International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-7, Issue-6, March 2019

An Experimental Study to Find the Optimum Dosage of Admixtures in Blended Concrete

Avuthu Narender Reddy, T. Meena

Abstract*: Blended Concrete (BC) is environmental friendly concrete and could be considered as a construction material to promote the sustainable development. In this paper mineral admixture like Fly ash (FA), Ground Granulated Blast Furnace Slag (GGBS) and Alccofine (AL) were used with different combinations in different dosages as replacement for cement. Effects of varying dosages of mineral admixture, was studied for compressive strength of BC. Initially, the cement was replaced with FA and GGBS separately at 0%, 5%, 10%, 15%, 20%, 25%, 30%, 35% and 40%. The optimum percentage of FA and GGBS replacements were evaluated by the compressive strength. Keeping this optimum percentage of FA and GGBS as constant, further replacement of cement was done by AL at 6%, 8%, 10%, 12%, 14% and 16%. The study concludes that BC in the combination of FA and AL can be used for the general purpose of concrete as required compressive strength can be achieved. But the concrete with combination of GGBS and AL would not be useful in the formation of BC as the combination had failed to achieve the design strength and it had been clearly observed that as the AL percentage increases the compressive strength decreased.

***Index Terms*: Alccofine, Fly ash, Ground Granulated Blast Furnace Slag, Blended Concrete**

I. INTRODUCTION

The speedy improvement of buildings and civil engineering after the second global warfare is characterized by using huge application of Concrete because the first-rate construction material. Inside the growing creation discipline concrete plays a major role [1]. New sorts of systems and new technology in constructing, structural and civil engineering created greater tough requirements for this material. The possibility of using a combination of mineral admixtures as a replacement for cement may reduce the CO_2 emission which is implicated in global warming and climatic changes on the environment [2]. By using the combination of different by-products from various industries for replacing cement in concrete leads to saving in energy and natural resources. Some of them are Metakaoline, GGBS, Fly Ash, Alccofine and Micro Silica and so on. The mineral admixture considerably increases the workability of concrete [3,11]. Number of investigations show that the minimum capacity of modified concrete could be increased by multiple replacement mechanism thereby improving the performance of concrete [4,12]. This practical idea tends to be a promising alternative in terms of concrete strength and green construction. As the material AL is a newly introduced pozzolanic material and from literature review it proves better results in binary mixes as cement replacement. We tried using AL along with our pozzolanic materials to form blended concrete. Two pozzolanic materials which are most commonly in construction now-a-days such as FA and GGBS are selected and compressive strength were found to check the compatibility nature of AL with other pozzolanic materials.

The characteristics of combination of mineral admixtures such as FA with AL and GGBS with AL to replace partially cement in concrete have been tested. The aim of this study is to determine the optimum percentage of combination of AL with other pozzolanic materials like FA and GGBS forming a BC.

II. LITERATURE REVIEW

D. Siva Kumar et al., (2016) [5] have done experimental investigation on mechanical behavior of concrete when cement is replaced with AL at various percentages of for M40 grade concrete. From the results it was concluded that maximum strength was achieved with 15% replacement of cement by AL for all the mechanical properties. D. K. S. Roy et al., (2016) [6] have conducted experimental study on AL concrete and concluded that AL increases the mechanical properties in large extent at 10% replacement of cement. The strength had increased about 25.5% - 27.6% in all the properties when compared with nominal concrete. They also concluded that the AL acts as a filler material and also yielded good workability to the concrete. Manisha M. et al., (2016) [7] have studied the behavior of AL with hybrid fiber reinforced concrete. They concluded that the AL reduces the shrinkage, thermal cracks and increased strength when compared with conventional concrete. They also concluded that the AL boosts the compressive strength and the fibers helped in increasing the flexural strength of hybrid fiber reinforced concrete. Prasanna et al., (2015) [8] have studied the properties of M50 concrete containing combination of FA and AL. They concluded that the AL had improved the hardened properties of concrete. Maximum strength was achieved with concrete containing 30% FA and 10% AL.
S. S. Deval et al., (2013) [9] have done experimental study on the effect of combination of FA and AL on High Performance Concrete (HPC).

