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Studies on Effective Utilization of WTP Sludge in Brick Manufacturing

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Abstract – India is second largest producer of bricks accounting for over l0°/o of the global production. As bricks are economical. durable and easy to handle these are widely used in India. The demand for bricks has been increasing year by year with the increased building construction activities. 140 billion bricks were produced in 2001 and 250 billion bricks in 2012. The production of bricks is estimated to be growing at a rate of 4% per year. India is the largest producer of fired clay bricks with more than hundred thousand brick kilns in operation. The brick sector is growing as the demand for bricks is increasing in the towns and villages due to the fast economic growth, urbanization and prosperity. India's brick sector is characterized by traditional firing technologies, high dependency on human and animal labour and low mechanization rate, Brick sector in India is of small-scale with limited financial, technical and managerial capacity. Brick industry in India is widely spread all around but situated in rural and periphery of urban areas. Quality of brick changes from place to place due to changes in raw material and manufacturing process of brick. The brick manufacturing process is conventional and brick industry is unorganized. Different parts of country produce bricks with different engineering properties. Bricks from northern India region, which lies in the Indo-Gangetic plains have good engineering properties as compared to bricks from others parts of India. In this research the water treatment sludge is utilized for manufacturing the clay bricks.

Key Words – Bricks, Clay, WTP Sludge, Strength

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I. INTRODUCTION

Brick is solid rectangular block of kneaded clay used in masonry construction, Brick consists of inorganic matter which is hardened by firing. Brick is produced in numerous Classes, types, materials, and sizes which vary with region.

Brick is oldest construction material known to mankind. Brick masonry structures are widespread over the globe. History of brick is 2000-3000 years old. Bricks began its history in Egypt and Ancient Rome: this is where bricks were used for the construction of complex structures, which included arches, vaults and other items. Many brick masonry structures which were made hundreds of years ago are still standing high. Brick is essentially a local building material and consequently there exist considerable variation in quality of raw material, the process of manufacture and quality of finished product. Up until the mid-l9th century, technology used for brick production was of low level and depended on demand. In olden days bricks were manufactured manually, drying was done only in the warm seasons, and fired bricks were produced in primitive kilns, By the end of the 19th century annular kiln, belt press, as well as machines to process clay was introduced. Due to its intensive properties, bricks are still used in modern age without much Iteration in its manufacturing material and process,

II. AIM:

The aim of this research "Effective Utilization of WTP Sludge for Manufacturing of Clay Bricks "

III. OBJECTIVES

1. To conduct survey of brick industries in four places from Pune district of Maharashtra and study methodology of brick production and their environmental impact.

2. Find out physical properties of conventional bricks from four places from Pune district of Maharashtra.

3. To arrive at ideal/optimal mix of clay and WTP sludge for manufacturing of burnt clay brick,

4. To evaluate the engineering properties of bricks as per IS: 3495 produced using WTP sludge

5. To analysis the economic aspects between conventional bricks and new material Bricks

IV. METHODOLOGY

For this research, the following flow of work followed –

Step 1- Conduct survey of brick industries in four places from Pune district of Maharashtra and study methodology of brick production and their environmental impact.

Step 2- Collect the conventional brick Sample from four places and find out the physical properties

Step 3: Collect the WTP sample from adjoining plant physical and chemical properties of WTP sludge clay

Step 4- By experimental analysis find out ideal/optimal mix of clay and WTP sludge for manufacturing of burnt clay brick

Step 5:evaluate the engineering properties of bricks as per IS: 3495 produced using WTP sludge

V. WATER TREATMENT PLANT SLUDGE

Water treatment plant sludge is semi-solid slurry and it is produced water treatment processes or as a settled suspension obtained from conventional drinking water treatment Quantities and chemical-physical characteristics of Water Works residuals also depend on the sources of water (surface or ground water) an on the treatments to which water is subjected (coagulation-flocculation-filtration, softening, membrane separation, ion exchange, powdered or granular activated carbon adsorption, stripping, etc…). The main components of the sludge from WTP are clay minerals, very fine grained minerals, oxides and hydroxides of aluminium and iron, organic matter and contaminants.

