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Utilization of Sewage Sludge Waste as Brick Materials: A Review

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Abstract – ***Sewage sludge/bio solids are by-products of municipal and industrial waste water treatment and a rich source of organic nutrients. Despite being an important biological resource for sustainable agriculture it is used in brick production which can be considered as an economic and environmentally sound option. This paper presents the results of the utilization of dried sludge and fly ash as brick making materials. As sludge is generated every year from STP in a large quantities in our nation, most Common method adopted for disposing the sludge is land filling. Landfill disposal of the sludge has drawbacks like high cost of transportation, difficulty in getting suitable sites for land filling, heavy metal contamination of the land, emission of foul gases etc. Thus the disposal of sludge has become a major issue in our nation. The maximum percentages of dried sludge that can be mixed with fly ash for brick making are 40% and 50% respectively.***

Keywords: Sewage Treatment Plant Sludge, Brick, Fly Ash, Compressive Strength etc.

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INTRODUCTION

Sludge is defined as a semi-solid slurry residue produced from wastewater treatment processes or as a settled suspension obtained from conventional drinking water treatment and numerous other industrial processes. Due to rapid growth of industrialization and technology it is our prime duty to save our nature. A large quantity of sludge is generated every year from different sewage treatment plant and from various industries causing difficulties for municipality to dispose the sludge. This study focuses on the possibility of using sludge as a brick material. From centuries bricks have been used in constructions work. The earliest bricks were dried brick, meaning that they were formed from clay-bearing earth or mud and dried (usually in the sun) until they were strong enough for use. Many attempts have been carried out to find an environmental friendly material and method, as well as alternative low cost material for building purposes. The sludge for this study was collected from Old Sangvi Sewage Treatment Plant, Pune. Recycling of sludge generated from STP or industrial activities as building materials appear to be a solution for economic design of the building as well as in environment pollution problem. Sludge are easily available in any STP, so bricks produced for sludge can be considered as economical in compare to commercial bricks.

Many successful cases of reusing STP sludge in brick making by using sludge as artificial aggregates has been reported by many investigators. They concluded that satisfactory results were achieved when the ratio of STP sludge in the range 15% to 30 % by weight of the sludge-clay mixture. The influence of sludge proportion in the raw materials, the temperature in relating to the brick qualities, and metal leach ability were examined. In this study burning may be done for brick making with a mixture of fly ash and red soil. The utilization of these wastes in clay bricks usually has positive effects on the properties such as lightweight bricks with improved shrinkage, porosity, thermal properties, and strength. The light weight bricks will reduce the transportation and manufactured cost. Moreover, with this waste incorporation it will reduce clay content in the fired clay brick, and then reduce the manufacturing cost. This motivates many researches to investigate more potential of different sludge to been corporate into the brick.

RELATED WORK

Chih-Weng, et al (2003Huang) (7), ***"Utilization of Sludge as Brick Materials",*** In this study, the suitable conditions of using dried sludge in manufacturing of bricks under the criteria of Chinese

National Standards (CNS) were investigated. The influence of sludge proportion in the raw materials, the temperature in relating to the brick qualities, and metal leach ability were examined. This work has demonstrated the suitable conditions for using dried sludge as a clay substitute to produce an engineering quality of brick. Increasing the sludge content results in a decrease of brick shrinkage, water absorption, and compressive strength. Results also showed that the brick weight loss on ignition was mainly attributed to the organic matter content in the sludge being burnt off during the firing process. The proportion of sludge in the mixture and the firing temperature are the two key factors affecting the quality of brick. In all, the recommended proportion of sludge in brick is 10%, with a 24% optimum moisture content, prepared in the moldedmixtures and fired between 880 ℃ and 960 ℃ to produce a good quality brick.

Abdul G. Liew, et al (2003) (3), *"Reusability of Sewage Sludge in Clay Bricks",* Wastewater sludge has long been considered to be a nuisance for environmental control. Increasingly stringent environmental regulations and industrial growth have increased the disposal requirements. Therefore, disposal of sludge from wastewater treatment plants (WWTPs) is a problem for any municipality. Ocean dumping has been prohibited in many countries. Landfilling and spreading on reclaimed land are the most current sludge disposal methods worldwide. Therefore, alternative ways to reuse or to incorporate several types of waste materials have been attempted in recent decades, including incorporation into building materials. Heavy clay ceramic materials, namely bricks and roof tiles, or floor tiles, are generally very heterogeneous, because they consist of natural clays with a very wide-ranging overall composition. For this reason, such materials can tolerate the presence of different types of wastes, even in considerable percentages. The present work aims at studying the recycling ability of a sludge generated from sewage treatment plants. In these studies, suitable conditions for using dried sludge for hand mold bricks under the criteria of the Malaysian Standards were investigated. The influence of sludge proportion in the raw materials was therefore examined.

