International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347 - 6435 (Online)) Volume 4, Issue 9, September 2015)

Analysis of Strength Optimization of Blended Cement using FLY ASH and Alccofine

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Abstract**-- Fly ash and Alccofine has the potential to be the key to a brand new world in the field of construction and building materials. The role and application of the Alccofine with cementitious materials (fly ash) have been studied and discussed in details. The amount of alccofine was increased from 0% to 25% and amount of fly ash decreased from 50% to 25%, the increase in strength was positive at various ages of 3, 7, 28, 56, and 90 days till certain percentage i.e. 32.5% for alccofine and 17.5%for fly ash. The present study focuses particular attention to use of blended cement (tenary cement) in recent times, on various properties of cement and mortar.**

Keyword**-- Fly Ash, Cement, GBFS**

I. INTRODUCTION

The high cost of conventional building materials has necessitated research into alternative materials of construction. With the advancement in technology it is now feasible to use various materials in structural applications which were once considered a waste product. Normally, cement used in mortar produced in factories which require large amount of energy to produce the cement, also clinker are being mined and then converted into cement which lead to the mining problem [1]. This practice leads to the natural degradation as more amount of energy is being consumed. The creation of non-decaying waste materials, combined with a growing consumer population has resulted in a waste disposal crisis leading to an economic and environmental problem. This rapidly increasing waste stream remains a significant environmental issue and needs to manage in an economic and environmentally sustainable manner. India also faces this crisis to a large extent [2].

One solution to this crisis lies in recycling waste into useful products to replace the natural/commercial products wherever possible which will reduce the economic and environmental problem of waste disposal and also reduce the depletion of natural resources. Space limitations on existing landfill sites and problem of waste stabilization have prompted investigations into alternative reuse techniques and disposal routes for sludge.

One of the practical ways to be adopted for reducing waste is of recycling these wastes into useful products like use in civil engineering constructions since bulk quantities of materials are used in a short time in civil engineering constructions [3]. So in order to reuse this waste the study have been conducted by replacing cement by Flyash (waste from thermal plants) and Alccofine(waste from iron plants).Cement has been replaced partially and results have been noted for compressive strength and water absorption.

II. BLENDED CEMENT

Hydraulic cement is made by replacing some of the cement in a concrete mix with activated aluminum silicates, Pozzolanas such as fly ash, to activate cement setting in wet condition or underwater and further protects hardened concrete from chemical attack, (e.g., Portland cement) hardening because of hydration and also called as Blended cement [4].

Supplementary cementitious material fly ash and alccofine are used as supplementary materials to replace cement to make it blended cement.

Blended cement is also produced either by inter grinding Portland cement clinker with the other materials or by a combination of cement and supplementary material.

The blended cement are manufactured by adding Pozzolana or cementitious materials like fly ash, ground granulated blast furnace slag (GGBFS) known as alccofine which is a type of GGBFS to Portland cement [5].The beneficial effect of the various cementitious materials are so significant that their use in reinforced concrete liable to corrosion in hot climates (which is the condition prevailing in entire India during most part of the year) is virtually necessary. Portland cement alone should not to be used in future marine structures and in coastal areas. At present in India OPC is considered as the best if not the sole, cementitious material in the concrete. The other materials like fly ash and GGBFS [6, 7] are viewed as replacement or substitutes for cement, whereas these cementations materials are today concrete ingredients in their own weigh.

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III. FLYASH

Fly ash, also known as flue-ash, is one of the residues generated in combustion, and comprises the fine particles that rise with the flue gases. Ash which does not rise is termed bottom ash. In an industrial context, fly ash usually refers to ash produced during combustion of coal [8]. Fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys of coal-fired power plants, and together with bottom ash removed from the bottom of the furnace in this case jointly known as coal ash. Depending upon the source and makeup of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of silicon dioxide (SiO2) (both amorphous and crystalline) and calcium oxide (CaO), both being endemic ingredients in many coal-bearing rock strata [9].

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Fly ash produced from the burning of younger lignite or sub bituminous coal, in addition to having Pozzolana properties, also has some self-cementing properties. In the presence of water, Class C fly ash will harden and gain strength over time. Class C fly ash generally contains more than 20% lime (CaO). Unlike Class F, self- cementing Class C fly ash does not require Alkali and sulphate (SO4). The burning of hardern older anthracite and bituminous coal typically produces Class F fly ash. This fly ash this fly ash is pozzolanic in nature, and contains less than 20% lime (CaO).

