A Review on Self Compacting Concrete by utilizing Sugarcane Bagasse Ash: Future Concrete

Amreen Khatun[1], Khushpreet Singh[2]

[1]P.G student of Civil Engineering Department of Chandigarh University
[2]Astt. Prof. of Civil Engineering Department of Chandigarh University

---

***ABSTRACT** - The cement is most important component of the concrete mix for the construction work. And cement is the second highest consumed material in the world after water. But we are aware that it leads to lot of damage to the environment because the manufacturing process of cement produces carbon dioxide. It has been found by the researcher that every 1 tone of the cement manufacture release half tone of carbon dioxide, so it is very importance to take an immediate action to control this. As the consumption and demand of the cement is increasing day by day so it is very important to find an alternate binding material that can replace cement. The agricultural waste Sugarcane Bagasse Ash (SCBA) can be used as a binding material in this study. Utilization of SCBA in concrete for different composition like 0%, 5%, 10%, 15%, 20% and 25% is determined in this study.*

KEYWORDS: Sugarcane Bagasse Ash (SCBA), Binding Material, Agricultural Waste, Concrete.

1. INTRODUCTION:

Agro wastes are used as a construction material in the concrete mix. Agro waste which is also called as agricultural waste such as rice husk ash, wheat straw ash, hazel nutshell and sugarcane bagasse ash are used as pozzolanic materials for the development of concrete and mortar [1]. Sugarcane which is the major crop grown in over 110 countries and total production of sugarcane is over 1500 million tons. Total production of sugarcane is in India is over 300 million tonnes per year. This processing of sugarcane in sugar-mill generates about 10 million tonnes of Sugarcane Bagasse ash as a waste material. Approximate 26% of bagasse and 0.62% of residual ash can obtained from one tonne of sugarcane. After combustion the residue presents a chemical composition dominates by silicon dioxide [2-3].

In the year of 2009, the total production of sugarcane in the world was estimated approximately 1661 million tonnes. The largest production of sugarcane is in Brazil and second largest production of sugarcane is in India [4-5]. All the economical sugar is extracted from the sugarcane and after this extraction of sugar about 40%-45% fibrous residue was obtained. That obtained residue is reused in the same industry for the purpose of heat generation which produces 8%-10% of ash as waste, which is called as Sugarcane Bagasse Ash (SCBA). It contains high amount of un-burnt matter, silicon, aluminium and calcium oxides [6-7]. This paper deals with the history of SCC development and its basic principle, different testing methods to test flow ability, resistance against segregation, comparison with ordinary concrete or conventional concrete, and the future of SCC in the construction work.

1.1 DEVELOPMENT OF CONCRETE BY SUGARCANE BAGASSE ASH:

Ganesan et al. [1] studied the effects of Sugarcane Bagasse Ash content as partial replacement of cement as (0%, 5%, 10%, 15%, 20% and 25%) on physical and mechanical properties of hardened concrete. The properties of concrete were investigated by performing different tests like Compressive strength test, Flexural strength, Split tensile strength, water absorption, permeability characteristics, chloride diffusion and resistance to chloride ion penetration. All the tests were performed and carried out according to the Indian Standard (IS). It was found from the test results that Sugarcane Bagasse Ash is an effective mineral admixture and the usage of Bagasse Ash up to 20% as a partial replacement is advantageous.

The pozzolanic reaction may lead to the increase in strength of concrete [8-13].

Kawade et al. [3] studied the effect of Sugarcane Bagasse Ash by partially replacement of cement at the ratio of 0%, 10%, 15%, 20% and 25% on strength of concrete by weight for compressive strength. If any of raw material having the same composition then that material can be replaced by the weight of cement in concrete, so that it could reduce the cost without affecting the quality [14]. In this study it was found that up to 15% of replacement

of Bagasse ash by weight of cement in concrete is advantageous. It was also found in this study that partial replacement of Sugarcane Bagasse Ash (SCBA) with cement increases the workability of fresh concrete, so that the usage of Superplastisizer is not essential in concrete.

