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RESEARCH ARTICLE

COMPARITIVE STUDY OF FOUNDRY SAND AND ARECANUT HUSK ASH ON CONCRETE MEMBERS

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A B S T R A C T

Foundry sand is the waste sand which is obtained when the sand can no longer be used in the metal foundries. Foundries successfully recycle and reuse the sand many times in casting process. Generation of waste foundry sand, by-product of metal casting industries causes environmental problems because of its improper disposal. Thus, its usage in building material, construction and in other fields is essential for reduction of environmental problems. As per the previous work the foundry sand is found to increase the compression criteria of the concrete but the split tensile strength is found to be decreased. In our project work an attempt is made to increase the split tensile strength of the concrete by the partial replacement of the cement with the Areca nut husk ash and replacement of fine aggregate with the foundry sand. The assumption is considered that the Areca nut ash consists of fibrous properties and as it is unutilized it is available in a very large quantity leading to the formation of large bio waste, hence the Areca nut husk can be used for good results. This work is conducted to investigate the performance of concrete discarded foundry sand as a replacement of fine aggregate and cement with partial replacement of Areca nut husk ash. The cement is partially replaced with the percentages of 0, 5, 10, 15, 20. Compressive strength was increased from 16.8N/mm² to 19.22N/mm² for 7 days of curing and compressive strength is increased 21.33N/mm² to 21.55N/mm² that is upto 10% replacement of AHA for 28 days of curing and it was seen that the tensile property is decreased from 1.98N/mm^2 to 1.83 N/mm^2 for 7days of curing and relatively the tensile strength is increased from2.05 N/mm^2 to 2.26 N/mm^2 for 28days of curing, Thus increasing the tensile property of the concrete. This gives lesser strength than that of conventional concrete.

INTRODUCTION

General

Concrete is one of the major construction material used, which is next to the consumption of water by the mankind. It is estimated that six billion tons of concrete is produced every year throughout the world. This is due to the availability of the abundance of the raw materials, low relative cost and adoptability of concrete forming various shapes. The extraction of raw materials causes depletion of resources. In recent times, the environmentalists are more concerned regarding the cement manufacture.

One tons of cement manufacture emits approximately one tons of CO_2 in to the atmosphere. This causes greenhouse effect and global warming of the planet. Hence an emission of six billion tons of CO_2 every year which causes an environmental impact. The way to reduce the environmental impact is the use of supplementary cementitious materials. These alternative materials are generally selected on the basis of additional functionality that they offer and their cost effectiveness. Typical examples are fly ash, slag cement formerly called ground granulated blast furnace slag, silica fume, rice husk and egg shell, one such material is Areca nut husk ash.

The applications of AHA and Foundry sand are replacement as partial and fully to the cement and fine aggregate (sand), depending on their chemical composition and grain size. The use of these materials in concrete, apart from the environmental benefits, also produces good effects on the properties of final products. One of the waste materials used in the concrete industry is foundry sand and Arecanut husk ash. Most of the aggregates used in our country are river sand as fine aggregates and crushed rock of quarries as coarse aggregates. Fine aggregates used for concrete should conform to the requirements for the prescribed grading zone as per IS: 383 1970 [3]. Natural or river sand may not conform to all the above requirements and may have to be improved in quality. Improvements by washing, grading and mixing may have to be done before use at the consumer end. River sand is becoming a very scarce material. The sand mining from our rivers have become objectionably excessive in view of both economy and environment. It has now reached stage where it is killing all our rivers day by day. Hence sand mining has to be discouraged so as to save the rivers of our country from total death. The problem of how to meet the increasing demand and cost of concrete in sustainable manner is a challenge in the field of civil engineering and environmental. Because of environmental and economic reasons it require thinking about the use of industrial wastes and naturally available waste material as alternative materials in concrete production, which not only reduces the cost of production of concrete but also controls the pollution relatively**.**

Aims &Objectives of the study

The aim of the research is to evaluate the performance and suitability of AHA as a cementitious material for the use of ordinary Portland cement (OPC) in the production of concrete.

To evaluate the different strength properties of concrete mixture with AHA replaced in percentage to the cement and FS is replaced fully to the fine aggregate for making workable, high strength and durable concrete using AHA and FS on concrete members.

MATERIALS USED

Areca Nut Husk Ash (AHA)

Arecanut husk were collected from areca nut gardens of Tumkur District of Karnataka, India. The husk were cleaned with water, dried in sunlight and incinerated in open furnace at a rate of 10˚C per min up to 700˚C for 6 hours to remove volatiles and residue carbon. After the burning process is completed, the ash was left to cool down to room temperature (Figure 1). In order to achieve fineness comparable to OPC, the burned AHA was grounded for 30 minutes and screened through 150µ sieve. The sieved ash was stored immediately in air tight containers to avoid pre-hydration.

