THE BEHAVIOR OF FUME SILICA AND BAGASSE ASH IN CONCRETE

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Abstract

The nanotechnology has added new trends in concrete. By virtue of it has enhanced the concrete properties. The study is associated with the application of nano silica (Fume silica) and Bagasse Ash. The reason for the tests conducted was to discover impacts of fumesilica (FS) & B-A on the quality features of concrete. B-A & fume-Silica were used to examine whether these nano materials are capable to enhance the concrete bonds or they are weak. The tests when conducted, the nano material B-A, replaced cement by 10 percent & 20 percent & (1, 2 & 3)percent of fume-Silica was added by weight. The tests when conducted, showed impressive increase in early age compressive strength and steady increase in overall compressive strength. The increased strength was due to the percentage addition nano materials. The FESEM micrographs illustrated that the nano materials have hardened the concrete bonds up to certain addition by weight and a gradual decrease was seen when the amounts of nano materials exceeded than the required ratios.

Keywords: Concrete, Fume silica, Compressive strength, Bagasse Ash (B-A).

I. Introduction

Concrete is vastly used across the world. The reason it is used is because of its strength and its durability. Studies have been conducted to improve its strength and its impacts on the environment. The environmental aspect is studied because concrete involves cement which contains clinker and high calcium quantities, resulting in CO₂ emissions, which adversely affects the environment. These emissions are due high calcination which contributes towards its strong bond formation [VIII]. Distinctive investigators assessed that every year about 4.5 - 8% of anthropogenic CO₂-outflows are observed worldwide, only from concrete [VII]. It is conceivable
that despite the fact that concrete is related with high CO2 impression, it is still used because of its little cost & overall broad utilize. Above all criticism, Concrete is widely used due to its strength and durability [V]. Recent innovations in material technology have opened doors to materials having fewer ecological affects & economical utilization. Such ways of innovating materials, decreases the ecological effects of concrete incorporating improved calcinations and pounding procedure of raw materials. New concrete innovation techniques such as upgraded evaluating bends, and utilization regarding latest super-plasticizer & responsive fasteners or latent fillers, adjusts hydration conduct (retarders or quickening agents) have been adopted making it somehow a little sustainable or eco cements[VI]. The execution of these "green" ideas infers that specific parameters in the blend configuration should be changed to acquire an adequately useful, and sturdy concrete. In addition, the particular purpose & ecological (introduction period) for the concrete utilization, should viewed as improvements within fume-technology. Such demonstrations provide an insight on a significant number of the difficulties to deliver naturally available concrete. The utilization of nanotechnology gives us new leaps forward in numerous regions, for example, pharmaceutical and social insurance, vitality, biotechnology, data innovation, hardware, resources & producing, & numerous others [IX]. The nano-technology idea be presented out of blue [II], a renowned work by him entitled "There's a plenty of room at the bottom". The last term have no importance until [X], linked nano-technology handling of resources, and particle via iota or atom via atom.

Afterward, supplementary precise meaning regarding nano-technology is exhibited, for example, generation through measurements & accuracy among 0 nm, 1 nm & 100 nm. An additional acknowledged expression, nano-technology includes investigation by nano-run (1 n-m equal’s 1x10-9 meter). According to RILEM Technical Committee report 197-(NCM), "Nano-technology within development resources" [I], be primary record with the intention of stresses unmistakably capability of nanotechnology as far as improvement regarding development & construction supplies, a multi-scale material known as Concrete will be considered beginning or starting ,ranging nano scale (10 to 9 meter) to a full scale (10 to 2 meter).additionally holds regarding binary concrete fixings (ranging nano powders to C.A & microstructure of concrete (nano sized CSH gel to C.A) All such things considers, the development segment is moderately ease back to embrace the upheaval in nano-technology that is continuous in different areas of supplies look into [III], a few conceivable purposes behind that deferral, incorporating the need in comprehension regarding physical & compound systems & a configuration on nanometer level, an absence regarding appropriate instrumentation & furthermore moderately low down concrete’s cost, regularly restricting components regarding usage of nano-technology. Right now, utilization of nano materials & examination at nano-scale of concrete is considered since developing themes of intrigue furthermore, have turned into concentration by some analysts.
II. Methodology

A. Cement
Cement (Portland) confirming in with ASTM C150/C150M-18 is utilized for getting ready concrete cubes.

B. Fine Aggregate
Locally accessible waterway sand affirming to ASTM C33/C33M-18 particulars was used as f- aggregates in concrete. The f-aggregate, going through sieve 4.75mm be used.

