The Asian Review of Civil Engineering
ISSN: 2249-6203 (P) Vol.9 No.2, 2020, pp.8-11
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DOI: https://doi.org/10.51983/tarce-2020.9.2.2557

Prediction of Compressive Strength of Nano Alumina, Micro Alumina & Fly Ash Blended with Cement by Using Coefficient of Correlation

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Abstract - **In this research study, the effect on High Strength Concrete (HSC) by partial replacement of cement with Nano alumina, micro alumina and fly ash on the mechanical properties of the concrete is studied. In this investigation the cement is replaced by 20% Fly ash, 5% micro alumina and nano alumina of different proportion i.e., 0.25%, 0.5%, 0.75%, 1% in M60 grade of concrete. It is observed that the concrete's workability is reduced by increasing the content of nano alumina from 0% to 1% and constant micro alumina particles of 5% cement (by Wt.) and fly ash of 20% cement (by wt.). The results showed that 0.75% of the combination of nano alumina, micro alumina and fly ash increases the properties of the high strength concrete. The microstructure characteristics results revealed that the Nano alumina, micro alumina and fly ash particles incorporated enhances the cement's mechanical strength properties and the voids were filled up with these materials. The present investigation is mainly focused on reliability assessment to the High Strength Concrete by using by using Karl Pearson's correlation coefficient.**

Keywords: **Nano alumina, micro alumina, fly ash, workability, compressive strength**

I. INTRODUCTION

Of all the materials used, cement is important material in concrete. Cement is produced by calcinating argillaceous and calcareous materials at a high temperature. During this procedure, enormous amount of CO_2 (i.e. 1 ton of cement=0.8 ton of CO_2) is released into the environment. Therefore decrease in the utilization of cement will reduce the emission of CO_2. So there is necessity of replacing cement with some different materials. There is also requirement of increase of the various qualities of concrete with the usage of different materials. Nano material is defined as materials with size less than 200nm.

The use of nano materials will improve the binding effect. It also acts as a filler agent that helps to reduce the micro pores in the concrete results in a dense concrete structure. Fly ash reduces the C-S-H when reacts with free lime in cement during hydration. Fly ash contributes towards enhancing the properties of material, increases workability and strength, decreases heat of hydration and shrinkage. Correlation is the measure of how two variables are related to one another. There is several correlation coefficients which measures degrees of correlation. The Karl Pearson's correlation coefficient is currently defined as the quality of least squares fitting to the original data it is the ratio of co variance of two variables, normalized to square root of their variances there is covariance of two variables by the product of their standard deviations. This is mainly used to measure the dependency among random variables and it is sensitive to linear values. This correlation coefficient tries to establish a line of best fit through a data set of two variables. In this research reliability can be observed by correlates the two variables by using Karl Pearson's correlation coefficient formulae by observing the reliability of concrete.

TABLE I QUALITY OF CONCRETE

Reliability of Concrete	Quality of concrete
>0.95	Excellent
0.75-0.94	High
0.50-0.74	Medium
0.35-0.49	Low
<0.34	Poor

II. LITERATURE REVIEW

Karthikeya Rao and SenthilKumar [1] In their research It is observed that 2%by cement volume with Nano Alumina and 50% GGBS exhibits better Compressive quality in comparison with conventional concrete.

Agarkar and Joshi [2] in their experiment they observed that partial change of cement with Nano alumina particles magnifies the compressive quality of cement even through diminishes its workability.

P.Jai Shankar & C Karthikeyan [3] in their study it is concluded that "incorporating the nano alumina up to 1% of cement by weight increases the compressive strength of the modified concrete by 33.14% at the age of 28 days.
Jugal A Mistry AND Dr.Indrajith N Patel et.al.,[4] they investigated that in M50 and M60 Grade concrete cement replaced with 1.5% nano silica and 55% fly ash in concrete they attended 10% increased compressive strength compaired with normal concrete

III. OBJECTIVES OF THE STUDY

1. To study the effect of combination of nano alumina, micro alumina and fly ash on compressive strength.
2. Comparing the conventional concrete and of nano alumina, micro alumina and fly ash mixed concrete
3. Compressive strengths are 3, 7 and 28days results can be drawn in graphically in figure1.
4. Mat lab program developing and reliability can be evaluated.

IV. EXPERIMENTAL DETAILS

A. Materials

1.Cement

In this investigation, 53-grade OPC ACC cement Company is used and its specific gravity is found to be 3.15 the cement have preliminary tests are fineness of cement , normal consistency of cement ,initial setting time , final setting time conducted and results are shown in table II .

TABLE II TESTS FOR CEMENT

Tests for cement	Obtained results
eness of cement	2.6%
mal consistency of cement	32%
ial setting time	30 minutes
al setting time	600 minutes
cific gravity of cement	3.15

2.Coarse Aggregates

Aggregates are critical constituents of concrete. 70-80% of the volume of the concrete is occupied by aggregates. Coarse aggregate of nominal sizes of 20mm, 12mm are used. Water absorption test value is found to be 0.30-0.35%. Fineness modulus is calculated as 6.5-6.8. Specific gravity was calculated as 2.8 and some more preliminary tests results are shown in below table III.

