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Comparative Analysis for the Use of Non-Conventional Material in Bricks

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Abstract:
Bricks contribute a very significant share as a building material, excessive removal of fertile layer of soil poses a serious ecological problem. An attempt has been made to investigate the effect on mechanical properties of bricks when blended with various wastes. Puzzolonic material along with certain waste material blends will be studied, various mechanical properties and their variation with change in composition is involved in the scope of this study. Traditional brick-making would be the focus of research; the most suitable material will be suggested based on the findings.

Keywords: Bricks, clay, Bagasse fly-ash, Granulated blast furnace slag, porosity, Quarry dust, saw dust.

I. INTRODUCTION

Bricks have been a major construction and building material for a long time. The dried-clay bricks were used for the first time in 8000 BC and the fired clay bricks were used as early as 4500 BC. The worldwide annual production of bricks is currently about 1391 billion units and the demand for bricks is expected to be continuously rising. Conventional bricks are produced from clay with high temperature kiln firing or from ordinary Portland cement (OPC) concrete. Quarrying operations for obtaining the clay are energy intensive, adversely affect the landscape, and generate high level of wastes.

The high temperature kiln firing not only consumes significant amount of energy, but releases large quantity of greenhouse gases. Clay bricks, on average, have an embodied energy of approximately 2.0 kWh and release about 0.41 kg of carbon dioxide (CO2) per brick. It is also (newspapers, invitation cards, magazines etc.) in order to determine their aptness for use as a building construction material. While noted that there is a shortage of clay in many parts of the world. To protect the clay resource and the environment, some countries such as China have started to limit the use of bricks made from clay. The OPC concrete bricks are produced from OPC and aggregates. It is well known that the production of OPC is highly energy intensive and releases significant amount of greenhouse gases.

A new nature study estimates the world has 3.04 trillion trees. Almost 4 billion trees worldwide iscut down each year for making paper. The construction industry has been known as one of the largest consumers of non-renewable resources. On the other hand, more waste paper ends up in landfill or dump sites than those recycled. The purpose of this research is to determine the weight, compressive strength, water absorption capacity, fire resistance, hardness etc of papercrete brick by using waste papers using paper pulp with cement and sand the weight of the brick is approximately 50% lesser than the conventional clay brick. Therefore papercrete bricks will decrease the dead weight of the structure to a significant amount. So it changes our design and building cost as in an economical point of view.

II. LITERATURE REVIEW

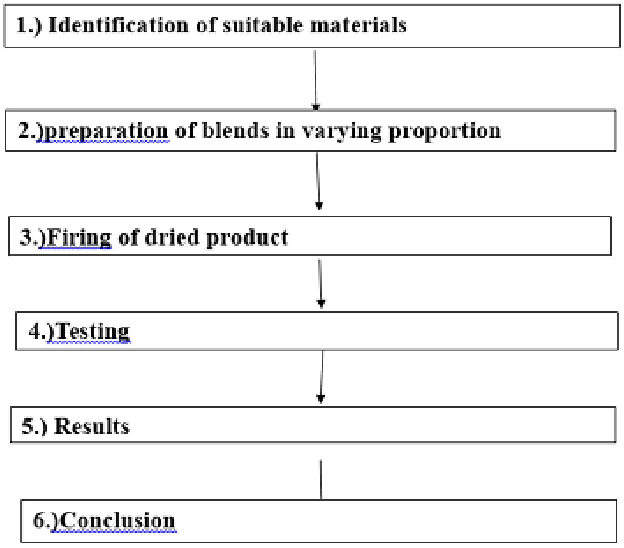
SUGAR CANE BAGASSE ASH FOR ECO-FRIENDLY FLYASH BRICKS

(Bhavya Rana, Prof. Jayeshkumar Pitroda, Dr F S Umrigar) (Proceedings of National Conference CRDCE13, 20-21 December 2013, SVIT, Vasad) Due to limited availability of natural resources and rapid urbanization, there is a shortfall of conventional building construction materials. On the other hand, energy consumed for the production of conventional building construction materials pollutes the air, water and land. Accumulation of unmanaged agro-waste, especially from the developing countries, has an increased environmental concern. Therefore, development of new technologies to recycle and convert waste materials into reusable material is important for the protection of the environment and sustainable development of the society. Waste materials, including sugarcane bagasse ash (SBA), recycled paper-mill waste, petroleum effluent treatment plant sludge, billet scale, red mud, fly ash, granulated blast furnace slag, steel industry dust and sewage sludge were used to manufacture brick and other construction materials. The cementitious binder, fly ash–lime–gypsum finds extensive application in the manufacturing of building components and materials such as bricks, hollow bricks and structural concrete. Attempts were also made to incorporate agro-industrial waste in the production of bricks; for instance, the use of straw, cotton waste, rice husk ash, limestone dust and wood sawdust and processed waste tea. Thermal conductivity was reduced by the addition of pore-forming agents (waste material) to the bricks before firing. The need to conserve traditional building materials that are facing depletion has forced engineers to look for alternative materials. Recycling of such wastes by incorporating them into building materials is a practical solution to the pollution problem. Bagasse Ash as an Effective Replacement in Fly Ash Bricks (Apurva Kulkarni1, Samruddha Raje2, Mamta Rajgor3) *International Journal of Engineering Trends and Technology (IJETT) – Volume 4 Issue 10 - Oct 2013*

