e-ISSN:2582-7219

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

Volume 7, Issue 5, May 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.521

6381 907 438 6381 907 438 ijmrset@gmail.com www.ijmrset.com

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 5, May 2024 |

| DOI:10.15680/IJMRSET.2024.0705103 |

An Experimental Study on Sludge Bricks

Devendra Hatwar, Junaid Ansari› Pratum Tamble, Roshan Mate, Prof. Vrushali Paraye, Prof. Atif Nawab

Department of Civil Engineering, Nagarjuna Institute of Engineering Technology & Management, R.T.M.N.U, Satnavari Village Nagpur, Maharashtra, India

ABSTRACT: This research explores the development and performance of bricks made from sludge waste, focusing on their potential as sustainable construction materials. Municipal and industrial sludge, often considered a waste byproduct, poses significant environmental challenges. By incorporating sludge into brick production, this study aims to mitigate waste disposal issues while creating eco-friendly building materials. The experimental approach involves varying the sludge-to-clay ratios and manufacturing bricks through a process of mixing, molding, drying, and firing. Comprehensive testing is conducted to evaluate the physical, mechanical, and thermal properties of the sludge bricks, including compressive strength, water absorption, density, and thermal conductivity. The results indicate that sludge bricks, with optimized formulations, can achieve comparable or superior performance to traditional clay bricks. This study not only highlights the viability of sludge bricks in construction but also emphasizes their environmental benefits, offering a sustainable solution for waste management and resource conservation.

I.INTRODUCTION

For thousands of years, bricks have been made from clay. Brick is one of the most common masonry units as a building material due to its properties. Many attempts have been made to incorporate wastes into the production of bricks, for examples, rubber, limestone dust, wood sawdust, processed waste tea, fly ash, polystyrene and sludge. Recycling such wastes by incorporating them into building materials is a practical solution for pollution problem. This project reviews the recycling of different wastes into fired clay bricks. Most manufactured bricks with different types of waste have shown positive effects on the properties of fired clay bricks.

Brick is one of the most important construction elements. The history of brick manufacturing goes back 8000 years when the fabrication of the earliest sun dried clay bricks was discovered. Sludge generated at water treatment plants should be treated and handled in an environmentally sound manner. Coagulant sludge is generated by water treatment plants, which use metal salts such as aluminium sulphate (alum) or ferric chloride as a coagulant to remove turbidity. The traditional practice of discharging the sludge directly into a nearby stream is becoming less acceptable because these discharges can violate the allowable stream standards (Sullivan, C., et al., 2010). The discharging of sludge into water body leads to accumulative rise of aluminium concentrations in water, aquatic organisms, and, consequently, in human bodies. Some researchers have linked aluminium's contributory influence to occurrence of Alzheimer's disease, children mental retardation, and the common effects of heavy metals accumulation (Prakhar, P.E. and Arup, K.S., 1998).

