Industrial Engineering Journal
ISSN: 0970-2555
Volume : 54, Issue 4, April : 2025

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

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ABSTRACT: Conventional cement production poses environmental challenges, prompting a shift towards sustainable and alternative building materials. This study examines the potential of Sugarcane Bagasse Ash (SCBA) and Waste Paper Sludge Ash (WPSA) as partial substitutes for cement in concrete to minimize environmental impact and repurpose industrial and agricultural waste.

The study focuses on assessing the feasibility of SCBA as a construction material, analyzing the effect of different cement replacement levels on concrete strength, and evaluating the mechanical properties of SCBA- and WPSA-incorporated concrete. Cement was replaced with SCBA and WPSA at weight percentages of 0%, 3%, 6%, 9%, 12%, and 15% in an M25 grade concrete mix. SCBA was also used to enhance durability and workability. Concrete specimens were tested for compressive strength, tensile strength, workability, and other durability aspects.

The findings reveal that integrating SCBA and WPSA into concrete enhances strength development, reduces waste, cuts carbon emissions, and promotes sustainable construction practices. This study highlights SCBA and WPSA as promising eco-friendly materials that improve structural performance while positively impacting 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:

Concrete is the world's most widely used material, created by blending cement, various-sized pebbles, and water-soluble materials in specific proportions. The mixture's strength depends on its composition, material ratios, and the efficiency of mixing and compaction processes. The physical, chemical, and mineral properties, combined with efficiency, define its success, aiming for improved material accuracy. While cement is crucial to concrete production, its manufacturing process releases significant amounts of carbon dioxide, contributing to environmental harm. Consequently, the industrial sector seeks ways to minimize CO2 emissions. One effective strategy involves replacing a portion of cement with alternative materials, enhancing sustainability goals. The addition of industrial and agricultural byproducts can further improve concrete quality. Using pozzolans to substitute a significant amount of cement reduces CO2 emissions and enhances both fresh and hardened concrete properties, offering an eco-friendly alternative.

This study explores the effects of incorporating various proportions of Sugarcane Bagasse Ash (SCBA) and Waste Paper Sludge Ash (WPSA) into cement on the mechanical properties, durability, and sustainability of concrete. The research aims to develop more efficient and sustainable construction methods by examining the interactions between these materials and cement mixtures, thereby reducing the sector's carbon footprint and promoting waste recycling. In conclusion, employing SCBA and WPSA as partial cement substitutes holds great potential for advancing sustainable construction practices. The study focuses on mitigating the environmental impact of cement production, encouraging waste reuse, and fostering the development of eco-friendly building materials. These findings could drive wider adoption of these alternatives, aiding the construction industry's transition to a more resource-efficient and sustainable future.

By addressing environmental concerns and the demand for sustainable solutions, the study emphasizes the importance of incorporating byproducts like SCBA and WPSA into cement production. It advocates for environmentally friendly construction methods and supports the broader goal of achieving sustainable practices.

SUGARCANE BAGASSE ASH (ScBA)

Sugarcane Bagasse Ash (SCBA) is derived from the combustion of the fibrous residue left after extracting sugarcane juice. While many sugar mills use bagasse as a biofuel for electricity generation, the resulting ash is often discarded as waste. However, recent studies have identified SCBA as a promising material for the construction industry, especially as a partial cement replacement in concrete. Its high silica, alumina, and mineral ion content endows SCBA with pozzolanic properties, enabling it to react with cement's calcium hydroxide to form additional cementitious compounds. This enhances the mechanical properties, strength, and durability of concrete.

Incorporating SCBA into concrete production offers significant environmental benefits. By reducing cement usage, SCBA helps lower greenhouse gas emissions, including the high carbon dioxide output associated with cement manufacturing. Additionally, SCBA contributes to efficient agricultural waste management by reducing landfill dependence and promoting recycling efforts.

Concrete containing SCBA proves to be a sustainable alternative, delivering advantages such as improved workability, reduced heat of hydration, and higher resistance to chemical attacks.

