Experimental Investigation on Bricks in Replacement of Soil by Municipal Solid Waste

P.S.Lakman Prabu [1], M.Anitha [2], N.Siva [3], A.Mahadur Banu [4], A.Ayyappan [5]
[1, 2, 3, 4] UG student, Department of Civil Engineering, Shivani Engineering College, Tiruchirappalli, Tamil Nadu, India.
[5] Assistant Professor, Department of Civil Engineering, Shivani Engineering College, Tiruchirappalli, Tamil Nadu, India.

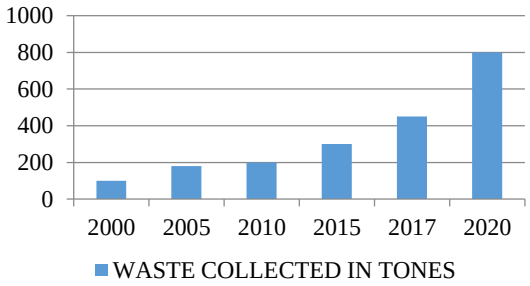
Abstract – The Concept of the research based on what are the possible resources to reduce the decomposed solid wastes. It is natural that anything buried into the earth, gets converted into earth itself. The same principle applies to the MSW lying at dumping ground. MSW – dumped is subjected to extensive chemical, physical and micro-biological process- collectively called as decomposition. This process converts MSW into decomposed solid waste, new biomass, generates gases, contaminants in solution (leachate), heat, etc., These wastes are converted to useful building and construction material. Recycling of such waste as raw material alternatives may contribute in the exhaustion of the natural resources. In the review of utilization of those waste, this paper reviewed recycling various waste materials in bricks production. The effects of those wastes on the bricks properties as physical, mechanical properties will be reviewed and recommendations for future research as out comings of this review will be given. This reviewed approach on bricks making from waste is useful to provide potential and sustainable solution.

Index Terms – Solid Waste Compost, Soil.

1. INTRODUCTION

Bio-degradable waste substance which takes 4-6 weeks to decompose that creates land as well as water pollution to the environment. To recover the problem of pollution and disposal of solid waste , the invention is made of preparing the bricks from solid waste. The quantity of degradable waste in Municipal Solid Waste (MSW) is expanding rapidly. It is estimated that the rate of usage is twice for every 5 years. The Deposition of municipal solid waste requires large area for dumping. This paper is based on the comprehensive review of waste solid materials in powder form which is mixing with soil. The organic compost is act as a fertilizing powder.

It is observed that organic bricks have preferable water absorption like normal bricks, low porosity and affordable compressive strength as compared to conventional bricks. To safeguard the environment, many efforts are being made for the replacing of different types of solid waste compost with a view to utilizing them in the production of various construction materials. This compost are handled everywhere in today's lifestyle. So from this, we got inspiration of using degradable waste in construction field for casting the bricks.



Waste Collected in tones (year by year chart)

2. THIS STUDY IS A SMALL STEP TOWARDS

- Use of organic waste
- Better Brick Production
- Saving of Soil
- Cost Less
- Job for Self Helping Group
- Creating pollution free environment

3. OBJECTIVES

Investigate the potential use of organic waste blending with soil.

To develop an efficient way to effectively utilize the organic waste and that wastes acts as a great threat for the sustainment of ecological balance.

To reduce the consumption of earth based material as clay for the manufacturing of brick that resulted in resource depletion, environmental degradation.

To avoid land and water pollution.

To reduce the dumping area of wastes.

To produce the cost effective materials.

3.1 Solid Waste organic compost

Municipal solid waste (MSW), commonly known as trash or garbage in the United States and as refuse or rubbish in Britain, is a waste type consisting of everyday items that are discarded by the public. "Garbage" can also refer specifically to food waste, as in a garbage disposal; the two are sometimes collected separately.

3.2Composition

The composition of municipal solid waste varies greatly from municipality to municipality, and it changes significantly with time. In municipalities which have a well developed waste recycling system, the waste stream mainly consists of intractable wastes such as plastic film and non-recyclable packaging materials and it includes food wastes, market wastes, yard wastes, plastic containers and product packaging materials, and other miscellaneous solid wastes from residential, commercial, institutional, and industrial sources.

