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A Critical Study on High Reactive Matakaolin Modified Concrete.

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Abstract—*For infrastructural development and implementation for the use of mineral and natural resources like fly-ash, silica, metakaolin etc. New technology and other equipments which are used for major projects as well as smaller ones, with reduced cost and increased durability for a longer period. This work is carried out with clear objective to get the benefit of advanced concrete technology with reduced cost Metakaolin is relatively new mineral admixture for concrete. It is comparable with silica fume in pozzolanic reactivity, but at lower cost. Metakaolin modified concrete has a creamier texture sets somewhat faster, generates less bleed water, and has a better finish ability than concrete with silica fume.*

Key words*— metakaolin, silica fume fly-ash, strength, workability.*

I. INTRODUCTION.

Metakaolin is relatively new mineral admixture for concrete. It is comparable with silica fume in pozzolanic reactivity, but at lower cost. Metakaolin is commercially available since 1990.High reactive metakaolin is one of the recently developed supplementary cementing materials for high performance concrete. The particle size of metakaolin is generally less than 2.0 microns, which is significantly smaller than the cement particles, though not as fine as silica fume. Metakaolin improves concrete performance by reacting with calcium hydroxide to form a secondary C-S-H. Because of its white color, high reactivity, metakaolin does not darken concrete as silica fume typically does. This makes it suitable for color matching and other architectural applications. Metakaolin modified concrete has a creamier texture sets somewhat faster, generates less bleed water, and has a better finish ability than concrete with silica fume.

II. MATRIALS AND SPECIMENS

The cement used was ordinary Portland cement 53 grade L&T made. Locally available sand in Vadodara city was used as fine aggregate for present study. Dried angular aggregates, of 20 mm maximum size, available locally in Vadodara city.

TABLE 1.0 PROPERTIES OF METAKAOLIN

PHYSICAL PROPERTIES			
Specific Gravity:	2.60	+325 Mesh (44um) (%max):	0.05
Physical Form:	Powder	+16um (%max):	2.0
Color:	Off – White	-2 microns (%min):	40.0
Brightness:	80-82 Hunter L	Bulk Density (g/cm^3):	0.4
CHEMICAL COMPOSITION, WT.:			
Sio_2 =	52-54%	CaO =	0.1%
Al_2O_3 =	42-44%	MgO =	<0.1%
Fe_2O_3 =	<1-1.4%	Na_2O =	<0.05%
TiO_2 =	<3.0%	K_2O =	<0.4%
SO_3 =	<0.1%	L.O.I. =	<1.0%

2.1 CURING OF THE SPECIMEN

After demolding the specimens all the concrete elements were kept in curing tank filled with water for required period of curing. All the specimens were properly grouped according to their coding so that removal of the specimen from their place for testing work could be conveniently done in a proper sequence. The elements were left undisturbed for the whole period of curing.

2.2 FLEXURAL STRENGTH

The flexural strength of the concrete can be determined under third point loading using ASTMC 78 or C 1018, or by center point loading using ASTMC 293. The point loading is preferred technique. Three beams of 100 mm X 100 mm X 600 mm were tested on universal testing machine under third point loading. Ultimate loads were recorded for each specimen. The average of three loads was taken to calculate the flexural strength.

2.3 RESERCH SIGNIFICANCE

High reactive metakaolin is a supplementary cementing material developed recently for high performance as well as normal strength concrete. Information about the properties of metakaolin modified concrete is still limited and somewhat contradictory, which retards its application in construction practice. This study systematically investigates the effect of high reactive metakaolin on properties of normal strength concretes (M20 & M25), especially on compressive strength, flexural strength in hardened state and workability parameters in fresh state (i.e. slump and compaction factor values).

III. EXPERIMENTAL PROGRAMME

Cubes, cylinders and beams were cast using fourteen concrete mixes of 0,5,10 and 15 % mass replacement and addition of cement with high reactive metakaoline. Two different grades of mixes were prepared. The mixes are M1 (1:1.67:3.33) and M2 (1:1.45:2.70) by weight with a water cement ratio of 0.45. The water cement ratio of 0.45 is kept constant for all mixes. A total number of one hundred and forty four cubes of 150 mm X 150 mm X 150 mm size, ninety cylinders of 150 mm X 300 mm long were cast for compressive strength and twenty four beams of 100 mm X 100 mm X 600 mm size were cast for flexural strength. Tests were conducted on universal testing machine for compressive strength at seven days, seven days curing and thirty – eight days strength, thirty eight days curing and days strength on cubes and cylinders.

Beams were tested for flexural strength under two point loads using universal testing machine. The slump values and compaction factor values are recorded the casting of specimens by using the slump cone apparatus and compaction factor apparatus.

