An Experimental Study on Partial Replacement of Cement Using Oyster Shell Powder in Concrete

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Abstract : **In this day and age we are in front of most complex safety problems connected to environment. Many things which are made-up for our comfortable life are accountable for polluting environment due to offensive waste management technique. The present exploration assesses the merging of oyster shell in concrete. The consequence of oyster shell as fractional replacement of cement on the compressive strength (primary) of concrete has been investigated. Globally, over 150 countries produce cement and/or clinker, the primary input to cement. In 2001, the United States was the world's third largest producer of cement (90 million metric tons (MMT)), behind China (661 MMT) and India (100 MMT). This work reports an experimental procedure to investigate the effect of using oyster shell powder as partial replacement of cement. Tabby is a type of concrete made by burning oyster shells to create lime, then mixing it with water, sand, ash and broken oyster shells. Tabby was used by early Spanish settlers in present-day North Carolina and Florida, then by English colonists primarily in coastal South Carolina and Georgia. Oyster shell as a alternate for straight cement with partial replacement using M25 grade concrete The main objective is to support the use of these outwardly waste products as a construction material.**

Keywords: Compressive strength,* Oyster shell*, split tensile strength, Durability test, Flexural strength.

1. INTRODUCTION

1.1 GENERAL

Concrete is one of the two most used structure materials in construction. In order to reduce reliance of raw material in concrete producing, the green concrete had been promoted. Green concrete is the concrete that had been produced using recycle or wasted natural materials. One of the ways to produce green concrete is by using modified cement. Cement is the second largest volume materials used by human being after water. Cement plays the role of a binder, a substance that sets and hardens and might bind alternative materials along. During production of cement and hydration process of cement, the amount of CO2 emitted by the industry is nearly 900 kg of CO2 for every 1000 kg of cement produced. This CO2 production causes serious environmental damages. The sea shells are high potential materials to become partial cement replacement and filler in concrete. The calcium carbonate (CaCO3) in the sea shells is more than 90% and is similar to contain of calcium carbonate in the limestone dust that been used in the Portland cement production. Impressively, the crystal structures of seashells are largely composed of calcite and aragonite, which have higher strengths and density than limestone powder. Also, the particle sizes of seashells are between 36μm to 75μm and are similar to the particle size of Portland cement. Due to the physical and chemical properties of conch and oyster shells, they may be a suitable substitute for cement and aggregates.

1.1 OBJECTIVES OF STUDY

Investigation on the concrete mixes containing 2%, 4% and 6% of shell as partial replacement of cement to evaluate the mechanical properties of concrete such as compressive strength, tensile splitting strength, and flexural strength characteristics.

- My research is on increasing the strength of concrete by using oyster shell powder as a partial substitute for cement.
- My aim is to prepare concrete by mixing oyster shell powder particles as a partial substitute for cement and find durability test and flexural strength test in it to improve the durability of concrete.

I am testing the strength of concrete by using oyster shell powder as a substitute for cement.

2. REVIEW OF LITERATURE

2.1 LITERATURE BASED ON OYSTER SHELL POWDER CONCRETE

1.Experimental study on partial replacement of cement by oyster shell powder Yamuna Bharathi in (2016)

This research helps to access the behavior of concrete mixed with osp and determination of optimum percentage of combined mixture which can be recommended as suitable alternative construction material in low cost housing delivery especially in coastal areas and near fresh water where they are found as waste. Seashell osp is mainly composed of calcium and the rough texture makes it suitable to be used as partial cement replacement which provides an economic alternative to the conventional materials such as gravel. Experimental studies were performed on conventional concrete and mixtures of seashell with concrete. The percentage of seashell is varied from 2%, 4%, and 6%.

3. MIX DESIGN

Grade	Cement Kg/m³	Fine aggregate Kg/m³	Coarse aggregate Kg/m³	Water Content Lit/m³
M25	426.66	654.89	1161.73	191.5

- Mix Ratio
- 1 : 1.5 : 2.7
- w/c = 0.45

4. DURABILIY TEST

In civil engineering, a durability test is a type of testing that evaluates the ability of building materials, structures, and infrastructure to resist deterioration, degradation, and damage over time, while maintaining their performance, safety, and functionality.

TYPES OF DURABILITY TEST

(TEST CONDUCTED ON CUBES & DISK SPECIMEN)

- ❖ WATER ABSORPTION TEST
- ❖ ACID ATTACK TEST
- ❖ SULPHATE ATTACK TEST
- ❖ SORPTIVITY TEST

4.1 WATER ABSORPTION TEST

The Water Absorption Test is a laboratory test used to determine the amount of water that a material can absorb. It is an important test in civil engineering and construction, as it helps to evaluate the durability and resistance of building materials to water penetration

- ❖ Evaluate the porosity and permeability of materials.
- ❖ Determine the material's resistance to water penetration and absorption.
- ❖ Assess the material's durability and resistance to weathering and erosion.
- ❖ Compare the performance of different materials
- ❖ Identify potential issues with water infiltration and damage.

Fig 4.1 WATER ABSORPTION TEST CONDUCTED

DAYS	OSP 0%				OSP 2%			
	Dry weight (Kg)	Final weight (Kg)	Water absorption (%)	Avg (%)	Dry weight (Kg)	Final weight (Kg)	Water absorption (%)	Avg (%)
15 Days	2.524	2.58	2.22	2.27	2.430	2.456	1.07	1.03
	2.536	2.595	2.33		2.438	2.462	0.99	
30 Days	2.486	2.546	2.42	2.43	2.430	2.470	1.65	1.55
	2.582	2.645	2.44		2.430	2.465	1.45	

Table 4.2 WATER ABSORPTION TEST

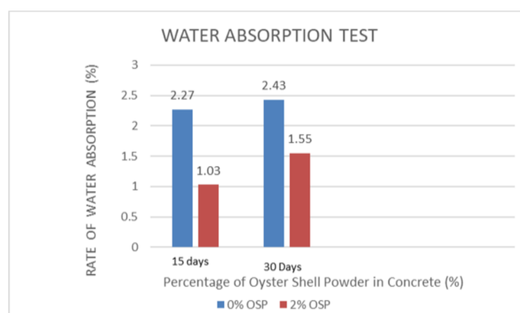

Fig 4.3 WATER ABSORPTION REST RESULT

4.2 ACID ATTACK TEST

The acid attack test, also known as the acid resistance test, is a laboratory test used in civil engineering to evaluate the resistance of building materials, particularly concrete and mortar, to acid corrosion.

In this test, a sample of the material is exposed to a controlled acid solution, typically hydrochloric acid (HCl) or sulfuric acid (H2SO4), to simulate the corrosive effects of acid rain, industrial emissions, or other environmental factors.

Fig 4.2.1 Compressive Strength Test

Fig 4.2.2 Acid Attack Test Conducted

DAYS	OSP 0%				OSP 2%			
	Dry weight (Kg)	Final weight (Kg)	Decrease in mass (%)	Avg (%)	Dry weight (Kg)	Final weight (Kg)	Decrease in mass (%)	Avg (%)
15 Days	2.595	2.538	2.25	2.57	2.505	2.486	0.77	1.87
	2.545	2.486	2.38		2.433	2.386	1.97	
30 Days	2.830	2.768	2.24	2.63	2.498	2.466	1.30	1.48
	2.610	2.546	2.52		2.466	2.428	1.57	

Table 4.2.3 Acid Attack Test Result

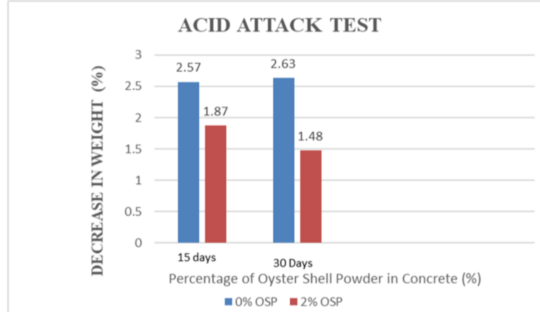

Fig 4.2.4 Acid Attack Test Result

DAYS	SPECIMEN	COMPRESSIVE STRENGTH (MPA)				
		INITIAL LOAD (kN)	FINAL LOAD (kN)	DECREASE IN STRENGTH (N/mm²)	Avg (kN)	RESIDUAL STRENGTH (N/mm²)
15 DAYS	OSP 0%	42	37.5	10.72	13.37	**86.63**
		42	35	16.67		
	OSP 2%	45.3	39.5	12.81	12.77	**87.23**
		45.3	42	7.29		
30 DAYS	OSP 0%	42	34.5	17.86	18.60	**81.40**
		42	36	14.29		
	OSP 2%	45.3	38.5	15.02	16.50	**83.50**
		45.3	40	11.7		

Table 4.2.5 Compressive Strength Test Result

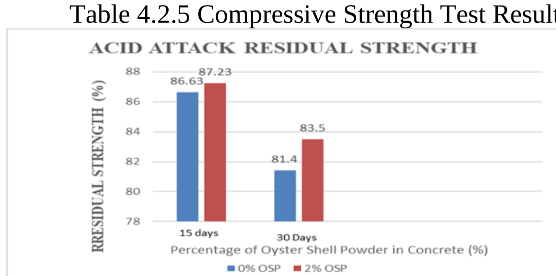

Fig 4.2.6 Acid Attack Residual Strength Test Result

4.3 SULPHATE ATTACK TEST

The sulphate attack test, also known as the sulphate resistance test, is a laboratory test used in civil engineering to evaluate the resistance of building materials, particularly concrete and mortar, to sulphate ions. A sample of the material is immersed in a sodium sulphate (Na_2SO4) or magnesium sulphate ($MgSO_4$) solution. And I have used in sodium sulphate at 2%.

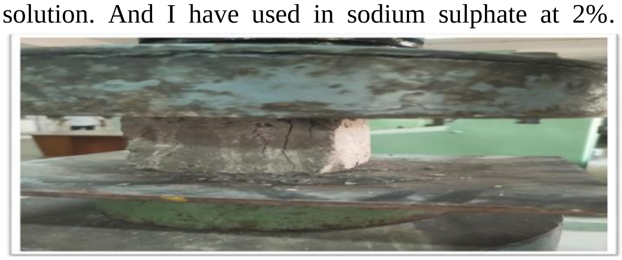

Fig 4.3.1 Sulphate Attack Compressive Strength Test

DAYS	OSP 0%				OSP 2%			
	Initial weight (Kg)	Final weight (Kg)	Increase in mass (%)	Avg (%)	Dry weight (Kg)	Final weight (Kg)	Increase in mass (%)	Avg (%)
15 Days	2.472	2.540	2.76	2.58	2.484	2.525	1.66	1.58
	2.490	2.545	2.21		2.444	2.456	0.50	
30 Days	2.610	2.67	2.3	2.97	2.504	2.543	1.56	1.38
	2.592	2.662	2.71		2.478	2.498	0.81	

Table 4.3.2 Sulphate Resistance Test Result

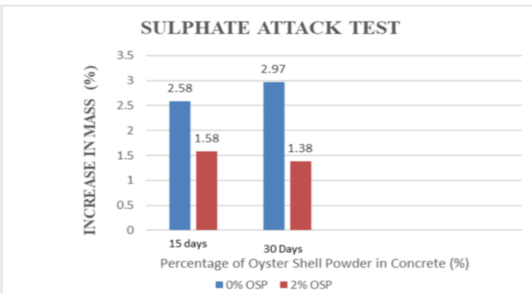

Fig 4.3.3 Sulphate Attack Test Result

DAYS	SPECIMEN	COMPRESSIVE STRENGTH (MPA)				
		INITIAL (kN)	FINAL (kN)	DECREASE IN STRENGTH (N/mm²)	Avg (kN)	RESIDUAL STRENGTH (N/mm²)
15 DAYS	OSP 0%	42	37	11.91	12.50	87.50
		42	36	14.29		
	OSP 2%	45.3	39	13.91	11.65	88.35
		45.3	40.45	10.71		
30 DAYS	OSP 0%	42	35	16.67	17.44	82.56
		42	37	11.91		
	OSP 2%	45.3	39	13.91	14.61	85.39
		45.3	39.45	12.92		

Table 4.3.4 Sulphate Residual Strength Test Result

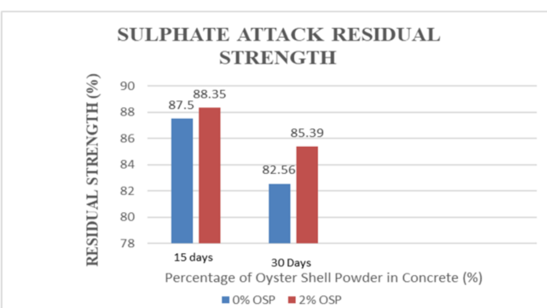

Fig 4.3.5 Sulphate Attack Residual Strength Test Result

4.4 SORPTIVITY TEST

The sorptivity test is a laboratory test used in civil engineering to measure the capacity of a material, typically concrete or mortar, to absorb and transport water by capillary action.

SORPTIVITY FORMULA

Sorptivity test for cylinder disc was tested at 28 days and it was conducted with to ASTM C1585-13.

$$S = I/t^{1/2.}$$

Here;
S= sorptivity in mm,
t = elapsed time in mintues
$I=\Delta w/Ad$;

Fig 4.4.1 Sorptivity Test Specimen Conducted

MIX	SORPTIVITY SPECIMEN 1 (mm/s^1/2)	SORPTIVITY SPECIMEN 2 (mm/s^1/2)	AVERAGE (mm/s^1/2)
OSP 0%	0.0345	0.0345	0.0345
OSP 2%	0.0320	0.00004	0.0162

Table 4.4.2 Average For Sorptivity Test

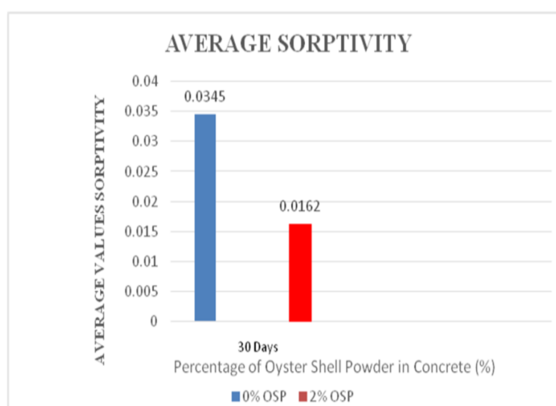

Fig 4.4.3 Average For Sorptivity Test

5.1 FLEXURAL BEHAVIOUR OF BEAM

Understanding flexural behavior is crucial for designing and analyzing beams in various engineering applications, such as buildings, bridges, and mechanical structures.

The specifications are:

- Size of beam : 1000mm x 150mm x 150mm.
- Bottom reinforcement : 2 numbers of 12mm diameter bars.
- Cover block : 25 mm.

Grade of steel : Fe500 HYSD

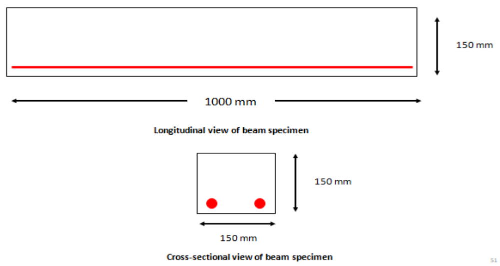

Fig 8.1 Cross-Sectional View of Beam Specimen

Fig 8.1.2 Casting of Beam

Fig 8.1.4 Casting of Beam

Fig 8.1.5 Set Up Testing of Specimen

Fig 8.1.6 Failure of Beam

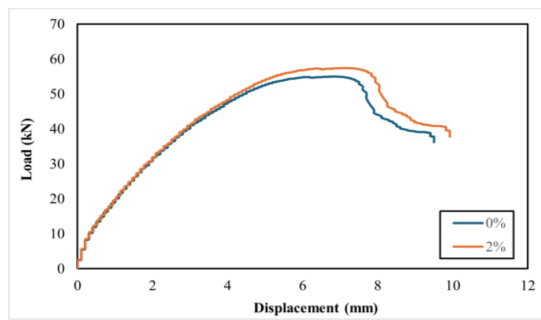

Fig 8.1.7 Displacement in 0% OSP

Max load = 50.5 kN

Section capacity = 30.3 KN-m

Flexural strength = 23.22 N/mm^2

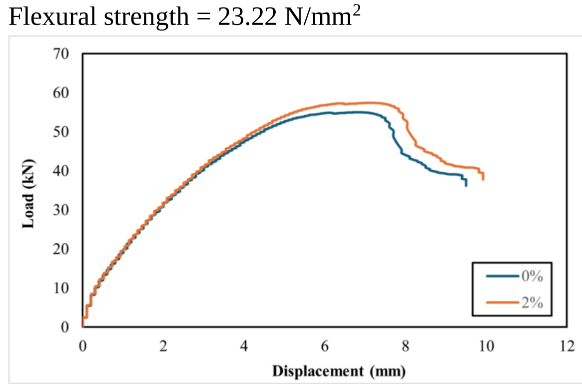

Fig 8.1.7 Displacement in 2% OSP

Max load = 57.54 kN

Section capacity = 34.52 KN-

Flexural strength = 27.28

6.CONCLUSION

Based on the research, here's a possible conclusion for the study on replacing 2% of cement with oyster shell powder in concrete Durability test & flexural beams.The experimental results show that replacing 2% of cement with oyster shell powder in concrete flexural beams leads.The oyster shell powder acts as a supplementary cementitious material, contributing to the improved properties of the concrete. This sustainable approach merits further investigation and consideration for practical applications in the construction industry.

- In water absorption test , OSP 2% Specimen shows water absorption 40% less than conventional concrete for 30 days.
- In Acid resistance test , the OSP 2% Specimen found to be 2.6% higher compressive strength than conventional concrete for 30 days.
- In Sulphate Resistance test, the OSP 2% Specimen found to be 3.5% higher compressive strength than conventional concrete for 30 days.
- Sorptivity results shows that concrete with OSP 2% found to be 10% less capillary rise than conventional concrete for 30 days.

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