STRENGTH AND DURABILITY OF M30 CONCRETE WITH VARIOUS MINERAL AND CHEMICAL ADMIXTURES

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ABSTRACT
The present trend in the concrete technology is of increasing the strength and durability of concrete to meet the demands of modern construction world. These factors can be achieved in concrete by adding various blending materials with cement or separately to concrete. The materials suitable for blending are ground granulated blast furnace slag, silica fume, fly ash super plasticizers etc., The experimental investigations have been made to study the suitability of the use of mineral and chemical admixtures from the industry for the replacement in concrete in order to reduce the environmental problems. This experimental investigation is aimed to utilize such mineral and chemical admixtures as a partial replacement for cement in concrete. M30 grade concrete is taken for investigation. The cement is replaced by fly ash, ground granulated blast furnace slag from 10% to 50 % with an increment of 10%, and silica fume 10%.The chemical admixture super plasticizer is used at 0.5% by weight of replacement of cement in order to improve the properties of fresh concrete. The strength and durability properties studied of hardened concrete include compressive strength of cube and cylinder, split tensile strength of cylinder, flexural strength of prism and stress strain behavior of cylinder and durability tests such as water absorption, sulphate attack and chloride attack for various percentage of replacement of cement by fly ash, silica fume, ground granulated blast furnace slag, super plasticizers etc., have been studied. The results are compared with that of the conventional concrete. Based on the results of the experimental study some important conclusions have been drawn.

KEYWORDS- *Compressive strength, flexural strength, GGBS, Recron 3s fiber, Split tensile strength.*

I. INTRODUCTION

A concrete structure is said to be durable if it withstand the condition for which it has been designed without deterioration, over a period year's .Deterioration is an inherent process from any material and concrete is no exception to this. Therefore it would be unrealistic to expect any concrete structure to maintain its "as new" condition without suitable maintenance. The present trend in the concrete technology is of increasing the strength and durability of concrete to meet the demand of modern construction world. These factors can be achieved in concrete by adding various blending materials with cement or separately to concrete. The materials suitable for blending are fly ash, ground granulated blast furnace slag, silica fumes and super plasticizer etc. The term durability of concrete is used to characterize in broad terms the resistance of concrete to a variety of physical or chemical attacks due to either external or internal cause may be due weathering, occurrence of extreme temperatures, abrasion, electrolytic action and attacks by natural or industrial liquids and gases. The extent of damage due to external agents depends to a great extent on the quality of the concrete.

Adlireza naji givi et al 2010 reported that the compressive strength, water permeability, and workability of concrete by partial replacement of cement with rice husk ash. Two types of rice husk ash with average particle size of 5 micron and 95 micron and with four different contents of 5%, 10 %, 15 %, and 20% by weight were used. It is concluded that partial replacement of cement with rice husk ash improves the compressive strength and workability of concrete and decreases its

water permeability. In addition decreasing rice husk ash average particle size provides a positive effect on the compressive strength and water permeability of hardened concretes by indicates adverse effect on the workability of fresh concrete. Aquino et al, 2001 Attempt is made by the authors to study the influence of SF (Silica Fume) and HRM (High Reactivity Metakaolin) on the chemistry of ASR (Alkali Silica reaction) products. They observed that silica fume and high reactivity Metakaolin reduce expansion due to ASR. Also they observed that the calcium content of ASR products is increasing with time in all the samples without mineral admixtures and a lower level of calcium was detected in samples containing mineral admixtures. In addition, X-26 ray micro-analysis showed that calcium content increases with time in ASR products. It was found that as ASR reaction proceeds, the calcium to silica reaction of the reaction products increases following a linear trend. From the results it is suggested that calcium in gel products may be responsible for expansion. Behera .J.P et al investigation has been made to develop fly ash in activated form. Fly ash mixed in the ratio of 20%, 30%, 40% and 50 percent by replacing Portland cement. The cement has been prepared by grinding in ball mill with 30% of gypsum. Different physical properties of the cement thus prepared have been examined. It has been found that up to 40% fly ash in an activated form can be used for manufacturing blended cement as per Indian standard.

