To study the hardened properties of SCC by effectiveness range of SCBA of different regions

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ABSTRACT: - *Self compacting concrete (SCC) is a high performance concrete that can flow under its own weight to completely fill up the formwork and self consolidates without any mechanical vibration. Such concrete an accelerated the placement, reduce the labor requirement needed for consolidation, finishing and eliminate environment pollution. The so called first generation SCC is mainly for repair application and for casting concrete in restricted areas, including section that present limited access to vibrate. Such value added construction material has been used in this application to justify the higher material and control cost when considering the simplified placement and handling requirement of the concrete.*

For such application, the fresh concrete must possess high fluidity and good cohesiveness. The uses of fine material such as three different region Sugarcane Bagasse Fly ash (SCBA) ensure the required concrete properties. The initial results of an experimental program aimed at producing and evaluating SCC made with high volume of SCBA in river sand mix are presented and discussed. The process of selecting suitable ingredient of concrete and determining their relative amount with an objective of producing concrete of required strength as economical as possible is termed as concrete mix design. The mix design for concrete M40 grade is being done as per Indian Standard Code IS: 10262-1982. The self compacting mixtures had cement replacement of 10%, 20%, 30%, and 40% by SCBA. Tests are carried out on all mixtures to obtain the fresh concrete in terms of viscosity and stability. The mechanical properties of hardened concrete such as compressive strength, split tensile strength and flexural strength are also determined. The results show that an economical self compacting concrete could be successfully developed by incorporating high volume of SCBA.

(Keywords – Self compacting concrete, SCBA, Mix Design)

I. INTRODUCTION

Ordinary Portland cement is one of the important construction materials, now days it is need of time to find its replacement from industrial or agricultural waste. This will help in many ways, foreign exchange earnings environmental pollution control & also economy industrial waste such as blast furnace slag, fly ash, & silica fumes are being used. The residue from sugar industry is attempted to use. When waste is burned under controlled conditions it gives ash having amorphous silica having properties. Sugar cane production in India is oven 300 metric tons per year from which 10 million tons is unutilized & hence waste material. There are many studies related to the reuse of SCBA as supplementary cementations material in concrete & mortars. The use of SCBA in alkali – activated system was reported by tippy ash etc. they found that 100% BA was inappropriate to produce geo polymers because of their low compressive strength. Some fly ash SCBA mixture was activated by means of 40% activating solution & compressive strength.

II. SCOPE OF WORK

Initially self compacting concrete is not popular because its high cost compared to conventional concrete but now days several researcher institute and construction companies have undertaken research and development work on SCC.

In India SCC was introduces in nineties, but the development of SCC is still in its infancy state and it is used on special project only. Multinational construction companies were facing the problems labour requirement, time constraint, and concrete placing difficulties then SCC method rises in Indian sub-continent.

Recent most of construction industries conventional cement concreting has been done in cast in-situ are frequently used. Conventional concrete casting required external energy to ensure adequate strength and durability. In 1988 Okamura in Japan first introduce the need of SCC to overcome the problem like increase the production time, unavailability of skilled labour, unhealthy environment and durability of concrete etc. SCC concrete flows through the congested reinforcement gap and fill the every corner of the moulds without external energy and compaction at the time of placing of concrete. Although the concept of SCC was developed to enhance the long term durability of concrete structure having congested reinforcement, the distinct-user friendly properties of SCC being attracted greatly in the traditional construction industry also.Generally SCC from production to application is very complex process already. But it is necessary to partial replacement of bagasse fly ash in concrete for a performance growth of SCC. This work planned to fulfillment the following quarries in this regard.

- For achieving self compatibility in mix design of SCC what should be the mix proportion in concreting.
- To optimize the bagasse fly ash proportion for the overall performance of SCC.
- Examine the impact of adding bagasse fly ash by partial replacement of cement at the ratio of 10%, 20%, 30%,

40%, by weight on the fresh and hardened properties of SCC.

- If no, what optimum percentage of bagasse fly ash can be replaced in concrete to achieve the strength?
- If any impact of different region bagasse fly ash to achieve the fresh and hardened properties of SCC.

