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Experimental Study on Steel Fiber Reinforced Metakaolin Concrete

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Abstract – *This paper describes the experimental study of fibre reinforced cement concrete in addition of metakaolin by using M-sand. In the present study experimental investigation was done by using M60 mix in addition of metakaolin 5%-25% and crimped steel fiber 2%-10% having aspect ratio 85.and also study of effect of FRMC on properties of fresh concrete including workability, temperature, dry density, compressive strength.*

KeyWords*: *M60Concrete, Crimpedsteefiber, Metakaolin, Temperature, wet Density

1. INTRODUCTION

Cement concrete is the most widely used material for various constructions. Properly designed and prepared concrete results in good strength and durable properties. Even such well- designed and prepared cement concrete mix under controlled conditions also have certain limitations, because of which above properties of concrete are found to be inadequate for special situation and for certain special structures. The main ingredient in the conventional concrete is Portland cement. The amount of cement production emits approximately equal amount of carbon dioxide into the atmosphere. Cement production is consuming a significant amount of natural resources. To overcome above ill effects, the advent of newer things materials and construction techniques and in this drive, admixture has taken newer things with various administers has become a necessity. Availability of mineral admixtures marked opening of a new era for designing concrete mix of higher and higher strength. As a result, the use of new mineral admixture has considerably increased within the concrete industry. For attaining a high strength and durable concrete for major applications in the constructions such as high-rise building, tall structures, nuclear power plants etc., the essential need for additives both chemical and mineral are must to improve the performance of concrete.

Metakaolin is new mineral admixture, whose potential is not fully utilized. Moreover only limited etakaolin have been carried out in India on the for the development of high strength concrete. Several experimental investigations studies use of metakaoline have been carried out to study the workability, mechanical and durability characteristics.

1.1RESEARCH SIGNIFICANCE-

In this research experimental investigation was done by replacing partial weight of cement to the metakaolin and crimped steel fiber with the variation of mk 5%-25% and steel fiber 2%-10%.

And also the study of different properties of concrete which influenced by MMFRC. This property includes workability, density, compressive strength, temperature.

1.2 Experimental Programme-

The test materials used for this investigation given-

1. Cement-Ultratech 53 OPC cement has been used for casting. All properties of cement are tested by IS12269:1987.Having specific gravity 3.15,fineness is 3.75%,standard consistency 29%,initial setting time 135min,fina setting time 240min and compressive strength after 28days 69.5MPa

2. Aggregates-Coarse Agrregate were used in this experimental work 20mm and 10mm.These tested by referring IS 383:1970.The 20mm C.A having specific gravity 2.74,Fineness modulus 7.25,particle shape has rounded and water absorption 0.4% and same 10mm C.A tested having specific gravity 2.74,fineness modulus 6.872,particle shape has angular, water absorption 0.5%.

3. Fine Aggregate(Crushed sand)-

   It tested by referring IS 383:1970(Zone-2).The particle shape rounded, fineness modulus 2.97, silt content 1.9%, specific gravity 2.8, water absorption 1.1%.

4. Superplaseticizer-MYK arment Superplast used for increasing workability and other strength properties of MMFRC.

5. Water-Portable water available in laboratory having pH value lies between 6-8 and water should be free from organic impurities used for casting also curing.

6. Metakaolin-It is the chemical which used for present experimental study. This obtained from Golden micro chemicals, Thane.

7. Crimped steel fiber-ISO9001:2008 certified steel fibers confirming to ASTM A820 M04 Type1 standard are used for this research. Which having 0.70mm diameter, aspect ratio 85 and modulus of elasticity 200GPa.

-Crimped steel fiber-

- Metakaolin-

- Crushed sand-

- Coarse Aggregate-

- **Cement-**

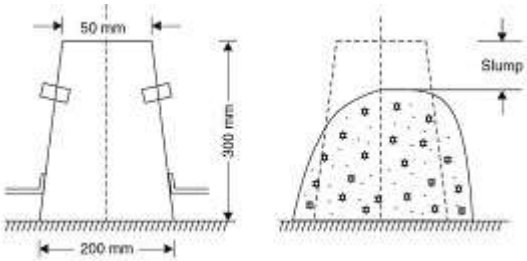
1.3 THEORY-

- Workability-

The no.of test are available for measuring workability such as by compacting factor, flow test, vee-bee consistency test, and slump cone test. These test used for checking and controlling workability of fresh concrete. In present study of SFRMC the workability is determined by using slump cone test.

The slump test is the widely used for finding the workability of fresh concreteThe Slump test indicates the behavior of a compacted concrete under the action of gravitional forces. The test is carried out with malled called as slump cone. During testing time slump cone placed on horizontal and non absorbent surface filled in 3 layers & each layer being tamped by 25 times with tamping rod.

