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A Review on Properties of Self Compacting Concrete using Bagasse Ash

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Abstract- Where the placing and compaction of concrete are difficult (such as structural element jacking, filling near retaining structure) self-compacting concrete play a vital role in these condition. Self-compacting concrete (SCC) is widely used where the ability of flow and self-compaction is required. Main benefit of these concrete (SCC) is to save labour cost and minimize the construction time. In the view of materials, there is slightly different from commonly used material for construction. The coarse aggregate used in SCC is taken less i.e. up to 50 per cent. Bagasse ash is used as a partial replacement for cement. The research work is done, by considering the variation of water cement ration from 0.25 to 0.35 and the percentage of bagasse ash varies from 10 to 20 per cent. For defining the flow-ability of SCC slump test, V –funnel, U-box test and L- box test had conducted. The value of horizontal slump flow varies from 560 to 760 mm. The flow time in V- funnel test varies from 8 to 12 second is taken satisfactory.When the bagasse ash is used up to limited range from 10 to 20 per cent slump flow gradually decreases but when super plasticizer is used there will be improvement in slump flow. By the use of bagasse ash the compressive strength will also increase at lower w/c ration 0.275 and with 15% bagasse ash. When we further increase in the bagasse ash per cent there is very less increase in compressive strength.

Keyword: self-compacting concrete, Bagasse Ash, slump flow, flow ability, compressive strength, super plasticizer.

I. INTRODUCTION

Now a days self-compacting concrete (SCC) is widely used due to its various properties such as compressive strength, flow ability and durability. SCC is that concrete which flow each and every corner or at difficult place and where compaction is not easy to do. Main advantage of using SCC is reducing labour cost and minimizing the construction time. Commonly used materials in SCC are cement, coarse aggregate, fine aggregate, water and admixture.

The research work on SCC is still continuing with many reasons such as durability, permeability, flow ability and compressive strength. The main aim is to increase compressive strength and the use of super plasticizer as admixture allows decreasing the water- cement ratio up to 0.3 or lesser.

In self-compacting concrete, the coarse aggregate is limited to approximately 50 per cents, whereas in the conventional concrete it varies from 70 to 75 per cent, this is the main difference between SCC and conventional concrete. In SCC, the compaction machine is not required.

The bagasse ash is obtained from the sugarcane, which is the by-product of sugar industry. The by-product of sugar industry is burn at the sugar mill to make it use for a different purpose. It is used for replacing the cement, in limited amount. This bagasse ash has pozzolanic property. Mainly it is the wastage of sugar industry, it contains a high amount of silica about 70 to 85 per cent. It is tested in various part of the world for use as cementitious material.

By the use of bagasse ash as cementitious material it reduce the amount of super plasticizer required, improve the yield stress and flow-ability. This paper is mainly for studying the workability and compressive strength of SCC by partial replacement of cement with bagasse ash.

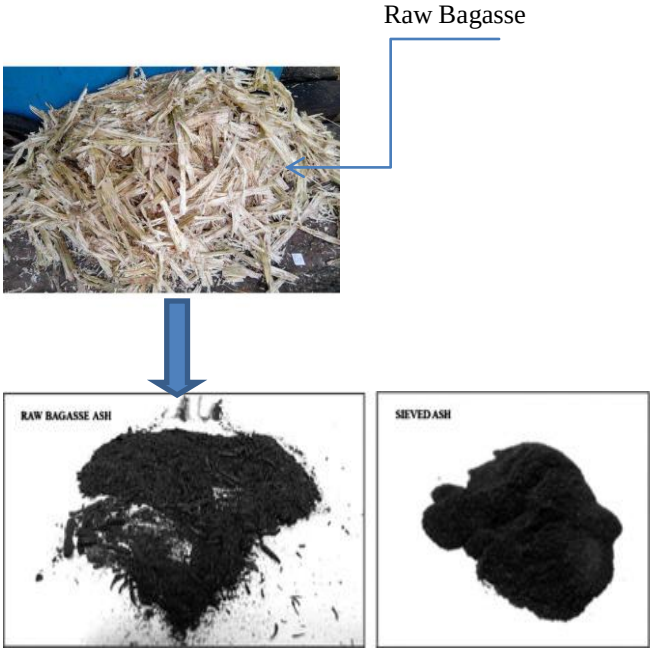

Figure1sugarcane bagasse conversion to bagasse ash.