As per investigations reported by Alhozaimy et al. (1996), Zollo (1997), Safiuddin and Hearn (2005) and Bozkurt and Yazicioglu (2010) fly ash, ground granulated blast furnace slag (GGBFS), rice husk ash, high reactive metakaolin, silica fume are some of the pozzolanic materials which can be used in concrete as partial replacement of cement, satisfying the desired qualities of concrete.

Qian Jueshi and Shi Caijun (2000) studied on high performance cementing materials from industrial slag. They found that most industrial slags were used without taking full advantage of their properties or disposed rather than used. The industrial slags, which have cementitious or pozzolanic properties, should be used as partial or full replacement for Portland cement rather than as bulk aggregates or ballasts because of the high cost of Portland cement, which is attributable to the high energy consumption for production. According to Ganesh Babu and Sree Rama Kumar (2000) the utilization of supplementary cementitious materials is well accepted because of several improvements possible in the concrete composites and due to the overall economy.This paper is an attempt to study the mechanical properties of a concrete made with partial replacement of cement with GGBS and recron 3's fibers in different proportions.

II. EXPERIMENTAL INVESTIGATION

Concrete is an artificial material, which is made up of cement, fine aggregates and water. In this study an attempt have been to a part of place cement by fly ash, silica fume , ground granulated blast furnace slag to improve some of properties of concrete.

A. Materials used

1) *Aggregates:* The fine aggregate comprised of sand of Zone-II, according to Bureau of Indian Standard (BIS) 383 (1970). As per the same code, the maximum size of coarse aggregate was 20mm and 60% of coarse aggregate was of 10mm size and the rest of 20mm size. The specific Gravity, water absorption and fineness modulus of coarse aggregates were 2.67, 0.4% and 4.11 respectively.
2) *Cement:* The commonly used Portland Slag Cement (PSC) has been used in this study. Its physical properties such as specific gravity, initial setting time (min) and final setting time (min) are 2.96, 125 and 235 respectively.
3) *Ground granulated blast furnace slag (GGBFS):* GGBFS is a non-metallic product essentially consists of silicates and alumino silicates of calcium and other bases. The four major factors, which influence the hydraulic activity of slag, are glass content, chemical composition, mineralogical composition and fineness. It has specific surface of about 400-500 m2 /kg (Blaine). It has been used as partial replacement of cement because of its advantages like lower energy cost, higher abrasion resistance, lower hydration heat evolution, higher later strength development. Specific gravity test conducted using Le-Chatelier apparatus is found to be 2.77.

4) *Fly Ash :* Fly ash is the finely divided residue from the combustion of ground or powdered coal which is transported from the fire box by the fuel gases and is subsequently removed from the gas by electrostatic precipitators. During combustion of coal in thermal power plants, the volcanic matter and carbon are burnt off, whereas mineral impurities in the coal such as clay, quartz, feldspar etc., melt and are transported to lower temperature zones, where it is solidifies as spherical particles of glass. Some of this mineral matter agglomerates to form bottom ash, but most of its flies out with the flue gases called fly ash.
5) *Silica Fumes:* Silica fume, a by-product in the production of silicon and Ferro-silicon alloys is pozzolanic material used in concrete mixes. Micro silica obtained from the manufactures namely elkenmetallergy ltd., Mumbai was used in this experimental investigation. The study of the mixes showed that the silica fume used in average 40% of the cement to reduce the drying shrinkage of concrete

III. RESULTS AND DISCUSSION

Strength Tests Concrete mix of M30 was used for the experimental investigation. The mix design was done as per IS 10262-2009 guidelines and final mix proportion was obtained as Cement: FA: CA =1: 1.17: 2.17

The Compressive, tensile and flexural strength were conducted on the concrete specimens without and with admixtures and the optimum percentage was found as 30% for GGBS and Fly Ash and 10% for silica fumes. The combinations of mineral admixtures were decided and strength and durability tests were performed and the results are discussed below

1) Results of Compressive Strength of Cubes for Combined Admixtures

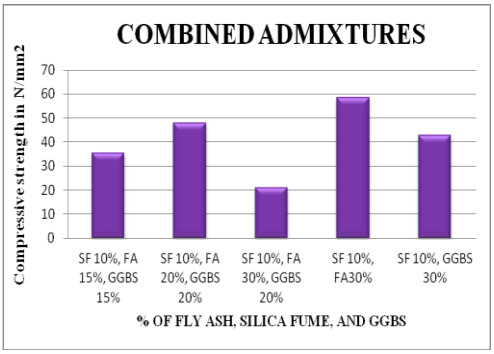

Fig.1. Cube Compressive Strength of Combined Admixtures

The Fig 1 shows the cube compressive strength of SF 10% & FA 30% replaced by weight of cement is increased 43.50% when compared to the normal concrete.

