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UTILIZATION OF UNDER WATER TREATMENT PLANT SLUDGE IN CERAMIC BRICK

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ABSTRACT

A large quantity of sludge is generated each year from water treatment plants in India.Disposing the sludge to the nearest watercourse is the common practice in India, which accumulatively rise the aluminum concentrations in water and consequently in human bodies. This practice has been linked to occurrence of Alzheimer's disease. Landfill disposal of the sludge is impractical because of the high cost of transportation and depletes the capacity of the landfill. The use of sludge in construction industry is considered to be the most economic and environmentally sound option. Due to the similar mineralogical composition of clay and water treatment plant sludge, 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, different series of sludge and clay proportioning ratios were studied, which exclusively involved the addition of sludge and 0-50% of the total weight of sludge-clay mixture. Each series involved the firing of bricks at 900,950 and 1000 ˚C giving different brick types. The physical properties of the produced bricks were then determined and evaluated according to Indian Standard Specifications from the obtained results.

Keywords*: Natural Rubber, Vulcanization, Rubber*.

I. INTRODUCTION

The construction sector is an important part of the Indian economy with the contribution of 10% in the GDP and is registering an annual growth of 9%. Clay fired bricks are the backbone of this sector. The Indian brick industry is the second largest producer of bricks in the world after China. India is estimated to produce more than 250 billion of bricks annually, mainly by adopting age-old manual traditional processes.

The brick sector consumes more than 35 million tonnes of coals annual along with huge quantity of biomass fuels. Due to large scale construction activities in major towns and cities, a number of brick plants have been set up on the outskirts of these cities.

While studying the market in the developed countries, it has been observed that the process of manufacturing of brick in India is less developed.

II. LITERATURE REVIEW

The effect of incorporation of Brazilian WTP sludge on the properties of Ceramic material.
S.R.Teixeira[#],G.T.A Santos[#],AE.Souza[#],P.Alessio[#], S.A. Souza[#],N.R. Souza.[#]
We computed the practicability of incorporating sludge from decantation ponds of a water treatment plant (WTP) into a ceramic body used in ceramic brick production. The sludge grain-size distribution & the effects of its incorporation on the ceramic body properties were studied. Samples were collected during 10 months period. The WTP sludge's chemical & mineralogical composition varied according to the sludge production month, but the compositions are same to those of the natural raw material used by the ceramic brick industry. Ceramic probes technological tests showed that this residue can be incorporated into clays used to manufacture the ceramic bricks. The concentration of sludge to be incorporated depends on its physical properties, but mainly depend on the properties of the raw material used.

Characterization and performance evaluation of water works sludge as Brick's material.
Anyakora Nkolika Victoria.[#]-Sludge collected from Lower Usuma Dam Water Treatment Plant (LUDWTP) Abuja, Nigeria was investigated for use as material for brick manufacturing. The reuse of sludge as brick material is a long-term method to sludge disposal for economic and environmental sustainability. Characterization & laboratory trials validated that LUDWTP sludge could be used as a colorant and clay supplement in brick production. Five unlike mixing ratios of sludge at 0, 5, 10, 15 and 20 per cent of the total

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weight of sludge-clay combinations were studied. Each group of hand-mould produced green bricks was fired in a heat controlled furnace at higher temperatures of 850˚C, 900˚C, 950˚C, 1000˚C, and 1050˚C correspondingly.

Reuse of WTP sludge in brick manufacturing.

Mohammed O. Ramadan.[#], Hanan A. Fouad.[#], and Ahmed M. Hassanain.[#]-A large quantity of sludge is produced each year from water treatment plants in Egypt. Disposing the sludge to the nearest waterbodies is the common practice in Egypt,which materialistically increase the aluminum concentrations in water and accordingly in human bodies. This practice has been linked to occurrence of Alzheimer's disease. Landfill disposal of the sludge is unfeasible because of the high cost of transportation and reduces the capacity of the landfill. The consumption of sludge in construction industry is considered to be the most economic and ecologically sound option. Due to the similar mineralogical configuration of clay and water treatment plant sludge, this study concentrated on the reuse of sludge in clay-brick manufacture.The study examined 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 solely involved the addition of sludge with ratios 50, 60, 70, and 80 percent of the total weight of sludge-clay combination. Each series involved the firing of bricks at 950, 1000, 1050, and 1100 ˚C giving 16 unlike brick varieties. The physical properties of the manufactured bricks were then determined and assessed according to Egyptian Standard Specifications and British Standards from the gained results, it was decided that by operating at the temperature normally practiced in the brick kiln, 50 % was the optimum sludge addition to yield brick from sludge-clay mixture. The manufactured bricks properties were superior to those existing in the Egyptian market.