Mohammed O. Ramadan, et al (2008) (19), *"Reuse of Water Treatment Plant Sludge in Bricks Manufacturing",* The main object of the study was to produce a lab scale brick units made of mixtures of clay and water treatment plant sludge with various ratios that meet the obligatory values of compressive strength and water absorption assigned by the Egyptian Standard Specifications for load bearing bricks. Also it was objected in this research to produce bricks that can compete with most of the commercial brick types available in the Egyptian market. This study focused on the reuse of sludge in clay-brick production. The study investigated the use of sludge as partial substitute for clay in brick manufacturing. In this study, four different series of sludge and clay proportioning ratios were studied, which exclusively involved the addition of sludge with ratios 50, 60, 70, and 80 percent of the total weight of sludge-clay mixture. Each series involved the firing of bricks at 950, 1000, 1050, and 1100 ℃, giving 16 different brick types. The physical properties of the produced bricks were then determined and evaluated according to Egyptian Standard Specifications and British Standards from the obtained results, it was concluded that by operating at the temperature commonly practiced in the brick kiln, 50 percent was the optimum sludge addition to produce brick from sludge-clay mixture. The produced bricks properties were superior to those available in the Egyptian market.

A.A.Mageed, et al (2011) (1), *"Utilization of Water Treatment Plants Sludge Ash in Brick Making",*The present study investigates the possibility of using water treatmenplant (WTP) sludge of New Assiutcity (Assiut- Egypt) as partial substitute for shale in brick making. Due to the high content of organic matter in water sludge, incineration of the WTP sludge is necessary to remove of all organic compounds contained therein. For brick making, mixture of various proportions from 10 % to 50% by weight of sludge ash added to shale are used as raw materials in hand molding brick making. The produced brick samples after drying process and firing at 1000 ℃ for 6 hrs, received a series of tests including firing shrinkage, weight loss on ignition water, absorption, bulk density, compressive strength, slake durability and efflorescence test. Satisfactory results were achieved when the percentage of sludge ash was up to 30% (by wt.) or less in the mixture. The specifications of the produced bricks match the Egyptian standard ES: 1756/1989 of fired clay building units for non-load bearing walls. The test results indicate that the sludge ash proportions are one of the most important key factors determining the quality. Reuse of sludge ash as a construction and building material converts the waste into useful products that can alleviate the disposal and environmental problems.

Badr El-Din E. Hegazy, et al (2012) (4), "*Brick Manufacturing from Water Treatment Sludge and Rice Husk Ash",* For thousands of years, bricks have been made from clay. The water treatment plant sludge is extremely close to brick clay in chemical composition. So, the sludge could be a potential substitute for brick clay. The water treatment process generates a sludge that must be disposed of in an environmentally sound manner. The sludge generated in most of the treatment systems around the world is discharged into the nearest watercourse, which leads to accumulative rise of aluminium concentrations in water and human

bodies. This practice has been linked to occurrence of Alzheimer's disease. Among all disposal options, the use of sludge in producing constructional elements is considered to be the most economic and environmentally sound option. One of the most common agricultural wastes, which contain high silica content, and might be incorporated with sludge in brick manufacturing, is rice husk ash (RHA). So, this trend also provides an environmentally sound manner to reuse rice husk ash (RHA). The study investigated the complete substitution of brick clay by water treatment sludge incorporated with rice husk ash (RHA). In this study, three different series of sludge to rice husk ash (RHA) proportions were studied, which exclusively involved the addition of sludge with ratios 25, 50, and 75% of the total weight of sludge-RHA mixture. Each brick series was fired at 900, 1000, 1100, and 1200 ℃. 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 brick made entirely from clay. From the obtained results, it was concluded that by operating at the temperature commonly practiced in the brick kiln, 75 % was the optimum sludge addition to produce brick from sludge-RHA mixture. The produced bricks properties were obviously superior to the clay control-brick and to those availablein the Egyptian market.

