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Review JoPC

Investigation of Mechanical Properties of Concrete Using Agriculturally Based Waste and Fibers as Additives

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Abstract

In today's world one of the most common man-made materials widely used as concrete. Around 1 ton of concrete is produced every year for an individual person. Concrete is composed of mainly cement, fine aggregates, coarse aggregates & water. As the construction industry is the 2nd biggest industry, environmental and social responsibility contributes to the sustainable development. Bamboo leaf ash has received recent interest as an agricultural waste with pozzolanic reactivity. An estimated 20 million tons of bamboo are used annually in the culinary, brewing, building, agricultural, fiber, paper, and board industries. The usage of banana leaf ash (BLA) has shown itself to be a substitute for cement for similar materials More than 10 billion metric tons of concrete are utilized worldwide as building materials. Both (bamboo leaf and banana leaf) leaves are dried in the sun for 15 days before being burned outside. Ash is the term for the leftover substance from burning. The finished product is sufficiently fine to mix with cement. The Portland cement (PC) was then combined with the bamboo leaf and banana leaf ash to create high-performance concrete (HPC) at 0, 5, 10, and 15% by weight of cement. keeping the 5% by weight of maize silk fibers, an addition to cement, constant. Slump flow testing was used to assess the workability of recent HPC samples. HPC samples' mechanical (compressive) properties were assessed after 28 days of hydration. SEM (Scanning electron microscope) is used for morphological research.

Keywords: Compressive strength, argo waste, corn silk fiber, sem, bamboo leaf ash, banana leaf ash

INTRODUCTION

Concrete is one of the most popular man-made materials in use today. For each person, about 1 ton of concrete is produced annually. Cement, fine and coarse aggregates, and water make up the majority of the ingredients in concrete. Due to its position as the second-largest sector of the economy, the construction industry has a duty to protect the environment and promote social justice. One of the main sources of air pollution and significant water and natural resource use is the concrete industry. Conventional concrete (CC) needs to change in order to adapt to modern innovation and strength requirements [1] Because they are used in concrete, naturally occurring aggregates are being used more frequently as a result of urbanization. Because of this, the building industry is under pressure to find substitute materials for the use of natural aggregates [2] In the modern world, there is a greater need for cement and natural aggregates, which is accompanied by an increase in price. The clever and practical answer to this is to use locally accessibale agricultural waste materials, [7]. such as fibers and ashes, etc. as an alternative to cement. Bamboo leaf ash has been used in numerous trials to test the strength of the concrete The purpose of this study is to create nano cementitious additives for the corban neutral cement using rice husk ash [6]. and palm oil fuel

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ash By substituting NCA at dosages of 0.55 and 1% for OPC in OPC concrete, the performance of NCA was assessed [3] They came to the conclusion that fibers with micro and nanoscales helped to improve a concrete matrix's ability to bend. supplying sustainable building materials and aiding green construction, the adoption of these materials promotes environmental sustainability by mitigating environmental damage and reducing the consumption of conventional material [9] Optimum requirements of natural fibers and polymer matrices are given [13].

In order to produce ultrahigh-performance concrete (UHPC), Mohamed Amin et al. (2021) examined the use of rice straw ash (RSA) and palm leaf ash (PLA) as partial cement replacements. This study specifically examines the impact of utilizing PLA and RSA as pozzolanic materials on the microstructure, mechanical characteristics, and fresh properties of UHPC. Eleven UHPC combinations without RSA or PLA are created as control mixtures. Five combinations each contain 10%, 20%, 30%, 40%, and 50% RSA, while five mixtures each include 10%, 20%, 30%, 40%, and 50% PLA in the residual mixtures [4] They came to the conclusion that UHPC samples with 20% RSA and 20% PLA produce the greatest results, 188.5 MPa and 185 MPa, respectively, by increasing compressive strength by roughly 13.2% and 11.1%.

The mechanical and dynamic characteristics of coconut coir reinforced concrete have been researched by Antony Liu et al. (2012) [5]. and they have the potential to be employed as reinforcement in low-cost constructions. The increase in flexural strength with alkali treatment [10]. and Investigated are the effects of coir lengths of 2.5, 5.5, and 7.5 cm and coir contents of 1%, 2%, 3%, and 5% by mass of cement. They came to the conclusion that the characteristics of concrete may be improved by adding 5% coir by mass of cement and coir lengths of 5 cm.

