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Experimental Study on Performance of Concrete Incorporated with Alccofine-1203 And Fly ASH

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ABSTRACT

The main issue with cement manufacture is that a considerable amount of carbondioxide is released, which raises the temperature of the atmosphere, resulting in global warming. As a result, we need a long-term replacement of cement in concrete to address the problem of global warming caused by carbon dioxide emissions. Alccofine 1203 is a custom-made material generated by a controlled granulation process with a high glass content and strong reactivity. Concrete gets extraordinary strength at a young age due to the use of Alccofine material. In this experiment, alccofine was replaced for the weight of cement by 0 percent, 10%, 15%, 20%, and 25% of the time, respectively. Several criteria were studied at 7 and 28 days after curing, including workability of fresh concrete using a slump cone and a compaction factor test, compressive strength on concrete cubes, and split tensile strength on concrete cylinders. The concrete grade used was M30. The findings reveal that the Alccofine material increases concrete strength significantly up to a replacement level of 25%, beyond which the concrete's strength starts to decrease. Based on the increase in strength in the variation of concrete mix, it provides better performance, implying that the use of waste material as a mineral supplement for concrete should be promoted.

Keywords : Alccofine, Compressive Strength, Split Tensile Strength.

I. INTRODUCTION

In the building industry, concrete is one of the most often utilised materials. For the most part, Portland cement is used as the primary component in the production of concrete. This research focuses on using fly ash and ALCCOFINE 1203 to partially replace cement. Concrete's strength, durability, and resistance to chemical assault are all improved with this substitution. Concrete is usually the most densely packed material. Portland cement, aggregate, and water are the main ingredients of concrete. Although Portland cement provides for just around 12% of the mass of concrete, it contributes for about 93 percent of the total embodied energy of concrete and 6 to 7% of global CO_2 emissions. Silica Fume is often recommended as the ideal cement extender in high-performance concrete applications where high strength and low permeability are the primary criteria. Though silica fume is known to enhance durability, the increased water and/or additive dose necessary to improve the workability and handling attributes of new concrete generally negates its inclusion.

Concrete is a composite material made up mostly of coarse aggregate linked together by a fluid cement that hardens over time. In today's environment, producing high-quality concrete is not exclusively dependent on reaching high strength properties. Lime-based concretes, such as Portland cement concrete or concrete manufactured with various hydraulic cements, are the most often utilised. However, road surfaces are a sort of concrete, with asphalt concrete including bitumen as the cementing ingredient and polymer concretes containing a polymer as the cementing material.

1.1 FLY ASH

The finest coal ash particles are called fly ash. Fly ash gets its name from the fact that it is carried out from the combustion chamber by exhaust gases. Fly ash is a fine powder produced from the mineral content in coal, consisting mostly of noncombustible materials and a tiny amount of carbon left over after incomplete combustion. Fly ash has a light brown hue and is largely made up of glassy spheres the size of silt and clay. Fly ash properties vary greatly depending on coal content and plant operating circumstances. In the United States, over 50 million tonnes of fly ash are recycled each year.

1.2 ASH PROPERTIES

Specific gravity, fineness, as determined by the amount retained when wet-sieved on No. 200 and No. 325 sieves; pozzolanic activity index with portland cement and pozzolanic activity index with lime; and lime-pozzolan strength development, as well as the related ASTM specification criteria, were all performed on the fly ashes. Except for the loss on ignition values and CaO concentrations, the utility companies gave data on the chemical tests of the ashes given in the table. The Amos ash, on the other hand, has a greater total quantity of glassy components (Si02, Al0, and Fe20 3) than the Harrison ash, as well as a higher pozzolanic activity index with lime and a higher lime-pozzolan strength development value.

1.3 ALCCOFINE-1203

The alccofine-1203 will be utilised as a partial cement alternative (OPC). The study also looks at the behaviour of alccofine-1203, which is utilised in stiff pavement concrete mixes. It also examines workability, compressive strength, and flexural-strength values. To compare the engineering qualities of traditional concrete and an alccofine concrete mix, as well as to investigate the impact of alccofine on fresh and hardening properties.