III. SUGARCANE BAGASSE FLY ASH

In SCC mineral admixture are commonly used due to the need for large extent of the fine particles. It helps to improve the workability, heat of hydration reduces, and material cost also reduces by the partial replacement. These are supplementary cementations material which gives the desirable characteristic of the concrete mix which also helps in enhance the fresh and hardened properties of SCC. The properties of bagasse fly ash are listed below.

Table.1:-Bagasse composition (mass in %)

Cellulose	Hemicelluloses	Lignin	Ashes	References
50	25	25	0.62	Cordiero, et al.2004
38	33	22	3	Trikett,R.C,Neytzell-dewildeF.G.1989
37	28	21	-	Bon, E.S.B. 2007
26-47	19-38	14-23	1-5	Paturua J.M. 1989

Table.2:- Physical properties of bagasse fly ash

Properties	Values
Specific gravity	2.20
Colour	Black
Density(gm/cm^3)	1.20
Moisture content	6.28%

Table.3:- Chemical properties of bagasse fly ash

Component	% Mass
Silica (SiO_2)	52.65 ± 9.5
Calcium (CaO)	4.9 ± 2.9
Potassium (K_2O)	12.1 ± 2.3
Iron (Fe_2O_3)	7.5 ± 4.3
Sodium (Na_2O)	3.8 ± 1.2
Aluminum (Al_2O_3)	22.8 ±5.4
Magnesium (MgO)	1.3 ± 0.7
Titanium (TiO_2)	<0.06
Loss of ignition	2.6 ± 2.4

IV. MIX DESIGN

The concrete mix design the process of proportioning and selecting suitable ingredient of concrete for finding out their appropriate strength, durability, and as economical as possible. The performance of concrete that is plastic state and hardened state of concrete is mainly depending upon the proportioning of the ingredient

Design of M40 grade concrete -

- Grade designation M40
  Type of cement – OPC 53 grade confirming
  Minimum cement content-320 kg/m^3
  Maximum cement content – 450 kg/m^3
  Maximum size of course aggregate - 20mm
  Maximum water cement ratio – 0.45
  Workability – 100 mm slump
  Exposure condition – moderate
  Degree of supervision – good
  Types of aggregate – crushed
- Test data for materials
  Cement used – OPC 53 grade
  Chemical admixture - CONPLAST SP 430 RV
  Specific gravity of CA - 2.68
  Specific gravity of FA – 2.65
  Free moisture – Nil for both CA and FA
  Fine aggregate – confirming to grading zone II of table 4 of IS: 383
- Target mean strength for mix proportion –
  F'ck = fck + 1.65 S
  F'ck = 40 + 1.65 × 5
  F'ck = 48.25 N/mm2
- Selection of water cement ratio – from table no 5 of IS 456, maximum w/c ratio = 0.45
- Selection of water content – from table no 2 of IS 10262:2009
  Maximum water content = 186 lit (for 25-50 mm slump)
  Estimated slump for 100 mm slump = 180 + 0.06 × 186 =197 lit
  As superpasticizer is used the water content can be reduced up to 30 %
  Therefore, based on trial with SP the water content = 197 × 0.70=140 lit
- Calculation of cement content -
  Water cement = 0.40
  Cement content = 140 ÷ 0.4 = 350 kg/m3 >320 kg/m3
- Proportion of volume of coarse aggregate and fine aggregate content –
  Volume of CA = 0.62 × 0.9 = 0.56
  Volume of fine aggregate = 1-0.56=0.44
- Mix proportion
  The mix calculation per unit volume of concrete shall be as follows
  Volume of concrete = 1 m3
  Volume of cement = (350÷3.15) × (1 ÷ 1000) = 0.111m3
  Volume of water = 140) × (1 ÷ 1000) = 0.140 m3
  Volume of chemical admixture = (7 ÷ 1.145) × (1 ÷ 1000) = 0.006 m3

Volume of all aggregate = 1- (0.111+0.140+0.006)
Mass of course aggregate = volume of CA × Specific gravity × 1000 = 1140 kg
Mass of fine aggregate = 0.743 × 0.56 × 2.74 × 1000 = 896 kg