The studied properties included water absorption, flexural strength, impact strength, tensile strength, and hardness properties. The tensile and flexural properties improved [11]. promising and sustainable approach to cost-effective composite production [12].

ELEMENT USED AND PROCEDURES

Elements Used

Table 6 shows physical properties of Bamboo leaf ash (BMLA) & table 7 explains banana leaf ash (BLA), corn silk fiber, coarse aggregate (CA) explained in table 5, water, fine aggregate (FA) in table 3 & 4, and ordinary Portland cement (OPC) in table 1 & 2 are the materials used in these investigations. The taps potable water was used.

Procedures: Various Test conducted for the materials [8]

Table 1. Physical properties of OPC.

Property	Result
Specific Gravity	3.15
Fines of cement	0.18

Table 2. Chemical properties of OPC.

Oxides	Coromandel king OPC	Oxides (%)	Coromandel king OPC
CaO	7.60	MgO	1.39
SiO2	6.72	Fe2O3	1.69
Al2O3	2.65	K2O	0.43

Table 3. Tests on fine aggregates.

Property	Result
Specific Gravity	2.63
Fine modules	3.45

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Table 4. Tests on fine aggregates
Sand confirms zone II as per IS 383:1970

IS SieveSize	Weight Retained (gm.)	CumulativeWeight Retained	CumulativePercentage Retained	CumulativePercentage Passing
4.75 mm	40	4	4	96
2.36 mm	30	3	7	93
1.18 mm	110	11	18	82
600	240	24	42	58
300	440	44	86	14
150	120	12	98	2
PAN	20	2	100	0

Table 5. Tests on coarse aggregates.

Property	Result
Specific Gravity	2.68
Impact test	6.3
Water absorption test	0.6

These leaves are exposed to the light for 15 days before being burned outside. Banana Leaves Ash is the term for the byproduct of burning banana leaves. The finished product is sufficiently fine to mix with cement.

Table 6. Physical properties of bamboo leaf ash.

Property	Result
Specific Gravity	2.53
Color	Grey

These leaves are exposed to the light for three days before being burned outside. Bamboo Leaves Ash is the accumulated leftovers from the burning process. The finished product is sufficiently fine to mix with cement.

Table 7. Physical properties of BLA.

Property	Result
Specific Gravity	2.9
Color	Black

The long, threadlike strands of plant matter that develop under the husk of a young ear of corn are known as corn silk. The compressive and breaking tensile strengths of cemented soil were increased by the addition of cornsilk fibers.

Mix Design

Finding the proportions of a concrete mix's SMS of cement, sand, and coarse particles is the process of concrete mix design explained in table 8. For instance, a 1:2:4 concrete mix means that the proportions of cement, fine aggregate, and coarse aggregate are 1:2:4 or that the mix comprises one part of cement, two parts of fine aggregate, and four parts of coarse aggregate. Contrary to standard mix proportion shown in table 9, concrete mix design is favored. According to the IS 10262:2009 and IS 456:2000 approach, the mix design is completed and material required for 1m^3 is discussed in table10.

Table 8. Mix Design.

M30 Grade MIX DESIGN OF CONCRETE

Type of Cement	**Opc 53 Grade**
Grade of concrete	M30
Maximum nominal size of aggregate	20mm
Maximum water cement ratio	0.5
Workability	75mm (slump)
Type of aggregate	Crushed angular aggregate
Specific gravity of cement	3.1
Specific gravity of Bamboo leaf ash	2.9
Specific gravity of Banana leaf ash	2.53
Specific gravity of fine aggregate	2.68
Specific gravity of coarse aggregate	2.6
Fine aggregates corresponding to Zone	I

Table 9. Mix Proportions Calculation of weight of materials for 1 cube.

Cement	**FA**	**CA**	**Water**	**BLA**	**BMLA**
1	1.659	2.88	0.50	0.053	0.087

Table 10. Weight of materials for 1 cube.

