Experimental study on metakaolin & nano alumina based concrete

Kunchala Ashok¹, B Kameswara Rao² and B Sarath Chandra Kumar³

¹Asisstant Professor ©, Department of Civil Engineering, JNTUH college of Engineering Hyderabad, Kukatpally, TS, India.
²Professor, Department of Civil Engineering, Koneru Lakshmaiah Education Foundation, Vaddeswaram, AP, India.
³Associate Professor, Department of Civil Engineering, Kallam Haranadhareddy Institute of Technology, Chowdavaram, Guntur, AP, India.

ABSTRACT
The experimental work carries around the impact of investigation of Nano Particle like Nano Alumina (NA) and further more one of the beneficial cementitious (pozzolanic) material in cement to improve the mechanical properties of the concrete. Nano Particle and pozzolanic material is partially replaced by the weight of cementitious material into concrete. The experimental work examine was done on Nano replaced concrete were cured for 28, 56 and 90 days of water for various concrete mixes like M30, M40 and M50 to calibrate the mechanical properties of concrete like compressive strength, flexural strength and split tensile strength of concrete and also Non Destructive tests like UPV and Rebound hammer test on the hardened concrete. The workability and mechanical properties were also studied for the conventional and Nano replaced Concrete. Based on the experimental test results obtained the influence of Nano particle in concrete can be examined in both fresh and hardened state.

KEYWORDS: Nano Alumina, Metakaolin, Workability, NanoTechnology, Mechanical property, NDT.

1. INTRODUCTION

The normal cement influences the ordinary Portland cement which will act as a fillers, for example, sand, coarse, admixtures and water. This blend of ingredients permits concrete to be produce in a liquid structure that can be siphoned and formed. The measure of CO2 radiated from the overall creation of OPC relates to roughly 8% of the outflows into the world's environment [2] [13]. To reduce the utilization of natural resources, for example, lime stone, shale, clay, characteristic stream sand, shakes that are being devoured for the improvement of human humankind that are not rewarded the earth and utilization of waste materials in solid that likewise forestalls tremendous zone of land that is utilized for the capacity of waste materials that outcomes in the land, air and water contamination [3] [12] [16 – 23]. The concrete should bring about the manageable advancement without decimation of natural resources.

Nano innovation can be utilized for development cycles and plan in numerous regions since the Nano innovation produced materials have numerous special qualities [4] [15]. The utilization of Nano particles in solid will lessen huge measure of outflows and the utilization of warm prots the exhibition will bring about effective utilization of energy for cooling [5]. As the solid material is generally usable in the construction industry it has been needed to improve its quality and execution over conventional concrete [6]. Nano substituted cement is characterized as the material made by making up for the short comings and pores in Normal concrete utilizing Nano particles of lesser size than 30 Nano meters [7]. The diverse Nanoparticles are accessible like Nano silica, alumina, iron, carbon cylinders and titanium dioxide [22]. In the current age Nano innovation was created with
perceptible rate and furthermore the imaginative expected employments of Nano particles there is a worldwide premium in examination of consolidating of Nano particles in development materials in concrete mortar and cement [8]. The utilization of Nano particles has as of late been investigated to defeat the insufficiency of low early age compressive strength in concretes. The Nano particles have a high molecule surface zone to volume proportion and will go about as a filler impact by possessing up the voids between concrete grains with the correct arrangement brings about higher packing density [9].

In the exploration work the impact of Nano particle like Nano Alumina and also one of the strengthening cementitious (pozzolanic) material like metakaolin in concrete to improve the mechanical properties of ordinary standard and high strength concrete. The Nano particle like Nano Alumina and pozzolanic material like metakaolin were incompletely supplanted with concrete by 1% and 15% separately in the concrete blends for various evaluations of concrete. The Nano particle will bring about more prominent execution in strength and manageability. The fractional substitution of concrete by a mineral admixture called metakaolin will shows better execution in both better and economy. The concrete presented with a blend of Nano particle and mineral admixture improves the miniature structure just as decline the calcium hydroxide fixation by devouring it through a pozzolanic response. The resulting change of the miniature structure concrete composites improves the mechanical properties, functionality properties and increment the administration life properties adding to economically assembled climate.

