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Experimental Study on Partial Replacement of Cement with Fly Ash and Coarse Aggregate with Sea Shells

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ABSTRACT

As there is a rapid development in and around . Infrastructure was developing day by day . There by we can see all type of construction around us taking in to the focus, to reduce the cost we need to implement new techniques and partial replacement of materials. Concrete is a composite material consisting mainly of cement, fine aggregate, coarse aggregate , water. The partial replacement is done in order to reduce the cement content and cost of materials. In this project , we present an experimental study on partial replacement of sea shells and fly ash with coarse aggregate and cement. This will be studied on workability, compressive strength, flexural strength, and split tensile strength at 7days, 14days and 28 days taken at room temperature of M30 concrete with partial replacements of cement by fly ash 5% ,10% and 15% and partial replacement of sea shells with coarse aggregate by 10% ,20% and 30%. The obtained results are compared with conventional concrete.

KEYWORDS: *Compressive strength, Flexural strength, fly ash, sea shells, Split tensile strength*

I. INTRODUCTION

Concrete is a composite material composed of fine and coarse aggregate bonded together with a fluid cement (cement paste) that hardens (cures) over time. In the past lime based cement binders were often used, such as lime putty, but sometimes with other hydraulic cements, such as a calcium aluminates cement or with Portland cement to form Portland cement concrete (for its visual resemblance to Portland stone). Many other non-cementitious types of concrete exist with different methods of binding aggregate together, including asphalt concrete with a bitumen binder, which is frequently used for road surfaces, and polymer concretes that use polymers as a binder.

When aggregate is mixed with dry Portland cement and water, the mixture forms a fluid slurry that is easily poured and moulded into shape. The cement reacts with the water and other ingredients to form a hard matrix that binds the materials together into a durable stone-like material that has many uses. Often, additives (such as pozzolans or super plasticizers) are included in the mixture to improve the physical properties of the wet mix or the finished material. Most concrete is poured with reinforcing materials (such as rebar) embedded to provide tensile strength, yielding reinforced concrete.

Because concrete cures (which is not the same as drying such as with paint) how concrete is handled after it is poured is just as important as before. Concrete is one of the most frequently used building materials. Its usage worldwide, ton for ton, is twice that of steel, wood, plastics, and aluminium combined.

Aggregate consists of large chunks of material in a concrete mix, generally a coarse gravel or crushed rocks such as limestone, or granite, along with finer materials such as sand Cement, most commonly Portland cement, is the most prevalent kind of concrete binder. For cementitious binders, water is mixed with the dry powder and aggregate, which produces a semi-liquid slurry that can be shaped, typically by pouring it into a form. The concrete solidifies and hardens through a chemical process called hydration. The water reacts with the cement, which bonds the other components together, creating a robust stone- like material. Other cementitious materials, such as fly ash and slag cement, are sometimes added—either pre-blended with the cement or directly as a concrete component—and become a part of the binder for the aggregate. Admixtures are added to modify the cure rate or properties of the material.

Structures employing Portland cement concrete usually include steel reinforcement because this type of concrete can be formulated with high compressive strength, but always has lower tensile strength. Therefore, it is usually reinforced with materials that are strong in tension, typically steel rebar.

Other materials can also be used as a concrete binder; the most prevalent alternative is asphalt, which is used as the binder in asphalt concrete. The mix design depends on the type of structure being built, how the concrete is mixed and delivered, and how it is placed to form the structure.

1.1 Need for the study

The program of work undertaken is summarized below: Characteristics of fly ash and sea shells in concrete. In order to assess the characteristics of fly ash and sea shells, the following aspects were considered:

1. Mix design
2. Workability
3. Ease of preparation and finishing.

The workability was assessed using Standard testing equipment and procedures, including Slump cone test. Characteristics of hardened concrete by replacement of cement and coarse aggregate by fly ash and sea shells respectively. The following tests were carried out to establish the engineering properties of fly ash and sea shells in concrete:

1. Compressive strength
2. Split tensile strength
3. Flexural strength

The above properties were determined using Standard testing equipment and procedures.

1.2 Objectives of the project

The present investigation aims at conducting a feasibility study of producing concrete with fly ash as cement and sea shells as coarse aggregate in concrete. Different specimens viz., cubes, cylinders, beams will be cast and tested for obtaining properties like compressive strength, tensile strength and flexural strength. Accordingly, the specific objectives of the present work are listed below.

