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*Research Paper*

# STRENGTH AND DURABILITY EVALUATION OF FLY ASH-BASED GEOPOLYMER CONCRETE

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***Abstract***— Concrete is the one of the most widely used construction material throughout the world. Hence it has been labelled as the backbone to the infrastructure development of nation. To fulfill the requirement of industries here we have replaced partially the constituent materials of concrete by using waste material. It was carried out to evaluate the properties of concrete by replacing the cement by eggshell powder and silica fume by varying the percentage of 2.5%, 5%, 7.5%, 10% eggshell and silica fume. A comparison of partially replaced concrete with conventional concrete was also include into the study. Comparison of weights of natural concrete with partially replaced concrete after 7, 14 and 28 days of curing was included. The mix design arrived for an M25 mix. As I know the carbon dioxide produced by cement industry causes environmental pollution and global warming. In 1000 Kg of cement manufacturing process approximately 900Kg of carbon dioxide is emitted. In order to reduce the cement production into atmosphere waste by products are used admixture in study so that environmental pollution and natural resources consumption is reduced. In India, eggshell powder which in calcium and silica fume is thrown away as waste. In the present study, use of eggshell and silica fume as a partial replacement of cement and various properties like workability, compressive strength and spilt tensile strength was determined. Keep silica fume and eggshell percentage equal and finding strength of blocks.

***Keywords***— Concrete, Infrastructure, Eggshell, Silica fume, Cement, Global Warming, Calcium.

## I. INTRODUCTION

Cement is the costliest and energy intensive component of concrete. The unit cost of concrete can be reduced by partial replacement of cement with Eggshell Powder and partial replacement of cement with micro silica fume. Eggshell increases the solid waste which is a major issue for environment. The utilization of eggshell and silica fume instead of throwing itas a waste material can be partly used on economic grounds with partial replacement of cement.

It has been used particularly in mass concrete applications and large volume placement to control expansion due to heat and also helps in reducing cracking at early ages. Silica fume is by product of producing silicon metal or ferrosilicon alloys. One of most beneficial use of silica fume in concrete because it's chemical and physical

properties. Concrete containing silicafume can have high strength and can durable.

It is the action of human being that determines the worth of any materials having potentials for gainful utilization remain in the category of waste until its potential is understood and put to right use. Eggshell and silica fume is one such example, which has been treated as awaste material in India.

This project comprises of replacing of cement (OPC,53grades) for different percentage of Eggshell Powder and Silica fume and then testing them for their compressive strength.

## I. Chemical Composition Of The Egg Shell Powder

| Oxide contents | Percentage (%) |
|---|---|
| CaO | 50.7 |
| SiO2 | 0.09 |
| Al2O3 | 0.03 |
| MgO | 0.01 |
| Fe2O3 | 0.24 |
| Na2O | 0.19 |
| P2O5 | 0.24 |
| SrO | 0.13 |
| NiO | 0.001 |
| SO3 | 0.57 |
| C1 | 0.219 |

TABLE-1- CHEMICAL COMPOSITION OF THE EGG SHELL POWDER

## II. CHEMICAL COMPOSITION OF SILICA FUME

| Oxide contents | Percentage (%) |
|---|---|
| CaO | 0.30 |
| SiO2 | 90.21 |
| Al2O3 | 0.12 |
| Fe2O3 | 0.15 |
| MgO | 0.73 |

TABLE-2-CHEMICAL COMPOSITION OF SILICA FUME

## III. Mix Proportion Ratio

| Cement | Fine aggregate | Coarse aggregate | water |
|---|---|---|---|
| 439 | 656.03 | 1111.53 | 197.16 |
| 1 | 1.49 | 2.53 | 0.45 |

TABLE-3- MIX PROPORTION RATIO

## IV. SLUMP TEST OF CONCRETE FOR REPLACING EGG SHELL AND SILICA FUMEPOWDER

| S.NO | MIX DESIGN | SLUMP VALUS M25 | SLUMP DESIGATION |
|---|---|---|---|
| 1 | Nominal | 90 | True slump |
| 2 | Mix (2.5%) | 85 | True slump |
| 3 | Mix (5%) | 75 | True slump |
| 4 | Mix (7.5%) | 70 | True slump |
| 5 | Mix (10%) | 60 | True slump |

TABLE-4- SLUMP TEST OF CONCRETE FOR REPLACING EGG SHELL AND SILICA FUMEPOWDER

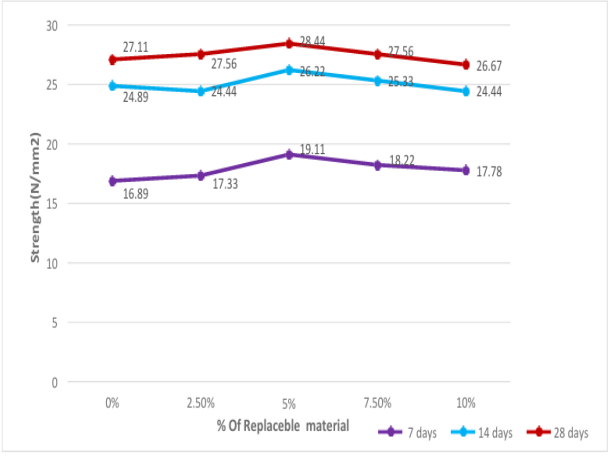
## V. Compressive Strength For 7,14, And 28 Days

| S.No | % Of Replaceable Material | Area($mm^2$) | Strength($N/mm^2$) | | |
|---|---|---|---|---|---|
| | | | 7 days | 14 days | 28 days |
| 1 | Nominal | 22500 | 16.89 | 24.89 | 27.11 |
| 2 | Mix (2.5%) | 22500 | 17.33 | 24.44 | 27.56 |
| 3 | Mix (5%) | 22500 | 19.11 | 26.22 | 28.44 |
| 4 | Mix (7.5%) | 22500 | 18.22 | 25.33 | 27.56 |
| 5 | Mix (10%) | 22500 | 17.78 | 24.44 | 26.67 |

