International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 02 | Feb 2021 www.irjet.net p-ISSN: 2395-0072

INFLUENCE OF FLY ASH ON STRENGTH OF PAVEMENT QUALITY CONCRETE

BODDU PHANI KUMAR[1], B.SRIKANTH[2]

[1] *M.Tech Scholar, MVR College of Engineering, Beside Hanuman Statue, On Nh-9, Vijayawada Rural, Paritala, AP-521180*

[2] *Assistant Professor, MVR College of Engineering, Beside Hanuman Statue, On Nh-9, Vijayawada Rural, Paritala, AP-521180*

Abstract - *We are careful that some short damage is done to climate in the fabricating interaction of concrete which includes emanation of larger part of carbon related with different synthetic compounds. There are confirmations from investigates that each one ton of concrete assembling need to control the use of concrete. Then again material squanders like fly ash is hard to arrange which thusly a deterrent to the natural wellbeing is. Fly ash is a finely separated buildup coming about because of the ignition of pummeled coal and moved by the pipe of boilers that diverts vaporous burning from the point of ignition. The fly ash at first gives high solidarity to concrete and furthermore lessen the porousness of cement. It was gotten from Thermal force station, dried and utilized. This venture fundamentally manages the replacement of concrete by fly ash taken in fixed extents and examining the influence of fly ash mixed cement. The solid blend is set up by shifting the extents of fly ash for 30%, 40% and half of solid shapes furthermore, crystals restored in typical water for as long as 28 days and the properties like Slump cone test, Compaction factor test for new concrete and Compressive strength for hardened concrete are verified and the results are analyzed.*

Key Words: Fly ash, Strength of Pavement, Compressive, Flexural strength, Concrete

1. INTRODUCTION

Customary Portland concrete is the most usually utilized structure material worldwide and it will hold its status soon as a result of its interest and extension of development industry everywhere on the world. Further the best test looked by the solid development industry is to serve the two demanding requirements of Human culture which incorporate the ecological wellbeing and meeting the framework prerequisites of our developing populace. Constructions which are implicit forceful conditions are responsible to be exposed to acidic assault. One of such significant dangers is sulfate assault against solid designs coming about in deficiency of weight and decrease in strength of cement. Tainted ground water and ocean water by modern effluents establish a portion of the wellsprings of sulfate that assault on concrete.

Fly ash concrete is extensively used among various industries. Use of such concrete is increasing because of higher performance, environment friendly and conserves natural resources. By adding admixture to concrete makes the concrete mix workable with lower water cement ratio and improves the strength of concrete..

1.1 Fly Ash

It is a fine grey powder produced by burning coal in power generating industries. It consists of iron, silica, calcium and alumina. It is a pozzolanic material which has almost negligible cementitious property. It shows cementitious property when react with cement in the presence of moisture. Only because of this reason it can be used as a substitute of cement in concrete mix with many advantages. Ash generation from Thermal power plants is increasing day by day. Disposal of fly ash is required as it pollutes environment and causes serious health issues. As maximum number of power generating plant uses coal they ultimately produces large amount of fly ash. So for disposal of fly ash many acres of land are occupied by ash ponds.

ASTM categorizes fly ash into two types and they are: Class C & Class F. Composition of both fly ashes differentiates them from each other which mainly include content of silica, calcium, iron and alumina. The chemical property of fly ash mainly depends on burned coal.

Class F Fly ash:

It is produced from burning anthracite and bituminous coal. It has little or no cementitious property. It has pozzolanic property with lime content less than 20%. As it is pozzolanic material produces cementitious material when react with lime with certain moisture content.

Class C Fly ash:

Burning of lignite or sub-bituminous coal produces Class C fly ash. Being a pozzolanic material it has cementious property. It can gain strength in the presence of moisture. In this fly ash lime content is more than 20%. It also has higher content of sulfate and alkali. Class C fly ash can replace higher percentage of cement than Class F fly ash.

1.2 Ordinary Portland cement (OPC)

Ordinary Portland cement is a controlled blend of calcium silicates, aluminates and ferrate which is ground to a fine powder with gypsum and other materials. After 1987, OPC was divided is three types based on the strength obtained by 28 days. The types are as follows: OPC 33 grade – strength not less than 33N/mm^2 at 28 days. OPC 43 grade – strength not less than 43N/mm^2 at 28 days. OPC 53 grade – strength

not less than 53N/mm² at 28 days Portland cement obtains its strength as a result of chemical reactions between cement and water. The process is known as hydration. This is a complex process that is best understood by elucidating the chemical composition of cement.

