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A RESEARCH ON PRACTICAL STUDY OF M30GC BY LIMITED REPLACEMENTS OF COCONUT SHELL AS COARSE AGGREGATE & ORANGE PEEL ASH WITH CEMENT

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ABSTRACT

Material shortages throughout the supply chain have become a serious problem. Effective material management is vital to solve shortages and limit inventory costs. The continued demand for building services leads to increasing costs. Sustainable building materials serve a crucial role in resolving environmental issues and boosting resilience in civil engineering projects. The easiest technique to handle this problem is includes the waste products towards elements in concrete. As we know that so many wastes which can be used in traditional concrete like E- wastes, biomedical wastes, Agricultural wastes etc.

Coconut casing and orange peel ash are also the key waste which is easily and plenty available in home needs and that can be used in usual concrete. Coconut shell material could be used in rural areas and places where coconut is plentiful and may also be used where the usual aggregate is costly. With a focus on the strength properties of OPA-cement blends for cement replacement ranging from 0-12% at 2% intervals, this investigation will examines the potential of orange peel ash (OPA) as a cement replacement material. The effect of varied % additions of OPA on the qualities of fresh concrete was investigated experimentally by measuring consistency, fineness of cement, soundness of cement, setting times, workability, compressive, split tensile strength and flexural strengths. An ideal concentration of 0%, 2%, 4%, 6%, 8%, 10% & 12% of OPA admixture was determined, and consistency improved with increasing additions on M30 Grade of Concrete.

The Coconut Shells(CS) were taken on constant 5% with replacement of coarse aggregate and Orange Peel Ash(OPA) were taken on 0%, 2%, 4%, 6%, 8%, 10% & 12% with limited replacement of cement on M30 Grade of Concrete(GC).This study continues to seek creative methods to employ such materials in sustainable building processes.

Keywords: Coconut Shell (CS), Orange Peel Ash (OPA), Cement & M30 GC.

I. INTRODUCTION

In recent years, alternatives for materials used in concrete production have gained widespread adoption, and the suggestion to utilize different materials assists in managing concrete resources. Coconut shell (CS) serves as one aggregate, and numerous research studies have been conducted on coconut shell concrete. It has been established that in all these investigations, CS was utilized in place of traditional coarse aggregate and yielded favorable outcomes for creating reinforced concrete. To minimize the usage of ordinary Portland cement and aid in reducing CO_2 emissions, OPA can be employed, thus decreasing the landfill of OPA and protecting the environment.

Terminologies

1.2.1 Coconut shell

Coconut shell was sun dried for 2 months before being crushed by the quarry. But In general I have collected the coconut shell in the home itself and dried up for 15- 20 days. This is to ensure that the moisture content is reduced to the minimum. The crushed coconut shell was shortly transported to the lab where they were thoroughly cleaned and washed, then permitted to dry below ambient temperature.

The coconut shells will be in the shapes of flaky, elongated, curved, roughly parabolic and other irregular shapes. In order to ascertain the properties of coconut shell aggregate the following tests are made they are specific gravity, bulk density, particle size distribution, aggregate impact value, aggregate crushing value, water

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absorption value. The chemical compositions of the Coconut shell are about lignin of 36.51%, cellulose of 33.61%, pentosans of 29.27% and powder of 0.61%.

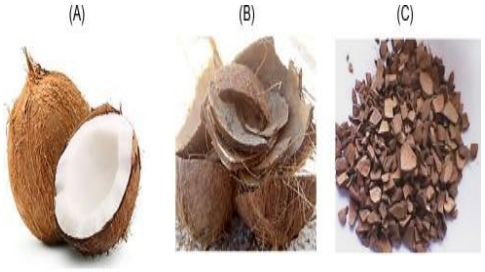

Figure 1: Coconut Shell Pieces

1.2.2 Applications

- ✓ It is used in low cost building and marine structures
- ✓ Used as concrete blocks
- ✓ Eco friendly