Krishna PriyaNai, et al (2013) (15), *"Suitability of Sludge as a Building Material",* The objective of this study is to identify the possibilities of using sludge obtained from effluent treatment plant in Hindustan Latex Limited Lifecare Limited; Peroorkada, Trivandrum as a brick material. The different engineering properties were also studied by conducting tests on brick specimens of various mix proportions prepared. It was seen that when percentage of sludge was increased beyond 60%, water requirement as well as water absorption of the bricks increased by 18%. But at the same time, compressive strength of the brick decreased by 10.85%. But on addition of cement, flyash and sisal fibres, the compressive strength increased by 30% and the properties of the bricks improved. Further it can be added that other alternatives like coir fibres, charcoal husk, lime whose addition shall enhance the properties which can be considered as the scope for future research. Different engineering properties of the sludge such as specific gravity and moisture content were studied. Specific gravity of sludge was obtained as 1.53 while moisture content was observed to be 162%.

Mary Lissy P N, et al (2014) (18), *"Utilization of Sludge in Manufacturing Energy Efficient Bricks",* The most energy efficient bricks were casted using sludge as raw materials at a temperature of 500℃.By casting bricks with different raw materials, sludge bricks showed the maximum compressive strength when compared to control bricks. The sludge bricks were kept for sundry for three nights and four days. It was burnt to a temperature of 500 ℃ in muffle furnace for three days and three nights. The control bricks and sludge bricks were casted with same condition for comparison. Since the test results showed more than the minimum compressive strength of an ordinary brick, it can be concluded that energy efficient bricks made of sludge can be used for construction purposes due to its good strength. The bricks casted with less number of days of burning at low temperature can be used instead of ordinary bricks in construction at a faster rate.

M. Angeline Swarna, et al (2014) (17), *"Manufacturing of Bricks Using Tannery Effluent Sludge",* Tanneries in India are mainly located in four states of Tamilnadu, West Bengal, Uttar Pradesh and Punjab. There are nearly 900 tanneries in Tamil Nadu. The wastewater from the tannery industries are sent to tannery Effluent Treatment Plant. The sludge resulting from tannery effluents plants creates problems of disposal. General dewatered sludge is disposed of by spreading on the land or by land filling. However, for highly organized cities, sludge disposal by landfilling might not be appropriate due to land limitation. This project will lead to evaluate the suitability of sludge in manufacturing of bricks. Tannery sludge can replace cement up to 20% and quarry dust can replace sand up to 100% in cement bricks. The properties of tannery sludge and quarry dust is found out by using standard test procedures. In this project different proportions of cement, sludge and quarry dust are thoroughly mixed and moulded in the cube size of 7.045 cm X 7.045 cm X 7.045 cm and test were performed for the property of comprehensive strength for 7 days and 14 days of curing and 24 hours of sun drying.

B. Shoba, (2015) (5), *"Utilization of Water Treatment Plant Sludge in the Brick Manufacturing",* Sludge refers to the residual, semi-solid material left from industrial waste water or sewage treatment processes. The aim of project is to develop sustainable, low energy construction product by partially replacing the water treatment plant sludge in brick and determining the compressive strength and water absorption test. The water treatment plant sludge could be used as a partial substitute for clay in the manufacture of bricks. The percentage of sludge addition is based on the need for which bricks are produced. Utilising the alum sludge bricks saves the aquatic environment. This paper reports the use of sludge as new and non-conventional construction materials as an alternative means of sludge disposal. Sludge percentage is varied from zero to thirty percentages by weight. Parameters such as compressive strength and water

absorption are studied as per BIS (Bureau of Indian Standards) procedure. Water treatment plant sludge up to 15 % can be added to get the higher compressive strength of 8.30N/mm².

R.P.Hari, et al (2017) (22), *"Study of Municipal Sludge Ash as a Bricks Material",* The target of this review is to distinguish the conceivable outcomes of utilization ooze fiery debris acquired from districts squanders as a block material. The distinctive designing properties were additionally considered. The ooze is having a run of the mill structure promoting a preparatory property examination. The blocks hence fabricated were subjected to compressive quality test and water retention test was analysed.

CONCLUSION

On the basis of literature discussed above sewage treatment plant sludge can be successfully used as a partial substitute for the brick clay incorporated with agricultural waste materials; which contain high silica content; under the conditions, mixing proportions, firing temperatures, and manufacturing methods. Different conditions affecting the strength of bricks were studied. It was seen that when percentage of sludge was increased in the mix, water requirement as well as water absorption of the bricks increased. But at the same time, compressive strength of the brick decreased. But on the addition of cement and flyash, the properties of the bricks improved. Thus it could be concluded that the sludge alone cannot be used for brick manufacture. The bricks made from sludge are light in weight. Various properties of bricks can be evaluated and can be recommended for the use in the constructions works.

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