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INVESTIGATION ON THE COMPRESSIVE STRENGTH WITH USE OF ScBA AND WPSA WITH PARTIAL REPLACEMENT OF CEMENT IN CONCRETE.

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ABSTRACT: Since conventional cement production raises environmental issues, the use of sustainable and alternative materials for building purposes is becoming more popular. In order to lessen the influence on the environment and investigate creative ways to reuse industrial and agricultural waste materials, this study focuses on using Sugarcane Bagasse Ash (SCBA) and Waste Paper Sludge Ash (WPSA) as partial substitutes for cement in concrete.

Investigating the feasibility of employing sugarcane bagasse to be a building material, evaluating the impact of varying cement replacement percentages on concrete strength, and determining the impact of SCBA and WPSA on concrete's mechanical qualities are the main goals of this study. WPSA and ScBA was used to replace cement at weight percentages of 0%, 3%, 6%, 9%, 12%, and 15% in an M25 grade concrete mix. Additionally, SCBA was added to improve durability and workability. Compressive strength, tensile strength, workability, and other durability-related characteristics were evaluated in concrete specimens. By reducing waste and carbon emissions, the results show that adding SCBA and WPSA to concrete improves its strength development and advances the idea of green construction.

This study demonstrates the possible benefits of SCBA and WPSA as environmentally friendly concrete materials that can improve structural performance while also benefiting the environment.

Keywords: Sugarcane Bagasse Ash (SCBA), Waste Paper Sludge Ash (WPSA), Cement replacement, Sustainable construction, Compressive strength, Tensile strength, M25 grade concrete, Eco-friendly materials, Partial cement substitution.

INTRODUCTION: The most used material in the world is concrete. It is generated by mixing the proper proportion of cement, pebbles of different sizes, and materials that dissolve in water.

The combination's proportions, component ratios, and the efficiency of the mixing and compaction processes all affect how strong the mixture is. Success is determined by business definitions of physical, chemical, and mineral qualities and the efficiency that goes along with them. More accurate materials should be the outcome of the increased advantages. Although cement is essential to the creation of concrete, the process of making it releases a lot of carbon dioxide into the atmosphere, which is bad for the environment. As a result, the industrial sector is working to reduce its CO2 emissions. Using alternative materials in place of some cement components is a very efficient way to foster the sustainable goals. Concrete quality can also be improved by adding manufacturing and agricultural byproducts. By substituting a significant amount of cement in concrete, pozzolans not only assist reduce CO2 emissions but also enhance the qualities of the concrete both while it is new and after it has hardened. Concrete is now more ecologically friendly thanks to this alternative.

The influence of adding different amounts of ScBA and WPSA to cement on the mechanical characteristics, longevity, and sustainability of concrete is investigated in this study. The study intends to aid in the creation of more effective and sustainable building techniques that lessen the carbon footprint of the sector and promote waste recycling by investigating the interactions between these components and cement and concrete mixes. In conclusion, there is a lot of promise for promoting sustainable building practices by employing waste paper sludge ash and sugarcane bagasse ash as partial cement substitutes. This study intends to lessen the negative effects of cement manufacturing on the environment, encourage recycling of waste, and aid in the development of environmentally friendly construction materials.

The findings could lead to a wider use of these substitute materials, which would eventually aid in the building sector's shift to a more resource-efficient and sustainable future. The findings could lead to a wider use of these substitute materials, which would eventually aid in the building sector's shift to a more resource-efficient and sustainable future.

This study highlights the necessity of using substitute materials like sugarcane bagasse ash and waste paper sludge ash in cement manufacturing in light of environmental issues and the growing need for sustainable alternatives. The study promotes environmentally friendly building methods and helps the broader goal of attaining environmentally conscious practices by promoting the usage of these by-products.

SUGARCANE BAGASSE ASH (ScBA)

Sugarcane Bagasse Ash (ScBA) is created by burning the fibrous residue that remains after sugarcane juice is extracted. Many sugar mills utilize bagasse as a biofuel to generate electricity, and the ash that is produced is usually thrown away as garbage. Recent research, however, has shown that it has the potential to be a useful material in the building industry, particularly when used in concrete as a partial cement alternative. High concentrations of mineral silica, alumina, and other ions in ScBA provide it pozzolanic qualities, which allow it to combine with cement's calcium hydroxide to produce more cementitious compounds. This reaction improves concrete's overall strength and durability in addition to its mechanical qualities.

Furthermore, the environmental effect of producing concrete may be greatly reduced by employing ScBA as a partial cement alternative. By using ScBA, cement demand may be decreased, which would minimize greenhouse gas emissions. Cement making produces a lot of carbon dioxide emissions. ScBA also helps with efficient agricultural waste management, reducing landfill strain and promoting recycling. Concrete that contains ScBA is a possible substitute for sustainable building as it provides additional advantages including better workability, lower heat of hydration, and increased resistance to chemical attacks. ScBA offers a workable solution that promotes resource efficiency and environmental conservation as the building sector moves toward more environmentally friendly materials, which is in line with the growing emphasis on sustainable development.

Chemical composition of Sugarcane Bagasse Ash (ScBA)

The type of sugarcane utilized, temperature, and burning method can all affect the chemical makeup of Sugarcane Bagasse Ash (ScBA). Nonetheless, the following are common chemical components of ScBA:

1. **Silica (SiO_2)**: The primary ingredient in ScBA, silica, usually accounts up 40% to 60% of the mixture.
2. **Al2O3 (alumina)**: Between 3% and 10% of ScBA is made of alumina. Concrete's chemical properties are improved by alumina's contribution to the overall pozzolanic activity.
3. **FeO_3, or iron oxide**: About 2% to 5% iron oxide is often present in ScBA, which might have a little impact on the ash's color and help with qualities like workability and strength.
4. **CaO (calcium oxide):** ScBA typically has a modest calcium concentration, between 1% and 5%.
5. **MgO (magnesium oxide):** Magnesium oxide, which can alter compatibility with other concrete ingredients, may be present in ScBA at levels of 1% to 3%.
6. **Sodium Oxide (NaO) and Potassium Oxide (KO):** Typically, alkaline minerals are found in trace levels (less than 1%). They may have an impact on the initial phases of hydration, but they have no discernible effect on the qualities of concrete.

