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STUDY ON THE MECHANICAL PROPERTIES OF CONCRETE (M40) WITH THE PARTIAL REPLACEMENT OF FLYASH, METAKOLIN AND M-SAND TO CEMENT AND FINE AGGREGATE

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Abstract - *Concrete is one of the major constituent as it is used for the construction purposes. Here the study deals with the use of cementitious materials such as fly ash with varying percentages 0, 5, 10, 15 & 25% and metakolin (15%) as a partial replacement of cement and M-sand (100%) replacement to fine aggregate. The M-sand produced under controlled and well supervised conditions can a better substitute for river sand in this work the mechanical properties of concrete are tested with two mineral admixtures and about 30 concrete cubes of size 100x100x100mm,15cylinders of size 300mm height and150mm diameter and 15 Beams of size 500x100x100 mm are cast for M-40 grade of concrete and tested for compressive strength, split tensile strength and flexural strength for 7 and 28 days respectively and investigated their strength properties. The obtained results were found to be encouraging and further this study can be done with the combination of other mineral admixtures.*

Key Words: Fly ash, Metakolin, Compressive Strength, Spilt tensile strength, Flexural strength.

1. INTRODUCTION

Inside the growing creation discipline concrete plays a major role. New sorts of systems and new technology in constructing, structural and civil engineering created greater tough requirements for this material. Cement intake will become an increasing number of very hastily all over the globe. There's a need to reduce the co_2 emissions inside the environment. One of the treatments to overcome this example is to reduce the cement content material and make use of Pozzolanic materials for the training of concrete. Some of them are Metakolin, GGBS, Fly Ash, and Micro Silica and so on. After a long time a constituent in concrete is partially replaced by means of a nano fabric (Nano-Silica).One of the great acknowledged Pozzolanic materials inside the world is FLY ASH. Metakaolin particulates are too small which tends to mingle and mix uniformly with all the materials in a perfect manner which results in proper bonding.

1.1 OBJECTIVES

1. To examine the impact of Fly ash and metakolin content material on compressive strength of concrete for 7 and 28 days.
2. To study the split tensile strength of concrete, with the combined effect of application of Metakolin and Fly ash and manufactured sand.
3. To study the behaviour of concrete under flexure with the influence of Fly ash and metakolin as substitute of Cement, manufactured sand as substitute of fine aggregates.
4. To investigate the strength of the replaced concrete with that of the conventional concrete.

1.2 SIGNIFICANCEOF PRESENT INVESTIGATION

The aim of this work is to study the mechanical properties of concrete with flyash and metakolin as an alternative constituent for cement and with manufactured sand as an alternative constituent for fine aggregate in concrete. It is developed to study the effective utilization of the metakolin and fly ash and manufactured sand in a sustainable and economic construction. Manufactured sand can be used to overcome the scarcity of the natural sand in the environment and metakolin that helps to utilize the industrial byproducts. This and hence reduces the land filling and to save huge areas filling by the waste byproducts.

2. LITERATURE REVIEW

1. Muthupriya.P et al., (2010) Conducted a study on the effect of mineral admixtures such as silica fume, metakolin and fly ash towards the performance of concrete. An effort has been made to focus on the mineral admixture towards their pozzolanic reaction, contribution towards strength properties, and durability studies. The compressive strength of HPC with mineral admixtures at the replacement levels of 0%, 5%, 10% and 15% were studied at 3 days, 7 days, 28 days, of curing. The tensile and flexural strength of HPC were obtained at the replacement levels of mineral admixtures at 28 days of curing. The durability studies such as permeability, acid resistance, alkalinity measurement and water absorption were conducted. The authors concluded that, in durability point of view all the three mineral admixtures perform well.

2. Nova John (2013).,conducted a study on strength properties of metakolin admixed concrete., in this study the metakolin is partially replaced for 5,10,15 and 20%by weight., the test results indicated that 15% replacement of metakolin had higher ultimate strength than concrete with portland cement in both 7 and 28days, i.e 41.19N/mm^2 and 51.56N/mm^2,from the test results the authors concluded that the results encourage the use of metakolin, as

pozzolanic material for partial cement replacement in producing high strength concrete.

3. **P.Jaishankar et.al (2016)**.,conducted a experimental study on strength of concrete by using metakolin and M-sand., this study was carried out for M-30 grade of concrete here metakolin is partially replaced to cement by 5, 10, 15 and 20%, the test results indicated that the compressive strength has achieved higher strength at 15% replacement of metakolin and 50% M-sand at both 7 and 14 and 28 days i.e 27.71N/mm^2,35.165N/mm^2 and 42.75N/mm^2, and also split tensile strength has achieved higher strength at 15% replacement of metakolin for 28days i.e 4.07N/mm^2. From the results the authors concluded that the M-Sand can be used as a replacement for fine aggregate. And it was found that 50% replacement of fine aggregate by M-sand gives maximum result in strength.

