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DURABILTY ON UTILIZATION OF WASTE FOUNDRY SLAG WITH ALCCOFINE IN DEVELOPING CONCRETE

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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. The addition of alccofine shows an early strength gaining properties with increase flexural strength of concrete. This study presents the results of an experimental investigation carried out to evaluate the flexural strength of concrete incorporated with ultrafine slag (alccofine) by studying the effects of different proportions of ultrafine slag in the mix and to find optimum dose of alccofine content in the mix. The concrete specimens were cured on normal moist curing under elevated atmospheric temperature for better heat of hydration. Main aim was confined to find the change of flexural strength of reinforced concrete beams. The flexural strength was determined at 7 ,14 and 28 days and comparisons were made for both plain concrete and reinforced cement concrete

Though the recent advancements have conquered the hurdles of the preparation of high performance concrete, the use of green materials such as Fly Ash and Rice Husk Ash is limited. Apart from the green materials, many conventional and mineral admixtures or micro materials are available in the market, which enhances the quality and performance of concrete such as Metakaoline, Alccofine and Silica Fume etc. The quality of concrete mix is assessed through various mechanical properties like compressive strength, flexural strength and split tensile strength and various durability tests like rapid chloride penetration test (RCPT), sorptivity test, chloride resistance test, accelerated corrosion test and sea water attack test are carried out to analyse the performance of HPC.

Key words: High performance concrete, alccofine, steel fibers, flexural strength

I. INTRODUCTION

Concrete is the most commonly used construction material on earth. When considered over its entire life cycle extraction, processing, construction, operation, demolition and recycling concrete makes a significant contribution to the triple bottom line – environmental, social and economic –of sustainable development. Concrete is a versatile construction material: it is plastic and durable when hardened. These qualities explain why concrete can be used to build skyscraper, bridges, sidewalks, highways, houses and dams.

The demand of better concrete is increasing day by day. Improved quality of concrete will only perform better if concrete improves workability, durability, flow ability & resistance to chemical attack/corrosion and reduce water cement ratio, heat of hydration & segregation mainly. For the fulfilment of above properties waste produced from the steel & other industries are used for effective & efficient strength & durability of concrete. Large scale of sand quarrying from riverbeds creates environmental problems such as shortage of ground water and changing watercourses. Manufactured sand is produced from hard granite stone by crushing for substitute of river sand. High strength and high performance concrete are gaining popularity day by day in the construction industry worldwide. Practically high strength is generally said to be high strength concrete having high cement content and very low water cement ratio.

Alccofine 1203 is a specially processed product based on the slag of high glass content with high reactivity obtained through the process of controlled granulation. It is an alccofine with low calcium silicate. Alccofine 1200 series is of 1201, 1202, 1203 which represents fine, micro fine, ultrafine particle size respectively. Alccofine 1203 is a slag based supplementary cementitious materials having ultra-fineness with optimized particle size distribution. Due to its unique chemistry and ultra-fine particle size Alccofine 1203 provides reduced water demand for a given workability, even up to 70% replacement level as per requirement of concrete performance and it is manufactured by Ambuja Cements Ltd. In this experiment alccofine is used partially with varied percentage of 5%, 10%, 15%, 20%, 25% by weight of cement.

II. Materials:-

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. At least 75% of the volume of concrete is occupied by aggregates. The aggregates are classified on the basis of their weight and size.

Table 1 Physical properties of Coarse Aggregates (20mm)

S. No	Type of Test	Results
A	Specific Gravity	2.88
B	Water absorption	0.95%
C	Bulk density	1478
1	Aggregate impact Value	8.6
2	Aggregate Crushing Value	16.5
3	Aggregate abrasion Value	16.6
D	Particle shape and size	
1	Flakiness and Elongation Index	22.9
E	Soundness	
1	By Sodium Sulphate	1.5
2	By Magnesium Sulphate	1.8

Table 2: Physical properties of Fine Aggregates

S. No	Type of Test	Results
A	Specific Gravity	2.64
B	Water absorption	0.7%
C	Particle shape and size	
1	Material Finer than 75- micron	1.6

Binder:-

Cement:- OPC 43 grade was procured from Ambhuja Cement Ltd

Table: 3: Physical and chemical Properties of Cement

Property	Average Value
Specific gravity	3.15
Consistency	32%
Initial setting time	62 min
Final setting time	260 min
Soundness	2 mm
Fineness	5% retained
3-days	24
7-days	35
28-days	47

Fly Ash:- There are many uses of Fly ash. It can be used as filler or can also be used as a mineral admixture.

Silica fume:- It is another material that is used as artificial pozzolanic admixture. It also referred to as micro silica or condensed silica fume. Condensed silica fume is essentially silicon dioxide (more than 90%) in noncrystalline form.

Rice Husk Ash:-It is obtained by burning rice husk in a well controlled manner. Rice husk ash exhibits high pozzolanic characteristics and contributes to high strength and high impermeability of concrete. Rice husk ash (RHA) essentially consists of amorphous silica (90% SiO2), 5% carbon, and 2% K2O.

Metakaoline:-Highly reactive pozzolanic material with average diameter around 1-2 μ. Its pozzolanic reaction is considered to be similar to that of silica fume.

Ground granulated blast furnace slag (GGBS):-Ground Granulated Blast furnace Slag popularly called GGBS is a non metallic product consisting essentially of silicates and aluminates of calcium and other bases.

Alccofine :-Ultra fine slag or Alccofine is more advanced form of GGBS in which slag is further ground to less than 20 micron. As a result its specific surface area is increased dramatically to 3000-5000 m2/kg (Bet Analysis). Particle shape of ultrafine slag is spherical (Scanning electron microscope) which due to ball bearing effect gives increased workability at much reduced water content.

