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AN EXPERIMENTAL STUDY ON THE MECHANICAL PROPERTIES OF CONCRETE BY PARTIAL REPLACEMENT OF CEMENT WITH COCONUT SHELL ASH AND COARSE AGGREGATES WITH PLASTIC WASTES

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Abstract - *Cement, Coarse aggregate, Fine aggregate, Water and Admixtures are used in combined form to prepare concrete. The demand for concrete is expected to rise by the year 2050 by which the estimated production of concrete is about 18 billion tonnes annually. There is huge demand of concrete as the construction paces with time. The cement production pollutes our environment and causes the depletion of our natural resources. Other concrete constituents like coarse aggregates, generally obtained from crushed rocks can pollute the environment too. Most of the researchers have already worked a lot to reduce the use of cement and replace cement with such suitable materials, which give the properties like the concrete. The focus is being put forwarded to the utilization of industrial and agricultural wastes, as they are the environmental burden. In this experimental work, coconut shell ash partially replaced cement by percentages of 0%, 8%, 16%, 24% and 32% and coarse aggregates with plastic wastes at pace of 0% , 12%, 24%, 36% and 48% are done to make sustainable concrete mix. M20 Grade of concrete mix is prepared for experimentally investigate the fresh and hardened state properties. Cubes, Cylinders and Beam specimens were prepared and cured for 7days and 28 days before testing. From the study it has been observed that the test results shows optimum proportion for concrete mix and are within acceptable limits.*

Key Words: **Coconut Shell Ash, Cement, Coarse Aggregates, Plastic Wastes, Compressive strength, Tensile Strength, Flexural Strength, Concrete mix, Workability.**

1. INTRODUCTION

By the year 2050, the concrete requirement is expected to about 18 billion tonnes annually for construction projects. Consequently, the cement demand is also increasing with every passing day. The present use of cement is evaluated to be around 12 million tonnes per year and is yet expanding day by day. The factual data state that one-tonnes of cement production exhaust around one tonnes of CO_2, which directly affects our atmosphere. Other, constituents of concrete like coarse aggregates obtained by cutting and blasting of hills and mountains also affects the environment. With the previous studies, researchers have done number of investigations on the reduction of usage of cement i.e. it is partially replaced with other suitable materials like GGBFS, Silica Fumes, Coconut Shell Ash, etc. and makes the sustainable concrete. Some researchers also studied over the concept of aggregate replacement with substitute of other wastes. The versatility, strength and durability of cement are of utmost priority over other construction materials. The basic materials for concrete production are: cement, fine aggregate (sand), coarse aggregate (granite chippings or gravel) and water, and sometimes admixtures are also used to improve the properties of concrete mix. The overall cost of concrete production depends largely on the availability of these basic constituents. Reduction in construction costs and the ability to produce light-weight concrete structures (LWC) are added advantages. The primary aim of this study is to determining the suitability of partial replacement of cement with coconut shell ash (CSA) and Coarse aggregates with Plastic Wastes in concrete so as to minimize their ill effects in the environment too.

1.1 ADVANTAGES OF COCONUT SHELL ASH

1. Because of its superior natural structure and low ash content, coconut shell is a great material for manufacturing carbon black.

2. A substitute for cement that can be used to partially replace cement is agricultural waste.

3. CO2 emissions are nearly nonexistent.

4. Enhances the concrete mix's strength and durability.

5. Lessens the mix's permeability.

6. Increases the concrete's capacity to be worked.

1.2 ADVANTAGES OF PLASTIC WASTE IN CONCRETE

1. Increase pumpability over long distances and mix cohesiveness
2. Increase impact resistance, abrasion resistance, and freeze-thaw resistance

3. Strengthen the plastic's resistance to shrinkage during curing.
4. Increase ductility and structural strength,
5. Minimize the need for steel reinforcement,
6. Crack widths should be narrowed and strictly controlled to increase longevity..