The initial strength of alccofine 1203 concrete is comparable to or higher than that of silica because it activates the main reaction during hydration, and alccofine also consumes calcium hydroxide from the hydration of cement from extra C-S-H gel, which is similar to pozzolana. Based on particle size distribution, the estimated blain value is roughly 1200cm2/gm, which is indeed super fine.

II. METHODOLOGY

2.1 MATERIAL INVESTIGATION:

Cement:

Cement is a binder, which is a substance that sets and hardens and may be used to join various materials together. Cement comes in a range of shapes and sizes. The cement was split into three classes based on its strength after 28 days: 33 grade, 43 grade, and 53 grade. Pozzolona Portland cement, grade 53, from the Ultratech cement brand is utilised in this experiment.

Fine aggregate:

Fine aggregate is defined as aggregate with a size smaller than 4.75mm. The sand particles should be devoid of clay and inorganic components, as well as firm and long-lasting. River sand from Zone II was used in this project.

Coarse aggregate:

Crushed angular aggregate of size 20mm have been used.

Water:

Locally available potable water is used.

Fly Ash:

Class F Fly Ash is used.

Alccofine-1203:

Alccofine-1203 (AF) is a product of Ambuja Cement Ltd, an extra high-purity, high-grade, highlyslag cement material. Alccofine 1203 is a slag based supplementary cementitious material having ultra-finenesss with optimized particle size distribution. Due to its ultra fineness of alccofine 1203, it gives reduced water demand for given workability of concrete, even up to 70% substitution level as per requirement.

In the mix design of concrete of alccofine 1203, the initial strength is found similar or increased to that of silica as it triggers the primary reaction during hydration and alccofine also cosumes by product calcium hydroxide from the hydration of cement from additional C-S-H gel which similar to pozzolana. The computed blain value based on particle size distribution is approximately 1200cm2/gm and is truly ultra fine.

Alccofine-1203 is an additive to concrete and mortars. The density ranges from 600 -700 kg / m 3. • The Alcofine-1203 metal blend can be used to increase strength and economic design. • Alccofine 1203 is a revolutionary new material, used as a substitute to Micro Silica /

Silica Fumes. • Alccofine-1203 provides innovative solutions to improve the performance of Concrete many folds without increasing the cost.