TABLE III TESTS FOR COARSE AGGREGATE

Tests for coarse aggregate	Coarse aggregate results
Specific gravity	2.8
Bulk density	1620 kg/m3
Water absorption	0.30-0.35
Fineness modulus	6.5-6.8
Aggregate crushing value	25%
Aggregate impact value	27%

3.Fine Aggregates

The important role of the aggregates is to give good workability and uniformity in concrete mixture. The fine aggregate used in this study is from local river bank chitravathi. Water absorption test is performed and the value is 0.35-0.40%. Fineness modulus of fine aggregate is 3.05.The specific gravity of sand is found to be 2.70 and some more preliminary tests results are shown in table IV.

TABLE IV TESTS FOR FINE AGGREGATE

Tests for fine aggregate	Fine aggregate results
cific gravity	2.70
k density	1620 kg/m3
ter absorption	0.35-0.40
eness modulus	2.46

4.Nano Alumina

The properties of nano alumina are particle density, surface area, average particle sizes are shown in table V, as follows

TABLE V PROPERTY NANO ALUMINA

Property	Nano alumina
Particle density (g/cm^3)	3.6
Surface area (m^2/g)	>150
Formula	Al_2O_3
Average particle size	20-50
Solubility in water (%)	Insoluble
Colour	White

5.Micro Alumina

Micro alumina enhances the physical properties, durability and workability of concrete. It can also be used to build marine structures as it reduces the damage caused due to the reaction of chlorides and various chemicals and some physical properties of micro alumina are shown in table VI.

TABLE VI PHYSICAL PROPERTIES MICRO ALUMINA

Physical properties	Micro alumina
Physical state	Micronized powder
Odour	Odourless
Appearance	White colour powder
Colour	White
Pack density	0.76 gm/cc
pH of 5% solution	6.90
Specific gravity	2.63
Moisture	0.058%
Oil absorption	55 ml/100gms

6.Super Plasticizer

Conplast SP430 is used to obtain high workability. Utilization of super plasticizers permits the decrease of

water to the degree up to 30% without lessening workability. The utilization of super plasticizer is being used for generation of streaming, self-leveling, and self-compacting for the creation of High Strength Concrete (HSC).

B. Mix Proportions

As per IS-10262 this investigation is done on M60 grade concrete. The proportion of mix attained is 1:1.353:2.78 with W/C ratio as 0.32. Subsequent mixes were prepared with replacement of cement partially by varying percentages from 0%, 0.25%, 0.50%, 0.75% & 1% of Nano aluminum oxide particles (Nano Al2O3), 5% micro alumina and 20% fly ash constant quantity of mix are shown in table VII.

TABLE VII MIX PROPORTIONS

Sl. No.	**Material**	**Quantity in kg**
1	Cement	462.5
2	Fine aggregate	626.08
3	Coarse aggregate(max 20 mm size)	1285.76
4	Water	148
5	Super plasticizer	5.55

TABLE VIII MIX DESIGNATION SLUMP RESULTS

Sl. No.	**Mix designation**	**Slump values in mm**
1	M0 (M60)	85
2	M1 (M60+0.25% nano+20%Flyash+5% micro)	81
3	M2(M60+0.50%nano+20%Flyash+5% micro)	76
4	M3(M60+0.75%nano+20%Flyash+5% micro)	72
5	M4 (M60+1.00% nano+20%Flyash+5% micro)	68
Sl. No.	**Mix designation**	**Compactionfactor (weight)**
1	M0 (M60)	0.927
2	M1(M60+0.25%nano+20%Flyash+5% micro)	0.914
3	M2(M60+0.50%nano+20%Flyash+5% micro)	0.893
4	M3(M60+0.75%nano+20%Flyash+5% micro)	0.864
5	M4(M60+1.00%nano+20%Flyash+5% micro)	0.841

C. Compressive Strength

This test is done on 150 mm *150 mm *150 mm specimens are used.

This cube strength is calculated with different rates of replacement of Nano alumina, and constant rate of micro alumina and fly ash within concrete for 3,7 and 28 days has found out and values are noted in table X and recorded graphically in fig. 1. We can incur that maximum strength is obtained when cement is replaced by 0.75% nano alumina.

