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Experimental Study on Concrete Containing Hypo Sludge and Silica Fume as A Partial Replacement of Cement

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Abstract - *Cement being bonding material in concrete releases plenty of CO2 and pollute environment. Also tone of waste is generated by various industries, there material can be utilized as a partial replacement of cement so as to reduce pollution and manage industrial waste. Hypo sludge and silica fume being industrial waste can be used as partial replacement of cement. For pilot study, OPC cement of grade 53 was 10% replaced by silica fume and 5% replaced by hypo sludge. Then, 10% cement was replaced by both the materials. Then, 15% by silica fume and 5% hypo sludge, and at last 15% cement was replaced by silica fume and 10% was replaced by hypo sludge. And compressive strength was determined for all the concrete specimens prepared by different amount of replacements.*

Key Words*: *Hypo Sludge, Silica Fume, Ordinary Portland cement, Compressive Strength.

1. INTRODUCTION

Concrete, is most widely used man made construction material and is the largest production of all the materials used in construction industry. Concrete is basically made of cementitious materials which have to properly bind themselves together, as well as with other materials to form a solid mass. Concrete or mortar is made up of cement, water and aggregates (Coarse and Fine Aggregate) and sometimes with necessary admixtures. Concrete has attained the status of a major building material in all the branches of modern construction. It is difficult to point out another material of construction which is as variable as concrete

Concrete is the best material of choice where strength, durability, impermeability, fire resistance and absorption resistance are required. Compressive strength is considered as an index to assess the overall quality of concrete and it is generally assumed that an improvement in the compressive strength results in improvement of all other properties. The strength of concrete is measured in pounds per square inch or kilograms per square centimeter of force needed to crush a sample of a given age or hardness.

Concrete is the most commonly used man-made material on earth. It is important construction material used extensively in buildings, bridges, roads and dams. Its uses range from structural applications, to pervious, Krebs, pipes and drains.

2. MATERIAL

2.1 Cement

Ordinary Portland Cement(OPC) is the most widely used cement in the world for producing concrete, mortar, stucco, and non-specialty grouts. Ordinary Portland Cement has 3 grades based on its strength namely 33, 43 and 53 grade that indicates the compressive strength obtained after 28 days of setting.

2.2 Coarse Aggregate

The size of coarse aggregate is used up to 20 mm. The aggregate is important constitute of concrete. The larger size of aggregate affects the thickness of rib.

2.3 Fine Aggregate

The fraction of particles which pass through 4.75 mm sieve and retained on 150 microns is termed as fine aggregate. River sand is use as a fine aggregate. According to particle size the fine aggregate is divided into four zone as per IS: 383(1970). Fine aggregate screened through 4.75 mm sieve to remove larger particles.

2.4 Hypo Sludge

Hypo sludge is a type of waste obtained by paper production of industrial Disposal of this waste become. Over 300 million tons of waste produced per annum in India in the form of chemical and agricultural waste. Paper making industries generally produces a large amount of solid waste. This paper mill sludge consumes a large percentage of local landfill space for each and every year.

Fig -1: Hypo sludge

Hypo sludge contains maximum calcium chloride and low calcium with minimum amount of silica. It is having the behavior of cement with silica and magnesium properties. This silica and magnesium prolongs the setting time of the concrete.

Table-1: Physical properties of Hypo sludge

Property	Value
Color	Light gray
Bulk Density	730 kg/m^3
Specific Gravity	2.8
Water absorption	7 %

Table 2 Chemical properties of Hypo sludge

Chemical Components	Value
CaO	47.40%
Al_2O_3	0.09%
FE_2O_3	0.75%
SIO_2	9.20%
MGO	6.5%
K_2O	1.20%
SO_3	0.19%
LOI	33%

2.5silica Fume

Silica fume is a byproduct of producing silicon metal or ferrosilicon alloys. One of the most beneficial uses for silica fume is in concrete. Because of its chemical and physical properties, it is a very reactive pozzolan. Concrete containing silica fume can have very high strength and can be very durable. Silica fume consists primarily of amorphous (non-crystalline) silicon dioxide (SiO2). The individual particles are extremely small, approximately 1/100th the size of an average cement particle. Because of its fine particles, large surface area, and the high SiO2 content, silica fume is a very reactive pozzolan when used in concrete.