Environmental Life Cycle Assessment of Traditional Bricks in Western Maharashtra, India.

A,Shridhar Kumbhar[#] ,b, Nitin Kulkarni[#] ,c, Anand B. Rao.[#] ,and Bakul Rao.[#]-Bricks are one of the chief constituents used for the construction of buildings. With the growing infrastructure in India; 140 billion bricks were manufactured in 2001and 250 billion bricks in 2012. The manufacture of bricks is estimated to be increasing at a rate of 4% per year. India is the second largest manufacturer of fired clay bricks with more than hundred thousand brick kilns in action. Brick manufacture is known to have diffused and seasonal environmental effect along with the social and economic impact. A life cycle assessment (LCA) study, to recognize and calculate the environmental performance of the brick as a product, is carried out for the traditional brick kilns in and around the Sangli-Karad area of western Maharashtra, India.

III. METHODOLOGY

Selection of Materials

A) Brick Clay, Coal Powder, Foundry Sand & Bagasse.
Place: Junnar
Primary Observation:
Type of clay- Alluvial soil
Quantity (1000 bricks): 2 - 2.5 m3
Source (River/pond): Kukadi River.
Preliminary survey was carried out to know best raw material available to get good mechanical and physical properties of bricks. The raw materials essential are sludge, clay, bagasse, coal ash etc.

B) SLUDGE:
Properties of sludge required for brick production are
Based on above things various water treatment plants were visited and proper sludge was collected for brick making.

Brick Making Process

Introduction

Bricks prepared by shaping a plastic mass of clay and water, which is then toughened by drying and firing. Brick is the oldest produced building material, and much of its history is lost in antiquity. Until comparatively recent times the clay was dug, the bricks were prepared and the kilns set or drawn by manual labour with help from animal power. About 100 years ago, the first effective machines for brick production appeared, and the tendency towards mechanization of clay winning, production and handling operations has continued at a growing pace to the present day. Clay bricks are used in an extensive range of buildings from housing to factories, and in the construction of tunnels, waterways, bridges etc. Their properties vary according to the purpose for which they are intended, but clays have provided the basic material of construction for centuries.

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Materials required for brick manufacturing

1. Clay
2. WTP Sludge
3. Additives : Bagasse
4. Water
5. Tools and Equipment
6. Space Requirement

Clay: Clay soils are compounds of silica & alumina. Calcareous clays have calcium carbonate & will burn to a yellow or cream colour. Non-calcareous typically contain feldspar caned iron oxides, and will burn to a brown, pink or red, depending on the quantity of iron oxide. The silica in the clay, when fired at 900˚C -1200˚C degrees C, will turn to a glassy phase. This process, called verification, will turn the clay to a crystalline structure. Therefore, temperature is vital. If under-fired, the bonding between the clay particles will be poor and the brick will be weak. The bricks will melt or slump, if the temperature is too high. Verification does not have to be complete, and does not actually arise in many of the small traditional brick making plants around the world. However, the verification does occur enough to give sufficient strength to the brick. It takes about 3 m^3 of clay soil to make 1000 bricks.

WTP sludge: Conventional water treatment plants (WTPs) convert crude water into drinkable water using a series of processes: coagulation, flocculation, decantation and filtration. The process of coagulation consist of the use of Fe or Al salts that form floccules with impurities in water, which sediment (or float) and are later filtered out. This treatment produces a solid residue (alum or ferric sludge) with a high-water content, whose composition depends on the source of the crude water collected (surface water or groundwater through wells), the type of soil of the region, the material discharged into the river, chemical products present, the process of dark brown. Initially it is rough & coarse in texture but breaks up under ambient pressure & heat into fine particles

Water: To yield bricks you must have water available in enough quantity. To produce 1000 bricks per day, minimum 600 liters of water will be required. Water should be from impurities like oil, organic material, etc. otherwise it will affect the manufacturing process and brick properties.

