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Experimental Investigation On Lightweight Concrete Containing Oil Palm Kernel Shell As Replacement Of Coarse Aggregate And Binding Material With Flyash

1 Ms. D. PAVANI, **2** N.V. N RAVALI, **3** M. PHANINDRA

1ASSISTANT PROFESSOR, 2ASSISTANT PROFESSOR, 3 PG STUDENT
Dept of CIVIL ENGINEERING
CMR COLLEGE OF ENGINEERING & TECHNOLOGY, HYDERABAD
1 dakipavani@cmrcet.ac.in 2 nvnravali@cmrcet.ac.in, 3 mokaphani@gmail.com

ABSTRACT

Sanctuary is a basic human need. Alas, adequate shelter for the majority; the destitute has remained elusive over time. The expense of concrete materials in construction and civil engineering projects has been a source of worry for the public. As a result of these and other factors, study has been conducted on genetic local resources that are thrown as trash into our environment, creating contamination and traffic clogging as alternative materials. As a result, this study was conducted in order to gauge the usage of palm kernel shell as a partial substitute for coarse aggregate in concrete. Oil palm kernel shell (OPKS) is a bio solid waste from the palm oil industry in tropical regions that may be utilised as a concrete aggregate. Since 1984, OPKS has been used in research projects to make lightweight concrete as a natural lightweight aggregate (LWC). The fresh, mechanical, and bond characteristics of grade M30 lightweight concrete, specifically oil palm kernel shell concrete (OPKSC), are compared to similar strength normal weight concrete (NWC). The OPKSC has utilised oil palm kernel shell (OPKS), an industrial waste, into lightweight aggregates (LWA). A constant 5 percent flyash was used as a preferential replacement of binding material for every combination of mix proportions of 10 percentage, 20 percentage, 30 percentage, and 40 percentage oil palm kernel shell partial substitute of course aggregate. When compared to NWC, the OPKSC produced a density drop of around 20%.

INTRODUCTION

Albeit concrete is the most generally utilized structure material on the planet today, the significant expense of substantial components like concrete, fine and coarse total has provoked the mission for elective structure materials. It is difficult to exaggerate the significance of cement in development projects and common works. The enormous interest for concrete in development, which utilizes typical weight totals (NWAs) like rock and sand, has brought about a huge exhaustion of normally happening totals, making irreversible ecological damage. A large number of them can be utilized as lightweight total (LWA) to make light weight concrete, which enjoys the benefit of bringing down oneself load of substantial designs when contrasted with regular cement, which has a high dead burden. They can likewise be utilized for underlying strength, flexibility, and financial feasibility. As a result, integrating these waste elements will assist to minimise the pace of non-renewable natural resource exploitation and create more durable concrete. Lightweight aggregates made from wastes such as expanded pelletized fly ash aggregates, sintered fly ash aggregates, expanded slag gravel, and blast furnace slag are manufactured and used. In reality, waste utilisation has been shown to be successful in industrialised countries. Modern design methods in industrialised nations tell volumes about the level of competence in terms of knowledge, research, and experience available. As a result, the creation of new types of lightweight aggregates on a wide scale is quicker. There has been increased awareness of the use of agricultural and industrial wastes as possible construction materials, particularly in agro-based developing nations like India. As a sustainable alternative, industrial wastes may be used to make environmentally friendly concrete.

LITERATURE REVIEW:

1. U. Johnson Alengaram in his study Impact of cementitious materials and total substance on Palm shell concrete expressed that The impact of cementitious materials, fine and coarse total substance on functionality and compressive strength of palm portion shell concrete. cementitious material was added 10% silica rage as extra cementitious material.
2. Payam Shafigh stated that Oil palm shell (OPS) is a type of horticultural strong waste in the tropical systems. Examination throughout the most recent twenty years shows that OPS can be utilized as a lightweight total for creating underlying lightweight total cement. The thickness of OPS concrete is around 20 - 25% lower than ordinary weight concrete.
3. Johnson Alengaram mentioned that the physical and mechanical properties of OPKS are summed up alongside mechanical, strength and utilitarian properties and underlying conduct of OPKS concrete (OPKSC) in his work Utilization of oil palm part shell as lightweight total in concrete – A survey.
4. MuhammadAslam discussed that OPBC lightweight total produces underlying lightweight cement. OPBC total has great holding strength with mortar because of its surface. OPBC RC radiates have comparable shear and disappointment conduct to the traditional RC radiates in his work Oil-palm side-effects as lightweight total in substantial combination.

Methodology

Theproject is accomplishedbyundertakingthe methodology as shownbelow and the various material process are detailed in this chapter.

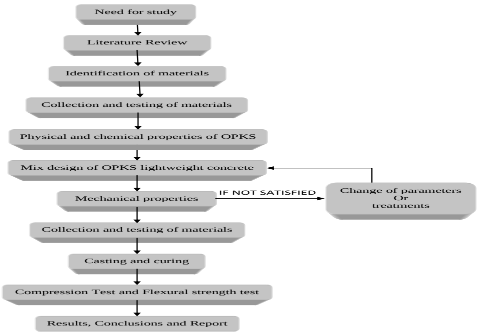


Fig 1 Methodology Flow Chart

OBJECTIVES

- To determine the characteristics of Oil Palm Kernel Shells as fractional replacement of coarse aggregate with and alternative replacement of binding material with Fly Ash to produce low density concrete.
- To study the feasibility of using OPKS as coarse aggregate in concrete to make lightweight concrete.
- To reduce the water absorption rate of OPKS aggregate and thereby analyse the alkali-silicate reaction in OPKS concrete.
- To study the mechanical properties of OPKS concrete.

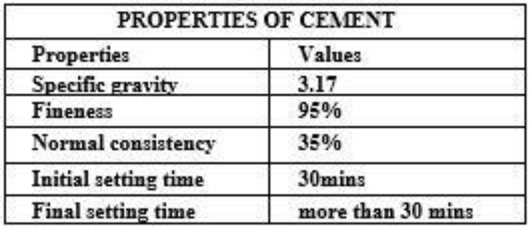
MATERIALS USED:

The materials used usually need to be placed in dry environment and air dry naturally. The detailed description of each material that were required for this study is discussed below:

Cement

The cement utilized in the examination is ordinary Portland cement of 53 grades provided from Ultra Tech concrete industrial facility.

