Compatibility of Glass Fibre , Silica Fume And Bagasse Ash As Pozzolanic Material In Concrete

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Abstract- *The making of Ordinary Portland Cement involves enormous size of energy consumption, leading to mammoth discharge of carbon dioxide to the air. This is being great task to the sustainable advance. Cement being the major constituent in building construction, contributes about 7-8% to the emission of green house gases. The environmental impact of carbon dioxide emission due to production of Portland cement can be reduced by partial replacement of cement with supplementary cementitious materials. Sugarcane bagasse ash (SCBA) and Silica Fume (SF) are waste materials comprising pozzolanic properties but their disposal is causing acute environmental setbacks. The utilization of industrial and agricultural waste product in concrete has been a major step on waste reduction. silica fume and Sugarcane bagasse ash can by effectively used in concrete as partial replacement of Cement because of their high content of silica and pozzolanic properties which plays an important role in achieving high strength and durability in concrete. This Study describes the feasibility of using the Glass fiber, Sugarcane bagasse ash and silica fume in concrete production as partial replacement of cement to reduce disposal and pollution problems and detecting workability, compressive strength, tensile strength on comparison with conventional concrete.*

I. INTRODUCTION

Cement is the most important ingredient of the concrete which produces carbon dioxide which is May harmful. So it is a main concern to reduce the usage of cement. The increase in cost of the cement not only increases the budget of a construction but also poses a serious threat to the country's development. It is identified that some industrial waste products like Bagasse Ash are having some cementitious and siliceous properties. So the use of the industrial and agricultural wastages in concrete partly as cement replacement, reduce the cost of making concrete, also causes improvement in the properties of concrete and reduce environmental pollution. The making of Ordinary Portland Cement involves enormous size of energy consumption, leading to mammoth discharge of carbon dioxide to the air. This is being great task to the sustainable advance. Cement being the major constituent in building construction, contributes about 7-8% to the emission of green house gases. The environmental impact of carbon dioxide emission due to production of Portland cement can be reduced by partial replacement of cement with supplementary cementitious materials. Sugarcane bagasse ash (SCBA) and SF (silica fume) are waste materials comprising pozzolanic properties but their disposal is causing acute environmental setbacks. The utilization of industrial and agricultural waste product in concrete has been a major step on waste reduction. SF and Sugarcane bagasse ash can by effectively used in concrete as partial replacement of Cement because of their high content of silica and pozzolanic properties which plays an important role in achieving high strength and durability in concrete

Sugarcane Bagasse ash:- Sugarcane Bagasse ash is a byproduct of the sugar factories found after burning sugarcane Bagasse which itself is found after the extraction of all economical sugar from sugarcane. The disposal of this material is already causing environmental problems around the sugar factories. Due to the boost of the construction activity in the country, a huge shortage is created in most of the construction materials especially cement, resulting in steady increase of price

Silica fume:- Silica fume is a by-product from the production of elemental silicon or alloys containingsilicon in electric arc furnaces. At a temperature of approximately 2000°C the reduction of high-purity quartz to silicon produces silicon dioxide vapor, which oxidizes and condenses at low temperatures to produce silica fume Plain concrete members cannot sustain tensile stresses developed due to the applied forces without the addition of reinforcing elements that are able to withstand tensile stresses. The propagation of micro cracks and macro cracks, however, still cannot be arrested or slowed by the sole use of discrete reinforcement such as steel and composite rebars. It is believed that the mixing of randomly spaced discontinuous small fibers helps in arresting the propagation of the micro cracks and macro cracks

Hence fibres are added to concrete to overcome these disadvantages. The addition of fibres in the matrix has many important effects. Most notable among the improved mechanical characteristics of Fibre Reinforced Concrete (FRC) are its superior fracture strength, toughness, impact resistance, flexural strength resistance to fatigue, improving fatigue performance is one of the primary reasons for the extensive use of Glass Fibre Reinforced Concrete (SFRC) in pavements, bridge decks, offshore structures and machine foundation, where the composite is subjected to cyclically varying load during its lifetime.

