International Journal of
Advanced Structures and Geotechnical Engineering
ISSN 2319-5347, Vol. 03, No. 02, April 2014

Strength study on high volume fly ash concrete

JINO JOHN, M. ASHOK
Department of Civil Engineering, Sri Krishna College of Technology, Coimbatore, Tamil Nadu, India
Email: jinojohn@gmail.com, ashok.cape1@gmail.com

Abstract: Fly ash is finely divided residue resulting from the combustion of powered coal and transported by the flue gases and collected by electrostatic precipitator. There are multiple benefits for the sustainable development of the construction industry by using fly ash to increase the strength characteristics of structural members. The objective of the present investigation is to study the mechanical strength behavior of High Volume Fly ash concrete pavement slab. In this study the mechanical properties are studied with various replacements with cement like 50%, 60%, and 70% of Fly ash. % saves the higher compressive strength. When compared with control mix the strength of HVFA concrete reduced % for 50%, 60% and 70% at 7 day and 28 day respectively.

Keywords: *High volume fly ash concrete, Portland Cement, Class F type Fly ash, Conplast SP430*

I. Introduction:

Cement concrete is the most widely used construction material in any infrastructure development projects. The production of Portland cement, an essential constituent of concrete, release large amount of CO_2 into the atmosphere. These gases are the major contributor to the green house effect and the global warming of the planet, which is a major global environmental global issue currently the planet is encountering. The development and use of mineral admixture for cement replacement is growing in construction industry mainly due to the consideration of cost saving, energy saving, environmental production and conservation of resources. Mineral admixtures generally used are raw fly ash, rice husk ash, metakaolin, silica fume etc. Addition of such materials improves the concrete property. Fly ash is finely divided residue resulting from the combustion of powered coal and transported by the flue gases and collected by electrostatic precipitator. There are multiple benefits for the sustainable development of the construction industry by using fly ash to increase the strength characteristics of structural members. Fly ash reacts with calcium hydroxide, a byproduct of the hydration of Portland cement.

Use of cement leads to large amount of CO_2 emission which leads to environmental problem. Fly ash which is obtained from thermal power plant when added to cement reduces the cost and the problem of disposal of fly ash is solved.

II. Materials Used:

The materials used for high volume fly ash concrete are cement, fine aggregate, coarse aggregate, mineral admixture, chemical admixture and water. In this investigation, Ordinary Portland cement (43 Grade) was used for casting all the specimens Fineness (wt of residue) and specific gravity were 7% and 3.12 respectively. Class F type of fly ash is obtained from Metur power plant with fineness modulus and specific gravity were 7.86 and 2.30 respectively. Clean and dry river sand available locally will be used. Sand passing through IS 4.75mm Sieve will be used for casting all the specimens. The fineness modulus and specific gravity were 2.89 and 2.68. The coarse aggregate with specific gravity 2.75 and size passing from 12.5 to 20mm was used. Super Plasticizer is used as the chemical admixture. Conplast SP430 is based on Sulphonated Napthalene Polymers and is supplied as a brown liquid instantly dispersible in water. Conplast SP430 has been specially formulated to give high water reductions up to 25% without loss of workability or to produce high quality concrete of reduced permeability.

III. Mix Design:

The mix composition is chosen to satisfy all performance criteria for the concrete in both the fresh and hardened states. Proportioning of concrete mixes can be regarded as a procedure set to proportion the most economical concrete mix for specified durability and grade for required site conditions. The basic principle of the concrete mix design is to select the proportion of all the-ingredients the basis of the irresolute volume and taking total absolute volume of concrete $1m^3$.Inthe present Guidelines, the absolute volume of air has been considered as nil as against 2 per cent for 20 mm and 1percent for 40mm maximum size of aggregate each provided in IRC: 44-2008. The method given in these Guide lines is to be regarded as guidelines only, to arrive at an acceptable product which satisfies the requirements of replacement quire with development of strength with age and ensures the requirements of durability. A rational mix design process should be used, to reduce the number of trial tests in laboratory. Table 1 shows the mix proportions for various mixes (M0, M1, M2 and M3).

Table 1 Total Mix Proportion

Mix	Cement (kg)	Fly ash (kg)	FA (kg)	CA (kg)	SP (lit)	Water (lit)
M0	416	----	668	1242	8.32	158
M1	229	229	610	1184	4.58	158
M2	183	275	602	1170	3.66	158
M3	137	321	596	1158	2.75	158

IV. Method of Experiment:

Mould for casting specimens for strength study are of cast iron. Oil was applied on the inner surface of the moulds of cube and cylinder. Concrete was mixed in a concrete mixer. The cube, cylinder and prism were cast from the same batch of concrete. The specimens were compacted using table vibratos. The test specimens were cured for 7 day, and 28 day in curing tanks. Concrete cubes of size 150mm x 150mm x 150mm were cast to test the compressive strength of concrete. Concrete cylinder of size 150mm diameter and 300mm height were cast to test the tensile strength of concrete. Concrete prism of size 100x100x500mm was cast to test the flexural strength of concrete. Experimental investigations carried out on the test specimens to study the mechanical properties of HVFA concrete. All the test specimens such as cube and cylinder were cast using steel moulds. The specimens were removed from the mould after 24 hours and cured in water. The cube specimens were used for compressive strength and cylinder specimens were used to study the split tensile strength.