The slump test is not considered applicable for concretes with a maximum coarse aggregates size greater then 1.5 inches in size, such larger particles can be removed by wet sieving. Additional qualitative information on the mobility of fresh concrete can be obtained after reading the slump measurement. Concrete with the same slump can exhibit diferent behavior when tapped with a tamping rod such as pavements or mass concrete. Alternatively, the concrete may be very close the concrete may be very cohesive when tapped, and thus be suitable for difficult placement conditions. The subsidence of concrete in mm known as slump.



- Temperture-

The temperature of FRMC is measured by using thermometer during the casting of concrete specimen.

- Wet density and Dry density-

Density of concrete specimen depends on weight of casted specimen and its volume. The wet density is evaluated after casting specimen means its wet weight and dry density is measured after the curing period means dry weight.

- Compressive strength-

Cubes are casted for this test having size of 15cmX15cmX15cm.This test is conducted after 28 days.

2. RESULT-

- Workability-

Workability of concrete with and without fiber & metakaolin is measured by slump cone test for different series of FRMC. For M60 grade of concrete 0.3 w/c is used. The experimentally result observe the when steel fiber and metakaolin increases simultreasaneously then workability decreases. That is the for M60 fresh concrete having the slump of 20mm and it decreased in addition of 10% steel fiber with 25% metakaolin by weight of cement. Similarly only addition of metakaolin Percentage of metakaoline increases then wo-rkability of mix incearses that is the MK 25% added then slump gives 24mm.

- Temperature-

Temperature of SFRMC is measured by using Thermometer during the casting process. When addition of steel fiber and metakaolin the temperature decreases at favourable level such as Normal mix M60 has 29^0. MK and SF increases temperature decreased. The 2%SF and 5%mk temperature is 28.5^0, 4%SF with 10%MK having temperature $28^0$and 6%SF with 15%MK has $27^0$and same 10%SF with 25%MK has 26^0.

Similarly Only Metakaolin is added in normal concrete M60 mix with certain percentage. Result shows the percentage of MK increases then temperature suddenly decreases such result as the percentage of MK 5% temperature is 28.5^0, 10%MK temperature is 27.5^0 and 15%MK temp. Is 27^0, 20%MK temperature is 26^0 same 25%MK temp is 25.5^0

- Compressive Strength-

The compressive strength of cubes M60 mix and SFRMC tested after 28 dayS. For M60 mix without MK and SF strength is 67.83MPa.

When percentage of metakaolin and steel increases in normal mix then compressive strength decreases at further stage 2% SF & 5% MK strength is 68.06MPa,4%SF and 10%MK strength is 65.24MPa, 6%SF and 15%MK has 65.12MPa, 8%SF with 20%MK having strength 64.72MPa and 10%SF & 25%MK strength is 64.08MPa.

Similarly, only metakaolin added in normal mix M60 then compressive strength increases. Linearly in addition of MK the percentage of 5%, 10%, 15% and 20%, 25%. The compressive strength of this percentile is 67.28MPa, 67.87MPa, 68.16MPa and 68.30MPa, 68.75%.

- Wet density and Dry density-

Wet density of cubes rises at the stage of steel fiber and metakaolin increases certain percentage.Dry density is less than the Wet density but it also increases same at increasing steel fiber and meatakaolin.

Which result concluded that if 2%SF and 5%MK Wet density is 2618.33kg/m^3 & Dry density is 2615.41 kg/m^3.it goes on increasing at stage of 10%SF &25%MK.There wet density is 2698.26 kg/m^3 & Dry density is2695.45 kg/m^3.

Similarly, in addition of 4%SF & 10%MK Wet density is 2642.39 kg/m^3 & Dry density is 2640.30 kg/m^3 6%SF & 15%MK the Wet density and Dry density is 2662.94 kg/m^3 and 2660.80 kg/m^3 also at 8%SF with 20%MK wet density is 2689.15 kg/m^3 & Dry density is 2686.91 kg/m^3 & 10%SF with 25%

MK has wet density and dry density 2698.26 kg/m^3, 2695.45 kg/m^3

3. CONCLUSIONS-

1. Temperature of SFRMC goes on decreasing in addition of metaKaolin.
2. Wet density of SFRMC goes on increasing with the addition of MK & SF.
3. Slump cone test gives best result of workability this method simple & suited for short time.
4. Compressive Strength of SFRMC improves with Addition of Metakaolin.
5. Slump of SFRMC rises in addition of Metakaolin. But decreases in addition of Steel fiber at certain stage.

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