Utilization of Waste Plastic in Manufacturing of Bricks

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Abstract— Plastic is a non-bio-degradable substance which takes thousands of years to decompose that creates land as well as water pollution to the environment. It is estimated that the rate of usage is double for every 10 years. The Plastic usage is large in consumption and one of the largest plastic wastes is polyethylene (PE). The utilization of earth based clay material resulted in resource depletion and environmental degradation. As amount of clay required for brick is huge, in this project these waste plastics are effectively utilized in order to reduce the land space required to dump these wastes. Polyethylene (PE) bags are cleaned and added with fine aggregate ,Fly ash, Bagasse, GGBS, Quarry Dust at various ratios to obtain high strength bricks that possess thermal and sound insulate ion properties. Presently waste plastics are effectively converted into useful building materials like bricks, using either single origin plastic waste material or a mixture of different plastic wastes. The plastic waste is naturally available in surplus quantity and hence the cost factor comes down. Also Coloring agents can be added to the mixture to attain desired shades. After conducting several trials with the variety of industrial wastes processed into composite brick.

Key words: Waste Plastic, Bricks

I. Introduction

Plastic is one of the daily increasing useful as well as a hazardous material. At the time of need, plastic is found to be very useful but after its use, it is simply thrown away, creating all kinds of hazards. Plastic is non-biodegradable that remains as a hazardous material for more than centuries.

The quantity of plastic waste in Municipal Solid Waste (MSW) is expanding rapidly. It is estimated that the rate of expansion is double for every 10 years. This is due to rapid growth of population, urbanization, developmental activities and changes in life style which leading widespread littering on the landscape. They are non-biodegradable and also researchers have found that the plastic materials can remain on earth for 4500 years without degradation In India approximately 40 million tons of the municipal solid waste is generated annually, with evaluated increasing at a rate of 1.5 to 2% every year.

Hence, these waste plastics are to be effectively utilized. Today, it is impossible for any vital sector to work efficiently without usage of plastic starting from agriculture to industries. Thus we cannot ban the use of plastic but the reuse of plastic waste in building constructions, industries are considered to be the most practicable applications.

II. Literature review

This chapter presents the background information on the issues to the to be consider in the present research work and to focus the significance of the current study.

Kulkarni Apurva, Raje Samruddha, Rajgor Mamta(1) studied that Utilization of industrial and agricultural waste products in the industry has been the focus of research for economic, environmental, and technical reasons. Bagasse ash can be utilized by replacing it with fly ash and lime in fly ash bricks. Trial bricks of size (230x100x75) mm were tested with different proportions of 0%, 10%, 20%, 30%, 40%, 50% and0%,5%, 10%, 15% and 20% with replacement of lime.

Deng Fong Lin and Chin Huang Weng(3) has used sewage sludge ash as brick material. The result of the compressive strength test on the bricks made from both clay and sludge ash mixtures. The optimum amount of sludge ash that could be mixed with clay to produce mix bonding bricks was 20% by weight. As shown with up to 40% sludge ash added to the bricks, the strength achieved at all temperature can be as high as that of normal clay bricks. With up to 50% ash in the bricks, the strength is even higher than that of normal clay bricks. The compressive strength of the bricks made from ash-clay mixture all meet the standards (CNS 1999b) for the bricks requirement: 100 kg/cm2 for a first class bricks and 75 kg/cm2 for second class bricks. It is concluded that sludge ash can be blended with clay in different proportions to produce a good quality of brick under a certain firing temperature.

According to a Technical newsletter “Focus on PET”, Polyethylene terephthalate belongs to the polyester family of polymers, one of the largest and most diverse of the polymer families His family of polymers is linked by the common feature of having an ester (-COO-) link in the main chain, but the range of polyester materials is probably the largest of all the polymer families. And also the chemical structure of the PET is having only atomic species that are carbon, hydrogen and oxygen. Therefore melting of PET won’t result in release of noxious gases and also its properties reveal that a melting temperature of 260 ºC is required. Also from the properties of the PET it can be understood that it has got good chemical resistance and better resistance to UV rays. In a paper “An review on waste plastic utilization in asphalting of building material” , the techniques to use plastic waste for construction purpose for building material , which were developed by various researchers has been reviewed. And collectively emphasises the concept of utilization of waste plastic in construction of flexible road pavement. In the construction of building, bricks lays the role for manufacturing of these bricks the plastic is using as a binding material. It also helps to improve the strength and life of Building. But its resistance towards water is also good. This plastic bricks show better binding property, stability, density and more resistant to water. And also emphasized the availability of plastic.

