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The critical review based on biomass made from agricultural waste for cementitious products

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Abstract:

The goal of this study is to give a complete look at how biomass made from agricultural waste is being used in cementitious products now. As the globe tries to be more environmentally friendly, recycling agricultural waste into cement-based products has become more popular. This process is very important for turning trash into eco-friendly products that can be used. It also helps keep dangerous substances from being made in an eco-friendly way. The parts of different types of biomass-based materials and how they affect the mechanical and long-lasting properties of both unhardened and hardened concrete are spoken about. A possible way to do this is to add more waste cementitious materials to the mix to make the average cement flecks bigger. Carbocation and mechanochemical treatment were used to find out how stable and sticky the eco-friendly supplementary cementitious material was. Supplemental cementitious materials (SCMs) were researched to find out the total reactivity, tell the difference between pozzolanicity and latent hydraulicity, and swiftly get rid of any inert elements.

Keywords — **Supplementary cementitious materials, Cementitious products, Biomass Waste.**

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I. INTRODUCTION:

Recycling agricultural wastes into cementitious products has become a popular way to help the world reach its sustainability goals since it helps the economy and the environment and is a safe way to get rid of trash. [1] One of the key metrics for measuring the sustainability of a building is its energy efficiency, which is also linked to energy conservation and the sustainable growth of the construction sector. Using agricultural waste with cementitious to create salvaged biomass aggregates allows for the development of novel wall materials that are both affordable and energy-efficient. To improve the alternate level of cement clinkers with supplemental cementitious materials made from waste is a practical way to do this (SCMs). [4] As output of concrete stays the same or even goes up, other supplementary cementitious materials (SCMs) besides fly ash must be looked into to meet demand as fly ash becomes less available. Other than fly ash, a variety of SCMs, a few that come from other businesses' byproducts, have been used in concrete. These include bottom ash, combustion ash from fluidized beds and collected ash, as well as byproducts from other coal combustion processes like silica fume, waste glass, and municipal waste sludge ash. [7] Given that the grain husk makes up 24–36% of the mass of oats, it is projected that more than 5.5 million metric tonnes of oat straw are produced yearly. So, a sustainable means of getting rid of this kind agriculture trash can prevent unchecked burning and the buildup of a lot of rubbish in landfills, both of which would otherwise contaminate the environment. [6] On the other side, recycling or reusing waste materials can lead to a decrease in greenhouse gas emissions and landfill disposal. Using biomass waste is a popular concept. Animals are fed on them. They are transformed into humic substances that might improve soil fertility. Moreover, there may be alternative applications for biomass wastes. Biochar has attracted interest as an additive in cement products. Excellent water retention, low thermal conductivity, strong chemical and structural stability, and complex porous network capacity are only a few of the characteristics that make biochar an acceptable component in building materials. Because biochar can hold onto carbon, using it in building materials helps store carbon in the structure for decades and keeps the carbon cycles of the Earth in balance. Biochars do not comprise When compared to raw biomasses, alcohol, phenol, or methylene groups are known to be deleterious to the cementitious matrix's chemical and physical stability. [11] Because of this, the main focus of alternate cementitious material discovery and characterization in the last few years has been on agricultural byproducts. As the number of biomass-based power plants grows, more agro-waste ashes are being thrown away. Agro-waste ashes are recommended as an alternative cementitious material in many parts of the world, especially in Asian and Latin American countries, because they have a high pozzolanicity and are easy to get. [12] It is well known that developing and using biomass resources is good for the environment, cheap, and doesn't add to carbon emissions. Plants, like crop waste, wood waste, and seaweed, are used most often as biomass. It also reveals numerous crucial results as well as various ways in which exploitation techniques could be improved in terms of efficacy and waste generation. In the steel industry, biomass has already shown that it can save energy and cut down on pollution. Other SCMs are now being explored because some of them, such as fly ash, blast furnace slag, and silica fume, have already been sold and used to partially replace cement in the cement industry. [14] Even though agroindustrial biomass wastes have been employed in eco-friendly concrete in a number of studies, it is hard to make these alternative materials work in the building industry. For green concrete to be used all over the world, research needs to be done, agroindustrial ash needs to be used in different types of concrete, the industry needs to understand how to use new materials, and there needs to be a need for appropriate standards, transdisciplinary collaboration, training, and field applications. [20]