2. MATERIAL PROPERTIES
Nano replaced concrete comprises of cement, metakaolin, Nano alumina, fine aggregate, coarse aggregate, water and chemical admixture.

2.1 Cement
The binding material utilized in the current research work is standard Portland cement of 53 grade and the essential properties of concrete like fineness, specific gravity, consistency, initial setting time and final setting time have been researched according to BIS 4031: 1996 and is introduced in table 1. [11]

| S.No | Property               | Test results |
|------|------------------------|--------------|
| 1.   | Fineness               | 3.5%         |
| 2.   | Specific gravity       | 3.1          |
| 3.   | Standard consistency   | 29%          |
| 4.   | Initial setting time   | 45 minutes   |
| 5.   | Final setting time     | 450 minutes  |
| 6.   | Compressive strength   | 51.5 N/mm²   |
|      | at 28 days             |              |
2.2 Metakaolin

White shaded metakaolin of explicit surface region of 150000 to 180000 cm$^2$/gm having explicit gravity of 2.5 and mean grain size of under 1 micron and having a fineness of 700 to 900 kg/m$^2$. The metakaolin is an exceptionally responsive material which can contend silica [5] [10].

2.3 Nano particle (Nano Alumina)

The properties of Nano particles are particle size, purity, specific gravity, density and colour are appeared in beneath tables. The actual properties of Nano particle like Nano alumina is presented in table 2 and the chemical composition of Nano particle like Nano alumina was referred to in the table 3 [22].

| Properties     | Nano Alumina |
|----------------|--------------|
| Morphology     | spherical    |
| Colour         | White        |
| Purity         | 99.9%        |
| Particle size  | 30 – 50 nm   |
| Specific gravity | 3.9        |
| Density        | 90 (g/l)     |

* Properties of Nano Alumina is provided by the supplier.

Table 2: Properties of Nano Alumina

| Al$_2$O$_3$ | Cao   | Fe$_2$O$_3$ | Mgo   | Ca    |
|-------------|-------|-------------|-------|-------|
| $>$99.5%    | $<$0.017% | $<$0.035% | $<$0.01% | $<$0.05% |

* Chemical Composition of Nano Alumina is provided by the supplier.

2.4 Aggregates

Fine aggregate passing through 4.75 mm IS sieve with fineness modulus 2.47 and specific gravity 2.67 was used for the present work. Coarse aggregate less than 20 mm size with fineness modulus 7.05 and specific gravity 2.62 were used after testing in the research work. The testing was conducted as per BIS 2386:1963 [12].

2.5 Water

The water used in the present research work is potable water which having a pH value is 6.5 to 8. The limits for permissible solids in water as mentioned in IS 456:2000 [22].

2.6 Super plasticizer

Fosroc Conplast SP 430 which appears in blackish brown colored fluid based super having plasticizer was utilized in the investigation which having a specific gravity is 1.18. To provide excellent acceleration of strength gain at early ages and significant expansions in strength at all ages by essentially reducing water interest in a concrete blend. Especially suitable for precast concrete and
other high early strength necessities. To essentially improve the functionality of site blended and precast concrete without increasing water demand. The pH estimation of SP 430 is 7 to 8 [5].

3. EXPERIMENTAL INVESTIGATION

3.1 Proportioning of Mix Design

The mix proportioning for traditional concrete specimens was designed as per code IS 10262:2019 with Ordinary Portland Cement, fine aggregate, coarse aggregate, and water [13]. The Nano replaced concrete was prepared by the partial substitution of normal concrete by Nano alumina and metakaolin by 1% and 15% of material is substituted by the mass of cement. The water cement ratios used for different grades are 0.48, 0.45 and 0.4. The different mixes used in the experimental work for different grades and their mix proportions are represented in the table 4. The sample designation for different concrete grades like M30, M40 and M50 with and without Nano Alumina are represented like NC30, NA30, NC40, NA40, NC50 and NA50.

