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Experimental Investigation on Strength of Concrete by Using Metakaolin and Flyash

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ABSTRACT

Concrete is the most commonly used for construction. The need of high Strength concrete is increasing day by day. The test carried out on concrete specimens with 0,6,12,18% replacement of cement by using Metakaolin and FlyAsh together. Concrete is very strong in compression but very weak in tension. However it is reported that tensile and bending strength of concrete is 10 to 15% of the compressive strength respectively. The addition of different types of pozzolonic material in concrete have significantly improves its compressive as well as tensile strength. In the present study Metakaolin and FlyAsh are used in the concrete mixes and compressive of the specimens to be tested. A total of (4+4) mixes are to be prepared by varying the percentages of Metakaolin and FlyAsh on M40 and M20 Grade of Concrete Mix. Certain properties such as workability, later age strength development and few durability characteristics due to the addition of FlyAsh in concrete improves. Concrete is the high volume of fly ash and Metakaolin as a partial replacement of Ordinary Portland Cement. The conventional concrete M40 and M20 are made with the mixture of Metakaolin and FlyAsh in order to evaluate different properties based on concrete and compare with conventional mix. From the optimization 18% cement replacement by Metakaolin and FlyAsh superior than all the mixes.

Keywords : Metakaolin, FlyAsh, Mixture , supplementary cementitious material (SCM) & Serviceability

I. INTRODUCTION

When we talk about Construction considering the modern Infrastructure, Concrete plays a very important role. Concrete is an composite material in which cement is used on a large scale. Due to different circumstances on the construction site such as cost issue, early days strength pozzolonas are prefered in order to enhance the properties of Concrete.

The most important pozzolanic materials are fly ash, silica fume, and metakaolin whose use in cement and concrete is thus likely to be a significant achievement in the development of concrete technology in coming few decades. The benefits of using metakaolin or fly ash separately in concrete as partial replacement for Portland cement are fairly well-established, especially for fly ash. However, because the cost of metakaolin is about 4-5 times the cost of ordinary Portland cement, thus using metakaolin alone as a supplementary cementitious material (SCM) may not be cost effective. On the other hand, the slow reaction rate of fly ash can make its use impractical when rapid early strength development is required. However, use of these materials in combination – as a ternary blend – has the potential to overcome the higher cost associated with metakaolin concrete and

the slower strength development associated with fly ash concrete.

In this modern age, civil engineering constructions have their own structural and durability requirements, every structure has its own intended purpose and hence to meet this purpose, modification in traditional cement concrete has become mandatory. It has been found that different type of pozolonic materials are added in specific percentage to concrete improves the mechanical properties, durability and serviceability of the structure.

These pozolonic materials can be use in many large projects involving the construction of industrial floors, pavements, highway-overlays.

II. EXPERIMENTAL WORK

Experiments were conducted on concrete prepared by Partial Replacement of cement with addition of the mixture of Flyash and Metakaolin with various proportions such as 6%, 12% & 18%. Mix Design for M20 and M40 grade of concrete was prepared and Compressive Strength was done.

III. MATERIALS USED

A.CEMENT and WATER:

Ordinary Portland cement of grade 43 is used to prepare the mix design of M-20 and M40 grade. The cement used was fresh and without any lumps Water – cement ratio is 0.45 for this mix design using IS 456:2007.

B. FINE AGGREGATE:

Aggregate of maximum Size 4.75 mm are used as a fine aggregate the Experimental program was locally procured And conformed to grading zone 3 as per IS: 383-1970.

C. COARSE AGGREGATE:

The coarse aggregates are locally available was used having maximum size of 20 mm.

D. MOULDS:

Here we used three types of moulds to check strength at various proportions of replacement.

E. FLY ASH:

Fly ash is the ash removed from the exhaust gas of burning coal at power plants to generate electricity. The ash is removed from the exhaust by air pollution control equipment such as electrostatic precipitators before the exhaust is emitted through stacks or chimneys into the atmosphere

F.METAKAOLIN:

The Metakaolin is obtained From the 20 MICRONS LIMITED Company at Dadar in Mumbai. The specific gravity of Metakaolin is 2.4. The metakaolin is in conformity with the general requirement of Pozzolona.

G. MIX DESIGN:

The concrete mix design was proposed according to Indian standard code 10262-2009 for control concrete. The grade was M20 & M40 and water - cement ratio is 0.45 which is constant for all mix design. Natural coarse and fine aggregate were used. The replacement proportions of cement were kept as- 3% MK + 3% FA, 6%MK + 6% FA & 9% MK & 9% FA.

IV. RESULTS AND DISCUSSION

A. COMPRESSIVE STRENGTH TEST:

Cubes were prepared with different replacement of cement with metakaolin and fly ash were tested after 28 days.

Compression Test Results Of M20 On 28th Day

SR NO	CUBE NO	CEMENT+FA+MK %	COMP STRENGTH (N/mm^2)	AVG COMP STRENGTH (N/mm^2)
1	C1	100+0+0	26.2	26.37
2	C2	100+0+0	26.5	
3	C3	100+0+0	26.4	
4	C4	94+3+3	26.94	27.01
5	C5	94+3+3	27.12	
6	C6	94+3+3	26.99	
7	C7	88+6+6	27.94	27.73
8	C8	88+6+6	27.55	
9	C9	88+6+6	27.72	
10	C10	82+9+9	28.18	28.52
11	C11	82+9+9	28.642	
12	C12	82+9+9	28.75	

Compression Test Results Of M40 On 28^{th} Day

SR NO	CUBE NO	CEMENT+FA+MK %	COMP STRENGTH (N/mm^2)	AVG COMP STRENGTH (N/mm^2)
1	C1	100+0+0	49.12	48.98
2	C2	100+0+0	48.89	
3	C3	100+0+0	48.94	
4	C4	94+3+3	49.16	49.37
5	C5	94+3+3	49.45	
6	C6	94+3+3	49.52	
7	C7	88+6+6	51.3	51.18
8	C8	88+6+6	51.02	
9	C9	88+6+6	51.22	
10	C10	82+9+9	52.24	52.8
11	C11	82+9+9	52.95	
12	C12	82+9+9	53.21	

V. CONCLUSION

The following conclusions have been arrived from the study:

1. Ternary blending by Metakaolin in combination with Fly Ash was found leading to further technical improvements to concrete strength. Especially, blended concrete mixtures with Metakaolin / Fly Ash -ratio to 50/50 by weight revealed higher efficiency for improving strength at older ages.
2. The 28-days compressive strength of concrete was improved by partial replacements of OPC by metakaolin in the range up to 9% by weight. The highest 28-days strength improvement of concrete can be expected at partial replacements in the 10-15% range.
3. Metakaolin is an effective pozzolona and results in enhanced early strength and ultimate strength of concrete.
4. The compressive strength of young concrete, i.e., 7 days is improved by blending the OPC with 9% of metakaolin by weight.
5. The 9% replacement with metakaolin is the most optimum replacement, enhancing the concrete's compressive strength at all ages.
6. Addition of flyash results in economy of the mix because of low cost of fly ash.

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