Objectives of the present work

- The main objective is to encourage the use of these products as construction material in building
- To evaluate the cockle shells and lime powder, compressive strength and split tensile strength at 7 days, 14days and 28 days by replacing in concrete.
- These should reduce the usage of natural products like aggregates.
- Enironmental friendly disposal of cockle shells. Hence this should controls the pollution of environment.

II. LITERATURE REVIEW

The literature review presents the current state of knowledge and examples of successful uses of alternative materials in concrete technology. Some of the earlier studies on the effectiveness in designing of structures with concrete are as follow

Adarsh, A.S and Senthil Kumar, G.R (2018): An experimental study on role of marine shells in cement mortar preparation. In this study Meretrix casta (bivalve) shell powder has experimented as a partial replacement in cementations mortar compositions. Meretrix casta shell powder (MCSP) as partial replacement for cement in the cement mortar with 8.33%, 8.75% and 8.95% of the cement weight. 7days and 28 days compressive strengths of cured mortar cube specim ens were analyzed. The optimum compressive strength is obtained at 8.95% replacement of meretrix casta shell powder in place of cement.

Gurikini lalitha, C.Krishana Raju (2014): Studied the performance of M30 concrete with partial replacement of sea shells and coconut shells. Coarse aggregate is replaced with sea shells and coconut shells at different proportions. Results produced that compressive strength of concrete cubes has gradually decreased from addition of 10 %(5%+5%) of coconut shells and sea shells. Whereas comparing to traditional concrete, compressive strength of 10 %(5%+5%) of coconut shells 5% of seashells increased.

Osarenmwinda et al (2009): Investigated the potential of periwinkle shell as coarse aggregate for concrete. The results showed that concrete produced with ratio (1:1:2, 1:2:3 and 1:2:4) mixes indicate compressive strength of 25.67N/mm2, 19.5N/mm2 and 19.83N/mm2 at 28 days curing age respectively. These strength values met the ASTM-77 recommended minimum strength of 17N/mm2 for structural light weight concrete.

III. MATERIALS AND TEST PROCEDURES

Properties of cement

Various properties of cement such as Specific gravity, Normal consistency, Initial & Final setting time of cement are performed. The cement properties are determined from experimental investigations and presented in Table 3.1. The cement is confirming to the IS: 8112-1989.

Table 3.1 Properties of Cement

S.NO	Characteristics	Values obtained
1	Specific gravity of cement	3.16
2	Fineness of cement	7.2%
3	Standard consistency	33%
4	Initial setting time	35mins
5	Final setting time	600min
6	Compressive strength of cement(MPa) 3days 7days 28days	 28.4 36.9 54.2

Properties of fine aggregates

The properties of Fine aggregates such as Specific gravity, Fineness modulus, Water absorption, Grading of fine aggregates are determined from experimental investigations and presented in a Table. 3.2. Fine aggregate confirming to IS 383-1970.

Table 3.2 Properties of Fine Aggregates

S. No	Property	Test Results
1	Specific gravity (Fine aggregate) Zone II Sand	2.62
2	ineness modulus of Fine aggregates	2.58
3	Bulk Density in Fine aggregates	1.49
4	Water absorption	1.62%

Properties of coarse aggregates

The properties of coarse aggregates such as maximum nominal size, Specific gravity, Water absorption, Fineness modulus, Toughness, Hardness, Bulk density are studied. The properties of coarse aggregates are determined by using IS: 383-1970. Coarse aggregates properties are determined from experimental investigations and presented in Table 3.3.

Table.3.3 Properties of Coarse Aggregates

S.No	Property	Test Results
1	Specific gravity	For 20mm-2.64
2	Water Absorption	For 20 mm-0.62%
3	Bulk density (kg/m ^{3})	1738
4	Flakiness Index %	11.3%
5	Elongation Index	18.9%
6	Aggregate Impact Value	28.6%
7	Aggregate Crushing Value	26.459%
8	Fineness modulus	6.27

SEA SHELLS

A cockle is an edible, marine bivalve mollusc. Although many small edible bivalves are loosely called cockles, true cockles are species in the family Cardiidae. True cockles live in sandy, sheltered beaches throughout the world. The distinctive rounded shells are bilaterally symmetrical, and are heart-shaped when viewed from the end. Numerous radial, evenly spaced ribs are a feature of the shell. There are more than 205 living species of cockles, with many more fossil forms. Seashell is a waste obtained near the seashore area as the result of disintegration of dead animals. Seashell consists of three layers outer, intermediate and inner layer .Outer layer is made up of calcite material whereas inner layer is otherwise known as nacre which is made up of calcium carbonate. Since 95% of calcium carbonate present in seashell, it has the strength nearly equal to coarse aggregate. The sieve analysis for seashell is executed to find out its size.