Table -1: Chemical composition of cement

Compound	Formula	Mass%
Calcium oxide	CaO	61-67%
Silicon dioxide	SiO_2	19-23%
Aluminum oxide	Al_2O_3	2.5-6%
Iron oxide	Fe_2O_3	0-6%
Sulphate	SO_3	1.5-4.5%

1.3 Objective and Scope of Work

Fly ash has been used to certain extend to replace cement in preparation of concrete for various applications. An attempt has been made in this study to utilize fly ash in varying quantities for preparation pavement quality concrete and study the effect of fly ash on strength properties of this type of concrete. In this study fly ash obtained from the nearby distributor of fly ash bricks near Vijayawada.

To achieve the above objective the following scope of work has been planned. To determine the physical properties of ingredient materials such as Ordinary Portland Cement (OPC) grade-43, fly ash, aggregate and sand. To develop mix design for concrete with and without fly ash in varying percentage. To perform compressive strength and flexural strength test on both cube and prism specimen for all type of concrete mix samples. To study the effect of fly ash replacement on strength characteristics of concrete.

2. Literature Review

Tan and Pu (1998) they studied the use of supplementary material such as fly ash to improve various properties of concrete like strength and permeability. Being eco-friendly it reduces heat of hydration, cost of production, and use of water due to use of admixture. Using admixture also improves the strength of concrete at higher period of curing. Many studies show that use of slag along with fly ash increases the strength.

Marceau (2002) shows that earlier fly ash used in concrete vary between 15% and 25%. It is taken by the mass of the cementitious material. The quantity of fly ash used actually depends on the place of application, fly ash property and the geographic location and climatic condition. Higher percentages of fly ash (30% to 50%) have been used in large structure such as foundations and dam so that it will control the rise in temperature. Many researchers have shown that higher percentage (more than 50%) of fly ash can be used in structures having sound properties and being economical.

Mini Soman and Sobha.K (2014) they presented that workability of concrete improves by using fly ash and contributing to a sustainable development. The tests are performed on concrete beams. The strength of concrete with 50% fly ash shows reduction in strength of about 20% at an age of 7 days but at 28 days it acquire the required strength. HVFA concrete can carry larger load than Portland cement concrete. From the various studies it is found that HVFAC are more crack free than OPCC. It helps in reducing the cost of construction about 24% with a replacement of 50%.

Jino John and M. Ashok (2014) they presented the mechanical properties of HVFAC. The mechanical properties of HVFAC are studied with replacement of cement about 50%, 60% and 70% of fly ash. The HVFAC attains less compressive and tensile strength as compared to the ordinary Portland cement concrete. The various other mechanical properties of HVFAC shows lesser value than that of OPCC.

Carette et al. (1990) studied the use of fly ash in concrete as a cementitious material. The fly ash being used in concrete with a replacement over 55% with cement. It also studied the mechanical properties of fly ash concrete with a water cement ratio of 0.3 and 0.35 in order to get required workability super plasticizer is also added to concrete. The evaluation of physical properties of high volume fly ash was done and they are modulus of elasticity, particle size and pore size distribution, electron-microscopically observation, compressive strength and non- evaporable water. The water cement ratio of concrete paste formed with fly ash and cement affects the porosity of paste and hydration of cement. The reaction of fly ash and CaOH2 begins between 3 and 7 days as large amount of fly ash as a cementitious material is used in concrete as a replacement of cement. A concrete mix with low water cement ratio with low CaOH2 content produces stronger concrete. In another study developed the concrete mix using ASTM class F fly ash with a replacement of 55% to 60%. The result of eight different fly ash concrete mixes shows better performance in mechanical property, workability, temperature rise, bleeding and setting time.

Claudia Ostertag (2005) presented that Fly Ash Concrete produce sustainable concrete as well as reduces negative effect on environment. Class F and Class C fly ash is being used. The need of cement is increasing as the development increases so by using fly ash in place of cement will reduce the cost of construction. Researches show that HVFAC with a replacement of approx. 50% can be used in places where strength at initial days is less required. Even strength at initial age can be obtained by adding superplasticizer to concrete mix having lower water to cementitious material ratio. HVFAC reduces the cost of construction and give better surface finish. Fly ash can be used even in a higher percentage of about 60%-80% with proper mix design. In such cases Class C fly ash is used as it contain high lime and have high cementitious property than Class F.

Naik et al. (2003) presented the investigation carried out on performance of Class F and Class C fly ash. They prepared

concrete mix using fly ash upto 70% for Class C and 67% for Class F. Density of concrete doesn't get affected by any of the factors like type or amount of fly ash used. Concrete containing Class C fly ash shows early age strength as compared to concrete containing Class F fly ash. Required flexural and tensile strength can be achieved by Hcase of long term Class F fly ash gives higher strength both in case of compressive and pozzolanic contribution as compared to the Class C fly ash.