C. Coarse Aggregate
20mm down size C- aggregates are used in the investigation crushed stones gained from quarries, affirming to ASTM C33/C33M.

D. Bagasse Ash
B- Cinder leftovers comprise approximately half of cellulose, 25% of hemicelluloses and 25% lignin. These deposits on burning contributes a substance arrangement drives (SiO2). Slighting nearness a texture of burdensome debasement which contributions compelled supplements, fiery the powder is used in farms as synthetics in the sugar-cane gathers.

E. Fume-SiO2
In this examination, a powder compose known as fume-Sio2 is used, likely more than the inverse of materials like pozzolanz’ attributable to high substance of amorphous SiO2 (greater than 99%) & in this way diminished mass of its round particles of request (10-19nm). Amid this investigational consider the bond is substituted by 1, 2 & 3% of F –SiO2 by weight.

F. Water
For examination ordinary domestic water was utilized. Chacteristics are thought to be same as that of normal water. Specific- gravity is in use as 1.00.

G. Test Specimens
Concrete test samples comprise of 6inch×6inch×6inch shapes, respectively. Concrete cubes were tried distinctive curing periods (7 and 28 days) to get compressive quality. The rate of loading is according to the ASTM determination.

H. Mix Design And Mix Calculations
For acquiring of Samples of Coarse and fine aggregate, Sources were visited in a considerable quantity of the sample was taken in a specified manner for the representation of the samples and then stored. Three trials of gradation were done at a constant temperature and moisture content, by following ASTM 702. For mixing of concrete, courting box has been used and the mixing has been repeated for 3-4 times.
Fig. 1: Shows blending of a coarse and Fine aggregate

Table 1: Batch weight for 1 cubic meter of concrete

| Materials Composition | Corrected Weight, kg/m³ | Corrected Weight lb/yard³ |
|-----------------------|-------------------------|---------------------------|
| Cement                | 300 kg/m³               | 24.48 lb/yard³            |
| Water                 | 211 Lit/m³              | 17.22 lb/yard³            |
| 3/4" Agg              | 493 kg/m³               | 40.24341 lb/yard³         |
| 3/8" Agg              | 492 kg/m³               | 40.16178 lb/yard³         |
| Sand                  | 857 kg/m³               | 69.95659 lb/yard³         |
| B-A                   | 0.0 Kg/m³               | 0 lb/yard³                |
| F-S                   | 0.0 Kg/m³               | 0 lb/yard³                |

Table 2: Batch weight for four cubes of 1:2:4 concrete (0% Bagasse Ash and 0% Fume Silica b.w.c)

| Materials Composition | Batch Weights, g.4 Cubes | Corrected Weight lb/yard³ |
|-----------------------|--------------------------|---------------------------|
| Cement                | 0.2570 Kg/m³             | 0.020979 lb/yard³         |
| Water                 | 0.1460 Lit/m³            | 0.011918 lb/yard³         |
| 3/4" Agg              | 0.205 Kg/m³              | 0.016734 lb/yard³         |
| 3/8" Agg              | 0.205 Kg/m³              | 0.016734 lb/yard³         |
| Sand                  | 0.2050 Kg/m³             | 0.016734 lb/yard³         |
| B-A                   | 0 Kg/m³                  | 0 lb/yard³                |
| F-S                   | 0 Kg/m³                  | 0 lb/yard³                |
III. Experiments

Four tests compressive strength test, Schmidt hammer test and UPV tests and FESEM (Field Electron Spectrograph Emission Microscope) were performed in lab by following all ASTM rules and regulations and all the tests were performed in a control environments i.e. temperature and humidity, to avoid any errors in testing procedures.