- NC – Normal Concrete
- NA – Nano Alumina Concrete

| Grade of concrete | Type of concrete | Cement (kg/m³) | Metakaolin (kg/m³) | Nano Alumina (kg/m³) | Fine Aggregate (kg/m³) | Coarse aggregate (kg/m³) | Water (kg/m³) | SP (kg/m³) |
|------------------|------------------|----------------|--------------------|---------------------|------------------------|--------------------------|--------------|-----------|
| M 30             | NC30             | 365            | -                  | -                   | 672                    | 1194                     | 175          | -         |
|                  | NA30             | 307            | 54.75              | 3.65                | 672                    | 1194                     | 175          | 3.65      |
| M 40             | NC40             | 378            | -                  | -                   | 662                    | 1206                     | 170          | -         |
|                  | NA40             | 317.5          | 56.70              | 3.78                | 662                    | 1206                     | 170          | 3.78      |
| M 50             | NC50             | 390            | -                  | -                   | 652                    | 1242                     | 156          | 1.95      |
|                  | NA50             | 327.1          | 59.0               | 3.90                | 652                    | 1242                     | 156          | 5.85      |

The supplementary cementitious material in each sample was substituted by Nano alumina and metakaolin by 1% and 15% of the weight of cement. The super plasticizer solution with a dosage of 1 and 1.5% is incorporated to Nano particle concrete mix proportions for improving the workability and flow characteristics of concrete.
3.2 Preparation of concrete specimens

The concrete samples are casted containing Nano particle for various evaluations were set up by beginning drying blending of cement, sand and metakaolin for around 2 minutes in container blender. The chemical compound admixture was broken down in 30% of fluids and Nano particles were added and mixed at a pace of 350 RPM for around 5 minutes for uniform scattering with no coagulation. At that point this arrangement was added to the dry combination with the excess 70% of water followed by ceaseless blending for about an additional 3 minutes in pan blender. The control samples was set up in the comparable manner as depicted above, however with no expansion of Nano particle. The cubes of standard in measurements and cylinder of 150 mm in diameter and length of 300 mm were casted in steel form and compacted. The prism molds of size 100 mm x100 mm x500 mm in measurements are likewise projected in steel molds. The samples were demolded from the molds 24 hours in the wake of projecting, and were permitted to cure in water for 28, 56 and 90 days. After the curing time the samples with standard dimensions of cubes were utilized for the assurance of compressive strength, 150 x 300 mm cylinders for tensile strength and 100 x 100 x 500 mm prisms for flexural strength were determined according to BIS codes. The Non destructive tests like ultra sonic pulse velocity test and rebound hammer test on hardened concrete for 90 days.

4. POZZOLANIC REACTION

The pozzolanic reaction describes that the aluminous and siliceous materials that itself has a practically no cementitious material worth anyway that will, in finely isolated structure inside seeing moistness falsely react with calcium hydroxide at typical temperatures to outline compound having cementitious properties. The hydration of concrete improvement the calcium hydroxide and calcium silicate hydrate are released inside the hydration of two guideline parts of cement specifically tricalcium silicate and dicalcium silicate. The occupation of Nano particles will go about as fillers in the voids or void spaces and all around dissipated Nano particles will go probably as a nucleation or crystallization focal points of the hydrated items, in this way extending the hydration rate, i.e., Nano particles will helped towards the improvement of littler size CH valuable stones and homogeneous gatherings of C-S-H structure. They improved the structure of the advancement zone among aggregates and stick and the effect of Nano particles on the mechanical quality of cementitious materials, the development of Nano particles to solid pastes was found to extend the axial strength to some extent that was dependent on the Nano atom content, water-to-cover weight extent (w/b), and alleviating time. The Nano particles can improve the filler sway and besides the high pozzolanic reactivity of fine particles increases impressively the measure of C-S-H gel.
It can adjust the microstructure in the ITZ progress zones and therefore the assessment of C-S-H gel achieves reducing the water vulnerability. The purpose of the utilization of super fine added substances (Nano particles) in cementitious structures is to improve the characteristics of the plastic and hardened material. The Nano particles have a filler sway by garnish off the pores between the solid grains with the right creation; the higher squeezing thickness achieves a lower water solicitation of the mix and it. It moreover adds to quality improvement as a result of the diminished fine porosity. Moreover speaking to its solidness examines, results show that extension of Nano particles shows better strength execution of the solid. Making of Nano changed solid will achieve better with respect to quality, strength and viability. The fragmented replacement of cement by a mineral admixture called Metakaolin will gain both better and economy. Solid mixes are changed with extension of admixtures and Nano particles, which improve the microstructure similarly as decrease the calcium hydroxide center by burning-through it through a pozzolanic response. The subsequent difference in the microstructure of solid composites improves the mechanical properties, strength and constructs the existence administration properties adding to reasonably fabricated climate.

