International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.10 No.11, pp 23-38, 2017

Eco Friendly Building Materials Used for High strength and high performance Concrete

A Jayaraman*, Karthiga Shenbagamn N, V Senthilkumar

Department of Civil Engineering Bannari Amman Institute of Technology, Sathamangalam-638401, India.

Abstract : Bottom ash and lateritic sand is an alternative for river sand. Due to fast growing construction industry, the demand for sand has increased tremendously, causing deficiency of suitable river sand in most part of the word. Due to the depletion of good quality river sand for the use of construction, the use of lateritic sand has been increased. Another reason for use of Bottom ash is its availability and waste product and low cost. Since this sand can be produced from power plants (NLC), it can be readily available at the nearby place, reducing the cost of transportation from far-off river sand bed. Hence the practice of replacing river sand with hydro sluiced bottom ash and lateritic is taking a tremendous growth. It is also inferred from the literature that replacement of normal sand with hydro sluiced bottom ash and lateritic sand produces no appreciable increase in compressive strength due to the variation in the pore size of concrete at micro level. This paper presents the optimization of partially replacement of hydro sluiced bottom ash and lateritic sand by natural sand with nano silica in high performance concrete. The ordinary Portland cement is partially replaced with nano-silica by 0.35 %, 0. 5 %, 0.75 % and natural sand is partially replaced with hydro sluiced bottom ash and lateritic sand. Samples of concrete (eg.cubes) are made in M25 grade. The studies reveal that the increase in percentage of partial replacement of nano silica increased the compressive, tensile and flexural strength of concrete. It was found that 0.55 water/cement ratio produced higher compressive strengths, tensile strength and better workability for partially replaced with nano-silica by 0.50 % mix, proportion. These results compare favourably with those of conventional concrete. By practice it shows that conventional mix has more strength than bottom ash sand and lateritic sand mix so we will be adding various % of nanosilica to the bottom ash mix and compare the values of compressive strength, corrosion resistance, tensile strength and economy in practice of conventional mix. Since we are replacing nanosilica with cement the strength increases and the porosity decreases as the nano materials fill the fine pores between the aggregates and the cement. The practicality for its usage in the marine environment, Nuclear power plants, Chemical Industry, etc are studied.
Key words : compressive strength, flexural strength, Hydro sluiced bottom ash, nano silica, tensile strength, lateritic sand.

1. Introduction

Laterite is a reddish weathering product of basalt. Atleast this is what it is in India where this rock or a soil type was first defined by a Scottish scientist Francis Buchanan-Hamilton in 1807. However, not all laterites are enriched in iron and sometimes they are not even reddish. Some lateritic rocks (bauxite) are mined because of their high aluminium content. Iron-rich variety is mostly used as a construction stone, especially in Asia. Laterite is a residual material. This is what is left of common silicate rocks if we remove much of silica, alkali, and alkaline earth metals. It is mostly composed of iron, aluminium, titanium, and manganese oxides because these are the least soluble components of the rocks undergoing a type of chemical weathering known as laterization or lateritization. These may be naturally occurring materials, industrial wastes or, by products or the ones requiring less energy to manufacture. Some of the commonly used SCM are fly ash, silica fume (SF), GGBS, rice husk ash and metakaolin (MK), etc. Metakaolin is obtained by the calcination of kaolinite. It is being used very commonly as pozzolanic material and has exhibited considerable influence in enhancing the mechanical and durability properties of concrete. M-sand is crushed aggregates produced from hard granite stone which is cubically shaped with grounded edges, washed and graded with consistency to be used as a substitute of river sand. Usage of M-Sand can overcome the defects occurring in concrete such as honey combing, segregation, voids, capillary, etc. In this project, experimental study was carried out on M-30 grade of concrete. In this concrete mixes sand was replaced by M-sand by a constant percentage and cement was replaced by metakolin in various percentages such as 5%, 10%, 15% and 20%. Concrete specimens containing metakaolin were studied for their compressive, split tensile and flexural strengths according to Bureau of Indian standards. The results thus obtained were compared and examined with respect to the control specimen. From the test results, it was found that 15% of the Ordinary Portland cement could be beneficially replaced with the metakaolin to improve compressive, split tensile and flexural strengths of concrete [1] .Use of hydro sluiced bottom ash and lime stone filler as fine aggregate study investigating the structural characteristics of concrete using various combinations of bottom ash sand and lime stone filler as complete replacement for conventional river sand fine aggregate. Specifically compressive and tensile strength ranged from 21.06 -35.2 N/mm2 and 10.06 -15.5 N/mm2 for the mixes considered. These results compare favourably with those of conventional concrete. The concrete was found to be suitable for use as structural members for buildings and structures, where bottom ash content did not exceed 50% [2] lime sludge of 10%, 20%, 30%, 40% and 50% by weight of cement was added as a partial replacement and strength, initial and final setting time, water absorption and soundness were evaluated. At 30% of replacement of cement the results obtained are same as that of Ordinary Portland Cement [3].The practical use of Bottom ash shows a great contribution to waste minimization as well as resources conservation. The workability of Bottom ash concrete reduces with the increase in bottom ash content due to the increase in water demand. The density of Bottom Ash concrete decreases with the increase in bottom ash content due to the low specific gravity of bottom ash as compared to fine aggregates. Compressive strength of sand replaced bottom ash concrete will be lower than normal concrete specimens at all the ages. Splitting Tensile strength of sand replaced bottom ash concrete will be lower than normal concrete specimens at all the ages. Flexural strength of fine aggregate replaced bottom ash concrete will be lesser than normal concrete specimens at all the ages. Effective splitting tensile strength can be achieved after 90 days compared to normal concrete. The strength difference between bottom ash concrete and normal concrete will become less distinct after 28 days. By replacing sand with bottom ash in the range of 30% to 50% bottom ash, at 90 days, attains a higher compressive strength and flexural strength compared to the strength of conventional concrete at 28 days. Water absorption is more Bottom Ash Concrete compared to conventional concrete. Strength characteristics of Bottom Ash Concrete can be improved by adding suitable fibers and incorporating other materials [4].The maximum compressive strength of mix proportion is 32.14 N/mm2, 34.85 N/mm2, 36.20 N/mm2 and 39.16 N/mm2 at 7 days, 14 days, 28 days and 56 days respectively at 40% replacement of bottom ash in concrete while the minimum compressive strength is found 23.56 N/mm2, 28.18N/mm2, 30.40 N/mm2 and 32.87 N/mm2 is at 7 days, 14 days, 28 days and 56 days respectively when no replacement of bottom ash in concrete. After 40% replacement of bottom ash in the concrete it is found that the compressive strength is decreasing. The maximum flexural strength of concrete is found 7.94 N/mm2,8.80 N/mm2, 9.04 N/mm2 and 9.24 N/mm2 at 7 days, 14 days, 28 days and 56 days respectively at 40% replacement of bottom ash in concrete while minimum flexural strength of concrete is found 2.20 N/mm2, 3.10 N/mm2, 3.40 N/mm2 and 4.27 N/mm2 is at 7 days, 14 days, 28 days and 56 days respectively when there is no replacement of bottom ash in concrete. After 40% replacement of bottom ash in the concrete it is found that the flexural strength is decreasing [5].The combinations obtained by replacing cement with 30% of textile sludge and fibre added at 0.75% and 1% yielded with 28 days compressive strength more than 30 Mpa and it can be used as paver blocks for non-traffic application such as building premises, monument premises, public gardens/parks, domestic drives, paths, embankment slopes, sand stabilization area etc [6] .Today a significant growth is observed in the manufacturing of composite materials. Intensively developed polymer composite materials (PCM) are used in different sectors of industry and technology. They are successfully replacing traditional construction materials and also permit the conditions that exclude use of metals. By industrial production of basalt fibers on the basis of new technologies their cost is equal and even less than cost of glass fiber, moreover basalt fibers and materials on their basis have the most preferable parameter, a ratio of quality and the price in comparison with glass &

