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Sustainable Building Blocks Utilizing E-Waste and Sugarcane Bagasse

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***Abstract*– Since large demand has been placed on building material industry especially in the last decade owing to the increasing population which causes a chronic shortage of building materials, the civil engineers have been challenged to convert waste to useful building and construction material. Utilization of Sugarcane waste materials and Electronic waste products is a sustainable solution to environmental and ecological problems. In this paper the feasibility of utilization of electronic waste and sugarcane bagasse in brick production is analyzed so as to reduce the use of natural materials and to reduce the solid waste in the environment. The effects of those wastes on the bricks properties were experimentally analyzed conclusions were arrived.**

***Index Terms:* E-waste, Building blocks, Bagasse, Sustainable blocks**

I. INTRODUCTION

Since large demand has been placed on building material industry especially in the last decade owing to the increasing population which causes a chronic shortage of building materials, the civil engineers have been challenged to convert waste to useful building and construction material. Utilization of waste materials and electronic waste products is a sustainable solution to environmental and ecological problems. Use of such materials reduces the cost of manufacturing. Other indirect benefits include reduction in landfill cost, energy saving and reduction in solid waste.

"Electronic waste" or "E-Waste" may be defined as discarded computers, office electronic equipment, entertainment devices, electronics, mobile phones, television sets, and refrigerators. This includes used electronics which are destined for reuse, resale, salvage, recycling, or disposal. Bagasse is the fibrous matter that remains after sugarcane or sorghum stalks are crushed to extract their juice. It is dry pulpy residue left after the extraction of juice from sugar cane. For each 10 tonnes of sugarcane crushed, a sugar factory produces nearly 3 tonnes of wet bagasse. Since bagasse is a by-product of the cane sugar industry, the quantity of production in each country is in line with the quantity of sugarcane produced.

Panneer Selvam. Gopala Krishna experimentally analyzed the utilization of recycled e-waste in concrete. Conventional specimens with partial replacement of E-waste on a percentage of 10%, 20%, and 30% to coarse aggregate with water cement ratio of 0.45 were prepared and the effect of physical, and mechanical properties of the concrete were studied.

Amiya Akram et.al. utilized e-plastics in concrete mixture as coarse aggregate replacement. This study focuses on the utilization of e-waste plastic particles in concrete and tests the feasibility of utilizing shredded-plastic particles as partial replacement of coarse aggregate. It was observed that when e-plastic alone was used, there was a decrease in strength but when 10% fly ash was added results comparable to control specimen were obtained. It is thereby suggested that utilization of this e-waste in concrete will reduce the requirement for conventional coarse aggregates thereby resulting in conservation of natural resources.

G. Viruthagiri et.al investigated about the reuse of sugarcane bagasse ash for clay brick production. In this research, bagasse ash has been chemically and physically characterized, and partially replaced in the ratio of 0 %, 5 %, 10 %, 15 % and 20 % ash by weight of weight in Clay brick. The results showed that the amount of ash to be incorporated will depend mainly on the composition of clay but also ash, and indicated that the clay used in this work can incorporate upto 15% weight of ash to produce solid bricks. The results also showed an improvement in clay/ash properties at sintering temperature 1000 ºC.

II. EXPERIMENTAL INVESTIGATION

A. Materials

Electronic waste (E-waste)

Electronic waste was collected from localities at Madurai. The wastes collected are then grinded to less than 10mm size.

Sugarcane bagasse

Sugarcane bagasse was collected from localities at Madurai and Vadipatti. The waste collected was crushed to small pieces.

B. Mix proportion

Five different mix proportions were determined in which the cement, fly ash and quarry dust content, electronic waste and sugarcane bagasse percentage are varied. The compositions of different materials in each mix were tabulated below.

Fig1. E-waste and Sugarcane Bagasse

Table 1. Mix proportion of brick 1

MATERIALS	PERCENTAGE (%)	WEIGHT (kg)
Fly ash	60	2
Quarry dust	30	1.05
Cement	10	0.350
Electronic waste	1	0.035
Sugarcane bagasse	0.5	0.0175

Table 2. Mix proportion of brick 2

MATERIALS	PERCENTAGE (%)	WEIGHT(kg)
Fly ash	60	2
Quarry dust	30	1.05
Cement	10	0.350
Electronic waste	2	0.070
Sugarcane bagasse	1	0.035

Table 3. Mix proportion of brick 3

MATERIALS	PERCENTAGE (%)	WEIGHT(kg)
Fly ash	60	2
Quarry dust	30	1.05
Cement	10	0.350
Electronic waste	4	0.140
Sugarcane bagasse	1.5	0.0525

Table 4. Mix proportion of brick 4

MATERIALS	PERCENTAGE (%)	WEIGHT(kg)
Fly ash	60	2
Quarry dust	30	1.05
Cement	10	0.350
Electronic waste	8	0.140
Sugarcane bagasse	2	0.070

Table 5. Mix proportion of brick 5

MATERIALS	PERCENTAGE (%)	WEIGHT(kg)
Fly ash	50	1.75
Quarry dust	40	1.40
Cement	10	0.350
Electronic waste	8	0.140
Sugarcane bagasse	2	0.070

Preparation of Test Specimens

According to the mix proportions, the materials are weighed and kept separately. The materials are then mixed so that they mix uniformly. The bricks were cast in machine. For each separate ratio nine numbers of bricks were cast. The curing is done for 28 days. Water is sprinkled over the bricks at morning and at noon for 28 days.