Kevin Hii, Abbas Mohajerani, Paul Slatter and Nicky Eshtiaghi(4) has used Desalination Sludge for brick making in partial and full replacement of clay. Theoretically, if the bricks were made using industrial size equipment, a higher density and strength should be achievable. The OMC% for 30% bricks was 20.5 and maximum dry density was 1660 kg/m3.Theoretically, if the bricks were made using

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industrial size equipment, a higher density and strength should be achievable. So the compressive strength values scaled up to match a 15 MPa pure clay brick and shows that at 20% sludge addition , a compressive strength of 4 MPa may still be achievable.

III. METHODOLOGY

In this study mixes, we are planned to make with fiber with varying proportion of 0.5%, 1% and 1.5%.Control mix was taken with 0%fiber.

Collection of raw materials:

The materials used in this study are:

- Plastic
- Bagasse Ash
- Fly Ash
- GGBS
- Sand

A. *Plastic*

Plastic is collected from the commercial areas, dumping yards in the Visakhapatnam district. These plastic are chapped into 5cm length and washed these for polishing purposes. Plastics are organic substances formed by macro cells called polymers. These polymers are large groups of monomers linked by a chemical process called polymerization. Plastics provide the necessary balance of properties that cannot be achieved with other materials such as: color, lightweight, soft touch and resistance to environmental and biological degradation.

The properties and characteristics of most plastics (though not always fulfilled in certain special plastics) are these:

- Easy to work and shape,
- Have a low production cost,
- Possess low density,
- Tend to be waterproof,
- Good electrical insulators,
- Acceptable acoustic insulation,
- Good thermal insulation, but most cannot withstand very high temperatures,
- Resistant to corrosion and many chemical factors;
- Some are not biodegradable or easily recyclable, and if they burn, are highly polluting.

Fig. 1: Waste Plastic

B. *Bagasse Ash*

The sugarcane bagasse consists of approximately 50% of cellulose, 25% of hemicellulose and 25% of lignin. Each ton of sugarcane generates approximately 26% of bagasse (at a moisture content of 50%) and 0.62% of residual ash. The residue after combustion presents a chemical composition dominates by silicon dioxide ($SiO2$). In spite of being a material of hard degradation and that presents few nutrients, the ash is used on the farms as a fertilizer in the sugarcane harvests. In this sugarcane bagasse ash was collected during the cleaning operation of a boiler operating in the NCS Sugar factory, located in the city of Vizianagaram.

SL. NO	COMPONENT	MASS%
1	Density (g/cm^3)	2.52
2	Surface Area (cm^2/gm)	5140
3	Particle size (μm)	28.9
4	Color	Reddish grey

Table 1: Physical properties of Bagasse Ash

C. *Fly Ash*

Fly ash is a good material for a wide range of applications viz. manufacture of cement, substitute of cement in concrete, manufacture of bricks, blocks, tiles, etc. It is highly useful as a geo-technical material for construction of embankment and reclamation of low lying areas, filling of underground, open mines, use in agriculture and reclamation of degraded / waste lands, etc. The pozzolanic property coupled with lime reactivity makes it very suitable for cementitious binding applications. Its geo-technical property makes it a good substitute of soil and the presence of required percentage of silica, alumina and iron oxide etc. makes it suitable for sintered applications. The suitability of flyash for various applications is very safe due to very low levels of heavy metals, toxic elements and radio nuclides in fly ash as well as its physical and chemical properties being very close to the range of common soils.