2) Results of Compressive Strength of Cylinders for Combined Admixtures

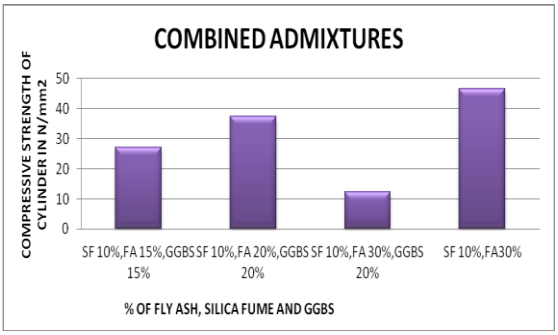

Fig.2. Cylinder Compressive Strength of Combined Admixtures

The Fig 2 shows the cube compressive strength of SF 10% & FA 30% replaced by weight of cement is increased 48.77% when compared to the normal concrete

3) Results of Tensile Strength of Cylinders for Combined Admixtures

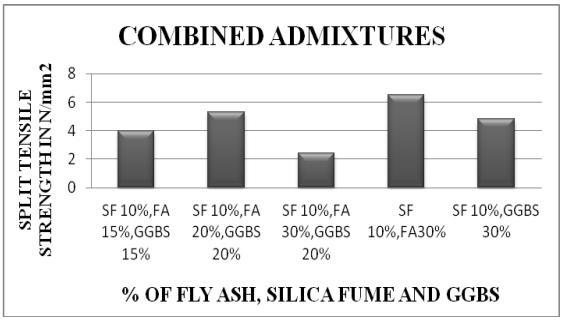

Fig.3. Cylinder Split Tensile Strength of Combined Admixtures

The Fig 3 shows the split tensile strength of SF 10% & FA 30% replaced by weight of cement is increased 47.80% when compared to the normal concrete

4) Results of Flexural Strength of Prisms for Combined Admixtures

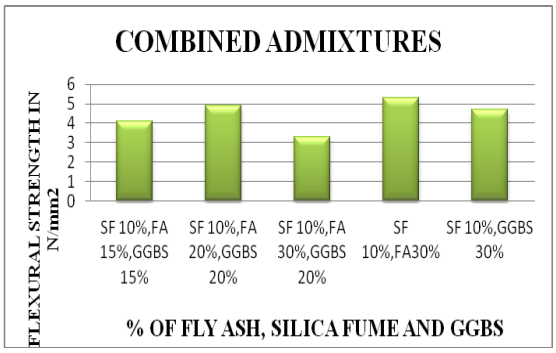

Fig.4. *Flexural strength of prism for Combined admixtures*

The Fig 4 shows the split tensile strength of SF 10% & FA 30% replaced by weight of cement is increased 24.50% when compared to the normal concrete

B. Durability Tests

1) Results of Water Absorption Tests:

Table 1 : Result Of Water Absorption Tests

S. no	Mix	Average Water Absorption %
1	Conventional concrete	3.36
2	SF10%,FA15%,&GGBS 15%	2.86
3	SF10%,FA20%,&GGBS 20%	2.25
4	SF10%, FA30%	1.50
5	SF 10%, GGBS 30%	2.80

The water absorption of combined admixtures with different percentage of replacement was found after saturation was found to be less when compared with conventional concrete. The water absorption decreases compared to normal concrete

