International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-2, July 2019

Sound Absorption Characteristics of Ternary Concrete using SCBA and Silica Fume as Partial Replacement of Cement in Concrete

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***Abstract** The ambient noise from transportation and in metro politan areas due to tremendous inhabiting density, it promotes infelicitous noise threats, which originates severe health problems to humans and other living organisms. The present study focus on the employment of industrial and agricultural misuse can be adopted in concrete as partly replacement of cement to reduce the cost, also improves the concrete properties and reduce environmental pollution. The main objective is to assess sound absorption of TBASF concrete by partly replace with cement with SCBA (0%, 5%, 10%, 15%, 20%, and 25%) and additionally 10% Silica Fume. Compressive strength, Split tensile strength, Flexural strength tests were conducted for 7days, 28days, and 56days and sound absorption test was conducted for 7days and 28days. The optimum strength obtained for the mix TBASF15 at all the ages. Further, the results of the sound absorption coefficient (α) of SCBA Silica Fume concrete compared with the sound absorption coefficient (SAC) (α) of parent concrete is carried out by using the impedance tube.*

***Keywords:** Sound absorption test, Flexural strength Compressive strength, Split tensile strength, Sugarcane bagasse ash, Silica Fume*

I. INTRODUCTION

In urban societies and rural areas, there is a growing concern that the sound is growing because of its negative impact on people's lives. Noise found from different sources such as vehicles, airplanes, power stations and machinery is not uncomfortable, even unsure of health. This involvement has led to major development in the area of sound absorbing materials. For uniformity and isotropic materials, sound performance is experimental determinants, such as: absorption coefficient, acoustic resistance and noise reduction coefficient.Transport in urban zones because of high inhabiting density, particularly highways and railways; However, this creates unwanted echo problems, which can also cause severe health problems for living creatures. In addition, the noise from highway traffic and high speed trains will lead to health hazards for wild life and cattle in rural areas. Hence, acoustic control from the surrounding environment has become a necessary engineering field in a new society, because of the new receipt, such as a dangers of health, living and living standards are becoming more prominent.

Revised Manuscript Received on 30 July 2019.
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SCBA has latterly been tested in the world adopted as a partly replacement of cement. The SCBA was created to better properties of the concrete, mortar, and paste, containing water tightness and compressive strength in particular fineness and replacement percentages.

The huge content of silica in the SCBA was advised to be the main source of these improvements. Whereas the content of silica may change from ash to ash, confide in the other properties and fiery conditions of the raw materials, containing the Sugarcane has a growing soil, it has been described that Silicate cemented a pozzolanic reaction with cement's hydration products and leads to the degradation of free lime in the concrete.

SF is a co-product from a ferrosilicon or silicon metal product, a modular silicon dioxide (sio_2), which reduces very pure quartz in the presence of the sunken electrical arc furnace. This gas is condensed in the steam baghouse, which is an accurate delicate dry sphere of spherical particles with a mean 0.1 to 0.3 microns 17 to 30 m^2/g will be in the diameter of the surface area. SF is adopted in a difference of cementitious (grouts, concrete, and mortars), refractory, polymer, and elastomer applications.

When used in shotcrete, concrete, oil well and repair products. SF performance as both a filler developing the physical structure by filling a space between the cement particles and as a pozzolan reacting chemically to transmit far greater durability and strength to concrete.

II. MATERIALS AND METHODS

A. Cement

The cement is tested in the laboratory and tested for its quality requirements as per Indian Standards. The cement utilized was (OPC 53) confirming to IS 12269 – 1987. Its PP are illustrated in Table 2.1 below.

Table 2.1: Cement Physical Properties

S.NO	Description of test	Test outcomes
1.	Specific gravity of cement	3.13
2.	Fineness of cement	7.8%
3.	Standard consistency	33%
4.	Initial setting time	85 min
5.	Final setting time	240 min

B. Aggregates

As per IS 383-1970 the locally available coarse aggregate used to have a maximum size of 20mm and placed on fine gravel and 600µm sieve through a 4.75mm sieve, conforming Zone-2 was used in this study. Its PP are granted in Table 2.2 below.

