as reducing the annual energy cost. At present building rating systems are transforming the construction industry by focusing on high performance, energy efficient, economical and environmental friendly building.

The paper presents an overview of the effect of rice husk ash on building thermal insulation, thermal insulation types, materials, properties and testing methods as per the BIS and ASTM standards.

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