- Therefore, mix proportion of trial mix
  Cement = 350 kg/m³
  Water = 140 kg/m³
  Fine aggregate =896 kg/m³
  Course aggregate = 1140 kg/m³
  Chemical admixture = 7 kg/m³
  W/C ratio = 0.40

V. EXPRIMENTAL WORK OF SCC

Proportion of fresh concrete

Table.4:-Typical Acceptance Criteria for SCC [6]

Sr. No.	Method / Test	Typical Range	Unit
1	Slump Flow Diameter	650 to 800	Mm
2	$T_{50\,cm}$ Slump Flow	2 to 5	Sec
3	V-Funnel Flow	8 to 12	Sec
4	V-Funnel at T_5 min. Flow	8 to 15	Sec
5	L-Box Ratio	0.8 to 1.0	H2/H1

By conducting above tests, the handling ability i.e. workability of freshly mixed of SCBA in percentage by weight replacing cement, can be analyzed for optimization of SCBA content and also compared the result of river sand.

Testing of hardened properties

Therefore after determining the properties of fresh concrete an extensive test work was implemented to test characteristic strength of M40 grade of concrete containing 0%, 10%, 20%, 30%, 40% SCBA and different mixes of river sand. In this batching for 3 cubes is done as per M40 mix design with percentage cement replaced by SCBA. The following properties are then tested in the well establishment and working laboratory set in the standard manner.

Compressive strength

The compressive strength of M40 grade concrete containing percentage replaced cement by SCBA (by weight) with different mix river sand are tabulated below one by one. The strength of one cube determined after 7 days and two cubes tested after 28 days.

Table.5:-Region I SCBA Compressive strength of River sand mix

Amount of fly ash (%)	Compressive strength (N/mm²)		
	Days 14	28 Days	Average 28 days
0	19.3	42.4	42.15
		41.9	
10	22.7	45.6	45.84
		46.07	
20	21.5	42.3	42.25
		42.2	
30	20.5	41.7	41.95
		42.2	
40	18.3	37.5	38.1
		38.7	

Table.6:-Region II SCBA Compressive strength of River sand mix

Amount of fly ash (%)	Compressive strength (N/mm²)		
	14 Days	28 Days	Average 28 days
0	19.7	43.0	42.85
		42.7	
10	23.1	46.1	45.95
		45.8	
20	21.9	42.9	43.05
		43.2	
30	20.8	41.8	42.05
		42.3	
40	18.6	38.2	37.75
		37.3	

Table.7:-Region III SCBA Compressive strength of River sand mix

Amount of fly ash(%)	Compressive strength (N/mm²)		
	14 days	28 Days	Average 28 days
0	21.5	43.0	42.85
		42.7	
10	23.4	46.1	45.95
		45.8	
20	22.1	42.9	43.05
		43.2	
30	20.6	41.8	42.05
		42.3	
40	18.9	38.6	38.3
		37.9	

The compressive strength of the different mixture of river sand with replaced cement by percentage (in weight) of SCBA shown in above table. The compressive strength decreases with an increase in the percentage of SCBA. Apart from mixture of river sand with 40% SCBA of 3 regions, all the remaining mixtures achieved the targeted 28 days strength approximately 40Mpa.
The above results also conclude that the cheapest mixture that achieved the targeted 28 days compressive strength of approximately 40Mpa is the control concrete by the SCC made with 30 % SCBA in river sand. The typical development compressive strength for river sand with SCBA adding 0%, 10%, 20%, 30%, 40% , the test result at 14 days and 28 days it seen that the compressive strength of concrete increases in 10 % SCBA then decreases up to 40 % SCBA at different region. From the results clearly indicate that for a given water cement ratio, increases in 40% SCBA with river sand not achieved the targeted mean strength of concrete.
From 28 days average strength it comes to know that SCBA are responsible used up to 30% in river sand achieving targeted mean strength of M40 grade concrete. The compressive strength increased by using 10% SCBA at the age of 14 days and 28 days river sand mix after increasing percentage decrease the compressive strength. It also observed that tree different region SCBA has small change in compressive strength.