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 5, May 2024 |

| DOI:10.15680/IJMRSET.2024.0705103 |

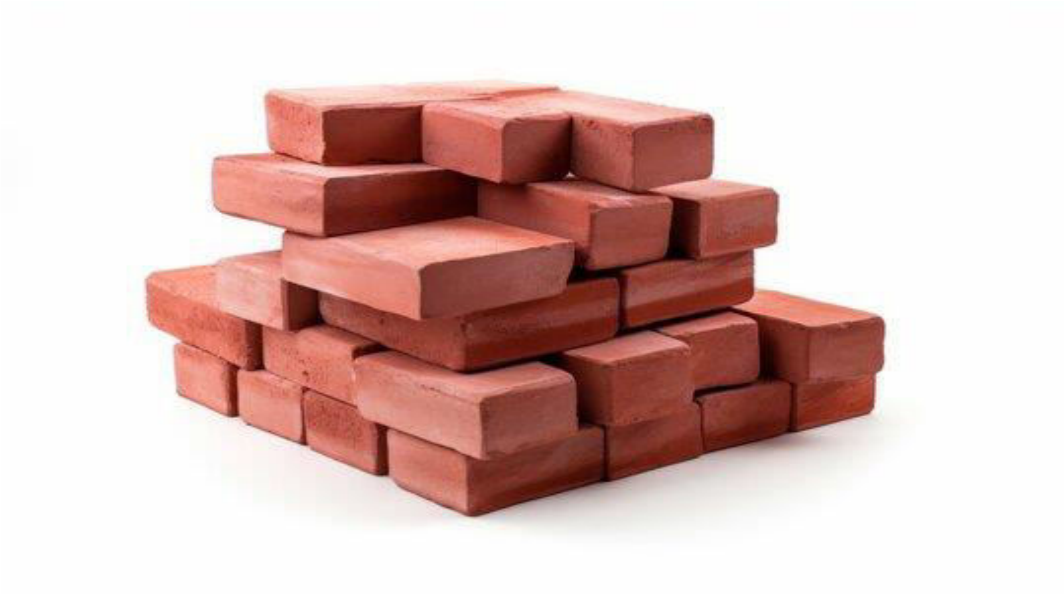

Figure 1.1 Clay Brick

It is recognized that the disposal of aluminium-laden solids from water treatment plants will receive a closer scrutiny in the coming years. Several trials have been reported in Taiwan, UK, USA, Egypt, and other parts of the world to use water treatment sludge in various industrial and commercial manufacturing processes. Studies have been carried out on using sludge in brick, artificial aggregate, cement, and ceramic making. Also, some trials have been conducted to use sludge in land application. Due to the similar mineralogical composition of brick clay and water treatment plant sludge, the use of water treatment sludge in brick manufacture has been highly encouraged.

However, it also needs to be recognized that construction is also adversely affect the environment, through physical disruption. The depletion of key renewable resources like fertile top soil, forest cover and excessive consumption of energy. Therefore, there is a strong need to adopt cost-effective, environmentally appropriate technologies by up-gradation of the traditional technologies and also using local materials as well as using appropriate and intermediate technologies using modem construction materials with efficient, effective technology inputs.

Building materials is an area where enormous amount of innovation for cost reduction can be achieved. May bricks being the most important area for innovation as the total demand of clay bricks, as an challenged walling material in India, is estimated at 180 billion per annum causing the depletion 540000 metric tonnes of fertile soil. Sludge basically a waste material, has a clear edge over the other construction material as these can be converted to a resource with minimum amount of investments. Further, it can help to increase the speed and quality of construction and thereby helping in enhancing the efficiency of housing delivery mechanism.

II.LITERATURE REVIEW

Badr El-Din Ezzat Hegazy et al. (2012), The water sludge is generated from the treatment of water with alum. Disposing of sludge again to the streams raises the concentrations of aluminium oxides in water, which has been linked to Alzheimer's disease. The use of water treatment plant (WTP) sludge in manufacturing of constructional elements achieves both the economical and environmental benefits. Due to the similar mineralogical composition of clay and WTP sludge, this study investigated the complete substitution of brick clay by sludge incorporated with some of the agricultural and industrial wastes, such as rice husk ash (RHA) and silica fume (SF). Three different series of sludge to SF to RHA proportions by weight were tried, which were (25: 50: 25%), (50: 25: 25%), and (25: 25: 50%), respectively. Each brick series was fired at 900, 1000, 1100, and 1200oC. The physical and mechanical properties of the produced bricks were then determined and evaluated according to Egyptian Standard Specifications (E.S.S.) and compared to control clay-brick. From the obtained results, it was concluded that by operating at the temperature commonly practiced in the brick kiln, a mixture consists of 50% of sludge, 25% of SF, and 25% of RHA was the optimum materials proportions to produce brick from water sludge incorporated with SF and RHA. The produced

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 5, May 2024 |

| DOI:10.15680/IJMRSET.2024.0705103 |

bricks properties were obviously superior to the 100% clay control-brick and to those available in the Egyptian market. WTP sludge can be successfully used in brick manufacture incorporated with agricultural and industrial waste materials, which contain high silica content, such as RHA and SF. The results are limited to the study conditions such as mixing proportions, firing temperatures, and manufacturing methods used in this study.

