A COMPARATIVE STUDY AND EVALUATION IN ENHANCING STRENGTH OF PLAIN CEMENT CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT BY METAL KAOLIN AND FLY ASH

VARIKUTI SRIVANI
M. Tech Structural Engineering,
Roll No: 16MA1D8710
QIS Institute of Technology,
Ongole, Prakasam(Dist.)

B. SANDHYA RANI
Assistant Professor, M. Tech
QIS Institute of Technology,
Ongole, Prakasam(Dist.)

ABSTRACT:

In the past few years, many research and modifications has been done to produce concrete with desired characteristics. Concrete is the most widely used and versatile building material having high compressive strength, by additions of some Pozzolanic materials, the various properties of concrete wiz, workability, durability ,strength, resistance to cracks and permeability can be improved. Experimental work was carried out to investigate the effect of Meta kaolin and Fly ash by partial replacing cement and keeping same water cement ratio to ordinary concrete & Meta kaolin and fly ash. Present project samples of size 150mmx150mmx150mm for different percentages of Meta kaolin and Fly ash with partial replacement of cement will casted and tested. A percentage of 2%, 6%, 10%, 14% added with cement and fly ash mixture to check the strengthening properties. .Using the optimum mix proportion giving the best results in compressive strength of cube testing, beam specimens will casted and tested for their flexural strength. Experiments are carried out for beams of 750X150X150 on UTM at a time periods of 7 days, 14 days, and 28 days.

Keywords: *concrete, Pozzolanic materials.*

INTRODUCTION

The cement and concrete industry has in part, focused on the use of less energy intensive materials such as Fly ash, Slag and Silica Fume. Lately some attention has been given to the use of Natural Pozzolans like Meta kaolin as a possible partial replacement for cement. Amongst the various methods used to improve the durability of concrete, and to achieve high performance concrete, the use of Meta kaolin is a relatively new approach. Meta kaolin, or heat-treated clay, may be used as a Supplementary Cementations Material in concrete to reduce cement consumption, to increase strength. Meta kaolin reduces the porosity of concrete. Plain concrete possesses a very low tensile strength, limited ductility and little resistance to cracking. Concrete is one of the most common materials used in the construction industry. In the past few years, many research and modifications has been done to produce concrete with desired characteristics. Concrete is the most widely used and versatile building material having high compressive strength, by additions of some Pozzolanic materials, the various properties of concrete wiz, workability, durability ,strength, resistance to cracks and permeability can be improved. The use of Meta kaolin as a partial cement replacements material in mortar and concretes has been studied in recent years, despite of numbers of studies, use of Meta kaolin is still not popular in practice. The use of cement replacing materials fundamental in developing low cost construction materials. Concrete is the most widely used and versatile building material which is generally used to resist compressive forces. By addition of some pozzolanic materials, the various properties of concrete viz., Compressive

Strength, Flexural Strength Porosity can be improve.

INITIATIVES AND BENEFITS OF FLY ASH:

Most of the developing countries face energy scarcity and huge housing and other infrastructure shortage. Ideally in these countries materials for habitat and other construction activities should be energy efficient (having low energy demand). The following table shows some examples of energy savings achieved through the use of Fly Ash in the manufacture of conventional building materials.

LITERATURE REVIEW

Gideon Olukunle Bamigboye (2015) the paste, comprised of Portland cement and water, binds the aggregates (usually sand and gravel or crushed stone) into a rocklike mass as the paste hardens because of the chemical reaction of the cement and water. In our society today some of the cement brands that are being sold are not up to standard and this may be traced to negligence on the part of the manufacturers by paying very little attention to the quality and also the regulatory body does not put strict measures to enforce the required standard. This problem has led to the production of poor quality concrete that increases the risk of collapse of building structures. This research determined the cement brands that have the highest compressive strength to enhance the quality and durability of the structures being built in the country. Different brands of Portland cement were used to produce concrete varying with1:2:4 and 1:3:6 mix ratio respectively with a curing date of 3, 7, 14, 21, and 28 days respectively. No additive was used in any of the mix. The tests carried out include slump test at its fresh state while compressive strength was carried out for the hardened concrete, also test was carried out on the cement brands to determine the setting time.

