ISSN XXXX XXXX © 2018 IJESC

Research Article Volume 8 Issue No.6

Effects of Partially Replacing Meta-Kaolin, Fly-Ash and Rice-Husk Ash on Flexural of Concrete

Shibin R Nambiar[1], Sunil Kumar .K[2]
M.Tech Student[1], HOD[2]
Department of Civil Engineering
SCEM, Mangalore, India

Abstract:
Supplementary binder materials are used in concrete for economical, technical and environmental reasons. OPC Grade 53 cement was replaced with Meta-Kaolin (MK), Fly-Ash (FA) and Rice-Husk Ash (RHA) to study the effect of pozzolanic variations .Cement was replaced with MK by 10%, 12%, 14% and 16%, FA by 7.5%, 10% and 15% and RHA by 2%, 4% and 6% it was concluded that a controlled replacement of cement by 14% of MK, 15% of FA and 2% of RHA improvement of properties of concrete i.e. Flexural strength

Keywords: Meta-Kaolin (MK), Fly-Ash (FA), Rice-Husk Ash (RHA).

1. INTRODUCTION

Concrete has played important role in infrastructure development and thus world's manufacture of cement has significantly amplified. Concrete is extensively used, because it has several benefits over other building materials including low cost, compliance under several conditions etc. Use and production of cement has progressively come to be a foremost cause of global environmental complications in reference to the over abuse of non-renewable natural resources. Concrete comprises of coarse aggregate, fine aggregate, cement and admixtures. Supplementary materials could be incorporated to enhance the strength and workability properties of concrete. In all the various types of admixtures used, MK takes up a distinct position because it increases durability, freezing and thawing, reduces the permeability and bleeding resistance to chloride and sulphate attack, alkali silica reaction and increase in compressive strength. As MK is expensive when compared to cement, a cheaper replacement material was sought which can go hand in hand with MK without altering the strength properties of MK. Hence Rice-Husk Ash (RHA) and Fly-Ash (FA) are incorporated in the mix. Fly-ash is a derivative produced from incinerating powdered coal in electric power generation plants. The fine powder resembles Portland cement but is chemically of different constitution. Rice husk is an agricultural by-product produced by partially burning husk from the milling plants. By addition of MK, FA and RHA as a substituent pozzolanic material, the various properties of concrete viz., Compressive Strength, Flexural Strength Porosity can be improved.

2. LITERATURE REVIEW

E. Badogiannis et al (2002) [1] Conducted on two definitive areas of research on Meta-Kaolin. The first one concerns the influence of the kaolin structure on the kaolinite to meta-kaolinite alteration and the utilization of thermo-analytical procedures in the investigation of kaolin thermal treatment. The other area of study shows the pozzolanic behaviour of meta-kaolinite and its effect on concrete characteristics. The study indicated that after 28 days and 90 days Meta-kaolin has a very positive effect on the concrete strength. 10 % and 20 % of cement was replaced with MK which developed a strength of 87 Mpa and 92 MPa at the age of 90 days where as ordinary Portland cement concrete shown 68 MPa of strength. It's concluded that Meta-kaolin concrete exhibits drastically low chloride permeability and gas permeability compared with OPC concrete.

M. Narmatha et al (2016) [2] Drew inferences from the examination of the result of partial replacement of cement with Meta-kaolin by 0, 5, 10, 15 and 20 % are that the strength of all Meta-kaolin mixes over-shoot the strength of OPC. For every mix 24 cubes, 12 cylinders and 12 prisms were casted. 15% replacement by Meta-kaolin in cement shows higher strength against all other mixes. The increase in Meta-kaolin content progresses the compressive and split tensile strength up to-15% cement replacement. With compressive strength of 72.7 MPa, a 17.45% strength gain was observed in comparison with conventional mix. For flexural strength, the observations indicated that 15% replacement improve the performance of the prism by 0.9MPa. Split tensile strength of the cylinders showed a 20.56% increase in comparison with conventional concrete at cement replacement of 15%. The results suggests the use of Meta-kaolin as a pozzolanic material in manufacturing high performance concrete is beneficial.