Fig. 2: Performing of compressive strength apparatus.

Fig. 3: Performing Schmidt hammer Test.

Fig. 4: Performing ultrasonic pulse test for concrete samples.

IV. Results

A. Compressive Strength

Comparison of Results between 10% B-A and 10%B-A+1, 2, 3% F-S

Figure 5 gives blend of 10% B- Ash + 10% B- ash + 1% Fume-S, crushing quality 2997 & 3309 psi, 3184.8 & 3809psi by 7 and 28 days separately. In like manner blend 10% B-red hot garbage +2% fume-S the crushing quality be 3250 psi & 3812 psi by 7 and 28 days separately. By keeping the B- red hot (10%B-A) & growing fume-S, 2 to 3% crushing quality decreases i.e. 1935 psi & 3091 psi by 7 and 28 days of curing. Our line graph recognized an increment in % of crushing quality for 10%B-A & 10 % B-A +1% F-S is 6% in 7 days and 15% at 28 days. Independently when appeared differently in relation to 10% Bagasse searing stays content mix the extending of level of fume-silica i.e. from 1 to 2% F-S the increase in percentage of crushing quality is 2.04% for 7 days and 0.078% at 28 days. When stood out from...
10% Bagasse slag content mix + 2% F-S to 10% B-A + 3% F-S, crushing quality is decrease to 40.46% at 7 days 18% at 28 days. We see 10% B- fiery debris + 2% fume-S will be more triumphant.

**Fig. 5:** BA10% + % NS V/s Compressive Strength 7 Days and 28 Days

**Comparison of Results between 0% B-A+ 0%F-S, 10%B-A+ 0%F-S and 20% B-A+0%F-S**

Fig 6 blends of 0% B-A + 0% Fume-S the crushing quality be 2654psi %3122psi, by 7 and 28 days respectively. In like manner blend of 10% B-A+0% F-S, the crushing quality and increment is noticed like 2997psi % 3309 psi by 7 and 28days separately. B-red hot 20%+0% F-S, crushing quality is decreasing i.e.1500psi & 2186 psi by 7 and 28 of curing. Our line graph recognized an increment in % of crushing quality for 0% B-A+ 0% F-S to 10% B-A+0% F-S is 12.92 in 7 days and 5.98% at 28 days. Independently when appeared differently in relation to 10% Bagasse+0% F-S is to 20% B-A+0% F-S i.e. the decrease in % of crushing quality is 49.94% for 7 days and 33.93% at 28 days. We see 10% B. fiery debris + 0% fume-S blend will be more triumphant.

**Fig. 6:** B-A 0%, 10%, 20% + 0% F-S Verses crushing quality 7 Days & 28 Days.
Comparison of Results between 0% B-A + 0% F-S, 0% B-A + 1, 2, 3% F-S.

Figure 7, blend of 0% B-A + 0% Fume-S crushing quality be 2654 psi & 3122 psi, by 7 and 28 days respectively. In like manner 0% Bagasse+1% F-S, the crushing quality increases like 2700 psi & 4433 psi at 7 and 28 of curing. B-Red hot content 0% + 2% F-S, crushing quality increments i.e. 3154 At 0% Bagasse, 3% F-S the compressive strength decreases 3122 psi and 3747 psi at age of 7 and 28 days, or line the graph recognized that an increment in % of crushing quality 0% B-A + 0% F-S to 0% B-A+1% F-S is 1.73 in 7 days and 41.99% at 28 days . Independently when appeared differently in relation to 0% Bagasse+1% F-S is to 0% B-A+2% F-S, an increment in % of crushing quality is 5.91% for 7 days and 3.22% at 28 days .From 0% Bagasse slag mix + 2% F-S to 0% B-A + 3% F-S, strength is decreased to 1.01% at 7 days & 18.11% at 28 days. We see 0% B- fiery debris + 2% fume-S will more triumphant.

