iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** X **Month of publication:** October 2023

DOI: https://doi.org/10.22214/ijraset.2023.56009

Production of SCC Using Bagasse Ash as Fine Aggregate

S. Sathishkumar[1], Mrs. P. Somiyadevi[2], S. Maluvu[3]
[1]PG Scholar, Department of Civil Engineering, Adhiparasakthi Engineering College, Melmaruvathur, Tamilnadu, India
[2, 3]Assistant Professor, Department of Civil Engineering, Adhiparasakthi Engineering College, Melmaruvathur, Tamilnadu, India

Abstract: In this study an experimental investigation on production of self-compacting concrete with bagasse ash as partial replacement of fine aggregate is done. River sand has been partially replaced with bagasse ash from 0% to 80% by volume. Cement and fly ash is used as a powder material. Two concrete mixtures with cement content of 375 Kg/m^3 and 500 Kg/m^3 was proportioned. The workability properties such as slump flow, inverted flow, V-funnel flow time and J-ring flow were measured. The hardened properties such as density, compressive strength, split tensile strength, modulus of elasticity and flexural strength of concrete in each mixture were measured at various ages. Water absorption and weight loss ratio on drying of concrete was measured at 28 days. Micro structural properties such as SEM and XRD analysis were examined for SCC specimens.From the test results, it was found that (a) Workability properties depends upon the bagasse ash content (b) Partial replacement of BA up to 20% by volume of bagasse ash enhanced both the workability and hardened properties of self-compacting concrete (c) SEM micrograph images shows that irregular porous particles increases as BA increases and XRD pattern reveals that presence of silica peak increases as the BA content increases from 10% to 80%.

Keywords: Self compacting concrete (SCC), Bagasse ash, Class C Fly ash, Workability, Hardened properties, SEM and XRD.

I. INTRODUCTION

The main parameter which has greater influence on the economy and the durability of the concrete structures are the quality and the density of the concrete cover as well as the compaction of the concrete. For this, self-compacting concrete (SCC) offers new possibilities and prospects. Self compacting concrete is a highly flow able concrete which does not segregate and can spread into place, fill the form work with heavily congested reinforcement, and encapsulate the reinforcement without any mechanical vibration. The present procedure for the production of SCC is predominantly empirical. The mix design is based on the experience from Japan, Netherlands, France and Sweden. SCC is a generic term for mix designs that differ from traditional concretes at the molecular interface between the cement compounds and the admixture polymers. The fluidity of SCC ensures a high level of workability and durability whilst the rapid rate of placement provides an enhanced surface finish. SCC is certainly the way forward for both in situ and precast concrete construction.

Production and control of SCC is very demanding. Compared to traditional concrete SCC has proven much more difficult to control both the flowing properties and stability at the same time. It may be difficult to obtain a high flow ability without segregation occurring. Therefore, it is important to put much effort in optimization of the whole concrete composition from particle composition to water and super plasticizer concentrations.

II. LITERATURE REVIEW

Self-compacting concrete is a non-vibratory concrete which can attain full compaction by its own weight, reduce construction time & labor requirements. Various industrial by products such as quarry dust, bagasse ash, recycled fine aggregates, RHA etc., are partially replaced for sand for economy, environmental issues and to avoid depletion of natural resources. Addition of quarry dust gradually increases slump flow up to 100% replacement level of river sand in SCC [1]. Compressive strength is about 15% higher at 100% replacement of QD when compared to 0% replacement. Slump flow of SCC with rice husk ash (RHA) partially replaced for sand up to 40% satisfies EFNARC guidelines [2]. Above 40% RHA level, extreme blockage greater than 50mm was noticed at J-ring. When limestone (LS) powder was added to SCC, J ring values were enhanced up to 60% RHA level. Compressive strength of concrete was decreased with increase in percentage of RHA level and it was about 19% lower than control SCC [3]. Use of bagasse ash as partial replacement of fine aggregate in SCC results in increase in water requirement of SCC mixtures which is about 35% higher than mix with both BA & LS due to the porous nature of the BA particles and their greater surface area. Unit weight of concrete mixtures decreased to about 12% with increasing BA content, due to increase in porosity [4].

The workability properties of SCC mixtures containing bagasse ash are enhanced with the addition of limestone powder. Slump flow was at acceptable range for partial replacements of BA up to 60% for fine aggregate [5]. The compressive strength of SCC mixtures with BA was comparable up to 20% replacement and gradually decreases with increase in percentage of BA replacement. Compressive strength of BA & LS mixture is about 27% higher than the mix with BA as fine aggregate [6]. Literature study reveals that studies on production of SCC with fly ash and bagasse ash has not been reported so far [7,8].

III. MATERIALS

A. *Cement*

Ordinary portland cement of 53 grade confirming to IS 12269-1976 is used in this project work. The physical properties of the cement used in this work were tested in accordance with IS: 4031-1988 and the test values are given in the Table 1

Table 1 Physical properties of OPC 53 grade

S.NO	Test	Value
1	Specific gravity	3.11
2	Standard consistency (%)	32
3	Initial setting time (mins.)	45
4	Final setting time (mins.)	160

B. *Fly ash*

Fly ash used in this study was obtained from Neyveli thermal power plant. It falls in the category of class 'C' grade and the physical properties of fly ash are determined as per IS: 1727-1967 and presented in Table 2 and its chemical composition is given in Table 3 [Xiaolu,2010].

Table 2 Physical properties of class C fly ash

S.NO	Test	Value
1	Specific gravity	2.05
2	Consistency (%)	34
3	Fineness, % passing on 75μm sieve (%)	95

Table 3 Chemical composition of Neyveli fly ash (class C) [Xiaolu, 2010]

Components	SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO	MgO	Na_2O	K_2O
% by mass	32.62	31.23	8.48	1.65	17.12	3.49	0.91	0.10

C. *Fine Aggregate*

Locally available river sand passing through 4.75mm was used in the experiment work. The properties of fine aggregate are determined as per IS: 2386-1963 and IS: 383-1970 is given in Table 4 & 5 and the gradation curve of fine aggregate is given in Fig.1

Table 4 Physical properties of fine aggregate

S.NO	Test	Value
1	Specific gravity	2.57
2	Bulk density (kg/m^3)	1589
3	Water absorption (%)	1.2
4	Fineness modulus	3.04
5	Zone	I

Table 5 Sieve analysis of fine aggregate

SL No.	Sieve size (mm)	Wt retained (kg)	Wt retained (%)	Cumulative retained (%)	% passing
1	4.75	0.037	3.7	3.7	96.3
2	2.36	0.060	6.0	9.7	90.3
3	1.18	0.270	27	36.7	63.3
4	0.6	0.372	37.2	73.9	26.1
5	0.3	0.095	9.5	83.4	16.6
6	0.15	0.138	13.8	97.2	2.8

Fineness modulus of fine aggregate is 3.04 and belongs to zone I

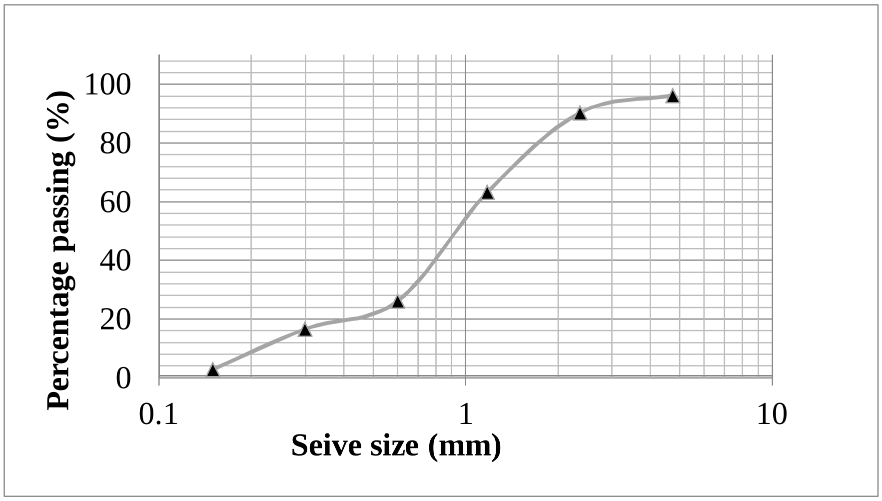


Figure 1 Gradation curve of fine aggregate

D. Coarse Aggregate

Crushed granite stone was used as coarse aggregate for experiment work. The coarse aggregate passing through 16mm and retaining on 4.75mm were used for experimental work. The following properties of coarse aggregate are determined as per IS: 2386-1963 and given in Table 6 & 7 and the gradation curve of coarse aggregate is given in Fig.2

Table 6 Physical properties of coarse aggregate

S.NO	Test	Value
1	Specific gravity	2.69
2	Bulk density (kg/m^3)	1618
3	Water absorption (%)	0.84
4	Fineness modulus	7.4

Table 7 Sieve analysis of coarse aggregate

S.No.	Sieve size (mm)	Wt retained (kg)	Wt retained (%)	Cumulative retained (%)	% passing
1	40	0	0	0	100
2	20	0	0	0	100
3	16	4.0074	40.074	40.074	59.93
4	12.5	1.3087	13.087	53.161	46.84
5	10	1.1747	11.747	64.908	35.09
6	4.75	1.5047	15.047	79.955	20.05