1.2.3 Advantages

1. **Eco-friendly building material** – Coconut shell concrete is a green option, meaning it's kinder to the setting as it uses waste products as an alternative of depleting natural resources.
2. **Reduces construction costs** – It's also a way to cut down on building expenses. By using this type of concrete, the overall cost of construction can be significantly reduced.
3. **Enhances concrete strength** – The strength of concrete can be improved by adding coconut shells. This results in a robust and durable structure that can withstand heavy loads.
4. **Lighter than traditional concrete** – Compared to conventional concrete, this category of concrete is lighter, making it easier to hold and moved.
5. **Good heat filling properties** – It offers excellent heat insulation. This property helps to keep buildings cool in hot weather, leading to energy savings and increased comfort.

1.2.4 Disadvantages

1. **Difficult to source constantly** – Consistent sourcing of coconut shells can be a dare, leading to issues with material accessibility.
2. **Increased water absorption** – This variety of concrete absorbs further water, which could potentially deteriorate its structure over time.

1.3 OPA

Certainly! Let's delve into the background of **Orange Peel Ash (OPA)** as a cement replacement material.

1.3.1 Research Findings:

- ❖ **Objective**: Researchers investigated the potential of OPA as a cement substitute, focusing on its impact on various properties of OPA-cement blends.
- ❖ **Calcination Conditions**: The optimal calcination temperature and time for orange peel were determined. The best conditions were achieved by calcining the peel at 600°C for 2 hours.
- ❖ **Physicomechanical Properties**:
  - o **Consistency**: As OPA content increased from 2.5% to 10%, the water required for consistency also increased due to unburnt carbon content in the ash.
  - o **Setting Time**: Gradual increases in OPA content led to prolonged setting times, attributed to reduced clinker content and higher water demand.
  - o **Soundness**: OPA-cement blends showed an increase in free lime content as OPA content rose from 2.5% to 10%.

1.3.2 Strengths: Compressive and flexural strengths decreased with higher OPA content. However, over curing days, strengths improved. Remarkably, 5% cement replacement with OPA did not adversely affect strength compared to ordinary Portland cement (OPC) due to pozzolanic reactions, especially at 28 days.

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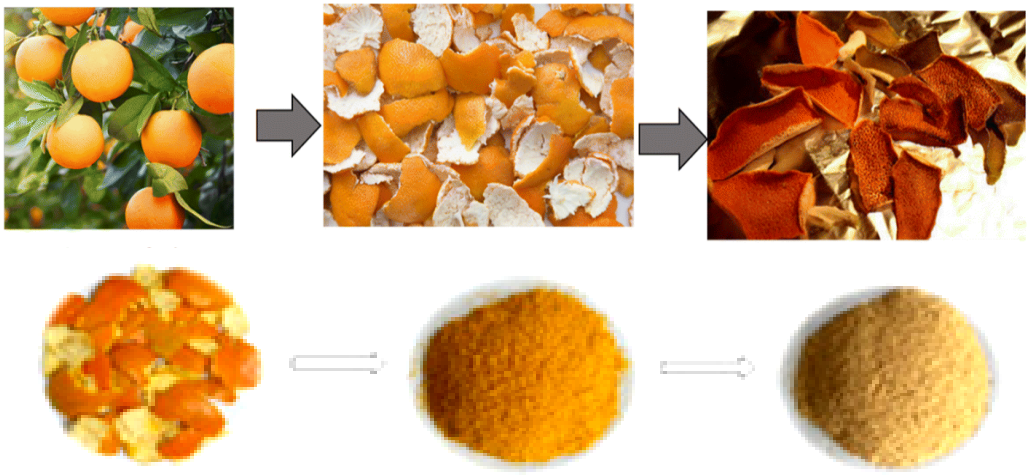

Figure 2 Orange Peel Ash

1.4 Objectives

- To get better understanding of the coconut shell and orange peel ash as a construction material.
- To know the properties of coconut shell and rice husk powder.
- Study of compressive strength, flexural strength, split tensile strength of concrete by conducting different tests on cement, fine aggregate, coarse aggregate.
- To prepare the cubes, cylinders, beams of concrete by using coconut shell and orange peel ash.