5. RESULTS AND DISCUSSIONS

5.1 WORKABILITY

The workability property of Nano altered cement represents to that the level of Nano particles are expanded beyond the permissible value the slump values are diminishing for various evaluations for various water concrete proportions. The workability property like slump test is led on concrete by supplanting the Nano particles. The expansion of Nano particles and mix of mineral admixtures additionally diminishing the water concrete proportions. The slump values are represented underneath table 5.

Table 5: Workability for different Mixes and its density

| Grade of concrete | Type of concrete | Slump (mm) | Density (kg/m³) |
|-------------------|-----------------|------------|----------------|
| M 30              | NC30            | 65         | 2350           |
|                   | NA30            | 95         | 2360           |
From the above representation in graphically from figures 1 and 2 the workability and density of Normal and Nano Alumina concrete are represented to in graphically and the functionality of Nano Alumina solid abatements contrasted with Normal cement because of the Nano particles and the mineral admixture acquainted in cement due with the water fastener proportion diminished and furthermore the Nano particles have a surface to volume proportion the Nano Alumina molecule is
under 20 Nano meters in width. The particle have high responsive and the conduct of such materials is mostly impacted by substance responses at the interface. The higher surface zone is to be wetted, it diminishes the free dispersant water in watery framework accessible in blend. The density of Nano Alumina concrete expanded contrasted with Normal cement for various grades like M30, M40 and M50 because of the particles shows enormous surface area to volume proportion.

5.2 COMPRESSIVE STRENGTH

The compressive test was performed by the codal arrangements i.e. IS 516:1959 on samples of blocks 150 mm X 150 mm X 150 mm for 28, 56 and 90 days of curing. The test results consequences of compressive strength are appeared in table 6 which was normal of average three samples. The results outcomes indicated that the samples containing Nano particles demonstrated an expansion in concrete compressive strength contrasted with Normal concrete.

**Table 6: Compressive Strength of Concrete**

| Grade of concrete | Type of concrete | 28 Days (N/mm²) | 56 Days (N/mm²) | 90 Days (N/mm²) |
|-------------------|-----------------|-----------------|-----------------|-----------------|
| M 30              | NC30            | 39              | 42              | 47              |
|                   | NA30            | 46              | 53              | 59              |
| M 40              | NC40            | 48              | 51              | 56              |
|                   | NA40            | 55              | 60              | 67              |
| M 50              | NC50            | 58              | 61              | 69              |
|                   | NA50            | 66              | 70              | 75              |

**Figure 3: Compressive strength**
The importance of above test results obtained from the average of three samples as represented in figure 3 the results displays that the samples containing Nano particles shows an expansion in compressive strength when contrasted and the Normal concrete. The results outcomes shows that the concrete altered by Nano Alumina of 1% respectively of 18%, 26%, 26% & 15%, 18%, 15% and 14%, 20%, 10% are improved in compressive strength with that of Normal cement for 28, 56 and 90 days for various grades like M30, M40 and M50. The upgrade of compressive strength of concrete can be primarily because of that Nano particles go about as a cores in advancing the concrete hydration and topping of pores to augment in the compressive strength of concrete. The impact of Nano Alumina particle in concrete improves the low early age compressive strength in concrete.