Kligys M., Pundiene I. and Pranckevičiene J. (2015) As there has not been a better alternative over the years modern structures in developed and developing nations are mostly built in concrete. Concrete is an artificial stone-like material used for various constructional purposes and manufactured by mixing cement and various aggregates. Better still, concrete could be a composite material, which is made up of filler and a binder. Concrete as the most widely used man-made construction materials is second only to water as the most utilized substance on the planet It is obtained by mixing cementitous materials, water and aggregate (and sometimes admixtures) in required proportion found that concrete develops an average of 26 % of the 28 days strength in 1 day and 85 % in 21 days and concluded that concrete develop strength rapidly at early age compared to later ages. Quality of concrete material can have positive or negative impact on a society. For instance, in Nigeria the most dominant construction material is concrete and the most collapse structures are concrete structures. Various researches have all identified the use of substandard materials, particularly concrete as the leading causes of building collapse reported that, the strength of concrete is mainly affected by the water cement ratio; the workability is affected by aggregate to water ratio and the cost by the aggregate cement ratio. The evolution of concrete has pass through plain concrete, reinforced concrete, precast concrete, pre-stressed

concrete to the contemporary concrete

Pundiene I. and Vitola L.(2017) The degree of cement hydration which is a function of water to cement ratio has a direct impact on the porosity and consequently on the strength. The richness of the mix is one of the factors that affect the rate of strength development in concrete mix and is a direct function of the quality and quantity of the cementitus material. Knowledge of the rate of reaction between cement and water is important because it determines the rate of hardening. The initial reaction must be slow enough to allow time for the concrete to be transported and placed. Once the concrete has been placed and finished, rapid hardening is desirable. Gypsum added at the cement mill when clinker is ground, acts as a regular of the initial rate of setting of Portland cement. Other factors that influence the rate of hydration include cement fineness, admixture, amount of water added and temperature of the material at the time of mixing. Compared compressive strength of four brands of cement, Ordinary cement Concluded that Eagle cement has the highest compressive strength at 28 days.

METHODOLOGY

Concrete is a one of the among the most comprehensively used advancement material. Portland solid age is an imperative supporter of carbon dioxide outpourings. The overall temperature change is caused by the radiation of nursery gasses, for instance, carbon dioxide, to the earth by human activities. Among the nursery gasses, carbon dioxide contributes around 65% of an overall temperature modification. Various undertakings are being made remembering the ultimate objective to diminish the use of Portland bond in concrete. These undertakings fuse the utilization of supplementary building up materials; for instance, fly searing remains, silica smolder, granulated impact heater slag, rice-husk cinder and metakaolin, and discovering elective folios to Portland bond. Regarding diminishing the a dangerous atmospheric deviation, the geo polymer innovation could decrease the carbon dioxide outflow to the environment caused by Cement around 80% In this paper, the effort was There are two main constituents of geo polymers, to be specific the source materials and the basic fluids. The source materials for geo polymers in light of alumina-silicate ought to be rich in silicon (Si) These could be common minerals, for example, kaolinite, muds, and so forth. On the other hand, by-item materials, for example, fly ash and so forth could be utilized as source materials. The decision of the source materials for making geopolymers relies upon elements, for example, accessibility, cost, kind of use, and particular request of the end clients. The basic fluids are from dissolvable antacid metals that are generally sodium or potassium based.

3.1 Metakaolin:

Meta kaolin is not a by-product. It is obtained by the calcinations of pure or refined Kaolinite clay at a temperature between 6500 C and 8500 C, followed by grinding to achieve a finesse of 700-900 m2 /kg. It is a high quality pozzolonic material, which is blended with cement in order to improve the durability of concrete. When used in concrete it will fill the void space between cement particles resulting in a more impermeable concrete. Meta kaolin, is a relatively new material in the concrete industry, is effective in increasing