II. VARIOUS AGRICULTURAL WASTE FOR CEMENTITIOUS PRODUCTS:

A. Pistachio shell ash cementitious products:

In this study, the ash from the pistachio shells was made using a certain method. At first, the pistachio shells were sold by a business in Siirt that made pistachios. The acquired pistachio shells were next dried at 250 C for 45 mins and then burned at 850 C for 30 mins in a temperature-controlled furnace. A well-known way to make carbon-based materials with a high specific surface area is to dry them and then burn them in two steps at high temperatures. The temperatures mentioned above were determined after a series of preliminary testing on the study's pistachio shells. The furnace was sealed to keep the carbon dioxide from the ash from being sucked away during the cremation process. After letting the burned shells cool to room temperature in the furnace, they were crushed in a vertical stirring ball mill for 10 minutes to make the PSA that was utilized in the first step of the study. Structures made of pistachio shell ash, graphene, alumina, silica, and calcite are waste materials with a high specific surface area. Because the ash included carbon-based structures, it caused a cement-based substance with a big specific surface area to rise up a lot. This made it take longer for the cement to set. The formation of black-colored mixed cements based on the ratio of ash added may be due to the ash's dark colouring. [2] Furthermore to 10% of pistachio shell ash was added, and the resulting early strength development (after two days) was similar to that of uncolored cement mortar. Pistachio shell ash (10%) can increase the compressive strength of ordinary concrete mortars by up to 17% over extended cure times. At 28 days and longer cure periods, cement mortars containing 20% pistachio shell ash still maintain appropriate strength values. These compounds' compressive strength values were significantly lower for all ages that cure due to the increased proportion of PSA (30%). The 30% mortars made of pistachio shells that contain ash notably greater porosity properties contributed to these strength losses. Because to its high carbon concentration, the addition of PSA caused the CH products to change into carbonate forms. The higher ash particle and the presence of graphitic plates, as well as fineness greatly enhanced the mortar matrix, which accounts for the reported increases in strength metrics, according to our interpretation of microstructural investigations. In addition to its pozzolanic impact, it must have been discovered where the addition of PSA as a finely textured additive had an intriguing function in the hydration product modification containing CeSeH. It is acknowledged that the cement and concrete industries stand to benefit from these first findings on the PSA carrying the cement. [3] Because of the observed discrepancies in the properties of this ash from the authors of the current study, other often used biomass ashes in the literature, recommend future studies on the behaviour of PSA in concrete mixed materials.

B. Crushed coconut shell cementitious products:

In the study, the crushed coconut shell was used as making cementitious products. Under standard conditions, coarse aggregate is defined as particles in a combination more than 4.75 mm. Natural coconut shell typically ranges in thickness from 4.7 to 7 mm. According to the specification, the coarse aggregate thickness in concrete must not exceed 0.4 times the size of the typical particle. The particles are screened if their size is more than 13.2 mm because it is a flat portion. The crushed coconut shell particles' diameter distribution interval following sieve treatment. Physical cues include the crushed coconut shell's apparent density after treatment. This study presents a unique attempt by using processed CCS to create synthesised recycled biomass aggregates. The crushed coconut shell aggregate was checked for volume stability and condition by first completely submerging it in water prior to the test. The test consisted of adding dry powder composite cementitious material (GGBS: FA = 8:2), Sustained mixing with a pestle mixer, followed by alternate steps of adding the combined alkali solution. The alkaline treatments were applied using a sprayer, which ensured that they were fully mixed with the gelling ingredient. When the solution-to-binder ratio is around 0.25, the cement slurry adheres to the CCS more successfully, and a synthetic recycled stone with a thickness of approximately 1.5 mm is produced. The compressive strengths of concrete made with different coarse particles. The concrete was 28 days old at the conclusion of the curing time, and the compressive strengths of CCSAC and SBRAC were 69.1% and 86.6% of those of NAC, respectively. In three days, CCSAC and SBRAC compressive strength values reached 67.9% and 91.9%, respectively, of NAC compressive strength. [4] The area where the aggregate and cement paste meet, known as the interface transition zone, is a critical aspect in influencing the performance of concrete (ITZ). Due to the fact that CCS absorbs a lot of water, when it is placed directly on concrete, a little "puddle" will form around it. This makes the ITZ between the crushed stone and the concrete cement material structure thinner. When the ratio of water to binder is around 0.25, the cement slurry may stick to the surface of the CCS better and form the SBRA, which is usually oval-shaped and has good aggregate grading. In the SBRAC recipe, there was pulverized coconut. The amount of the slurry of cement and shells is the same. After 3 days and 28 days, SBRAC's compressive strength is 91.9% and 86.6% of NAC, respectively. Compared to CCSAC, the attached mortar shell structure on the surface of SBRA keeps the volume of the coconut shell aggregate stable and reduces the tendency for concrete to shrink. The pace at which synthetic biomass recycled aggregate concrete (NAC) shrinks on its own is usually 800 106, while the rate for natural aggregate concrete (NAC) is 400 106. Because SBRAC has a lower thermal conductivity than common wall materials like clay bricks and regular concrete, it has a better potential to minimise building energy use at 28 days old. CCSAC and ABRAC's compressive strength-cost ratios were 93% and 92% of NAC, respectively, indicating that they were both cost-effective concretes. The cost of CCSAC and ABRAC under the same volume was 74.9% and 95.2% of that of RAC, respectively. The performance of concrete was not significantly diminished when SBRA was used to totally replace NA, but there is still room for improvement in SBRAC's cost and shrinkage performance. This is why it is crucial to apply SBRAC in a way that properly addresses these issues.