IV. RESULTS AND DICUSSION

It can be seen from Fig.1 by increasing the percentage of HRM (High Reactive Metakaolin) the slump values are decreasing.

The slump values show only a small decrease at the replacement level of 5%. If replacement level is 15 % the slump values are decreasing to almost zero for M2 mix (1:1.45:2.7:0.45).

For mix M1 (1:1.67:3.33:0.45) at 15 % replacement level. 40 % reduction in slump was observed.

At the addition level of 15 % the slump values are reducing to almost zero for both the grades of concrete. As the cement content is more, the HRM content is also more. HRM has a tendency to absorb more water and therefore with higher % of HRM slump decrease.

Fig. 3 to Fig. 5 demonstrates the effect of HRM compressive strength at different replacement and addition levels of metakaolin. It is clear that at all the replacement and addition levels HRM increases the strength. Literature suggests that there existed an optimum replacement level of approximately 20 % to give maximum long-term strength enhancement for high performance concrete. In this study for low-grade concretes, if the replacement or addition level is increased from 0 % to 10 % the rate of strength increment is more, however if the replacement or addition level is increased from 10 % to 15 % the rate of increment of strength is decreasing.

The strength gaining by addition of HRM is more as compared to the replacement of HRM. From economy point of view, for low grade concretes the optimum level is in between 10 to 15 % replacement of HRM.

It can clearly observe that curing period is very less to achieve the required strength for HRM modified in concrete. It is achieving 95 % of strength in 7 days of curing in both addition and replacement of HRM percentage. This shows HRM modified concrete is especially useful where proper curing is problematic. HRM modified concrete is particularly suitable for rapid construction activities where early age strength is required.

From the figures we observe that HRM modified concrete offers better strength results for mix 1 (1:1.67:3.33) compared to mix 2 (1:1.45:2.7) i.e. it offers better results for higher cement to aggregate ratio mixes.