strength, reducing sulphate attack and improving air-void network. Pozzolanic reactions change the microstructure of concrete and chemistry of hydration products by consuming the released calcium hydroxide (CH) and production of additional calcium silicate hydrate (C-S-H), resulting in an increased strength and reduced porosity and therefore improved durability. It is acquired from the calcination of kaolinitic dirt at temperatures running from 500 - 750^{O}C. The further calcination of kaolinite at higher temperatures prompts the arrangement of more requested crystalline stages, for example, spinel, mullite and cristobalite. It is recommended that terminating kaolinite at bring down temperatures (< 500 ^{O}C) does not offer adequate vitality to reprieve the crystalline structure of kaolinite. Therefore, shapeless metakaolinite isn't framed. Be that as it may, calcination at higher temperatures, i.e. higher than a limit temperature turns the metastable stage, met kaolinite, into more requested crystalline stages, which are non-receptive upon alkali activation. The high amorphicity of metakaolinite prompts the high reactivity when it is enacted in soluble base arrangements. MK has the littlest molecule estimate in contrast with FA or fly ash. The fine and irregular particle shape of MK often mean that MK generally requires more solution for wetting and reaction to take place appropriately

Physical Properties of Metakaolin

Colour	Pink / Off-white
Pozzolan Reactivity mg Ca (OH)2 / gm	900
Average Particle size	1.4 micron
Brightness (ISO)	75 ± 2
Bulk Density (Gms / Ltr)	320 to 370
Specific Gravity	2.5

Metakaolin

Mix Proportions Table (1): Mix Proportions for M25 & M30 per m3

Mix Description	Cement (Kg/m3)	Sand (Kg/m3)	Aggregate (Kg/m3)	Water (Lit.)	MK+FA (Kg/m3)
2%	383	735	1103	192	-
6%	363.85	735	1103	192	19.15
10%	344.70	735	1103	192	
14%	325.55	735	1103	192	

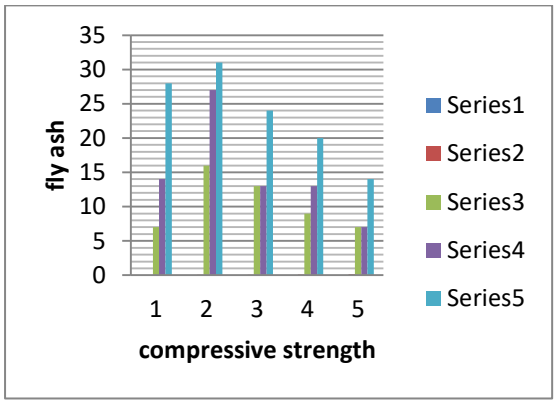
RESULTS

Fly ash particles are generally spherical in shape and reduce the water requirement for a given slump. The spherical shape helps to reduce friction between aggregates and between concrete and pump line and thus increases workability and improve pump ability of concrete. Fly ash use in concrete increases fines volume and decreases water content and thus reduces bleeding of concrete. This recent report aimed at energy conversation in the cement and concrete industry has in part, focused on the use of less energy intensive materials such as Fly ash, Slag and Silica Fume.

Lately some attention has been given to the use of Natural Pozzolans like Meta kaolin as a possible partial replacement for cement. Amongst the various methods used to improve the durability of concrete, and to achieve high performance concrete, the use of Meta kaolin is a relatively new approach. Meta kaolin, or heat-treated clay, may be used as a Supplementary Cementations Material in concrete to reduce cement consumption, to increase strength. Meta kaolin reduces the porosity of concrete.

Table: Compressive Strength Add with cement fly ash mixture:

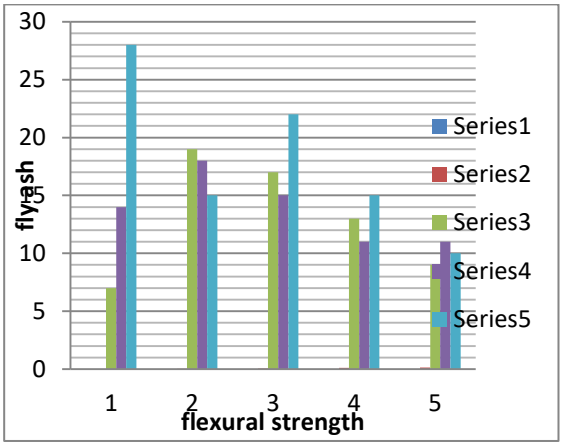
curing days	BEAMS	Compressive Strength (N/mm2)			
	150mmx150mmx150mm	2%	6%	10 %	14 %
7		16	13	9	7
14		27	13	13	07
28		31	24	20	14



