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A Study on Mechanical Properties of High Strength Metacem Admixtured Concrete

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ABSTRACT

The infrastructure development is an important aspect for the overall development of country. India is developing as a major hub for service industry, automobile industry and for which the infrastructure development plays an important role. In case of infrastructure development construction of bridges, aqueducts, high rise buildings, off shore structures, nuclear power stations, dams, and high strength concrete above M55 is commonly adopted. The necessity of high strength concrete is increasing because of demands in the construction industry. In all construction works, concrete is an important and costly issue, which governs the total cost of the project. Concrete can generally be produced of locally available constituents.

However environmental concerns, stemming from the high energy expense and Co2 emission associated with cement manufacture have brought about pressures to reduce cement consumption through the use of supplementary materials. It reduces the cost, makes concrete more durable and it is eco-friendly. Concrete is probably the most extensively used Construction material in the world. The addition of mineral admixture in cement has dramatically increased along with the development of concrete industry, due to the consideration of cost saving, environmental protection and conservation of resources. However, environmental concerns both in terms of damage caused by the extraction of raw material and carbon dioxide emission during cement manufacture have brought pressure to reduce cement consumption by the use of supplementary materials.

Mineral admixtures such as fly ash, metakaolin, silica fume, etc., are more commonly used in the development of HSC mixes. Addition of such materials indicated the improvement in the strength and *durability properties of concrete. The utilization of calcined clay, in the form of High Reactivity metakolin (HRM) in concrete has received considerable attention in recent years.*

The mix design developed for high strength concrete, a partial replacement of cement with metakaolin a comparison is shown. The use of High strength concrete allows for the construction of modern-day, high-rise buildings concrete is a composite material composed of aggregate bonded together with a fluid cement which hardens over time. Concrete is the essential material that is used in the major construction work. It involves the process of determining experimentally the most suitable concrete mixes in order to achieve the targeted mean strength. In this work 53 Grade Ordinary Portland cement, the locally available river sand, 16mm grade with 60% and 10mm grade with 40% by volume coarse aggregate were selected based on ASTM C 127 standard for determining the relative quantities and proportions for the grade of concrete M60. In the present work, few mixes were designed and ultimately one best mix was treated as basic mix and water to cement ratio was fixed to 0.32.

After finalizing the basic mix, five mix proportions were designed with metacem-85C quantities varied from 0 to 20% weignt of cementitious materials.

Each mix 9 150mmX150mmX600mm were casted then kept in curing tank. After 3days, 7days, 28 days of curing the specimens were tested flexural strength is also found out. The appropriate mix proportions were obtained. For M60 grade of concrete, the cementitius material is replaced with Metacem-85C in the proportion of 0%, 5%, 10%, 15%, 20% (by volume) in all mixes. In the present investigation, cement is partially replaced with metacem-85C of various proportions in concrete. Results of this study showed that metakaolin is very effective in improvement of mechanical properties of concrete.

KEY WORDS: High strength concrete, Metacem-85C, Admixtures, Flexural strength,

1. INTRODUCTION

Concrete is most important part in the structural construction. High strength concrete is used more widely with each passing year. It is important to remember several things about High strength concrete.

Initially, it is just one many types of concrete mixes that have been adjusted to deliver a specific property or properties. In this case, it is compressive strength. The same understanding which made it possible to develop High strength concrete is also applied when developing concrete mixes with high flexural strengths, High durability benefits, high skid resistance, high abrasion resistance, and super-flat characteristics. In other words, High strength concrete is just one type of high-performance concrete. Secondarily, High strength concrete is not a large part of the production output of any ready mix plant. However, the ability to produce this type of concrete without difficulty requires a higher level of sophistication and skill than is considered necessary for more conventional 3000-psi and 4000-psi concrete mixes. Replacement of cement by Metacem-85C increases the strength of the concrete and enhances the durability of the concrete. The reasons for this interesting property may be matakaolin is highly efficient pozzolana and reacts rapidly with the excess calcium silicate hydrates and calcium aluminosilicate hydrates. The particles of metakaolin are smaller than the cement grains. Mean grain size is approximately 2.54µm.

It has been observed that the replacement of metakaolin can be used in structural purpose in civil engineering. Based on revie of literature is clear that among many mineral admixtures available, Metakaolon (MK) is a mineral admixture, whose potential is not yet fully tested and only limites studies have been carried out in india on the use of MK for the development of High Strength Concrete.