The major pollution problems faced by small-scale process industries are due to the huge amount of solid and sludge waste generation and the limited treatment facilities. The use of waste as the brick material is a sustainable solution to solid waste management; it provide alternative raw material and an additional source of revenue. The raw materials used here are otherwise landfilled and thus add to ever escalating cost of disposal. The burnt sugarcane bagasse residue is commonly known as SBA. The potential production capacity of burnt sugarcane bagasse residue is around 7–8% of total bagasse consumed. The resulting CO2 emissions from bagasse are equal to the amount of CO2 that the sugarcane absorbs from the atmosphere during its growing phase, which makes the process of co-generation greenhouse gas neutral. The bricks thus manufactured using these wastes are energy-efficient due to zero emission of the principal raw materials. The present communication focuses on the development of SBA–quarry dust (QD) – lime (L) brick combination which is useful for the sustainable development of the construction industry. The automated brick plant was used for brick manufacturing. Optimal composition of the brick with respect to SBA–QD–L was determined from various proportions by evaluating the properties. "Cotton and limestone powder wastes as brick material (Halil Murat Algin *, Paki Turgut) *Elsivier"* Large amounts of cotton and limestone wastes are accumulated from the countries all over the world. The majority of cotton wastes (CW) and limestone powder wastes (LPW) is abandoned, and causes certain serious environmental problems and health hazards. This paper presents a parametric experimental study, which investigates the potential use of CW–LPW combination for producing new low cost and lightweight composite as a building material. The physical and mechanical properties of concrete mixes having high level of CWand LPW are investigated. The obtained compressive strength, flexural strength, ultrasonic pulse velocity (UPV), unit weight and water absorption values satisfy the relevant international standards. The results show that the effect of high level replacement of CW with LPW does not exhibit a sudden brittle fracture even beyond the failure loads, indicates high energy absorption capacity, reduces the unit weight dramatically and introduces smother surface compared to the current concrete bricks in the market. The process undertaken can easily be applied in the current brick plants. It results a sturdy lighter weight composite having potential to be used for walls, wooden board substitute, economically alternative to the concrete blocks, ceiling panels, sound barrier panels, etc. Paper presents the results and draws conclusions. Development of Bricks from Waste Material: A Review Paper (Alaa.A.Shakir, Sivakumar Naganathan, Kamal Nasharuddin Bin Mustapha) *Australian Journal of Basic and Applied Sciences, 7(8): 812-818, 2013 ISSN 1991-8178* (Chee Ming, 2011) examined the mechanical properties of clay brick made by adding two natural fibers like oil palm fruit (OF), and pineapple eaves (PF) to clay-water mixture with baked and non baked conditions. Compressive strength, water absorption and efflorescence were performed according to British standard BS3921:1985, and Malaysian Standards MS 76:1972. Results indicated that the compressive strength of the bricks were fulfilled the minimum requirement of BS3921:1985 for compressive strength which is 5.2 MPa for conventional bricks. Efflorescence was only feasible for baked samples as the non baked ones formed severe deterioration while testing. The prevailing benefit of the fiber inclusion was more benefit for baked specimen where the strength get surpassed that of non-baked added only specimen. (Paki *et al*. 2012) investigated the potential use of crumb rubber–concrete combination for producing a low cost and lightweight composite brick with improved thermal resistance. The obtained compressive strength, flexural strength, splitting strength, freezing–thawing resistance, and unit weight and water absorption values satisfy with the relevant international standards. The experimental observations reveal that high level replacement of crumb rubber with conventional sand aggregate does not exhibit a sudden brittle fracture even beyond the failure loads, indicates high energy absorption capacity, reduces the unit weight dramatically and introduces smoother surface compared to the current concrete bricks in the market. Thermal insulation performance is improved by introducing various amount of crumb rubber into the ordinary cementitious mixes. (Luciana C.S *et al*., 2012), proposed mixing of textile laundry wastewater sludge with clay to produce bricks for civil construction. All bricks were fabricated by extrusion method, dried at 100°C and then fired at 900°C. Mechanical properties of ceramics as flexural strength and water absorption were satisfactory within the Brazilian legislation. The obtained results showed that sludge can be incorporate bricks until a concentration of 20% (mass basis) producing suitable bricks in terms of its mechanical properties. Besides, the produced brick are safe and inert according to the applied leaching a solubilization tests. "Effect of Incorporation of Chips and Wood Dust Mahogany on Mechanical and Acoustic Behavior of Brick-Clay" (Gilbert Ganga1, Timothee Nsongo, Hilaire Elenga, Bernard Mabiala, Thomas Tamo Tatsiete, Nzonzolo) *Journal of Building Construction and Planning Research, 2014, 2, 198-208* Central Africa is a timber-producing sub-region. Wood industries generate a great quantity of waste woods that management has serious pollution problems. The use of waste wood in construction can be an alternative for the protection of the environment. The incorporation of wood waste in building materials has been the subject of several studies, most of which focused on the influence on the mechanical properties, on the mechanical properties of concrete. Meukam has shown that stabilized ground bricks, incorporating sawdust present the better performances as regards to thermal isolation than those used currently in the houses construction. Taoukil *et al*. have shown that the incorporation of the waste wood (sawdust or chip) reduces the concrete blocks of ground. Khelifi has shown that the concretes' density decreases with the increase in the rate of the shavings; that the mechanical resistances of the concretes with chip untreated decrease in an important way compared to the concretes with the treated shaving. Mekhermeche has shown in his study, that the ground bricks with 3% of wood fibers (date palm) present an improvement of the heat and acoustic insulation of these materials. In this study, we focus on the comparative study of the influence of the chips and sawdust mahogany content on the compressive strength.