C. Bamboo Leaves Ash Cementitious Products:

Bamboo is the fastest-growing and most productive natural building material now available to mankind. It is made up of approximately 1250 species, and its annual production is estimated to reach 20 million tonnes worldwide. About 0.8% of Earth's surface (31.5 million ha) is occupied by bamboo forests. Cementitious materials have been successfully strengthened using the new bamboo clippings that create the environmentally beneficial bamboo fibres. But typically, 35 to 40 percent of the bamboo's weight that is grown is burned in open landfills. The bamboo leaves were calcined for two hours in 600 °C electrical discharge furnace. The end product was a fine-grained, grey-colored ash with a D50 average size of 58.1 m and grain sizes ranging from 1 to 100 m. The conductometric approach was used to measure the pozzolanic behaviour (electrical conductivity). However, a slight delay in setting time was noticed for the paste containing 20% BLA. The volume stability of cement types containing BLA was equivalent to that of the control paste. Mortar mixtures with 10% and 20% BLA had compressive strengths that were 1.2% and 6.7% less than those of the control mix after 7 days. [5] At 90 days, however, the comparable losses in strength were only about 1% and 2.8%.

D. Date Palm Ash Cementitious Products:

The cement-like thing being looked into in this study is made from the ash of date palms. The date palm (Phoenix dactylifera L.) is one of the most important fruit crops. It is harvested every year to increase yields in the Arabian Peninsula, Middle East, North Africa, and many other hot and dry tropical and subtropical places, leaving behind huge amounts of date palm fibers and leaves. The 10% DPA-containing mixtures outperformed the control mix in terms of compressive strengths. The comparable strength gains were 2.5% and 4% at 28 and 360 days, respectively. [6] Also, the rapid chloride permeability of mixes with 10% DPA was 19% lower, and the initial and secondary water absorption rates were 35% and 20.5% lower than in the control mixture, respectively.

***E. Elephant Grass Ash Cementitious Products*:**

Napier grass, which is also called elephant grass (Pennisetum purpureum Schum), grows quickly and produces about 40 tonnes per acre per year. It has been shown to be one of the most important types of biomass in a number of places around Brazil. EG is a grass that grows again every year and may grow up to 5 meters tall. In the 1920s, it was brought from Africa to Brazil. Farmers used to grow EG, which is usually used to feed animals, to manufacture charcoal for the second generation of ethanol production. Because Brazil grows so much elephant grass every year, it may be able to make up to 1.2 Gt of charcoal and up to 2 Gt of bio-oils. Recently, elephant grass has been used in methods of cogeneration. (the process of creating thermal energy). It is burned as a biomass fuel in continuous furnaces at different ceramic plants to make bricks and tiles. Elephant grass ash (EGA), which is a byproduct of the process and makes up around 4-5% of the entire grass mass, has mineral, physical, and chemical qualities that make it a possible eco-efficient cement additive with several economic and environmental benefits. The two types of elephant grass, Cameroon (EGC) and Napier (EGN), were mostly made up of quartz and cristobalite. These two ashes had oxides that were made up of 50–80% silica, 7.1–8.6% potassium, 1.1–4.2% magnesium, 0.6–10% phosphorus, and 1.8–10.4% calcium, which are the maximum and minimum chemical compositions of the EGA. [7] After 7 days of chemical reaction, both EGC and EGN had a lot of pozzolanic activity (85.5% fixed lime for EGN and 96% for EGC). In EGC, the pozzolanic activity of fixed lime was almost the same as that of silica fume. During the pozzolanic process, it was also found that there were crystalline and amorphous phases. Microstructural investigations showed that type-II C-S-H gel was present, with Ca/Si ratios of 1.96 for EGC and 1.64 for EGN. EGA's use as a possible pozzolanic material is shown by the fact that it can keep concrete strong and by the fact that it can be described based on chemical analysis. So, EGA is a key renewable resource that can make pozzolans in many places across the world, mostly in tropical and subtropical areas.

