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Sustainable Green Concrete with a Partial Replacement of Cement and Sand Review

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Abstract – *This review paper explores The rapid surge in population and industrialization has resulted in the generation of substantial waste volumes. Large quantities of waste from industrial, commercial, mining, agricultural, and domestic activities are discharged into the soil, either treated or untreated. This discharge has profound effects on soil properties, potentially leading to improvements or degradations in the soil's engineering behavior.*

The review explores the This study explores the advantageous effects of specific agricultural and domestic wastes in geotechnical applications, using them to create a mixture. Agricultural and industrial waste materials are employed in the production of what is termed "Green Concrete."

This type of concrete is crafted using eco-friendly waste materials, thereby earning the designation of green concrete. The utilization of agricultural and industrial waste in this context not only addresses waste management concerns but also aligns with environmentally conscious practices, contributing to sustainable and eco-friendly construction solutions.

Keywords: **Waste Valorization, Soil Engineering Behavior, Environmental Impact, Waste Disposal Practices, Industrial Waste, Agricultural Waste, Domestic Waste, Geotechnical Applications, Green Concrete, Eco-Friendly Construction, Sustainable Practices.**

I. INTRODUCTION

The other important characters of concrete than the other materials while its strength, are easy Molded in any forms, an engineered material that can meet almost any desired specification, adaptable, quite incombustible, affordable, and easily obtained. Concrete has the advantage of having outstanding mechanical and physical properties when properly planned and constructed. Concrete is widely employed in modern industrial civilization, with more than 10 billion tonnes produced annually [1]. By 2050, it is expected that the world's population would have exploded from 1.5 to 9 billion people, resulting in increased need for energy, housing, food, and clothes, as well as a rise in demand for concrete, which is expected to climb by 18 billion tonnes annually [2].Unfortunately, the benefits of concrete are inversely proportional to the volume of concrete produced. The concrete industry has left an immense alteration in the environmental appearances during a 100-year period. In addition, CO2 emissions are produced during the manufacturing process, which requires a vast volume of raw materials to make the billions of tones of concrete produced each year across the world.

The concrete industry has left an immense alteration in the environmental appearances during a 100-year period. In addition, CO2 emissions are produced during the manufacturing process, which requires a vast volume of raw materials to make the billions of tonnesof concrete produced each year across the world. The cement industry alone is estimated to be responsible for about 7% of all CO2 generated in the world [3]. Hereafter, the reality shows that every ton production of Portland cement releases nearly one ton of CO2 into the atmosphere. On the other hand, issues such as carbon dioxide emissions and energy consumption, large aggregate consumption, concrete demolition waste, and filler requirements all contribute to the common environmental impact that concrete is not environmentally friendly or appropriate for the needs of sustainable development.

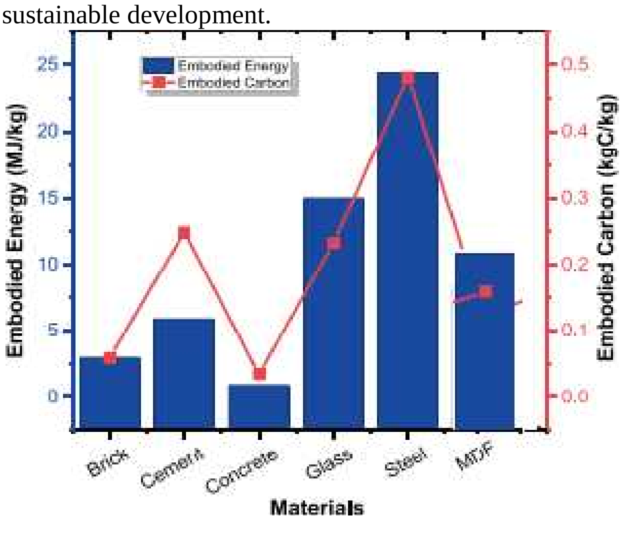

Figure 1: Embodied energy and carbon for building materials

Cement is also one of the main constituent of concrete. The manufacturing process of cement results the emission of about 8 to 10 percent of worlds total carbon-dioxide. when the ingredients of cement, limestone and clay is crushed and heated at a temperature of about 1500 degree centigrade to produce cement, global warming gas is released. So to avoid these big problems, Green Concrete is brought into practice. Green Concrete reduces the emission of carbon-dioxide up to 30 percent and saves energy, also reduces the pressure on natural resources to some extent. Green concrete plays a vital role in prevention of environment and natural resources. The constituent of this concrete does not respond to carbon footprint and give healthy environment to all. Architects and engineers are strongly motivated to choose the ingredients that are more effective in achieving sustainability in the field of construction. Environmental impact is minimized by the selection of material of concrete.

