ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 3, Issue 1, January 2018

Compressive Strength Evaluation by Replacing Pozzolanic Material in High Alumina Cement

[1] Leemonlisa Raj, [2] Shashwati Soumya Pradhan
[1] Assistant Professor, PMEC, Berhampur, 761003, [2] Assistant Professor, CAPGS, BPUT, Rourkela, 769015

Abstract: **-- Due to the rapid growth of construction activity and the rising cost of construction materials in developing countries has required research into the utilization of substitute materials in the structural building industry. The aim of this study is to examine the influence of pozzolanic material such as Fly Ash (FA) as a partial replacement in High Alumina Cement (HAC). In this experiment, different types of concrete mixes were designed such as HAC1, HAC2 and HAC3 where FA have replaced by different proportions such as 0%, 10%, 20% in HAC1 and similarly for HAC2 and HAC3 respectively. An M35 grade of concrete was used for a total nine numbers of different concrete mixes were selected where FA was used to replace HAC by volume. Nine number of cubes were cast for each concrete mixes to evaluate the performance of concrete mixture in terms of compressive strength for 7, 14 and 28 days at a constant temperature. The experimental test results obtained after 7 and 14 days signify that the compressive strength test results do not vary more. But 28 days test results showed that compressive strength increases as compared to control specimen.**

Index terms **: - Compressive strength, Concrete mix design, Fly Ash, High Alumina Cement.**

I. INTRODUCTION

Concrete is the most widely used man-made construction material in the world, and is second only to water as the most utilized substance on the planet. It obtains by mixing of cementing materials, water and aggregates and an admixtures in the required proportion. The mixture when placed and allowed to cure hardens into a rock like material known as concrete. The hardening of concrete is caused by chemical reaction between water and cement and consequently the concrete grows stronger with its age. Then the harden cement concrete may also be considered as an artificial stone in which the voids of large particles are filled with smaller particles (fine aggregate) and voids of fine aggregate are filled with cement. The strength, durability, serviceability and other characteristics of concrete depends upon the properties of its ingredients and on the proportions of the mix, the method of compaction and control during placing, compaction, curing and transport. Now a day in the civil engineering industry, many pozzolanic materials plays an important role. Pozzolanic materials are used to enhance the performance of hydrated cement. The concrete industry is constantly looking for different supplementary materials with their objective to reduce the solid waste disposal and use as a supplementary cementitious material like fly ash (FA) and silica fume etc. These are pozzolanic material which can be use as a partial replacement of cement and reduces the CO2 emission by reducing the production cement amount in the concrete production. Menon et. al. [1] studied the effect of mineral admixtures with super plasticizer on high strength concrete in the development of compressive strength. The disposal of FA is one of the important issues for environmentalists as damping of FA as a waste product may cause different environmental hazards.
The FA or pulverized fuel ash (PFA) is the residue from the combustion of pulverized coal collected by the mechanical dust collectors or electrostatic precipitors or separators from the fuel gases of thermal power plant. Some principal compositions of FA are:
SiO2: 30% to 60%
Al2O3: 15% to 30%
Carbon: up to 30%
CaO : 1% to 7%
MgO : small amounts
SO3 : small amounts
The FA may be used in concrete either as an additive or in-part replacement of cement. Fly ash also makes concrete sustainable [6]. The pozzolanic activity is due to finely divided glassy silica and lime which produce calcium-silicate-hydrate as is produced in hydration of cement. The FA is a very eco-friendly material and increase the workability of concrete [2]. The magnitude of this effect

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 3, Issue 1, January 2018

depends on the nature and proportion of fly ash used [5]. In this study FA is used as an additive material replacement of high alumina cement (HAC).

HAC is a special type of material. For today's application the usage of HAC is increased rapidly [3]. Once HAC or calcium aluminate cement concrete is hardened, it undergoes a chemical change that results in a reduction in the strength of concrete when cured in hot and humid environment conditions known as conversion [4]. This conversion can take place in just a few hours or in several years depending upon the temperature. That's why calcium aluminate concrete is not used for structural purpose. Jena and Panda [11] studied the development of mechanical properties in blended concrete made with slipozz to improve the durability of marine structure.

A. Concrete Mix Design

The concrete mix design is a process of selecting suitable ingredients for concrete and determining their proportions for concrete, i.e. concrete having certain minimum compressive strength, workability and durability. The proportioning of the ingredients of concrete is an important part of concrete technology as it determines quality and economy.

