ISSN:2348-2079

Volume-7 Issue-2

International Journal of Intellectual Advancements and Research in Engineering Computations

An experimental study on structural behaviour of blended cement concrete

Tamil Selvan J[1] Abdul Hameed A[2]

[1]P.G.Student (M.E. Structural Engineering), Nandha Engineering College (Autonomous), Erode, Tamilnadu, India-638052.

[2]Assistant Professor, Nandha Engineering College (Autonomous), Erode, Tamilnadu, India-638052.

ABSTRACT

Fly ash or coal ash has been partly used to replace cement in concrete industry for a long period because it contributes beneficial properties to concrete. It improves the workability, durability and chemical resistance of concrete. Despite these benefits, the use of fly ash is limited due to the low early strength of fly ash concrete. To eliminate this problem studies have been conducted on accelerating the pozzolanic properties of fly ash. The pozzolanic property of fly ash can be improved by various types of activations namely, thermal activation, mechanical activation and chemical activation. Thermal activation by heating and mechanical activation by grinding requires costly equipment and energy Compared to these chemical activation is cheap and easy. Many researchers have carried out studies on microstructural development of strength with chemical activation. Calcium oxide and sodium silicate are used in 1:8 ratio for activating fly ash in the project study.The main objective of the thesis is to study the strength behavior of beams using chemically activated fly ash at various cement replacement of 40%, 50% and 60% with water binder ratio 0.45.The results are compared with ordinary cement concrete and activated fly ash concrete.

Keywords: Concrete, Fly Ash, Fine Aggregates, Coarse Aggregates, Activated Fly Ash.

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 CO2 into the atmosphere.CO2 is major contributor to the green house effect and the global warming of the planet, which is a major global environmental 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. The fly ash is among the commonly used mineral admixtures as it is available in large quantities in many developing countries. The blending materials like fly ash and rice husk are already used without activation and their physical and chemical properties are studied by many authors. The performance of fly ash concrete can be improved by many means. The methods like chemical activation, mechanical and thermal activation are in practice. The objective of the present investigation is to improve the quality of fly ash by chemical treatment and to study the flexural behavior of reinforced cement concrete beams. For this project work the chemicals like sodium silicate, calcium oxide are used to activate the fly ash. In this study the material properties of activated fly ash like compressive strength, tensile strength, and flexural strength are studied with

Author for correspondence:
Department of Structural Engineering, Nandha Engineering College (Autonomous), Erode, Tamilnadu, India-638052.

Tamil S J et al., Inter. J. Int. Adv. & Res. In Engg. Comp., Vol.–07(02) 2019 [1752-1759]

various replacements with cement like 40%, 50%, and 60%.The results are compared with fly ash concrete and control mix. [1-5]

MATERIALS USED

Cement

A cement is a binder, a substance used for construction that sets, hardens, and adheres to other materials to bind them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate produces mortar for masonry, or with sand and gravel, produces concrete. [6-10]

Fly ash

Fly ash or flue ash, also known as pulverised fuel ash and it is a coal combustion product that is composed of the particulates (fine particles of burned fuel) that are driven out of coal-fired boilers together with the flue gases. Fly ash produced from the burning of younger lignite or sub-bituminous coal, in addition to having pozzolanic properties, also has some self-cementing properties. In the presence of water, Class C fly ash hardens and gets stronger 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 an activator.

Fine aggregates

Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 3/8-inch sieve. Coarse aggregates are any particles greater than 0.19 inch, but generally range between 3/8 and 1.5 inches in diameter.

Coarse aggregates

Construction aggregate, or simply "aggregate", is a broad category of coarse to medium grained particulate material used in construction, including sand, gravel, crushed stone, slag, recycled concrete and geosynthetic aggregates. Aggregates are the most mined materials in the world.

Silica fumes

Silica fume is a by product of producing silicon metal or ferrosilicon alloys. One of the most beneficial uses for silica fume is in concrete. Because of its chemical and physical properties, it is a very reactive pozzolan. Concrete containing silica fume can have very high strength and can be very durable.