III. METHODOLOGY

The scope of current study aims at identifying non-conventional materials for use in bricks, this can be achieved by making trial mixes of various materials to be added in varying percentages. These bricks can then be fired using traditional methodologies. The physico-mechanical tests will be carried out on fired product according to recommended Indian standards. The tests are compressive strength IS 3495 (Part-I): 1992, water absorption IS 3495 (Part-II): 1992 efflorescence IS 3495 (Part-III): 1992 and brick density IS 2185 (Part-I): 1979. The compressive strength will be determined using compression testing machine. For each composition, six samples will be tested for compression strength, three samples respectively, for water absorption, efflorescence and dry density test after complete drying, and the average will be obtained. The comparative parametric analysis of all samples will help in determining the feasibility of practical field applications of a particular material. After conducting advanced physio-mechanical tests, the most cost – effective, feasible and practical material will chosen.



Identification of materials
Bagasse fly ash:-

Nowadays, it is commonplace to reutilize sugar cane bagasse's a biomass fuel in boilers for vapor and power generation in sugar factories. Depending on the incinerating conditions, the resulting sugarcane bagasse ash (SCBA) may contain high levels of SiO2 and Al2O3, enabling its use as a supplementary cementitious material (SCM) in blended cement systems. Uses of Sugarcane bagasse ash waste in brick can save the sugarcane industry disposal costs and produce a 'greener' bricks for construction. The burning of bagasse which a waste of sugarcane produces bagasse ash. Presently in sugar factories bagasse is burnt as a fuel so as to run their boilers. This bagasse ash is generally spread over farms and dump in ash pond which causes environmental problems also research states that Workplace exposure to dusts from the processing of bagasse can cause the chronic lung condition pulmonary fibrosis, more specifically referred to as bagassosis. So there is great need for its reuse, also it is found that bagasse ash is high in silica and is found to have puzzolonic property so it can be used as a substitute to construction material.

Blast Furnace slag:-

Blast furnace slag, a waste product from steel plants, is at present being used for many purposes. Air-cooled, it is used as aggregate for concrete, for road making and as a fill under buildings and engineering structures. A large proportion of slag is quenched in water resulting in a glassy granulated slag with latent hydraulic properties. In a milled form it is used for the manufacture of Portland blast furnace cements and, overseas, for super sulphate slag cement. Slagwool prepared from molten slag is used as an insulating material**.** The material used in blend is granulated blast furnace slag, any reference to granulated blast furnace slag hereon will be stated as blast furnace slag.

