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PRACTICAL REPORT ON CONCRETE;

**EFFECT/BEHAVIOUR OF BLACK CURRANT LEAF ASH ON THE STRENGTH OF CONCRETE WITH RESPECT TO A
CONTROL MIXES STRENGTH.**

BY

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CERTIFICATION

We certify that this report has been conducted by all the listed members of the group under the supervision of Engr. Buba A. Umdagas of Civil and Water Resources Engineering, Faculty of Engineering, University of Maiduguri.

DEDICATION

This Practical Report is dedicated to Almighty God, Our Lovely Parents and Guardians.

ACKNOWLEDGEMENT

First of all, we thank Almighty God who has given us ability to sail through the undulating pathways. May his peace and blessings be upon on us and our families. Our ample thanks and inevitable appreciation with great honour to goes to our parents, for their unending supports and prayers, care and non-fading love from cradle to adulthood. Our profound gratitude and appreciation goes to our erudite lecturer and supervisor, Engr. Buba A. Umdagas. We will not forget our friends and colleagues, indeed you have inspired something into our work and life.

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ABSTRACTS

The use of waste materials with pozzolanic products in concrete production is becoming a worldwide practice. The assessment of the pozzolanic activity of cement replacement materials is becoming increasingly important because of the need for more sustainable cementing products. In this report, black currant leaf ash is used as partial replacement of 5% of the concrete material. The Strength and durability test were carried out in order to assess the feasibility of using black currant leaf ash as partial replacement of cement in concrete. A total of 18 concrete cubes of 150mm x 150mm x 150mm in size were produced with ordinary Portland cement, 9 concrete cubes as control mix and 9 concrete cubes of black currant blended cement concrete, the samples were tested, weighed, and crushed to obtain their compressive strength after curing in water at age 7, 14 and 21 days. The after the study was completed it was found that the strength of the concrete increase as the samples with replacement were almost the same in strength as the control, Therefore, ordinary Portland cement-black currant blended cement concrete could be used in civil engineering and building works, especially where early strength is not a major requirement, thereby reducing the cost of production.

AIMS AND OBJECTIVES

- To know the strength of a concrete (1:3:6) with black currant leaf ash replacement of 5% of cement with respect to the different curing days.
- To compare the strength of a concrete (1:3:6) with black currant leaf ash replacement of 5% of cement with respect to a control mix.
- To know possible effects/behaviour of black currant leaf ash on concrete.

INTRODUCTION

Compressive strength of concrete is one out of many test applied to the concrete, this is the most important which gives an idea about all the characteristics of concrete. By this single test one judge that whether concreting has been done properly or not. Compressive strength of concrete depends on many factors such as water-cement ratio, cement strength, quality of concrete material, quality control during production of concrete etc [12].

Compressive strength or compression strength is the capacity of a material or structure to withstand loads tending to reduce size, as opposed to tensile strength, which withstands loads tending to elongate. In other words, compressive strength resists compression (being pushed together), whereas tensile strength resists tension (being pulled apart) [6]. In the study of strength of materials, tensile strength, compressive strength, and shear strength can be analyzed independently [9]. Some materials fracture at their compressive strength limit; others deform irreversibly, so a given amount of deformation may be considered as the limit for compressive load [8]. Compressive strength is a key value for design of structures. Compressive strength is often measured on a universal testing machine; these range from very small table-top systems to

ones with over 53MN capacity. Measurements of compressive strength are affected by the specific test method and conditions of measurement. Compressive strengths are usually reported in relationship to a specific technical standard [12].

Compressive strength is one of the most important engineering property of Concrete which designers are concerned of. It is a standard industrial practice that the concrete is classified based on grades. This grade is nothing but the Compressive Strength of the concrete cube or cylinder. Cube or Cylinder samples are usually tested under a compression testing machine to obtain the compressive strength of concrete. The test requisites differ country to country based on the design code [10]. As per Indian codes, compressive strength of concrete is defined as; the compressive strength of concrete is given in terms of the characteristic compressive strength of 150 mm size cubes tested at 28 days. The characteristic strength is defined as the strength of the concrete below which not more than 5% of the test results are expected to fall [8].

