Development of Sustainable Concrete By Replacing Coarse Aggregate And Cement By Palm Kernel Shell And Palm Oil Fuel Ash in Concrete

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Abstract- *The consumption of agricultural and industrial wastes has grown rapidly across the world which leads to create large quantities of wastes. It reflects the problem of having a limited number of landfills due to a huge amount of waste produced. Therefore, the solution is recycling the agricultural and industrial wastes as one of the materials use in concrete. One of these important biogenic waste is the palm oil fuel ash (POFA) - generated as by-product from palm oil mills. The production of POFA increases every year, it is disposed for landfills without any return value and now becomes a burden. It contains a non-crystalline silicon dioxide with high specific surface area and high pozzolanic reactivity. Reducing the use of cement which is one of the major production of Carbon Dioxide (CO2) gas emissions. This study was conducted to determine the properties of concrete in fresh and hardened state incorporating POFA and granular palm kernel shells. This project presents the results of an investigation carried out on the strength characteristics of concrete produced using crushed, granular palm kernel shells as substitutes for conventional coarse aggregate and palm oil fuel ash a cement in gradation. The cubes of size 150*150*150 mm are to be casted, tested and their physical and mechanical properties will be determined. The project aims to show that palm kernel shell aggregate is a potential construction material and simultaneously reduces the environment problem. The main objective is to encourage the use of these "seemingly" waste products as construction materials in low-cost housing. Considering the strength/economy ratio, the palm kernel shells and palm oil fuel ash is utilized as good substitutes for conventional aggregates and cement in concrete production respectively.*

Keywords- Carbon Dioxide (CO2) gas emissions, palm oil fuel ash (POFA),Granular palm kernel shells, Compressive strength, split tensile strength test.

I. INTRODUCTION

Cement is the most important ingredient of the concrete which produces carbon dioxide which is May harmful. So it is a main concern to reduce the usage of cement. Creation of cement isn't just making ecological contamination moreover that the creation of cement requires tremendous measure of crude materials. Because of the overabundance utilization of crude materials they may confront a risk of getting removed in the close by future.

Concrete is the most widely used man-made construction materials in the world. Slightly more than a ton of concrete is produced each year for every human being on the planet. Fundamentally, concrete is economical, strong, and durable. Although concrete technology across the industry continues to rise to the demands of a changing market place. The construction industry recognizes that considerable improvements are essential in productivity, product performance, energy efficiency and environmental performance. The industry will need to face and overcome a number of institutional competitive and technical challenges. One of the major challenges with the environmental awareness and scarcity of space for land-filling is the wastes/byproducts utilization as an alternative to disposal. Throughout the industrial sector, including the concrete industry, the cost of environmental compliance is high. Use of industrial by-products such as foundry sand, fly ash, bottom ash and slag can result in significant improvements in overall industry energy efficiency and environmental performance.

The consumption of all type of aggregates has been increasing in recent years in most countries at a rate far exceeding that suggested by the growth rate of their economy or of their construction industries. Artificially manufactured aggregates are more expensive to produce, and the available source of natural aggregates may be at a considerable distance from the point of use, in which case, the cost of transporting is a disadvantage. The other factors to be considered are the continued and expanding extraction of natural aggregates accompanied by serious environmental problems. Often it leads to irremediable deterioration of the country side. Quarrying of aggregates leads to disturbed surface area etc., but the aggregates from industrial wastes are not only adding

extra aggregate sources to the natural and artificial aggregate but also prevent environmental pollution.

Foundry industry produces a large amount of by-product material during casting process. The ferrous metal casts in foundry are cast iron and steel, non ferrous metal are aluminum, copper, brass and bronze.