The following tables provide general range of physical, chemical, geo-technical properties, available major, secondary, micro-nutrients and trace / heavy metals and radio-activity levels in flyash and soil (source: Fly Ash India 2005 - International Congress)

Physical properties of fly ash	
Parameters	**Fly Ash**
Bulk Density (gm/cc)	0.9-1.3
Specific Gravity	1.6-2.6
Plasticity	Lower or non-plastic
Shrinkage Limit (Vol stability)	Higher
Grain size	Major fine sand / silt and small per cent of clay size particles
Clay (percent)	Negligible
Free Swell Index	Very low
Classification (Texture)	Sandy silt to silty loam
Water Holding Capacity (WHC) (per cent)	40-60
Porosity (per cent)	30-65
Surface Area (m2 / kg)	500-5000
Lime reactivity (MPa)	1-8

Table 2: Physical properties of fly ash

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D. GGBS (Ground Granulated Blast furnace Slag)

This paper presents an investigation into the geometric characteristics of different ground granulated blast furnace slag (GGBS), including particle size distribution (PSD), shape and their influences on cement properties. Samples of GGBS with different PSDs are prepared using in three processing approaches, a ball mill, an airflow mill and a vibromill. The morphology of GGBS and the PSD is studied, respectively, with scanning electron microscope (SEM) and laser particle analyzer (LPA). The results indicate that the PSD of GGBS processed by an airflow mill is concentrated on a narrow range, whereas the size of GGBS made by a ball mill are distributed in a large range. The morphology of GGBS processed by a vibromill is mostly spherical and its surface is very smooth. The results also show that when GGBS has a similar surface area, the strengths of cement mortar, in which 50% cement is replaced by GGBS, are related to PSD of the GGBS. The early strength of sample containing GGBS processed by a ball mill is higher than that by an airflow mill, whereas the long-term strength of this mix is lower

Properties	GGBFS Specification	Requirements as per BS: 6699
Fineness (m^2/kg)	340	275 (min.)
Soundness Le-Chatelier expansion (mm)	1.5	10.0 (max.)
Insoluble residue (%)	1.5	1.5 (max.)
Magnesia content (%)	12.0	14.0 (max.)
Sulfide sulfur (%)	1.7	2.00 (max.)
Sulfite content (%)	2.5	2.50 (max.)
Loss on Ignition (%)	1.0	3.00 (max.)
Manganese content (%)	1.0	2.00 (max.)
Chloride content	0.05	0.10 (max.)
Moisture content	1.0	1.0 (max.)
Glass content (%)	90	67 (min.)

Table 3: properties of GGBS

E. SAND

Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. It is defined by size, being finer thangravel and coarser than silt. Sand can also refer to a textural class of soil or soil type; i.e., a soil containing more than 85 percent sand-sized particles by mass.

The composition of sand varies, depending on the local rock sources and conditions, but the most common constituent of sand in inland continental settings and non-tropical coastal settings is silica (silicon dioxide, or SiO_2), usually in the form of quartz. The second most common type of sand is calcium carbonate, for example, aragonite, which has mostly been created, over the past half billion years, by various forms of life, like coral and shellfish. For example, it is the primary form of sand apparent in areas where reefs have dominated the ecosystem for millions of years like the Caribbean. Sand is a non-renewable resource over human timescales, and sand suitable for making concrete is in high demand. Basic test results of materials: For all the materials used in the project following basic tests were conducted according to the IS specifications.

IV. EXPERIMENTAL WORK

First of all literature survey is being carried out to study the availability of the non-recyclable plastic material in India. It has been observed that mass quantity of the non-recyclable plastic materials available in our country. So we can carry forward our research in this field. Then the materials which we have to use is selected and the properties of those materials are studied. Then after selection the binding property of these materials are tested whether the materials are forming a bond or not. The laterite quarry waste was collected from Quarry (kothapalli), Fly Ash collected from NTPC, Sand Collected from Coastal Areas, Bagasse Ash Collected from Sugar Factory these all materials are waste materials out from industries and also non-recyclable plastic collected from dumping yards. After collection of materials we have taken few material and is heated up to a molten state. After testing binding property the required proportions of the materials are selected by the percentage of plastic by using different types of additives. The plastic material is heated to obtain in the form of liquid state and additive materials like Fly ash , Bagasse, GGBS, Sand are added to plastic which is in the form of Liquid state and then it is mixed together thoroughly in a pan. The hot mix is poured into the moulds (19x19x9) and then compacted by rammer. To obtain a brick in definite Shape and Size. The kneading process is very carefully done. The bricks are de-molded after 1 to 2hrs and air dried for a period of 24hr for proper heat dissipation. The drying must be done at room temperature and also in sun drying to attain required strength.