Revised Manuscript Received on 30 March 2019.
***** Correspondence Author
Avuthu Narender Reddy*, Research Scholar, Department of Structural and Geo-Technical Engineering, School of Civil Engineering, Vellore Institute of Technology, Vellore, Tamil Nadu, India.
Prof. T. Meena, Associate Professor, Department of Structural and Geo-Technical Engineering, School of Civil Engineering, Vellore Institute of Technology, Vellore, Tamil Nadu, India.

From the results they concluded that the highest strength of concrete was achieved with combination of 20% FA and 8% AL when compared with conventional concrete.

Deshmukh, et al., (2012) [10] have done an experimental investigation on blended concrete containing AL and concluded that the incorporation of AL had increased the workability and pump ability of fresh concrete. The concrete containing 30% AL had showed high strength, low permeability and better durability when compared with normal concrete.

III. MATERIALS

A. Cement

OPC 53 grade cement having Specific gravity of 3.12, Finess modulus of 6.50%, initial and Final setting time of 50 min and 420 min, Normal consistency of 32%, confirming the requirements according to IS 12269 was used in our investigation.

B. Fly Ash (FA)

Class F type of FA was used in the entire investigation having Specific gravity of 2.3 and Finess modulus of it was acquired from Dr. NTR Vijayawada Thermal Power Station (VTPS), Vijayawada, Andhra Pradesh.

C. Ground Granulated Blast Furnace Slag (GGBS)

GGBS is the by-product from blast furnace in steel industry. GGBS was acquired from Salem Steel Plant Salem, Tamil nadu having the Specific gravity of 2.8, Finess modulus of 390 (m/kg) and particle size of 97 Microns.

D. Alccofine (AL)

AL is a slag based product produced by controlled granulation with high glass content. AL-1203 type is used in our investigation having Specific gravity of 2.9 and Particle size of 9 Microns.

E. Fine Aggregate

Regionally accessible river sand having Specific gravity of 2.68, Finess modulus of 2.7%, Water absorption of 1.02% and belongs to Zone II, confirming with IS 383 specifications were used in our investigation.

F. Coarse Aggregate

Locally available crushed stone passing through 20 mm sieve, having Specific gravity of 2.78, Finess modulus of 7.2%, Water absorption of 0.8%, confirming to IS 383 were used as coarse aggregate in our investigation.

G. Water

Tap water available in our campus with pH value 7.0 to 8.0 was used in our investigation.

IV. MIX PROPORTIONS AND MIX NOTATIONS

A. Mix Design

In our investigation, M30 grade concrete mix design was carried out according to IS 10262. The mix proportions are given below in table. The 100 mm x 100 mm cubes were tested at 7 and 28 days.

Table 1: Mix Design (kg/m^3)

Material	Cement	Fine aggregate	Coarse Aggregate	w/c ratio
Quantity	350.2	721.5	1273.8	150.6