IV. ALCCOFINE

Alccofine 1203 is a new generation, ultrafine, low calcium silicate product, manufactured in India. It has distinct characteristics to enhance 'performance of concrete' in fresh and hardened stages. It can be considered and used as practical substitute for Silica Fume as per the results obtained. If the advantages of alccofine 1203 are observed in the concrete mix design, the initial rate of strength development was found to be increased or similar as that of Silica Fume [10].

As a result of growth in advance technology in concrete, high performance concrete (HPC) has gained worldwide popularity in the construction industry since 1990. In practice, high performance concrete, are generally characterized by high cement factors and very low w/cm ratios. Such concrete suffer from two major weaknesses. It is extremely difficult to obtained proper workability, and to retain the workability for sufficiently long period of time with such concrete mixes. High dosage of high range water reducing agents(HRWR) then become a necessity, and resulting cohesive and thyrotrophic, sticky mixes are equally difficult to place and compact fully and efficiently. These problem indicate that there is probably a critical limit for the water content below which high HRWR dosage become not only essential but also unhelpful and undesirable, and often even harmful from a durability point of view. In high performance concrete applications, Silica Fume is generally proposed as the appropriate cement extender where high strength, low permeability are the prime requirements. Though silica fume is known to improve durability, its addition in concrete is often negated by the increase water and/or admixture dosage required to improve the workability and handling properties of the fresh concrete.

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 12000cm2/gm and is truly ultra-fine. 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 permanent.

V. EXPERIMENTAL PROGRAM

1. Material Used

Portland cement

Ordinary Portland cement (43 grade) was used confirming to IS 8112:1989 of BIS (Reaffirmed 2005).Cement available in local market used in the investigation. Its physical properties are given in table 1

Physical Property	Results obtained	IS:8112-1989 Specifications
Normal Consistency(%)	28.5	----
Initial Setting time (min)	145	30(min)
Final Setting time(min)	265	600(max)
Fineness(%)	4	10(max)
Specific gravity	3.11	----
Soundness(mm)	1.50	1-2

Fine Aggregates

Locally available natural sand resulting from the natural disintegration of rock which has been deposited by various agencies, with the sand passing through 4.75 mm sieve was used as fine aggregates.

Its physical properties and sieve analysis are given in table 2 and 3 respectively

S.no	Properties	Observed Values
1	Bulk density (loose),kg/m^3	1782
2	Bulk density (compacted),kg/m^3	1809
3	Specific gravity	2.43
4	Water absorption %	0.87

The sieve analysis of sand was carried out as per the guidelines given in IS: 383-1970.

The grading of fine aggregates when determined as described in IS:2386(Part I)-1963 shall be within the limits given in table 3.

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S.No.	IS Sieve Designation	Percentage Passing			
		Grading Zone 1	Grading Zone 2	Grading Zone 3	Grading Zone 4
1.	10 mm	100	100	100	100
2.	4.75 mm	90-100	90-100	90-100	90-100
3.	2.36 mm	60-95	75-100	85-100	95-100
4.	1.18 mm	30-70	55-90	75-100	90-100
5.	600 micron	15-34	35-59	60-79	80-100
6.	300 micron	5-20	8-30	12-40	15-50
7.	150 micron	0-10	0-10	0-10	0-15

