EXPERIMENTAL STUDY ON HPC WITH SUPPLEMENTARY CEMENTITOUS MATERIALS

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ABSTRACT: ***This paper deals with an experimental study on High Performance Concrete (HPC) with partial replacement of cement by Fly Ash and Alccofine. The use of Alccofine and fly ash in high performance concrete as a supplementary cementitious material was an alternative to traditional concrete. The research work is carried out on M80 grade concrete with constant water cement ratio 0.33 and partial replacements of cement by Alccofine and Fly Ash with different percentages (i.e., 0%, 2%, 4%, 6%, 8% and 10%.) together making the total replacement limited to 30% of cement. Properties like compressive strength, split tensile strength, flexural strength, workability and durability for M80 grade concrete at 28days are studied. The materials like waste Alccofine and fly ash which are used in this work have potential to reduce the CO2 emissions from cement industry in addition to contributing high performance concrete. For M80 grade, maximum compressive strength of 93.52 MPa, Split tensile strength of 9.8 MPa and Flexural strength of 7.9 MPa had occurred for Mix-3 with cement replaced by fly ash at 22%and Alccofine at 8%. In case of durability study the replacement of cement by fly ash and Alccofine has shown better results in attaining resistance to acid attach.. Acid attack for M80 concrete is more for cubes immersed in H2SO4 when compared with HCL. The percentage loss of strength loss was found to decrease with increase in percentages of supplementary cementitious materials for M80 grade.***

KeyWords: High performance concrete, compressive strength, durability, Alccofine and fly ash.

I. INTRODUCTION

High-performance concrete is defined as concrete that meets special combinations of performance and uniformity requirements that cannot always be achieved routinely using conventional constituents and normal mixing, placing, and curing practices. Ever since the term high-performance concrete was introduced into the industry, it had widely used in large-scale concrete construction that demands high strength, high flow ability, and high durability.Concretes of strengths above 40 MPa are generally considered to produce high strengths.

HPC is nothing but high strength concrete not only gives high ultimate strength but performs better in many aspects like durability, abrasion resistance and sulphate attack etc. According to ACI High performance concrete is defined as material meeting special combinations and uniformity requirements and performance that cannot be always be achieved by Normal mixing, placing and using conventional materials. Production of concrete having high strength and showing high performance has become the need of the hour as construction industry is rapidly progressing. Such concrete is known as high performance concrete(HPC).

High Performance Concrete plays an important role in present constructional activities. High rise buildings and off shore structures and long span bridges, structures at marine environment are requires high strength concrete for its more stability and durability for lifetime. There is a possibility of obtaining required high performance characteristics for concrete with low water cement ratios and use of super-plasticizers.

The usage of cement in constructions and the cement manufacturing industries are releasing large amount of CO2 into the atmosphere. This results in increasing the global warming there by increasing the environmental pollution. So the need of alternatives for cement is necessary.The chief green house gas, CO2 is mainly coming out from cement industries next to thermal power plants. Hence any work which reduces the emission of CO2 is the need of the hour. Hence from historical observations cement is partially replaced by fly ash for obtaining good quality concrete versions.

The research shows that cement may be partially replaced by fly ash to achieve concrete which is economical and having better performance. Fly ash replacing the cement in concrete improves durability, workability, lowers heat of hydration hence helps in elimination of cracks. The main problems in using crushed glass as aggregate in Portland cement concrete are expansion and cracking caused by the glass aggregate due to alkali silica reaction. This may be tackled by the silica content of the fly ash which is a pozzolanic material. Addition of Alccofine is another supplementary cementitious material which is being used in production of HPC.

To produce high performance concrete in economical way, need of alternatives is necessary for the sustainable growth. Due to the increasing the demand of conventional materials, search for alternatives to produce sustainable constructions is on the platform. So it is hoped that use of Alccofine and Fly ash to produce high strength concrete as a replacement of cement will definitely becomes as a good alternative materials. Through this experimental study this is investigated.

II. OBJECTIVE IF THE PRESENT WORK

- To investigate the strength properties of HPC by M80 grade.
- To investigate the durability properties of HPC by M80 grade.
- To investigate the maximum percentage partial replacement of cement by Fly ash Alccofine.
- To investigate how the Alccofine and Fly ash improves the pore structure and durability of concrete.

III. MATERIALS USED

In this experimental program, the primary stage includes the preliminary research on selecting the raw materials. Number of conventional trails is prepared and the mix proportion for M80 grade is selected by choosing constant water cement ratio (0.33). By replacing the cement by30% with fly ash and Alccofine. Fly ash and Alccofine were added in varying percentages individually without crossing the limit of 30%. The main experimental work involves the replacement with Fly ash and Alccofine and study of strength and durability properties for M80 grade concrete.

CEMENTITIOUS MATERIALS:

CEMENT: Cement is the main ingredient in manufacturing of concrete. The characteristics of concrete will be greatly affected by changing the cement content. The cement used in this project is Ordinary Portland cement of 53 grade confirming to IS 12269 – 1987.