OBJECTIVES OF PARTIAL REPLACEMENT OF CEMENT IN CONCRETE

The primary reasons for the development of concrete that uses palm oil ash as a partial replacement for cement are as follows

- To ensure that natural resources such as lime stone, coal, fuel, and gypsum are preserved for future generations.
- For the safe and efficient disposal of palm kernal shell ash and palm kernal shells.
- The use of palm kernal shell ash as a partial replacement for cements and palm kernal shells as a partial replacement for coarse aggregate in concrete is cost-effective and environmentally sustainable.
- The concrete with mineral admixtures provides lower permeability and reduces heat of hydration, making it more durable.

II. REVIEW OF LITERATURE

In the present construction world, the solid waste is increasing day by day from the demolitions of constructions. There are some researchers are also going on solid waste from construction to reuse them again in the construction to reduce the solid waste and to preserve the natural basic aggregates. These researches promotes to use the recycled aggregates in the concrete mix and they got good result when adding some extent percentages of recycled aggregates in place of natural coarse aggregate.

This research is supported with the related reading material previous research about the palm oil fuel ash and shells material which had been done as the references to describe more and explain the characteristic and application of waste ash as partial replacement in the concrete production. So far the reutilization of palm kernal shell and has been practiced, but the amount of wastes reused in that way is still negligible. Hence, the need for its application in other industries is becoming absolutely very useful for getting benefit. Construction industry can be the end user of all tile wastes and in the same way can contribute Green building practices.

Falade (1995) also carried out investigation on the use of periwinkle shells partially or wholly in concrete. The results of the investigation showed that the workability of the concrete batches, density, compressive and flexural strengths of specimens tested decreased with increase in the proportion of periwinkle shells to granite in the mixes.

Celik et al. (1996), Sahu et al. (2003), Tripathy and Barai (2006) and Shi -cong et al (2009) have reported the use of stone dust (SD) as partial replacement of fine aggregate.

Falade et al (2010) investigate the behavior of lightweight concrete containing periwinkle shells at elevated temperature; the parameters that were measured are compressive strength, density and bond characteristics of the concrete matrix. The results showed that the compressive strength of concrete decreased with increase in water/cement ratio and temperature but increased with increase in curing age and cement content while the density decreased with increase in temperature. They affirm that lightweight concrete containing periwinkle shells is only suitable for structures that will be subjected to temperature less than 300°C.

Deb, P. S., Nath, P., & Sarker, P. K. (2014): Ground granulated blast furnace slag (GGBS) with mixture of flyash content showing huge improve in the consequences of workability and high strength contrasted with Ordinary Portland Cement (OPC). By changing dissimilar (0%,10% and 20%)contents of Ground granulated blast furnace slag (GGBS) with various proportions of flayash content showing a few blemishes, One of them is with increment in GGBS content workability is diminishing simultaneously strength is expanding. By keeping up silicates to alkaline proportions of 1.5 to 2.5 and following ACI 318 and AS 3600 codes for curing we can accomplish above outcomes when contrasted with OPC.

Rao, G. M., and Rao, T. G. (2015): He proposed the method of replacement cementitious materials with pozolonic fly ash materials and alkaline solutions of sodium meta silicate, sodium hydroxide with various molarities of (8,12,16 M). At long last he reasoned that for the proposed configuration mix of geopolymer concrete the proportion of sodium silicate to sodium hydroxide is 2.5 and by utilizing above pozolonic materials and alkaline solutions he accomplished the decline in definite setting time and expanded compressive strength.

MallikarjunaRao, G., &GunneswaraRao, T. D. (2018): In this paper a broad research was done to discover the plan mix and routine properties of geopolymer concrete. Mr. MallikarjunaRao got ideal outcomes with 30% replacement of

GGBS with fly ash. Proportion between alkaline solution and binder of 0.5 invigorated better workability and compressive. He got effective to take out broiler curing and supplanted it with encompassing curing interaction to try not to cure issues related with it by supplanting GGBS in the spot of fly ash. It is seen that GGBS and fly ash based geopolymer concrete is giving preferred outcomes over fly ash based geopolymer concrete. Various molarities were tried and best economic molar focus is discovered alongside strength and workability.