carbon fibers, and other types of fibers. Though Basalt fiber has good wear resistance still increasing the wear resistance, decreasing friction coefficient, and increasing the hardness also gives more applications to basalt fiber like car brakes, interior decorations, car headliner, etc. more over increase in basalt fiber's tensile strength will give more applications to basalt fiber like bridges, underground tunnels, etc. From the results, it can be concluded that adding titanium oxide, silicon carbide and barium sulphate to the fiber matrix shows the increase in the above said properties, thus the above said mixture are added to the basalt fiber. The wear rate of specimen 1 is the highest among the specimens for 700rpm and it gradually increases and maintains the same wear rate at increasing the speed and load[7]. The compressive strength of hybrid fiber reinforced high strength concrete specimen (HYFRC), steel fiber reinforced high strength concrete (HSFRC) specimen was improved compare with that of high strength concrete specimen (HSC)[8]. Concrete is the material of choice where strength, performance, durability, impermeability, fire resistance and abrasion resistance are required. The hunger for the higher strength leads to other materials to achieve the desired results and thus emerged the contribution of cementitious material for the strength of concrete. Addition of pozzolonic admixture like the pulverized Fly ash (PFA)contributes to the improvement of strength and also by adding the Nano materials, concrete composites with superior properties can be produced.Nano Technology applied to concrete includes the use of Nano materials like Nanosilica, Nano fibers etc. The compressive strength of concrete had shown an increasing trend with the increase in the quantity of Nano-silica but the increment was stopped when the Nano-silica was beyond 3%. The percentage increase in compressive strength and split tensile strength of concrete with the Nanosilica at 3% is 14% more compared to control concrete. The increase in flexural strength is only 2% at 3% Nano-silica partially replacing concrete compared to control concrete. The strength of concrete has drastically decreased by 50% when the Nano-silica is at 4%. It has also been observed that for combination of 4% Nano-silica the strength is decreased as the dosage might have been crossed the optimum level. Therefore the optimum amount of Nano-Silica partially replacing cement is 3%. Nano-silica in high performance concrete cause to reduce in pores size and the concrete structures will be more dense and durable [9]. One of the most beneficial uses for silica fume is concrete. Due to its chemical and physical properties, it is a very reactive pozzolan. Concrete that contains silica fumes can have very high strength and be very durable [10].Nanotechnology has gained its place in mainframe drug delivery system particularly in enhancing bioavailability of poorly soluble drugs, achieving controlled release, and drug targeting. It has resulted in increased efficacy and safety as well as improved patient compliance[11]. A reddish brown lateritic soil was treated with up to 16% rice husk ash. Treated specimens were, compacted using standard proctor effort at different moulding water con-tents (2% dry of optimum, optimum moisture content and 2% wet of optimum) and subjected to one dimensional consolidation test; to assess their consolidation character-istics [12]. The user-friendly geo polymerization conditions applied to the system fly ash/slag/Na-silicate/H2O yielded geo polymer bodies resembling concrete product, acts as a binder cured at room temperature. Synthesized Geo polymer have shown excellent mechanical strength compared to that of ordinary Portland cement. Compressive strengths of Geo polymer mortar were found to increase with increase in activator concentration and decrease in activator-to-binder ratio The Geo polymer mortars made using GGBS as the starting material showed higher compressive strengths compared to those made with fly ash because of the self cementing property of GGBS and higher binder content used. Geo polymer mortars made using GGBS and fly ash had similar compressive strength when activated using higher concentration of the activator. At lower concentrations of the activator, GP concretes with GGBFS showed higher compressive strength of structural grade concretes of order starts from 30MPa - 60Mpa. Building blocks made of Geo polymer mix proportions having 25% FA & 75% GGBS with partial replacement of sand with quarry dust showed comparatively high compressive strength than that of ordinary Portland cementitious system[13]. The influence of Nano particles on mechanical properties and durability of concrete has been investigated. For this purpose, constant content of Nano-ZrO2 (NZ), Nano-Fe3O4 (NF), Nano TiO2 (NT) and Nano-SiO2 (NS) have been added to concrete mixtures. Results of this study seem to indicate that the Nano-SiO2 (NS) is most effective nano-particle of examined nano materials in improvement of mechanical properties of high performance concrete [14]. Replacement of cement with 0.75% of nano silica gives more strength than the bottom ash mix and also the durability has been increased compared to the bottom ash sand Mix. The self weight of the Nano mix is lighter than the bottom ash sand and the conventional mix. The workability decreases with the addition of Nano-Silica compared to the conventional mix and the bottom ash sand mix.The penetration level of chlorides and acids are less in Nano concrete compared to that of conventional and fully replacement of bottom ash sand [15] .The compressive strength and tensile strength of concrete using lateritic sand lime stone filler are measured in the laboratory. Compressive strength and tensile strength is found to increase with age as for normal concrete. The 28 – day compressive strength is found 21.06 -35.2 N/mm2 for different mixes. The above strength properties the proportion of 25% laterite to 75% lime stone filler produced higher values of compressive strength. For the same proportion of 25% laterite to 75% lime stone filler at 1:15:3 mix and 0.55 water cement ratio, a logarithmic model has been developed for predicting the compressive strength of concrete between 0 and 28 days [16]. Limestones are generally obtained from the calcareous remains of marine or fresh water organisms embedded in calcareous mud. They change from the soft chalks to hard crystalline rocks. The use of limestone as a concrete aggregate has sometimes been suspect on account of the unsuitability of the poorer grade rocks, and also because of a widespread fallacy that limestone concrete is less resistant to the action of fire than concrete made from other aggregates. Laterite stone is commonly used for the construction purpose. There are several laterite stone quarries in Konkan region. During excavation of laterite stone, around 25–30 per cent laterite stone scrap is generated. It is estimated that about 2.83 cum of the laterite stone scrap is generated during excavation of about 11.33 cum of the laterite stone. This laterite stone scrap creates problem in quarries and needs removal for further excavation. In order to add value to this waste material, it is felt necessary to manufacture the blocks using different constituents that are suitable for the construction. In this In this overview determine the Compressive strength, toughness index and water absorption capacity of the laterite stone scrap blocks[17]. The natural sand was replaced with coal bottom ash by0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, and 100% by weight, as water absorption of bottom ash was more so that quantity of water was increased to achieve 100 mm slump. The results shows that the compressive strength, split tensile strength and flexural strength decreased as the percentage of replacement coal bottom ash increased as compared to controlled concrete[18]. The advanced technology used to find the compressive strength artificial neural networks (ANN) a sub-field of intelligent systems, are widely employed to resolve a diversity of civil engineering problems. In the present paper, using data from literature ANN models (ANN-A, ANN-B & ANN-C) was modelled to predict the compressive strength of concrete, having different mixtures at different age of 1, 3, 7, 28, 56, 90 and 180 days [19]. By practice it shows that conventional mix has more strength than bottom ash and lateritic sand mix so we will be adding various % of nanosilica to the bottom ash and lateritic sand mix and compare the values of compressive strength, corrosion resistance, tensile strength and economy in practice between the conventional and the M sand with 0.75% nano silica mix. Since we are replacing nanosilica with cement the strength increases and the porosity decreases as the nano materials fill the fine pores between the aggregates and the cement. The practicality for its usage in the marine environment, Nuclear power plants, Chemical Industry, etc are studied.