C.S. Poon et al (2000) [3] in this paper explains the outcomes of experimental study on concrete equipped with enormous quantities of low calcium fly ash in which parameters considered includes heat of hydration, pore structures ,chloride diffusivity, degree of hydration and compressive strength of fly ash/cement concrete. The investigational outcomes indicated that with a fly ash content of 45% and a water-to-binder (w/b) ratio of 0.24, the compressive strength of 80 MPa could be attained in concrete at the age of 28 days. Such concrete has poorer heat of hydration and chloride diffusivity than the regular plain cement concrete. The test results showed that the influence to strength by the fly ash was advanced than in the mixes prepared with higher w/b ratios. The study also enumerated the reaction rates of cement and fly ash in the cementitious materials and these results confirmed the dual effects of fly ash in concrete as in it acts as a micro-aggregate and also as a pozzolana

Harun Mallisa et al (2017) [4] An investigation was conducted on the extent of fly ash to supplant part of OPC in manufacturing concrete. The properties in both fresh and hardened state of can progress by incorporation of fly ash in the mix. The water-binder ratio of 0.30 was considered and the used sand was medium sand along with the coarse aggregate as 20 mm as the maximum size. The cement of Type I was used while incorporating the super platicizer Naptha 511P, the percentages of fly ash to the total of a binder 0, 10, 15, 20, 25 and 30%. The results exhibited that the compressive strength higher than the minimum strength at one day of high-strength concrete was brought about by the substitution of fly ash up to 25 % of the total weight of binder.

B. Prabu et al [5] An observation through the study of the hardened specimen strength and durability properties the development of RHA as the source for geopolymer concrete was conducted. Diluted hydroxide (NaOH), fly ash, GGBS and rice husk ash were incorporated into the mix for the purpose of the study. RHA blended concrete can decrease the total porosity of concrete and modifies the pore structure of the cement, mortar, and concrete, and significantly reduce the permeability which allows the influence of harmful ions leading to the deterioration of the concrete matrix. RHA blended concrete can improve the compressive strength and helps in enhancing the early age mechanical properties as well as long-term strength properties of cement concrete. Partial replacement of cement with RHA reduces the water penetration into concrete by capillary action. RHA replacement of cement is effective for improving the resistance of concrete with sulphate attack. The addition of RHA as a silica source effects on the strength of Geopolymer positively.

George Washington et al (2017) [6] Studied and explained that the results were compared with cement concrete which is without any replacement and that of concrete having the partial substitution of RHA done at 10, 20 and 30%. The water necessity for workability was found to be amplified as observed by the slump value that increased whereas the compressive strength of concrete was established to somewhat decrease. Initial and Final setting time were also delayed. The compressive strength of concrete was found to be 35.05Mpa for 10 % 30.37Mpa for 20% and 24.6 for 30 % replacement respectively. It was concluded that it can be a decent replacement of cement at10% and 20%. When 30% replacement was taken, the compressive strength after 28 days was found to be 24.6Mpa, which is less than 30Mpa thereby concluding that replacement of RHA up to 20% is suitable.

3. MATERIALS:

3.1 CEMENT

This experimental study employs the use of OPC of 53 Grade. The chemical composition of cement used is shown in Table 3.1. The cement used in this project is from RAMCO Cements.

3.2 FINE AGGREGATE

Sand that is locally acquired river sand and that passes through 4.75mm IS sieve conforming to grading of zone II as per IS383-1970 is used.

3.3 COARSE AGGREGATE

A maximum size of 20 mm was considered and crushed stone metal from a local source conforming IS: 383-1970 is used. Sieve analysis was conducted on the crushed stone metal specimens as per IS: 2386 part-1.

3.4 META-KAOLIN

Meta-kaolin is not a by-product however is acquired by the calcinations of unadulterated Kaolinite at a temperature ranging between 6500° C and 8500° C, fineness of 700-900 m2/kg is attained by granulating. MK is blended with cement because it is a high quality pozzolanic material in order to achieve superior compressive strength of concrete. MK is used in to fill the void space between cement particles resulting in a more impermeable concrete since the particle size is finer than that of cement. A superior quality and diminished porosity is brought about by the pozzolanic reactions that change the microstructure of cement and expending the discharged calcium hydroxide (Ca(OH)2) and generation of extra calcium silicate hydrate (C-S-H), bringing about enhanced toughness.