2. LITERATURE REVIEW

Edmund T.S.J.*, Jun Hon C., F Hejazi and M. S. Jaafar (2019) studied about partial replacement of aggregates with plastic Waste and stated the mechanical properties of the concrete. With different percentage replacement of aggregates will affect the different properties such as slump, compressive strength and ultimate strength of the concrete and compare with the control sample in order to find the suitable percentage of the waste plastic to replacement of aggregates for the concrete used. It was found that partial aggregates replacement has lower compressive quality of the concrete, almost the same or lower slump test value for ordinary concrete and waste plastic concrete and lower density for the waste plastic concrete compare to the ordinary concrete.

Aadeala A.J, olaoye J.O & adeniji A.A (2020) researches about Potential of cement replacement with coconut shell ash in Concrete Production. Concrete cubes were produced using graded levels of 0, 10, 15, and 20 percent replacement of CSA for Ordinary Portland Cement. The concrete mix ratio of 1:2:4 with water cement ratio of 0.5 were used and total of 60 cubes were produced and cured in water for 7, 14, 21 and 28 days. Workability, density, compressive strength and water absorption were determined in accordance to British Standards and pozzolanic property in accordance to American Standards. The results showed that the densities of concrete cubes for 5% replacement was above 2400Kg/m 3 while compressive strength were 25.17 N/mm2 , 24.72 N/mm2 , 23.08 N/mm2 and 20.94N/mm2 in step of 5% up to 20% at 28 days. It was observed that 10% replacement of CSA as has the lowest water absorption of 0.66%. XRF analysis showed that the CSA belongs to class F. Thus, replacement of OPC with CSA from 5% up to 15% is recommended for normal weight concrete production. (BS 8110:2, 1985).

Mohd Fazil Danish, Dr. Kuldeep Dabhekar, Dr. Isha Khedikar, Manish Lende(2020) researches about review on partial replacement of coarse aggregate. This waste material must be reused so as to manage the restricted natural aggregate and to decrease construction wastes. This article is tied in with looking into the ideal level of various material as substitution of coarse aggregate as well as fine aggregate.

Naraindas Bheela, Sajjad Ali Mangib & Shanker Lal Meghwar (2021) This research explores the use of coconut shell ash to partially replace cement. This study's objective is to see how different quantities of coconut shell ash (CSA) behave in concrete. Coconut shell is a plentiful resource and a waste product in the local agricultural areas. In contrast, the manufacture of cement releases a lot of poisonous chemicals into the atmosphere, which contributes to environmental pollution and the production of greenhouse gases. CSA might therefore be used as a cementitious component in concrete to promote sustainable development. It has been discovered that adding 10% CSA to concrete improves its mechanical qualities, such as compressive strength, split tensile strength, and flexural strength, after each curing day. Also, the workability of fresh concrete decreased as the percentage of CSA increased whereas the modulus of elasticity increased when 10% of CSA was used in concrete. Moreover, the usage of CSA in concrete can lower the overall cost of producing concrete while lowering the overall carbon footprint.

2.1 OBJECTIVES

1. To minimise the use of cement and make an economical concrete by replacing cement with agricultural wastes i.e. CSA.
2. To optimise the percentage of Coconut Sell Ash and Plastic Coarse Aggregates for mixing in M20 grade concrete.
3. To Study the workability of concrete by slump test containing varying percentage of Coconut Sell Ash and Plastic Coarse Aggregates.
4. To determine maximum value of Compressive Strength, Split Tensile strength and Flexural strength of concrete containing Coconut Sell Ash and Plastic Coarse Aggregates.

3. MATERIALS

3.1 CEMENT

The cement used in this research is 43 grade OPC of trademark ACC.

3.2 WATER

The potable water used in concrete mix to maintain its strength. The pH range of water should be within normal limits in order to prevent concrete quality issues.

3. 3 FINE AGGREGATES

The particles which are passing through 4.75 mm sieve known as fine aggregates. The Fine Aggregate was used in this study confirming to IS: 383-1970.

3.4 COARSE AGGREGATES

Coarse aggregate and its grading are carried out in accordance with the instructions in IS: 383-1970. The aggregates utilized is 10 mm in size. Here, angular-shaped crushed pebbles are used in experimental work.

