EXPERIMENTAL STUDY ON REPLACEMENT OF BAGASSE ASH AS CEMENT AND QUARRY DUST AS SAND IN SELF -COMPACTING CONCRETE

Ganga T[1], Chandramohan.N[2]

[1] Post Graduate Student, Department of Civil Engineering, New Prince Shri Bhavani College of Engineering and Technology, Chennai-600073,India

[2]Assistant Professor, Department of Civil Engineering, , New Prince Shri Bhavani College of Engineering and Technology, Chennai-600073,India

Abstract— Self-compacting concrete (SCC) is a flowing concrete mixture that is able to consolidate under its own weight. The highly fluid nature of SCC makes it suitable for placing in difficult conditions and in sections with congested reinforcement. But its initial higher supply cost over conventional concrete, has hindered its application to general construction. Therefore, for producing low cost SCC, it is prudent to look at the alternates to help reducing the SCC cost. This project aims at incorporating Bagasse Ash, which is a by-product from the sugar factor as a partial replacement material for cement to reduce the cost of cement and enhance the flow of SCC and sand was replaced by Quarry Dust, which is a by-product from the stone crushing factory. These two waste materials may bring the efficiency of the concrete to a considerable amount. The concrete mix proportions are varied for attaining the full characteristics of the SCC. The fresh and hardened concrete properties of various mixes of bagasse ash and quarry dust replacement mixes revealed that 7.5 percentage replacement of Bagasse ash and 40 percentage replacement of Quarry Dust yielded good workability and higher strength concrete than the control mix.

Keywords- *Self Compacting Concrete, slump flow test,T_{50}cm flow test, ,V-Funnel test, L-Box test, compressive strength test, flexural strength test.*

I. INTRODUCTION

Self-Compacting Concrete (SCC) is a flowing concrete mixture that is able to consolidate under its own weight. The highly fluid nature of SCC makes it suitable for placing in difficult conditions and in sections with congested reinforcement. Use of SCC can also help in minimizing hearing-related damages on the worksite that are introduced by vibration of concrete. Another advantage of SCC is that the time required to place large sections is considerably reduced. European Federation of National Association for Reinforced Concrete (EFNARC) has developed specifications and guidelines for the use of SCC that covers a number of topics, ranging from materials selection and mixture design to the significance of testing methods.

A. Materials For Scc

The materials used for SCC are selected from those by the conventional concrete industry. Typical materials used for SCC are coarse aggregate, fine aggregation, cement, mineral admixtures (fly ash, ground granulated blast furnace slag), and chemical admixtures (super plasticizer, viscosity modifying agents). SCC can be designed and constructed using a broad range of normal concreting materials, and that this is essential for SCC to gain popularity.

1.Cement

The cement content plays a major role in SCC because of the requirement of high powder content for good performance. Higher grade cements will give better results. Ordinary Portland Cement (OPC) can be preferable than Pozzolanic Portland Cement (PPC) in the case of additional of mineral admixtures or fillers with the cement.

2.Fine Aggregate

The influence of fine aggregates on the fresh properties of the SCC is significantly greater than that of coarse aggregate. Particles size fractions of less than 0.125mm should be include the fines content of the paste content of the paste and should also be taken into account in calculating the water-powder ratio.

The high volume of paste in SCC mixes help to reduce the internal friction between the sand practices but a good grain size distribution is still very important. Many SCC mix design methods use blended sands to match an optimized aggregate grading curve and this can also help to reduce the paste content.

3.Coarse Aggregate

The coarse aggregate chosen for SCC is typically round in shape, is well graded, and smaller in maximum size than that used for conventional concrete. Typical conventional concrete could have a maximum aggregate size of 40mm or more. Gradation is an important factor in choosing a coarse aggregate, especially in typical uses of SCC where reinforcement may be highly congested or the formwork has small dimensions. Gapgraded coarse aggregate promotes segregation to a greater degree than well-graded coarse aggregate. As with conventional concrete construction, the maximum size of the coarse aggregate for SCC depends upon the type of construction. Typically, the maximum size of coarse aggregate used in SCC ranges from approximately 10mm to 20mm.

4. Super Plasticizer

The main action of Super Plasticizer (SP) is to fluidity the mix and improves the workability of concrete. Portland cement, being in fine state of division will have a tendency to flocculate in wet concrete. This flocculation entraps certain amount of water used in the mix and there by all the water is not freely available to fluidity the mix. When plasticizers are used, they get absorbed on cement particles. The absorption of charged polymer on cement particle creates particle repulsive forces, which depends on the base, solid contents and quality of super plasticizer used. The overall result is that the cement particles are deflocculated and the water trapped inside the flocks gets released and now available to fluidity the mix.

5.Viscosity Modifying Agent

Admixtures that modify the cohesion of the SCC without significantly altering its fluidity are called viscosity modifying agent (VMA). These admixtures are used in SCC to minimize the effect of variations in moisture content fines in the sands or its grain size distribution making the SCC more robust and less sensitive to small variations in the proportions and condition of other constituents. However they should not be regarded as a way of avoiding the need for a good mix design and careful selection of other SCC constituents.