V. RESULTS

A. Plastic with Bagasse Ash

Sl.no	Description	Sample no:1	Sample no:2	Sample no:3
1	Plastic (in kgs)	1.00	1.00	1.00
2	Bagasse (in kgs)	0. 12	0.12	0.12
3	Proportion	1: 0.12	1: 0.12	1: 0.12
4	Volume of Brick	0.001539	0.001539	0.001539
5	Area of Brick	0.00171	0.00171	0.00171
6	Weight of Bricks (in kgs)	0.94	0.92	0.95
7	Compressive Strength (in KN)	3	2.5	2.9
8	Water absorption (%)	18	18	18
9	Fire resistance	135	135	135

Table 3: plastic with bagasse ash

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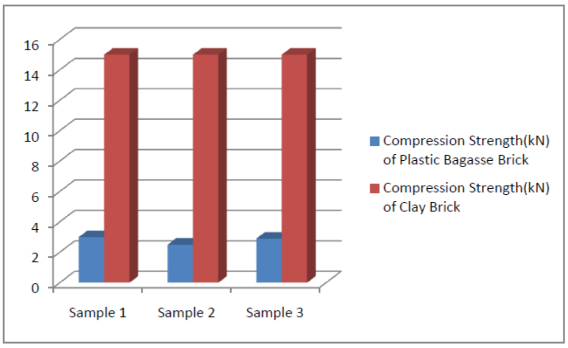

Fig. 2: Comparison of compression strength of Plastic Bagasse Brick and Clay Brick

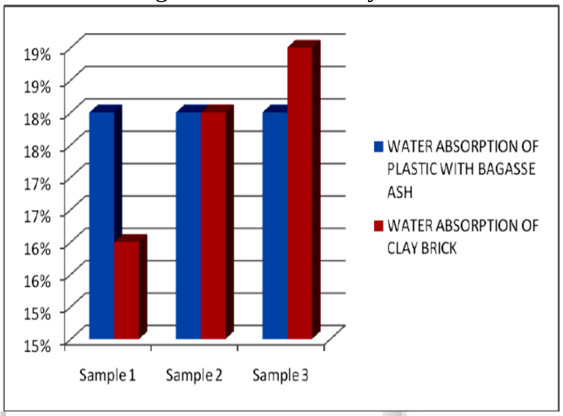

Fig. 3: Comparison of Water Absorption of Plastic Bagasse Brick and Clay Brick

B. *Plastic with Fly Ash*

Sl.no	Description	Sample no:1	Sample no:2	Sample no:3
1	Plastic (in kgs)	1.5	1.5	1.5
2	Fly ash (in kgs)	2.25	2.25	2.25
3	Proportion	1: 1.5	1: 1.5	1: 1.5
4	Volume of Brick	0.001539	0.001539	0.001539
5	Area of Brick	0.00171	0.00171	0.00171
6	Weight of Bricks (in kgs)	2.61	2.5	2.55
7	Compressive Strength of Brick	250	245	250
8	Water absoption (%)	0	0	0
9	Fire resistance	135	135	135

Table 4: plastic with fly ash

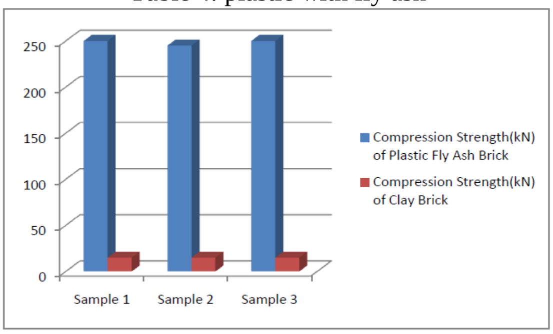

Fig. 4: Comparison of compression strength of Plastic Fly Ash Brick and Clay Brick

