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Research Article

DURABILITY OF CLAY BRICKS MADE WITH SLUDGE AND TREATED DOMESTIC WASTEWATER

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A B S T R A C T

Use of industrial bi-product and treated domestic wastewater is a cost effective and protect environment solution. Present investigation deals with the feasibility of use of sludge from sand beneficiation treatment plant and treated domestic wastewater (TDWW) in the production of bricks. The experimental results show that the 40 % of brick earth can be replaced with sludge to making conventional purpose bricks. At 5% replacement of earth, the quality of bricks is superior to the bricks made with earth. Mixing waters in bricks i,e,. Potable water (PW) and treated domestic wastewater (TDWW) performed in same manner. Bricks, at 5% replacement of earth, 90 days cured in 4% sulfuric acid solution, loss in compressive strength was 3% less than reference bricks. Hence, bricks with 5% sludge and TDWW may be used in superior quality construction work.

INTRODUCTION

Reduction of environmental pollution, contamination is main concern for the world. In order to reduce pollution and contamination of environment, use of industries bi-products and treated wastewater has to be practiced where ever they are fit in various industries. Considerable research was carried or being carried out on reuse of solid industrial waste but reuse of treated wastewater not got significant attention [1-3]. The literature search indicates that, not much research work was carried out on the non potable water in construction industry. An estimated annual production of 250 billion bricks per year in India, and is the second largest brick producer globally [4]. Industrial wastes, depending on their composition, may be used in brick making industry to reduce firing temperature, to modify plasticity of the locally available soil or as a filler material in the brick earth. Huge volume of water is also required in brick industry. Hence, in this investigation an attempt has been made to use the sludge from sand beneficiation treatment plant and treated domestic wastewater in bricks. This will result in get sustainable development. Sand beneficiation treatment plant in TADA produces silica sand, which is required for glass industry. The quantity of sludge produced is around 6 to 10 tons per day.

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MATERIALS AND METHODS

Sludge

The sludge contains predominantly silt and clay sized particles (98.2%). Its pH is 5.5. Liquid limit is 41.5% and plasticity index 19%. It may be classified as clay of intermediate compressibility (CI) as per Indian Standard Soil Classification System [5].

Soil

Bricks were made with locally available soil. The soil consists of 52% of sand and 48% of silt and clay sized particles. Its liquid limit is 29.5%. Plasticity index 16.5% and pH 7.11. The soil may be classified as clayey sand as per the Indian Standard Soil Classification System [5].

Water

Potable water (Reference bricks) and treated domestic wastewater (Test bricks) were used in bricks. Treated domestic wastewater collected from domestic wastewater treatment plant in Vishnu educational society, Vishnupur, Bhimavaram, Andhra Pradesh. Plant has been treating 2000 kL/day. The characteristics of treated domestic wastewater were pH 7.2, Total solids 15 mg/L, Total inorganic solids 5 mg/L.

METHODS

In order to study the possibility of sludge from sand beneficiation treatment plant and treated domestic wastewater in brick making, air dried sludge from industry was mixed thoroughly with soil in proportion of 5%, 10%, 15%, 20%, 30%, 40%, and 50% by weight. Potable water(reference bricks)) and Treated domestic wastewater(Test bricks) were added to these soil sludge mixes so as to produce a homogeneous paste having enough consistency to mould it into the brick shape by hand. Bricks of size 19cm x 9cm x 9cm were fabricated from these pastes using hand moulding and soft extrusion technologies as carried out in the brick making industry. The reference and test bricks were air dried for 7 days under shade and burnt at 800^0C in muffle furnace. The test performed on burnt bricks were efflorescence test, water absorption test and compressive strength test as per I.S: 3495-1976 (Part I to IV)[6] . Each test was conducted on at least five bricks and their average values were taken for design. The soil sludge mixes were also tested for liquid limit and plastic limit to assess the influence of sludge on plasticity of soil. The plasticity of a good brick earth should lie between 15% and 25% (IS: 2117-1975)[7].

Durability

In order to study Sulfuric acid (H_2SO_4) effect, the reference (Brick earth + PW) and test (5% sludge + TDWW) specimens were immersed in 4% concentration of sulfuric acid solution for four months. The concentration of the sulfuric acid solution was renewed once in a two months. The effect of sulfuric acid on the durability of reference and test specimens was evaluated by measuring the reduction in compressive strength. The compressive strength reduction in percentage of test specimens was compared with reference specimens.