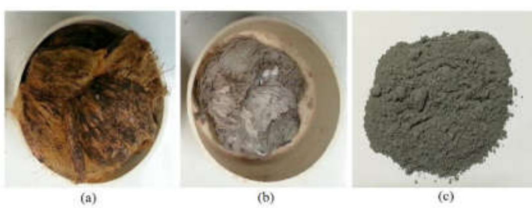

Figure1 Steps of areca nut husk ash preparation (a) initial dry form, (b) after open furnace and (c) after grinding and sieving.

Table 1 Chemical composition of AHA

Constituents	Values (%)
SiO_2	28.44
Al_2O_3	3.64
Fe_2O_3	1.91
CaO	2.71
MgO	3.87
SO_3	7.80
Na_2O	0.24
K_2O	26.52

Foundry Sand

Foundry sand is waste sand from metal casting industries, when the sand can no longer be reused in the foundry sand, it is removed from the foundry and is termed as "foundry waste sand." Foundry sand consists primarily of silica sand, coated with a thin film of burnt carbon, residual binder and dust. Foundry sand can be used in concrete to improve its strength and other durability factors. Foundry Sand can be used as a partial replacement of fine aggregates or total replacement of fine aggregate and as supplementary addition to achieve different properties of concrete. Foundry sand was obtained from metal casting industries, Bangalore.

Table 2 Foundry sand chemical oxide composition

Constituents	Value (%)
SiO_2	87.91
Al_2O_3	4.70
Fe_2O_3	0.94
CaO	0.14
MgO	0.30
SO_3	0.09
Na_2O	0.19
K_2O	0.25
TiO_2	0.15
P_2O_5	0.00
Mn_2O_3	0.02
SrO	0.03
LOI	5.15

Fine aggregate

Sand plays a very important role in concrete. It fills in the voids between the coarse aggregates. The sand should be well graded from the particle size point of view, in order to guarantee the filling between the various aggregates as much as possible. The fine aggregate used is sand only for conventional concrete mix. Locally available river sand which is the natural sand passing through 4.75 mm sieve and retained on 75 micron sieve is used.

Coarse aggregate

Coarse aggregate is the strongest and least porous component of concrete. Presence of coarse aggregate reduces the drying shrinkage and other dimensional change occurring on account of movement of moisture. It is generally found that crushed stone aggregates lead to higher strengths than rounded ones. In the present investigation, locally available crushed granite aggregate with 20 mm down size were used.

Cement

43 grade Ordinary Portland Cement (ACC) is used in this present investigation. Cement is a fine powder, when mixed with water and allowed to set and hardened components or members together to give a mechanically strong structure. Cement can be used as a binding material with water for binding solid particles of different sizes like bricks, stones or aggregates to form a monolith.

Mix Design

Concrete mix design is an attempt to ensure the judicious proportions of constituent materials so as to meet the requirements of the structure to be constructed. The strength level required, age, material characteristics and type of application greatly influence the mix proportions. Raw material properties and quantities must be selected to achieve the desired mix in terms of strength, durability, flow ability, workability and economy.

Table 3 Materials required for $1m^3$of concrete

Constituents	Quantity
Cement	437.77 Kg
Coarse aggregate	1063.78 Kg
Foundary sand	551.59 Kg
Water	197 Liter

The investigation was done on the proportion 1:1.65:2.33 for conventional concrete mix there is no change, where as for other mixes like replacing the fine aggregate to foundry sand fully and replacing the AHA to cement with varying percentages. For 0% AHA only Foundry sand is fully replaced for fine aggregate and for the rest fully replacement of FS and percentages of AHA.

Table 4 Replacement of Cement by AHA

Mix Id	Cement	AHA
A_0	100	0
A_5	95	5
A_{10}	90	10
A_{15}	85	15
A_{20}	80	20

Casting, Curing & Testing of the Specimen

Casting of specimen

AHA, FS, Coarse aggregate were taken in mix proportion 1:1.26:2.43 which correspond to M25 grade of concrete. Cement is replaced with AHA with varying percentages. All the ingredients were dry mixed homogeneously. To this dry mix, water-cement ratio of 0.45 was added and the entire mix was again homogeneously mixed. This wet concrete was poured into the moulds which was compacted by tamping rod in three layers and then kept into the vibrator for compaction. After the compaction, the specimens were given smooth finishes and were covered with gunny bags. After 24 hours, the specimens were de moulded.

Curing of the specimens

The de moulded specimens were transferred to curing. The curing is done in the water, where they were allowed to cure for 7 & 28 days.