Future Scope

❖ In future, first proper mix design for the project is equipped &then the coconut shell is compacted either by mechanical or by using hammer.

❖ The mix proportions of normal coarse aggregates and the coconut shells as coarse aggregates are also kept prepared as 1% to 10% coconut shells with accepted coarse aggregates by weight.

❖ The Orange peel ash can be used up to 12% in the place of cement.

❖ Physical properties of the coconut shell aggregate are examined.

❖ Tests namely compressive strength, tensile strength, flexural strength, durability test is carried.

1.7 Limitations

1. Study was carried out on M30 grade of concrete.
2. Proportion of coconut shell was kept 5% Constant.
3. Orange peel ash proportion was kept as 0%, 2%, 4%, 6%, 8%, 10% and 12%.

II. LITERATURE REVIEW

The feasibility of using Orange peel ash (OPA) as a substitute for cement was explored, concentrating on how varying OPA levels affect the physio-mechanical characteristics, such as consistency, setting times, soundness, compressive, and flexural strengths of the OPA-cement mixture for cement replacement ranging from 1. 5-3. 5% in 1% increments. The ideal calcination temperature and duration for orange peel (OP) were determined by heating the OP at different temperatures (600 °C, 700 °C, 800 °C) and times (1 hr. and 2 hrs.), respectively. Consistency and setting time measurements were carried out using a Vicat apparatus on the binary cement pastes, following ASTM standards. The findings revealed that the amount of water needed for consistency increased as the OPA percentage rose from 1. 5-3. 5 %, which was linked to the residual carbon present in the ash. The soundness of the OPA cement mixture showed a rise in free lime content as the OPA proportion increased from 1. 5-3. 5 %. Compressive and flexural strengths decreased with the gradual increase of OPA content, while improvements in strengths were noted as the number of curing days increased. Additionally, it was noted that a 1% cement substitution with OPA did not negatively impact the strength compared to the OPC control, owing to the pozzolanic reaction that led to enhanced strengths, particularly at 28 days.

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Rathanak and Ranat (2005) reported the great potential of coconut shell powder as a filler in producing biodegradable plastic composite in future. They studied the mechanical properties and bio degradability study of coconut shell powder filled low density polyethylene filler. The parameters tested include mechanical testing, tensile, and burst test. While the biodegradable test was carried out using microbes, Pseudomonas and E. Coli. It was concluded that the integration of coconut shell powder resulted in increment in modulus of elasticity burst strength and biodegradability, but reduction of tear strength, tensile strength and elongation at break. This is due to poor adhesion between the polymer and fiber.

III. MATERIALS USED AND METHODOLOGY

3.1 MATERIALS:

3.1.1 Cement:

Specific gravity of cement is 3.15. Ordinary Portland cement grade 43 of IS 8112-1976 was used for this project. Portland cement used in this investigation. The tests on the cement were done in Dr kvsr civil labs. I have used the UltraTech cement in this project. The Portland cement conformed to the standards.

3.1.2 Fine aggregate:

Sand with particle size less than 4.75 mm, Fine aggregate usually consists of natural, crushed, or manufactured sand. Natural sand is the common component for regular weight concrete. In various cases, manufactured light weight particles used for lightweight concrete and mortar.

3.1.3 Coarse Aggregate:

Use 20 mm crushed stone with a specific gravity of 2.45 & a density of 1389 kg/m^3 as coarse aggregate. Smaller sized aggregates make higher concrete strength. Regularly an aggregate with specific gravity more than 2.55 and absorption less than 1.5% (except for light weight aggregates) can be regarded as being of excellent quality. Where aggregates strength is higher, concrete strength is also higher.