Hadi, M. N., Zhang, H., & Parkinson, S. (2019): In this paper he compared the result of OPC paste vs proposed geopolymer concrete mix. In suggested mix he used ground granulated blast furnace slag (GGBFS) and Class F fly ash (FA) as silicate fount and Instead of using W/C ratio he used , sodium silicate solution to sodium hydroxide solution SS/SH, Aw/Bi ratio & alkaline solution to binder (Al/Bi) ratio in his proposed mix. Finally he concluded that at given alkaline solution to binder (Al/Bi) ratio of 0.5, sodium silicate solution to sodium hydroxide solution (SS/SH) ratio of 2, Aw/Bi of 0.15 & 40% GGBS proposed geopolymer paste given better results in respect of compressive strength, Slump test & setting time.

Atuluniyal, Karan Singh (2019) describes the purpose of this paper is to investigate waste and provide a solution to what has become the world's most severe problem today. Nowadays, waste utilization has become a popular alternative to waste disposal. There have been numerous studies on the use of trash in industry, with the majority of them focusing on the use of waste in building or the use of garbage in concrete to generate new types of concrete. The use of waste production is not only cost-effective, but also a very good and appealing solution to the problem of garbage disposal. By replacing cement with ceramic waste from the ceramic industry, a new type of concrete is created. According to a statistic from India, waste accounts for 30% of daily production throughout manufacturing, usage, and transportation. Because of its widespread use in building, ceramic waste is growing by the day. As a result, recycling, reusing, and substituting concrete elements are important for the ceramic sector in order to reduce waste dump. Ceramic waste from industry is long-lasting, robust, and resistant to biological, chemical, and physical forces of deterioration. Without impacting the strength of the concrete, ceramic waste powder can be used to make lightweight concrete. The application of an optimal dosage of ceramic tile powder increased the concrete's compressive strength.

The purpose of this study was to acquire the results of a test on a tile powder modified cement concrete mix in order to determine the impact of tile powder on the characteristic strength of concrete.

1. The best dosage for using ceramic tile powder as a partial replacement for cement is 15%.
2. When more than 15% of dose is added to concrete, the compressive strength of the concrete is reduced. The findings indicate how 20 percent cement replacement with ceramic tile powder affects concrete strength.
3. By completing this project, we will be able to contribute to society by making the environment eco-friendlier by scientifically utilizing ceramic waste. As a result, we can overcome issues such as trash disposal crises by using the replacement technique.
4. The most efficient method for addressing the high value use of such waste is the utilization of tile powder and its application for the sustainable development of the construction sector.

III. MATERIALS AND METHODS

The experimental investigation work is started with various tests on the constituent materials. The constituent materials are given below.

1. Cement
2. Fine aggregate
3. Coarse aggregate
4. Water
5. Palm oil fuel ash
6. Palm kernal shell

I. Cement

Ordinary Portland Cement (OPC) was used in the experimental work which is conforming to I.S 4031-1988.The O.P.C is classified into three grades, those are 33grade, 43grade and 53 grade, depending upon the strength of the cement in this experiment 43grade cement is used.

II. Fine Aggregate

Fractions from 4.75 mm to 150 microns are termed as fine aggregate. Locally available river sand passed through 4.75mm IS sieve is applied as fine aggregate conforming to the requirements of IS 383:1970.

III. Coarse Aggregate

The crushed aggregates used were of 20mm nominal maximum size. Aggregate most of which is retained on 4.75-

mmIS Sieve and containing only so much finer material as is permitted for the various types described in this standard.

IV. Palm oil fuel ash

Palm kernel shells are not common materials in the construction industry. This is either because they are not available in very large quantities as sand or gravel, or because their use for such has not been encouraged. For some time now, the Nigerian government has been clamoring for the use of local materials in the construction industry to limit costs of construction and it was obtained from Ruchi industries samarlakota.

