STUDY ON UTILIZATION OF SOLID WASTES FOR THE MANUFACTURING OF CEMENT BRICK

STUDENT- FAIZAN AHMAD KHAN

CO-GUIDER- MR.ADIL MASOOD

1 Research Scholar, Department of Civil Engineering, AL-FALAH University,Hayana,INDIA

2 Co-Guider, Department of Civil Engineering, AL-FALAH University, Hayana, INDIA

ABSTRACT

*This project deals with utilization of solid wastes for manufacturing of cement bricks and act as a replacement for traditional clay bricks. First of all the different solid waste materials were studies so that their geotechnical properties could be analyzed. The waste materials that were under study were Brick kiln dust, Rice Husk Ash (RHA), and fly ash. After the analysis various conclusions were drawn out and from the analysis it was found out that the specific gravity of RHA was the least with respect to other waste materials taken into account. The brick samples were prepared as per the standard size of the brick i.e. 19cm*9cm*9cm. 10 samples were prepared by mixing the wastes with cement in different proportions to form modified bricks with waste material in them. They were immersed in water for the process of curing for a period of 3, 7, 14, and 21 days.*

Keywords: *Rice Husk Ash, Brick Kiln Dust, Fly Ash.*

INTRODUCTION

India is the second-largest brick producer in the world, producing 200 billion bricks every year that comprises 13% of global production. The sector consumes around 35-40 million tonnes of coal per year. Despite its gargantuan size, the brick kiln sector of India remains largely unorganized, according to Delhi-based Centre for Science and Environment, an advocacy group. The brick industry is considered the industry of the poor, employing around 10 million people directly and indirectly.Rice is a major cereal in India accounting for about 40% of food grain production and over 30% of its cropped area.' India's share in world rice production is 21 % Rice is the edible form of paddy (also known as rough rice) and in the process of conversion from paddy, rice husk is generated as by-product. Husk is generally used as a fuel, for generating heat for the parboiling of paddy or other applications, often at efficiencies below 10%,

Surplus husk has many applications, mainly in tobacco curing operations and brick kilns, but include production of furfural, cement, boards etc. Use of husk in industries other than rice processing involves handling and transportation of this low bulk density (112-144 kg/m') by-product. On-site use of husk in the rice processing industry, which needs energy in both thermal and mechanical forms, avoids the necessity of transportation. Technologies for conversion of husk into electricity and thermal energy at relatively higher efficiencies are being researched. So for every 1000 kgs of paddy milled, about 220 kgs (22 %) of husk is produced, and when this husk is burnt in the boilers, about 55 kgs (25 %) of RHA is generated. About 20 million tons of RHA is produced annually. This RHA is a great environment threat causing damage to the land and the surrounding area in which it is dumped.The rice husks used to fuel the process are purchased from local rice mills for less than one rupee per kilogram. Estimates are that 1.8 billion kilograms (4 billion pounds) of rice husks are left over from rice processing in UP each year and almost all of it had previously been used unproductively as there had been no uses identified for it.

Fly ash is a fine powder which is a byproduct from burning pulverized coal in electric generation power plants. It is a pozzolan, a substance containing aluminous and siliceous material that forms cement in the presence of water. When mixed with lime and water it forms a compound similar to Portland cement. During combustion, mineral impurities in the coal (clay, feldspar, quartz, and shale) fuse in suspension and float out of the combustion chamber with the exhaust gases. As the fused material rises, it cools and solidifies into spherical glassy particles called fly ash. Fly ash is collected from the exhaust gases by electrostatic precipitators or bag filters. The fine powder does resemble Portland cement but it is chemically different. Fly ash chemically reacts with the byproduct calcium hydroxide released by the chemical reaction between cement and water to form additional cementitious products that improve many desirable properties of concrete. All fly ashes exhibit cementitious properties to varying degrees depending on the chemical and physical properties of both the fly ash and cement. Compared to cement and water, the chemical reaction between fly ash and calcium hydroxide typically is slower resulting in delayed hardening of the concrete. Delayed concrete hardening coupled with the variability of fly ash properties can create significant challenges for the concrete producer and finisher when placing steel-toweled floors.

1.2 OBJECTIVE

- The primary objective of the present work is to provide a systematic methodology for the utilization of such waste material in cement bricks that are both economically feasible and environment friendly.
- The present work is an attempt at assessing the financial feasibility of using solid wastes like rice husk ash and brick kiln dust as an alternative to modern day construction clay bricks.

