"STUDY ON EFFECT OF BAMBOO CHARCOAL ASH AS PARTIAL REPLACEMENT FOR CEMENT ON PROPERTIES OF SELF COMPACTED CONCRETE"

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Abstract - In this thesis, properties of M30 Grade of Self-Compacted Concrete (SCC) are investigated through adhering to IS standards. Concrete properties are assessed by partially replacing cement with varying percentages of BCA, accordingly in the range of 0% (without BCA), 5%, 10%, 15%, and 20% by weight of cement. Properties of SCC will be evaluated using tests such as slump flow, V-funnel flow time, L-box, and J-ring, compressive strength, flexural strength, and split tensile strength will be conducted at different curing ages. The aim is to optimize BCA content for improved mechanical and durability properties while preserving the self-compacting characteristics of the concrete mix.

***Key Words*:** Bamboo Charcoal Ash, Self-Compacted Concrete, Supplementary cementitious materials.

1.INTRODUCTION

In the late 1980s, inspired by Japanese scholar Prof. Okamura's ground-breaking work in 1986 at Tokyo University, there was a surge of interest in finding a solution to the issues arising from inadequately compacted cast concrete. The goal was to develop a vibration-free concrete that could effortlessly create durable and reliable structures. This initiative led to the inception of self-compacting concrete (SCC), a modified cement-based material. SCC possesses the unique ability to flow, pass, fill, and compact under the influence of its own weight, eliminating the need for external compaction energy. This innovative material finds application in casting heavily reinforced members, areas with limited or no vibrator access, and highly intricate formwork shapes.

Bamboo charcoal ash (BCA): it is often referred to simply as bamboo ash, is the residue obtained after burning bamboo in a controlled environment with limited oxygen. It is a fine, grayish-black powder that contains various chemical compounds and minerals derived from the bamboo plant. Bamboo charcoal ash has gained attention for its potential applications in various fields, including agriculture, construction, and environmental remediation, due to its unique properties and composition.

OBJECTIVES OF THE STUDY:

- The primary objective of this thesis is to investigate the impact of BCA as a supplementary cementitious material on the properties of self-compacted concrete (SCC).
- M30 SCC mix incorporating varying percentages of BCA as a partial replacement for cement. Explore different mix proportions to achieve desired fresh and hardened properties of SCC.
- Prepare SCC specimens with different BCA percentages and conduct a series of tests, including slump flow, J-ring, L-box, and V-funnel tests, to evaluate self-compatibility. And performed compressive strength tests, splitting tensile strength tests, and Flexural strength tests on hardened SCC specimens.
- Analyzing the experimental data to compare the properties of SCC mixes containing BCA with traditional SCC mixes.
- Preparing conclusions regarding the effectiveness of BCA as a supplementary cementitious material in enhancing the properties of SCC.

2.LITERATURE REVIEW

- **Anastasiou E.K. et al., (2014):** In this study behavior of self-compacting concrete containing ladle furnace slag and steel fiber reinforcement. And how the addition of steel fibers enhances the mechanical properties and durability of self-compacting concrete containing ladle furnace slag.
- **Bani Ardalan R et al., (2017):** Investigated the impact of incorporating pumice powder and silica fume as supplementary materials on the workability retention and compressive strength of SCC. The study examined the fresh properties, such as slump flow and viscosity, to assess workability.
- **Celik K et al., (2015):** In this research they studied the mechanical properties, durability, and life-cycle assessment of self-consolidating concrete mixtures made with blended Portland cements containing fly ash and limestone powder. Blended cements with fly ash and limestone powder are often used to improve concrete performance.
- **Gupta N et al., (2021):** In This research review surveyed on recent advancements in incorporating industrial by-products into SCC. The review serves as a roadmap for researchers and practitioners, guiding them toward greener and more efficient SCC formulations.
- **Ouchi, M et al., (2003):** An overview of self-compacting concrete, discussing its development and

key properties. Offers insights into the rheological characteristics and workability of SCC, laying a foundation for understanding its behavior.

- **Zhao H et al., (2015):** In This research they investigated the properties of SCC with fly ash and GGBS mineral admixtures. This study is significant as it delves into the synergistic effects of combining multiple mineral admixtures in SCC. Understanding how different materials interact within the concrete matrix is crucial for optimizing SCC for both mechanical strength and long-term durability.