RESULTS AND DISCUSSION

Influence of Sludge on Water Adsorption

Compressive strength of bricks is depicted in Fig.3.1. The fig reveals that the water adsorption is almost constant up to 10% sludge. Water absorption increased with percent sludge increases above 10% sludge. Addition of sludge to soil leads to increase in fine fraction (finer than 0.075mm) which has ability to consume water by absorption. The water is held at the surface of the clay particles which are electrically active owing to structure and mineralogical composition [8]. The plasticity index and liquid limit of soil sludge mixes are found to be more than, liquid limit and plasticity index of soil alone. This indicates that water adsorption of mixture is more than the soil. However, the fine fraction is able to fill the voids between the bigger sized particles which leads to less pore space and less pore water thereby less water absorption. The results reveal that the possible reduction in water absorption due to reduction in pore space when percentage of sludge added is less than 10%. There is a gradual increase in water absorption, when the sludge added is more than 10%, indicating that the effect of water adsorption is predominant when the percent sludge added is more than 10%. The water absorption of bricks rose to 19.5% when the sludge added is 50%. According to I.S: 3495 (1976) [6] for the bricks of class up to 12.5 N/ mm^2, the water absorption should be less than 20% by weight. Hence, it is recommended to limit the percentage of sludge to be added to less than 50% by weight from the view point of water absorption. At the same time, it reveals that no difference between TDWW and PW in water absorption.

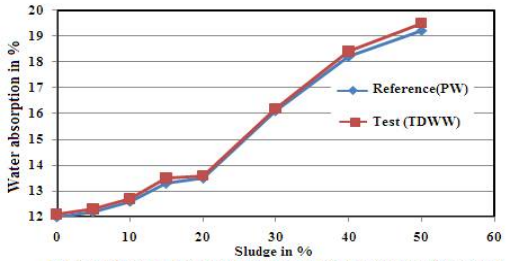

Fig 3.1 Effect of sludge and mixing waters on water absorption of bricks

Influence of Sludge on Compressive Strength

Compressive strength of the bricks is shown in Fig 3.2. The compressive strength of bricks without any addition of sludge is 11.7 MPa, 5% soil replaced with sludge increased the compressive strength of bricks to 17.6 MPa. However, the addition of sludge beyond 5% resulted in reduction of compressive strength from 17.6 to 10.5 MPa, when the percentage of sludge added to the soil is 40%, the compressive strength is 12.2 MPa. Hence, 40% of sludge can be added to the soil without any compromise on compressive strength of bricks. If higher strength bricks are required, the proportion of sludge should be kept at 5% to 40% depending on the strength requirement ranging from 17.6 to 12.2 MPa. The observed changes in compressive strength of bricks due to addition of sludge may be attributed to changes in plasticity characteristics and filler action of sludge. Sludge being finer and having more plasticity than the soil, the addition of sludge to the soil resulted in increased plasticity. The strength is known to decrease with plasticity [9] as it results in lesser friction. Hence, addition of sludge to soil should result in lesser compressive strength of bricks. However, sludge being finer than soils itself, it also may fill the voids within the soil causing reduction in void space thereby making bricks denser. Hence, the filler action of sludge should increase the compressive strength of bricks. The observed changes in strength should obviously be the sum total of these two effects. Filler action is dominant when percentage sludge added is less than 5%. Further addition of sludge occupies the space only by pushing the coarse sand particles in the soil apart. This will result in reduction in the friction between sand particles which contribute significantly to the compressive strength of bricks. Apart that, result also indicate that PW and TDWW are affected in same, hence, compressive strength is affected by only sludge.

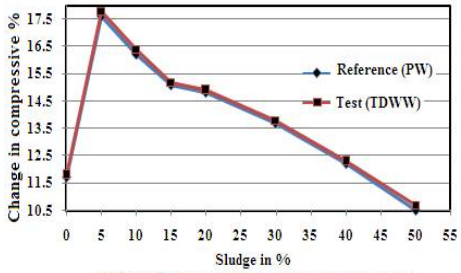

Fig3.2 Effect of sludge and mixing waters on compressive strength

Effect of sulfuric acid on bricks

Effect of 4% sulfuric acid on compressive strength is illustrated in 3.3. It makes know that test specimen (5%

sludge + TDWW) is performed much better than the reference (Earth +PW) specimens. At 30 days, 60 days and 120 days, loss in compressive strength for PW is 2.1%, 3.2% 4.0%, TDWW is 0.5%, 0.74, and 0.96% respectively.

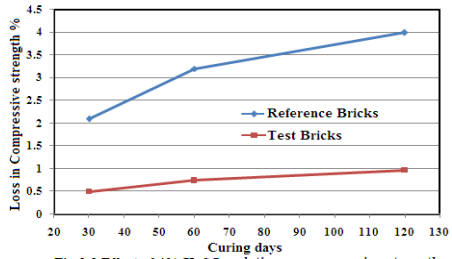

Fig 3.3 Effect of 4% H_2SO_4 solution on compressive strength

CONCLUSION

Based on the experimental result, the following conclusions can be drawn.

- Sludge generated from sand beneficiation treatment plant can replace brick making earth up to 40%.
- Treated domestic wastewater may be recommended to use in making of bricks.
- Water absorption is also less than 20% up to maximum 50% of sludge.
- No efflorescence appeared on bricks due to use of treated domestic wastewater
- Test specimens are much better than reference specimens in durability.

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