Generally in conventional water treatment plant, sludge is generated in clarifier after the process of coagulation and flocculation. In coagulation, coagulants is used to destabilizing the colloidal particles and in flocculation destabilized particles brought together to form macro flocs. In this process conversion of non settleable colloidal particles into settleable takes place which settle down under the influence of gravity. Colloidal particles found in the raw water typically have the net negative surface charge. The size of colloidal particle is in the range 0.01-1 µm, due to such size attractive forces between particles are less than the repelling forces of the electrical charge. Under these stable conditions, Brownian motion keeps he particles in the suspension. Brownian motion is brought about by the constant thermal bombardment of the colloidal by the relatively small water molecules that surrounds them. Coagulation process is complex and numerous side reactions with other substance in the water may take place depending on the characteristics of the raw water which may vary throughout the day as well as seasonally. Coagulation processes primarily depend on the chemical used for the coagulation, inorganic chemicals most commonly used for coagulation and precipitation in the water treatment.

5.3.1 Destabilization Mechanisms

Destabilization occurs due to following mechanisms

1. Double-Layer Compression
2. Adsorption and charge neutralization.
3. Adsorption and inter-particle bridging
4. Sweep coagulation

1. Double-Layer Compression

The classical melhod of colloid destabilization is double-layer compression. Ln this process with the addition of coagulant results into low ionic to higher ionic solution. Higher ionic solution reduces the repulsive forces between the colloidal particle and force of attraction (weak wander wall forces) becomes significant. To affect double-layer compression.a simple electrolyte such as NaCl is added to the suspension. The ions that are opposite in sign to the net charge on the surface of the particles enter the diffuse layer surrounding the particle, If enough of these counter- ions are added, the diffuse layer is compressed. reducing the energy required to move two particles of like surface charge into close contact. Destabilization by double-layer compression is not a practical method for water treatment because the salt concentrations required for destabilization may approach that of seawater and in any case, the rate of particle aggregation would still be relatively slow in all but the most concentrated suspensions. Double-layer compression. However, is an important destabilization mechanism in certain natural systems.

2. Surface Charge Neutralization

Destabilization by surface charge neutralization involves reducing the net surface charge of the particles in the suspension. As the net surface charge is decreased the thickness of the diffuse layer surrounding the particles is reduced and the energy required to move the particles into contact is minimized. Two processes are used to accomplish surface charge neutralization. In the first, coagulant compounds that carry a charge opposite in sign to the net surface charge of the particles are adsorbed on the particle surface. (in some cases the coagulant is a small particle that deposits on the particle surface.) The coagulants used to accomplish this usually have a strong tendency to adsorb on (attach to) surfaces Examples include the synthetic and natural organic polyelectrolytes and some of the hydrolysis products formed from hydrolyzing metal salt coagulants. The tendency for these compounds to adsorb is usually attributable to both poor coagulant-solvent interaction and a chemical affinity of the coagulant or chemical groups on the coagulant for the particle surface. Most of the coagulants that are used for charge neutralization can adsorb on the surface to the point that the net surface charge is reversed and, in some cases increased to the point that the suspension is restabilized. Adjustment of the chemistry of the solution can be used to destabilize some common types of suspensions by reducing the net surface charge of the particle surfaces For example, when most of the surface charge is caused by the ionization of surface sites, pH adjustment with acid or base may lead to destabilization For some surfaces. such as positively charged oxides and hydroxides, the adsorption of simple multivalent anions (such as sulphate and phosphate) or complex polyvalent organic compounds such as humic materials will reduce the positive charge and destabilize the suspension. Heterocoagulation IS a destabilization mechanism that is similar to the process of surface charge neutralization by the adsorption of oppositely charged soluble species. However. In this case, the process involves one particle depositing on another of opposite charge For example, large particles with a high negative surface charge may contact smaller particles with a relatively low positive charge. Because the particles have opposite surface charge, electrostatic attraction enhances particle-particle interaction As the stabilizing negative charge of the larger particles is reduced by the deposited positive particles, the suspension of larger particles is destabilized.