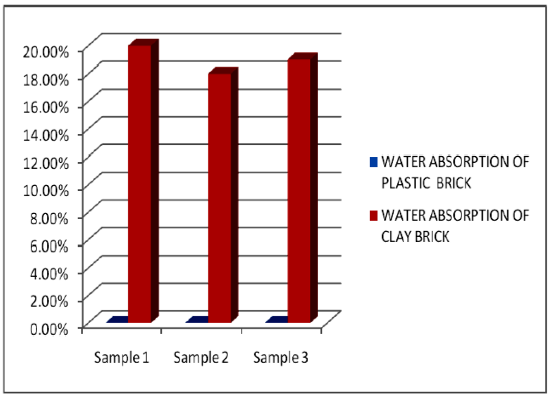

Fig. 5: Comparison of Water absorption of Plastic Fly Ash Brick and Clay Brick

C. *Plastic with GGBS*

Sl.no	Description	Sample no:1	Sample no:2	Sample no:3
1	Plastic (in kgs)	1.0	1.0	1.0
2	GGBS (in kgs)	2.4	2.4	2.4
3	Proportion	1: 2.4	1: 2.4	1: 2.4
4	Volume of Brick	0.001539	0.001539	0.001539
5	Area of Brick	0.00171	0.00171	0.00171
6	Weight of Bricks (in kgs)	2.5	2.3	2.4
7	Compressive Strength (in KN)	205	190	195
8	Water absorption	0	0	0
9	Fire resistance	135	135	135

Table 4: plastic with GGBS

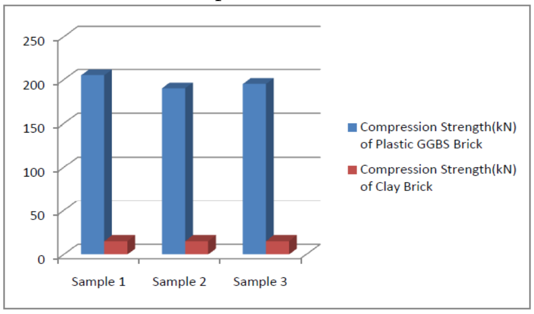

Fig. 6: Comparison of compression strength of Plastic GGBS Brick and Clay Brick

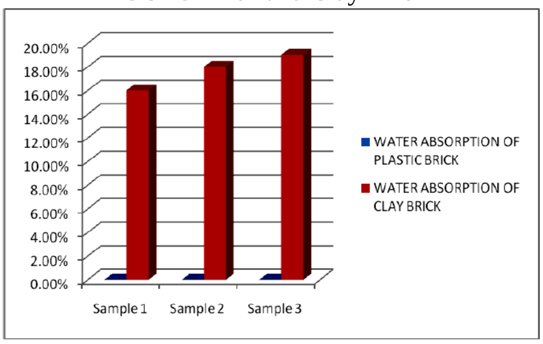

Fig. 7: Comparison of Water absorption of Plastic GGBS Brick and Clay Brick

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D. Plastic with Sand

Sl.no	Description	Sample no:1	Sample no:2	Sample no:3
1	Plastic (in kgs)	0.64	0.64	0.64
2	Sand (in kgs)	2.5	2.5	2.5
3	Proportion	1:5	1:5	1:5
4	Volume of Brick (m3)	0.001539	0.001539	0.001539
5	Area of Brick	0.00171	0.00171	0.00171
6	Weight of Bricks (in kgs)	2.73	2.65	2.73
7	Compressive Strength (in KN)	70	60	70
8	Water absorption	1.00 %	1.00 %	1.00 %
9	Fire resistance (◦c)	135	135	135

