Experimental Investigation on Sound Absorption Property of Concrete Block using Agro-waste

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Abstract- ***Noise pollution is a type of pollution which is a serious issue of concern. In the entire world, every living thing like human beings, domestic and wildlife animals has a certain frequency of hearing. Also, the constant noise affects the hearing ability and causes severe problems to the health. To address this problem and to replace the sound absorbents which are made of harmful materials causing harm to the environment a solution is tried to be introduced by using agro waste in the bricks. The bricks cast using agro waste absorb the sound and convert it into thermal energy. The specific formulations of the mix ratio are done by mixing all the used agro waste in equal ratios as per calculations with the cement of the same quantity and sand. It was also focused on to replacing the sand with some percentages to find whether the agro waste works as a replacement of sand. The goal of the research paper is the investigate the sound absorption property of brick using agro wastes like rice husk, sugarcane bagasse and coconut shell.***

Index Terms- ***Agro waste, Acoustic Property, Brick, ultrasonic pulse velocity***

I. INTRODUCTION

Noise is a sound type that is unwanted and cause chaos to living things. In the current era, it's observed that there are various sources of noise pollution. As the world is developing and introducing new technologies, various kinds of pollution are caused and are increasing a at high rate.

Focusing on noise pollution, there are various methods & techniques introduced to control, avoid and block noises caused due to noise pollution. This research, was focused on blocking the sound waves that of high frequency and amplitude and were disruptive. Currently, there are lots of solutions available in the markets which are made up of chemical compositions and also by using harmful materials. The chemical namely fiberglass, and Foam plastic made sound absorption materials harms the environment during their manufacturing process by emitting VOC (Volatile Organic Compound) and some during their use. To avoid these factors which cause environmental harm, it is experimented in this research to use Agro waste and investigate whether the naturally made agro waste does provide sound absorption property when used in blocks. The blocks emitting sound absorbing property made of agro waste absorbs the sound and converts it into thermal energy.

There is a large-scale production of Agriculture waste (agro waste) in India. Also, it will be best replacement for harmful chemicals that causes pollution and it will also be the reuse of the wastage, which comes from the agricultural side. The need for Acoustical bricks, blocks & panels will be high in the future due to the continuous increase in noise pollution and also to avoid the seamless noise surroundings near main roads and marketplaces. The Acoustical blocks are needed to create productive places like offices, Schools and educational places, Hospitals and healthcare centers, Theaters, recording studios, etc.

The agro waste used were rice husk, sugarcane bagasse and coconut shell, all these agro waste have high scale of production in India. Also, their waste is thrown away a high scale or else it is burnt. It have many advantages compared to another chemically made sound absorbent like light in weight, low cost as compared to chemically made bricks & blocks, availability of agro waste is constant that is why the stock will be always available, and reuse of waste collected from the agricultural industry, no damage to the environment, no need of highly toxic chemicals, etc.

II. MATERIALS

Figure 1: The Agricultural Waste used for the preparation of Brick

The materials used for the preparation of the sound absorption property of brick are Cement, sand, water and agro waste like rice husk, sugarcane bagasse and

coconut shell powder. All the agro waste was used in its powdered form in the cement concrete mortar with the proper proportions taken out from the calculations.

A. *Cement:-* Cement is the second most used material in the world which is made up of calcareous and argillaceous materials. Basically, it works as a binder in cement concrete mortar when mixed with water. The cement when mixed with aggregates, sand and water form concrete, after getting hard it possesses high compressive strength and is used in every work of construction.

B. *Sand:-* Sand is also known as fine aggregate and the size of the fine aggregate lies between 0.075mm to 4.75mm. The use of fine aggregates are to fulfill various requirements such as providing workability to concrete, filling the voids in the mortar it is used as a filler material, building a good bond between coarse aggregates and cement by filling the minute voids between them and increasing its strength, etc.

C. *Water:-* The water used in construction works must be potable, clean and free from chemicals to avoid damages and failures to meet the quality standards of the building construction.

D. Agriculture waste:-

1) *Rice Husk:* - The production of rice is high in West Bengal, Andhra Pradesh, Uttar Pradesh, Punjab and Tamil Nadu due to the favourable climatic and agricultural conditions. The rice husk is the by-product of the rice grains after harvesting. The rice husk is composed major percentage of lignin, cellulose and hemicellulose and some percentage of silica and another organic compound.

