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Experimental Analysis on Concrete with Partial Replacement of Sawdust Ash and Coir Fibre

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Abstract:
In this project the saw dust ash and coir fibre are added in the concrete to increase tensile and compressive strength of the concrete. The characteristic compressive strength of concrete is 20N/mm^2. Additional of the saw dust is 5%, 10% and 15%, the coir fibre is 2%. Use of sawdust in concrete permits disposal of waste (sawdust) and make concrete light in weight. Concrete, cubes measuring 150x150x150mm and cylinder measuring 150x300mm are casted. The tensile strength of concrete is increased to extent as the coir fibre is introduced. The coir fibre is treated using natural latex before using in concrete, so that it is not affected by moisture content presented in concrete. This paper presents an experimental study on tensile and compressive strength concrete with partial replacement of sawdust ash and addition of coir fibre. Increase in percentage of sawdust in concrete cubes led to a corresponding reduction in compressive strength values. The addition of coir fibre increases for compressive strength and tensile strength of concrete for some extent. The studies related to the use of natural organic fibre in concrete have show strength variation with respect to the various types of fibre content. India is the third largest coconut producing country in the world. As we all know, concrete is good in compression but weaker under tensile forces.

I. INTRODUCTION

Concrete is one of the most widely and commonly used building material in civil engineering around the world. As a result, cracks develop whenever loads give rise to tensile stresses exceeding the tensile strength of concrete. Concrete durability, sustainability, and economy have made it the world's most widely used construction material. About four tons of concrete are produced per person per year worldwide and about1.7 tons per per son in the United States. The cement industry is essential to the nation construction industry. Few construction projects are viable without utilizing cement-based products. The United States consumed 86.5 million metric tons (95 million short tons) of portland cement in 2014. U.S. Cement production is dispersed with the operation of 91 cement plants in 33 states. The top five companies collectively operate around 59% of U.S.

SAWDUST ASH

This paper summarized the behavior of concrete involving partial replacement of cement by saw dust ash as 0%,5% 10%, 15%, by weight which may help to reduce the disposal problems of saw dust ash and enhance properties of concrete.

The present boom in the field of construction has caused the huge rise in the demand for Portland cement which is the important material in the production of concrete. Currently, about 3 billion tons of Portland cement are consumed worldwide and for the every 600 kg production of cement, a 400 kilograms of carbon dioxide (CO2) gas is released.

In the recent years, raising concern about global environment and utilization of renewable energy resources leads to modify the traditional practices of energy production. Among these resources, wood waste is a promising source of renewable energy.

COIR FIBRE

The use of natural fibres as reinforcement is a way to recycle these fibres and to produce a high performance material. Coir derived from tamil word "kayiru" is a natural fibre obtained from the husk of coconut. Coir possesses about 48% of lignin increasing strength and elasticity of fibre; It also reduced the biological degradation with average life nearly 20 years. Coir is produced in India at a large scale, references says more than 90% of the world coir production is from India. Kerala leads in India with producing more than 60% of the Indian production alone.

PROPERTIES

- ✓ Colour
- ✓ Fibre length(mm)
- ✓ Fibre diameter(mm)
- ✓ Bulk density(kg/m3)
- ✓ Ultimate tensile strength(N/mm2)
- ✓ Modulus of elasticity(N/mm2)
- ✓ Water absorbtion(%)

II. OBJECTIVES AND SCOPES

- ❖ To prepare light weight saw dust concrete of nearly equal advantages like conventional concrete.
- ❖ To prepare economical concrete.
- ❖ Good disposal of waste (Sawdust).
- ❖ It has many advantages over traditional concrete such as,
- ❖ Internal curing due to the absorbed water in the sawdust.
- ❖ Better heat dissipation and heat insulation property.
- ❖ Efficient in case of acoustics.