3.1.4 Coconut shell:

Coconut shell pieces is a waste product from coconut shell and dried up for some time and then crushed it into pieces, piece crushed into 20mm same as coarse aggregate size and spe cific gravity of 1.47. The coconut shells are obtained from a local coconut field or from home itself. It should be sun dried facing being crushed by hand. Coconuts show a wide diversity in size, shape, weight and color, depending on genetic variety and maturity of the nut at harvest. The particle sizes of the coconut shell range from 5 to 20 mm.

3.1.5 Orange peel ash:

Orange peel ash is a waste product from the rice grain industry by burning this husk grains, rice husk has a mass of 95µ and spe cific gravity of 2.14. It is a fine powder resulting from the combustion of rice grain industry and collected in the Electrostatic Precipitators. Conversion of waste into a resource material is an age-old practice of civilization.

Figure 3 Cement, Fine Aggregate, Coarse Aggregate, Coconut Shell, Orange Peel Ash

3.2 METHODOLOGY:

3.2.1 Preparation of materials:

The rice husks and coconut shells were subjected to sun drying to remove moisture. Then, it was subjected to uncontrolled combustion through an open-air burning and allowed to cool. Then, the materials were sent to the hollow block-making station

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3.2.2 Sample Preparation

Samples will be prepared for each mix by mixing the materials in the concrete mixer according to the mix design. The samples will be cast in cube molds, cylinders, beams of standard dimensions and cured in water for 7, 14, 28 days.

3.2.3 Steps:

- Collecting the coconut shell from coconut waste and the orange peel ash from rice waste.
- Replacing 5% aggregate by coconut shell and variation of 0% with addition of 4% up to 24% cement by orange peel ash.
- And then all these materials are mixed with cement and M30grade of concrete is made.
- Then after the appropriate amount of water is added on it and the concrete paste is made.
- After paste is made the concrete is putted on mould so that it get proper shape for our experimental work.
- And after 24 hours it is kept for curing. Then at last after 7 days, 14 days, 28 days the concrete cubes are tested.

3.2.4 Testing of cubes

- Compressive strength will be measured at 7, 14, and 28 days using a compression testing machine.
- Flexural strength will be measured at 7, 14, and 28 days using a Flexural testing machine
- Split Tensile strength will be measured at 7, 14, and 28 days using a compression testing machine or split tensile testing machine.

Figure 4 Concrete materials with CS&OPA, Cubes, Cylinders

IV. MIX DESIGN

Grade	M30
Proportion	1:1.49:2.49
W/C ratio	0.45
Cement	438
Fine Aggregate	654
Coarse Aggregate	1089
Water	197

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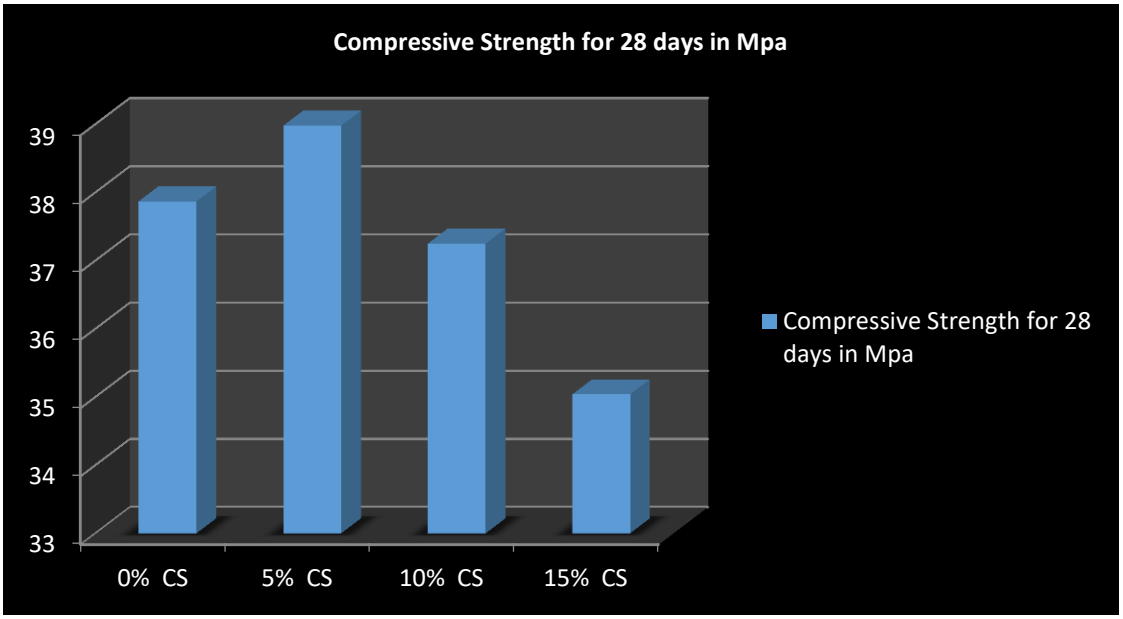
V. TEST RESULTS