2) *Sugarcane Bagasse:-* The sugarcane bagasse is already being used as an Environment-friendly source of energy generation in the production of Biomass fuel, etc. It has high cultivation in the states like Karnataka, Tamil Nadu, Maharashtra and Uttar Pradesh. It is a residue containing fiber left out when the sugarcane's juice is extracted completely, it also contains lignin, cellulose, hemicellulose and some quantity of pectin, etc.

3) *Coconut shell:* - The coconut shell is the outermost layer of the Coconut fruits with acts as the hard covering of the fruit. When the coconut fruit is taken out from the coconut shell by breaking, it remains a by-product of the coconut fruit. The coconuts are highly cultivated in the southern side of Indian states like Kerala, Tamil Nadu, Karnataka and Andhra Pradesh due to the suitable coastal climatic conditions.

4) *Wheat Husk:* - In wheat, the husk is the outer cover of the wheat and it's known as wheat husk.Wheat is majorly cultivated in the states like Punjab, Uttar Pradesh, Haryana and Madhya Pradesh. Like Rice husk and other agro waste, it also consists of lignin, cellulose and hemicellulose along with some small ratio of another organic compounds.

III. METHODOLOGY

Figure 2: Process of preparation of brick emitting sound absorbing property using agro waste

A. *Material Sourcing:-* The materials like agro waste were sourced from the places where they are produced. The Rice husk & wheat husk, Sugarcane bagasse, and coconut shell were sourced from farms, juice centers and temples respectively.

B. *Sun Drying:-* After sourcing the materials from their respective sources they were kept for drying naturally under sunlight. The need for sun drying was only required for sugarcane bagasse and coconut shell, as rice husk and wheat husk are already available in dry conditions. Sugarcane bagasse requires up to 15-20 days of drying due to its dense fibrous material in the month like December due to cold temperatures and coconut shell took around one week to dry as it was already semi-dry.

C. *Cleaning:-* All the agro waste after drying was cleaned manually as the rice husk had some small size of aggregates and insects and sugarcane bagasse had a hard layer outside which was hard for grinding hence it has to be removed.

D. *Grinding:-* All the Agro-waste was grinded after cleaning and were converted into its powdered form.

E. *Sieving:-* The agro wastes after grinding were sieved in the 100-micron sieve.

F. *Batching:* - After sieving of Agro wastes the materials were batched according to the requirements as mentioned in table 1.

Sr. no.	Sample	Quantity of cement (kg)	% of replacement of sand by Agro-waste (kg)	Quantity of sand (kg)	Quantity of particular Agro-waste (kg)				Total quantity of Agro-waste mix (kg)
					Qty. of rice husk (kg)	Qty. of Sugarcane Bagasse (kg)	Qty. of coconut Shell (kg)	Qty. of Wheat husk (kg)	
1	Sample A	3.456	0%	18.432	---	---	---	---	---
2	Sample B	3.456	20%	14.7456	0.925	0.925	0.925	0.925	3.6864
3	Sample C	3.456	40%	11.0592	1.843	1.843	1.843	1.843	7.3728
4	Sample D	3.456	60%	7.3728	2.764	2.764	2.764	2.764	11.0592
5	Sample E	3.456	80%	3.6864	3.686	3.686	3.686	3.686	14.7456

G. *Moulding:* - When all the pre-procedures were completed successfully the molding (casting) of the brick began. Where the cement concrete mortar was made using cement, sand, water and a mix of agro waste mixed and molded based on the calculative formulations.

H. *Drying:* - After the molding of the brick of dimension 0.35m*0.127m*0.203m it was allowed to dry naturally for 14days.

I. *Testing:* - When the bricks were hard and had gained enough strength so that they could be tested the testing was done. Two types of tests were done compression test in the Compressive Testing Machine to determine the compressive strength and Impedance Tube test for the sound absorption coefficient.

J. *Analysis:-* After performing both tests the results were analyzed and the investigation results were declared.

The quantity of cement, sand and agro waste mix are mentioned in Table 1, which were used in the manufacturing of the brick of dimension 0.35m*0.127m*0.203m.