F. Rice Straw Ash Cementitious Products:

In this study, cementitious products were made with rice straw ash (RSA). More over half of the people in the world eat rice every day. About 752 million tons of paddy rice (*Oryza sativa*) are made around the world every year. China, India, Indonesia, Bangladesh, Thailand, Vietnam, Burma, the Philippines, Cambodia, and Pakistan are the 10 countries that make and eat the most rice. Between 0.41 and 3.96 kg/kg of rice straw is made from the farm waste left in the field after crops are picked. The amount of rice straw made around the world was estimated to be between 685. [8] Pollutants such carbon monoxide, methane, sulphur dioxide, carbon dioxide, nitrogen oxides, unburned carbon, and dioxins can impair the environment and people's health. The RSA made from rice straw is a good material for cementitious composites since it has pozzolanic qualities. Grey rice straw ash (RSA), which has a silica concentration of 82% and a specific surface area of 18,460 cm2/g, makes up 15% of the 150 kg of ash that is made when rice straw is burned. What happens to the performance of concrete when the air is more acidic and carbonation cures faster? The least amount of strength and mass was lost in concrete with 5% micro silica and 10% RSA. In the presence of hydrochloric acid, the mass dropped by 2.19 percent and the compressive strength dropped by 3.69 percent. On the other hand, and with the most carbonation, they had 1.27% and 1.81% sulfuric acid in the air. (17 mm).

G. Biomass Power Plant Ash Cementitious Products:

The biomass power plant's boiler is rated to evaporate 130 tons of water per hour and uses circulating fluidized bed (CFB) combustion technology. The main raw resources for the biomass power plant were sawdust, old furniture, branches, wood boards, bark, and straw from forestry, farming, and the furniture industry. At an inside temperature of 800°C, the biomass and air are mixed together and burned while the water wall of the furnace exchanges heat. [9] When the flue gas leaves the furnace, it has a lot of bottom ash in it. The unburned fuel particles are taken out by the high-temperature cyclone separator and sent back to the furnace. In this test, the BPPA has limited how waste branches, waste wood boards, sawdust, and waste furniture can be burned together. Ash was taken from a biomass power plant, dried in an oven at 105°C, and then ground up in a ball mill until it was the same size. Before the particles were added to the cement mix and given the name BPPA, they were put through a 100-m sieve to stop them from sticking together. Based on what the BPPA washing experiments showed, chloride salts and sulfates might be removed by washing and filtration. The addition of BPPA lowered the amount of SAC, which slowed the hydration of cement particles and made it take longer for SAC to set blended cement. This is why adding BPPA increased the time it takes for cement to set. [12] When trying to slow down the setting of SAC-mixed cement paste, it turned out that unwashed BPPA worked better than washed BPPA. When the replacement rate reached 10–15% of the total binder weight, it was able to make SAC-mixed cement with good strength.

H. Date Palm Tree Cementitious Products:

Date palm tree (DPT) stems are covered with a mesh or sheath. The fruits were peeled off of the date palm stalks and cleaned very well. This study looked at the chemical make-up of DPF as well as its physical and mechanical properties. After 7 days of curing in a water bath, introducing treated DPF with a 20-mm length and 1% weight content increased the strength of the fibers by up to 75%. Using the same mix design and letting it cure in an ion water bath for 28 days, the compressive strength went up by 31%. The bond between the DPF and the binder matrix system was made better by treating the DPF's surface with alkaline. So, the fibers must be treated before the mixing stages in order to get better qualities. The curing conditions have a big effect on how much water is in the binder, which makes the HCP stronger. Both in water and in the air, treated DPFRCC absorbed less water than untreated DPFRCC. [14] As the DPF weight% went up, so did the rate at which water was taken in. Samples that were dried in the air also took in a lot more water than samples that were dried in water. After 28 days, untreated DPFRCC samples that were dried in the air may be able to absorb 17% more water if they were not treated.