3.5 COCONUT SHELL ASH

Coconut shell, has cause copiously obtainable agricultural waste from local coconut industries. The coconut shell was obtained from local areas of Jammu to carry out our experimental work. The properties of Coconut shell ash are discussed below in Table 3.1

Table 3.1: Chemical Composition of Coconut Shell Ash

Source: Jurnal Kejuruteraan 33(1) 2021: 27-38 https://doi.org/10.17576/jkukm-2020-33(1)-03

Constituents	Values
SiO_2	37.90
Al_2O_3	24.12
Fe_2O_3	15.48
CaO	4.98
MgO	1.89
Na_2O	0.95
K_2O	0.83
P_2O_5	0.32
SO_3	0.71
Loss of ignition	11.94

Figure 3.1: Coconut Shell Ash

3.6 PLASTIC WASTE

The reuse of plastic waste as a substitute for aggregate in concrete production can help in mitigating and addressing the environmental pollution problems related to plastic. The properties of plastic waste as coarse aggregates are discusses below in table 3.2

Table 3.2: Properties of Plastic waste as coarse aggregates

Source: Ahmad et.al. Performance Evaluation of Plastic Concrete Modified with E-Waste Plastic as a Partial Replacement of Coarse Aggregate. Materials 2022, 15, 175. https://doi.org/10.3390/ ma15010175

Property	Values
Max. nominal size (mm)	20
Min. nominalsize (mm)	4.75
Specific Gravity	1.21
Color	Black brown
Shape	Angular
Aggregate crushing value	1.3
Aggregate impact value	8.1
Fineness modulus	NIL
Bulk density (g/cm^3)	0.49