Joo-Hwa Tay (1987), Sludge resulting from wastewater treatment plants creates problems of disposal. Generally, dewatered sludge's are disposed of by spreading on the land or by land filling. However, for highly urbanized cities, sludge disposal by land filling might not be appropriate due to land limitation. Incineration might be an alternative solution. However, a substantial amount of ash will be produced after the burning process and must be disposed of by other means. This paper presents the results of the utilization of dried sludge and sludge ash as brick making materials. The maximum percentages of dried sludge and sludge ash that can be mixed with clay for brick making are 40% and 50% respectively. The compressive strength of the bricks is 87.2 N/mm2 for 0% sludge, decreasing to 37.9 N/mm2 for 40% dried sludge, and 69.4 N/mm2 for 50% sludge ash. The maximum percentages of dried sludge and sludge ash that could be mixed with clay for brick making are 40% and 50% by weight, respectively. Beyond that, bonding of the mixture is poor and extrusion of the bricks results in "dog-earing" of the products. The large amount of organic matter present in the sludge resulted in high shrinkage of the bricks during firing. The texture and finish on the surface of the bricks made from the mixtures of clay and sludge are rather poor, and they may not be acceptable for use as facing brick. Specific gravity of the bricks decreases as the percentage of dried sludge increases. For the sludge ash bricks, the specific gravity of the bricks increases slightly as the percentage of sludge ash increases.

III.METHODOLOGY

This chapter provides essential thoughts on the material & methodology used to conduct this research. The properties and the detail of the all kind of material to be used in the mix design are as given bellow.

- Dry Sludge
- Fly Ash
- Cement

Dry Sludge: - Now a day, disposal of sewage has become a necessity for societies. The construction of treatment plants has caused problems with huge content of dry sludge. It has been found that each person produce 35 to 85 grams of solid sludge per day. In recent years, waste production has increased dramatically in developing nations such as India. There are two methods to solve the problem such as disposal of solid waste (dry sludge) including land filling and using dry sludge as fertilizers. But by both these methods some harmful material remains in sludge which causes harm to environment including land, air and water as a whole. In the sense grit sludge may be generated in a grit channel or chamber. Grit particles are removed because they may damage pumps and other equipment. Here, we try dry sludge too replace as a soil.

Figure 3.1 Dry Sludge

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 5, May 2024 |

| DOI:10.15680/IJMRSET.2024.0705103 |

Properties of Dry Sludge

Physical Properties

Table 3.1 Physical Properties of Sludge

SR.NO	PROPERITES	RESULTS
1	Specific Gravity	**1.34-1.45**
2	Bulk Density, kg/m3	**687**
3	Water Absorption,%	**0.6**
4	Clay And Sulphate Content,%	**0.1-0.5**
5	Softening Coefficient	**0.96**
6	Grain Type Coefficient	**1.1**
7	Moisture Content, %	**0.1-11.5**

Chemical Properties

Table 3.2 Chemical Properties of Sludge

SR.NO	PARTICULARS	% OF CONTENT
1	(Silica) SiO2	**28.28**
2	(Alumina) Al2O3	**1.54**
3	(Iron Oxide) Fe2O3	**2.46**
4	(Manganese Oxide) MgO	**1.79**
5	(Calcium Oxide) CaO	**5.59**
6	(Sodium)Na2O	**9.08**
7	(Loss On Ignition) LOI	**48.58**

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 5, May 2024 |

| DOI:10.15680/IJMRSET.2024.0705103 |

Sieve Analysis of Dry Sludge

Determination of quantitative size distribution of particles of dry sludge to fine grained fraction.

Procedure

1) Take a suitable quantity of oven dried dry sludge. The mass of dry sludge sample required for each test depends on the maximum size of material.
2) Clean the sieve to be used and record the weight of each sieve and the pan.
3) Arrange the sieves to have the largest mesh size at the top of the stack. Pour carefully the soil sample into the top sieve and place lid over it.
4) Place the sieve stack on the mechanical shaker, screw down the lid, and vibrate the dry sludge sample for 10 minutes.
5) Remove the stack and re-weight each sieve and the bottom pan with the soil sample fraction retained on it. 6) Initial mass of soil sample taken for analysis (kg) = 0.500 kg.