Table 5: plastic with sand

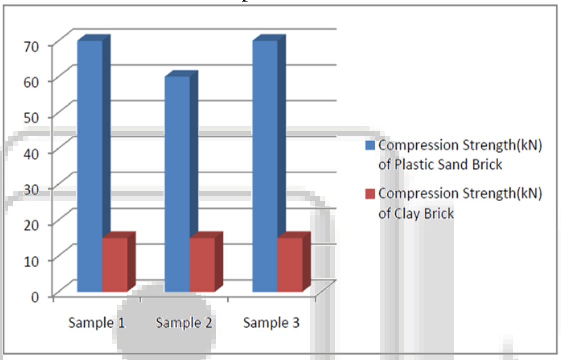

Fig. 8: Comparison of compression strength of Plastic sand Brick and Clay Brick

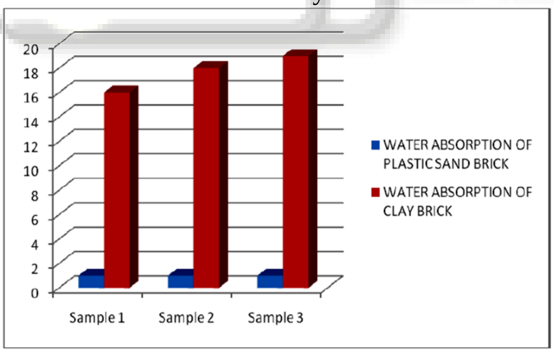

Fig. 9: Comparison of Water absorption of Plastic sand Brick and Clay Brick

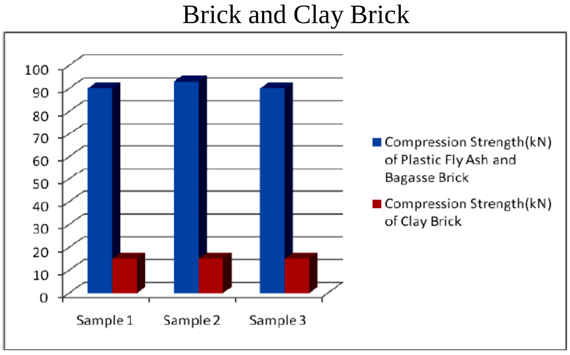

Fig. 10: Comparison of compression strength of Plastic fly ash and bagasse ash Brick and Clay Brick

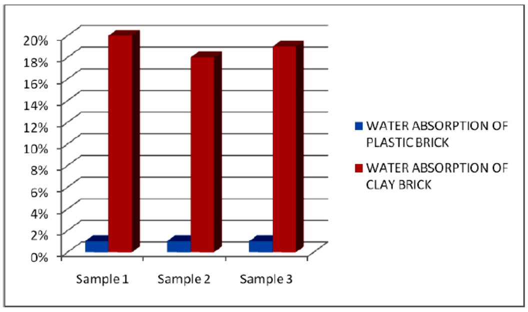

Fig. 11: Comparison of Water absorption of Plastic fly ash and bagasse ash Brick and Clay Brick

E. Plastic with Fly Ash and Bagasse

Sl.no	Description	Sample no:1	Sample no:2	Sample no:3
1	Plastic (in kgs)	1.0	1.0	1.0
2	Bagasse	0.233	0.233	0.233
3	Fly Ash	0.8	0.8	0.8
4	Proportion	1:1.03	1: 1.03	1: 1.03
5	Volume of Brick	0.001539	0.001539	0.001539
6	Area of Brick	0.00171	0.00171	0.00171
7	Weight of Bricks (in kgs)	1.8	1.9	1.85
8	Compressive Strength (in KN)	90	93	90
9	Water absorption (%)	1.02	1.02	1.02
10	Fire resistance	135	135	135

Table 4: plastic with Fly ash and bagasse

VI. Conclusions

After preparing a brick out of plastic waste it can be concluded that this project will be proved very helpful for the rural and coastal region people and will have a great impact on environmental pollution created by plastic wastes .Local people of these areas will be free from the hazardous issues of waste around them and this brick will be used for redesigning their houses which used to get washed away in the monsoon season. This project is an innovative and new idea in itself because it deals with the problem at a very macro level but solves it in a very micro perspective view. Plastic sand brick possess more advantages which includes cost efficiency, resource efficiency, reduction in emission of greenhouse gases, etc., Plastic sand brick is also known as “Eco-Bricks” made of plastic waste which is otherwise harmful to all living organisms can be usedfor construction purposes. It increases the compressive strength when compared to fly ash bricks. By use of plastic sand bricks, the water absorption presence of alkalies was highly reduced. Owing to numerous advantages further research would improve quality and durability of plastic sand bricks.

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