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Study of the properties of PFC Bricks made from PVC crush, Fly ash and Cement

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Abstract — *Plastic is one of the daily increasing useful as well as a hazardous material. At the time of need plastic is found to be very useful, but after its use, its simply thrown away, creating all kinds of hazards. Plastic is not bio-degradable, so it will continue to be hazardous for more than centuries. The idea of this paper is to recycle this plastic scrap into usable product so that it helps nature.so we used PVC crush from waste PVC pipe in this study. The thought of this study was to mix of PVC crush with fly ash and cement to create a new type of brick, which we named PFC Bricks. Since it is not economical to approach a local brick manufacturer for lending the machine, we design and manually manufacture the brick. The PVC used in our brick was leftover pieces of pipes. So, as a trial the PVC was crushed into small pieces of 3 mm size. The mixture consists of cement, fly ash, and PVC crush of small size with added water in suitable proportions and after thorough mixing, the paste was poured into a rectangular mold having standard brick dimensions. The paste took only 24 hours to settle and harden. After the brick was extracted from the mold and Kept in oven for 72 hours to oven dry. At last we tested its properties and compare it with the properties of conventional clay burnt bricks.*

Keywords- *Plastic; PVC crush; Fly ash, Cement; Bio-degradable*

I. INTRODUCTION

Brick is one of the construction materials which is normally used as masonry units in almost every building construction. Generally, we consider brick as a material used for partition element but along with this it also strengthens the partition wall structure. So, the usual defects occur in burnt clay bricks that will probably not occurred in this case. Demerits of burnt clay brick will be overcome by this brick containing PVC crush. As bricks may suffer damage and defects during its service life due to number of reasons i.e.

1. Improper Handling
2. Poor workmanship
3. Overloading
4. Chemical Reactions
5. Efflorescence

To prevent from above defects we can use this brick due its enhancing properties. This attempt we made to incorporate waste into production of bricks as building materials. Which is practical solution for pollution problem. As There are many problems related to ground water problems related to ground water contamination and air pollution because of the managed the waste of raw PVC pipe material. PVC pipe crush is also the waste product for pipe industry / irrigation system. But many studies have been done for using the raw PVC pipe crush into the brick and future of there are number of PVC pipe bricks plants are developed. We have also used cement for giving the best strength to the brick. Therefore, there is a strong need to adopt cost effective, environmentally appropriate technologies by up-gradation of the traditional techniques by using local material. There is a huge amount of scope for improvement in Building materials. The total demand of clay brick required for walling materials in India, is estimated at 180 billion per annum causing the depletion 540000 metric tons of fertile soil and exhausting approximately 340 billion tons of clay every year and about 5000acres of top soil land made unfertile for a long period.

The government is seriously concerned about soil erosion for large quantities of brick development, in the context of huge housing needs.

Industrial brick making creates a lot of air pollution. The process used to produce PFC bricks (containing PVC crush, fly ash and cement) is environmentally friendly. Like traditional bricks there is no need for fire activity in development. Coal exists among the conventional sources of fossil fuel in amounts able to meet a significant portion of the nation's energy need. In India, approximately 80 thermal power plants are sources of fly ash, where about millions of tons of coal are used every year. As per Global report India produces about 180 million-tons of fly-ashes. The disposal of these large quantities of ash is a serious problem. Hence to tackle with this problem we are using this fly ash waste as raw material for bricks.

In the above, PVC crush and Fly Ash, basically a waste material, has a clear edge over the other construction material as these can be converted to a resource with minimum amount of investments. As Fly ash is a fine, glass-like powder recovered from gases created by coal-fired electric power generation. Fly ash material is solidified while suspended in

the exhaust gases and is collected by electrostatic precipitators or filter bags. Since the particles solidify while suspended in the exhaust gases, fly ash particles are generally spherical in shape and range in size from 0.5 µm to 100 µm. They consist mostly of silicon dioxide (SiO2), aluminum oxide (Al2O3) and iron oxide (Fe2O3). Which enhanced properties of brick. Combination PVC crush, fly ash, cement further will help to increase the speed and quality of construction and thereby helping in enhancing the efficiency of construction by imparting high strength. As in construction industry is all about to strengthen the structure in every aspect keeping its dead low minimum as possible. PVC crush and fly ash are lightweight raw materials which give high strength at low weight.

