

An Experimental Investigation on Burned Coconut Shell Powder in Concrete to Reduce the Agricultural Waste

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ABSTRACT

Coconut shells are a form of agricultural waste that may be recycled into something valuable. As a result, this study's purpose was to look into the physical characteristics of concrete composed of the filler material ofburnt coconut shell powder (BCSP), and also find the optimum proportion of BCSP to use as a filler in concrete. There have been comparisons made between regular concrete mixtures and concrete incorporating BCSP. BCSP was added to concrete mixtures in various amounts in this research (0%, 0.5%, 1%, 1.5%, 2%). Before being used, the coconut shell was crushed and burnt to make it powder. Workability, Mechanical Properties of the various proportion BCSP is identified from fresh and hardened concrete experimental tests carried out in this study. The findings of this experiment results may be used in the concrete technology sector since BCSP can be utilized as a concrete filler. The utilization of redundant material in concrete can enhance the sustainability of nature without affecting the environment.

Key Words: *Coconut shells, recycled agricultural waste, concrete filler.*

INTRODUCTION

The globe has been coping with an increasing amount of solid waste, including agricultural waste. The environment has been harmed by agricultural waste. It is the primary source of water contamination, and it has the potential to cause human health concerns. Various methods exist to minimize pollution caused by the disposal of coconut shell trash [1][2]. Burnt Coconut Shells can be used as an additive in concrete production, for example. Coconuts are cultivated in 40–50 million tonnes per year in nations like the Philippines, Indonesia,and India, which account for 75 percent of global output. Coconuts are also utilized for religious festivals and cultural ceremonies. Coconuts, for example, are significant to Indians in Malaysia during the Diwali celebration. Milk from coconut is frequently utilized in traditional Malay cooking and preparing food. Coconut shells, on the other contrary, are a type of substantial waste that has the potential to harm the environment. Coconut shell output is estimated to be at 3.16 million tonnes per year. In addition to rice husks and corn cobs, other agricultural waste products have become a major environmental issue, such as groundnut shells and coconut shells.[3][5]As a result, there is a need to transform them into

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usable products to reduce their environmental impact. Researchers have recently started experimenting with utilizing these leftovers as a partial substitute for traditional concrete-making ingredients, with some surprising results. Furthermore, reusing agricultural waste in concrete manufacturing may lower production costs while also lowering the health hazards connected with solid waste disposal. Finally, by using agricultural waste for construction, both building materials and trash disposal costs may be decreased [4]. The bulk of past research on alternate ecological fillers in composites has concentrated on this topic. Coconut shell as a filler material has outstanding strength and modulus properties, making it a competitor in the development of new composites. BCSP's usage in concrete has gotten little research due to the lack of studies. Finally, the efficacy of utilizing BCSP as a filler in conventional concrete is the subject of this research. As a result of a research gap, this study focuses on BCSP as a concrete filler.[6][7]

COCONUT SHELL PROPERTIES

Coconut shells are a hard, fibrous cellulosic agro-waste produced from a coconut's quasi-part. According to a comparative study, concrete made using coconut shells has a higher compressive strength than concrete made with oil palm shells. This concrete's ultimate bond strength is considerably greater than the theoretical bond strength. Due to their outstanding characteristics, coconut shells have demonstrated tremendous promise as concrete admixtures. Coconut shell concrete provides more warning before failure than ordinary concrete, demonstrating the importance of coconut shells in concrete ductility. Concrete with coconut shells may assist customers since it provides warning signs before breakdown. At 1.05–1.20 and 1.40–1.50, respectively, the averaged specific gravity and apparent specific gravity was lower than the typical aggregate's specific gravity. As a consequence, further study is needed to improve or extend the use of coconut shells in concrete as a composite material or additive.

MATERIAL AND LAB WORK

Material preparation

Coconut shells were cleaned and manually broken before being pulverized. The crushed powder was then coiled and passed through a mesh dresser to obtain the desired mesh size. This requires good pulverizing and screening. All of this was done at a coconut shell plant. There were 0, 0.5, 1, 1.5, and 2 percent BCSP in the concrete in this investigation. The BCSP % was calculated from the concrete weight. This experiment used ordinary

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Portland cement as a binding agent. The 20mm sieve was used to remove coarse aggregates, while the 5mm screen was used to keep the finer particles in place.

Lab work

Workability test.

The test was carried out by ASTM C143. A hollow mould in the shape of a 304 mm high cone frustum is used for the majority of slump testing equipment. The cone's 202 mm diameter base rests on a level platform with a top diameter of 101 mm. The concrete is poured into the moulds in three equal-volume phases, each of which is rodded 25 times with a 16mm steel rod. By subtracting the height of the moulds from the height of the concrete above the original axis of the specimen's base, the slump is determined.

Compressive strength test

In line with ASTM C39, cylindrical concrete samples (150mm in dia x 300mm high) were tested using digital compression. The load was applied in such a way that the stress built up gradually until the component broke. The maximum force was observed and the value was divided by the cross-sectional area of the specimen to estimate the compressive strength of concrete. The average compressive strength of three cylinders was tested for each batch.

Splitting tensile strength test.

According to ASTM, a compressive splitting tensile strength test was conducted. The specimens utilized had a diameter of 150mm and a length of 300mm. The test specimen was put in the centering jig, and the packing was gently removed from the top and bottom of the specimen in a diametrically vertical plane. The splitting tensile strength, fsp, was calculated using the following formula:

$$f_{sp} = 2P/(\pi dL),$$

where P represents the highest load applied. d- is the cross-sectional diameter in millimeters, and L-Specimen's length (mm).

Modulus of Elasticity test.

Concrete's modulus of elasticity was measured using cylinders of 150mm in dia and 300mm in height. The specimens were subjected to up to 40% of their ultimate load, according to ASTM469. The modulus of elasticity was calculated using Eq. 2:

$$E = (S_2 – S_1) / (\epsilon_2 – 0.000050)$$

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Where E = modulus of elasticity.$\in_2$ = longitudinal strain produced by stress S_1. S_1 = stress corresponding to the longitudinal strain of 50 x 10-6 (MPa). S_2 = stress corresponding to 40% of the ultimate load (MPa).

RESULTS AND DISCUSSION

Sieve analysis

The particle size distribution fulfilled the relevant specification requirements, according to the results of a sieve study. In this research, sieve analysis was used to examine fine aggregates and burned coconut shell powder. According to the results of the sieve analysis test, the cumulative percentage passing for BCSP measuring 600 m, 300 m, and 150 m was higher than fine aggregates. It is possible to say that BCSP has a smaller particle size than fine aggregates. Figure 5 shows the size distribution of small particles and BCSP.

Workability

The workability of each proportional mix of concrete generated, from regular concrete and with0%,0.5%,1%,1.5%,2%,BCSP, was tested. Each of the specimens had a similar water-to-cement ratio of 0.46. Slump ranged from 55 mm to 70 mm in concrete mixes containing 0%,0.5%,1%,1.5%,2%, BCSP. The workability of these combinations was medium, with a compacting factor of 0.92. The slump value of concrete mixtures containing 1.5%, 2%BCSP was 70mm. The workability of this combination was enhanced. It can be observed from the findings that as the proportion of BCSP added with the concrete mix increases, the degree of workability increases. This is due to the burnt coconut shell's geometric ability which is after burnt becomes spherical on average. The results of the workability test are shown in Figure 1.

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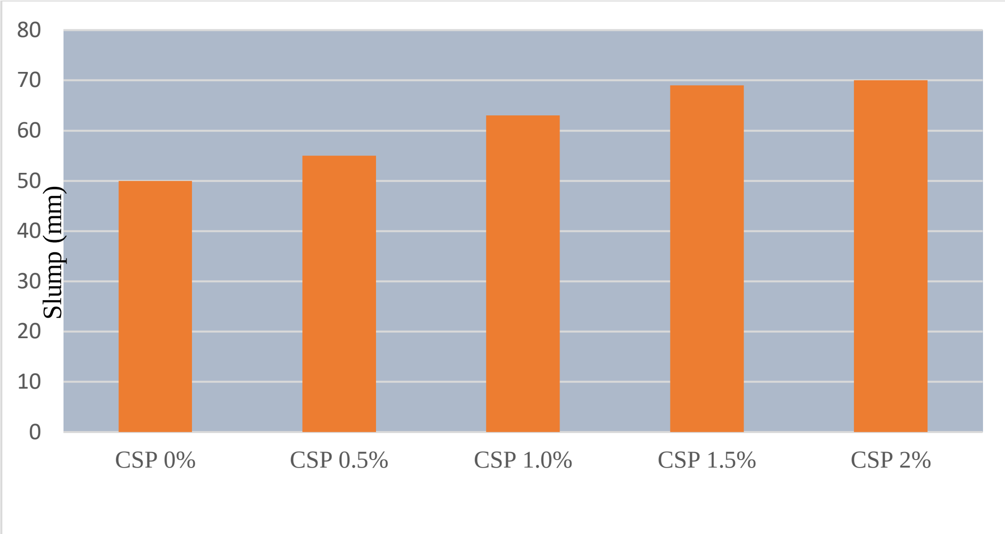

Fig:1 Workability test results.

Compressive strength test

Every specimen's compressive strength was recorded and tabulated. There we can find the data of the various percentage of BCSP added with the traditional concrete and the compressive test is made to determine the variation of strength corresponding to the individual percentage of BCSP. By adding the BCSP the density of concrete varies, when the nominal percentage of BCSP is added to the concrete, the compression strength of the concrete increases. Comparatively, the traditional concrete falls less density while comparing with the inclusion of BCSP as a filler material. The traditional concrete attains 36.3 MPa after 7 days, where 2% BCSP concrete attains the compressive strength of 39.2 MPa which is 8% higher than Traditional concrete. This is due to the size of BCSP as they turn to ash, pores of the concrete are filled by BCSP. Similarly, 1% BCSP concrete attains the compressive strength of 38.6 MPa which is 6.3% higher than the traditional concrete.

In comparison of 28th day strength of concrete, 2% BCSP concrete attains 39.9 MPa, 1% BCSP concrete attains 39.2 MPa. On the other hand, traditional concrete attains 38.5MPa, were 4% with 2% BCSP, and 2% with 1% BCSP, the strength of traditional concrete is reduced. This variation is comparatively smaller in range. Since the for the sustainability and increase in density of concrete, we can enhance with the inclusion of BCSP as a filler material in the traditional concrete.

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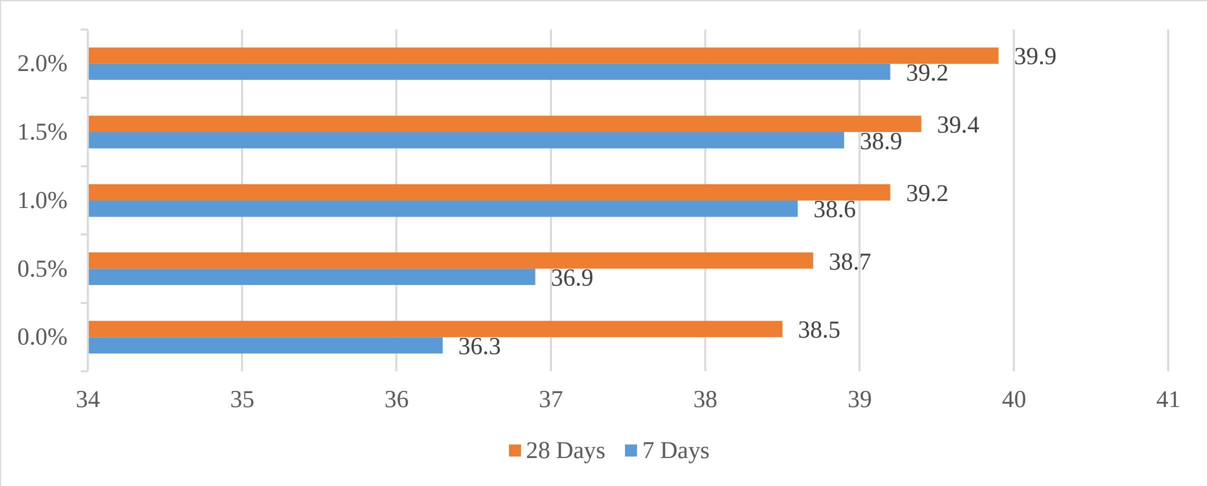

Figure2. Compressive strength of 7days and 28days.

Density of concrete

The density of normal concrete and concrete with different quantities of burned coconut shell powder as a filler is indicated in Figure 3. With a density of 2445 kg/m3, ordinary concrete was determined to have the highest density. According to the results, the density of concrete containing burned coconut shell powder rises as the proportion of burnt coconut shell powder used as a filler in concrete increases.

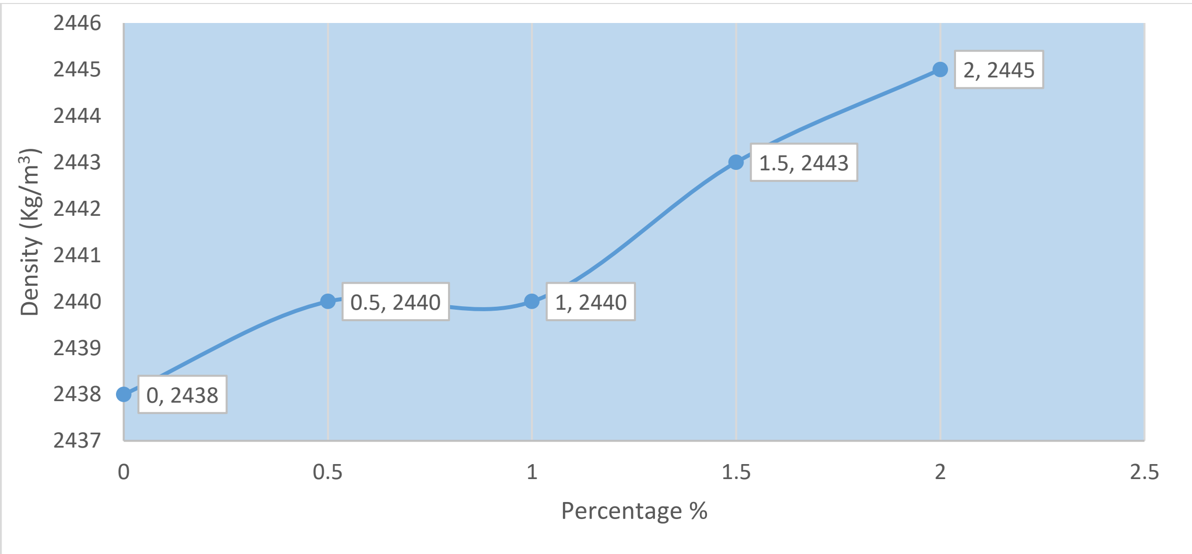

Fig 3: Densityofconcrete

Splitting tensile strength Test

Figure 4 present the graph of splitting tensile strength concerning the percentage of BCSP added to the concrete. The value obtained from the results is compared, wherein the split tensile condition has similar values with a lesser variation. The value is obtained in 1% BCSP

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is about 6.26 MPa, for 2% BCSP 6.25MPa. Traditional concrete attains 6.22MPa (0.6% variation for the concrete with higher value). The split tensile strength for 1% BCSP is 16% of its compressive strength. Hence, it is concluded that there is lesser variation by adding filler material with a nominal amount. For the future study, the quantity of filler material with a higher range is taken.

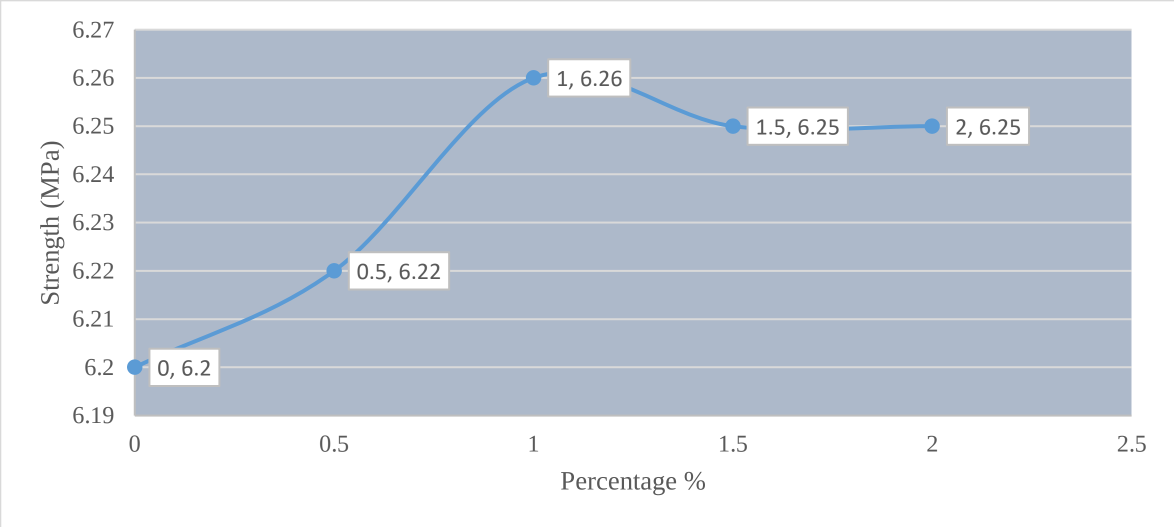

Fig4:Splittingtensilestrength.

Modulus of Elasticity

From the results obtained, the modulus of elasticity varies between 23.69 to 29.01. The maximum modulus of elasticity is about 29.01GPa, it is achieved from the 2% BCSP concrete which is denser than the traditional concrete. Comparatively the least value of elasticity of modulus appears in traditional concrete in this study. In the future we can customize the variation in the percentage of filler material to verify the constant ability of the elastic modulus which will verify whether increasing in percentage, increase or decrease after the addition of optimum content.

Table1. Modulusof elasticityofconcretecontaining BCSP in differentpercentages.

% Of BCSP	CompressiveStrength,(MPa)	40%ofultimateload,(MPa)	Strain,∈x10 $^{-4}$(mm)	ModulusofElasticity,E_C(GPA)
0%BCSP	38.5	15.4	6.5	23.69
0.5% BCSP	38.7	15.48	6.0	25.80
1% BCSP	39.2	15.68	5.5	28.51
1.5%BCSP	39.4	15.76	5.3	29.73
2% BCSP	39.9	15.96	5.5	29.01

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CONCLUSION

From this study, we can observe that BCSP as a filler material enhances the workability of the concrete Since the unburnt coconut shell powder will reduce in workability and also absorbs more water, where burnt coconut shell powder overcomes these effects. From the results, as the percentage of filler material increases the compressive strength is increasing up to 2% in this case. In the future, furthermore, a percentage of filler material is added to find the optimum content. The highest compressive strength obtained is 39.9MPa, for the 2% BCSP concrete. However, the spilt tensile strength results optimum for 1% BCSP, in increasing more than that constant variation concerning its compressive strength is observed. Modulus of elasticity is increasing with an increase in the percentage of filler material up to 2% where the values tabulated between 23.69 to 29.01GPa. The further additive percentage is taken as future work to find the optimum content in the mode of Compressive strength, split tensile strength, and Modulus of elasticity of the concrete.

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