II. EXPERIMENTAL INVESTIGATIONS

A. Materials

In this study, HAC of 35 grade is used and fine aggregate (sand) of Zone-II is used as per IS 383-1970 [13] and 20 mm and 10 mm coarse aggregate is used with the following properties shown in Table 1 and Table 2 respectively and the chemical compositions of HAC are also tabulated in Table 3. In this study FA is used as replacement of HAC from 0%, 10%, 20%. FA is used to increase the workability of concrete. FA is generally used for excellent durability, high water reduction, and high flowing,

Table 1: Properties of fine aggregate

Property	River sand
Specific gravity	2.67
Loose density	1.57g/cc
Rodded density	1.72 g/cc
Grading zone	II

Table 2: Properties of coarse aggregate

Property	Coarse aggregate
Specific gravity	2.67
Density	1.47 g/cc

Table 3: Chemical composition of High Alumina Cement

Oxides	Composition
Al2O3	73.5%
CaO	25.0%
Fe2O3	0.40%
SiO2	0.20%
Others	Less than 1.0%

B. Mixture proportion

The M35 grade concrete was designed according to standard specification IS: 10262-2009 [12]. The mix proportions were taken for this experiment with w/c ratio of 0.36. The different mixes of concrete mixtures were prepared by replacing 0%, 10% and 20% of FA in concrete for HAC1, HAC2 and HAC3. HAC1FA0 indicate 0% FA with 100% cement, HAC1FA10 indicate 10% FA with 90% cement, and HAC1FA20 indicate 20% FA with 80% cement. HAC2FA0 indicate 0% FA with 100% cement, HAC2FA10 indicate 10% FA with 90% cement, and HAC2FA20 indicate 20% FA with 80% cement. HAC3FA0 indicate 0% FA with 100% cement, HAC3FA10 indicate 10% FA with 90% cement, and HAC3FA20 indicate 20% FA with 80% cement.

III. TEST PROGRAM

The compressive strength is can evaluate by using cube specimens. The size of the cube specimen is 150 mm × 150 mm × 150 mm. In this investigation nine numbers of cubes were cast for each mix and each three cubes were cured in normal water for 7, 14 and 28 days. As the amount of fly ash increased slump values increased. Fly ash also has not more binding property so slump values increased. Water/cement ratio also plays an important role in preparing concrete mix, can be determined according to standard consistency of cement. If water is added more in wet concrete, then it possesses less workability and strength. Table 4 represents the different slump value for different percentages of fly ash.

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 3, Issue 1, January 2018

Table 4: Slump value of concrete

Fly ash content	Slump value (mm)
0%	22
10%	29
20%	35

IV. RESULTS AND DISCUSSIONS

The compressive strength test results were shown in figure 1, figure 2 and figure 3.

Table 5: Test result of compressive strength for HAC 1

Days	0% FA		10% FA		20%FA	
	Compressive strength in kN		Compressive strength in kN		Compressive strength in kN	
7	44.45	1000	44.89	1010	46.22	1040
14	45.78	1030	47.11	1060	46.67	1050
28	48.44	1090	50.22	1130	51.56	1160

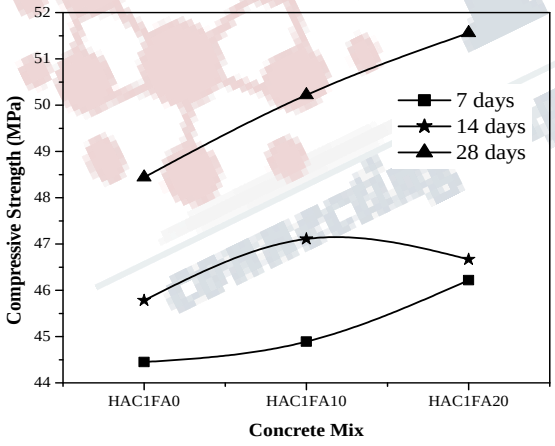

Figure 1: Compressive strength of different HAC1FA mix

The test results indicate that in HAC1 concrete mixes, the higher compressive strength was obtained after 28 days of curing. HAC1FA20 provides better results as compared to HAC1FA0. But HAC1FA20 at 14 days curing period shows less compressive strength as compared to HAC1FA10.

Table 6: Test result of compressive strength for HAC 2

Days	0% FA		10% FA		20%FA	
	Compressive strength in kN		Compressive strength in kN		Compressive strength in kN	
7	43.56	980	45.78	1030	46.67	1050
14	45.33	1020	47.11	1060	48.00	1080
28	49.33	1110	51.56	1160	52.44	1180

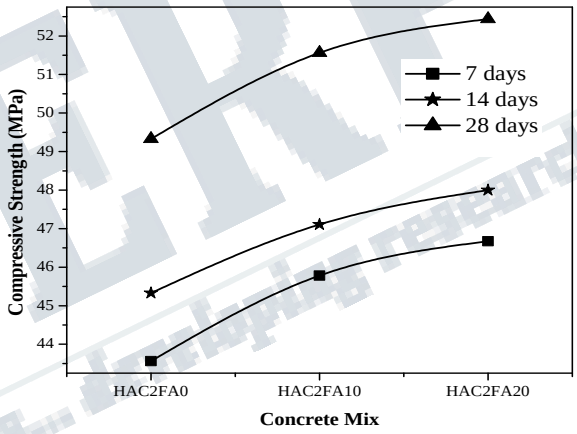

Figure 2: Compressive strength of different HAC2FA mix

Figure 2 shows the graphical representation of compressive strength of concrete versus age in days in HAC2 concrete mix. As the day's increases, the compressive strength also increases in figure 2. HAC2FA20 shows better compressive strength as compared to HAC2FA0.

