International Journal on Applications in Civil and Environmental Engineering
Volume 2: Issue 3: March 2016, pp 8-13. www.aetsjournal.com ISSN (Online) : 2395 –3837

Experimental Investigation of Concrete With Groundnut Shell Ash as a Partial Replacement of Cement with Sisal Fibers

Padmavathi.S , D.Preethika

Abstract— The continues increase in the price as well as huge amount of CO2 emission during production of Portland cement required supplementary material to replace it partially. In this work, Groundnut Shell Ash (GSA) is used as a partial replacement for Ordinary Portland Cement (OPC) in concrete. The percentage replacement of Ordinary Portland Cement (OPC) varies from 0% to 20%. The results generally show a decrease in density and compressive strength as the percentage replacement with GSA increases suggesting less hydration with cement. Sisal fibers are the natural fibers which are used as the reinforcement in concrete. Sisal Fiber reinforced concrete is a concrete containing fibrous material which increases its structural integrity. The addition of sisal fibers to concrete considerably improves its structural characteristics such as compressive strength, tensile strength and bending strength. The sisal fibers' added in various percentages such as 1%, 2% and 3%.

This paper highlights about the behavior of concrete when Groundnut Shell Ash and sisal fiber are added in concrete. Groundnut Shell Ash has been used by replacing cement in percentages, and sisal fibers are added by volume of concrete in different percentages. Based on a general analysis of the results as well as the logical comparison to the acceptable standard, a percentage replacement of GSA and addition of sisal fibers' are suggested for sustainable construction.

Keywords : concrete , cement.

I. INTRODUCTION

In the present scenario, no construction activity can be imagined without using concrete. Concrete is the most widely used building material in construction industry. The main reason behind its popularity is its high strength and durability. The potential applications of industry by-products in concrete are as partial aggregate replacement or as partial cement replacement, depending on their chemical composition and grain size. The use of these materials in concrete comes from the environmental constraints in the safe disposal of these products. These studies try to match societal need for safe and economic disposal of waste materials with the help of environmental friendly industries, which needs better and cost-effective construction materials. A vast majority of the cement used in construction work is the Portland cement. The continuous increase in the price of Portland cement is attributed to the insufficient production rate of the raw materials when compared with the demand rate in the construction industries. Cement is not an environment friendly material from the stand point of energy consumption and release of green-house gases (GHG) leading to global warming. Furthermore, the resource productivity of Portland-cement concrete products is much lower than expected because they crack readily and deteriorate fast.In recent times, many waste materials like fly ash periwinkle shell ash, and ashes produced from various agricultural wastes such as palm oil waste, rice husk ash, corncob ash, millet husk ash, groundnut husk have been tried a pozzolanas or secondary cementitious materials. These supplementary cementing materials play an important role when added to Portland cement because they usually alter the pore structure of concrete to reduce its permeability, thus increasing its resistance to water penetration and water related deterioration such as reinforcement corrosion, sulphate and acid attack. The partial replacement of OPC with GSA in concrete production is a welcome development. The cost of GSA when compared with OPC is very low due to the availability of Groundnut shell in large quantities as agricultural farm wastes. The utilization of Groundnut shell will promote waste management at little cost,reduce pollution by these waste and increase the economic base of the farmer when such waste are sold thereby encourages more production.

Padmavathi.S, M.E. Mount Zion Engineering College, Pudukkottai-622507 (Email : Padmadurai308@Gmail)
D.Preethika M.E., Asst.Prof./Civil Engg. Mount Zion Engineering College Pudukkottai-622507.

II. LITERATURE SURVEY

Buari T.A et al. (2013) describe the Characteristics Strength of groundnut shell ash (GSA) and Ordinary Portland cement (OPC) blended Concrete in Nigeria as the Pozzolanic activity of GSA increases with increase of time. GSA is a good Pozzolanic material which reacts with calcium hydroxide forming calcium silicate hydrate. The specific gravity of the GSA gotten was less than that of the OPC it replaced, this means that a considerable greater volume of cementitious materials will result from mass replacement[1]. The compressive strength value of the GSA/OPC blended concrete at 10% replacement level performed better and would be acceptable and considered as a good development for construction of masonry walls and mass foundations in low-cost housing in Nigeria. And he found the Specific gravity of GSA is being 1.54.

