Engineering and Scientific International Journal (ESIJ)
Volume 2, Issue 2, April - June 2015
ISSN 2394-187(Online)
ISSN 2394-7179 (Print)

Impact on Thermal Properties of Burnt Clay Bricks using Foundry Sand

Mr. Pradeep G.Patil[1] and Dr Vijayadevi S. Patil[2]
[1]*Department of civil engineering D.Y.P, Ambhi-Talegaon*
Email: patilpg24@gmail.com
[2] *Department of civil engineering D.Y.P, ambhi - Talegaon*
Email: vijaya@rediffmail.com

Abstract— Industrial waste such as foundry sand and many others are posing problems to manufacturing industries as strict environmental policies are not allowing open dumping or stacking of these waste materials. To solve the problem many countries are using these wastes as construction material in various areas of construction.

In this work, use of foundry sand and sawdust with various percentages is done to manufacture clay bricks. Percent replacement of soil is done by 20%, 30% & 40% with foundry sand and compared with normal bricks from three different manufactures from different areas. At 20% replacement of foundry sand bricks have shown optimum thermal and physical properties.

Keywords— Foundry sand, Thermal properties, saw dust, Compressive strength, water absorption.

1. Introduction

External walls of the building component are one which is exposed maximum to the environment, with its maximum area exposed, on a façade. Facades are normally constructed with burnt clay bricks. Heat transfer through this façade of burnt clay bricks increases the indoor temperatures leading to discomfort[1]. To improve thermal properties of burnt clay bricks industrial wastes (i.e. Foundry sand & Saw dust) are used with various percentage mix proportion bricks are manufactured and tested for their thermal conductivity. Improved thermal property can be used as thermal insulation, which will reduce heat transfer and be one good way of energy conservation.

The thermal conductivity (k) of insulation is a measure of the effectiveness of the material in conducting heat. Thermal resistance (R) and the thermal transmittance (U) these are two properties related to thermal performance of insulation. The thermal resistance of a material can be defined as the measure of the resistance to heat flow as a result of suppressing conduction, convection and radiation. The thermal transmittance is defined as the rate of heat flow through a unit area of a component with unit temperature difference between the surfaces of the two sides of the material. The thermal properties of bricks are directly related to porosity of a material[16] so to improve thermal properties we have to increase porosity of material. The problem industry facing today is waste disposal. Reuse of waste in construction or as a construction material may be cheapest and best solution. Foundry sand and saw dust are two low cost and abundantly available waste materials which can be used as construction material. Dumping of foundry sand can form the leachate due to its chemical properties. Disposal of saw dust is important it can form the leachate in the local water bodies. So reuse of foundry sand and saw dust can be proved economical and environment friendly.

The brick industry uses good quality top soil from agricultural fields. The unplanned and unregulated exploitation of good quality agriculture soil for brick making is a major area of concern. In India 140 billion bricks are manufactured yearly which requires around 540 million tons of soil. Due to this around 500 sq. km of agriculture land is adversely affected by brick production every year. Sand dredging in river side harms the environmental conditions on river side which further causes the problems like bank collapse and erosion. So use of industrial waste in manufacturing bricks can avoid depletion of river banks for brick manufacturing. Most of the wastes used in this dissertation work are currently disposed in sanitary landfills or open-dumped into uncontrolled waste pits and open areas. For long-term sustainability of the industry, it is important to move towards products that are less resource intensive and fulfill market requirements. Production of less resource intensive clay products and use of alternate building materials can result in significant conservation of top soil.

2. Procedure of Manufacturing of Bricks Using Industrial Waste

For the manufacturing of bricks firstly the foundry sand and saw dust are transported on kiln site. After that by volume the raw material is taken for brick manufacturing. For volumetric mixing of raw material 18’’ size pan is taken. The quantity of waste material and clay used for each proportion are stated below.