3. Adsorption and Inter-Particle Bridging

Destabilization by bridging occurs when segments of a high-molecular-weight polymer adsorb on more than one particle, thereby linking the particles together. When a polymer molecule comes into contact with a colloidal particle, some of the reactive groups on the polymer adsorb on the particle surface and other portions extend into the solution. If a second panicle with open surface is able to adsorb the extended molecule, then the polymer will have formed an inter-particle bridge. The polymer molecule must be long enough to extend beyond the electrical double layer (to minimize double-layer repulsion When the particles approach) and the attaching particle must have available surface. The adsorption of excess polymer may lead to restabilization of the suspension. lons such as calcium are known to affect the bridging process, aparently by linking sites on interacting polymer chains.

4. Sweep coagulation

Addition of relatively large doses of coagulants usuallyaluminium or iron salts which results in precipitation as hydrous metal oxides. Most of the colloids and some of dissolved solids are literally swept from the bulk of the water by becoming enmeshed in the settling hydrous oxide floc. This mechanism is often called sweep flocculation. Sweep floc is achieved by adding so much coagulant to the water that the water becomes saturated and the coagulant precipitates out. Then the particles gel trapped in the precipitant as it settles down (Edzwald.2011).

VI. EXPERIMENTAL METHODOLOGY

Following Steps are taken for the data collection and Analysis

Step No1: The questionnaires survey carried out for the from various brick Industries.

Step No2: Collection of Brick Sample and Testing of Brick Sample

Step No3: Collection of WTP Sludge from adjoining industry and decided mix proportion

Step No4: Manufacturing of Bricks and Testing of Bricks

Step No 5: Analysis the Economic Aspects by comparing the Conventional bricks and New Material Bricks.

Questionnaire Survey

To understand the process of brick making and variation in the process with changing place, a questionnaire survey was under taken. The questionnaire survey shows that in all four places, clamps were used for firing the bricks and coal was used as fuel. Table 3.3 shows the detailed information collected from various brick industries in the places of Perne, Markal, Hadapsar, Kesanand

Table No 1: Questionnaires Results

Sr. No.	Factor	Perne	Hadapsar	Markal	Kesanand
1	Source	Bhima-koregav river	Fields	Fields	Fields
2	Structure	Clamp	Clamp	Clamp	Clamp
3	Mixing	Manually	Manually	Manually	Manually
4	Molding	Hand molding	Hand molding	Hand molding	Hand molding
5	Drying	10-15 days	7-10days	10-15 days	10-12 days
6	Burning fuel	Coal	Coal	Coal	Coal

VII. ENGINEERING PROPERTIES OF COLLECTED BRICK SAMPLES

Engineering properties of the brick samples collected from different places in Pune district were carried out and presented in tables.

Table 2 Test Result of engineering properties of brick samples collected from Perne.

Sample No.	Water absorption (%)	Efflorescence	Compressive strength (N/mm2)
1	18.35	Nil	4.91
2	20.65	Nil	3.9
3	22.45	Nil	2.5
4	17.20	Nil	1.97
5	16.3	Nil	4.2
AVERAGE	18.99	NIL	3.5

Table 3 Test results of engineering properties of brick samples collected from Markal.

Sample No.	Water absorption (%)	Efflorescence	Compressive strength (N/mm2)
1	15.2	Nil	4.2
2	17.7	Nil	3.87
3	19.45	Nil	3.92
4	15.37	Nil	4.17
5	21.58	Nil	3.45
AVERAGE	17.86	NIL	3.9

Table 4 Test Result of engineering properties of brick samples collected from Hadapsar.