5.1 Compressive Strength To Coconut Shell For 28 Days At Different Percentages

Table 5.1 compressive strength to coconut shells for 28 days

Mix % Replacement	Compressive Strength for 28 days in Mpa
0% CS	37.87
5% CS	38.98
10% CS	37.25
15% CS	35.04



Graph 5.1 compressive strength to coconut shell for 28 days

5.2 Flexural Strength To Coconut Shell For 28 Days At Different Percentages

Table 5.2 Flexural Strength To Coconut Shell For 28 Days

Mix % Replacement	Flexural Strength to coconut shell for 28 days in Mpa
0% CS	5.8
5% CS	6.95
10% CS	6.26
15% CS	5.5

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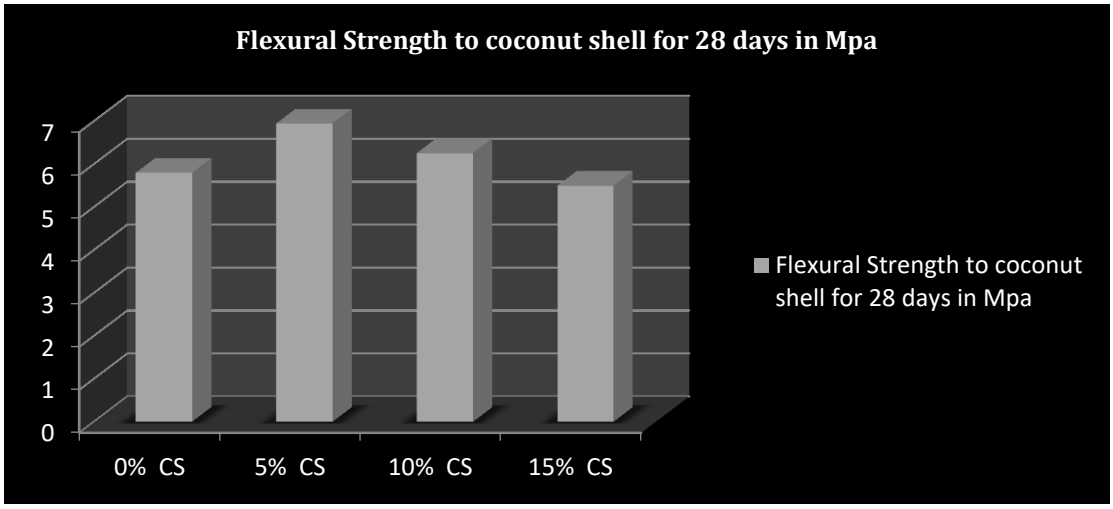
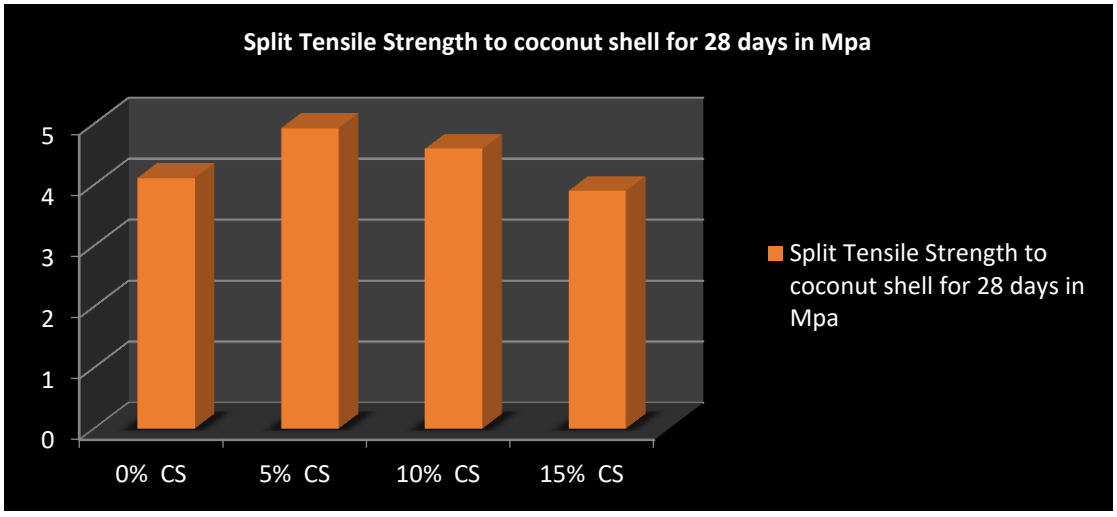