Table 1 Properties of cement



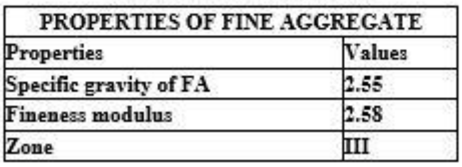
PROPERTIES OF CEMENT	
Properties	Values
Specific gravity	3.17
Fineness	95%
Normal consistency	35%
Initial setting time	30mins
Final setting time	more than 30 mins

Fig 2 Cement

Fine Aggregate

It represents 60-80 percentage of capacity and 70-80 percentage of the heaviness of cement and characterizes concrete dimensional security. The actual properties of soil are arranged in table 2.

Table 2 Properties of Sand



PROPERTIES OF FINE AGGREGATE	
Properties	Values
Specific gravity of FA	2.55
Fineness modulus	2.58
Zone	III

The sieve analysis table & graph of fineaggregate is given in Table 3 & Fig. 7

FinenessModulus FM =∑F/100

=258/100

= 2.58

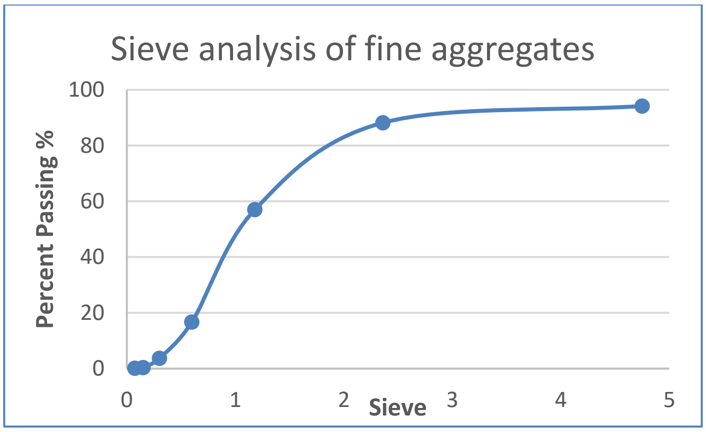
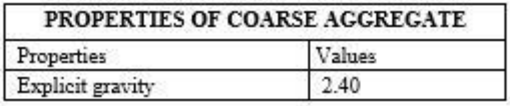


Fig 3 Sieve analysis of fine aggregates

CoarseAggregate

Properties of totals to a great extent affect the strength, toughness, usefulness and economy of cement. The actual properties of soil are classified in table3Table Properties of coarse aggregate

Table 3 Table Properties of Coarse Aggregate



PROPERTIES OF COARSE AGGREGATE	
Properties	Values
Explicit gravity	2.40

Oil PalmKernelShell

Oil Palm portion shells (OPKS) otherwise called Oil Palm Shells (OPKS), are the side-effect of palm oil and palm bit oil creation and are parts of shells that outcome from the separating of the nuts. OPKS is obtained as crushed pieces, the sizes of which vary from fine aggregates to coarse aggregates, after the crushing of palm kernel to remove the seed, which is utilized in the creation of palm kernel oil (Olutoge, 2010). Oil Palm kernel shells are tough, flaky and of irregular shape (Oti and Kinuthia, 2015). There is no specific type of structure that can be used to refer to the palm kernel shell. The structure depends on the precedent of breaking during the nut cracking. It is usually composed of many shapes among which are roughly parabolical or quasi-circular shapes, flaky shapes and other irregular shapes (Okafor, 1988). OPKS are solid in nature and do not deteriorate easily when used for concrete and therefore, do not dirty or leach to produce poisonous substances

(Basri et al., 1999). OPKS may consists of about 65 to 70 percentage of medium size particles in the range of 5 to 10 mm based on the method of cracking the nut (Alengaram et al., 2010).

Fig 4 : Crushed oil palm kernel shells of different sizes

OPKS physical and mechanical properties make it suitable for so many applications. It can be utilized as an aggregate for concrete creation (Okafor, 1988; Okpala, 1990; Osei and Jackson, 2012). Okoroigwe et al. (2014) used OPKS as a sorbent material for industrial water treatment and stated that the physical and chemical properties of the material make it suitable for the purpose. OPKS can also be used in road construction. However, for heavily trafficked roads, OPKS replacement for aggregate of stone dust and bitumen in 10% blend with asphalt is recommended (Ndoke, 2006). OPKS is also used in the preparation of pozzolana, a cement substitute material that has been developed by the Kwame Nkrumah University of Science and Technology, Kumasi, Ghana (FAO Rome, 2002). Also, Oti and Kinuthia (2015) used OPKS ash to produce concrete and stated that the potential to replace up to 509a Portland cement with OPKS ash burnt at oven temperature of 750°C is more feasible. Also, a recent study has shown that OPKS can be used as a partial replacement for sand in sandcrete block production. Blocksproduced from OPKS aggregates are heavier, denser and stronger than the traditional sandcrete blocks when the OPKS aggregate content do not exceed 109c (Dadzie and Yankah, 2015).

Physical properties for treated OPKS.

Greatest grain size of OPKS total utilized in present examination is 12 mm though Malaysian OPKS has 13 mm. Mass thickness of OPKS total is 350–480 kg/m3 and this is the justification lower thickness of cement. Water ingestion of OPKS utilized in this examination and Malaysian OPKS are comparable. Thickness of OPKS utilized in this exploration is 3 mm while Malaysian OPKS goes from 0.3 to 8 mm. Flakiness record and prolongation list are comparable for OPKS totals utilized in this examination and Malaysian OPKS however higher than regular totals.