1.3 SCOPE OF PRESENT STUDY

- Scope of present study states that, previously no such work was done to analyze the properties of these materials and utilize these wastes, i.e., brick kiln dust and rice husk ash in a cement brick. Also, the objective was to make such bricks that have a load bearing capacity more than clay bricks and are economically feasible too. With more authentic input data availability in near future, the methodology presented in this work could be used to arrive at specific realistic conclusions

- **Table-1 Typical Chemical Composition (% by w/w) of Fly ash**

Composition	Indian fly ash	British fly ash	American fly ash	German fly ash
Silica as SiO2	45 – 65.25	41.5 – 47.8	35-52	42.0-56.0
Alumina as Al2O3	14 – 31.10	26.4 – 29	15-32	24.0-33.0
Iron Oxide as Fe2O3	3 – 15.0	9.1-13.9	8_25	5.4-13.0
Calcium Oxide as CaO	0.1 – 6.5	4.2-4.3	0.7-8.0	0.6-8.3
Magnesium Oxide as MgO	0.2 – 3.9	1.5-1.9	0.3-1.3	0.6-4.3
Sulphur as SO3	0.4 – 1.8	0.7-1.7	0.1-2.8	0.1-1.9
Loss on Ignition	1 – 11.3	1.7-7.3	1.3-13.0	0.8-5.8

LITERATURE REVIEW

Literature pertaining to similar studies conducted all over the world is collected from various sources (surveys, research papers, interviews, and practices) to determine the feasibility and scope of the work. Similar studies undertaken are as follows

C.S POON et al.,(2010) - This study reports on a recent study conducted in Hong Kong relating to material waste control on construction sites with high-rise multi-story buildings. In this paper, the causes of building wastage are identified at different levels of various trades for public housing and private residential projects in Hong Kong are quantified

Minaxi Rani and Alisha Gupta (2016) - The aim of paper to know about the sources of waste generation in the construction industry, to study about construction and demolition waste management and how to reduce the wastage and the process of reducing the wastage etc.

In [1] a preliminary study was carried out and extensive work on some characteristics of husk ash / ordinary Portland cement concrete. Test results indicate that the compressive strength for all mixes containing husk ash increases with age up to the 14 day hydration period but decrease to the 28 day hydration period while conventional concrete steadily up to 28 day hydration period.

In [2] was worked on rice husk as stabilizing agent in clay bricks in which clay bricks were produced with 0%, 1%, 2%, 3%,4%, 5%, 10% rice husk. Some of the bricks were burnt in an electric furnace to a temperature of 1005C for about 3-4 hours. Compressive strength and absorption tests were carried out. It was concluded that the addition of the husk reduces the compressive strength of the bricks and husk clay bricks become lighter as the percentage of husk clay increases.

In [3] the report discussed the effect of rice husk and compressive strength and durability of burnt clay bricks. Test results show that rice husk has a decreasing effect on the compressive strength of the brick & increasing effect on the water absorption of the bricks.

In [4] was carried out a resource work on the use of rice husk ash in concrete. Test results indicate that the most convenient and economical temperature required for the conversion into ash is 500C.Water requirement decreases as the fineness of RHA increases. The higher percentage of RHA contains the lower compressive strengths.

In [5], the report focused to find out the physical properties of waste brick kiln dust (B.K.D.) as a constructional material in civil engineering as partial replacement of OPC cement through various lab testing's

In [6], the compressive strength of some commercial sandcrete blocks in Minna, Nigeria was investigated. Rice Husk Ash (RHA) was prepared using Charcoal from burning firewood. Preliminary analysis of the Constituent materials of the ordinary Portland Cement (OPC) / Rice Husk Ash (RHA) hollow sandcrete blocks were conducted to confirm their suitability for block making. Physical test of the freshly prepared mix was also carried out. 150mm×450mm hollow sandcrete blocks were cast cured and crushed for 1, 3, 7, 14, 21, and 28 days at 0, 10, 20, 30, 40 and 50 percent replacement levels. The study arrived at an optimum replacement level of 20%.

[7] Aims to study effect between rice husk and rice husk ash to properties of bricks. Comparative adding between rice husk and rice husk ash were varied by 0 -10% by weight. The results showed that more adding rice husk less compressive strength and density of specimens. Otherwise the porosity increases when adding rice husk. By adding 2 % of rice husk ash by weight is the best of bricks properties which 6.20MPa of compressive strength, 1.68 g/cm3 of density, and 15.20% of water absorption.