II. LITERATURE SURVEY

The literature survey on analysis different author work based on proposed method. This section gives the view how we go further to make efficient concrete based on waste.

Sarra Guefrachi et.al. (2024) - The purpose of this Kalyana Chakravarthy Polichetty Raja et al.(2023) "Characteristics of Green Concrete with Industrial Wastes as Replacement of Fine and Coarse Aggregate "

The outcomes of an experimental investigation into green sustainable concrete incorporating 10% and 15% coconut shell as coarse aggregate, along with varying proportions (15%, 20%, 25%, 30%) of foundry sand (FS) as fine aggregate replacement, are summarized as follows:

Concrete compositions utilizing 20% foundry sand (FS) and 15% coconut shell (CS) exhibit enhanced durability compared to conventional concrete. This is evident through favorable results in accelerated corrosion tests, quick chloride permeability tests, and acid resistance tests.

The utilization of foundry sand (FS) and coconut shell (CS) in concrete formulations significantly contributes to cost reduction, facilitates the preservation of natural resources, and promotes environmentally responsible waste disposal practices. This underscores the potential of these materials to address economic and environmental considerations

M. Manjunatha et al. (2022) " Engineering properties and environmental impact assessment of green concrete prepared with PVC waste powder: A step towards sustainable approach " Author studied aims to provide a comprehensive comparison, evaluating the potential environmental impact and energy reduction in concrete preparation using industrial wastes such as PVC waste powder (PWP) and ground granulated blast furnace slag (GGBS) in comparison to conventional concrete. The focus of the investigation is on the experimental study and environmental impacts, utilizing the life cycle assessment (LCA) approach.

The LCA models are developed for green concrete, incorporating industrial waste by-products like GGBS and PWP. In this research, green concrete is formulated with a constant 30% GGBS across all mixes. Conversely, PWP is introduced in varying percentages (0%, 5%, 10%, 15%, 20%, 25%, and 30% by weight of cement) and compared against conventionally prepared concrete. To assess the environmental impacts, the authors initially compared the physical and chemical properties of materials, as well as the fresh and hardened properties of concrete for all the mixes.

Hisham Alabduljabbar et.al. (2021) “Green and sustainable concrete production using carpet fibers waste and palm oil fuel ash” The impact of polypropylene carpet fibre waste on compressive strength at volume fractions ranging from 0.25 percent to 1.25 percent, tensile and flexural strengths, and drying shrinkage of concrete incorporating 20% POFA was investigated experimentally. The following are the conclusions drawn out of the results found and the observations made in this study. The incorporation of carpet fibre waste reduced the workability significantly. Slump values decreased as fibre content was increased, although VeBe time increased. The fiber–matrix compressive strength decreased as the fibre content increased. The compressive strength of POFA-based concrete increases at a rate that is almost identical to that of OPC concrete mixtures over time. When compared to combinations containing only OPC, all POFA concrete mixtures had a significant drop in compressive strength at the age of 7 and 28 days.

Tahira Zahoor et.al. (2020) “A Study on Green Concrete” The byproduct of some industry is silica fume which may cause air pollution. To make concrete more sustainable the more silica addition is necessary in cement which reduces air pollution. Waste material has a lot of promise for making green concrete. By substituting some by-products and industrial wastes for typical concrete elements, it is possible to generate cost-effective and environmentally friendly concrete. In order to understand the final concrete qualities, a full life cycle analysis of green concrete using multiple criteria is required. The better compressive strength, tensile strength, improved sulphate resistance, decreased water absorbing capacity and improved workability can be achieved by the partial replacement of ingredients by using waste materials and admixtures. The strength of cement gets increased when the appropriate amount of silica fume is added but this replacement of silica fume may decrease the strength of the concrete. By using the technologies, we prepare a concrete by using industrial waste which is more beneficial and economical than conventional concrete.