7. **Phosphorus Pentoxide (P_2O_5):** ScBA may include trace amounts of phosphorus pentoxide (between 0.5% and 2%), which might improve the material's pozzolanic qualities.
8. **Ignition Loss (LOI):** The weight lost after burning as a result of the emission of volatile ingredients and the percentage of water is known as the LOI, and it normally falls between 5% and 15%.

Physical Properties of Sugarcane Bagasse Ash (ScBA)

ScBA is often light gray or white in color, depending on the circumstances of combustion. Density: Although it can fluctuate, the ash's bulk density usually falls between 0.4 and 0.9 g/cm³. The size of the particles is ScBA comes in a variety of particle sizes, most commonly in the form of fine powder.

Worldwide Sugarcane Production

According to recent estimates, 1.9 billion metric tons of sugarcane are produced worldwide each year. The world's top producers of sugarcane are:

1. **Brazil:** is the world's largest producer of sugarcane, accounting for over 40% of total production.
2. **India:** With over 20% of the world's sugarcane crop, India is the second-largest producer. In addition, it is the world's biggest producer of sugar.
3. **China:** With around 6% of the world's sugarcane production, China comes in third place. Southern regions like Guangxi and Yunnan are the primary locations for sugarcane cultivation.
4. **Thailand:** With about 5% of the total production, Thailand is a major producer. A significant amount of sugar is exported from the nation.
5. **Mexico, Pakistan, and Indonesia:** These countries contribute to the global supply of sugarcane by playing a significant role in its production.

On a smaller basis, other nations including Egypt, the Philippines, Australia, and other African countries also contribute to the world's sugarcane output.

WASTE PAPER SLUDGE ASH (WPSA)

In the drive for environmentally conscious waste disposal and the recovery of resources, the utilization of industrial leftovers has received a lot of attention. Waste Paper Sludge Ash (WPSA) is a byproduct of the paper recycling process. Waste paper sludge is produced by processing paper mill wastewater and comprises a mixture of organic and inorganic particles such as cellulose particles, chemicals, and minerals. When sludge is burned, it turns into WPSA, or white powdery ash. WPSA disposal offers environmental issues because to its high volume and potential detrimental impacts, prompting interest in developing ecologically acceptable solutions to recycle the ash.

WPSA has developed as a useful material in a variety of fields, including building, agriculture, as well as energy recovery. Its high concentration of silica, and calcium, alongside other organic compounds makes it an attractive power for cement as well as concrete. manufacture, as well as agricultural soil amendment. However, WPSA's full potential has yet to be realized, particularly in terms of chemical composition, physical qualities, and environmental effect. As the need for environmentally conscious disposal of waste and then resource recovery grows, WPSA provides a feasible option for waste reduction, natural resource conservation, and lowering the paper industry's environmental effect.

Constituents of Waste Paper Sludge Ash

The chemical makeup of Waste Paper Sludge Ash (WPSA) is heavily impacted by the kind of paper it is recycled from, the chemicals used in paper manufacture, and the conditions under which the waste product is combusted. The following is an outline of the common elements with Waste Paper Sludge Ash.

1. **Silica (SiO_2):** Silica is a significant component of WPSA, accounting about 20-40%.
2. **Calcium Oxide**: Calcium Oxide generally accounts for 10-20% of the litter.
3. **Potassium Oxide (K_2O):** Kcl oxide is commonly found in WPSA in levels ranging from 1-10%..
4. **Magnesium Oxide (MgO):** The mineral magnesium Oxide is often found in modest amounts, about 1-5
5. **Aluminum Oxide** (Al_2O_3): The metal aluminum oxide is commonly found in negligible concentrations (less than 5%).
6. **Phosphorus Pentoxide (P_2O_5):** Phosphorous substances, including the mineral phosphorus Pentoxide, are infrequently found in trace levels, often about 1-5%, according on the compounds and chemicals used in paper manufacture.
7. **Sodium Oxide (Na_2O):** Sodium Oxide is often found in tiny levels, ranging from 1-3%.
8. **Sulfur Compounds:** Sulfate may be incorporated in trace levels as Sulfur Oxide (SO_3) from sulfur-based compounds used in paper manufacture (e.g., sulfuric acid or sodium ions).

9.Organic Matter: WPSA may still include organic leftovers after combustion, particularly if the combustion temperature was inadequate or unburned fibers remained. These leftovers can impact the physical qualities of the ash; however, they are usually in trace levels once the burning process is complete.

10.Moisture Content: Although WPSA is not an aromatic element, its moisture content might vary based on place of storage and combustion circumstances. It often stays low after the solid residue has been completely dried and treated.

These components can differ based on the kind of waste paper with him, the chemicals employed in manufacture, and the situation of burning.

Literature Review

Amreen Khatun et al (2024): The utilization of sugarcane bagasse ash (SCBA), a silica-rich, renewable agricultural waste, as a partial cement substitute in concrete is investigated in this study. To evaluate strength and durability, different amounts of SCBA (2.5–20%) were added to concrete mixtures. According to the testing results, using 10% SCBA in place of cement produced the best flexural behavior as well as the highest compressive & split tensile strengths. The microparticle size and crystalline characteristics of SCBA are responsible for its exceptional performance in treated concrete. With the environmentally friendly reuse of agricultural waste, this study demonstrates how SCBA can improve the overall performance and durability of concrete while lowering its environmental effect.