Most definitions of municipal solid waste do not include industrial wastes, agricultural wastes, medical waste, radioactive waste or sewage sludge. Waste collection is performed by the municipality within a given area. The term residual waste relates to waste left from household sources containing materials that have not been separated out or sent for reprocessing. Waste can be classified in several ways but the following list represents a typical classification:

a.Biodegradable waste: food and kitchen waste, green waste, paper (most can be recycled although some difficult to compost plant material may be excluded Recyclable materials: paper, cardboard, glass, bottles, jars, tin cans, aluminum cans, aluminum foil, metals, certain plastics, fabrics, clothes, tires, batteries, etc.

b.Electronic waste: construction and demolition waste, dirt, rocks, debris Electrical and electronic waste (WEEE) - electrical appliances, light bulbs, washing machines, TVs, computers screens, mobile phones, alarm clocks, watches, etc.

c.Composite wastes: waste clothing, Tetra Packs, waste plastics such as toys Hazardous waste including most paints, chemicals, tires, batteries, light bulbs, electrical appliances, fluorescent lamps, aerosol spray cans, and fertilizers Toxic waste including pesticides, herbicides, and fungicides Biomedical waste, expired pharmaceutical drugs, etc.

Table 1 General components of soil ad powdered organic waste

Components	Normal Brick soil	Powered organic waste
Silica (SiO_2)	55%	30%
Alumina (Al_2O_3)	30%	15%
Ferric oxide (FeO)	8%	10%
Magnesium oxide (MgO)	5%	2.2%
Organic matter	1%	30%
Calcium oxide (CaO)	1%	6.8%
Potassium (K)	0%	0.7%
Phosphates	0%	4.5%
Sodium (Na)	0%	0.8%

*The above ideas are taken from "Research on making BRICKS from DECOMPOSED MUNICIPAL SOLID WASTE" by Mr.Govardhan B Chaudhari- B.E. (Civil), M.Tech. (Soils).

d.Collection

The functional element of collection includes not only the gathering of solid waste and recyclable materials, but also the transport of these materials, after collection, to the location where the collection vehicle is emptied. This location may be a materials processing facility, a transfer station or a landfill disposal site.

e.Dry clay soil

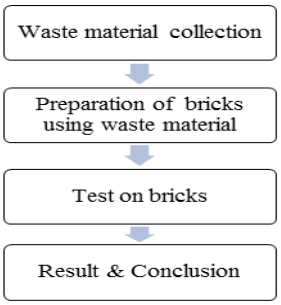
The natural clay soil was used as a fine aggregate in dry form . The properties of soil were determined by conducting tests as per IS: 2386 (Part-1). The results are shown in test data of materials. The results obtained from sieve analysis are furnished. The results indicate that the soil conforms to zone 11 of IS: 383-1970.

f.Clay soil test :

Table 2 Test of clay soil

S.No	Test	Results
1	Specific gravity	2.62
2	Bulk density	1690kg/m^3
3	Fineness modulus	2.91

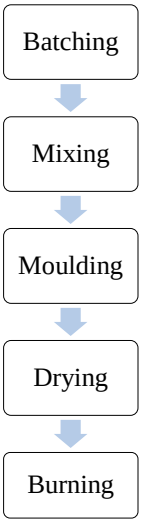
4. METHODOLOGY



4.1 Raw materials used

1. Clay soil
2. Powdered Organic Waste
3. Water

Procedure for casting with compost organic bricks:



5. TEST FOR MATERIALS

1. Clay
2. Bricks

5.1CLAY:

Field Test

Laboratory Testy

5.1.a.Field Test:

i.Smearing Test

ii.Dilatancy Test / Shaking Test

iii.Ball Test

a.i.SMEARING TEST:

Take some loose soil from the possible brick making soil and put an appropriate amount of water into it in order to make a sticky paste. After the soil is saturated with water, mix the soil paste by hand. Try to make a ball with this soil. Roll the moist ball in the hand enough so that the ball is dried out a little bit. Pinch out a little bit of the soil with the thumb and the index finger and smear on the thumb by the index finger at one go. The smearing should be done as fine as possible. During this process, feel for any coarse particles. It will be felt by the fingers. After the smearing, if the soil does not form a smooth and thin layer, then the soil is sandy. If the thin soil layer is shiny and evenly spread out over the thumb then the soil is plastic in nature. Let the thumb dry out. After drying, if the soil layer falls off easily or can be removed then the soil is sandy or silts in nature with probably low plasticity. However if the soil sticks to the thumb and index finger after drying, then it is plastic in nature.

a.ii DILATANCY TEST/SHAKING TEST:

Since silts are considerably more permeable than clays, the dilatancy or shaking test may also be used to distinguish between the two materials. In this test a small amount of soil is mixed with water to a very soft consistency in the palm of the hand. The back of the hand is then lightly tapped. If the soil is silty, water rises quickly to its surface and gives it a shiny or glistening appearance. Then if the soil part is deformed, in some instances by squeezing and in others by stretching, the water flows back into it and leaves the surface with a dull appearance. Usually, the greater the proportion of clay in the sample, the slower the reaction to the test. The reaction is described as rapid, slow or none.

a.iii) BALL TEST:

Ball test is mainly for getting a first feeling about the soils sand and clay proportion. Take a handful of soil and put some water in it. Water should be enough to make the soil moist and make dough by hand. With the hand and fingers mix the soil and water thoroughly. After uniform mixing try to make a ball out of the soil. This activity might take some time depending on the amount of water added. If the water content is too much then add more dry soil. Observe the smoothness of the surface of the ball. For plastic soils the surface will be shiny and uniform. For sandy soils the surface will be dull and rough. Also with sandy soils it will be difficult to make a round shaped ball.

a. Wet ball
b. Dry ball

a) Wet ball test:

Immediately after the ball is reasonably well formed, drop the ball from a height of at least 1 meter. Alternatively the ball can be dropped from shoulder height with hands straight. Take care that the surface on which the ball is dropped is leveled and clean – preferably a concrete surface or a hard surface. Never do the test on a wet or a loose surface. Observe the ball on the floor. If the ball retains its shape with little amount of deformation at the bottom only, then the soil is plastic clayey

in nature. However if the ball flattens out upon hitting the floor, then the soil is sandy in nature.

b)Dry ball test:

Repeat the tests by making balls and dry them under atmosphere or under a small open fire. Cool the balls and repeat the test. If the ball cracks into many pieces after contact with the floor then the soil is sandy in nature. However, if the ball breaks into two to three pieces then the soil is clayey and plastic in nature.

Dry Ball of Clay | Dry Ball of Compost | Dry Ball of Clay and Compost

5.1.bLABORATORY TEST:

i. Plastic limit and Liquid limit
ii. Plasticity
iii. Shrinkage limit
iv. Specific Gravity test.

b.i)LIQUID LIMIT AND PLASTIC LIMIT TEST:

a) Liquid limit Test:

This test is done using casagrande apparatus. In this test a soil paste is formed using soil sample passing 425 micron sieve and water. This paste is then placed in the cup of casagrande device. The soil part is then divided into two halves by making a groove using the grooving tool. Then the cup is dropped by turning the crank until two halves of the soil cake come in contact with each other. The test is repeated by adding different amount of water with the soil. Finally by plotting a graph we can determine the liquid limit of soil.

b) Plastic limit Test:

Plastic limit is the constant defined as the lowest moisture content and expressed as a percentage of the weight of the oven dried soil at which the soil can be rolled into threads one-eighth inch in diameter without the soil breaking into pieces, also the moisture content of a solid at which a soil changes from a plastic state to a semisolid state.