Figure 3.2: Plastic Coarse Aggregates

4. RESULTS AND DISCUSSIONS

4.1 WORKABILITY TEST

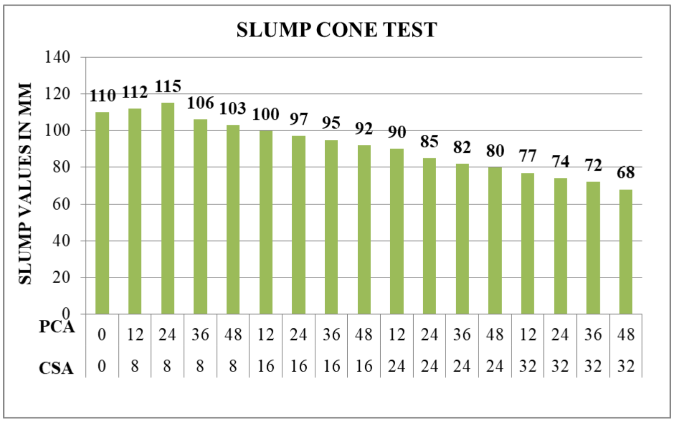

Figure 4.1 Workability test results

4.2 COMPRESSIVE STRENGTH TEST

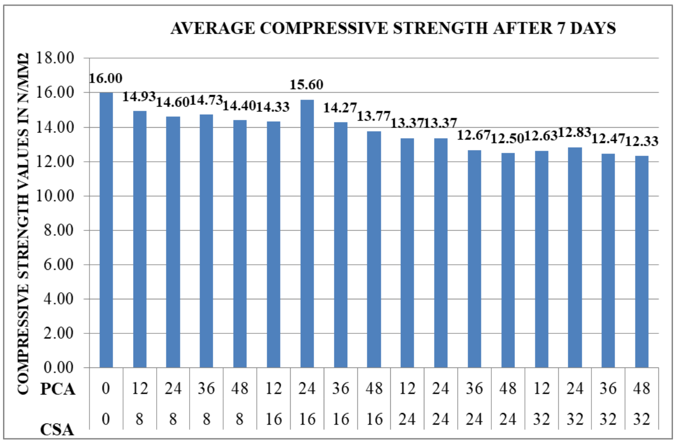

Figure 4.2: Compressive Strength of Cubes after 7 days

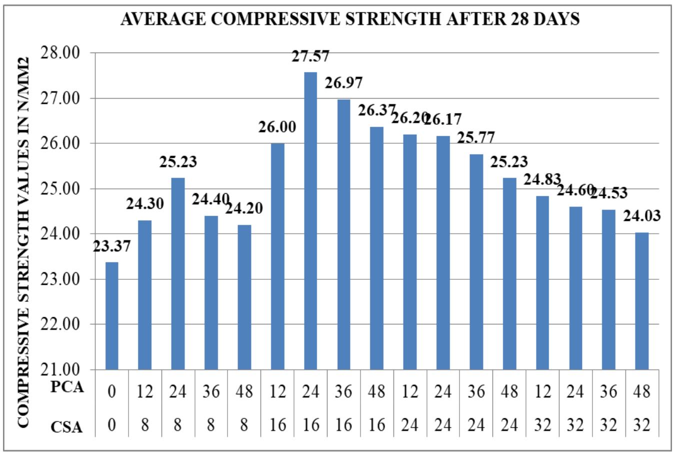

Figure 4.3: Compressive Strength of Cubes after 28 days

4.3 SPLIT TENSILE STRENGTH TEST

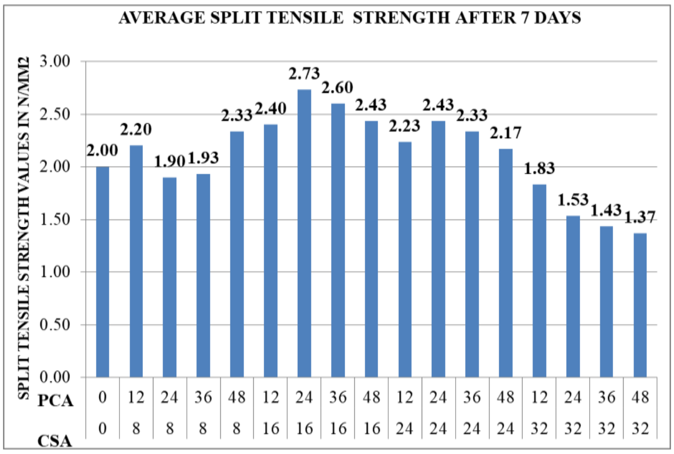

Figure 4.4: Split Tensile Strength of concrete mix after 7 days

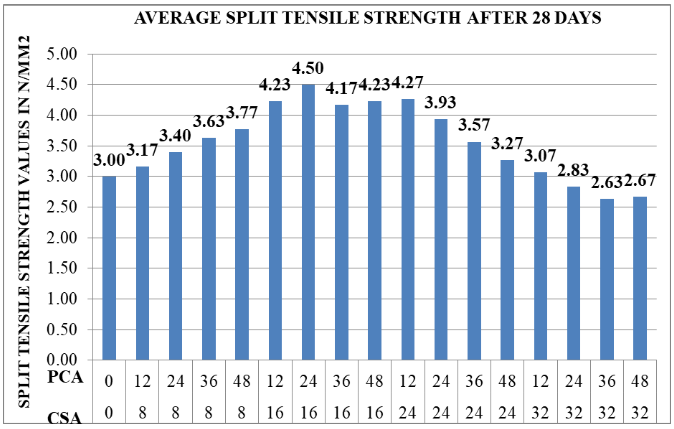

Figure 4.5: Split Tensile Strength of concrete mix after 28 days

4.4 FLEXURAL STRENGTH TEST

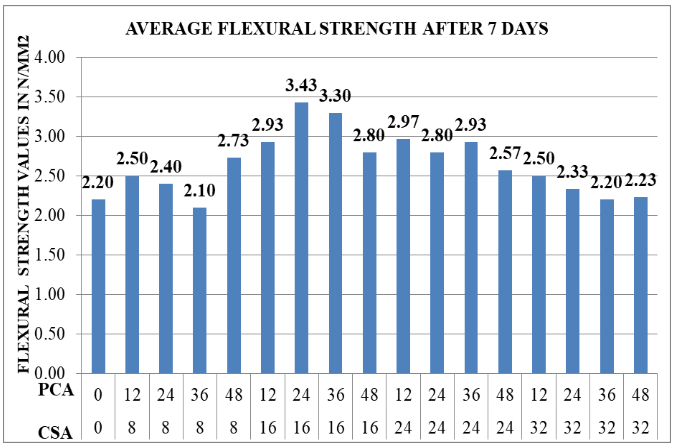

Figure 4.6: Flexural Strength of concrete mix after 7 days

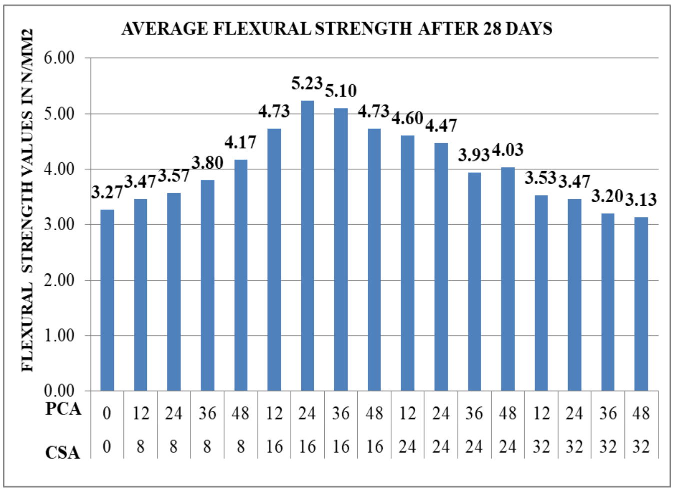

Figure 4.7: Flexural Strength of concrete mix after 28 days

5. CONCLUSIONS

1. The plastic waste used in this research will helps to enhance the workability of the concrete upto certain percentage. The slump values represents the workability of the mix as 115 mm where CSA replace cement by 8% and PCA replaced coarse aggregates by 24%.

2. After the replacement level of CSA8%PCA24%, the slump values goes on decreasing with the reason of increasing the percentage levels of coconut shell ash. CSA has water absorption property leads to decreases the water content in the mix.

3. The optimum strength parameters are obtained for the mix is CSA16%PCA24%.

4. The compressive strength obtained at the optimum mix is 15.60N/mm^2 and 27.57 N/mm^2 for 7 days and 28 days, respectively represents the maximum values.

5. The Split Tensile Strength of mix achieves maximum value of 2.73 N/mm^2 and 4.50 N/mm^2 when CSA is 16% PCA is 24% are added to concrete mix. The values are calculated after 7 and 28 days of curing.