OBJECTIVES OF THE STUDY:

1. To know the fresh and hard stage properties of concrete of High Strength Concrete
2. To know the flexural behavior of concrete of HSC
3. To know the modes of failure under flexural load.
4. To know the compressive strength of concrete of HSC
5. To know the workability of HSC.

SCOPE OF PRESENT WORK:

According to the codal procedures, we have to perform the tests to know the fresh and hardened properties of High strength concrete made with metacem-85C replacement. The experimental work was conducted on cubes, cylinders, beams so that it leads to evaluate the compression and flexural strengths of concrete

2. LITERATURE REVIEW

Niva john (2013) investigated the cement replacement levels were 5%,10%,15%,20% by weight of metakaolin. The strength of all metakaolin admixed concrete mixes over shoot the strength development of concrete. Mix with 1% metakaolin is superior to all other mixes. The increase in metakaolin content improves the compressive strength, flexural strength, split tensile strength up to 15% replacement. The result encourages the use of metakaolin, as pozzolanic material for partial replacement in producing high strength concrete. The inclusion of metakaolin results in faster early age strength development of concrete. The utilization of supplementary cementitious material like metakaolin concrete can compensate for environmental, technical and economic issues caused by cement production.

Dr. Hattori developed formaldehyde condensates of beta-naphthalene sulfonates with the primary aim of significantly reducing the water demand of concrete to produce high strength concrete. Water reductions of up to 30% were achieved with the use of this super plasticizer called mightly 150. This admixture was introduced into the Japanese concrete industry as a nominal name of “high-range water-reducing admixture”

ErhanGuneyisi (2007) reported that the inclusion of metakaolin as a supplementary cementitous material in concrete helps in a wonderful way to reduce drying shrinkage strain. The pore structure of concrete was greatly enhanced due to the utilization of ultrafine metakaolin which was also accompanied by the decrease in the harmful large pores thereby improving the overall permeability of concrete.

The imperviousness was greatly seen at 20% replacement level. The studies also revealed that the strength was dependent on the levels of replacement, water cement ratio and age of testing and also the strength enhancement was in varying magnitudes.

3. MATERIALS USED

The materials used for this experimental work are cement, sand, water, Metakaoline, and super plasticizer.

A. Cement:

Ordinary Portland cement of grade 53 AAC Cement was used in this experimental work the properties of cement are tabulated as follows:

A sample of cement

Cement is a fine grey powder. It is mixed with water and materials such as sand gravel and crushed stone to make concrete. The cement was of uniform colour and was free from any hard lumps.

Properties of this cement had been tested and listed below.

1. Fineness of cement = 5%
2. Specific gravity if cement = 3.02
3. Standard Consistency of cement = 33%
4. Initial placing time = 50mins
5. Final putting time = Not extra than 10 hours.

B. AGGREGATES:

Construction aggregate, or absolutely "aggregate", is a huge class of coarse particulate fabric used in production, including sand, gravel, beaten stone, slag, recycled concrete and geo-artificial aggregates. Aggregates are the most mined materials within the world.

Coarse aggregate:

Crushed stone mixture of 20mm size is added from nearby quarry. Aggregates of length greater than 20mm size are separated by using sieving. Tests are carried which will find out the

• Specific gravity = 2.98
• Fineness modulus = 7.5

Coarse aggregates

Fine aggregate:

Locally available sparkling sand, unfastened from natural count number is used. The result of sieve evaluation confirms it to Zone-II (in step with IS: 383-1970).The tests are carried out and results are shown below.

• Specific gravity = 2.3
• Fineness modulus = 3.06

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Fine aggregates

C. Metakaolin

Metakaolin is a dehydroxylated form of the clay mineral kaolinite. Stone that are wealthy in kaolinite are known as china clay or kaolin, historically used inside the manufacture of porcelain. The particle size of metakaolin is smaller than cement particles, however not as best as silica fume.

