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A Study on Durability Properties of High Strength Concrete by Effect with Mineral Admixtures in Aggressive Environment

Miss. Nagulapalli Mounika[1], Miss. M. Divya Tejaswi[2]
[1]*PG Scholar, Department of Civil Engineering, Aditya College of Engineering & Technology, Surampalem, Andhra Pradesh, India.*
[2]*Assistant Professor, M.tech, Department of Civil engineering, Aditya College of Engineering & Technology, Surampalem, Andhra Pradesh, India*

Abstract: Portland cement is the most important ingredient of concrete and is a versatile and relatively high cost material. Large scale production of cement is causing environmental problems on one hand and depletion of natural resources on other hand. The main parameter investigated in this study of M100 grade concrete with partial replacement of cement by silica fume by 0, 5, 10,15,20,25and by 30% and study of M100 grade concrete with partial replacement of cement by fly ash by 0, 5,10,15,20,25,30,35 and by 40%. Conplast sp430 is used as super plasticizer in this project. High strength concrete can be made by using low w/c.
Acidic attack is one of the world's wide problems that may cause gradual but severe damages to concrete structures. This paper presents a detailed experimental study on Compressive strength at age of 7,28,56,90 and 180 days. Durability study on acid attack was also studied and percentage of weight loss is compared with normal concrete. Test results indicate that use of Silica fume in concrete has improved the performance of concrete in strength as well as in durability aspect.
From these investigations we watch that 20% Micro silica and 30% Fly ash will give ideal quality for M100 review at water/cement proportion of 0.25. The impact Na2So4 on these blends is nil or very less where as HCL and H2So4 had considerable effect.

I. INTRODUCTION

It is estimated that cement clinker manufacturing consumes an energy of approximately 850 kcal per kg of clinker and has a significant environmental impact. For each tone of cement clinker manufacturing, it emits 850 kg of carbon dioxide. It was therefore evaluated that the waste materials from different sectors were partly substituted in concrete for cement in order to decrease their efficiency. When waste products such as fly ash, silica fume, steel slag, metakaolin etc. are used as concrete substitute for cement, this results in tremendous energy savings and has significant environmental advantages.
It also achieves cost advantages through the use of these waste, as cement occupies more than 45 percent of concrete cost. Fly ash, produced as waste from thermal power plants, is one of the commonly used admixtures in concrete. Many of the past study work on fly ash has shown that fly ash concrete has the advantage of decreased hydration heat. Excellent durability results from concrete with 50 percent fly ash. Unlike fly ash, silica fume has a quality of rapid pozzolanic reaction rate, resulting in early concrete resistance growth. The reason for the decreased concrete bleeding is the presence of silica fumes.
The pozzolonic activity in silica fume powder has ultra-fine admixture size will also have a beneficial impact on concrete. Because of this research in this document, the ultra-fine size of silica fume and fly ash is used in concrete for partial substitute of cement and research has been carried out on the strength and durability features of such concrete. When powdered silica fume is used as a pozzolonic admixture in concrete, a reduction in strength was noted in early centuries. Therefore, to counteract this, a very tiny proportion of cement as a partial substitute. Therefore, to counteract this, a very tiny proportion of silica fume is also used as a partial substitute of cement and then the features of strength and durability are studied.

II. PROPERTIES OF MATERIALS

A. Cement

Ordinary Portland cement of 53 grade having specific gravity was 3.02 and fineness was 3200cm2/gm was used in the investigation. The Cement used has been tested for various proportions as per IS 4031-1988 and found to be confirming to various specifications of are 12269-1987.

B. Coarse Aggregate
Crushed angular granite metal of 10 mm size having the specific gravity of 2.65 and fineness modulus 6.05 was used in the investigation.

C. Fine Aggregate
River sand having the specific gravity of 2.55 and fineness modulus 2.77 was used in the investigation.