As the construction industry shifts towards eco-friendly practices, SCBA provides a practical solution for advancing resource efficiency and environmental conservation, aligning with global sustainable development goals.

Chemical composition of Sugarcane Bagasse Ash (ScBA)

The chemical composition of Sugarcane Bagasse Ash (SCBA) can vary based on factors such as the type of sugarcane used, combustion temperature, and the burning process. However, SCBA typically contains the following components:

1. **Silica (SiO_2):** The major constituent, making up 40% to 60% of SCBA, provides pozzolanic properties crucial for improving concrete strength.
2. **Alumina (Al_2O_3):** Constituting 3% to 10%, alumina enhances the pozzolanic activity and the chemical properties of concrete.
3. **Iron Oxide (Fe_2O_3):** Present at 2% to 5%, it slightly influences SCBA's color and contributes to workability and strength.
4. **Calcium Oxide (CaO):** Found in smaller amounts (1% to 5%), calcium aids the cementitious reaction.
5. **Magnesium Oxide (MgO):** Typically 1% to 3%, magnesium oxide influences compatibility with other concrete ingredients.
6. **Sodium Oxide (Na_2O) and Potassium Oxide (K_2O):** Found in trace amounts (<1%), these alkaline compounds play a minor role in hydration phases.
7. **Phosphorus Pentoxide (P_2O_5):** Present in small quantities (0.5% to 2%), phosphoruspentoxide enhances pozzolanic characteristics.
8. **Ignition Loss:** Represents the weight reduction due to volatile emissions and water content, generally ranging from 5% to 15%.

Physical Properties of Sugarcane Bagasse Ash (SCBA)

Color: SCBA typically appears light gray or white, influenced by combustion conditions.

Density: The bulk density of SCBA generally ranges from 0.4 to 0.9 g/cm^3, though it can vary.

Particle Size: SCBA is commonly available as a fine powder, though its particle sizes can differ.

Worldwide Sugarcane Production:

Approximately 1.9 billion metric tons of sugarcane are produced globally each year. The leading producers are:

1. **Brazil:** The largest global producer, contributing over 40% of the total sugarcane output.
2. **India:** The second-largest producer, accounting for more than 20% of the world's sugarcane crop, and the top producer of sugar.
3. **China:** Produces around 6% of global sugarcane, with cultivation concentrated in southern regions like Guangxi and Yunnan.
4. **Thailand:** Contributes roughly 5% of global production and exports a substantial amount of sugar.
5. **Mexico, Pakistan, and Indonesia:** These nations are significant contributors to the global sugarcane supply.
6. **Other countries:** Smaller producers include Egypt, the Philippines, Australia, and various African nations, all adding to worldwide sugarcane output.

Waste Paper Sludge Ash (WPSA)

The focus on sustainable waste management and resource recovery has led to growing interest in utilizing industrial byproducts. Waste Paper Sludge Ash (WPSA) is a residue from the paper recycling process, created by burning waste paper sludge derived from processing paper mill wastewater. This sludge, composed of organic and inorganic particles such as cellulose, chemicals, and minerals, turns into WPSA, a fine white ash, upon combustion. Its disposal poses environmental challenges due to its large volume and potential negative impacts, encouraging the development of eco-friendly recycling solutions.

WPSA has shown promise across various sectors, including construction, agriculture, and energy recovery. Its high silica and calcium content, along with other organic compounds, makes it valuable for concrete production, cement manufacturing, and agricultural soil improvement. Despite its potential, further exploration is required to fully understand its chemical composition, physical properties, and environmental benefits.

As demand for sustainable waste disposal and resource recovery increases, WPSA offers a practical solution for reducing waste, conserving natural resources, and mitigating the environmental footprint of the paper industry. Its versatility supports efforts to promote sustainability while addressing pressing ecological concerns.