B.H. Sada, Y.D. Amartey, S. Bako (2013) studied Investigation into the use of Groundnut shell as fine aggregate replacement**.** The suitability of groundnut shell as a constituent material in concrete was investigated by replacing proportions by volume of fine aggregate (river sand) with groundnut shells. Physical properties of cement, groundnut shells and aggregates were determined. Concrete cubes measuring 150x150x150mm were cast. Groundnut shells were used to replace fine aggregate at 0, 5, 15, 25, 50 and 75% replacement levels[2]. Increase in percentage of groundnut shells in the cubes led to a corresponding reduction in densities of the cubes and compressive strength values. At a replacement value of 25% and above, of fine aggregate with groundnut shells; lightweight concrete was produced which could be used where low stress is required. Hence groundnut shells can be used for the production of lightweight concrete.

S.B.Raheem, G.F.Oladiran, F.A.Olutoge and T.O.Odewumi (2013) reported Strength properties of groundnut shell ash (GSA) blended concrete, the experiments were designed to include two main mixes (with variations in the water/cement ratios) with different percentages by weight of OPC to GSA in the order of 100:0, 95:5, 90:10, 85:15 and 100:0, 90:10, 80:20 for mixes 1:2:4 and 1:2.3:2.6 respectively. For mix ratio 1:2:4, the highest compressive and tensile strengths were 24.06 (2.67) and 21.34 (2.11 N/mm2) at 28 days for 0 and 10% GSA respectively[3]. While mix ratio of 1:2.3:2.6 gave the highest compressive and tensile strengths of 35.11 (4.21) and 27.33 (4.01 N/mm2) at 28 days for 0 and 10% GSA respectively. It was observed that 10% GSA replacement was appropriate for both mixes. The specific gravity of the GSA gotten was less than that of the OPC it replaced, this means that a considerable greater volume of cementitious materials will result from mass replacement.

DR. F. A. Olutoge1 et al. (2013) describe the Characteristics Strength and Durability of Groundnut Shell Ash (GSA) Blended Cement Concrete in Sulphate Environments**.** From the result of the tests and analysis carried out, the following conclusions were drawn: The Groundnut Shell Ash blended cement concrete haven proven resistance to magnesium sulphate, sodium sulphate and calcium sulphate media and would perform better in soils containing these media (MgSO4, Na2SO4, CaSO4.)[4]. concrete as its Slump values decreases with increasing GSA replacement. The compressive strength value of the GSA/OPC blended concrete at 10% replacement level performed better and would be acceptable and considered as a good development for construction of masonry walls and mass foundations in any sulphate environment.

T.C. Nwofor and S. Sule (2012) found the stability of groundnut shell ash (GSA)/ordinary portland cement (OPC) concrete in Nigeria**,** the results show that the compressive strength value of the GSA/OPC concrete ranged from 29% at 40% replacement level to about 70% at 10% replacement level of the compressive strength of the control (0% GSA replacement) at the 28th day[5]. It can be concluded that a good tendency for pozzolanic activity especially for percentage replacement less than 10%. Base on previous research which is focused on looking for alternatives for OPC concrete, the GSA/OPC concrete is considered as a good development for construction of masonry walls and mass foundations.

M.A.Adole, W.E.Dzasu, A.Umar, and O.M.Oraegbune (2011) studied the effects of Groundnut Husk Ash-blended Cement on Chemical Resistance of Concrete, the principal characteristic measured was the compressive strength of Ordinary Portland Cement (OPC) concrete and OPC/GHA concrete after curing in three chemical solutions (MgSO4, NaCl and H2SO4) at 14, 21 and 28 days hydration periods[6]. The results revealed that the OPC/GHA concrete performed best in most of the chemical solutions at 28 days hydration period with compressive strength values of 21.05N/mm2 in MgSO4 solution and 22.55Nmm2 in NaCl solution.