A. Appearance of Metacem-85C

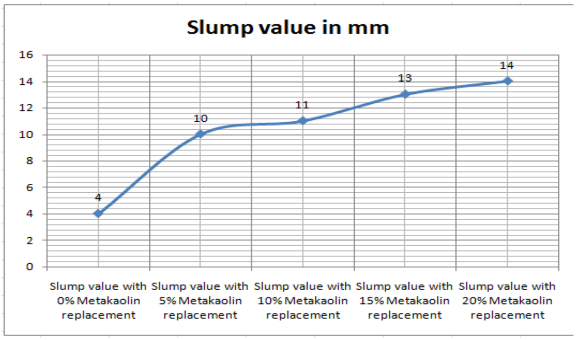
Mix proportion for M60 grade concrete is 1:1.34:2.54 at w/c 0.32

4. RESULTS AND ANALYSIS

WORKABILITY OF HPC (Fresh concrete tests)

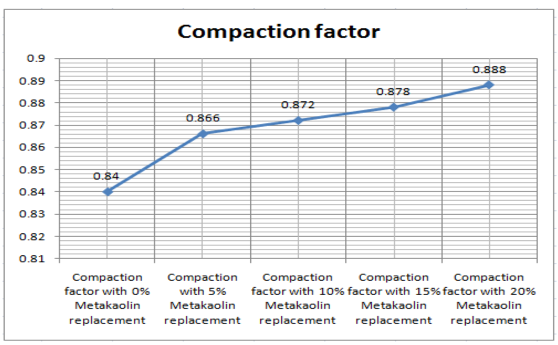
1. SLUMP CONE TEST

S.no	Nomenclature	Slump value in mm	Inference
1	Slump value with 0% Metakaolin replacement	4	Low workability
2	Slump value with 5% Metakaolin replacement	10	Low workability
3	Slump value with 10% Metakaolin replacement	11	Low workability
4	Slump value with 15% Metakaolin replacement	13	Low workability
5	Slump value with 20% Metakaolin replacement	14	Low workability



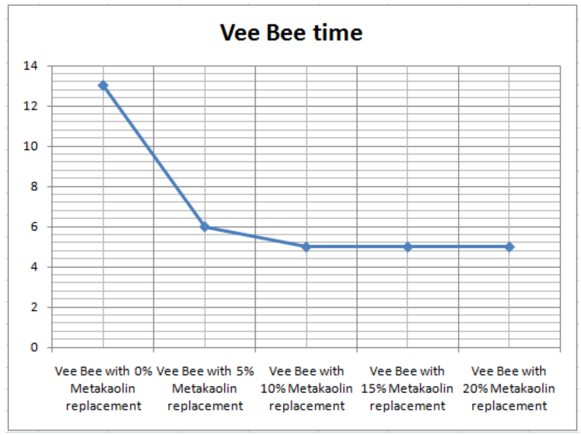
2. COMPACTION FACTOR TEST

S.no	Nomenclature	Compaction factor	Inference
1	Compaction factor with 0% Metakaolin replacement	0.84	Low workability
2	Compaction with 5% Metakaolin replacement	0.866	Low workability
3	Compaction factor with 10% Metakaolin replacement	0.872	Low workability
4	Compaction factor with 15% Metakaolin replacement	0.878	Low workability
5	Compaction factor with 20% Metakaolin replacement	0.888	Low workability



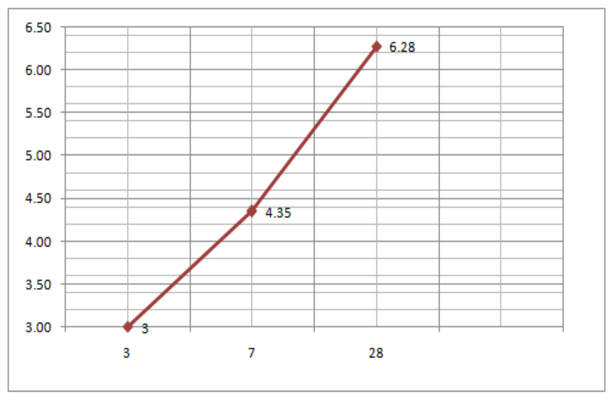
3. VEE-BEE TEST

S.no	Nomenclature	Vee Bee time	Inference
1	Vee Bee with 0% Metakaolin replacement	13	Low workability
2	Vee Bee with 5% Metakaolin replacement	6	Low workability
3	Vee Bee with 10% Metakaolin replacement	5	Low workability
4	Vee Bee with 15% Metakaolin replacement	5	Low workability
5	Vee Bee with 20% Metakaolin replacement	5	Low workability