5.3 SPLIT TENSILE STRENGTH

The split tensile strength test was performed by the codal arrangement i.e IS 516:1959 on cylindrical specimens of 150 mm diameter and length of 300 mm for 28, 56 and 90 days of curing water. The Nano particle and other pozzolanic material mixtures are shows preferable results over the traditional concrete. The test results of split tensile strength are exhibits in table 7 which was average of three casted samples. The results shows that the casted specimens containing Nano particles shows an increase in split tensile strength compared to traditional concrete.

| Grade of concrete | Type of concrete | 28 Days (N/mm²) | 56 Days (N/mm²) | 90 Days (N/mm²) |
|-------------------|-----------------|-----------------|-----------------|-----------------|
| M 30              | NC30            | 3.28            | 3.96            | 4.13            |
|                   | NA30            | 4.2             | 4.5             | 4.78            |
| M 40              | NC40            | 3.65            | 4.06            | 4.2             |
|                   | NA40            | 4.4             | 4.78            | 5               |
| M 50              | NC50            | 4.62            | 4.8             | 4.9             |
|                   | NA50            | 5.0             | 5.3             | 5.5             |

Table 7: Split Tensile Strength of Concrete
The above test results of split tensile strength obtained from the above average of three samples represented as shown in figure 4 the results represents that the specimens incorporated Nano particles shows an increase in strength when compared with the Normal concrete. The results exhibits that the concrete replaced by Nano Alumina of 1% respectively of 30%, 14%, 16% & 21%, 18%, 19% and 8%, 10%, 12% enhanced in indirect tensile strength with that of traditional concrete for 28, 56 and 90 days for different grades like M30, M40 and M50. The enhancement of split tensile strength of concrete can be due to that Nano particles incorporated in concrete which could be more C-S-H gel formation in the presence of Nano particle in concrete and the denser packing of material at their interfacial transition zone.

5.4 FLEXURAL STRENGTH

Based on the obtained results of Flexural strength was performed by the IS codal provisions i.e IS 516:1959 on casted specimens of prisms of size 100mm X 100mm X 500 mm for 28, 56 and 90 days of curing. The test results are shown in table 8 which was average of three casted samples. The results obtained showed that the casted specimens incorporating of Nano particles showed an increase in concrete flexural strength compared to traditional concrete. The Nano particles and other mineral admixtures mixes shows very preferable outcomes results over the normal concrete. The results showed that the specimens containing Nano particles showed an increase in concrete flexural strength compared to Normal concrete.

Table 8: Flexural Strength Results

| Grade of concrete | Type of concrete | 28 Days (N/mm²) | 56 Days (N/mm²) | 90 Days (N/mm²) |
|-------------------|-----------------|-----------------|-----------------|-----------------|
| M 30              | NC30            | 3.76            | 4.8             | 4.97            |
|                   | NA30            | 4.61            | 5.07            | 5.6             |
|                   | NC40            | 4.12            | 5.22            | 5.3             |
The above test results obtained of flexural strength of concrete obtained from the average of three casted samples as shown in figure 5 the results obtained shows that the specimens incorporated Nano particles shows an increase in the flexural strength of concrete when compared with the traditional concrete. The test results shows that the concrete replaced by Nano Alumina of 1% respectively of 23%, 5.6%, 13%, & 23%, 4%, 5% and 6%, 6.3%, 4% enhanced in flexural strength with that of traditional concrete for 28, 56 and 90 days for different grades like M30, M40 and M50. The enhancement of flexural strength of concrete can be mainly due to that Nano particles induced in concrete in promoting the cement hydration and filling up of pores to increase the flexural strength of concrete.

**5.5 CYLINDER COMPRESSIVE STRENGTH**

The cylinder compressive test was performed by the IS codal arrangements i.e IS 516:1959 on samples of diameter 150 mm and length of 300m mm for 28, 56 and 90 days of curing. The test consequences of cylinder compressive strength are appeared in table 9 which was normal of three casted samples. The result outcomes indicated that the samples containing Nano particles demonstrated an expansion in concrete cylinder compressive strength contrasted with traditional concrete.
Table 9: Cylinder Compressive Strength of Concrete

| Grade of concrete | Type of concrete | 28 Days (N/mm²) | 56 Days (N/mm²) | 90 Days (N/mm²) |
|-------------------|------------------|----------------|----------------|----------------|
| M 30              | NC30             | 27             | 34             | 39             |
|                   | NA30             | 38             | 45             | 53             |
| M 40              | NC40             | 36             | 41             | 46             |
|                   | NA40             | 45             | 52             | 56             |
| M 50              | NC50             | 46             | 50             | 57             |
|                   | NA50             | 53             | 60             | 63             |