Shatha R Ahmedizat et.al. (2020) “Fabrication green concrete by Recycled wastepaper” The dry density of paper fibers wastepaper concrete mixes was increased with age of curing. The waste paper fibers do not affect the density significantly at lower percent ratio of paper

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fibers addition lower than 0.6% by volume. Then density of paper fibers concrete decreases with higher wastepaper fibers content (0.8% and 1%) by volume . The dry density result for (P- 0.6) blend is close to result of conventional mix. the concrete mixtures containing wastepaper, compressive strength increased with increasing regarding wastepaper's content up to (1%) by volume related to the concrete. The best fiber content has been (0.8%) by concrete volume. Such addition level result in massive elevation in the compressive strength. Such elevation has been (22.56%) at (28) days regarding age in comparison to control concrete. Generally, each group related to the concrete mixes consisting of wastepaper, splitting tensile strength elevated with the elevation in the content with regard to wastepaper up to (1%) by volume of concrete. The best fiber content is (0.8%) by concrete volume . This increase reached to (17.66%) at (28) days of age in comparison to the control concrete. The flexural tensile strength fibers concrete mixes with (, 0.6% and 0.8%) of paper fiber exhibit increase in flexural tensile strength values by about (0.789% and 4.819%) respectively at 28 days , as relative to ordinary blend. While the (1%) blend of wastepaper fibers reduction in flexural tensile strength by about (11.498%).The wastepaper fibers concrete mixes with (, 0.8% and 1%) of paper fiber exhibit increase in absorption values by about (44.19% and 80.591%) respectively at 28 days , as relative to ordinary blend. While the (0.6%) blend of wastepaper fibers reduction in water absorption by about (5.483%).The reuse of wastes is important from different materials It help to save and sustain the natural resources

Ashfaque Ahmed Jhatial et.al. (2019) "Green and Sustainable Concrete – The Potential Utilization of Rice Husk Ash and Egg Shells" Concrete has a carbon footprint, which is a common material in the building industry. Cement production accounts for about 10% of worldwide CO2 emissions. Cement is a critical component of concrete. Cement manufacturing is increasing, which has an impact on global warming and climate change. As a result, many attempts to make green and sustainable concrete using various waste elements have been made. CO2 emissions can be minimized and environmental difficulties associated with the disposal of waste materials can be resolved by using waste materials as cement substitutes. The potential and novel use of Rice Husk Ash (RHA) and Eggshells as partial cement replacements to make green concrete is discussed in this research . RHA which is rich in silica and eggshells contain identical amount of calcium oxide as cement, when finely grinded and used together as partial cement replacement, can trigger a pozzolanic reaction, in which silica reacts with calcium oxide resulting in the formation of calcium silicates which are responsible for achieving higher strengths.

Noridah Mohamad et.al. (2019) "Innovative and sustainable green concrete–A potential review on utilization of agricultural waste" Concrete is the most adaptable building material in the world's construction sector, and it emits carbon dioxide into the atmosphere. Cement production accounts for 8% to 10% of worldwide carbon dioxide (CO2) emissions. Cement use at its highest contributes to global warming and climate change. As a result, several academics have been working on developing green and sustainable concrete that incorporates various waste elements. CO2 emissions will be reduced by using waste materials as a cement substitute. The potential and novel use of agricultural waste as a partially cement-replacing ingredient in green concrete is discussed in this research. Agricultural waste contains pozzolanic elements, which, when finely ground, produce a pozzolanic reaction in whichsilica reacts with calcium oxide to form calcium silicates, which is responsible for the concrete's enhanced strength. According to earlier research, agricultural waste with a high silica content causes a pozzolanic reaction in concrete, which contributes to the increase in strength. The pozzolanic materials are RHA, SCBA POFA, and a 10 percent -20 percent utilisation of these wastes is ideal for increasing the 20 percent -30 percent strength of concrete. The Banana Skin Powder (BSP) also contains a significant amount of silica, which will cause a pozzolanic reaction in the concrete mix and improve the strength of the concrete in the same way that other agricultural waste does..

III. Method

In response to escalating environmental challenges, there is a growing imperative to explore green and sustainable materials as viable alternatives to conventional counterparts across diverse applications. The term "green concrete" is not indicative of its color but rather signifies concrete that incorporates at least one ingredient derived from waste or follows an environmentally benign manufacturing process. Maintaining strength and performance is crucial when integrating waste resources into green concrete. Key determinants of green concrete include manufacturing methods, life cycle sustainability implications, and the extent of cement replacement. While adhering to the principles of reduce, reuse, and recycle, the primary objective of green concrete development is to curtail CO2 emissions, limit the consumption of natural resources, and repurpose waste materials that would otherwise contribute to disposal costs and environmental pollution.