II. LITERATURE REVIEW

KP. Ravikumar et al, they have studied about partial replacement of coarse aggregate with PVC at levels of 15, 20, 25 percent and the basic material properties, strength parameters are studied. The strength will be tested increase in strength compared to traditional mix is obtained. We also studied the method used by Chandana Sulekh et al, they have experimented about the partial replacement of cement in concrete by use of waste material Plastic. They have found that the addition of up to 30-40percentage of PVC by weight of Ordinary Portland Cement. The strength found to be two times greater than the plain cement concrete. With these results it is very clear that we can effectively use PVC in partial replacement of cement. Similarly, we decided to replace the PVC crush with soil in brick.

Yadav Ashwini et al, effectively utilized the plastic by manufacturing paver blocks by replacing percentage of sand in 0%, 15 % 25% and 35% by the PVC plastic waste. Compressive strength test on above blocks for the 7, 14, and 28 days are conducted and they have found that PVC waste plastic paver block gives better result than concrete paver blocks and also reduce the cost of manufacturing of same paver block.

Mahavir Varma et al, studied fly ash brick properties, the sample with additives contain spherical fly ash particles. These particles of fly ash led to a reduction in the density of the bricks and a substantial improvement in their durability. They conducted test and found that absorption coefficient, shape and size, density, weight, porosity, thermal conductivity and compressive strength of fly ash brick compare with normal clay bricks that delivered good results. They concluded that fly ash bricks used as an alternative to clay bricks. After doing above research we decided to use Fly ash with PVC crush in bricks.

Conventional method Brick manufacturing and its properties we studied in construction materials. But The use of waste plastic in bricks making is partially solution to the environmental and ecological challenges associated with the use of plastic, as conventional bricks made up from clay having high water absorption where Plastic having negligible water absorption. If we consider this it also had good resistant to acid. Plastic waste, which is increasing day by day, about 56 lakh ton of plastic waste dumped in India every year. The dumped waste pollutes the surrounding environment. It is necessary to dispose of plastic waste from the environment. Its harmful to the human as well as animals. Disposal of plastic from the environment is the problem now a days. As it has very low biodegradability. Plastic is effectively reuse and replaceable. Plastic blocks drains and gutters when it burnt it release toxic gas into the atmosphere. These plastics is cleaned and added with fly ash and cement in various proportions to obtain high strength brick that possess thermal and sound insulation properties to control pollution and to reduce the overall cost of construction.

2.1. Material used

2.1.1. Fly Ash

Fly ash is waste generated from combustion if coal in power generation plants. Due its pozzolanic properties, utilized in construction industry. Mechanical separators, electrostatic precipitators, or bag fillers collect the fly ash. The fly ash can be divided in two types as per ASTM C-618[4].

1. Low calcium fly ash: (Class F) It is produced from combustion of bituminous coals or anthracite coals. It has low percentage (Cao) percentage about 3% and silica + alumina + iron oxide more than 70%.
2. High Calcium fly ash:(Class C) It is produced from combustion of sub-bituminous of lignite coals and It has about 20% of calcium (Cao) content and percentage of Sio2+Al2O3+ Fe203 in this fly is less than 70%.

2.1.1.1. Advantages of Fly Ash

Delay the hydration heat that helps to minimize concrete thermal cracks; boost concrete workability and enhance the life of structures and buildings among others the fly ash demand is rising day by day due to urbanization in developing economies and increasing construction activity internationally.

Fly ash cannot react with water. It needs free lime, based on Portland cement hydration. This causes the pozzolanic effect to turn off. Fly ash in concrete construction contributes to longer life. Ghatghar dam in India, for example, is a classic example that is constructed using fly ash and the world's tallest building Burj Khalifa in Dubai is another structure designed using fly ash. Brick performance is affected directly by its permeability. Permeability is characterized as the property determining the rate of fluid flow into a porous surface. The key reasons for brick permeability are soil nature and pores interconnectivity in the soil.

2.1.2. PVC Crush

Polyvinyl chloride is a white, brittle solids. The worlds third most widely produced synthetic plastic polymer about 40 million tons of PVC are produced each year. It comes into two basic forms as follows

1. Rigid: This form of PVC is used in construction for pipe and in profile applications.
2. Flexible: PVC can be made softer and more flexible by the addition of plasticizers.

The heat stability of raw PVC is very poor, so the addition of heat stabilizer during making of PFC brick is needed.