Prital Kalasur et al (2023): The implementation of sugarcane bagasse ash (SBA), a byproduct of sugar production, as a sustainable substitute in the manufacturing of concrete is examined in this study. Because of its pozzolanic qualities, ground SBA improves the performance of concrete. The study focuses on the use of refined SBA, or RSBA, in self-compacting concrete (SCC) in different proportions. To assess mechanical characteristics, tension resistance, structural integrity, and load-bearing capability, compression & tensile tests were performed. Additionally, durability was evaluated in a variety of environmental settings, demonstrating RSBA's promise for resilient and sustainable building. The feasibility of using RSBA as a partial cement substitute in SCC was confirmed by the precise performance analysis made possible by Ansys Workbench integration.

Leila Nóbrega Sousa et al (2023): This study focuses on the technical, external factors and economic feasibility of utilizing Sugar Cane Bagasse is Ash (SCBA) and a partial substitute for cement made from Portland cement clinker. The data suggest that the SCBA, which in particular when broken (SCBAG) as well as re-burnt and powdered (SCBA RG), may successfully replacement Portland cement at 10%, 20%, and 30% levels, with SCBA RG outperforming the other options. Notably, at a 30% exchange rate, SCBA RG effectively reduced alkali-silica processes (ASR) in concrete, increasing the reliability of mixes incorporating reactive materials. Additionally, replacing SCBA for Portland sand decreases cement consumption, lowering cement and mortar budgets by up to 8% while maintaining enough compressive strength. SCBA-based cements also showed good durability, with strong flexural properties even following 900 day-long accelerated ASR testing. Overall, the findings support SCBA that is as a feasible, advantageous alternatives to Portland cement that provides combined environmental and economic benefits.

Aliyu Abubakar et al (2023): The usage of sugarcane bagasse ash (SCBA) and metakaolin (MK) as partial cement substitutes in concrete is investigated in this work. The experimental design used a 1:2:3 mix design, a 0.5 water-to-binder ratio, 5% MK, and different SCBA levels (0–20%) by weight. Tests were performed on samples at 7, 14, 28, and 60-day intervals. The findings indicated that workability, density, and water absorption decreased as SCBA content increased. 10% SCBA and 5% MK produced the best compressive strength (22.17 N/mm^2 at 60 days). Compressive strength decreased with 10% SCBA. A substantial correlation between compressive strength, curing time, and SCBA content was validated by statistical analysis. According to the study's findings, producing structural concrete with a blend of 5% MK and 10% SCBA offers improved sustainability and performance.

Krishnan Chandra Sekar et al (2023): In order to lower CO2 emissions and supervise industrial waste responsibly, this study assesses the use of hypo sludge, or waste from the paper industry, as a partial substitute for cement with M30 grade concrete. To increase durability and post-cracking performance, hypo sludge was tested in different percentages (5–30%) and improved with basalt fibers (BF) and Styrene-Butadiene Rubber (SBR) latex. 10% SBR latex, 0.3% onyx fiber, and 15% hypo sludge were determined to be the ideal mixture. This combination increased tensile strength by 14.29%, flexural strength through 14.55%, and compressive strength with 17.08% when compared to the control mix. SBR latex increased consistency and bonding, according to microstructural study. The outcomes demonstrate how well hypo sludge can increase concrete strength while fostering environmental sustainability.

Muhammad Izhar Shah et al (2022): This study focuses on the potential use of treated ash from sugarcane bagasse (SCBA) as a sustainability supplemental cementing component (SCM) in concrete. After a 45-minute processing procedure, the pozzolanic responsiveness of SCBA was dramatically increased, resulting in improved mechanical characteristics and stability of the concrete. When SCBA was used at a 30% replacement rate, it enhanced workability, density, and compressive strength, fulfilling the ACI 318-16 criteria for structural applications. Furthermore, SCBA increased the concrete's resilience to scale and leaching acids by encouraging the production of reductive absorbs water, which densified the underlying microstructure. This study indicates the viability of employing SCBA as an environmentally acceptable alternative to typical cement, solving waste disposal issues while providing harder cost-efficient concrete solutions.

William Earl Farrantet al (2022): Using binary and ternary blends of SCBA (sugarcane bagasse ash) and SF (silica fume) with Portland cement, boosted by an alkali activator, this study examines the mechanical and durability performance of concrete. After being calcined, processed SCBA showed improved pozzolanic qualities, including an amorphous phase and a higher silica concentration. By forming the C-S-H phase, SF showed remarkable pozzolanic qualities that greatly enhanced the concrete's strength and microstructure. In terms of compressive and tensile strength, the ternary blend (SCBA 30% + SF 10%) performed better than plain concrete, reducing cement by up to 40% while preserving excellent mechanical performance and durability. Additionally, it demonstrated decreased porosity interconnectivity and improved oxygen permeability, which increased the resilience of concrete. The study promotes additional alkali activation optimization to increase early-age concrete strength while highlighting the potential for sustainable construction methods with lower carbon emissions and clinker factor.

Tareg Abdalla Abdalla et al (2022): Sugarcane bagasse ash (SCBA) and other industrial and agricultural waste are used in modern concrete to achieve high strength, early setting, longevity, and environmental friendliness. A byproduct of sugar manufacture, SCBA is typically thrown away, which contributes to pollution. It turns into a pozzolanic substance that works well for concrete when handled correctly. In this study, concrete containing 10–40% SCBA (silica fume) is evaluated for strength or water absorption. Although a higher SCBA content decreases workability for the fresh state, the results indicate that 10% SCBA provides the best strength and enhanced durability by reducing water absorption.

Behailu Zerihun et al (2022): In order to determine whether agricultural crop wastes such as bamboo leaves ash (BLA), banana leaves ash (BNLA), corncob leaves ash (CCA), groundnut ash (GNA), rice husk ash (RHA), and sugarcane bagasse ash (SCBA) can partially replace cement in the manufacturing of mortar and concrete, this study examines their physical and chemical characteristics. These wastes satisfy the specifications for pozzolanic materials since they are mostly made of aluminosiliceous components. With ideal replacement levels at up to 10%, the results show that their finer particle size and larger surface area improve mechanical performance and durability. However, because of their delicate texture, there was a noticeable decrease in workability. Without affecting the performance of concrete, partial replacements promote secondary reactions engaging amorphous silica, thereby densifying the gel's structure and enhancing morphology, strength, and durability. The potential application of agricultural residue in environmentally friendly building techniques is highlighted in this review.

