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Eco: Friendly bricks

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Abstract
In India a number of waste materials are produce by different manufacturing companies, thermal power plant, municipal solid waste and other waste solid as well as liquid waste management is one of the biggest problems of the whole world. Disposal of waste in the land causes serious impact on environment and humans. By using the alternative materials often cause cost reduction, energy saving and few hazards in the environment. So, for reducing the pollution and cost of construction, bricks are manufactured by using waste materials like recycle paper mill waste, tiles powder, marble powder, fly ash, etc. This paper illustrate the performance of waste materials bricks with these sustainable materials and aggregates used in it. This paper will also draw our focus towards the impact on the various property of bricks when its raw material are partially replaced with waste product.

Keywords: fly ash, recycle paper mill waste, tiles powder and marble powder

1. Introduction
Clay bricks have recently been primarily used for all major construction purpose approximately, 40% of the total expenditure occur in brick laying and related process. Being the prime component in construction industry it is used up many critical resources. The bricks industry is one of the prime contributor to the air pollution. It amounts to 28.8% of the total air pollution, second only to transportation. Emission of huge quantity of toxic elements from bricks kilns is causing serious health hazards. The bricks kilns emit toxic fumes containing suspended particulate matters rich in carbon partitions and high concentration of carbon mono-oxides and oxides of sulphur (SOx) that are harmful to eye, lungs, and throats. The oxides of sulphur also causes important monuments to corrode like Taj Mahal which is turning yellow due to pollution. The bricks filled owner have been burning bricks with fire wood. As a result a large number of trees like keora,'chaila', sundari, mehgini, Bain etc. Are being felled indiscriminately. Causing vast deforestation further disadvantage of clay bricks include consumption of natural resources, fertile top soil causing exposure of an unfertile soil which is unsuitable for farming. Further, the clay once used for bricks production cannot be recycled or reused for other purpose as brick manufacturing include burning of clay.
Another major drawback of clay bricks is the presence of effloresces due to wrong proportion of material. Since, we cannot be sure about the proposition of materials in the top soil, it sometimes lead the higher alkali contain which causes white material to flake out of the bricks.

2. Literature review
Many literature work has been done on manufacturing of eco-friendly bricks with the help of different materials. Some of them are given below:-
Alaa Shakir *et al,* (2013) [1] in this research author has used different types of wasted that are presently recycled in bricks preparation. The change in physical and mechanical properties of the bricks are reviewed. For designing the green building a good performance bricks with respect to environment i.e. with don't emit harmful gases as well as nor consume energy resources and which are economical can be a better option. Non- fired bricks can also be produced by waste products. This will helps in reducing the consumption of energy resources or fossil fuel in kiln during brick firing. Also it results in reduction of m3any pollutant gases like ammonia (NH_3), Carbon mono oxide (CO) and carbon-dia oxide (CO_2). The aim of the researcher is to use environmental and economical approach so that less pollutant gases can be emitted and less energy will be consumed.
Rohit Kumar Arya *et al.,* (2016) [2] used paper pulp with the sand and cement for the manufacturing of bricks and found brick weight is approx. 50 % lesser than the normal brick. Thus it decrease the dead load of the structure. It has been concluded the paper pulp brick has the ability to provide an ecofriendly, light weight concrete block with the use of less number of natural resources. Moreover, the water absorption capacity of paper pulp brick was found to be more than 20%, which makes it not suitable for water logging and external walls. These bricks can be used for non-load bearing walls only as their compression strength is also not so good. Besides all this paper pulp has a high fire resistance, good thermal resistance and good sound absorbent properties. It is ideal for earthquake prone regions. Also, these bricks does not expand nor shrinks. As these bricks mainly consists of waste materials therefore it reduces landfills and pollution and hence reduced the overall cost by 20% to 50 %.
Zeshan Khan *et al*. (2017) [3] In this research author has used marble dust for the manufacturing of bricks and then the change in properties of bricks has been studied. It was observed that if weight of marble dust is increased, porous and lightweight bricks will be produced. The decrease in bulk density was observed 16.10% and increases in porosity was 52.32% as compared to normal bricks. It was also observed that up to 10 % addition of marble dust, it satisfies the water absorption requirement of brick but with increase in percentage of marble dust water absorption capacity also increases. Further, it was observed that with the increase in

percentage of marble dust compressive strength of the brick is decreasing. The addition of marble powder up to 20% satisfies the requirements of compressive strength for individual bricks.