University of Nebraska (2002) presented the investigation with the use of fly ash in large quantity from a power plant in Omaha, Nebraska. The replacement of cement with fly ash as cementitious material was 40%, 50% and 60%. The results shows compressive strength of fly ash concrete at 28 days is almost same even better than those without any fly ash.

3. METHODOLOGY

In this section brief description of experimental works are carried out in the present work. It is divided into three sections. The first section deals with the material used, second with the tests carried out on materials and last section with the procedure of mix design

3.1 Materials

Cement

The cement used in concrete mixes is Ordinary Portland Cement of grade 43, as it is fine in nature, having nice particle size distribution, it gives higher strength to the structures. The other laboratory property of Ordinary Portland Cement of grade 43 exceeds the properties of OPC 43 Grade.

Fly Ash

The Fly ash is used for the concrete mix and it is of class F. It is a fine grey powder byproduct from power generating plants obtained by burning coal. It is also commonly known as Pulverized Fuel Ash. Fly ash is mainly consisting of calcium oxide and silicon dioxide, used as replacement of cement as it contains cementitious material. Fly ash is a Pozzolanic material which means it has binding property which keeps all the materials together.

Aggregates are one of the important ingredients of the concrete. They impart strength to the concrete. It is used as economical space filler. These are of two types:

Fine aggregate
Coarse aggregate
The maximum nominal size of coarse aggregate is 20mm is used.

Admixture

Polymer based admixture is used for the concrete mixes. It is a superior quality super plasticizer. It is light coloured and does not change the colour of concrete mix. It increases the workability of concrete mix without adding water in excess amount. It reduces the water content which ultimately helps in achieving higher strength.

Water

It is one of the important ingredients of concrete. It helps in distributing the cement evenly and helps in lubricating the concrete paste. W/C ratio is a vital parameter which controls the amount of water required to add to the concrete mixture. Variation in water content affects various properties.

3.2 Tests conducted

In this study we had performed tests on cement (OPC 43 grade), coarse aggregate, and fine aggregate.

Tests on cement:

Standard consistency test
Initial setting time
Final setting time
Specific gravity of Cement

Tests on fine aggregate and coarse aggregate has done

Tests on workability

Slump cone test and Compaction factor test has been done.

4. RESULTS AND DISCUSSION

The results of experimental tests on various materials used in Pavement Quality Concrete for cube and prism specimen are presented to improve the mechanical properties. Replacement of cement with fly ash is being done with varying percentage.

In this experimental study, a total of 52 numbers of concrete specimens were casted. The specified size of cube 150mm×150mm×150mm and prism of 100×100×500is used. The mix design of concrete was done according to IS 10262:2009 for M20, M25, M30 and M40 grades. Depending on the quantities of ingredients in the mixes, the quantities of Fly ash of 30%, 40% and 50% replacement by weight were estimated and Cubes and prisms were casted. The specimens were taken out of the curing tank just prior to the test. The compressive test was performed using a Compression testing machine and flexural strength was conducted by Flexural strength testing machine.

The results are discussed in details in the following section.

Table -2 : Nominal Mix Design

Grade	Cement (kg)	Water(kg)	W/C (kg)	FA (kg)	CA (kg)
M20	310	197	0.5	908.3	1070.8
M25	330	191	0.45	805.3	1117.5
M30	385	175	0.42	690.43	1246.7
M40	380	175	0.38	915.6	1155.4

Table -3 : Cement by replacing fly ash

Grade designation	Cement (kg)	Replacing of fly ash in cement 30% (kg)	Replacing of fly ash Increment 40% (kg)	Replacing of fly ash Increment 50% (kg)
M20	310	98	128	162
M25	330	104	136	171
M30	385	118	155	195
M40	380	114	151	189

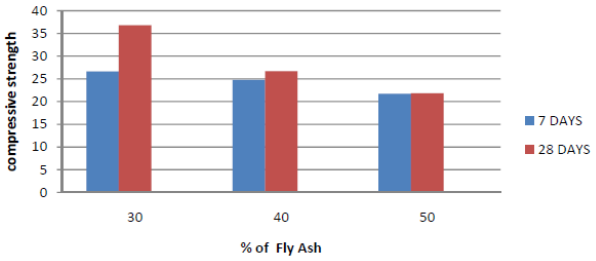

Fig -1: Compressive Strength for Mix Proportions (M20)