Nuradila Izzaty Halim et al (2021): The effects of partially replacing cement in High Strength Concrete (HSC) with nano-engineered Waste Paper Sludge Ash (WPSA) are examined in this study. Despite its reputation for strength and durability, HSC usually uses a lot of cement, which raises CO2 emissions. In order to solve this, WPSA was ground into nanoparticles and substituted for cement in different proportions (1% to 10%). The HSC mix aimed for a strength greater than 40 MPa while maintaining a stable water-to-cement ratio of 0.2. Over the course of 28 days, testing for compressive strength and flow tables were carried out. A 1% nano-WPSA replacement improved compressive strength about 10.7% without compromising workability, according to the results, making it a viable substitute for the fabrication of sustainable HSC.

Serhiy Solodkyy et al (2021): The potential application use wastepaper sludge ash (WSA) and a material for soil reinforcement in road building is examined in this study. It concentrates on four types of soil: silty clay, sandy loam, loamy sand, and silty clay. The Proctor method is used in the study to calculate the optimum soil density with ideal moisture levels. To fortify the soils, WSA and Portland cement, grading 400 were applied separately. For every soil type, the study looks at six distinct soil compositions, evaluating each one's strength using water-saturated samples taken at 7, 14, and 28 days. The findings imply that WSA may successfully stabilize different kinds of soil, attaining stabilization grades between M10, M20, and M40.

Bikila Meko et al (2020): This research looked into the use of paper waste and the ash (the WPA) an an indirect replacement for Portland cement (PC) in concrete. The findings demonstrated that, while WPA is not a pozzolanic, it can improve the compressive force of concrete when added at a 10% replacement rate. As the WPA concentration grew, the strength of the concrete reduced, and setting times increased. The highest degree of compression (37.89 MPa) was reached with a 5% WPA substitution, representing a 5.6% increase over the control mix. However, as the replacement rate topped 10%, the compressive value dropped. To summarize, WPA can be an efficient partial cement substitute, providing a sustainable choice for the creation of concrete, with an ideal replacement range of 5-10%.

Solahuddin B et al (2020): In order to address environmental problems brought on by the growing amount of paper waste that ends up in landfills, this review paper looks at the possible advantages of utilizing waste paper as a supplement to or replacement for cement in the manufacturing of concrete. Paper trash increases every year, contributing to pollution, issues with land use, energy loss, and increased waste handling expenses. These environmental problems might be lessened by mixing waste paper into concrete. The impact focus waste paper on concrete's mechanical qualities, specifically its flexural and compressive strengths, is the main topic of this research. According to earlier research, waste paper can be added to the mix or used in place of 5% to 10% of cement to increase both flexural and compressive strength. According to the review's findings, waste paper can be a useful and sustainable material for improving the qualities of concrete and lowering pollution levels in the environment.

Sho Mohd Abdul Nayeem et al (2020): According to the study's findings, M25 concrete's strength can be increased by up to 15% when cement is substituted with hypo sludge. At 15% hypo sludge, the highest compressive, split tensile, and flexural strengths were attained after 7, 14, and 28 days of curing. Strength started to decrease after 15%. Therefore, the best replacement amount for improving concrete performance via paper waste is 15%. According to tests of compressive strength, ordinary concrete is stronger. Because of contaminants such free lime & raw minerals, adding hypo sludge weakens the mixture. Nevertheless, the concrete still reaches the desired strength even after 15% replacement. The strength drops below the intended level after 15%.

R. Berenguer et al (2020): About one ton of CO2 is released for every ton of cement produced, making cement production a major contributor to environmental impact. To lessen this, green techniques have been developed, such as partially substituting natural or waste materials like fibers and ashes. A byproduct of the manufacturing of sugar and alcohol, sugarcane bagasse ash (SCBA) is primarily made of silica and has both economic and environmental advantages, particularly in countries that produce sugar, such as Brazil. In order to lower the amount of clinker and related CO2 emissions, this study investigates the partial substitution of SCBA (up to 15%) for Portland cement. The potential of SCBA as a long-lasting and sustainable component of concrete construction was demonstrated by experimental campaigns using cementitious pastes, which showed that 15% SCBA replacement produced encouraging durability results.

Akshay H. Shirbhateet al (2019): The requirement for cement is growing due to population growth and construction, which raises CO2 emissions and depletes natural resources. In order to lessen the influence on the environment, this study investigates the use of waste from industry, municipalities, and agriculture as cement alternatives. Glass powder was identified as an efficient, cost-effective, and environmentally friendly substitute that lowers the amount of cement used, porosity, or water absorption into concrete after the physical and chemical features of several waste materials were examined.

Dr. N. Nagarajan et al (2019): Since continuous recycling weakens paper fibers and makes them unsuitable for producing high-quality paper, this study tackles the difficulties associated with recycling paper waste. Hypo-sludge, a waste byproduct made from broken paper fibers, is widely accessible and reasonably priced. It contains useful chemicals like CaO, SiO2, and MgCO3. The use of hypo-sludge as a partial lime substitute in the manufacture of fly-ash bricks is investigated in this study. In accordance with Indian Standards, tests were conducted on substitution percentages of 5%, 10%, 15%, and 20% in terms of compressive strength & water absorption. The objective is to create affordable, environmentally friendly bricks to address the problem of ash disposal and promote environmental sustainability. The effective use of hypo-sludge presents a viable way to produce long-lasting and environmentally friendly building materials in a nation like India where not renewable resources are limited.

Dr. P Krishnakumar et al (2019): This study investigated the feasibility of employing paper sludge as an additional cementitious ingredient to produce low-cost, sustainable concrete. The experiment focused on concrete's mechanical qualities, especially compressive toughness and tensile strength at splits, with paper sludge replacing 5%, 10%, and 15% of the cement. The results showed that substituting up to 5% of the cement via paper sludge increased equal bending and tensile strength. However, once the replacement rate approached 5%, the strength steadily decreased due to the reduced bonding performance of paper slime compared to cement.