MATERIALS	**0%**	**5%**	**10%**	**15%**
Cement in Kg	1.35	1.21	1.08	0.94
Fine aggregate in Kg	2.5	2.5	2.5	2.5
Coarse aggregate inKg	4.35	4.35	4.35	4.35
Banana leaf ash in Kg	0	0.68	0.135	0.203
Bamboo leaf ash in Kg	0	0.68	0.135	0.203
Corn Silk fibre (kg)	0	0.68	0.68	0.68
Water in ml	750	632	562	419

RESULTS AND DISCUSSION

In the current investigation, several strength and durability parameters of concrete grade M30 are evaluated. Among the several tests are SEM analysis represented in figure 3,4,5 and compressive strength. The test findings are briefly discussed in this chapter. It is the most often used test for hardened concrete, in part because it is simple to execute and in part because the majority of concrete's desirable attributes are qualitatively correlated with its compressive strength. On a specimen that is cubical in shape, the compression test is performed in accordance with IS 15658:2006. The cube specimen is 0.15 m by 0.15 m by 0.15 m. The alternative is to utilize cubes with the dimensions 0.1m0.1m0.1m if the aggregates' maximum nominal size does not exceed 20mm. At 28 days, the compressive strength of conventional concrete and concrete mixtures containing replacements of bamboo leaf ash and banana leaf ash were assessed. The table below displays the test results.

Table 11. Compressive strength result for 28 days.

Sl no.	**Banana leaf ashin %**	**Bamboo leaf ashin %**	**Area**	**Compressive Strength for 28 daysin N/mm²**
1.	0	0	22500	28.4
2.	5	5	22500	29.4
3.	10	10	22500	31.9
4.	15	15	22500	25.5

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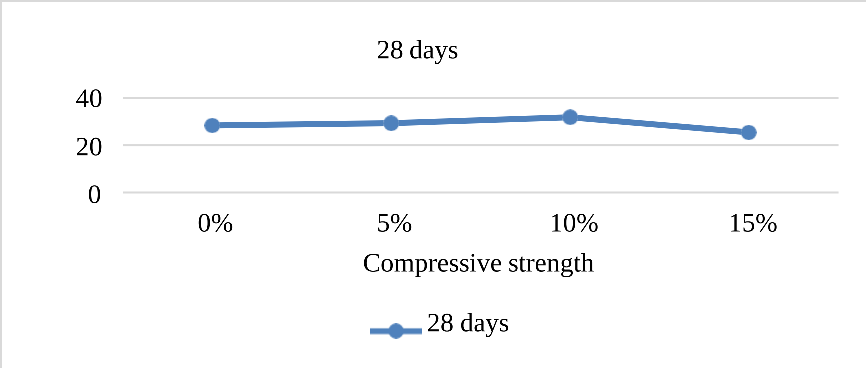


Figure 1. Compressive strength result for 28 days for conventional concrete.

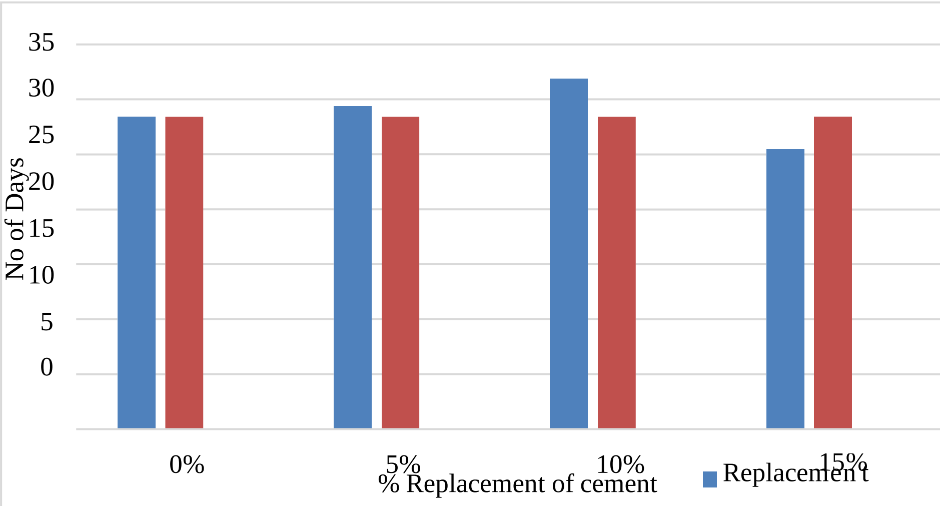


Figure 2. Bar Graph showing comparison between conventional and replacement compressive strength for 28 Days.