3. MATERIALS AND METHODOLOGY

3.1 CEMENT

In this experimental work, Ordinary Portland Cement (OPC) 43 grade conforming to IS: 8112 - 1989 was used. The cement used was ACC from the local distributors.

3.2 FINE AGGREGATE (M SAND)

Locally available M-Sand belonging to zone II of IS 383-1970 was used for this project work.

3.3 COARSE AGGREGATE

Locally available crushed aggregates confirming to IS 383-1970 are used in this experimentation.

3.4 FLY ASH

Fly ash is the finely divided mineral residue resulting from the combustion of ground or powdered coal in electric power generating thermal plant. Fly ash is beneficial mineral admixture for concrete. It influences many properties of concrete in both fresh and hardened state. In this work class F flyash has been used.

3.5 METAKOLIN

Metakaolin is one of the innovative clay products developed in recent years. It is produced by controlled thermal treatment of kaolin. Metakaolin can be used as a concrete constituent, replacing part of the cement content since it has pozzolanic properties.

3.6 WATER

Ordinary potable tap water available in laboratory was used for mixing and curing of concrete.

3.7 SUPER PLASTICIZER

Super plasticizer SP430 is a chloride free, superplasticising admixture based on selected sulphonated naphthalene polymers. It is supplied as a brown solution which instantly disperses in water. It provides excellent acceleration of strength gain at all ages by significantly reducing water demand in concrete mix and improves the workability of concrete mix. It provides improved durability by increasing ultimate strengths and reducing concrete permeability.

3.5 TESTS ON MATERIALS

Table -1 Shows basic test results of materials

Initial setting time	125 min
Final setting time	9hours
Specific gravity of Fly ash	2.1
Specific gravity of Metakolin	1.9
Specific gravity of M-sand	2.49
Specific gravity of coarse aggregate	2.82
Water absorption of coarse aggregate	0.88

4. METHODOLOGY

Calculate the material required for 30 cubes, 15 cylinders, and 15 beams specimens using the mix proportion by mass and water to W/C of 0.40. Sand was replaced by flyash and metakolin as per desired percentages. Mixing was done by hand. Cement and fine aggregate shall be mixed dry to a uniform color and then the coarse aggregate is added and mixed until the coarse aggregate is uniformly distributed. Now water is added and the whole mix is mixed until the resulting concrete is uniform in colour.


FIG 4.1 CASTED SPECIMENS

RESULTS AND DISCUSSIONS

5.1 SLUMP TEST RESULTS

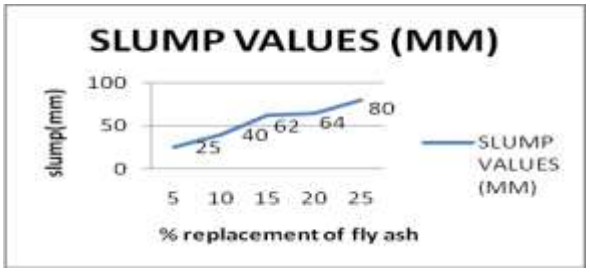

FIGURE 5.1: VARIATION OF SLUMP

The fig 5.1 shows variation of slump test results for 0.5,10,15,20 and 25 % flyash and Metakolin constant(15%) which are replaced to cement and 100% replacement of M-Sand to fine aggregate. From the above graph it is observed that as the percentage of flyash increases there is an increase in slump value from 25mm to 80mm.

5.2 COMPRESSIVE STRENGTH TEST

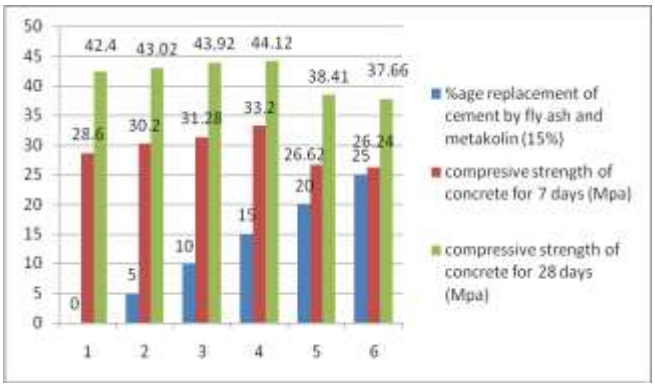

FIGURE 5.2: VARIATION OF COMPRESSIVE STRENGTH

The fig 5.2 shows compressive test results for 0.5,10,15,20 and 25 % flyash and Metakolin constant(15%) which are replaced to cement and 100% replacement of M-Sand to fine aggregate. It can be seen from figure that as the percentage of fly ash goes on increasing there is an increase in the compressive strength for both 7 & 28 days up to 15% i.e. from 28.6N/mm^2 to 33.2N/mm^2 for 7days and 42.4N/mm^2 to 44.12N/mm^2 for 28 days. And there after compressive strength decreases above 15% replacement i.e. 26.62, 38.41, 26.24 and 37.66N/mm^2 for 20 and 25% replacement. The maximum strength achieved was when 15% flyash and 15% metakolin was replaced. Hence these percentage replacements were consider for further studies.

