International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 03 Issue: 05 | May-2016 www.irjet.net p-ISSN: 2395-0072

A study on Strength Properties of Concrete with Partial Replacement of Cement by Fly Ash and Metakaolin

Surendra . B.V[1], Rajendra T N[2]

[1]*Associate Professor, Department of civil Engineering*
New Horizon college of Engineering, Bengaluru, Karnataka, India 560103
[2] *Assistant Professor, Department of civil Engineering*
New Horizon college of Engineering, Bengaluru, Karnataka, India 560103

Abstract *– This paper presents the results of an experimental study carried out to find the effect of fly ash and metakaolin by partial replacement of cement of M-40 grade concrete, in terms of improved performance on compressive, and split tensile strength. The controlled concrete specimen of M-40 grade was prepared using OPC 43 grade cement. The other specimens were prepared by replacing cement with 15% fly ash and metakaolin at 5%, 10%, 15% and 20%. The various strengths were compared with controlled specimens leading to a conclusion that there is an increase in compressive strength up to 48.88%, and split tensile strength up to 54%.*

Key Words: Cement concrete, Metakaolin, Fly ash, , Compressive Strength, Split tensile strength.

1. INTRODUCTION

With the advancement of technology and increased field of application of concrete and mortars, the strength, workability, durability and other characteristics of the ordinary concrete needed modification to make it more suitable for various situations[1].

Supplementary cementitious materials such as fly ash, Metakaolin, Rice husk ash, Silica fume etc have contributed towards higher performance and economy [2].

In use of fly ash for partially replacing the Portland cement in concrete not only reduces the amount of cement used, but also significantly enhances the properties of concrete, reduces the emission of CO_2, conserves the existing resources and greatly improves consistency [3]. The addition of fly ash in concrete improves certain properties such as workability, later age strength development and a few durability characteristics [3].

Blending metakaolin with Portland cement improves the properties of concrete by increasing compressive and flexural strength, providing resistance to chemical attack, reducing permeability substantially preventing alkali silica reaction, reducing efflorescence and shrinkage preventing corrosion of steel [1].

2. MATERIALS AND METHODS

2.1. Materials

2.1.1 Cement: Ordinary Portland cement of 43 grade confirming to Indian Standards was used for the experimental study and the tests were conducted to evaluate specific gravity. The results have been tabulated in table2.1.

2.1.2 Fine aggregates: River sand with fineness modulus 2.9 conforming to zone II was used for the experimental study and the tests were conducted to evaluate specific gravity. The results have been tabulated in table 1.

2.1.3 Coarse aggregates: Crushed granite with fineness modulus 7.1 having size between 20 mm and 4.75 mm was used for the experimental study and the tests were conducted to evaluate specific gravity. The results have been tabulated in table 1.

2.1.4 Water: Drinking water was used for the experimental study

2.1.5 Fly ash: The specific gravity of fly ash was evaluated for the experimental study. The results have been tabulated in table 1.

2.1.6 Metakaolin: The specific gravity of metakaolin was evaluated for the experimental study. The results have been tabulated in table 2.1.

Table 2.1: Significant properties of materials used

Materials	Specific gravity
Cement	3.15
Fine aggregates	2.58
Coarse aggregates	2.69
Fly ash	2.23
Metakaolin	2.4

Table 2.2: Mineral Composition of metakaolin

Major Minerals	Percentage
Lime (Cao)	1.2
Silica (SiO_2)	51.92
Alumina (Al_2O_3)	42.0
Iron oxide (Fe_2O_3)	0.93
Magnesium oxide (MgO)	0.06
Sodium oxide (Na_2O)	0.04

2.2 Mix Proportion

For the present study M40 grade of concrete was used. The mix proportion was evaluated confirming to the IS 10262-2009. The various mix proportions for conventional concrete (Control specimen) and fly ash based metakaolin concrete (by partially replacing OPC with fly ash and metakaolin) are presented in Table2.3.

Table 2.3: M40 Mix proportion

Mix Proportion	Cement content (Kg/m^3)	Metakaolin (MK) (Kg/m^3)	Fly ash (Kg/m^3)	F.A (Kg/m^3)	C.A (Kg/m^3)	W/C
Control specimen	492	…….	…….	673	1080	0.4
MK 5% Fly ash 15%	393.6	24.6	73.8	673	1080	0.4
MK 10% Fly ash 15%	369	49.2	73.8	673	1080	0.4
MK 15% Fly ash 15%	344.4	73.8	73.8	673	1080	0.4
MK 20% Fly ash 15%	319.8	98.4	73.8	673	1080	0.4

3. Experimental Program

3.1 Specimen

The experimental program consisted of casting and testing of M40 grade concrete specimens of cube (150 mm) and cylinder (150 X 300 mm).