Control Mix Proportion = 1:2.06:3.63:0.43

B. Mix Notations

CM - Concrete Mix
F1 - Cement replacement with 5% FA
F2 - Cement replacement with 10% FA
F3 - Cement replacement with 15% FA
F4 - Cement replacement with 20% FA
F5 - Cement replacement with 25% FA
F6 - Cement replacement with 30% FA
F7 - Cement replacement with 35% FA
F8 - Cement replacement with 40% FA
G1 - Cement replacement with 5% GGBS
G2 - Cement replacement with 10% GGBS
G3 - Cement replacement with 15% GGBS
G4 - Cement replacement with 20% GGBS
G5 - Cement replacement with 25% GGBS
G6 - Cement replacement with 30% GGBS
G7 - Cement replacement with 35% GGBS
G8 - Cement replacement with 40% GGBS
FA1 - Cement replacement with combination of 25% FA and 6% AL
FA2 - Cement replacement with combination of 25% FA and 8% AL
FA3 - Cement replacement with combination of 25% FA and 10% AL
FA4 - Cement replacement with combination of 25% FA and 12% AL
FA5 - Cement replacement with combination of 25% FA and 14% AL
FA6 - Cement replacement with combination of 25% FA and 16% AL
GA1 - Cement replacement with combination of 20% GGBS and 6% AL
GA2 - Cement replacement with combination of 20% GGBS and 8% AL
GA3 - Cement replacement with combination of 20% GGBS and 10% AL
GA4 - Cement replacement with combination of 20% GGBS and 12% AL
GA5 - Cement replacement with combination of 20% GGBS and 14% AL
GA6 - Cement replacement with combination of 20% GGBS and 16% AL

V. RESULTS AND DISCUSSION

A. Evaluation of optimum percentage of FA and AL

The cement is replaced with FA and GGBS separately at 5%, 10%, 15%, 20%, 25%, 30%, 35% and 40% to evaluate the optimum percentage of cement replacement by FA and GGBS separately. The results are graphically represented as in fig. 1 and fig. 2.

Fig. 1 represents the evaluation of optimum percentage of FA content and fig. 2 represents the evaluation of optimum percentage of GGBS content. From figure 1 the higher compressive strength is achieved for F5 mix (Mix with 25% FA as replacement of cement) and from fig. 2 the higher compressive strength was achieved for G4 mix (Mix with 20% GGBS as replacement of cement).

So, it is concluded that the optimum percentage replacement of cement by fly ash is 25% and for GGBS is 20%. Therefore the mixes F5 and G4 are selected for further studies.