ISSN 2394-187(Online)
ISSN 2394-7179 (Print)

Table 1: the quantity of percentage mix proportion

A. **Foundry Sand Percentage**	*B.* **No. Pan for clay**	*C.* **No. of pan for Waste material**
D. 20%	*E.* 8 nos.	*F.* 2 nos.
G. 30%	*H.* 7 nos.	*I.* 3 nos.
J. 40%	*K.* 6 nos.	*L.* 4 nos.

Before the mixing of raw material waste material is sieved. After mixing of waste material and clay approximately water is used to get desire consistency to mould the bricks. This mix has kept for sundry for 1 to 2 days to become hard and can be mould easily. For molding of bricks mold of size 19X9X9 is used. After molding brick moulds are kept for drying under sunlight for 3 to 4 days. When the moulds become dry enough then they are kept into furnace for heating. The temperature of furnace is around 800 to 900 ºC. Bricks are heated in furnace for 8 to 10 days.

3. Experimental setup for thermal testing

3.1 Construction of brick chamber

This setup consist heater to warm up internal temperature of chamber, thermocouples for measurement of heat loss through the brick wall. For establishment of this setup total 40 bricks are used. This setup consists thermal insulation layer on both upper and bottom side of the wall. Insulation layer consists of asbestos sheets and 12'' thick plywood panel. The thermal conductivity of asbestos sheets and plywood is very less. This layer of insulation is very important to avoid heat loss through the air. This setup is developed for the measurement of thermal gradient of a brick wall. Thermal gradient is important to measure heat holding capacity of brick wall.

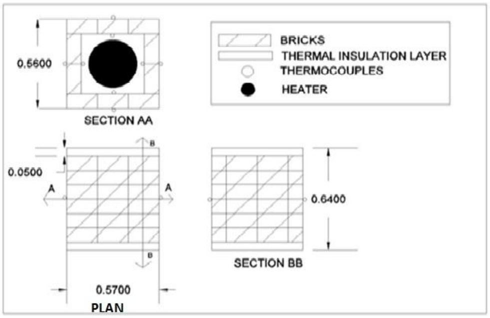

Fig.1: Arrangement of experimental setup for Brick Chamber

4. Results

Brick are manufactured by using 20%, 30% & 40% foundry sand and 20%, 25% & 30% sawdust as replacement to soil/clay. Normal bricks are brought from local manufacturers in the nearby vicinity (Masuchiwadi, Shiroli and belgaon) these places were selected based on the demand for bricks

4.1 Physical Property Analysis

4.1.1 Compressive strength (N/mm^2)

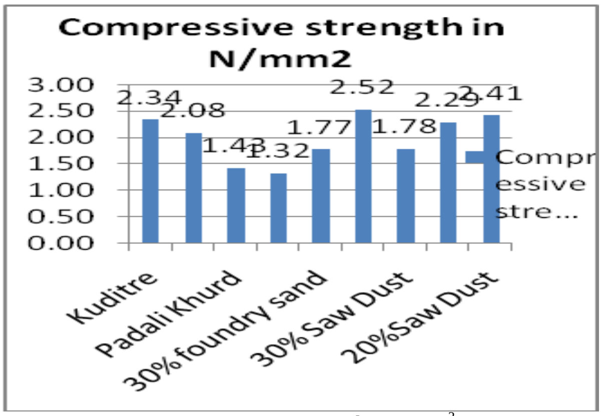

Fig.2: Compressive Strength in N/mm^2

4.1.2 Water Absorption (in %)

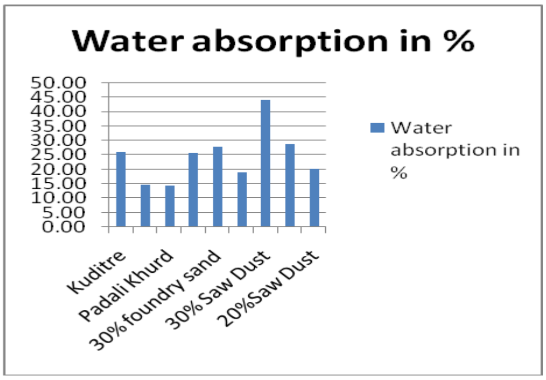

Fig.3 Water Absorption percentage

5. Percentage Mix Optimization

For optimization of mix proportion the different properties of mixed bricks are compared. For construction of brick chambers bricks prepared from optimize mix proportion are used.