Graph 5.2 Flexural strength to coconut shell for 28 days

5.3 Split Tensile Strength To Coconut Shell For 28 Days At Different Percentages

Table 5.3 Split tensile strength to coconut shell for 28days

Mix % Replacement	Split Tensile Strength to coconut shell for 28 days in Mpa
0% CS	4.11
5% CS	4.93
10% CS	4.59
15% CS	3.9



Graph 5.2 Split tensile strength to coconut shell for 28 days

5.4 Compressive Strength for 7, 14.28 Days

Table 5.4 Compressive strength for 7, 14, 28 days

Mix % Replacement	7 days in Mpa	14 days in Mpa	28 days in Mpa
5% CS+ 0% OPA	24.54	28.01	36.11
5% CS+ 2% OPA	25.58	28.77	36.77
5% CS+ 4% OPA	25.97	29.24	37.09
5% CS+ 6% OPA	26.34	31	37.58
5% CS+ 8% OPA	26.73	31.93	38.14

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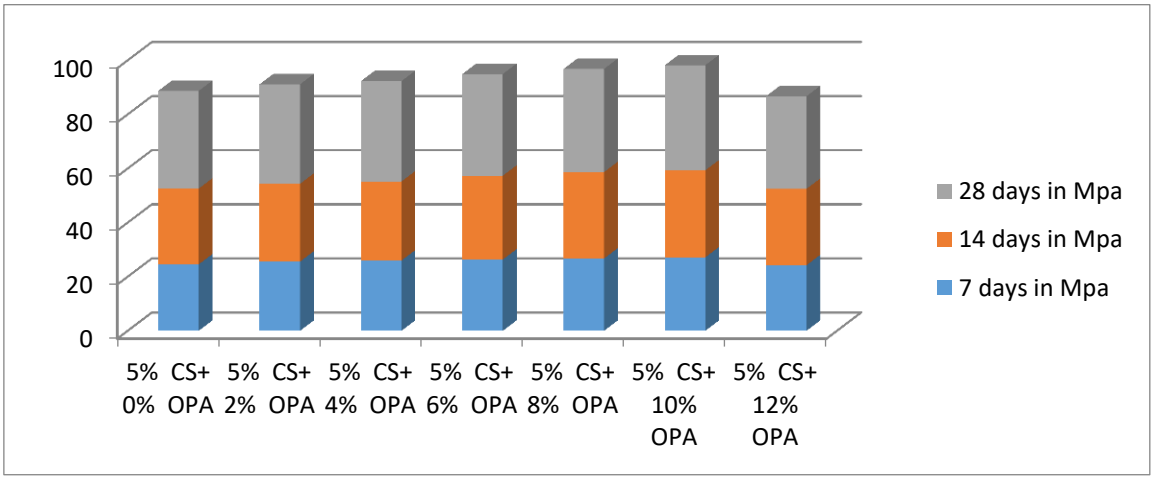
5% CS+ 10% OPA	27.15	32.15	38.87
5% CS+ 12% OPA	24.24	28.24	34.24

