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RESEARCH ARTICLE

STUDY ON PARTIAL REPLACEMENT OF CEMENT WITH RHA AND METAKAOLIN.

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Abstract

Concrete is the most widely used construction material in civil engineering because of its high structural strength and stability. Ternary blended concrete is developed by partial replacement of cement with metakaolin and rice husk ash in high performance concrete mix design. Rice husk ash is a by-product material obtained from the controlled combustion of rice husk which consists of non crystalline silicon dioxide with high specific surface area and high pozzolanic reactivityRice husk ash which reduces the emission of carbon and produces green effect in environment. Metakaolin helps to reduce the amount of calcium hydroxide, thus resulting in stronger and durable concrete.

In this research the experimental investigations carried out in three phase M30 mix grade concrete is used with RHA in proportions of 0%,5%,10%,15% and 20% .In second phase metakalon in various proportions of 2.5%and 5% and in third combination of metakaolin and RHA were tested. From this research the results are much better as compare to conventional concrete.

Introduction:-

Concrete is the most widely used construction material in the world. In recent times, there is a lot of development in the field of concrete technology. Many investigators have been developed several techniques to improve workability, strength and durability parameters of the concrete. Enormous studies have been carried out to investigate the possibility of utilizing a wide range of materials as partial replacement material for cement in the preparation of concrete. The use of supplementary cementitious material in the preparation of concrete may result in major saving of energy, cost and reduction in environmental pollution. It is also helps to improve workability, strength, durability and chemical resistance of concrete. There are number of supplementary cementitious material are available such as fly ash, metakaolin, silica fume, slag cement, rice husk, coconut shell etc.

Out of all cementitious materials mentioned above, rice husk ash and metakaolin were selected to carry experimental investigation on split tensile strength of concrete with partial replacement of cement. The tests were conducted after 7days and 28 days curing and the results were published.

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Dinakar et.al., By using Metakaolin and cement with low water/binder ratio of 0.3 , high performance concretes can be developed. From results it can be realized that Cube Compressive strength, Splitting tensile strengths and elastic modulus results shown higher values at 10% replacement of cement by Metakaolin.

Nova John , The results shows by the partial replacement of cement with Metakaolin helps in achieving high strengths in concrete. At 15% replacement of cement with Metakaolin content improves the strength characteristics such as of Cube Compressive Strength, Split Tensile Strength and FlexuralStrength.

M. Tamil Selvi, Dr. T.S. Thandavamoorthy , The test results showed by introducing steel fibers in concrete which increased the cube compressive strength and split tensile strength values. Cube compressive strength was increased in range of 3 to 60 percent between 7 and 28 daysfor Steel Fiber Reinforced concrete. For PPFRC it was observed that the cube compressive strength was increased between 10 per cent and 18 per cent for 7 and 28 days. For composite fiber (steel and p olypropylene fibers) reinforced concrete the strength was increased by 3 per cent to 22 per cent for 7 to 28 days when compared to normal concrete. The ductility properties of concrete specimens were also observed to be increased by the use of fibers.

SAvinash Gornale et.al., The increase in Compression strength for M-20,M-30 and M-40 at 3,7 and 28 days was increased by 20% to 30%. The increase in flexural strength for M-20, M-30 and M-40 at 3,7 and 28 days was increased by 25% to 30%.The increase in Flexural strength for M-20,M-30 and M-40 at 3,7 and 28 days was increased by 25% to 30% when compared with the normal concrete at 28 days.

Dr. K.Srinivasu et.al., Better Results are achieved by adding mineral admixtures like metakaolin with silica fume, fly ash and steel fibres in HPC. Water absorption is improved by use of metakaolin in concrete which increases density.

M. Nazeer, R. Arun Kumar, The impact resistance of both binary blended and
ternary blended mixes shows remarkable improvement compared to concrete mix with cement as the only binder

Materials Used:-

Cement:-

The ordinary Portland cement of 53 grade conforming to IS 12269: 2013 was used. The specific gravity of cement was 3.11

Fine Aggregates:-

Natural river sand was used as a fine aggregate conforming to grading zone I of IS: 383 1970 was used. Its specific gravity was 2.6.

Coarse Aggregates:-

Coarse aggregate obtained from local quarry units has been used for this study. Maximum size of aggregate used is 20mm with specific gravity of 2.67.