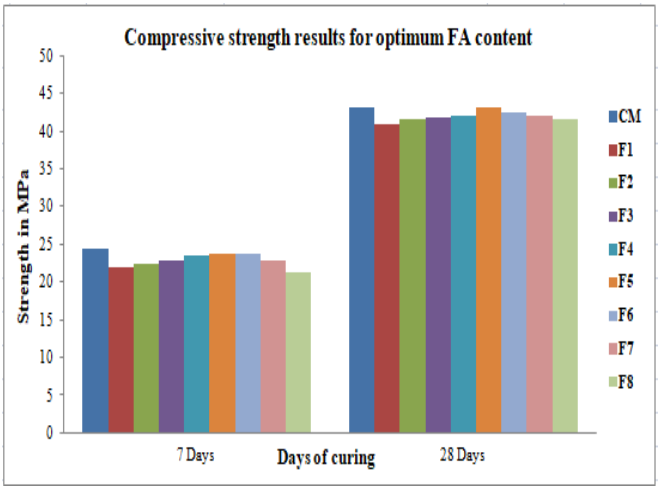

Fig. 1: Graphical representation for optimum percentage of FA content

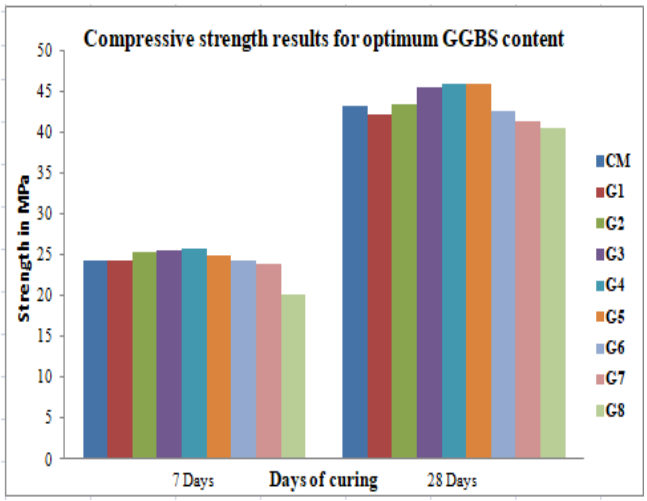

Fig. 2: Graphical representation for optimum percentage of GGBS content

B. Evaluation of optimum percentage of combination of FA with AL and GGBS with AL

By maintaining the constant FA content at 25% and GGBS at 20% the remaining cement content was replaced with AL at 6%, 8%, 10%, 12%, 14% and 16% with FA and GGBS separately to find the compatibility nature of the AL. the results are graphically represented in fig. 3 and fig. 4.

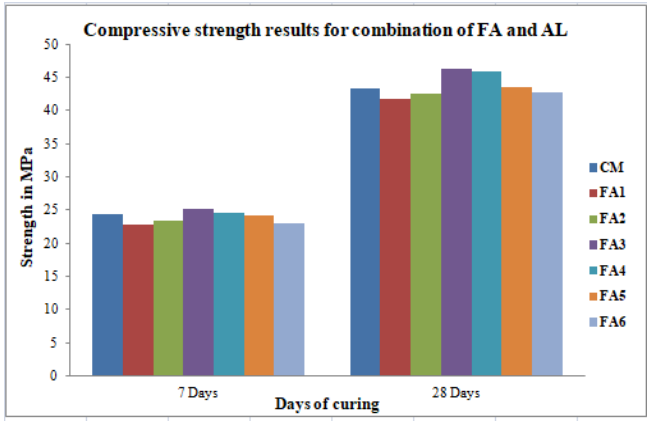

Fig. 3: Graphical representation for combination of FA and AL

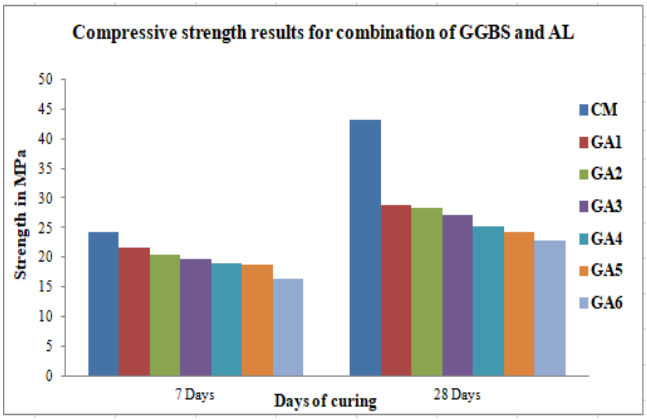

Fig. 4: Graphical representation for combination of GGBS and AL

Fig.3 represents the optimum percentage of FA and AL content and fig. 4 represents the optimum percentage of GGBS and AL content. From fig. 3 the maximum compressive strength is achieved for FA3 mix (Mix with combination of 25% FA with 10% AL totally 35% as replacement of cement) and from fig. 4 result it is clearly seen that the combination of GGBS and AL had failed to achieve the design strength. Also it is clearly observed that as the percentage of AL increases the strength decreases. This is may be due to the in compatibility nature of these two pozzolanic materials.

VI. CONCLUSION

From the investigation it is clearly observed that the mix containing AL sets very quickly than all mixes. The results of compressive strength on BC with combination of 25% FA and 10% AL had shown highest strength than that of all other mixes. But the mixes with combination of GGBS and AL compressive strength was not superior when compared to normal concrete. It is clearly seen that as the percentage of AL increases the compressive strength decreases. This is due to the in-compatibility nature between AL and GGBS. From the results it is clearly seen that the compatibility nature of FA and AL is good and the strength had increased 7.08% at 28 days with total cement replacement of 35%.

The highest compressive strength for BC mix was achieved with combination of Cement – FA - AL at 65% - 25% - 10% respectively. The cement replacement with combination of FA and AL materials leads to eco-friendly and sustainable concrete and at the same time results in the reduction of overall cost of manufacture of blended concrete.