B.A. Alabadan et al. (2006) estimates the Potentials of Groundnut ShellAsh as Concrete Admixture, Pozzolanic materials have long demonstrated their effectiveness in producing high-performance concrete. Artificial pozzolanas such as rice husk ash have gained acceptance as supplementary cementing materials in many parts of the world[7]. This work evaluates the potentials of groundnut shell ash (GSA) as a partial replacement for ordinary Portland cement (OPC) in concrete. Chemical analysis of the ash was carried out to ascertain whether it possesses pozzolanic or cementing properties and the partial replacement of OPC by GSA was varied from 0% to 70% in the concrete.

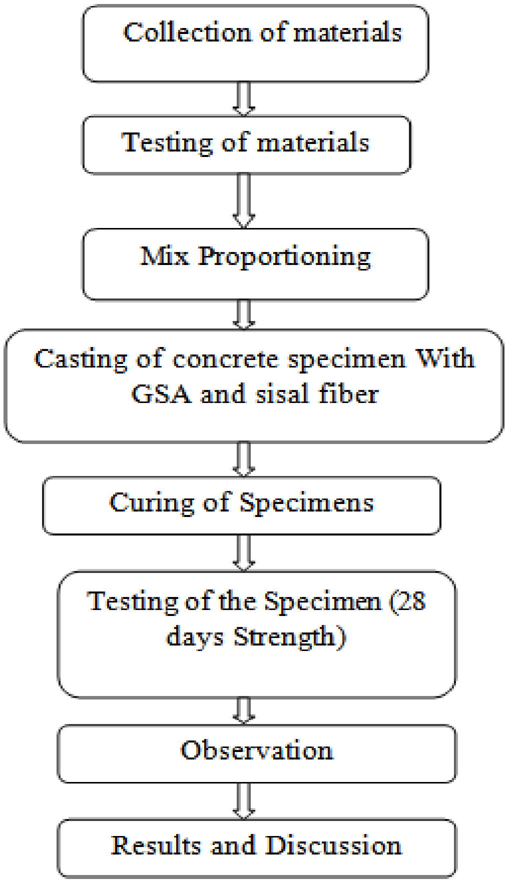
T.S.Ketkukah and E.E.Ndububa (2006) studied Groundnut Husk Ash as a partial replacement of cement in mortar. This paper examines some properties of Ordinary Portland Cement (OPC) and Groundnut Husk Ash (GHA) mortar. The GHA was used as a partial replacement of OPC. The replacement levels of 0%, 2%, 4%, 6%, 8% and 10% ash were used. The chemical analysis of the ash carried out ascertained its pozzolanic properties[8]. The initial and final setting times of the paste were 95 minutes and 11 hours respectively.The density and water absorption capacity of the mortar decreased as the percentage of ash increased. OPC/GHA mortar is recommended for production of sandcrete blocks in hot weather climate.

Prof. Yogesh Ravindra Suryawanshi, Mr. Jitendra D Dalvi (2013) reported the Study of Sisal Fibre as Concrete Reinforcement Material in Cement Based Composites, in last around 30 years, a great concern is created worldwide on the potential applications of natural fibre reinforced cement based composites[9]. Investigations have been carried out in many countries on various mechanical properties, physical performance and durability of cement based matrices reinforced with naturally occurring fibres including sisal, coconut, jute, bamboo and wood fibres.

J.B. Zhong, J. Lv, C. Wei (2007) studied the mechanical properties of sisal fibre reinforced urea-formaldehyde resin composites. Alkali-treated sisal fibres were used as novel reinforcement to obtain composites with self-synthesized urea-formaldehyde resin as matrix phase[10]. The composites were prepared by means of compression molding, and then the effects of sisal loading on mechanical properties such as impact strength, flexural strength, and wear resistance were investigated. In addition, water uptake was studied and structural features were revealed by the scanning electron microscopy (SEM).