Table 3 Liquid Limit and Plastic Limits of soil

Description	**Plastic Limit (PL)**	**Liquid Limit (LL)**
Water content (%)	15.0	21.2

b.ii) PLASTICITY/TOUGHNESS TEST:

The property of plasticity is characteristic of clays and may be used as the basis for a simple field test. At certain moisture contents a soil that contains appreciable quantities of clay can be deformed and remolded in the hand without disintegration. Thus, if a sample of moist soil can be manipulated between the palms of the hands and fingers and rolled out into a long thread, it unquestionably contains a significant amount of clay. As moisture is lost during continued manipulation, the soil approaches a non-plastic condition and becomes crumbly. Just before the crumbly state is reached, a highly plastic clay can be rolled into a long thread, with a diameter of approximately 3mm, which has sufficient strength to support its own weight. Silt, on the other hand, can seldom be rolled into a thread with a diameter as small as 3mm without severe cracking, and is completely lacking in tensile strength unless small amounts of clay are present. The record of a simple plasticity test should indicate not only whether a plastic thread can be formed, but also the toughness of the thread as it nears the crumbling stage. This condition is described as weak and friable, medium, or tough.

b.iii) SHRINKAGE LIMIT TEST:

It is the maximum water content at which a reduction in water content will not cause a decrease in volume of the soil mass. It is the lowest water content at which soil can still be saturated.

5.2 PROCESS OF MANUFACTURING

a) Batching

The collected waste bags are shredded into pieces and then weighed. The soil was sieved by using 2.36mm sieve. The soil and the compost were weighed in various proportions. During batching process the weight of organic wastes are kept as constant and decreasing the soil content for different proportions.

Batching of clay and organic waste

b) Mixing:

Then the mixing process is done at site with the use of brick making materials such as compost, soil, and water.

Table 4 Mix proportions for compost organic bricks

Sample No	Red Brick soil (in Kg)	Organic compost sample (in Kg)
S1	1.50	1.50
S2	1.25	1.75
S3	1.00	2.00

c) Moulding:

The mixture is then poured into the brick mould. The surface is finished by using trowel. Before placing the mixture into the mould, the sides of the mould are oiled to easy removal of bricks. Mould removed after 2 hours. The mould is used for preparing brick in uniform shape. The size of mould is 190×90×90 mm. The mould were assembled and placed on the base plate. The faces must be thinly coated with mould oil to easily remould after casting.

Moulding of soil-organic waste

d) Drying:

After moulding process, the bricks contain some amount of moisture in it. So drying is to be done otherwise they may cracked while burning. The drying of bricks is done by sun drying for 10 days. The period of drying is also depends upon the weather conditions.

e) Burning of bricks:

In the process of burning, the dried bricks are burned either in clamps (small scale) or kilns (large scale) up to certain degree temperature In this stage the bricks will gain hardness and strength. so it is a important stage in manufacturing of bricks. The temperature required for burning is about 1100ºC. If they burnt beyond this limit, they will be brittle and easy to break. If they burnt under this limit, they will not gain full strength, and there is a chance of absorb moisture from the atmosphere. Hence burning should be done properly to meet the requirements of good brick.

6. TESTING OF ORGANIC SOIL BRICKS

a) Compressive Strength

Crushing strength of the brick is measured by using the compression testing machine. The bricks to be tested is placed in the compression testing machine and the load is applied till the brick breaks. As per IS:1077:1957, the minimum compression strength of the brick is 3.5N/mm^2.

Compressive strength

=Maximum load/Area of the specimen

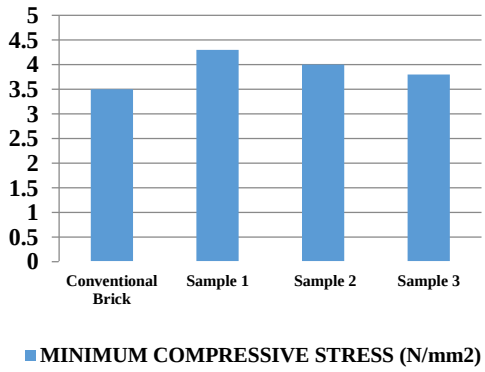
= P/A

Where,

P -Maximum load (KN)

A - Area of the specimen (mm^2)

These bricks are classed as class C bricks because of it crushing strength ranges between 3.5-7 N/mm^2.