II. Aim of the Study

Fully replacement of bottom ash sand & lateritic sand and nano silica by natural sand & cement .The study is mainly done to find the compression strength, corrosion resistance, tensile strength and economy in practice.

Iii .Experimental Investigation

3.1 Materials

Materials Used

3.1.1 Cement:

Ordinary Portland cement (OPC) 53 grade conforming to IS 8112 – 1989, and specific gravity of cement is found to be 3.15.The properties of cement given in Table 1.

Table 1 Properties of OPC Cement

Physical properties of cement	
Initial setting time(minutes)	53 mins
Final setting time(minutes)	257 mins
Standard consistency	31.0%
Fineness of cement	10%
Chemical properties of cement	
SiO2	20 - 21
Al2O3	5.3 - 5.6
Fe2O3	4.4 - 4.8
CaO	62 - 63
MgO	0.5 - 0.7

3.1.2 Fine aggregates:

Local clean river sand fineness modulus of medium sand equal to 2.49 conforming to grading zone of III of IS: 383-1970. The specific gravity of fine aggregate is 2.62. The specific gravity of fine aggregate given in table 2.

Table 2 Sieve analysis of fine aggregate.

IS sieve designation	Weight of retained on sieve (gm)	River sand % Passing	Requirement IS:383 - 1970
10mm	0	100	100
4.75 mm	16	98.4	90 - 100
2.36mm	82	90.2	85 - 100
1.18mm	150	75.2	75- 100
600nm	133	61.9	60- 100
300um	298	32.1	13 - 40
150um	257	6.2	0 - 10

3.1.3 Hydro Sluiced Bottom Ash:

Hydro Sluiced Bottom ash is replaced is fully replacement of river sand .It is collected from NLC India. The bulk density of bottom ash 1460 kg/m^2 and the specific gravity 2.71 and fineness modulus of bottom ash is 2.26.the maximum size of the aggregate is 4.75 mm. The testing of bottom ash is done as per Indian standard specifications IS: 383 – 1970. The properties of Bottom ash given in Table 3.and shown in figure .1

Figure 1.Hydro Sluiced Bottom Ash

Table 3 Chemical properties of Bottom Ash

Chemical ingredient	% by mass
SiO_2	79.65
Al_2O	14.71
Fe_2O	3.20
CaO	0.39
MgO	0.55
SO_3	0.70
Loss on ignition (LOI)	0.67

3.1.4 Course aggregates:

Locally available well graded aggregates of normal size greater than 4.75 mm and less than 16 mm having a fineness modulus of 2.72 was used as coarse aggregates. The aggregates are tested as per the procedure given in BIS: 238

3.1.5 Nano-silica:

The nano silica is partially replaced for cement. Steel Authority of India has provided necessary facilities to produce annually about 3000 tons of nano silica at their Bhadravathi Complex. In India, However, the nano silica of International quality is marketed by Elkem Metallury (P) Ltd. The properties of nano silica given in Table 4. and shown in Figure .2

Figure 2 .Nano Silica

Table 4 Properties of Nano – Silica

Physical properties of Nano - Silica	
Specific Surface Area	200 m2 / g to 300 m2 / g
Particle Size	≤ 1
Specific gravity	0.13 to 0.14
Chemical Composition of Nano – Silica	
Si O2	93.3
Al2 O3	0.49
Fe2 O3	0.32
Ca O	0.24
Mg O	0.44
K2 O	0.67
Na2 O	0.36

3.1.6 Lateritic sand:

Lateritic sand is partially replacement of river sand .It is collected from BAG Groups Coimbatore, India. The bulk density of lateritic sand 1460 kg/m^2 and the specific gravity 2.56 and fineness modulus of rive Sand is 2.76.The properties of lateritic sand given in Table 5. and shown in figure .3

Figure 3 . Lateritic sand

Table 5 Properties of lateritic sand

Physical properties of Lateritic sand	
Liquid limit	28.76%
Plastic limit	13.4
Plasticity index	14
Moisture content	13.22%
Sieve analysis	0.53 mm to 4.2mm

Iv. Experimental Procedure

The mix ratio is prepared for M25 grade concrete for both conventional concrete and Bottom ash & lateritic Sand mix concrete. The Cube size of (150 x 150 x 150) mm Specimen is prepared for compressive strength. The cylinder of height 30 cm and 15 cm diameter is prepared for tensile strength. The specimens are tested for 3 days, 7 days, 14 days and 28 days with each proportion of Nano silica, bottom ash and lateritic sand mix. Totally there are 60 cubes and 60 cylinders are casted. The specimen size of (70x10x10) cm is used for flexural strength test, for durability test mortar specimen is prepared in a mix ratio of 1:3, the cube size of (50 x50 x 50) mm is prepared for water absorption test, acid penetration test and for RCPT a concrete disc of size 85 mm diameters and 50 mm thickness. The specimen is tested 28 days totally for 30 cubs and 15 cylinders. All the specimens are demoulded after 24 hours, and curing is done in water for 7 days, 14 days and 28 days.