Rice husk ash:-

Rice husk ash is a pozzolanic material .A residual obtained from open field burning .In this investigation specific gravity for RHA is 2.3

Metakaolin:-

Metakaolin is refined kaolin clay that is fired (calcined) under carefully controlled conditions to create an amorphous aluminosilicate that is reactive in concrete. Metakaolin reacts with the calcium hydroxide (lime) byproducts produced during cement hydration.

Experimental Investigation:-

In present study M30 grade concrete were designed as per IS: 10262-2009

Workability:-

Freshly mixed concrete were tested for workability by slump test. In this investigation, M30 mix concrete the test by-weight basis by replacing cement by 0%,10%,15%,20% with RHA and 2.5% and 5% with Metakaolin.

Compressive strength:-

In this investigation, M30 mix concrete is considered to perform the test by-weight basis with 0%,10%,15% and 20% of cement replaced by RHA and 2.5%,5% of cement by Metakaolin and combination of both RHA and Metakaolin. A 150x150 mm concrete cube was used as test specimens to determine the compressive strength of concrete cubes. The ingredients of concrete were thoroughly mixed till uniform consistency was achieved. The cubes were properly compacted. All the concrete cubes were de-moulded within 24 hours after casting. The de-moulded test specimens were properly cured in water available in the laboratory at an age of 28 days. Compression test was conducted on a 2000KN capacity universal testing machine. The load was applied uniformly until the failure of the specimen occurs. The specimen was placed horizontally between the loading surfaces of the compression testing machine and the load was applied without shock until the failure of the specimen occurred.

Split tensile strength:-

In this investigation, M30 mix concrete is considered to perform the test by-weight basis by replacing 0%,10%,15% and 20% of cement replaced by RHA and 2.5%,5% of cement by Metakaolin and combination of both RHA and Metakaolin and combination of both quarry dust and Metakaolin. Cylinders of 150 mm diameter and 300 mm length were used as test specimens to determine the split tensile strength of concrete .The ingredients of concrete were thoroughly mixed till uniform consistency was achieved. The cylinders were properly compacted. All the cylinders were de-moulded within 24 hours after casting. The de-moulded test specimens were properly cured in water available in the laboratory for an age of 28 days. The split tensile strength was conducted as per IS 5816-1976.The specimen was placed horizontally between the loading surfaces of the compression testing machine and the load was applied without shock until the failure of the specimen occurred.

Results And Discussion:-

Workability:-

Slump test of various mix proportions of RHA and Metakaolin in concrete are shown below

Table 1: Slump values with various proportions of Rice husk ash and Metakaolin replacing cement in M30 grade concrete