Stone dust:-
Large quantity of stone dust is left in stone crushers, this can be effectively used in blend with traditional bricks to decrease the voids. This will also reduce the water absorption in final product.it is proposed to use basalt or any other massive igneous rock stone dust for blending.

Saw dust:-
Saw dust is the waste material generated in saw mills, with the increase in volume of wood processed there has been a tremendous increase in saw dust waste generation. This dust often lies unused as it is too fine to be used in particle boards. This can be used effectively in blend with traditional brick-making soil.

Figure.1. Mixing and blending

Figure.2. Making of the traditional brick kiln at site

Figure.3. Laboratory testing for water absorption

Figure.4.efflorescence test at the laboratory

IV. RESULTS

The results obtained for compressive strength of various blends is tabulated below.

TABLE.I. OBSERVATION FOR BLAST FURNACE SLAG

Sr. No.	Percentage	Size of Brick (cmxcmxcm)	Compressive Load(KN)	Compressive Strength N/mm^2
1	4 %	19 x 9 x 9	63.0	368.42
2	6 %	19 x 9 x 9	55.9	326.9
3	8 %	19 x 9 x 9	53.5	312.865
4	10 %	19 x 9 x 9	51.4	300.6

TABLE.II. OBSERVATION FOR BAGGASE FLY-ASH

Sr. No.	Percentage	Size of Brick (cmxcmxcm)	Compressive Load(KN)	Compressive Strength N/mm^2
1	4 %	19 x 9 x 9	53.6	313.450
2	6 %	19 x 9 x 9	59.3	346.784
3	8 %	19 x 9 x 9	42.4	247.953
4	10 %	19 x 9 x 9	60.33	352.807

TABLE.III. OBSERVATION FOR QUARRY DUST

Sr. No.	Percentage	Size of Brick (cmxcmxcm)	Compressive Load (KN)	Compressive Strength N/mm^2
1	4 %	19 x 9 x 9	50.2	293.567
2	6 %	19 x 9 x 9	41.6	243.247
3	8 %	19 x 9 x 9	39.55	231.286
4	10 %	19 x 9 x 9	47.9	280.11

TABLE.IV. OBSERVATIONS FOR SAW DUST

Sr. No.	Percentage	Size of Brick (cmxcmxcm)	Compressive Load (KN)	Compressive Strength N/mm^2
1	4 %	19 x 9 x 9	34.86	203.859
2	6 %	19 x 9 x 9	35.72	208.889
3	8 %	19 x 9 x 9	37.5	219.298
4	10 %	19 x 9 x 9	39.45	230.701

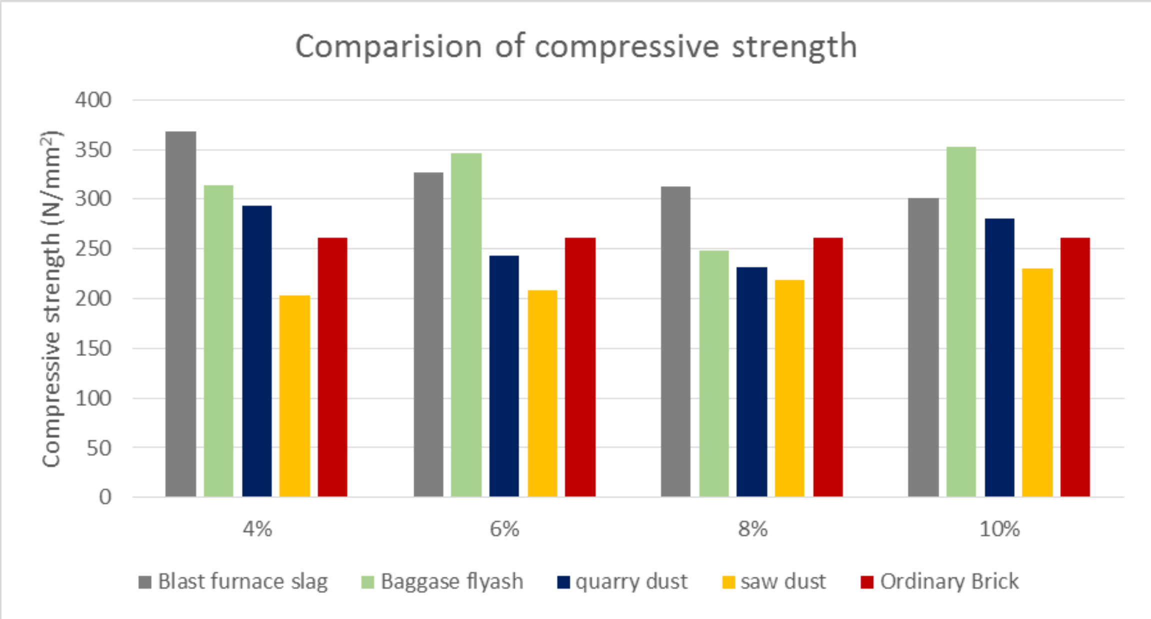


Figure.5. Graphical representation of compressive strength values for all blends

Similarly, results for water absorption values of different blends are tabulated as follows