Comparison of Results between 20% B-A, % F-S and 20% B-A 1, 2, 3% F-S.

Fig 8, blend of 20% B-A + 0% Fume-S , the crushing quality 1500 psi & 2186 psi , by 7 & 28 days respectively. In like manner blend 20% B-A +1% F-S , the crushing quality increments like 1935 psi and 3059 psi by 7 and 28 days separately. B- A 20% + 2% F-S, crushing quality increments i.e. 2169.6 psi & 4371 psi by 7&28 of curing. when the blend is 20% Bagasse, 3% F-S the crushing quality decreases 1835 psi & 2872 psi by 7 and 28 days, our graph recognized, an increment in % of crushing quality of 20% B-A+ 0% F-S to 0% B-A + 1% F-S is 29% in 7 days & 39.93% at 28 days . Independently when appeared differently in relation to 20% Bagasse+ 1% F-S to 20% B-A+2% F-S i.e. the increase in percentage of compressive quality is 12.09% for 7 days and 42.88% at 28 days. when stood out from 20% Bagasse slag content mix + 2% F-S to 20% B-A + 3% F-S , crushing quality is decrease to 15.42% at 7 days 34.29% at 28 days .we see 20% B- fiery debris + 2% fume-S blend will be more triumphant.

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### Schimdt Hammer Test

#### Comparison of Results between 10% B-A and 10%B-A+1, 2, 3% F-S

Fig 9, gives blend of 10% B-Ash and10% B-A+ 1% Fume-So f crushing quality of 2867 psi and 3400 psi, 3000psi & 3867psiby of 7 & 28 days respectively. In like manner blend 10% B- red hot garbage + 2%fume-S the crushing quality is 3320 psi &3978 psi by 7 & 28days separately. The B. red hot stays (10%B-A) and growing the fume-S in the mix from 2 to 3% it is found that the crushing quality decreases like 2000 psi & 2800 psi by 7 and 28 of curing. Our line graph recognized an increment in percentage of crushing quality for 10%B-A & 10 % B-A + 1% F-S is 4.63 in 7 days and 13.75% at 28 days . Independently when appeared differently in relation to 10% B-A searing stays mix the extending level regarding fume-S i.e. i.e. starting 1 to 2% F-S, an increment in % of crushing quality is 10.66% for 7days and 2.87 % at 28 days. When stood out from 10% B-slag content mix + 2% F-S to10 % B-A and 3% F-S, crushing quality is decrease to 39.75% at 7 days 29.6% at 28 days. We see 10% B-fiery debris +2% fume-S blends will be more triumphant.
Comparison of Results between 0% B-A+ 0%F-S, 10% B-A+ 0%F-S and 20% B-A+0%F-S

Figure 10 gives blend of 0% B-A + 0% Fume-S the crushing quality is seen to be 2615 psi and 3219psi, by 7 and 28 days respectively. In like manner the blend of 10% B-A+0% F-S, the crushing quality increases like 2867psi and 3400 psi by 7 and 28 days separately. By keeping the B- red hot content to 20% crushing quality is decreasing i.e. 11486psi and 2207psi by 7 and 28 days of curing. Our line graph recognized an increment in percentage of crushing quality for 0% B-A + 0% F-S to 10% B-A+0% F-S is 9.63 in 7 days and 5.62% at 28 days. Independently, when appeared differently in relation to 10% Bagasse+0% F-S is to 20% B-A+0% F-S i.e. the decrease in percentage of crushing quality is 48.16% for 7 days and 35.01% at 28 days. We see 10% B-fiery debris + 0% fume-S blend will make more triumphant.

Fig. 10:B-A 0, 10, 20% +0 % F-S V/s Schmidt Hammer Strength 7 Days and 28 Days.

Comparison of Results between 0% B-A+ 0%F-S, 0%B-A+ 1, 2, 3%F-S.