III. METHODOLOGY

This chapter briefly explains the methodology adopted for this experimental work. In the first phase, the physical properties of ingredients of concrete have been found and also a mix design for concrete was calculated. Then the results of the preliminary test the entire all the specimens, moulds, concrete mixing, curing and testing are made in the future.



IV. MATERIALS USED IN CONCRETE

Cement concrete is the most widely used building material due to its satisfying performance in strength requirements and its ability to be molded into a variety of shapes and sizes. However, the durability aspects of concrete, including resistance to chemical attack (which results in volume change, cracking of concrete and the consequent deterioration of concrete) are matters of concern.

V.INGREDIENTS IN CONCRETE MIX

a) Cement Fine aggregate
b) Coarse aggregate
c) Water
d) Groundnut ash
e) Sisal fiber

A. CEMENT – OPC 43 grade

With the extensive use of cement, for widely varying conditions, the types of cement that could be made by the use of additives, changing chemical composition, and using different raw materials have resulted to the need of construction industries for specific purpose. These are all mainly classified into Portland and Non-Portland cements. Ordinary Portland cement was far most important type of cement. The OPC was classified into three grades namely 33 grade, 43 grade, 53 grade depending upon the strength of cement at 28 days when tested as per IS 4031-1988.

1) FUNCTION OF CEMENT

1) It fills up voids existing in the fiber aggregate and makes the concrete impermeable.
2) It provides strength to concrete on setting and hardening.
3) It binds the aggregate into a solid mass by virtue of its setting and hardening properties when mixed with concrete.

2) FINE AGGREGATE

Sand is a major component of concrete and without sand , concrete will not function as intended. Natural river sand was used as fine aggregate. The properties of sand were determined by conducting tests as per IS: 2386 (Part-I).

3) FUNCTION OF SAND

1) It fills the voids existing in the coarse aggregate.
2) It reduces shrinkage and cracking of concrete.
3) It helps in hardening of cement by allowing the water through its voids.

B. COURSE AGGREGATE

Aggregates are the most mined material in the world. Aggregates are a component of composite materials such as concrete and asphalt concrete; the aggregate serves as reinforcement to add strength to the overall composite material. Coarse aggregate of size 20mm is sieved and used. Generally crushed stone is only used as coarse aggregate.

C. WATER

The water is used in concrete plays an important role on mixing, laying, compaction, setting and hardening of concrete. The strength of concrete directly depends on the quality and quantity of water is used in the mix.

- Water is only the ingredient that reacts chemically with cement and thus setting and hardening takes place.

D. GROUNDNUT ASH

Groundnut shell used for this research was obtained from Groundnut mill. The shells was collected in bags and transported to site, where the burning and grinding were carried out. The ash was obtained by burning the groundnut shells on an iron sheet in the open air under normal temperature. Consequently, the ashes were collected in bags and were taken to the Concrete and Structural Laboratory of the Department of Building. The sieve analysis and the specific gravity were carried out on GSA at the Soil Mechanics Laboratory of the Department of Building. The ash are shown in fig 4.7

Fig.1: Groundnut ash

E. SISAL FIBRE

A great number of fiber plants are exploited for their ability to yield fibers directly from their wild or natural form, particularly in developing countries.

While a great number of species are employed in fiber production, relatively few species show high quality, good yield and hence are of commercial importance. Fibers of economic importance are members of various botanical families, the more exploited of which include sisal (Agave sisalana) belongs. Several varieties of sisal exist in different climatic conditions and with different morphological characteristics.

Generally, the fibers are used in the fabrication of cordage, strings, twines and ropes and the fibers of low-quality are used as fillings in furniture and in the manufacture of paper. Sisal is among the hard fibers of the World and represents around 70% of the World's market in fibers.