2. Scope of the Self Compacting Concrete in future:

Self-Compacting Concrete was first developed in the year of 1988 to achieve a durable concrete for the construction work by improving the quality of construction processes [15]. SCC finds the special applications in the construction work in some places like highly reinforced columns of the construction work, congested reinforced sections, rafts and the places where ordinary vibrated concrete or conventional concrete is not effectively utilized. According to the recent studies done on the Self Compacting Concrete by the researchers they concluded that the SCC would replace the ordinary vibrated concrete or Conventional concrete in the near future altogether. Therefore, Self-Compacting Concrete can also be called as the future concrete.

Self-Compatibility of the concrete is one in which the concrete can be placed and compacted under its own weight, which means no external force is required to place this type of concrete except gravity. For this reason SCC can be placed in every comer of formwork without applying any vibration causing no segregation. According to the researchers in the previous studies they have made, the elasticity modulus have high value for the studied cases so it proves that SCC are not very deformable ones, so that they can be applied for precast structures with large spans. SCC is a way forward to both in situ and precast construction of work.

3. Advantages of SCC:

a.) Use of Self Compacting Concrete helps in minimizing hearing related problems at the construction site because vibrators are not used to compact the concrete.

b.) It also reduces the time required to place the concrete for large sections because the high workability of SCC provide an ease to do work at site.

c.) Self Compacting Concrete increases the reliability of the structure and also reduces the number of workers at the construction site [16].

d.) This concrete is highly effective to reduce the noise at the site because vibrators are not required at the construction site.

e.) Minimizes voids on highly reinforced areas [17].

f.) It is recommended foe deep sections and long span applications.

g.) SCC produces superior surface finishes [18].

4. Materials and Methods:

4.1 Step1: Introduction of material used and the preliminary investigation:

Concrete is a mixture of some materials, which is composed of Fillers and Binders. It is a Composite material in which Coarse aggregates (Fillers) are imbedded in a hard matrix of material which is Cement (Binder) which fills the space between the material and bind them together. The simplest representation of concrete can be = Filler + Binder, and the composition can be represented as follows:

Cement paste + Water → Mortar

Mortar + Aggregates → Concrete

Step 2: Material Used:-

Cement: Cement is the main component of concrete mix which consists of some binding properties. Therefore it is also known as the binder of concrete which binds the material together. In this study Ordinary Portland Cement (OPC) of 43 Grade is used. Some constituents of cement are:

Calcium oxide (lime) → CaO

Iron oxide → Fe_2O_3

Silicon dioxide (silica) → SiO_2

Water → H_2O

Aluminium oxide (alumina) → Al_2O_3

Sulphate →SO3

Coarse Aggregates: The crushed aggregates of nominal maximum size of 10mm – 20mm were used. Specific Gravity and Fineness Modulus of aggregates were taken within the permissible limit according to the Indian Standard (IS: 10262 and IS: 383).

Fine Aggregates: Fine aggregates used for this study was according to Indian Standard, which satisfy the requirements of the experimental work. Fine aggregates were taken by doing sieve analysis as per the specifications of IS: 383 were used for this study. Fineness Modulus and Specific Gravity of Fine Aggregates were also taken according to (IS: 10262 and IS: 383).

Water: Clean Portable water is used and the curing was done according to IS: 456:2000.

Bagasse Ash: The ash obtained by burning the bagasse after extracting the economical sugar is normally known as the Bagasse Ash. This contains some cementitious properties like Silica oxide, Calcium oxide, Iron oxide, Magnesium oxide and Alumina oxide. So it can be easily replaced with cement as a partial replacement for comparing the results on strength of concrete after performing certain tests on it. Since Bagasse Ash is rich in Silica so it is advantageous to replace cement partially with this ash.

Factors to Be Considered In Mix Design:

1. Grade of concrete
2. Type of cement
3. Type & size of aggregate
4. Type of mixing & curing
5. W/C ratio
6. Workability

7. Density of concrete

8. Air content

Size of the cube taken to perform the test was 150mm × 150mm × 150mm.

Step 3 and 4: Casting & Curing of Specimens:-

Standard size of cube for casting the specimens is (150x150x150) mm. Casting will be done by taking different percentage of SCBA. After casting the specimens curing is done according to Indian Standard code and testing of cubes is done after 7days, 14days and 28days as per the requirements of the experimental work.

