Experimental study on high performance concrete using waste material

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ABSTRACT

The High Performance Concrete is the special concrete that shows in all aspects namely durability, workability strength and tensile properties of concrete and also the productivity of concrete. The utilization of high performance concrete in construction industry is increasing because its performance is good in all aspects. There is a tremendous growth in construction activities and the usage of high performance concrete is higher when compares to the normal concrete, due to its potential performance like durability and other engineering factors. The production of HPC is made by replacing some admixtures in place of normal OPC. The present study focuses on economical concrete and also high performance concrete for this the following materials have been selected for the study Flyash, GGBFS and Alcofine 1203. In this experimental investigation the alcofine is replaced by 5% and 3% in the place of normal cement, and 30% of GGBFS is added and finally the results of HPC are studied for fresh concrete mix and hardened concrete.

Key words: M65 Grade, GGBFS, Crushed sand, Alcofine

Introduction

The High Performance Concrete is the concrete (HPC) which have the special characteristics like highly durable, workable, very good in tensile strength and shear strength. In this present experimental study the pozzolanic admixtures like Flyash, GGBFS and Alcofine are used for making the HPC concrete cubes for M65 grade is prepared with the water cement ratio of 0.29. The mix design is carried out by IS 10262: 2019 is used. The experimental studies like various mechanical properties like compressive strength, flexural strength and split tensile strength have been studied and also slump test for various mix proportions is carried out to understand the workability parameters of HPC. The various percentage replacement of OPC by Alcofine is 5%,

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3% and 0 and the experimental study was performed. The materials used for the study was Flyash it is a byproduct coming from power plant and it has its own pozzolonic property, GGBFS also shows cementitious property and alcofine is a ultrafine material that is coming from GGBFS and it have very good binding property, initial test on the various materials are studied and the values are incorporated in the mix design.

Materials Used and its Properties

In this current research work on HPC the materials used are OPC cement 53 grade is used the mineral admixtures are Flyash, GGBFS and alcofine are taken for this study. The cement is confirming to IS 12269 – 1987. The Flyash and GGBFS are used for the test because the calcium content is more than

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40% so it has very good cementitious property. The alcofine is the sub product of GGBFS it is ultrafine particles it's filled up the pores present in the concrete and improve the durability of the concrete. In this study combined aggregates were used like coarse and fine aggregates are utilized. The crushed sand was used its confirming to zone-II as per IS-383-2016 specifications. In coarse aggregate more than 4.75 mm are taken 10 mm and 20 mm in 50% ratios are incorporated. The coarse aggregates was used its confirming to zone-II as per IS-383-2016 specifications. Water conforming to IS: 456-2000 was used for mixing and curing. The chemical admixture is FORSOC Auramix 402 is a super plasticizer used for high performance concrete for reducing the water content in concrete mix. The chemical compositions of GGBFS and Alcofine is shown in Table 1 and 2.

Table 1. Chemical Composition of GGBFS

S.No	Ingredient	% of content
1.	Calcium Oxide (CaO)	40%-52%
2.	Silicon ioxide (SiO2)	10% - 19%
3.	Iron Oxie (FeO)	10%-40
4.	Manganese Oxide (MnO)	5-8
5.	Magnesium Oxide (MgO)	5-10
6.	Aluminium Oxide	1-3

Concrete Mix Design

The HPC mix design is made with the IS: 10262: 2019. In this study M65 grade concrete strength was done by IS code provisions. The design mix are prepared for the various materials like, OPC 53 grade cement, sand conforming to zone-II and coarse aggregates of size 20mm & 10mm was used. And mineral admixture of GGBFS and alcofine 1203 is utilized and water cement ratio of 0.29 is used in the mix design. The initial test values on various materials are tabulated in Table 3. The HPC trail mix proportions of M65 grade concrete is tabulated in Table 4. The mix design values are arrived and the mate-

Table 3. Experimental Values of Materials

S.No	Tests	Values
1	Consistency of cement	27%
2	Initial setting time of Cement	35 min
3	Final setting time of Cement	200 min
4	Fineness of Cement	1.23%
5	Soundness of Cement	1mm
6	Specific Gravity of Cement	3.12g/cm ³
7	Specific Gravity of Fine Aggregate	2.71
8	Specific Gravity of Coarse Aggregate	e 2.71
9	Fineness modulus Fine Aggregate	2.84
10	Specific Gravity of GGBS (JSW)	2.94
11	Specific Gravity of Alcofine-1203	2.85
12	Specific Gravity of FOSROC 402	1.088
13	Zone of Fine Aggregate	Π
14	Compressive Strength of Cement	64.87N/mm ²

rials are batched for preparation of cubes, prisms and cylinders for finding out the mechanical properties of the concrete, and also after the mixing of ingredients the fresh concrete test was performed, the slump cone is done for various proportions of concrete and slump cone test results are tabulated in Table 5.

The slump results are tabulated in that the adding of alcofine to the cement that reduces the water cement ratio and increase the workability because of the ultrafine property to increase the less friction between the particles and make more lubricating and then the workability is increased.

Preparation of Test Specimens

For conducting the compressive strength the cube was casted at the size of 150 X 150 X 150 mm, then the fresh concrete is mixed in the pan mixer to get the uniform blend along with the mix ingredients, and the needle vibrator is used to compact the mould, after 24 hours the cubes are demoulded and immersed in water for 28 days for curing.

The compression test was performed in compression testing machine and the compressive strength is arrived for the three different proportions. The split

Table 2. Chemical Composition of Alcofine (Ultra fine GGBFS)

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Chemical	Analysis Mss %	Physical Analysis	Range
CaO	32-34	Bulk Density	600-700 KG/m3
A1,0,	18-20	Surface area	12000 CM2/GM
Fe ₂ O ₃	1.8-2	Particle Shape	Irregular
SO ₃	0.3-0.7	Particle Size D10	<2µ
MgO	8-10	D50	<5μ
SiO	32-34	D90	<9µ

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Fig. 1. Cubes casted for compressive strength.

tensile strength of concrete cylinder of size 150mm diameter and 300 mm height conforming to IS:



Fig. 2. Compressive test on M65 grade concrete.

Table 4. Mix Proportions	5 M65	grade	concrete.
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Fig. 3. Split Tensile strength .

10086-1982 and split tensile strength was determined, for determining the flexural characteristics of concrete prisms were casted to the size of 15 X 15 X



Fig. 4. Flexural Strength test setup.

Ingredients	Concrete Trail Mix			
	M65-1	M65-2	M65-3	
Cement	377 kg	375 kg	400 kg	
GGBS	174 kg	168 kg	170.4 kg	
Ultrafine GGBS Alcofine 1203	5%-29 kg	3.04 % -17 kg	0	
Coarse Aggregate 20 mm	564.3 kg	523.57 kg	510 kg	
Coarse Aggregate 10 mm	461.71 kg	523.57 kg	510 kg	
Crushed Stone Sand	673.91kg	687.79kg	670kg	
Water	168.2 kg	162.4 kg	162.4 kg	
Admixture 1.05% (Super Plasticizer)	5.880 kg	5.880 kg	5.880 kg	
Total	2453.92 Kg	2463.21 Kg	2428.68 Kg	

Table	5.	Mix	Pro	portions	M65	grade	concrete.
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Trail Mix No.	Alcofine/cement	Initial	30 Min	60 Min	90 Min	120 Min
M65-1	5% -29	Collapse	Collapse	190	155	125
M65-2	3.04%-17	Collapse	Collapse	190	150	125
M65-3	0	Collapse	Collapse	150	130	100

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Trail Mix No	Alcofine Percentage by wt. of cementitious material	07 Days N/mm²	28 Days N/mm²
M65-1	5% -29 kg	79.56	98.77
M65-2	3.04%- 17kg	77.34	88.02
M65-3	0	60	75

Table 6. Compressive Strength Results.

Table 7. Split Tensile Strength Results.

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Trail Mix No	Alcofine Percentage by wt. of cementitious material	07 Days N/mm²	28 Days N/mm²
M65-1	5% -29kg	4.1	9.25
M65-2	3.04%- 17Kg	3.6	6.89
M65-3	0	3.4	5.23

Table 8. Flexural Strength results.

Trail Mix No	Alcofine Percentage by wt. of cementitious material	07 Days N/mm²	28 Days N/mm ²
M65-1	5% -29kg	6.5	11.36
M65-2	3.04%- 17Kg	4.8	8.53
M65-3	0	4.5	6.81

70 cm respectively and its is tested in amslers UTM testing machine under two point loading.

In the compressive strength, the test carried out for the three different proportions for 5 % of replacement of alcofine to cement in this the concrete attains the higher strength of 98.77 N/mm^2 .

The split tensile strength results show that the M65 grade of mix proportions of 5% replacement of alcofine with cement posses the better result.

Conclusion

Concrete is the most used materials on this earth next to the water because of huge demand in construction industry. The drastic change in construction industry is the one of the responsible for the global warming effects because of high usage of cement to replace and cement with other binding material to the cement will reduce the cement consumption and the usage the global warming effect will be reduced and also on the other side waste materials are generating abundantly in the environment and it is very difficult to dump and handle it will make a nuisance to the public and the environment. In this research work such a novel approach is made and the waste is utilized in a proper manner, in the current study the GGBFS and Alcofine that is ultrafine GGBFS is used to make more durable high performance concrete of strength grade M65.

The HPC is made with 5% replacement of alcofine with cement and crushed sand is used. In the construction industry the time is an important component for accomplishing the task and also the strength, workability, durability and placement of concrete likewise the performance should be enhanced for the better output. This study was carried out in there different proportions from that 5% of alcofine replacement and 30% of GGBFS produces the better results. In the mechanical properties like compressive strength, flexural strength, split tensile strength the 5% replacement of alcofine produces the good results that are tabulated. The fresh concrete test also shows good move that the replacement of alcofine with cement have some viscous effect and the workability is increased with less amount water cement ratio is adopted. Hence the M65 grade HPC proves the better results with incorporating the alcofine and GGBFS with the normal cement.

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