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Experimental study on Properties of Concrete of grade M20 by Fractional Replacement of Cement with Banana Leaf Ash

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Abstract - *This experiment was undertaken to know about the properties of concrete using Banana Leaf ash. Concrete is one of the extremely good materials that are extensively used in construction everywhere in the complete global. Concrete is extensively used because it has many benefits such as durability, energy efficiency, low maintenance, fire resistance, super thermal mass, and versatility. The world is now focusing on alternative physical sources that are eco-friendly and biodegradable in nature. Banana Leaf Ash is an agricultural waste that has the potential to replace one of the building materials which is cement. Banana Leaf Ash undergoes a pozzolanic reaction that typically takes place in Portland cement. As opposed to developing a banana tree handiest for fruit consumption and discarding the trunks, the use of banana leaf must be explored after the fruit has been harvested.*

This undertaking is conducted to determine the energy of concrete the use of Banana leaf Ash to provide suitable cementitious material. The source of Banana Leaf Ash is found in banana plants and is readily available, eco-friendly, and inexpensive. further, Banana Leaf Ash has an incredible capacity to improve the performance of concrete. The banana stem ash turned into constituted of the technique of burning the dried banana stem and accumulating its stays. The Banana Leaf Ash might be used to update approximately 0%, 10%& 20% respectively in cement. Mechanical properties such as compressive, split tensile, and flexural strength were determined by casting cubes, cylinders, and beams respectively.

***Key Words*: Banana Leaf Ash, Coarse Aggregate, Fine Aggregate, Cement.**

1. INTRODUCTION

Concrete is most widely used as a building material due to its good compressive strength & durability. It is the material that is used for construction work more than any other man-made material on the earth. The main factor which determines the strength of concrete is the amount of cement used in the mix and the water/cement ratio. Depending on the nature of the work the cement, fine aggregate, coarse aggregate & water are mixed in specific proportions to make concrete. Plain concrete requires a suitable environment by providing moisture for a minimum timeframe of 28 days for better hydration &for joining to the desired strength. As we know that the hydration process requires concrete to cure. Any deficiency in curing will severely affect the strength & durability of the concrete The use of alternative materials in construction is increasing day by day. The project deals with the comparative study of the properties of concrete by using Banana Leaf Ash as cementing material in the concrete mix. The ash generated from various types of agricultural waste can be effectively used as a partial replacement for cement. Many researchers evaluated the presence of pozzolanic activity in the derived ash of Banana Leaf. The total production of bananas in India is about 16.71million Tonnes from 491thousand Hectares, with a national average of 34 Tonnes/Ha. Maharashtra is the number one producer with 60 tonnes per hectare. After cutting off the banana tree the outstanding part of the tree which is the stem and leaf is directly dumped or burned after drying it. It can be used as an alternative material for the partial replacement of cement. The banana tree contains approximately 80% fluid; after drying, its weight is reduced to about 80%. After burning dry leafs, it gives 21% ash by its dry weight. That is, if you dry 1000 kg of fresh leafs and stems of a banana tree see, you will get 210 kg of dry leaf's and 21 kg of leaf ash. Banana leafs are mainly sourced from various banana growers. Leafs are dried from the sun for a timeframe of 30 days &open-air burning is accomplished. The remainder of leafs after the burning is collected and known as Banana Leaf Ash. If required, this ash is made fine by using a ball mill for 30 minutes. The final product obtained in is finer enough to mix with the cement.

This research is carried out to overcome the problem of disposal of farming waste Banana Leafs Ash.

2. OBJECTIVE

The research motive is to evaluate the feasibility of Banana Leafs Ash as an alternative for the fractional replacement of cement.

1. Knowledge on using banana leaf ash in concrete mixes to improve the performance of concrete in construction.
2. Knowing the optimal percentage of banana leaf ash in concrete.
3. To know about the workability of concrete with Banana Leaf Ash.