Figure 6: Cylinder Compressive strength

The importance of above test results obtained from the average of three casted samples as represented in figure 6 the results displays that the samples containing Nano particles shows an expansion in cylinder compressive strength when contrasted and the Normal concrete. The outcomes shows that the concrete altered by Nano Alumina of 1% respectively of 41%, 32%, 36% & 25%, 27%, 27% and 15%, 22%, 11% are improved in cylinder compressive strength with that of Normal concrete for 28, 56 and 90 days for various grades like M30, M40 and M50. The upgrade of cylinder compressive strength of concrete can be primarily because of that Nano particles go about as a cores in advancing the concrete hydration and topping off of pores to augment in the cylinder compressive
strength of concrete. The impact of Nano Alumina particle in concrete improves the low early age compressive strength in concrete.

**5.6 NON DESTRUCTIVE TESTS**

**5.6.1 Ultra Sonic Pulse Velocity**

The ultra sonic pulse velocity test criterion for concrete quality grading based on IS 13311:Part 1. The Nano alumina concrete has high velocity compared to Normal concrete. This is due to the contribution of Nano alumina due to dense packing the ultrasonic pulse pass through the cube with high velocity. The Nano material in concrete results in less porous and impermeable concrete. The estimated strength may vary from the actual strength by +/- 20 percent.

**Table 10:** Velocity ranges for concrete quality grading from IS 13311: Part 1.

| S.no | Pulse Velocity (Km/sec) | Concrete Quality Grade |
|------|------------------------|------------------------|
| 1.   | Above 4.5              | Excellent              |
| 2.   | 3.5 – 4.5              | Good                   |
| 3.   | 3.0 – 3.5              | Medium                 |
| 4.   | Below 3.0              | Doubtful               |

**5.6.2 Rebound Hammer Test**

The rebound hammer test is conducted by IS 13311:Part 2 on concrete hardened surface. When the rebound hammer plunger is pressed against the concrete surface the spring controlled mass rebounds such rebounds depends upon concrete surface hardness. The surface hardness and therefore rebound is considered here to be related to compressive strength of concrete. The rebound is read off along a graduated scale and is designated as the rebound number or rebound index. The strength of the concrete by rebound hammer is varying by +/- 25% with respect to actual strength of concrete.

**Table 11:** Ultra Sonic Pulse Velocity Test and Rebound Hammer Test at 90 Days

| Grade of concrete | Type of concrete | UPV (90 Days) | Rebound Number(90 Days) | Compressive Strength (N/mm²) |
|-------------------|-----------------|---------------|-------------------------|------------------------------|
|                   |                 | Velocity (km/s) | Quality               | Compressive Strength (N/mm²) | Rebound No | Compressive Strength (N/mm²) |
| M 30              | NC30            | 3.7           | Good                   | 55                           | 41         | 44                           |
|                   | NA30            | 4.6           | Excellent              | 71                           | 44         | 51                           |
The test results of Rebound number and ultra-sonic pulse velocity obtained from table 11 shows that the quality of Nano Alumina concrete is increases compared to traditional concrete. The quality of Nano Alumina concrete is above 4.0 km/sec and the quality of Normal concrete is below 4.0 km/sec due to dense particle packing done by the influence of Nano Alumina particle in concrete which have
huge surface area to volume ratio. The results derived from the rebound number of Nano Alumina concrete is more compared to Normal concrete due to more surface hardness due to the influence of Nano Alumina in mixes of concrete which improves more compactness.

5.7 WATER ABSORPTION

Water absorption test was done according to ASTM C 642-06 on sample of size 100 mm X 100 mm following 90 days of curing water. The test results are shown in table 12 and based on the test results evident that NA has greater reduction in water permeation amongst addition of individual Nano particle due to lesser size of particles in effective filling of gel pores present in the concrete specimen.