"Table 1.PVC crush properties"

Properties	Value
Density	1380 kg/m^3
Thermal conductivity	0.14- 0.28
Youngs modulus	2900-3300MPa
Tensile strength	50-80 MPa
Elongation at break	20-40%
Impact strength	2-5 kJ/m^2
Melting point	212^0 c
Water absorption (24hrs) %	0.04-0.40

2.1.3. Cement

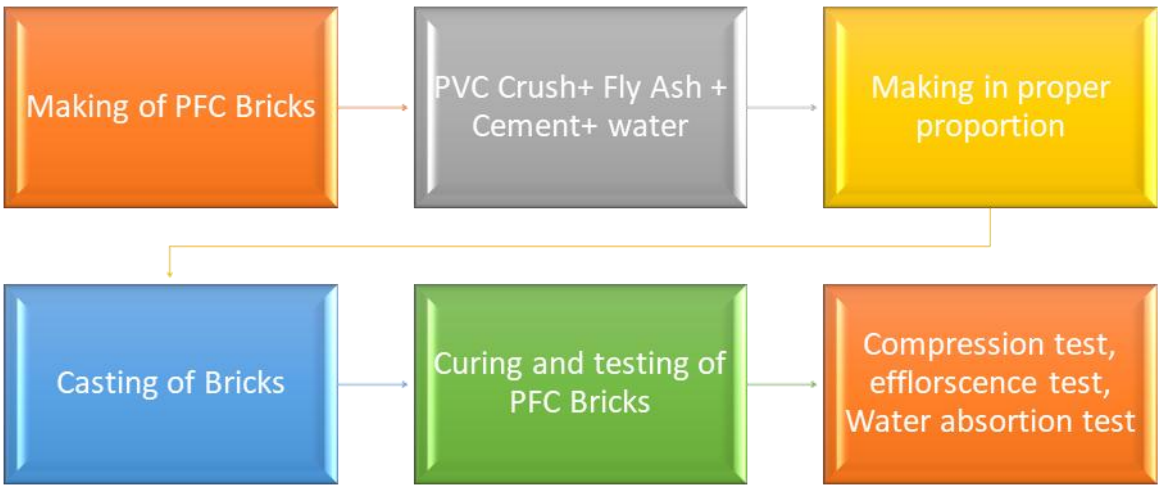
Ordinary Portland cement was used to create the brick mortar. Cement quality was tested through various tests.

"Table 2. Comparing Ordinary Portland properties with standard values"

Properties	Standard Value	Ordinary Portland values
Fineness by sieve	225	300 (IS 90 micron)
Specific Gravity	3.15	3.16
Setting time (Initial)	>30 <600	81 480
Compressive strength (7 Days) Compressive strength (28 Days)	>33 >43	38.87 N/mm^2 47.94 N/mm^2

III. METHODOLOGY

In this study, PFC Brick is developed with different composition.



"Figure 1.PFC brick making methodology"

3.1. Casting of bricks

The normal mold is used to cast the bricks with the standard size of 270mm x 100mm x70mm.They were cast according to the standard procedure with various proportions. The required quantity of crush PVC, fly ash & Cement is calculated, according to that the materials mixed properly. Then required quantity of water was added. Then they mixed thoroughly. Then the prepared mix was poured in to the mould and it is compacted. After compacting gets over then the

mould is removed. Then the wet brick was kept under air curing for 2 days and then bricks were water cured for a period of 28 days. Below the fig, shows the materials used and mixing of materials to cast the bricks.

"Figure 2. Casting of bricks process"

The various proportions for PFC bricks are as follows:

1. PVC Crush (10 %), Fly Ash (60%), Cement (30%)
2. PVC Crush (15%), Fly Ash (65%), Cement (20%)
3. PVC Crush (20%), Fly Ash (65%), Cement (15%)
4. PVC Crush (30%), Fly Ash (60%), Cement (10%)

3.2. PFC bricks test

The PFC Bricks were tested with standard test procedures. Following test are taken:

A. Compressive test
B. Efflorescence test
C. Water absorption test

A. Compressive test

PFC bricks were tested on the compressive testing of machine of capacity 2000 KN. The universal testing machine is used to test bricks for compressive strength. Place the one by one PFC brick on machine then axial load was applied steadily and uniformly rate of 5.2N/mm^2. Load was noted for each brick individually. Load Divided by area of brick we get compressive strength. The load at failure is the maximum load at which specimen fails to produce any further increase in the indicator reading on the testing machine.

Three bricks of each type were tested for average compressive strength. The fly ash brick's compressive strength is three times that of the usual clay brick.

The minimum compressive strength of clay brick =3.5 N / mm2.

Compressive strength of fly ash brick = 10-12 N / mm2.

Bricks that are to be used for different works do not have less compressive strength than the above. After testing Graph was drawn.

B. Efflorescence test

To check the degree of Efflorescence taken out 5 bricks from sample. Fill the enough quantity of distilled water in shallow flat bottom dish of size 180*180mm with 40 mm height. Depth of water 25 mm using measuring scale required for complete saturation. Kept the 5 cleaned brick samples in the water by immersing its header end, so that the immersed brick will absorb the water completely as per its full capacity. Allow to evaporate the surplus water and brick will appear to be dry within maximum 48 hours or more. Observed the dry surface of brick for the presence of soluble salts in the form of white or grey spot in the average% area coverage by efflorescence. Then identified degree of efflorescence.