MIX DESIGN

Based on the basic test on materials the mix proportion is arrived as per IS 10262:2009

1 : 1.25 : 2.997

with water-cement as 0.50

Mix Proportion Of Ratio

Cement	= 425.77 kg/cu.m
Water	= 191.6 kg/cu.m
Fine aggregate	= 532.38 kg/cu.m
Coarse aggregate	= 1276.35 kg/cu.m

CASTING AND CURING

The concrete was filled into the mould in layers approximately 5cm deep and each layer was compacted by using table vibrator after the top layer was smoothly finished by using a trowel. The specimens were demoulded after 24 hours and cured for 7, 14, and 28 days in curing tank. After curing period, the specimens were kept for drying and tested.

Fig I. Casting of cube specimen

Experimental Testing is comparision of comressive, split tensile strength and flexural tensile strength with conventional concrete.

TEST RESULTS OF CONCRETE SPECIMEN

For conventional concrete test report on phase 1 project. Concrete mix was designed as per IS 10262-2009. M30 grade concrete having mix proportions of cement: River Sand: Coarse aggregate proposal ratio of 1:1.25:2.997 used by weight and the w/c ratio was fixed as 0.40 as per the designed curve.

Table I. Conventional Concrete Compression strength Results for M30 grade of concrete

Trail. No	conventional concrete	7 Days N/mm²	28 Days N/mm²
1	1:1.25:2.997	22.7	32.1
2	1:1.25:2.997	20.5	30.8
3	1:1.25:2.997	21.4	31.6

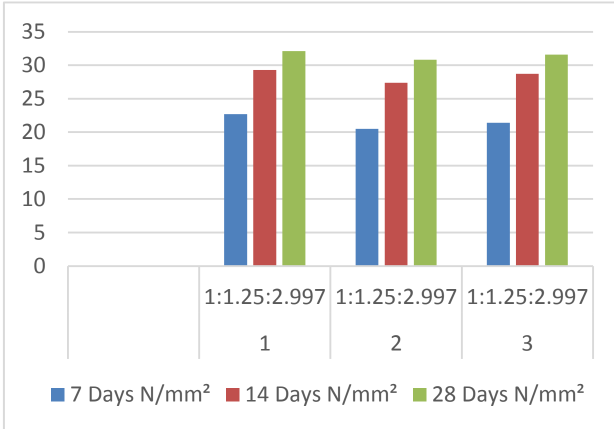

Fig II. Flow chart for conventional concrete compression strength results for M30 grade of concrete

For compressive strength of concrete by replacement of cement by FA40%+AFA40%, FA50%+AFA30%, FA60%+AFA20%.

Table II. Compressive strength results for M30 grade of concrete for partial replacement of cement by fly ash and activated fly ash.

Specimen	Mix	7 days N/mm2	14 days N/mm2	28 days N/mm2
Trail 1	FA40% + AFA40%	18.8	25.4	33.7
	FA40% + AFA40%	19.3	24.8	32.9
	FA40% + AFA40%	18.9	25.2	33.3
Trail 2	FA50% + AFA30%	17.2	23.5	30.5
	FA50% + AFA30%	17.3	23.6	31.3
	FA50% + AFA30%	16.9	23.8	30.9
Trail 3	FA60% + AFA20%	16.2	20.6	28.9
	FA60% + AFA20%	16	21.4	29.3
	FA60% + AFA20%	15.9	20.9	29.5

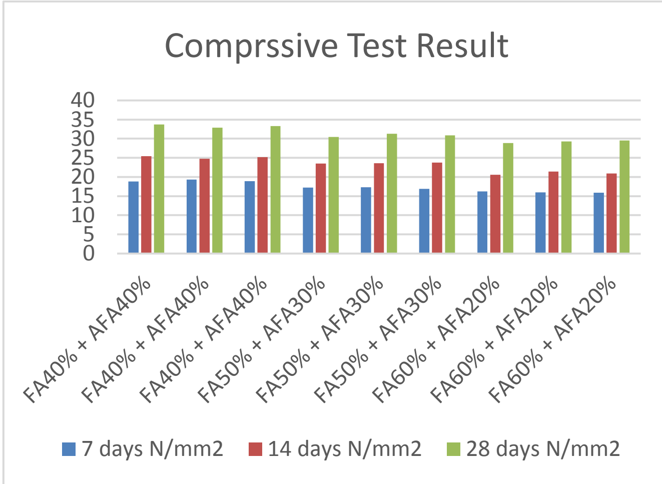

Fig III. Flow chart for compressive strength Results for M30 grade of concrete for partial replacement of cement by fly ash and activated fly ash.