Fineness modulus of coarse aggregate is 7.4

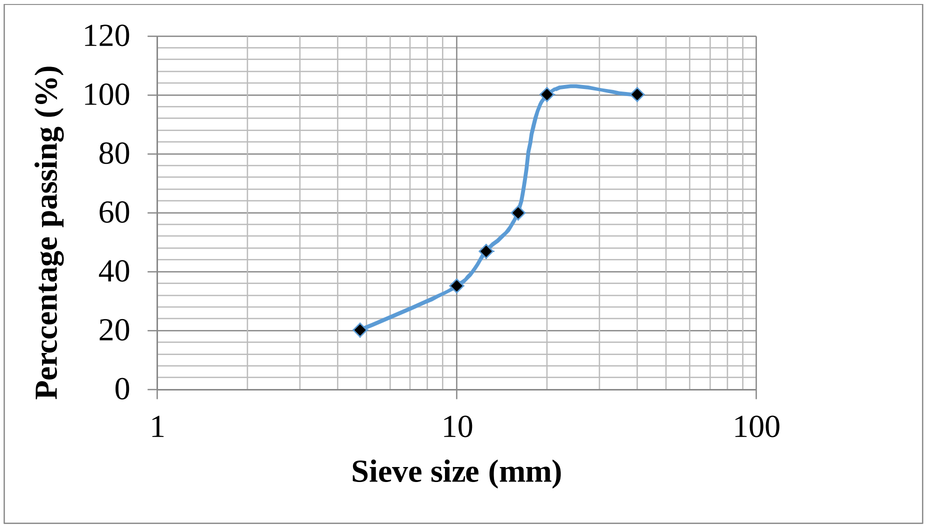


Figure 2 Gradation curve of coarse aggregate

E. Bagasse ash

Mill fired bagasse ash, locally available waste material was collected from Pondicherry co-operative sugar mill, Lingareddipalyam, Puducherry. The material passing through 4.75mm is used as fine aggregate in this work. The physical properties of bagasse ash are determined as per IS: 1727-1967 & IS: 2386-1963 and presented in Table 8 & 9 and the gradation curve of bagasse ash is given in Fig. 3 and the combined gradation curve of various replacements of bagasse ash with river sand is given in Fig. 4 and the photograph of BA is shown in Fig. 5

Table 8 Physical properties of bagasse ash

S.NO	Test	Value
1	Specific gravity	2.07
2	Water absorption (%)	1.5
3	Bulk density (kg/m^3)	778
4	Fineness modulus	1.94
5	Fineness, % passing on 75µm sieve (%)	48
6	LOI (%)	9.47

Table 9 Sieve analysis of bagasse ash

S.No.	Sieve size (mm)	Wt retained (kg)	Wt retained (%)	Cumulative retained (%)	% passing
1	4.75	0.002	0.2	0.2	99.8
2	2.36	0.003	0.3	0.5	99.5
3	1.18	0.084	8.4	8.9	91.1
4	0.6	0.299	29.9	38.8	61.2
5	0.3	0.129	12.9	51.7	48.3
6	0.15	0.429	42.9	94.6	5.4

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue X Oct 2023- Available at www.ijraset.com

Fineness modulus of bagasse ash is 1.94 and belongs to zone III

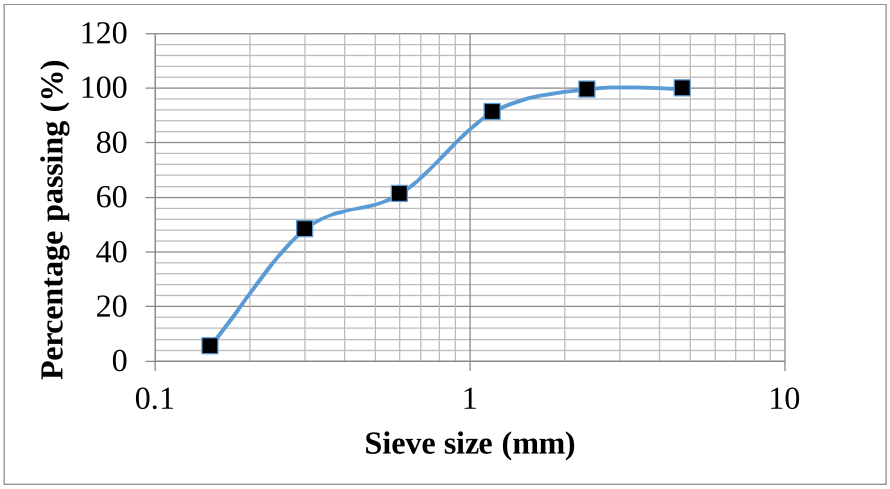


Figure 3 Gradation curve of bagasse ash

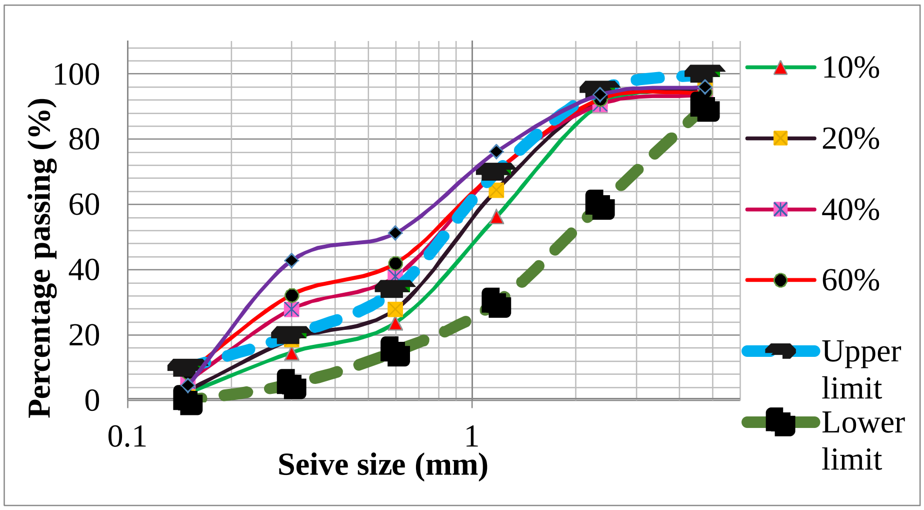


Figure 4 Combined gradation curve of BA and river sand for all replacements

Figure 5 Bagasse ash

F. Super Plasticizer

In order to improve the workability of fresh concrete Naphthalene formaldehyde based super plasticizer were used for concrete mixture as water reducing agents. The super plasticizer was a dark brown solution containing 35% solids. Details of super plasticizer are presented in Table10.

Table 10 Properties of SP used (Details obtained from supplier)

S. no	Parameters	Specification
1.	Colour	Brown liquid
2.	Specific gravity at 27 deg.C	1.20
3.	Dry material content (%)	35

G. Potable drinking water available *Water*
Within the Pondicherry engineering college campus has been used for making self-compacting concrete.

H. Proportioning of Mixtures for SCC MIX - 1 and 2:
For SCC mix-1 up to 20% the fresh properties were satisfied whereas, at 40% replacement level, the mix was too dry and the fresh properties were not satisfied. SCC mix-2 was proportioned with the cement content up to 500 kg/m^3 and reduced fly ash content of 70 kg/m^3 so that it satisfied slump flow for all replacements when the bagasse ash is partially replaced with river sand. The mixture proportion for both the SCC mixes is tabulated in Table 11.

Table 11 Mixture proportions for SCC mix-1 and SCC mix-2

Materials	SCC mix - 1 quantity (kg/m^3)	SCC mix - 2 quantity (kg/m^3)
Cement	375	500
Fly ash	140	70
Fine aggregate	860	676
Coarse aggregate	787	928
Water	210	240
Super plasticizer	5.5	3

IV. RESULTS AND DISCUSSION

A. Slump Flow
The slump flow diameter was aimed to be maintained as per EFNARC guidelines in the range of 650-700mm for all mixtures. The slump flow diameter of the SCC mix-1 was attained in the range of 650-670mm up to 20% of BA as presented in Figure 6. For SCC mix-2, the slump flow diameter of about 660-680mm was achieved for all replacements levels up to 80%, which is an indication of good workability which is shown in Fig.6 & 7. The slump flow diameter was increased with increase in percentage replacement of BA for all mixtures. Increased surface area of BA mixtures is due to the increased water requirement, which resulted in weaker cohesion and interlocking between the river sand and BA particles (Sua-iam and Makul et al, 2013).

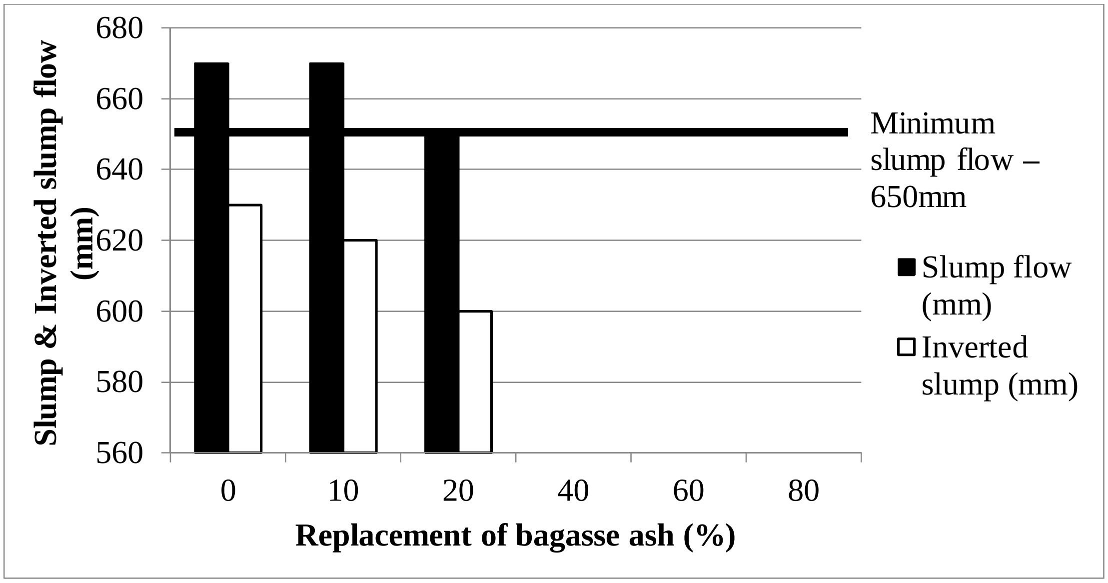


Figure 6 Slump & inverted slump flow for SCC mix-1 for various replacements of BA