V. Research Program:

A. Slump Test

This test is performed to check the workability of freshly made concrete. It is a term which describes the state of fresh concrete. It refers to the ease with which the concrete flows. It is used to indicate the degree of wetness. A higher slump implied better consistency and workability. Slump test is the most commonly used method of measuring workability of concrete. The apparatus for conducting the slump test essential consists of a metallic mould in the form of a cone having the internal dimensions as under. The test is performed and results are shown in table 2.

B. Compaction factor

Prepare a neat concrete mix for the given grade. Place the sample of concrete in the upper hopper up to the brim. Open the trap door so that the concrete felt into the lower hopper. Then open the trap door and allow the concrete fall into the lower hopper cylinder. Open the trap door of the upper hopper and allow to fall the concrete into the cylinder, the excess is removed from the top level of the cylinder. Then the cylinder was weighted after it all the concrete was removed and again fill by 5cm layers. Then again weight this weight known as weight of fully compacted concrete. The test is performed and results are shown in table 3.

C. Compressive Strength

Compression test is the most common test conducted on hardened concrete, partly because it is easy test to perform, and partly because most of the desirable characteristic properties of concrete are qualitatively related to its compressive strength. The compression test is carried out on specimens cubical or cylindrical in shape. The cube specimen is of the size 150 x 150 x 150mm. Due to compression load, the cube or cylinder undergoes lateral expansion owing to poisons ratio effect. Table 4 shows the compressive strength for various mixes. The influence of HVFA on the compressive strength of concrete mixes and the variation of concrete mixes are shown in the fig 1.

D. Splitting Tensile Strength

The split tension test is a method of determining the tensile strength of concrete. The experiment consists of casting and testing of cylinder, 150mm diameter and 300mm height. Specimens were cured for 7, 28 days under water prior to testing. Compression testing machine having 2000kN is used for loading. The load was applied until the cylinder splits across the diametric plane connecting the loading strips. The influence of different ratios fly ash of concrete specimens according to split tensile strength can be calculated. Table 5 shows the split tensile strength for various mixes. The influence of HVFA on the split tensile strength of concrete mixes and the variation of concrete mixes are shown in the fig 2.

E. Flexural strength

A beam specimen was to test the flexural strength of the concrete. The standard specimen size is 100x100x500 mm. The test specimen should be casted and cured for 7,28days and tested for maximum load. The results of the flexural strength of various concrete mixes at the age of 7, 28 are given the table 6. The influence of HVFA on the flexural strength of concrete mixes and the variation of concrete mixes are shown in the fig 3.