Sisal fiber reinforced concrete should be hand mixed. The influence of sisal fibers on the development of plastic shrinkage in the pre-hardened state, on tensile, compressive and bending strength in the hardened state of mortar mixes. The production of sisal fiber as compared with synthetic fibers or even with mineral asbestos fibers needs much less energy in addition to the ecological, social and economical benefits Sisal fiber is exceptionally durable and a low maintenance with minimal wear and tear. Its fiber is too tough for textiles and fabrics. It is not suitable for a smooth wall finish and also not recommended for wet areas. The fine texture of Sisal takes dyes easily and offers the largest range of dyed colors of all nature fibers.

Fig.2: Sisal fiber

VI. PROPERTIES OF SISAL FIBRES

- Sisal Fiber is exceptionally durable with a low maintenance with minimal wear and tear.
- It is Recyclable.
- Sisal fibers are obtained from the outer leaf skin, removing the inner pulp.
- It is available as plaid, herringbone and twill.
- Sisal fibers are Anti static, does not attract or trap dust particles and do not absorb moisture or water easily.
- The fine texture takes dyes easily and offers the largest range of dyed colors of all natural fibers.
- It exhibits good sound and impact absorbing properties.

CHEMICAL COMPOSITION OF SISAL FIBER

Sl.no	Chemical composition	Percentage
1	Cellulose	65%
2	Hemi cellulose	12%
3	Lignin	9.9%
4	Waxes	2%
	Total	100%

VII. MIX DESIGN

The process of selecting suitable of concrete and determining their relative amounts with the objective of producing a concrete of required strength, durability and workability as economically as possible is termed the concrete mix design. The proportioning of concrete is governed by the required performance of concrete in two states namely plastic and hardened state. From the technical point of view the rich mixes may lead to high shrinkage and cracking in the structural concrete and to evolution of high of hydration in mass concrete which may cause cracking.

A. REQUIREMENTS OF MIX DESIGN

For the design of concrete mix the following information is required.

- Grade of concrete
- Type of cement
- Minimum cement content
- Maximum water cement ratio
- Size of aggregate
- Type of admixture , if required
- Exposure condition
- Method of placing
- Degree of supervision

From the design mix prepare the quantity of materials whish was used in the project. For the replacement of cement GSA and Sisal fiber adding with the various %. GSA adding with the ratio of 5% to 20% and fiber adding in the ratio of 1% to 3%.

VIII. CUBE PREPARATION AND TESTING

Cube was prepared in the proposed mixing ratios. Finally have to compare the cube with conventional concrete cubes.

International Journal on Applications in Civil and Environmental Engineering
Volume 2: Issue 3: March 2016, pp 8-13. www.aetsjournal.com ISSN (Online) : 2395 –3837

Fig 3 : Image of wet mix of concrete.

Fig 4 :Image of dry mix of concrete.

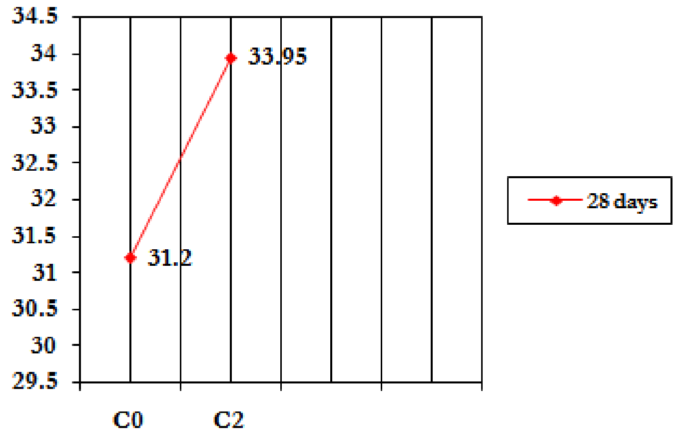
Fig 5 : Compression test on cube

COMPRESSIVE STRENGTH RESULTS

Specimen	GSA %	Sisal fiber%	Com. Strength (28 DAYS)
C0	-	-	31.20
C1	5	1	30.80
C2	5	2	33.95
C3	5	3	33.38
C4	10	1	30.57
C5	10	2	32.22
C6	10	3	29.20
C7	15	1	28.08
C8	15	2	26.75
C9	15	3	26.35
C10	20	1	24.08
C11	20	2	23.51
C12	20	3	22.97

