

An Experimental Study on Low Density Polyethylene (LDPE) and Linear Low Density Polyethylene (LLDPE) in Fly ash Bricks

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ABSTRACT—Fly ash brick made up of with Class C flyash, fine aggregate and water. It is mainly used in masonry units. In modern construction building conventional brick is replaced by fly ash brick, as it covers more area than clay bricks & its high strength. In this project we focused on utilization of waste plastic material in the flyash brick & their significance. Generally, plastics are non-disposable materials which pollute the environment, so the plastic wastes are collected and recycled to a powder form. According to statistics around 381 billion tonnes of plastic is produced in the world. The various form of recycled plastics are poly ethylene terephthalate, low density polyethylene, linear low density polyethylene, poly vinyl chloride, polypropylene, polystyrene and high density poly ethylene. In this study we have used, low density polyethylene (LDPE), linear low density polyethylene(LLDPE) as plastic waste material as a partial replacement of fine aggregate with various mix proportion and determined the compressive strength.

KEYWORDS: fly ash, bricks,waste material, plastic,low density poly ethylene, linear low density poly ethylene, strength

I. INTRODUCTION

Around 182 billion tonnes of clay bricks is produced annually around 5200 acres of top soil is cleared out for the manufacture of bricks. The problems that are posed by brick industry is soil erosion, emission from burning the coal which then leads to deforestation. A study says that in Chennai alone nearly 1.5 crore bricks per day is the need for construction purpose. To provide a solution for this problem, fly ash bricks can be used instead of clay bricks. Fly ash bricks are comprised withfly ash, lime, gypsum and sand. Such type of bricks can be used in any construction sites instead of conventional bricks. The fly ash bricks weigh less and are stronger than conventional clay bricks. In today's busy world plastic is being one of the major material which is used everywhere. But the disposal of these materials is considered as a serious issue. To dispose the plastic wastes properly, the best alternative is to recycle. The disposal of plastic waste is a major problem everywhere in the world. By using such plastic waste after some process it can be used for production of fly ash bricks. Through this the plastic waste can also be disposed properly. In this paper, two types of recycled plastic wastes are used which are in the powdery form. This study presents the proper utilization of replacement of fine aggregate with plastic waste powder in flyash brick to enhance performance, to protect environment.

II. MATERIALS

A. Fly ash

Fly ash is a by-product from the thermal power plants. The fly ash is considered as a waste and it requires large area to dump only 30% of fly ash is used by various industries others are dumped in land. Waste generation can be reduced by using it as a construction material. The fly ash produced in thermal power plants are fine, and has high pozzolanic activity. So, it can be used in making bricks, blocks, tiles, concrete products etc. The fly ash is of two types Type C and Type F. In Type C fly ash contains high calcium content and Type F contains low calcium content. Type C fly ash is used in our project.

B. Lime

Lime is one of the most important and traditional construction materials used by architects of olden days. Lime is obtained from lime stone. It is broken in to pieces by using stone jaw crusher. The charcoal is mixed along with the crushed lime in proper ratio. Then the mixture is loaded in to the kiln and burnt for 24hrs. Then after allowing

it for next 24hrs to dry it is loaded in to the pulverized hopper and grinded. Finally the fly ash is obtained. It contains inorganic substance in which carbonates, oxides, and hydroxides predominate.

TABLE I Chemical Properties of Lime

Available Lime as Ca(OH) ₂	72.0% (Calcium Hydroxide)
Calcium Oxide CaO	50% - 52%
Magnesium Oxide MgO	0.8%
Calcium Carbonate CaCO ₃	less than 1%
Alumina (as Al ₂ O ₃)	0.1%
Iron (as Fe ₂ O ₃)	0.12%
Moisture	0.8%
Acid Insoluble	0.6%

C. Gypsum

Gypsum is found in the form of soft sedimentary rock in nature. It is obtained by surface mining process. The rock is mined, crushed and then it is grinded in to a fine powder. It contains calcium sulphate dehydrate, which on addition of water to it sets and hardens and it can be used as a construction material instead of cement along with gypsum. Gypsum is also known as plaster of Paris. It gives light weight when added to the mix and it is a fire resistant material.