S.No	RHA Content	Slump
1	0%	96
2	5%	90
3	10%	85
4	15%	79
5	20%	75

S.No	Metakaolin content	Slump
1	0%	96
2	2.5%	97
3	5%	98

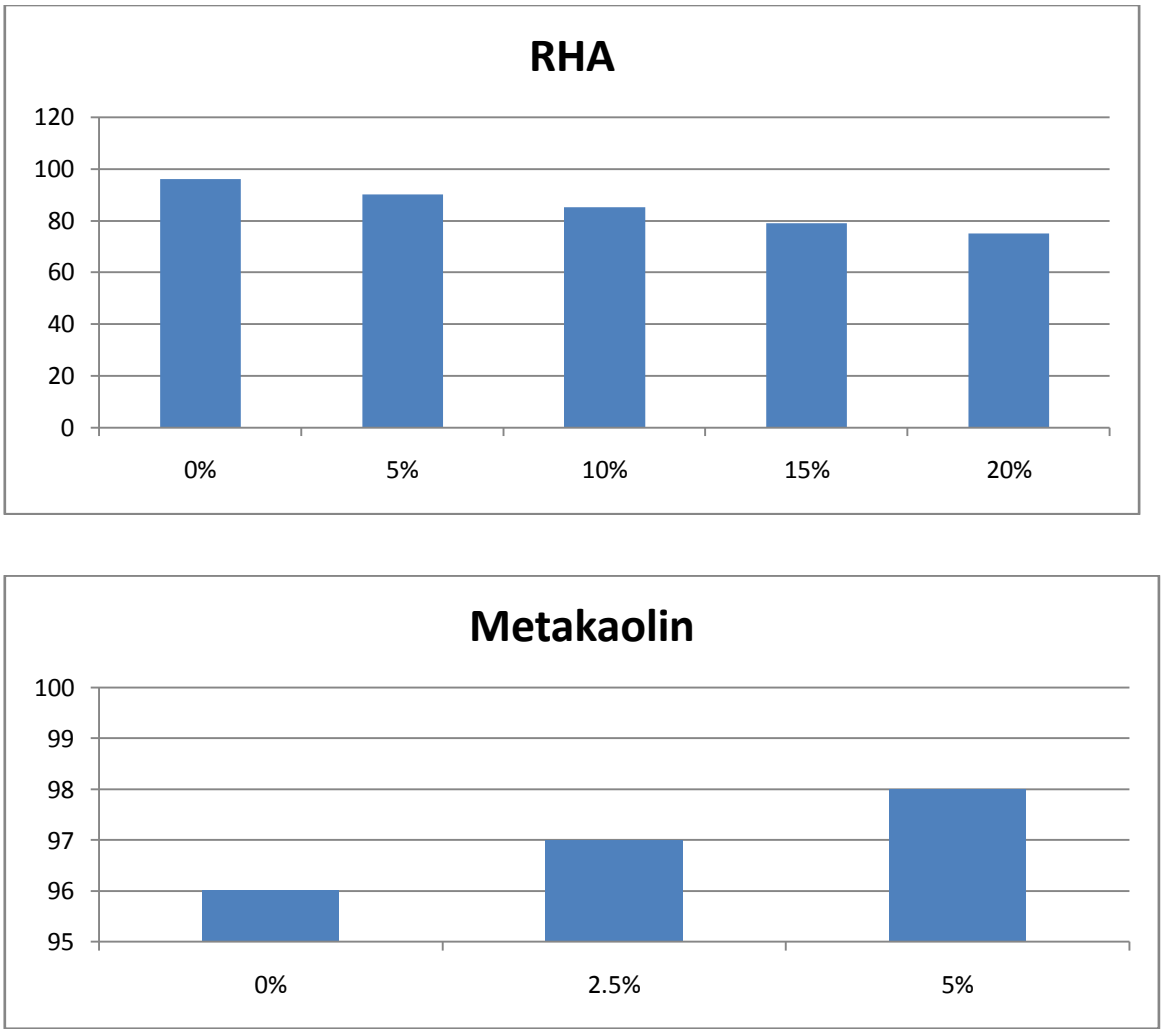

Fig 1:- slump values when replacement of cement by RHA and Metkaolin

Compressive Strength Test:-

The compressive strength of concrete was achieved in 28 days of various proportions and presented below. The specimens were cast and tested as per IS: 516-1959.

Table 2:- Compression test at 28 day with various Proportions of RHA and Metakaolin replacing cement in M30 grade concrete

S.No	Percentage of Replacement	Compressive strength N/mm^2
1	0%	32
2	5% RHA	33.44
3	10% RHA	35.8
4	15% RHA	30.4
5	20%RHA	29
5	2.5%Metakaolin	36.9
6	5%Metakaolin	37.2
7	10%RHA+2.5% M	37.9
8	10%RHA+5%M	39