Testing of the specimens

The test specimens for compressive strength test were made of cubes having a size of 150mm x 150mm x 150mm cast iron steel moulds were used. For each mix proportion two numbers of cubes were cast and tested at the age of 7 days and 28 days.

The test specimens for split tensile strength test were made of cylinders having a size of 100mm diameter and 300mm high cast iron moulds were used. For each mix proportion two numbers of cylinders were cast and tested at 7 days & 28 days.

Compressive Strength Test

Specimens of dimensions 150x150x150mm were prepared. They are tested on 2000kN capacity compression testing machine as per IS 516-1959. The compressive strength is calculated by using the equation,

F=P/A
Where; F=> Compressive stress in N/mm^2
P=> Maximum load in N
A=> Cross sectional area in mm^2

Compressive strength of 28 days curing of fully replaced FS to fine aggregate gives 21.33 N/mm^2 and it is observed that 32% of strength is decreased when compared to conventional concrete.

The average Compressive strength of various proportions is given in table.

Table 5 Compressive Strength of AHA Specimeus

% of AHA	7days N/mm²	28days N/mm²
0	16.8	21.33
5	16.4	20.11
10	17.91	21.55
15	15.1	19.11
20	19.22	18.22

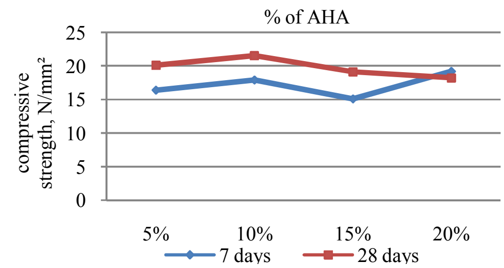

Figure 2 Comparison of Compreive Strength of AHA Specimeus

Split tensile Strength test

Cylindrical specimens of diameter 150mm and length 300mm were prepared. Split tensile test was carried out on 2000 KN capacity compression testing machine as per IS 5816-1999. The tensile strength is calculated using the equation.

F=2P/ (π x D x L)
Where; F=> Split tensile stress in N/mm2
P=> Load at failure in N
D=> Dia of the cylindrical specimen in mm
L=> Length of the cylindrical specimen in mm

The average split tensile strength of various proportions is given in table.

Table 6 Split Tensile Strength of AHA Specimeus

% of AHA	7days N/mm²	28days N/mm²
0	1.98	2.05
5	1.83	2.33
10	1.84	2.26
15	1.80	1.90
20	1.75	1.83

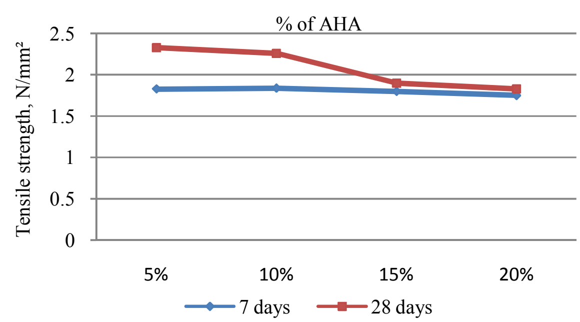

Figure 3 Comparison of Split Tensile Strength of AHA Specimeus

Split tensile strength of 28 days curing of fully replaced FS to fine aggregate gives 2.05 N/mm2 and it is observed that 27% of strength is decreased than conventional concrete.

RESULTS & DISCUSSION

The comparison graph shown in graphs wich shows the compressive strength of cubes & split tensile strength of cylinders respectively shows for different percentage AHA. For ambient curing of specimens of 100% FS which gives 16.8 N/mm^2 , when compared to the others specimens using different percentage of AHA and fully replaced FS gives maximum strength at 10%. The maximum strength achieved in 28 days curing. For split tensile also there is maximum increase in 10% replacement.

Table 6 Test results on materials used

Materials	Characteristics	Result
Cement	Standard consistency	30%
	Initial setting time	150min
	Final setting time	300min
	Specific gravity	2.98
Fine aggregate	Specific gravity	2.6
	Sieve analysis	Zone-II
	Water absorption	1%
	Moisture content	Nil
Coarse aggregate	Specific gravity	2.7
	Sieve analysis	20mm down size
	Water absorption	0.6%
	Moisture content	Nil
Foundry sand	Specific gravity	2.5
AHA	Specific gravity	2.97

CONCULSION

- Complete replacement of Foundry sand to the fine aggregate gives lesser strength than that of conventional concrete, due to the presence of excess amount of silica.
- As per the previous works, partial replacement of foundry sand to fine aggregate was given good results than these results.
- Compressive and tensile strength at 10% replacement of Arecanut husk ash to cement gives optimum strength.

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