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# Comparative Study of Strength on Normal Concrete and Geopolymer Concrete

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***Abstract:*** *Concrete is the most widely used construction material in civil engineering industry because of its high structural strength and stability. The concrete industry is constantly looking for supplementary cementing material with the objective of reducing the solid waste disposal as well as the cost.*

*The main aim of this research work is to study about partially replacing of cement by fly ash which can be techno economic alternative. The study focuses on the compressive strength performance of the blended concrete containing different percentage fly ash. The sequential step involved in the project are the first phase of mixing M30 grade concrete with replacement of 0%,25%,50%,75%,and 100% of fly ash with cement is carried out to determine the optimum percentage of replacement at which maximum compressive strength is achieved. In the second phase the cement is partially replaced with fly ash by 0%, 25%, 50%, 75% and 100% and geopolymers are added in the mix. Tests conducted for this project are like compressive strength, split tensile strength, Results of first phase and second phase are compared. The code referred for this research work are IS:516-1959,IS:5816-1999,IS-10262:2009.*

***Key words:*** *Cement, compressive strength, FLY ASH and Geo Polymer.*

## 1. Introduction

Cement industry is one of the major contributors to the emission of green house gasses like carbon dioxide which is about 1.35 billion tons annually. Day by day the World's Portland cement production increases with the increasing demand of construction industry which crossed one thousand million tons per year. On the other side, fly ash is the waste material of coal based thermal power plant, which is available abundantly but creates disposal problem. Several hectors of valuable land is required for their disposal. As fly ash is light in weight and easily flies, this creates severe health problems like asthma, bronchitis, and so forth. According to the survey, the total fly ash production in the world is about 780 million tons per year . With silicon and aluminum as the main constituents, fly ash is an effective cement replacing material. At present, fly ash is used in the production of Portland Pozzolana Cement, partial replacement of cement and workability improving admixture in concrete, and also in the production of cellular blocks and bricks and in soil stabilization. For every ton of fly ash used in place of Portland cement saves about a ton of carbon dioxide emission to the atmosphere. The mortar and concrete made with fly ash are eco-friendly and can be made to replace more than 50% of the cement to produce high volume fly ash concrete. But for full utilization of fly ash, Davidovits suggested the activation process in which cement is totally replaced by pozzolanic material and activated by alkaline solution known as geopolymer. The development of geopolymer concrete/mortar can provide a solution to produce greener construction materials for sustainable development.

## 2. Materials used.

*A) CEMENT:*

In this experiment 53 grade ordinary Portland cement is used. The testing of cement is done as per IS 4031-11-1988 code. The specific gravity of cement is 3.02.

*B) FINE AGGREGATE:*

In this experiment the locally available sand is used. The specific gravity of fine aggregate is to be obtained by using IS 2720 part 3.The specific gravity Of fine aggregate is 2.6.The fine aggregate is used which passes through the 4.75mmsieve.

*C) COARSE AGGREGATE:*

In this experiment also locally available aggregate is used and the specific gravity of coarse aggregate is to be obtained by using IS 2386 part31963 code. The specific gravity of coarse aggregate is 2.7.The coarse aggregate is which passes through the 20mm sieve.

*D) WATER:*

The least expensive but the most important ingredient of concrete is water. The water which is used for mixing concrete was clean and free from harmful impurities such as oil, alkali, acid etc. The

portable water was used for mixing and curing work. The specific gravity of water is 1.

E) *FLY ASH*

Fly ash material solidifies while suspended in the exhaust gases and is collected by electrostatic precipitators or filter bags. Since the particles solidify rapidly while suspended in the exhaust gases, fly ash particles are generally spherical in shape and range in size from 0.5 µm to 300 µm. The major consequence of the rapid cooling is that few minerals have time to crystallize, and that mainly amorphous, quenched glass remains.

F) *GEO POLYMER*

The term 'geo polymer' was first introduced by Joseph Davidovits in 1978. He proposed that binder could be produced by a polymeric reaction of alkaline solution and the aluminum in source materials of geological origin or by-product materials such as fly ash. Because the chemical reaction take place in this case is a polymerization process, davidovits coined the term 'geo polymer' to the represent these binder.

G) CHEMICAL PROPERTIES OF FLYASH

| Component | Bituminous | Sub bituminous | lignite |
|---|---|---|---|
| SiO2 (%) | 20-60 | 40-60 | 15-45 |
| Al2O3 (%) | 5-35 | 20-30 | 20-25 |
| Fe2O3 (%) | 10-40 | 4-10 | 4-15 |
| CaO (%) | 1-12 | 5-30 | 15-40 |
| LOI (%) | 0-15 | 0-3 | 0-5 |

*H) KEROSENE:*

Kerosene (kerosene), also called paraffin or paraffin oil, is a flammable pale yellow or colorless oily liquid with a characteristic odor intermediate in volatility between gasoline and gas/diesel oil that distills between 125°C. Specific gravity of kerosene is 2.7.

In this investigation we are using M30 grade mix design. And extra 10% of materials were added, because the mixing is not properly.