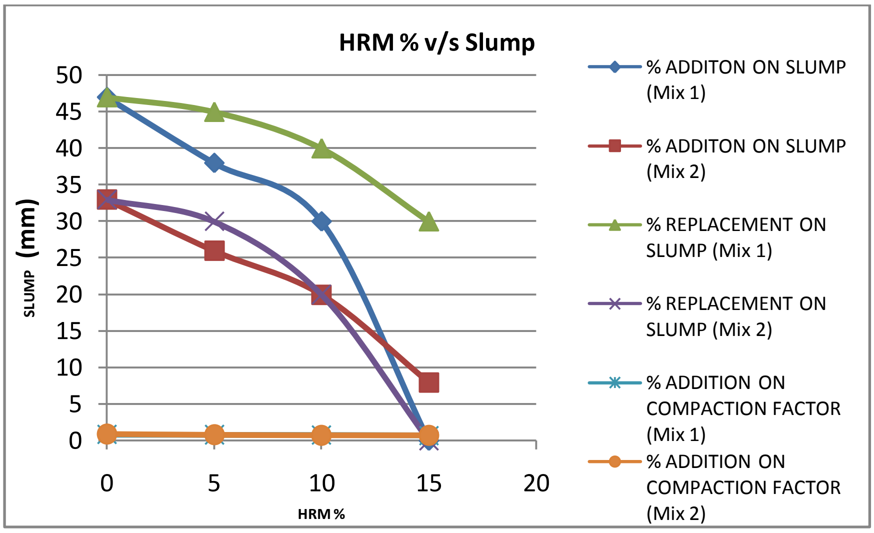

Fig.1.0 slump v/s % hrm

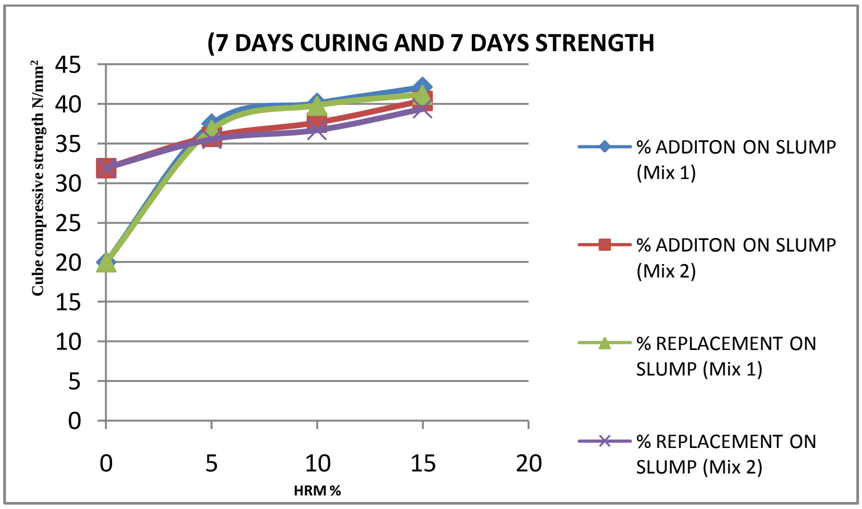

Fig.2.0 cube strength v/s % hrm

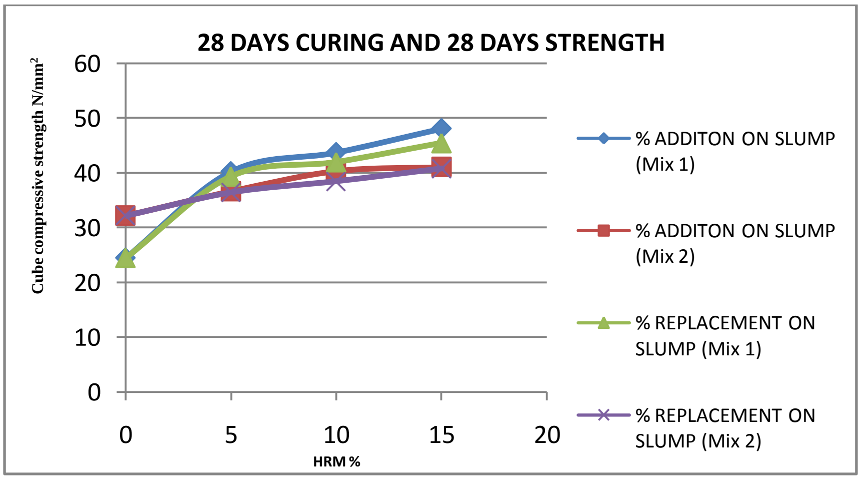

Fig.3.0 cube strength v/s % hrm

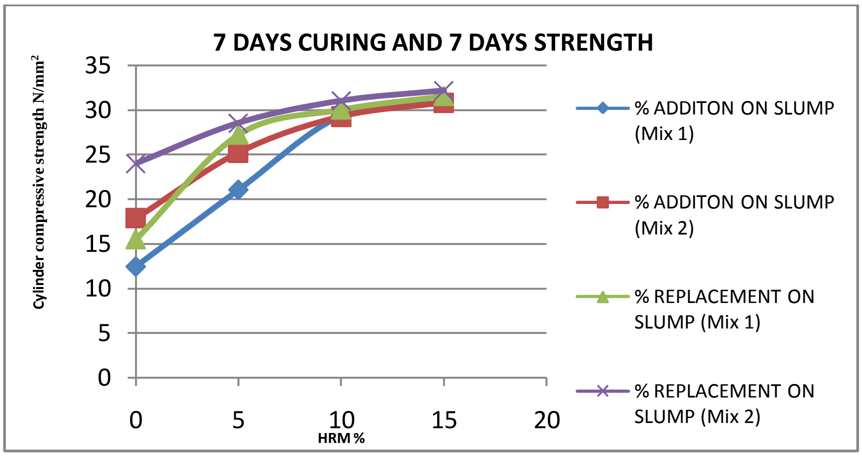

Fig.4.0 cylinder strength v/s % hrm

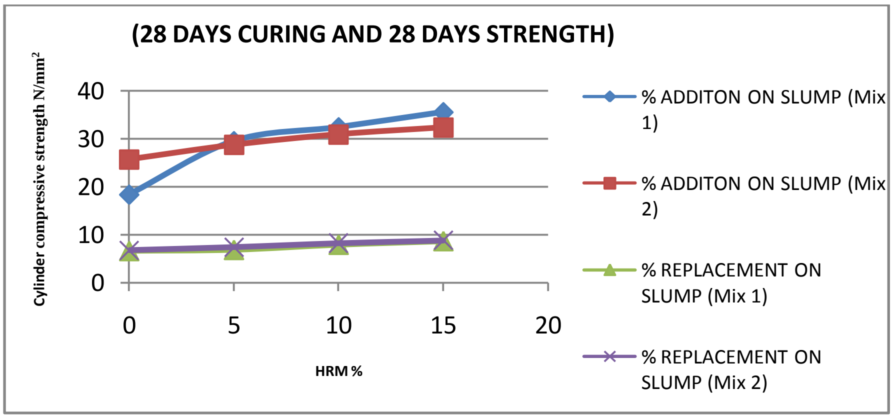

Fig.5.0 cylinder strength v/s % hrm

V. CONCLUSION

In general HRM reduces the workability of the mix. As replacement or addition level increases, the strength of HRM Modified concrete increases at all ages .The HRM Modified concrete is gaining 95% of strength in seven days of curing. The HRM modified concrete offers better strength results for mix M1 Compared to Mix M2 i.e it offers better results for higher cement to aggregate ratio mixes.

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