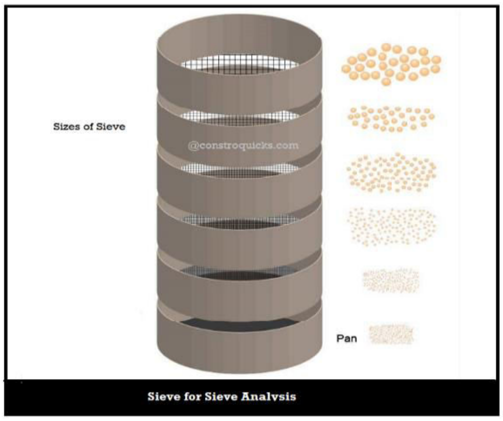

Figure 3.2 Sieves

Table 3.3 Observation Table of Sieve Analysis

SIEVE SIZE (MM)	SOIL RETAINED (G)	PERCENT RETAINED (%)	CUMULATIVE PERCENT RETAINED (%)	PERCENT FINER (%)
4.75 mm	223.4	44.7	44.7	**55.3**
2.0mm	97.1	19.4	64.1	**35.9**
1.0mm	90.2	18	82.1	**17.9**
600 µm	23.4	4.7	86.8	**13.2**
425µm	17.2	3.4	90.2	**9.8**
300µm	10.8	2.2	92.4	**7.6**
212µm	9.1	1.8	94.2	**5.8**
150 µm	8.5	1.7	95.9	**4.1**
75 µm	10.2	2.0	97.9	**2.1**
Pan	**10.1**	**2.1**	**100**	**0**

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 5, May 2024 |

| DOI:10.15680/IJMRSET.2024.0705103 |

Fly Ash
Fly ash, also known as flue-ash, is one of the residues generated in combustion, and comprises the fine particles that rise with the flue gases. Ash which does not rise is termed bottom ash. In an industrial context, fly ash usually refers to ash produced during combustion of coal.

Table 3.4 Major constituents of Fly-ash

Item	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	Na_2O	L.o.I
%	27.88-59.4	1.21-29.63	1. 5.23-33.99	0.37-27.68	0.42-8.79	0.20-6.90	0.21-28.37

Ordinary Portland Cement
Portland cement is the most common type of cement in general use around the world, used as a basic ingredient of concrete, mortar, stucco, and most non-speciality grout. It was developed from other types of hydraulic lime in England in the mid 19th century and usually originates from limestone. It is a fine powder produced by heating materials in a kiln to form what is called clinker, grinding the clinker, and adding small amounts of other materials.

Several types of Portland cement are available with the most common being called ordinary Portland cement (OPC) which is grey in color, but a white Portland cement is also available. Portland cement is caustic, so it can cause chemical burns, the powder can cause irritation or with severe exposure lung cancer, and can contain some hazardous components such as crystalline silica and hexavalent chromium.

Environmental concerns are the high energy consumption required to mine, manufacture, and transport the cement and the related air pollution including the release of greenhouse gases (e.g., carbon dioxide), dioxin, NOx, SO2, and particulates. The low cost and widespread availability of the limestone, shales, and other naturally occurring materials used in Portland cement make it one of the lowest-cost materials widely used over the last century throughout the world. Concrete produced from Portland cement is one of the most versatile construction materials available in the world.

Figure 3.3 Ordinary Portland Cement

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 5, May 2024 |

| DOI:10.15680/IJMRSET.2024.0705103 |

Chemical Composition of O.P.C

Sr.No	Name of Constituent	Formula	Percentage (%)
1	Lime	CaO	60-67
2	Silica	$Si0_2$	17-25
3	Alumina	$Al_2 0_3$	3-8
4	Iron oxide	$Fe_2 0_3$	0.5-6
5	Magnesia	Mg0	0.1-4
6	Sulphur trioxide	SO_3	1-2
7	Soda and potash	(Na_2O+K_2O)	0.5-1.3
8	Calcium Sulphate	$CaSO_4 \cdot 2H_2O$	3-4

Table 3.5 Major Constituent of OPC

Mix Design

% OF Sludge	% of Fly-Ash	% of Cement
50	40	10
60	30	10
70	20	10

Table 3.6 Mix Design for Bricks

Manufacturing Process

Batching
The measurement of materials for making is known as batching.
There are two method of batching.