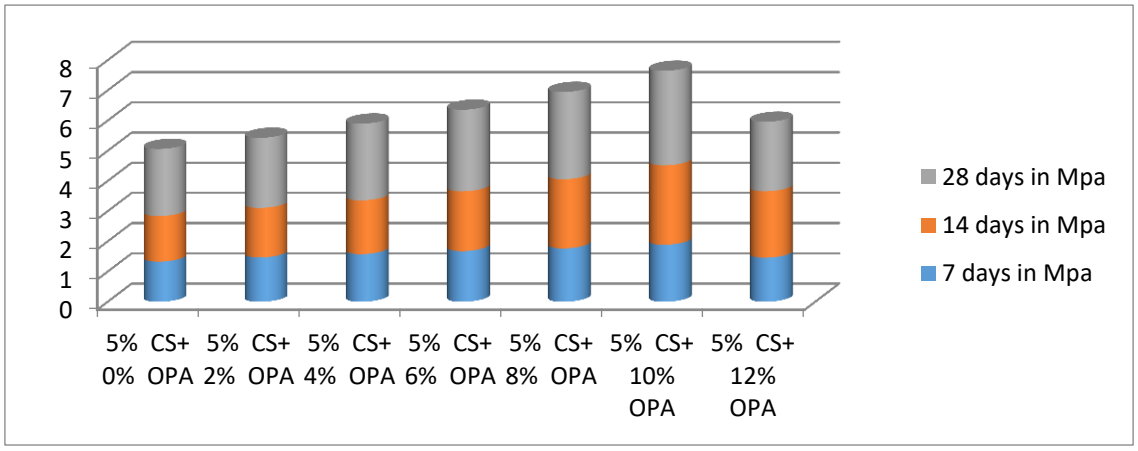


Graph 5.4 Flexural strength to coconut shell for 7,14,28 days

5.5 SPLIT TENSILE STRENGTH FOR 7, 14.28 DAYS

Table 5.5 Split tensile strength for 7,14,28 days

Mix % Replacement	7 days in Mpa	14 days in Mpa	28 days in Mpa
5% CS+ 0% OPA	1.33	1.51	2.22
5% CS+ 2% OPA	1.47	1.64	2.32
5% CS+ 4% OPA	1.58	1.78	2.54
5% CS+ 6% OPA	1.68	1.98	2.7
5% CS+ 8% OPA	1.77	2.29	2.89
5% CS+ 10% OPA	1.89	2.63	3.13
5% CS+ 12% OPA	1.46	2.2	2.3



Graph 5.5 comparision of split tensile strength for 7,14,28 days

5.6. Flexural Strength For 7, 14, 28 Days:

Table 5.6 Flexural strength for 7,14,28 days

Mix % Replacement	7 days in Mpa	14 days in Mpa	28 days in Mpa
5% CS+ 0% OPA	1.53	3.51	4.32
5% CS+ 2% OPA	1.65	3.64	4.87