A viable approach to harness waste materials for green concrete development involves utilizing them as partial replacements for cement. Many waste materials, arising from rapid industrialization and urbanization, are generated globally, with disparities in quantity and type across regions. Unfortunately, a significant portion of these waste materials ends up in landfills without proper treatment or re-use, posing a substantial environmental challenge. Solid waste management (SWM) has emerged as a critical concern due to the proliferation of landfill sites, prompting a reevaluation of waste disposal practices in both developing and developed nations.

V. CONCLUSION

In this paper has provided the development of sustainable green concrete by partially replacing cement and sand with industrial by-products, namely Fly Ash (FA), Rice Husk Ash (RHA), and Stone Dust (SD), in varying proportions. The aim is to create a cost-effective and environmentally friendly concrete utilizing these studied by-products as substitutes for traditional materials.

Through systematic experimentation with different combinations of FA, RHA, and SD, our study investigates the impact on concrete performance, particularly in terms of strength. Despite the introduction of FA, RHA, and SD showing marginal decreases in strength, the overall outcomes highlight the potential of green concrete in reducing carbon dioxide emissions and optimizing the utilization of non-biodegradable industrial wastes

Reference

[1] Kalyana Chakravarthy Polichetty Raja, M. Nithya, S. Banupriya , Kidus Tesfay Areki, Ilango Thaniaras, Asheesh Sehgal and S. Padmanabhan (2023) "Characteristics of Green Concrete with Industrial Wastes as Replacement of Fine and Coarse Aggregate " E3S Web of Conferences 399, 03015 .

[2] Wei Quan Chin ,Yee Yong Lee, Mugahed Amran, Roman Fediuk, Nikolai Vatin, Ahmad Beng Hong Kueh and Yeong Huei Lee (2022) " A Sustainable Reuse of Agro-Industrial Wastes into Green Cement Bricks " .mdpi.com journal of materials.

[3] M. Manjunatha, Dinesh Seth, Balaji KVGD and Bharath A (2022) " Engineering properties and environmental impact assessment of green concrete prepared with PVC waste powder: A step towards sustainable approach " elsevier Case Studies in Construction Materials 17 .

[4] Musa A. and Alhaji M. M., 2007 Effect of rice husk ash on cement stabilized laterite, Leonard. Elect. J. Prac. Tech., 6(11), 47-58,(2007) Mohammed A. M., Influence of compactive effort on Bagasse ash with cementtreatedlateritic soil, Leonard. Elect. J. Prac. Tech., 6(10), 79-92,

[5] Alabadan B. A., Olutoye M. A., Abolarin M.S. and Zakariya M., (2005). Partial Replacement of Ordinary Portland Cement (OPC) with Bambara Groundnut Shell Ash (BGSA) in concrete, Leonard. Electro. J. Prac. Tech., 4(6), 43-48,

[6] Alabadan B.A., Njoku C. F. and Yusuf M. O., ,(2006) The potentials of groundnut shell ashas concrete admixture, Agri. Eng. Int. CIGR E. J., 8, 5-12.

[7] Oriola, Folagbade and Moses G., (2010). Groundnut shell ash stabilization of black cottonsoil, Electron. J. Geotech. Eng., 15, 415-428, Journal of Environmental Research And Development Vol. 5 No. 3, January-March 2011678.

[8] Mousa F. A. and Munjed (1998). M. A. Soil stabilization with burned olive waste,Appl. Clay Sc. 13(3), 219-230,

[9] Zalihe N. and Salma T., (2006). Evaluation of the effectiveness of olive cake residue asan expansive soil stabilizer, J. Environ. Geol., 60(5), 803-807,

[10] Tchobanoglous G., Thiesen H. and Vigil S.A., 1993 Integrated solid wastemanagement, Engineering principles and management issues, McGraw Hill

[11] Consoli N.C., Montardo J. P., Prietto P. D. M. and Pasa G. S. (2002), Engineering behavior of a sand reinforced with plastic waste., J. Geotech. Geoenviron. Eng., 128(6), 462- 472,.

[12] Youjiang W. ,(2006)., Utilization of recycled carpet waste fibers for Reinforcement of Concrete and soil, Recy. Tex., Y., Wood head Publishing Ltd., Cambridge, UK, 14, 1-14

[13] Benson C. Tatlisoz N.and Edil T., (1998). Geosynthetic reinforced walls and embankments using soiltire chip mixtures, J. Geotech. Geoenviron. Eng., ASCE, 124(11), 1109-1119,

[14] Benson C. and Edil T., ,(1995) Using scrap tires in civil and environmental construction, Reso. Recy., The University of Wisconsin-Madison.