Table 2.2: Aggregate Physical properties

S.NO	Description of test	Coarse Aggregate	Fine Aggregate
1.	Fineness modulus	6.27%	4.037%
2.	Specific gravity	2.67	2.71
3.	Water absorption	0.44%	0.80%

C. Sugarcane Bagasse Ash (SCBA)

SCB consists of relatively 25% of hemicelluloses of lignin, 50% of cellulose. Each ton sugarcane produces about 0.62% of residual ash and. 26% of bagasse. After the combustion, the debris will have a combustion chemical composition effect by modular silicon dioxide (Sio_2). In the existing cyst, providing freezing material and some nutrients, this grass rearing is a fertilizer in livestock farming. In this SCBA was taken during a boiler cleaning in the NCS sugars limited, located in the town of Bobbili, Andhra Pradesh.

Fig 2.1: SCBA

Table 2.3: Chemical Composition of SCBA

S. NO	Component	Oxide	Mass percentage (%)
1.	Silica	Sio_2	63
2.	Alumina	Al_2O_3	31.5
3.	Ferric Oxide	Fe_2O_3	1.79
4.	Calcium Oxide	CaO	0.48
5.	Magnesium oxide	MgO	0.39
6.	Manganese oxide	MnO	0.004
7.	Loss on ignition	LOI	0.71

D. Silica Fume (SF)

SF is co-production from a ferrosilicon or silicon metal product, a modular silicon dioxide (sio_2) which reduces very pure quartz in the presence of the sunken electrical arc furnace. This gas is condensed in the steam baghouse, which is an accurate delicate dry sphere of spherical particles with a mean 0.1 to 0.3 microns 17 to 30 m^2/g will be in the diameter of the surface area. SF is adopted in a difference of cementitious (grouts, C, and mortars), refractory, polymer, and elastomer applications.

Fig 2.2: SF

Table 2.4: Chemical composition of SF

S.NO	Component	Oxide	Mass percentage (%)
1	Silica	Sio_2	96
2	Alumina	Al_2o_3	0.25
3	Ferric Oxide	Fe_2o_3	0.5
4	Calcium Oxide	Cao	0.25
5	Sodium Oxide	MgO	0.56
6	Sulfur trioxide	Na_2o	0.25
7	Potassium Oxide	So_3	0.12
8	Potassium Oxide	K_2O	0.56

E. Sound absorption test

To find the sound absorption coefficients (α) Impedance Tube is used. In this the testing is done for two sizes of specimens i.e. large sample tube of dia 99.5 mm for low frequency (0 to 1600 Hz), and small sample tube of dia 29.5 mm for high frequency (1600 to 6000 Hz). In this study, the sound absorption coefficient was measured using an impedance tube as per ISO 10534-2 (1988).

Retrieval Number: B2050078219/19©BEIESP
DOI: 10.35940/ijrte.B2050.078219
Journal Website: www.ijrte.org

Published By:
Blue Eyes Intelligence Engineering & Sciences Publication

Fig 2.3: Impedance tube

III. EXPERIMENTAL WORK

Experimental work using the results of mixing of concrete to conduct concrete analysis of SCBA and SF according to Indian Standard approach and to achieve concrete of quality and energy required. Later, it has been proven for concrete performance parameters by performing slump cone test, compaction factor test on it, conveying concrete cubes for further research. The strength investigations carrying by a 45 total of concrete cubes, 45 cylinders, and 45 prisms were examined to carry the samples. Based on a mixes, the quantities of partly replace cement with SCBA (0%, 5%, 10%, 15%, 20%, and 25%) and additionally 10% SF. The W/C kept 0.45 and standardized conditions were tested for 7 to 56 days flexural strength, compressive strength, and split tensile strength, concrete samples were tested in the laboratory.