[8] **Emamul-** suggested that an evolution change have bring cement concrete technologies and apart from the strength consideration, durability and economy have become most important factors for deciding the quality class of the cement concrete. Presently cement concrete has four essential ingredients - cement, coarse and fine, water and fly ash in place of conventionally three ingredients cement, aggregates and water. specifies use of fly ash as part replacement of cement in concrete, in actual practice it is in nascent stage .In utilization of Fly ash in Indian cement industry has different situation, these enables its huge utilization by cement firms but on other hand restrictions also occurs, like lack of essential information to 12 definite uses of Fly ash by state or central government construction section, builders and development teams etc.

[9] **Kadir and Mohejerani-** investigated that Based on the extensive literature review Many attempts have been made to included to wastes for the production of bricks, This paper presents the different wastes can be recycled into fired clay bricks. Most manufactured bricks with different types of residue have shown positive results on the properties of fired clay bricks. By showing improvement in all the properties used during firing. Thus, utilization of solid residue has been optimistic as one of the most commercial alternative materials that can be used in fired clay brick manufacturing.

[10] **Kumar and Hooda** -suggested that improvement in significant characteristics of the Flyash bricks is evaluated. The results of these characteristics of the Fly ash bricks are good enough and can grow more as compared to mud bricks. Furthermore, fly ash bricks are obtain with a naturally in reddish colour like as that to normal clay bricks. The research presents results of test and the better obtained form of fly ash bricks over the normal clay bricks. the present study talks about the effects of Flyash on the properties of bricks and the behavior of Fly ash bricks is compared with the normal burnt clay bricks. The various properties of fly ash bricks were conducted with various materials. As compared to normal clay bricks Fly ash brick are strongest, more durability and yet more economically stable. the procedure of fly ash brick mechanized proves in less pollution. Being less porous as compared to normal clay bricks humidity related issues far less in case of Flyash bricks than their normal clay bricks.

[11] **Narmatha et al.-** investigated on strengthened the compressed fly ash bricks by inclusion of Ironite fine particles. The sustainable growth has majorly influenced the design and building of the built infrastructure diagonally to the

global world. A high-performance structure is defined for Energy Policy Act of 2005:A construction that integrates and optimizes all major elevated performance construction attribute, counting energy effectiveness, toughness, life cycle presentation, and occupant efficiency. In this paper focus was on the understanding of high performance buildings through escalating more environmental and tough walling fundamentals based on the utilization of compressed Flyash bricks by addition of the admixture name as Ironite materials to compressed Flyash bricks at definite ratio.

[12] **Sachdeva and Aggarwal-**investigated aim to account its appropriateness for concrete paver blocks with the use of Flyash concrete. In this study, the effect of mix design fly ash all 16 the required properties can be extracted of concrete has been extracted. It is observed that all the Flyash based mixes are able to acquire the essential compressive and flexural strengths. In association to control mixes, the results for properties of the fly ash based proportion are found to be slightly less at early days(7 days) and a little more on longer span(90 days) and also With the addition of fly ash, ratio is negligible for all mixes for same point of workability.

METHODOLOGY

Sample collection

Brick kiln dust was collected from the local brick kiln plants of Kanpur City. Rice husk ash was collected from the rice mill exits in industrial area of the city. Fly ash generated from the Panki Thermal Power Plant was collected for the study.

Parameters to be tested

Geotechnical properties like specific gravity, particle size analysis, liquid limit, plastic limit and plasticity index of brick kiln dust, rice husk ash and fly ash were determined. Specific gravity

Test Performed

The aim of study is to find out the utilization of this waste as a construction material in civil engineering works as a partial replacement of cement. The physical and mechanical properties of these wastes have to be known before its use in cement bricks.

Sieve Analysis

Fig -FLY ASH

Sieve Analysis of Brick Kiln Dust

Fig 3- Brick Kiln Dust

Sieve No.	Retained Weight	Retained Per cent	Cumulative Weight	Cumulative Per cent	Pass Percent
4.75	0	0	0	0	100
2.36	0	0	0	0	100
1.18	8	8	8	8	92
0.6	26	26	34	34	66
0.3	44	44	78	78	22
0.15	12	12	90	90	10
0.075	6	6	96	96	10
Pan	2	2	98	98	2

Table 4 : Calculation of sieve Analysis of Brick kiln Dust

Sieve Analysis of Rice Husk Ash

Fig 4- Sieve Analysis of Rice Husk Ash

Calculation of sieve Analysis of Rice Husk Ash.

