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STRENGTH STUDIES ON CONCRETE BY PARTIAL REPLACEMENT OF CEMENT WITH GGBS AND SILICA FUME

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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 GGBS and silica fume by varying the percentage of 2.5%, 5%, 7.5%, 10% GGBS 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 M30 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 the present study, use of GGBS and silica fume as a partial replacement of cement and various properties like compressive strength and spilt tensile strength was determined.

Keywords— Concrete, Infrastructure, egg shell powder, Silica fume, Cement, Global Warming, Calcium.

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 GGBS and partial replacement of cement with micro silica fume. GBBS increases the solid waste which is a major issue for environment. The utilization of GGBS and silica fume instead of throwing It as 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 silica fume 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 remainin the category of waste until its potential is understood and put to right use. GGBS and silica fume is one such example, which has been treated as a waste material in India.

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

CHEMICAL COMPOSITION OF THE GGBS

Chemicals	Percentage (%)
SiO**2**	31.52
Al**2**O**3**	17.43
Fe**2**O_3	3.82
MgO	13.29
CaO	32.34
SO_3	1.60

TABLE-1- CHEMICAL COMPOSITION OF THE GGBS

CHEMICAL COMPOSITION OF SILICA FUME

Oxide Contents	Percentage (%)
CaO	0.33
SiO_2	90.25
Al_2O_3	0.125
Fe_2O_3	0.145
MgO	0.76

TABLE-2-CHEMICAL COMPOSITION OF SILICA FUME

MIX PROPORTION RATIO

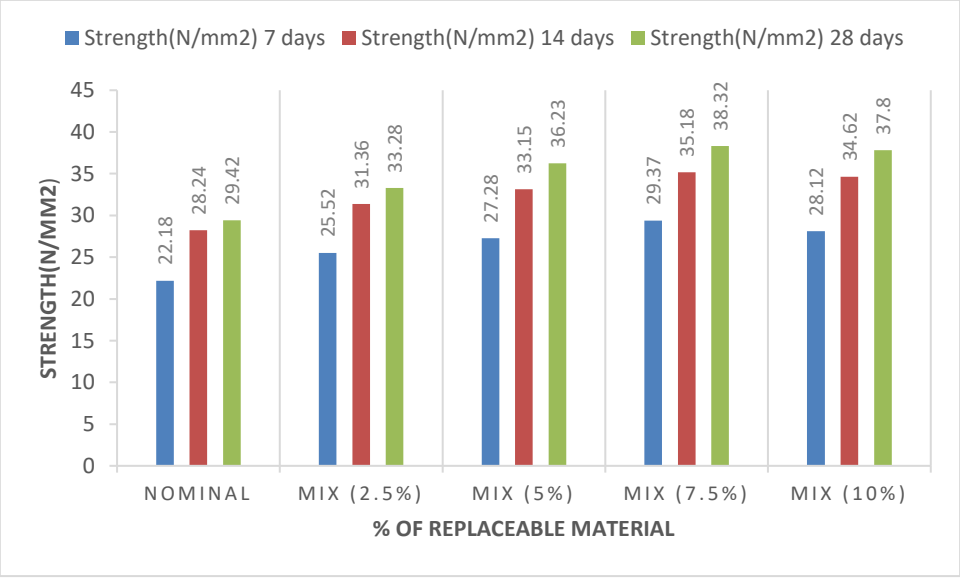
Cement	Fine aggregate	Coarse aggregate	water
439	659.03	1115.53	197.16
1	1.50	2.54	0.449

TABLE-3- MIX PROPORTION RATIO

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	22.18	28.24	29.42
2	Mix (2.5%)	22500	25.52	31.36	33.28
3	Mix (5%)	22500	27.28	33.15	36.23
4	Mix (7.5%)	22500	29.37	35.18	38.32
5	Mix (10%)	22500	28.12	34.62	37.8

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

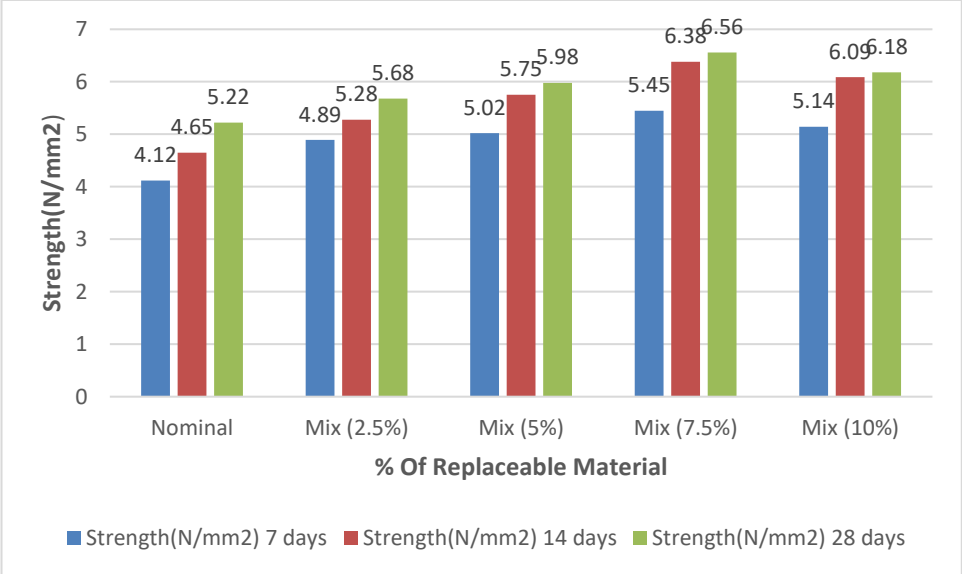


GRAPH-1- Split compressive Strength For 7,14, And 28 Days

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	4.12	4.65	5.22
2	Mix (2.5%)	4.89	5.28	5.68
3	Mix (5%)	5.02	5.75	5.98
4	Mix (7.5%)	5.45	6.38	6.56
5	Mix (10%)	5.14	6.09	6.18

TABLE-6-SPLIT TENSILE STRENGTH FOR 7,14, AND 28 DAYS



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

VII. CONCLUSIONS :

- The inclusion of silica fume, even at a low replacement level of 2.5%, significantly improves the compressive strength of M30 grade concrete compared to the nominal mix. This enhancement is evident across all curing periods (7, 14, and 28 days).
- The mix with 7.5% silica fume exhibits the highest compressive strength values at all ages tested, with strengths of 29.37 MPa, 35.18 MPa, and 38.32 MPa at 7, 14, and 28 days, respectively. This indicates that 7.5% is an optimal level for achieving the best performance in terms of compressive strength.
- While the 10% silica fume mix shows a commendable strength of 28.12 MPa at 7 days, it experiences a slight reduction in strength compared to the 7.5% mix at 14 and 28 days. This suggests that excessive silica fume can lead to diminishing returns in compressive strength, possibly due to workability challenges or increased water demand.
- All mixes demonstrate significant strength gain over time, reflecting the ongoing pozzolanic reactions facilitated by the silica fume. The increases from 7 to 28 days illustrate the material's contribution to long-term strength development.
- The results support the use of silica fume as an effective supplementary cementitious material in M30 grade concrete. Engineers should consider incorporating around 7.5% silica fume to optimize compressive strength without compromising workability.
- The positive impact on compressive strength underscores the benefits of using supplementary materials like silica fume and GGBS for applications requiring high durability and performance.

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