Pravin Gadling *et al* (2018) [4] has find out the optimum percentage of fly ash to be used with different combinations of materials in the brick and their effects on different properties of bricks has been discussed. The bricks manufactured from fly ash are environmental friendly. It increase the compressive strength when fly ash is added to 70 to 80 % while brick is manufactured. The durability of brick is increased when fly ash is mixed with lime. Cost of brick element can be reduced by using the fly ash bricks.

3. Experimental Work

In this research, different waste materials are used for manufacturing of Eco-friendly bricks. Later on their effects on properties of bricks has been studied. The bricks manufactured from different waste materials are:-

1. Paper Bricks
2. Tile Bricks
3. Marble Bricks
4. Fly Ash Bricks

3.1 Paper brick

It was found by us that 15% of the paper taken in left to sit in a landfill as sludge. "Recycle paper mill (RPM) contribute 30 percent of the total pulp and paper mill segment in India. With 85 percent being the average efficiency of RPM, 5 percent waste (RPMW) is produced annually. RPMW which otherwise is landfilled has been utilized to make construction bricks that serves a purpose of solid waste management.

Composition of material used in paper bricks

i) Paper pulp -60%
ii) Cement -10%
iii) Fly ash – 30%

Table 1: Composition of paper brick and its compressive strength

Paper Pulp	Fly Ash	Cement	Compressive Strength
50 %	40 %	10 %	5.2
60 %	30 %	10 %	7.5
80 %	10 %	10 %	6.8

Results of test done on paper bricks

1) **Compressive test:** According to the mix proportion its compressive strength is approx. 7.5Mpa.
2) **Weight:** Light weight brick also the most important objective of this project. Conventional clay bricks weigh around 30-35 but paper brick weighs 14.89 N
3) **Cost analysis:** In cost analysis paper brick costed only Rs1.37 per brick but, the rate of clay brick varies from approx. Rs. 5-6. So, the cost of building will be reduce.

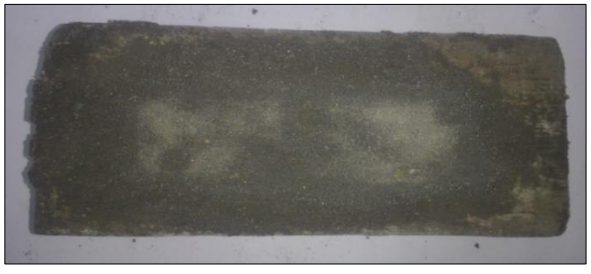

Fig 1: Paper brick

Merits of paper brick

- These bricks absorb earthquake vibrations.
- By using these bricks in the building total cost will be reduced from 10-20%.
- Since, the waste materials are used it will reduce the landfills and pollution.
- This brick does not expand or contract, so sheet of glass or glass block can be embedded in and trimmed with paper bricks.
- Since the waste material are used it will reduce the landfills and pollution.
- Since, in manufacturing of this brick, burning is not require so these brick is eco-friendly.
- This brick is suitable for framed structure as partition wall.
- The weight of this brick is 1/3rd to 2/5th lesser than the conventional clay brick.
- Due to less weight of these bricks, the total dead load of the building will be reduced.

3.2 Tile bricks

In India ceramic production is 100 million ton per year. The tile industry has about 15% to 30% waste material generated from the total production. This tile waste is dumped in landfilling and pit our vacant spaces causes the environmental pollution which is dangerous for human health. This waste is not recycle in any form at present.

Composition of material used in tile bricks

Mix proportion of tile bricks on the basis of their weight:-

i) Tile powder -60%
ii) Cement-20%
iii) Fly ash-20%

Table 2: Show the composition of tile brick and its compressive strength

Tile Powder	Fly Ash	Cement	Compressive Strength
50 %	40 %	10 %	15.4
60 %	30 %	10 %	17.23
80 %	10 %	10 %	12.8

Results of test done on tile bricks

1. Compressive strength: Its compressive strength is 17 MPa.
2. Cost analysis: The cost of one tile bricks is about 2 Rs.