There is a growing interest to recycle waste materials by using them to modify concrete mixes. Several works have been done in the area of adding and replacing the cement with different pozzolans to improve mechanical strength and durability of concrete [8]. It is generally known that portland cement based concrete materials are limited by their negative environmental impact arising from cement production. portland cement production is considered as a major contributor to greenhouse gas emission known to be a major cause of global warming [10]. The cement products are also faced with durability problems which impact on resource utilization for reconstruction and maintenance. The incorporation of agricultural by-product pozzolans has been studied with positive results in the manufacture and application of blended cements [11].

METHODOLOGY

APPARATUS

1. **Universal Test Machine (Compression testing machine):** It was used for testing the strength of concrete cubes by crushing.
2. **Concrete Mould (150mm x 150mm x 150mm):** It was used as the mould for which the shape of cubes is originated.
3. **Tamping Rod (16mm diameter and 600mm long):** It was used for compacting the concrete fresh mix in several layers.
4. **Stop Watch:** It was used to time the shaking period of the sieves.
5. **Sets of Sieves:** It was used to perform the sieve analysis for particle size distribution of aggregates.
6. **Head pan:** It was used as the principal measuring and transporting container.
7. **Shade:** It was used as fletching and mixing tool.
8. **Graduated cylinder:** It was used as the water measuring container.
9. **Slump cone:** It was used to test the workability of the fresh concrete mix.
10. **Analog Weighing balance:** It was used as the principal measuring tool of larger weights.
11. **Digital weighing balance:** It was used as the measuring tool for light weights as it has high precision.
12. **Sieve shaker:** It was used as the shaking device for the set of sieves.
13. **Wire brush:** It was used as a sieve clearing tool.

MATERIALS USED

- 1. Cement:** It is the binding agent of the concrete mix.
- 2. Fine sand:** It is an enhancer to add volume and strength to the mix.
- 3. Coarse sand:** It is an enhancer to add volume and strength to the mix.
- 4. $\frac{3}{8}$ Gravel:** It is an enhancer to add volume and strength to the mix.
- 5. Water:** It is the cement reaction triggering agent in the mix.
- 6. Black currant leaf ash:** It is the principal ingredient that replaces 5% of cement per cube in the mix.

SIEVE ANALYSIS

Objectives:

The Standard grain size analysis test determines the relative proportions of different grain sizes as they are distributed among certain size ranges.

PROCEDURE

1. We Measure 1000g of the dry soil sample.
2. Arrange the sieves according to their sizes ranging from maximum diameter from top to the pan below.
3. Pour the dry soil sample from top sieve and allow passing through to the pan.
4. Put the BS sieve set into the mechanical shaker and allow it to shake for 15minutes.
5. Remove the sieve from the mechanical shaker and measure the sample retained on each sieve and record.
6. The procedure can be repeated for all the samples.

SLUMP TEST

Objectives:

Test the Degree of workability of concrete, by improvement the water content of the concrete.

PROCEDURE

- First clean the inner surface of the empty mould and then apply oil to it.
- Set the mould on a horizontal non- porous and non- absorbent base plate.

- Fill the mould fully by pouring freshly mixed concrete in three equal layers.

Stroke each layer 25 times with the standard tamping rod over the cross section

- After stroking 25 times the top layer is struck off level, now lift the mould slowly in the vertical direction without disturbing the mould and the concrete
- Use the measuring scale to measure the difference level between the height of the mould and the concrete sample.

PREPARATION OF SAMPLES

The proportion and material for making these test samples are from the same concrete used in the field.

SAMPLES

A total of 18 cubes of 150×150×150mm, 9 cubes as control and 9 cubes for the ash blended cement replacement concrete.

MIX RATIO

Mix Ratio of 1:3:6.

HAND MIXING OF THE CONTROL

- a. Mix the cement and fine aggregate on a water tight none-absorbent platform until the mixture is thoroughly blended and is of uniform color.
- b. Add the coarse aggregate and mix with cement and fine aggregate until the coarse aggregate is uniformly distributed throughout the batch.

- c. Add water and mix it until the concrete appears to be homogeneous and of the desired consistency.