Fig. 3.1 Sea shells

3.4.1 Properties of sea shells

- Specific gravity and water absorption of sea shells
- Crushing strength of sea shells

3.4.2 specific gravity and water absorption of sea shells

Specific gravity test of aggregates is done to measure the strength or quality of the material. Specific Gravity is the ratio of the weight of a given volume of aggregate to the weight of an equal volume of water. It is the measure of strength or quality of the specific material. Aggregates having low specific gravity are generally weaker than those with higher specific gravity values. Higher specific gravity of material will corresponds to

1. Enough strength against impact load i.e., toughness
2. Higher value of Abrasion and attrition i.e., Los Angeles Test
3. Better soundness i.e. less impact of seasonal weathering 4 .Lesser water absorption

3.5 FLY ASH

Fly ash is a heterogeneous by-product material produced in the combustion process of coal used in power stations. It is a fine grey coloured powder having spherical glassy particles that rise with the flue gases. As fly ash contains pozzolonic materials components which reach with lime to form cementitious materials. Thus Fly ash is used in concrete, mines, landfills and dams.

Fig. 3.2 Fly ash

3.5.1 Chemical Composition of Fly Ash

The chemical composition of fly ash depends upon the type of coal used and the methods used for combustion of coal.

Table 3.4: Chemical composition of fly ash of different coals.

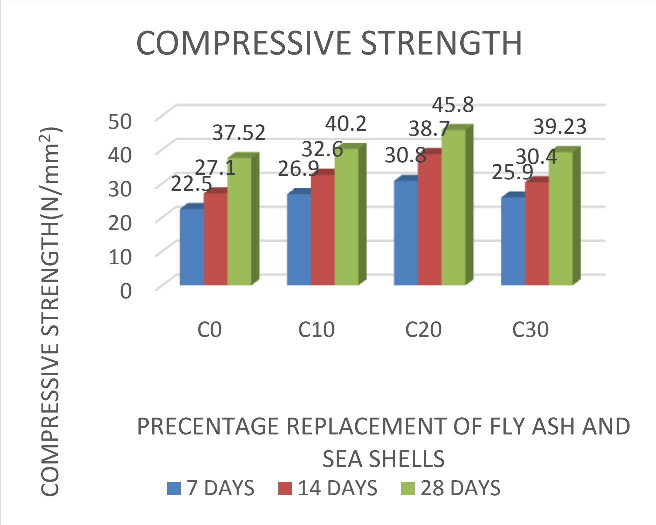
Component	Bituminous Coal	Sub bituminous Coal	Lignite Coal
SiO_2 (%)	20-60	40-60	15-45
Al_2O_3 (%)	5-35	20-30	20-25
Fe_2O_3 (%)	10-40	4-10	4-15
CaO (%)	1-12	5-30	15-40
LOI (%)	0-15	0-3	0-5

IV. Results and Discussions

The Testing of Hardened concrete plays a vital role in governing and checking the quality of cement concrete works and helps to determine the performance of the concrete with respect to strength and durability. In this study, for each batch of concrete, one cube of 150mm x 150mmx 150mm sizes are tested for Compressive Strength, one cylinder of 150mm diameter x 300mm height size are tested for Split Tensile Strength and one beam of 500mm length x 100mm length x 100mm width are tested for Flexural Strength.

