EXPERIMENTAL ANALYSIS ON STRENGTH AND DURABILITY OF CONCRETE BY PARTIALLY EXCHANGING FINE AGGREGATE WITH OYSTER SHELL

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Abstract:

The need of strength and durability of products or materials used in concrete is more considerable on the aspects of low cost in concrete applications. This project deals with the experimental analysis on strength and durability of concrete by partially exchanging fine aggregate with oyster shell which is an illegitimately disposed waste from oyster farm places. To pursue for a chance to recover the waste as building ingredients, crushed oyster-shell were partially substituted for fine aggregate. To estimate the real-world application of crushed oyster shells as building constituents, the effort has been made to analysis the compressive strength of oyster shell concrete.

Keywords – Compressive strength, Oyster shell, Casting, Portland cement, Durability and Stability.

1. INTRODUCTION

Now a day, from oyster farm places, a huge quantity of oyster-shell waste which is an illegitimately disposed every day. That waste unlawfully deserted into public waters and domestic parklands. If the waste has been left unprocessed for lengthy period, can be a cause of horrible smell as a significance of the deterioration of flesh remains devoted to oyster in the dumped site. According to the statistics conveyed by Tong-young oyster-fishery supportive association, the oyster farms made more than 90% of oyster harvests that are reached up to 28 million tons as the yearly by-products of oyster-shell. From this consideration, if oyster-shell products are used as building ingredients, particularly as concrete mixture, we need directly to improve a technique for oyster-shell reusing.

. In this project we have partially replaced fine aggregate with oyster shell to certain percentage like 10%, 20%. Different properties of cement, oyster shell, sand as fresh as well as hardened concrete which are influenced by adding this by product were going to study [4]. The usage of oyster shell as a fractional replacement to soil will offer a financial expenditure of the by product and subsequently yield cheaper slabs for low price constructions and increases the workability and firmness.

1.1 Advantages:

The utilization of oyster shell as fine aggregate has an apparent effect on carbonation. The oyster shell resists the chemical attack on concrete. Achieve levels of ultimate strength, workability when compare to conventional mixes [1]. Reduce excessive temperature differentials, therefore achieving a reduction in crack. The crushed oyster-shell is a worthy substitute material of deficient soil.

1.2 Objective:

The objective of this project is to study as to optimize compressive strength of concrete by replacing Oyster shell as fine aggregate, the properties of manufacturing waste and their suitability in concrete, the effect of Oyster shell on workability of concrete, the structural behaviour of concrete with industrial waste.

2. LITERATURE REVIEW

. A study has been done to recognize additional information about best compressive strength of oyster shell concrete. Gil-Lim Yoon, [2] Byung Tak Kim, Baeck Oon Kim, Sang-Hun Han "Chemical–mechanical characteristics of crushed oyster-shell", in Coastal & Harbor Engineering Research Division, Korea. Waste Management 23 (2003) 825–834. Accepted 16 October 2002.A huge amount of oyster-shell waste has been illegitimately disposed at oyster farm places beside the southern shore of Korea. To search for a chance to reuse the waste as building ingredients, biochemical and mechanical characteristics of crushed oyster-shell were examined [13]. Chemical and microstructure investigates exposed that oyster-shells are mainly composed of calcium carbonate ($CaCO_3$) with occasional foams.

EI Yang, ST Yi, YM Leem "Effect of oyster shell substituted for fine aggregate on concrete characteristics" Cement and concrete research (2005) Part I. Fundamental properties [9]. An investigational learning was approved out to examine the reusing options for fine aggregate of oyster shells (OS), which is a manufacturing waste, disposed of in open dumps at shore oyster organization zones. For this resolution, the chemical constituents of oyster shell and reactivity of oyster shell with cement adhesive were inspected. More precisely, the mechanical features of hardened concrete and fresh concrete were quantitatively examined on the aspects of substitution rate (SR) and fineness modulus (F.M.) of crushed oyster shell.

EunIk Yang, Myung Yu Kim, Hae Geun Park, Seong Tae Yi "Effect of partial replacement of sand with dry oyster shell on the long-term performance of concrete", [10] in construction build mater (2010). To estimate the real-world application of crushed oyster shells (OS) as building ingredients, an investigational learning was achieved depend on equivalent resources quantity and the fractional replacement of saturated-surface-dry sand with dry oyster shell. An experiment outcome specifies that long-term strength of concrete with 10% Oyster Shell replacement is nearly same to that of ordinary concrete. However, the long-term strength of concrete with 20% Oyster Shell replacement is considerably greater than that of standard concrete.

Lee, Jae Joon ; Park, Sung-Hyun ; Choi, Jung Soek ; Kim, Jong Hee ; Lee, Sang Hwa "Effect of Oyster Shell Powder on Quality Properties and Storage Stability" [11] Volume 31, Issue, 3, 2011. This experimental study was lead to estimate the practical properties of adding oyster shell (OS) powder on the excellence assets and storage firmness of emulsion-type pork sausages to additional phosphates as a preserving mediator. When compared to the other actions, adding 0.5% OS powder significantly improved pH values. Also Adding OS powder in the ranges like 0.15, 0.3, and 0.5% caused in expressively higher cohesiveness, hardness, springiness, and chewiness values when compared to other actions.

WenTien Tsai "Microstructure Characterization of Calcite-Based Powder (oyster shell) Received: 19 April 2013; in revised form: 20 June 2013 / Accepted: 24 July 2013 / Published: 7 August 2013 [12]. This paper is recognized that the oyster shell is a normal biomaterial with admirable crack strength and tough hardiness, which are qualified to its coated microstructure. This crystal material is mainly self-possessed of calcium carbonate ($CaCO_3$) minerals (i.e., calcite) arranged down in a protein matrix.

3. METHODOLOGY USED

The Methodology Flow chart is shown in Fig.1. The methodology contents details are given below.

3.1 Material Collection:

3.1.1 Cement:

Cement is a binding material in concrete that bins the other ingredients into a compact mass. Cement is categorized as Portland and Non-Portland cements, [5] which the use of additives, changing chemical composition, and non-Portland cement can be made for use in various environmental.

3.1.2 Aggregate:

Aggregate are inert granular materials like sand, gravel or crushed stone. They are of fine and coarse aggregates. Fine aggregate particles pass through 4.75 mm size sieve and retained in 75µ sieve. The factors that affect concrete properties are aggregate size, shape, texture, strength, surface moisture.

Flat particles have a negative influence on workability, strength, and durability. Angular aggregate exhibit a better interlocking effect in concrete and they have good bond strength too.

3.1.3 Water:

Water is the least expensive ingredient of concrete and it is used for hydration of cement. The hydration products have cement value. It distributes the cement evenly so that each element of gravels and sand is layered by it and carried into intimate and gives workability to moisture.

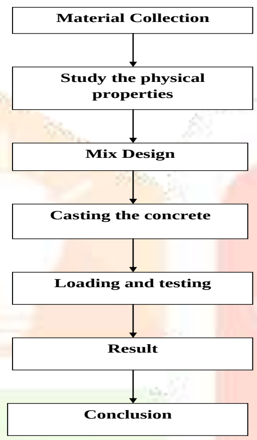

Fig 1. Methodology Flow chart

3.2 Mix Design:

3.2.1 Mix design procedure:

The Indian standard suggested a technique of concrete mix design. This mix design process is enclosed in IS 10262 – 82. The given technique can be used for both medium and high strength concrete. The target mean compressive (f_{ck}) strength at 28 days is given by

$$f_{ck} = f_{ck} + t_s \quad \text{------------} \ (1)$$

Where, f_{ck} is the characteristic compressive strength at 28 days and S is the standard deviation. According to IS 456 – 2000 and IS 1343 – 80, the value of normal has to be operated out from the traces lead in the laboratory or field [6-8] and the characteristic strength is well-defined as the value less which not extra than 5% outcomes are estimated to fall in which the above equation modifies to,

$$f_a = f_{ck} + 1.65s \quad \text{-----------} \ (2)$$

After that, the ratio of water/cement is selected due to concrete strength. Also the augmented test can be applied for slow down the delay.

3.2.2 Estimation of entrapped air:

From table 1, the air content is predictable for the ordinary full size of aggregate applied.

Table 1. Estimation of entrapped air

Maximum size of Aggregate (mm)	Entrapped air as % of Volume of concrete
10	3.0
20	2.0
30	1.0

3.3 Mix Design Calculation:

The mix design is calculated after the calculation of cement and aggregate content by general formulas. Mix design calculation is done by appropriate equations and the detailed step by step procedure is given below:

Characteristic compressive strength at 28 days = 20 Mpa
Maximum size of aggregate =20 mm (angular)
Degree of workability factor =0.90 compacting
Specific gravity of cement = 3.15
Specific gravity of coarse aggregate=2.72
Specific gravity of fine aggregate = 2.64
Target mean strength of concrete (f_t) =$f_{ck} + 1.65S$
F_t=20+ 1.65x 4 =26.6Mpa
Water-cement ratio = 0.45

[3] For 20 mm maximum size aggregate and water content ratio=0.45 and compacting factor =0.8 water content per cubic meter of concrete = 186kg and sand content as percentage of total aggregate by absolute volume = 35%.

Table 2. Selection of water and sand

Change in conditions stipulated Aggregate	Adjustment required in	
	Water content	% sand in total aggregate
For sand conforming to zone III	0	-1.5%
Increase in the value of compacting Factor 0.10	+3%	0
Decrease in water cement ratio by 0.1	0	-2%
Total	+3%	+3.5%

Therefore required sand content as percentage of total aggregate by absolute volume is 35-3.5
P=31.5%
Required water content=186 + (186 x 3/100)=191.6 kg/m^3
Water cement ratio = 0.45
Required water content = 191.6 Kg/m^3
Cement=191.6/0.45 = 424.58 = 425 Kg/m^3
Amount of entrapped air = 2%

Absolute volume of fresh concrete

V = $[W + \frac{C}{SC} + \frac{1}{P}\times\frac{fa}{Sfa}]\frac{1}{1000}$

Where, W =192 Kg/m^3, C = 425 Kg/m^3

S_c = 3.09

S_{fa} = 2.59, P= 31.5% = 0.315

Total amount of concrete V =100-2= 98%

0.98 = $[192+\frac{425}{3.09}+\frac{1}{0.315}\times\frac{fa}{2.59}]\frac{1}{1000}$

= 605 Kg/m^3

Fine aggregate, f_a = 605 Kg/m^3

Coarse aggregate, C_a $=\frac{1-P}{P}\times f_a\times\frac{Sfa}{Sca}$

$=\frac{1-0.315}{0.315}\times 605.35\times\frac{2.72}{2.59}$

C_a = 1156 Kg/m^3

Water	: Cement	: FA	: CA
192	: 425	:605	: 1156
0.45	: 1	:1.42	: 2.72

The ratio is 1:1.5:3

Predictable quantities of materials per cubic meter of concrete are,

Cement = 425 Kg, Fine Aggregate = 605 Kg, Coarse Aggregate = 1156 Kg Water = 192 Kg

4. TESTING AND RESULTS

4.1 Casting:

The compression test is done in the cubical shape specimen and the size of 15×15×15 cm. The Metal moulds, preferably essential steel or cast iron thick enough to stop distortion. They are prepared in such a way as to enable to eliminate the moulded specimen damage

4.1.1 Mixing of Concrete:

The mixing of concrete includes the proportioning of the various ingredients of concrete like cement, fine aggregate, and coarse aggregate. For the mix of strength M_{20}, a mix of ratio 1:1.5:3 is used. The total quantity of concrete required for the entire numbers of cubes are determined. From which, it is cleared the quantity of fine and coarse aggregate are determined by parts of excluding cement. From that quantity, the weight of each ingredient is determined by multiplying with its weight.

4.1.2 Casting of Specimens:

The materials that are proportioned by the above method can be added together. The materials are mixed thoroughly either by machine or by hand. If hand mixing is used, the materials must be turned at least three times to ensure the proper mixing of material. The concrete so prepared must be placed into the cubes moulds that are pre oiled to ensure removal from them. The concrete must be compacted properly to avoid any air voids inside**.**

4.1.3 Compression Strength Test:

Most of the necessary characteristic properties of concrete are qualitatively associated with its compression strength. So the compression test is the ordinary process that leads on hardened concrete partly.

The specimen so prepared must be cured for 7, 14 and 28 days and dried for an hour, prior to the testing. The compression testing includes placing the concrete cube in the compression testing device and compressed. The load at which the specimen shows the initial crack and the failure of the specimen are recorded and tabulated.

4.2 Test Results:

Table 3. Compression strength test is carried out after 7 days curing

Concrete	Replacement of oyster shell in%	Compressive load in KN	Compression strength in N/mm^2
PCC	0%	280	12.40
Oyster shell	10%	320	14.22
Oyster shell	20%	385	17.11

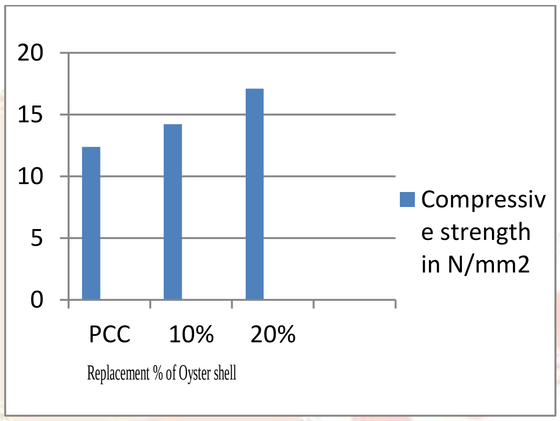

Fig 2. 7th day compressive strength

Table 4. Compression strength test is carried out after 14 days curing

Concrete	Replacement of oyster shell in%	Compressive load in KN	Compression strength in N/mm^2
PCC	0%	370	16.44
Oyster shell	10%	460	20.46
Oyster shell	20%	510	22.67

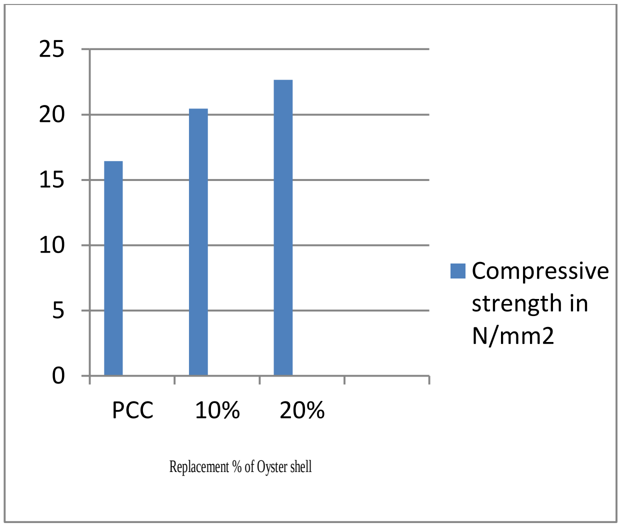

Fig 3. 14th day compressive strength

Table 5. Compression strength test is carried out after 28 days curing

Concrete	Replacement of oyster shell in%	Compressive load in KN	Compression strength in N/mm^2
PCC	0%	475	21.11
Oyster shell	10%	525	23.33
Oyster shell	20%	610	27.11

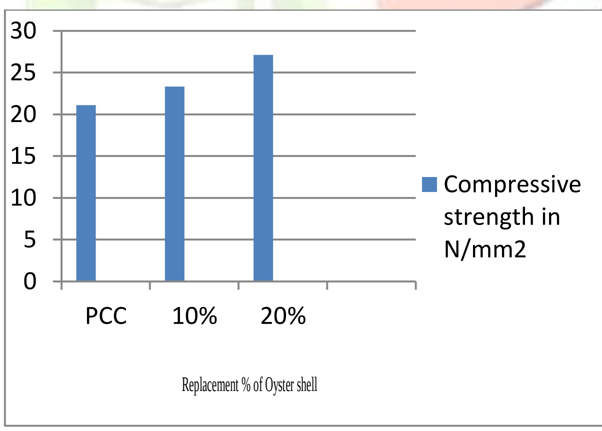

Fig 4. 28th day compressive strength

CONCLUSION

Based on this experimental study, it is concluded that the mix can be made by replacing oyster shell for fine aggregate without decreasing strength.20% of replacement of oyster shell for fine aggregate has produced maximum compressive strength. The comparative with ordinary concrete with oyster shell replaced concrete gave better performance in strength. Thus the study gave the results in increasing the strength of the concrete by replacing the oyster shell for fine aggregate. I

Now-a-days the cost of sand and demand for sand is increasing rapidly. This will reduce the availability of sand and cause the scarcity of sand in future. Also the test result concluded that the partial replacement of sand with oyster shell in concrete gives high compression strength than the ordinary concrete. Hence the demand for sand can be reduced.

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