Fig -2: Silica Fume

Table-3: Physical properties of Silica fume

Property	Value
Color	Dark gray
Bulk Density	650kg/m^3
Specific Gravity	2.2
PH value	7.8

Table-4: Chemical properties of Silica fume

Chemical Components	Value
CaO	0.70%
Al_2O_3	1%
FE_2O_3	1.40%
SIO_2	92%
MGO	0.70%
K_2O	1.10%
SO_3	0.45%
LOI	4.50%

3. EXPERIMENTAL WORK

3.1 Mix Design

A standard mix M20, M30, M40 grade was calculated as per (IS 10262-2009). The Concretes were preparing at cementations material.

Table-1: Mix ratio of material for M20 grade

The Mix Proportion then becomes (By Wt.) (Consumption per cubic meter)				
Water	Cement	FA	CA	Total
197.16	394.92	721.40	1155	2468.48
0.50	1.00	1.83	2.92	6.25

Table-6: Mix ratio of material for M30 grade

The Mix Proportion then becomes (By Wt.) (Consumption per cubic meter)				
Water	Cement	FA	CA	Total
197.16	469.43	695	1114	2475.49
0.42	1.00	1.48	2.37	5.27

Table-7: Mix ratio of material for M40 grade

The Mix Proportion then becomes (By Wt.) (Consumption per cubic meter)				
Water	Cement	FA	CA	Total
197.16	492.9	688	1102	2480
0.40	1.00	1.40	2.24	5.04

3.2 Test Procedure

For preparing cube of concrete is done by hand or by machine a batch mixing was used coarse aggregate, fine aggregate, cement, hypo Sludge, silica fume was mixed with ½ of the mixing water for 2 time. After this material is poured in to concrete block mould and pressing it.

3.3 Compressive Strength Result

The test used for determining the strength of concrete under applied load. The test is done on compression testing machine. It was done as per IS 516-1959.For the cube compression test, the specimens used generally are of two types either cubes of size having 150x150x150mm are used based on the consideration of the aggregate size.