Merits of tile brick

- Increase durability performance.
- Possible alternative solution for safe disposal of tile waste.
- Minimize cost and environmental hazards.
- Eco-friendly.

3.3 Marble brick

Marble is used for construction & decoration. A large quantity of marble powder is generated during the cutting process. The result is that the mass of marble waste which is 20% of total marble quarried has reached as high as millions of tons. This huge unattended mass of marble waste consisting of very fine particles is today one of the environmental problem around the world.

Composition of material used in marble bricks

Mix proportion of marble bricks on the basis of weight is:-

i) Marble powder-60%
ii) Cement-20%
iii) Fly ash-20%

Table 3: Show the composition of marble brick and its compressive strength

Marble Powder	Fly Ash	Cement	Compressive Strength (Mpa)
50 %	40 %	10 %	12.15
60 %	30 %	10 %	15.82
80 %	10 %	10 %	10.02

Results of test done on marble bricks

Compressive test: Compressive strength of this brick is 15 MPA.

Merits of marble brick

- Compressive strength increases with increases of marble powder.
- We can put forth step to minimize the cost of total construction by using marble bricks.
- Marble waste which is freely or cheaply available.
- Eco- friendly
- Due to its good finishing thin plaster is require so it also reduce cost of plaster.

3.4 Fly Ash Bricks

In India thermal power plant produce a large quantity of fly ash by combustion of coal but this fly ash is not useful and causing many environmental problem. This

Composition of material used in fly ash bricks

Mix proportion of fly ash bricks on the basis of weight

i) Fly ash -70%
ii) Cement-30%

Table 4: Show the composition of fly ash and its compressive strength

Fly Ash	Cement	Compressive Strength (Mpa)
50 %	50 %	10.97
70 %	30 %	9.87
100 %	0 %	4.32

Results of test done on fly ash bricks

1. **Compressive strength:** Its compressive strength is 9.87 MPa.
2. **On resistance to chemical attack:** Fly ash slightly improve the resistance of concrete to sulphate attack.
3. **Good strength:** Fly ash contain fine particle so it make good bonding with cement mortar and provide good strength.
4. **Permeability:** The permeability of concrete reduces on addition of fly ash to cement.

Merits of fly ash brick

- Due to perfect size savings in cement mortar for making the walls and plastering by 20-40%.
- Plaster of Paris, putty can be applied directly without a backing cost of plaster.
- Lower water penetration to clay.
- High strength bricks can be used for load bearing walls.
- Eco-friendly using fly ash.

4. Conclusion

Based on above experimental work it has concluded that materials like fly ash, paper bricks, marble waste and tile powder can be efficiently be used as brick ingredients.It is better to utilize these waste materials. Paper bricks have the ability to produce a light weight and eco-friendly bricks by using less number of natural resources. Compression test shows that the paper bricks are acceptable for non-load bearing walls i.e. they can used for partition wall.

As per the research, the paper brick should not absorb water more than 20 % by weight. Hence, the paper bricks are not suitable for water logged areas and external walls. However, by providing a water proof coating it can be used as in external wall. Due to its less weight and flexibility, these bricks are potentially ideal material for earthquake prone areas.

Paper bricks have moderate fire resistance and good sound absorbance. Paper bricks don not expand or shrink hence sheet of glass or glass block can be fixed.

Tile bricks increases the durability and performance. It minimize the cost and environmental hazards.

Marble bricks compressive strength increases with increase in marble powder. Due to their smooth finishing and perfect shape and size, thin plaster coating is required so they also reduce the cost of plaster.

Fly –ash bricks helps in saving cement mortar thus helpful in making the walls and plastering by 20-40 %.Plaster of Paris, putty can be applied directly without the cost of plaster.

By using all these eco-friendly bricks a cost reduction of 20-30% was observed.

Brick manufactured by these materials leads to good utilization of waste powder of tile, marble, fly ash and recycle paper mill waste. Its application for the sustainable development of the construction industry is the most efficient solution and also addresses the high value application of such waste.

Since the waste materials are used, they will reduce land fill as well as land pollution.

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