The compressive strength of various mix proportion at different curing days are found out. It has been observed in figure 1 & 2 that strength increases from 28.4 N/mm² to 31.2 N/mm² for 28 days test. In this investigation 10% replacement of Banana leaf ash and Bamboo leaf ash, achieved maximum compressive strength for 28days is 31.2N/mm².The 5% replacement of cement by Banana leaf ash and Bamboo leaf ash shows increment in the compressivestrength for 28 days is 29.4N/mm.

SEM ANALYSIS

SEM Representing 5% replacement of Bamboo leaf and Banana leaf ash.

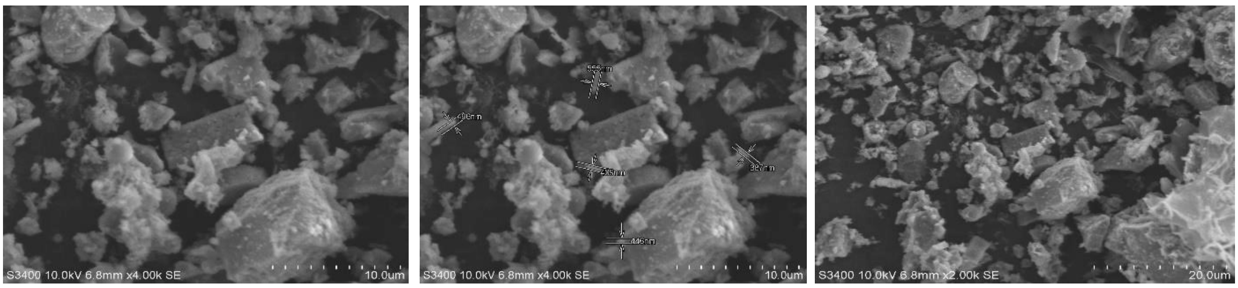
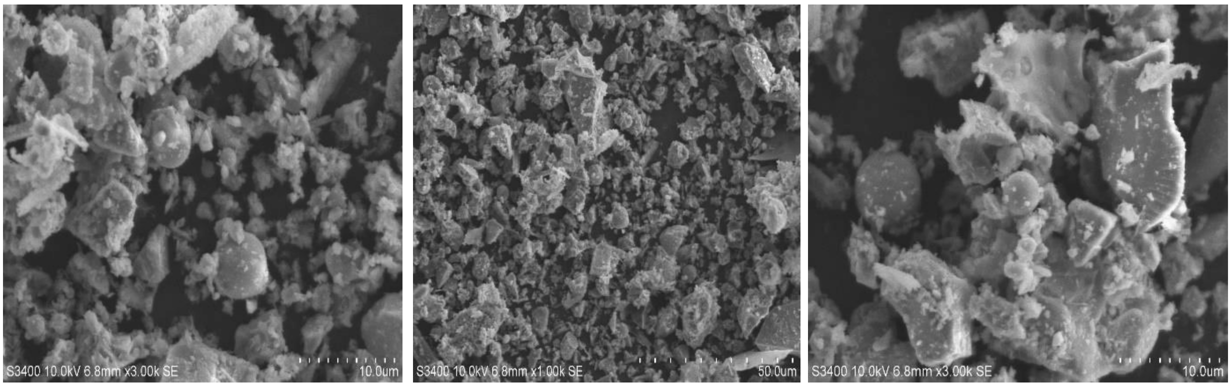


Figure 3. SEM of Banana leaf ash 5% and Bamboo leaf ash 5%.



SEM Representing 10% replacement of Bamboo leaf and Banana leaf ash.