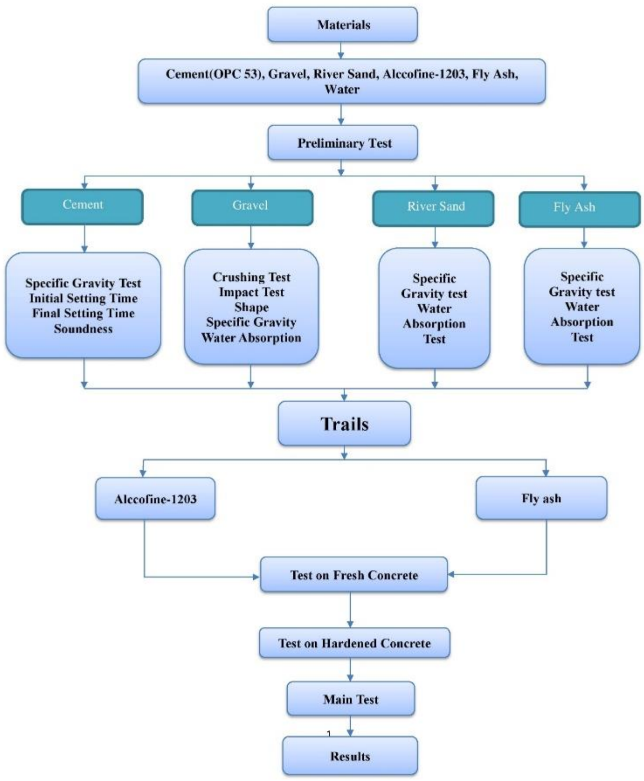

Figure 1: Proposed Methodology

2.2 WORKALIBITY TESTSLUMP CONE TEST

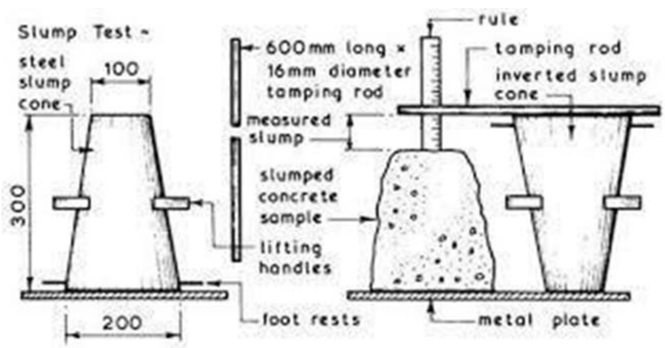

Figure 2 : Typical Mould for Slump Test

The slump test is used to determine if fresh concrete is workable. According to IS1199:1959, the slump measured during the test must be noted in millimetres of specimen sinking (Methods of Sampling and Analysis of Concrete). The test must be performed with a fresh sample if a slump specimen collapses or shears off laterally. The slump should be quantified and the fact that the specimen sheared documented if the specimen shears again in the repeat test.

Figure 3: Slump Cone Experiment

Figure 4: Slump of Concrete

Table 1 : Measured Slump of Concrete

SNO	CONCRETE TYPE	SLUMP VALUE
1	PCC	6 cm
2	SHC	4.5 cm

Step1: Target Strength For Mix Proportioning

$f^{1}_{ck} = f_{ck} + 1.65(s)$

Step2: Selection Of Water Content

Maximum water content for 20mm aggregate=186litres(as per IS1026:2009) Estimated water content for 120mm slump=195.3 litres

Step3: Calculation Of Cement Content

Water Cement Ratio = 0.46 Cement Content = 195.3/0.46

= 488.25kg/m³

Step4: Calculation Of Coarse and Fine Aggregate

Volume of coarse aggregate for water cement ratio of 0.40=0.062 For pumpable concrete these values should be reduced to 10% Volume of coarse aggregate = 0.62x0.9

= 0.56

Volume of fine aggregate = 1 - 0.56 = 0.44

Step5 : Mix Calculations

Volume of concrete =1m³

b) Volume of cement $= \frac{Mass\ of\ cement}{Specific\ gravity\ of\ cement} \times \frac{1}{1000}$

$$= \frac{488.25}{3.16} \times \frac{1}{1000}$$

$$= 0.154 m^3$$

c)Volume of water $= \frac{water\ content}{specific\ gravity\ of\ water} \times \frac{1}{1000}$

$$= \frac{195.3}{1} \times \frac{1}{1000}$$

$$= 0.195 m^3$$

Volume of all in aggregate = a - (b+c)
= 1-(0.154+0.195)
= $0.651m^3$

Mass of coarse aggregate
= Volume of all in aggregate x Volume of coarse aggregate xSpecific gravity of coarse aggregate x 1000
= 0.651x0.56x2.78x1000
= $1013.47kg/m^3$

Mass of fine aggregate
=volume of all in aggregate x volume of fine aggregate x specific gravityof fine aggregate x 1000
= 0.651 x 0..44 x 2.77 x 1000
= $793.43kg/m^3$

Step6 : Mix Proportions
Cement : fine aggregate : Coarse aggregate : water-cement ratio488.25: 793.43: 1013.47: 195.3
1 : 1.62 : 2.07 : 0.40

2.3 MIX PROPORTION:

For M30 grade concrete, maximum water-cement (w/c) ratio is . Here adopted water-cement (w/c) is for Target Mean Strength **N/mm^2**. The material for mix ratio is given below;

Table 2 : Calculated Quantity of Materials

S.NO	MATERIAL	QUANTITY (kg/m^3)	QUANTITY (kg/cube)
1	Cement	488.25	1.68
2	Fine aggregate	793.43	2.72
3	Coarse aggregate	1013.47	3.75
4	Water	195.3	0.46

The volume of cube is (150mmX150mmX150mm) $=3.375 \times 10^{-3}\ m^3$

2.4 QUANTITY OF ADMIXTURE (ALCCOFINE-1203 & FLY ASH) INCONCRETE

The same mix proportion is followed here. Additionally, Alccofine 1203 is added on the basis of various percentage.