V. Palm kernal shell

Palm kernel shell is a waste product of the palm mill industry; this industry extracts oil from oil palms fruits. The palm kernel shell used in this current work was supplied by a local contractor. Palm kernel shell are hard, flaky and of irregular shape. The most important aspects of using palm kernel shell as aggregate replacement was to ensure that the palm kernel shells are properly prepared. This is of extreme importance during the mixing of material for the various mixes and it was obtained from Ruchi industries samarlakota.

IV. MIX DESIGN

The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required, strength, durability, and workability as economically as possible, is termed the concrete mix design. M20 grade of concrete is used for the present study.

V. TESTS ON FRESH CONCRETE

5.1 WORKABILITY OF CONCRETE

The vertical settlement of unsupported fresh concrete, flowing to the sides and sinking in height is known as slump. Slump is a measure indicating the consistency or workability of cement concrete. It gives an idea of water content needed for concrete to be used for different works. A concrete is said to be workable if it can be easily mixed, placed, compacted and finished. A workable concrete should not show any segregation or bleeding.

TABLE 5.1 shows the Variation of Slump Values

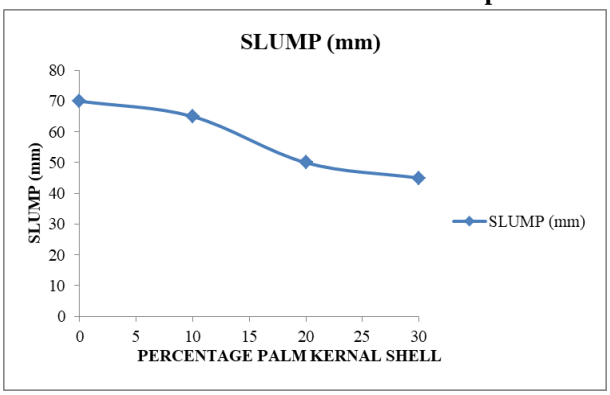

Fig 5.1 shows the slump values with different percentages of palm kernal shell

VI. TESTS ON HARDENED CONCRETE

6.1 EFFECT OF % PALM KERNEL SHELL (PKS) AS REPLACEMENT ON THE COMPRESSIVE STRENGTH CHARACTERISTICS OF CONCRETE

The individual influence of Palm Kernel Shell (PKS) on the Compressive Strength of Concrete is indicated in the below tables and figures. The percentage of Palm Kernel Shell (PKS) was varied from 0% to 30% with an increment of 10% in coarse aggregate.

Table 5.2: shows the compressive Strength Results for the different percentages of palm kernel shell

Cement+Fineaggregate+	CompressiveStrength(MPa)		
CoarseAggregate+PalmKernelShell	7days	14days	28days
100%+0%	18.43	23.60	28.40
90%+10%	17.05	21.40	22.38
80%+20%	15.80	19.15	20.06
70%+30%	12.64	16.47	18.01

From Fig, it was observed that there is an decrease of 7.48%, 14.27%, 31.41% in 7- days Compressive strength of mix with 10% PKS, 20%PKS and 30% PKS when compared to that of the control specimen .

It was observed that there is a decrease of 9.32%, 18.85%, 30.21% in 14- days Compressive strength of mix with 10% PKS, 20%PKS and 30% PKS when compared to that of the control specimen.

It was observed that there is a decrease of 21.19%, 29.3%, 36.58% in 28- days Compressive strength of mix with

10% PKS, 20%PKS and 30% PKS when compared to that of the control specimen.