V. Result and Discussion

5.1. Compressive strength of concrete.

The test is carried out conforming to IS 516 -1959 to obtain compressive strength of concrete at the 3 days, 7days, 14 days and 28 days. The cubes are tested using 1400 tonne capacity HELICO compressive testing machine (CTM).The results are presented in Figure.4 and table.6

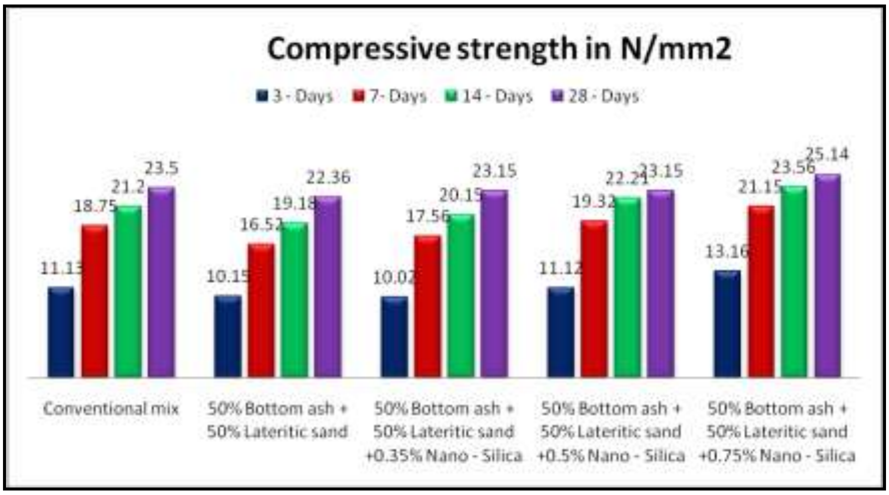

Figure 4.Compressive strength of concrete

Table 6 Compressive strength of concrete

S. No	Type of mix	3 Days Strength N /mm^2	7 Days Strength N /mm^2	14 Days Strength N /mm^2	28 Days Strength N/mm^2
1	Conventional mix	11.13	18.75	21.20	23.50
2	50% Bottom ash + 50 % lateritic Sand Mix	10.15	16.52	19.18	22.36
3	50% Bottom ash + 50 % lateritic Sand +0.35 % Nano silica	10.02	17.56	20.15	23.15
4	50% Bottom ash + 50 % lateritic Sand + 0.5 % Nano silica	11.12	19.32	22.21	23.15
5	50% Bottom ash + 50 % lateritic Sand +0.75 % Nano silica	13.16	21.15	23.56	25.14

3 - Days compressive strength of concrete.

The 3 days compressive strength of 50 % of bottom ash 50% lateritic sand concrete is 10.2 and 30.12 % of compressive strength is reduced when compared to the normal river sand and 50 % of bottom ash & 50% lateritic sand with 0.75% nano silica concrete. The compressive strength of conventional concrete and fully replacement of sand with 0.5% of Nano silica concrete is more or less same. The results are presented in Figure.5

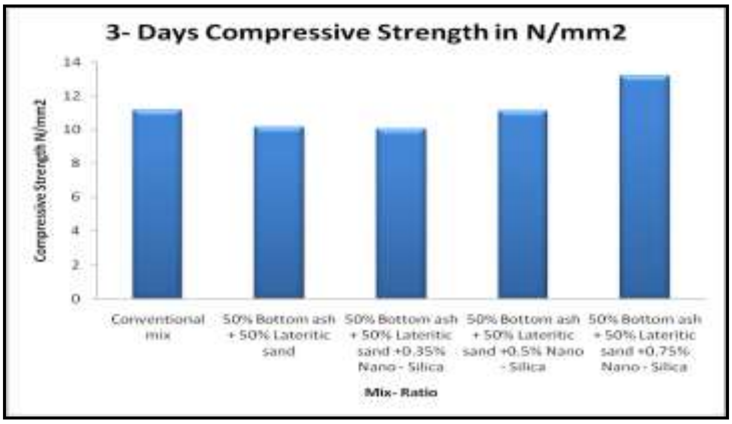

Figure 5. 3 Days Compressive strength of concrete

7 - Days compressive strength of concrete.

The 7 days compressive strength of 50 % of bottom ash 50% lateritic sand concrete is 13.5 and 28 % of compressive strength is reduced when compared to the conventional concrete and fully replacement of river sand with 0.75% nano silica concrete. The compressive strength of conventional concrete fully replacement of sand with 0.5% of Nano silica concrete and fully replacement of river sand concrete & fully replacement river sand with 0.35 % of Nano silica concrete is more or less same. The results are presented in Figure.6

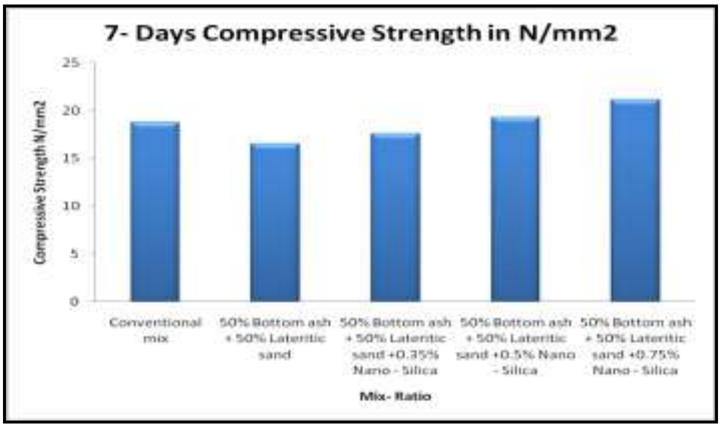

Figure 6.7 Days Compressive strength of concrete

14 - Days compressive strength of concrete.

The 14 days compressive strength of 50 % of bottom ash 50% lateritic sand concrete is9.52% , 13.5% and 22.83 % of compressive strength is reduced when compared to the conventional concrete , fully replacement of river sand with 0.5% nano silica concrete and fully replacement of river sand with 0.7 5% of nano silica concrete. The compressive strength of conventional concrete fully replacement of sand with 0.35% of Nano silica concrete is more or less same. The results are presented in Figure.7

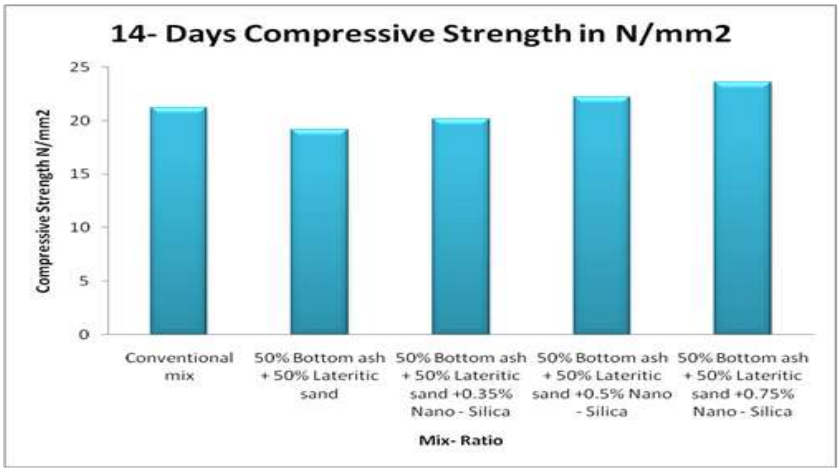

Figure 7. 14 Days Compressive strength of concrete

28 - Days compressive strength of concrete.