Based on these data, it is determined that as much as five per cent paper sludge can be utilized as an interim substitute for cement that was in concrete while maintaining strength. This provides an ecologically sound option both for the disposal of paper waste water and the adverse ecological impacts of cement manufacture. The mix design was completed for M25 grade concrete in accordance with IS: 10262-2009, and the evaluation indicates that integrating 5% of paper waste into concrete formulations might be a feasible and cost-effective construction material choice.

Sajan Sharma (2019): This study investigated the utilization of sugarcane ash Ash's (SCBA) as a substitute in part for cement that had been in M25 graded concrete, with the goal of reducing cement production's environmental effect and promoting handling of waste in construction. SCBA, the by-products of sugar mills that is commonly dumped of in landfills, has pozzolanic qualities that make it a suitable alternative bond in concrete. The study looked at the impacts of substituting cement. These were tested with SCBA that's at 0%, 3%, 6%, 9%, and 12% of size, as well as different concrete parameters including tensile strength, flex divide tensile strength, absorbent of water, hardness against a and water permeability after 28 days. The results revealed that replacing cements that were with SCBA up to a specific percentage increased compression, flexible, & split tensile strengths, with the best performance happening at intermediate SCBA values. However, once the replacement rate topped 9%, these qualities began to deteriorate.

Furthermore, when the SCBA level grew, so did water absorption, indicating that the concrete's impermeability had decreased. While SCBA substitution improved resistance to scratches and water permeability, it became obvious that replacing more than 9% of the material resulted in a decrease in total performance. Bagasse made from sugarcane Ash can be used as the partial replacement of cement in concrete because with a maximum suggested replacement rate of 9% for the greatest balance of strength and longevity. This technology decreases the environmental effect of cement manufacture while simultaneously promoting sustainable construction by mixing farm waste into building components.

Objectives

• To investigate the utilization of sugarcane bagasse as construction material.

• To investigate the influence of sugarcane bagasse and paper sludge ash on the strength of cement made with different cement replacement levels.

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• To utilize the waste paper as paper slug ash replacement material with cement.

Material and Methodology

Cement

For the production of concrete as well as mortar, which serve as the framework for structures, roads, bridges, as well as other infrastructure, cement is a crucial component in the construction sector. Clinker is a finely ground material that is mostly composed of silica, limestone, clay, and shells that have been heated to high temperatures. This clinker is then broken onto powder, which, when combined with water, causes a chemical process known as hydration, it allowing the substance to grow firm and harden over time. Ordinary Portland Cement, better known as OPC, is the most widely used cement in the world, however other varieties, such as Pozzolana Cement (PCC) and quick Hardening Cement, are also utilized for certain building applications.

The primary function of cement is to create a strong, long-lasting material that can withstand large loads & environmental stress by binding components similar to sand, gravel, the crushed stone together. Compressive strength, which gauges the cement's resistance to pressure, as well as setting time, which shows how long it takes for cement to solidify after being mixed with water, are important performance traits. Because of its cost-effectiveness, adaptability, and dependability, cement has become essential in the development of infrastructure. However, worries about how cement manufacturing affects the environment are growing.

Aggregate

The production of concrete, asphalt, and other building materials depends heavily on aggregate, which is an essential part of the construction sector. Inert elements such as sand, gravel, crushed stones, & recycled materials are mixed with cement to form a robust and long-lasting combination for structural uses. In general, aggregates are divided into two categories: coarse aggregates (such as crushed stone or gravel, greater than 4.75 mm) and fine aggregates (such as sand, that pass through a 4.75 mm filter). These ingredients are essential for concrete because they provide it volume, increase stability, improve workability, and lengthen its lifespan.

Fig. no:1 Aggregate

Sand

A frequent and necessary component of construction, sand is used to make plaster, cement, concrete, and numerous other building materials. Small mineral particles, mostly silica (SiO_2), make up sand, a fine aggregate that is usually created by the wear and tear of rocks like stone and sandstone. Sand used in construction is divided into two categories: coarse sand, which has bigger particles, and fine sand, which includes smaller particles. Sand's size of grain, texture, and cleanliness determine its quality and usefulness for building. Because it helps generate thick, compact mixes that increase both the durability and strength of concrete and mortar, well-graded sand with a variety of particle sizes is highly desired in the construction industry.

Fig.no: 2 Sand

Sugarcane bagasse ash (ScBA)

A by-product of burning bagasse, which is the fibrous waste left over after sugarcane juice is extracted, is sugarcane bagasse ash (ScBA). ScBA has garnered attention as a possible partial cement substitute for concrete because of its pozzolanic qualities, which allow it to react with calcium hydroxide when used in the presence water to create more cementitious compounds that can improve the concrete's strength and longevity. By reducing CO_2 emissions, using ScBA as a partial substitute not only lessens the environmental effect of cement production but also aids in the management of agricultural waste, making conc ScBA's chemical makeup, degree of fineness, and percentage in the asphalt mix all affect how effective it is. When suitably added, ScBA has been found to enhance concrete's workability, strength in compression, and protection from chemical assaults, among other qualities. Because of this, ScBA has promise for creating more resilient and environmentally friendly building materials, as well as for recycling waste and lowering dependency on conventional cement.

Water

An essential component of construction, water is mostly utilized to prepare grout, mortar, and concrete. It is crucial to the cement's hydration process, which creates a solid structure through a chemical reaction with the cement. Because contaminants like salts, chemicals, etc organic materials can impair the stability, strength, & durability of concrete, the quality of the water used in constructing is very important. For the majority of construction applications, pure, contaminant-free potable water is often selected.

