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STUDY ON STRENGTH CHARACTERISTICS OF CONCRETE BY PARTIAL REPLACEMENT OF CEMENT WITH ALCCOFINE

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ABSTRACT— The growth in the next leg of industrialisation and urbanization infrastructure is the biggest catalyst of India's growth. A landmark in history has been created by manufacturing Alccofine which is a new generation ultrafine low calcium silicate product. It is a typical ground granulated blast slag furnace modulated by certain chemicals. It is specially processed material based on slag of high glass content with high reactivity obtained through the process of controlled granulation. It consumes calcium hydroxide from the hydration of cement to form additional C-S-H gel. The partial replacement of cement with Alccofine reduces water demand for same workability. It produces dense pore structure and ultimately higher strength gain. For growing infrastructure especially at low levels of high buildings, high strength concrete is required. This partial replacement results in better durability also. In the present study, the strength characteristics of concrete are observed by partially replacing the cement in concrete with 8%, 10% and 12% Alccofine and compared with normal concrete.

KEYWORDS— Concrete, Cement, Alccofine, compressive strength, C-S-H Gel

I. INTRODUCTION

ALCCOFINE 1203 is a specially processed product based on slag of high glass content with high reactivity obtained through the process of controlled granulation. The raw materials are composed primary of low calcium silicates. The processing with other select ingredients results in controlled particle size distribution (PSD). The computed blain value based on PSD is around 12000cm^2/gm and is truly ultra-fine. The physical and chemical analysis of Alccofine is table 1. Due to its unique chemistry and ultra-fine particle size, ALCCOFINE1203 provides reduced water demand for a given workability, even up to 70% replacement level as per requirement of concrete performance. ALCCOFINE 1203 can also be used as a high range water reducer to improve compressive strength or as a super workability aid to improve flow. ALCCOFINE1203 performs in superior manner than all other mineral admixtures used in concrete within India. Due to its inbuilt CaO content, ALCCOFINE1203 triggers two-way reactions during hydration

• Primary reaction of cement hydration.

• Pozzolanic reaction: ALCCOFINE also consumes by product calcium hydroxide from the hydration of cement to form additional C-S-H gel, like pozzolans.

This results in denser pore structure and ultimately higher strength gain.

TABLE I
PROPERTIES OF ALCCOFINE

CHEMICAL ANALYSIS	**MASS %**	**PHYSICAL ANALYSIS**	**RANGE**
CaO	30-33	Bulk density	500-700 kg/m3
Al2O3	17-21	Surface Area	11000 cm2/gm
Fe2O3	1.7-2	Particle shape	Irregular
SO3	0.4-0.8	Particle Size, D10	<2µ
MgO	7-10	D50	<5µ
SiO2	32-36	D60	<9µ

II. LITERATURE REVIEW

Y. H Patel, P. J.Patel, Prof. J. M Patel and H S Patel (2013)[1] had done experimental investigation on durability properties of concrete by replacing cement with alccofine and fly ash. From the investigation they concluded that concrete incorporating alccofine and fly ash have better compressive strength compared to normal concrete. It is found that Alccofine improved the durability of concrete and decreased the chloride diffusion. it is determined that during accelerated electrolytic corrosion test loss of weight for steel in alccofine is much less, so in alccofine regular cover is sufficient to prevent steel from corrosion because of its pore filling and pore refining of particle.

Siddharth. P and Jamnu M. A (2014) [2] conducted experimental work on compressive strength of self-compacting concrete (SCC) by replacing cement with alccofine, fly ash and natural sand with m-sand. They observed that by adding alccofine the strength has been increased rapidly at early stages then that of fly ash. The combination of fly ash-alccofine yielded better strength than that of concrete with fly ash and alccofine at all levels. The highest compressive strength is achieved by replacing cement at 10% alccofine and 30% fly ash. The addition of alccofine increases the self-compatibility characters of concrete like filling and passing abilities, it also helps in resisting segregation.