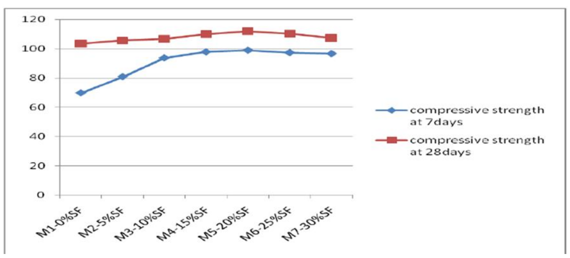
D. Fly Ash
Type-II fly ash confirming to I.S. 3812 – 1981of Indian Standard Specification was used as Pozzolana Admixture.

E. Micro Silica
The Micro silica having the specific gravity 2.2 was used in the present investigation

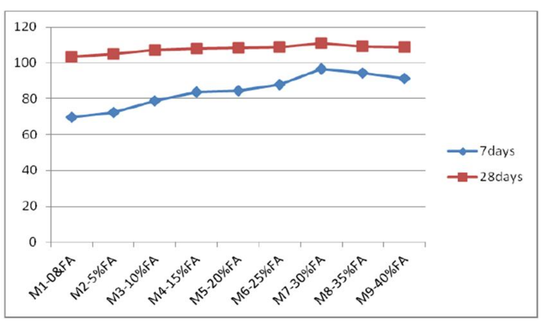
F. Conplast SP430
Specific gravity - 1.20, the rate of addition is generally in the range of 0.6 – 1.5 liters/100 kg cement

III. RESULT and DISCUSSION

A. Compressive Strength Test
The compressive strength of the concrete samples was determined in 7 days and 28 days. The sample size 150 x 150 x150 mm was used in this study as the largest symbolic size of the total not exceeding 20 mm. The compressive strength of the concrete samples was determined in 7 days and 28 days.



M100 with different proportions of silica fume at 7 days and 28 days compressive strength



M100 with different proportions of fly ash at 7 days and 28 days compressive strength

Compressive strength of M100 at different ages

Grade of concrete	Compressive strength in N/mm2 at different ages							
	1 day	3 days	7days	14days	28 days	56 days	90 days	180 days
M100	18.5	43.3	69.7	87.5	103.4	110.74	124.08	128.45

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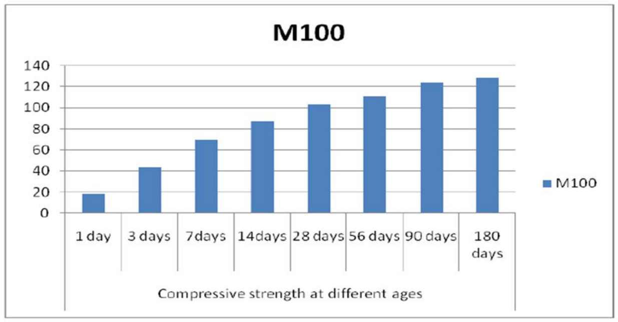

A total of 4 combinations were prepared for the present research work namely
M100 with 20%SF (SFC),
M100 with 30% FA (FAC),
M100 with 20% SF and 30% FA (FASFC),
And conventional concrete M100.

1) Test on sulphate resistance of high strength concrete using mineral admixtures

Sulphate resistance of concrete is determined by immersing test specimens of size 150 X150 X 150 mm cubes in 10% sodium sulphate. The deterioration of specimens are presented in the form of percentage reduction in weight and percentage reduction in compressive strength concrete of specimens at 28, 56, 90 and 180 days.

2) Test on acid attack of high strength concrete using mineral admixtures

Acid attack is determined by immersing test specimens of size 150 X150 X 150 mm cubes in 10% H2So4 solution and 10% HCl solution respectively. The deterioration of specimens are presented in the form of percentage reduction in weight and percentage reduction in compressive strength concrete of specimens at 28, 56, 90 and 180 days.