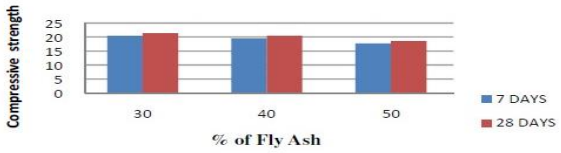

Fig -2: Compressive Strength for Mix Proportions (M25)

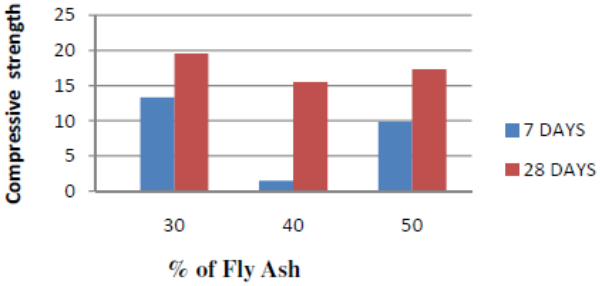

Fig -3: Compressive Strength for Mix Proportions (M30)

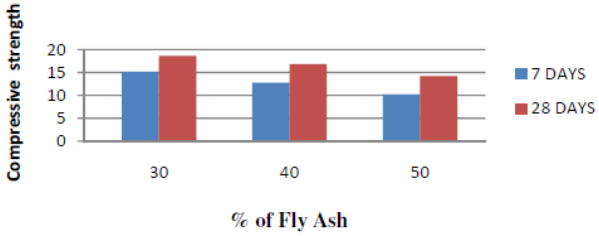

Fig -4: Compressive Strength for Mix Proportions (M40)

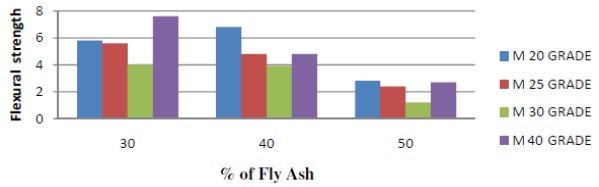

Fig -5: Flexural strength for 28 Day

5. CONCLUSIONS

Concrete cubes of size 150×150×150mm were casted and tested for compressive strength and prism size of 100×100×500mmin normal water of with 30%,40%,50% replacement of fly ash for M20, M25, M30 and M40 grades of concrete.

In order to study the durability of fly ash replaced concrete. A replacement of fly ash 30%, 40%, 50% were chosen for this study to find out the effect on compressive strength and flexural strength of concrete. From the results of the present study and information from the literature, the above mentioned replacement range was selected for this study of durability aspect. The compressive strength of normal concrete improves with adding fly ash The compressive and flexural strength of concrete with fly ash improves Satisfactory flexural strength of Pavement Quality Concrete is achieved with fly ash

REFERENCES

[1] Best JF, Lane RO. Testing for optimum pumpability of concrete. Concrete International. 1980 Oct 1;2(10):9-17.

[2] Pradhan, Arunima. "Effect of Fly Ash on Strength of Pavement Quality Concrete." PhD diss., 2016.

[3] Ghosh, Ram S., and John Timusk. "Creep of fly ash concrete." In *Journal Proceedings*, vol. 78, no. 5, pp. 351-357. 1981.

[4] IS: 2386. "Methods of test for aggregates for concrete–Part 3: Specific gravity, density, voids, absorption and bulking." (1963).

[5] IS2386–Part. I. I. I. "Methods of test for aggregates for concrete." (1963).

[6] Pradhan, Arunima. "Effect of Fly Ash on Strength of Pavement Quality Concrete." PhD diss., 2016.

[7] Malhotra, V. M. "Durability of concrete incorporating high-volume of low-calcium (ASTM Class F) fly ash." *Cement and Concrete Composites* 12, no. 4 (1990): 271-277.

[8] Marceau, Medgar L., John Gajda, and M. G. VanGeem. "Use of fly ash in concrete: Normal and high volume ranges." *PCA R&D Serial* 2604 (2002).

[9] Naik, Tarun R., Bruce W. Ramme, Rudolph N. Kraus, and Rafat Siddique. "Long-Term Performance of High-Volume Fly Ash." *ACI Materials Journal* 100, no. 2 (2003): 150-155.

[10] Pattanaik, Suresh Chandra, and Akshaya Kumar Sabat. "A study of NALCO fly ash on compressive strength for effective use in high volume mass concrete for a sustainable development." In *Proceedings of International Conference on Sustainable Technologies for Concrete Constructions, by India Chapter of American Concrete Institute at Hotel ITC-The Maratha, Mumbai*. 2010.

[11] Ravina, Dan, and Povindar K. Mehta. "Properties of fresh concrete containing large amounts of fly ash." *Cement and Concrete Research* 16, no. 2 (1986): 227-238.