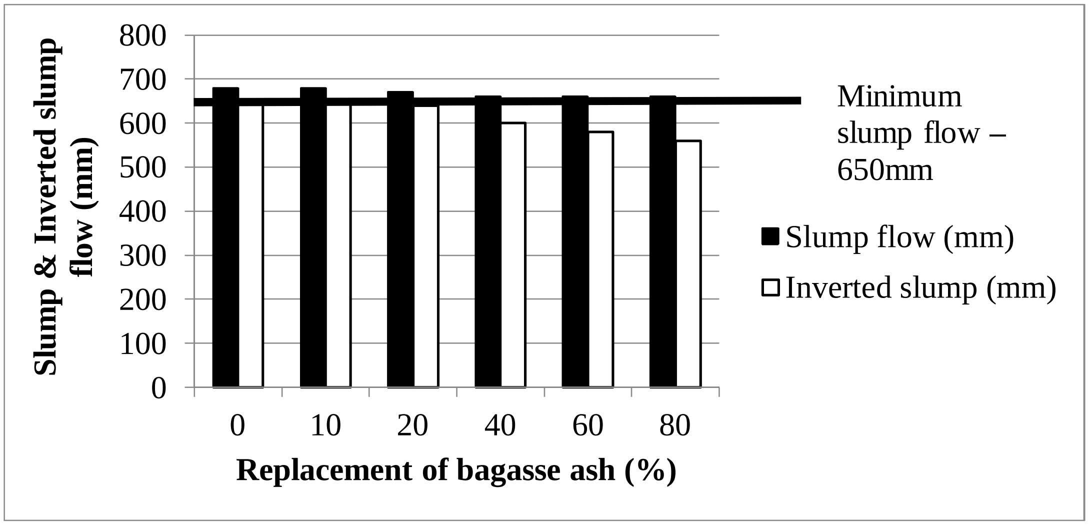


Figure 7 Slump & inverted slump flow for SCC mix-2 for various replacements of BA

B. *Inverted Slump*

The inverted slump cone flow spread is linked with the filling ability of concrete in a similar way as the slump flow. The inverted slump cone flow of the SCC mix-1 was attained in the range of about 590 to 640 mm up to 20% of BA. It was observed that the inverted slump cone flow spread values was about 30–60 mm lower than the slump flow value which is shown in Fig.6 & 7. The inverted slump flow for all replacements of SCC mixtures with BA is shown in Fig.7 The lower values of inverted slump cone flow spread was credited to the loss of energy that occurred because of the resistance caused by the tapered end of the inverted slump cone and owing to the crashing of concrete on the pan (Safiuddin 2008; Safiuddin et al. 2009). The flow increased with the increase in the quantity of super plasticizer used for flow ability. Proportionally the flow decreased with the increase in quantity of bagasse ash (Akram et al. 2009).

C. *J-ring*

The J-ring flow spread indicates the restricted deformability of SCC due to blocking effect of reinforcement bars. Less than 50 mm of blocking and permissible range of below 10mm was observed in samples up to 20% BA in both the SCC mixtures Mixtures containing BA up to 20% achieved adequate passing ability and maintained sufficient resistance to segregation around congested reinforcement areas due to combined influence of a decrease in BA content. At 40% noticeable blocking of 60 mm was observed which is shown in Figs.8 & 9. Whereas, beyond 40% extreme blocking of the mix was noticed this is mainly due to the large particle size of BA. The J-ring blocking effect is the difference in vertical distance at the centre of the ring and at the edge of the flow, which is recorded to as "8mm" (Permissible range is 0 to 10mm).

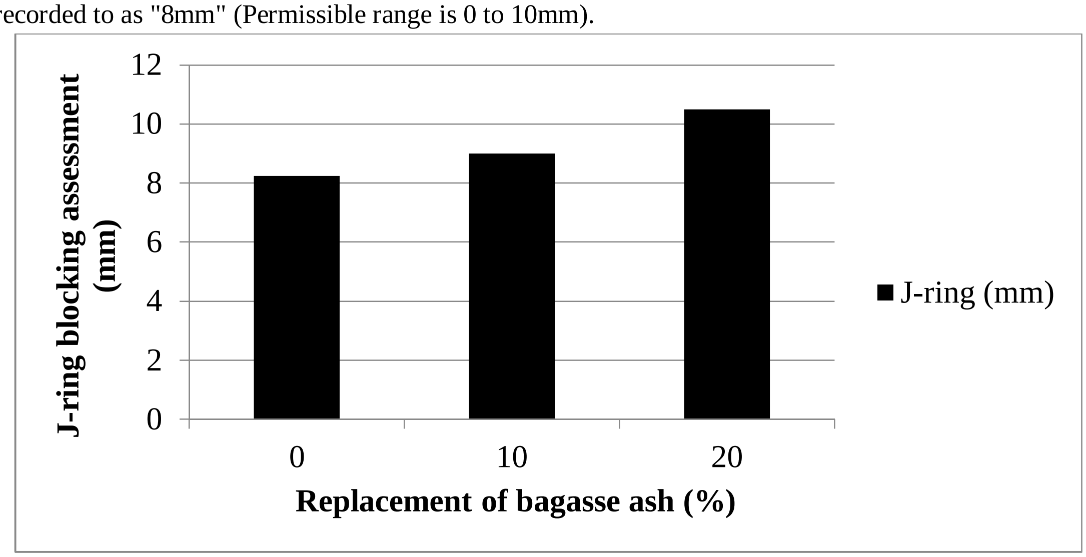


Figure 8 J-ring flow for SCC mix-1 for various replacements of BA.

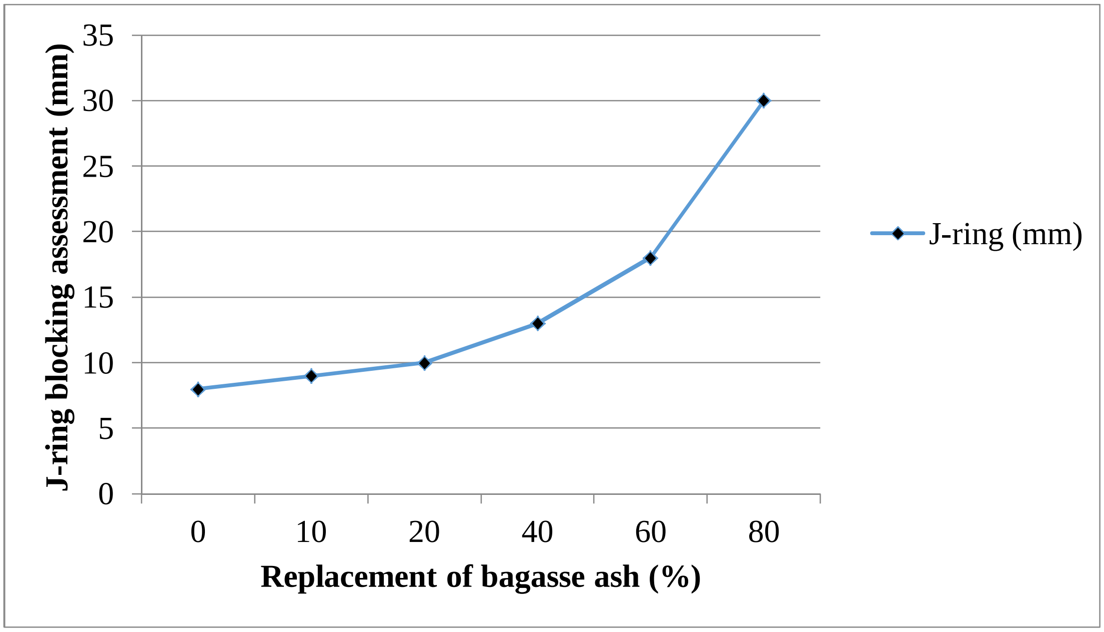


Figure 9 J-ring flow for SCC mix-2 for various replacements of BA.

D. V-funnel

The V-funnel test measures the effects of both internal and external friction within a gradually reducing funnel section. V-funnel flow times are specified in the EFNARC guidelines to be 8-12 sec. (EFNARC). The passing time increased in proportion to the water requirement and fine aggregate replacement level.

In mixtures containing BA up to 20%, the v-funnel times were within specified range of 9 to 12 sec. for both SCC mix-1 and SCC mix-2

The flow time for BA mixture at 40% resulted in flow with slight blockage. Whereas, the flow time for BA mixtures containing beyond 40% resulted in blockage of mixture due to lack of cohesiveness which is shown in Figs.10 & 11. The flow time increased with increasing amounts of BA because the particles absorbed water, resulting in highly viscous mixtures and leading to segregation of the fine aggregate.

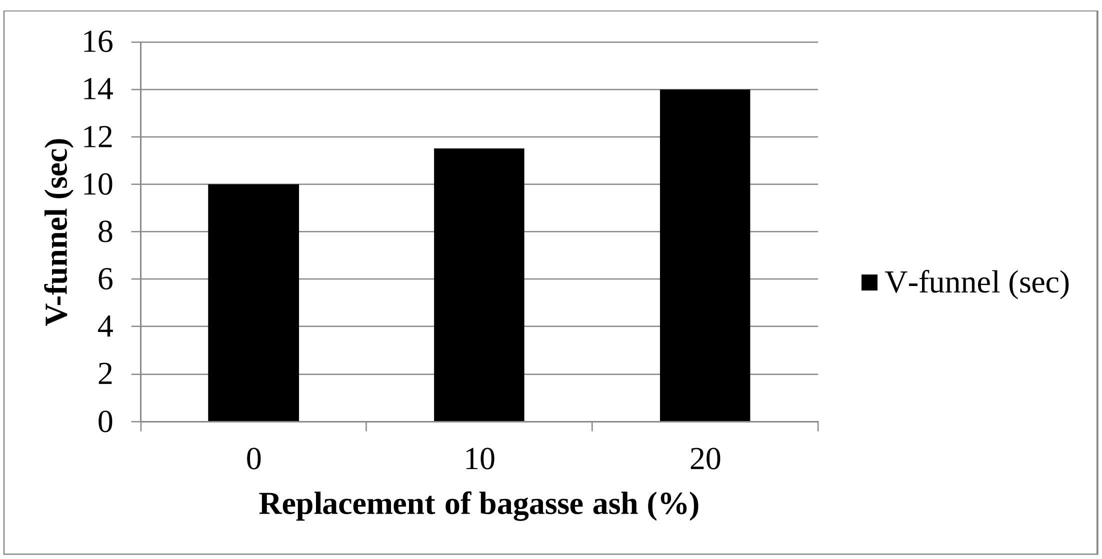


Figure 10 V-funnel flow for SCC mix-1 for various replacements of BA.