Weight loss of different concrete mix in acid and base curing

Grade of Concrete	10% HCl solution				10% Na2So4 solution				10% H2So4 solution			
	28 days	56 days	90 days	180 Days	28 days	56 days	90 days	180 days	28 days	56 days	90 days	180 days
Conventional	18.346	18.696	19.129	19.457	**5.24**	**5.29**	**5.34**	**5.4**	32.50	39.79	45.38	51.13
SFC	14.77	15.08	15.43	15.93	**2.41**	**2.46**	**2.49**	**2.513**	25.3	31.86	38.39	46.69
FAC	15.83	16.23	17.11	17.839	**3.51**	**3.57**	**3.612**	**3.684**	28.34	34.64	40.13	48.89
FASFC	15.29	15.55	16.18	16.67	**2.89**	**2.916**	**3.233**	**3.493**	27.3	33.11	39.62	47.13

Compressive strength loss of concrete mix in acid and base curing

Grade of Concrete	10% HCl solution				10% Na2So4 solution				10% H2So4 solution			
	28 days	56 days	90 days	180 Days	28 days	56 days	90 days	180 days	28 days	56 days	90 days	180 days
Conventional	18.346	18.696	19.129	19.457	**5.24**	**5.29**	**5.34**	**5.4**	32.50	39.79	45.38	51.13
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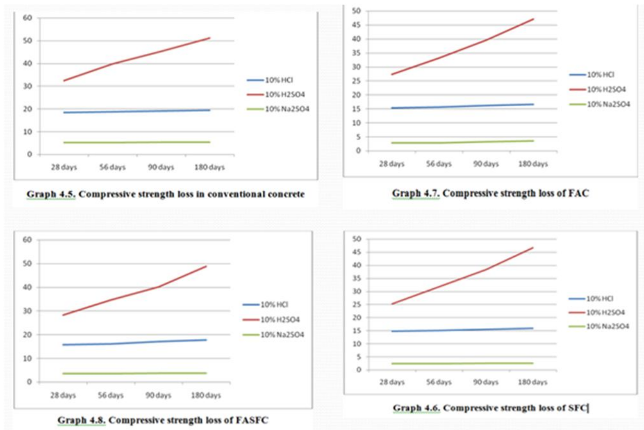


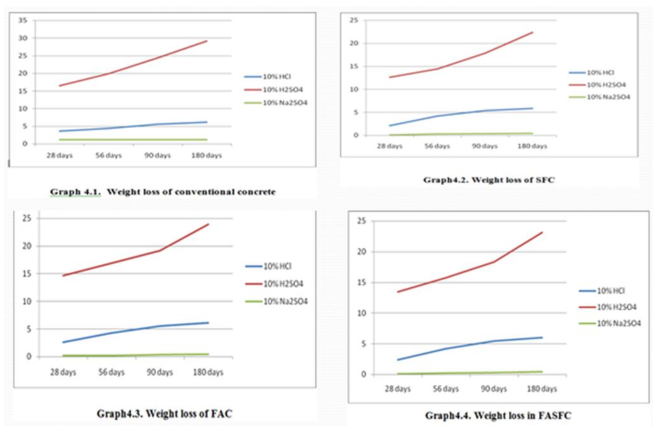
Graph 4.5. Compressive strength loss in conventional concrete

Graph 4.7. Compressive strength loss of FAC

Graph 4.8. Compressive strength loss of FASFC

Graph 4.6. Compressive strength loss of SFC

Compressive strength loss in diluted acid and base curing



Graph 4.1. Weight loss of conventional concrete

Graph4.2. Weight loss of SFC

Graph4.3. Weight loss of FAC

Graph4.4. Weight loss in FASFC

Weight loss in diluted acid and base curing

Cubes immersed in diluted acid and base

IV. CONCLUSION

A. In high strength concrete M100 Optimum results are obtained at W/C ratio 0.25.

B. Excess amount of super-plasticizer may result in segregation of concrete and make concrete weaker.

C. Optimum silica fume content is 20%.

D. Optimum fly ash content is 30% .

E. Silica fume provided better stability and good flow properties than flyash. Silica fume contribute to produce high compressive strength.

F. With these optimum contents of silica fume and fly ash made another combination of concrete i.e FASFC. But strength values are less compared to SFC.

G. The loss of weight and strength is more in case of immersing in 10% H2SO4 compared to HCL. The loss of weight and strength is very less in Na2SO4 compared Acids.

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