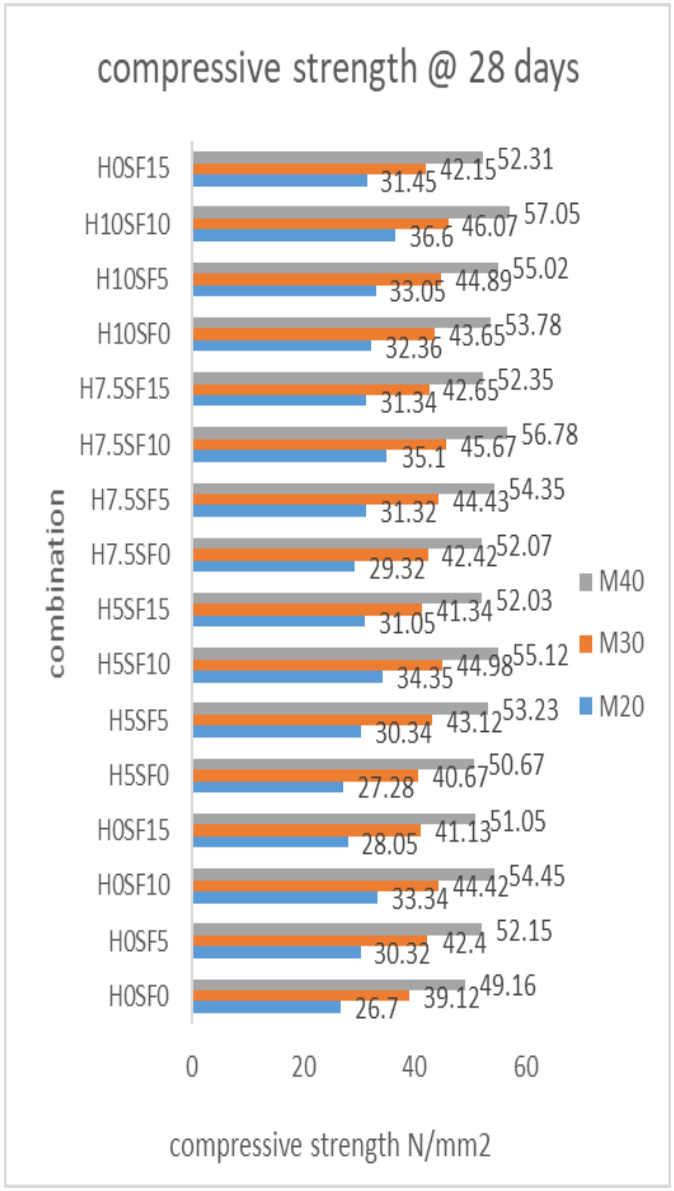

Figure 3 Compressive Strength @28 days

3.4 Acid Attack Test (HCL) Result for M30 Grade

Concrete cube of size 150x150x150 mm are prepared for various percentages of glass powder & plastic powder addition. After that the specimens are casted and cured in mould for 24 hours. After 24 hours, all the specimens are demolded and kept in curing tank for 7 days. After that the specimens are weighed and immersed in 5% hydrochloric acid (HCL) solution for 28 and 56 days. The pH value of the acidic media was at 0.3. The pH value was periodically checked and maintained at 0.3. After 28 and 56 day of immersing, the specimens are taken out and kept in atmosphere for 2 days for constant weight. After that the specimens are weighed the change in compressive strength.