I. Biomass Fly Ash Cementitious Products:

When biomass fly ash (BFA) is used instead of conventional Portland cement (OPC), cement-based items have less of an effect on the environment and put less of a financial and environmental strain on landfills. After the amount of BFA is added and the mixes are sieved, they tend to get thicker and harder to deal with, which makes mixing harder. Because of this, mortars with more BFA were less dense and had a higher density. Because there are more holes and less Ordinary Portland Cement (OPC), the material can hold less water and has less compressive and flexural strength. This trend can be stopped by using ground BFA, which has a smaller particle size distribution and fewer long particles. This makes the mixes more uniform and makes the mortars more compact. Even when a higher percentage of OPC (67 wt%) is used instead, the cured specimens had densities and water absorption rates that are more like those of the normal composition. [15] The results suggest that it is possible to use 17 percent BFA instead of OPC in a commercial screed mortar composition. Both the product made and the standard have the same mechanical strength. The pieces that are made can also survive 25 freeze-thaw cycles. BFA can be used instead of OPC in non-structural building parts to lessen the damage these cement-based materials do to the environment and help create a circular economy. Lowering the cost of raw materials and getting rid of the fees that come with BFA's landfilling could also help the economy. When SCBA and RHA are treated, they become more pozzolanic than they were before. In addition to being highly reactive, processing decreases loss on ignition within the allowed range by eliminating carbon-rich fibrous particles that have not yet been burned. When SCBA and RHA were added to blended cement, the viscosity, yield stress, and consistency index all went up. Due to their prismatic and irregular shapes, SCBA particles up to 30% raised the plastic viscosity and yield stress of binary blended paste by 2.3 to 3 times and 3 to 4 times, respectively. Also, adding 15% RHA with SCBA content to ternary mixed cement paste increased both the plastic viscosity and yield stress by up to 50%. This was because RHA particles have a lengthy, porous, cellular structure. Still, RHA has more of an effect on rheological parameters than SCBA. After 56 days of curing, the compressive strength of 20% SCBA blended binary concrete was found to be higher than that of 10% SCBA blended binary concrete and control concrete. After 28 and 56 days of curing, the specimens of ternary mixed concrete with 10% SCBA and 5% RHA had reached their maximum strength. When SCBA and RHA are added to concrete, they make it much less permeable, making it harder for chloride to get into the concrete. Up to 15% of RHA can be added to a SCBA blended system to make it less permeable. Also, based on SCBA, ternary mixed concrete specimens were better at resisting water absorption in one direction than control concrete and binary blended concrete.

J. Different Paper Mill Ashes Cementitious Products:

Four PMAs were taken at different points in the process of burning paper trash and sludge. the ESP ash, the ash from the second and third pass hoppers, and then the ash from the bag house filter. (BHF). In the flue gas channel, the ash from the paper mill is collected in the following order: 2A, ESP, 3A, and BHF. To make ash 2A, heated fly ash from the empty pass is mixed with fly ash from the second pass's channel, where the superheaters located. The heat level in this location goes down from 650 C to 350 ^{O}C. To keep the surfaces clean, the super heaters blow soot out and then let empty air pass through. Downstream of the superheated pass, ash is taken out of the stream of flue gas by an electrostatic precipitator. After the ESP, the third pass has the boiler banks and economizers. In this phase, the temperature of the flue gas goes from 320°C to 150°C. Fly ash is collected from this portion (3A) and put in a separate hopper below. In the last step, BHF, where the temperature is 150 °C, solid residues are made. Sodium bicarbonate is utilized as an APC (air pollution control) additive because the main goal of BHF is to cut down on dust and gaseous emissions. Because the "ash" made by BHF contains a lot of additive and is mixed with the finest fly ash residues, this ash fraction is often called APC-residue. [17] Based on the chemicals and minerals they contain, 2A and BFH ashes are put into the CMA category, whereas 3A and ESP ashes are put into the C-LA category. Except for the ash, which has no noticeable influence on the rate of hydration or the time it takes to set, the addition of paper mill ashes speeds up the early hydration reactions and shortens the time it takes for the first set. Sample strength data suggest that LA ashes have a better chance of being used as SCMs in cementitious materials, with up to 20% weight percent substitution and more than 75% relative compressive strength. Only 10% of the C-MA can be used to work with the ashes. By adding about 20% by weight of paper mill ashes as more cementitious materials, the GWP of mortar can be cut by 19.47%.