Oil PalmKernelShellConcrete

Oil Palm Kernel Shell concrete (OPKSC) is a concrete produce by substituting coarse aggregate partially with OPKS. Depending on the mix design, it can be classified as either Structural Light-Weight Concrete (SLWC) or an Insulating Lightweight Concrete when the 28-day compressive strength is below 17 MPa. According to the American Concrete Institute (ACI), Structural Light Weight Concrete is pigeon-holed as a substantial thru with low thickness total that has an air-parched thickness of not in excess of 115 lb/ft" (1840 kg/m") and a 28-day compressive strength of in excess of 2,500 psi/17 MPa (ACI 1 l6R, 2000).BS 5328 (1997) defined SLWC as hardened concrete having an oven dried density not greater than 2000 kg/m3. Okafor (1988) suggested that the use OPKS as a full replacement of coarse aggregate can’t make concrete with compressive strength above 30 MPa and that OPKS is suitable for concrete grade 25 and below compared to conventional coarse aggregates. Be that as it may, in last exploration, Alengaram et al. (2010) expanded the 28-days compressive solidarity to 36-38 MPa by fusing silica smolder while Shafigh et al. (2011) fostered another strategy to deliver high strength OPKS cement of 28-days compressive strength of 53MPa by utilizing squashed OPKS. Osei and Jackson (2012), examined OPKS as Coarse Aggregates in Concrete and discovered the likelihood to supplant coarse total up to 100% however suggested that clustering by volume ought to be utilized for better outcomes.The mechanical and underlying properties of OPKSC have been contrasted and ordinary weight concrete (NWC) by numerous scientists to show the viability of OPKSC (Alengaram et al., 2013).

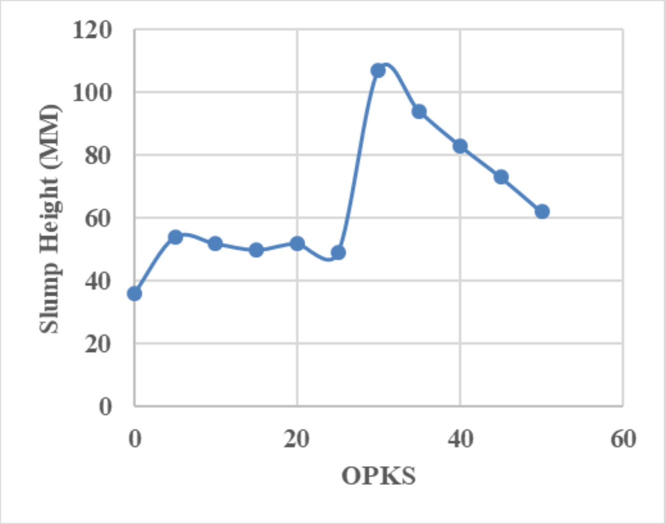
Physicalpropertiesof oil palmkernelshellconcrete

Physical properties of NWC are the same for OPKSC. Main physical properties of concern for OPKSC include those of workability, density, and water absorption of the concrete.

WorkabilityofPalmKernelShellConcrete

The most important property of fresh concrete is its workability defined as the ease with which concrete is mixed, transported, placed, compacted, and finished without segregation. Slump test is a standard test for determining the workability of concrete. It is used to calculate the variation in the uniformity of mix of a given proportion and to measure the consistency of the concrete. Workability of OPKSC is dependent on the water to cement ratio and the content of OPKS. As can be seen in Graph 3-2, Danashmand and Saadatian (2011) performed a slump test on OPKSC for different percentages of OPKS (Oil Palm Shell-OPKS) content as a partial replacement for coarse aggregate with a constant water cement ratio of 0.40 and showed that with increase in OPKS content, the workability of the concrete reduces.

Figure 5 : Slump Test for different percentage of OPKS content (Danashmand and Saadatian, 2011).



A drop in OPKS content and a subsequent increase in fine aggregate content rises workability as can be seen from reports by different researchers summarized in Table 5.

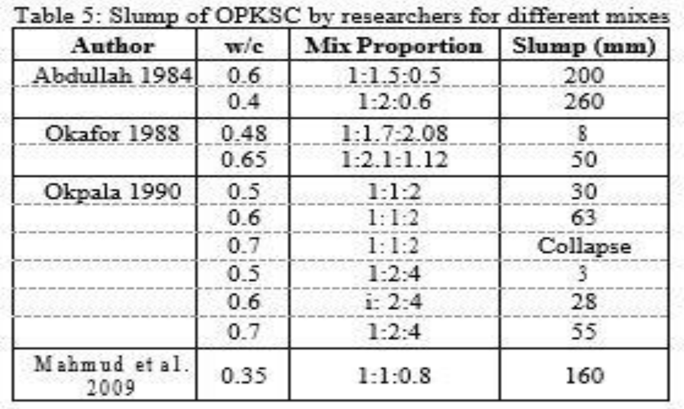


Table 5: Slump of OPKSC by researchers for different mixes

Author	w/c	Mix Proportion	Slump (mm)
Abdullah 1984	0.6	1:1.5:0.5	200
	0.4	1:2:0.6	260
Okafor 1988	0.48	1:1.7:2.08	8
	0.65	1:2.1:1.12	50
Okpala 1990	0.5	1:1:2	30
	0.6	1:1:2	63
	0.7	1:1:2	Collapse
	0.5	1:2:4	3
	0.6	i: 2:4	28
	0.7	1:2:4	55
Mahmud et al. 2009	0.35	1:1:0.8	160

DensityofPalmKernelShellConcrete

Structural uses of Light Weight Concrete (LWC), the mass is often additional important than the strength (Rossignolo et al., 2003). The density of concrete is study in terms of bulk density, fresh density, and dry density. According to Okafor (1988), the fresh density of OPKSC is in the range of 1753 — 1763 kg/m’ dependent on the mix proportion, water to cement ratio, and also the use of sand. Mannan and Ganapathy (2001), founded on the mix proportion also reported the fresh density of OPKSC in the range of 1910 1958 kg/m’. Alengaram et al., 2008, reported the fresh density of OPKSC to be approximately 1880 kg/m’ by incorporating l0'7o silica fume and 5to fly ash by weight with a cement: sand: aggregate: water ratio of 1: I.2:0.8:0.35. Usually, the freshing density of OPKSC is about one hundredto hundred and twenty kg/m3 lower than the saturated density of LWC (Alengaram et al., 2013). As shown on Graph 3-3, Osei and Jackson (2015) showed that the dried density of OPKSC reduces with an upturn in OPKS content but increases with curing time.