From the above result the optimum mix ratio for the concrete is FA40% +AFA40%

For split tensile strength of concrete by replacement of cement by FA40%+AFA40%, FA50%+AFA30%, FA60%+AFA20%.

Fig IV. Split tensile strength

Table III. Split tensile strength results for M30 grade of concrete for partial replacement of cement by fly ash and activated fly ash.

Specimen	Mix	7 days N/mm2	14 days N/mm2	28 days N/mm2
Trail 1	FA40% + AFA40%	6.98	9.92	11.67
	FA40% + AFA40%	6.9	9.99	11.52

	FA40% + AFA40%	7.1	9.72	11.63
Trail 2	FA50% + AFA30%	5.62	8.34	10.25
	FA50% + AFA30%	5.55	8.27	10.2
	FA50% + AFA30%	5.51	8.23	10.3
Trail 3	FA60% + AFA20%	4.98	6.9	8.44
	FA60% + AFA20%	4.97	7.2	8.5
	FA60% + AFA20%	4.9	6.94	8.35

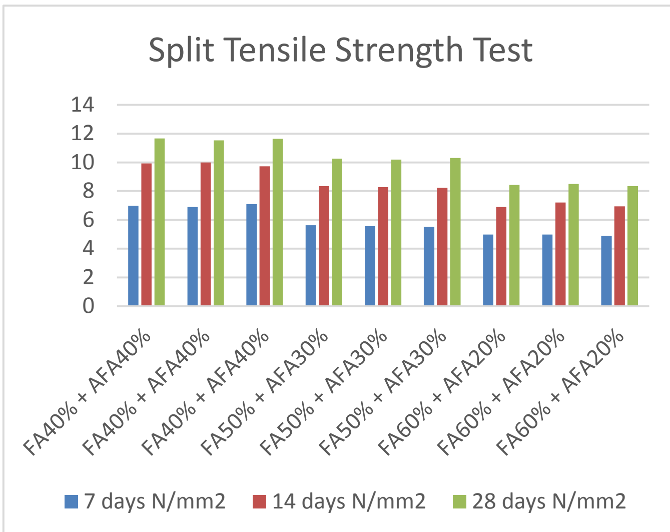

Fig V. Flow chart for split tensile strength Results for M30 grade of concrete for partial replacement of cement by fly ash and activated fly ash.

From the above result the optimum mix ratio for the concrete is FA40% +AFA40%

For flexural tensile strength of concrete by replacement of cement by FA40%+AFA40%, FA50%+AFA30%, FA60%+AFA20%.

Table IV. Split tensile strength results for M30 grade of concrete for partial replacement of cement by fly ash and activated fly ash.

Specimen	Mix	7 days N/mm2	14 days N/mm2	28 days N/mm2
Trail 1	FA40% + AFA40%	2.2	3.9	5.7
	FA40% + AFA40%	2.1	3.87	5.4
	FA40% + AFA40%	2.5	3.95	5.5

Trail 2	FA50% + AFA30% 1.98	3.18	5
	FA50% + AFA30% 2	3.15	5.2
	FA50% + AFA30% 2.09	3.2	5.1
Trail 3	FA60% + AFA20% 1.9	2.6	4.01
	FA60% + AFA20% 1.89	2.57	3.98
	FA60% + AFA20% 1.87	2.49	4.2

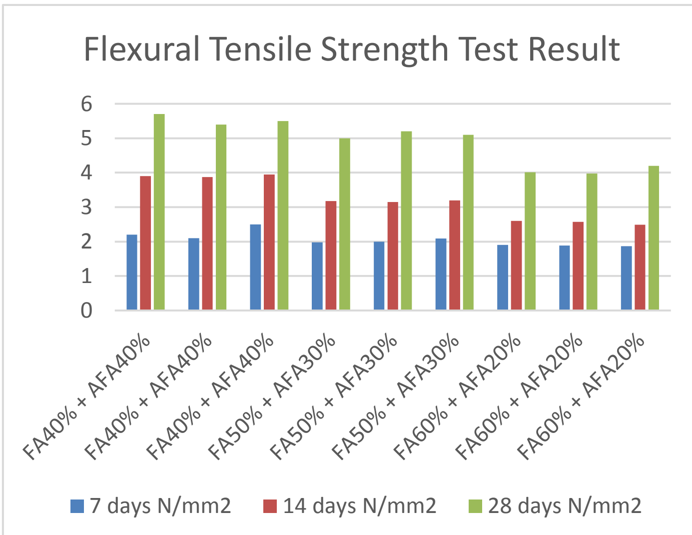

Fig VI. Flow chart for flexural tensile strength Results for M30 grade of concrete for partial replacement of cement by fly ash and activated fly ash.