Sample No.	Water absorption (%)	Efflorescence	Compressive strength (N/mm2)
1	17.4	Nil	3.67
2	21.3	Nil	2.89
3	15.4	Nil	4.23
4	17.56	Nil	3.37
5	19.65	Nil	3.92
AVERAGE	18.62	NIL	3.616

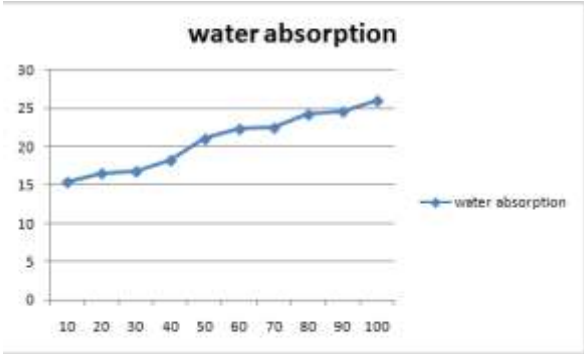
Table 5 results of engineering properties of brick samples collected from Kesanand.

Sample No.	Water absorption (%)	Efflorescence	Compressive strength (N/mm2)
1	22.34	Nil	3.79
2	16.3	Nil	3.9
3	17.86	Nil	3.43
4	15.4	Nil	5.14
5	16.84	Nil	4.2
AVERAGE	17.74	NIL	4.092

VIII. ENGINEERING PROPERTIES OF SLUDGE BRICKS

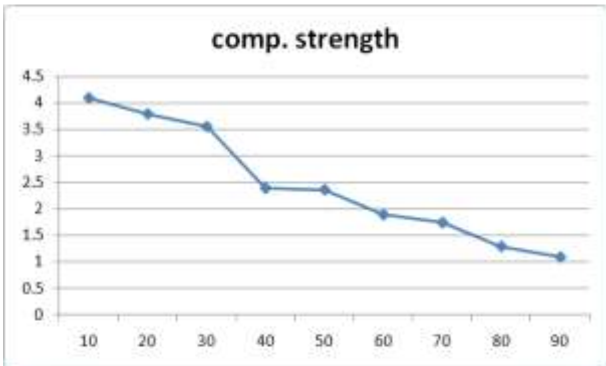
Table 6 Engineering properties of SLUDGE Bricks

Sr. No.	Water Absorption (%)	Effloresces	Compressive strength (N/mm²)
A (10% sludge)	15.36	NIL	4.1
B (20% sludge)	16.5	NIL	3.8
C (30% sludge)	16.75	NIL	3.56
D (40% sludge)	18.2	NIL	2.4
E (50% sludge)	21	NIL	2.37
F (60% sludge)	22.3	NIL	1.9
G (70% sludge)	22.45	NIL	1.75
H (80% sludge)	24.2	NIL	1.3
I (90% sludge)	24.57	NIL	1.1
J (100% sludge)	26	NIL	0.9
K (100% clay)	15.30	NIL	4.8



Graph 1 Effect of sludge on water absorption of Brick

In above figure, graph is plotted between water absorption of brick and sludge proportion in clay brick. X axis indicates percentage of sludge in clay bricks and Y axis indicates percentage water absorption of bricks. As shown in fig, when proportion of sludge is increased then water absorption of bricks increases



Graph 2 Effect of sludge on strength of bricks

In above figure, graph is plotted between compressive strength of bricks and sludge proportion in clay bricks. X axis indicates percentage of sludge in clay bricks and Y axis indicates compressive strength of bricks. As shown in fig compressive strength of bricks decreases when percentage of sludge is increased in sludge bricks.

IX. CONCLUSION:

When sludge is used as partial substitute in clay bricks it is seen that compressive strength decreases as sludge proportion is increase.

When sludge is used as partial substitute in clay bricks it is seen that water absorption of clay bricks increases when sludge is increase.

Bricks manufacture with sludge 30% and clay 70% gives strength of 3.56N/mm^2 which is good as per IS 1077:1992 as per this IS code minimum strength should be 3.5 N/mm^2

When sludge is increased more than 30% it gives strength less than $3.5N/mm^2$

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