[15] Thippareddy K.S. and Agrawal P., (2010) Pretreatment of agriculture waste using Aspergillus flavus for the production of ethanol by Saccharomycesescerviceae,J. Environ. Res. Develop., 5(2), 393-403,.

[16] Amu O.O., Fajobi A. B. and Oke B. O.,(2005) Effect of eggshell powder on the stabilizing potentialof Lime on an expansive clay soil, Res. J. Agri. Bio. Sc., 1(1), 80-84.

[17] Alaa A., Rory M. D., Delfin C. and Fikret A., ,(2006). Stabilization of marginal soils byusing recycled materials, Final Tech. report, Florida Department of Transportation, 17(25), 28. 38-48

[18] A. Siddika, M. A. Al Mamun, W. Ferdous, 2019. 3D-printed concrete: applications, performance, and challenges. Journal of Sustainable Cement-Based Materials 9(3):127 – 164, 2020.doi:10.1080/21650373..1705199.

[19] R. Prakash, R. Thenmozhi, S. N. Raman, (2020).

Mechanical characterization of sustainable fiber-reinforced lightweight concrete incorporating waste coconut shell as coarse aggregate and sisal fiber. International Journal of Environmental Science and Technology pp. 1 – 12,. doi:10.1007/s13762-020-02900-.

[20] A. K. Saha, P. K. Sarker, V. Golovanevskiy. (2019) Thermal properties and residual strength after high temperature exposure of cement mortar using ferronickel slag aggregate. Construction and Building Materials 199:601 – 612,. doi:10.1016/j.conbuildmat.2018.12.068.

[21] R. Prakash, R. Thenmozhi, S. N. Raman, C. Subramanian. (2019) Characterization of eco-friendly steel fiber-reinforced concrete containing waste coconut shell as coarse aggregates and fly ash as partial cement replacement. Structural Concrete 21:437 – 447,.doi:10.1002/suco.201800355.

[22] F. Moghaddam, V. Sirivivatnanon, K. Vessalas. (2019) The effect of fly ash fineness on heat of hydration, microstructure, flow and compressive strength of blended cement pastes. Case Studies in Construction Materials 10:e00218,. doi:10.1016/j.cscm.2019.e00218.

[23] P. Chindaprasirt, C. Jaturapitakkul, T. Sinsiri. Effect of fly ash fineness on compressive strength and pore size of blended cement paste. Cement and Concrete Composites 27(4):425 – 428, 2005.doi:10.1016/j.cemconcomp.2004.07.003.

[24] P. Chindaprasirt, S. Rukzon, V. Sirivivatnanon. (2006) Resistance to chloride penetration of blended portland cement mortar containing palm oil fuel ash, rice husk ash and fly ash. Construction and Building Materials 22(5):932 – 938, 2008. doi:10.1016/j.conbuildmat..12.001.

[25] G. L. Golewski, T. Sadowski. (2016) A study of mode III fracture toughness in young and mature concrete with fly ash additive. In Advanced Materials and Structures VI, vol. 254 of Solid State Phenomena, pp. 120 – 125.. doi:10.4028/www.scientific.net/SSP.254.120.

[26] R. Prakash, R. Thenmozhi, S. N. Raman, et al. An investigation of key mechanical and durability properties of coconut shell concrete with partial replacement of fly ash. Structural Concrete pp. 1 – 12.doi:10.1002/suco.201900162.

[27] V. N. Kanthe, S. V. Deo, M. Murmu. (2018) Effect of fly ash and rice husk ash on strength and durability of binary and ternary blend cement mortar. Asian Journal of Civil Engineering 19:963 – 970,.doi:10.1007/s42107-018-0076-6.

[28] M. A. Mamun, M. S. Islam. (2017) Experimental investigation of chloride ion penetration and reinforcement corrosion in reinforced concrete member. Journal of Construction Engineering and Project Management 7:26 – 29, doi:10.6106/JCEPM.2017.3.30.026.

[29] G. L. Golewski. (2019.) Estimation of the optimum content of fly ash in concrete composite based on the analysis of fracture toughness tests using various measuring systems. ConstructionandBuildingMaterials213:142–155, doi:10.1016/j.conbuildmat.2019.04.071..

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