3. METHODOLOGY

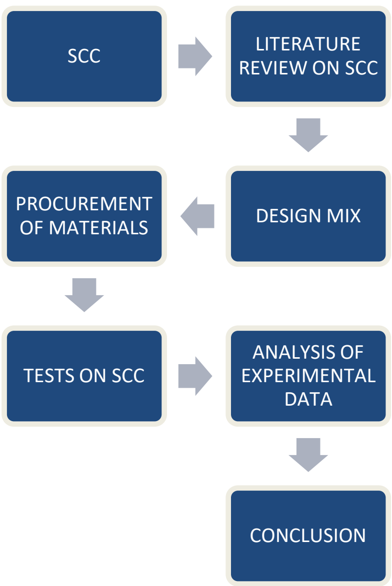

Fig -1: **Flow Chart of Methodology**

4. EXPERIMENTAL STUDY

Table -1: Physical Properties of Cement (OPC 53)

Property	IS Code	Test Method	Test Result
Compressive Strength	IS 4031-6	Compression testing machine (3days)	34 N/mm2
		(7days)	49 N/mm2
		(28days)	57 N/mm2
Specific Gravity	IS 4031-4	Le Chatelier Flask	3.11
Consistency	IS 4031-4	Vicat apparatus	32.15%
Setting Time	IS 5513	Vicat apparatus	42 min (Initial)
			527 min (Final)

Table -2: Chemical Properties of Cement (As Per Supplier)

S.No	Type of Property	Percentage %
1	Cao	61.8
2	Sio2	20.2
3	Mgo	1.83
4	Fe2O3	4.62
5	Al2O3	5.32
6	SO3	2.5
7	Na2O	0.16
9	LOI	2.7
10	K2O	0.87

Table -3: Properties of Fine Aggregate

S.No	Property	IS Code	Test Method	Test Result
1	Fineness Modulus	IS 2386-3	IS Sieves	2.67
2	Specific Gravity	IS 2386-3	Pycnometer	2.71
3	Grading Zone	IS 383	IS Code	II

Table -4: Properties of Coarse Aggregate

S.No	Property	IS Code	Test Method	Results
1	Specific Gravity	IS 2386-3	Pycnometer	2.82
2	Water Absorption	IS 2386-3	Oven	0.52%
3	Impact Value	IS 2386-4	Impact testing machine	26.7%
4	Crushing Value	IS 2386-4	Compression testing machine	22.15%
5	Los Angeles	IS 2386-4	Los Angeles abrasion	19.18%

	Abrasion Value		testing machine	
6	Flakiness and Elongation Index	IS 2386-1	Thickness gauge and elongation index gauge	13.9%, 14.1%
7	Grading Zone	IS 383	IS Code	I

Table -5: Physical Properties of BCA (As Per Supplier)

S.No	Type of Property	Results
1	Colour	Black
2	Texture	Fine powder
3	Odour	Odourless
4	Specific Gravity	2.68
5	Fineness	30.45

Table -6: Chemical Properties of BCA (As Per Supplier)

S.No	Type of Property	Percentage %
1	Cao	4.45
2	Sio2	80.1
3	Mgo	1.51
4	Fe2O3	2.12
5	Al2O3	4.99
6	K2O	3.15
7	MNO2	0.56
8	TIO2	0.38
9	LOI	1.82
10	P2O5	0.92

Fig -2: Slump Flow Test for SCC

Fig -3: J-Ring Test Equipment

Fig – 4: V-Funnel Test for SCC

Fig -5: L-Box Test for SCC

Fig -6: Compressive Strength Test

5. RESULTS AND DISCUSSIONS

Table -7: Slump Test Results

S.No.	BCA Replacement (%)	Slump Flow (mm)	% of Variation
1	0	657	
2	5	674	2.59
3	10	693	2.81
4	15	716	3.31
5	20	651	9.99

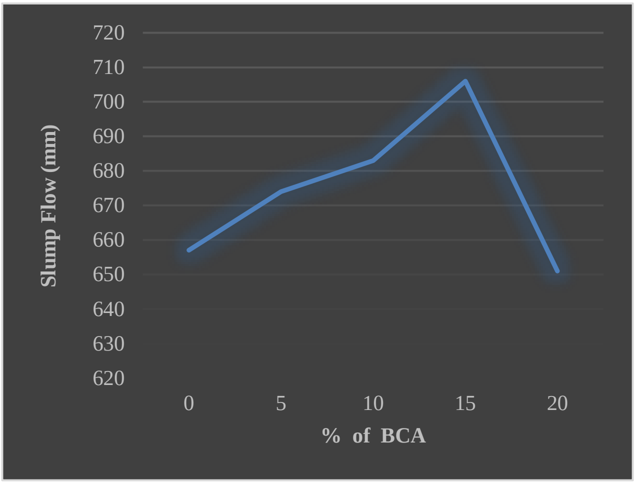

Fig -7: Slump Test Results

Table -8: J-Ring Flow Test Results

S.No.	BCA Replacement (%)	J-Ring Flow (Sec)	% of Variation
1	0	7	
2	5	6	16.67
3	10	5	16.67
4	15	3	66.67
5	20	4	33.33