Table.1. Chemical Composition of Sawdust Ash

Test parameter	Results %
Alumina(Al2O3)	9.85
Silica (SiO2)	62.87
Calcium (CaO)	10.35
Iron (Fe2O3)	4.45
Magnesium Oxide (MgO)	4.18
Sodium (Na2O)	0.035
Potassium (K2O)	1.71
Loss on ignition	5.85

Aggregate, Sawdust, Coirs and Water.

Process:

- Material collection.
- Priliminary test (Seive analysis and Specific gravity).
- Mix design (IS10262).
- Casting.
- Curing.
- Testing (compressive test and tension test).
- Result compression and discussion.
- Conclusion.

III. METHODOLOGY

Materials used: Cement, Fine Aggregate, Course

Table.2. Properties of Materials

Parameter	F.A	C.A	SDA	Cement
Specific gravity	2.46	2.57	2.75	3.16
Water absortion (%)	3.5	1	373	_
Bulk density (dry loos e state) (kg/m^3)	1552.91	1468.25	_	_
Bulk density (compa ct state) (kg/m^3)	1642.85	1711.64	489.41	_
Fineness modulus (%)	4.04	5.46	5.48	2

CONCRETE MIX DESIGN

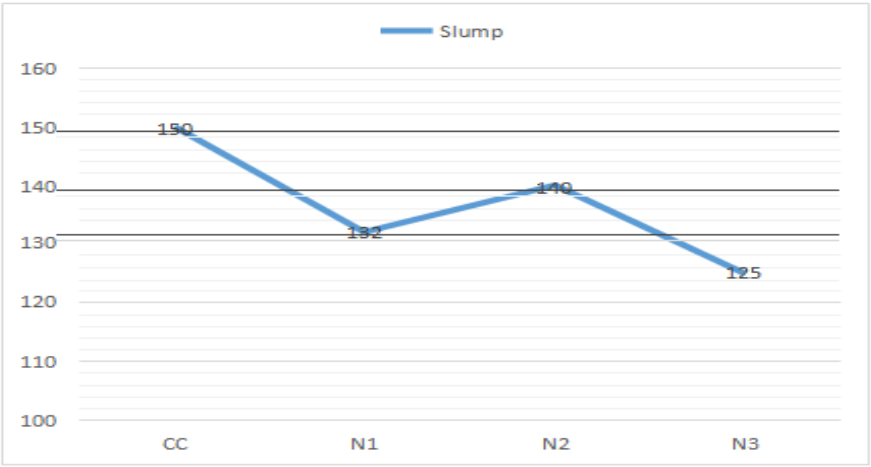
- Concrete mix design is done accordingto10262.
- The following results were obtained
- For one meter cube of concrete
- Cement=394.32(kg/m3)
- Sand =669.527(kg/m3)
- Aggregate =987.35(kg/m3)
- The proportional material is1:1.698:2.504.

SLUMP CONE TEST

The slump cone test is the most simple workability test for concrete, involves low cost and provides immediate results. Generally concrete slump value is used to find the workability, which indicates water-cement ratio, but there are various factors including properties of materials, mixing methods, dosage, admixtures etc., also affect the concrete slump value

Table.3. Slump Cone

SI.NO	Sawdust Ash	Coir Fibre	Slump (mm)
1	0%	2%	150
2	5%	2%	132
3	10%	2%	140
4	15%	2%	125



X - axis is % of replacement of concrete Y - axis is slump in mm

Slump Concrete

COMPACTION FACTOR TEST

Compaction factor testis the workability test for concrete conducted in laboratory. The compaction factor is the ratio of weights of partially compacted to fully compacted concrete. It was developed by Road Research laboratory in United Kingdom and is used to determine the workability of concrete. The compaction factor test is used for concrete which have low workability for which slump test is not suitable.

Table.4.Compaction factor test

Workability	Compaction Factor	Slump (mm)
Very low	0.78	0 - 25
Low	0.85	25 - 50
Medium	0.92	50 - 100
High	0.95	100 - 175

CASTING AND CURING

- Cube size150X150X150mm
- Cyclinder size150X300mm
- No.of cube casted is36.
- No of cyclinder casted is36.
- The concrete are casted in the mould with three layers.
- Each layer compacted by tamping rod of 15mm diameter and 60 mm length with 25 stokes.
- The curing is done by immersing the specimen into curing tank for 7days, 14days and 28days.