TABLE-5- COMPRESSIVE STRENGTH FOR 7,14, AND 28 DAYS

## VI. COMPRESSIVE STRENGTH FOR 7,14, AND 28 DAYS

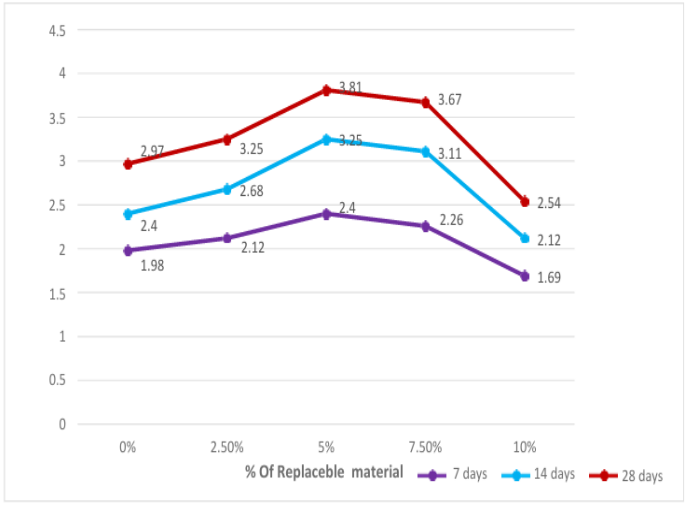
| S.No | % Of Replaceable Material | Strength(N/mm$^2$) | | |
|---|---|---|---|---|
| | | 7 days | 14 days | 28 days |
| 1 | Nominal | 1.98 | 2.40 | 2.97 |
| 2 | Mix (2.5%) | 2.12 | 2.68 | 3.25 |
| 3 | Mix (5%) | 2.40 | 3.25 | 3.81 |
| 4 | Mix (7.5%) | 2.26 | 3.11 | 3.67 |
| 5 | Mix (10%) | 1.69 | 2.12 | 2.54 |




GRAPH-1-COMPRESSIVE STRENGTH FOR 7,14, AND 28 DAY

## VII. SPLIT TENSILE STRENGTH FOR 7,14, AND 28 DAYS

| S.No | % Of Replaceable Material | Strength(N/mm$^2$) | | |
|---|---|---|---|---|
| | | 7 days | 14 days | 28 days |
| 1 | Nominal | 1.98 | 2.40 | 2.97 |
| 2 | Mix (2.5%) | 2.12 | 2.68 | 3.25 |
| 3 | Mix (5%) | 2.40 | 3.25 | 3.81 |
| 4 | Mix (7.5%) | 2.26 | 3.11 | 3.67 |
| 5 | Mix (10%) | 1.69 | 2.12 | 2.54 |




GRAPH-2- Split tensile Strength For 7,14, And 28 Day

## VI. CONCLUSIONS

- The compressive strength of conventional concrete is 27.11 N/mm$^2$ while adding 5% of egg shell powder and silica fume the compressive strength increases by 5%.
- The egg shell powder and silica fume is replaceable up to 10% in concrete because the compressive strength is more than conventional concrete near 5% while egg shell powder and silica fume is added i.e (adding of egg shell powder the compressive strength is 28.44 N/mm$^2$, the compressive strength of conventional concrete is 27.11 N/mm$^2$)
- The split tensile strength of conventional concrete is 2.97 N/mm$^2$ while adding 5% of eggshell powder and silica fume the split tensile strength increases by 28.5%.
- The split tensile strength may increases up to 28.5% of egg shell powder and silica fumeadding in concrete.
- The split tensile strength of concrete while adding 5% of egg shell powder and silicafume is 3.81 N/mm$^2$, the split tensile strength of conventional concrete is 2.97 N/mm$^2$.
- By increasing the egg shell powder and

silica fume of 5% in conventional concrete theworkability of the concrete is increasing.

- The compressive strength of conventional concrete is 28.44 N/mm$^2$ while adding 5% ofsilica fume the compressive strength increases by 5%.
- The compressive strength of concrete while adding 5% of egg shell and silica fume is 28.44 N/mm$^2$, the compressive strength of conventional concrete is 27.11 N/mm$^2$.
- The split tensile strength of conventional concrete is 2.97 N/mm$^2$ while adding 5% of egg shell powder and silica fume the split tensile strength increases by 28.5%.
- The split tensile strength may increases up to 5% of egg shell powder and silica fume adding in conventional concrete.
- The split tensile strength of conventional concrete while adding 5% of egg shell powder and silica fume is 2.97 N/mm$^2$, the split tensile strength of conventional concrete is 3.81 N/mm$^2$.
- By increasing the egg shell powder and silica fume in conventional concrete the workability of concrete is increasing.

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