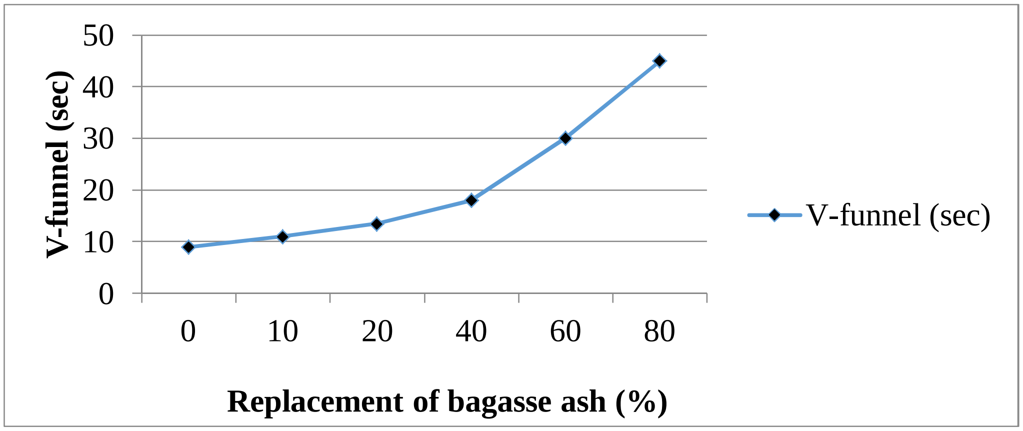


Figure 4.11 V-funnel flow for SCC mix-2 for various replacements of BA.

E. Compressive Strength

The compressive strength results of self compacting concrete for various partial replacement percentage of BA to river sand were found at 3, 7, 28 and 60 days. The test results reveal that the compressive strength of SCC mix-1 ranges from a minimum of about 19.12MPa to a maximum of about 54.36MPa at 28 days. And the compressive strength of SCC mix-2 ranges from a minimum of about 31MPa to a maximum of about 58.3MPa. The results show that the strength development is related to the partial replacement of BA. The compressive strength of both SCC mixture specimens at each age are plotted in Figs.12 to 16. The compressive strength continued to increase as the curing age increases. At later ages (28 and 60 days), rate of increase in compressive strength was found to be higher due to the pozzolanic reaction which develops strength at later ages. In general, compressive strength was increased with increase in partial replacement of BA up to 10%. Compressive strength achieved at 20% of BA was almost equivalent to reference mixture. Compressive strength was found to be decreased beyond 20% of BA. The above trend was same for all mixtures irrespective of age. The decrease in strength was about 52% to 63% for 40% to 80% replacement of BA when compared to reference SCC mix-1. The decrease in strength was about 29% to 43% for 40% to 80% replacement of BA when compared to reference SCC mix-2. Addition of increasing amount of BA generally decreased the strength at a given age due to the greater porosity of the material as indicated by higher water requirement (Rashad et al, 2013).Compressive strength at 10% of BA is 5.4% and 7.4% higher when compared to reference SCC mix-1 and reference SCC mix-2 respectively. Maximum compressive strength of about 58.3MPa was obtained at 10% replacement for SCC mix-2. At 80% replacement of BA the decrease in strength was about 63% when compared with reference SCC mix-1. Comparing the compressive strength results of SCC mix-1 and SCC mix-2 at 28 days the rate of decrease in strength was observed to be lesser for SCC mix-2 when compared with SCC mix-1. The compressive strength of SCC mix-2 was found to be higher when compared with SCC mix-1.

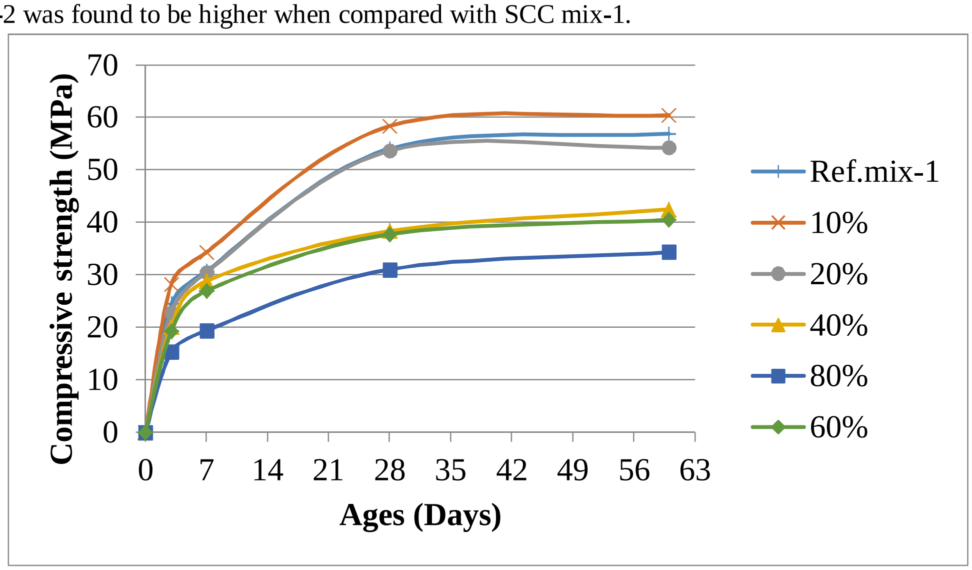


Figure 12 Compressive strength of SCC mix-1 at various curing ages.

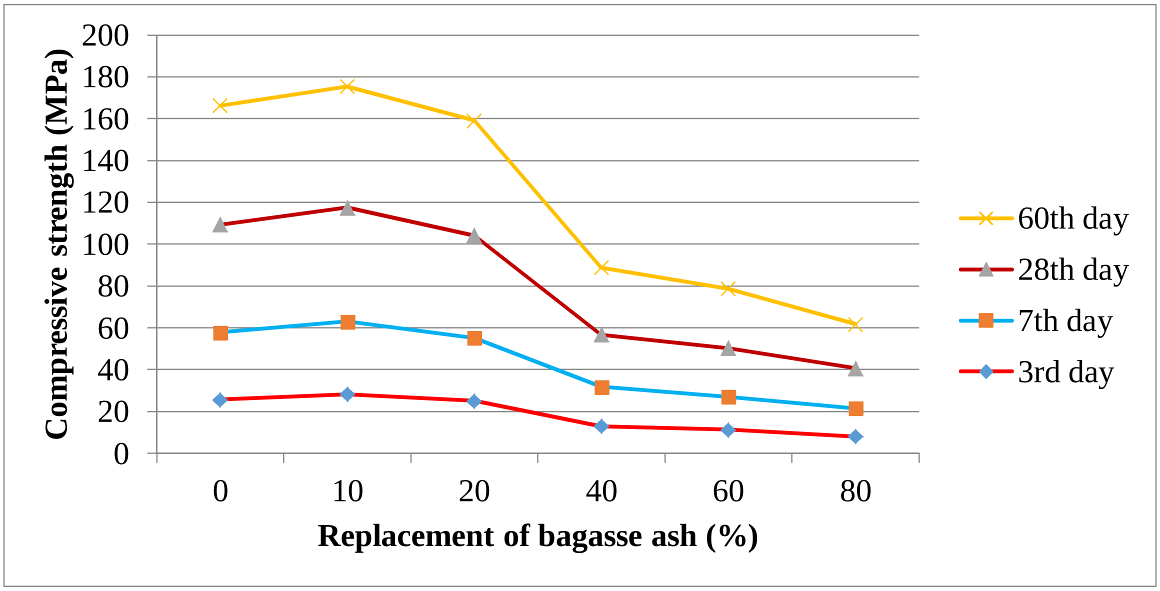


Figure 13Compressive strength of SCC mix-1 for various replacements of BA.

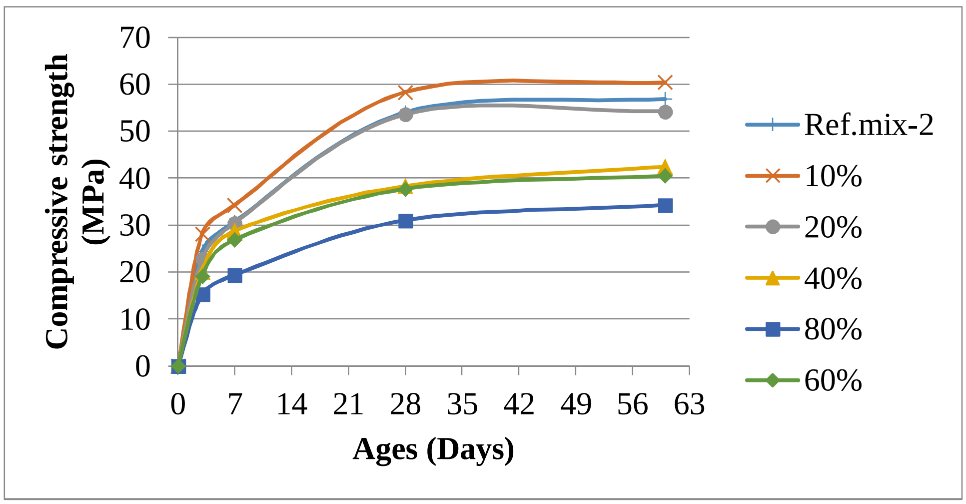


Figure 14 Compressive strength of SCC mix-2 at various curing ages.