HAND MIXING OF THE ASH BLENDED CEMENT REPLACEMENT CONCRETE

- a. Subtract 5% of cement and replace it with the black currant leaf ash of 5% for each cube.
- b. Then mix the cement and fine aggregate on a water tight none-absorbent platform until the mixture is thoroughly blended and is of uniform color.
- c. Add the coarse aggregate and mix with cement as well as the fine aggregate until the coarse aggregate is uniformly distributed throughout the batch.
- d. Add water and mix it until the concrete appears to be homogeneous and of the desired consistency.

CASTING AND SAMPLING

- i. Clean the moulds and apply oil.
- ii. Fill the concrete in the moulds in layers approximately 5cm thick.
- iii. Compact each layer with not less than 25 strokes per layer using a tamping rod (steel bar 16mm diameter and 600mm long).
- iv. Level the top surface and smoothen it.

CURING

The test samples are stored in moist air for 24 hours and after this period the samples are marked and removed from the moulds and kept submerged in clear fresh water until taken out prior to test, depending on required days to be submerged (in this case; 7, 14, 21 days).

PRECAUTIONS

The water for curing was tested every 7days and the temperature of water was kept at 20⁰C to 27⁰C.

PROCEDURE

The following procedure is the actual procedure followed by in the laboratory and discussed in details in the report.

- a. Remove the sample from water after specified curing time and wipe out excess water from the surface.
- b. Take the dimension of the samples to the nearest 0.2m
- c. Clean the bearing surface of the testing machine
- d. Place the sample in the machine in such a manner that the load shall be applied to the opposite sides of the cube cast.
- e. Align the sample centrally on the base plate of the machine.
- f. Rotate the movable portion gently by hand so that it touches the top surface of the sample.
- g. Apply the load gradually without shock and continuously at the rate of 140kg/mm²/minute till the sample fails
- h. Record the maximum load and note any unusual features in the type of failure.

RESULTS AND CALCULATIONS

SIEVE ANALYSIS RESULTS

Table 1: Particle Size Distribution for Fine Sand Aggregate

<i>Sieve size</i> <i>(mm/μm)</i>	<i>Material retained</i> <i>(g)</i>	<i>Material passing</i> <i>(g)</i>	<i>Percentage passing (%)</i>
15.00	0.0	1000	100
6.70	0.0	1000	100
6.30	0.0	1000	100
5.60	0.0	1000	100
4.75	7.0	993.0	99.30
4.00	9.8	983.2	98.32
3.35	15.0	968.2	96.82
1.40	27.8	940.4	94.04
600	10.8	929.6	92.96
425	68.4	861.2	86.12
300	87.8	773.4	77.34
150	366.8	406.6	40.66
75	225.2	181.4	18.14
pan	181.1	0.0	0.0

Source: University of Maiduguri, Faculty of Engineering, Department of Civil and Water Resources, Laboratory Test and Measurements, 2017.

Figure 1

Source: University of Maiduguri, Faculty of Engineering, Department of Civil and Water Resources, Laboratory Test and Measurements, 2017.

In table 1 and figure 1, it shows that the aggregate sample is a well graded fine sandy soil with fine sand of 55%, medium sand of 38%, coarse sand of 7%, and gravel of 0%. The aggregate sample constitutes of 93% fine and medium sand as well as 55% fine particles than any other.

Table 2: Particle Size Distribution for Coarse Sand Aggregate

<i>Sieve size</i> <i>(mm/μm)</i>	<i>Material retained</i> <i>(g)</i>	<i>Material passing</i> <i>(g)</i>	<i>Percentage passing (%)</i>
15.00	0.0	1000	100
6.70	0.0	1000	100
6.30	2.2	997.8	99.78
5.60	9.4	988.4	98.84
4.75	81.6	906.8	90.68
4.00	324.0	582.8	58.28
3.35	146.0	436.8	43.68
1.40	124.0	312.8	31.28
600	105.0	207.8	20.78
425	78.6	129.2	12.92
300	47.4	81.8	8.18
150	36.2	45.6	4.56
75	26.6	19.0	1.90
pan	18.7	0.0	0.0

Source: University of Maiduguri, Faculty of Engineering, Department of Civil and Water Resources, Laboratory Test and Measurements, 2017.