3.5 FLY ASH

It is the remainder from the incineration of widely available coal in electricity generating plants. The exhaust gasses that float out of the combustion chamber during the combustion of minerals like clay, feldspar, quartz, contains impurities in the coal that fuse in suspension. As these fused material ascents spherical polished particles called fly ash cools and solidifies which is accumulated from the fumes gases by bag filters.

3.6 RICE-HUSK ASH

The rice husk generated during milling of paddy is generally used as a fuel in the boilers for treating of paddy or for power generation that uses paddy husk as fuel. Only about 25% by weight of rice husk is leftover when burnt in the boilers and this is termed as Rice husk ash. The incineration of paddy husk at a temperature below 800°C is done in order to produce RHA which makes it highly pozzolanic.

4. METHODOLOGY

Mix was designed for M25 concrete and this was used to conduct the experiment. The replacement was done to cement by other binder materials as given in table 4.1.

Table 4.1

Mix	%MK	%FA	%RHA
A0	0	0	0
A1	10	5	2
A2	12	5	2
A3	14	5	2
A4	16	5	2
A5	10	5	4
A6	12	5	4
A7	14	5	4
A8	16	5	4
A9	10	10	2
A10	12	10	2
A11	14	10	2
A12	16	10	2
A13	10	10	4
A14	12	10	4
A15	14	10	4
A16	16	10	4
A17	10	15	2
A18	12	15	2
A19	14	15	2
A20	16	15	2
A21	10	15	4
A22	12	15	4
A23	14	15	4
A24	16	15	4
A25	10	15	6
A26	12	15	6
A27	14	15	6
A28	16	15	6

4.1 FLEXURAL STRENGTH TEST

Flexural test studies the tensile strength of concrete by testing the capability of un-reinforced concrete beam to endure bending without failure by using three point load test and is expressed as a modulus of rupture in MPa. Beam mould of size 10 x 10 x 50 cm was cleaned and oiled and freshly prepared concrete was poured into it .The beam specimens were left off in this state for a one entire day and was de-moulded and was left in a curing tank .After 28 days the beams were dried and placed in a three point loaded system and tested by loading it axially and without exposing the specimen to any torsional stresses.

5. RESULT AND DICUSSION

5.1FLEXURAL STRENGTH

The flexural strength of concrete was obtained by testing 10X10X50 cm beam in a three point loaded system as shown below. The results obtained were tabulated in Table 5.1

Table 5.2: Flexural Strength

Mix	28-Day Flexural Strength (MPa)	Mix	28-Day Flexural Strength (MPa)
A0	8.67	A19	9.5
A1	7	A20	7.5
A2	7.5	A21	7.5
A3	8.5	A22	7.5
A4	8	A23	7.5
A5	7.5	A24	7.5
A6	7.5	A25	7
A7	8	A26	7
A8	7	A27	6.5
A9	7.5	A28	6.5
A10	8.5	A29	7
A11	9	A30	7.5
A12	7.5	A31	7.5
A13	7	A32	7
A14	7	A33	7
A15	7.5	A34	7.5
A16	7	A35	7.5
A17	8	A36	6.5
A18	8		

