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"INFLUENCE ON COMPRESSIVE STREGNTH OF CONCRETE ON ADDITION OF MICRO ALUMINA PARTICLES TO CEMENT"

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Abstract - *In this experimental work, micro Alumina particles have been mixed in M 25 grade concrete with various percentage (by weight of cement) to know the effect of micro Alumina particles on compressive strength of concrete. The percentages of micro Alumina particles range from 0% to 15% with an increment of 1%. For each sample three specimens were casted and tested for 7 days compressive strength and three specimens were casted and tested for 28 days compressive strength. The compressive strength test has been conducted after 7 days curing and 28 days curing. The specimens containing 4% of micro Alumina particles showed peak average compressive strength of 22.6N/mm at 7 days age, which was 13% higher than average compressive strength of controlled specimens at 7 days age. The specimens containing 12% of micro Alumina particle showed peak average compressive strength of 40.51N/mm at 28 days age, which was 22.79% higher than average compressive strength of controlled specimens at 28 days.*

***Key Words*: Micro Alumina, Concrete, Cement, Compressive Strength, Addition.**

1. INTRODUCTION

1.1 General Overview

Concrete is a homogeneous mixture of cement, fine aggregate, coarse aggregate and water which has very high compressive strength and very low tensile strength. There are many substance available which can help to achieve a higher compressive strength as compare to conventional concrete if they simply added or partially or fully replaced with the basic ingredients of concrete. Among those substance micro Alumina particle is one of the substance which helps to achieve a higher compressive strength concrete (by mixing in cement} as compare to conventional concrete for the same mix proportion. Various experimental studies has carried out recently by using different particle size of Alumina (i.e., nano size and micro size) in concrete mix and mortar mix to investigate the mechanical properties of concrete. The Alumina particle shows some extra ordinary properties in nano size and micro size, which is beneficial for improving mechanical properties of concrete. This is main reason behind the researcher's intrest in this field.

1.2 Objectives of Study

The objectives of this experimental study are as follows:

i) To find out that percentage of micro Alumina at which average peak compressive strength develops.
ii) To compare the average compressive strength of all samples and find out the reason behind the variation in average compressive strength.
iii) To know cost difference between production of controlled concrete and concrete contained micro Alumnia particles.

1.3 Scope of Study

The main focus area of this experimental study is to determine the increment or decrement in compressive strength of different concrete mixture having different percentage of micro Alumina particle. For compressive strength test sixteen cube samples has casted. For each sample three cube specimen has casted. The compressive strength test has performed in CTM (Compression Testing Machine) having capacity of 2000KN.

2. MATERIALS

Ordinary Portland cement, sand, coarse aggregate, micro Alumina particle and water has used for experimental work. Essential test has performed for all the materials to confirm that material properties meet the requirements of experimental work and codal provisions.

2 .1 Ordinary Portland Cement:

For this experimental work "Maha" cement has been used as ordinary Portland cement.The grade of cement is 53. based on laboratory test and test has done as per to IS 4031(Part 6):1988. This cement confirms to IS 8112:2013. This physical properties of cement obtained from laboratory test conforms to requirements against IS 269:2015.

2.2 Aggregate:.

In this experimental work crushed stone has used as coarse aggregate and sand has used as fine aggregate. The aggregates were clean, dry and free any absorbed chemical. The maximum size of coarse aggregate is 20mm and the

maximum particle size of sand is 4.75 mm. Sieve analysis of sand has carried out to find the zone of sand. By sieve analysis the sand has confirmed to zone II as per IS 383:1970. Specific gravity test, Water absorption test and bulk density test has carried out for aggregates. The physical properties of aggregates were evaluated as per IS 2386 (Part3):1963.

2.3 Micro Alumina:

In this experimental work micro Alumina particles has used along with cement, aggregates and water.

Micro Alumina particle was in form of powder. The colour of the powder was white. The particle size of micro alumina particle was in micron. So that it has good specific surface area and the bulk density was also good. The physical properties of micro Alumina particles are given below.