Graph: Compressive Strength Add with cement fly ash mixture

Table: Flexural strength Add with cement fly ash mixture

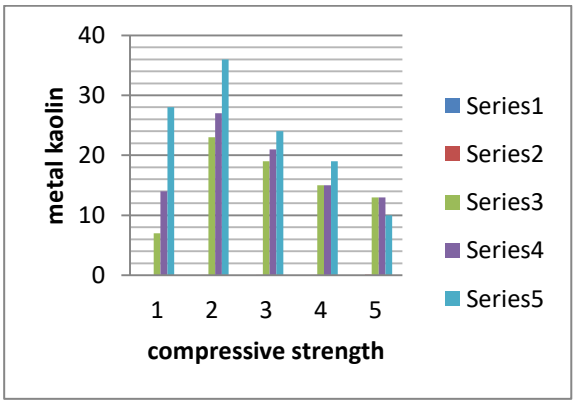
curing days	**beams**	**Flexural strength**(N/mm2)			
	150mmx150mmx150mm	2%	6%	10 %	14 %
7		19	17	13	9
14		18	15	11	11
28		15	22	15	10



Graph: Flexural strength Add with cement fly ash mixture

Table: Compressive Strength Add with cement Metal Kaolin mixture

curing days	beams	Compressive Strength (N/mm2)			
	750X150X150	2 %	6 %	10 %	14 %
7		23	19	15	13
14		27	21	15	13
28		36	24	19	10



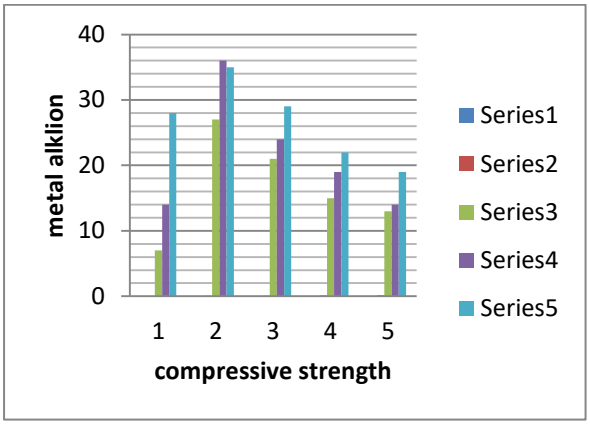
Graph: Compressive Strength Add with cement Metal Kaolin mixture

Table: Compressive Strength Add with cement Metal Kaolin mixture

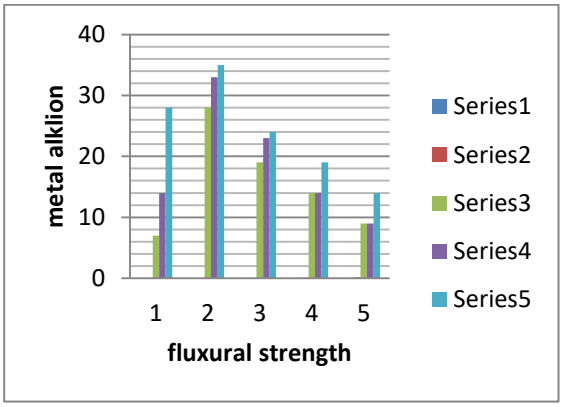
curing days	beams	Compressive Strength (N/mm2)			
	750X150X150	2 %	6 %	10 %	14 %
7		27	21	15	13
14		36	24	19	14
28		35	29	22	19

Table: Flexural strength Add with cement Metal Kaolin mixture

curing days	**beams**	**Flexural strength**(N/mm2)			
	750X150X150	2 %	6 %	10 %	14 %
7		28	19	14	09
14		33	23	14	09
28		35	24	19	14