Fibre Reinforced Concrete (FRC):- is a composite material essentially consisting of concrete reinforced by random placement of short discontinuous and discrete fine fibers of specific geometry. It is now well established that the addition of short, discontinuous fibers plays an important role in the improvement of the mechanical properties of concrete. In the FRC, the fibers help to transfer load to the internal micro cracks. In the recent past, many developments have been made in the fiber reinforced concrete. Also it has been recognized that addition of small, closely spaced and uniformly dispersed fibers to concrete would act as crack arrester and would substantially improve the properties and can cause a change in the failure mode under compressive deformation from brittle to pseudo-ductile, thereby imparting a degree of toughness to concrete. silica fume can be used as partial replacement of cement for better performance and it helps in producing high strength concrete because of the total participation in hardening process. Fibres are generally used to resist cracking and to assist in strengthening of concrete

II. REVIEW OF LITERATURE

Sinha (1973) studied on the use of banana plant fibre as a substitute for Jute. Banana-plant fibre is strong, soft, and coarse and technique developedfor processing the fibre on standard jute machinery is reported. In some trialsthe banana fibre were also blended with Mesta (cellulosic fibre). The bananafibre spin ability and weaving performance were invested, so that it can beused as a good substitute for jute in making of sacks and packaging materials. The yarn composed of entirely of banana fibre can replace jute onweft, sacking warp yarn and still maintain the standard cloth characteristicBanana. The study also affirmed that sacking fabrics woven with banana-fibreyarn as weft and with jute yarn in the other direction compiled with standardspecifications and performed better than corresponding all-jute fabrics

Kurein (1981) studied on the dyeing behavior of banana fibre. During this study 4 different classes of dyes were used on un mercerized, mercerized cotton fibre and banana fibre. Their dye-uptake, wash-fastness and lightfastness were determined. The dyes selected were direct dye, vat dye,reactive dye, and azo dye

The following conclusions have been drawn Correlating the dye uptake and the fastness properties it may be concluded that the fastness properties may not necessary depend upon the amount of dye present on the fibre. It may be said that this property depends more on the structure of the fibre and the manner in which the dye is present on the fibre

It has been noted that the light fastness of banana fibre is inferior to cotton. This may be attributed to the impurities present in the banana fibre in the form of lignin and the other insoluble matter.bThe published research works on flexural ductility of Glass Fibre reinforced concrete beam have been studied by many researches D.Y. Gao discussed the influence of Glass Fibre factor on flexural ductility of beam and concluded that ductility indexes increase with increasing of fiber factor

A.N.Dancygier and Z.Savir studied the influence of Glass Fibre on flexural performance of high strength concrete beam with low longitudinal reinforcement ratio, which proved that Glass Fibre enhance brittleness of beam compared to that of beam with minimum longitudinal reinforcement ratio. Compared to Glass Fibre reinforced concrete, the hybrid fiber with different type and size can improve effectively strength and toughness of concrete, form hybrid effect during different fiber, play respective beneficial influence from different level. However, few researches on flexural performance of hybrid fiber reinforced RC beam were studied

Mr. U.R. Kawade et al., had studied on “Effect of use of Bagasse ash on Strength of Concrete” they had Chemically and Physically Characterized and partial replaced in the ratio of 0%, 10%, 15%, 20%, 25% and 30% by weight of cement in concrete. The results show that the SCBA concrete had significantly higher compressive strength compared to that of the concrete without SCBA. It is found that the cement could be advantageously replaced with SCBA up to maximum limit of 15%. Although the optimal level of SCBA content was achieved with 15% replacement. Partial replacement of cement by SCBA increases workability of fresh concrete, therefore use of Super Plasticizer is not essential

omualdi and Batson (1963) after conducting impact test on fibre reinforced concrete specimens, they concluded that first crack strength improved by addition of closely spaced continuous Glass Fibres in it. The Glass Fibres prevent the adverting of micro cracks by applying pinching forces at the crack tips and thus delaying the propagation of the cracks. Further, theyestablished that the increase in strength of concrete is inversely proportional to the square rootof the wire spacing

Lachemi M, et al.(2004)the author statedthat to getstable rheology of the SCC use of Viscosity Modifying Agents has been showed to be very operative. To know the appropriateness of four types of poly-carboxylic based VMA for the growth of the SCC mixes was studied. The author found that the new type VMA are the suitable and better for preparing the SCC mix as compared to the commercially accessible VMA. Author also suggested the amount of 0.04% of dosage fulfills the fresh and hardened properties of SCC, which is 6% less than the commercially accessible VMA.