The 28 days compressive strength of 50 % of bottom ash 50% lateritic sand concrete is 5% and 12 % of compressive strength is reduced when compared to the normal river sand and 50 % of bottom ash & 50% lateritic sand with 0.75% nano silica concrete. The compressive strength of normal river sand fully replacement of sand with 0.5% of Nano silica concrete & fully replacement of sand with 0.35% of Nano silica concrete is more or less same. The results are presented in Figure.8

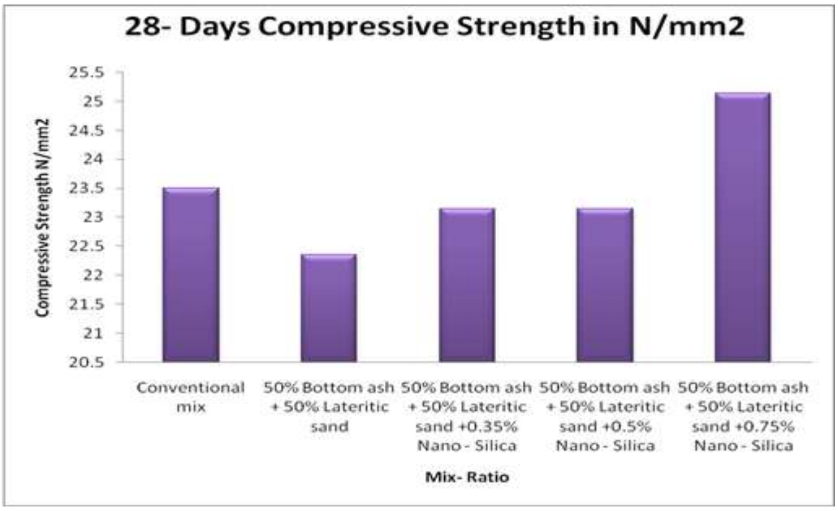

Figure 8. 28 Days Compressive strength of concrete

5.2. Tensile strength of concrete

The test is carried out conforming to IS 516 -1959 to obtain tensile strength of concrete at the 3 days,7 days, 14 days and 28 days. The cylinders are tested using 1400 tonne capacity HELICO compressive testing machine (CTM).The results are presented in Fig.9.table.7

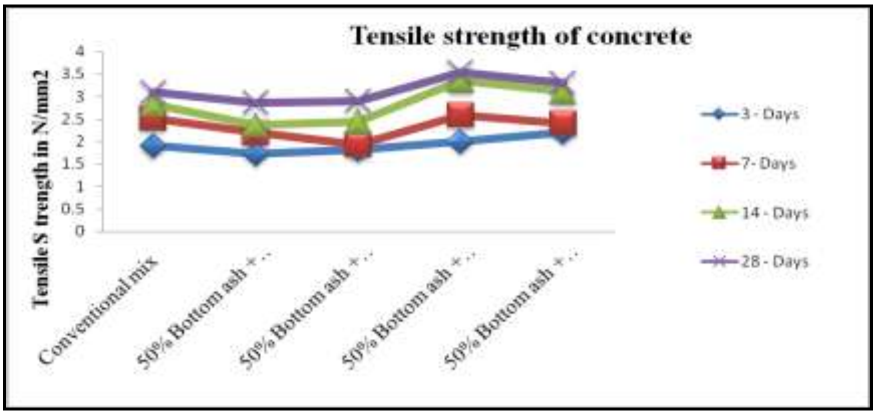

Figure 9 .Tensile strength of concrete

Table 7 Tensile strength of concrete

S. No	Type of mix	3 Days Strength N /mm^2	7Days Strength N /mm^2	14 Days Strength N /mm^2	28 Days Strength N/mm^2
1	Conventional mix	1.90	2.52	2.82	3.1
2	50% Bottom ash + 50 % lateritic Sand Mix	1.72	2.19	2.36	2.87
3	50% Bottom ash + 50 % lateritic Sand +0.35 % Nano silica	1.82	1.92	2.43	2.91
4	50% Bottom ash + 50 % lateritic Sand + 0.5 % Nano silica	2.00	2.59	3.36	3.55
5	50% Bottom ash + 50 % lateritic Sand +0.75 % Nano silica	2.21	2.41	3.11	3.31

3 - Days tensile strength of concrete.

The 3 days tensile strength of 50 % of bottom ash 50% lateritic sand concrete is 10.40 and 28.40 % of tensile strength is reduced when compared to the normal river sand and fully replacement of river sand with 0.75% nano silica concrete. The tensile strength of conventional concrete and fully replacement of sand with 0.5% of Nano silica concrete is more or less same. The results are presented in Fig.10

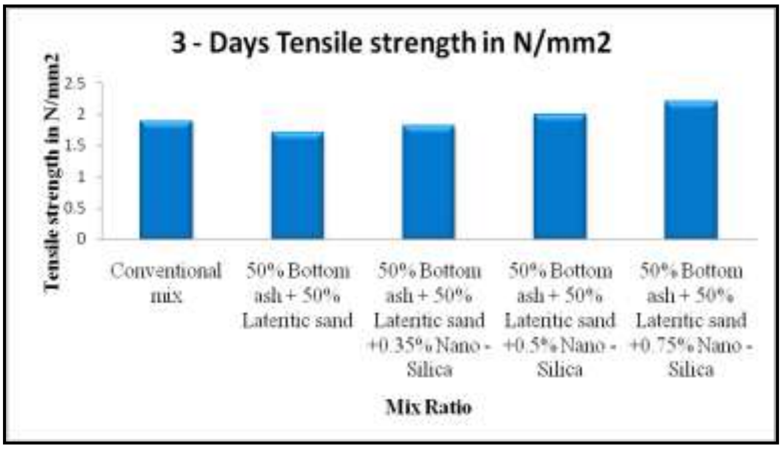

Figure 10. 3 days Tensile strength of concrete

7 – Days tensile strength of concrete.

The 7 days tensile strength of 50 % of bottom ash 50% lateritic sand concrete is 15.60 and 22.169 % of tensile strength is reduced when compared to the conventional concrete and fully replacement of river sand with 0.5% nano silica concrete. The tensile strength of conventional concrete and fully replacement of sand with 0.75% of Nano silica concrete is more or less same and fully replacement of sand with 0.35% of Nano silica concrete is 31.25 % of tensile strength reduced when compared to the conventional concrete. The results are presented in Fig.11

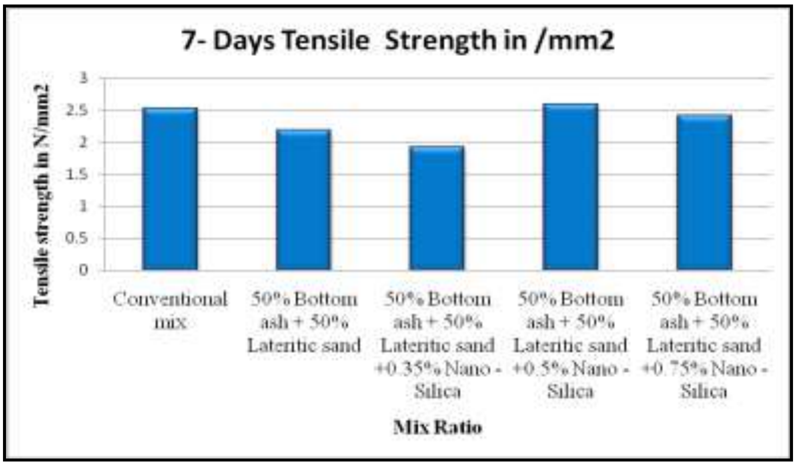

Figure 11. 7 days Tensile strength of concrete

14 - Days tensile strength of concrete.