3.2 Compressive strength

Nine numbers of cubes were cast for each mix and tested using 200T capacity Compression Testing Machine (CTM).

3.3 Split Tensile strength

Nine numbers of cylinders were cast and tested using 200T capacity Compression Testing Machine (CTM).

4. Results and discussions

4.1 Compressive strength: The compressive strength was determined after normal curing for 3days, 7 days and 28 days. The results are presented in Table 4.1 and are also depicted graphically in figure 4.1.

Table 4.1 Compressive Strength Test results

specifications	Compressive strength (N/mm^2)		
Control specimen	18	29	45
MK 5% Fly ash 15%	19	31	48
MK 10% Fly ash 15%	22	36	56
MK 15% Fly ash 15%	25	40	62
MK 20% Fly ash 15%	27	44	67

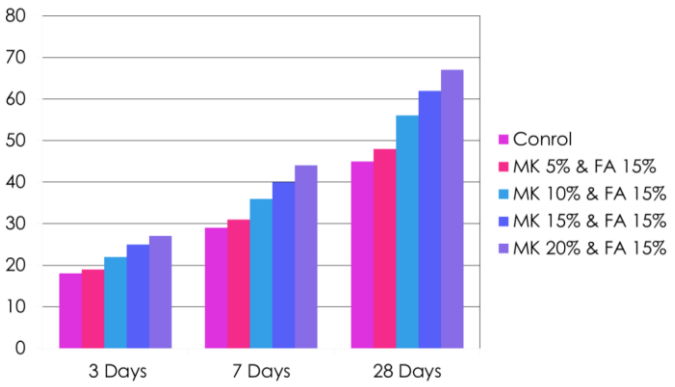

Fig. 4.1 Compressive strength test results

4.2 Split Tensile strength

The split tensile strength was determined after normal curing for 28 days. The results are presented in Table 4.2.

Table 4.2 Split tensile test results

Specifications	Split Tensile Strength (N/mm²)
Control specimen	2.61
MK 5% Fly ash 15%	2.91
MK 10% Fly ash 15%	3.38
MK 15% Fly ash 15%`	3.75
MK 20% Fly ash 15%	4.02

The results indicate that there is a substantial increase in the compressive strength with the increase in % of Metakaolin replacing cement.

5. Conclusions

The present study led to the following conclusions.

1. Addition of Metakaolin and flyash has resulted in enhanced early strength and ultimate strength of concrete.
2. The partial replacement of cement results in reduction in the emission of green gases.
3. The easy availability of metakaolin and flyash and their lesser cost affects in cheaper economy

REFERENCES

1. Mohammad Azhar, Mohammed Moshin Ali Qureshi, "Strength Development in Concrete by Incorporating Metakaolin" International Journal of Advanced Trends in Computer Science and Engineeering, -2013,Vol.2, pp 634-639.
2. Nova John, " Strength Properties of Metakaolin Admixed Concrete" IJSRP, volume 3, Issue 6.
3. M. Nazeer, R. Arun Kumar, "Strength Studies on Metakaolin Blended High-Volume Fly Ash Concrete", IJEAT-August 2014 Vol. 3, pp-176-179.
4. Murali.G., Sruthee P., "Experimental study of concrete with Metakaolin as Partial replacement of cement", International Journal of Emerging trends in Engineering and development, Issue 2, Vol.4, May 2012, ISSN 2249-6149.
5. Vikas Srivastava., Rakesh Kumar., Agarwal V.C., "Metakaolin inclusion: Effect on mechanical properties of concrete", J. Acad. Indus. Res. Vol. 1(5), pp. 251-253, October 2012, ISSN: 2278-5213.
6. IS 10262:2009 Concrete Mix Proportioning Guidelines - Code of Practice, Bureau of Indian Standard, New Delhi 110002.
7. IS 456:2000 Indian Standard, Plain and Reinforced Concrete - Code of Practice, Bureau of Indian Standard, New Delhi 110002.
8. Sabir B.B, Wild S, Bai J, "Metakaolin and calcined clay as pozzolans for concrete :a review" Cement and concrete composite 23, (2001),pp.441-454.
9. Jiping Bai, Albinas Gailius "Consistency of fly ash and metakaolin concrete" journal of civil engineering and management 15(2):(2009),pp.131–135.
10. Pacheco Torgal F, Arman Shasavandi, Said Jalali "Using metakaolin to improve the compressive strength and the durability of fly ash based concrete" Invaco2: International seminar, innovation & valorization in civil engineering & construction materials,Rabat-Morocco, 23-25 November(2011), ISBN 987-9954-30-595-9.

BIOGRAPHIES

Surendra B V (M.E, (PhD))
Associate Professor.

Rajendra T N (M.Tec h)
Assistant Professor.