Split tensile strength

The cylinder is casted with 0%, 10%, 20%, 30%, 40% percentage of cement is replaced by SCBA (by weight) in river sand. The load is transferred through the loading device resulted in a clear split of the cylinder in two parts. The indirect tensile was measured on 150*300 mm cylinder and result are tabulated given below a total 40 cylinder were cast for different mixes. The tested value at the 14 days and 28 days was reported the split tensile strength is shown in tables.

Table.8:-Region I SCBA split tensile strength of River sand mix

Amount of fly ash (%)	Split tensile strength (N/mm^2)	
	14 days	28 days
0	2.71	3.97
10	2.89	4.3
20	2.64	3.92
30	2.43	3.75
40	2.19	3.59

Table.9:-Region II SCBA split tensile strength of River sand mix

Amount of fly ash (%)	Split tensile strength (N/mm^2)	
	14 days	28 days
0	2.61	3.79
10	2.64	3.83
20	2.59	3.76
30	2.29	3.62
40	2.12	3.41

Table.10:- Region III SCBA split tensile strength of River sand mix

Amount of fly ash (%)	Split tensile strength (N/mm^2)	
	14 days	28 days
0	2.64	3.88
10	2.73	3.92
20	2.66	3.83
30	2.31	3.69
40	2.20	3.61

From the split tensile test results observed that tensile strength of mixes increases with 10% replacement of SCBA compared with the river sand. The split tensile strength is gradually decreases after 20% SCBA replacement. Self compacting concrete has attained lesser split tensile strength than that of the conventional concrete, it is due to the use of percentage of SCBA replaced in the cement and to the slower Pozzolanic action of SCBA that decreases the split tensile strength at early stage. It is also conclude that for a given strength split tensile strength mainly depends upon the paste composition of the mixture and secondary on the CA content, it is analyzed that more content CA higher the split tensile strength.
The split tensile strength of river sand mix SCBA 20% at the age of 28 days has decreases its strength by 1.25%, 0.79%, 1.28% when compared with the nominal mix of SCBA region I, II, III respectively
The split tensile strength of river sand mix SCBA 10% at the age of 28 days has increases to its strength by 1.61%, 1.14%, 1.20% when compared with the nominal mix of SCBA region I, II, III respectively.

Flexural strength of beam

The flexural strength values obtained by testing standard cubes with different mixes of 0%, 10%, 20%, 30%, 40% SCBA with river sand and. The shallow beams of 150mm depth have the flexural resistance tested under one point

loading. The simple support carrying these FASCC with river sand beam less flexural strength as compared with nominal mix of river sand, so as to carry the maximum load till its failure. The surface observed after failure showing crack formation at bottom side that is tension side of the beam. The early crack width formation is in case of SCBA concrete beam as compared to nominal mix.
The casted M40 grade nominal mix SCC and SCBA SCC are tested under DUTM after completion 14 days and 28 days curing. The failure loads on digital display of DUTM and respective tensile strengths all observation are stated given in tables.

Table.11:-Region I SCBA Flexural strength of River sand mix

Amount of fly ash (%)	Split tensile strength (N/mm^2)	
	14 days	28 days
0	4.43	6.10
10	4.92	6.17
20	4.70	6.02
30	4.19	5.13
40	3.77	4.29

Table.12:-Region II SCBA Flexural strength of River sand mix

Amount of fly ash (%)	Split tensile strength (N/mm^2)	
	14 days	28 days
0	4.63	5.58
10	4.71	6.03
20	4.25	5.31
30	3.93	4.92
40	3.72	4.78

Table.13:-Region III SCBA Flexural strength of River sand mix

Amount of fly ash (%)	Split tensile strength (N/mm^2)	
	14 days	28 days
0	4.51	5.48
10	4.54	5.61
20	4.27	5.12
30	3.89	4.68
40	3.27	3.79

From the flexural strength and plotted graph, it is found to be increasing flexural strength with the addition of 10% SCBA in river sand. But it reduces when an increasing SCBA was added. From the flexural strength graph of the type of different region SCBA found to be different results. It also proved again that more than 20% SCBA are responsible to reduce the flexural strength of the concrete member ultimately.
It was observed that the flexural strength of SCBA 10% in river sand mix at the age of 28 days has increased the region first1.65%, second 3.09%, third 3.96% when compared with nominal mix. It also observed that the flexural strength of SCBA 20% in river sand mix at the age of 28 days has decreased the region first0.56%, second 1.23%, third 2.06% when compared with nominal mix.