Step 5: Testing of concrete specimens:- After curing is done the testing of the specimens is done in three stages:

Stage 1. Testing after 7 days of curing.

Stage 2. Testing after 14 days of curing and

Stage 3. Testing after 28 days of curing.

4.2 Test Adopted:- Various tests were adopted to find out the properties of fresh and hardened concrete are given as follows:

A.) Tests Performed on the fresh concrete are:

Slump test

V-Funnel test

L Box test

B.) Tests performed on the hardened concrete:

Compressive Strength Test

Split Tensile Strength Test

Flexural Strength Test

Sulphate Attack Test

Abrasion Test

5. Results and Discussions:

Table1: showings the results at the Age of 28 Days for M20 Grade:

S.NO	% of SCBA	Author Name	Compressive Strength(Mpa)
1.	10%	Prashant O Modania, M R Vyawahare (2013)	23.85
2.	15%	Abdolkarim Abbasi and Amin Zargar (2013)	25
3.		Prashant O Modania and M R Vyawahare (2010)	24.7
4.		Prashant O Modania and MR Vyawahare (2013)	24
5.	20%	M. Sivakumar and Dr. N. Mahendran (2013)	18.76

Table 2: showing the results at the age of 28 days for M30 Grade:

S.NO.	% of SGBA	Author Name	Compressive Strength (Mpa) M30
1.	10%	-	-
2.	15%	V. Horsakulthai et.al(2011)	24.7
3.		Lavanya M.R et.al(2012)	24
4.	20%	H. S. Otuoze et.al(2012)	22.12
5.		-	

Table 3: showing the results at the age of 28 days for M35 Grade:

S.NO	% of SCBA	Author Name	Compressive Strength in Water(Mpa)	Compressive Strength in HCL
1.	0%	Balaji Kvgd (2015)	45	42.5
2.	5%	Balaji Kvgd (2015)	48.8	43.5
3.	10%	Balaji Kvgd (2015)	52.3	51.33
4.	15%	Balaji Kvgd (2015)	48.5	40.5
5.	20%	Balaji Kvgd (2015)	44.83	40
6.	25%	Balaji Kvgd(2015)	43.66	30.66

Table 4: showing the results at the age of 28 days for M40 Grade:

S. NO	% of SCBA	Author Name	Compressive Strength(Mpa)
			28 Days
1.	10%	K. Ganesan et.al (2007)	42
2.	5%	B. Radke (2012)	43
3.		K. Montakarntiwong et.al (2013)	44
4.	20%	N. Chusilp et.al (2009)	44.5
5.		R. Somna et.al (2012)	41.5

Above given data in different tables is showing the results for compressive strength of concrete specimens, tested at the age of 28 days of curing. Concrete prepared for casting the cubes by using different % of Sugarcane Bagasse Ash and then different results were obtained and values of compressive strength were compared in this study.

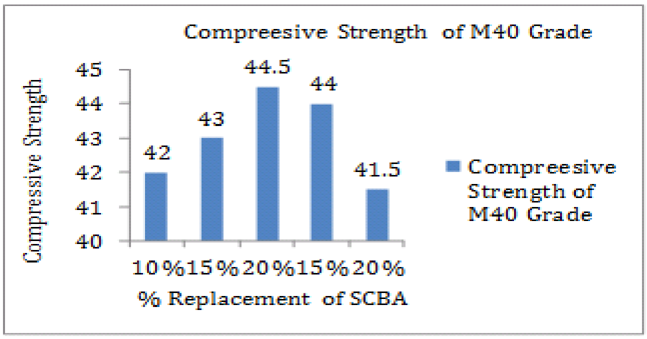

Chart-1: Graphical Representation of M40 Grade Compressive Strength.