Fig 2. Casting & Curing

Testing of Specimens

The prepared specimens were tested for compressive strength and water absorption and the results were discussed in the next chapter.

Fig 3. Experimental Setup

III. RESULT AND DISCUSSION

Compressive strength

The blocks of size 230x10.5x8mm were cast. The maximum load at failure reading was taken and the average compressive strength is calculated.

Water absorption

The specimens were cooled to room temperature and weighed (M_1).Completely dried specimen was then immersed in clean water at a temperature of 27+2°C for 24 hours. The specimen after removed from water was weighed (M_2). Water absorption % was calculated and the results were tabulated.

IV. CONCLUSION

The following conclusions were drawn from the experimental investigation

- The utilization of E-waste in production of bricks has productive way of disposal of E-waste.
- The cost of bricks is reduced when compared to that of conventional bricks.
- Bricks made using E-waste and sugarcane bagasse have shown better result.
- The compression strength of bricks is also good. It attains ¾ compression strength of normal bricks in seven day itself.
- The weight of brick is less when compared to conventional bricks and hence easy to handle
- It can be used in all class of buildings.

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Table 6. Compression Strength Result For Block Type I

Proportion name	Cement (kg)	Quarry dust (kg)	Fly ash (kg)	Electronic waste (kg)	Sugarcane bagasse (kg)	Compressive stress (N/mm²)
B-1	0.400	1.050	2.000	0.035	0.0175	12.3
B-2	0.400	1.050	2.000	0.035	0.0175	10.50
B-2	0.400	1.050	2.000	0.035	0.0175	10.33
					Avg	11.04

Table 7. Compression Strength Result For Block Type II

Proportion name	Cement (kg)	Quarry dust (kg)	Fly ash (kg)	Electronic waste (kg)	Sugarcane bagasse (kg)	Compressive stress (N/mm²)
B-1	0.400	1.050	2.000	0.070	0.035	4.00
B-2	0.400	1.050	2.000	0.070	0.035	3.09
B-2	0.400	1.050	2.000	0.070	0.035	3.56
					Avg	3.58

Table 8. Compression Strength Result For Block Type III

Proportion name	Cement (kg)	Quarry dust (kg)	Fly ash (kg)	Electronic waste (kg)	Sugarcane bagasse (kg)	Compressive stress (N/mm²)
B-1	0.400	1.050	2.000	0.140	0.070	3.74
B-2	0.400	1.050	2.000	0.140	0.070	3.73
B-2	0.400	1.050	2.000	0.140	0.070	4.84
					Avg	3.92

Table 9. Compression Strength Result For Block Type IV

Proportion name	Cement (kg)	Quarry dust (kg)	Fly ash (kg)	Electronic waste (kg)	Sugarcane bagasse (kg)	Compressive stress (N/mm²)
B-1	0.400	1.050	2.000	0.280	0.035	4.00
B-2	0.400	1.050	2.000	0.280	0.035	3.09
B-2	0.400	1.050	2.000	0.280	0.035	3.56
					Avg	3.55

Table 10. Compression Strength Result For Block Type V

Proportion name	Cement (kg)	Quarry dust (kg)	Fly ash (kg)	Electronic waste (kg)	Sugarcane bagasse (kg)	Compressive stress (N/mm²)
B-1	0.400	1.500	1.500	0.280	0.035	8.47
B-2	0.400	1.500	1.500	0.280	0.035	8.90
B-2	0.400	1.500	1.500	0.280	0.035	10.31
					Avg	9.31

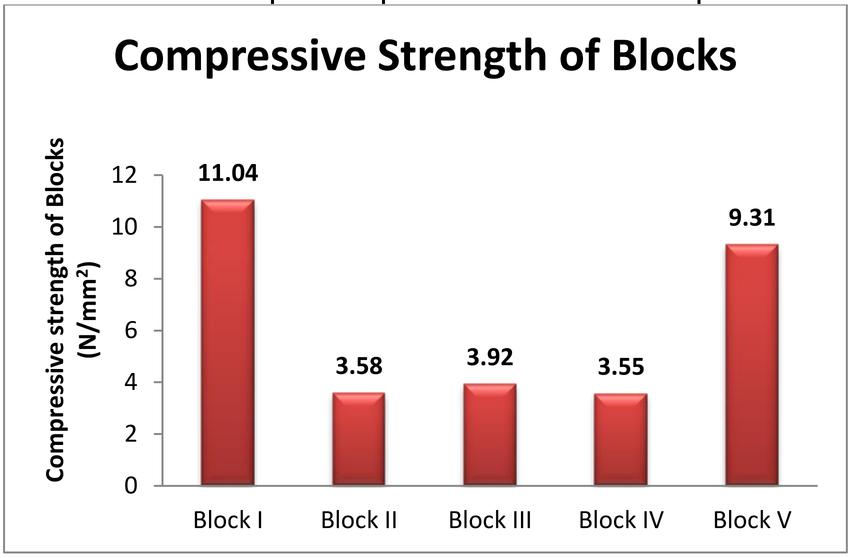

Fig 4. Comparison of Compressive Strength of Blocks

Table 11. Water Absorption Test Results

Proportion name	Dry Weight(kg)	Wet weight(kg)	Water Absorption(%)
Block I	3.87	4.080	15.42
Block II	2.7	3.175	17.40
Block III	2.5	3.010	20.4
Block IV	2.6	3.110	19.60
Block V	3.3	3.415	17.40