*I) PREPARATION OF ALKALINE SOLUTION*

A combination of the sodium hydroxide and sodium silicate solutions was used as the alkaline liquid to activate Fly ash. Sodium hydroxide pellets and sodium silicate solution used in this study are shown in Fig.1 and Fig.2. A sodium hydroxide solution was prepared by dissolving the sodium hydroxide pellets show in Fig. in water. The degree of purity of the pellets was 97% and was taken into account to modify the quantities. Distilled water was used to dissolve the pellets to avoid the solutions by tap water contaminations.

Sodium based solutions were chosen because they were cheaper than Potassium based solutions. The sodium hydroxide solids were either a technical grade in flake or pellets. The sodium hydroxide flakes were obtained from local chemist. The chemical composition of sodium silicate solution was Na2O = 14.7%, SiO2=29.4%, and water 55% by mass.

**Fig 1 Sodium hydroxide pellets**


**Fig 2 Sodium silicate solution**

## 3. Experimental Tests

### COMPRESSIVE STRENGTH:

Out of many test applied to the concrete, this is the utmost important which gives an idea about all the characteristics of concrete. By this single test one judge that whether Concreting has been done properly or not. For cube test two types of specimens either cubes of 15 cm X 15 cm X 15 cm or 10cm X 10 cm x 10 cm depending upon the size of aggregate are used. For most of the works cubical moulds of size 15 cm x 15cm x 15 cm are commonly used.

Normal concrete is poured in the mould and tempered properly so as not to have any voids. After 24 hours these moulds are removed and test specimens are put in water for curing. The top surface of this specimen should be made even and smooth. This is done by putting cement paste and spreading smoothly on the whole area of specimen.

These specimens are tested by compression testing machine after 28 days curing. Load at the failure

divided by area of specimen gives the compressive strength of concrete.

For geo polymer concrete after casting the specimens, they are kept in rest period in room temperature for 2 days. Geo polymer concrete will harden at steam curing or hot air curing and the minimum curing period shall be 24 hours .

These specimens are tested by compression testing machine after 24hours curing and then tested Load at the failure divided by area of specimen gives the compressive strength of concrete.

## 4. RESULT AND DISCUSSION:

**Table.2 Compressive strength of cubes with different percentages of flyash @3 days**

| S.No | Type of Concrete | Avg. Load @ 3days (KN) | Avg. Compressive Strength ($N/mm^2$) |
|---|---|---|---|
| 1 | Normal Concrete | 340 | 15.11 |
| 2 | 25% Fly ash | 170 | 7.55 |
| 3 | 50% Fly ash | 60 | 2.66 |
| 4 | 75% Fly ash | 40 | 1.77 |
| 5 | 100% fly ash | Nill | Nill |

**Table.3 Compressive strength of cubes with different percentages of flyash @ 28 days**

| S.No | Type of Concrete | Avg. Load @ 28 days (KN) | Avg. Compressive Strength @ 28 days ($N/mm^2$) |
|---|---|---|---|
| 1 | Normal Concrete | 731 | 31.73 |
| 2 | 25% Fly ash | 466.66 | 20.74 |
| 3 | 50% Fly ash | 313.33 | 13.86 |
| 4 | 75% Fly ash | 203.33 | 9.03 |
| 5 | 100% fly ash | Nill | Nill |

**Table.4 Compressive strength of Geo Polymer cubes with different percentages of fly ash.**

| S.No | Type of Concrete | Avg. Load @ 3days (KN) | Avg. Compressive Strength ($N/mm^2$) |
|---|---|---|---|
| 1 | Normal Concrete | 740 | 32.88 |
| 2 | 25% Fly ash | 500 | 22.22 |
| 3 | 50% Fly ash | 333.3 | 14.18 |
| 4 | 75% Fly ash | 230 | 10.22 |
| 5 | 100% fly ash | 140 | 6.22 |

**Table.5 comparative compressive strength between normal concrete and geo polymer concrete.**

| Flyash % | Concrete Cubes @3days | Concrete Cubes @28days | Geo Polymer Concrete |
|---|---|---|---|
| 0% | 15.06 | 31.73 | 32.88 |
| 25% | 7.55 | 20.74 | 22.22 |
| 50% | 2.66 | 13.86 | 14.18 |
| 75% | 1.77 | 9.03 | 10.22 |
| 100% | 0 | | 6.22 |

## Conclusion:

- Compressive strength of geopolymer concrete is % more than normal concrete.
- As the % of flyash is increased in concrete, strength reduced.
- When compared to normal concrete, geopolymer concrete attains more strength with in 3days by hot air curing.
- Geopolymer concrete is requires less usage of water, improves cohesiveness of concrete which was observed during experimentation, improves the mechanical properties of concrete and also reduces the emission of CO2.
- Cement is replaced with the fly ash up to 25% for which strength is increased, however optimum replacement level could not be predicted since trend of strength due to replacement of cement with fly ash in concrete is reported to be in increasing order. When cement is replaced beyond 25% up to 50% by the fly ash then it gives more accurate behavior of concrete in construction of PPC.

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