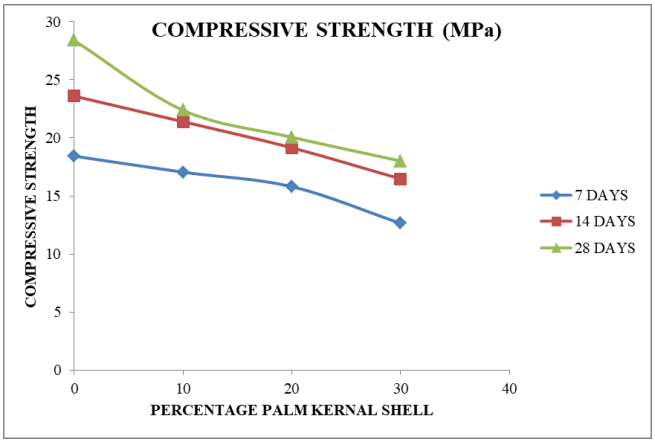

Fig shows Compressive Strength Results with Palm kernel shell replacement in coarse aggregate

EFFECT OF PALM KERNEL SHELL ON THE DENSITIES OF CONCRETE MIXES

The variation of the density of the concrete with palm kernel shell of different mixes used in our study is tabulated in Table 5.6.The replacement of coarse aggregate of equal weight of palm kernel shells leads to the introduction of more palm kernel shells in the mix and this leads to an increase in volume without increase in weight which reduces the density since coarse aggregate is heavier than palm kernel shell.

From figure, it was observed that there is a decrease of 3.94%, 9.54%, 12.11% in density of mix with 10% PKS, 20%PKS and 30% PKS when compared to that of the control specimen.

It was observed that there is a decrease of 5.63%, 10.02%, 16% in 14-day density of mix with 10% PKS, 20%PKS and 30% PKS when compared to that of the control specimen.

It was observed that there is a decrease of 7.98%, 10.67%, 16.80% in 28-day density of mix with 10% PKS, 20%PKS and 30% PKS when compared to that of the control specimen.

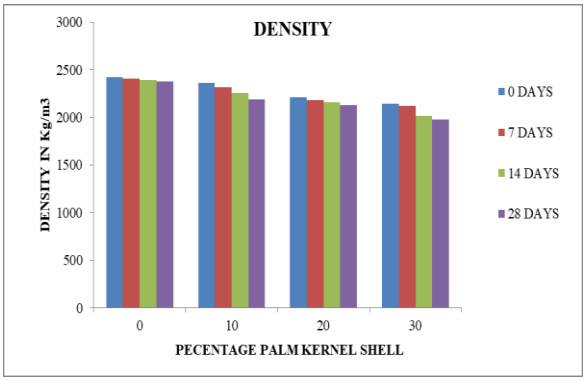

Figure shows the Variation of Density Values with percentage of palm kernel shell in coarse aggregate

EFFECT OF PALM KERNEL SHELL ASH ON THE COMPRESSIVE STRENGTH CHARACTERISTICS OF CONCRETE + PALM KERNEL SHELL (PKS) MIXES

The influence of Palm Kernel Shell ash as a binder with cement on the Compressive Strength characteristics of Concrete + Palm Kernel Shell (PKS) mixes are presented in Figures for different percentages of Palm Kernel Shell ash. The percentage of Palm Kernel Shell ash was varied from 0% to 15% with an increment of 5%.

Table shows compressive Strength Results for the different percentages of palm kernel ash

Cement + PalmKernel Shell Ash	7days	14days	28days
100%+0%	15.80	19.15	20.06
95%+5%	17.35	20.90	21.64
90%+10%	18.10	23.06	27.85
85%+15%	17.25	20.18	20.55

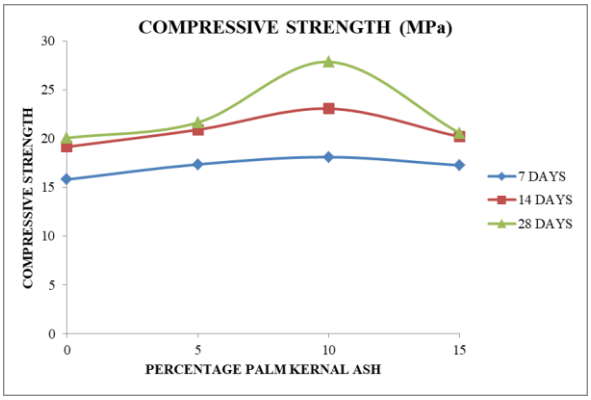

Figure shows the Variation of Compressive Strength Results with palm kernel shell ash as a replacement in cement with optimum mix

From Fig, it was observed that there is an increase of 9.81%, 14.55%, and 9.17% in 7- day Compressive Strength of mix with 5% PKSA, 10% PKSA and 15% PKSA when compared to that of the optimum mix. There was an increase in the 7- day Compressive Strength till 10%PKSA and decreased further.

