Experimental Investigation on Properties of Concrete by Partial Replacement of Cement with Banana Leaves Ash

[1]Jugal R. Pawar,[2]Aman S. Khaire,
[1,2]UG Students, Department of Civil Engineering, GCOERC Nashik.
Mr.Sudarshan V. Pund
Asst. Prof, Department of Civil Engineering,
[1]Guru Gobind Singh College of Engineering and Research Centre, Nashik, India.

Abstract:*This study was under taken to know the concrete properties using Banana Leaves ash. Concrete is one of the materials that is widely used in construction all around the world. This material is widely used because it has several benefits such as durable, energy-efficient, low maintenance, affordability, fire-resistance, excellent thermal mass and also versatility. World is as of now concentrating on alternate material sources that are environment agreeable and biodegradable in nature. The Banana Leaves Ash is an agriculture waste that has potential to replace one of construction material which is cement. Banana Leaves Ash contains a pozzolanic reaction that usually occurs in Portland cement. Instead of growing banana tree only for fruit consumption and discard the trunks, the use of banana leaves after the fruits are harvested should be explored. This project is conducted to determine the strength of concrete to produce good cementitious material by using Banana Leaves Ash. The source of BLA are found in banana plant and they are readily available, environmental friendly and cheap. In addition, BLA has an excellent potential to improve the performance of concrete. The banana trunks ash was produced from the process of burning the dried banana trunk and collecting the residue of it. The BLA will be used in cement to replace about 0%, 15%& 25% respectively.Mechanical properties such as compressive, split tensile and flexural strength were determined by casting cubes, cylinders and beam respectively.*

Key words:BLA, Compressive, Flexure & Split tensile strength, Super Plasticizer

_

1. INTRODUCTION

Concrete is most widely used as a construction material due to its good compressive strength & durability. It is material which is used more than any other man-made material on the earth for construction work. The main factor which determines the strength of concrete is the amount of cement used and water/cement ratio in the mix.

Depending upon nature of work the cement, fine aggregate, coarse aggregate & water are mixed in specific proportions to produce concrete. Plain concrete needs suitable atmosphere by providing moisture for a minimum period of 28 days for good hydration & to attend desired strength. We know that for hydration process curing is must for the concrete. Any lack of curing will badly affect the strength & durability of concrete

The use of alternative material in the construction is increasing day by day. The project deals with the comparative study of properties of concrete by using Banana Leaves Ash as a cementitious material in the concrete mix. The ash produced from various types of agricultural waste can be used effectively as a partial replacement of cement. Some researchers evaluated the presence of pozzolanic activity in the deriving ash of Banana Leaves.

The overall production of banana In India is approximately 16.91 Million Tonnes from 490.70 Thousand Hectares, with national average of 33.5 T/Ha. Maharashtra ranks first in production with 60 T/Ha.

After cutting of banana tree the remaining part of tree i.e. stem and leaves are directly dumped or burned after drying it. That can be utilised as an alternative material for partial replacement of cement. Banana tree contains approximately 80% liquid matter and after drying its weight reduces up to 80% approximately. After burning dry leaves it gives 20% ash by its dry weight. Means if we dry 500 kg of fresh leaves and stems of banana tree, we will get 100 kg dry leaves and 20 kg of leaves ash.

Banana Leaves are mainly obtained from various Banana Production farms (Maximum production is in Jalgoan District). These leaves are sun dried for a period of 30 days and open air burning is carried out. The residue remained after the burning is collected and known as Banana Leaves Ash. If required, this ash is made fine by using ball mill for 30 minutes. The final product obtain is finer enough to mix with the cement.

The grade of concrete to be used is M30 with super plasticizer. The BLA will be used in cement to replace about 0%, 15% & 25% respectively. The concrete obtained after this replacement will be analysed with the normal concrete by conducting various tests like Compressive Strength, Split Tensile strength & Flexural Strength after period of 7 days and 28 days curing. This might achieve economy, strength requirement and durability of concrete.

1.1. Problem statement :

Farming waste material generally disposed-off by land-filling or open burning which leads to air pollution. This material can be utilized to improve the quality and properties of concrete by partial replacement of cement or additive material for concrete. It provides good strength and durability. The economy achievement is also the key factor to utilize farming waste.

This research is carried out to overcome the problem of disposal of farming waste (BLA).

1.2. Objective :

This study aims to evaluate the feasibility of BLA as an alternative material for partial replacement of cement.

1. To investigate the use of BLA in concrete mixes to improve the performance of concrete in construction.
2. To determine the best proportion of BLA in concrete mix.
3. To evaluate the workability of the concrete with BLA as compared to normal mix of concrete.
4. To compare the compressive, flexural & split tensile strength of 0%, 15% and 25% BLA replacement with cement.
5. To compare economy of concrete mix by using BLA and normal concrete.