TABLE II. Physical Properties of Gypsum

Chemical Formula	H ₂ CaO ₅ S
Appearance	Pure White
Particle Size	300 mesh (Fineness)
CaSO ₄ , 1/2H ₂ O	93 % Calcium Sulphate
Plaster to Water ratio	60:40 or 1.5 : 1
Initial Setting Time	16 to 24 minutes
Final Setting Time	24 to 30 minutes
Linear Expansion	0.1 to 0.2%

TABLE III. Chemical properties of gypsum

Magnesium Oxide MgO	0.12%
Soluble magnesium salt expressed as Mg ²⁺	< 0.5%
Soluble Chloride expressed as Cl	< 0.2%
Heavy Metal	< 2 ppm
Loss Of Ignition (LOI)	Max. 6.50%

D. LDPE

LDPE is known as Low Density Poly Ethylene. It is a thermo plastic which is made from the monomer called poly ethylene. It is prepared from the first grade poly ethylene wastes. The poly ethylene waste materials are collected and recycled to a powder form by using various processes. The powder is used by industries for various purposes. By using this in bricks the fine aggregate can be replaced by some amount of this and the plastic waste generation can also be reduced. The cost is low when compared to fine aggregate.



Fig 1. Low Density Poly Ethylene(LDPE)

TABLE IV. Physical Properties of LDPE

Chemical Formula	-(CH ₂ -CH ₂) _n -
Tensile strength	0.20-0.40 N/mm ²
Thermal coefficient of expansion	100-220 x 10 ⁻⁶
Max. continued use of temperature	65°C
Melting point	110 °C
Density	0.910-0.940 g/cm ³
Specific gravity	0.915

E. LLDPE

LLDPE is known as the Linear Low Density Poly Ethylene. It is prepared by the copolymerization of ethylene. The waste materials of ethylene are collected such as waste bottles, buckets etc and taken to the plant. Then by melting and copolymerization process under low pressure LLDPE is produced. Then it is grinded to powder form. It

can also be used by replacing fine aggregate in bricks to a little extend. Its cost is also low when compared to fine aggregate.

TABLE V. Physical Properties of LLDPE



Fig.2.Linear Low Density Poly Ethylene(LLDPE)

Chemical Formula	$-(CH_2-CH_2)_n-$
Tensile strength	30 N/mm ²
Thermal coefficient of expansion	150×10^{-6}
Max. continued use of temperature	50°C
Melting point	120-160 °C
Density	0.915g/cm ³
Specific gravity	0.923

III. METHODOLOGY

The data was collected from various sources and the literatures were studied for knowing the mix proportions of all materials used in the fly ash bricks. The bricks of size 200mm x 100mm x 80mm are casted as per IS. 30 numbers of brick was casted by using the raw materials fly ash, lime, gypsum, fine aggregate, and by partial replacement of fine aggregate with plastic powder i.e., LDPE and LLDPE. The partial replacement of fly ash is done with 0%, 2%, 4%, 6% and 8%. Once the casting is over the curing is done for a period of 24 hours by oven curing and the temperature range is maintained at 110 °C. The compressive strength of bricks is obtained after curing. The compressive strength of 28 days is achieved by the sample, by the oven curing of 24 hours. Efflorescence test and water absorption test are also carried out. And finally the results are compared.



Fig.3. Sample of fly ash bricks with LDPE & LLDPE

1. Water absorption test

This test is carried out to determine the amount of water absorbed by the brick. This test is carried out in accordance with IS 3495 (Part 2): 1992. When immersed in water for a period of 24 hours it should not, in any case, exceed 20% of weight of dry brick. This test is carried out for all the samples of fly ash bricks.

TABLE VI. Water Absorption Test Results

%Replacement	Fly ash brick with LDPE(%)	Fly ash brick with LLDPE(%)
0%	6.5	6.5
2%	5.78	6.6
4%	3.38	4.64
6%	2.15	4.42
8%	1.79	1.13

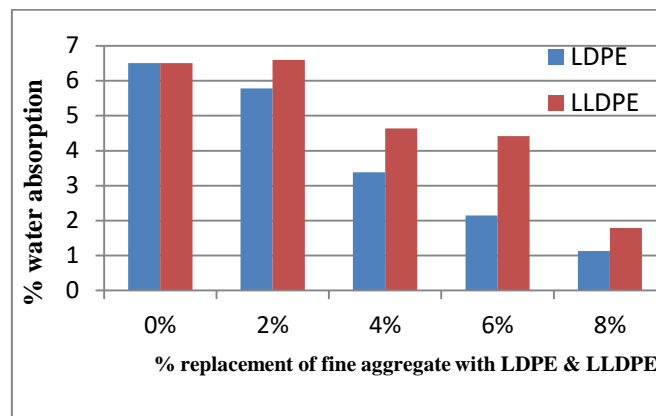


Fig.4.Comparison of water absorption for LDPE and LLDPE

We can notice that there is slightly decreasing value of water absorption when replacement of LDPE and LLDPE are increased.