Waste paper sludge ash (WPSA)

Paper sludge, the leftover material following sewage treatment in paper mills, is burned to create recyclable paper waste ash (WPSA), a byproduct of the document recycling process. WPSA has drawn interest as a possible partial cement substitute in concrete because of its high silica, alumina, & iron oxide concentration. WPSA has pozzolanic qualities when employed in the right amounts, which means that it combines with cement's calcium hydroxide to make other cementitious compounds that improve concrete's strength, longevity, and general performance. By replacing some of the cement with WPSA, industrial waste may be managed and traditional cement consumption can be decreased, which lowers carbon emissions associated with cement manufacturing. According to studies, WPSA increases concrete's workability and strengthens its defenses against chemical assaults, including contacting sulfates as well as chlorides, which is important for constructions in harsh environments. Additionally, by keeping trash out of landfills and encouraging the circular economy, WPSA promotes sustainability. However, elements such as WPSA's chemical makeup, the number of particles, and the ideal quantity utilized in concrete mixtures will determine how well it works as a cement substitute. WPSA provides an eco-friendly substitute for conventional cement, lowering environmental impact while preserving concrete's performance criteria as the building sector adopts more sustainable practices. **Methodology**

Compressive Strength Of Concrete

The compressive strength of concrete is a critical property that determines how much load a concrete structure can safely carry. It refers to concrete's ability to withstand axial forces (either compression or tension) without failing. Since concrete is typically strong in compression, it is extensively used in building structures like bridges, roads, and buildings that bear heavy loads. Compressive strength is measured in terms of force per unit area (MPa or psi) and is commonly tested by applying a compressive load to a standard concrete specimen, usually in the form of cubes or cylinders, until it fails.

Importance of Compressive Strength

Compressive strength is crucial for determining the maximum load that a structure can sustain, which is why it is important for structural integrity. It assists engineers in designing components like as slabs, beams, and columns to guarantee that they can support the necessary loads for the duration of the construction.

- **Quality Control:** The test for compressive strength is crucial for verifying that the concrete employed in a project satisfies the appropriate criteria for durability as well as strength.
- **Sturdiness and Security:** Higher compressive strength concrete mixes usually provide longer-lasting structures that are more resilient to weathering, wear, and chemical deterioration.
- **Design Codes:** When designing concrete buildings, compressive toughness is a key consideration in design codes like the Indian Standard 456 (the Republic of India and ACI 318 (USA).

Fig.no 3: Compression Testing Machine

Testing for Compressive Strength:

The typical specimens used in testing of compressive strength are:

- Cubes (usually 6 inches by 6 inches or 150 mm by 150 mm by 150 mm).
- Cylinders (usually 6 inches by 12 inches, or 150 mm in diameter by 300 mm in height).
- A compression apparatus is used to test these specimens, applying progressively more stress until the specimen breaks.

Compressive Strength Test

Procedure:

1. **Mixing:** To ensure homogeneity, concrete is mixed with the proper amounts of Portland cement, fine aggregate (Sand), large stones, and water.
2. **Casting:** To prevent segregation, the new mixture is put into molds, which can be either cubes or cylinders, and crushed.
3. **Curing a Concrete Specimen:**

To guarantee complete cement hydration, the examples are allowed to cure for a duration, usually 28 days, following casting. Although it may also be evaluated at early durations (e.g., seven consecutive days) for beginning strength evaluation, this time frame offers the concrete to reach its target strength.

4. **Testing**

After curing, the specimens are put in a machine that provides a continuous rate of compressive stress until they break.

Fig.5: Cube Specimen Before Testing

How to Determine Compressive Strength:

The following formula is used to determine the compressive strength: $fc = P/A$

f c = A /P

Where:

A = specimen cross-sectional area (mm² or cm²), P = the maximum load at breaking (N or kN), and f c = compression strength (MPa or N/mm²).

Test again:

Three specimens are usually examined at the designated ages (7 and 28 days), when the average compressive strength value is noted as the outcome.

Ages for Standard Testing:

7-Day Strength: Offers a preliminary assessment of the quality of concrete, particularly in situations requiring a quick increase in strength.

Since test captures the concrete's complete hydration and long-term strength, the 28-Day Strength is regarded as the benchmark for concrete strength.

Compressive strength-influencing factors include:

1. **Water-Cement Ratio**: Concrete that has a lower water-to-cement ratio tends to be stronger, but too much water may dehydrate the concrete and a lack of water can render the mix unworkable.
2. **Cement Quality:** The compressive strength is greatly influenced by the kind and quality of cement, as various cements have varying rates of strength growth.
3. **Aggregate Quality:** To achieve greater strength, aggregate size, form, and grading are crucial.

4. **Mixing Ratios:** For concrete to be strong, the proper ratio of the cement, aggregates, or water is essential.
5. **Curing Conditions:** While improper curing can impede the development of strength, proper curing guarantees proper hydration and helps to increased strength.
6. **Age of Concrete:** Over time, especially over the first 28 days, concrete becomes stronger.
7. **Temperature:** Warm temperatures hasten strength and hydration.

Compressive Strength Categories:

1. **Normal Strength Concrete:** Usually used for routine building projects like pavements and foundations, normal strength concrete has a strength of 20–40 MPa.
2. **High-strength concrete**, which is utilized in bridges and tall structures, has a strength more than 40 MPa.
3. **Ultra-High Strength Concrete:** Used in specialist industries such as aerospace or military applications, this type of concrete has a strength of more than 100 MPa.