Water Absorption of Palm Kernel Shell Concrete

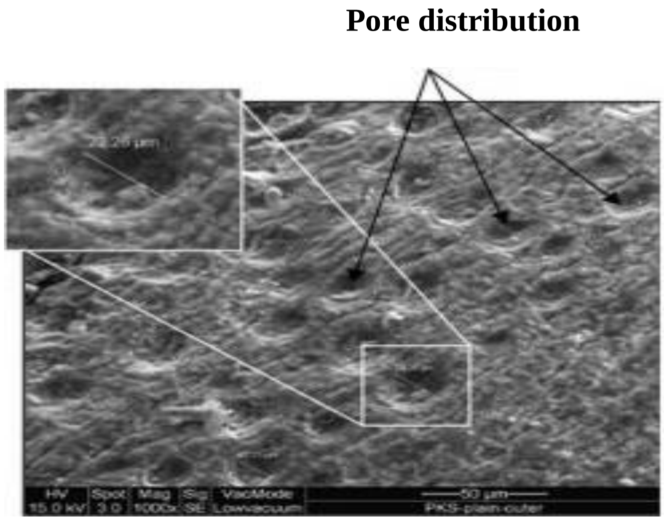


Figure 6 :Poresoftheoutersurfaceof OPKS(Alengarametal.,2011).

According to Basheer et al. (2001), water assimilation is the means of means of transport of liquids in permeable solids affected by surface tension acting in the ducts. Water absorption for LWC such as enlarged polystyrene concrete and pumice stone aggregate concrete is in the range of 369 corresponding to Babu and Babu (2003), and 14 22% according to Guduz and Ugur (2005) respectively. For OPKSC, Teo et al. (2007) showed that the water absorption is 11.23' o and 10.64' o for air dry curing and full water curing respectively.

Mechanicalpropertiesof oil palmkernelshellconcrete

The mechanical properties of OPKSC are dependent on the mixed design chosen. As indicated by Shetty (2005), blend plan techniques that apply to ordinary weight concrete are for the most part hard to use with lightweight total cement. Abdullah (1996) recommended that preliminary blends are important to accomplish a decent blend plan for OPKSC. Likewise, Osei and Jackson (2012), subsequent to clustering by weight and by volume for OPKSC, inferred that grouping by volume gives great quality mechanical properties than bunching by weight.

CompressiveStrengthof Oil PalmKernelShellConcrete

The compressive strength is the most utilizedconstraint to illustrate the quality of concrete in preparation (Weigrink et al., 1996). Any remaining mechanical boundaries, for example, flexural strength, parting rigidity and modulus of versatility straightforwardly rely upon the compressive strength of the substantial (Alengaram et al., 2013).As shown in Graph 3-5, Ikponmwosa et al., (2014), Daneshmand and Saadatian (201 I), and Olutoge et al. (2012), all reported that the compressive strength of OPKSC is dependent on the amount of OPKS as aggregate in the concrete and that the strength increases with curing age.

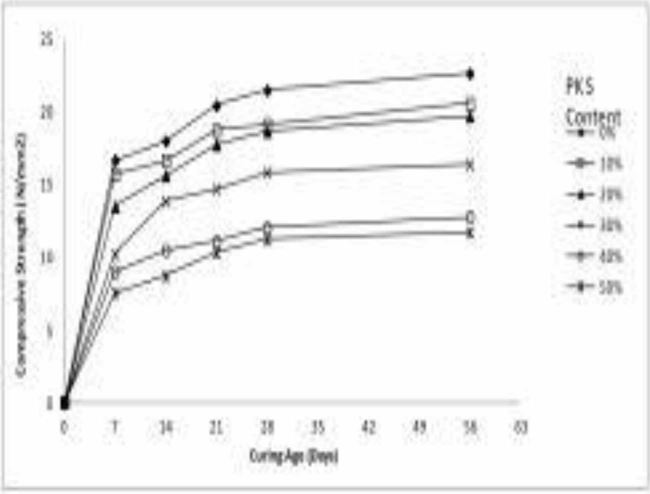


Figure 7:Compressivestrengthof OPKSCwithcuringage(Ikponmwosaetal.,2014)

Depending on the mix design, percentage of OPKS aggregate, and method of curing, different grades of OPKSC have been reported by researchers. Table 6 shows the compression strength of OPKSC by various researchers. Okpala (1990) reported a 28-day compressive strength of 22.2 MegaPa using a water to cement ratio of 0.5 and a mix design of 1: 1: 2 (cement: sand: aggregate). Shafigh et al. (2011), incorporated steel fibers using a water to cement ratio of 0.38 and a design mix of 1: 1.736: 0.72 (cement: sand: aggregate) and reported a 28th-day compressive strength in a range of 39.34 — 44.95 MegaPa.

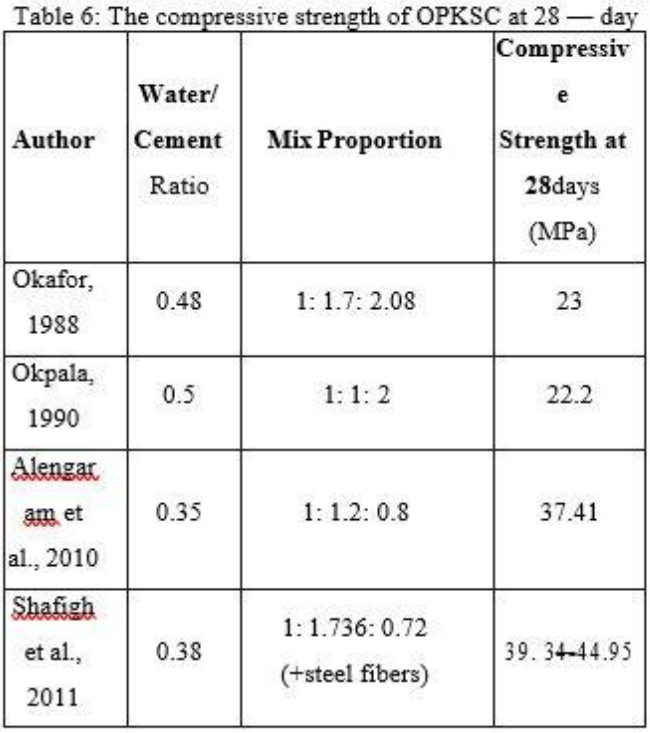


Table 6: The compressive strength of OPKSC at 28 — day

Author	Water/ Cement Ratio	Mix Proportion	Compressive Strength at 28days (MPa)
Okafor, 1988	0.48	1: 1.7: 2.08	23
Okpala, 1990	0.5	1: 1: 2	22.2
Alengaram et al., 2010	0.35	1: 1.2: 0.8	37.41
Shafigh et al., 2011	0.38	1: 1.736: 0.72 (+steel fibers)	39. 34–44.95