Table 7: Test result of compressive strength for HAC 3

Days	0% FA		10% FA		20%FA	
	Compressive strength in kN		Compressive strength in kN		Compressive strength in kN	
7	44.45	1000	44.89	1010	46.22	1040
14	45.33	1020	47.56	1070	48.89	1100
28	49.7	112	52.0	117	52.8	119

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 3, Issue 1, January 2018

	8	0	0	0	9	0

Figure 3 shows the graphical representation of compressive strength of concrete versus age in days in HAC3 concrete mix. Compressive strength test results of HAC3FA20 concrete mix indicate highest compressive strength as compared to control mix. The 14 days test results of HAC3FA0 is lower than HAC3FA10. HAC3FA improves the strength characteristics of all other concrete mixes.

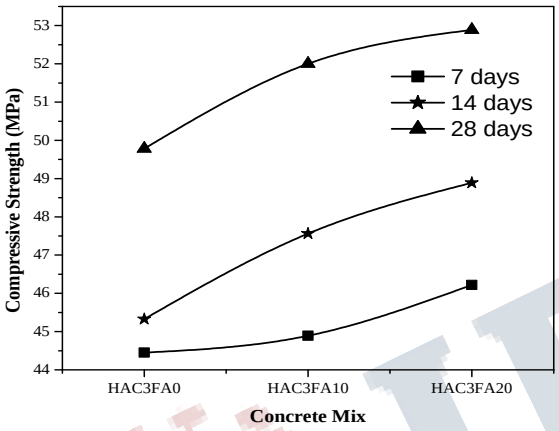

Figure 3: Compressive strength of different HAC3FA mix

V. CONCLUSIONS

The following conclusion can be drawn from the above experiment.

1. In slump test, fly ash concrete has more workability as compare to normal fresh concrete.
2. Increasing the curing time increases the strength at all replacement levels.
3. Partial replacement of FA in HAC increases the compressive strength at all ages.
4. The 20% replacement of FA increases the compressive strength as compared to 10% replacement and control specimen.
5. HAC2FA20 shows better results as compared to all other concrete mix specimens after 28 days of curing period. HAC3 provides better results as compared to HAC1 and HAC2.

REFERENCES

1. M. Mazloom, A. A. Ramezanianpour, J.J. Brooks, "Effect of silica fume mechanical properties of high-strength concrete", Cement & Concrete Composites, pp. 347-357, 2004.
2. Y. Shrivastava and K. Bajaj, "Performance of Fly Ash and High Volume Fly Ash Concrete in Pavement Design", IACSIT Coimbatore Conferences IPCSIT vol. 28, IACSIT Press, Singapore, 2012.
3. R. Lukose, "Characterization of Portland Cements, Expansive cement and High-Alumina Cement, and their Variation in Properties with Different Components", International Journal of Research in Modern Engineering and Emerging Technology, Vol. 1, pp. 2320-6586, July: 2013.
4. D. Joseph, M. Devi and S. S. kumar, "experimental investigation of concrete with combined high alumina cement, silica fume and m-sand", International Journal of Engineering Research and Applications (IJERA), Vol. 3, Issue 2, pp.425-428, March -April 2013.
5. K. Bazzar, M. R. Bouatiaoui, and A. Hafidialaoui, "Performance Approach the Durability of High Volume Fly Ash Concrete", International Journal of Engineering Science and Innovative Technology (IJESIT), Volume 2, March 2013.
6. Shirish and V. Deo, "A Review of High Volume Low Lime Fly Ash Concrete", International Conference on Biological, Civil and Environmental Engineering (BCEE-2014), March 17-18, 2014.
7. T. Subramani and K. S. Ramesh, "Experimental Study On Partial Replacement Of Cement With Fly Ash And Complete Replacement Of Sand With M sand", International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 4, May 2015.
8. D. Karoriya and Prof. R. Gupta, "Performance of Concrete with Fly Ash and Kaolin Inclusion", Imperial Journal of Interdisciplinary Research (IJIR), Vol-2, pp. 2454-1362, 2016.
9. A. Kumar, S. Jai and S. Gupta, "A Research Paper on Partial Replacement of Cement in M-30 Concrete from Silica Fume and Fly Ash", International Journal of Civil Engineering (SSRG-IJCE), volume 3, May 2016.

10. A. Gunaseelan, K. M. Ramalingam, "Experimental Study on Performance of High Volume Fly Ash Concrete", International Journal for Innovative Research in Science & Technology, Volume 2, pp. 2349-6010, May 2016.

11. T. Jena, K. C. Panda, "Influence of sea water on strength and durability properties of concrete", advance in structural engineering, vol. 03, Springer India, pp. 1863-1873.

12. IS: 10262-2009, Guide lines for concrete mix design proportioning, Bureau of Indian standards, New Delhi, India.

13. IS: 383-1970, Indian standard specification for coarse and fine aggregate from natural sources for concrete, Bureau of Indian Standards, New Delhi.