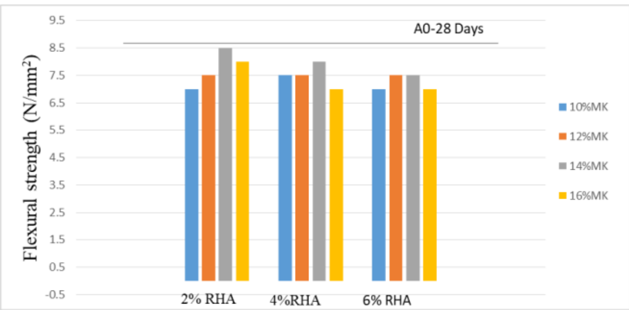

Figure.5.1. Variation of Flexural Strength for 5% FA & RHA & MK for 28 days

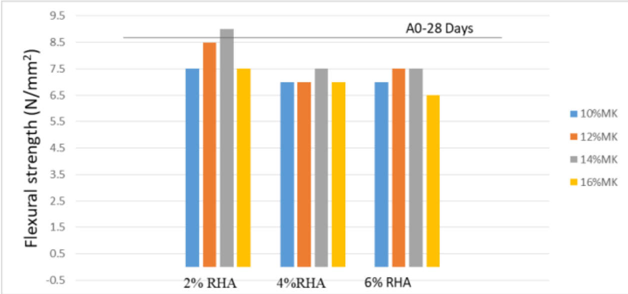

Figure. 5.2: Variation of Flexural Strength for 10% FA & RHA & MK for 28 days

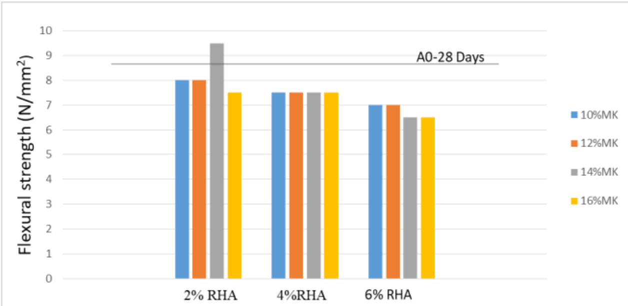

Figure.5.3: Variation of Flexural Strength for 15% FA & RHA & MK for 28 days

5. CONCLUSIONS

The Geopolymer concrete of high strength was developed using of Rice-Husk Ash, Fly-Ash and Meta-kaolin as a controlled replacement material for cement materials. Hardened properties of this geopolymer concrete was examined and a correlation with the conventional concrete was studied.

The following were concluded after the experimental investigation on Geopolymer concrete,

- RHA, MK and FA can be viably used as a controlled substitution material for cement.
- When cement was substituted for 2% RHA, 15% FA and 14% MK a 14% increase in strength was observed.
- It was evident that when cement was replaced with 14% MK the performance was better in most of the cases. Hence it can be concluded that MK plays a Major influence to the mechanical properties in the mix.
- It was also observed that as the RHA Content increased in the mix in most of the cases it adversely affected the mechanical properties of the mix.
- A slight improvement in the flexural performance of geopolymer concrete was observed in comparison with flexural performance conventional concrete.

6. REFERENCES

[1]. E. Badogiannis, S. Tsivilis, V. Papadakis and E. Chaniotakis, "The Effect of Metakaolin on Concrete Properties", International Congress: Challenges of Concrete Construction, 81-89, 2002.

[2]. M.Narmatha and Dr.T.Felixkala, "Meta kaolin –The Best Material for Replacement of Cement in Concrete", Journal of Mechanical and Civil Engineering, Vol. 13, ISSN: 2278-1684, PP 66-7, 2016.

[3]. C.S.Poon, L.Lam and Y.L.Wong, "A study on high strength concrete prepared with large volumes of low calcium fly ash", Cement and Concrete Research, Pages 447-455, 2000.

[4]. Harun Mallisa and Gidion Turuallo, “The Maximum Percentage of Fly Ash to Replace Part of OPC in Producing High Strength Concrete”, International Conference on Construction and Building Engineering. AIP Conference Proceedings 1903/030012, 2017.

[5]. B.Prabu, A. Shalini and J. S. Kishore Kumar, “Rice Husk Ash Based Geopolymer Concrete – A Review”, Chemical Science Review and Letters, Article CS092043CN, ISSN: 2278-6783, 2014.

[6]. George Washington, Kshyana Prava Samal ,Zishane Haider and Polin Kumar Sahoo, “Use of Rice Husk Ash as Partial Replacement with Cement in Concrete”, International Journal of Advanced Research in Science and Engineering, Vol.06, ISSN: 2319- 8354, 2017.