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Effect of Alccofine on High Strength Concrete

K Jagan

Department of Civil Engineering, Visakha Institute of Engineering and Technology, Visakhapatnam, India.

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ABSTRACT

There have been enormous researches going on the use and utilization of industrial , agricultural and thermoelectric plant residues in the production of concrete. Production of high-strength concrete (HSC) plays an important role with different pozzolanic materials like fly ash, condensed silica fume, blast furnace slag, rise husk ash etc. There has been increase in the consumption of mineral admixture by cement and concrete industries. This rate is expected to increase day by day. The presence of mineral admixture in concrete is known to impart significant improvement in workability and durability in concrete. The present study involves the use of mineral admixture "ultrafine slag" as a cementitious material forcement and to evaluate the threshold limit of replacement of cement. Main aim of this work is to evaluate the compressive strength, flexural strength and split tensile strength of High strength concrete by partial replacement of cement (0,5,10,15,and20%) with ultra-fine slag (Alccofine 1203) for M60 grade of concrete. OPC of 53grade from single source isused in this investigation. Different durability analysis of concrete incorporating ultrafine slag was also carried out. The combination of ordinary Portland cement (OPC) with alccofine was found to increase the compressive strength of concrete on all ages when compared to concrete made with ordinary Portland cement alone and has showed excellent durability characteristic.

KEYWORDS:High strength concrete, alccofine, supplementary cementitious materials

1. INTRODUCTION

Concrete is a hard material that has cementitious medium with in which aggregates areembedded. With the development of concrete technology, the use of concrete in the construction industries have gained pace. Cement is one of the major constituents of aconcrete. Materials other than cement used in the manufacture of concrete are coarse and fine aggregates, admixtures and water. Cement is an extremely important constituen to faconcreteasitbinds together other materials. The raw materials used for the manufacture of cement consist mainly of lime, silica, alumina and iron oxide. These oxides interact with one another in the kiln at high temperature to form four major complex compounds. Concrete is strong and tough material. Reinforced concrete resists cyclones, earthquakes, blast and fires much better than timber and steel if designed properly.

The quality of concrete is determined by its mechanical properties as well as its ability to resist deteriorations. Hardened concrete can be considered to have three distinct phases i.e. the hardened cement paste (HCP) or matrix, the aggregate and the interfacial or transition zone(TZ) between HCP and the aggregate. For optimum performance all the three phases should be considered explicitly. The HCP is about 30% to 40% of the volume of concrete and aggregates constitute 60% to 70% of the volume. Fig shows the different constituents of concrete. Concrete also contains air which iscategories depending on its density and strength as recommended by IS456:2000. The aggregates used in making concrete contribute mainly to its density.

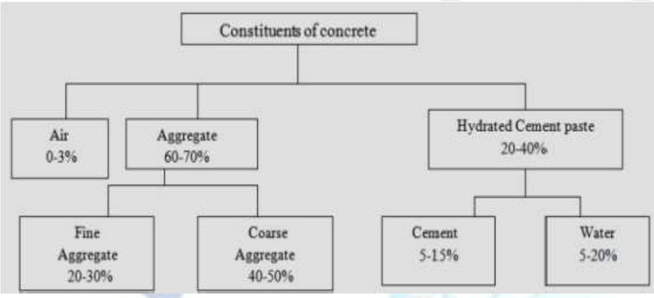

Fig1:Constituents ofConcrete

Classification	MaximumStrength (MPa)	Type
OrdinaryConcrete	<20	Lowstrength
Standardconcrete	20-40	Mediumstrength
HighstrengthConcrete	40-80	Highstrength

Table 1: Classification of concrete based on strength (Source: IS: 456-2000) The strength of concrete is the most important characteristic as it has strong relationship with quality. Strength as a parameter is used for controlling as well as evaluating other properties of concrete because of its relationship with durability and dimensional stability.

Various parameters that affect the strength of concrete are shown in Fig. Specimen parameter includes dimension, moisture state and shape of a specimen. Most important factor which affect the strength is the porosity which can result from either the matrix, aggregate, or the interfacial transition zone. Porosity in turn is influenced by w/c ratio, degree of hydration and air content.