4. To know about the strength of concrete like compressive, split & flexural while using Banana Leafs Ash using 0%, 10%, and 20%.
5. Knowledge of the economics of concrete mixed with banana leaf ash and ordinary concrete.

3. LITERATURE REVIEW

Ogenyi Ikenna Ndubuisi (2020) said that the mass strength and density of the specimens decreased as the cement levels were replaced with banana leaf ashes, but the concrete remains of its plastic nature. The reason is that it maintains its workability, so it needs to be increased, practicality by adequate utilization of suitability so that work efficiency is improved and in turn, its high power is maintained. Concrete with 15% banana leaf ash content for cement replacement of 15–20% by weight can be used for works requiring medium-strength concrete as it exhibits sufficient compressive strength. Replacing cement with banana leaf ash is beneficial to low-income communities due to its availability and ease of procurement.

K. Madhu prasad et.al. (2019) According to their investigation the strength value decreases slightly by increasing the amount of ash in the banana compared to controlling the banana. Whenever the strength achieved exceeds the target strength of 30 N / mm2. Pozzolanic reactions also increase strength with age. Thus, the use of BLA in concrete helps convert environmental concerns into a useful resource for the production of highly effective alternative cementitious materials. The process employed to produce banana leaf ash can be improved as this research has employed banana leaf ash derived from agricultural wastes.

Jugal R. Pawar et.al. (2018) They have conducted experimental investigations on the properties of concrete by partial replacement of cement with banana leaves. The partial replacement of cement with BLA results in compression, flexural, and split tensile changes in the concrete according to their investigation. They analyzed properties such as compressive, partition tensile, and flexural strength were determined by casting cubes, cylinders, and beams. The BLA will be used in cement to replace approximately 0%, 15%, and 25% respectively. As the percentage of BLA in concrete increases, the compressive strength is joined to the desired strength that decreases with 28 days for 15% replacement with cement and 25% for replacement. The flexible and split tensile strength increases for replacement by 15% and decreases by 25%, respectively, compared to normal mixtures. It concludes that a 15% replacement of cement with BLA increases compressive, flexural, and split tensile strength.

S. Sakthivel et.al. (2019) conducted experimental research for concrete with partial replacement of cement by banana leaf ash (2%, 4%, and 6%) and tested in addition to banana fiber with 0.2%, test results show that the strength of concrete increases. Concrete mixtures differ in workability compared to conventional mixtures. The addition of banana leaf ash increased the compressive strength of concrete by 2% and 6%. As a result, it was clarified that ash substitution can fully satisfy the properties of cement. Adding banana fiber to the conventional mixture by 0.2% increases the tensile strength of the concrete.

4. MATERIALS

4.1 Cement

During the experiment used Ultratech Cement 53 grade OPC confirming to IS: 12269-1987 for the present research. The properties of cement are given below.

Physical Properties	Results
Fineness	2939 cm^2/gm
Normal consistency	28%
Vicat's initial setting time (min.)	64
Vicat's final setting time (min.)	192
Specific gravity	3.1
Compressive strength at 7 days	36.01 Mpa
Compressive strength at 28 days	45.20 Mpa

Chemical Properties	Percentage
Lime (CaO)	60-64
Silica (SiO2)	17-23
Alumina (Al2O3)	3.5-8.5
Ferrous Oxide (Fe2O3)	0.4-6.0
Magnesium Oxide (MgO)	0.2-4.0
Alkalis (K2Na2O)	0.5-1.2
Sulphur di oxide (SO2)	1.2-3.0

4.2 Banana Leafs Ash

The Banana leafs with stems used for this study are obtained from local banana farms. In this process, the available leafs are dried for a period of 30 days (min), after which the dried banana leafs are burned in a controlled atmosphere and residual ash of the leafs is collected along the stem. This ash is sieved through a 90micron sieve to obtain a fine powder of Banana Leafs Ash. This ash is used to partially replace cement in the percentage calculated in our study.