Suitability of oil palm kernel shells in concrete

OPKS has been experimented in research as light weight aggregate (LWA) to produce light weight and low-cost concrete since 1984 (Alengaram et al., 2013). According to Shafigh et al. (2010), research throughout the most recent twenty years has shown that OPKS can be utilized as a lightweight total for creating minimal expense and underlying lightweight cement.Also, it has been reported by Yap et a1. (2013), that OPKS is a suitable replacement for coarse aggregate to emithigh-level strength LWC with 28 days compressive strength up to 53 Mega Pa.

Okafor (1988) tested the actual properties of the shell, the compressive, flexural, and malleable parting strength of the OPKS concrete. Three blends of generally unique water to solidify proportion were utilized with 1009c coarse total supplanting with OPKS. The properties tried were contrasted and those of comparable substantial examples made with squashed rock as coarse total.The results showed that the material is suitable to produce concrete grade 25 and below. Also, Williams et al. (2014), created some substantial with 1009c substitution of coarse total utilizing OPKS at a blend plan of I:2:4 (concrete: sand: coarse total) and a water to solidify proportion of 0.65. The outcomes showed that the compressive and flexural strength improved with period of relieving, however the compressive and flexural strength of OPKSC were low when contrasted with that of the NWC. They reasoned that OPKS can be utilized for substantial creation as lightweight total and along these lines can be utilized to deliver LWC. The properties of OPKS new cement are anyway fantastic, entirely serviceable, reliable, and effortlessly positioned.

Therefore, with the above information, the OPKS is suitable to produce low structural concrete by replacing coarse aggregate.

Fly Ash

The ignition of coal at high temperatures and pressing factors in power stations produces various sorts of debris. The 'fine' debris portion is conveyed upwards with the vent gases and caught prior to arriving at the climate by profoundly proficient electrostatic precipitators. This material is known as fly debris. It is made for the most part out of incredibly fine, smooth circles and looks like concrete. The coarse debris part falls into the meshes beneath the boilers, where it is blended in with water and siphoned to tidal ponds. This material, known as base debris, has a dirty, sand-like surface. The utilization of fly debris and base debris in development has been set up for quite a long time. Applications range from giving the cementations material in concrete, to use as a basic fill material or a lightweight total in the production of squares. Utilizing fly debris makes a positive commitment to the climate. Fly debris is utilized in numerous applications to supplant normally happening totals and minerals, which can diminish fundamentally the interest for ordinary totals (stone). Fly debris is additionally utilized as a segment in the creation of flowable fill, which is utilized as self-evening out, self-compacting inlays material in lieu of compacted earth or granular fill. Flowable fill incorporates combinations of Portland concrete and filler material and can contain mineral admixtures, like fly debris. Filler material normally comprises of fine total (much of the time, sand), however some flowable fill blends may contain around equivalent segments of coarse total and fine totals.

Properties of fly ash

Studies by Khairul Nizar. (2007) have shown that the physical and substance properties of FLA are reliant upon the dirt science and climatic conditions. Similarly, studies made by Mohd Mustafa Al Bakri Abdullah. (2014) also showed that the distinctions in the physical and compound properties of FLA might be because of waste produce during quarrying. Therefore, properties of FLA largely depend on chemistry, climatic conditions, and internal grain structure applied during the cooling of molten.

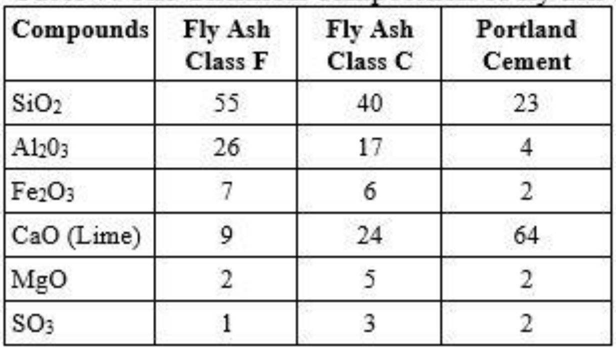
ChemicalPropertiesofFly Ash

The compound sytheses of FLA from different areas are introduced in Table 7. Fly debris comprises basically of oxides of silicon, aluminum iron and calcium. Magnesium, potassium, sodium, titanium, and sulfur are likewise present less significantly. At the point when utilized as a mineral admixture in concrete, fly debris is named either Class C or Class F debris dependent on its substance organization. American Association of State Highway Transportation Officials (AASHTO) M 295 [American Society for Testing and Materials (ASTM) Specification C 618] characterizes the substance piece of Class C and Class F fly debris.

- Class C remains are for the most part gotten from sub-bituminous coals and comprise essentially of calcium alumino-sulfate glass, just as quartz, tricalcium aluminate, and free lime (CaO). Class C debris is likewise alluded to as high calcium fly debris since it normally contains in excess of 20% CaO.

- Class F cinders are commonly gotten from bituminous and anthracite coals and comprise fundamentally of an alumino-silicate glass, with quartz, mullite, and magnetite likewise present. Class F, or low calcium fly debris has under 10% CaO.