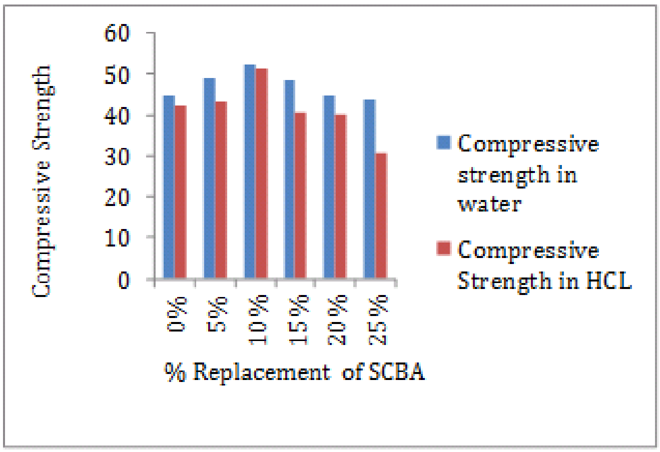

Chart-2: Graphical Representation of M35 Grade Compressive Strength.

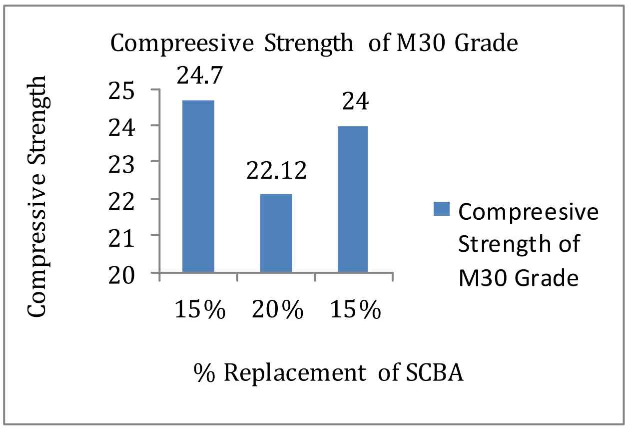

Chart-3: Graphical Representation of M30 Grade Compressive Strength.

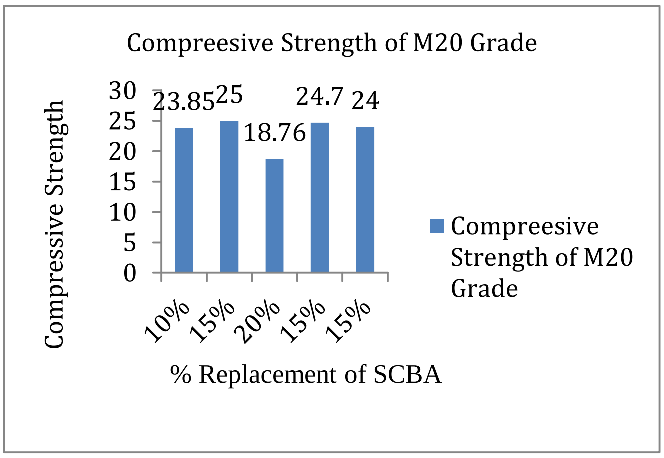

Chart-4: Graphical Representation of M20 Grade Compressive Strength.

These charts are graphical representations of the data given in the tables and representing the values for compressive strength for different grades of mix when tested after 28 days of curing.

6. Conclusion:

1. Replacement of 10% sugar cane bagasse ash performed better when compared to Ordinary Concrete when tested for M35 Grade.

2. Increase of strength is mainly due to the presence of high amount of Silica content in Sugarcane Bagasse Ash.

3. Compressive strength is decreased for concrete cured in 5% of HCL solution compared with the concrete cured in normal water as per the results shown in the compassion in table 3.

4. Compressive strength is increased for 28 days when cured in normal water, compressive strength is reduced very low acid attack after cured of 28 days in HCL solutions.

5. Utilization of the waste material Sugar Cane Bagasse ash is advantageously used as a partial replacement of cement in the preparation of concrete.

6. Replacement of 15% of Baggase Ash as a partial replacement with cement performed better compressive strength when tested for Grade M30 and M20 shown in table 1 and table 2.

7. Replacement of 20% Baggase Ash performed better Compressive Strength of M40 Grade of mix when tested, after 28 days of curing in normal water as shown in the table 4.

8. So, as per the data given above it can be concluded that the replacement of Sugarcane Baggase Ash with cement for different proportions as a partial replacement is advantageous and it also increases the durability and strength of the concrete as compared to the ordinary concrete.