Minimum Compressive stress for III class bricks are not less than 3.5 N/mm^2. In this study compressive stress of the Organic soil bricks falls between 3.5-7 N/mm^2, so these are termed as III class bricks.

b) Water Absorption

In this test, bricks are weighed in dry condition and let them immersed in fresh water for 24 hours. After 24 hours of immersion, those are taken out from water and wipe out with cloth. Then, brick is weighed in wet condition. The difference between weights is the water absorbed by brick. The percentage of water absorption is then calculated. The less water absorbed by brick the greater its quality. Good quality brick doesn't absorb more than 25% water of its own weight.

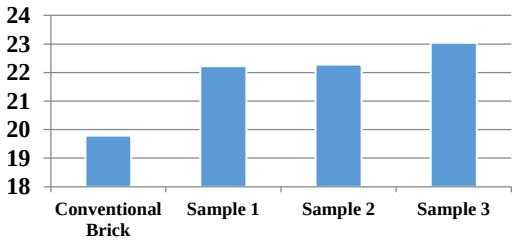
Water absorption in % by weight = $\frac{W2 - W1}{W1} X\ 100.$

Where,

W1 = Weight of dry brick (kg)

W2 = Weight of wet brick (kg)

Water absorption test of Organic compost soil bricks possessing various ratios



c) Efflorescence Test

The presence of alkalis in bricks is harmful where it forms a gray or white layer on brick surface by absorbing moisture. To find out the presence of alkalis in bricks, this test is performed. In this test, a brick is immersed in fresh water for 24 hours. Then, it is taken out from water and allowed to dry in shade. If the whitish layer is not visible on surface, it proofs that absence of alkalis in brick. If the whitish layer visible about 10% of brick surface, then the presence of alkalis is in acceptable range. If that is about 50% of surface, then it is moderate. If the alkali's presence is over 50%, then the brick is severely affected by alkalis.

Table 5 Efflorescence test ratio

S.NO	MIX RAIO		TRACES
	Red Brick Soil (in Kg)	Organic Compost	
S1	1.50	1.50	Slight
S2	1.25	1.75	Slight
S3	1.00	2.00	Slight

d) Soundness Test for brick

This sound is carried out to find out that a clear ringing sound is produced or not when the two bricks are struck with each other without breaking any of the two bricks. If the two bricks are not broken after striking with each other and a clear ringing sound is produced, then it means that the bricks are sufficiently sound. In this project, Organic soil bricks gives clear ringing sound produced.

e) Hardness test

In this test a scratch is made on brick surface, bad impression is not found.

f) Shape and Size test

As per Indian Standard, 190mm*90mm*90mm sized bricks are used in India. The surface and edges of the bricks are square, smooth.

g) Weight of the brick

The average weights of the traditional bricks are 3 to 3.5 Kg and weight of the Organic soils bricks are 2 to 2.5.

7. CONCLUSION

- Reduces area of dumping.
- Initiative studies of these bricks are Eco-bricks.
- These bricks are resulting as III class bricks.
- Reducing area of City Corporation for solid waste storage ground.

REFERENCES

[1] Abdul G. Liew, Azni Idris, Calvin H. K. Wong, Abdul A. Samad, Megat Johari, M.M. Noor, Aminuddin M. Bakri, 2004. Incorporation of sewage sludge in clay brick and its characterization. Journal of Waste Management and Research, 22: 226-233.

[2] Quintilio Piattoni, Enrico Quagliarini, Stefano Lenci, 2011. Experimental analysis and modeling of the mechanical behavior of earthen bricks. Journal of Construction Building Material, 25: 2067-2075.

[3] Rania, A., Hamza, Salah El-Haggar, and Safwan Khedr, 2011. Marble and Granite Waste: Characterization and Utilization in Concrete Bricks. International Journal of Bioscience, Biochemistry and Bioinformatics, 1: 286-290.

[4] Taner Kavas, 2006. Use of boron waste as a fluxing agent in production of red mud brick. Journal of Building and Environment, 41: 1779-1783.

[5] Toledo, R., D.R. dos Santos, R.T. Faria Jr., J.G. Carrio, L.T. Auler, H. Vargas, 2004. Gas release during clay firing and evolution of ceramic properties. Applied Clay Science, 27: 151-157.