Table 12: Water Absorption Test at 90 Days

| Grade of concrete | Type of concrete | Water Absorption (%) |
|-------------------|------------------|----------------------|
| M 30              | NC30             | 2.2                  |
|                   | NAC30            | 1.6                  |
| M 40              | NC40             | 2                    |
|                   | NAC40            | 1.3                  |
| M 50              | NC50             | 1.8                  |
|                   | NAC50            | 1.1                  |

Figure 9: Water absorption test results at 90 days
The above test results obtained from the figure 9 represents in a graphically manner such that the influence of Nano particle in concrete reduces the water permeation amongst the addition of Nano particle in concrete. This is mainly due to the lesser size of particles less than 20 Nm in effective occupying of the voids and the gel pores present in the concrete specimen. From the test result obtained the values are 27%, 35% and 39% of water absorption is decreased compared to Normal concrete due to the reason filling of pores at Nano scale and densification results in reduction of permeable pores present in the concrete specimen at 90 days.

6. CONCLUSIONS

The following observations and conclusions are made on the basis of the experiments conducted on the normal concrete and Nano alumina concrete specimens are:

1. The compressive strength of Nano replaced concrete by 1% and 15% met kaolin is found to be increased to a maximum values of 18%, 26%, 26% & 15%, 18%, 15% and 14%, 20%, 10% with the partial substitution of Nano alumina with respect to traditional concrete specimen at 28, 56 and 90 days for M30, M40 and M50.

2. The split tensile strength of Nano replaced concrete by 1% and 15% met kaolin is found to be increased to a maximum values of 30%, 14%, 16% & 21%, 18%, 19% and 8%, 10%, 12% with the partial substitution of Nano alumina with respect to Normal concrete specimen at 28, 56 and 90 days for M30, M40 and M50.

3. The flexural strength of Nano replaced concrete by 1% and 15% met kaolin is found to be increased to a maximum values of 23%, 56%, 13% & 23%, 4%, 5% and 6%, 6.3% ,4% with the partial substitution of Nano alumina with respect to Normal concrete specimen at 28, 56 and 90 days for M30, M40 and M50.

4. The cylinder compressive strength of Nano replaced concrete by 1% and 15% met kaolin is found to be increased to a maximum values of 41%, 32%, 36% & 25%, 27%, 27% and 15%, 22%, 11% with the partial substitution of Nano alumina with respect to Normal concrete specimen at 28, 56 and 90 days for M30, M40 and M50.

5. The water absorption of Nano replaced concrete by 1% and 15% met kaolin is found to be decreased to a value of 27%, 35% and 39% with the partial substitution of Nano alumina with respect to Traditional concrete specimen at 90 days for M30, M40 and M50.

6. The influence of Nano particle by 1% and 15% met kaolin was enhanced in improvement of concrete which could be because of high explicit zone of 20 Nm size of particle. The utilization of Nano Alumina in cement improves the early age advancement of concrete strength.

7. The partial substitution of Nano particle by 1% and 15% met kaolin in concrete exhibits high velocity which is very excellent compared to Normal concrete. The setting time of concrete is decreased by the contribution of Nano particle in concrete and also it modify the structure of ITZ between cement paste and aggregate.

8. Based on the above preliminary mixes the increase of Nano particle in concrete decreases the workability and setting time of concrete is decreases. Nano particle decreases the water absorption of concrete and the Nano particles in cementitious systems is to improve the characteristics of the plastic nature and hardened concrete.

9. The contribution of metakaolin and Nano Alumina by 1% and 15% met kaolin will enhance in the improvement of the micro structure as well as reduce the free calcium hydroxide concentration by utilizing it through a pozzolanic reaction.

10. The modification of the micro structure of concrete by 1% and 15% met kaolin will improves the strength properties of the Nano particle concrete and increase the service life characteristics which will contributing to sustainable built environment.

11. The utilization of Nano particles by 1% and 15% met kaolin in concrete have overcome the deficiency of low early age compressive strength in concrete.
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