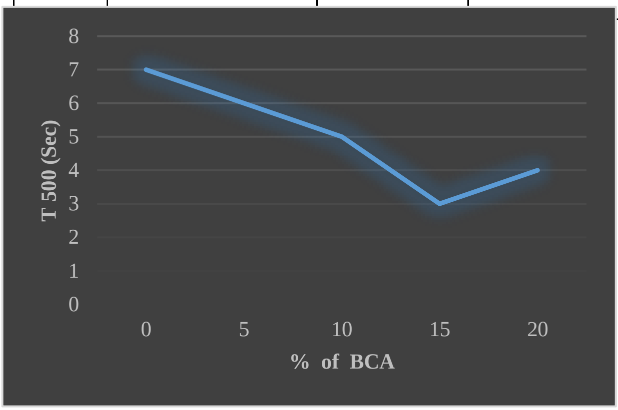

Fig -8: J-Ring Test Results

Table -9: V-Funnel Flow Test Results

S.No.	BCA Replacement (%)	V-Funnel Time (s)	% of Variation
1	0	9.2	
2	5	8.0	15.00
3	10	7.1	12.67
4	15	6.4	10.94
5	20	8.9	39.06

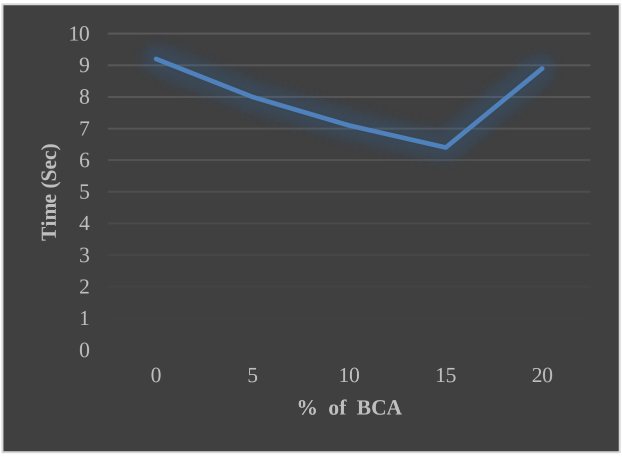

Fig -9: V-Funnel Test Results

Table -10: L-Box Test Results

S.No.	BCA Replacement (%)	L-Box Results (mm)	% of Variation
1	0	652	
2	5	669	2.61
3	10	721	7.77
4	15	746	3.47
5	20	678	10.03

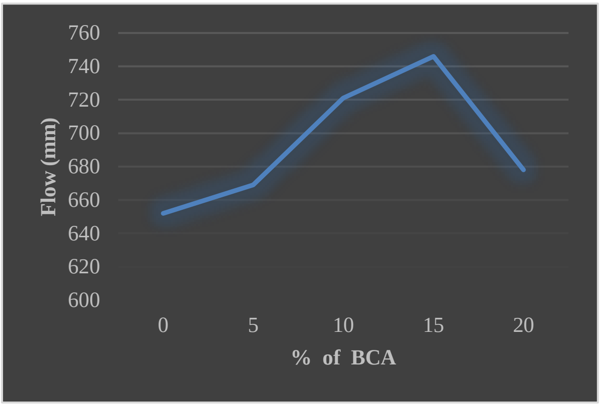

Fig -10: L-Box Test Results

Table -11: Compressive Strength Test Results

S.No.	BCA Replacement (%)	Compressive Strength (MPa)	% of Variation
1	0	33	
2	5	36.4	10.30
3	10	37.02	12.18
4	15	41.11	24.57
5	20	35.1	6.36

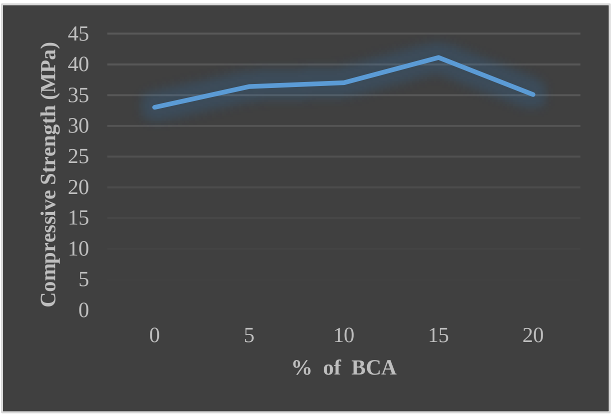

Fig -11: Compressive Strength Test Results

Table -12: Split Tensile Strength Test Results

S.No.	BCA Replacement (%)	Split Tensile Strength (MPa)	% of Variation
1	0	3.5	
2	5	3.6	2.85
3	10	3.7	5.71
4	15	3.8	8.57
5	20	3.19	19.12