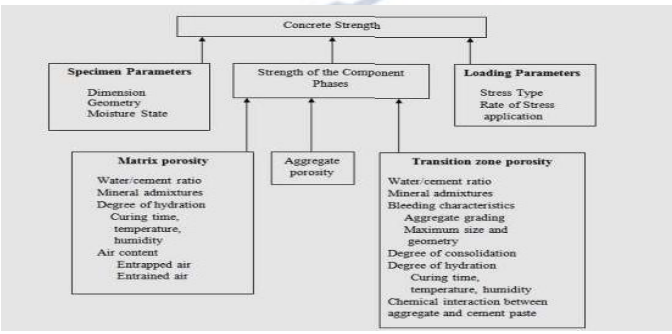

Fig2:Factors affecting the strength of concrete

2. RELATED WORK

1. Y.H. Patel et al. studied the durability of high performance concrete in corporatingalccofine and fly ash. The study investigates the performance of concrete mixture interms of Compressive strength, Chloride Attack tests, Sea water test and Accelerated corrosion test at age of 28 and 56 days. In addition the optimum dosage of Alccofine and fly ash from given mix

2. S.B. Sutharand B.K. Parekh. Studied the strength development of high strength concrete containing alccofine and fly Ash in which the compressive strength was determined at 56days of curing. There sults indicated that the concrete made with varying proportions generally show excellent fresh and hardened properties since the combination is somewhat synergistic. The addition of Alccofine shows an early strength gaining property and that of fly ash shows long term strength. The ternary system that is ordinary Portland cement-fly ash alccofine concrete was found to increase the compressive strength of concrete on all age when compared to concrete made with fly ash and Alccofine alone.

3. D. Soni et al. Investigated the Strength of concrete of grade M80 with locally available ingredients and then to study the effects of different proportions of 16 Alccofine and flyash in the mix and to find optimum range of Alccofine and flyash content in them ix. The Alccofine and flyash is added by weight of cement as are placement. The 17 Concrete specimens were tested at different age level for mechanical properties of concrete,However there has been little to no work put into the viability of image processing to achieve electronic automated invoicing.

4. S.P. Upadhyaya and M.A.Jamnu.Investigated effect on Compressive strength of High Performance Concrete(HPC) incorporating Alccofine and FlyAsh and concluded that the addition of Alccofine shows an early strength gaining property and that of Flyash shows long term strength. The combination of Ordinary Portland cement-fly ash Alccofine concrete was found to increase the compressive strength of concrete on all ages when compared to concrete made with flyash and Alccofine alone.

3. METHODOLOGY

Materials and Porperties:

Concrete is a hard material that has cementitious medium within which aggregates are embedded. Potential strength and durability of concrete of a given mix proportion is very much dependent on the degree of its compaction. The materials used for preparation of concrete are reviewed in the following sections.

Aggregates:

Aggregates are the important constituents in concrete. They give body to the concrete.They also help in reducing shrinkage. Aggregates impart considerable influence on strength, durability and dimensional stability to concrete [137]. At least 75% of the volume of concrete is occupied by aggregates. The aggregates are classified on the basis of their weight and size. The strength of concrete in general cannot exceed the strength of the aggregates that constitute it. However it aggregate for its strength.

Cement:

The cement is to be tested in the laboratory for its quality requirement limitations as per Indian Standards. The cement used was ordinary Portland cement of OPC 53 grade (KCP 53 grade) as shown in Figure3.4 confirming to IS: 12269-2013.Various tests are conducted to know the physical properties of cement and the results are tabulated below in Table.

Fig 3: cement

Initial and final setting time:

Lower the needle gently and bring it in contact with the surface of the test block and quicklyrelease. Allow it to penetrate into the test block. In the beginning, the needle will completely piercethrough the test block. But after some time when the paste starts losing its 17 plasticity, the needle maypenetrate only to a depth of 33-35mm from the top.The period elapsing between the times when water isadded to the cement at the time of which the needle penetrates the test block to a depth equal to 33-35mm from the top is taken as initial setting time. Replace the needle of the Vicat apparatus by a circular attachment. The cement shall be considered as finally set when, lowering the attachment gently cover the surface of the test block, the centre needle makes an impression, while the circular edge of theattachment fails to do so. In other words the paste has attained such hardness that the centre needle does not pierce through the paste more than 0.5mm.

Table2:Propertiesofcement

S.NO	Property	values
1	normal consistency	31%
2	Specific gravity	3.14
3	Initial setting time	94 minutes
4	Final setting time	197 minutes

WATER:

This is the least expensive but most important ingredient of concrete. The quantity and quality of water is required to be looked in to very carefully. In practice very often great control on the properties of all other ingredients is exercised, but the control on the quality of the water is often neglected. Since quality of the water effects strength, it is necessary for us to go in to the purity and quality of water.

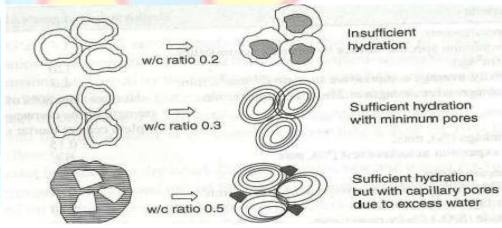

Fig 4: Schematic representation of insufficient, sufficient and excess waterfor hydration

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Parameters	ISStandards	Results obtained	Maximum permissible limits as perIS456: 2000
Sulphates	IS3025Part 24	75mg/l	400mg/l
Chlorides	IS3025Part 32	55mg/l	2000mg/lforPCCand500mg/l forRCC
pH		6.8	Shallnot beless than6

Table 3:PhysicalandChemicalpropertiesofwater

Mixproportioning:

The Concrete mix design was done by Departmental of Environment method popularly known as DOE method. The DOE method utilizes Britishtest data obtained at the building Establishment, the Transport and RoadResearch Establishment and the British cement association. This method isfrequently used in India with minor modifications [137]. The high strength concrete mix design for M60 grade of concrete was taken from past research and shown in Table.