VI. CONCLUSIONS

Now a day's SCC is a highly innovative and research concrete to be used in widely in most part of the countries. The present work has shown that it is possible to design SCC incorporating SCBA. The effectiveness of varying range of SCBA helps to modifying fresh properties of SCC up to certain extent. From the experimental work and analysis of result of finding in this project work, conclude the following facts are listed below.

- By using SCBA, in the mix of river sand it helps to reduce cement requirement up to certain extent and improve the workability.
- Exceeding segregation, bleeding by increase the chemical admixture, and chemical admixture gives better flow ability of concrete.
- In addition, partial replacements of ordinary Portland cement with agricultural waste such as SCBA. Contributes to useful disposal of the waste materials, and reduce the consumption of cement thus lowering adverse affect on the environment.
- The requirement of water increased as the percentage of SCBA got increased.
- The workability of the concrete is depending upon the percentage use of SCBA in the mix.
- It has been shown in this study that 30% SCBA can be used to achieve the targeted mean strength 40MPa in river sand mix.
- Expected test results were obtained as per mix design such as compressive strength, split tensile strength and flexural strength.
- The greater surface and larger average particle are highly suitable for the workability also enhance water absorption.
- The SCC can replace the control with 28 days compressive strength(40MPa) without extra cost
- The hardened property of three different regions SCBA has a different test results with small variation.
- From the compressive strength result concludes that the strength of river sand mixes with 10% SCBA increased

at the age of 14 days and 28 days may due to the Pozzolanic properties of SCBA.

- Various regions SCBA gives better compressive strength, flexural resistance showing its suitability in concrete work.
- The use of SCBA is not only beneficial in reducing cement content, but it helps to maintain workability of concrete.
- The increased dosage of chemical admixture concrete become Flowable but the extra dosage leads to segregation and bleeding.
- By using 40% SCBA in rives mix would not achieving the targeted mean strength of concrete.
- Experimental Remarks
- This experimental research forced to draw following experimental remarks as an outcome. The laboratory test results are summarized as follows.
- In terms of mix design, the self compacting concrete that achieved 28 days strength of approximately 40MPa was that made with 30% replaced in river sand by SCBA and with a water cement ratio of 0.5.
- The self compacting concrete develops compressive strength ranging from nominal mix 19.3MPa and 42.15MPa, 10%SCBA 22.7MPa and 45.84MPa, 20%SCBA 21.5MPa and 42.25MPa, 30%SCBA 20.5MPa and 41.95MPa, 40%SCBA18.3MPa and 38.1MPa of river sand mix at 14 days and 28 days respectively.
- The split tensile strength of river sand mix SCBA 20% at the age of 28 days has decreases its strength by 1.25%, 0.79%, 1.28% when compared with the nominal mix of SCBA region I, II, III respectively.
- The split tensile strength of river sand mix SCBA 10% at the age of 28 days has increases to its strength by 1.61%, 1.14%, 1.20% when compared with the nominal mix of SCBA region I, II, III respectively.
- The flexural strength of SCBA 10% in river sand mix at the age of 28 days has increased the region first1.65%, second 3.09%, third 3.96% when compared with nominal mix.
- The flexural strength of SCBA 20% in river sand mix at the age of 28 days has decreased the region first0.56%, second 1.23%, third 2.06% when compared with nominal mix.

VII. Scope of Future Work

Beyond this experimental research work workability characteristics can determined by conducting all other test to get more clarity in overall flexibility in workable concrete. In addition to this following points could be considered as an extensive of this work.

- For greater use of SCC can be solved by developing rational mix design method and appropriate testing method at the job site for self compatibility of concrete.
- For the use of SCC widely to promote the rapid diffusion of the technique.
- Expected to encourage the use of SCC with partial replacement of Portland cement with SCBA in high rise building.
- We will have succeeding in creating durable and reliable concrete by using different waste products could reduce the environmental problems and minimizing the requirement of landfills.

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