Sieve No.	Retained Weight	Retained %	Cumulative Weight	Cumulative %	Pass %
4.75	0	0	0	0	100
2.36	0	0	0	0	100
1.18	8	8	8	8	92
0.6	26	26	34	34	66
0.3	44	44	78	78	22
0.15	12	12	90	90	10
0.075	6	6	96	96	10
Pan	2	2	98	98	2

Table 5 Calculation of sieve Analysis of Rice Husk Ash.

Specific Gravity of Brick Kiln Dust

Specific gravity of brick kiln dust passing through 4.75 mm IS sieve is done by density bottle and its observation is shown in table 6.

Sp. gravity of BKD $= (W2-W1)/\ (W4-W1) - (W3-W2)$

$= (W2-W1)/ (W2-W1) - (W3-W4)$

$= (990-590)/ (990-590) - (1622-1466)$

$= 2.35$

Table 6 : Observations of Specific Gravity of B.K.D

S.No.	Observation	Records
1	Weight of sample taken(gm)	400
2	Weight of density bottle(W1,g)	590
3	Weight of density bottle + dry BKD(W2,g)	990
4	Weight of bottle+dry BKD+water (W3,g)	1622
5	Weight of bottle water (W4,g)	1486

3.3.4 Table-7 Specific gravity and Plasticity Index

GEOTECHNICAL PROPERTIES	BRICK KILN DUST	RICE HUSK ASH	FLY ASH
Specific Gravity	2.43	2.15	2.30
Liquid limit	None	22.5	None
Plastic Limit	None	6.5	None
Plasticity Index	None-plastic	16.33	None-plastic

Test for determining the Liquid limit and Plastic Limit of Brick Kiln Dust

Plastic limit: The water content at which soil sample change from plastic state to semi-solid state. (I.e. soil loses its plasticity & behaves like a brittle material).

Liquid limit: It is defined as minimum water content at which soil sample has tendency to flow.
And it is determined by Casagrande Apparatus

Liquid limit and Plastic Limit test of Brick kiln dust

Taking 200 gram of sample passing through 40 ASTM sieve as per IS 2720. Mixing water in the sample and following the procedure of liquid limit and plastic limit ***but sample of B.K.D. has no liquid limit and plastic limit that means B.K.D. has no Plastic Index***

Drop test for Strength

Place two brick on top of another in a 'T' shape about 2 meters from the ground and drop them together, If both the brick break then the compressive strength of brick is very low, and if only the top brick is broken then the strength is medium, and if none of the bricks is broken then the strength of the bricks is good.

While doing the drop test, we notice that the sample A, C-4 is not broken.

But the sample D, and F is broken.

This result tells that sample A, C-4 is a good quality brick.

Efflorescence Test (ISS 1077-1970)

(i) Take five bricks at randomly.

(ii) Place each brick on end in a separate shallow flat bottom dish containing distilled water. Note that depth of immersion of bricks should not be less than 2.5 cm in each case.

(iii) Keep the above dishes (containing water and bricks) in a warm (18°C to 30°C) room which has adequate Ventilation. (The water from the dishes will be lost due to absorption by bricks and subsequent evaporation).

(iv) Add fresh quantity of distilled water when the bricks appear having dried.

(v) At the end of the second drying, each brick is observed for efflorescence; that is an appearance of any white patch of salt on the surface of the brick.

Important Note:- *Efflorescence test of our Brick sample is Nill.*

EXPERIMENTS CONDUCTED

Particle Size Distribution

The particle-size distribution (PSD) of a powder, or granular material, or particles dispersed in fluid, is a list of values or a mathematical function that defines the relative amount, typically by mass, of particles present according to size.Significant energy is usually required to disintegrate soil, etc. particles into the PSD that is then called a grain size distribution.

- Weight Of brick kiln dust taken:- 500gm
- Weight Of RICE Husk ash taken:- 100gm
- Weight of fly ash taken :- 350 gm

S.NO	RETAINED ON SIEVE NO.	Brick kiln Dust	Rice Husk Ash	Fly ash
1	4.75mm	106	0	0
2	2.36mm	28	0	0
3	1.18mm	72	8	5
4	600microns	128	26	9
5	300microns	48	44	96
6	150microns	90	12	183
7	75microns	26	6	51
8	Pan	2	2	4

	Total	**500gm**	**98gm**	**348gm**

Table -8 Particle size distribution

Coefficients of Uniformity and Curvature:

- The coefficient of uniformity, C_u is a crude shape parameter and is calculated using the following equation:

  $C_U = D_{60}/D_{10}$

  where D_{60} is the grain diameter at 60% passing, and D_{10} is the grain diameter at 10% passing

- The coefficient of curvature, C_c is a shape parameter and is calculated using the following equation:

  $C_C = \{(D_{30})^2/(D_{10}*D_{60})\}$

  where D_{60} is the grain diameter at 60% passing, D_{30} is the grain diameter at 30% passing, and D_{10} is the grain diameter at 10% passing

Table-9 Coefficient of Uniformity and Curvature of waste materials

Samples	**D10**	**D30**	**D60**	**Coefficient of uniformity(Cu)**	**Coefficient of curvature(Cc)**
Brick Kiln Dust	0.08	0.35	0.55	6.87	2.75
Rice Husk Ash	0.2	0.5	1.5	7.5	0.83
Fly Ash	0.09	0.15	0.25	2.77	1

PREPRATION OF BRICK SAMPLES

First of all the mixture of waste materials and cement was mixed property with water and a proper cement paste was formed . Special attention was needed while mixing of water as rice husk ash absorbs large amount of water in the beginning causing difficulty in bonding but as soon the material was left to set for a few min it extra waters tries to expels out .

- The standard brick mould of inner dimension 19cm*9cm*9cm with a frog impression was used for the manufacturing of bricks. Before pouring paste into the mould , mobile oil was applied on the side walls of the mould so that the brick can be taken out from the wall without causing any difficulty and also avoid breaking of edges of bricks.
- The brick was then left for sun drying for 48 hr then taken out from the mould. Then the brick samples were immersed in water for different curing period.
- After curing the the frog was filled with a cement paste then again left to dry for 24 hours.
- Now the samples were tested for compressive strength in a compressive testing machine. The readings were noted down carefully and strength was calculated in kg/cm^2.

Chemical Composition of RHA

Oxide Composition (%by mass)	OPC	RHA
SiO_2	20.99	88.32
Al_2O_3	6.19	0.46
Fe_2O_3	3.86	0.67
CaO	65.96	0.67
MgO	0.22	0.44
Na_2O_3	0.17	0.12
K_2O	0.60	2.91
LOI	1.73	5.81
Specific Gravity	2.94	2.11

Table -10 Chemical composition of RHA

MANUFACTURING OF BRICK SAMPLES

Sample A

Constituents

- Cement : 1kg
- Rice husk ash : 0.362 kg
- Water : 700 ml

Cured for no of days = 3

Compressive strength=60 kg/cm^2

- **Fig-SAMPLE A**

Sample B

Constituents

- Cement : 1kg
- Rice husk ash : 0.300 kg
- Brick Kiln Dust : 0.400kg
- Water : 1ltr

Cured for no of days = 0

Compressive strength=0

Result:

The sample failed due to bulging and crack appeared on the bricks

Fig- SAMPLE B

Sample C-1

Constituents

- Cement : 0.900 kg
- Rice husk ash : 0.600 kg
- Brick Kiln Dust : 1.5 kg
- Water : 1.5ltr

Cured for no of days = 7

Compressive strength=30

Fig-9 SAMPLE C-1

Sample C-2

Constituents

- Cement : 0.900 kg
- Rice husk ash : 0.600 kg
- Brick Kiln Dust : 1.5 kg
- Water : 1.5 ltr

Cured for no of days = 14

Compressive strength=44

Fig-10 SAMPLE C-2

Sample C-3

Constituents

- Cement : 0.900 kg
- Rice husk ash : 0.600 kg
- Brick Kiln Dust : 1.5 kg
- Water : 1.5 ltr

Cured for no of days = 21

Compressive strength=46 kg/cm^2

Fig-11 SAMPLE C-3

Sample D

Constituents

- Cement : 0.750 kg
- Rice husk ash : 0.450 kg
- Brick Kiln Dust : 1.5 kg
- Fly ash : 0.300 kg
- Water :1.5ltr

Cured for no of days = 7

Compressive strength=15

Fig-SAMPLE D

Sample E

Constituents

- Cement : 0.600 kg
- Rice husk ash : Nil
- Brick Kiln Dust : 1.8 kg
- Fly ash : 0.600 kg
- Water : 1ltr

