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Research paper

Applications of green materials for the preparation of eco-friendly bricks and pavers

B. Vamsi Krishna [1] *, E. Rakesh Reddy [2]

[1] Associate Professor Civil Department, Malla Reddy Engineering College (Autonomous), Secunderabad
[2] Assistant Professor Civil Department, Malla Reddy Engineering College (Autonomous), Secunderabad
**Corresponding author E-mail: localvamsi1987@gmail.com*

Abstract

The most basic and primary building material for construction of houses is the conventional brick. The rapid growth in today's construction industry has obliged the civil engineers in searching for more efficient and durable alternatives far beyond the limitations of the conventional brick production [1-2]. A number of studies have been made and serious steps have been taken in manufacturing of bricks from several waste materials. However, the traditional mean of bricks production which has brought hazardous impacts to the context has not yet been changed or replaced by more efficient and sustainable one [3], [4]. Most of the researches went through enhancing the clay brick quality and properties by mixing the clay with various recycled wastes as foundry sand, granite sawing waste, harbour sediments, perlite, sugarcane, baggase ash, clay waste and fine waste of boron, sewage sludge, waste glass from structural wall and other different wastes. Compile this state of the art work of manufacturing bricks in the past and the current trend in the bricks industry with respect to the raw materials, ways of manufacturing and the out- comings.
This project presents an experimental study on the utilization of waste materials which replaces clay with (Plastic covers, Ceramic Powder, Egg Shell Powder, GGBS, Silica Fume, Rice Husk Ash and Lime Powder) and Fine Aggregate with (Recycled glass, Dry Grass, Dead Leaves, Tree barks powder, Sugar cane powder, crumbed rubber) to produce eco-friendly Bricks. This project is an attempt to fill the gap of the past studies and suggest more sustainable and sophisticated methods of brick manufacturing in the future. 40 percent replacement of fine aggregate with crumbled rubber and dry grass in mortar bricks have given encouraging results, also the replacement of cement by egg shell powder at 20% has given a considerable result

Keywords: *Eco Friendly Materials; Waste Plastic; Ceramic Powder; Crumbed Rubber; Sugar Cane Powder; Dry Grass; Dead Leaves Etc.*

1. Introduction

Since the 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 [5]. The civil engineers have been challenged to convert the organic wastes to useful building and construction materials. The conventional method of bricks making has caused serious environmental contamination represented by the enormous emissions of green house gases (GHG) resulted in unusual climate changes as smog, acid rain and global warming. Furthermore, energy as fuel and electricity showed a drastic consumption during the traditional manufacturing of bricks led to highly economical expenditures



Fig. 1.1: Waste Tires from Vehicles.



Fig. 1.2: Sugarcane Waste.



Fig. 1.3: Tree Bark.

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Fig. 1.4: Eggshell Waste.



Fig. 1.5: Dry Grass Waste.

2. Objective of study

To understand the possibility of using waste materials such as

- Sugarcane waste as a replacement of fine aggregate in cement mortar brick in various proportions and to test the strength of the brick against various tests
- Dry grass waste as a replacement of fine aggregate in cement mortar brick and to check the possibilities of it for various applications.
- Crumbled rubber generated from tyre waste as a replacement of fine aggregate in the cement mortar brick making and identify various applications
- Tree bark waste replacement of fine aggregate in cement mortar brick and to check its strength for various strengths
- Egg shell powder replacement of cement in cement mortar brick making, and recommend those materials for various applications and as alternative eco-friendly materials for construction purpose.

3. Methodology

Crumbled Rubber: Waste rubber obtained from used and abandoned tyres have been collected. These tyres are crumbled in machine. The rubber that passes through 2.36 mm sieve is being used. The rubber should be free from deleterious materials such as stones, and other debris [6].



Fig. 3.1: Crumbled Rubber.

Dry grass: Dry grass obtained from yard waste is being collected. It is made ground into fine matter. It should pass through 2.36mm sieve and should be free from deleterious substances.



Fig. 3.2: Dry Grass Powder.

Sugarcane waste: Bagasse waste is being collected and made into fine particles free from deleterious substances. The material should be homogeneous and pass through 2.36mm sieve.



Fig. 3.3: Sugarcane Waste.

Tree bark: Tree bark waste is collected from trees and ground into fine powder that passes through 2.36mm sieve. It should be free from debris and deleterious material



Fig. 3.4: Tree Bark Aggregate.

Egg shells: Egg shells are collected from various sources such as domestic and commercial sources. These are neatly washed and air dried for two days. They are ground into fine powder in a mixer. The egg shell should pass 80 micron sieve [1].