Chemical Properties of Banana Leaves

Parameter	Composition of Banana Leaves Ash (%)
Silicon Dioxide (Si02)	48.2
Iron Oxide (Fe2O3)	1.25
Aluminium Oxide (Al 203)	2.62
Sodium Oxide (Na2O)	0.25
Sodium Oxide (Na2O)	5.12

4.3 Coarse Aggregates

The coarse aggregate used was a normal-weight aggregate with a maximum size of 20mm and was got from a local supplier.

4.4 Fine Aggregates

Using good quality fine aggregates that are available locally.

4.5 Mix Design of Concrete

Experimental study concrete mix design of M25 grade is designed as per IS 10262-2009. This code represents the method for the selection of mixed proportions. The quantities of materials used in this experiment are given below.

Banana Leaf Ash Replacement(%)	Mix Proportion	Cement (kg)	BLA (kg)	F. Agg (kg)	C. Agg (kg)	Water(liters)	Admixture kg/M³
0	1:1.2:2.1	355	0	670	1201	160	3.4
10	1:1.2:2.1	319.5	35.5	670	1201	160	3.4
20	1:1.2:2.1	284	71	670	1201	163	3.5

4.6 Mixing

The mixing of material is completed by weight batching. This method is used for that mixing manual. The cement is fractional replaced by Banana Leaf Ash in percentages of 0, 10& 20 respectively. The admixture is used with different quantities in this experiment for getting workability.

4.7 Pouring of Specimens

The total specimens used for are36 which includes 6 cubes, 3 beams &3 cylinders for each casting of 0 %, 10 % & 20 %. The cubes of size 150x150x150 mm, beams of size 700x150x150 mm & cylinders of size 300 mm height x 150 mm diameter. The concrete is mixed, compacted using a table vibrator & finished as per the standard specification of casting the specimens.

4.8 Curing of cubes, beams & cylinders

All casted elements are cured for 7 & 28 days from the time of casting in the curing tank at normal temperature.

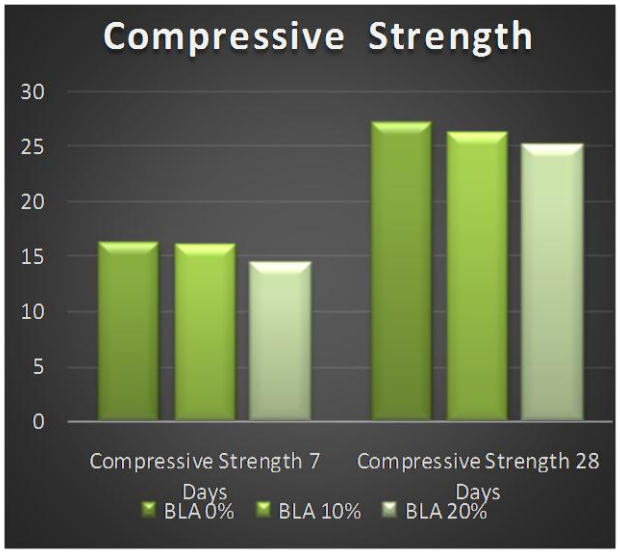
4.9 Checking of Specimens

All casted elements are tested at 7 & 28 days for Compressive, Flexural & Split tensile strength. The cubes & cylinders specimens are tested by using (CTM) of their capacity is 2000 KN in the site laboratory. The beams are tested on (UTM) their capacity is 1000 KN.

4.9.1 Compressive Strength testing [As per IS:516]

The compressive strength test is performed on the cubes at 7 & 28 days. to determine compressive strength. Concrete cube size is 150 x150 x 150mm.The specimens are step-by-step loaded in CTM till the specimen fails.