K. Coal Ash Cementitious Products:

Coal ash can be used as a cementitious material because, after being heated to high temperatures and then quickly cooled in a boiler, it gets pozzolanic activity and cementitious properties. Its quality is based on the type of coal used, the size of the pulverized coal particles, and the type of boiler and how it is run. Based on how coal is burned, there are two different kinds of coal ash. First is fly ash from pulverized coal boilers, and second is fly ash from circulating fluidized bed (CFB) boilers. Because CFB boilers employ low-grade coal and a desulfurizer, their fly ash emissions are almost twice as high as those from typical pulverized coal boilers for the same amount of energy produced. When put in front of the chimney of a coal-fired boiler, an electrostatic precipitator gathers the tiny, light volcanic ash particles that are carried in the flue gas. This makes coal fly ash. The heavy, dense ash particles descend to the bottom of the combustion chamber and come out as coal bottom ash, which looks like river sand and has the same size and shape of particles. Many countries have recently made it harder to get rid of mercury from coal-fired boilers, get rid of sulfur, and get rid of nitrogen. Activated carbon injection (ACI), dry sorbent injection (DSI), and selective catalytic reduction are three ways to reduce pollution that have changed the quality of coal ash in some power plants (SCR). One way to solve the problem is to make CLSM from low-quality coal ash. These investigations will give solutions that can be used for green building, saving energy, cutting CO_2, and protecting the environment.

L. Natural Pineapple Fiber Cementitious Products:

Around the world, almost 60 million people work in the natural fibers industry. 45 million families make cotton, 6 million families make jute, kenaf, and other related fibers, 5 million families make wool, 1 million families make coconut fiber, and another million families make other natural fibers like pineapple, hemp, sisal, and seda. After the first step, the fibers were put in an aqueous solution of NaOH with a 10% concentration and a temperature of 80 °C while being strongly agitated by machines. There was 1.5 L of solution for every 15 g of fiber. After being in the solution for a while, the fibers were gently rinsed in running water until their pH was back to normal. Then, they were dried in an oven at 80°C for another 24 hours, until their mass had stabilized. Using treated fibers has turned out to be quite helpful, since almost all of the attributes tested in the hardened state were better than those of the reference combination, especially when 2.5% treated fibers were employed. [18] In terms of durability, the combination with 2.5% treated fibers and the mixtures with 2.5% and 5% treated fibers exhibited less strength loss than the reference mixture, and both fulfilled the fundamental requirements for their application after durability cycles. When compared to samples that didn't break down, treated fibers lost less mass.

M. Banana Leaf Ash Cementitious Products:

III. Banana leaf ash (BLA), which comes from a banana plantation, is used to make things like cement. After it was gathered, the organic parts of the BLA were burnt off in a muffle furnace at 90 ^{0}C. This made it more useful as a pozzolanic material. Before going through a 75 m sieve, the calcined material was processed in a ball mill for 30 minutes. By adding BLA, eco-friendly concretes were developed that were better than reference concretes in terms of compressive strength (up to 18% better at 90 days), dry density, and water absorption and voids indices (both improved by up to 47% at 90 days). This was achievable because of how filling and pozzolanic BLA is. The performance and durability tests showed that when CLB is used in concrete, less cement is needed to reach a compressive strength of 1 MPa than when there is no ash in the concrete. [19] Cement Intensity Hardened After 90 days, BLA lost some of its properties, which went up by 9.23% from 28 days to 90 days. The hardened results match the SEM micrographs of the concrete samples, which show that the BLA is more dense and has fewer holes. The TGA says that BLA paste has less free calcium hydroxide and more water that is chemically bonded. This shows that BLA and $Ca(OH)_2$, which is made when PC is hydrated, can work together to make more C-S-H. Based on what we found, BLA can partly replace PC to improve the physical, mechanical, and microstructural performance of concretes. By letting biomass waste from the agroindustrial sector be used, BLA may also help make concrete in a cleaner way.

IV. CONCLUSION:

In conclusion, this study showed that, in render applications, cement may be replaced up to in weight with biomass derived from agricultural waste without changing their overall behaviour. The results of the investigation show that agricultural waste products have the ability to lessen the damaging effects of the construction industry on the environment. It is currently very difficult to create agricultural waste derived biomass concrete that has high mechanical qualities over the long-term using a straightforward, inexpensive, ecologically friendly process. This review article analyses and maps alternative policy interventions for a cement system that uses biomass made from agricultural waste across several regions.

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