Table 7: The Chemical composition of fly ash



Compounds	Fly Ash Class F	Fly Ash Class C	Portland Cement
SiO_2	55	40	23
Al_2O_3	26	17	4
Fe_2O_3	7	6	2
CaO (Lime)	9	24	64
MgO	2	5	2
SO_3	1	3	2

Physical Properties of Fly Ash

Colour

Fly debris can be tan to dim dark, contingent upon its compound and mineral constituents. Tan and light tones are commonly connected with high lime content. A caramel tone is ordinarily connected with the iron substance. A dull dim to dark tone is regularly credited to a raised unburned carbon content. Fly powdery grey is normally extremely steady for each force plant and coal source

SuperPlasticizer

- An industrially accessible sulfonated naphthalene formaldehyde-based superplasticizer (CONPLAST SP 430) was utilized as a synthetic admixture to upgrade the usefulness of the solid.

- To give astounding quickening of solidarity acquire at early ages and significant expansion in strength at all ages by altogether diminishing water interest in the solid blend.

- Particularly appropriate for high early strength necessities.

- To essentially improve the functionality of blended and expanding water.

- To give improved toughness by expanding by-expanding extreme strength and lessening solid penetrability.

Dosage

7ml of conplast for 1kg of cement

Fig 8 : Conplast

Water

Consumable water utilized for projecting and relieving.

CONCRETE MIX PROPORTION

Stipulations forProportioning

Gradedesignation:M30

Typeofcement:OPC 53grade

Max nominal sizeofaggregate:20mm

Mincementcontent :320kg/m^3

Maxw/cratio:0.40

Workability:25-50 mm (slump)

Exposurecondition :Mild

Degreeof supervision:Good

Typeofaggregate:Crushedangular

Maxcementcontent:450kg/m^3

Chemicaladmixture:Super-plasticizer

Test Data of Materials

Compressive strength	**= 30 N/mm^2**
Aggregate Type	**= Crushed**
Degree of workability	**= 0.90**
Degree of quality control	**= Good**
Type of exposure	**= Mild**
Specific Gravity, Cement	**= 3.15**
Coarse aggregate	**= 2.6**
Fine aggregate	**= 2.6**
Water Absorption, Coarse aggregate	**= 0.5%**
Fine aggregate	**= 1.0 %**

Results

Compressive Strength after 7Day

The deliberate compressive strength esteems are introduced in the accompanying Tables. The outcomes got for different rates of Fly ash and Oil palm kernel shell i.e., 0%, 10%, 20%, 30%, and 40%of Oil palm kernel shell and 5 % of fly ash is arranged. In view of the test outcomes, diagrams are plotted.

Table 8: Compressive Strengthafter 7 days

S. No.	Percentage of Replacement	Compressive strength (N/mm2)	Average compressive strength (N/mm2)
1	LWC-OP0	20.74	20.091
		21.09	
		20.89	
2	LWC-OP10	21.67	21.85
		21.92	
		21.96	
3	LWC-OP20	23.21	23.29
		23.26	
		23.30	
4	LWC-OP30	24.52	24.75
		24.54	
		25.18	
5	LWC-OP40	24.37	23.48
		23.07	
		23.01	

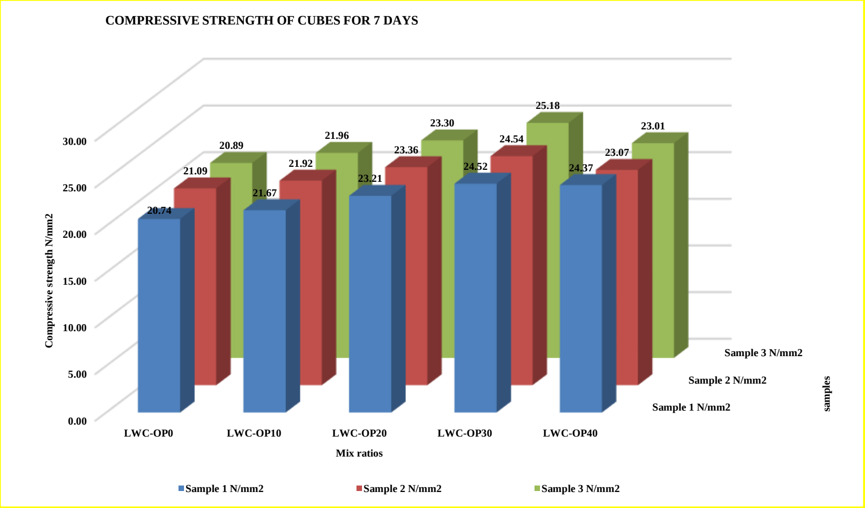


Figure 9 : Compressive strength after 7 days

Table 9: Compressive Strength after 14 days

S. No.	Percentage of Replacement	Compressive strength (N/mm2)	Average compressive strength (N/mm2)
1	LWC-OP0	30.11	29.95
		30.37	
		29.37	
2	LWC-OP10	28.01	30.26
		31.24	
		31.52	
3	LWC-OP20	32.15	32.25
		32.45	
		32.16	
4	LWC-OP30	34.02	34.26
		34.26	
		34.49	
5	LWC-OP40	32.10	32.52
		32.90	
		32.56	

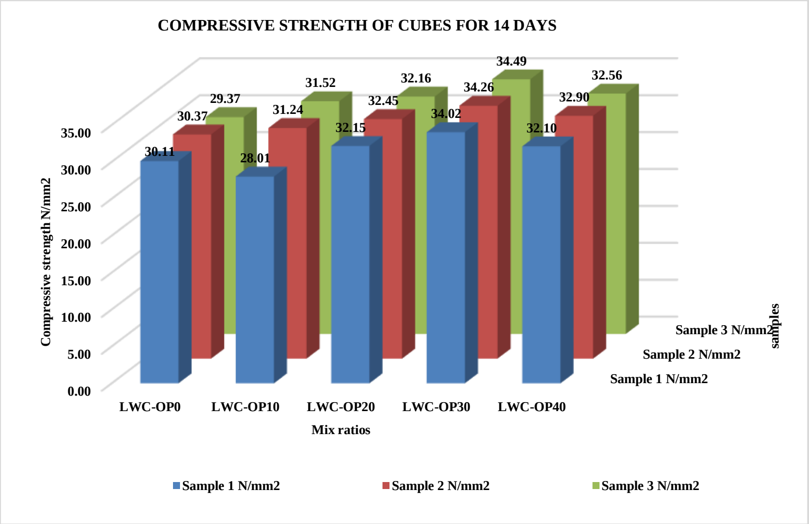


Figure 10 : Compressive strength after 14 days

Table 10: Compressive Strength after 28 days

S. No.	Percentage of Replacement	Compressive strength (N/mm2)	Average compressive strength (N/mm2)
1	LWC-OP0	30.81	32.17
		33.41	
		32.31	
2	LWC-OP10	33.51	33.62
		33.45	
		33.90	
3	LWC-OP20	35.74	35.83
		35.91	
		35.85	
4	LWC-OP30	38.59	38.07
		37.69	
		37.94	
5	LWC-OP40	35.62	36.13
		36.49	
		36.29	