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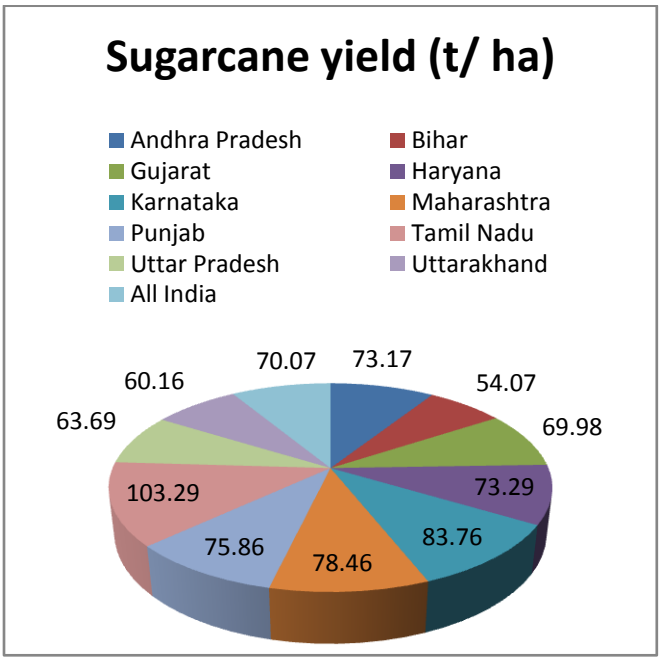

Figure 2 State wise Sugar yield TE2016-2017

Source: CACP calculation using data from directorate of sugar (DFPD)

II. Review of Literature

Thirumalai Raja Krishnaswami et al proposed that for the hydration process, the physical and chemical composition of bagasse ash and rice husk ash is mainly responsible. In the point of workability, the fineness and specific surface area of this material is highly responsible. After 30 minutes of slump flow test give the effective value of 8 % replacement with rice husk and for the combination of bagasse ash and rice husk. The compressive strength test, tensile strength test, durability test and flexural strength test gives a positive result with these amounts of addition of rice husk and bagasse ash. By the use of the rice husk and bagasse ash as cementitious material, it will lower down the adverse effect on the environment and subsidize to useful dumping of these waste materials.

HardikUpadhyay et al in 2011 carried out research on a "testing and mix design method self compacting concrete". The paper was all about the basic principle, different test technique, the history of SCC, resistance of segregation and passing ability. In this paper there was discussion on various design mix by using different ingredient's and how self compacting concrete is influenced by the material property and mix proportion. For passing ability of concrete from heavy reinforced region the amount finer material in more the coarse aggregate.

Duc-Hien Le et al in 2018 proposed environment friendly concrete by using a combination of agro and industrial waste. In this research work sugarcane bagasse ash(SBA), granulated blast furnace slag (BFS) and ordinary Portland cement are used in self – compacting concrete and their fresh and hardened characteristic is examined through an experimental work. The SCC tested for different content of bagasse ash (SBA) such as SBA10, SBA20 & SBA30 corresponding to replacement of cement in the same percentage. After that in same way blast furnace slag (BFS) was also added in different per cent and being tested. The combination of these two materials was used. Slump flow, V- funnel, L- Box test and setting time were measured to determine fresh properties. For hardened properties compressive strength, ultrasonic pulse velocity, sulphate attack, water absorption was determined. By adding SBA or BFS or combined, in place of cement will reduce the flowability. 30% SBA and 30% BFS improve the compressive strength and enhance the resistance to sulphate attack.

Syed MinhajSaleemKazmi et al in 2017 studies the behaviour of sugar cane bagasse ash (SBA) and investigation of controlling Alkali Silica reaction (ASR). For improving the properties of concrete, pozzolanic material is used all around the world. To reduce the ASR by using SBA, mortar bar specimens were prepared with different doses of SBA (10%, 20%, 30% & 40% by weight of cement). Thermal analysis and strength activity index test were performed to study the behaviour of SBA. When the cement has partially replaced SBA, the mortar bar expansion reduces. When 40% SBA was used maximum reduction in mortar bar expansion observed that leads to control ASR. The replacement of cement with SBA induced dense structure with no sign of cracking and ASR.

SeyedAlireza Zareei[1], Farshad Ameri[2], Nasrollah Bahrami[3] has proposed the uses of bagasse ash (SBA) as partial replacement of cement. In research work the mixes were prepared with different proportion of SBA such as 5, 10, 15, 20 & 25% added in place of cement (by mass of cement). Workability, compressive strength, impact resistance, water absorption and ultrasonic pulse velocity (UPV) were performed to determine the mechanical properties of concrete sample. When the cement is placed by SBA the test result shows improvement in strength and impact resistance as compared to control concrete. The durability and quality of SCC can also improve by using SBA. Due to carbon content and irregular & porous material in SBA the water demand increase with increasing the quantity of SBA.

Hanafiah[1], Saloma[2] and PutriNurulKusuma Whardhani[3] in 2017 study the behaviours of SCC using SBA. Mainly the workability of SCC by conducting the test such as slump

flow, V- funnel, L-Box test were taken into consideration at different W/C ratio. It was found that at higher W/C ratio, large slump diameter obtained. More the amount of SBA was used the slump diameter decreased. Similarly in V-funnel test with higher W/C ratio the passing ability was good and take less time to flow through the V- funnel. When the amount of SBA increased the passing ability get decrease and time taken to pass concrete through apparatus increases. It was found that at W/C 0.30 & 15% SBA gives the satisfactory result. In case of compressive strength as W/C ratio increase the strength decreases. Beyond 20% of SBA replacement, the compressive strength starts decreasing. When the SBA was taken 15% by mass of cement & W/C 0.30 the maximum compressive strength was obtained. When the amount of SBA was increased beyond 20% or above it damages the chemical reaction in concrete.

Tayyeb Akaram[1], Shazim Ali Memon[2], Humayun Obaid[3] in 2009 studies the uses of bagasse ash to reduce the cost of SCC. In this paper, the aim was to find the suitable SBA and used as viscosity modifying agent in SCC. The use of bagasse ash provides the agro industry as environment friendly disposal of wastage and also reduces the cost. In this study the amount of cement and water content were kept constant. The test result provides the satisfactory value to develop low cost SCC using SBA. The SCC specimen using SBA were tested on compression testing machine after 28 days of curing and compared to the control concrete. It was found that both samples had compressive strength above 34 MPa. The cost of SCC with SBA was found 35.63 % less than that of control concrete.

Table 1.Comparision of the chemical composition of bagasse ash

S. no.	Authors and country	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	SO_3/ SO_4	K_2O	LOI
1.	A. Bahurudeen et al.,2014(India)	57.63	1.50	1.33	6.14	1.56	3.52	7.33	21
2.	GritsadaSua-iam et al.,2013 (Thailand)	65.26	3.65	6.91	4.01	1.10	0.21	1.99	15.32
3.	TyyebAkram et al.,2008 (Pakistan)	62.44	5.77	6.74	6.16	2.97	0.72	6.87	2.58
4.	Thirumalai Raja krishnasamy et al.,2015 (India)	51.47	-	9.33	1.01	24.04	6.70	3.18	-
5.	Hanafiah et al 2017 (Indonesia)	83.40	5.00	0.00	2.38	0.00	8.36	-	83.40
6.	Duc-Hein le et al 2018 (Vietnam)	53.2	3.00	6.89	3.451	2.821	-	7.076	22.9
7.	SeyedAlireza Zareei et al 2018 (Iran)	64.23	5.47	9.08	8.17	2.97	-	1.32	-
8.	Syed MinhajSaleemKazmi et al 2017 (Australia)	85.17	2.73	1.69	2.59	0.69	0.17	0.36	3.55

III Influence on the Fresh Properties of SCC

The fresh properties of SCC include the following test: slump flow, V- funnel, L-Box and U-Box test as per EFNARC specification.

i. The replacement of cement with 20% SBA (by mass of cement) gives the satisfactory result. Beyond the 20% SBA the slump flow start decreasing. Due to the higher specific surface area of SBA about 4010gm/cm^3. This makes the SCC mix blended with SBA less workable. The one more cause for less slumps was very high loss of ignition.

ii. V-funnel test is conducted to check the segregation resistance ability of SCC. When SCC blended with SBA 20% by mass of cement, it was found satisfactory passing ability & segregation resistance. Beyond 20% of SBA, the viscosity starts increasing.

iii. In the L- Box apparatus there are two legs, through one leg the concrete is pour and gate is attach with that leg. When gate is opened the concrete start flowing to another leg. After stability of flow H_1 and H_2 is measured. When the ratio of H_2 and H_1 leads to value near 1 then the result is satisfactory. On 20% SBA the L-Box test result was in range as compared to control concrete. Beyond 20% SBA the value was so low and blockage was high. Due the large amount of SBA viscosity increased and did not passage through the reinforcement gaps.

IV Influence on the Harden Properties of SCC

The harden properties of concrete includes the compressive strength, flexural strength, ultrasonic pulse velocity, split tensile strength, sulphate attack and water absorption.

i. As the W/C ratio increases the compressive strength decreases. The SCC sample with different per-cent of SBA such as 5%, 10%, 15%, 20% and 25% was tested on compression testing machine. It was found that up to 15% SBA the compressive strength increased but at 20% and above the compressive strength starts decreasing.

ii. In UPV the strength and quality of SCC specimen is determined by measuring the velocity of ultrasonic pulse. The entire samples were tested after 28 days. When cement replaced by 5%, 10% and 15% SBA the test result of SCC specimen gave positive effect on strength. Beyond 15% SBA there was negative effect on strength. Due to excess amount of SBA the UPV reduces in samples.

iii. In this study sulphate attack is mainly concern with weight loss. The SCC samples using SBA and control concrete were immerse in sulphate solution. The weight loss was measured after 28 days of immersion. It was found that weight loss of control concrete was 2.52% and weight loss of SCC with 10%, 20% and 30% SBA was 2.06%, 2.00% and 1.83% respectively.

IV Conclusions

By using bagasse ash as partial replacement of cement the cost of SCC will be reduced i.e. due to reduction in consumption of cement.The use of bagasse ash reduces the wastage of sugar industries and also reduces the adverse effect on the environment.The compressive strength is improved by using the bagasse ash in limited amount i.e. 15% to 30% by weight of cement.

Using the bagasse ash as pozzolanic material, it also improves the sulphate resistance of concrete.When the SBA was used between 10% to 20% by w.t cement the flowability or workability or fresh properties result was satisfactory. Beyond the above limit the slump diameter and passing ability start decreasing.

By studying all above research paper there is more work on workability and strength in normal environmental condition, rather than work on durability. If we can work on acid attack, sulphate attack, alkali silica reaction, interface zone, sea water effect etc. using bagasse ash then it will be better achievement.

In the study of research paper, the results were positive for given concrete mixes to additional flexural strength test, split tensile strength test, compressive strength test and durability test.

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