1) Specific surface area-70 m2/gram

2) Bulk density- 1050 kg/m3

3) Average particle size- 45±5 µm

2.4 Water

In this experimental work potable water has used. The water was clean and free from suspended solid and other Impurities. The water quality has confirmed to IS 3025 (Part 22):1986 and IS 3025 (Part 23):1986

3. METHODOLOGY

3.1 Overview:

All the tests for raw materials were performed. The various percentage of micro Alumina particles which have to present in each sample were also determined. So that it came to know that how many cubes to be cast.

3.2 Research Planning:

For this experimental study following sequence of work has followed:

Preparation of moulds

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Batching of materials

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Mixing of materials

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Casting of specimens

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Curing of specimens

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Testing of specimens

↓

Analysis of result

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Conclusion

3.3 Experimental Program

For 7 days compressive strength 17 samples has taken. Similarly for 28 days compressive strength 17 samples has taken. For each sample three cube specimen had casted. Total 102 cube specimen had casted. The dimension of cube specimens were 150mm x 150mm x 150mm.

For casting and testing of cube specimens some steps given below has followed:

3.3.1 Preparation of Moulds:

For casting of cube specimens cast Iron moulds have used. The inner dimension of mould is 150mm x 150mm x 150mm. For preparation of moulds at first all mould were cleaned and then bolts were tightened. Then with the help of a brush oil was applied on the inner bottom surface and on the inner side walls of all moulds..

3.3.2 Batching of Materials:

As per mix design proportion the quantity of cement, sand, coarse aggregate and water were batched. The batching was done by weight. Micro Alumina particles were also batched by weight. The various percentage of Micro Alumina particles is taken as percentage weight of cement.

3.3.3Mixing of Materials:

The next step was mixing. The main purpose of mixing is to produce a homogeneous concrete mixture with any segregation and bleeding. For mixing cement, sand, coarse aggregate, water and micro Alumina particles following steps has followed:

a) At first cement was taken in a tray. Then micro Alumina Particles poured into cement and mixed uniformly with the help of trowel. (For controlled concrete micro Alumina particles were not mixed with cement)

b) Then this mixture of poured into sand and mixed uniformly with the help of trowel.
c) Then the cement-sand-micro Alumina Particles mixture poured into coarse aggregate and mixed uniformly with the help of trowel.
d) Then water added to the dry mixture and mixed thoroughly.

3.3.4 Casting of Specimens:

a) Placing – After mixing the wet concrete mixture is poured into prepared mould
with the help of trowel. Moulds were filled upto top most level.

b) Compaction – To remove those air voids from fresh concrete table vibrator has used. Moulds were completely filled with wet concrete mixture place on the top of table vibrator and compaction was done 1 to 2 minutes again wet concrete mixture poured into mould upto top most level and compaction was done. This process is repeated 2 to 3 times.

c) Finishing - After compaction finishing was done on top most surface of concrete with the help of trowel.

3.3.5 Curing of Specimens:

After 24 hours of casting all the moulds were unmoulded. Then all the cubes were placed in a water tank filled up with water. For 51 cube specimens curing had been done for 7 days. And for rest 51 cube specimens curing had been done for 28 days.

3.3.6 Testing of Specimens

3.3.6.1Testing of Fresh Concrete:

For fresh concrete slump test had performed. The test had performed as per guidelines of IS 1199:1959. For this test the required apparatus are slump cone (10cm top diameter, 20cm bottom diameter, and 30cm height), weighing machine, tray (small and big size), trowel and tempering rod (16mm diameter and 600mm length). The required materials are cement, sand, coarse aggregate, water and oil.

3.3.6.2 Testing of Hardened Concrete:

The compressive strength test was performed as per guidelines of IS 516:1959. The testing was performed in compression testing machine (capacity 2000KN).

At first compressive strength test was conducted for 7 days compressive strength. At first cube specimens were extracted from the water tank. Then dried in laboratory room. When surface of specimens became dry, then at one time each specimen placed in compression testing machine. Then load was applied and increased gradually till crack appeared on specimen surface. When cracks were appeared on specimen, applied peak load was noted and load was removed. After that the cracked specimen was dumped in disposal area.