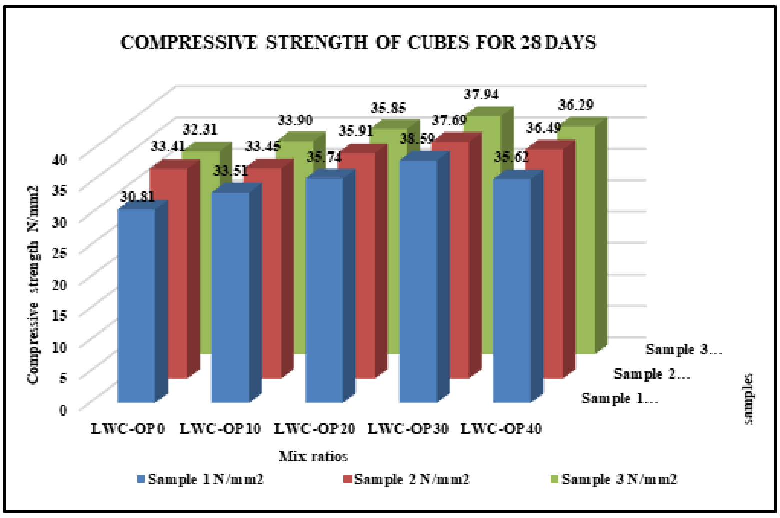


Figure 11 : Compressive strength after 28 days

Table 11: Comparison of Compressive Strength between 7,14, 28 days

S.No.	Mix	7 days	14 days	28 days
1	**OPKSC0**	20.91	28.95	32.17

2	**OPKSC10**	21.85	30.26	33.62
3	**OPKSC20**	23.29	32.25	35.83
4	**OPKSC30**	24.75	34.26	38.07
5	**OPKSC40**	23.48	32.52	36.13

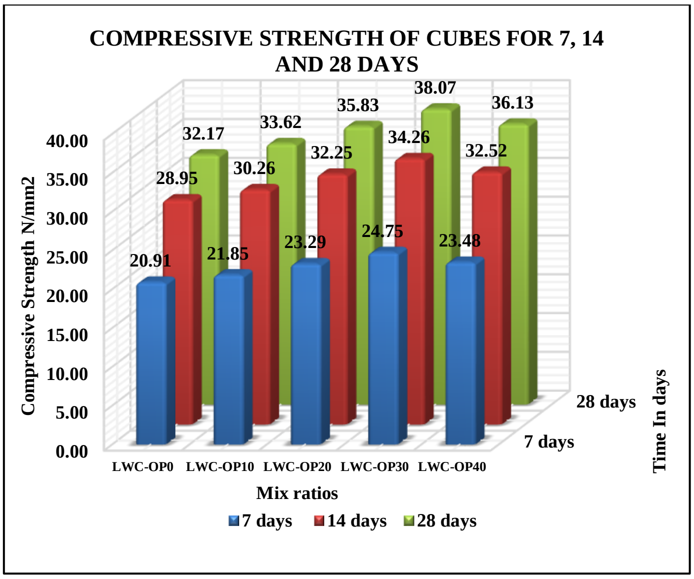


Figure 12 : Compressive strength after 7, 14, 28 days

Table 12: Flexural Strength after 7 days

S. No.	Percentage of Replacement	Compressive strength (N/mm2)	Average compressive strength (N/mm2)
1	LWC-OP0	20.74	20.091
		21.09	
		20.89	
2	LWC-OP10	21.67	21.85
		21.92	
		21.96	
3	LWC-OP20	23.21	23.29
		23.26	
		23.30	
4	LWC-OP30	24.52	24.75
		24.54	
		25.18	

5	LWC-OP40	24.37	23.48
		23.07	
		23.01	

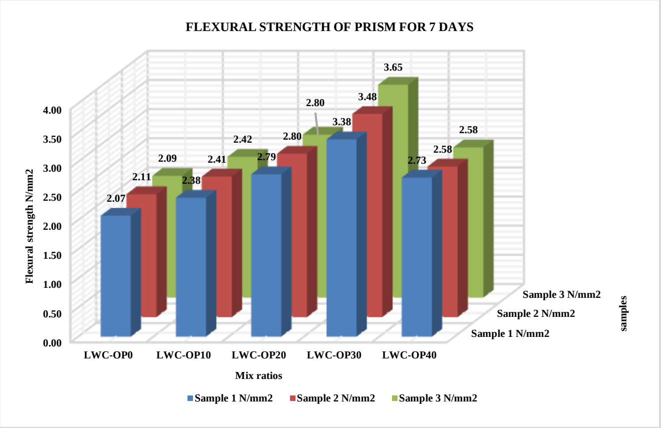


Figure 13 : Flexural strength after 7 days

Table 13: Flexural Strength after 14 days

S. No.	**Percentage of Replacement**	**Compressive strength (N/mm2)**	**Average compressive strength (N/mm2)**
1	LWC-OP0	20.74	20.091
		21.09	
		20.89	
2	LWC-OP10	21.67	21.85
		21.92	
		21.96	
3	LWC-OP20	23.21	23.29
		23.26	
		23.30	
4	LWC-OP30	24.52	24.75
		24.54	
		25.18	
5	LWC-OP40	24.37	23.48
		23.07	
		23.01	