TESTING ON SPECIMENS

- **Compressive strength**

The cubes were kept in the compression testing machine (CTM) of capacity 2000KN.
Ulimate compressive strength = Ulimate compressive load (pu) / Area of the specimen (A)

- **Split tensile strength**

The cylindrical specimen kept horizontal in between the steel plates and the load is applied perpendicularly and the load at faliure is noted
Ultimate split tensile strength = 2P(Load) / πDL

Table.5. Compression Test for Cubes - 7 Days

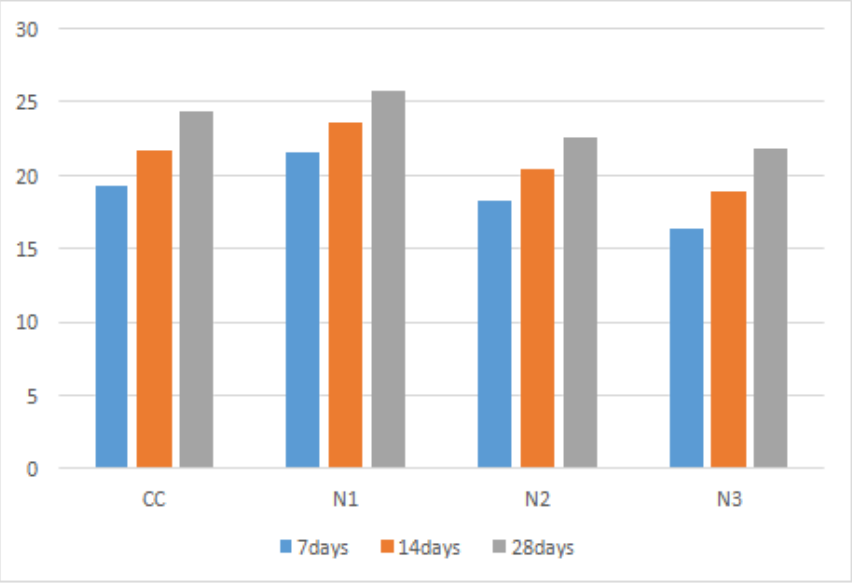
Specimen mark	Load KN	Compressive Stress (N/mm^2)
CC	432.26	19.21
N_1	485.76	21.58
N_2	411.33	18.28
N_3	367.33	16.32

Table.6. Compression Test for Cubes - 14Days

Specimen Mark	Load KN	Compressive Stress (N/mm^2)
CC	487.7	21.65
N1	530.6	23.56
N2	458.8	20.39
N3	423.51	18.86

Table.7.Compression Test for Cubes - 28Days

Specimen mark	Load KN	Compressive stress (N/mm^2)
CC	546.53	24.32
N1	575.98	25.69
N2	508.84	22.59
N3	490.09	21.78



Compressive Strength Tests

The chart consists of specimens in x - axis and compressive strength in y - axis

Table.8. Density Test for Sawdust Ash Concrete

Specimen mark	Sawdust ratio (%)	Density (Kg/m^3)
CC	0	2556
N1	5	2523
N2	10	2490
N3	15	2445