Table. 4: Mix Proportion of Concrete

Water (liter)	**179.88**	0.3
aggregate(Kg)	**600**	1
Aggregate(Kg)	**551**	0.918
Water (liter)	**1133**	1.88

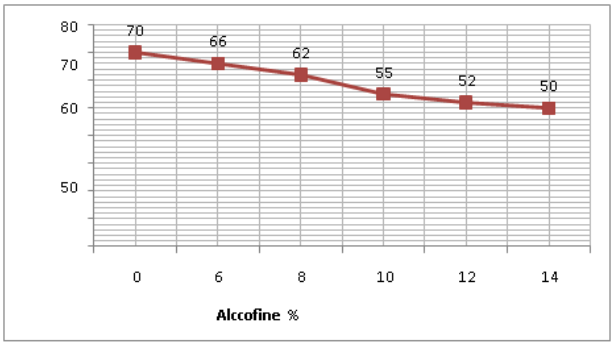

Fig. 1: Graphical variation of slump with variable percentages of alccofine

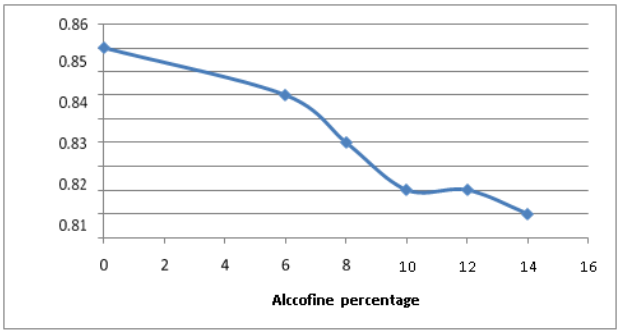

Fig. 2: Compaction factor test result

III. RESULTS:-

Compressive strength, Flexural Strength, Split tensile strength, Fire resistance test and Chloride resistance of various concrete mixes incorporating ultrafine slag (Alccofine-1203) in varying percentages is discussed. All the tests conducted were in accordance with the methods described in chapter three. Results were compared and checked for compressive strength, split tensile strength, fire resistance, and chloride resistance of concrete.

Compressive strength Test:- when 8% to 12% by weight replacement of alccofine 1203 for cement was done increase in compressive strength was observed. When 14% replacement of cement was done strength started decreasing. Compressive strength of ultrafine slag concrete at 28 days when compared to control mix was found to increase by 11% to 39 % on increasing the alccofine content from 8% to 12%. Decrease in compressive strength was observed when replacement of cement was increased from 12% to 18%.

Flexural strength test:- Maximum value of flexural strength was obtained at 12% replacement of cement with alccofine. When compared with controlled concrete flexural strength has increased by 45.62% at 28 days. The flexural strength decreased thereafter and at 18% replacement flexural strength has drop down to 10.11%.

Table. 5: Properties of steel fibres used

Length	50mm
Appearance	Clear and Bright
Tensile strength	800-2500 MPa
Shape	Rectangular
Size	0.8mmx35mm
Aspect ratio	43.75

Table 6 Different nomenclature of specimen used

Cylinder designation	Beam designation	% of alccofine (by weight)	% of steel fibers (by volume)
SC0	CB0	12%	0%
SC5	CB5	12%	0.5%
SC1	CB1	12%	1.0%
SC15	CB15	12%	1.5%
SC20	CB20	12%	2.0%

Split tensile test of SFRC:- It is seen that the split tensile strength with 12% alccofine and varying % of steel fibers initially there is very less gain of strength but after 28 days there is significant gain of tensile strength. It can be observed that tensile strength of concrete cylinders in SC15 has shown 38% of increase in tensile strength when compared with controlled concrete SC0.

Flexural strength of SFRC: - Comparison of flexural strength is also .which shows maximum gain of flexural strength of 29% is achieved in SB15 when compared with controlled concrete SB0.

IV. CONCLUSIONS:-

- Compressive strength of concrete increases after adding alccofine. Optimum dose of alccofine that can be replaced is 12%. As compared with controlled concrete there is 39.5% increase in compressive strength.
- Flexural strength of plain concrete beams at 12% replacement of cement with alccofine shows 45% increase in flexural strength when compared with controlled concrete. Flexural strength of reinforced concrete beams at 12% replacement of cement with alccofine shows 62% increase in flexural strength when compared with controlled

concrete. From Table 2.11 it can be concluded that to achieve same amount of deflection higher amount of load is required in case of concrete incorporated with alccofine.

- There is significant increase in split tensile strength of steel fiber reinforced concrete when compared with controlled concrete. There is increase in 38% of split tensile strength of concrete cylinders with 12% alccofine and 1.5% by volume of steel fibers. There is also significant increase in flexural strength of steel fiber reinforced concrete beams with same amount of alccofine and steel fibers.
- Fire resistant test was also conducted to find the residual compressive strength after increasing the temperature of concrete upto 800ºC. It has been observed that along with increased compressive and flexural strength of concrete, it can also withstand the elevated temperature upto a certain value. As seen from Fig. 3.6 at 28 days of curing maximum % residual compressive strength was noticed when the cubes were heated at 500ºC for 1 hour.
- From durability analysis test it can be concluded that the concrete incorporating ultra fine slag (alccofine) shows much improved resistant to acid attack. From Table 2.16 it can be observed that % reduction in compressive strength of concrete cubes incorporating alccofine cured in 5% HCl is much less than ordinary concrete cured under same conditions.

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