The 14 days tensile strength of 50 % of bottom ash 50% lateritic sand concrete is 19.49 , 42.37 and 31.77 % of tensile strength is reduced when compared to the normal river sand , fully replacement of river sand with 0.5% nano silica concrete and fully replacement of river sand with 0.75% nano silica concrete . The tensile strength of conventional concrete and fully replacement of sand with 0.35% of Nano silica concrete is more or less same. The results are presented in Fig.12

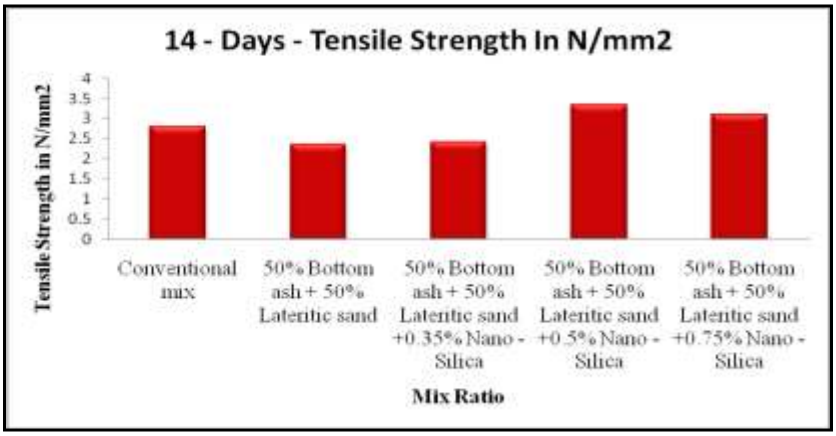

Figure 12. 14 days Tensile strength of concrete

28 - Days tensile strength of concrete.

The 28 days tensile strength of 50 % of bottom ash 50% lateritic sand concrete is 8.01 , 23.69 and 15.33 % of tensile strength is reduced when compared to the normal river sand , fully replacement of river sand with 0.5% nano silica concrete and fully replacement of river sand with 0.75% nano silica concrete . The tensile strength of conventional concrete and fully replacement of sand with 0.35% of Nano silica concrete is more or less same. The results are presented in Fig.13

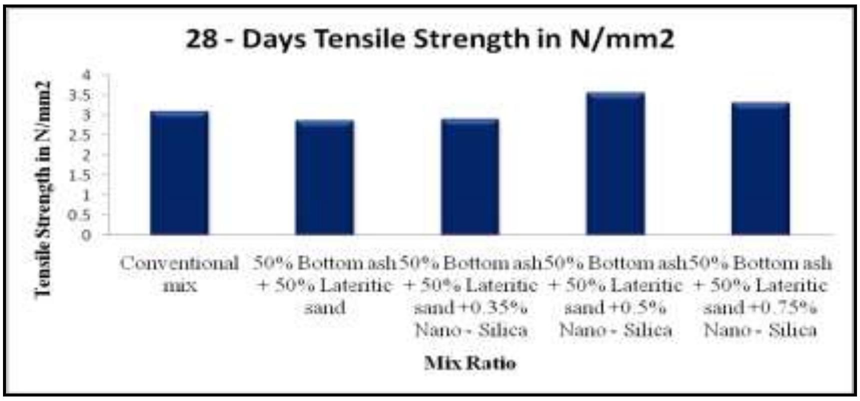

Figure 13. 28 days Tensile strength of concrete

5.3. Flexural Strength of concrete

The test is carried out conforming to IS 516 -1959 to obtain flexural strength of concrete at the 7days, 14 days and 28 days are tested using loading frame 750 kN. The results are presented in Fig.14

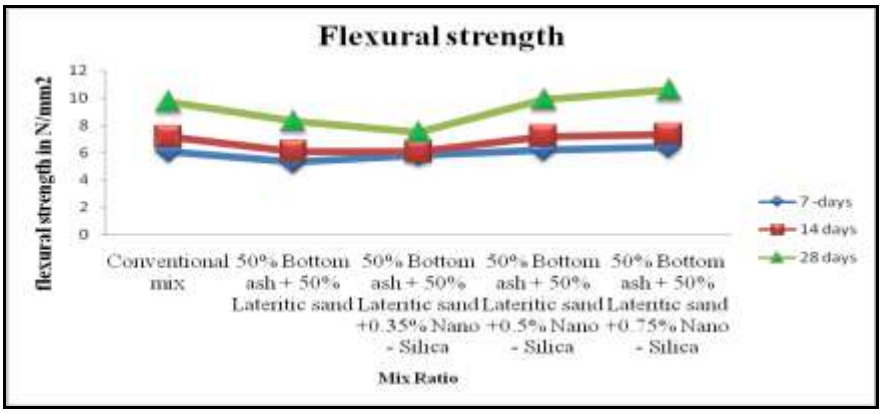

Figure 14. Flexural strength of concrete

The 28 days flexural strength of bottom ash with 0.75% nano silica concrete are found to be 7.9 % more than the conventional concrete and fully replacement of bottom ash and lateritic sand concrete, fully replacement of river sand with 0.35% nano silica concrete and fully replacement of river sand with 0.5% nano silica concrete found to be 17.29%, 26.98 % and 8.69 % of flexural strength is reduced when compared to the fully replacement of river sand with 0.75% nano silica concrete. Results of this test are show in table .8.

Table 8 Flexural strength of concrete

S. No	Type of mix	7Days Strength N /mm2	14 Days Strength N /mm2	28 Days Strength N/mm2
1	Conventional mix	6.12	7.19	9.72
2	50% Bottom ash + 50 % lateritic Sand Mix	5.311	6.11	8. 32
3	50% Bottom ash + 50 % lateritic Sand +0.35 % Nano silica	5.82	6.10	7.51
4	50% Bottom ash + 50 % lateritic Sand + 0.5 % Nano silica	6.21	7.21	9.91
5	50% Bottom ash + 50 % lateritic Sand +0.75 % Nano silica	6.43	7.35	10.61

5.4. Water absorption test

This test is done as per procedure given in ASTM C 642-97 by oven-drying method. The results are presented in Fig.15. For this test 50mm x 50mm x 50mm cubes are cast. After 24 hours of remolding, the specimens are kept immersed in water. At the end of 28 days, the specimens are taken from the curing tank and air-dried to remove the surface moisture then taken the initial weight (W1) is taken. The final weight (W2) is taken to the specimens are dried in an oven at a temperature of 100+10^{o} C for 48 hrs, and allowed to cool at room temperature.