FLY ASH :The fly ash used in the present work is supplied by VTPS power plant in Vijayawada and the fly ash is of class C-type. Fly ash is largely made up of calcium oxide and silicon oxide can be used as a substitute or as a supplement for ordinary port land cement. Normally Fly ash used concrete is also known as green concrete. The specific gravity of Fly ash is 2.04

ALCCOFINE :Alccofine 1203 is proprietary low calcium silicate based mineral additive. Controlled granulation process results in unique particle size distribution. Its latent hydraulic property and pozzolanic reactivity results in enhanced hydration process. Addition of Alccofine 1203 improves the packing density of paste component. This results in lowering water demand, admixture dosage and hence improving strength and durability parameters of concrete at all ages.

Fig. 1. Alccofine

FIELDS OF APPLICATION

1. RCC residential, commercial structures
2.High rise structures with challenging situations to pump the concrete with ease
3.Temperature controlled mass concrete for raft and pile foundations
4.Aluminium / tunnel form work with high flow or self-compacting concrete
5.High performance concrete with extremely low water to binder ratio
6.Shotcrete with improved cohesion and faster initial strength gain
7.Precast concrete elements for tunnels, bridge, segmental construction, blocks, hollow core slabs, commercial precast units
8.Post tension / pre stressed concrete slab
9.Construction grouts, plasters, repair mortars
10.LEED / GREEN compliant structures

FINE AGGREGATE: Aggregates of size ranges between 0.075mm – 4.75mm are generally considered as fine aggregates. In this experimental work two types of fine aggregate were used. They are River sand and Glass powder. The river sand was partially replaced by the Glass powder. The fine aggregates are selected as per IS-383 specifications.

RIVER SAND: It is also called as natural sand. In this work a good quality of natural sand was used. The sand is medium sand and is confirming to Zone-II as per standard specifications.

COARSE AGGREGATE: Aggregates of size more than 4.75mm are generally considered as coarse aggregate. The maximum size of coarse aggregate used in this experimental are 20 mm. A good quality of coarse aggregates is obtained from nearest crusher unit. The coarse aggregates are selected as per IS-383 specifications.

CHEMICAL ADMIXTURE: Chemical admixtures in concrete are confirms to ASTM C 494 Specifications. Chemical admixtures will gives required workability with low water contents. They improves the workability and concrete quality. In this Experimental work GLENIUM B233 is used as a super plasticizer. GLENIUM B233:BASF GLENIUM B233 is a super plasticizing admixture. Glenium B233 is an admixture of a new generation based on modified poly-carboxylic ether. The product has been primarily developed for applications in high performance concrete where the highest durability and performance is required. In this experimental work, the amount of Super Plasticizer used is of 0.3% by cement weight.

IV. EXPERIMENTAL PROGRAM

In this experimental work, the mix design method used is of ACI 211.1 – 1991. This mix design is adopted after conducting several conventional trails.

Table .1 Mix proportion ratio for M80

Grade	Mix Ratio	W/C ratio
M80	1: 0.93: 1.81	0.33

MIX PROPOTION DETAILS

Cement = 600Kg/m^3

Fine aggregate = 558 Kg/m^3

Coarse aggregates = 1086 Kg/m^3

Table .2 Composition for trial mixes

	CEMENT	FLY ASH	ALCCOFINE
Mix name	(%)	(%)	(%)
CM	100	0	0
M1	70	26	4
M2	70	24	6
M3	70	22	8
M4	70	20	10

Table. 3 Quantities of trial mix proportions

Mix name	Cement (kg)	Fine aggregate(kg)	Course aggregate(kg)	Fly Ash (kg)	Alccofine (kg)	Water (lit/m^3)	Super plastizer
CM	600	558	1086	0	0	198	1.8
M1	420	558	1086	156	24	198	1.8
M2	420	558	1086	144	36	198	1.8
M3	420	558	1086	132	48	198	1.8
M4	420	558	1086	120	60	198	1.8

V. RESULTS AND DISCUSSION

The research work is carried out on M80 grade concrete with constant water cement ratio 0.33 and partial replacements of cement with Fly ash and Alccofine..

COMPRESSIVE STRENGTH:

Compressive strength is obtained by applying crushing load on the cube surface. So it is also called as Crushing strength. Compressive strength of concrete is calculated by casting 150mm x 150mm x 150mm cubes. The test results are presented here for the compressive strength of 28 days of testing.