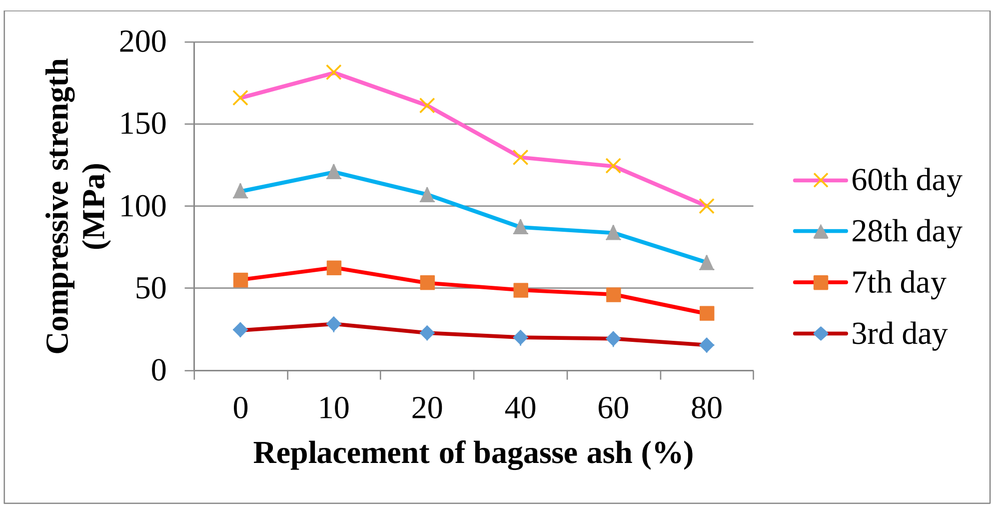


Figure 15 Compressive strength of SCC mix-2 for various replacements of BA.

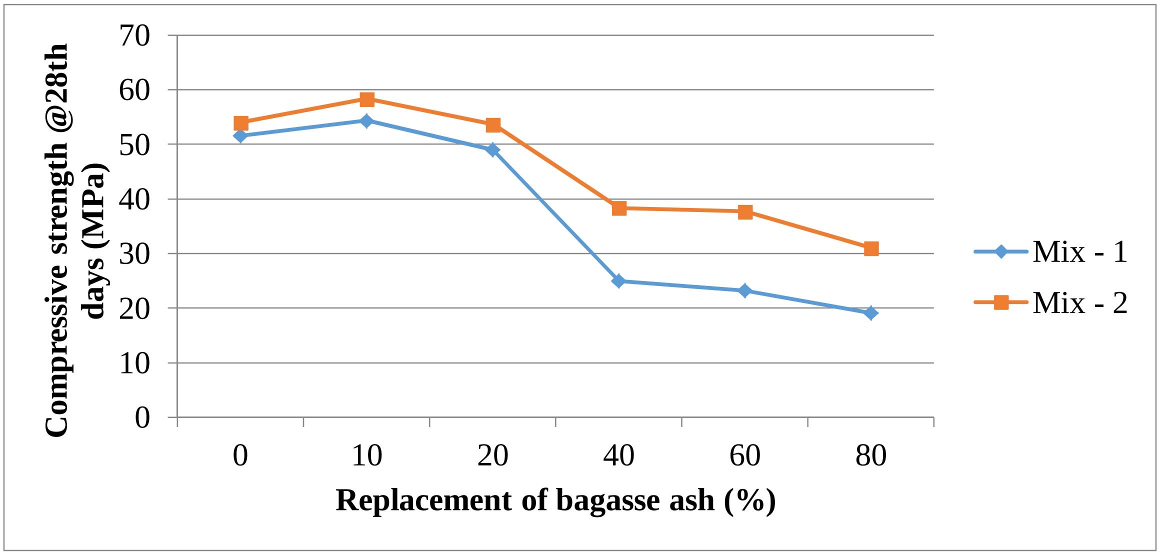


Figure 16 Compressive strength of SCC mix-1 & SCC mix-2 for various replacements of BA.

F. Split Tensile Strength

Split tensile strength is one of the most important fundamental properties of concrete. An accurate prediction of split tensile strength of concrete will help in mitigating cracking problems, improve shear strength prediction and minimize the failure of concrete in tension. Split tensile strength developed for SCC mix-1 and SCC mix-2 specimens with BA percentage varying from 0% to 80% are shown in Figs.17 &18. For reference SCC mix-1 the split tensile strength ranges between 2MPa and 3.1MPa at 7 and 28 days. At 10% replacement of fine aggregates with BA strength were observed to be in the range of about 2.73MPa at 7 days and 3.87MPa at 28 days and it was about 1.53MPa and 2.72MPa at 20% of BA when compared to reference SCC mix-1. The test results show that the split tensile strength increases at 10% of BA and it was comparable at 20% of BA at various curing ages when compared with reference SCC mix-1. The test results reveal that the split tensile strength of SCC mix-2 specimens ranges from a minimum of 2.72MPa to a maximum of 3.87MPa at 28days. For reference SCC mix-2 the split tensile ranges between 2.3MPa and 4.22MPa at 7 and 28 days. According to the test results, split tensile strength values at 28 days are comparable up to 20% of BA and decreases by about 20% to 50% for replacement ratios of 40% to 80% of BA respectively. Split tensile strength tends to decrease with the increase in percentage of BA beyond 20%. Evidently these results agree with Prashant et al, 2013.

Maximum split tensile strength of about 4.22MPa was obtained for SCC mix-2. At 80% of BA the decrease in strength was about 50% compared to reference SCC mix-2. Rate of decrease in split tensile strength was higher at later ages when compared to early age. Split tensile strength values were about 27% higher for SCC mix-2 compared with SCC mix-1.

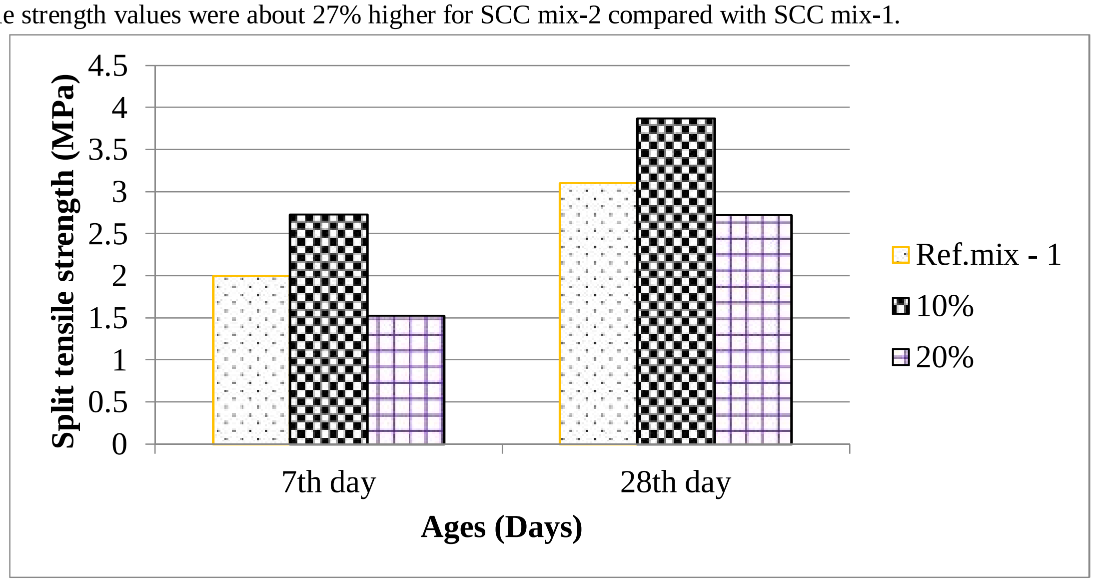


Figure 17 Split tensile strength of SCC mix-1 at various curing ages.

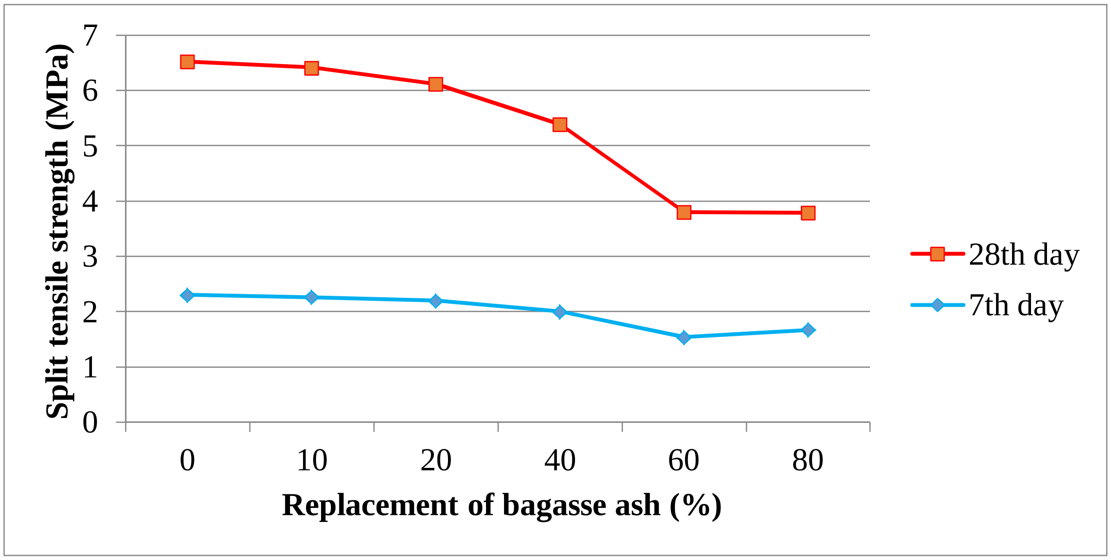


Figure 18 Split tensile strength of SCC mix-2 for various replacements of BA.