VI. RESULTS

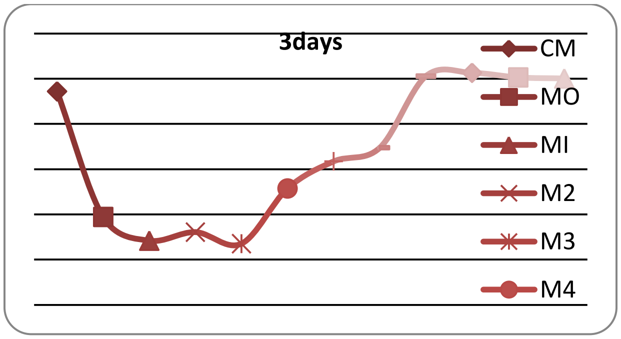

Figure 1 Compressive strength of various mixes at 3 days

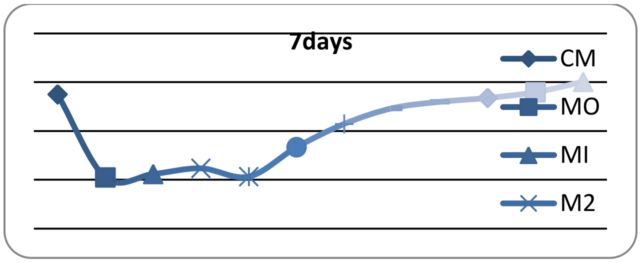

Figure 2 Compressive strength of various mixes at 7 days

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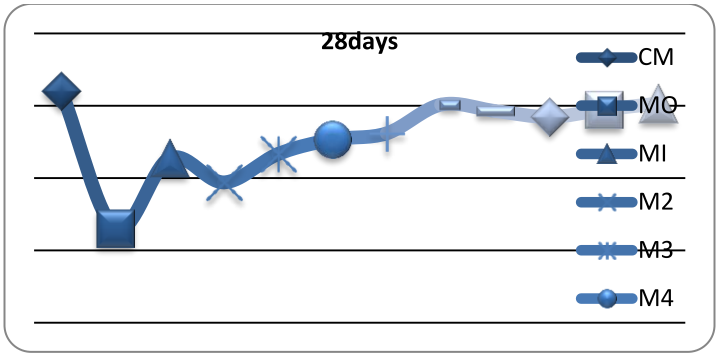

Figure 3 Compressive strength of various mixes at 28 days

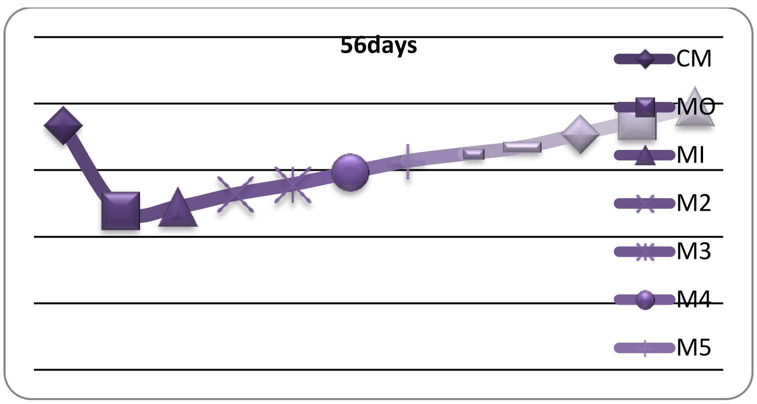

Figure 4 Compressive strength of various mixes at 56 days

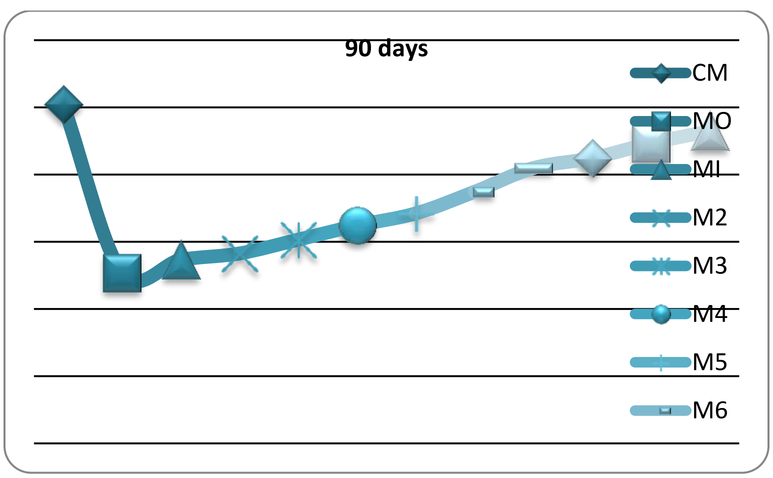

Figure 5 Compressive strength of various mixes at 90 days

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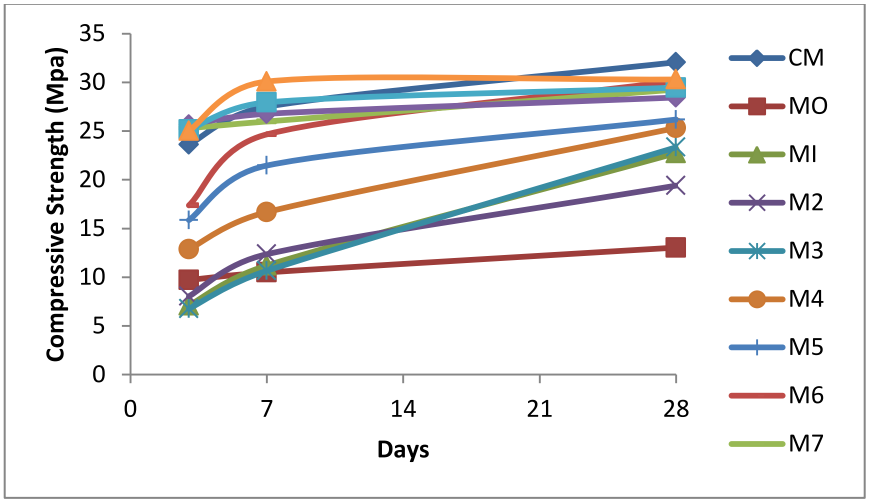

VII. Conclusion

It is apparent that ternary cementitious blends of Ordinary Portland cement, Alccofine, and fly ash offer significant advantages over binary blends and even greater enhancements over plain Portland cement. The combination of Alccofine and fly ash is complementary: the alccofine improves the early age performance of mortar with the fly ash continuously refining the properties of the mortar as it matures.

