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# The Strength Properties of Flyash Based Light Weight Geopolymer Concrete Using EPS

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**ABSTRACT:** As per the current study it has been observed that, in the past many years, the construction industry has been making some progress by using waste materials in concrete. The Geopolymer concrete is made from the by-products like fly ash and GGBS which are generated from the industries which are enabled to minimize the waste products and also to reduce the CO emission by decreasing the usage of Portland cement. The goal of this work is to learn the properties of Geopolymer concrete by replacing the normal coarse aggregate with lightweight expanded Polystyrene. The works mainly aim to reduce the structural weight of the concrete by using expanded polystyrene aggregate which has the advantage of being lightweight. The Expanded material has chemical resistance, fire resistance, easy to handle and also to transport.

**KEYWORDS:** GGBS, Fly ash, Geopolymer Concrete, EPS etc.

## I. INTRODUCTION

Concrete, as a major construction material, is being used at an ever increasing rate all around the world. Almost all of this concrete is currently made using OPC, leading to a massive global cement industry. Every year the production of Portland cement is increasing with the increasing demand of construction. Therefore, the rate of production of carbon dioxide released to the atmosphere is increasing. Each ton of Portland cement releases a ton of carbon dioxide into the atmosphere. The greenhouse gas emission from the production of Portland cement is about 1.35 billion tons annually, which is about 7% of the total greenhouse gas emission. On the other side, fly ash is the waste material of coal based thermal power plant, available abundantly but pose disposal problem. Several hectares of valuable land are acquired by thermal power plant for the disposal of fly ash. As it is light in weight and easily flies, creates severe health problems like asthma, bronchitis, etc. The survey shows the total production of fly ash in the world is about 780 million tons per year after 2010. In India more than 100 million tons of fly ash is produced annually, out of which 17 – 20 % fly ash is utilized either in concrete as a part replacement of cement or workability improving admixtures or in stabilization of soil. There are environmental benefits in reducing the use of Portland cement in concrete, and using a by-product cementations material, such as fly ash, silica fume, ground granulated blast furnace slag, rise husk ash, etc. as a partial substitute. Fly ash has great potential as a cement replacing material in concrete. The concrete made with such industrial wastes is eco- friendly and hence called as “Green concrete”. Some fly ash is utilized in the production of Portland pozzolanic cement or part replacement of cement in concrete. In recent years’ attempts are been made to replace the cement by more than 50% with fly ash in concrete to produce High volume fly ash concrete.

## II. RELATED WORK

**The following are the constituents of Geopolymer concrete:**

1. Fly Ash
2. Cement
3. Aggregate

#### 4. Expanded Polystyrene (EPS)

##### **Fly Ash:**

Fly ash is the residue obtained from combustion of pulverized coal collected by the mechanical or electrostatics separators of the fuel gases of thermal power plants. Its composition varies with the type of fuel burnt, load on boiler and type of separator etc. fly ash mainly consist mainly of spherical glassy particle ranging from 1 to 150 micrometres in diameter, out of which the bulk passes through a 45 micrometre sieve. This spherical shape of particle improves the flow ability and reduces the water demand.

##### **Cement:**

Ordinary Portland cement is used with standard specification.

##### **Aggregate:**

Aggregates are the most mined materials in the world. An aggregate is a main component of composite materials such as concrete. Due to the relatively high compressive strength the aggregates are widely used in foundation, septic drain fields, retaining wall drains, and road side edge. Aggregates are also used as base material under foundations, roads, and railroads. In other words, aggregates are used as a stable foundation or road/rail base with predictable, uniform properties.

##### **Expanded polystyrene (EPS):**

Expanded polystyrene (EPS) is a geo foam is a lightweight material that has been used in engineering applications since at least the 1950s. It has good thermal insulation properties with stiffness and compression strength. It is utilized in reducing settlement below embankments, sound and vibration damping, reducing lateral pressure on sub-structures, reducing stresses on rigid buried conduits and related applications. Expanded polystyrene waste in a granular form is used as lightweight aggregate to produce lightweight structural concrete with the unit weight varying from 1200 to 2000 kg/m<sup>3</sup>. The polystyrene aggregate concrete was produced by partially replacing fine aggregate in the reference (normal weight) concrete mixtures with equal volume of the chemically coated crushed polystyrene granules. Lightweight concretes (LWC) can be used in various construction fields. It can be used for repairing wooden floors of old buildings, carrying walls of low thermal conduction, bridge decks, floating quay, etc.



Fig. 1 Expanded polystyrene (EPS)

### III. METHODOLOGY

#### Mixture Proportions:

The ratio is selected based on laboratory test. In this experimental work, EPS is used with 16% and 33%. The details of mix design for the given combination is shown in Table1.

Table1. Ingredients for light weight Geopolymer concrete with EPS

Ingredient	Unit	Weight	16% EPS	33% EPS
Cement	kg/m <sup>3</sup>	390	390	390
C.A	kg/m <sup>3</sup>	1267.51	1267.51	1267.51
F.A	kg/m <sup>3</sup>	672.50	565.33	500.74
EPS	kg/m <sup>3</sup>	12	0.120	0.250
Fly ash	kg/m <sup>3</sup>	60	60	60

#### Compressive strength of cube specimens:

Compressive strength is the capacity of a material or structure to withstand against the compression loads. In other words, compressive strength resists compression. Compressive strength is a key value for design of structures. Cubes of size 150 x 150mm are more commonly used to find out the compressive strength.



Fig. 2 Concrete Cubes

#### Preparation of specimens:

Materials are collected from the source and properly mixed as per standards in the laboratory either by hand or in a laboratory batch mixer. Clean the moulds and apply grease or oil and fill the mixed concrete in the moulds in 3 equal layers. Compact each layer with not less than 25 strokes per layer using a tamping rod 16mm diameter and 60 cm long.



Fig. 3 Concrete Cubes

#### IV. EXPERIMENTAL RESULTS

##### Compressive Strength Test Result:

The specimen was removed from curing tank hours before testing so as to allow the specimen to get dry. In order to remove the moisture inside the specimen the specimen was placed in open to sun area. Compression tests on Three specimens of each mix were conducted on CTM and the average value is shown in Table 2.

Table 2. Compressive Strength of Concrete at 28 days

Sr. No.	EPS content	Load in N	Comp. Strength at 28 days' in N/mm <sup>2</sup>
1	16%	990	46
2	33%	602	29

#### V. CONCLUSION

The compressive strength of lightweight Geopolymer concrete is reduced as compared to normal concrete. The experimental work shows that the partial replacement of aggregate with expanded polystyrene (EPS) make the concrete lighter than the conventional normal concrete. The replacement of fly-ash with cement gives higher compressive strength compare to normal concrete. It is reported that the fly ash content is much significant in the Geopolymer concrete. Fly ash-based Geopolymer concrete offers several economic benefits over Portland cement concrete.

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