Table 3: Mix Proportions for Natural Aggregate Concrete

Grade designation	Cement (Kg/m^3)	Fine Aggregate (Kg/m^3)	Coarse aggregate (Kg/m^3)	Water (Kg/m^3)	W/C	Target Strength (Mpa)
M30	380	803.358	1386.07	171	0.45	38.25

IV. TEST METHODS

After the completion of each curing period, each concrete asset has 3 samples tested. According to the Indian standard sound absorption test was (99.5mm diameter and 50mm height) cylindrical specimens, compressive strength test was (150mm × 150mm × 150mm) cube specimens, split tensile strength was (150mm diameter and 300mm height) cylindrical specimens, and flexural strength was (100mm × 100mm × 500mm) prisms specimens.

V. RESULTS AND DISCUSSION

5.1 Compressive strength

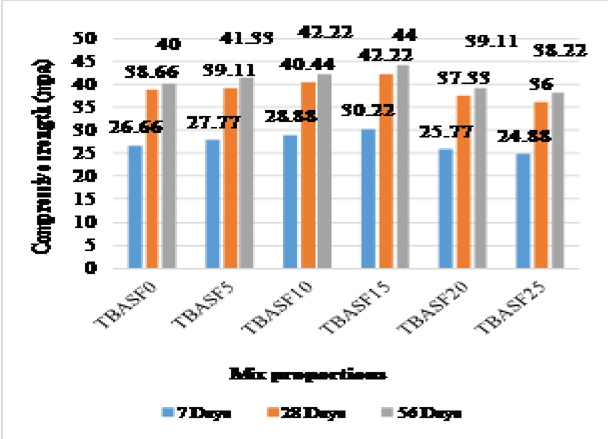

Fig 5.1: 7 to 56 Days Compressive strength for all mixes

The figure 5.1 shows that compressive results of TBASF concrete for 7 to 56 days of curing. It was noticed that by replacing 15% of SCBA and 10% SF gives optimum strength when examined to all other mixes. By increment of SCBA in the concrete mix, it was noticed that significant fall in compressive strength and workability. Expected strength was achieved by increasing the curing age of concrete for 56 days for all the mixes using SCBA and SF.

5.2 Split tensile strength

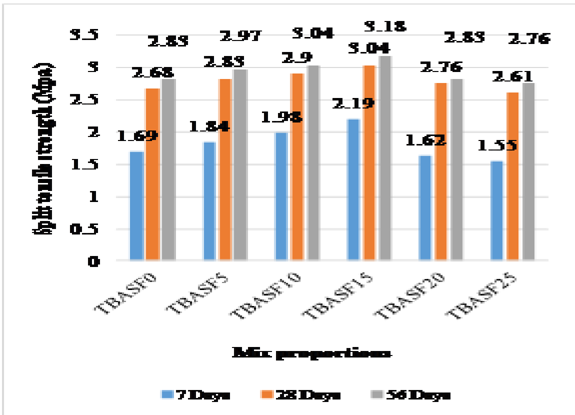

Fig 5.2: 7 to 56 Days Split tensile strength for all mixes

Figure 5.2 shows that Split tensile strength of TBASF concrete for 7 days, 28 days and 56 days of curing. It was concluded that by replacing 15% of SCBA and 10% of SF gives optimum strength when examined to all other mixes. By increment of SCBA in the concrete mix, it was concluded that significant decrease in tensile strength. The strength was decreased in all the mixes significantly by 30%, 26%, 24%, 21%, 28% and 32% for characteristics target strength of M30 at 28 days.