Table 4.1 Compressive Strength for Cube

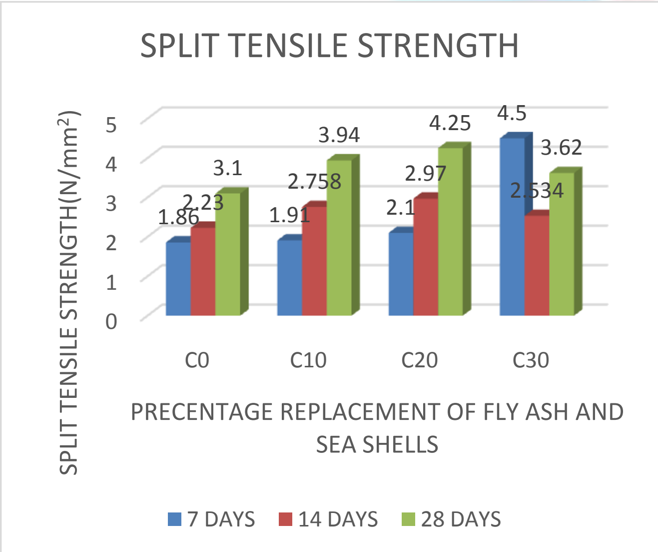
S.NO	MIX DESIGNATION	REPLACED CONCRETE %		COMPRESSIVE STRENGTH N/mm²		
		FLY ASH %	SEA SHELLS %	7 DAYS	14 DAYS	28 DAYS
1.	C_0	0	0	22.5	27.1	37.52
2.	C_{10}	5	10	26.9	32.6	40.2
3.	C_{20}	10	20	30.8	38.7	45.8
4.	C_{30}	15	30	25.9	30.4	39.23



Graph 4.1 Compressive Strength Results

Table 4.2 Split Tensile Test for Cylinder

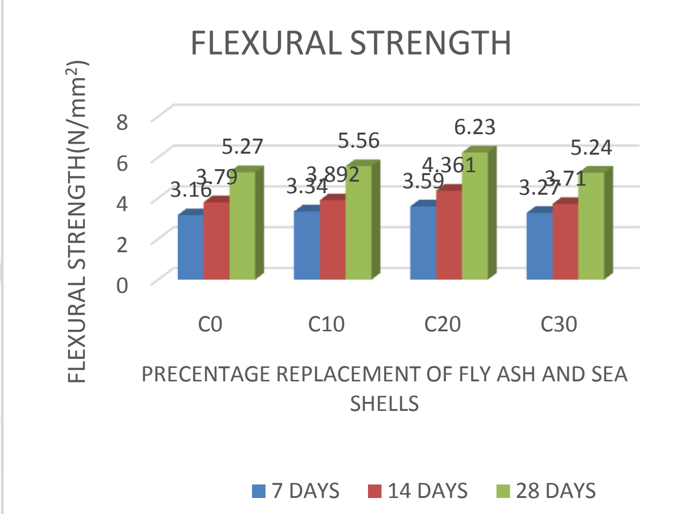
S.NO	MIX DESIGNATION	REPLACED CONCRETE %		TENSILE STRENGTH N/MM²		
		FLY ASH %	SEA SHELLS %	7 DAYS	14 DAYS	28 DAYS
1.	C_0	0	0	1.86	2.23	3.1
2.	C_{10}	5	10	1.91	2.758	3.94
3.	C_{20}	10	20	2.1	2.97	4.25
4.	C_{30}	15	30	1.79	2.534	3.62



Graph 4.2 Split Tensile Strength results

Table 4.3 Flexural Strength

S.NO	MIX DESIGNATION	REPLACED CONCRETE %		FLEXURAL STRENGTH N/MM²		
		FLY ASH %	SEA SHELLS %	7 DAYS	14 DAYS	28 DAYS
1.	C_0	0	0	3.16	3.79	5.27
2.	C_{10}	5	10	3.34	3.892	5.56
3.	C_{20}	10	20	3.59	4.361	6.23
4.	C_{30}	15	30	3.27	3.71	5.24



Graph 4.3 Flexural Strength Results

V. CONCLUSION & FUTURE SCOPE

Based on the experimental investigation conducted on conventional concrete and modified fly ash and sea shells concrete the conclusions are drawn out as follows:

The basic properties like Specific gravity, impact strength and crushing strength of ferrochrome slag aggregates are higher than conventional concrete. The percentage replacement of 10% fly ash with 20% sea shells was found to have a greater compressive strength, split tensile strength and flexural strength. So it is better than other replacements.

FURTHER SCOPE OF WORK:

Although several studies were conducted on behavior of normal concrete and by replacing cement with Fly ash and coarse aggregate with sea shells. Different physical and mechanical properties on fly ash and sea shell concrete were also studied to find the optimum dosage of fly ash and sea shells. Following few avenues may be studied further to understand to deliver guidelines useful for design of concrete structure. The grade of cement used in present study is 53. The study can be further investigated with 33 and 43 grades. The grade of concrete used is M30 and the study further investigated with M25 and M35. Experimenting the concrete mixes containing 0%, 5%, 10%, 15%, and of fly ash as partial replacement of cement along with partial replacement of coarse aggregate by sea shells

0%,10%,20%,30% and also we can mix different percentages.

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