Light Weight Concrete Using Oil Palm Shell as Coarse Aggregate

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***Abstract*— This work presents an investigation to make Light Weight Concrete using Oil Palm Shell (OPS) as coarse aggregate and to compare with conventional stone aggregate concrete. Utilizing OPS in concrete production not only solve the problem of disposing this solid waste but also helps conserving natural resources .Data presented include density, compressive strength, flexural strength, splitting tensile strength and modulus of elasticity.**

I. INTRODUCTION

Concrete is the most versatile and widely used man made construction material in the world. This work aims at production of light weight concrete using oil palm shell as coarse aggregate and to compare with conventional stone aggregate concrete

At the oil extracting mills where the fresh fruit bunch is processed and oil extraction takes place, solid residues and liquid wastes are generated. These waste includes empty fruit bunches, shell and effluent. In general the fresh fruit bunches contains about 5.50 % of shell and consequently over 2 million tons of oil palm shell solid waste is produced annually. This waste is normally disposed through incineration and at times, the shell is left to rot in huge mounts. This will ultimately cause pollution and health problems . Environmental regulations have become more stringent causing this waste to become increasingly expensive to dispose. Therefore, exploitation of this material as sustainable building material in the construction industry helps to preserve the natural resources and helps to maintain the ecological balance. OPS are hard stony endocarps that surround the kernel and shells are in different shapes and sizes.

II. MATERIALS

A. Cement

Portland cement is an extremely ground material having adhesive and cohesive properties which provide a better binding medium for the discrete ingredients. Portland Pozzolana Cement conforming to IS :12269-1987 was used in the study. The brand of cement used for the study was Ramco. The physical properties of cement are given in Table 1.

Table 1. Physical properties of Cement

Sl.No.	Properties	Results
1	Specific Gravity	2.98
2	Standard Consistency	34 %
3	Initial Setting Time in minutes	95
4	Final Setting Time in minutes	370
5	Compressive strength	35.2 N/mm^2

B. Fine aggregate

River sand was used as fine aggregate. The properties of fine aggregate are given in Table 2.

Table 2 Properties of Fine aggregate

Sl.No.	Properties	Results
1	Specific Gravity	2.60
2	Effective size	280 microns
3	Uniformity Coefficient	2.71
4	Fineness modules	3.6
5	Grading	Zone II

C. Coarse aggregate

Crushed rock and oil palm shell were used as coarse aggregate. The properties of crushed rock and oil palm shell are shown in Table 3 and Table 4.

Table 3 Properties of crushed stone

Sl.No.	Properties	Results
1	Specific Gravity	2.73
2	Effective size	15000 microns
3	Uniformity Co-efficient	1.27
4	Fineness modules	3.35

Table 4 Properties of Oil palm shell

Sl.No.	Properties	Results
1	Specific Gravity	1.27
2	Effective size	8500 microns
3	Uniformity Co-efficient	1.43
4	Fineness modules	1.34

D. Water

Water cement ratio is the major factor for the strength of concrete. The water cement ratio of 0.4 was taken for the preparation of concrete. The water used for the mixing and curing of concrete should be free from injurious amount of deleterious material. So potable water was used for mixing and curing.

E. Super Plasticizer

In this study, commercially available high range water reducing admixture GLENIUM 233 B, manufactured by BASF construction chemicals Pvt Ltd was used. Areas of application of this plasticizer are ready mix concrete, hot weather concrete, long haul concrete pavement etc.. The dosage of this plasticizer is 300 ml to 1000 ml per bag.

III. DESIGN OF CONCRETE MIX

For the study a mix of M 20 grade was considered and designed using the Indian Standards Code procedure. Saturated surface dry condition was assumed for the aggregate as per the design. The design stipulations are shown in Table 5.

Table 5. Design stipulations For Mix design

Sl.No.	Properties	Results
1	Characteristic Compressive strength at 28 days	20 N/mm^2
2	Maximum size of aggregates	20 mm (Angular)
3	Degree of workability	0.9

The quantities of different materials for 1 m^3 of concrete are given in Table 6

Table 6 Quantities of materials for concrete mix

Sl.No.	Materials	Quantity
1	Cement	370 kg
2	Fine aggregate	625.4 kg
3	Coarse aggregate	1272.1 kg
4	Water	150.55 L

IV. EXPERIMENTAL STUDIES AND DISCUSSION

An attempt was made to examine the variations of compressive strength, tensile strength and flexural strength of oil palm shell concrete .For both concretes M 20 mix was used, water cement ratio was kept as 0.4 and also the cement content was kept constant. Since the concrete is a harsh mix, a suitable admixture was used to enhance workability. The compression test is carried out on specimens cubical and cylindrical in shape. The cubes were 150 mm size, the cylinders were 150 mm diameter by 300 mm height and the beams were 100 mm x 100 mm x 300 mm.

A. Workability

Workability indicates the degree of mobility or degree of fluidity. The workability of concrete is given in Table 7

Table 7. Workability

Specification	Slump (mm)	Compacting Factor
Conventional Concrete	57	0.82
Oil Palm Shell Concrete	90	0.85

B. Density and Strength of Concrete

Density and strength were determined by the Indian Standards. The density, compressive strength, tensile strength and flexural strength are given in Table 8.

Table 8 Strength of concrete

Sl. No.	Property	**Conventional Concrete**	**Oil Palm Shell Concrete (OPS 50)**	**Oil Palm Shell Concrete (OPS 100)**
1	Density (kN/m^3)	24.88	21.33	18.04
2	Cube compressive strength (N/mm^2)	25.30	20.16	13.05
3	Cylinder compressive strength (N/mm^2)	12.12	10.90	9.03
4	Flexural strength (N/mm^2)	5.33	2.91	1.44
5	Split tensile strength (N/mm^2)	2.67	2.42	1.70
6	Modulus of elasticity (N/mm^2)	1.96x10^4	1.5x10^4	1.74x10^4

The results obtained for compressive strength, flexural strength, splitting strength and modulus of elasticity for OPS aggregate concrete was lower compared to conventional concrete. The mechanical properties of cement concrete which consists of inert aggregate bounded by the cement matrix depend upon the strength of aggregate and the stability of concrete through the matrix. In particular the interface between the aggregate and the matrix must be capable of transferring the stresses due to loads to aggregate. This is

generally achieved in cement concrete through the strong Van der Waals bonds between the cement matrix and aggregates. In conventional concrete the aggregates are stronger and the failure happened through this interface, but in the case of OPS aggregate concrete the failure happened by breaking of the OPS aggregate. That may be due to the relatively lower quality of aggregate.

Besides OPS aggregate has oily matter in it, this may cause a lubricating effect. Due to the lack of proper cleaning it may also contribute to the lower strength of OPS aggregate Concrete.

V. CONCLUSION

Oil palm shell has a good potential as a coarse aggregate in structural concrete production. Mix of full replacement of crushed stone by OPS do not give the desirable strength for light weight concrete. But concrete prepared with 50 % replacement is found feasible and can be used for low to moderate strength applications such as concrete members for low cost construct houses. It is advantageous for low income families, as this concrete can be used for the construction of low cost houses, especially in the vicinity of oil palm plantations. Depletion of crushed stone and health problems in the vicinity of factories can be reduced. By adding value to the waste product, both waste management and concrete industries stand to benefit financially.

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