5.3 SPLIT TENSILE STRENGTH TEST RESULTS

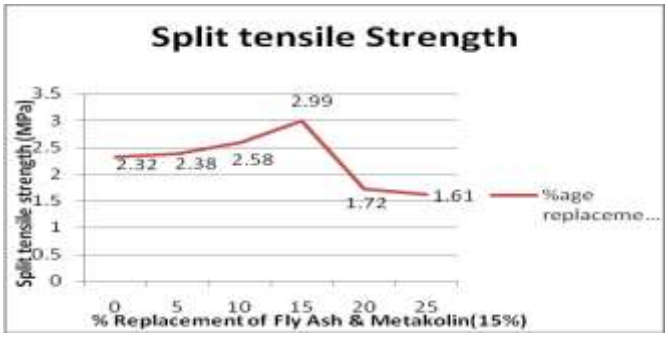

FIGURE 5.3 VARIATION OF SPLIT TENSILE STRENGTH

The figure 5.3 shows split tensile strength result for 0, 5, 10, 15, 20 & 25% flyash and metakolin constant(15%) replacement for 28 days. Which are replaced to cement & 100% replacement of M-sand to fine aggregate. It can be seen from figure that as the percentage of flyash increases there is a increase in split tensile strength upto 15% replacement from 2.32N/mm^2 to 2.99 N/mm^2 for 28 days & there after strength decreases above 15% replacement i.e. 1.72 and 1.61N/mm^2 for 20 and 25% replacement. The maximum strength was when 15% flyash and 15% metakolin was replaced hence these percentage replacements were considered further studies.

5.4 FLEXURAL STRENGTH TEST RESULTS

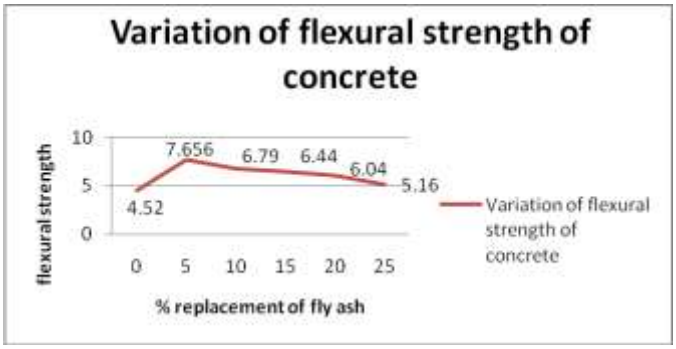

FIGURE 5.4: VARIATION OF FLEXURAL STRENGTH

The Fig 5.4 gives flexural strength result for 0, 5, 10, 15, 20 & 25% flyash and metakolin constant (15%) for 28 days which are replaced to cement and 100% replacement of M-sand to fine aggregate. It can be seen from fig. that as percentage of flyash increases there is increase in the flexural strength upto 15% replacement from 4.52N/mm^2 to 6.78N/mm^2 for 28 days & there after strength decrease above 15% replacement i.e. 6.04N/mm^2 to 5.36N/mm^2 for 20 and 25% replacement. The maximum strength achieved was when 15% flyash & 15% metakolin was replaced hence these percentage replacements were considered for further studies.

6. CONCLUSIONS

1. The Higher strengths can be achieved when the cement is partially replaced by both fly ash and Metakolin with 15%.
2. Workability of the concrete goes on increasing up to 1.4% addition of Super plasticizer.
3. Beyond 1.4% addition level workability of concrete drastically decreases.
4. Workability of concrete produced by addition of Super plasticizer is higher as compared to concrete produced by natural water.
5. The compressive strength gets increases for 15% replacement of fly ash and their after it decreases. 15% fly ash and 15% metakolin for 7 and 28 days produces 33.20 N/mm^{2}and 44.12 N/mm^2 is found to be optimum, compare to normal concrete i.e. 28.6 N/mm^2 and 42.4 N/mm^2 .
6. The split tensile strength gets increases for 15% replacement of fly ash and metakolin (15%) i.e. 2.99 N/mm^2 for 28days and their after it decreases, hence 15% fly ash and 15% metakolin is found to be optimum, compare to normal concrete i.e. 2.32 N/mm^2.
7. Concrete produced by replacing cement by fly ash and metakolin (15%) i.e. 6.78N/mm^2 for 28days exhibit higher flexural strength as compared to Normal concrete i.e. 4.52 N/mm^2
8. Finally the compressive strength, split tensile strength and flexural strength increases and the required strength is achieved with the replacement of 15% fly ash and 15% metakolin compare to nominal mix concrete.

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