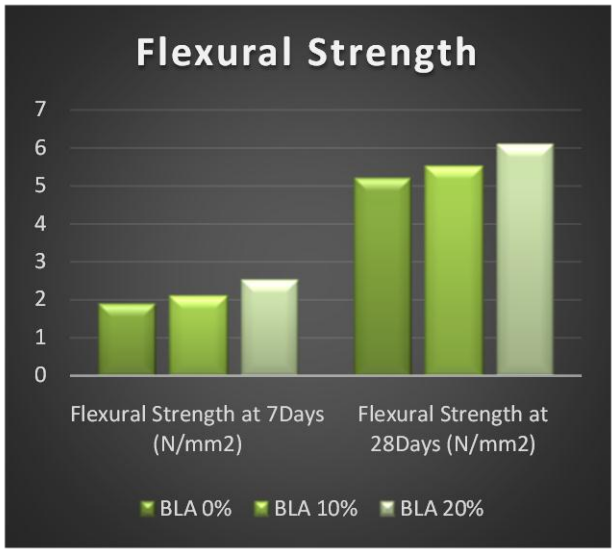
Banana Leaf Ash Replacement (%)	Curing time (Days)	Compressive Strength (N/mm2)
0	7	16.30
	28	27.20
10	7	16.10
	28	26.40
20	7	14.55
	28	25.30



4.9.2 Flexural Strength Testing [As per IS:9399]

The flexural strength test is performed on the beams at 7 & 28days to determine flexural strength. Beam size is 700 x 150 x 150 mm. The elements are tested on UTM at the standard loading system.

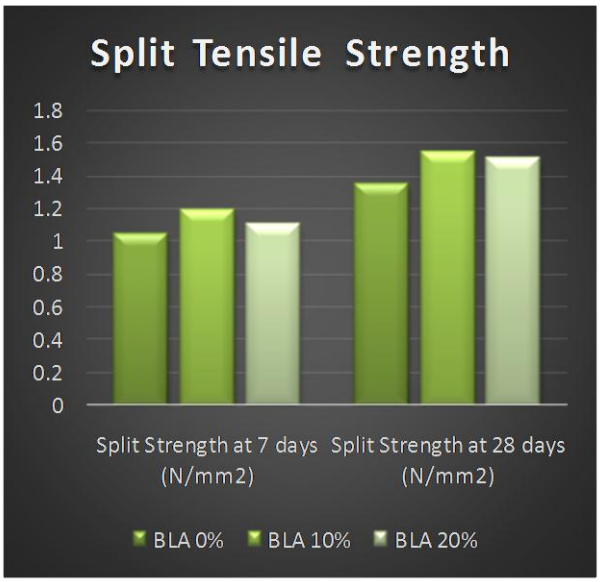
Banana Leaf Ash Replacement (%)	Curing time (Days)	Compressive Strength (N/mm2)
0	7	1.90
	28	5.20
10	7	2.10
	28	5.50
20	7	2.50
	28	6.10



4.9.3 Split Tensile Test

The Split Tensile test is performed on the cylinders at 7 & 28 days to determine tensile strength. The concrete cylinder size is 300 height x 150 diameter mm.

Banana Leaf Ash Replacement (%)	Curing time (Days)	Compressive Strength (N/mm2)
0	7	1.05
	28	1.35
10	7	1.20
	28	1.55
20	7	1.11
	28	1.52



5. CONCLUSION

The study leads to the following conclusions: - Partial replacement of cement that changes the Compressive, Flexural & Split tensile strength of concrete. Increasing the proportion of banana leaf ash in concrete reduces its compressive strength compared to ordinary cement. Combined use of the above partial replacements can reduce concrete costs and improve concrete strength. So, the combination of the two materials can be used to get better Strength properties at min cost. As per the presence of pozzolanic essential compound as required by standards, the presence of finer particles, and a larger surface area per particle make Banana Leafs Ash pozzolanic material. The strength parameter decreases slightly with increasing banana leaf ash content in the concrete compared to normal concrete. Also, the strength increases with age with pozzolanic reactions. Thus, the use of Banana Leafs Ash in concrete helps to transform it from an

environmental concern to a useful resource for the production of a highly effective alternative cementing material. Using banana leaf ash as a cement substitute for concreteresults in a moredurable and stronger concrete.

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