M.Collepardi, et al.(2006)the author studied the role of VMA with the non-availability of the chosen volume range 170-200 liters /m^3 of binding material (max size = 90µm) to create consistent SCC and determined that the combination of VMA and without mineral filler. In such a case, a minor increase convoyed by cement content must be in the dosage of VMA (for instance from 3 to 8 Kg/m^3 to attain an unsegregable SCC without mineral filler. In short, the dosages of mineral and chemical admixtures are necessary in keeping the fresh and hardened properties, and improving the durability characteristics of SCC

Okamura et al. (1995) author established a special type of concrete that flows and gets compacted at every place of the formwork by its own weight. This research work was started combined by prof. Kokubu of Kobe University, Japan andProf. Hajime Okamura. Previously it was used as anti washout concrete. They initiate that for attainment of the self-compact ability, usage of Super Plasticizer was necessary.The water/cement ratio should be in between 0.4 to 0.6. The self-compactability of the concrete is mainly affected by the material characteristics and mix proportions. Author restricted the coarse aggregate content to 60% of the solid volume and the fine aggregate content to 40% to attain self-compact ability

Yin-Wen Chan,et al. (1999)by enhancing the micromechanical parameters which control composite properties in the hardened state, the author developed self-compacting Engineered Cementitious Composite (ECC), and the treating parameters, which control the rheological properties in the fresh state. For the growth of self-compacting ECC, micromechanics was accepted to suitably select the matrix, fiber, and interface properties so as to show strain hardening and various cracking behavior in the composites. Self-compact ability of ECC was then understood by the organized rheological properties of fresh matrix,comprising deformability and flow ratewith the certain ingredient materials. Self-compactability was a result of accepting an optimum mixture of super plasticizer and viscosity modifying agent.

Kung-Chung Hsu, et al. (2001) Authors projected a new mix design technique for SCC and their main emphasis was with binder paste to fill voids of loosely filled aggregate. They familiarized a factor called Packing Factor (PF) for aggregate. It is the ratio of mass of aggregates in firmly packed state to the one in loosely packed state. The method completely influenced bythe Packing Factor (PF). The amount of binders used in the proposed method can be less than that required by other mix design methods due to the increased sand content. Packing factor influence the aggregate content and that affects the fresh properties of concrete.

M. Sonebi,et al. (2002) Thisresearch shows results of fresh properties of self-compacting concrete, like, filling ability measured by slump flow apparatus and flow time measured by orimet apparatus and plastic fresh properties measured by column apparatus. The fresh properties were affected by water/binder ratio, nature of sand, slump were estimated. The fresh tests and hardened test results like compressive strength and splitting tensile strength were compared to a control mix. The properties of fresh SCC improved by increasing in water/binder ratio and nature of sand but the volume of coarse aggregate and dosage of chemical admixture kept

Chihuahua Jiang, et al (2014) in this field, the effects of the volume fraction and length of basalt fiber (BF) on the mechanical properties of FRC were Analyzed.The outcomes indicate that adding BF significantly improves the tensile strength, flexural strength and toughness index, whereas the compressive strength shows no obvious gain. Furthermore, the length of BF presents an influence on the mechanical properties

III. METHODOLOGY

3.1 Materials Used And Their Properties;- In this study, the mechanical behavior of fiber reinforced self-compacting concrete of M30 grade prepared with basalt fiber, glass fiber and carbon fiber were studied. For each mix six numbers of cubes (150×150×150) mm, three numbers of cylinders (150×300) mm and six numbers prisms (100×100×500) mm were cast and investigations were conducted to study the mechanical behavior, fracture energy behavior, microstructure of plain SCC, basalt fiber reinforced SCC (BFC), glass fiber reinforced SCC (GFC), carbon fiber reinforced SCC (CFC). The observational plan was held up in various steps to accomplish the following aims

CEMENT: Portland slag cement of Konark brand available in the local market was used in the present studies. The physical properties of PSC obtained from the experimental investigation were confirmed to IS: 455-1989

FINEAGGREGATE: Aggregate whose sizes are lesser than 4.75 mm are fine aggregate which satisfied the required properties for experimental work and conforms as per the specification of IS: 383- 1970.Sand is a naturally and obviously occurring granular material collected of finely divided rock and mineral particles. The composition of sand is extremely variable, depending on the local rock sources and conditions, but the for the most part frequent constituent of sand in inland continental settings and non-tropical coastal settings is silica (silicon dioxide, or SiO_2), usually in the form of quartz.

COARSE AGGREGATE: Construction aggregate, or simply "aggregate", is a wide group of coarse particulate material used in construction, as well as sand, gravel, crushed stone, slag, recycled concrete and geo synthetic aggregates. Aggregates are the majority mined materials in the world. Aggregates are a constituent of composite materials such as concrete and asphalt concrete; the aggregate serve as reinforcement to insert strength to the overall composite material

Bagasse ash:- Bagasse is a by-product from sugar industries which is burnt to generate power required for different activities in the factory. The burning of bagasse leaves bagasse ash as a waste, which has a pozzolanic property that would potentially be used as a cement replacement material. It has been known that the worldwide total production of sugarcane is over 1500 million tons.

Sugarcane bagasse ash has recently been tested in some parts of the world for its use as a cement replacement material. The bagasse ash was found to improve some properties of the paste, mortar and concrete including compressive strength and water tightness in certain replacement percentages and fineness.

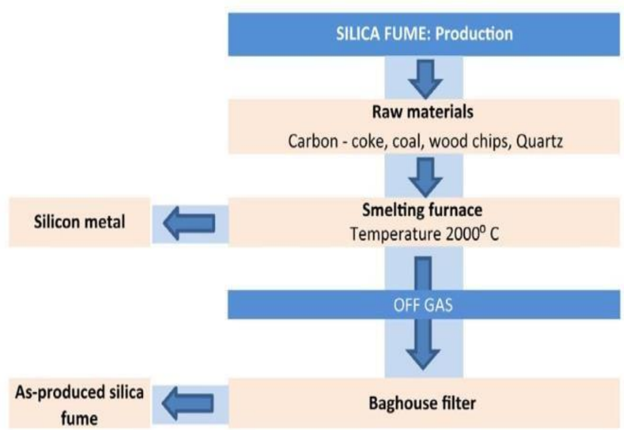
Table3.1: Physical Properties of SCBA

S.No.	**Property**	**Value**
1.	Density	570 Kg/m3
2.	Specific Gravity	2.1
3.	Mean particle size	0.1-0.2 µm
4.	Min specific surface area	2500m2/ kg

Table3.2: Chemical Properties of SCBA

S No	Component	Symbol	Percentage
1.	Silica	SiO_2	62
2.	Alumina	Al_2O_3	32.5
3.	Ferric Oxide	Fe_2O_3	1.78
4.	Manganese Oxide	MnO	0.005
5.	Calcium Oxide	CaO	0.50
6.	Magnesium Oxide	MgO	0.37
7.	Loss on Ignition	LOI	0.71

SILICA FUME:- Silica fume is a by-product from the production of elemental silicon or alloys containing silicon in electric arc furnaces. At a temperature of approximately 2000°C the reduction of high-purity quartz to silicon produces silicon dioxide vapor, which oxidizes and condenses at low temperatures to produce silica fume



Concrete made with Silica fume cement sets more slowly than concrete made with ordinary Portland cement, depending on the amount of ground granulated blast furnace slag in the cementitious material. For the present study the silica fume was brought from the Visakhapatnam steel plant by using wet bags.

Glass Fibre :- Glass fiber-reinforced concrete ceramic consists of high-strength, alkali-resistant glass fiber embedded in a concrete &ceramic matrix. In this form, both fibers and matrix retain their physical and chemical identities, while offering a synergistic combination of properties that cannot be achieved with either of the components acting alone. In general, fibers are the principal load-carrying members, while the surrounding matrix keeps them in the desired locations and orientation, acting as a load transfer medium between the fibers and protecting them from environmental damage. The fibers provide reinforcement for the matrix and other useful functions in fiber-reinforced composite materials. Glass fibers can be incorporated into a matrix either in continuous or discontinuous (chopped) lengths.