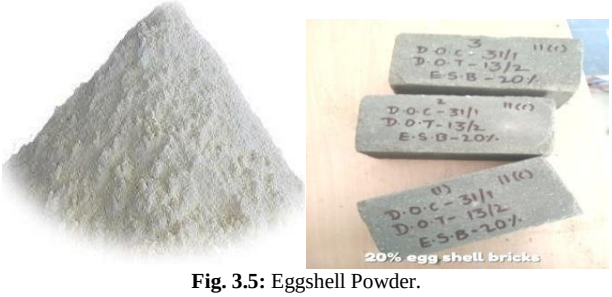


Fig. 3.5: Eggshell Powder.

4. Test on bricks

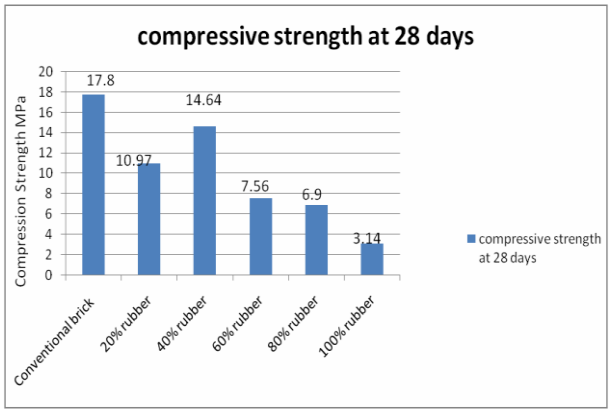
Compression strength test
The bricks should be tested in accordance with the procedure laid in IS 3495 (Part-2): 1976.Crushing strength of bricks is determined by placing brick in compression testing machine. After placing the brick in compression testing machine, apply load on it until brick breaks. Note down the value of failure load and find out the crushing strength value of brick.
Efflorescence Test on Bricks
The bricks should be tested in accordance with the procedure laid in IS: 3495 (Part-2): 1976. A good quality brick should not contain any soluble salts in it. If soluble salts are there, then it will cause efflorescence on brick surfaces. To know the presence of soluble salts in a brick, placed it in a water bath for 24 hours and dry it in shade. After drying, observe the brick surface thoroughly. If there is any white or grey color deposits, then it contains soluble salts and not useful for construction.
Water absorption test
The bricks should be tested in accordance with the procedure laid in IS: 3495 (Part-2): 1976
after immersion in cold water for 24 hours, shall have water absorption not more than one-sixth of the dry weight of brick.
Cement Brick Specifications

- The bricks shall be of first class, regular in shape, size and color.
- The bricks should be free from flaws, cracks and lumps of any kind.
- Shall have minimum Compressive Strength of 10.5N/mm2.
- The bricks shall not absorb the water more than one sixth of the weight of the brick.
- The sand used shall be medium coarse, clean, sharp, free from clay, mica and other organic matter.

5. Results and discussion

Table 5.1: Test Results of Crumbled Rubber

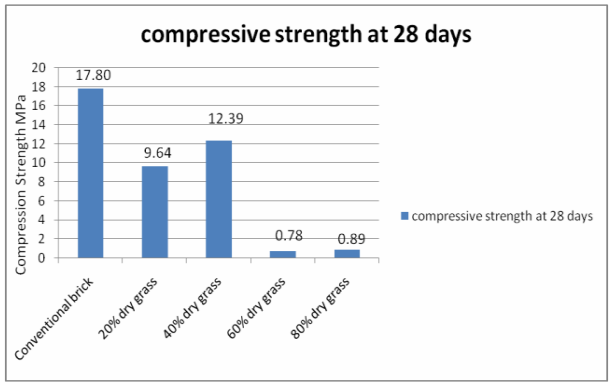
S. No	Description	Density KG/m3	Compressive strength MPa	Weight KG	Water Absorption (%)	Efflorescence	Crack
1	Fine Aggregate	1450	17.8	3.37	3.91	No	High
Crumbled Rubber							
a.	20% Replacement	393	10.97	3.315	0.91	No	High
b.	40% Replacement	393	14.64	3.19	0.92	No	Moderate
c.	60% Replacement	393	7.56	3.225	0.65	No	Moderate
d.	80% Replacement	393	6.9	2.73	0.74	No	Low
e.	100% Replacement	393	3.14	2.62	3.03	little	Low



Graph. 5.1: Test Results of Crumbled Rubber.