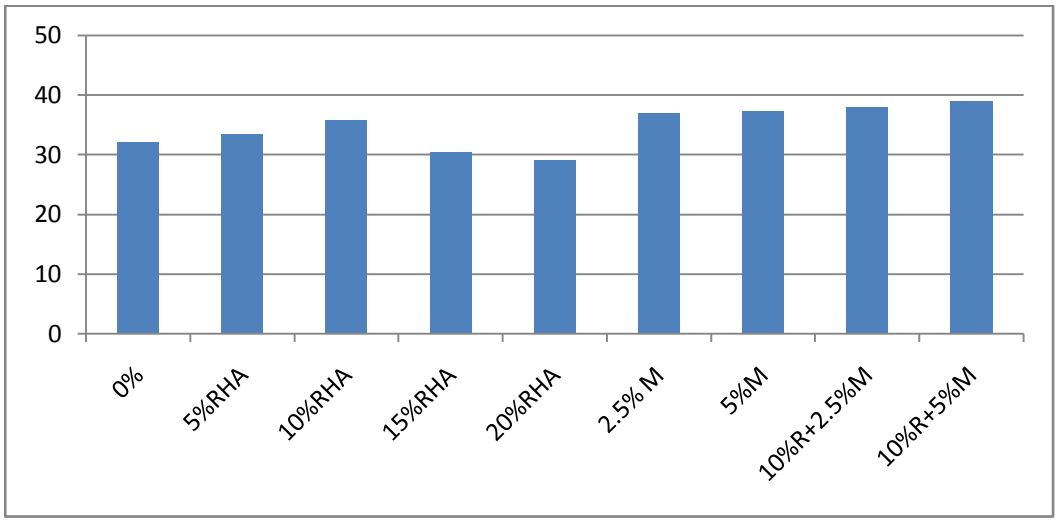

Fig 2:- Compressive Strength when replacement of Cement by RHA and Metakaolin

From the figure 2 and table 2 it is observed that combine 10% RHA and 5% Metakaolin achieved maximum strength in comparison to normal concrete.

Split Tensile Test:-

The tensile strength of concrete with 28 days curing period for various proportions and presented below .The specimens were cast and tested as per IS: 516-1959.

Table 3:- Split tensile test at 28 day with various Proportions of RHA and Metakaolin replacing cement in M30 grade concrete

S.No	Percentage of Replacement	Split tensile strength N/mm^2
1	0%	3.56
2	5%	3.57
3	10%	3.6
4	15%	3.4
5	20%RHA	3.1
5	2.5%Metakaolin	3.7
6	5%Metakaolin	3.89
7	10%RHA+2.5% M	3.91
8	10%RHA+5%M	4.02

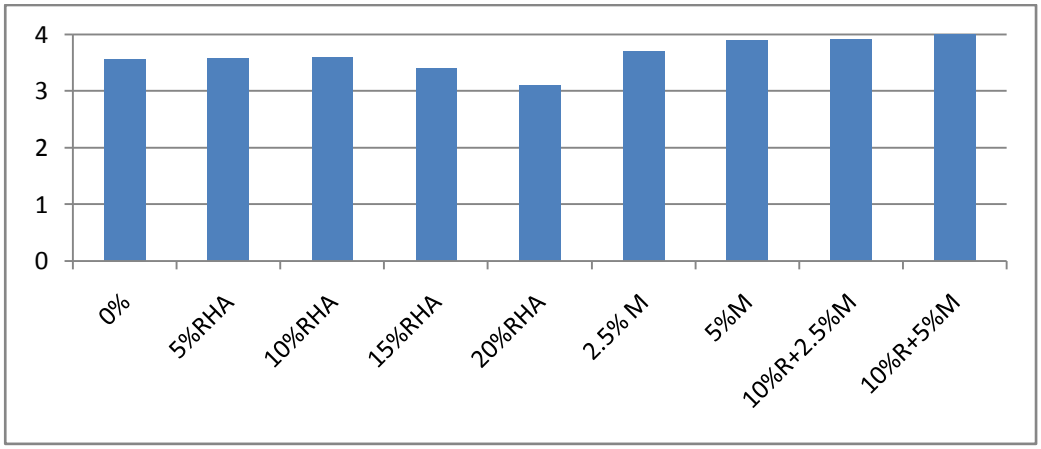

Fig 3:- split tensile Strength when replacement of Cement by RHA and GGBS

From the figure 3 and table 3 it is observed that 10% Rice husk ash (RHA) and 5% Metakaolin achieved maximum strength in comparison to normal concrete.

Conclusion:-

Based on the experimental investigations the following conclusions are drawn:

- As cement is very costlier and use of cement creates a environmental problems need to find alternative material. Rice husk ash is a waste material which is obtained from rice mills a, it is a suitable substitute for cement at very low cost.
- By adopting critical mix and replacing the cement by rice husk ash fine, it is found that by increasing the percentage of rice husk ash workability decreases because of its increased water absorption and strength decreases gradually.
- Similarly replacing cement with metakaolin increases the workability
- From the above compressive strength results, it is observed that rice husk ash based concretes have achieved an increase in strength for 10% replacement of cement and 5% replacement of cement by metakaolin and combine 10% RHA and 5% metakaolin at the age of 28 days when compared to conventional concrete.
- From the above split tensile strength results, it is observed that rice husk ash based concretes have achieved an increase in strength for 10% replacement of cement and 5% replacement of cement by metakaolin and combine 10% RHA and 5% metakaolin at the age of 28 days when compared to conventional concrete.
- From the above experimental investigation rice husk ash(RHA) can be used as alternate material to cement up to 10% ,20% and metakaolin 2.5%and 5% combine effect of RHA and metakaolin are given result at 10%RHA and 5% metakaolin.

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