Table 3.3: Properties of Glass fiber

S. No	Description	Result
1	Length	50 mm
2	Diameter	0.75 mm
3	Aspect Ratio	67
4	Tensile strength	1100 MPa
5	Young‟s modulus	210 GPa
6	Density	7.85 g/cm3
7	Specific gravity	7.9

ADMIXTURES

Admixtures means a material, apart from cement, water Associate in Nursingd aggregates that's used as an ingredient of concrete and is extra to the batch straight off before or throughout mix. Additive is a material which is added at the time of grinding cement clinker at the cement factory.For modifying the mix properties the chemicals that are added to the concrete mix.These should never be considered as a substitute for good mix design, for workmanship, or use of good materials. Currently concrete is getting used for wide styles of functions to create it appropriate in numerous conditions. In these conditions normal concrete could fail to exhibit the desired quality performance or sturdiness. In such cases, admixtures are accustomed modify the properties of normal concrete therefore on build it a lot of appropriate for any scenario. Till concerning 1930 additives and admixtures through used, weren't thought-about as necessary a part of concrete technology. The super plasticizer used in concrete mix makes it highly workable for more time with much lesser water quantity

IV. RESULTS OF THE EXPERIMENTAL INVESTIGATIONS

In the present experimental investigation sugar cane Bagasse ash has been used as partial replacement of cement in concrete mixes. On replacing cement with different weight percentage of SCBA the compressive strength is studied at different ages of concrete cured in normal water. The details of laboratory experimentation are as follows

IMPORTANCE OF MIX DESIGN Mix design can be defined as the process of selecting suitable ingredients of concrete and determining their relative proportions with the object of producing concrete of certain minimum strength and durability as economically as possible

In concrete laboratories the test specimens are stored in a place free from vibrations in moist air of at least 90% relative humidity and at a temperature of $27^{o}C \pm 2^{o}$C for 24 hours from the time of addition of water to the dry ingredients. After this period, the specimens are marked and removed from the moulds. Unless required for testing within 24 hours, they are immediately submerged in clean fresh water and are kept there until they are taken out just prior to test. The water or solution in which the specimens are submerged, are renewed every seven days and are maintained at a temperature of 27^{o} c + 2^{o} c. The specimens are not to be allowed to become dry at any time until they have been tested

The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required, strength, durability, and workability as economically as possible, is termed the concrete mix design. The proportioning of ingredient of concrete is governed by the required performance of concrete in two states, namely the plastic and the hardened states. If the plastic concrete is not workable, it cannot be properly placed and compacted. The property of workability, therefore, becomes of vital importance. Percentage dosage of super plasticizer was fixed as per the mix design method described in IS 10262- 2009. Mix proportion was arrived through various trial mixes. The grade of concrete prepared for the experimental study was M35

SLUMP TEST

The vertical settlement of unsupported fresh concrete, flowing to the sides and sinking in height is known as slump. Slump is a measure indicating the consistency or workability of cement concrete. It gives an idea of water content needed for concrete to be used for different works. A concrete is said to be workable if it can be easily mixed, placed, compacted and finished. A workable concrete should not show any segregation or bleeding

Variation of Slump Values

SAMPLE DESIGNATION	% REPLACEMENT OF SCBA IN CEMENT	SLUMP(mm)
A0	0	75
A1	5	80
A2	10	83
A3	15	87
A4	20	98
A5	25	110

Evaluating the optimum percentage of bagasse ash

BA (%)	7 days	14 days	28 days
0	25.63	34	37.49
5	23.67	35.46	39.08
10	22.81	37.08	40.21
15	21.45	34.13	37.15
20	19.82	27.43	32.08

% Replacement of BA

VARIATION OF COMPRESSIVE STRENGTH FOR ADDITION OF SILICA FUME TO OPTIMUM PERCENTAGE OF BAGASSE ASH

BAGASSE ASH + SILICA FUME	7 days	14 days	28 days
10%BA+0% SILICA FUME	22.81	37.08	40.21
10%BA+10% SILICA FUME	24.81	39.61	42.5
10%BA+20% SILICA FUME	26.64	40.5	43.91
10%BA+30% SILICA FUME	28.7	41.91	45.12
10%BA+40% SILICA FUME	24.9	39.82	41.85

EFFECT OF STEEL FIBER ON COMPRESSIVE STRENGTH USING BAGASSE ASH AND SILICA FUME

BA+SILICA FUME+GF	7 days	14 days	28 days
10%BA+30%SILICA FUME+0%GF	28.7	41.91	45.12
10%BA+30%SILICA FUME+1%GF	29.5	42.6	46.7
10%BA+30%SILICA FUME+1.5%GF	31.2	43.2	48.1
10%BA+30%SILICA FUME+2%GF	28.9	42.1	45.97

SPLIT TENSILE STRENGTH

The size of specimens 150 mm dia and 300 mm length was used and the specimens were cured in normal water. Concrete specimen cubes are used to determine compressive strength of concrete and were tested as per as per IS 516 (1959) and IS 5816 (1999)