ACKNOWLEDGMENT

We are thankful to Mrs. Sapna Devendra, Regional Manager- South at Ambuja Cements Ltd, for providing the required material Alccofine and for her continuous support in our research.

REFERENCES

1. Bourtsalas (Thanos) A.C, Zhang J, Castaldi M.J.B and Themelis N.J, " Use of Non-recycled Plastics and Paper as Alternative Fuel in Cement Production". *Journal of Cleaner Production*, vol. 181, 2018, pp. 8-16.
2. Turu'allo G, "Using GGBS for partial cement replacement in concrete: effects of water-binder ratio and ggbs level on activation energy". *Inter national Journal of Technology*, vol. 6, issue 5, 2015, pp. 790-799.
3. Meena. T, "A study on compressive behavior of ternary blended concrete incorporating alccofine". *Materials Today Proceedings*, vol. 5, 2018, pp.11356–11363.
4. Meena. T, "A study on compressive behavior of ternary blended concrete incorporating alccofine". IOP Conference Series: Materials Science and Engineering, vol. 263, 032010.
5. D. Sivakumar, T. Hemalatha, N. S. Sri, T. Shobana and C. Soundarya, "Durability and Mechanical Characterization of Concrete Using Alccofines Durability and Mechanical Characterization of Concrete Using Alccofines". *International Journal of Applied Engineering Research*, vol. 10, issue 1, 2016, pp. 178–182.
6. D.K. S. Roy, S. Rajesh Kumar, and Amiya K. Samanta, "Characterization and Development of Eco-Friendly Concrete using GGBS and Alccofine". *Research Journal of Applied Sciences*, vol. 11, issue 5, 2016, pp. 183–187.
7. Manisha M. Magdum, Dr. V. V. Karjinni, "Influence of Mineral Admixture (Alccofine-1203) On the Properties of Hybrid Fiber Reinforced Concrete", *American Journal of Engineering Research (AJER)*, vol.5, Issue-10, 2016, pp 45-51.
8. Prasanna, T. M, Sandya, D. S, and Arjun B, "Experimental study on Development of Normal Strength Concrete and High Strength Concrete Using Alccofine*", International Research Journal of Engineering and Technology*, vol. 2, issue 5, 2015, pp. 203- 209.
9. Deval Soni Suhasini Kulkarni Vilin Parekh "Experimental Study on High- Performance Concrete, with Mixing of Alccofine and Flyash" *International Journal of Scientific & Engineering Research*, Vol.3, issue 4, 2013, pp. 871-876.
10. Deshmukh, S. H, Bhusar, J. P, and Zende, A. M, "Effect of Alccofine on Ordinary Portland Cement Concrete", *IOSR Journal of Mechanical and Civil Engineering*, vol 9, issue 3, 2012, pp. 21-25.
11. Meena. T, "Study on effect of colloidal Nano silica blended concrete un der compression". *International Journal of Engineering and Technolo gy (UAE)*, vol. 7, issue 1, 2018, pp. 210-213.
12. Narender Reddy. A and Meena. T, "Behavior of ternary concrete under compression". *International Journal of Civil Engineering and Technol ogy*, vol. 84, 2017, pp. 2089–2097.

AUTHORS PROFILE

Mr. Avuthu Narender Reddy is currently pursuing Ph.D in Structural Engineering from Vellore Institute of Technology, Vellore. He completed his M.Tech in Structural Engineering from Jawaharlal Nehru Technological University Kakinada. He has published number of research articles in number of reputed journals.

Dr. Meena Thiruvadi completed her Ph. D from Anna University, Chennai. She is working as Associate Professor in Department of Structural and Geo-Technical Engineering, School of Civil Engineering (SCE), Vellore Institute of Technology, Vellore Campus, Vellore, Tamil Nadu, India. She has published number of research articles in number of reputed journals.