Table 5.2: Test Results of Dry Grass

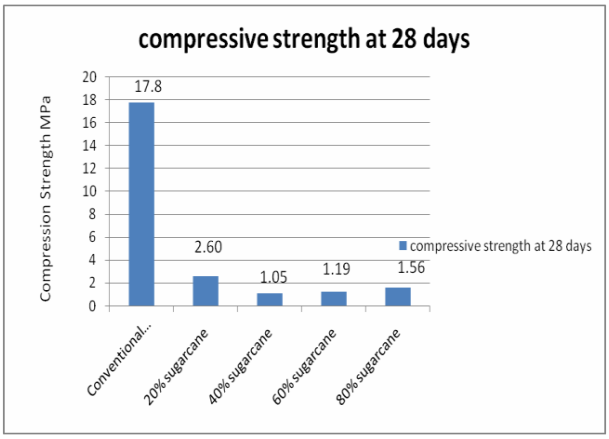
S.No	Description	Density kg/m3	Compress save strength MPa	Weight kg	Water sorption (%)	ab-Efflorescemcee	Crack
Dry Grass							
a.	20% Replacement	55	9.64	3.26	5.74	No	Moderate
b.	40% Replacement	55	12.39	3.08	4.03	No	Moderate
c.	60% Replacement	55	0.78	2.64	16.37	No	High
d.	80% Replacement	55	0.89	1.99	-	-	-
d.	100% Replacement	55	_	1.66	-	-	-



Graph. 5.2: Test Results of Dry Grass.

Table 5.3: Test Results of Sugarcane Waste

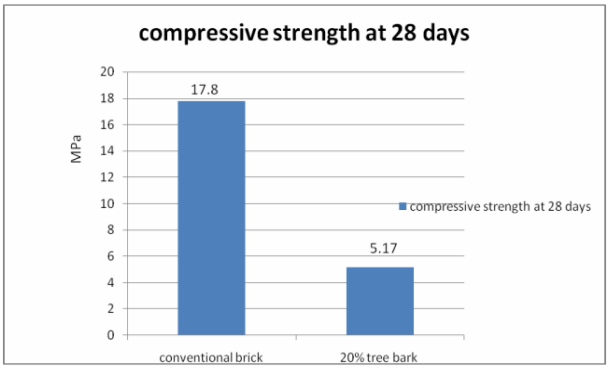
S. No	Description	Density g/m3	Compress sive strength MPa	Weight kg	Water sorpti on (%)	ab-Efflo-rescence	Crack
Sugarcane							
a.	20% Replacement	47.24	2.6	3.19	4.5	No	High
b.	40% Replacement	47.24	1.05	2.9	13.53	No	Moderate
c.	60% Replacement	47.24	1.19	2.57	11.34	little	Low
d.	80% Replacement	47.24	1.56	2.15	13.72	little	Low



Graph. 5.3: Test Results of Sugarcane Waste.

Table 5.4: Test Results of Tree Bark.

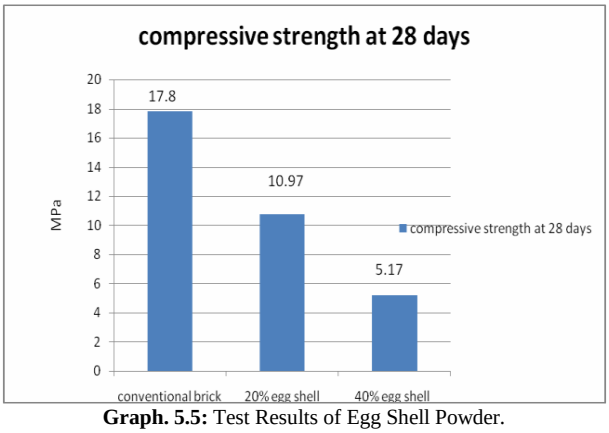
S. No	Description	Densityk g/m3	Compress sive strength MPa	Weight	Water absorpti on	Efflorescence	Crack
Tree bark							
1	20% replacement	347	5.17	2.79	14.13	No	High
2	40% replacement	347	-	-	-	No	High



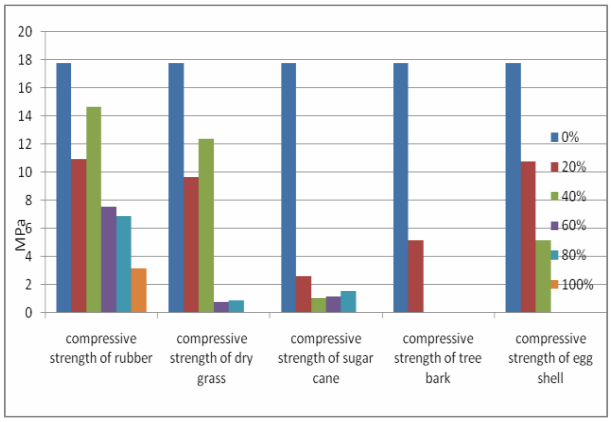
Graph. 5.4: Test Results of Tree Bark.