Split tensile strength of concrete keeping 10% bagasse ash and 30% silica fume as constant and with different percentages of Glass Fibre for curing period of 7-days, 14-days and 28-days respectively and TABLE 6.5 shows the summarized Split tensile strength Results for differentcuring periods– M35 grade

Table 6.5 shows the effect of Glass fiber on splitting tensile strength using bagasse ash and silica fume

BA+SILICA FUME+GF	7 days	14 days	28 days
10%BA+30% SILICA FUME+ 0%GF	2.1	2.79	3.8
10%BA+30% SILICA FUME+1%GF	3.7	4.42	4.95
10%BA+30% SILICA FUME+ 1.5%GF	4.1	4.91	5.63
10%BA+30% SILICA FUME+2%GF	3.5	3.81	4.12

FLEXURAL STRENGTH The size of specimens 100 mm x 100 mm x 500 mm was used and the specimens were cured in water. Concrete specimen beams are used to determine flexural strength of concrete and were tested as per as per IS 516 (1959)

EFFECT OF STEEL FIBER ON FLEXURAL STRENGTH USING BAGASSEASH AND SILICA FUME

Flexural strength of concrete keeping 10% bagasse ash and 30% silica fume as constant and with different percentages of Glass Fibre for curing period of 7-days, 14-days and28-days respectively and TABLE 6.5 shows the summarized Split tensile strength Results for different curing periods– M35 grade

The Flexural strength of the concrete mix for M-35 with partial replacement of cement by SCBA and silica fume respectively showed higher Flexural Strength after 7 and 28 days. The 7 days and 28 days Flexural strength of mix with 10% partial replacement of Bagasse ash, 30 % replacement of silica fume and 1.5% of Glass Fibre showed higher strength compared to other mixes

Table 6.6 shows the effect of glass fiber on flexural strength using bagasse ash and silica fume

BA+ SILICA FUME+ GF	7 days	14 days	28 days
10%BA+30%SILICA FUME+0%GF	28.7	41.91	45.12
10%BA+30%SILICA FUME+1%GF	29.5	42.5	46.12
10%BA+ 30%SILICA FUME+ 1.5%GF	30.6	43.1	47.23
10%BA+30% SILICA FUME+2%GF	29.3	42.3	45.6

From the results it is evident that with the increase of fibre content the tensile nature of the concrete also increases results in higher values compared to that of Plain concrete

The figure shows that the test results of splitting tensile strength of specimens after water curing, it is concluded that the percentage increase in strength increases with the increase in percentage of fiber content. Also, from the results it is evident that compressive and flexural strength also increases with the increase of fiber content.

V. CONCLUSIONS

The Conclusions and Recommendations that could be drawn from the results of this project and experiments are summarized and the use of Bagasse ash and silica fume as a cement replacingmaterial in concrete production was studied and after the research work is done, the following conclusions were made:-

1. It has been observed that by the incorporation of SCBA & silica fume as partial replacement to cement in fresh and plain concrete increases workability when compared to the workability with reference to concrete made without SCBA & silica fume
2. SCBA concrete performed better when compared to ordinary concrete up to 10% replacement of sugar cane bagasse ash
3. The bond strength exhibited improvement with bagasse ash replacement level. A 7.2% increase in the strength was observed when compared with conventional concrete for 28 days. Increase of strength is mainly to presence of high amount of Silica in sugarcane bagasse ash
4. The mix with replacement of cement with 10% SCBA and 30% silica fume has shown good strength properties like compressive and tensile and flexural strength. This may be due to the fact that the CSH gel formed at this percentage is of good quality and have better composition
5. The highest compressive strength value i.e. 45.12 MPa, was obtained for a mix having 10% bagasse ash and 30% silica fume
6. It is evident from the present investigation that the addition of Glass Fibres to concrete improve compressive strength, split tensile strength, flexural strength etc. of the mix
7. There was a 6.5% increase in the compressive strength and 48% increase in the tensile strength because of the high elastic modulus of Glass Fibre. Due to the high stiffness of Glass Fibres, resulted in a significant enhancement in split tensile strength
8. The use of SCBA and silica fume combined is economic when compared to cement in concrete. Likewise saves a great deal of waste disposal problems and reduces the cement price rise and intensities of CO_2 release by the cement production. Also these materials make the concrete more sustainable, light weight and low energy emitting which is noble.

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