Saurabh, Dr. Sanjay and Dr. Devinder (2013) [3] have done investigation on strength of concrete containing alccofine and concluded that the use of alccofine as mineral admixture will increase the strength than traditional concrete. The concrettion level of alccofine is extended beyond the limit it acts as a filler material and yields high workability to the concrete. The concrete with alccofine shows higher workability and retain the workability for sufficient time. Alccofine can be easily mixed with cement and materials and it also helps in reducing water-binder ratio

Ansari, Chaudhri, Ghuge N.P and Phatangre (2015) [4] conducted an investigation on replacing cement by supplementary cementitious materials like alccofine and fly ash for M70 grade of concrete. In this research the compressive strength of concrete with alccofine, fly ash and the results are compared with normal concrete. From this investigation they observed partially replacing cement by alccofine the strength of concrete increased by 20%. It was found that alccofine is less expensive than cement and so it achieved higher strength then ordinary concrete, so it is recommended by them in Indian construction industry.

D. Soni, S. Kulkarni and V. Parekh (2013) [5] evaluated the mechanical properties of concrete containing alccofine and concluded that alccofine will increase the strength in both compression and in flexure to a huge extent at 10% substitute level of cement. It is found that the strength development take place in concrete at all ages of curing. The strength increased rapidly at early age and after that increased gradually. If the proportion level of alccofine is extended beyond the limit it acts as a filler material and yields high workability to the concrete.

III. MATERIALS USED

A. Cement

In the present investigation, 53 Grade of Cement (OPC) was used for all concrete mixes and it is manufactured by Zurai cements pvt ltd. The table 2 below shows the properties of cement tested in the laboratory.

TABLE 2

SR. NO	Properties	Result
1	Fineness	5%
2	Specific Gravity	3.13

B. Fine Aggregates

Fine aggregate is defined as material that will pass through 4.75mm sieve and will, for the most part, be retained on a 75 sieve. For increasing the workability and economical purpose, the fine aggregate should have a rounded shape.

The purpose of the fine aggregate is to act as a workability agent. For this purpose, we have used aggregates passing through the2.36 mm sieve. Table 3 shows the properties of fine aggregate used in the experiment.

TABLE 3
PHYSICAL PROPERTIES OF FINE AGGREGATE

SR. NO	Properties	Result
1	Specific gravity	2.63
2	Fineness modulus	3.002
3	Water absorption	0%

C. Coarse Aggregate

Coarse aggregate used can be gravel resulting from the crushing of parent rock, natural rock, slags, expanded clay and shale (lightweight aggregates) and other approved inert materials with similar characteristics, having hard, strong, durable particles. Table 4 shows the properties of coarse aggregate used in the experiment.

TABLE 4

PHYSICAL PROPERTIES OF COARSE AGGREGATE

SR. NO	Properties	Result
1	Specific gravity	2.702
2	Fineness modulus	7.82
3	Water absorption	0%

IV.MIX DESIGN FOR M50 GRADE OF CONCRETE

M50 Grade of concrete mix design was done according to the code IS 10262-2009. The following proportions are formulated. Mix Proportioning of M50 Grade is shown in Table 5.

TABLE 5
MIX PROPORTION OF M50 GRADE OF 1m^3 CONCRETE

Cement	Fine Aggregate	Coarse Aggregate	Water
437.77	648.03	1236.43	157.6
1	1.48	2.82	0.36

V.METHODOLOGY

The methodology adopted includes collection of data from literature reviews, case studies, questionnaires and websites. Then preliminary tests like specific gravity of cement, fine aggregate and coarse aggregate, grain size distribution of fine aggregate and coarse aggregate are performed. Mix design of M50 grade of concrete is formulated and sample cubes of dimensions 150*150*150 mm are prepared which are shown in Figure 1 to determine the compressive strength of the mix. The number of cubes casted are shown in table 6. Then concrete cubes are prepared by partially replacing the cement in concrete with 8%, 10% and 12% Alccofine. These cubes are allowed to cure for 7 days to determine 7 day compressive strength and 28 days to determine characteristic compressive strength.

The compressive strength of concrete mixes was studied using cubes of size 150 mm x 150 mm x 150 mm in accordance with ASTM C109. All the cubes were cured under ambient temperature condition. For each trial mix, the average of three specimens were taken to determine the compressive strength at the age of 7 and 28 days of curing loaded under 3000 kN capacity compression testing machine (CTM). The arrangement of the cube in the CTM before loading is shown in Figure 2.