Sand*:* Sand is used as a releasing agent during the brick moulding. It prevents the wet clay from sticking to the mould's sides. Sometimes it is also used as a stabilizer & mixed with very clayey soils to prevent the bricks from cracking when drying.

Space**:** Appropriate space will be essential to mould and dry the bricks. The site should be smooth & flat. Generally, a brick unit producing 1000 bricks per day will require an area from600 to 1000 square meters. A brick production unit will require basic tools in order to manufacture the bricks. Tools and plants necessary are:

- Pick axes
- Shovels
- Buckets or pails
- Mould**:** Mould size: (7.5 * 7.5 * 7.5 (cm))

Assistance**:** All brick units need support before preparatory unit for ex-Technical Assistance, Financial Assistance and Management Assistance.
Basically, bricks are manufactured by mixing ground clay & sludge with water, forming the clay into the required shape, & drying & firing.

Quantity of Materials necessary for 22 brick
Proportions

Phases of Manufacturing
The manufacturing process has 5 general phases:
1) Preparation of clay & sludge
2) Mixing
3) Moulding
4) Drying
5) Firing

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Preparation of Clay & Sludge: To break up large dried sludge lumps & stones, the material is processed through ball mill before raw material mixing.

Tempering: Tempering is the process of adding water to the clay along with sludge and allowing it to stand unobstructed for a day before mixing occurs. The quantity of water can vary and will depend on the type of soil & how damp it is. The dry clay soil should be in powder form or only small lumps before the water is added. This is to help the clay absorb the water faster. This will initiate to soften and break down the lumps of clay creating the mixing process easier.

A simpler method favored by many first-time manufacturers which will give very good results, is to mix the tempered clay along with sludge with hand. The tempered mixture is taken from the tempering platform and spread on top of a hard surface where workers trample it with their hand until it becomes a smooth mixture with a uniform colour. After mixing, the mixture of clay & WTP sludge can be used immediately for bricks moulding.

Moulding: This covers a number of steps where bricks are formed in mould boxes. There are several methods but all have a common theme. Soft mixture of clay and sludge is thrown into a mould, a mould release medium avoids the mix from sticking to the box (oil). The extra clay is stuck off from the top of the mould & the bricks are turned out.

In its most simple form this is done by hand by a craftsman who would yield one brick at a time. This is labor rigorous, slow and costly usually only used now for producing special shape or decorative bricks.

Steps for moulding

1. Apply the oil to the mould.
2. Place mould on a plane platform.
3. Throw the mixture in 3 layers with adequate tamping.
4. After 2 minutes, release the mould.

Drying: Before the bricks can be fired, as much dampness as possible must be removed or they will explode in the furnaces. Drying involves the removal of water from the wet brick in such a way as to dry them out regularly from inside out. After coming out of the mould, the brick is carefully selected up and placed down on clean, level ground. After one or two days, the bricks are turned up on end which is the best point for a brick to dry regularly. After a total drying time of about six days, the bricks should be hard and dry enough to place them in long open drying lots.

Firing & cooling: Firing temperatures vary considerably between different clay types and are frequently quite serious. Bricks are fired at temperatures 900°, 950° and 1000°C in the Muffle Furnace. During firing, bricks experience a physical change. Clay particles & impurities are joined together to produce a hard durable and weather resistant product. This is called confirmation. This is usually supplemented by further shrinkage and a colour change. Obviously bricks cannot quickly be subjected to these temperatures so firing is in stages. When a brick is heated to a temperature between 20°C and 150°C, it drops most of the water added to the clay during the training phase. When heated from 150°C to 600°C, the clay brick loses its remaining water. When the temperature starts to rise over 600°C, chemical changes begin to occur in the clay which gives the brick colour, hardness and strength. Temperatures of 900°C and above cause confirmation to occur.

Cooling - After the temperature has thin and is maintained for a prescribed time, the cooling process activates. Cooling time hardly exceeds 24hours .Cooling is an important stage in brick manufacturing because the rate of freezing has a direct effect on colour.