REFERENCES:

1. Ganesan, K., Rajagopal, K., and Thangavel, K. “Evaluation of bagasse ash as supplementary cementitious material” Cement and Concrete Composites, 2007.

2. Nuntachai Chusilp, Chai Jaturapitakkul, Kraiwood “Utilization of bagasse ash as a pozzolanic material in concrete” Construction and Building Materials 23 (2009) 3352–3358.

3. Mrs.U.R.Kawade, Mr.V.R.Rathi, Miss Vaishali D. Girge, “Effect of use of Bagasse Ash on Strength of Concrete”, ISSN: 2319-8753 Vol. 2, Issue 7, July 2013.

4. Abdolkarim Abbasi and Amin Zargar, “Using Baggase Ash in Concrete as Pozzolan”, Middle-East Journal of Scientific Research 13 (6): 716-719, 2013.

5. Prashant O Modania, M R Vyawahare, “Utilization of Bagasse Ash as a Partial Replacement of Fine Aggregate in Concrete”, Procedia Engineering 51 (2013) 25 – 29.

6. Rattapon Somna , Chai Jaturapitakkul ,Pokpong Rattanachu, Wichian Chalee, “Effect of ground bagasse ash on mechanical and durability properties of recycled aggregate concrete”, Materials and Design 36 (2012) 597–603.

7. Kawee Montakarntiwong, Nuntachai Chusilp, Weerachart Tangchirapat, Chai

Jaturapitakkul, “Strength and heat evolution of concretes containing bagasse ash from thermal power plants in sugar industry”, Materials and Design 49 (2013) 414–420.

8. Hernandez JM, Middendorf B, Gehrke M, Budelmann H. “Use of wastes of the sugar industry as pozzolana in lime-pozzolana binders: study of the reaction”. Cem Concr Res 1998; 28(11): 1525–36.

9. Singh NB, Singh VD, Sarita Rai. “Hydration of bagasse ash – blended Portland cement”. Cem Concr Res 2000; 30:1485–8.

10. Hernandez JM, Rodriguez BS, Middendorf B. “Pozzolanic properties of residues of sugar industries”. Mater de Construction 2000; 50(260):71–8.

11. Hernandez JM, Rodriguez BS, Middendorf B, “Pozzolanic properties of residues of sugar Industries”. Mater de Construction 2001; 51(261):67–72.

12. Paya J, Monzo J, Borrachero MV, Pinzon DL, Ordonez LM. “Sugarcane bagasse ash (SCBA): studies on its properties for reusing in concrete production”. J Chem Tech Biotech 2002; 77(3):321–5.

13. [20] Cordeiro, “Influence of mechanical grinding on the pozzolanic activity of residual Sugarcane bagasse ash”. In: Vzquez E, Hendricks ChF, Janssen GMT, editors. Proceeding of international RILEM conference on the use of recycled materials in building structures; 2004. Nb reference 18.

14. R.D.ToledoFilho, L.M. Tavares, E.M.R. Fairbairn, “Pozzolanic activity and filler effect of sugarcane bagasse ash in Portland cement and limemorters”, Cement and Concrete composites, vol. 30, pp410-418, 2008.

15. Ozawa K, Maekawa K, Kunishima H, Okamura H. Performance of concrete based on the durability design of concrete structures. Proc Second East Asia-Pacific Conf Struct Eng Const 1989; 1:445–56.

16. https://www.thebalance.com/self-compacting-concrete-844767

17. https://www.thebalance.com/self-compacting-concrete-844767

18. https://www.thebalance.com/self-compacting-concrete-844767

19. https://www.researchgate.net/publication/288165926

20. https://www.researchgate.net/publication/288165926

21. https://www.researchgate.net/publication/288165926

22. https://www.researchgate.net/publication/288165926

23. International Journal of Advanced Research in Education & Technology (IJARET) 256 Vol. 3, Issue 2 (April - June 2016) ISSN: 2394-2975, ISSN: 2394-6814

24. Volume 6, Issue 4, April (2015), pp. 94-106_ IAEME: www.iaeme.com/Ijciet.asp Journal Impact Factor (2015): 9.1215 (Calculated by GISI) www.jifactor.com