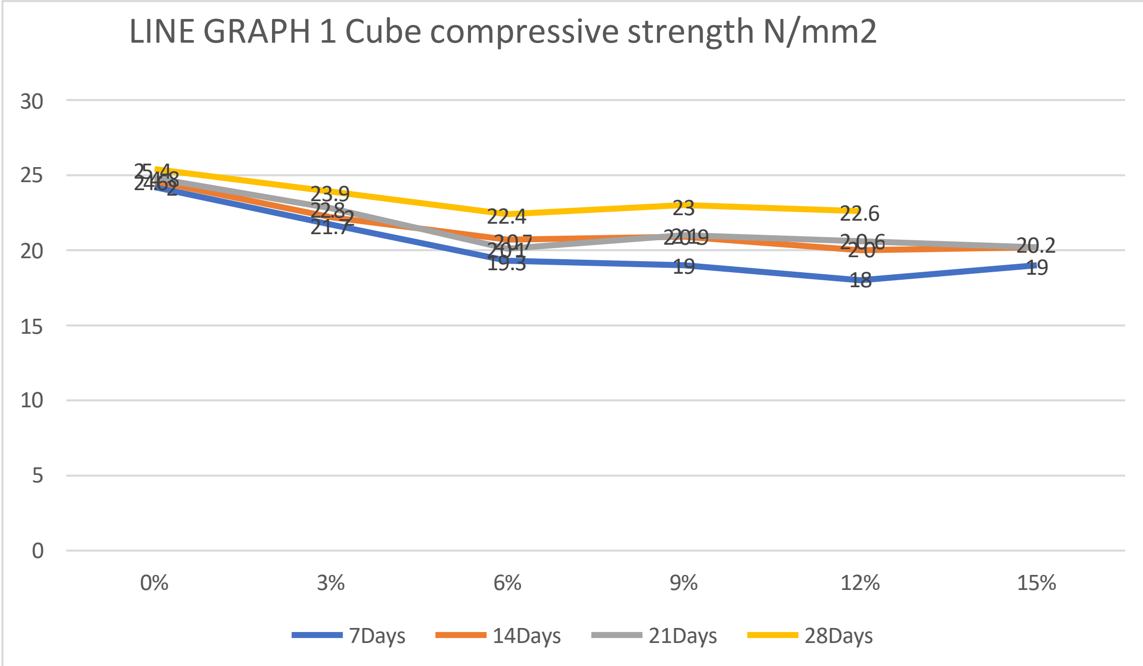
Results

The M25 Grade concrete has strength of 33.80 N/mm2 after 28 days.

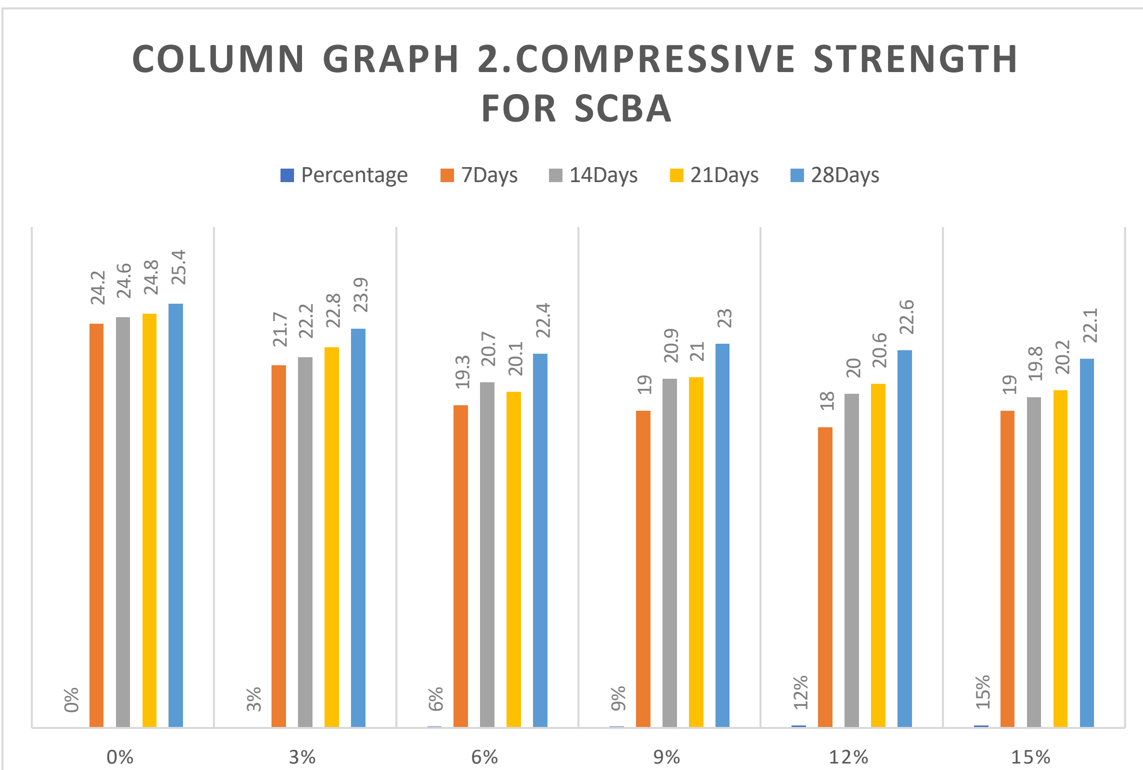
Compressive Strength Test of ScBA Concrete.

Table no.1 Compressive Strength Test of ScBA Concrete.

MIX	**%of cement Replaceme nt**	**Cube Compressive Strength N/mm2**			
		7 Days	14Days	21Days	28 Days
ScBA	0%	24.2	24.6	24.8	25.4
	3%	21.7	22.2	22.8	23.9
	6%	19.3	20.7	20.1	22.4
	9%	19	20.9	21	23.0
	12%	18	20.0	20.6	22.6
	15%	19	19.8	20.2	22.1