ISSN 2394-187(Online)
ISSN 2394-7179 (Print)

	Compressive Strength	**Water Absorption Capacity**
40% Foundry sand	*M.* 1.32	*N.* 25.66
30% foundry sand	*O.* 1.77	*P.* 28.01
20% foundry sand	*Q.* **2.52**	*R.* **18.91**

Table 2: Percentage mix Optimization

At 20% Foundry sand replacement the properties of bricks are better than other mix proportions.

6. Analysis of Bricks

6.1 Temperature Gradient Analysis of Brick Chambers

Thermal properties of bricks are important to improve indoor conditions of a building. Temperature gradient of a chamber shows the heat holding capacity of bricks. Higher gradient shows good heat holding capacity of bricks. In following tables temperature gradient of bricks is shown

Sr No.	Type of Brick	Time Duration (In Minutes)	Internal Temperature				External Temperature				Average		ΔT
			Ti1	Ti2	Ti3	Ti4	Te1	Te2	Te3	Te4	Internal Temperature (T1)	External Temperature (T2)	
1	40% mixed bricks	15	36	37	37	36	27	26	27	26	36.5	26.5	10
2		30	44	45	45	44	28	27	29	27	44.5	27.75	16.75
3		45	51	52	51	52	32	31	32	31	51.5	31.5	20
4		60	55	54	54	54	38	38	38	37	54.25	37.75	16.5

Table 3: Temperature gradient of Kuditre Bricks

Sr No.	Type of Brick	Time Duration (In Minutes)	Internal Temperature				External Temperature				Average		ΔT
			Ti 1	Ti2	Ti3	Ti4	Te 1	Te 2	Te 3	Te 4	Internal Temperature (T1)	External Temperature (T2)	
1	Padali Khurd	15	36	35	37	31	27	26	26	26	34.75	26.25	8.5
2		30	45	42	43	35	28	27	27	27	41.25	27.25	14
3		45	51	48	50	45	31	29	28	28	48.5	29	19.5
4		60	58	53	58	55	37	36	37	37	52.2	36.75	15.45

Table 4: Temperature gradient of 40% mixed foundry sand Bricks

Sr No.	Type of Brick	Time Duration (In Minutes)	Internal Temperature				External Temperature				Average		ΔT
			Ti1	Ti2	Ti3	Ti4	Te1	Te2	Te3	Te4	Internal Temperature (T1)	External Temperature (T2)	
1	Kuditre	15	37	35	37	35	25	24	24	25	36	24.5	11.5
2		30	43	41	43	40	27	26	26	29	41.75	27	14.75
3		45	51	50	52	50	33	32	33	34	50.75	33	17.75
4		60	58	55	56	57	39	38	39	41	53	39.25	13.75

Table 5: Temperature gradient of Bhatanwadi Bricks

ISSN 2394-187(Online)
ISSN 2394-7179 (Print)

Sr No.	Type of Brick	Time Duration (In Minutes)	Internal Temperature				External Temperature				Average		ΔT
			Ti1	Ti2	Ti3	Ti4	Te1	Te2	Te3	Te4	Internal Temperature (T1)	External Temperature (T2)	
1	Bhatan wadi	15	37	35	37	35	28	27	28	26	36	27.25	8.75
2		30	44	43	44	42	31	30	30	31	43.25	30.5	12.75
3		45	52	51	52	50	39	40	39	38	51.25	39	12.25
4		60	58	55	56	58	46	45	43	44	54.6	44.5	10.1