As per Indian standard code and American Standard code tests required to be conducted are as follows:

A] Test on Bricks-

1) ***Compressive Strength*** - After conducting compressive strength test on such WTP sludge containing bricks, we compare it with the strength of IS bricks.
2) ***Water Absorption Test*** - This test can be conducted to conclude water absorption of such WTP sludge content bricks in comparison with IS bricks**.**

3) ***Initial Rate of Absorption -*** The initial rate of absorption (IRA) is a significant property of brick because it affects mortar and grout bond, brick will absorb moisture from the mortar or grout at a quick rate, and may impair the strength and amount of the bond in comparison with IS bricks.
4) ***Efflorescence Test-*** To determine the salt content in the brick.

B] Test on Clay -

1) ***Specific Gravity Test-***
This test is to be carried to determine the density of clay so it is possible to compare it with the IS recommendations.
2) ***Sedimentation Analysis- Hydrometer Method -*** This test is to be carried out to determine the particle size for the brick manufacturing.
3) ***Liquid, Plastic and Shrinkage Limit Determination Test -***
This test is to be carried to overcome the effect of cracks, shrinkage etc. after producing of bricks.

Bricks Tests

1. Compressive Strength: IS 3495 (Part 1) : 1992 (Ref. 5) -

The brick specimen is deeped in water for 24 hours. The frog of the brick is filled flush with 1:3 cement mortars & the specimen is stored in damp jute bag for 24 hours and then submerged in clean water for 24 hours. The specimen is placed in compression testing machine with 6 mm plywood on top and bottom of it to get constant load on the specimen. Then load is applied axially at a constant rate of 14 N/mm². The crushing load is distinguished. Then the crushing strength is the ratio of crushing load to the area of brick loaded. Average of 5 specimens is taken as the crushing strength.

2. Water Absorption Test: IS 3495 (Part 2): 1992

Brick specimens are weighed dry. Then they are submerged in water for a period of 24 hours. The specimen are taken out & wiped with cloth. The weight of each specimen in wet condition is evaluated. The difference in weight specifies the water absorbed. Then the percentage absorption is the ratio of the water absorbed to dry weight multiplied by 100. The average of 5 specimens is taken. This value should not surpass 20% sharp edges. To check it, 20 bricks are selected at random & they are stacked along the length, along the width and then along the height.

3. Initial Rate of Absorption: ASTMC 67

The initial rate of absorption (IRA) is an important property of brick because it affects mortar & grout bond. Brick IRA and mortar retentively should be considered when choosing brick and mortar type. If the initial rate of absorption is over 1 gram per minute per sq.in, brick will absorb moisture from the mortar or grout at a quick rate, and may weaken the strength and extent of the bond.

ASTM C 67 needs a tray with a cross-sectional area of at least 300 sq. in (1935.5 sq.cm). For a brick with an IRA of 40 g/min/30 sq. in. the water level would drop less than 1/100 in., which is hardly computable. However, ASTM C 67 offers recommendations on maintaining the water level. Figure demonstrates the tray with a brick placed for testing. The method is relatively direct and easy to implement. The results are reported in grams of water gained per 30 sq. in. when the brick are dipped in 1/8 in. (3 mm) of water for 1min.

The calculation of IRA is as follows:

IRA = 30 W / LB

Where: W = actual gain in weight of specimen in grams,
L = length of specimen, in in. and
B = width of specimen, in in.

Soil Tests

- Determination of Specific gravity of soils:
- Determination of Atterberg's limit:

A) Liquid Limit: Liquid limit is the minimum moisture content expressed as a percentage of the dry weight at which the soil has negligible shear strength such as it flows to close a groove of standard dimensions. When 25 blows are given to it in liquid limit device

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B) Plastic limit determination:**-** The plastic limit of the soil is the minimum moisture content at which the soil rolled into thread of 3mm diameter

IV. CONCLUSION

This review paper concludes that physical as well as mechanical properties of natural rubber or styrene butadiene rubber are improved by the process of vulcanisation. Sulphur is commonly used for the process of vulcanisation. Apart from sulphur there are many other vulcanizing agents exist. These vulcanizing agents require additives for efficient reaction and desired results. The mechanical properties of vulcanized rubber are increased i.e. its tensile strength, elasticity, hardenability, wear, and life span. There are also many new technologies invented and possibly can be invented for further improvement of vulcanized rubber as well reducing its effect directly or indirectly on the environment.

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