Figure 11 gives blend 0% B-A + 0% Fume-S the crushing quality is seen 2654 psi and 3122 psi, by age of 7 and 28 days respectively. In like manner blend 0% B-A+1% F-S, the crushing quality decreases like 2700 psi and 4407psi by 7 and 28 days separately. Keeping B- red hot 0% + 2% F-S, crushing quality increases i.e. 3000 psi and 4000 psi after age 7 and 28 of curing. When the blend is 0% Bagasse+3% F-S the compressive strength increases 3180 psi and 4012 psi by 7 and 28 days, our line graph recognized an increment in percentage of crushing strength for 0% B-A + 0% F-S to 0% B-A +1% F-S is 1.73 in 7 days and 41.15% at 28 days. Independently when appeared differently in relation to 0% Bagasse+1% F-S is to 0% B-A+ 2% F-S i.e. the increase in percentage of compressive quality is 11.11 for 7 days and 2.11% at 28 days. When stood out from 0% Bagasse slag content mix + 2% F-S to 0% B-A + 3% F-S, strength is decrease to 6% at 7 days 0.26% at 28 days. We see 0% B-fiery debris +3% fume-S concrete blend will make higher triumphant.

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Fig. 11: B-A % +1, 2, 3 % F-S v/s Schmidt Hammer Strength 7 Days and 28 Days.

Comparison of Results between 20% B-A, %F-Sand 20% B-A + 1, 2, 3%F-S.

Figure 12 gives blend 20% B-A + 0% Fume-S, the crushing quality is seen 1486 psi & 2207 psi, by age of 7 and 28 days period respectively. In like manner blend 20% B-A+1% F-S, the compressive strength increases like 1956 psi and 2978 psi by 7 and 28 days time period separately. Keeping the B. red hot 20% + 2% F-S, compressive strength increases i.e. 2187psi and 3200 psi after age 7 and 28 of curing. when the blend is 20% Bagasse+3% F-S the compressive strength decreases 1800psi and 2850 psi by 7 and 28 period days. Our line graph recognized an increment in percentage regarding crushing strength for 20% B-A + 0% F-S to 20% B-A + 1% F-S is 34.93 % in 7 days and 34.93% at 28 days. Independently when appeared differently in relation to 20% Bagasse, 1% F-S is to 20% B-A,2% F-S i.e. the increase in percentage of compressive quality is 11.80% for 7days and 7.45 % at 28 days. When stood out from 20% Bagasse slag content mix + 2% F-S to 20% B-A + 3% F-S, strength is decrease to 17.69% at 7 days 10.93 % at 28 days. We see that for 20% B. fiery debris +2% fume-S in blend will make more triumphant.

Fig. 12: B-A20 % +1, 2, 3 % F-S v/s Schmidt Hammer Strength 7 Days and 28 Days.

C. Field Emission Scanning Electron Microscope (FESEM) IMAGE

The F-E-S-E-M micros-graphs of 4 samples that appeared underneath. Dual type diverse amplification was decided with end goal of correlation.
Comparison of FESEM Micrographs

In figure 13 & 14, a micro-graph regarding 10 percent B-A blend, which evidently shows a blend having lesser porosity & having compact configuration when in contrast with other blends. But strength quality of this blend will be low as compared with other blends, this is due to B-A which absorbs extra water. 7 days micro-graph shows more Ca(OH)2, shiny color shows Ca(OH)2. It shows that less water for washing Ca (OH)2. While in 56 days micrograph which shows more grayish color of cement shows that pozolanic action reaction happens.

Figure 13: F-E-S-E-M micro picture regarding sample having 10% B-A (56 days) b-w-c amid with diverse magnification.

Figure 14: F-E-S-E-M micro picture regarding sample having F-S F-S 10% B-A (7 days) b-w-c amid with diverse magnification.