Graph: Compressive Strength Add with cement Metal Kaolin mixture



Graph: Flexural strength Add with cement Metal Kaolin mixture

As expected the compressive strength increases with increase in content of metakaolin. As the total water/binder ratio is kept constant, the variation of strength with respect to constant water/cement ratio remains open to discussion. The compressive strength of metakaolin concrete increases with increase in metakaolin content upto 12% and further increment of metakaolin will result in strength reduction evaluated the effect of Metakaolin on concrete. Eight blend proportions were used to provide excessive-overall performance concrete, in which Metakaolin changed both cement or sand of 10% or 20% by weight of the manage cement content. The strength development of Metakaolin concrete turned into evaluated the use of the performance element With regard to strength improvement the Metakaolin and commercially obtained Metakaolin yielded the equal results.

CONCLUSION

In this paper an attempt is made for assessment of compressive strength of Fly ash and metal kaolin Concrete mixes M25, M30, are designed as per the Indian standard code (IS-10262-82) by adding, 0%, 10%, 20%, 30% and 40% of fly ash. Concrete cubes of size 150mm X 150mm X150 mm are casted and tested for compressive strength at7 days , 14 days, and 28 days for all mixes and comparing the results of the cubes containing fly ash and the pure concrete .The compressive strength of all mixes is tabulated. The

compressive strength of fly ash cement concrete is assessed for concrete mixes M25 and M30 grade concrete with 2%, 6%, 10%, 14% and 40% of fly ash. It is found that there is a decrease in compressive strength for M25 and M30 grade concrete with increase in the percentage of fly ash is less than to the metal alkalion because metal alklion strength is very highAddition of Meta kaolin & Fly ash to concrete changes its brittle mode of failure into a more ductile one and improves the concrete ductility. The compressive strength and flexural strength of concrete increases with meta kaolin & fly ash content. It is true up to 15% replacement if we replace cement by more than 15% strength starts reducing. Therefore it always preferable to use Meta kaolin & Fly ash with 10% replacement of cement and it gives us better result

REFERENCE:

[1] *Kligys M., Pundiene I. and Pranckevičiene J. (2015) "Effect of limestone particles on rheological properties and hardening process of plasticized cement pastes," Medziagotyra, 21, no. 1, pp. 143–148,*

[2] Pundiene I. and Vitola L.(2017) "Effect of Pozzolanic Additives on the Strength Development of High Performance Concrete," Procedia Eng., 172, pp. 202–210,

[3] B.Damodhara Reddy et al.(2013) "Coal Combustion Bottom Ash as Microfiller with Pozzolanic Properties for Traditional Concrete," Procedia Eng., 57, pp. 149–158,

[4] Bajare D., Korjakins A., Kazjonovs(2012). "Pore structure of lightweight clay aggregate incorporate with non-metallic products coming from aluminium scrap recycling industry," J. Eur. Ceram. Soc., 32, no. 1, pp. 141–148,

[5] Grigonis D., Ivanauskas(2011),"Concrete Dust Influence on Cement Stone Properties," Mater. Sci., 17, no. 2, pp. 197–202,

[6] Bajare D. and Bumanis G. (2011) "Effect of Ground Glass Fineness on Physical and Mechanical Properties of Concrete," in 10th International Congress for Applied Mineralogy, pp. 395–402.

[7] Sahmenko G. and Justs J.(2012)"High Performance and Conventional Concrete Propreties Affected by Ashes Obtained from Different Type of Grasses," in Tweltfh International Conferencee on Recent Advances in Concrete Technology and Sustainability Issues, 2012, pp. 317–330.

[8] Chindaprasirt P.(2012) "Assessing the effect of biomass ashes with different finenesses on the compressive strength of blended cement paste," Mater. Des., 42, pp. 424–433

[9] Gideon OlukunleBamigboye (2015) Assessment of Compressive Strength of Concrete Produced from Different Brands of Portland Cement", Civil and Environmental Research, ISSN 2224-5790, Vol.7, No.8

[10] Jian-Tong Ding and Zongjin Li "Effects of Metakaolin and Silica Fume on Properties of Concrete" ACI Materials Journal/July-August 2002,pp.393-398