Table .4 Compressive strengths for M80

Mix name	Compressive strength(N/mm^2) @28days
CM	90.01
M1	91.29
M2	92.07
M3	93.52
M4	89.72

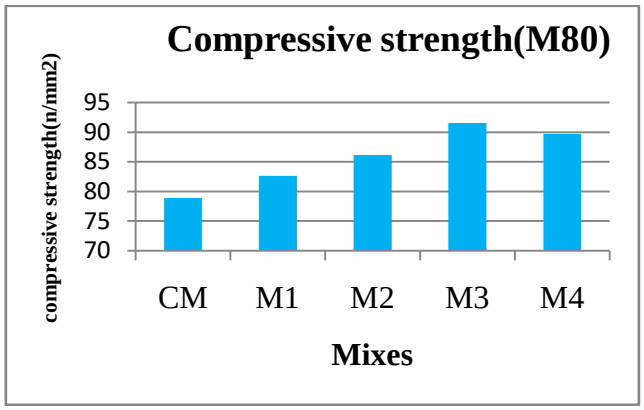

Fig .2 Compressive strength variation for M80 grade at28 days

FLEXURAL STRENGTH:

The modulus of rupture is the main property for the flexural members. To improve the flexural strength of concrete is one main task in present construction activities. The beam dimensions are of 500mm x 100mm x 100mm. The test results are presented here for the compressive strength of 28 days of testing.

Table .5 Flexural strength for M80

Mix name	Flexural strength(N/mm2) @28days
CM	8.2
M1	8.6
M2	9.2
M3	9.8
M4	9.1

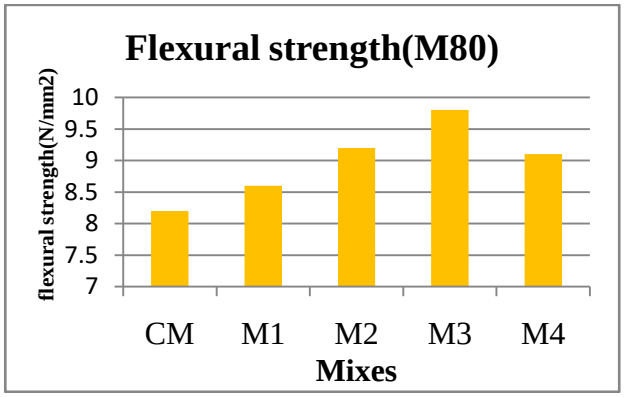

Fig .3 Flexural strength variation for M80 grade at 28 days

SPLIT TENSILE STRENGTH:

Out of all the properties of concrete, tensile strength is very important one. The tensile strength is calculated by testing cylindrical specimens of size 300mm height and 150mm diameter. Here each set of specimens are tested for 28 days of curing.

Table .6 Split tensile strength for M80

Mix name	Spilt tensile strength (N/mm^2) @28days
CM	6.2
M1	6.5
M2	7.4
M3	7.9
M4	7.1

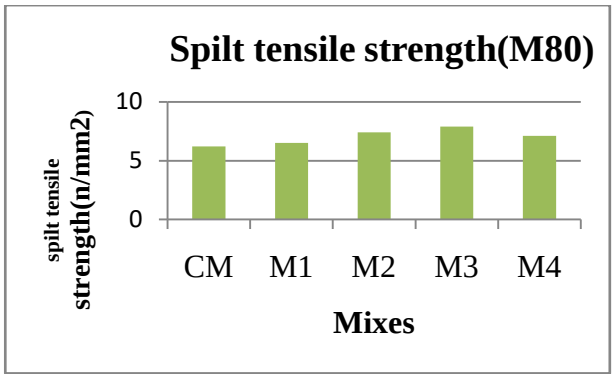

Fig .4 Split Tensile strength variation for M80 grade at 28 days

VI. CONCLUSIONS

These following conclusions are given based on the above experimental results.

- In the present investigation possibility of using supplementary cementitious materials in achieving high strengths for M80 grade concrete.
- The material Alccofine is a good alternative to replace cement that it satisfied all the requirements and it can be used for all constructional purposes .
- The waste material from thermal power plants called Fly Ash can be effectively used as supplementary cementitious materials.
- The combination of Fly Ash and Alccofine found to yield good results in making high strength concretes.
- By using Glenium B233 as superplastisizer at a dosage of 0.3% shows better workability and uniformity in mixing of concrete. It is a good water reducing agent.
- In the present study the partial replacement of cement was limited to 30%. Hence with in the 30% the Fly ash and Alccofine contents were varied.
- Alccofine was added at 4, 6,8 & 10 % of weight of cement and remaining was added with Flyash.
- In this experimental study it was identified that the higher strength is achieved at partial replacement of cement by Fly ash in 22% and Alccofine in 8% individually. Beyond 8% addition of Alccofine, strength starts decreasing.
- For M80 grade, maximum compressive strength of 93.52 Mpa, Split tensile strength of 7.9 Mpa and Flexural strength of 9.8Mpa had occurred for cement by fly ash 22%and Alccofine 8%.

Scope for further study:

- ✓ Higher percentages of Alccofine may be added and studied with different concretes.
- ✓ Different admixtures can be used along with alccofine and fly ash, and the strength and durability tests can be conducted for observing further improvement.

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