B. MATERIAL DESCRIPTION

1. Cement

Ordinary Portland cement (53 Grade) with specific gravity of 3.15 and fineness modulus of 4 percentage confirms to IS 12269:1987

2. Bagasse Ash

The Bagasse Ash (BA) has been produced from E.I.D Parrys (India) Limited, Cuddalore and it is grounded down to less than 90µm particle size. It has the specific gravity of 2.15 and it has the fineness modulus of 2 percentage. The chemical composition of BA was determined using ED-XRF (Energy Dispersive X- Ray Fluorescence) Spectrometer and it is given in the **Table 1.1**

TABLE 1.1 CHEMICAL COMPOSITION OF BAGASSE ASH

S.No	Components	in%
1	SiO2	64.56
2	K2O	12.936
3	CaO	10.298
4	Fe2O3	7.341
5	SO3	1.886
6	P2O5	1.287
7	TiO2	0.952
8	SrO	0.215
9	MnO	0.202
10	ZrO2	0.139
11	ZnO	0.096
12	CuO	0.096
13	Rb2O	0.06
14	Al2O3	<0.010
15	AgO	<0.010

3. Fine Aggregate

Locally available river sand of specific gravity 2.53, bulk density of 1185kg/m^3 which confirms to zone II as per IS:2386 (Part I).

4. Quarry Dust

Quarry Dust of specific gravity 2.68, Bulk density of 1285 kg/m^3 which confirms to Zone II as per IS: 2386 (part I).

5.Coarse Aggregate

Crushed Granite coarse aggregate of 12mm down size with specific gravity of 2.81 and bulk density of 1505 kg/m^3 confirms to IS 383:1970

6. Super Plasticizer

A Poly Carboxylic Ether (PCE) based super plasticizer; GLENIUM B233 has been procured from BASF Construction Chemicals Company. It has the specific gravity of 1.09

7. Viscosity Modifying Agent

Chlorides free Viscosity Modifying Agent, GLENIUM STREAM 2 to enhance segregation resistance, to improve the viscosity and to modify cohesiveness of the mix. It has the specific gravity of 1.19.

Table 1.2 Properties of Chemical Admixtures

S.No	Parameters	Glenium B2331	Glenium Stream 2
1	Aspect	Light Brown Liquid	Colorless free flowing liquid
2	Relative Density	1.09±0.01at 25ºc	1.19±0.01at 25ºc
3	Ph	≥6	≥6
4	Chloride Ion Content	<0.2%	<0.2%

C. PROPERTIES OF SCC

Specific requirement for SCC in the fresh state depend on the type of application and especially on

- Confinement conditions related to the concrete element geometry, quantity, type and location of reinforcement, inserts, cover and recesses ect.
- Placing equipment (e.g pump, direct from truck-mixer, skip, termite)
- Placing methods (e,g number and position of delivery points)
- Finishing method
- Passing ability, viscosity and segregation resistance will affect the in-situ properties of the hardened concrete but should only be specified if specifically needed.

- If there is little or on reinforcement they may be no need to specify passing ability as a requirement.
- Viscosity may be important where good surface finish is required or reinforcement is very congested but should not be specified in the most other cases.

The required consistence retention time will depend on the transportation and placing time. This should determined and specified and its responsibility of the producer to ensure that the SCC maintains its specified fresh properties during this period.

D.FACTORS INFLUENCING SCC

1.Mortar

Mortar also plays a vital role as solid particle in SCC. This property is so called "pressure transferability" which can be apparent when the coarse aggregate particles approach each other and mortar is in between coarse aggregate particles. Here the mortar is subjected to normal stress. The degree of the decrease in shear deformability of mortar largely depends on the physical characteristics of the solid pattern in the mortar. It was found that the relation between the flow ability of mortar and concrete couldn't always be same due to differences in the characteristics of the solid particles in the mortar.

2. Coarse Aggregate Shape and Grading

The influence of the coarse aggregate on self-compacting of fresh concrete is more. Proper care should be taken while grading the coarse aggregate, whereas presence of more uneven size of aggregate may lead to the blockage of concrete due to the action of internal sources.

3. Water-powder ratio and S.P Dosage

The characteristics of powder and S.P largely affect the mortar property and so the proper water-powder ratio and S.P dosage cannot be fixed without trial mixing. Therefore once the mix proportion is decided self-compatibility has to be formulated. So that a rational method can be established for adjusting the water-powder rational S.P dosage to achieve appropriate deformability and viscosity.

4. Workability

Workability is a measure of ease by which fresh concrete can be placed and compacted. It is a complex combination of aspects of fluidity, cohesiveness, transportation, compact ability and stickiness. A good SCC shall normally reach a slump flow exceeding 600mm without segregation.

E. NEED FOR THE STUDY

Self-compacting concrete (SCC) is a development of conventional concrete in which the use of vibrator for compaction is no more required. This property of self-compacting concrete has made its use more attractive all over the world. But its initial higher supply cost over conventional concrete has hindered its application to general construction. Therefore for producing low cost SCC it is prudent to look at the alternates to help reducing the SCC cost.

Cement plays a great role in the production of concrete and is the most expensive of all other concrete making materials. In addition, there is environmental concern in the production of cement. 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 gives bagasse ash as a waste, which has a pozzolanic property that would potentially be used as a cement replacement material. Thus the utilization of waste products can be effectively used in the production of SCC which may reduce the cost of concrete comparing to conventional concrete.

F.OBJECTIVE

To study the feasibility of utilizing Bagasse Ash as Cement Replacement in Self-compacting Concrete.

1. SCOPE OF THE PROJECT

To study the fresh properties of Self-Compacting Concrete by conducting the following tests

- Slump Flow Test
- T_{50}cm Slump
- L Box Test
- V Funnel Test

To study the hardened properties of SCC by conducting the following tests

- Compressive Strength Test
- Flexural Strength Test

2. MIX PROPORTIONING

To produce SCC, the major work involves designing an appropriate mix proportion and evaluating the properties of the concrete thus obtained. In practice, SCC in its fresh state shows high fluidity, self-compacting ability and segregation resistance, all of which contribute to reducing the risk of honey combing of concrete. With these good properties, the SCC produced can greatly improve the reliability and durability of the reinforced concrete structures. No standards or all-encapsulating method for determining mixture proportions currently exists for SCC.

2.1 Production of SCC

Based on the original conception of Okamura and Ozawa, in general three types of SCC can be distinguished

Powder type SCC: This is proportioned to give the required self- compatibility by reducing the water-powder ratio (material < 0.1mm) and provide adequate segregation resistance. Super plasticizer and air admixtures give the required deformability.

VMA type SCC: This type is proportioned to provide self-compaction by the use of a VMA to provide segregation resistance. Super plasticizers and air entrainment admixtures are used for obtaining the desired deformability.

Combination type SCC: This is proportioned so as to obtain self-compatibility mainly by reducing the water-powder ratio, as in the powder type, and a viscosity modifying admixture is added to reduce the quality of fluctuation of the fresh concrete due to the variation of the surface moisture content of the aggregates and their graduations during the production. This facilitates the production control of the concrete.

TABLE 2.1 LIMITS ON SCC MATERIAL PROPORTIONS

Description	Powder Type	VMA Type	Combination Type
Cementitious Content(in kg/m3)	450-600	385-450	385-450
Water-Cementitious Content	0.28-0.45	-	0.28-0.45
Fine Aggregate / Mortar (in %)	35-45	40	40
Fine Aggregate / Total Aggregate	50-58	-	-
Coarse Aggregate / Total Aggregate	28-48	45-48	24-48

To achieve the required combination of properties in fresh SCC mixes

- The fluidity and viscosity of the paste is adjusted and balanced by careful selection and proportioning of the cement and additions, by limiting the water-powder ratio and then by adding a SP and (optionally) a VMA. Correctly controlling these components of SCC, their compatibility and interaction is the key to achieving good filling ability, passing and resistance to segregation.
- The paste is the vehicle for the transport of the aggregate; therefore the volume of the paste must be greater than the void volume in the aggregate so that all individual aggregate particles are fully coated and lubricated by a layer of paste. This increases fluidity and reduces aggregate friction.

The coarse to fine aggregate ratio in the mix reduced so that individual coarse aggregate particles are fully surrounded by a layer of mortar. This reduces aggregate interlock and bridging when the concrete passes through narrow openings or gaps between reinforcement and increases the passing ability of the SCC.

These mix design principles results in concrete that, compared to traditional vibrated concrete, normally contains

- Lower coarse aggregate content
- Increased paste content
- Low water-powder ratio
- Increased SP dosage
- Sometimes a VMA

TABLE 2.2 MIX PROPORTIONS

mix constituent	Quantity
Cement	524.47 kg/m3
Bagasse Ash	42.52 kg/m3
Quarry Dust	700.95 kg/m3
Fine aggregate	166.56kg/m3
Coarse aggregate	708.75kg/m3
Super plasticizer	1.3%
Viscosity modifying agent	0.2%

G. FRESH PROPERTIES OF SCC

A wide range of test methods have developed to measure and assess the fresh properties of SCC. No single test is capable assessing all of the key parameters, and a combination of tests is required to fully characterize an SCC mix, Some of the commonly used tests are given

1. OPTIMISATION OF BAGASSE ASH DOSAGE

From the tests on various trial mixes, a control mix was fixed which has the mix proportion as follows:

Cement : F.A : C.A : W/C : SP : VMA
1 : 1.53 : 1.25 : 0.36 : 1.3% : 0.2%

Now from the trial mix proportion the finely grounded bagasse ash of particle size less than 90μm is replaced with the cement demands higher dosage of super plasticizer than the control mix because of its high specific surface area.

TABLE 2.3 ACCEPTANCE CRITERIA FOR SCC

Sl.no	Method	Unit	Typical range of values	
			Minimum	Maximum
1	Slump flow test	Mm	650	800
2	T50 cm slump flow test	Sec	2	5
3	V-Funnel test	Sec	6	12
4	L-Box test	H2/H1	0.8	1

2. Determination of optimum dosage of SP

The optimum SP dosage (sp/c) can be determined by marsh cone test. The test consists of determining the time needed for certain volume of paste to flow through the Marsh cone for varying sp/c. Here, a metal cone with an aperture of 8mm is used, where 1 liter of paste is introduced and the time taken for 500ml to flow out of it is measured. The flow time (T) are plotted in normal scale with respect to sp/c and the optimum sp/c is defined as the saturation point beyond which the flow time does not decrease significantly. For an objective definition, the saturation point is taken as the dosage where the internal angle in the curve is 140º±10º.

The optimum dosage of SP was determined for various replacements (7.5,10,12.5 and 15%) of cement with BA by weight basis. The curves of various mix proportions are given in the following figures.

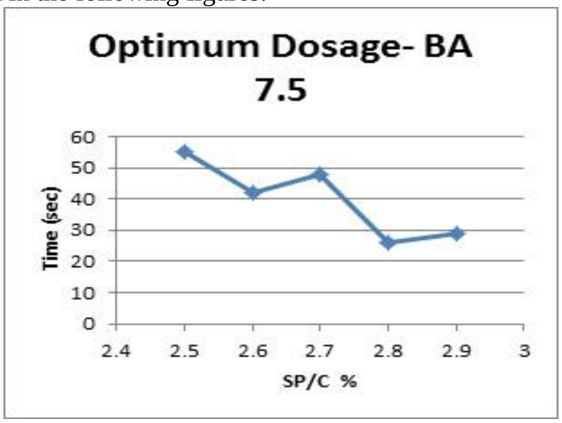

Figure 2.1 Optimum Dosage of BA 7.5

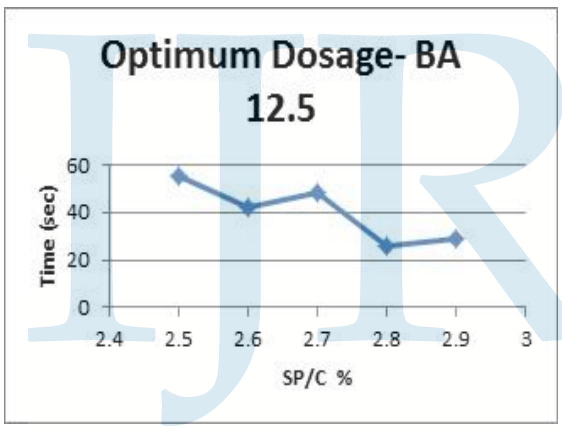

Figure 2.2 Optimum Dosage of BA 12.5

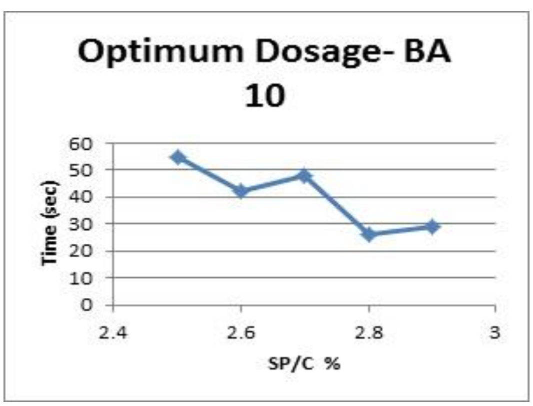

Figure 2.3 Optimum Dosage of BA 10

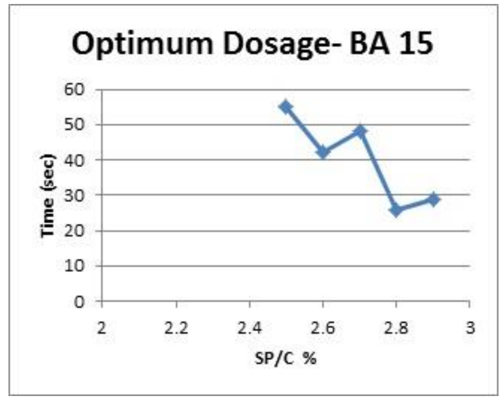

Figure 2.4 Optimum Dosage of BA 15

3. Bagasse Ash replacement mixes

From the results of marsh cone test, concrete mix proportion for various replacement of cement with bagasse ash were prepared by various ratios like (BA0, BA2.5, BA5, BA7.5, BA10, and BA12.5) and the results of fresh concrete tests on these mixes are

TABLE 2.4 FRESH CONCRETE TESTS ON BAGASSE ASH REPLACED MIXES

Mix	**Slump Flow (mm)**	**T50 (sec)**	**V- Funnel (sec)**	**L- Box (h2/h1)**
BA 0	685	6	8	0.9
BA 2.5	687	6	9	0.9
BA 5	688	5	9	0.91
BA 7.5	690	5	10	0.9
BA 10	700	4	10.5	0.9
BA 12.5	710	3.8	11.5	0.93
BA 15	698	2.5	10	0.88

4. Hardened Concrete Property

After the fresh concrete tests, the concrete cubes of 10x10x10 cm has been casted and cured the immediate next day. On comparison scale, 3 day compressive strength of the various mix proportions was determined using the compressive strength testing machine and the density of the cubes were also determined. The result of 3-days strength of all mix proportions are listed.

TABLE 2.5 RESULTS OF HARDENED PROPERTIES OF BAGASSE ASH REPLACED SCC

Mix	3- days strength MPa	Density Kg/m3
BA 0	20.3	2478
BA 2.5	20.9	2450
BA 5	21.4	2447
BA 7.5	22.0	2445
BA 10	20.1	2346
BA 12.5	19.6	2326
BA 15	18.4	2340

Interpretation of Results

Though all percentage replacement of Bagasse ash satisfies the fresh concrete property for SCC from the result of compressive strength it has been concluded that the 7.5 percentage replacement of Bagasse ash with cement produces higher compressive strength than the control mix.

TABLE 2.6 TEST VALUES OF SCC

Sl.no	Method	Unit	Bagasse Ash 7.5
1	Slump flow test	Mm	690
2	T50 cm slump flow test	Sec	5
3	V-Funnel test	Sec	10
4	L-Box test	H2/H1	0.9

II .QUARRY DUST REPLACEMENT

A. Mix combinations and Designations

After obtaining the optimum dosage of Bagasse Ash 6 mix proportions were prepared by varying the proportion of sand with Quarry dust by 0, 20, 40, 60, 80 and 100 percentage and the mix designation of Fresh and hardened concrete tests are conducted for the same to study the influence of quarry dust and bagasse ash in fresh and hardened state. lists the mix proportions of SCC for constant Bagasse Ash dosage but varying Quarry Dust dosage. SP dosage has been changed to get the required flow property for all mixes

B. MIXING

Cement and Bagasse Ash were mixed together properly. The amount of fine aggregates, coarse aggregates, quarry dust, water and chemicals were measured based on their weight. First the aggregates were mixed in the mixer. Then the powder materials were added, after attaining a uniform dry mix, 70% of water was added to the mixer in small amounts. 15% of the remaining water was mixed with SP while the other 15% of water was mixed with VMA added finally to attain a good flow able concrete.

1.CASTING AND CURING

Cubes of size 100 x100 x 100mm for compressive strength and prism of size 100x 100 x 500mm for flexural strength were casted for the study. The moulds to be used were cleaned properly with dry cloth and oil was applied before casting. After mixing the fresh concrete its flow property tests like slump flow test, T_{50}cm slump test, L-box test and V- funnel test are tested. Then the concrete were filled in the moulds. After 36 hours, the specimen was demoulded and then they were put into the curing tank for required period.

2. Compressive strength test

Compressive strength is the most common of all tests on hardened concrete and it is most important parameter in structural design. Three standard cubes were produced for each mix. The compressive strength tests were carried out according to IS 567:1959 at age 7 and 28 days. The specimen were placed in the machine in such manner that the load was applied to opposite side of the cubes as cast that is not to top and bottom. Digital load indicator was used to measure the applied load. The maximum load to be applied by the specimen was recorded. The flexural strength of the specimen shall be expressed as modulus of rupture and it is calculated using the following formula

Modulus of rupture, $f_b = PL/bd^2$ N/mm^2

Where

P = Maximum load applied on the specimen

L = Length of the span on which specimen is supported

B = Width of the specimen

D = Depth of the specimen at the point of failure

III.RESULTS AND DISCUSSIONS

The results and analysis of the influence of Bagasse ash in the fresh and hardened properties of self-compacting concrete.

A. FRESH PROPERTIES OF SCC

1. Slump Flow and T_{50} cm Test

Results of slump flow test are given Table 4.1. All slump flow values are in the range of 660-750mm. Therefore the concrete has classified as SF2 according to EFNARC 2005 guideline. And we have concluded that the concrete can be used for any normal application like construction of concrete wall and columns. A rising trend was observed till 40% QD replacement then the flow value decreases. This could be explained by the increase in fineness and the specific surface area of the fine aggregate due to the increase in fine content and hence more water is required to wet the surface of particle.

TABLE 4.1 SLUMP FLOW TEST RESULTS

S.No	Designation	Slump flow (mm)	T50 cm (sec)
1.	BA0 QD0	685	3.0
2.	BA7.5 QD0	678	3.5
3.	BA7.5 QD20	682	3.0
4.	BA7.5 QD40	704	3.4
5.	BA7.5 QD60	693	4.0
6.	BA7.5 QD80	668	5.5
7.	BA7.5 QD100	672	6.0

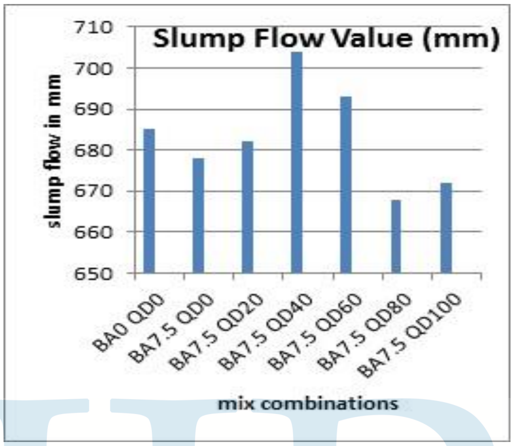

Figure4.1 Slump Flow Test Values

The T_{50} cm which is the time taken for the concrete to spread to 50 cm was measured. Since most of the test results are above 2 sec so we have classified that the concrete as VS2 as per EFNARC 2005 guidelines. BA 7.5 QD80 and BA 7.5 QD 100 takes 5 sec to spread 50 cm and also their spread flow value is less than all mixes. Figure 4.2 shows the results of T_{50}cm values.

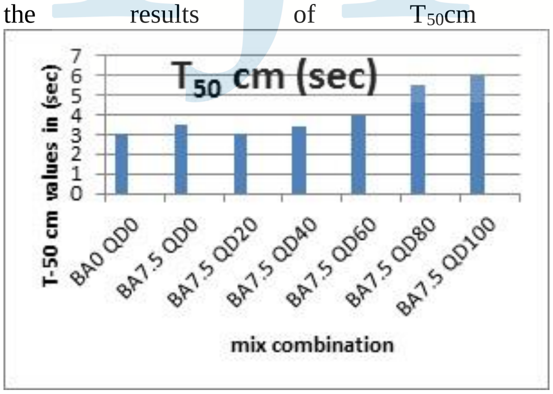

Figure 4.2 T_{50} cm Slump Test Values

4.2.2 L-Box Test

The ability of the concrete of compacting itself under its own weight was evaluated by means of L-Box with horizontal steel bars as show in Figure4.3.

The results obtained from the L-Box test are reported in Table 4.2 and in Figure4.3. The results shows much clear indication of how the addition of Quarry dust affect the flow of concrete through reinforcement.

The presence of high fines in quarry dust increases voids in the fine aggregate. Thus the water demand at higher replacement percentages. This is in turn reduces the passing ability of concrete. Since all the blocking ratio is higher than 0.8, all mixes can be classified as PA2 according to EFNARC 2005

guidelines and it is best suitable for civil engineering structures BA7.5 QD80 and BA7.5 QD100.

TABLE 4.2 L-BOX TEST RESULTS

S.No	Designation	L-Box (h2/h1)
1.	BA0 QD0	0.92
2.	BA7.5 QD0	0.90
3.	BA7.5 QD20	0.905
4.	BA7.5 QD40	0.91
5.	BA7.5 QD60	0.905
6.	BA7.5 QD80	0.89
7.	BA7.5 QD100	0.87

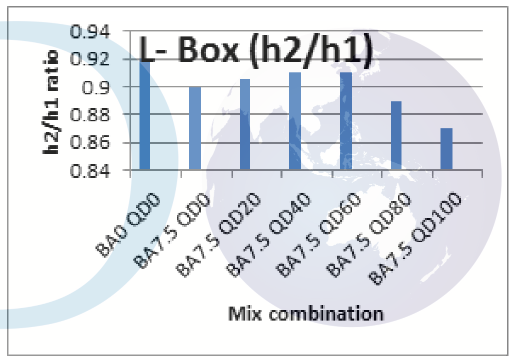

Figure 4.5 L-Box Test Values

4.2.3 V-Funnel Test

V- Funnel test results of fresh concrete are given in **Figure4.7** and **Table 4.3.** The test setup has been show in **Figure4.6.** Since all the results are greater than 8sec all concrete mixes can be classified as VF2 according to EFNARC 2005 guidelines. But values greater than 12sec show segregation. Hence BA7.5 QD80 and BA7.5 QD100 show segregation due to its high water requirement.

TABLE 4.3 V-FUNNEL TEST RESULT

S.No	Designation	V-Funnel (sec)
1.	BA0 QD0	9
2.	BA7.5 QD0	10
3.	BA7.5 QD20	12
4.	BA7.5 QD40	10
5.	BA7.5 QD60	11
6.	BA7.5 QD80	15
7.	BA7.5 QD100	17

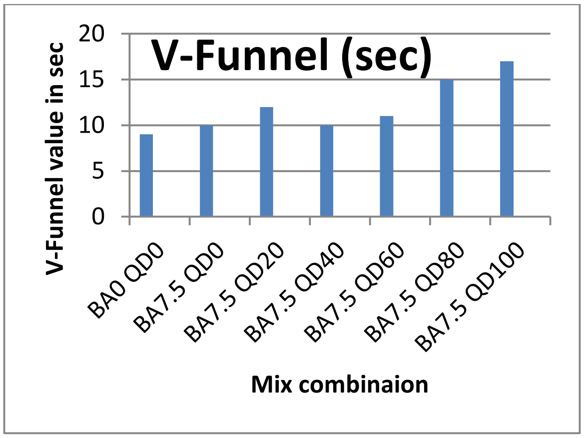

Figure 4.7 V-Funnel test Values

4.3 HARDENDARD PROPERTIES OF SCC

4.3.1 Compressive strength

Compressive strength tests were carried out on cubes of 100 mm size using a compressive testing machine of 1000 kN capacity as per IS 516:1959 and the result of 7th day and 28th day compressive strength are listed in **Table 4.4 and 4.5 Figure 4.8** presents the comparison chart of compressive strength.

TABLE 4.4 7TH AND 28TH DAY COMPRESSIVE STRENGTH

Designation	7th Day Compressive Strength Mpa	28th Day Compressive Strength Mpa
BA0 QD0	23.49	35.70
BA7.5 QD0	26.42	36.50
BA7.5 QD20	27.46	39.60
BA7.5 QD40	30.38	43.80
BA7.5 QD60	29.49	41.40
BA7.5 QD80	25.28	36.47
BA7.5 QD100	24.07	33.43

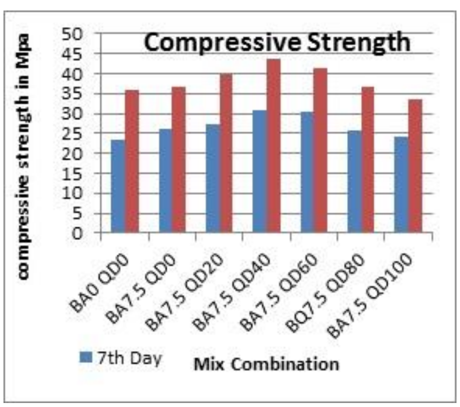

Figure 4.8 compressive strength Test values

From the results, it is understood that there exist a close relationship between the 7th day and 28th day compressive strength of concrete. As designed the control mix compressive strength was close to 35Mpa. It should be noted that, the compressive strength increases as quarry dust replacement increase up to BA 7.5 QD 40 then slight decrease is observed for other mixes. This is probably due to the insufficient cement paste to coat all the fine aggregate particles which consequently leads to decrease in compressive strength. Another reason may be the compacting factor, quarry dust being the very fine material, fills the voids in the aggregate skeleton. Maximum of 22.6 percentage increase in compressive strength was observed for BA7.5 QD40.

4.3.2 Flexural Strength

Flexural strength tests were carried out on prism of size 100x100 x500 mm on flexural testing machine of capacity 100kn as per IS 516:1959 and the result is given in present the comparison chart of flexural strength.

TABLE 7TH AND 28TH DAY FLEXURAL STRENGTH

Designation	7th Day Flexural Strength Mpa	28th Day Flexural Strength Mpa
BA0 QD0	3.01	4.34
BA7.5 QD0	3.22	4.47
BA7.5 QD20	3.27	4.74
BA7.5 QD40	3.44	4.92
BA7.5 QD60	3.69	4.99
BA7.5 QD80	3.19	4.49
BA7.5 QD100	2.90	4.02

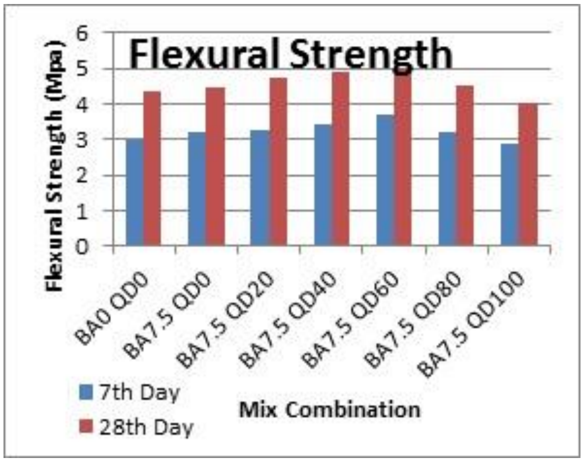

Figure 4.9 Flexural Strength Test values

Flexural strength was almost constant for most of the mix proportions. Comparing to all mixes BA7.5 QD40 and BA7.5 QD60 is having higher flexural strength than the control mix. This may be due to the addition of quarry dust which increases the fines content in the concrete to maximum extent. Extra fine content will always reduces the strength as expected.

4.3.3 Density and Modulus of Elasticity of Concrete

The density of the above said mixtures and theoretical modulus of elasticity which is determined from the compressive strength is listed in Table 4.8. The density chart and modulus of elasticity chart of all mixes has been shown in Figure 4.10 and 4.11.

TABLE 4.8 DENSITY AND MODULUS OF ELASTICITY ALL CONCRETE MIXES

Designation	**Density Kg/m3**	**Modulus of Elasticity N/mm2**
BA0 QD0	2556.67	29874.74
BA7.5 QD0	2570.00	30207.61
BA7.5 QD20	2581.00	31464.27
BA7.5 QD40	2580.00	33090.78
BA7.5 QD60	2566.67	32171.42
BA7.5 QD80	2550.00	30193.82
BA7.5 QD100	2540.00	28910.78

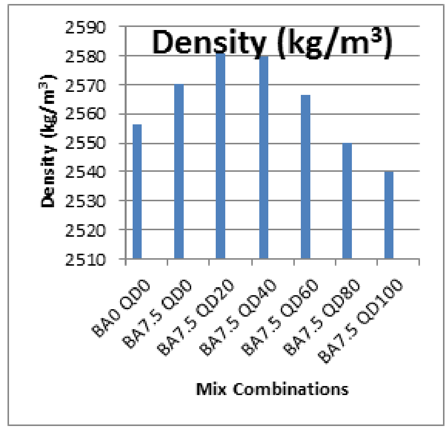

Table 4.8 Density of all Concrete Mixes

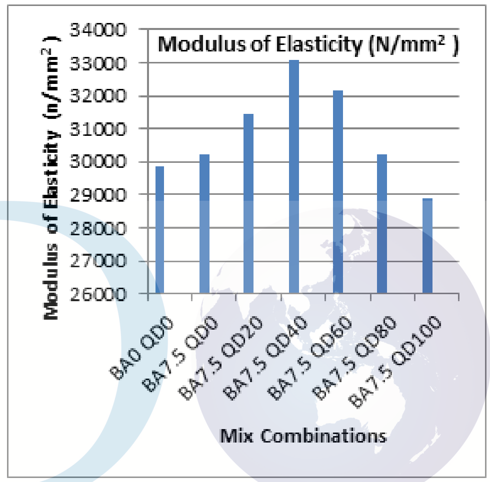

Table 4.8 oModulus f Elasticity all Concrete Mixes

IV CONCLUSION

In this work flow characteristics, compressive strength of SCC using Bagasse ash as cement replacement material was investigated. Based on the tests conducted on the SCC specimens, the salient features are represented as follows.

- From the study, it has been proved that Bagasse Ash which is an industrial by-product is a beneficial construction material. The incorporation of Bagasse Ash reduces the environmental hazard and reduces the cost of cement.
- The presence of high fines of quarry dust increases the water demand. However, the quarry dust helps to develop the aggregate skeleton to improve the strength of concrete to certain replacement levels.
- The result of slump flow test revealed that addition of quarry dust after 60% decreases the flow ability of fresh concrete.

- L-Box test results indicates that the increase in quarry dust dosage reduces the passing ability of fresh concrete.
- V-Funnel test results indicates that the higher dosage of quarry dust reduces the filling ability of concrete and leads to segregation also.
- Optimum dosage of super plasticizer and viscosity modifying agent will help for the better flow nature of concrete.
- Except for 100% quarry dust replacement, all mixes attained higher compressive strength than the control mix. Ultimately 40% replacement shows 22.68% increase in compressive strength than the control mix.
- Flexural strength of the concrete increases in a slight manner only 40% and 60% replacement mixes shows higher flexural strength than the control mix
- Higher dosage (>60%) decreases the fresh and hardened concrete property of SCC
- Quarry dust on other hand is a perfect alternative for river sand. It has numerous advantages over the river sand. Yet exact dosage of quarry dust has to be determined before using it for the construction process.

Hence, it is evident the Bagasse Ash can be utilized for the manufacture of self-compacting concrete.

V. REFERENCE

1. Biruk Hailu, AbebeDinku, (2010) ‘Application of Sugarcane Bagasse ash as a partial cement replacement material’, school of civil and environmental Engineering , Addis Ababa University.
2. BinuSukumar, Nagamani.k, and SrinivasaRaghavan.R, (2008) ‘Evauation of strength at early ages of self-compacting concrete with high volume fly ash’, construction and Building Materials, Volume 22
3. European Federation of national Associations Representing for concrete (2005) ‘Specification and Guidelines for Self- compacting concrete.
4. IS 383 (1970) ‘Specification for coarse and fine aggregate from natural source of concrete’, Bureau of Indian Standards, New Delhi.
5. IS 456 (2000) ‘Plain and Reinforced concrete’, Bureau of Indian Standards, New Delhi.
6. IS 516 (1959) ‘Method of Test for concrete’, Bureau of Indian Standards, New Delhi.
7. IS 2386-part 2 (1963) ‘Method of Test for Aggregate for concrete’, Bureau of Indian Standards, New Delhi.
8. IS 10262 (2009) ‘Concrete mix proportioning Guidelines’, Bureau of Indian Standards, New Delhi.
9. IS 12269 (1997) ‘Specification for 53 Grade OPC’, Bureau of Indian Standards, New Delhi.
10. Johnsirani K.S., Jagannathan.A, and Dinesh Kumar.R, (2013) ‘Experimental Investigation on Self-compacting concrete Using Quarry dust’, International journal of scientific and research publications, Volume 3 Issue 6.
11. Lasintha,E.D.L. Prabath , R.M.T. and sooriaarachchi, H.P(2012) ‘Influence of fine aggregate Types on the Performance self flowing Concrete’, ACEPS.
12. Okamura, H.Oguchi,M.(2013)’Self- Compacting Concrete’, Journal of Advanced Concrete Technology Volume 1,No.1, pp.5-15.
13. Sivakumar , M. and Mahendran,N.(2013) ‘Experimental Studies of Strength and Cost Analysis of Concrete Using Bagasse Ash’ , International Journal of Engineering Research And Technology , Volume 2 ,Issue 4.
14. Srinivasan , R. and Sathiya, S.(2010) ‘Experimental Study on Bagasse Ash in Concrete’ , International Journal for service Learning in Engineering Volume 5, No.2,pp.60-66.
Uma Shankar.K, and Pradeep Kumar.S, Arun praksh.K, (2013) ‘exprimental study on compressive strength of self-compacting concrete’, International Journal of Management Information, Volume I Issue 3, pp 37-44.