2.Efflorescence test

This test is conducted to find the presence of salt content in the bricks. This test is carried out in accordance with IS 3495 (Part 3): 1992. The sample bricks are partly immersed in the water for period of 24 hours then it is taken out from the water and allowed to dry in the normal temperature. If there is a presence of white spots in the sample bricks it indicates the salt content. When the white spots present in the sample bricks is less than 10%, it indicates little amount of salt is present in the sample bricks. If less than 50% it shows that brick has moderate salt content. If more than 50% it indicates severe salt content in the sample bricks. No white spots were seen on the surface of the sample bricks, so that the efflorescence is nil.

TABLE VII. Efflorescence Test Results

%Replacement	Fly ash brick with LDPE(%)	Fly ash brick with LLDPE(%)
0%	Nil	Nil
2%	Nil	Nil
4%	Nil	Nil
6%	Nil	Nil
8%	Nil	Nil

There is no change in efflorescence when LDPE and LLDPE are replaced.

3.Compressive strength test

This test is carried out in accordance with IS 3495 (Part 1): 1992. After curing the bricks are tested in a compressive testing machine of capacity 2000KN to determine its compressive strength. The load is applied at the uniform rate. The maximum load at which the failure occurs is noted and from which compressive strength is calculated. Three bricks were tested for each proportion and the average value is taken.



Fig.5. Compressive strength test of fly ash brick with LDPE

IV.RESULTS AND DISCUSSIONS

The compressive strength of 2% replacement of LDPE & LLDPE in fine aggregate is taken as the optimum values there is an increase in the compressive strength of 0% and 2%. The value decreases for the other mix proportions 4%, 6% and 8%. The compressive strength of LDPE & LLDPE in the fly ash bricks is compared as shown in Fig.6

TABLE VIII. Compressive Strength Test Results

%Replacement of fine aggregate	Compressive strength (N/mm ²)	
	Fly ash brick with LDPE	Fly ash brick with LLDPE
0%	4.85	4.85
2%	5.72	5.15
4%	4.3	3.73
6%	3.55	2.59
8%	2.61	2.1

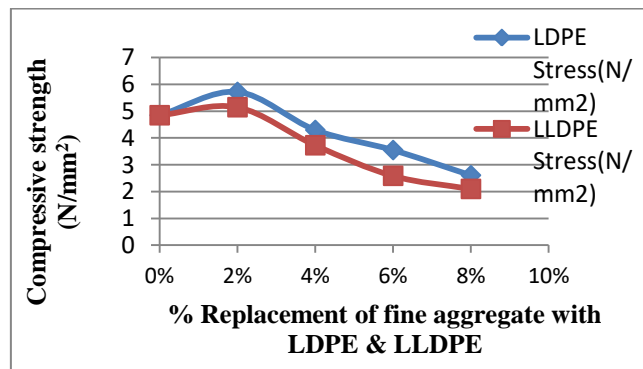


Fig.6.Comparison of compressive strength of LDPE and LLDPE

V. CONCLUSION

The recycled plastic waste is used as a partial replacement of fine aggregate in fly ash bricks. For optimum, water absorption rate is less when compared to conventional fly ash bricks. The 2% replacement of LDPE and LLDPE gives more compressive strength for this type of fly ash brick. The optimum value is taken as 2% as there is an increase in the compressive strength. The compressive strength is increased up to 18% when LDPE is added in the fly ash brick compared to conventional fly ash bricks for optimum. The compressive strength is increased up to 6.2% when LLDPE is added in the fly ash brick compared to conventional fly ash bricks for optimum. LDPE can be preferred as a partial replacement of fine aggregate up to 2% which gives the compressive strength equal to 28 days of the conventional fly ash bricks.

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