- Volume batching
- Weight batching
-

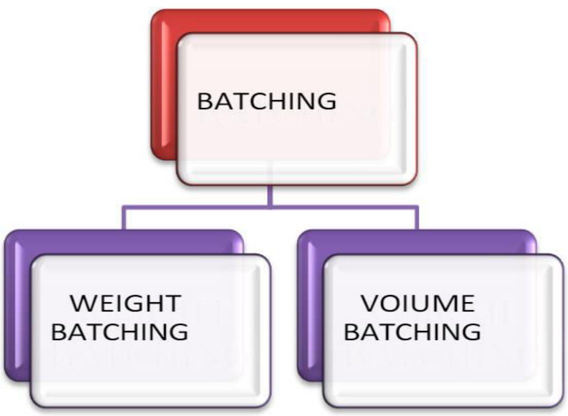

Figure 3.4 Type of Batching

| ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 7.521| Monthly Peer Reviewed & Referred Journal |

| Volume 7, Issue 5, May 2024 |

| DOI:10.15680/IJMRSET.2024.0705103 |

IV.CONCLUSION AND FUTURE WORK

CONCLUSION

- Its plastic limit is a zero.
- Dry sludge is available free of cost so, we will reduce cost of brick.
- After doing the practical we judge some properties are match with soil.
- In this project we have incorporated the use of Dry Sludge in brick up to 70% by
- replacing soil. (Dry Sludge 50%, 60% and 70%)
- Based on limited experimental investigation concerning the water absorption and compressive strength of brick, the following observations are made regarding the resistance of partially replaced Dry Sludge. The water absorption decreased up to 40% replacement of soil by Dry Sludge. Compressive strength increase when replacement of Dry Sludge percentage increases when compare to traditional Brick. From this project, replacement of soil with this Dry Sludge material provides good compressive strength at Dry Sludge 60 % replacement.

Thus, this project shows that replacement of soil with this Dry Sludge material reduce the weight of brick. And it's become light weight product.

FUTURE SCOPE

- Use of Dry Sludge in brick can save the ferrous and non-ferrous metal industries disposal, land pollution, cost and produce a „greener‟ brick for construction.
- Environmental effects from wastes and disposal problems of waste can be reduced or controlled through this research.
- A better measure by an innovative Construction Material is formed through the project.

REFERENCES

1. Yadav, S., Agnihotri, S., Gupta, S., & Tripathi, R. K. (2014). Incorporation of STP Sludge and Fly ash in Brick Manufacturing: An attempt to save the Environment. Int. J. Adv. Res. Technol, 3(5), 13
2. Kadir, A. A., & Mohajerani, A. (2011, July). Bricks: an excellent building material for recycling wastes-a review. In Proceedings of the IASTED International Conference on Environmental Management and Engineering (EME 2011), Calgary, AB, Canada (pp. 4-6).
3. Kadir, A. B. A., & Rahim, A. S. B. A. (2014). An overview of sludge utilization into fired clay brick. International Journal of Environmental, Ecological, Geological and Marine Engineering, 8(8), 528-532.
4. Victoria, A. N. (2013). Characterisation and performance evaluation of water works sludge as bricks material. International Journal of Engineering, 3(3), 8269.
5. Hegazy, B. E. E., Fouad, H. A., & Hassanain, A. M. (2012). Brick manufacturing from water treatment sludge and rice husk ash. Australian Journal of Basic and Applied Sciences, 6(3), 453-461.
6. Tay, J. H. (1987). Bricks manufactured from sludge. Journal of Environmental
Engineering, 113(2), 278-284.

Web Sites:
1. dspace.thapar.edu:8080/dspace/bitstream/123456789/.../8042307.pdf
2. www.afsinc.org/content.cfm?itemnumber=7116
3. www.epa.gov/sectors/sectorinfo/sectorprofiles/metalcasting/reuse.pdf
4. isddc.dot.gov/olpfiles/fhwa/011435.pdf 5.

INNO SPACE
SJIF Scientific Journal Impact Factor

ISSN INTERNATIONAL STANDARD SERIAL NUMBER INDIA

निस्केयर NISCAIR

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH IN SCIENCE, ENGINEERING AND TECHNOLOGY

| Mobile No: +91-6381907438 | Whatsapp: +91-6381907438 | ijmrset@gmail.com |

www.ijmrset.com