Ann. For. Res. 65(1): 9765-9773, 2022
ISSN: 18448135, 20652445

ANNALS OF FOREST RESEARCH
https://www.e-afr.org/

EXPERIMENTAL STUDY ON THE PARTIAL REPLACEMENT OF FINE AGGREGATE IN CONCRETE WITH GROUNDNUT SHELL POWDER

R.Rajesh Guna[1], M.Mariappan[2], M.Shivaraja[3]
Associate Professor [1&2], Professor[3]
Jyothishmathi Institute of Technology and Science, Karimnagar, Telangana, India[1]
Dr.Mahalingam College of Engineering and Technology, Pollachi, Tamil Nadu, India[2]
Nehru Institute of Technology, Coimbatore, Tamilnadu, India[3]
Corresponding Author: R.Rajeshguna, rajeshguna.r@gmail.com

Abstract
The suitability of groundnut shell as a constituent material in concrete was investigated by replacing proportions by volume of fine aggregate with groundnut shell powder. The physical properties of cement groundnut shell powder and aggregates were determined. Three various concrete mixes with groundnut shell powder replacement of 0%, 15%, 20% and 25% to the fine aggregate were prepared for M25 grade of concrete with a water cement ratio of 0.44. The effect of groundnut shell powder on workability of fresh concrete was determined by the slump and compaction factor test. Compressive strength, split tensile strength and flexural strength of concrete specimens were evaluated at 7days, 14days and 28 days at different percentage replacement. The experimental test results indicate that up to 20% replacement of groundnut shell powder with fine aggregate attains higher strength and decreases gradually if the percentage of groundnut shell powder increases.

INTRODUCTION

Concrete is a composite building material that is obtained by a proportional mix of aggregate, water and a binder. This mixture when cast into forms, demoulded and cured, hardens into a rock-like material by a chemical reaction between the binder and water. The flexibility in use in use of concrete, and its adaptability to environmental conditions make concrete suitable for applications in almost all civil engineering and building structures. Despite these attributes concrete still has a characteristics weight which presents problems and complications in construction usually resulting to high cost of construction of underlying sections. The introduction of lightweight concrete has to a large extent solved the attendant problems in concrete constructions. Various lightweight concrete have been formulated through different technical approaches, they are:

1. Inclusion of air voids into the concrete mix.
2. Omission of fine aggregate phase.
3. Replacing the normal natural aggregates with light weight aggregates.

In the third approach natural lightweight aggregate such as expanded slag, pumice, scoria and perlite, industrial and agricultural wastes have been used. Other wood waste such as splinters and shavings, suitably treated chemically have been used to make non-load bearing concrete. A part from being advantageous to construction, the use of these alternative aggregates reduces the over dependence on the conventional aggregates (river sand and crushed rock) which is increasingly

becoming expensive, limited and gradually degrading the natural habitat and causing ecological imbalance. Several comprehensive studies during the past years have dealt with the subject of aggregate supplies and needs and the possible use of waste materials as aggregates for concrete. Critical shortage of natural aggregate for concrete is developing in many regions. The needs for better methods of solid waste disposal and probably energy conservation have contributed to the increased interest in this technology. The use of agricultural waste products such as periwinkle shells and quarry dust, groundnut shells etc. as replacement for conventional aggregates could reduce the cost of construction and helps take care of energy and disposal problems. Periwinkle shell is a form of lightweight aggregate which can be used as partial replacement material for sand. In some parts of Nigeria periwinkle shells are used as conglomerate in the production of concrete. Quarry dusts are either lightweight or high density aggregates. Quarry dust material intended for use as fine aggregate should be defined as material less than 4mm size unless it is to used in aspalt. Groundnut botanically belongs to araches hypo gaealinn of leguminous family. A complete seed of groundnut is called pod and contains one to five kermils which develops underground in a needle like structure called peg which grow into the soil and then converts into a pod. Groundnut has taproot system which has many nodules, present in root and lateral roots. These nodules contain rhizobium bacterial, which are symbiotic in nature and focus atmospheric nitrogen. The shell constitute about 25-35% of the pod. The seed accounts for the remaining portion (65-75%). Nigeria is one of the foremost producers of groundnut in the world, producing up to about 2.69 million metric tones in 2002 and 1.55 million metric tones in 2008. Groundnut shell is found in large quantities as agricultural farm wastes in northern parts of Nigeria. Over the years groundnut shell constitutes common solid waste especially in the developing part of this world. Its potential as a useful engineering material has not been investigated. The utilization of groundnut shell will promote waste management at little cost, waste management at little cost, reduce pollution by these waste and increase the economic base of the farmer when such waste are sold thereby encouraging production.

The utilization of agricultural and industrial wastes are gift of other traditional materials in construction field both practical and economical benefits. The waste materials have normally no commercial value and being locally available. The major contribution of waste materials in construction industry to conservation of natural resources and protect the surrounding environment. The groundnut industries produce waste such as groundnut shell powder which is usually dumped in the open site by affecting of surrounding without any economic benefits.

II OBJECTIVES

The main objectives of this research was carried out the partial replacement fine aggregate in place of the ground nut shell ash.

- To obtained the various properties of fine and coarse aggregate.
- To determine the strength properties of harden concrete like compressive strength, split tensile strength and water absorption.
- Main objective to know about theground nut shell ash replaced by the fine aggregate.

III LITERATURE REVIEW

Mohit Sahu et al. (2021) They noticed that the compressive strength will be increased by adding 5% of groundnut shell ash and 0.3% of silica gel in the cement. In this experiment, they done a broad analysis of workability and compressive strength and they found that compressive strength increase approximately by 38% than normal concrete of M20 grade at 5% GNSA and 0.3% of silica gel replacement.

K. Pandi et al. (2018) Proved that the compressive strength and split tensile strength will be increased upto 15% replacement of fine aggregate with groundnut shell ash and also they have done water absorption test at different ages of 28, 60 and 90 days and the strength increases after 90 days compared to28 days.

P. Satya Sagar et al. (2017) They observed that 10% replacement of groundnut shell ash in cement gives higher strength values when compared to other percentages and they also observed that 15% replacement of groundnut shell ash in a cement gives higher compressive strength and split tensile strength rather than other flexural strength. The experimental investigation was carried out to evaluate the strength of concrete in which cement was replaced with groundnut shell ash and they observed that the water cement ratio is increased then the strength of concrete will also increase.

C. Navaneetha Krishnan et al. (2016) They proved that by adding 2.5% of groundnut shell ash in cement then the compressive strength will be higher. If it increases more than 2.5% the strength starts decreasing. They conducted tests on fresh concrete for M20 grade of concrete. This investigation is performed to evaluate the strength of concrete in which cement is replaced form 0-10% with GSA. Finally they got optimum value where groundnut shell ash can be replaced at 2.5% of cement in concrete.

K. Mujedu et al. (2016) They proved that the groundnut shell ash can be used in cement upto 15% such that it gains its strength and they also observed that by using groundnut shell ash as a partial replacement in a cement the cost will also be less. They proved that the strength of GSA is lower than the 100% cement and it can still be used for constructing of light load bearing structures.

Henry Tata et al. (2015) Proved that the groundnut panels cannot be used for structural purposes but will be suitable for non-load bearing partition walls and they did not used coarse aggregate in it and upto a replacement of 30-70% has suitable strength. They casted specimens of different percentages which is 0%, 10%, 20%, 30%, 50%, 70% and 100%
were tested for 7, 14 and 28 days. They proved that 30% replacement of groundnut shell replacement achieved high strength.

B.H. Sada et al. (2013) Proved that the compressive strength and workability will increase below 25% replacement of fine aggregate with groundnut shell with different ages of 7, 14 and 28 days. Concrete containing groundnut shell could be used in non-load bearing panels where structural strength is not of importance. They concluded that the use of groundnut shell in concrete reduces the workability due to high water absorption of water by the groundnut shell.

H. Mohmoud et al. (2012) They noticed that by adding 20% of groundnut shell ash in a cement then the strength increases and if it exceeds 20% then strength decreases and they also observed

that in the chemical composition of GSA as compared to cement, the amount of K2O is higher in GSA and also CaO was less than what is obtained in cement.

IV MATERIALS

Cement

Cement is a binder substance used for construction that sets, hardens and adheres to other materials to bind them together. Cement when it mixed with fine aggregate produces mortar for masonry or if the cement is mixed with sand and gravel produces concrete. In this project we had used 43 grade of Portland Pozzolana cement.

Fine Aggregate

Fine aggregate is a material that will pass through a 4.75mm sieve. To increase the workability and for economy as reflected by use of cement, the fine aggregate should have round shape. The purpose of fine aggregate is to fill the voids in the coarse aggregate and to act as a workability agent.

Coarse Aggregate

Coarse aggregate is an irregular and granular materials such as sand, gravel or crushed stones are used for making concrete. Coarse is a naturally occurring material and can be obtained by blasting quarries or crushing them by hand or crushers. It gives body to the concrete reduce shrinkage and effect economy. The aggregates occupy 70-80% of volume of concrete.

Groundnut shell powder

Groundnut shells are the waste obtained from the household which uses groundnut for oil making. The shells were sun dried and then grinded to reduce it to sizes. The size of groundnut powder is same as the size of fine aggregate it should pass through the 4.75mm sieve size.

Table 1 Properties of cement

Sl.No.	Properties	value
1	Specific Gravity	3.08
2	Fineness	4.5
3	Standard Consistency	35 %
4	Initial Setting Time	30 minutes
5	Final Setting Time	600 minutes

Table 2 Properties of fine aggregate &coarse aggregate

Sl.No.	Properties	FA value	CA value
1	Specific Gravity	2.67	2.63
2	Fineness Modulus	3.23	4.405
3	water absorption	0.80	0.81%
4	Size of particle	Upto 4.75mm	20mm and above 4.75mm

V METHODOLOGY

In this experimental research carried out to analyzes the strength properties of the concrete specimens M25 grade of concrete mixes with an aggregates of 20mm size of three mixes 15%, 20% and 25% replacement in fine aggregate with groundnut shell powder.

Table 3 Properties of ground nut shell ash

Sl.No	Properties	value
1	Specific gravity	1.04
2	Fineness modulus	2.88
3	Water absorption	2.04%
4	Colour	grey

Table 4 Mix proportion for concreteFine aggregate replacement by ground nut shell ash

Sl.No	Type of concrete	Description of concrete
1	G0	River sand concrete
2	G1	15% replacement by GNSP
3	G2	20% replacement by GNSP
4	G3	25% replacement by GNSP

VI METHODS OF TESTING

The finishing of each curing period a total of triplicate concrete specimen were tested for each concrete cube properties. The compressive strength test was evaluated on the 150mm cube specimens, while the split tensile strength test was carried out to 150mm diameter with 300mm of cylindrical specimens and flexural strength test were carried out.

VII RESULTS AND DISCUSSION

The experimental test results were various test performed the given table 5 and 6 shown in figures 1, 2, 3, 4 and 5

VII (A) Slump cone test

The slump values were also evaluated for different percentages replacement of GNSP in fine aggregate the percentages used to replace are 15%, 20% and 25%.

VII (B) Compaction factor test

The test was conducted for fresh concrete prepared before the moulding process. A total 4 concrete mixes are prepared at different times. Workability results obtained from slump cone test for M25 grade of concrete.

VII (C) Compressive strength

The compressive strength test results from the various mixes for 7days,14 days and 28days given table 5and shown in figure 1. It can be seen from the figure that the compressive strength test results of concrete cube specimens at 20% replacement of ground nut shell powder were higher than those at 0% of GNSP. Furthermore incremental of GNSP percentage results in decreases the various strength properties.

Table 5 slump cone and compaction factor test

% of groundnutshell powder used	Slumpvalues	Compaction factorvalues
0	293	0.955
15	290	0.980
20	287	0.946
25	285	0.932

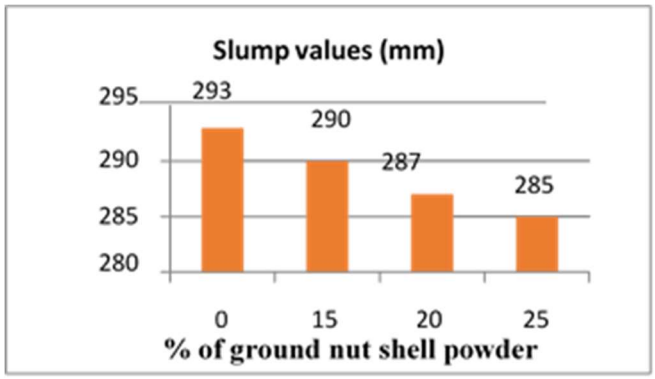

Fig. 1 slump for fine aggregate replacement in concrete with GNSP

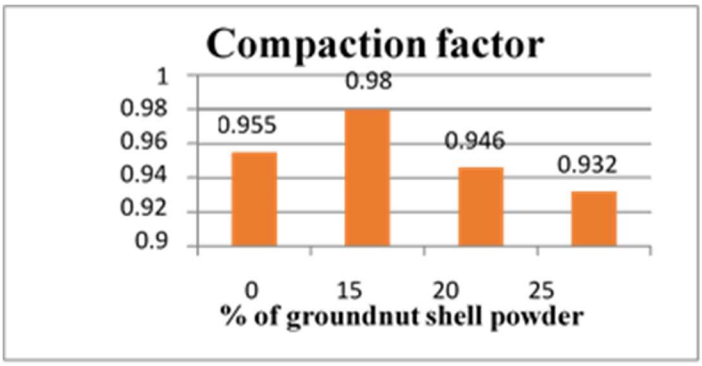

Fig. 2 compaction factor for fine aggregate replacement in concrete with GNSP

Table 6 test results on ground nut shell ash concrete

Designation	compressive strength in N/mm^2			split tensile strength in N/mm^2			Flexural strength in N/mm^2		
	7days	14days	28days	7days	14days	28days	7days	14days	28days
Conventional 0%	15.91	22.04	24.48	1.98	2.73	3.04	2.2	3.10	3.45
15%	16.62	23.02	25.6	2.07	2.85	3.18	2.3	3.2	3.55
20%	16.88	23.37	26	2.12	2.90	3.23	2.35	3.25	3.6

25%	16.26	22.48	24.97	2.02	2.81	3.14	2.25	3.15	3.5

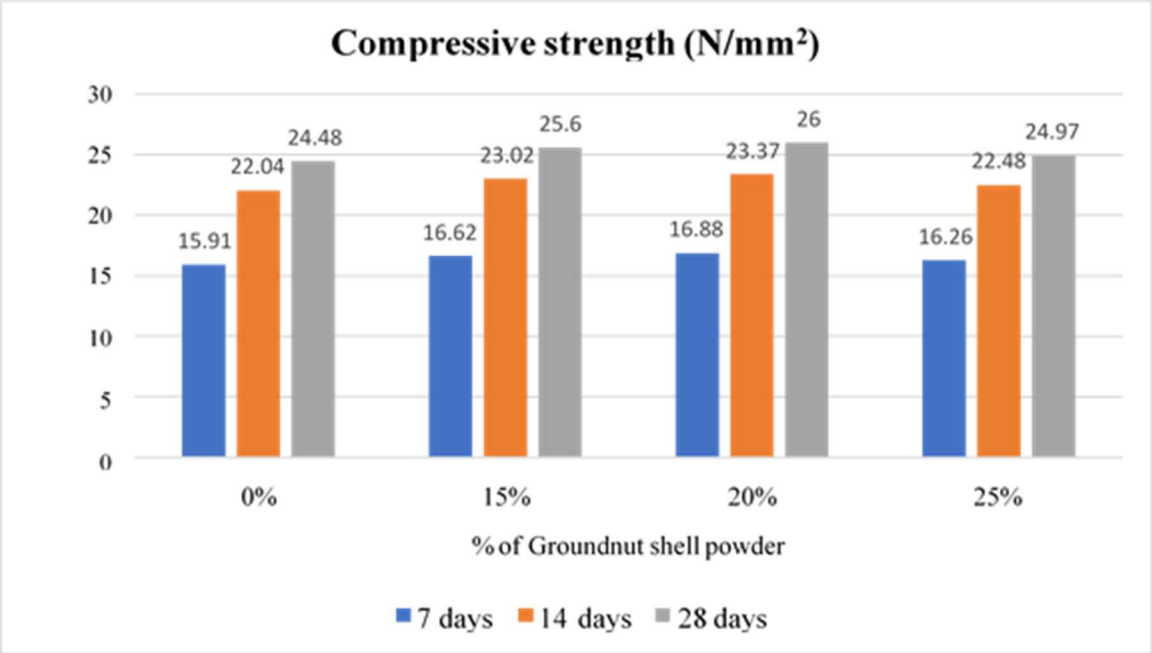

Fig. 3 compressive strength for Fine aggregate replacement in GNSP concrete

VII(D) Split tensile strength test

The split tensile strength test results for all the various mixes for 7 days, 14 days and 28 days curing for given table 6 and shown in figure. It was observed that the success of split tensile strength of mixes as decrement in partial replacement of GNSP.

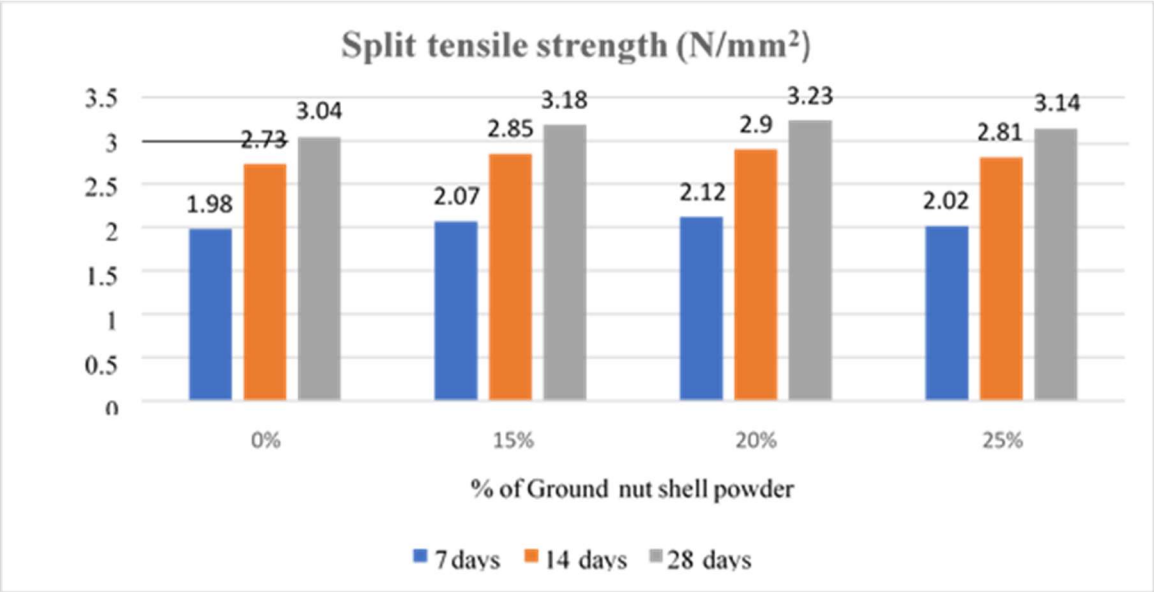

Fig. 4 Split tensile strength for Fine aggregate replacement in GNSP concrete

VI(E) Flexural strength test

The flexural strength test results for all the various mixes for 7 days, 14 days and 28 days curing for given table 6 and shown in figure. It was observed that the success of flexural strength of mixes as decrement in partial replacement of GNSP.

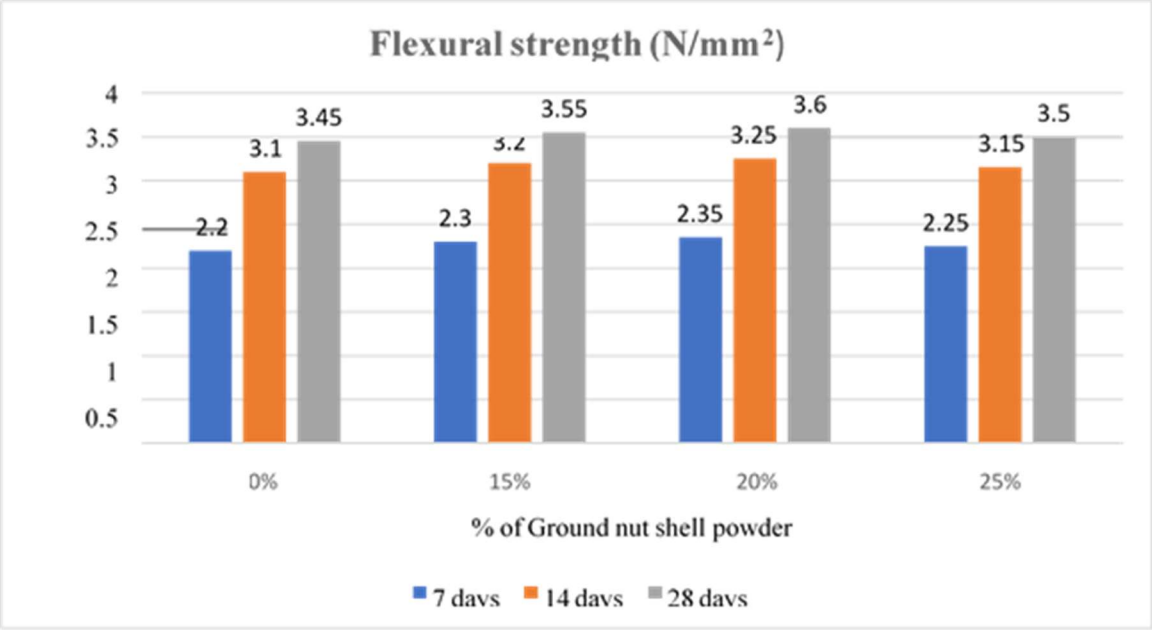

Fig. 5 Flexural strength for Fine aggregate replacement in GNSP concrete

VI Conclusion

The development of concrete with groundnut shell powder as fine aggregate has been s uccessfully completed and the results were presented and analysed in the previous chapters. Based on the test results of M25 concrete the following conclusions are drawn: We conclude that the use of groundnut shell powder in concrete reduces the concrete workability due to high absorption of water by the groundnut shell.

- We conclude that 20% replacement of groundnut shell powder in fine aggregate gives high strength compared to conventional concrete. If the percentage increases then the strength decreases.
- We conclude that the compressive strength for 28 days is more when compared to other days for 15% replacement the strength is increased up to 4.37% and for 20% replacement the strength is increased up to 5.84% and for 25% replacement the strength increases to 1.96% compared to conventional concrete.
- We conclude that the split tensile strength for 28 days is more when compared to other days for 15% replacement the strength is increased up to 4.40% and for 20% replacement the strength is increased up to 5.88% and for 25% replacement the strength increases to 3.18% compared to conventional concrete.
- We conclude that the compressive strength for 28 days is more when compared to other days for 15% replacement the strength is increased up to 2.18% and for 20% replacement

the strength is increased up to 4.16% and for 25% replacement the strength inc to 1.42% compared to conventional concrete.

REFERENCE

1. IS: 456 (2000) " Plain and reinforced concrete code of practice".
2. B. H. Sada and S. Boka (2013). An investigation into the use of groundnut shell as fine aggregate replacement, Nigerian journal of technology. ISSN 1115-8443.
3. K. Pandi and K. Ganesan (2018). Studies on the partial replacement of fine aggregate with groundnut shell ash in concrete. ISSN 2393-8374.
4. H. Mahmoud and Z.A. Belel (2012). Groundnut shell ash as partial replacement of cement in sandcrete blocks production, International journal of development and sustainability, Vol(3).
5. C. Navaneetha Krishnan and N. Mohamed Nizar (2016). Groundnut shell ash as partial replacement of cement in concrete, Journal of mechanical and civil engineering.
6. K. A. Mujedu and S. A Adebara (2016). The use of groundnut shell ash as a partial replacement for cement in concrete production, International journal of sciences. ISSN 0794-9650.
7. Henry Tata (2015). Feasibility study of the use of groundnut shells as fine aggregates in light weight concrete construction, International journal of advanced research in engineering, Vol(1).
8. Mohit Sahu and Saurav Kumar Nidhi (2021). Groundnut shell ash and silica gel as partial cement replacement in concrete, International journal of creative research thoughts. ISSN 2320-2882.
9. P. Satya Sagar and Nadiminti Lakshmi (2017). Study on partial replacement of groundnut shell ash with cement, Challenge journal of concrete research letters.