The 28 days compressive strength test carried out similarly as 7 days compressive strength test. (Except curing has done for 28 days)

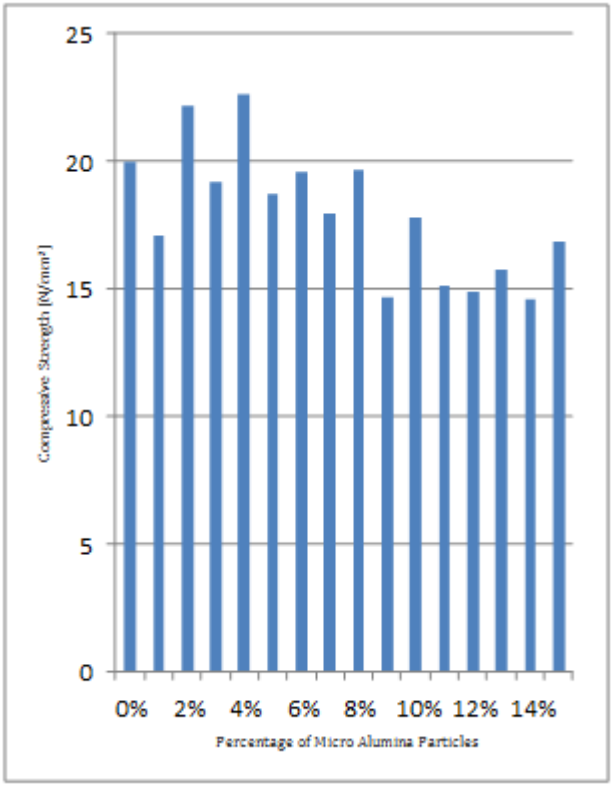
4. RESULTS AND DISCUSSION

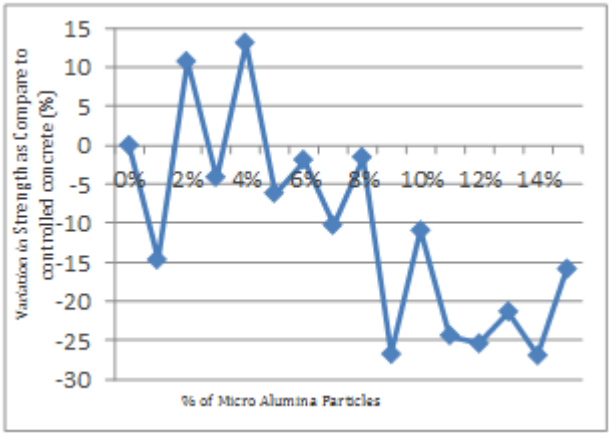
4.1 Test Results

4.1.1 Workability (Slump): The workability of controlled concrete mix has recorded in the form of slump i.e. 96mm.

4.1.2 7 Days Compressive Strength:

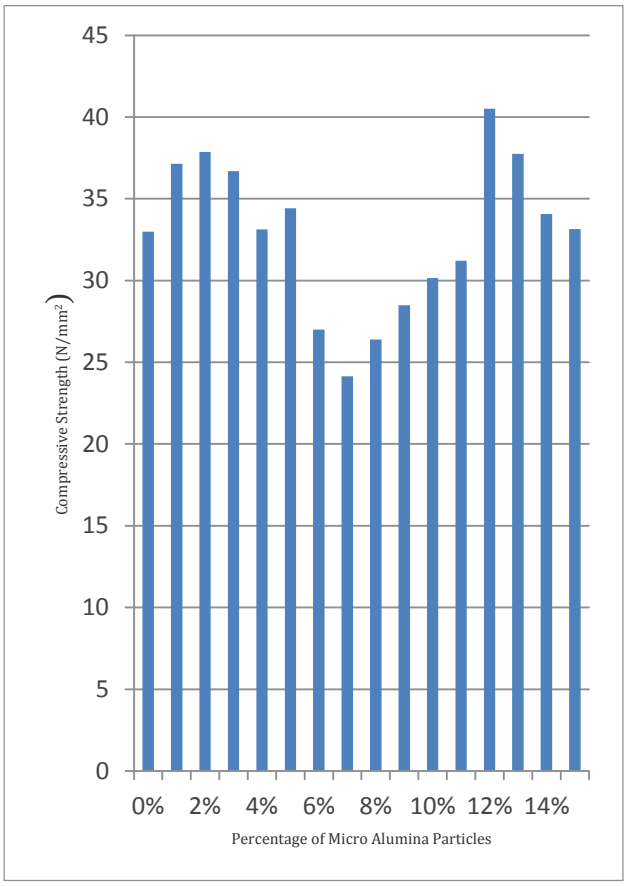
After 7 days curing of specimens compressive strength test had conducted. From there following result has obtain:

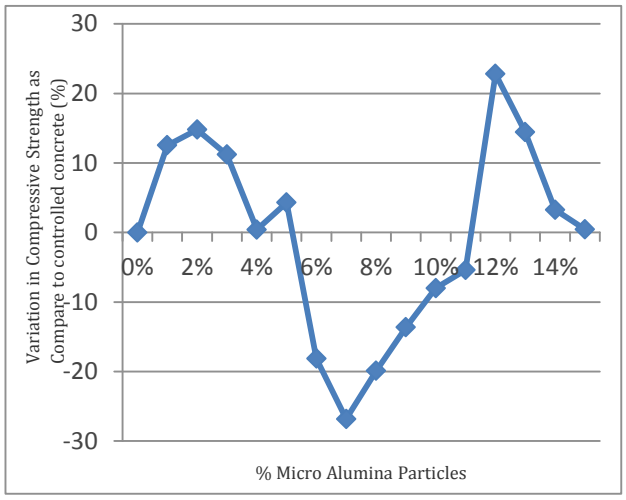




4.1.3 28 Days Compressive Strength:

After 28 days curing of specimens compressive strength test had conducted. From there following result has obtained:





4.2 Discussion:

For 7 days compressive strength test average compressive strength for controlled concrete specimen is 20N/mm² and the peak average compressive strength is obtained for concrete specimen contained 4% micro Alumina particles as 22.60N/mm², which is 13% more than average compressive strength of controlled concrete specimen. Graph shows that upto 4% of micro Alumina particles average compressive strength increases and then starts to decrease significantly upto 15% of micro Alumina Particles.

28 days compressive strength test average compressive strength for controlled concrete specimen is 32.99N/mm² and peak average compressive strength is obtained for concrete specimen contained 12% micro Alumina particles as 40.51N/mm², which is 22.79% more than average compressive strength of controlled concrete specimen. Graph 5.3 and graph 5.4 shows that the average compressive strength increases upto 2% of micro Alumina particles then decreases upto 7% of micro Alumina particles. After then again starts to increase upto 12% of micro Alumina particles (peak average compressive strength) and then decreases upto 14% of micro Alumina particles and then increases a little upto 15% of micro Alumina Particles.

The main reason behind the improvement in compressive strength from 0% to 2% of micro Alumina particles is that micro Alumina particles reacts with Calcium Hydro-oxide formed during the hydration of Tri-Calcium Silicate and Di-Calcium Silicate. Due to the reaction between micro Alumina particles and Calcium Hydro-oxide more surface is available for further hydration process of Tri-Calcium Silicate and Di-Calcium Silicate as a result more Calcium Silicate Hydrate (C-S-H) gel form, which contributes to more strength.

The main reason behind the decrement in compressive strength from 3% to 7% of micro Alumina particles is that between this percentages micro Alumina is available in excess quantity to react with total available quantity of Calcium Hydro-oxide to produce C-S-H gel due to which the surplus quantity of micro Alumina particles starts to agglomerate in concrete mixture and leads to form weak zone. Consequently compressive strength decreases.

The main reason behind the improvement in compressive strength from 8% to 12% of micro Alumina particles is that micro Alumina particles act as fine aggregate if present in higher percentage. . Due to which small pores present in concrete fill effectively with micro Alumina particles which is not possible with sand particles alone due to bigger particle size. Therefore concrete becomes more dense and compact. Consequently compressive strength increases.