TABLE .V. WATER ABSORPTION VALUES FOR VARIOUS BLENDS

Percentage	Blast furnace slag Water absorption (%)	Bagasse fly-ash Water absorption (%)	Quarry dust Water absorption (%)
4	17	19	18
6	16.5	18.67	17.47
8	15	16.5	16
10	14	15	16.5

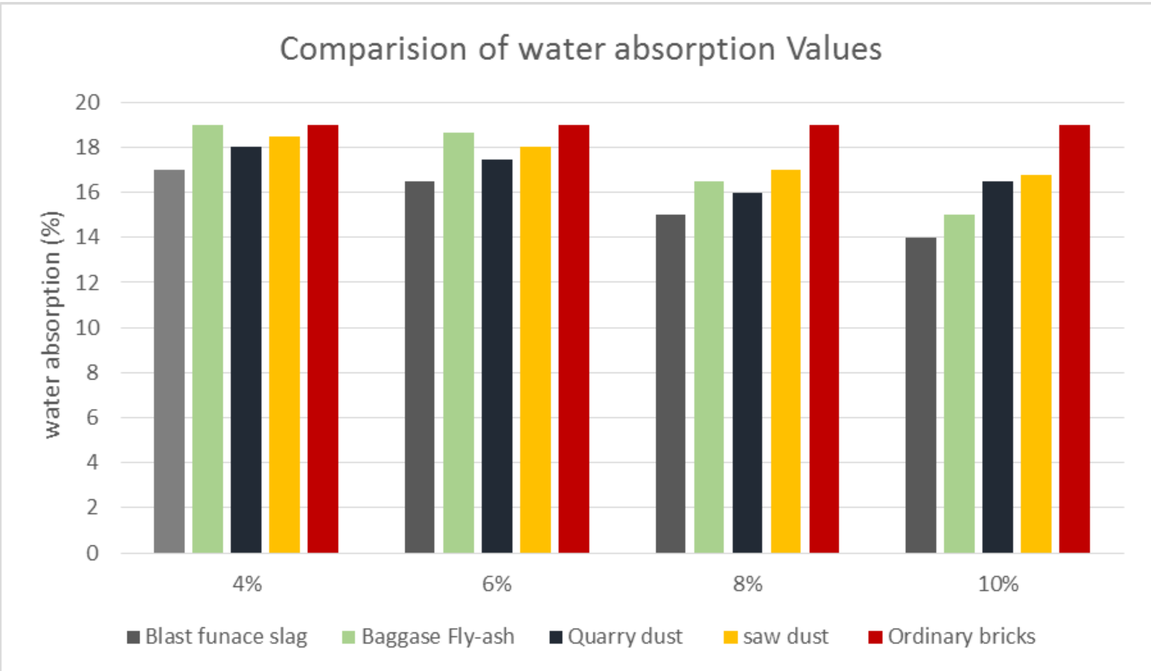


Figure.6. Graphical representation of comparative water absorption values for various blends

TABLE.VI. EFFLORESCENCE VALUES FOR VARIOUS BLENDS

Percentage (%)	Blast furnace slag	Bagasse fly-ash	Quarry dust
4	Nil*	Nil	Nil
6	Nil	Nil	Nil
8	Nil	Nil	Nil
10	Nil	Nil	Nil

*Nil indicates that efflorescence is less than 10% as per IS 3495:1992

Compressive strength= (Compressive load/area)

The results indicate that addition of blast furnace significantly improved the mechanical properties of bricks .Addition of bagasse fly-ash increases the compressive strength at a relatively higher percentage of blend, however compressive strength is comparable at these stages too. In spite of this fact bagasse fly- ash blended bricks are more porous if compared to blast furnace slag blended bricks of equivalent composition. Saw dust and Quarry dust also perform satisfactorily in the porosity criteria but are not desirable for increasing strength.

V. CONCLUSION

The study has established without doubt that addition of puzzolonic materials significantly improves the mechanical properties of bricks.

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