SPLIT TENSILE STRENGTH TEST

Table.9. Tensile Strength of Coir Fibre Curing days - 7 days

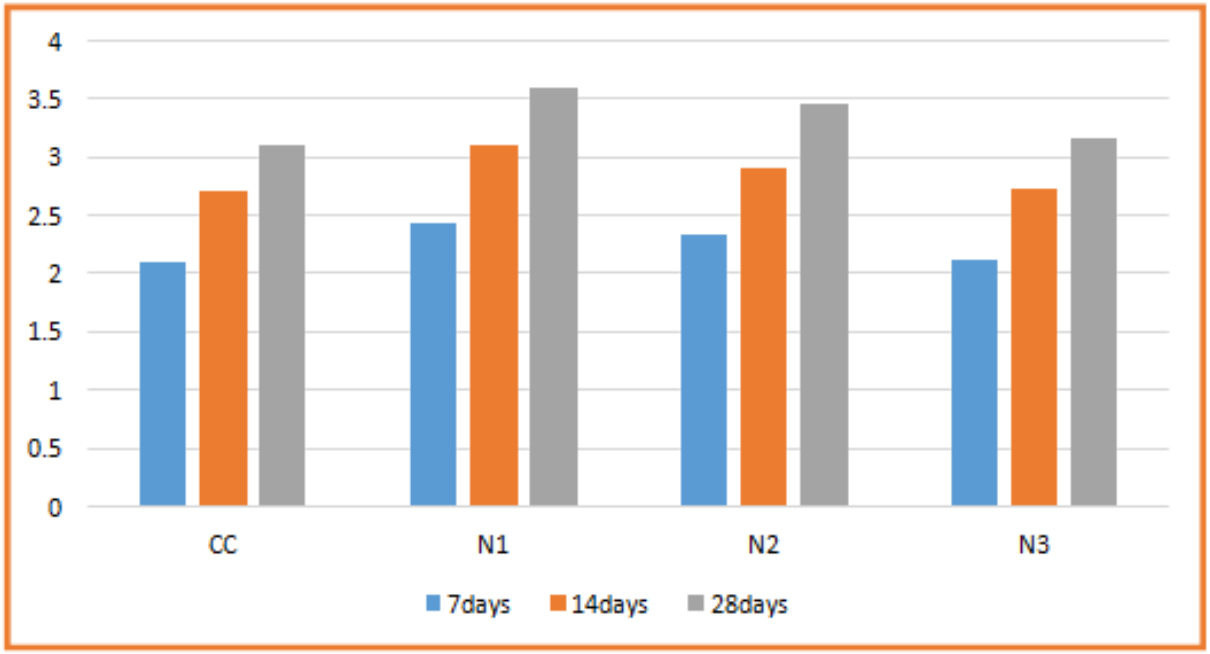
Specimen mark	Load KN	Tensile Stress (N/mm^2)
CC	148.1	2.1
N1	171.75	2.43
N2	164.83	2.33
N3	149.91	2.12

Table.10. Tensile Strength of Coir Fibre Curing - 14 days

Specimen mark	Load KN	Tensile Stress (N/mm^2)
CC	190.96	2.7
N1	219.14	3.1
N2	205.23	2.9
N3	192.45	2.72

Table.11.Tensile Strength of Coir Fibre Curing - 28 days

Specimen mark	Load KN	Tensile Stress (N/mm^2)
CC	219.15	3.1
N1	254.46	3.6
N2	243.88	3.45
N3	123.36	3.16



Split Tensile Strength Test

CC - Conventional Concrete - 0% Sawdust Ash 2% Coir Fibre.
N1- Specimen 1 - 5% Sawdust Ash 2% Coir Fibre.
N2- Specimen 2 - 10% Sawdust Ash 2% Coir Fibre.
N3- Specimen 3 - 15% Sawdust Ash 2% Coir Fibre.

IV. CONCLUSION

The following conclusions may be drawn from present experiment work.

1. The optimum addition of SDA as partial replacement for cement is in the range of 0- 15%.
2. The optimum result is found in specimen N1 (5%Sawdust Ash and 2% Coir fibre).
3. The compacting factors values of the concrete reduced as the percentage of SDA increased.
4. The bulk densities of concrete reduced as the percentage of SDA replacement increased.
5. The compressive strength of coir fibre reinforced concrete is nearly 15% more than that of a plain cement concrete.
6. The tensile strength is nearly 20% more than the plain cement concrete. This is a significant strength increment.
7. Using coir fibre in civil engineering reduces the environmental pollution.
8. Addition of coir fibre also arrests the micro cracks present in the concrete.

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