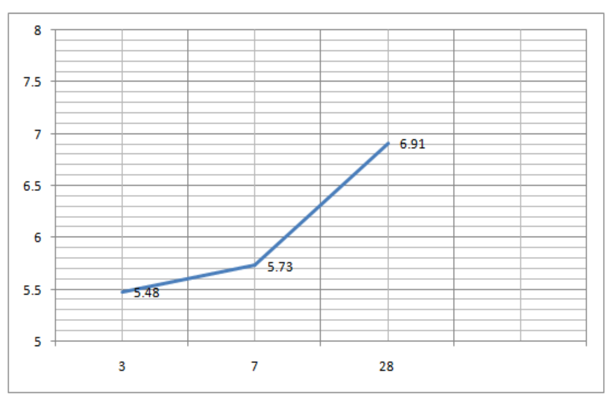


FLEXURAL STRENGTH OF CONCRETE (Hardened Concrete test)

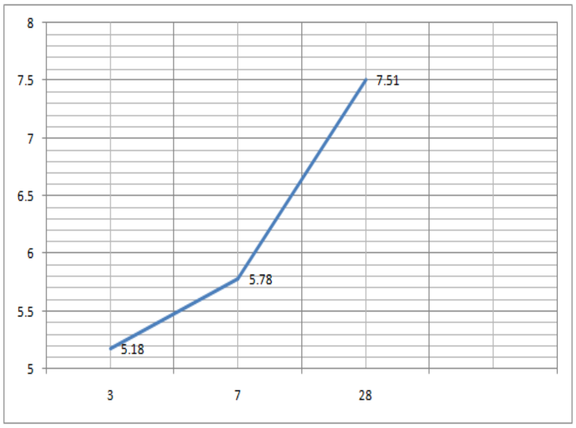
A. Variation of Flexural strength of beam at 0% replacement of Metakaolin



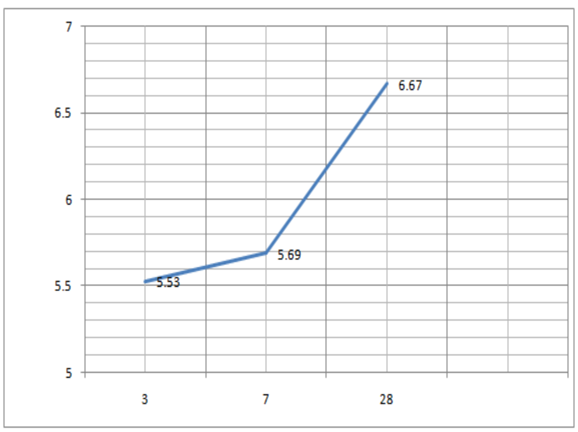
B. Variation of Flexural strength of beam at 5% replacement of Metakaolin



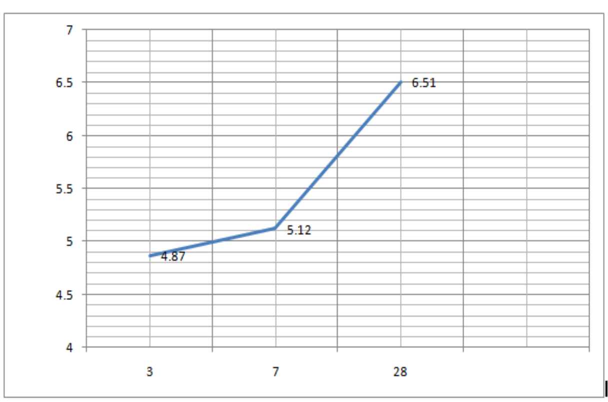
C. Variation of Flexural strength of beam at 10% replacement of Metakaolin



D. Variation of Flexural strength of beam at 15% replacement of Metakaolin



E. Variation of Flexural strength of beam at 20% replacement of Metakaolin



5. CONCLUSIONS

From the present investigation on the effect of partial replacement of cement with metakaolin in concrete, the following conclusions were drawn.

1. The flexural strength of HSC has increased for 5% and 10% replacement of metakaolin and decreases in 15% and 20% replacements.
2. Success of HSC requires more attention on proper mix design, production, placing and curing of concrete. For each of these operations controlling parameters should be achieved by concrete producer for an environmental that a structure has to face.
3. Even through the initial cost of HSC is comparatively higher than conventional concrete, considering the long service life of the structures and minimum maintenance required, the benefit cost ratio is very much in favor.
4. The HSC permits use of reduced sizes of structural members and increases available usable space in building, which is an important factor in congested urban locations.
5. HSC can be advantageously used for the production of precast products which can be mass produced and which utilize effectively the high durability and strength characteristics such as electric poles in coastal areas, pipes for transportation of corrosive liquids such as sewage, effluents.

6. Workability of HSC decreases with the increase in metakaolin replacement level.

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