VI. Results and Discussion:

F. Slump test

Table 2 Slump Cone Test Result

Mix proportions (%)	Slump (mm)
M0	27
M1	26
M2	28
M3	29

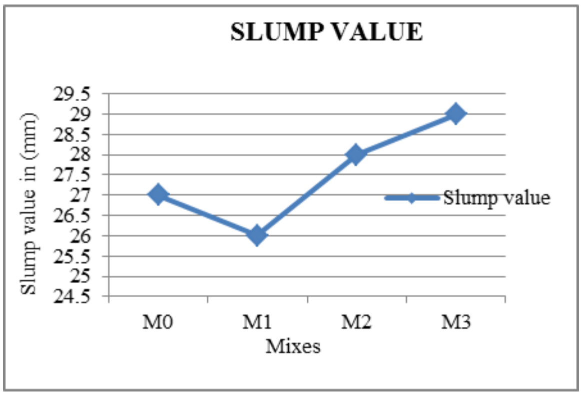

Fig 1 Slump Value

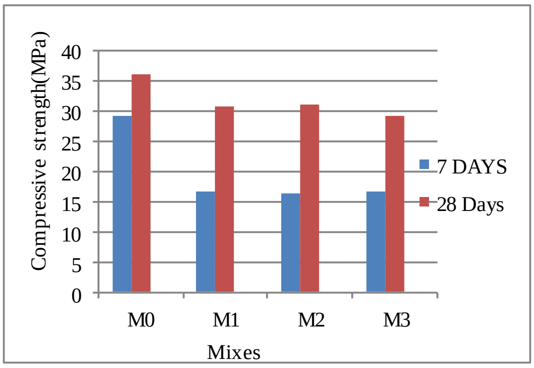

Fig 3 Variation of Compressive Strength with Various Mixes

G. Compaction factor test

Table 3 Compaction Factor Test Result

Mix proportions (%)	Compaction factor
M0	0.762
M1	0.712
M2	0.796
M3	0.812

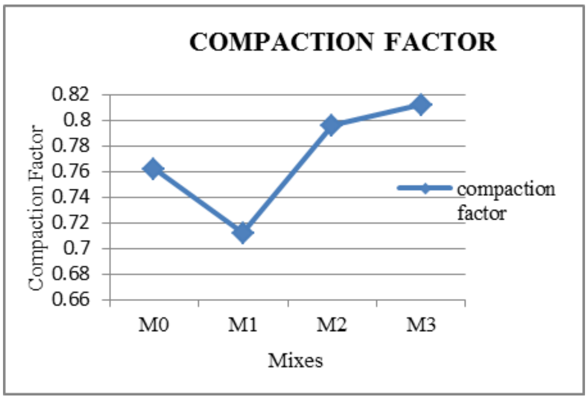

Fig 2 Compaction Factor Value

H. Compressive strength

Table 4 Compressive Strength Result

Mix	7 days	28 days
M0	29.34	36.13
M1	16.86	30.71
M2	16.47	31
M3	16.7	29.3

I. Split tensile strength

Table 5 Split Tensile Strength Result

Mix	7 days	28 days
M0	3.79	4.25
M1	3.08	3.43
M2	2.9	3.24
M3	2.51	3.32

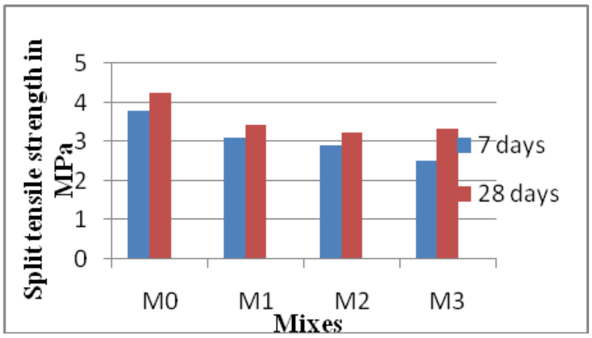

Fig 4 Variation of Split Tensile Strength with Various Mixes

J. Flexural strength

Table 6 Flexural Strength Test Result

Mix	7 days	28 days
M0	4.54	5.56
M1	4.41	4.82
M2	4.01	4.55
M3	3.56	4.43

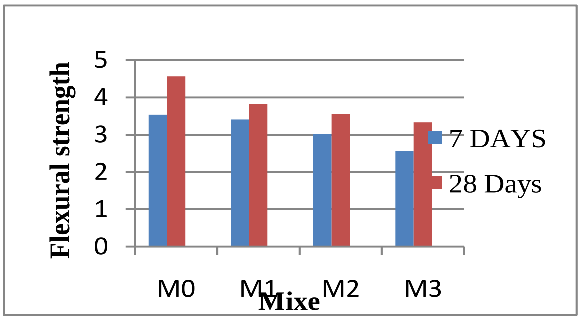

Fig 5 Variation of Flexural Strength with Various Mixes

II. Conclusion:

- In this investigation, the mechanical properties of HVFA concrete, and control concrete were studied and compared. The weight replacements of cement used were 50%, 60% and 70% and following conclusion are arrived.
- HVFA concrete attained lesser compressive and tensile strength when compared with OPC concrete.
- The maximum values 28 days strength of HVFA concrete with 0.34 w/b ratio was obtained with 50% replacement followed by 60% and 70% with 0.34 w/b ratio.
- The mechanical properties show that the HVFA concrete given lower strength than the control mix concrete.

References:

[1] Binod Kumar, et.al (2007) "Evaluation Of Properties Of High-Volume Fly-Ash Concrete For Pavements" Journal Of Materials In Civil Engineering, Vol. 19, No. 10 pp 906-911.

[2] Poon.C.S et.al (2000) "A Study On High Strength Concrete Prepared With Large Volume Of Low Calcium Fly Ash" Department Of Civil And Structural Engineering, The Hong Kong Polytechnic University, Hung Him, Hong Kong, People's Republic Of China. Cement and Concrete Research 30 pp 447-455.

[3] Rafat Siddique (2003) "Performance Characteristics Of High-Volume Class F Fly Ash Concrete" , Department Of Civil Engineering, Thapar Institute Of Engineering And Technology, Deemed University, Patiala, Punjab 147 004, India Received 18 March 2003; Accepted 4 September 2003. Cement and Concrete Research 34 pp 487–493.

[4] Tarun R, et.al (1991) "Superplasticized Structural Concrete Conntaning High Volume of Class C Fly Ash" Journal Of Energy Engineering. J. Energy Eng pp 87-96.

[5] Vanitaaggarwal, et.al (2010) Research Scholar,CED, NIT, Kurukshetra,Haryana, India. International Journal of Engineering Science and Technology. Vol. 2(9) pp 4473-4477.

[6] Yash Shrivastava And Ketan Bajaj (2012) "Performance Of Fly Ash And High Volume Fly Ash Concrete In Pavement". IACSIT Coimbatore Conferences IPCSIT Vol. 28 pp 188-192 IACSIT Press, Singapore.