The main reason behind the decrement in compressive strength from 13% to 15% of micro Alumina particles is that with increase in micro Alumina particles, cement content reduce for a particular volume of concrete. So that during hydration process less Calcium Silicate Hydrate (C-S-H) gel form as a result compressive strength decreases.

4.3 Cost Analysis:

According to mix design for 1 m³ of M25 concrete quantity of raw materials as follows:

Cement = 402.36kg = 8.047 Bags

Sand = 0.255m³

Coarse Aggregate = 0.420m³

Cost of materials:

Cement = 270 Rs. Per bag

Sand = 540Rs.per m³

Coarse Aggregate = 1050 Rs. per m³

Micro Alumina Particles = 25 Rs. Per kg

Cost of materials for 1 m³ of M25 concrete:

Cement = 2172.69 Rs.

Sand = 137.7 Rs.

Coarse Aggregate = 441Rs.

Total Cost = 2751.39 Rs. (Controlled Concrete)

Cost of 1% of Micro Alumina Particles = 100.575Rs.

For every 1% increment in micro Alumina particles total cost of 1 m³ of concrete increases by 112.025 Rs.

5. CONCLUSION

From this experimental study it can be concluded that for M-25 grade of concrete, if a certain percentage of micro Alumina particles (by weight of cement) is added to cement then characteristic compressive strength of concrete improves significantly. 12% dosage of micro Alumina particles increases the 28 days compressive strength by 22.79%(peak value) as compare to controlled concrete and decreases the 7 days compressive strength by 25.45%as compare to controlled concrete. However the 2% dosage of micro Alumina particles increases the 28 days compressive strength by 14.79% as compare to controlled concrete and increases the 7 days compressive strength by 10.75%as compare to controlled concrete. In both case (2% and 12% dosage of micro Alumina particles) the rate of strength gain for 28 days is higher than rate of strength gain for 7 days. 12% dosage of micro Alumina particles increases the total cost of M-25 concrete (per cubic metre) by 1207.075Rs. and2% dosage of micro Alumina particles increases the total cost of M-25 concrete by 201.175Rs. This indicates that addition of 2% of micro Alumina particles is more economical. So that it is concluded that the recommended dosage of micro Alumina particles is 2% (by weight of cement).

REFERENCES

[1] L. Moutei, Y. Benbrahim, T. El ghailassi, A. Bouih, S. Labied, T. Guedira, O. Benali "The effect of the addition of Alumina powder on the confinement properties of a cement mortar", MATEC Web of Conferences 149, 01055 (2018)

[2] B. A. Hase, Prof. V. R.Rathi, "Properties of High Strength Concrete Incorporating Colloidal Nano-Al2O3". International Journal of Innovative Research in Science, Engineering and Technology, Vol. 4, Issue 3, March 2015

[3] Mohammad Reza Sharbaf, Tayebeh Davoudzadeh, Mohammad Reza Eftekhar, Mehdi Kamali, "An Investigation on the Effects of Al2O3 Nano-particles on Durability and Mechanical Properties of High Performance Concrete", International Confrence on Concrete & Development, Technical Report - May 2013, DOI: 10.13140/RG.2.2.20157.67044

[4]Ali Nazari, Shadi Riahi, Shirin Riahi, Seyedeh Fatemeh Shamekhi and A. Khademno, "Mechanical properties of cement mortar with Al2O3 nanoparticles", Journal of American Science, 2009;5(7), Nazari, et al, Al2O3 nanoparticles in Concrete

[5] Ali Nazari, Shadi Riahi, Shirin Riahi, Seyedeh Fatemeh Shamekhi and A. Khademno, "Influence of Al2O3 nanoparticles on the compressive strength and workability of blended concrete", Journal of American Science 2010;6(5), Nazari, et al, Al2O3 nanoparticles in Concrete

[6] P Jaishankar* and C Karthikeyan, "Characteristics of Cement Concrete with Nano Alumina Particles", IOP Conf. Series: Earth and Environmental Science 80 (2017) 012005, doi:10.1088/1755-1315/80/1/012005