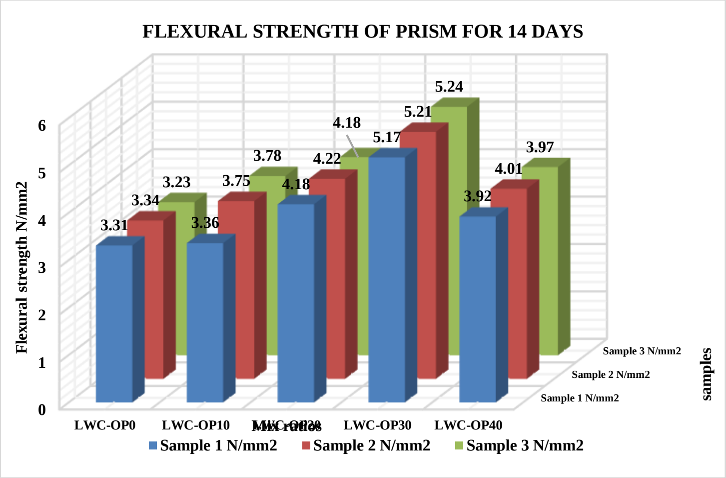


Figure 14 : Flexural strength after 14 days

Table 10: Flexural Strength after 28 days

S. No.	Percentage of Replacement	Compressive strength (N/mm2)	Average compressive strength (N/mm2)
1	LWC-OP0	20.74	20.091
		21.09	
		20.89	
2	LWC-OP10	21.67	21.85
		21.92	
		21.96	
3	LWC-OP20	23.21	23.29
		23.26	
		23.30	
4	LWC-OP30	24.52	24.75
		24.54	
		25.18	
5	LWC-OP40	24.37	23.48
		23.07	
		23.01	

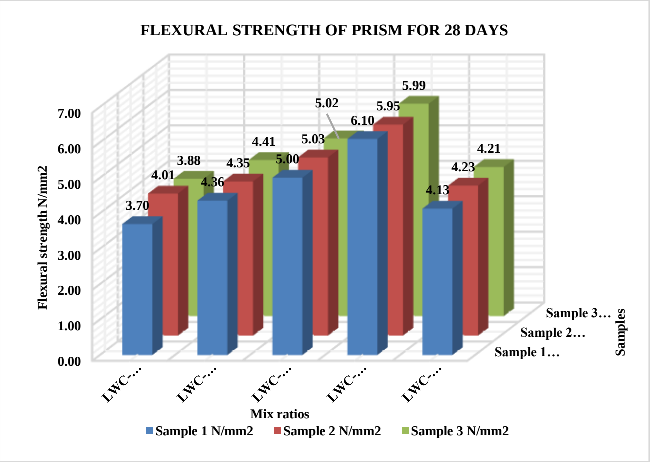


Figure 15 : Flexural strength after 28 days

Table 10: Flexural Strength after 7,14, 28 days

S.No.	Mix	7 days	14 days	28 days
1	**LWC-OP0**	4.18	6.59	7.72
2	**LWC-OP10**	4.81	7.26	8.74
3	**LWC-OP20**	5.59	8.39	10.03
4	**LWC-OP30**	7.01	10.41	12.03
5	**LWC-OP40**	5.26	7.93	8.38

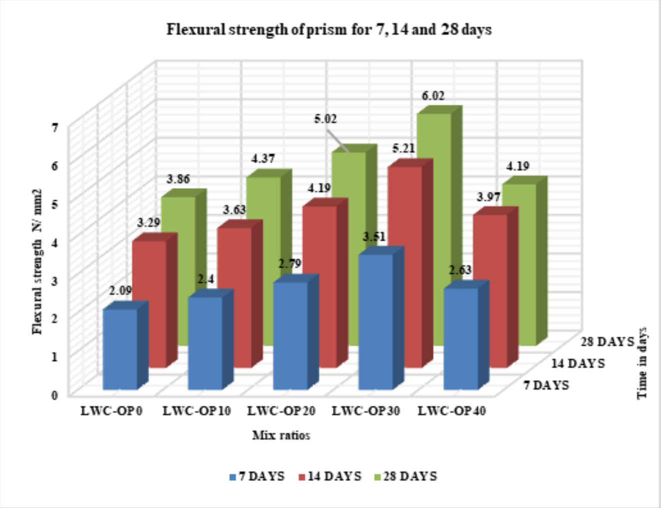


Figure 16 : Flexural strength after 7,14,28 days

CONCLUSION

The concluding remarks are obtained from the comparative study of strength using different percentage of replacements with OPKS. Based on the above results the ensuingsuppositions may be drawn.

- ✓ By and large, OPKS total was formed to be a decent replacer of coarse total in the creation of frivolous cement are inclined to high water ingestion pace of 24–25%. Thus, Operations are coated with water repulsive covering. This aides in keeping up the water assimilation rate to 6%.

- ✓ Additional utilization of mineral water by NTOPKS total prompts higher water concrete proportion just about 20% high, which influences the usefulness and toughness of the NTOPKS concrete. The effect of functionality is unmistakably noticed, as the compressive strength is 40–half lower in NTOPKS concrete than the TOPKS concrete.

- ✓ The strength of 10%,20%,30% and 40% OPKS concrete with an expansion of 5% fly debris to all blend proportions, tests delivered lightweight cement with compressive strength coming to up to limit of 38.07 N/mm2 and least of 33.62 N/mm2 for 28 days which fulfils the prerequisite for underlying light weight concrete.

- ✓ Concrete with the 30% substitution gives most elevated at all tests, for example, pressure test and flexural test. 40% substitution gives least compressive strength, pliable and flexural strength with more decrease in load of cement.

- ✓ In any case, the strength of the substantial is relying upon the two factors for example measure of OPKS and relieving period.

- ✓ At long last, from the outcomes we can presume that 10% substitution test is considered as fractional lightweight cement, since its Density more than 2000kg/m3.

- ✓ 40% examples additionally consider full light weight concrete, yet the outcomes are not fulfilling so they considered as non-primary light weight concrete.

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