Figure 2

Source: University of Maiduguri, Faculty of Engineering, Department of Civil and Water Resources, Laboratory Test and Measurements, 2017.

In table 2 and figure 2, it is observed that the aggregate sample is a poorly graded coarse sandy soil constituting of fine sand of 10%, medium sand of 25%, coarse sand of 56%, and gravel of 9%. The aggregate sample is having 35% fine and medium sand within it mass as well as 56% coarse particles than any other.

Table 3: Particle Size Distribution For $\frac{3}{8}$ Gravel Aggregate

<i>Sieve size</i> <i>(mm/μm)</i>	<i>Material retained</i> <i>(g)</i>	<i>Material passing</i> <i>(g)</i>	<i>Percentage passing (%)</i>
15.00	0.0	1000	100
6.70	196.6	803.4	80.34
6.30	316.8	486.6	48.66
5.60	96.6	390.0	39.00
4.75	95.8	294.2	29.42
4.00	88.6	205.6	20.56
3.35	67.2	138.4	13.84
1.40	46.7	91.7	9.17
600	31.7	60.0	6.00
425	27.8	32.2	3.22
300	10.8	21.4	2.14
150	9.1	12.3	1.23
75	6.5	5.8	0.58
pan	5.6	0.0	0.0

Source: University of Maiduguri, Faculty of Engineering, Department of Civil and Water Resources, Laboratory Test and Measurements, 2017.

Figure 3

Source: University of Maiduguri, Faculty of Engineering, Department of Civil and Water Resources, Laboratory Test and Measurements, 2017

In table 3 and figure 3, it is observed that the aggregate sample is well graded gravel aggregate consisting of 3% fine sand, 3% medium sand, 31% coarse sand and 63% gravel. The aggregate sample contains about 6% fine and medium sand within it mass as well as 63% gravel particles than any other particles.

Table 4: Percentage of particles sizes in the Aggregate samples.

<i>Aggregates</i>	<i>Fine Sand</i> (%)	<i>Medium Sand</i> (%)	<i>Coarse Sand (%)</i>	<i>Gravel</i> (%)	<i>Total (%)</i>
<i>Fine Sand</i>	55	38	7	0	100
<i>Coarse Sand</i>	10	25	56	9	100
$\frac{3}{8}$ <i>Gravel</i>	3	3	31	63	100

Source: University of Maiduguri, Faculty of Engineering, Department of Civil and Water Resources, Laboratory Test and Measurements, 2017.

In table 4 above, we can observe that the fine sand aggregate is consist of about 55% of fine sand, the coarse sand aggregate is consist of about 56% of coarse sand, and the $\frac{3}{8}$ gravel aggregate is consist of about 63% of $\frac{3}{8}$ gravel.

SLUMP TEST RESULTS

The slump obtained was a true slump all through for the samples, 10mm – 20mm.

REPLACEMENT DETAILS

Plant's name: Black currant.

Plant's Botanical name: Ribes nigrum.

Plant's Kingdom: Plantae.

Plant's Family: Grosulariceae.

Plant's local name: None.

Plant's Economic use: Culinary, food, beverages and Cosmetics etc.

Plant's Medicinal use: The leaves and fruits have traditionally been used for treating several diseases (predominantly in Europe).

Plant's Average Height: Usually about 1.5 meters.

Plant's Average Diameter: About 8 mm.

Black Currant Plant

Figure 4

RESULTS FOR CONCRETE CUBE SAMPLES

RECORDED DETAILS FOR 7 DAYS CONTROL MIX

- **Date of Test:** 24th April, 2017.
- **Age of Sample:** 7 Days.
- **Date of Manufacture of Sample:** 15th April, 2017.

Description of Failure When load is Applied = Shear failure (diagonal Cracks)

Average Sample Weight Before curing = 7.5kg

Average Sample Weight After curing = 7.8kg

Average Maximum load applied = 140,000 N

Average Compressive strength at 7 days = 6.2 N/mm²

RECORDED DETAILS FOR 7 DAYS WITH BLACK CURRANT LEAF ASH BLEND

- **Date of Test:** 24th April, 2017.
- **Age of Sample:** 7 Days.
- **Date of Manufacture of Sample:** 15th April, 2017.