C. Water absorption test

Water absorption test is used to find the durability, degree of compactness and quality of Bricks. For this 3 PFC Bricks were dried completely and weighted on sensitive balance which having least weight count 0.01. This reading as W1.

These were then immersed in water for 24 hours and then wipe out any traces of water weighed again as W2. % of water absorption is calculated by following formula.

(W2-W1/W1)*100

IV. RESULT

A. Compressive Strength test:

PFC Brick having average compressive strength

1. Sample I PVC Crush (10 %), Fly Ash (60%) = 13.27 N/mm^2
2. Sample II PVC Crush (15%), Fly Ash (65%) = 14.70 N/mm^2
3. Sample III PVC Crush (20%), Fly Ash (65%) = 18.35 N/mm^2
4. Sample IV PVC Crush (30%), Fly Ash (60%) = 19.84 N/mm^2

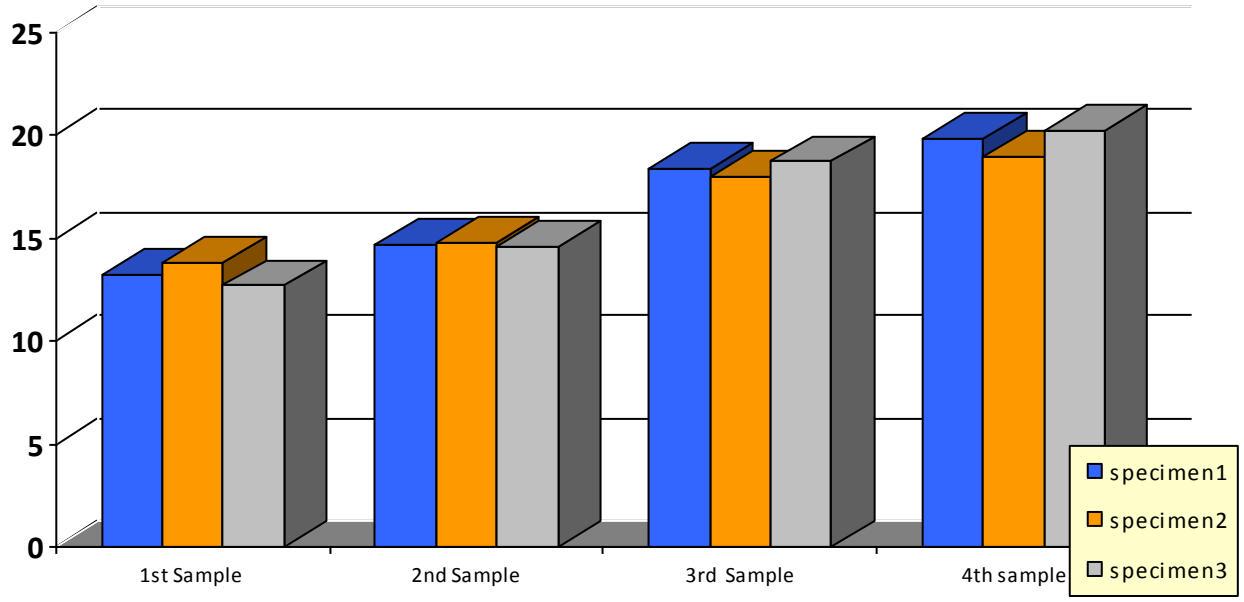
B. Efflorescence test:

Degree of efflorescence observed is slight.

Water absorption:

1) Sample I PVC Crush (10 %), Fly Ash (60%) = 12.45%
2) Sample II PVC Crush (15%), Fly Ash (65%) = 11.78%
3) Sample III PVC Crush (20%), Fly Ash (65%) = 11.35%
4) Sample IV PVC Crush (30%), Fly Ash (60%) = 10.32%

Obtained water absorption for optimal mix percentage is 10.32%. It is very lesser than the standard value of 12%.



"Figure 3. Compressive strength of different proportions"

Above graph of compressive strength clearly showing the compressive strength is continuously increasing as increase in % of PVC and Fly ash.

V. CONCLUSION

After this experimental study, we came to conclusion that PFC bricks of size 27cm*10cm*7cm is made to reduces environmental pollution possess good enough strength at various proportions at curing of 28 days. After testing the number of specimens, it was observed that we can use PVC crush up to 30% by volume with fly ash 60% and cement 10% which gives very good strength as compared to conventional bricks.

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