Cured for no of days = 7

Compressive strength=20

Fig-13 SAMPLE E

Graph between curing period and compressive strength

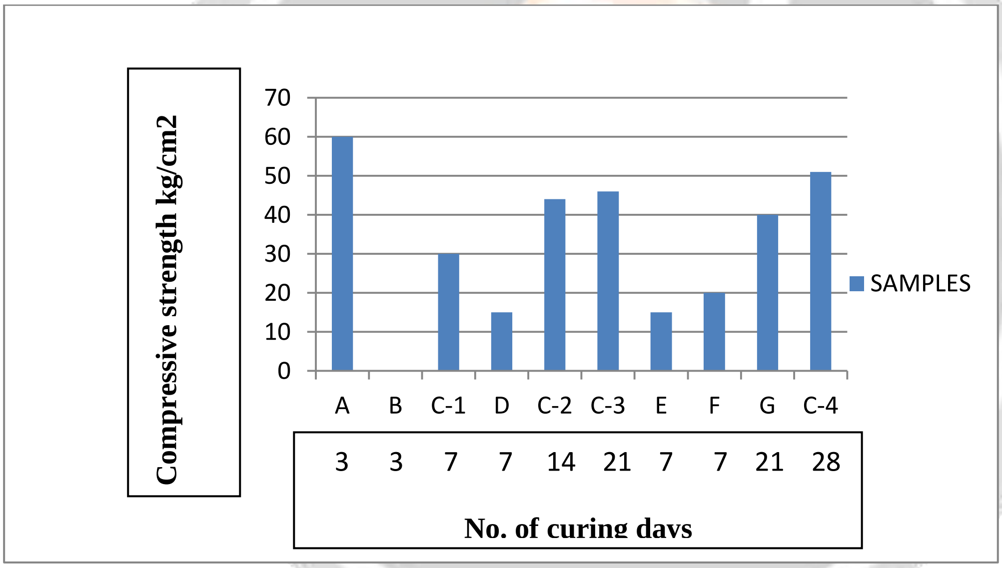

Fig-14 Graph between curing period and compressive strength

Proportion of waste samples in bricks prepared

SAMPLE	WEIGTH IN Kg				
	CEMENT	RHA	BRICK KILN DUST	FLY ASH	WATER
A	1 Kg	0.362 Kg	0	0	700ml
B	1 Kg	0.300 Kg	0.400 Kg	0	1ltr
C-1	0.900 kg	0.600 kg	1.5 kg	0	1.5 ltr
C-2	0.900 kg	0.600 kg	1.5 kg	0	1.5 ltr

C-3	0.900 kg	0.600 kg	1.5 kg	0	1.5 ltr
D	0.750kg	0.450 kg	1.5 kg	0.300 kg	1.5 ltr
E	0.600 kg	0	1.8 kg	0.600 Kg	1 ltr
F	0.600 kg	0	1.8 kg	0.600 kg	1.5 ltr
G	0.750 kg	0.300 kg	1.95 kg	0	1.5 ltr
C-4	0.900 kg	0.600 kg	1.5 kg	0	1.5 ltr

Table -11 Proportion of waste sample in brick prepared

Result and Discussion

Different geotechnical properties such as specific gravity, particle size analysis, liquid limit, plastic limit and plasticity index of brick kiln dust, rice husk ash and fly ash were assessed.

Physical Properties of Brick Powder Waste

Table Geotechnical properties of different waste materials

Geotechnical properties	Brick kiln dust	Rice husk ash	Fly ash
Specific gravity	2.43	2.15	2.3
Liquid limit	None	22.5	None
Plastic limit	None	6.5	None
Plasticity index	None	16.33	None

Particle Size Distribution

- Weight Of brick kiln dust taken:- 500gm
- Weight Of RICE Husk ash taken:- 100gm
- Weight of fly ash taken :- 350 gm

S.NO	**RETAINED ON SIEVE NO.**	**Brick kiln Dust**	**Rice Husk Ash**	**Fly ash**
1	4.75mm	106	0	0
2	2.36mm	28	0	0
3	1.18mm	72	8	5
4	600microns	128	26	9
5	300microns	48	44	96
6	150microns	90	12	183
7	75microns	26	6	51
8	Pan	2	2	4
	Total	**500gm**	**98gm**	**348gm**

Table -4.1.1.1 Particle size distribution

Coefficient of Uniformity and Curvature of waste materials

Samples	D10	D30	D60	Coefficient of uniformity(Cu)	Coefficient of curvature(Cc)
Brick Kiln Dust	0.08	0.35	0.55	6.87	2.75
Rice Husk Ash	0.2	0.5	1.5	7.5	0.83
Fly Ash	0.09	0.15	0.25	2.77	1

Table -4.1.1.1 Coefficient of Uniformity and Curvature of waste materials

Preparation of bricks

In this study, different proportions of waste materials with cement were mixed.