G. Flexural Strength

The flexural strength results of self-compacting concrete for various partial replacement percentage of BA to river sand were found at 28 days. The test results reveal that the flexural strength of reference SCC mix-1 was about 5.76MPa. The test results show that the flexural strength was comparable up to 20% of BA which is about 5.20MPa.

Variation of flexural strength for partial replacement of sand with BA is shown in Fig. 19 & 20. The flexural strength of reference SCC mix-2 was about 4.97MPa. The test results show that the flexural strength was comparable up to 20% of BA which is about 4.56MPa. According to the test results flexural strength at 28 days values are observed to decrease by 12% to 17% from 40% to 80% of BA respectively when compared to reference SCC mix-2.

Evidently these results agree with Rashad et al, 2013. The test results show that the flexural strength was comparable up to 20% of BA. Whereas, the flexural strength of SCC specimens decreases beyond 20% of BA. Flexural strength tends to decrease with the increase in percentage of BA replacement in SCC mixture.

Maximum flexural strength of about 5.76MPa is obtained for SCC mix-1. At 80% replacement of BA the strength decreases to about 17.3% when compared to reference SCC mix-2.

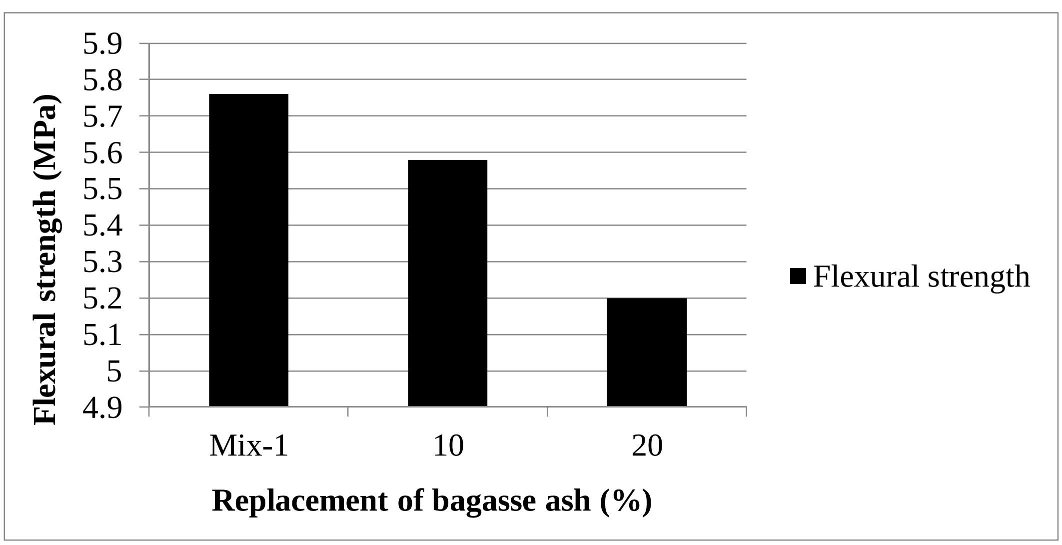


Figure 19 Flexural strength of SCC mix-1 for various replacements of BA.

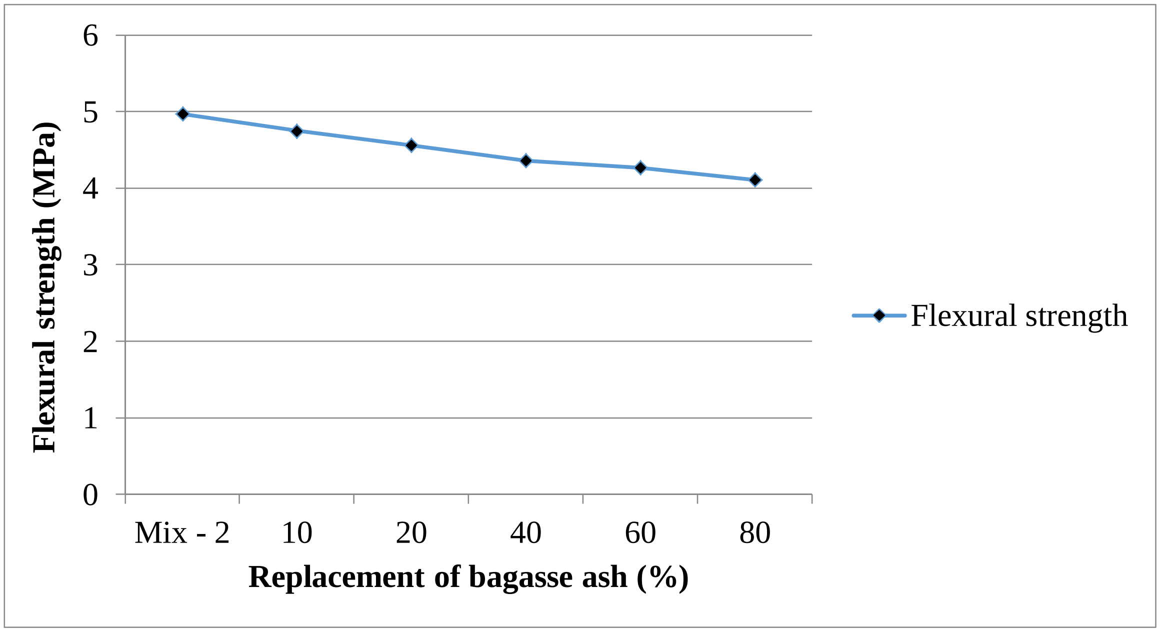


Figure 20 Flexural strength of SCC mix-2 for various replacements of BA.

H. Modulus of Elasticity

The effect of partial replacement of BA with sand on modulus of elasticity of SCC mix-1 and SCC mix-2 specimens were given in Fig 21 & 22. The test results shows that the modulus of elasticity of reference SCC mix-1 was about 25.2GPa. Whereas, the modulus of elasticity of specimens decreases to about 13% at 10% replacement of BA and 37% at 20% BA when compared to reference SCC mix-1. Modulus of elasticity tends to decrease with the increase in percentage of BA replacement compared with the reference SCC mix-1 as. Modulus of elasticity of SCC mix-2 was about 30.4GPa and the values are observed to decrease by 31% to 57% from 10% to 80% of BA respectively. Evidently these results agree with Rashad et al, 2013 who reports that modulus of elasticity of SCC mixture decreases when percentage replacement increases at 28 days.

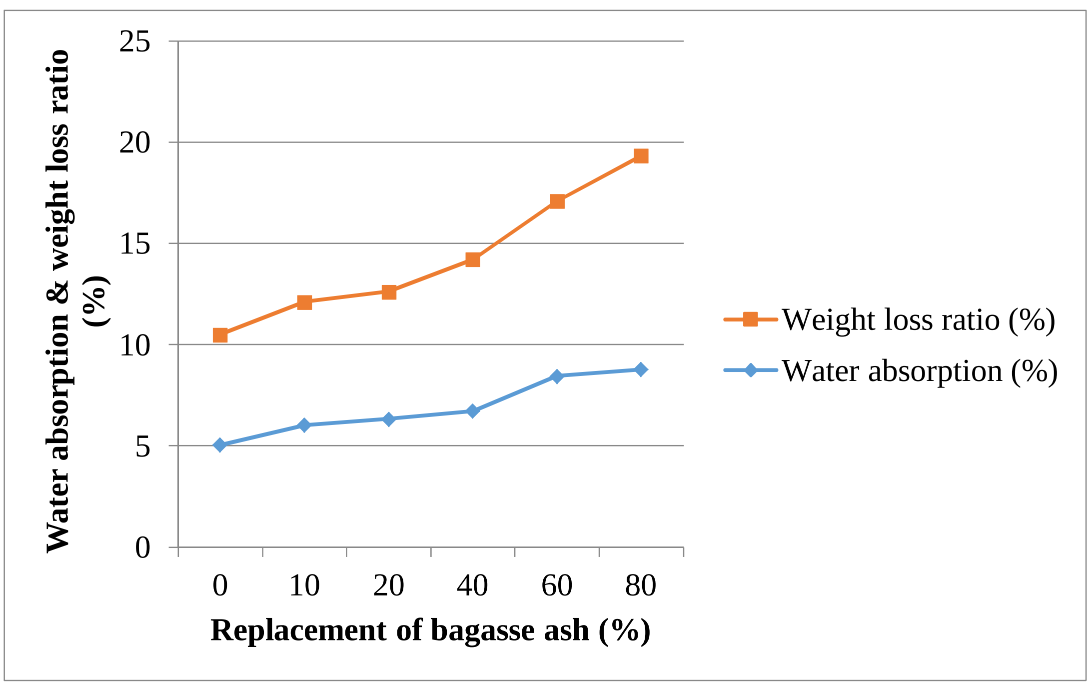


Figure 21Water absorption & weight loss ratio for SCC mix-1 for various replacements of BA.