In terms of durability, such blends are vastly superior to Ordinary Portland cement mortar. Based on the scope, materials, techniques, procedures and other parameters associated with this work, the following conclusions and recommendations can be stated: Based on the present study, the following conclusions, with respect to Sulphate resistance of cement concrete and mortar, are drawn.

- The blended cements, particularly those made with Silica Fume and Ground Granulated Blast Furnace Slag, are better in Sodium Sulphate environment.
- The blended cement mixes show more deterioration in Magnesium Sulphate exposure 268 J. Prasad, D.K. Jain and A.K. Ahuja in compared to plain cement mixes.
- The Magnesium Sulphate environment is more severe than Sodium Sulphate environment.
- The performance of low water/binder ratio mixes is inferior in Sulphate resistance.
- The little initial air curing of mixes is beneficial for Sulphate resistance.
- The deterioration of cement mixes increases with increase in the concentration of Sulphate.
- The presence of Chloride ions with Sulphate ions reduces the rate of Sulphate attack on cement mixes.
- The deterioration rate of mixes due to Sulphate attack is higher at high temperature with alternate wetting and drying cycles.
- Fly ash and Alccofine modified the characteristics of fresh mortar.
- With the increase in the alccofine content strength increases but after a certain percentage it starts decreasing with optimum strength achieved at 15% alccofine content.
- Incorporating alccofine to cement mortar mixtures generally enhance their mechanical properties.
- Enhancement in early age strength of mortar (at optimum level) by incorporation of alccofine
- The optimum mix was M6 in which the percentage of fly ash was 35% and alccofine was 15% with 50% cement content which gives a strength closest to the control mix ,by using this mix we can reduce the energy consumption for the manufacturing of cement by 50% as fly ash and alccofine are waste material which require a very less energy for the manufacturing and thus it would be sustainable to use them.
- The alccofine particles filled the spaces between the cement aggregates, increased the compactness of the cement mortar.
- The increase in the percentage/amount of alccofine decreases the water absorption of mortar specimens. It can be a result of the enhancement in permeability mechanism of mortars due to super-pozzolanic performance of alccofine particles.

REFERENCES

[1] ACI Committee 2011, "Guide for selecting Proportions for high Strength Concrete with Portland", ACI Materials Journal, 1 (97) 1998; 13-22.

[2] Al-Amoudi, O.S.B., Maslehuddin, M., and Saadi, M.M.," Effect of magnesium sulfate and sodium sulfate on the durability performance of plain and blended cements", ACI Materials Journal 1 (92)1995; 15-24

[3] Al-Amoudi, O.S.B., Maslehuddin, M., and Abdul-al, Y.A.B., "Role of chloride ions on expansion and strength reduction in plain and blended cements in sulfate environments", Construction and Building Materials, (90) 1995; 25-33.

[4] Al-Dulaijan, S.U., Maslehuddin, M., Al-Zahrani, M.M., Sharif, A.M., Shameen, M., and Ibrahim, M., "Sulfate resistance of plain and blended cements exposed to varying concentrations of sodium sulphate", Cement Concrete Composites, (25) 2003 429-437.

[5] Barnett, SJ. , Soutsos, MN.,Millard, SG., Bungey, JH. "Strength development of mortars containing Ground granulated

[6] Bonavetti, V., Donza , H., Menendez, G., Cabrera, O., and Irassar, E. F., 2000, "Influence of Initial curing on properties of concrete containing blended cement" Cement and Concrete Research ,30(1) 2000 ; 31-40

[7] Descher.R., "Cement and Fly Ash", ACI 211.4R-93, American concrete Institute, Farmington Michigan, 1993; 204-207.

[8] Detwiler,B., Rachel J., Bhatry, Javed I., and Bhattacharja, Sankar, "Supplementary Cementing Materials for Use in Blended Cements", Research and Development Bulletin RD112, Portland Cement Association, 1996; 108 .

[9] Berry, E.E., Malhotra V.M, "Fly ash for use in concrete—A critical review", J. ACI (77) 1980; 59– 73.

[10] Gonazalez, M.A., and Irassar, E.F., "Effect of GGBFS on the sulfate resistance of low C3A Portland cement," Cement and Concrete Research, (28) 1998; 1111..