COMPARATIVE STUDY

Specimen	GSA %	Sisal fiber%	Com. Strength(N/mm2)
C0	-	-	31.20
C2	5	2	33.95



FLEXURAL TEST ON BEAMS

From the result of compressive strength, flexural strength also determine for the comparative cube design mix.

FLEXURAL STRENGTH RESULTS

Specimen	Ultimate load(kN)	Flexural Strength(N/mm2) (28 days)
S0 (Conventional)	44.2	18.72
S1 (5%GSA &2%SF)	48.3	20.46

IX. CONCLUSION

The following are the conclusion obtained from the present study, it was seen that the value of cement material and their properties, fine aggregate properties, coarse aggregate properties and replacing material properties were studied. The replacing material properties are 70% satisfy the main materials which used to make the concrete.

From the comparative study 5% of GSA and 2% of sisal will satisfy the requirements. This was used in light loaded building construction.

- A detailed study of literature review had done by referring journals
- Collection of material regarding the availability condition.
- Testing was conducted all the materials.
- Designing the concrete mix.
- Cube & beam preparation and testing.
- Compare the results.

REFERENCES

[1] Buari T.A., Ademola S.A., Ayegbokiki S.T. (2013), “Characteristics Strength of groundnut shell ash (GSA) and Ordinary Portland cement (OPC) blended Concrete in Nigeria”, IOSR Journal of Engineering, Department of Building Technology, vol.3, pp. 01-07.

[2] Sada B.H., Amartey Y.D., Bako S. (2013), “An investigation into the use of Groundnut shell as fine aggregate replacement”, Nigerian Journal of Technology, Vol. 32, pp. 54–60.

[3] Raheem S.B., Oladiran G.F., Olutoge F.A and Odewumi T.O. (2013), “Strength properties of groundnut shell ash (GSA) blended concrete”, Journal of Civil Engineering and Construction Technology, vol.4, pp. 275-284.

[4] Olutoge F. A., Buari T.A. and Adeleke J.S. (2013), “Characteristics Strength and Durability of Groundnut Shell Ash (GSA) Blended Cement Concrete in Sulphate Environments”, International Journal of Scientific & Engineering Research, Vol.4.

[5] Nwofor T.C. and Sule S.(2012), “Stability of groundnut shell ash (GSA)/ordinary portland cement (OPC) concrete in Nigeria”, Pelagia Research Library, Advances in Applied Science Research,vol.3, pp. 2283-2287.

[6] Adole M.A., Dzasu W.E., Umar A. and Oraegbune O.M. (2011), “Effects of Groundnut Husk Ash-blended Cement on Chemical Resistance of Concrete”, ATBU Journal of Environmental Technology, vol.4, pp. 23-32.

[7] Alabadan B.A., Njoku C.F. and Yusuf M.O. (2006), “The Potentials of Groundnut Shell Ash as Concrete Admixture”, Agricultural Engineering International: the CIGR E journal, Vol.8.

[8] Ketkukah T.S. and Ndububa E.E. (2006), “Groundnut Husk Ash as a partial replacement of cement in mortar”, Nigerian Journal of Technology, Vol. 25, pp. 84-90.

[9] Aruna M. (2014), “Mechanical Behaviour of Sisal Fibre Reinforced Cement Composites”, International Journal of Mechanical, Aerospace, Industrial and Mechatronics Engineering Vol.8, pp. 84-87.

[10] Prof. Yogesh Ravindra Suryawanshi and Mr. Jitendra D Dalvi (2013), “Study of Sisal Fibre as Concrete Reinforcement Material in Cement Based Composites”, International Journal of Engineering Research & Technology, vol.2, pp. 1-4.