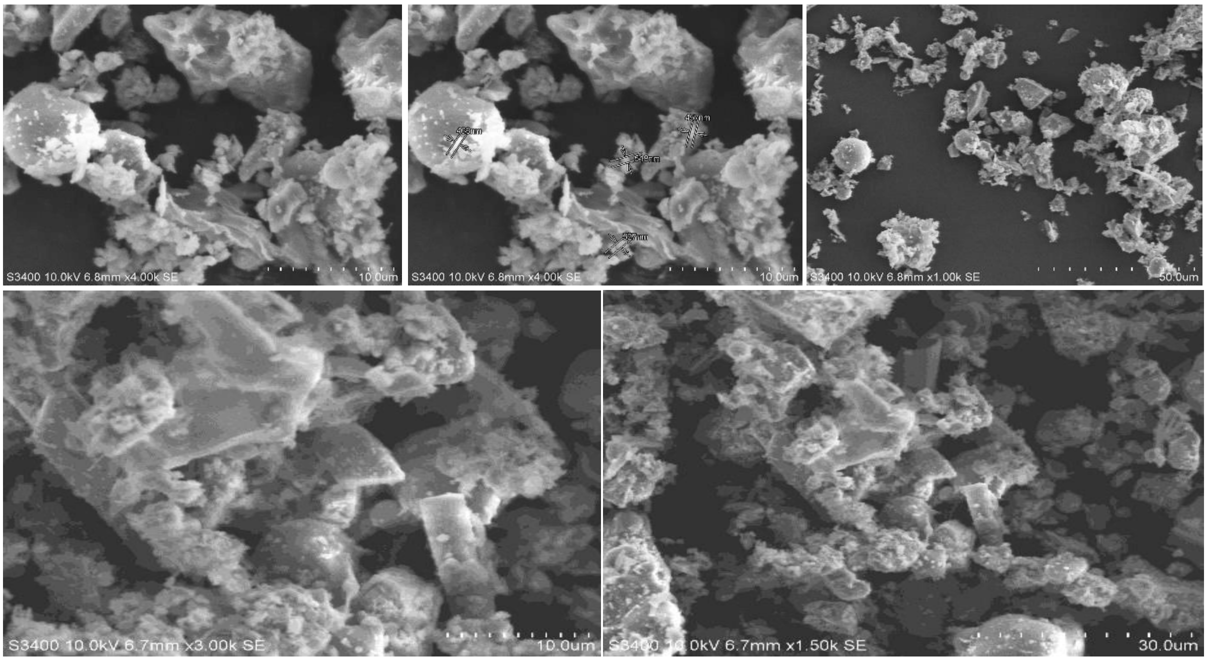


Figure 4. SEM of Banana leaf ash 10% and Bamboo leaf ash 10%

SEM Representing 15% replacement of Bamboo leaf and Banana leaf ash.

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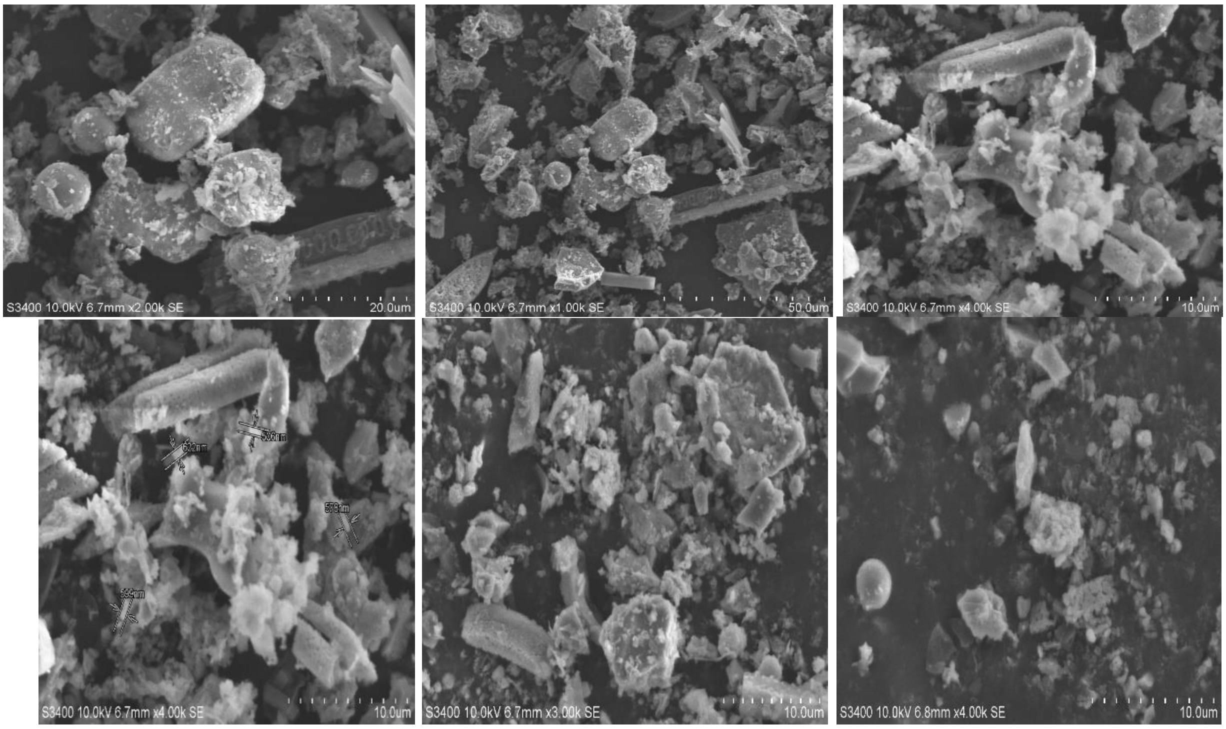