1) Sample - A = 0% Agro waste mix + cement +100% sand + water
2) Sample - B = 20% Agro waste mix + cement + 80% sand + water
3) Sample - C = 40% Agro waste mix + cement + 60% sand + water
4) Sample - D = 60% Agro waste mix + cement + 40% sand + water
5) Sample - E = 80% Agro waste mix + cement + 20% sand + water

IV. EXPERIMENTAL WORKS

A. *Ultrasonic Pulse Velocity test :-* The Ultrasonic Pulse Velocity testing machine was used to measure the sound absorption property of the concrete block by transmitting Ultrasonic pulse waves at some specific frequency through one end of the concrete block to its other end and the data is recorded by the data acquisition system at different levels and positions of sound pressures and frequencies. There are three methods of conducting ultrasonic pulse velocity test (i.e. Direct transmission, Indirect transmission and Semi-Direct transmission) from which the method of Direct transmission of ultrasonic pulse velocity waves were conducted along the long longitudinal side i.e at 0.35m. (Majorly for Sound Absorption Coefficient test it is recommended to adopt Impedance tube test.)

B. *Compression testing :-* In the Compression testing machine the compressive bearing strength of the concrete bricks and cubes are determined. It is also known as UTM i.e. universal testing machine or CTM i.e. compression testing machine.Usually, the test is conducted till the failure in the specimen occurs. It can be achieved by crushing the block or by reaching to the final predetermined maximum compressive load. The maximum load at which the

specimen failed is used for the calculation of compressive strength of the specimen, the results are expressed either in MPa i.e megapascals or Kn/mm^2 i.e. kilo-newton per millimeter square.

V. RESULTS & ANALYSIS

A. *Sound Absorption Coefficient:-* The Sound Absorption Coefficient is the Coefficient that represents the Sound Absorption dimension ranging from 0-1.Where the quality of sound absorption property of the specimen block was investigated. For the studies the range of the sound absorption coefficient has been derived as mentioned in the table 2.

Sr. No.	Sound Absorption Coefficient	C Class
1	0.90 to 1.00	Class - A
2	0.80 to 0.85	Class – B
3	0.60 to 0.75	Class - C
4	0.30 to 0.55	Class - D
5	0.15 to 0.25	Class - E
6	0.00 to 0.10	Not classified

Table 1: Range of Sound Absorption Coefficient

From the table 4, it is observed that the concrete bock with 0% Agro waste and 100% Sand has the least number of sound absorption coefficient as compared to the concrete block of 80% Agro waste and 20% Sand. All the Samples with decreasing quantity of sand and increasing quantity of Agro waste has resulted that there is an increase in the sound absorption coefficient of concrete block.

From table 2, the Class of the quality of the block can be determined. The Sample E falls under Class A with 0.91 sound absorption coefficient, The sample A falls under the Class E with 0.20 sound absorption coefficient and all the other Samples i.e Sample B, C and D comes under Class B,C and D with 0.84,0.65 and 0.54 respectively.

B. *Compressive strength :-* Compressive strength is the ability of the Concrete to have resistance without going into any failures and deformation against compressive axial forces.

Sr. No.	Sample	Compressive Strength (MPa)
1	Sample - A	17.2
2	Sample – B	15.8
3	Sample – C	13.2
4	Sample – D	12.4
5	Sample - E	8.6

Table 2:- Compressive Strength using Compression testing machine

From the above results of the compression test it was observed that Sample - A having 17.2Mpa of compression strength have least sound absorption coefficient and Sample – E having 8.6Mpa of Compression test have highest sound absorption coefficient, and all the other samples have similar results, from which it is confirmed that the concrete block with maximum quantity of agro waste is better in compression and best in sound absorption.

CONCLUSION

It can be concluded that the higher the quantity of Agro waste in the mix proportion of the concrete block of dimension 0.35m * 0.127m * 0.203m the higher is the sound absorption coefficient. On other side, it was observed that the decrease in quantity of the sand lead to the decrease in the Compressive strength of the block samples. So, there is an inversely proportional relation between the Sound absorption coefficient and the Compression strength of the block.

Sr. No.	Sample	Frequency (C)		Speed of Sound (v)	Transmission Loss (T.L.)	Sound Absorption Coefficient (α)
Units		Hz		m/s	Hz	α = 0, Perfect reflection α=1, Perfect Absorption
		P_i	P_r		P_i-P_r	
1	Sample – A 0% - Agro Waste 100% - Sand	3200	3200.99	241	0.990	0.20
2	Sample – B					

	20%-Agro Waste 80% - Sand	3200	3203.49	274	3.429	0.54
3	Sample – C 40%-Agro Waste 60% - Sand	3200	3200.65	567	4.569	0.65
4	Sample – D 60%-Agro Waste 40% - Sand	3200	3208.211	210	8.211	0.84
5	Sample – E 80%-Agro Waste 20% - Sand	3200	3210.655	1573	10.655	0.91

Table 3: Sound Absorption Coefficient

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