2. MATERIALS

2.1. Cement

Ultratech Cement 53 grade OPC confirming to IS: 12269-1987 is used for the present study. The physical & chemical properties of cementaregiven in table.

Table 1 Physical properties of cementTable 2Chemical properties of cement

Physical property	Results
Fineness	2940 cm^2/gm
Normal consistency	29 %
Vicat's initial setting time (min.)	64
Vicat's final setting time (min.)	192
Specific gravity	3.12
Compressive strength at 7 days	36.95 MPa
Compressive strength at 28 days	45.86 MPa

Oxide	Percent content
Lime (CaO)	60–67
Silica (SiO_2)	17–25
Alumina (Al_2O_3)	3.0–8.0
Ferrous Oxide (Fe_2O_3)	0.5–6.0
Magnesium Oxide (MgO)	0.1–4.0
Alkalies (K_2Na_2O)	0.4–1.3
Sulphur di-Oxide (SO_2)	1.3–3.0

2.2. Banana Leaves Ash

The Banana leaves with stemused for this study areobtainedfrom the local banana farms of Jalgoan district. The leaves available in this process are dried for period of 30 days (minimum), after which the dried banana leaves are combusted in a control environment and residual ash of the leaves with stemis collected. This ash is then sieved through 90micron sieve for getting a fine powder of Banana Leaves Ash. This ash is used in our study for replacing cement partially in calculated percentages. The chemical properties of the Banana Leaves Ash are given in table.

Table 3 Chemical properties of BLA

Parameter	Composition Banana Leaves Ash (%)
Silicon Dioxide ($Si0_2$)	48.7
Iron Oxide (Fe_2O_3)	1.4
Aluminium Oxide (Al_20_3)	2.6
Sodium Oxide (Na_2O)	0.21
Loss of Ignition (LOI)	5.06

2.3. Coarse aggregate

The coarse aggregate used was a normal weight aggregate with a maximum size of 20mm and was obtained from local supplier and it was tested and results are given in table.

2.4. Fine aggregate

Good quality artificial sand, which is locally available, was used in this study.

Table 4 Physical properties of coarse & fine aggregate

Physical tests	Coarse aggregates	Fine aggregates
Specific gravity	2.67	2.66
Fineness modulus	6.86	2.32
Bulk density	1540	1780

2.5. Super Plasticizer (SP)

Super plasticizer (SP) is a chemical compound used to increase the workability, without using any additional water. The super plasticizer used in the present work is the commercially available in various brands. We are using Condura company super plasticizer, situated at Sharanpur road, Nashik.

Dosage: 100ml to 200ml per bag of cement. Suggested dosage is 150ml/bag.

2.2. CONCRETE MIX DESIGN

In this experimental investigation concrete mix design of M30 grade is designed as per IS 10262-2009. This code presents the method for selecting mix proportion. The quantity of materials used in this study is given in table.

Table 5Quantity of materials required per cubic meter for trial mixes of M30 grade

BLA Replacement (%)	Mix Proportion	Cement (kg)	BLA (kg)	F.A. (kg)	C.A. (kg)	Water (liters)	Super Plasticizer (ml)
0	1 : 2.18 : 3.56	350	0	763.8	1246.2	205	147
15	1 : 2.18 : 3.56	297.5	52.5	763.8	1246.2	222	240
25	1 : 2.18 : 3.56	262.5	87.5	763.8	1246.2	231	365

2.3. BATCHING & MIXING

The batching of material is done by weight batching. The method used for mixing is manual. The cement is partially replaced by BLA in percentages of 0, 15 & 25 respectively. The super plasticizer is used with different quantities in this study for achieving workability.

2.4. CASTING OF SPECIMENS

The total number of specimens used are 42 which includes 6 cubes, 4 beams & 4 cylinders for each casting of 0 %, 15 % & 25 % respectively. 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 table vibrator & finished as per standard procedure of casting the specimens.

2.5. CURING OF SPECIMENS

The specimen casted are cured for 7 & 28 days from time after casting in curing tank at normal temperature.

2.6 TESTING OF SPECIMENS

The specimen casted are tested at 7 & 28 days respectively for Compressive, Flexural & Split tensile strength tests. The cubes & cylinders specimens are tested by using Compression Testing Machine (CTM) of capacity 2000 KN in college laboratory. The beams are tested in Universal Testing Machine (UTM) of capacity 1000 KN.