In figure 15 & 16 a micro-graph (7 days) regarding 10 percent B-A+3% F-S blend shows expansion of accurate & obvious Calcium Silicate Hydrate paste in numerous stages, very important point to be distinguished in micro-graph be that
Calcium Silicate Hydrate gel i.e. black accumulation & white accumulation fractions are stretched all over C.A & F.A thus performing like binder of glue in that order, we will also see that that strength quality less, this is because of large porosity & packing configuration regarding blend isn’t understandable while in contrast with other blends, 56 days micrograph shows whiteness becomes less so Ca (OH)\(_2\) changes to pozolonic reactants i.e. Ca (OH)\(_2\) + SiO\(_2\)+B-A reacts becomes grayish hence shows more strength.

![Micrograph Image](image1)

**Figure 15:** F-E-S-E-M micro picture regarding sample having F-S 10%B-A+3%F-S (7days) b-w-c amid with diverse magnification

![Micrograph Image](image2)

**Figure 16:** F- A+3%F-S b-w-c (56days) amid with diverse magnification E-S-E-M micro picture regarding sample having F-S 10%B-A

### Comparison of Chemical Composition of the Specimen

In figure 17&18 demonstrates the relative chemical makeup with 10% B-A +0% (F-S) b.w.c High grouping of calcium is because of the large development regarding Ca-(OH)\(_2\) crystals, debilitates I-T-Z.
Figure 17. Comparative chemical makeup regarding sample by means of B-A 10% +0% F-S (7 days) b-w-c.

Figure 18. Comparative chemical makeup regarding sample by means of B-A 10% +0% F-S (56 days) b-w-c. In figure 19 & 20 demonstrates the relative chemical composition with 10% B-A +3% (F-S) b.w.c. The high level of oxygen and equivalent measure of Ca and Si demonstrates a decent reaction amongst silica and Ca (OH) 2 to deliver C-S-H gel and subsequently an expansion in quality is watched.

Figure 19. Comparative chemical makeup regarding sample means of B-A 10% +3% F-S (56 days).

Figure 20. Comparative chemical makeup regarding sample by means of B-A 10% +3% F-S (7 days).

D. UPV Test

U-P-V examination, gives idea of concrete be incredible. 28-day crushing quality be better than the 7-days crushing quality, 1:2:4 specimen’s
examinations have higher crushing quality diverged from mixed concrete specimens

![Graph showing UPV velocity for 7 days and 28 days](image)

**Fig. 21:** UPV velocity 7, 28 days & time 7, 28 days

V. Conclusion

Following has been concluded after detailed study of literature and the experimental and theoretical work reported in this thesis:

1. Test examination gives having 10% B- Fiery Debris will make well swap of bond.
2. Crushing quality examination gives that 10% B- slag replacement of bond will make upper Crushing quality with normal cement.
3. From the trail work the extension of 0% B- blazing flotsam and level of assortment of fume silica (i.e. 1%, 2%, and 3%) which gives the extending requests of compressive quality.
4. Also 10% of B- ash and 2% on fume silica can be better than average substitute of concrete.
5. Better Cube compressive qualities separately when diverged from standard concrete we can construe the choice of up to 10% of B- slag and expansion of 2 % F-S since extra for attach, make structural concrete be used in favor of essential convenient utilize
6. Addition of F-S, a generous increment here early-age quality regarding concrete contrasted with the 28-day’s quality increments.
7. The U-P-V examination demonstrates nature of concrete gives somewhat influenced addition of F-S yet general nature regarding concrete is safeguarded.
8. The F-E-S-E-M micro-graph demonstrates homogeneous and minimized micro-structure on expansion with F-S.
9. SCBA in concrete gives the higher compressive quality when contrasted with the typical quality concrete, henceforth ideal outcomes were found at the 10 percent supplanting of bond with SCBA. • The utilization of SCBA in bond isn’t just a waste-limiting procedure; additionally it spares the measure of bond. • The supplanting of bond and B-A expands functionality of fresh concrete; hence, utilization of high strengthen chemicals aren’t basic. • Suggested that upcoming investigate ought to be done to evaluate utilization of B-A mixed concrete, a few qualities of concrete

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instances modulus of flexibility, flexure, split tensile, drying shrinkage experiments and so forth.

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