The 28 days water absorption fully replacement of river sand with 0.75% nano silica concrete are found to be 49.55 %, 62.65% , 48.96% ,and 29.78% of water absorption is reduced when compared to the conventional concrete, fully replacement of river sand , fully replacement of river sand with 0.35% nano silica concrete and replacement of river sand with 0.5% nano silica concrete. Fully replacement of river sand with 0.75% nano silica concrete is best impermeability of concrete compare to other mix ratio. Nano silica is the good durability of concrete. Results of this test are show in table .9.

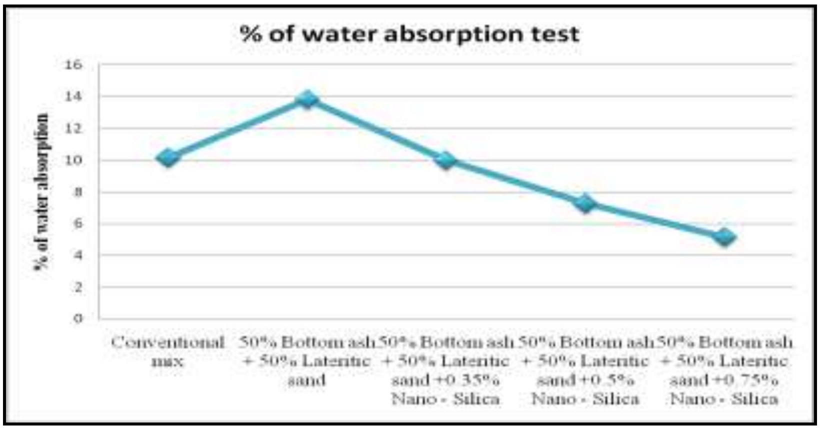

Figure 15. % of water absorption test

Table 9 % Water absorption test

S.No	Type of mix	%Water absorption test
1	Conventional mix	10.15
2	50% Bottom ash + 50 % lateritic Sand Mix	13.79
3	50% Bottom ash + 50 % lateritic Sand +0.35 % Nano silica	9.98
4	50% Bottom ash + 50 % lateritic Sand + 0.5 % Nano silica	7.25
5	50% Bottom ash + 50 % lateritic Sand +0.75 % Nano silica	5.12

% of Water absorption

% of water absorption = [(W2 – W1)/W1] x 100
Where,
W1 = weight of oven dried sample in air.
W2 = weight of surface dry sample in air after immersion in water.

5.5. Acid penetration test

This test is done as per procedure given in ASTM C 642-97 by oven-drying method. The results are presented in Fig.16. For this test 50mm x 50mm x 50mm cubes are cast. After 24 hours of remolding, the specimens are taken the initial weight (W1) after kept immersed in HCL (pickling solution). At the end of 28 days, the specimens are taken the finial weight (W2) is taken. The 28 days acid penetration of fully replacement of river sand with 0.5% nano silica concrete is high resistance in permeability and high durability of concrete compare to the other mix ratio. Results of this test are show in table .10

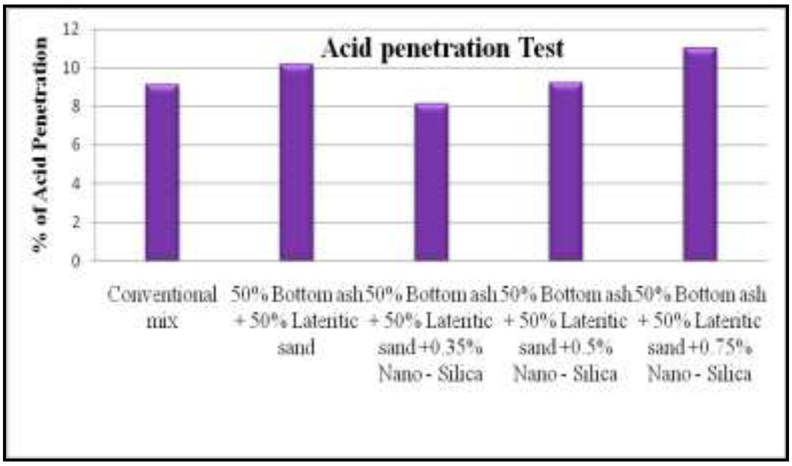

Figure 17. Acid penetration test

Table 10 Acid penetration test

S.No	Type of mix	% Acid penetration test
1	Conventional mix	9.13
2	50% Bottom ash + 50 % lateritic Sand Mix	10.15
3	50% Bottom ash + 50 % lateritic Sand +0.35 % Nano silica	8.15
4	50% Bottom ash + 50 % lateritic Sand + 0.5 % Nano silica	9.23
5	50% Bottom ash + 50 % lateritic Sand +0.75 % Nano silica	11

5.6. Rapid chloride penetration test

This test is conducted as per ASTM C1202-09. The results are presented in Fig.17. Concrete disc of size 85 mm diameters and 50 mm thickness average value of three samples. The specimens are carried at different stages, allowed to cure for 28 days and then they are subjected to RCPT test by impressing a voltage of 60v. The permeability of fully replacement of bottom ash mix is very high when compared to the bottom ash with 0.75% nano silica concrete and conventional mix. Fully replacement of river sand with 0.75% nano silica concrete is to found 30. 47% ,43.89% ,34.25% and 24.05 % found to be to less than conventional concrete, fully replacement of river sand , fully replacement of river sand with 0.35% nano silica concrete and fully replacement of river sand with 0.5% nano silica concrete There is a significant improvement in the durability of concrete because of high pozzolanic nature of the nano-silica and its void filling ability. The RCPT values show in table 11.

The columbs value ≥ 4000 the Chloride Ion high. In between 2000 – 4000 the Chloride Ion moderate,1000 –2000 the Chloride Ion low, In between 100 – 1000 the Chloride Ion very low and ≤ 100 negligible.

The constituents are weighted and the material is mixed by hand mixing. The mixes are compacted using table vibration. The water binder ratio (W/B) adopted is 0.375 concrete and mortar. The specimens are demoulded after 24h, cured in water for 7, 14 and 28 days and then tested for its compressive, tensile and durability test as per indian standards. There is a significant improvement in the strength of concrete because of high pozzolanic nature of the nano silica and its void filling ability.