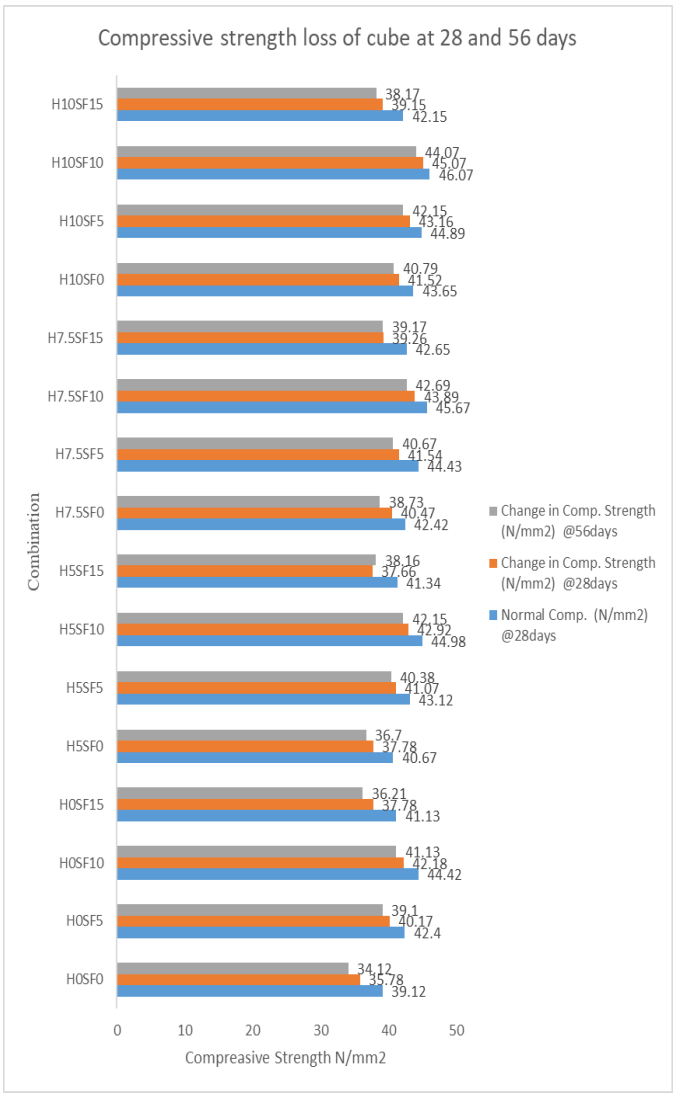

Figure 4 Compressive Strength loss of cube at @28 and 56 days

3.5 Resistance Against Salphate Attack (Na2SO4) for M30 grade

Concrete cube of size 150x150x150 mm are prepared for various percentages of copper slag & ceramic powder addition. After that the Specimen are casted and curing in mould. After 24 hours all the specimens are demoulded and kept in tank for 7 days curing. After 7 days all specimen are kept in atmosphere for 2 days for constant weight, subsequently, the specimens are weighed and immersed in 5% sodium sulphate (Na_2SO_4) solution for 28 and 56 days. After 28 and 56 days of immersing, the specimens are taken out and washed in running water and kept in atmosphere for 2 days. After that specimens are weighted check the change in compressive strength.

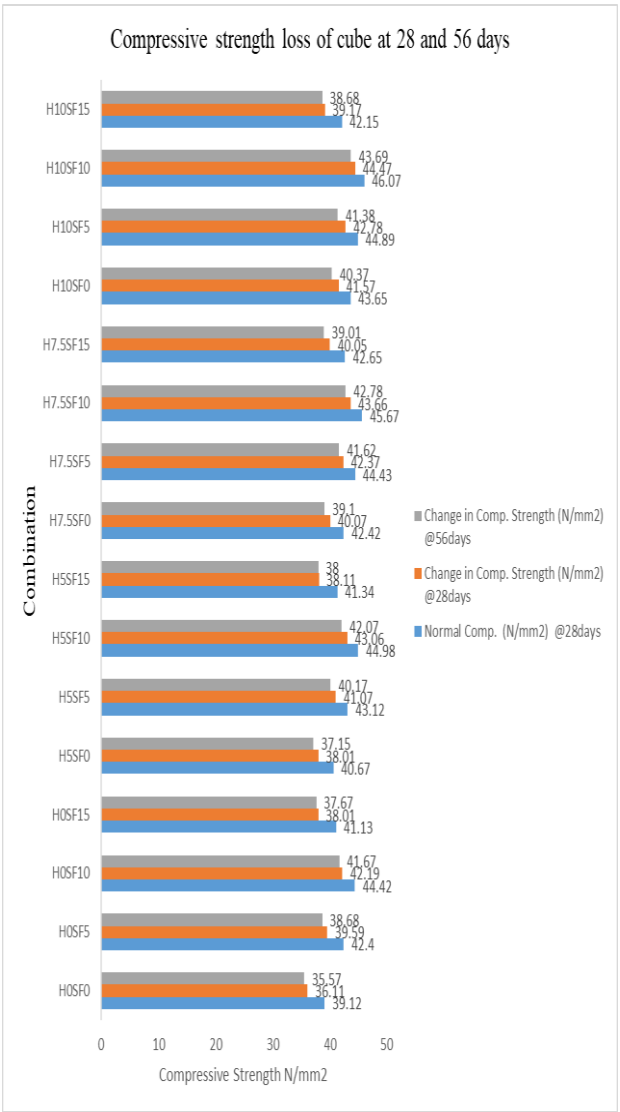

Figure 5 Loss of Compressive Strength N/mm² at 28 and 56 days

4. CONCLUSIONS

The replacement of Ordinary Portland Cement by Hypo-sludge and silica-fumes gave improvement in concrete properties such as compressive strength.

Optimum replacement of Hypo-sludge and Silica fumes is 10% and 10% respectively as replacement of cement at 28 days for M20, M30, and M40.

Replacement of Ordinary Portland Cement by Hypo-sludge and Silica-fumes improves the durability against acid sulphate attack.

Concrete loses only 2.17% and 4.34% of its strength at 28 days and 56 days respectively compared to 8.53% and 12.78% in normal concrete against acid attack when replacement of the cement by 10% Hypo-sludge and 10% Silica fumes when used combined for M30 grade concrete.

Concrete loses only 3.47% and 5.16% of its strength at 28 days and 56 days respectively compared to 7.69% and 9.08% in normal concrete against sulphate attack when replacement of the cement by 10% Hypo-sludge and 10% Silica fumes when used combined for M30 grade concrete.

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