Fig 1: CASTED CUBES

Fig 2: COMPRESSION TESTING MACHINE

TABLE 6
NUMBER OF CUBES CASTED

PURPOSE	NORMAL	8%	10%	12%
7 DAYS COMPRESSIVE STRENGTH	3	3	3	3
28 DAYS COMPRESSIVE STRENGTH	3	3	3	3

The experiments were performed at a consistent stress following the sample which has been kept at the centre in the CTM. The load was applied continuously till its direction gets reversed. The reversal of load direction demonstrates that the sample has failed. The load at that instant was noted which was recorded as ultimate load, which when divided by the cross-sectional area of the plane perpendicular to the axis of loading is equivalent to the compressive strength of concrete.

VI. RESULTS AND DISCUSSIONS

The 7 days and 28 days compressive strength are shown in table 7 and table 8. Figure 3 shows increment in compressive strength due to addition of alccofine.

TABLE 7
7 DAYS COMPRESSIVE STRENGTH

SR. NO	NORMAL	8%	10%	12%
1 (kN)	820	1020	1080	1050
2(kN)	910	980	1100	1110
3(kN)	850	1070	960	1040
Average Load at failure(kN)	860	1030	1046.66	1060
Compressive strength(N/mm^2)	38.22	45.71	46.51	47.1
Percentage increment in strength (%)	-	19.59	21.61	23.23

TABLE 8
28 DAYS CHARACTERISTIC COMPRESSIVE STRENGTH

SR. NO	NORMAL	8%	10%	12%
1(kN)	1310	1580	1610	1590
2(kN)	1290	1470	1640	1670
3(kN)	1350	1600	1570	1620
Average Load at failure(kN)	1316.6	1556.66	1606.6	1626.67
Compressive strength (N/mm^2)	58.51	69.18	71.4	72.29
Percentage increment in strength (%)	-	18.24	22.03	23.6

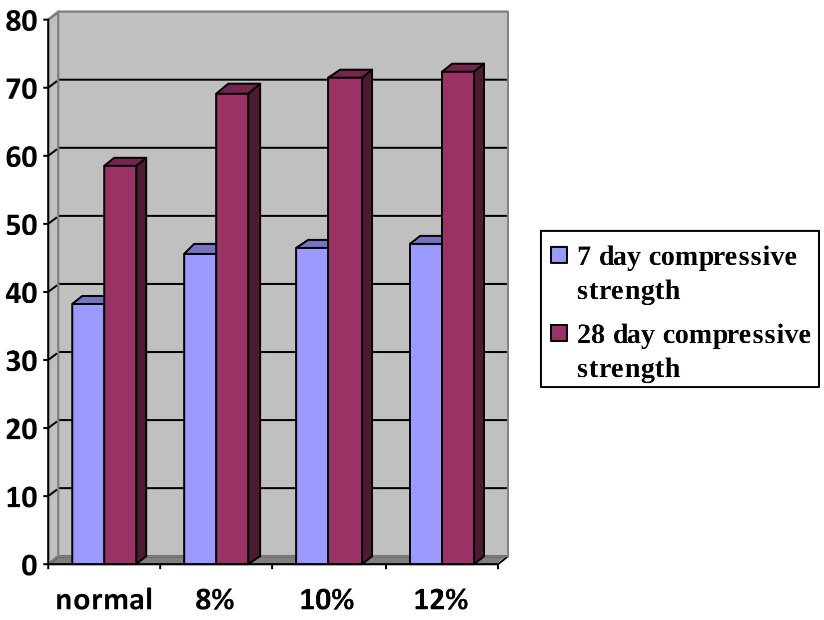

FIG. 3 FIGURE SHOWING INCREMENT IN COMPRESSIVE STRENGTH DUE TO ADDITION OF ALCCOFINE

From the above results, it shows there is strength increment of concrete with the partial replacement of cement with alccofine compared to that of normal concrete. The strength goes on increasing with the increasing replacement levels. The early strength increment is greater than 28 days compressive strength increment. The characteristic compressive strength increment at 8%, 10%, 12% replacement levels are 18.24%, 22.03%, 23.6% of that of normal strength concrete respectively.

VII. CONCLUSION

There is more strength increment between 8% and 10% replacement compared to 10% and 12% replacements. There is slight increment from 10% to 12% replacement levels and therefore it can be concluded that 10% replacement is the optimum percentage of replacement of cement.

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