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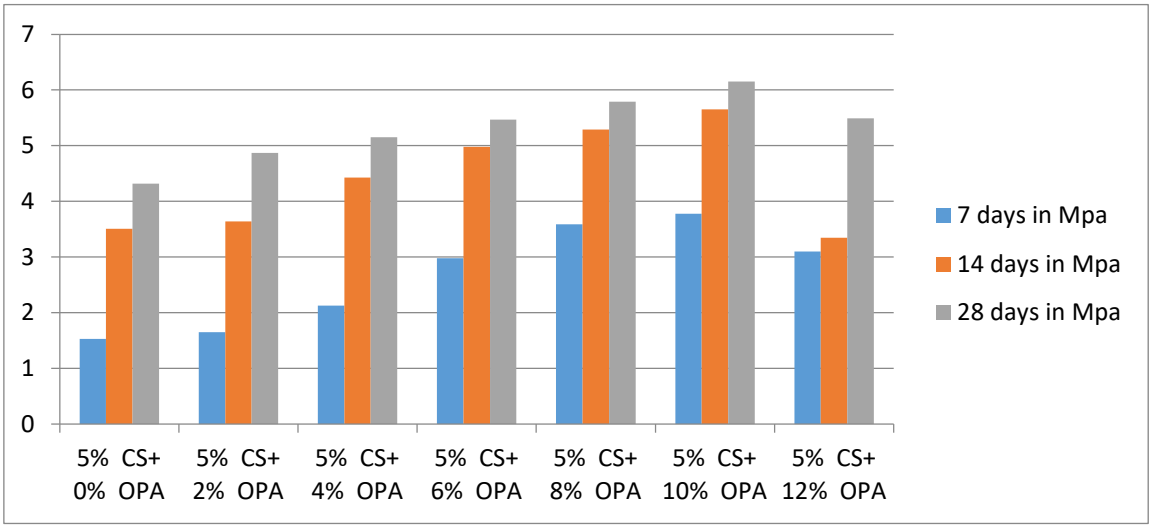
5% CS+ 4% OPA	2.13	4.43	5.15
5% CS+ 6% OPA	2.98	4.98	5.47
5% CS+ 8% OPA	3.59	5.29	5.79
5% CS+ 10% OPA	3.78	5.65	6.15
5% CS+ 12% OPA	3.1	3.35	5.49



Graph 5.6 Comparision of Flexural strength for 7, 14, 28 days

VI. CONCLUSION

The main aim of this research is to compare and to know the strength properties of concrete like compressive strength, split tensile strength, flexural strength for M30 grade of concrete with water-cement ratio of 0.45 and As I observed from the analysis of data from discussion in this study, it can be concluded that overall strength of concrete is increased. Orange peel ash concrete show better workability of concrete compared with the workability of coconut shell concrete. Based on the tests conducted on concrete on different percentages of coconut shell was taken to know the constant value and at 5% of coconut shell is increased the strength properties as reference from the above study I have taken constant 5% coconut shell and 0% with 2% increase of orange peel ash up to 12% then the compressive shows that the on 5% coconut shell and significantly compared with the 10% orange peel ash the concrete gets maximum strength. The compressive strength of a concrete at 7 days, 14 days and 28 days are 27.15 Mpa, 32.15Mpa and 38.87Mpa respectively. However, the large addition value of replacement percentage can also reduce the strength of concrete.

Same as compressive strength ,the split tensile strength, flexural strength also increased with constant 5% CS and 10% OPA then gradually decreased was observed based on the data and discussion, So the partial replacement with coconut shell as coarse aggregate and rice husk powder with cement if suitable for concrete grade of M30 at 5% CS and 10% OPA.

As per the results coconut shell and orange peel ash confirm that the it has light weight concrete property and also using of both waste materials can reduce the cost of construction, reduces the depletion of natural sources of conventional concrete and also helpful to make eco-friendly environment. It can be used in partition walls, floors, tiles, concrete brick blocks etc.

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