From the above result the optimum mix ratio for the concrete is FA40% +AFA40%

RESULTS AND DISCUSSIONS

The main objective of current experimental investigation is to find out the M30 grade design ratio of conventional concrete test report on phase 1 and test results of same M30 grade concrete with partial replacement of cement by fly ash and activated fly ash in the proportions of FA40%+AFA40%, FA50%+AFA30%, FA60%+AFA20% respectively. Concrete mix was designed as per IS 10262-2009. M30 grade concrete having mix proportions of cement: River Sand: Coarse aggregate proposal ratio of 1:1.25:2.997 used by weight and the w/c ratio was fixed as 0.40 as per the designed curve.

CONCLUSIONS

Concrete cubes were cast at using normal conventional mix and partial replacement of cement by fly ash and activated fly ash of our mix design. The water cement ratio for this work was taken as 0.35 and both grade of concrete slump of the fresh concrete varied between 8mm and 12mm. Cubes were tested for 7, 14 and 28 days to determine compressive strength, split tensile strength, flexural tensile strength of M30 concrete mixes. The compressive strength of all mixes increased with age from 7, 14 and 28 days. Current

Tamil S J et al., Inter. J. Int. Adv. & Res. In Engg. Comp., Vol.–07(02) 2019 [1752-1759]

investigation revealed that 100% of natural sand achieving maximum strength of M30 concrete and in case of partial replacement of cement by fly ash and activated fly ash also achieved the maximum strength of M30 concrete . In that reference to the test results of conventional concrete and partial replacement of cement by fly ash and activated fly ash both attain its desired strength according to its mix design so by reducing the amount of cement used we can reduce the co2 emission during concreting and make the surrounding eco friendly environment as well as cost efficient by using fly ash as raw material for concreting.

Table V. Comparision test results for M30 grade of concrete for conventional concrete and partial replacement of cement by fly ash and activated fly ash.

Mix	Compressive Strength N/mm2	Split Tensile Strength N/mm2	Flexural Tensile Strength N/mm2
Conventional Concrete	32.1	10.2	5.5
Optimum mix ratio FA40% + AFA40%	33.7	10.67	5.7

REFERENCE

[1]. A.Guerrero, S.GonaiI ,A.Macoaa "durability of fly ash –belite Cement mortars in sulfated and chloride medium" Cement and Concrete Research 30, 2007, 1231-1238

[2]. Alhozaimy.A, Soroushian.P, Mizra.F, Effects of curing conditions and age on chloride permeability of fly ash mortar, ACI Materials Journal, 93(1), 1996, 87 –95.

[3]. P.Arjunan, M.R.Silsbee, and D.M.Roy, Chemical activation of low calcium fly ash-identification of suitable activators and their dosages, Cement and Concrete Research 30, 2001, 1231-1238.

[4]. Antiohos.A.Papageorgiou, S.Tsimas, Activation of fly ash cementitious system in the presence of quicklime. ACI Materials Journal, 92(2), 2006, 178-187.

[5]. Baton Rouge "Alkali activated class C fly ash cement" ACI Materials Journal, 1987, Vol.84 (3), pp.286-295.

[6]. Bewailing, R. Michel V.M. Malhotra, Performance of high-volume fly ash concrete in large experimental monoliths, ACI Materials Journal, 91(2), 1994, 178-187.

[7]. Blanco,M.P.Garcia,J.Ayala,G.Mayoral, The effect of mechanically and chemically activated fly ashes on mortar properties, Cement & Concrete Composites 28, 2006, 673–680.

[8]. Caijun Shi "Early Microstructure Development of Activated Lime-Fly Ash Pastes" Cement and Concrete Research, 26(9), 1996, 1351-1359.

[9]. Enchancing Our Environment (Green building Using Environment), ICJ, 45, 270-279.

[10]. Palomo,S.Alonso, Composition and micro structure of alkali activated fly ash binder: effect of the activator, J. Am. Ceram. Soc. 87(6), 2005, 1141–1145.