Description of Failure When load is Applied = Shear failure (diagonal Cracks)

Average Sample Weight Before curing = 7.0kg

Average Sample Weight After curing = 7.3kg

Average Maximum load applied = 135000 N

Average Compressive strength at 7 days = 6.0 N/mm²

RECORDED DETAILS FOR 14 DAYS CONTROL MIX

- **Date of Test:** 30th April, 2017.
- **Age of Sample:** 14 Days.
- **Date of Manufacture of Sample:** 15th April, 2017.

Description of Failure When load is Applied = Shear failure (diagonal Cracks)

Average Sample Weight Before curing = 7.7kg

Average Sample Weight After curing = 8.0kg

Average Maximum load applied = 208000N

Average Compressive strength at 14 days = 9.24 N/mm²

RECORDED DETAILS FOR 14 DAYS WITH BLACK CURRANT LEAF ASH BLEND

- **Date of Test:** 30th April, 2017.
- **Age of Sample:** 14 Days.
- **Date of Manufacture of Sample:** 15th April, 2017.

Description of Failure When load is Applied = Shear failure (diagonal Cracks)

Average Sample Weight Before curing = 7.5kg

Average Sample Weight After curing = 7.7kg

Average Maximum load applied = 182000N

Average Compressive strength at 14 days = 8.10 N/mm²

RECORDED DETAILS FOR 21 DAYS CONTROL MIX

- **Date of Test:** 7th May, 2017.
- **Age of Sample:** 21 Days.
- **Date of Manufacture of Sample:** 15th April, 2017.

Description of Failure When load is Applied = Shear failure (diagonal Cracks)

Average Sample Weight Before curing = 8.1kg

Average Sample Weight After curing = 8.4kg

Average Maximum load applied = 223000N

Average Compressive strength at 21 days = 9.91 N/mm²

RECORDED DETAILS FOR 21 DAYS WITH BLACK CURRANT LEAF ASH BLEND

- **Date of Test:** 7th May, 2017.
- **Age of Sample:** 21 Days.
- **Date of Manufacture of Sample:** 15th April, 2017.

Description of Failure When load is Applied = Shear failure (diagonal Cracks)

Average Sample Weight Before curing = 7.7kg

Average Sample Weight After curing = 7.9kg

Average Maximum load applied = 212000 N

Average Compressive strength at 21 days = 9.42 N/mm²

Table 5: TABLE OF COMPARISON BETWEEN CONTROL MIX AND BLACK CURRANT LEAF ASH BLEND CONCRETE STRENGTHS

<i>TYPE</i>	<i>7 DAYS (N/mm²)</i>	<i>14 DAYS (N/mm²)</i>	<i>21 DAYS (N/mm²)</i>	<i>28 DAYS (N/mm²)</i>
CONTROL MIX	6.2	9.2	9.9	13.2
BLACK CURRANT LEAF ASH BLEND	6.0	8.1	9.4	12.5

Source: University of Maiduguri, Faculty of Engineering, Department of Civil and Water Resources, Laboratory Test and Measurements, 2017.

GRAPHICAL REPRESENTATION OF DIFFERENCES

Figure 5

From table 5 as well as figure 5, we can observe that the compressive strengths of the control mix are higher than that of the black currant leaf ash blend although both sample increases with the curing days.

CONCLUSION

The compressive strength test of the samples was carried out using universal test machine. It is observed from table 4 and figure 4 that the compressive strength decreases with increase in percentage of black currant leaf ash. The compressive strength of the black currant leaf ash blended cement concrete was lesser than that of the control mix by 3.2%, 12.3%, 4.8% and 5.3% respectively.

From the experimental investigation on concrete with black currant leaf ash the following conclusions are drawn;

1. The compressive strength of concrete decreases with increase in percentage of black currant leaf ash. Though black currant leaf ash contains SiO_2 which is required for pozzolanic reaction, the reason for reduced compressive strength was the chemical composition of the black currant leaf.
2. From strength and durability point of view, a concrete with blends of black currant leaf ash will have enough strength to build a lot of structures that needs minimum strength.
3. A Concrete with blends of black currant leaf ash can be used where early strength is not a major requirement, and also where weight of concrete is needed to be light, thereby reducing the cost of production.

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