Table 4.2: Compressive strength of bricks made in different proportions at different curing period

S.No	SAMPLE	BRICK KILN DUST (%)	CEMENT (%)	RICE HUSK ASH (%)	FLYASH (%)	CURING PERIOD	RE-MARKS	COMPRESSIVE STRENGTH (Kg/cm^{2})
1	A	0	70	30	0	3	✓	60
2	B	22	60	18	0	3	×	-
3	C-1	50	30	20	0	7	✓	30
4	D	50	25	15	10	7	✓	15
5	C-2	50	30	20	0	14	✓	44
6	C-3	50	30	20	0	21	✓	46
7	E	60	20	20	0	7	✓	15
8	F	60	20	0	20	7	✓	20
9	G	65	25	10	0	21	✓	40
10	C-4	50	30	20	0	28	✓	51

Samples and their proportion

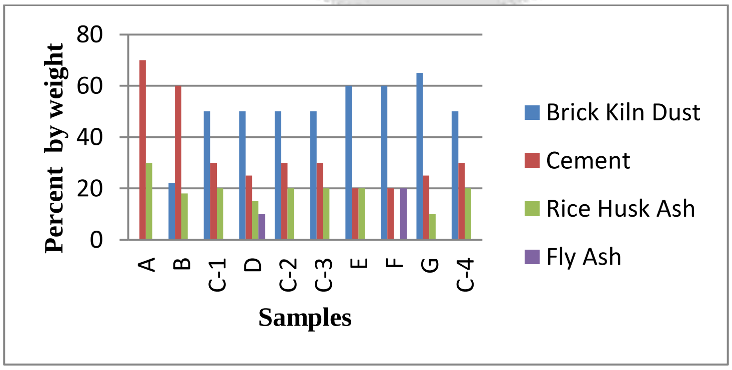

Fig-16 samples and their proportion

SAMPLEA

Rice husk ash is a waste material generated from rice milling. Though it has pozzolonic properties, it cannot be used directly for making the bricks; therefore, the first attempt was made to mix it with cement to make the bricks (Table 4.2) and cured for 3 days. The compressive strength of the brick was 60 kg/cm2. Since percentage of cement was high, hence it would not be economical. Therefore, another proportion with different waste materials was tried using cement as binding-materials.

SAMPLE B

Rice husk ash and cement, Brick kiln dust was mixed so that the cement content of the brick was reduced to 60%. But during the curing of the brick, cracking appeared in it due to which the sample failed.

SAMPLE C-1

In sample C-1, the quantity of BKD was increased to 50% and the quantity of cement was decreased to 30% because BKD had properties that were similar to that of cement. Also, 20% Rice Husk ash was added to it and the molded brick was kept for a curing period of 7 days. After 7 days of curing, the strength of the brick sample was found out to be 30kg/cm^2.

SAMPLE C-2&C-3

Sample C-2 and C-3 were casted using the same proportion of materials and kept for a curing period of 14 and 21 days. After 14 days, the strength achieved by C-2 was 44kg/cm^2, whereas after 21 days of curing period, the strength of C-3 brick was 46kg/cm^2.

SAMPLE C-4

The final strength of C-4 brick was 51kg/cm^2, which was achieved after 28 days of curing period.

SAMPLE D

In sample D, 10% flyash was added and the percentage of cement in the mix was reduced to 25%, but after 3 days of curing period, it was found out the strength of the brick was just 15kg/cm^2. It was concluded that the properties of brick kiln dust and fly ash were such that they both were not compatible with each other.

SAMPLE E

In sample E, the proportion of the mix was kept such that the percentage of BKD was 60%, cement was 20%, and that of RHA was 20%. After 7 days of curing period the strength of the brick was found out to be 15kg/cm^2. The sample's strength was way less than the desired strength which is required.

CONCLUSIONS

From the study, the following conclusions were drawn:

This project deals with utilization of solid wastes for manufacturing of cement bricks and act as a replacement for traditional clay bricks. First of all the different solid waste materials were studies so that their geotechnical properties could be analyzed. The brick samples were prepared as per the standard size of the brick i.e. 19cm*9cm*9cm.

The present research replicate the effect of waste product like Rice Husk, Fly Ash, Brick kiln dust, on compressive strength of brick and following results were obtained:-

The clay bricks gave the compressive strength of 5.26 N/mm2, but when uses of waste material is used with cement the following compressive strength are obtained. Different samples (A, B, C-1 to C-4, D, E, F and G) showed compressive strength at different curing period. In sample D, 10% fly ash was added and the percentage of cement in the mix was reduced to 25%, but after 3 days of curing period, it was found out the strength of the brick was just 1.53 N/mm^2. It was concluded that the properties of brick kiln dust and fly ash were such that they both were not compatible with each other.