Water(liter)	Cement(Kg)	Fine	Coarse
179.88	600	551	1133
0.3	1	0.918	1.88

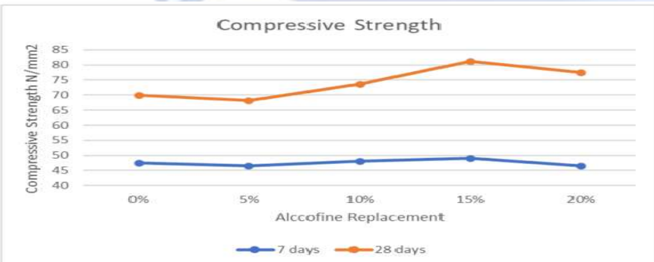
Table 4:Mix ProportionofConcrete

Compressive strength Test:

Concrete was prepared under moderate exposure condition and quality control was good. It was poured into cubical moulds and placed on vibrating table to minimize air entrapped which would otherwise affect the compressive strength. After 24 hrs the moulds were removed and the specimens were kept for curing at room temperature until taken out for testing. Specimens were tested at different ages i.e.7days, 28days, 56days and 90days of curing for determination of compressive strength. The load was applied at a constant rate thus ensuring progressive increase in stress as failure approached.

CompressiveStrengthofConcretespecimens(Mpa)					
Grade	AL%	7days	28days	56days	90days
M60	0%	47.50	69.90	70.00	72.00
	5%	47.80	68.20	71.30	71.40
	10%	48.00	73.60	75.80	76.80
	15%	49.00	81.10	83.50	83.60
	20%	48.50	77.50	78.00	79.00

Table5:CompressiveStrengthresultsofConcretespecimen s



Graph1:Compressivestrengthfordifferentreplacementafter7days,28days ofcuringatroomtemperatureforM60

The presence of calcium-silicate-hydrate (CSH) gel, which is produced bythe chemical reaction between silica, alumina, and free lime in cement, iswhat causes the increase in compressive strength to be observed. Excellentbinding qualities in this gelaid in enhancing compressive strength. The useof Alccofine to fill voids may also be afactoring the strength improvement.The particle size is 4-5 times smaller than cement, which makes concretedense in comparison to the control mix and make site as ier to pack voids.Additionally, wit 55 han increase in Alccofine, compressive strength is seento decrease past the 15% replacement 56 level. This is so that voids inconcrete can be packed in with significantly more cement than Alccofinewas originally used for. The loss of cohesion between in gredient particles due to an increase in Alccofine could affect compressive strength. According to the results of this test's compressive strength analysis, it ispossible totryreplacing 15%ofthecementwithAlccofine

Split Tensile strength:

For the M20, M30, M40, and M60 grades of concrete, 150x300mm concrete cylinders were cast and tested for split tensile strength at room temperature after 28 days of water curing. The results are shown in Table 5.7 For 0%, 5%,10%, 15%, and 20%of Alccofine. Cylindrical sample split tensile strength tests are performed. The tensile strength of concrete specimen with various percentages of Alccofine is shown in the figure

Graph2:Splittensilestrengthfor M60gradeconcrete

Concrete Specimens Exposed to Elevated temperatures:

For M60 grade concrete, the test results of the specimens exposed to elevated temperatures are compared with specimens in normal water curing. At 200’C, strength increase in 0% Alccofine mix concrete was 4%, 3%, 1% for 1hour, 2hours and 3hours exposure respectively. Similarly, strength increase in 15% Alccofine mix concrete was 4%, 3%, 3%for1 hour, 2 hours and 3hours exposure respectively.

4. FUTURE SCOPE AND CONCLUSION

Detailed laboratory experiments performed on M60 grade of concrete withwater cement ratio 0.3 is discussed in preceding Chapters. Main aim of thisstudy is finding the optimum do seofalcco fine that can be preplaced bycement and how this material affects the strength and durability of concrete.The majorexperimentaloutcomes areas follows Compressive strength of concrete increases after addin galccofine. Optimumdose of alccofine that can bere placed is15%.

Flexural strength of plain concrete beams at 15% replacement of cementwith alccofine shows increase in flexural strength when compared withcontrolled concrete. There is significant increase in split tensile strength of Alccofine concretewhen compared with controlled concrete.

Fire resistant test was also conducted to find the residual compressive strength after increasing the temperature of concrete up to 800ºC. It has been observed that it can also with stand the elevated temperature up toacertainvalue.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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