Table 5.5: Test Results of Egg Shell Powder

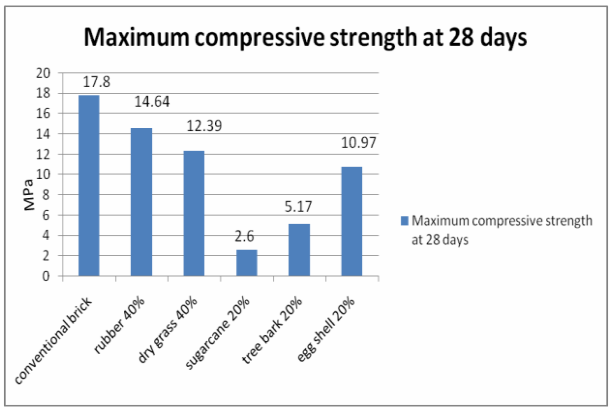
S. No	Description	Densityk g/m3	Compress sive strength MPa	Weight	Water absorpti on	Efflo-rescence	Crack
Egg shell							
a.	20% replacement	1150	8.94	3.26	0.89	No	Moderate
d.	40% replacement	1150	5.17	2.76	3.12	Little	High



Graph. 5.5: Test Results of Egg Shell Powder.



Graph. 5.6: Comparison of Conventional Brick Strength with Compressive Strength of Various Compositions of All the Bricks.



Graph. 5.7: Comparison of Conventional Brick Strength with Maximum Compressive Strength of Different Materials.

6. Conclusion

Tests Performed: Compressive Strength, Absorption Test, Efflorescence Test, Falling weight Test was performed on Eco-Friendly Bricks.

From this study the effective utilization of eco- friendly waste materials have been identified and were replaced in the cement brick mixture as fine aggregate and cement. At present Crumbled rubber, Dry Grass, Dry sugarcane pulp, Tree bark were used in replacing fine aggregate in various proportions like 20%, 40%, 60%, 80% and 100%. Egg shell powder was used in replacing cement with 20% and 40%. On the Basis of the test results the following conclusions are drawn. These conclusions also include structural applications of secondary type from medium to low strength requirements, benefiting from other features of this type of brick and pavers.

1) The compressive strength of crumbled rubber brick with 40% replacement of fine aggregate with crumbed rubber is 14.64 N/mm2. It is almost equal to the strength of conventional cement brick (17.8 N/mm2) on 28th day.
2) The compressive strength of Dry grass brick with 40% replacement of fine aggregate with dry grass is 12.39 N/mm2. It is almost equal to the strength of conventional cement brick (17.8 N/mm2) on 28th day.
3) The compressive strength of sugar cane brick in various proportions were not at all encouraging. Therefore, using of sugarcane pulp in brick manufacturing is not recommendable.
4) The compressive strength of Tree bark brick in various proportions were not at all encouraging. Therefore, using of tree bark in brick manufacturing is not recommendable.
5) The compressive strength of Egg Shell brick with 20% replacement of cement with eggshell powder is 11.00 N/mm2. It is a recommendable value.

From the test results, it is found that the compressive strengths of eco-friendly bricks, Crumbled rubber brick, Dry grass brick, Egg

Shell brick showed acceptable aesthetics. The use of these eco-friendly materials resulted in an appreciable reduction of block unit weight from 3.37 kg/m3 to 2.7 kg/m3, which is recommended for using as a construction material like brick and pavers.

7. Future scope of study

Only a few number of engineering properties of eco-friendly bricks have been examined in this study, Other properties such as skid resistance, abrasion resistance, deformation, volume change, fatigue resistance, Flexural test and environmental impact must be examined for comprehensive evaluation of this new eco- friendly materials.

Overall, Eco-friendly bricks have been observed to show a more inferior performance than conventional cement bricks in compression, water absorption, Falling weight and efflorescence, but showed an encouraging result in compression. Thus, crumbled rubber bricks have a great potential to be used for pedestrian pavements, flooring of indoor games. The replacement of fine aggregate with crumbled rubber which is produced from waste tires will reduce the consumption of primary aggregates and produce a high value use for the wastes

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