In Sample B, Rice husk ash and cement, Brick kiln dust was mixed so that the cement content of the brick was reduced to 60%. But during the curing of the brick, cracking appeared in it due to which the sample failed.

In Sample A, Rice husk ash is a waste material generated from rice milling. Though it has pozzolonic properties, it cannot be used directly for making the bricks; therefore, the first attempt was made to mix it with cement to make the bricks (Table 4.2) and cured for 3 days. The compressive strength of the brick was 6.12 N/mm^2. Since percentage of cement was high, hence it would not be economical. Therefore, another proportion with different waste materials was tried using cement as binding material. The final strength of C-4 brick was 5.20 N/mm^2, which was achieved after 28 days of curing period.

The Specific gravity of brick kiln dust, rice husk ash and fly ash were found to be 2.43, 2.15, and 2.30 respectively indicating that the brick prepared by these materials will not be heavier. Since the specific gravity of these materials is less than clay. While doing efflorescence test of brick we observe that , for the brick sample tested here the percentage area covered is nil and therefore the efflorescence is also nil. We can conclude that this brick specimen passes the efflorescence test.

The particle size analysis showed that BKD is a well graded material whereas RHA is a poorly graded material. Plasticity index showed that brick kiln dust and fly ash are the non-plastic materials whereas rice husk ash comes under medium plastic category.

Thus from above study, this project concluded that, with the addition of waste material like Rice Husk Ash & Brick Kiln Dust in the cement, the compressive strength of bricks increases , but with fly ash the compressive strength of bricks decreases. So for the Environment free purpose RHA & Brick KILN DUST can be used in the place of partially replacement of cement. For different brick projects, we hope that this project will act as guidance in terms of compressive strength.

REFERENCES

[1] Dashan I. I. and Kamang E. E. I., Some characteristics of RHA/OPC concretes: A preliminary assessment, Nigerian Journal of Construction Technology and management, 2(1), p.22-28, 1999.

[2] Michael K .O., Rice husk as stabilizing agents in clay bricks, higher national diploma project, Department of civil engineering, Federal polytechnic, Bida, Nigeria, 1994.

[3] Mbiminah G.Y., Effects of Rice husk on the comprehensive strength and durability of burnt - Clay bricks, B. Eng. Project., Department of civil Engineering, Ahmadu Bello University Zaria, Nigeria, 1992.

[4] Al-Kahalaf M. N. and Yousif H. A., Use of Rice Husk Ash in Concrete, The international Journal of Cement Composites and Lightweight Concrete, 6(4), p.241-248, 1984

[5] Sharda Sharma and Shiv Kumar Yadav, WASTE BRICK KILN DUST AS A CONSTRUCTION MATERIAL IN CIVIL ENGINEERING, GJESR RESEARCH PAPER VOL. 1 [ISSUE 8] SEPTEMBER, 2014

[6] E. B. Oyetola and M. Abdullahi, the Use of Rice Husk Ash in Low - Cost Sandcrete Block Production, Leonardo Electronic Journal of Practices and Technologies ISSN 1583-1078

Issue 8, January-June 2006

[7] J. Sutas Et. Al., Effect of Rice Husk and Rice Husk Ash to Properties of Bricks, Published by Elsevier Ltd. Selection and/or peer-review under responsibility of I-SEEC2011, 2010

[8] Emamul, M. "ENABLERS AND BARRIERS FOR UTILIZATION OF FLY-ASH IN INDIAN CEMENT INDUSTRY", International Journal of Advance Industrial Engineering, March 2013, vol. 1, pp. 31-35.

[9] Kadir, A.A. and Mohajerani, A. "BRICKS: AN EXCELLENT BUILDING MATERIAL FOR RECYCLING WASTE-REVIEW", International conference environmental management and engineering, 2011, pp. 108-115.

[10] Kumar, R. and Hooda, N. "AN EXPERIMENTAL STUDY ON PROPERTIES OF FLY ASH BRICKS", International Journal of Research In Aeronautical and Mechanical Engineering, 2013, vol. 2, pp. 56-67.

[11] Narmatha, M., Aruna. And Saraswathi, M. "STRENGTHENING OF FLY ASH BRICKS BY IRONITE", Journal of Mechanical and Civil Engineering, 2014, vol. 11, pp. 21-26

[12] Sachdeva,S. and Aggarwal,V. "HIGH VOLUME FLY ASH CONCRETE FOR PAVER BLOCKS", International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering, 2014, vol. 8, pp. 242-248.