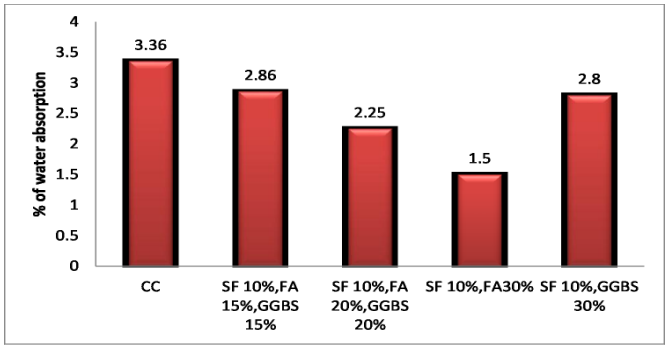

Fig.5. Result of Water Absorption Tests

2) Result Of Sulphate Attack Test

Table II gives the Average percentage loss in Weight (%) and test results obtained from compressive strength of cubes before and after attack is tabulated in Table III

Before Attack After Attack

Fig.6. Result of Sulphate Attack

Table II Result of Sulphate Attack Tests

Sl no	Mix	Average Percentage Loss In Weight (%)
1	Conventional concrete	3.38
2	SF10%,FA15%,&GGBS 15%	2.29
3	SF10%,FA20%,&GGBS20%	1.32
4	SF10%, FA30%	1.52
5	SF 10%, GGBS 30%	1.32

From the table shown above it was found that addition of pozzalano materials has reduced the percentage loss in weight due to Sulphate attack compared to conventional concrete

Table Compressive Strength Result Due To Sulphate Attack Test

SL NO	Mix	Strength in N/mm^2		% of loss in strength
		Before attack	After attack	
1	Conventional concrete	33.33	30.14	9.5
2	SF 10%, FA15%, & GGBS 15%	35.53	32.9	7.4
3	SF10% , FA 20%, & GGBS 20%	48.1	42.5	12
4	SF 10%, FA 30%	58.5	52.4	10.4
5	SF 10%, GGBS 30%	42.93	38.17	11

3) Result Of Chloride Attack Test

The chloride attack of combined admixtures concrete after the attack was found to be the gain in weight of cube was measured when compared with the normal concrete. Table IV & V gives to test results obtain from chloride attack test.

Before Attack After Attack

Fig.7. Result of Sulphate Attack

Table IV Result of Chloride Attack Tests

Sl no	Mix	Average Percentage gain In Weight (%)
1	Conventional concrete	2.19
2	SF10%,FA15%,&GGBS 15%	1.34
3	SF10%,FA20%,&GGBS 20%	0.95
4	SF10%,FA30%,&GGBS 20%	1.88
5	SF10%, FA30%	0.75
6	SF 10%, GGBS 30%	1.14

Table V Compressive Strength Result Due To Chloride Attack Test

SI NO	MIX	Before	After attack	strength
1	Conventional concrete	33.33	31	6.99
2	SF 10%, FA15%, & GGBS 15%	35.53	33.59	5.46
3	SF10% , FA 20%, & GGBS 20%	48.1	44.83	6.8
4	SF 10%, FA 30%	58.5	54.4	7.01
5	SF 10%, GGBS 30%	42.93	40.56	5.52

From table IV it is found that the gain in weight was found to decrease when compared to the normal concrete. And table V gives the compressive strength result due to Chloride attack test, it is observed that when compared to conventional concrete the other mixes gives more strength even after chloride attack.

IV. CONCLUSION

An experimental study has been carried out find strength and durability properties of concrete with and without mineral and chemical admixtures. The details of the experimental study are given in the previous chapter. Based on the experimental studies following conclusions are drawn.

- When Silica Fume 10% & fly ash 30% replaced by weight of cement the cube compressive strength increased by 43.50% compared to the normal concrete
- When Silica Fume 10% & fly ash 30% replaced by weight of cement the cylinder compressive strength increased by 48.77% compared to the normal concrete

- When Silica Fume 10% & fly ash 30% replaced by weight of cement the split tensile strength increased by 47.80% compared to the normal concrete
- When Silica Fume 10% & fly ash 30% replaced by weight of cement the flexural strength of prism increased by 24.50% compared to the normal concrete
- When Silica Fume 10% & fly ash 30% replaced by weight of cement its offering a less water absorption compared to the normal concrete
- When Silica Fume 10% & fly ash 30% replaced by weight of cement the its offering a very good resistance against sulphate effect compared to the normal concrete
- When Silica Fume 10% & fly ash 30% replaced by weight of cement the its offering a very good resistance against chloride effect compared to the normal concrete

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