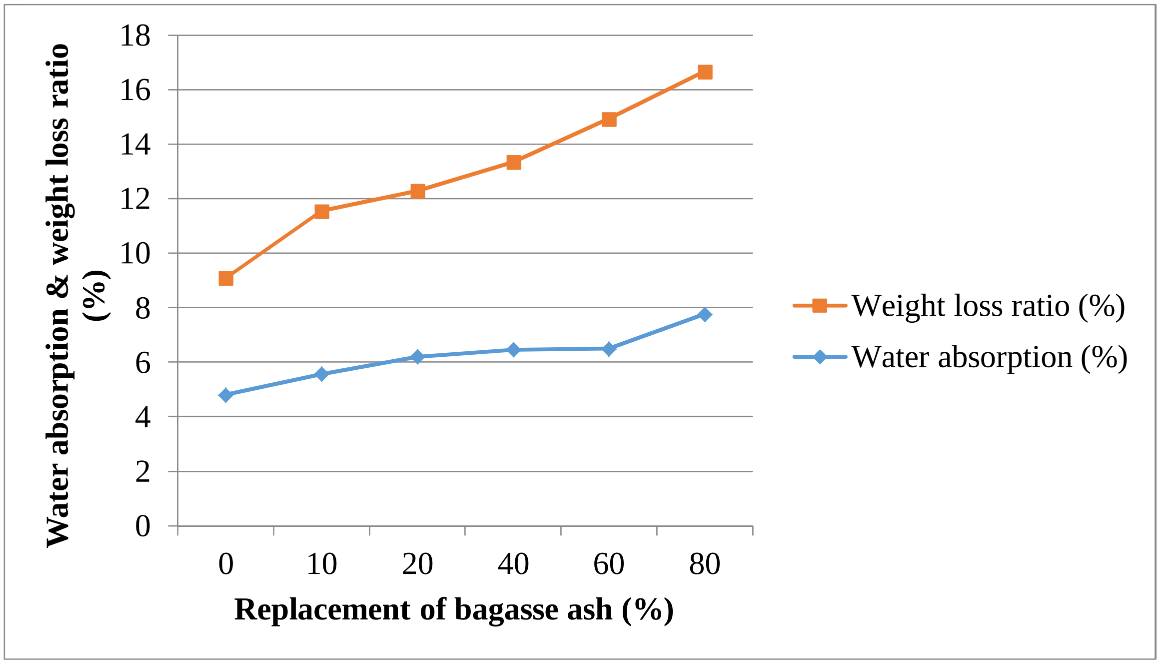


Figure 22 Water absorption & weight loss ratio for SCC mix-2 for various replacements of BA.

V. CONCLUSION

1) Workability of the SCC mixtures depends on BA content, mainly due to its increased water requirement.
2) Fresh properties of both the SCC mixtures up to 20% of BA were acceptable for all the workability tests. Slump flow is satisfied for all replacements up to 80% with the increase in dosage of SP and water content. However, some blocking is observed in mix containing 40% to 80% of BA in J-ring and V-funnel tests.
3) Fresh and hardened density of concrete was decreased as the percentage of BA content increased due to low bulk density of BA compared to sand.
4) Compressive strength of self compacting concrete was marginally increased with 10% of BA. Compressive strength development up to 20% of BA was comparable with reference SCC mix. Beyond 20% replacement level of BA, compressive strength was decreased with partial replacement of BA.
5) Maximum compressive strength of about 56.56MPa is achieved at SCC mix-2 at 10% of BA.
6) The rate of decrease in compressive strength of concrete is lesser for SCC mix-2 when compared with SCC mix-1.
7) Spit tensile strength and flexural strength of concrete was comparable at 10% and 20 % of BA to reference mix.
8) Modulus of elasticity of concrete was decreased with increase in percentage of BA.
9) Hardened properties of self-compacting concrete increases at later ages when compared to early ages.

REFERENCES

[1] Aigbodion V.S, Hassan S.B, Ause T and Nyior G.B, (2010), Potential utilization of solid waste (bagasse ash), Journal of Minerals & Materials Characterization & Engineering, 9, 67-77.
[2] Arjun B and Rame Gowda M, (2014). Development and study of behavior of self-compacting concrete using recycled aggregates, International Journal of Advanced Technology in Engineering and Science, 2(7).
[3] Ashok Gurjar H, (2004). Mix design and testing of self consolidating concrete using florida materials, The Florida Department of Transportation, 503.
[4] ASTMC 642-06, Standard test method for density, absorption, and voids in hardened concrete, American society for testing and materials.
[5] Boukendakdji O, Kenai S, Kadri E H and Rouis F,(2009). Effect of slag on the rheology of fresh self-compacted concrete, Construction and Building Materials, 23, 2593–2598.
[6] EFNARC(2002). The European guidelines for self-compacting concrete specification, production and use.
[7] Ganesan N, Bharati Raj J and Shashikala A P,(2012). Strength and durability studies of self compacting rubberised concrete, The Indian Concrete Journal.
[8] Girish S, (2012). Influence of powder and paste on SCC using recycled concrete aggregate, Bonfring International Journal of Industrial Engineering and Management Science, 2(4).
[9] Gritsada Sua-iam and Natt Makul, (2013). Use of increasing amounts of bagasse ash waste to produce self-compacting concrete by adding limestone powder waste, Journal of Cleaner Production, 1-12.

[10] Gritsada Sua-iam and Natt Makul,(2013). Use of high volume, untreated bagasse ash as a fine aggregate substitute for preparing self-compacting concrete, Research and Development Journal, 24(3).

[11] Guilherme Chagas Cordeiro, Romildo Dias Toledo Filho , Luis Marcelo Tavares and Eduardo de Moraes Rego Fairbairn, (2009). Ultrafine grinding of sugar cane bagasse ash for application as pozzolanic admixture in concrete, Cement and Concrete Research, 39, 110–115.

[12] Heba Mohamed A, (2011). Effect of fly ash and silica fume on compressive strength of self-compacting concrete under different curing conditions, Ain Shams Engineering Journal, 2, 79–86.

[13] IS 2386 (part I)-(1963). Methods of test for aggregate for concrete-particle size and shape, BIS, New Delhi.

[14] IS 2386 (part III)-(1963). Method of test for aggregate for concrete-specific gravity, density, voids absorption and bulking, BIS, New Delhi.

[15] IS 383-(1970). Specification of coarse and fine aggregate from natural sources for concrete, BIS, New Delhi.

[16] IS 516(1959). Methods of test for strength of concrete, BIS, New Delhi.

[17] IS 5816(1999). Method of test splitting tensile strength of concrete, BIS, New Delhi.

[18] IS 4031(1988). Methods of physical tests for hydraulic cement, Part 6: Determination of compressive strength of hydraulic cement, BIS, New Delhi.

[19] IS 1727(1967). Methods of test for pozzolanic materials, BIS, New Delhi.

[20] IS 12269(1987). 53 grade ordinary Portland cement, BIS, New Delhi.

[21] Kou S.C and Poon C.S, (2009). Properties of self compacting concrete prepared with coarse and fine recycled concrete aggregates, Cement & Concrete Composites, 31, 622–627.

[22] Lourdes Souza M.S, Eduardo Fairbairn M.R, Guilherme Cordeiro C and Romildo Toledo Filho D, (2012). Hydration study of sugar cane bagasse ash and calcium hydroxide pastes of various initial c/s ratios, Second International Conference on Micro structural-related Durability of Cementitious Composites,11-13.

[23] Mallikarjuna Reddy V, Seshagiri Rao M.V, Srilakshmi P and Sateesh Kumar B, (2013). Effect of w/c ratio on workability and mechanical properties of high strength self compacting concrete, 7, 06-13.

[24] Najim K.B and Hall M.R, (2010). A Review of the fresh/hardened properties and applications for plain (PRC) and self-compacting rubberised concrete (SCRC), Construction and Building Materials, 24, 2043–2051.

[25] Nan Su and Buquan Miao,(2003). A New method for the mix design of medium strength flowing concrete with low cement content, Cement & Concrete Composites, 25, 215–222.

[26] Nan Su, Kung-Chung Hsu and His-Wan Chai, (2001). A Simple mix design method for self-compacting concrete, Cement and Concrete Research ,31,1799-1807.

[27] Neelam Pathak and Rafat Siddique, (2012). Properties of self-compacting- concrete containing fly ash subjected to elevated temperatures, Construction and Building Materials, 30, 274–280.

[28] Prashant Modani O and Vinod Mohitkar M, (2014). Self-compacting concrete with recycled aggregate: a solution for sustainable development, International Journal of Civil and Structural Engineering, 2014, 4(3).

[29] Yoyok Setyo, Hadiwidodo and Sabarudin Bin Mohd, (2009). Effect of super plasticizer and water binder ratio on fresh properties and compressive strength of SCC, Journal of Engineering and Applied sciences, 4(3), 232-235.

