Experimental Study on Manufacture of Fly Ash Brick by Using Construction and Demolition Waste

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Abstract -*Developing a sustainable construction material (brick) using construction and demolition (C&D) waste by diversion of C&D waste from the main waste stream can help in gaining a substantial area of land.The study investigates the potential for reusing construction debris as a replacement for sand by using construction and demolition waste at a range of 0%, 25%, 50%, 75%, 100%. The material properties are checked, brick was casted, tested and compared the properties such as compressive strength, water absorption capacity, efflorescence, density. This project will thus be very useful in an eco- friendly environment.*

Key Words: C&D Waste, compressive strength, efflorescence, density, water absorption

1. INTRODUCTION

Increasing population and rapid urbanization contribute towards solid waste generation. Waste in construction activity is generated either in new projects or in the process of demolition of old structures. Construction and demolition waste may be generated due to various reasons such as demolition or dismantling structures, damaged or excess construction material, non use of material due to alteration in specification, change in design during construction, etc. Fly ash is produced as a by-product from municipal solid waste incinerators and coal fuelled power stations, is also an environmental pollutant like C&D waste, it has a potential to be a resource material.

Leaving the waste materials to the environment directly can cause environmental problems. Hence the reuse of waste materials has been emphasized. Waste can be used to produce new products so that natural resources are used more efficiently and the environment is protected from waste deposit. Partial replacement of building material by using C&D waste could lead to reduction in sand mining from river beds or cutting of rocks. The C&D plant can efficiently recover brick, soil, sand and concrete which can be re used. Thus the process not only helps in reducing waste, but also indirectly leads to decreasing pollution.

Here we are taking an effort towards use of waste material such as C&D waste and fly ash in manufacturing of structural element like brick without any combustion process and to compare the structural properties assigned by the Indian Standard specification for load bearing brick. This project will thus be very useful in an eco-friendly environment.

2. MATERIAL PROPERTIES

2.1 Fly Ash

Fly ash, the fine particulate waste material produced by pulverized coal-based thermal power station, is an environmental pollutant, it has a potential to be a resource material. It is nowadays used in cement, concrete, brick and other cement based applications in India.

The experiment were conducted to study the physical properties of fly ash as per IS code. The test results are tabulated below:

Table – 1: Properties of Fly Ash

S.No	Physical Properties	Standard Value	Experimental Values
2	Specific Gravity	1.9 to 2.96	2.3

2.2 Construction and Demolition Waste

Huge quantity of construction and demolition (C&D) debris is produced during the construction and development works. As the construction industry grows, it generates more and more C&D debris, which create a major portion of solid wastes. The amount and type of C&D debris depend on many factors such as the stage of construction, type of construction work, and nature of construction practice on site. Most of the C&D debris are generally disposed of in landfills or openly dumped into uncontrolled waste pits and open areas. Therefore, the continuous industrial development would pose a serious disposal problem of C&D debris. The use of C&D debris in construction materials could ease the process of waste management.

The experiments were conducted to study the physical properties of Construction and demolition waste as per IS 383-1970 code. The test results are tabulated below:

Table – 2: Properties of C&D Waste

S.No	Physical Properties	Experimental Values
1	Specific Gravity	2.6
2	Water Absorption	12%
3	Fineness	3.2

2.3 Sand

The experiment were conducted to study the physical properties of sand as per IS 383-1970. The test results are tabulated below:

Table – 3: Properties of Sand

S.No	Physical Properties	Experimental Values
1	Specific Gravity	2.71
2	Water Absorption	0.5
3	Fineness	2.9

2.4 Ordinary Portland Cement

The experiments were conducted to study the physical properties of cement as per IS code. The test results are tabulated below:

Table – 4: Properties of Ordinary Portland Cement

S. No	Physical Properties	Standard Values	Experimental Values
1	Specific Gravity	3.15	3.15
2	Setting Time		
	Initial	30 mts (min)	30 mts
	Final	600 mts (max)	480 mts
3	Consistency	26% - 33%	31.5%

2.5 Water

Water is an important ingredient of concrete as it actively participated in the chemical reaction with cement. Since it help to form the strength giving cement gel, the quantity and quality of water is required to look carefully. In practice, very often great control on quality of water is often neglected. Since quality of water affects the strength, it is necessary for us to go into the purity and quality of water.

3. EXPERIMENTAL INVESTIGATION

3.1 Methodology

First selected the topics that are "Experimental Study on Manufacture of Fly Ash Brick by using construction and demolition waste with fly ash" and then collected the literature review related on the selected title. After that materials were collected for the progress of work. The collected materials include construction and demolition waste, OPC, Sand and also coconut shell ash. Then the material properties were checked. The construction and demolition waste was collected from the backyards of the college itself which was crushed manually and sieved using IS 1.18 sieve. And the sand was also sieved using IS 1.18 sieve. After these, the materials collected were taken in proportion and mix was prepared for the casting purpose of bricks. After being casted the bricks were kept for curing. After 7 days and 28 days period of curing, the specimen were taken out and different properties of prepared specimen are tested and compared with properties assigned by Indian Standard specifications for normal fly ash bricks.

Table -5: Mix Proportions

	%Of C &D waste added	Weight of fly ash required	Weight of sand required	Weight of OPC required
MIX1	0	1400g	1300g	300g
MIX2	25	1400g	975g	300g
MIX3	50	1400g	650g	300g
MIX4	75	1400g	325g	300g
MIX5	100	1400g	0	300g

Fig – 1: Casted Specimens

3.2 Tests on Bricks

A. Compressive Strength

5 specimens of bricks are taken to laboratory for testing and tested one by one. In this test a brick specimen is put on crushing machine and applied pressure till it breaks. The ultimate pressure at which brick is crushed is taken into account. All five brick specimens are tested one by one and average result is taken as brick's compressive/crushing strength.

Fig – 2: Compressive strength testing apparatus

B. Water Absorption test

In this test bricks are weighed in dry condition and let them immersed in fresh water for 24 hours. After 24 hours of immersion those are taken out from water and wipe out with cloth. Then brick is weighed in wet condition. The difference between weights is the water absorbed by brick. The percentage of water absorption is then calculated. The less water absorbed by brick the greater its quality. Good quality brick doesn't absorb more than 20% water of its own weight.

C. Efflorescence test

The presence of alkalies in bricks is harmful and they form a grey or white layer on brick surface by absorbing moisture. To find out the presence of alkalis in bricks this test is performed. In this test a brick is immersed in fresh water for 24 hours and then it's taken out from water and allowed to dry in shade. If the whitish layer is not visible on surface it proofs that absence of alkalis in brick. If the whitish layer visible about 10% of brick surface then the presence of alkalis is in an acceptable range. If that is about 50% of surface then it is moderate. If the alkalies presence is over 50% then the brick is severely affected by alkalies.

4. RESULTS

A. Compressive Strength

Compressive strength tests were performed on brick specimen of size 230mm × 110mm × 70mm using compressive strength testing machine. Three samples per batch were tested with the average strength value reported in table:

Table – 6: Compressive Strength

S.No	% of construction and demolition waste added	Average Compressive Strength (N/mm²)	
		After 7 Days of Curing	After 28 Days of Curing
1	0 %	2.767	7.509
2	25 %	3.573	9.486
3	50 %	3.966	9.881
4	75 %	5.138	10.474
5	100 %	3.953	7.312

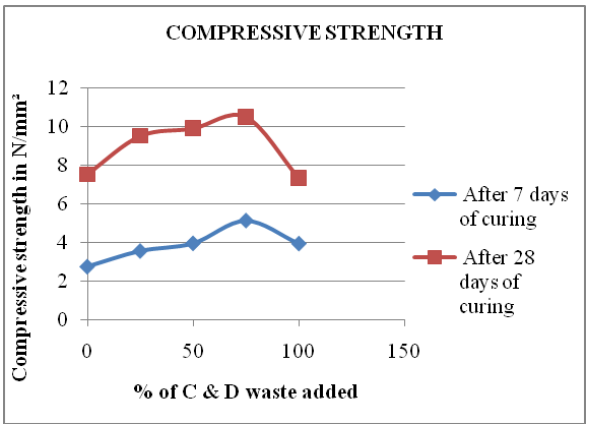

Chart – 1: Comparison of compressive strength

B. Water Absorption

Water absorption test were performed on the brick specimen of size 230mm × 110mm × 70mm by weighing in dry condition and wet condition after immersed in fresh water for 24 hours.

Table - 7: Water Absorption

	% of construction and demolition waste added	% of Water Absorption
1	0 %	3.271
2	25 %	7.393
3	50 %	7.427
4	75 %	9.578
5	100 %	9.842

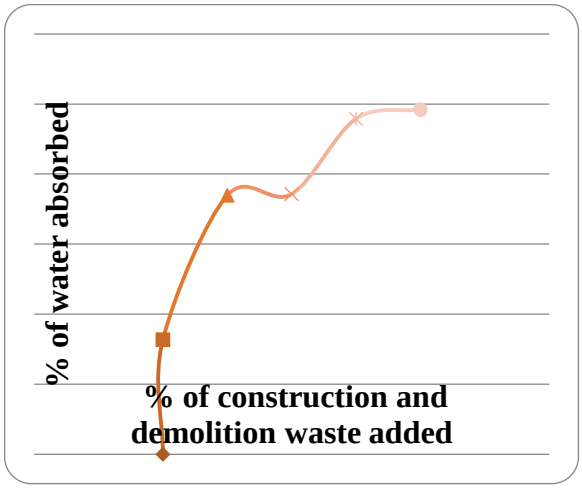

Chart – 2: Comparison of % of water absorbed

C. Density

Density tests were performed on one brick of size 230mm × 110mm × 70mm. Three samples per batch were tested with the average density value reported in the table:

Table – 8: Density of brick

S.No	% of construction and demolition waste added	Density of brick in kg/m³
1	0 %	2030.49
2	25 %	2001.12
3	50 %	1930.54
4	75 %	1879.73
5	100 %	1686.62

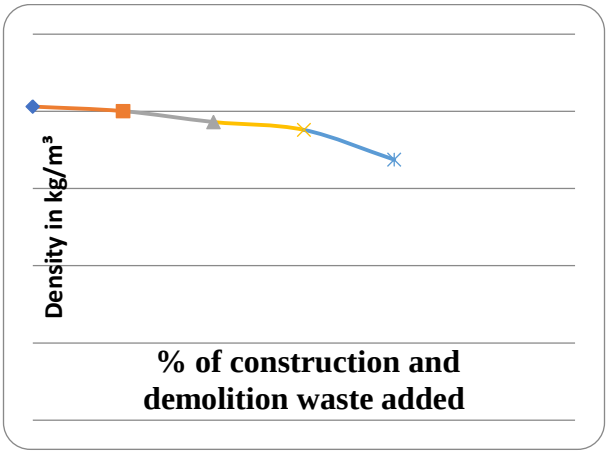

Chart – 3: Comparison of density of brick

D. Efflorescence

The test was conducted by soaking the bricks in water for 24 hours and depositions of patches on the bricks were studied. The liability to efflorescence shall be reported as 'nil', 'slight', 'moderate', 'heavy' or 'serious' in accordance with the following definitions and the results were shown in Table 4.9.

- Nil - When there is no perceptible deposit of efflorescence.
- Slight - When not more than 10 percent of the exposed area of the brick is covered with a thin deposit of salts.
- Moderate - When there is a heavier deposit than under 'slight' and covering up to 50 percent of the exposed area of the brick surface but unaccompanied by powdering or flaking of the surface.
- Heavy - When there is a heavy deposit of salts covering 50 percent or more of the exposed area of the brick surface but unaccompanied by powdering or flaking of the surface
- Serious - Place the end of the bricks in the dish, the depth of immersion in water being 25 mm. Place the When there is a heavy deposit of salts accompanied BP powdering and or flaking of the exposed surfaces.

Table – 9: Effect of Efflorescence

S.NO	% Of construction and demolition waste added	Effect of efflorescence
1	0%	Nil
2	25%	Nil
3	50%	Slight
4	75%	Slight
5	100%	Slight

4. CONCLUSIONS

The following conclusion can be drawn from the present investigation:

1. It is an eco-friendly brick because it reduces the environmental pollution by reducing the wastage of useful lands.
2. The average compressive strength of fly ash sand lime brick increases while replacing sand using construction and demolition waste up to 75%, after that it decreases.
3. Water absorption value increases with percentage of construction and demolition waste added, but it is not more than 20% by its weight.
4. Weight of the brick decreases with increase in percentage of construction and demolition waste added.
5. The maximum compressive strength occurs with 75% replacement of construction and demolition waste. It is 5.138 N/mm² at 7 days and 10.474 N/mm² at 28 days.
6. Density of the brick decreases with increase in percentage of construction and demolition waste added. That is the decrease in density is due to decrease in weight of brick.
7. The replacement of sand by construction and demolition waste is economical.

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