Table 6: Temperature gradient of Padali Khurd Bricks

Sr No.	Type of Brick	Time Duration (In Minutes)	Internal Temperature				External Temperature				Average		ΔT
			Ti1	Ti2	Ti3	Ti4	Te1	Te2	Te3	Te4	Internal Temperature (T1)	External Temperature (T2)	
1	20% mixed Foundry Sand bricks	15	37	36	37	36	25	24	25	24	36.5	24.5	12
2		30	44	43	43	42	29	28	28	27	43	28	15
3		45	53	52	52	53	33	32	32	33	52.5	32.5	20
4		60	59	58	59	59	38	38	37	37	54.6	37.5	17.1

Table 7: Temperature gradient of 20% mixed Foundry sand Bricks

Time Duration (In Minutes)	**ΔT**			
	Masuchi wadi	**Belgaon**	**Shiroli**	**20% mixed Foundry Sand bricks**
15	11.5	8.75	8.5	12
30	14.75	12.75	14	15
45	17.75	12.25	19.5	20
60	13.75	10.1	15.45	17.1

Table 8: Comparison of Temperature Gradient of bricks

7. Conclusions

1. The compressive strength of bricks is checked and compared with conventional bricks from Shiroli, Masuchi wadi and Belgaon bricks. The highest strength of mixed brick is at 20% Foundry sand i.e.2.52 N/mm^2.
2. At 20% Foundry sand water absorption capacity is within limit specified by IS 3492 part II Requirement (i.e. 20%).
3. From all mixed brick at 20% foundry sand replacement the results are optimized.
4. From the data collected from experimental setup thermal properties of bricks are analyzed and studied. Results have shown that use of industrial waste has significant effect on the thermal properties of bricks. At 20% foundry sand replacement the reduction in thermal conductivity is maximum i.e. 7.78%.
5. The comparison of conventional bricks from Shiroli, Belgaon & Masuchi wadi and mixed bricks is done. From comparison it is found the higher waste percentage replacement there is reduction in compressive strength and increase in water absorption capacity.

References

[1] Ahmad & Luai M. Al-Hadhrami (2008) "Assessment of thermal performance of different types of masonry bricks used in Saudi Arabia." Applied Thermal Engineering 29 (2009) 1123–1130(Sciencedirect)

[2] Halil Murat Algin , Paki Turgut (2007) "Cotton and limestone powder wastes as brick material" Construction and Building Materials 22 (2008) 1074–1080 (Science direct)

[3] Aeslina Abdul Kadir1, Abbas Mohajerani2, et al.(2009)"Density, Strength, Thermal Conductivity and Leachate Characteristics of Light-Weight Fired Clay Bricks Incorporating Cigarette Butts"

Felicity World Academy of Science, Engineering and Technology 53 2009

[4] Olga Koronthalyova, Peter Matiasovsky "Pore structure and thermal conductivity of burnt clay bricks". Institute of Construction and Architecture, Slovak Academy of Sciences, Dubravska 9,845 43 Bratislava, Slovakia.

[5] Ali M. Othman, "Experimental Investigations of the Effect of Some Insulating Materials on the Compressive Strength, Water Absorption and Thermal Conductivity of Building Bricks." Jordan Journal of Mechanical and Industrial Engineering. Volume 4, Number 4, September 2010 ISSN 1995-6665.

[6] Thompson Henry & Tolulope Ogunribido "Geotechnical Properties of Saw Dust Ash Stabilized Southwestern Nigeria Lateritic Soils" Environmental Research, Engineering and Management, 2012. No. 2(60), P. 29-33 ISSN 2029-2139

[7] M. Mageswari* and B. Vidivelli "The use of sawdust ash as fine aggregate replacement in concrete" Journal of Environmental Research And Development Vol. 3 No. 3, January-March 2009.