5.3 Flexural strength.

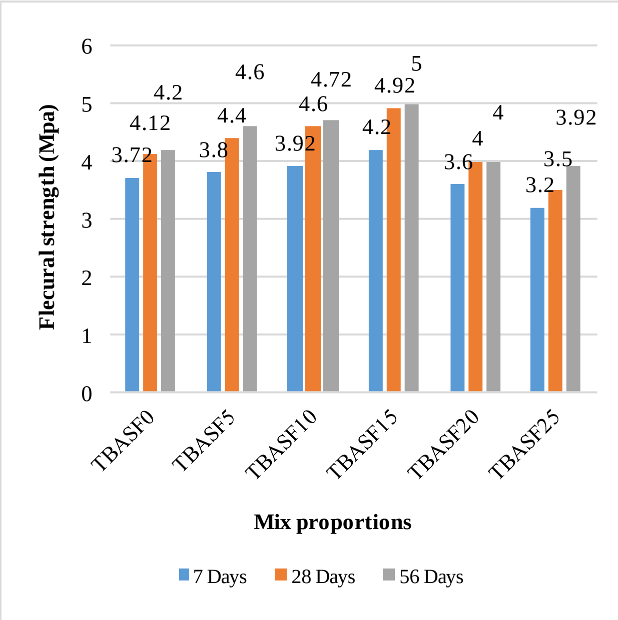

Fig 5.3: 7 to 56 Days Flexural strength for all mixes

Figure 5.3 shows that flexural strength results on TBASF concrete for 7-28-56 days when specimens are immersed in water. It was concluded that by replacing 15% of SCBA and 10% of SF gives optimum strength when examined to all other mixes by increment of SCBA in the concrete mix, it was found that significant decrease in tensile strength for 0%, 5% replacement of SCBA by 10.4% 4.3% and strength increase for 15% replacement of SCBA by 7% for 28 days of curing to the design strength of concrete.

5.4 Sound absorption test

5.4.1 Sound absorption coefficient of low frequency for 7 Days of curing

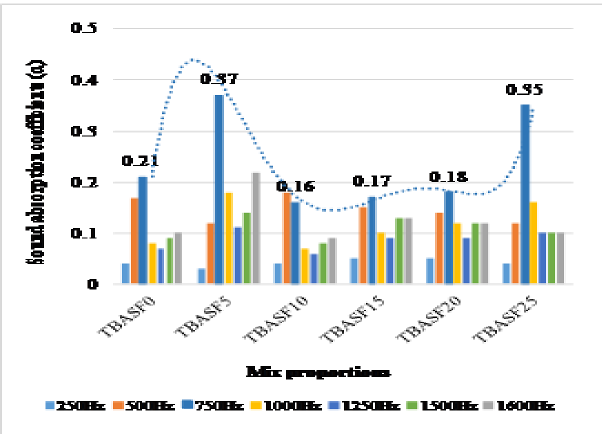

Fig 5.4: Sound absorption test results for Low frequency for 7 Days

Figure 5.4 shows that the SAC (α) of TBASF concrete for the mixes range in between TBASF0 to TBASF25 for 7 days of curing. From the figure, it was noticed that the optimum SAC (α) of all the mixes were compared with parent concrete. It was concluded that the highest SAC (α) has occurred at 750Hz for all the mixes at lower frequency levels passed through the impedance tube. The above figure shows there is 56.7% increment in SAC (α) when compared to parent concrete.

5.4.2 Sound absorption coefficients of High frequency for 7 Days curing

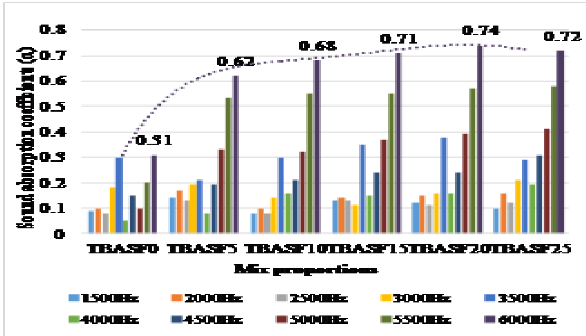

Fig 5.5: Sound absorption test results for High frequency for 7 Days

Figure 5.5 represents the frequency values of SAC (α) at the higher frequency levels passed through impedance tube. From the above figure, it was concluded that by an increment of SCBA 5% in each mix and SF with constant 10% in all mixes, it was concluded to SAC was increased by raising levels of frequencies. The above figure shows there is 47.9% increment in SAC in comparison to the parent concrete. The highest SAC was 0.74 with a frequency levels of 6000Hz. So, the TBASF concrete was substantiate to have a better acoustic performance of high frequency compared to parent concrete.

5.4.3 Sound absorption coefficients of Low frequency for 28 Days curing

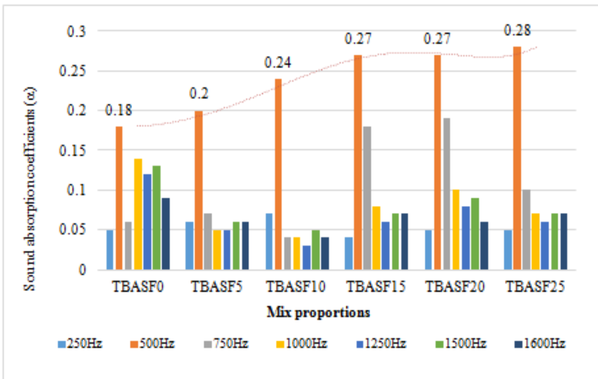

Fig 5.6: Sound absorption test results for Low frequency for 28 Days

Figure 5.6 shows the SAC of TBASF concrete for 28 days of curing. For 0%, 5%, 10%, 15%, 20% and 25% of SCBA and 10% SF in all the mixes to the weight of cement, the maximum sound absorption coefficient was found at a frequency at 500Hz by replacement of TBASF25. The above figure shows there is 64.2% increment in sound absorption coefficient (α) when compared to the parent concrete.

5.4.4 Sound absorption coefficients of High frequency for 28 Days curing

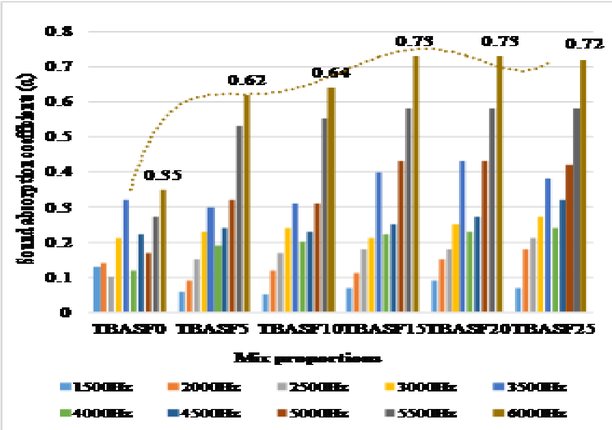

Fig 5.7: Sound absorption test results for High frequency for 28 Days

Fig 5.7 represents the values of SAC (α) at the higher frequency levels passed through impedance tube. From the above figure, it was concluded to be SAC was increased by raising levels of frequencies. The above figure shows there is 47.9% increment in SAC in comparison with parent concrete. The highest SAC was 0.73 with a frequency levels of 6000Hz. So, the TBASF concrete was substantiate to have a better acoustic performance of high frequency compared to parent concrete.

VI. CONCLUSIONS

1. SCBA ternary blended concrete showed better results when compared to parent concrete up to the percentage of TBASF 15.
2. The flexural strength, compressive strength, and tensile strength, of the concrete increased by replacing with TBASF5%, TBASF10%, TBASF15% and further strength decrease for TBASF20% and TBASF25%.
3. It was noticed that the maximum sound absorption frequency is 750Hz at TBASF5%.
4. For higher frequency as the percentage of pozzolanic material (SCBA and Silica Fume) increases, sound absorption coefficients also increased.
5. It was concluded that the SCBA ternary blended concrete enhances the coefficient of sound absorption when compared to parent concrete.

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