Figure 5. SEM of Banana leaf ash 15% and Bamboo leaf ash 15%

Above SEM images representing the clear morphology of carbon nano particles are clearly surfaced oncement particle and also the nano size distribution was identified.

ENERGY-DISPERSIVE X-RAY SPECTROSCOPY (EDS) EDS containing 5% replacement of Bamboo leaf and Banana leaf ash.

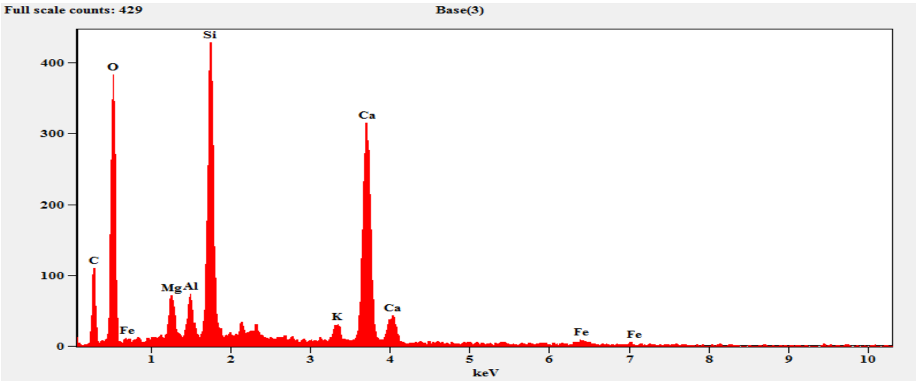

Figure 6. EDS containing 5% replacement of Bamboo leaf and Banana leaf ash

Table 12. Elemental Composition of 5% replacement of Bamboo leaf and Banana leaf ash

Element Line	**Weight %**	**Weight % Error**	**Atom %**
C K	18.80	± 1.28	28.28
O K	47.59	± 1.26	53.75
Mg K	1.89	± 0.20	1.41
Al K	1.57	± 0.13	1.05
Si K	10.71	± 0.25	6.89

Si L	---	---	---
K K	1.18	± 0.10	0.54
K L	---	---	---
Ca K	16.99	± 0.44	7.66
Ca L	---	---	---
Fe K	1.28	± 0.29	0.41
Fe L	---	---	---
Total	100.00		100.00

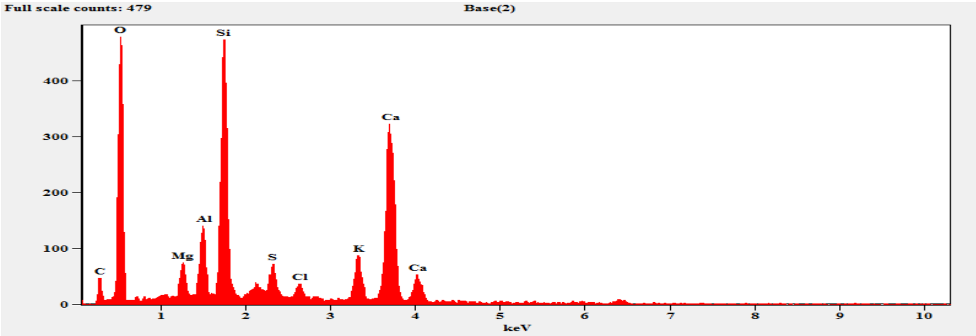

Figure 7. EDS containing 10% replacement of Bamboo leaf and Banana leaf ash.