SPECIMEN CASTED:

A total of 35 cubes were tested for Compressive Strength including both with and without bacteria concrete specimen. Compressive strength of 7 days and 28 days curing were tested.

Table 3 : Detail of Specimen Casted

S.NO	WEIGHT OFFLY ASH ADDED(gram)	WEIGHT OF ALCCOFINE 1203 ADDED(gram)	NUMBER OF CUBE CASTED
1	-	-	7
2	100g	200g	7
3	100g	300g	7
4	100g	400g	7
5	100g	500g	7

Figure 5: Cube Casted

CURING OF CONCRETE

Curing refers to the process of regulating the rate and degree of moisture loss from concrete during the hydration process. It can be done either after it has been installed (or during the manufacturing of concrete goods), allowing time for the cement to hydrate. Because cement hydration takes days, if not weeks, rather than hours, curing must be done for a suitable amount of time if the concrete is to reach its full strength and durability potential.

Because the rate of hydration and hence strength growth is quicker at higher temperatures, temperature is a crucial component in appropriate curing. For an optimum rate of strength development, the temperature of the concrete should be kept above 50 F (10 C). The casted cubes are then put in a curing tank and let to cure for 28 days.

Figure 6 : Curing of Cube

Compressive strength of cubes at 28 days curing

Si no	Grade of concrete	Discription		Compressive load (KN)	Compressive strength (N/mm)	Average strength(N/mm)
1	M30	Normal concrete		890	39.55	39.89
				905	39.9	
				910	40.22	
2	M30	Fly ash (100g)	Alccofine 10%	933	40.87	41.39
				937	41.54	
				940	41.77	
3	M30		Alccofine 15%	954	42.7	43.84
				956	44.37	
				960	44.46	
4	M30		Alccofine 20%	980	45.83	46.83
				983	46.17	
				990	46.78	
5	M30		Alccofine 25%	1022	47.13	47.26
				1027	47.31	
				1030	47.35	

Flexural strength for 28 days of curing

Si no	Grade of concrete	Name		C. load	Strength N/mm	Average strength
1	M30	Normal concrete		16	33.33	33.33
2	M30	Fly ash (100g)	Alccofine 10%	18	36.98	36.98
3	M30		Alccofine 15%	19	38.29	38.29
4	M30		Alccofine 20%	22	40.88	40.88
5	M30		Alccofine 25%	25	44.17	44.17

III. CONCLUSION

The technique of partial cement substitution utilising Alccofine-1203 and Fly ash was explored in this experimental investigation, and the following conclusions were reached. The optimal dose was found to be a partial replacement of around 25% (12.5 percent of both Alccofine and Fly Ash) based on the findings of the experiment. The quantity of cement in the mixture tends to increase hydration heat. Alccofine assists in the creation of free-flowing, high-flowing concrete with no bleeding or segregation. Hydraulic and pozzolanic dual action are also available from Alccofine. Alccofine helps to make high-strength, high-performance concrete for long-lasting structures. The addition of Alccofine to the combination improved early strength while also improving long-term strength. Following the completion of durability testing on the Alccofine material, it is recommended that it be used in conjunction with cement. This research looked at the effects of Alccofine as a supplementary cementing and filling agent on concrete strength. Self-compatibility properties such as filling, passage, and segregation resistance enhance when Alccofine is used. It increases durability and resilience to chemical attack while also decreasing hydration heat.

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