It was observed that there is an increase of 17.15%, 38.83%, and 3.10% in 28- day Compressive Strength of mix with 5% PKSA, 10% PKSA and 15% PKSA when compared to that of the optimum mix. There was an increase in the 28-day Compressive Strength till 10%PKSA and decreased further.

It was observed that there is an increase of 17.15%, 38.83%, and 3.10% in 28- day Compressive Strength of mix with 5% PKSA, 10% PKSA and 15% PKSA when compared to that of the optimum mix. There was an increase in the 28-day Compressive Strength till 10%PKSA and decreased further.

EFFECT OF PALM KERNEL SHELL ASH ON THE SPLIT TENISLE STRENGTH CHARACTERISTICS OF CONCRETE + PALM KERNEL SHELL (PKS) MIXES

The influence of Palm Kernel Shell ash as a binder with cement on the Split tensile Strength characteristics of Concrete + Palm Kernel Shell (PKS) mixes are presented in Figures for different percentages of Palm Kernel Shell ash. The percentage of Palm Kernel Shell ash was varied from 0% to 15% with an increment of 5%.

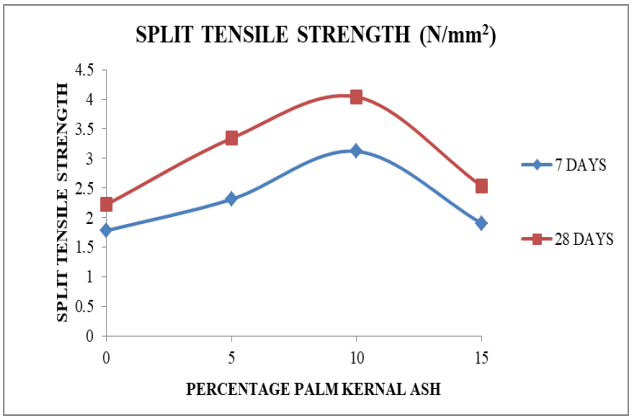

Fig shows the variation in split tensile strength for percentage replacement of palm kernel ash

VII. CONCLUSIONS

After completion of total experimental methodology, from the above investigations and from the test results some variations observed in workability and in compressive strengths of different concrete mixes having different percentages of replacing materials (palm kernel shells in place of coarse aggregate and palm kernel shell ash in place of cement) as mentioned below.

- After performing workability test observed that, when increasing percentage of palm kernel shell in concrete leads to the decrease in workability of the concrete.
- It was observed that the compressive strength increased with increase of palm kernel shell and attained the characteristic strength at 20%. So, it is considered ass optimum mix.
- The density of the mix decreased with the partial replacement of coarse aggregate with palm kernel shell.
- The density of the mix decreased with the increase in the curing period.
- It was observed that the 28 days compressive strength increased by 7.87% in the case of optimum mix with 5% palm kernel shell ash ,when compared to the optimum mix.
- It was observed that the 28 days compressive strength increased by 38.83% in the case of optimum mix with 10% palm kernel shell ash ,when compared to the optimum mix.
- The cylinder strength results of concrete mix are also observed and it shows that the tensile strength increases as compared to control mix as the percentage of palm oil ash is increased up to 10% and it was increased about 45%.
- So, feasible usage of waste palm kernel shell and palm kernel shell ash powder in replacement to coarse aggregate and cement is 20% and 10% respectively.

Finally it is concluded that Replacement of palm kernel shell and addition of palm kernel shell ash powder shown promising influence on the strength parameters and there by waste can be recycled.

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