Graph 1. Compressive Strength Value along Percentage of ScBA



Column Graph 2. Compressive Strength for ScBA

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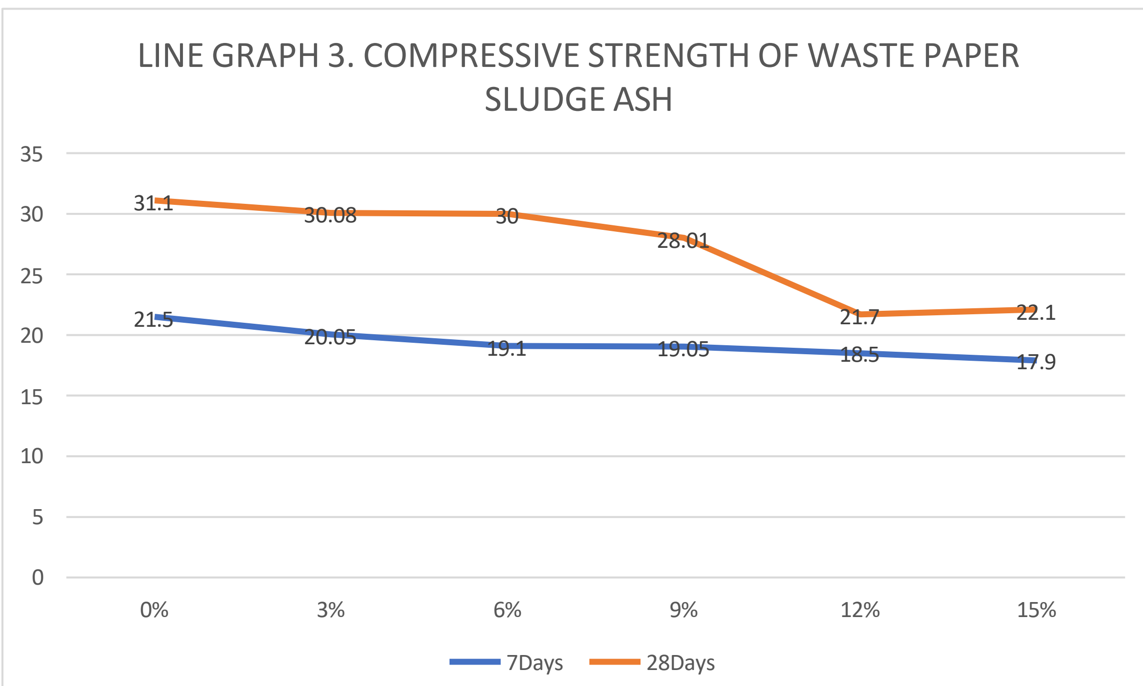
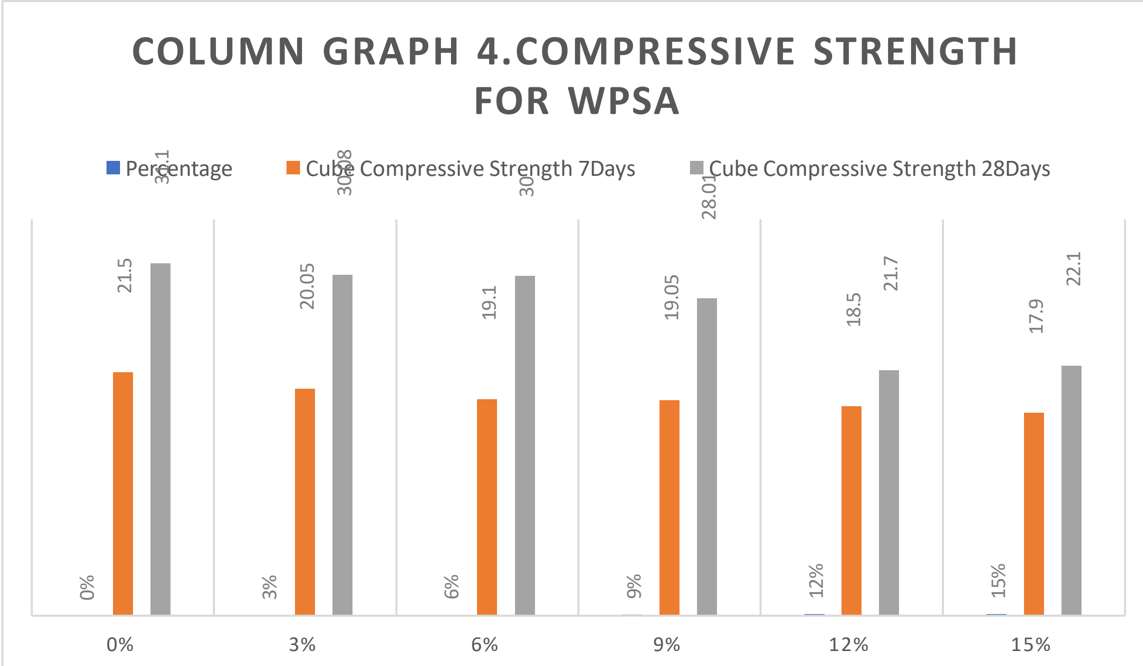
Compressive Strength of waste paper sludge ash Concrete

Table no. 7.2 Compressive Strength Value For WPSA

MIX	Percentage of Cement Replacement	Cube Compressive Strength N/MM2	
		7 days	28 days
Control	0%	21.5	31.10
WSPA	3%	20.05	30.08
	6%	19.10	30.00
	9%	19.05	28.01
	12%	18.50	21.70
	15%	17.90	22.10



Line Graph 3. Compressive Strength Value along Percentage of WPSA



Column Graph 4. Compressive Strength For WPSA

Conclusion

The study on the use of Sugarcane Bagasse Ash (SCBA) and Waste Paper Sludge Ash (WPSA) as partial cement replacements in concrete has yielded important findings regarding their effects on workability, strength, and overall performance.

Compressive Strength: The compressive strength of concrete decreased as the SCBA content increased, with the best results observed at 9% SCBA replacement (23.0 N/mm² at 28 days). In contrast, WPSA achieved its highest compressive strength at 3% replacement (30.08 N/mm² at 28 days), but strength began to drop noticeably at higher percentages. This indicates that WPSA performs better than SCBA in maintaining compressive strength at lower replacement levels.

In conclusion, SCBA and WPSA are promising materials for partially replacing cement in concrete, particularly when used in lower proportions (3%-9%). Their inclusion could help reduce the environmental impact of concrete production while offering a practical way to recycle waste. However, it is essential to carefully adjust the mix proportions and water content to ensure that the concrete meets required strength and workability standards.

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