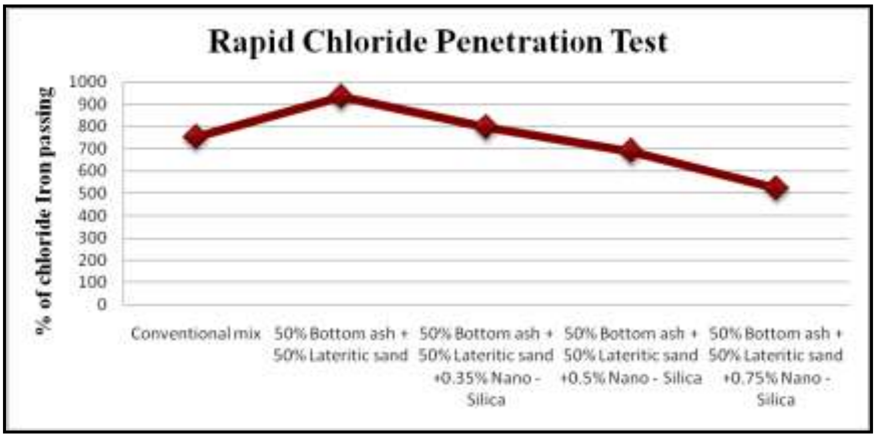

Figure 18. Rapid chloride penetration test

Table 11 Rapid chloride penetration test

S.No	Type of mix	% Chloride Ion passing
1	Conventional mix	752.10
2	50% Bottom ash + 50 % lateritic Sand Mix	931.86
3	50% Bottom ash + 50 % lateritic Sand +0.35 % Nano silica	795.28
4	50% Bottom ash + 50 % lateritic Sand + 0.5 % Nano silica	688.25
5	50% Bottom ash + 50 % lateritic Sand +0.75 % Nano silica	522.86

Vi. Conclusion

Addition of nano-Silica leads to a significance increase in the characteristic strength and durability of concrete. Replacement of cement with 0.75% of nanosilica gives more strength than the bottom ash mix and also the durability has been increased compared to the bottom ash lateritic sand Mix and conventional concrete mix. The self weight of the Nano mix is lighter than the bottom ash sand and the conventional mix. The workability decreases with the addition of Nano-Silica compared to the conventional mix and the bottom ash sand mix.The penetration level of chlorides and acids are less in Nano concrete compared to that of conventional and fully replacement of bottom ash and lateritic sand.

References

1. P. Jaishankar and Vayugundlachenchu Eswara Rao; Experimental study on Strength Of Concrete by using Metakaolin and M-Sand; International Journal of ChemTech Research; 2016, Vol.9, No.05, pp 446-452.
2. A Jayaraman, V Senthilkumar, M Saravanan; Experimental Study on Fully Replacement of River Sand by Bottom Ash and Lime Stone Filler; International Journal of ChemTech Research ; 2016, Vol.9, No.05, pp 870-886.
3. A.K.Priya, M.Nithya, M.Rajeswari, P.M.Priyanka, R.Vanitha;Experimental Investigationon Developing Low Cost Concrete by Partial Replacement of Waste Sludge; International Journal of ChemTech Research; 2016,Vol.9,No.01 pp 240-247.
4. Vikas R Nadig (etal) ; Bottom Ash as Partial Sand Replacement in Concrete; IOSR Journal of Mechanical and Civil Engineering(IOSR-JMCE);2015, Vo 12,PP148-151.

5. Dilip Kumar; Uses of Bottom ash in the Replacement of fine aggregate for Making Concrete; International Journal of Current Engineering and Technology; 2015,E-ISSN 2277 – 4106, P-ISSN 2347 - 5161.
6. Sudheesh.C ,T.R.Praveen Kumar, Sasi Kumar.S; Effect of Compressive Strength on Concrete by Partial Replacement of Cement with Textile Sludge and Polypropylene Fibres; International Journal of ChemTech Research; 2015, Vol.8, No.4, pp 2219-2226.
7. T. Narendiranath Babu; Microstructure Observation and Analysis on Hybrid Composite of Basalt Fiber with Titanium Oxide, Barium Sulphate and Silicon Carbide; International Journal of ChemTech Research;2016, Vol.9,No.05 pp371-382.
8. A. Annadurai , A. Ravichandran; Strength Prediction of Hybrid Fiber Reinforced High Strength Concrete ; International Journal of ChemTech Research;2015, Vol.8, No.12 ,pp 675-681.
9. P. Jaishankar, B. Muthu siva chandru, P. Verparasan, A. Vigneshwaran;Effect of Nano-silica additions on Mechanical and Microstructure analysis of High Performance Concrete; International Journal of ChemTech Research; 2016, Vol.9, No.05 pp 453-461.
10. Mohamed. A. Saad;Comparison between Polyester and Fiber Glass as Filter Media to Collect Silica Fumes: Case Study; International Journal of ChemTech Research; 2016 ,Vol.9, No.05 pp 185 -192.
11. Sarmistha Saha , Ravada Ramesh;Nanotechnology for Controlled Drug Delivery System; International Journal of PharmTech Research; 2015, Vol.7, No.4, pp 616-628.
12. Abdulhameed Umar Abubakar , Khairul Salleh Baharudin ;Properties of Concrete using tanjung bin power Plant coal bottom ash and fly ash; International Journal of Sustainable Construction Engineering & Technology;2012, Vol 3,Issu 2, pp 616-628.
13. Jeyalakshmi R. Dhinesh.M., Baskar Sundara Raj, Rajamane N.P.;Geopolymer Portlandcement Free Binder System From Industrial Wastes; International Journal of ChemTech Research;2015,Vol.7, No.7, pp 2846-2854.
14. P. Jaishankar1 and K. Saravana Raja Mohan; Experimental investigation on Nano particles in High Performance Concret; International Journal of ChemTech Research; 2015, Vol.8, No.4, pp 1666-1670.
15. Jayaraman A; Fully Replacement of Natural Sand With hydro Sluiced Bottom Ash in High Performance Concrete with Nanosilica; International Journal of ChemTech reserech;2014, Vol 3, Issue 2,pp 464-467.
16. Mohammad Reza Zamani Abyaneh, Seyed Mahdi Mousavi, Alireza Mehran, Seyed Mohammad, Mahdi Hoseini, Soroosh Naderi, Farhad Mesbah I ;Effects of Nano silica on Permeability of concrete and steel Bars Reinforcement Corrosion; Australian Journal of Basic and Applied Science; 2013 ,Vol 7,No2 pp :464-467.
17. S.K. Jai1, P.G. Patil, N.J. Thakor; Engineering properties of laterite stone scrap blocks; Agricultural Engineering International: CIGR Journal; 2011, Vol.13, No.3,Manuscrip No. 1738.
18. M.P.kadam, Dr.Y.D. Patil; Effect of coal bottom ash as sand replacement of the properties of concrete with different w/c ratio; International Journal of Advance Technology in Civil Engineering; 2013,Volume-2, Issue-1, ISSN: 2231 –5721.
19. Deepak , K. Ramakrishnan ; ANN Modelling for Prediction of Compressive Strength of Concrete Having Silica Fume and Metakaolin; International Journal of ChemTech Research; 2015 ,Vol.8, No.1, pp 184-189.

*****