TABLE IX MIX DESIGNATION COMPACTION FACTOR RESULTS

Sl. No.	**Mixdesignation**	**Compressive strength in N/mm^2**		
		3 days	**7 days**	**28 days**
1	(M60)	30.24	46.16	68.62
2	M1 (M60+0.25% nano+20%Flyash+5% micro)	34.12	50.34	73.26
3	M2 (M60+0.50% nano+20%Flyash+5% micro)	37.6	54.72	77.16
4	M3 (M60+0.75% nano+20%Flyash+5% micro)	40.89	58.16	80.64
5	M4 (M60+1.00% nano+20%Flyash+5% micro)	39.65	57.96	78.92

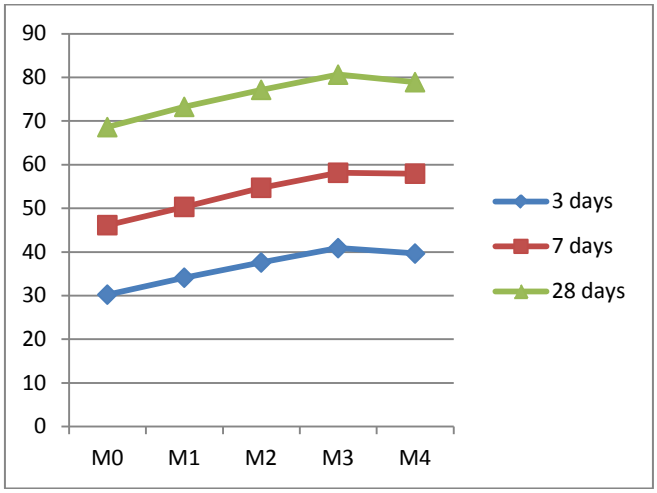

Fig. 1 compressive strength results for 3, 7 and 28 days M60 mix concrete

V. RELIABILITY ANALYSIS

Here reliability analysis is performed by a statistical tool , karl Pearson's correlation coefficient . This statistical tool gives reliability of a structure.

in determining the reliability of a structure different parameters considered in that life of a structure , environment friendly ,strengths. in this research I calculate the reliability indicators for various days like 3,7 and 28days. For 3 days I have attend r1= 0.5210, For 7 days I have attend r2= 0.7286, For 28 days I have attend r3= 0.8841.

In that 28 days were giving the best reliability of a structure these shown in graph as given below fig. 2.

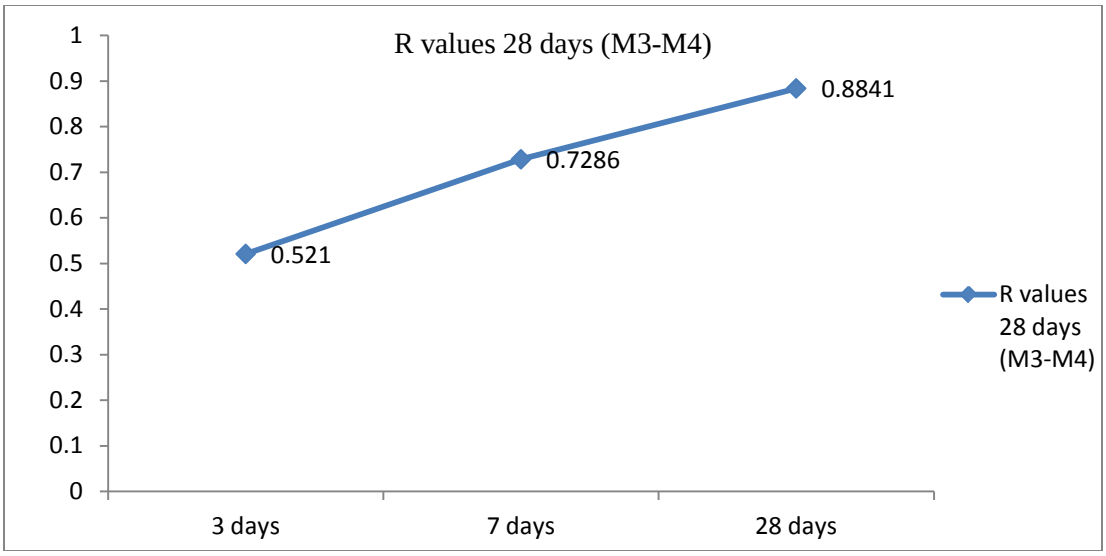

Fig. 2 Reliability of Concrete M3 And M4

VI. CONCLUSIONS

1. From the above investigations, the effect of Nano alumina, micro alumina and flyash as partial substitution of cement within mix but micro alumina and fly ash is constant for all proportions adding for cement replacement, we came to following tentative conclusions:
2. The results show us, constant Micro Alumina (5%), fly ash (20%) and with regular increase in nano alumina content (0.25%, 0.5%, 0.75%, 1%) gives higher compressive Strengths compare to plain M60 mix.
3. As Nano Alumina content increases, compressive Strengths increases till 0.75% & then decreases. Hence nano alumina optimum substitution is 0.75%.
4. The maximum growth in compressive strengths when compared to the plain mix.
5. In all 3, 7 and 28days the maximum compressive strengths were obtained at 0.75% Nano alumina particles with cement replacement.
6. Weight of specimens decreased when percentage replacement of cement with nano alumina increases.
7. The correlation coefficient results are drown in fig.2 those results are calculated by using MATLAB.

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