Table 13. Elemental Composition of10% replacement of Bamboo leaf and Banana leaf ash.

ElementLine	**Weight %**	**Weight %Error**	**Atom %**
C K	8.09	± 0.69	13.12
K	52.44	± 1.05	63.84
Mg K	1.20	± 0.21	0.96
Al K	2.92	± 0.28	2.11
Si K	11.84	± 0.31	8.21
Si L	---	---	---
S K	1.79	± 0.13	1.09
S L	---	---	---
Cl K	1.15	± 0.10	0.63
Cl L	---	---	---
K K	2.96	± 0.26	1.48
K L	---	---	---
Ca K	17.61	± 0.49	8.56
Ca L	---	---	---
Total	100.00		100.00

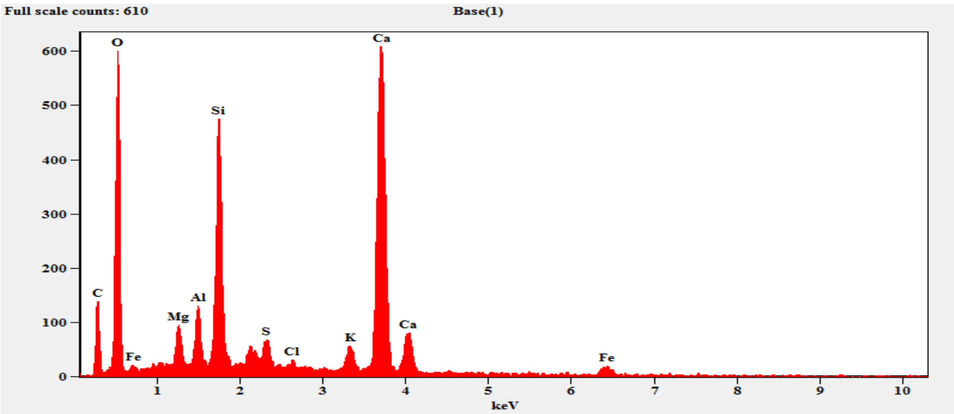

Figure 8. EDS containing 15% replacement of Bamboo leaf and Banana leaf ash.

Table 14. Elemental Composition of 15% replacement of Bamboo leaf and Banana leaf ash

ElementLine	Weight %	Weight %Error	Atom %
C K	15.43	± 0.57	24.36
O K	46.91	± 1.00	55.60
Mg K	1.22	± 0.19	0.95
Al K	1.72	± 0.23	1.21
Si K	7.83	± 0.23	5.29
Si L	---	---	---
S K	0.87	± 0.09	0.51
S L	---	---	---
Cl K	0.36	± 0.07	0.19
Cl L	---	---	---
K K	1.48	± 0.09	0.72
K L	---	---	---
Ca K	22.08	± 0.40	10.45
Ca L	---	---	---
Fe K	2.11	± 0.26	0.72
Fe L	---	---	---
Total	100.00		100.00

As EDS results in figure 6,7,8 indicating percentage of silica increased, increased in percentage of replacement. As per the current investigation silica imparts the mechanical strength, micro level investigation proved that elemental distribution of silica imparts good strength.

CONCLUSIONS

1. Concrete produced using bamboo leaf and banana leaf ash instead of cement is discovered to have improved workability, durability, and heat resistance.
2. When compared to ordinary concrete, a mixture of bamboo leaf ash, banana leaf ash, and maize silk fiber exhibits increased compressive strength.
3. In this experimental study, we are replacing 5%, 10%, and 15% of the banana leaf ash, bamboo leaf ash, and 5% of the maize silk fiber used as an additive for M30 grade concrete with a water cement ratio of 0.50.
4. The concrete's 28-day compressive strength has increased by 31.9% compared to normal concrete.

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