6. The Flexural Strength observed maximum with 16% CSA and 24% of PCA i,e. 3.43 N/mm^2 and 5.23 N/mm^2 of mix after curing of 7days and 28 days, respectively.

7. The overall cost of the concrete is reduced due to utilization of waste materials in concrete. These waste materials are available as free of cost or at very low prices in market. Thus introducing waste materials will lower the structure cost and contributes in protecting the environment.

REFERENCES

1. Ashwini Manjunath B T (2016) "Partial replacement of E-plastic Waste as Coarse-aggregate in Concrete" *Procedia Environmental Sciences* 35 (2016) 731 – 739 doi: 10.1016/j.proenv.2016.07.079

2. Fernando, P. R. (2017) "Mechanical and physical properties of fired clay brick partial doped with coconut shell ash" *American Journal of Energy and Natural Resources* 6(5): pp.58-63.

3. Fernando, P.R., Aazir, S.M., Pushpalatha, N., Puvanakanthan, N. and Nishantha, V.H.T., (2017) "The performance of the low cost masonry cement blocks as a partial substitution of coconut shell ash" *American Journal of Mechanical and Industrial Engineering* 2(6): 212-220

4. Bhartiya, A. and Dubey, M., (2018) "Replacement of cement with coconut shell ash and egg shell powder for preparation of fresh concrete" *International Research Journal of Engineering and Technology (IRJET)* 5: 1272-1275.

5. S. Osubor, K. A. Salam and T.M. Audu (2019) "Effect of Flaky Plastic Particle Size and Volume Used as Partial Replacement of Gravel on Compressive Strength and Density of Concrete Mix" *Journal of Environmental Protection* 10 (2019), 711-721.

6. Naraindas Bheel et.al. (2021) "Coconut Shell Ash as Cementitious Material in Concrete: A Review" *Journal Kejuruteraan* 33(1) 2021: 27-38 https://doi.org/10.17576/jkukm-2020-33(1)-03