2.6.1 Testing of fresh concrete for workability

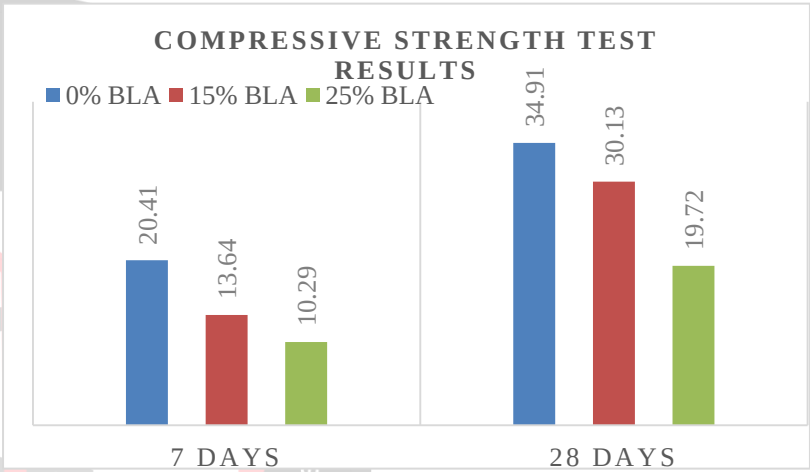
The workability of concrete is tested by using Slump Cone test as per special code of practices [10] in order to produce homogenous and workable mix. The concrete is mixed till the value of slump cone attends 100 mm. For making workable concrete mix the SP is used with varying quantities by trial and error method. Once an acceptable workability is achieved the concrete specimens are casted, compacted & finished.

2.6.2 Testing of Compressive Strength [As per IS:516 (1959)]

The compression strength test is carried out on the cubes at 7 & 28 Days curing to determine compressive strength.Concrete cube is of size 150 x150 x 150mm.The specimens are gradually loaded in Compression Testing Machine till specimen fails.

Table 6 Compression test results and graphs

BLA Replacement (%)	Age of curing (Days)	Compressive Strength (N/mm^2)
0	7	20.41
	28	34.91
15	7	13.64
	28	30.13
25	7	10.29
	28	19.72

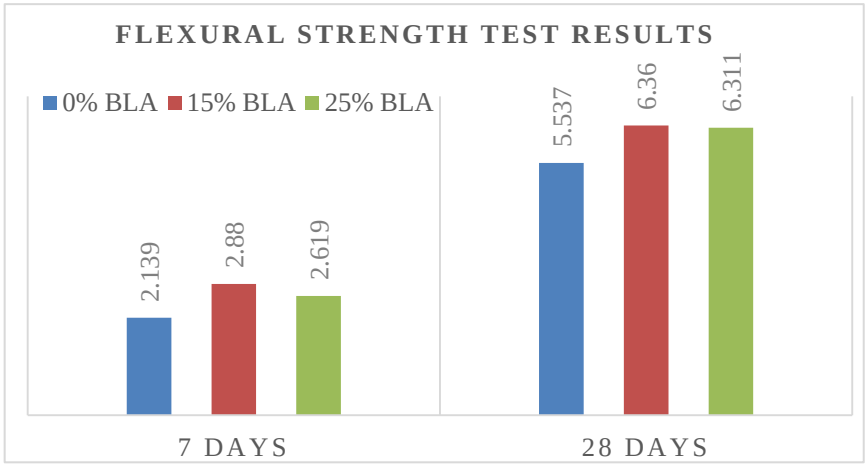


2.6.2 Testing of Flexural Strength[As per IS: 9399 (1979)]

The flexural strength test is carried out on the beams at 7 & 28days curing to determine the flexural strength. Beams are of size 700 x 150 x 150 mm. The specimens are tested in UTM at standard loading rates.

Table 7Flexural test results and graphs

BLA Replacement (%)	Age of curing (Days)	Flexural Strength (N/mm^2)
0	7	2.139
	28	5.537
15	7	2.880
	28	6.360
25	7	2.619
	28	6.311