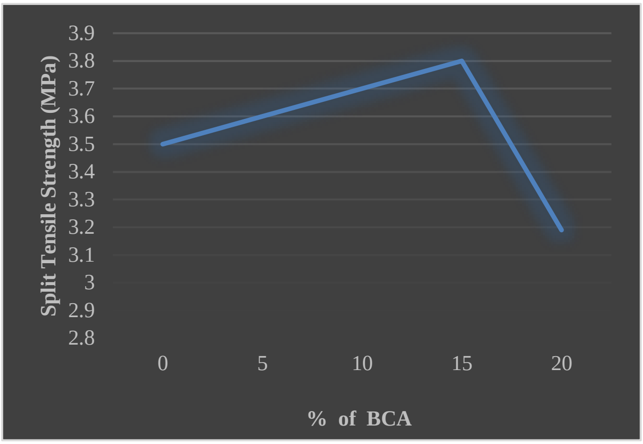

Fig -12: Split Tensile Strength Test Results

Table -13: Flexural Strength Test Results

S.No	BCA Replacement (%)	Flexural Strength (MPa)	% of Variation
1	0	4.5	
2	5	4.8	6.67
3	10	4.9	8.89
4	15	5.12	13.78
5	20	4.9	8.89

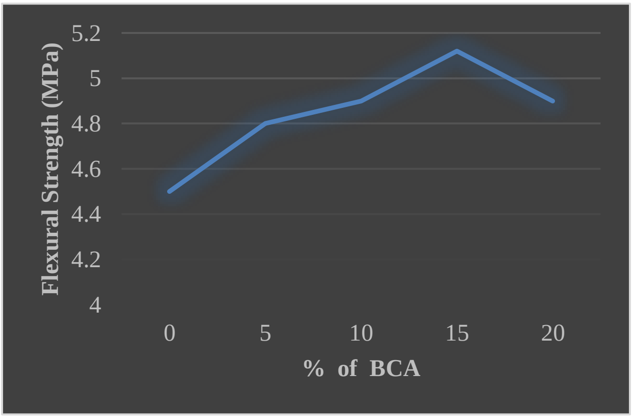

Fig -13: Flexural Strength Test Results

6. CONCLUSION

CONCLUSIONS:

- The addition of BCA (Bamboo Charcoal Ash) improves the slump flow, indicating enhanced workability.
- The maximum improvement in slump flow occurs with 15% BCA replacement, showing a significant
- increase in workability.
- BCA replacement positively impacts J-Ring flow, enhancing the passing ability of concrete through reinforcement congested areas.
- The maximum improvement in J-Ring flow is observed with 15% BCA replacement, indicating improved concrete manoeuvrability.
- V-Funnel time slightly increases with BCA replacement, suggesting a marginal decrease in flowability.
- The impact on flowability is relatively low, with a maximum variation of 10.94% at 15% BCA replacement.
- BCA replacement leads to a slight increase in L-Box, indicating improved flowability and passing ability through narrow spaces.
- The maximum improvement in L-Box ratio is observed with 15% BCA replacement, suggesting enhanced concrete spread ability.
- BCA replacement significantly enhances compressive strength, with a maximum increase of 24.57% at 15% BCA replacement.
- Higher BCA replacement percentages result in stronger concrete, indicating the potential for structural applications.
- Split tensile strength increases with BCA replacement, indicating improved tensile properties.
- The maximum increase in split tensile strength occurs at 15% BCA replacement, showing an 8.57% improvement compared to plain concrete.
- Flexural strength improves with BCA replacement, suggesting enhanced bending properties.
- The maximum increase in flexural strength is observed at 15% BCA replacement, with a 13.78% improvement compared to plain concrete.
- The optimum BCA replacement percentage varies based on the specific property being considered. For workability-related tests (slump flow, J-Ring flow, L-Box ratio), the best performance is observed at 15% BCA replacement. For strength-related tests (compressive strength, split tensile strength, flexural strength), the maximum improvement occurs at 15% BCA replacement as well.
- Therefore, a BCA replacement of 15% is recommended for achieving a balanced enhancement in both workability and mechanical properties of the concrete mix.

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