[30] Vengadesh Marshall Raman, J & Ramasamy, V 2021, 'Augmentation of dissimilar Technique for Enhancing the Concrete properties with Recycled Coarse Aggregate and Manufactured Sand', Journal of Material Research and Technology, vol.14, pp.1180-1190. ISSN: 2238-7854, Impact Factor – 5.039.-Annexure I https://doi.org/10.1016/j.jmrt.2021.06.094 (Elsevier)

[31] Kandasamy S, Gowthaman M , Gowdhamramkarthik P, Vengadesh Marshall Raman J, Magenthiran B,2022, "Strength and durability performance of concrete cast using permeable formwork liner', Journal of Building Pathology and Rehabilitation (2022) 7:89, https://doi.org/10.1007/s41024-022-00231-9 (Springer)

[32] J.Vengadesh Marshall Raman, R. Aswini."Studies on Self Compacting Fuel Dispenser Hose Pipe Rubber in Concrete", Volume 4, Issue XII, International Journal for Research in Applied Science and Engineering Technology (IJRASET) Page No: , ISSN : 2321-9653,www.ijraset.com

[33] J.Vengadesh Marshall Raman, M. Sriram ."Experimental Investigation on Fully Replacement of Steel Slag as Course Aggregate in M30 Grade Concrete", Volume 5, Issue II, International Journal for Research in Applied Science and Engineering Technology (IJRASET) Page No: , ISSN : 2321-9653, www.ijraset.com

[34] J. Vengadesh Marshall Raman, R. Senthil Raj."Mechanical Studies of Self Compacting Concrete Using Plastic Aggregate", Volume 5, Issue II, International Journal for Research in Applied Science and Engineering Technology (IJRASET) Page No: , ISSN : 2321-9653,www.ijraset.com

[35] J. Vengadesh Marshall Raman, R. Kirubakaran."Experimental Investigation of Partial Replacement of Sand by Laterite Soil in Concrete", Volume 5, Issue II, International Journal for Research in Applied Science and Engineering Technology (IJRASET) Page No: , ISSN : 2321-9653, www.ijraset.com

[36] J.Vengadesh Marshall Raman, M. Sriram."Study on Replacement Level of Concrete Waste as Fine Aggregate in Concrete", Volume 5, Issue II, International Journal for Research in Applied Science and Engineering Technology (IJRASET) Page No: , ISSN : 2321-9653,www.ijraset.com

[37] J.Vengadesh Marshall Raman , K.Jaiganesan , "Durability Study on Replacement Level of Concrete Waste as Fine Aggregate in Concrete" Vol. 2 - Issue 2 (January - February 2017), International Journal of Research in Engineering Technologys (IJRET) , ISSN: 2455- 1341 , www.ijretjournal.org

[38] J.Vengadesh Marshall Raman , K.Jaiganesan , "Non-Destructive Test and Durability Studies of Self Compacting Concrete Using Plastic Aggregate" Vol. 2 - Issue 2 (January - February 2017), International Journal of Research in Engineering Technologys (IJRET) , ISSN: 2455- 1341 , www.ijretjournal.org

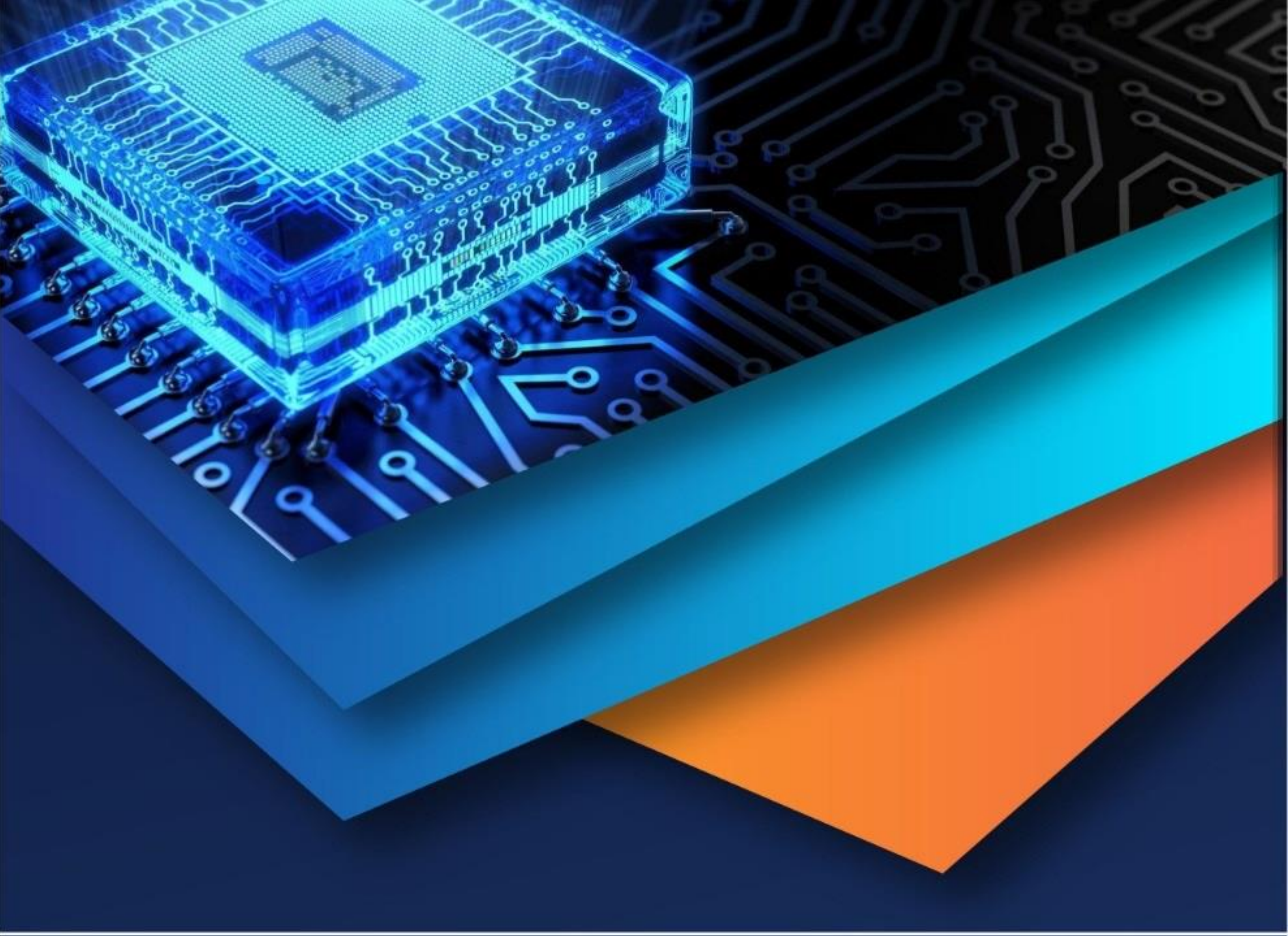
[39] J.Vengadesh Marshall Raman and K Ajeeth Kumar , "Studies on Partially Replacement of Municipal Solid Waste Ash as Cement in Concrete" Vol. 2, No. 2, April 2017, International Journal of civil engineering and construction structures (IJCECS), ISSN: 2455-7714, www.trpubonline.com

[40] J Vengadesh Marshall Raman and R Kirubakaran," Durability Properties on Fuel Dispenser Hose Pipe Rubber as a Coarse Aggregate in Self Compacting Concrete" Vol. 2, No. 2, April 2017 , International Journal of civil engineering and construction structures (IJCECS),ISSN:2455-7714, www.trpubonline.com

[41] J Vengadesh Marshall Raman and S Kirubakaran, " Study on Partial Replacement of Fine Aggregate by Crushed Waste Bottles in Concrete" Vol. 2, No. 2, April 2017, , International Journal of civil engineering and construction structures (IJCECS),ISSN 2455-7714, www.trpubonline.com

[42] J.Vengadesh Marshall Raman, V.Murali Krishnan "Partial Replacement of Cement with GGBS in Self Compacting Concrete for Sustainable Construction", SSRG International Journal of Civil Engineering (SSRG-IJCE),V4(3),24-28March2017.ISSN:2348–8352. www.internationaljournalssrg.org/IJCE/index.html. Published by: Seventh Sense Research Group

[43] J Vengadesh Marshall Raman and K Chellaperumal," Study on Mechanical Properties of Glass Fiber Reinforced Concrete" Vol. 2, No. 2, April 2017, International Journal of civil engineering and construction structures (IJCECS),ISSN:2455-7714, www.trpubonline.com
[44] J. Vengadesh Marshall Raman "Planning and Design of Seismic Resistant Structure using Base Isolation Technique" Vol. 6, Issue 02, 2018, IJSRD - International Journal for Scientific Research & Development, ISSN (online): 2321-0613, www.ijsrd.com.
[45] J.Vengadesh Marshall Raman and N.Vijay "Experimental Study On Glass Fiber Reinforced Concrete Using Metakaolin As Mineral Admixtures" Volume 10, Issue 5, May-2019 ,IJSER - International Journal of Scientific & Engineering Research, ISSN 2229-5518 , http://www.ijser.org
[46] J.Vengadesh Marshall Raman and P.Soundarya "An Experimental Study On Rapid Hardening Cement Concrete Paver Blocks By Using Corundum As A Mineral Admixture" Volume 16, Issue 3 Ser. I (May. - June. 2019),IOSR- Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, , PP 01-09 www.iosrjournals.org
[47] J.Vengadesh Marshall Raman and P.Soundarya "Planning, Designing and Estimation of High Ceiling Residential Building(G+1)" Vol. 9,Issue 5 (Series -V) May 2019, pp 60-75 ,Journal of Engineering Research and Application w.ijera.com ISSN : 2248-9622 Vol. 9,Issue 5 (Series -V) May 2019, pp 60-75
[48] J.Vengadesh Marshall Raman, V.Gnanadevi and V.Anitha "Experimental Investigation on Quarry Dust and Recycled Aggregates in Concrete", International Journal of Civil Engineering and Applications. ISSN 2249-426X Volume 9, Number 1 (2019), pp. 1-9 © Research India Publications http:// www.ripublication.com
[49] J.Vengadesh Marshall Raman, R.Rajesh and P.Sabari Velswaran "Study on Strength of High Performance Concrete by Partial Replacement of Fine Aggregate by Copper Slag" International Journal of Applied Engineering Research ISSN 0973-4562 Volume 14, Number 11 (2019) pp. 2795-2798 © Research India Publications. http://www.ripublication.com
[50] J. Vengadesh Marshall Raman "Sustainable Technological Solutions For Faster And Cost Effective Construction Of Mass Housing (A Case Study Of Rapid - Monolithic - Disaster Proof Technology) "Journal of Civil Engineering and Technology (JCIET) Volume 06, Issue 01, January - December 2019, pp. 01-16.
[51] Vengadesh Marshall Raman, J & Ramasamy, V 2020, 'various treatment techniques involved to enhance the recycled the recycled coarse aggregate in concrete: A review', Material Today Proceedings, vol.45, no.7, pp.6356-6363, ISSN: 2214-7853, Impact Factor -1.46. **(Elsevier)** https://doi.org/10.1016/j.matpr.2020.10.935



10.22214/IJRASET

INDEX COPERNICUS

45.98

IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY