International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

A Study of Waste Coffee Husk as Cover with Fine Aggregate & Burnt Rice Husk as Proxy to Cement for M40 Grade

Mohd Mujeeb Ur Rahman [a], P. Subhasri [b]

[a] *PG Scholar, Department of civil Engineering, Dr. K. V. Subbareddy Institute of Technology, Kurnool*

[b] *Assistant Professor, Department of civil Engineering, Dr. K. V. Subbareddy Institute of Technology, Kurnool*

ABSTRACT:

The persistent demand for construction services results in rising costs. Sustainable construction materials play a vital role in addressing environmental challenges and enhancing resilience in civil engineering projects. The simplest method to tackle this issue is to incorporate waste products into concrete components. WASTE COFFEE HUSK (WCH) is a byproduct derived from the incineration of coffee husks, which are generated in large quantities due to the global coffee bean trade. Researchers have explored the application of WCH in concrete, especially as a partial replacement for cement. The high price of standard construction materials impacts the financial framework of building. It is increasingly challenging to source natural resources. The incorporation of waste materials not only aids in their use within cement, concrete, and construction products but also provides multiple indirect advantages such as reduced landfill expenses, energy savings, and protection of the environment from potential pollution impacts. BURNT RICE HUSK (BRH) is used as cement with minimum replacement to enhance the strength.

This Paper speaks about preserve the consistent frequency to compose WCH with 10% Fine aggregate and BRH with cement 0%, 5%, 10%, 20% & 25% and also additionally the comparison is conducted with proxy blends like 0%WCH+0%BRH, 10%WCH+5%BRH, 10%WCH+10%BRH, 10%WCH+15%BRH, 10%WCH+20%BRH & 10%WCH+25%BRH for M40 Grade. In summary, both Waste Coffee Husk and Burnt Rice Husk provide viable solutions for strengthening concrete Characteristics while resolving waste management problems. This study continues to seek creative methods to employ such materials in sustainable building processes.

Keywords: Waste Coffee Husk (WCH), Burnt Rice Husk (BRH), Cement, Fine aggregate & M40 Grade

1. Review

1.1.1 Waste Coffee Husk

At the moment, construction has become the most fundamental component in the development of a country, and it plays a significant role in the social, economic, and particularly in the making of employment opportunities. When we speak about construction, it is directly or indirectly related to concrete making and which leads to huge extraction of natural resources. Concrete, as the major and the world's oldest and most generally used construction resources, is relatively economical to turn out due to the plenty of its works, which include aggregate and sand, as well as cement and water as the binder.

Rice husk is obtained from the rice milling industry because it is a byproduct. Research has confirmed that heating rice husk at a high temperature of 700°C makes a dust that has a plenty structure for pozzolanic materials. Research has also indicated that, because of BRH reduces the permeability of concrete when uses as a mineral admixture. Burnt Rice Husk (BRH) utilized in the current revision was gray, had a pH of 7.4, and prohibited silica of 62.3%. In broad I have bought it from the market and used it for my project at the compulsory percentages and tested various laboratory tests for the Burnt Rice Husk (BRH).

Figure 1 Coffee Husks

Figure 2 Waste Coffee Husk

1.1.2 Burnt Rice Husk

Rice husk is obtained from the rice milling industry because it is a byproduct. Research has confirmed that heating rice husk at a high temperature of 700°C makes a dust that has a plenty structure for pozzolanic materials. Research has also indicated that, because of BRH reduces the permeability of concrete when uses as a mineral admixture. Burnt Rice Husk (BRH) utilized in the current revision was gray, had a pH of 7.4, and prohibited silica of 62.3%. In broad I have bought it from the market and used it for my project at the compulsory percentages and tested various laboratory tests for the Burnt Rice Husk (BRH).

Figure 3 Rice Husks

Figure 4 Burnt Rice Husk

Objectives

- ✓ To get better understanding of the Waste Coffee husk and Burnt rice husk as a construction material.
- ✓ To know the properties of Waste coffee husk and Burnt rice husk.
- ✓ Study of compressive strength, split tensile strength, flexural strength of concrete by conducting different tests on cement, fine aggregate, coarse aggregate.
- ✓ To prepare the cubes, cylinders, beams of concrete by using WCH and BRH.
- ✓ To prove that rice husk can be used as a stabilizer of cement and coffee husk in fine aggregate.
- ✓ To create an economical and environmental friendly block material in support of a sustainable society.
- ✓ Therefore, the main objective of the study under consideration is to determine the effects of engineering properties (consistency, setting time, slump for workability, compressive strength, sulphate resistance, water absorption and microstructure properties, and compressive strength relationships with that of sulphate resistance and water absorption) of concrete containing waste coffee husk as partial replacement of cement on the concrete properties.

1.1.3 Uses of Waste coffee husk (WCH)

1. Durability and Long-Term Performance: The extended performance of concrete incorporating coffee husks must be continuously assessed to confirm that there are no negative consequences, such as deterioration or alterations in strength as time passes.

2. Standardization: Additional research and standardization are needed to identify the ideal replacement ratio of coffee husks in concrete to attain the required equilibrium of strength, workability, and durability.

3. Quality Control: Variations in the qualities of coffee husks (e. g. , moisture levels, particle dimensions) could influence the uniformity of the concrete mixture.

1.1.4 Uses of Burnt Rice Husk (BRH):

1. **Cement and Concrete**: BRH is routinely employed as a pozzolanic material in the fabrication of concrete and cement, enhancing the strength, durability, and chemical resistance of the material.

2. **Agriculture:** BRH serves as a soil conditioner and fertilizer because of its rich silica content, which can improve soil fertility.

3. **Energy Generation**: The combustion of rice husks can also produce energy in power generation facilities, making BRH a byproduct in bio-energy creation.

4. **Water Treatment**: Its adsorptive qualities are beneficial for eliminating impurities from water.

2. Literature Review

Burnt rice husk

In the process of creating concrete using maize cob ash, the characteristics and advantages of utilizing this pozzolan in concrete are outlined by Narmluk and Nawa, (2011). To put it differently, it can be contended that 7% of global carbon dioxide (CO_2) emissions are connected to the cement industry (Olutoge, 2010). Due to the Abstract: This research focuses on the examination of concrete produced by partially replacing cement with maize cob ash (BRH). Burnt rice husk was gathered and employed to partially substitute cement at specified rates of 5%, 10%, 15%, 20%, and 25%. Concrete cubes were cast and cured at ages of 7, 14, and 28 days respectively. Meanwhile, concrete beams were cast and allowed to harden for 28 days.

Biello (2008) indicated that Jimma is situated approximately 354 km southwest of Addis Ababa (GSE, 2012). The geographical setting of the town is roughly at 7°41'N latitude and 36°50'E longitude. The town experiences temperatures ranging from 20-30°C with an average annual rainfall of 800-2500 mm. It is positioned in a region with altitudes between 1718-2000 m above sea level. This area falls within the climatic zone referred to locally as Woyna Daga, which is deemed suitable for both agriculture and human habitation.

Waste coffee husk

Since Ethiopia produces coffee beans annually, approximately 450,000 tons were produced in the 2013/2014 period alone. Coffee production is particularly abundant in the Jimma zone. Thus, it can be economically utilized as a stabilizer. Jimma Zone is recognized as a coffee-producing area within the Oromia Regional State, comprising eight woredas: Gomma, Manna, Gera, Limmu Kossa, Limmu Seka, Seka Chokorsa, Kersa, and Dedo, covering a total land area of 1,093,268 hectares. Currently, the total coffee-covered land in the zone is around 105,140 hectares, which includes holdings from small-scale farmers, as well as state and privately owned plantations. Annually, the zone produces about 40–55 thousand tons of coffee. The processing of coffee results in considerable agricultural waste, constituting 30% to 50% of the total coffee weight produced, depending on processing methods.

For instance, Reta and Mahto, 2019 utilized waste coffee husk (WCH) as a partial substitute for the concrete mixture in industrial applications while considering some physical and chemical properties. The findings revealed that WCH as a substitute material can be employed for walls and light works where the strength that may be achieved is low, reaching similar conclusions as other reported studies for concrete or clays.

3. Materials & Methodology

3.1 Waste coffee husk (WCH):

Waste coffee husk (WCH) is a result of burning coffee leaves. These pods are widely found in coffee areas. Waste coffee husk (WCH) is a material made by burning coffee husks as a fuel source in different small businesses and farms. When burned, the organic molecules in the shells are oxidized, leaving behind artificial minerals and elements that form ash.

3.2 Burnt rice husk (BRH):

Burnt Rice husk 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 2.4. 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.

3.3 Super plasticizer

Conplast SP430 is a form of high-efficiency super plasticizer utilized in the construction sector, especially for improving the workability and flow characteristics of concrete. It is a product from Fosroc, a firm that focuses on construction chemicals.

Table No 1. Physical properties of Waste coffee husk (WCH) & Burnt rice husk (BRH):

S.No	**Physical Property**	**Waste coffee husk (WCH)**	**Physical Property**	**Burnt rice husk (BRH)**
1	Water absorption	3 %	Water absorption	High
2	Size of Particle	2.36 mm	Size of Particle	Fine powder; typically 10-200 microns
3	Color	Elephant Black	Color	White to greyish-white
4	Density	265 kg/m3	Density	1.5 - 2.0 g/cm³
5	PH Value	7.69	PH Value	6-9
6	Specific Gravity	2.3-2.61	Specific gravity	1.9-2.4

Table No 2. Chemical properties of (WCH) vs (FA) & (OPC) vs (BRH):

S.No	Chemical Composition	FA (%)	WCH (%)	OPC (%)	BRH (%)
1	CaO	-	9.45	60-65	1-10
2	SiO2	96.35	67.52	20-25	70-90
3	Al2O3	2.59	10.73	5-10	0-4
4	MgO	-	4.08	2-4	0.5-1.5
5	SO3	-	1.07	3-5	0.5-5
6	Fe2O3	0.06	3.05	-	-
7	Loss on ignition	1.00	4.1	-	-

3.4 Methodology

The Methodology describes the fill-ins used & mechanical attributes done over this paper:

1. Understudy of Burnt rice husk to Cement & Waste coffee husk to Sand with a fixed proportion of 10% in fine aggregate & a variable proportion of 0%-25% of BRH with frequency of 5% in cement respectively.

2. Property check of Compressive Strength for cubes with a size of 150mm*150mm*150mm.

3. Property check of Tensile Strength for cylinder with dimensions of 150mm diameter & 300mm Height.

4. Property check of Bending Strength for Beam with a dimensions of 500mm*100mm*100mm.

4. Mix Design

Table No 3 Mix proportion of M40

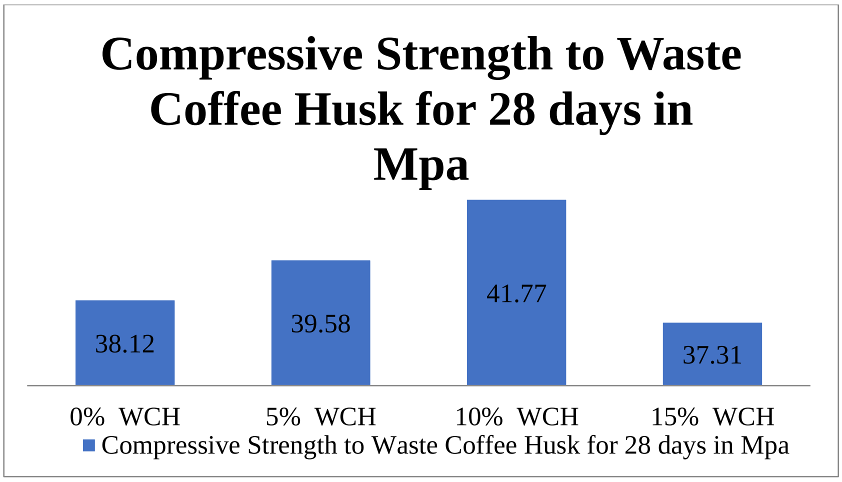
Grade	**M40**
Proportion	**1:1.82:2.39**
W/C ratio	**0.39**
Cement	**438.65**
Fine Aggregate	**799.87**
Coarse Aggregate	**1048.77**
Water	**163.7**

5.Tests and Results

Compressive Strength To Waste Coffee Husk For 28 Days At Different Percentages

Table no 4 Test results of Compressive Strength for 28 days to Waste Coffee Husk:

Mix % Replacement	Compressive Strength for 28 days in Mpa
0% WCH	38.12
5% WCH	39.58
10% WCH	41.77
15% WCH	37.31

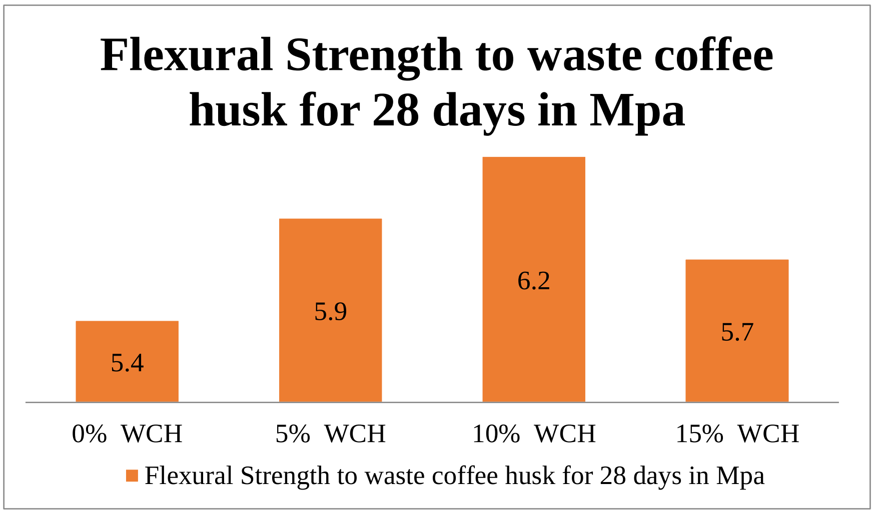


Graph No 1 Development of Compressive strength after curing 28 days for WCH

Flexural Strength To Waste Coffee Husk For 28 Days At Different Percentages

Table no 5 Test results of Compressive Strength for 28 days to Waste Coffee Husk:

Mix % Replacement	Flexural Strength to coconut shell for 28 days in Mpa
0% WCH	5.4
5% WCH	5.9
10% WCH	6.2
15% WCH	5.7

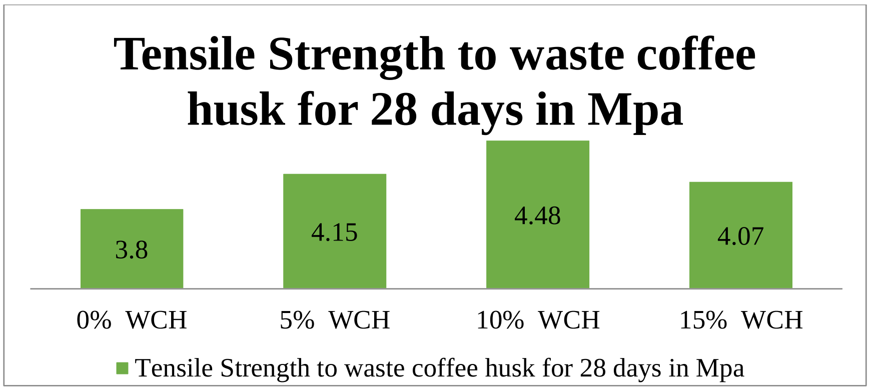


Graph No 2 Development of Flexural strength after curing 28 days for WCH

Split Tensile Strength To Waste Coffee Husk For 28 Days At Different Percentages

Table no 6 Test results of Compressive Strength for 28 days to Waste Coffee Husk:

Mix % Replacement	Split Tensile Strength to coconut shell for 28 days in Mpa
0% WCH	3.8
5% WCH	4.15
10% WCH	4.48
15% WCH	4.07



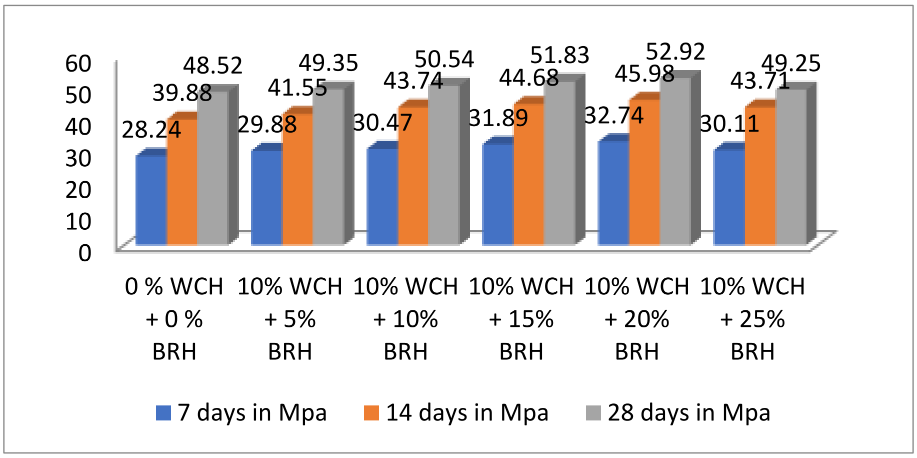
Graph No 3 Development of Split tensile strength after curing 28 days for WCH

As per the above study of strength properties I have taken 10% constant WCH as replacement of fine aggregate because the strength is increased at 10% of WCH so I have taken the highest strength gained value in the project.

Compressive Strength Test Results:

Table no 7 Test results of Compressive Strength at 7 days, 14 days & 28 days :

Mix % Replacement	7 days in Mpa	14 days in Mpa	28 days in Mpa
0 % WCH + 0 % BRH	28.24	39.88	48.52
10% WCH + 5% BRH	29.88	41.55	49.35
10% WCH + 10% BRH	30.47	43.74	50.54
10% WCH + 15% BRH	31.89	44.68	51.83
10% WCH + 20% BRH	32.74	45.98	52.92
10% WCH + 25% BRH	30.11	43.71	49.25



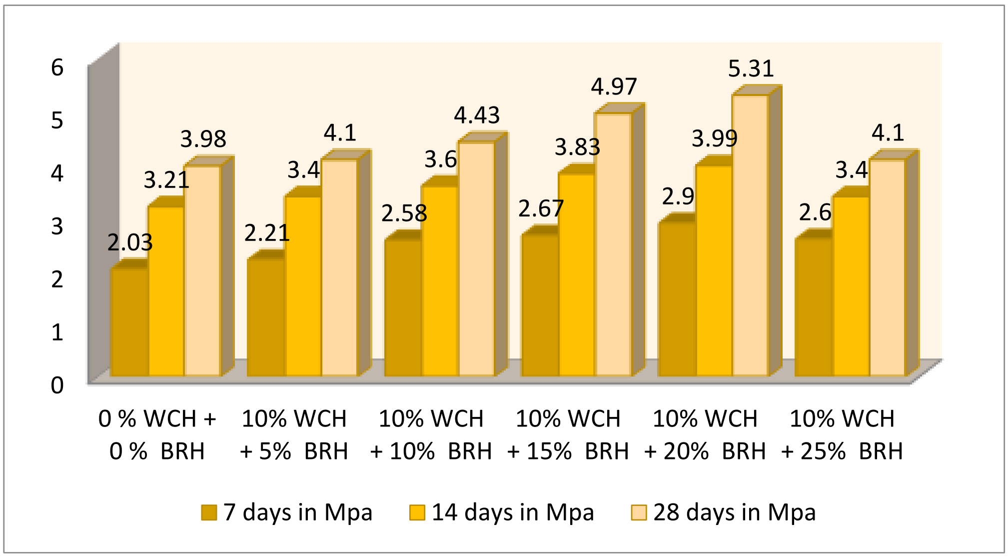
Graph No 4 Contrast values of Compressive strength for 7 days, 14 days & 28 days

Figure 5 Compressive strength test

Split Tensile Strength Test Results:

Table no. 8 Test results of Split Tensile Strength at 7 days, 14 days & 28 days:

Mix % Replacement	7 days in Mpa	14 days in Mpa	28 days in Mpa
0 % WCH + 0 % BRH	2.03	3.21	3.98
10% WCH + 5% BRH	2.21	3.4	4.1
10% WCH + 10% BRH	2.58	3.6	4.43
10% WCH + 15% BRH	2.67	3.83	4.97
10% WCH + 20% BRH	2.9	3.99	5.31
10% WCH + 25% BRH	2.6	3.4	4.1



Graph No 5 Contrast values of Split Tensile strength for 7 days, 14 days & 28 days

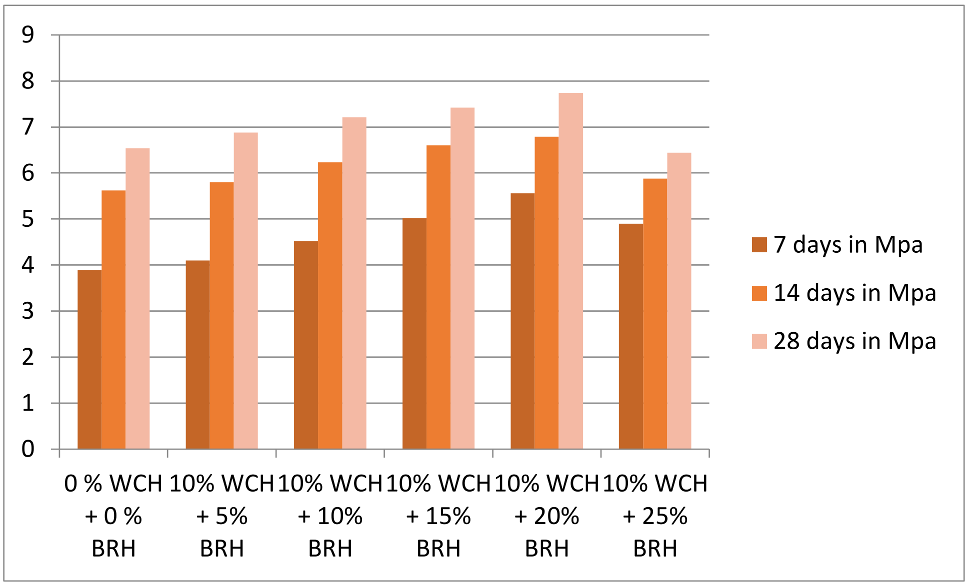
Figure 6 Split tensile strength test

Flexural Strength Test Results:

Table no 9 Test results of Flexural Strength at 7 days, 14 days & 28 days:

Mix % Replacement	7 days in Mpa	14 days in Mpa	28 days in Mpa
0 % WCH + 0 % BRH	3.9	5.62	6.54
10% WCH + 5% BRH	4.1	5.8	6.88
10% WCH + 10% BRH	4.52	6.23	7.21
10% WCH + 15% BRH	5.02	6.6	7.42
10% WCH + 20% BRH	5.56	6.79	7.74

10% WCH + 25% BRH	4.9	5.88	6.44



Graph No 6 Contrast values of Flexural strength for 7 days, 14 days & 28 days

Figure 7 Flexural strength test

Conclusion

In this research, the feasibility of utilizing waste coffee husk and burnt rice husk from Indian agriculture has been introduced as a partial substitute for fine aggregate and cement in concrete manufacturing. This document briefly outlined the production method of the waste coffee husk and burnt rice husk as well as a comprehensive material characterization (both physical and chemical). The generated waste coffee husk (WCH) and burnt rice husk (BRH) have demonstrated their suitability as potential substitutes for fine aggregate and cement due to their adequate content of essential pozzolanic compounds. In this study, the produced ash has been employed as WCH as fine aggregate with constant 10% replacement and BRH with varying replacement ratios (0%, 5%, 10%, 15%, 20%, and 25%) and cement substitution with BRH upto 25% replacement.

The various replacement ratios indicated an increase in compressive strength, split tensile strength, and flexural strength at early ages of 28 days; however, the concrete mixtures containing waste coffee husk and burnt rice husk achieved strength at 20% BRH and 10% WCH, even exceeding the control mix. The mechanical properties of the concrete developed from BRH and WCH can be summarized as follows: The 20% cement replacement and 10% fine aggregate exhibited the best performance in terms of compressive, flexural, and tensile splitting strength in comparison to the other tested replacement ratios and slump value of 89mm.

Additionally, the effect of using higher grade cement was evaluated by altering the cement grade in the control mix along with the 20% cement replaced mix and 10% fine aggregate mix. Furthermore, the cost and environmental friendliness of concrete utilizing the ashes have been evaluated through the two substitutions in concrete.

REFERENCES

I. A. Adetayo, and O. A. Bucknor, "Comparative Study on the Effect of Grinded Rice Husk and Rice Husk Ash on Compressive Strength of Concrete". ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering Tome XI, 2018.

II.H. Ghassan and M. Hilmi, "Study on Properties of Rice Husk Ash and Its Use as Cement Replacement Material". Materials Research. vol.13, no. 2, pp. 185-190, 2010.

III.K. John et al., "Iluence of Rice Husk Ash Density on the Workability and Strength of Structural Concrete". EJERS, European Journal of Engineering Research and Science Vol. 2, No. 3, March 2017. doi:10.24018/ejers.2017.2.3.292

IV.M. E. Ephraim et al., "Compressive strength of concrete with rice husk ash as partial replacement of ordinary Portland cement". Scholarly Journal of Engineering Research Vol. 1(2), pp. 32-36, May 2012. [17] B. V. Ashwini et al. "An Experimental Study on Rice Husk Ash as Partial Replacement for Cement in Concrete". Vol. 6, Issue 5, May 2017.

V.M.F. Junaid, Z. ur Rehman, M. Kuruc, I. Medveď, D. Baˇcinskas, J. Curpek, ˇ M. Cekon, ˇ N. Ijaz, W.S. Ansari, Lightweight concrete from a perspective of sustainable reuse of waste byproducts, Constr. Build. Mater. 319 (2022), 126061.

VI.J. Nelson and D. J. Miller, Expansive Soils: Problems and Practice in Foundation and Pavement Engineering, John Wiley & Sons, Hoboken, NJ, USA, 1997.

VII.D. Nebro, "Stabilization of potentially expansive subgrade soil using lime and con-aid," MSc. Tesis, Addis Ababa University, Addis Ababa, Ethiopia, 2002.

VIII.A. Maghfirah, A. P. Asmara, P. Sinuhaji, and E. Marlianto, "Improving the characterization of polymer concrete based on coffee shell and pumice waste with mixture of polyester resin and polyurethane resin," AIP Conference Proceedings, vol. 2221, no. 1, Article ID 110018, 2020.

IX.A. Maghfirah, P. Sinuhaji, A. Dani, and S. F. P. Harahap, "Manufacturing and characterization of high water absorbtion paving block by utilizing waste of coffee skin and pumice with polyurethane resin," AIP Conference Proceedings, vol. 2221, no. 1, Article ID 110016, 2020, March.