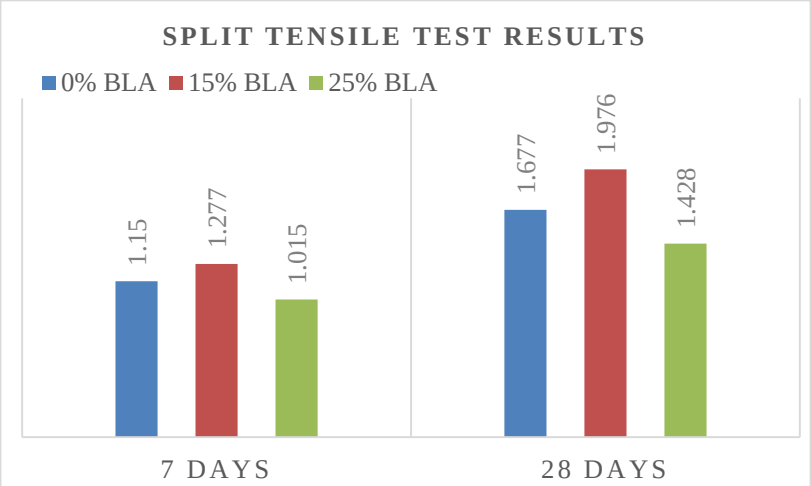


2.6.2 Testing of Split Tensile StrengthIS: 5816 (1999)

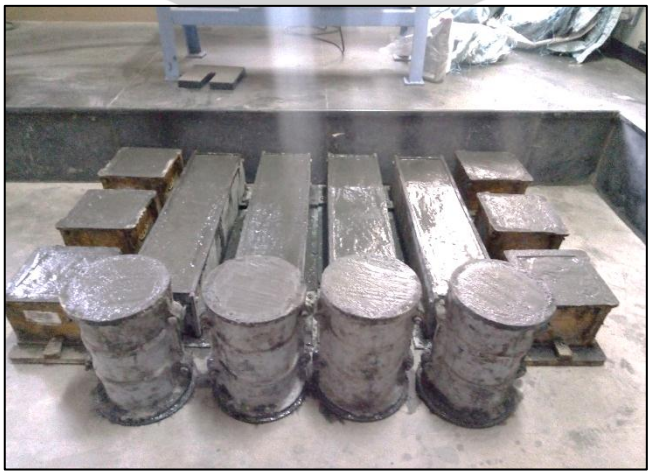
The Split Tensile strength test is carried out on the cylinders at 7 & 28 Days curing to determine tensile strength.Concrete cylinder is of size 300 height x 150 diameter mm.The specimens are gradually loaded in Compression Testing Machine till specimen fails.

Table 8 Split Tensile test results and graphs

BLA Replacement (%)	Age of curing (Days)	Split Tensile Strength (N/mm^2)
0	7	1.150
	28	1.677
15	7	1.227
	28	1.976
25	7	1.015
	28	1.428



3. MATERIALS AND PROJECT IMAGES DURING CASTING & TESTING



4. CONCLUSION

From the above experimental investigation the following conclusion are made:

1) Partial replacement of cement with BLA changes the Compressive, Flexural & Split tensile strength of concrete.
2) As the percentage of BLA increases in the concrete the compressive strength attends the desired strength at 28 days for 15 % replacement with cement & decreases for 25 % replacement.
3) The Flexural & Split Tensile strength increases for 15% replacement & slightly decrease for 25 % respectively as compare to normal mix.
4) From the above graphs we can conclude that the Compressive, Flexural & Split tensile strength increases at 15 % replacement of cement with BLA.
5) The optimum percentage of cement for partial replacement with BLA is 15 %.

REFERENCES

1) R.C. Kanning, K.F. Portella, M.R.M. Costa, R.F.K. Puppi, "Evaluation of Pozzolanic Activity of Banana Leaf Ash". International Conference of Durability of building materials and components, Porto – PORTUGAL, April (2011).
2) NurAqilah Bt. AbdKarim ,"Strength Performance of Banana Fiber Ash as Cementitious Material With Different Temperature", Report submitted to University Malaysia Pahang, July (2014)
3) I.O. Obilade , "Use of Rice Husk Ash As Partial Replacement For Cement In Concrete",International Journal of Engineering and Applied Sciences,Vol. 5. No. 04, September (2014)
4) S.M. Dumne," Effect of Super plasticizer on Fresh and Hardened Properties of Self-Compacting Concrete Containing Fly Ash", American Journal of Engineering Research (AJER), Volume-03, Issue-03, June-2014.
5) Marwan Mostafa and NasimUddin, "Effect of Banana fibers on compressive and flexural strength of compressed earth blocks". Open Excess Journal – "buildings", March(2015)
6) I. O. Olofintuyi, K.D. Oluborode, I. Adegbite , "Structural Value Of Bamboo Leaf Ash As A Pozzolanic Material In A Blended Portland Cement", IJESRT, International Journal Of Engineering Sciences & Research Technology, September (2015).
7) Rajendra Kumar Goyal, AbhishekTiwari, "Use of Banana Leaves Ash in Concrete",IJSRD - International Journal for Scientific Research & Development - Vol. 4, Issue 03, (2016)
8) SP 23, Handbook of concrete mixes (based on Indian standards), Bureau of Indian Standards, ManakBhaan 9 Bahadur Shah ZafarMarg, New Delhi 110002, 1982