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 54, Issue 4, April : 2025

Constituents of Waste Paper Sludge Ash (WPSA)

The chemical composition of WPSA depends significantly on the type of recycled paper, the chemicals involved in paper production, and the combustion conditions. Common components of WPSA include:

1. **Silica (SiO_2):** A major component, accounting for approximately 20–40%.
2. **Calcium Oxide (CaO):** Makes up about 10–20% of the ash.
3. **Potassium Oxide (K_2O):** Typically present in amounts ranging from 1–10%.
4. **Magnesium Oxide (MgO):** Found in smaller amounts, around 1–5%.
5. **Aluminum Oxide (Al_2O_3):** Usually less than 5% of the composition.
6. **Phosphorus Pentoxide (P_2O_5):** Found in trace quantities, about 1–5%, depending on the chemicals used in paper manufacturing.
7. **Sodium Oxide (Na_2O):** Present in small amounts, generally between 1–3%.
8. **Sulfur Compounds (SO_3):** Trace levels may result from sulfur-based compounds used in production, such as sulfuric acid.
9. **Heavy Metals:** Trace amounts of lead (Pb), zinc (Zn), and copper (Cu) may occur due to additives like inks and pigments.
10. **Organic Matter:** Residual unburned organic material may remain if combustion temperatures were insufficient, though typically minimal after proper burning.
11. **Moisture Content:** Moisture levels vary with storage and combustion conditions but are generally low after the residue is dried and processed.

Literature Review

Erniati Bachtiar et al (2019): This study investigates the feasibility of utilizing sugarcane residue Ash (SCBA) from the Arasoe Sugarcane Industry as an interim substitute from cement in concrete. The findings suggest that SCBA, with its tiny particle size & pozzolanic characteristics, may efficiently remove up to 5% of plaster. The samples of concrete through 0%, 2.5%, & 5% SCBA exhibited increased compressive durability as they aged, however those with a 7.5% SCBA showed a decrease in strength after 60 days. These findings imply that SCBA can be used as a partial alternative for cement, resulting in a more sustainable approach to waste management and building material utilization. Future research might investigate over time the endurance and efficiency of SCBA-based asphalt in real-world building conditions.

Honey Htun et al (2018): Human health is impacted by the substantial CO2 emissions and pollution in the atmosphere caused by the cement industry. The project looks into using sugarcane bagasse ash (SCBA) and a partial substitute for cement in order to remedy this. Two sources of SCBA, NwayDay and Oatkan, were evaluated with different water-to-cement ratios at replacement levels of 0%, 5%, 10%, and 15%. At 7, 14, 28, and 56 days, tests were performed on both fresh and hardened concrete. According to the results, Oatkan SCBA was a more efficient and environmentally friendly substitute since it had a higher compressive strength on 56 days.

D. Dinesh Kumar et al (2018): About 24–25 megatons of Sugarcane Bagasse Ash (SCBA), a fibrous waste that poses major environmental problems, are produced as a result of sugarcane production in India. In order to solve waste management and sustainability challenges, researchers are investigating its potential as an environmentally friendly cement substitute. In concrete, SCBA is investigated in this study as a partial cement substitution at 0%, 5%, 10%, and 15%. Over the course of 7, 14, and 28 days, experiments evaluated the compressive & split tensile strengths of both fresh (slump cone) or hardened concrete. Results indicate that SCBA improves the strength and durability of concrete, with 10% SCBA substitution showing the best results. This study highlights SCBA's capacity to cut waste, encourage environmentally friendly building methods, and lessen the sector's environmental impact.

Rasik Fayaz et al (2018): In order to lessen the impact on the environment and encourage the use of industrial waste, this study investigates the partial substitution of cement in concrete with a combination using rice husk ash (RHA) & waste paper sludge ash (WPSA). As substitutes for Ordinary Portland Cement, RHA and WPSA—by-products of rice processing as well as paper mills, respectively—are utilized in different amounts (5%, 10%, 15%, and 20%). Making use of standard cube (150×150×150 mm) and cyl (150×300 mm) samples, the study tests the compressive along with split tensile strength of concrete over 7 and 28-day curing periods. In addition to tests for consistency, setting and the duration of water absorption, a total of 78 cubes & 78 cylinders are going to be examined. The results are intended to evaluate the viability of employing RHA and WPSA in the manufacturing of sustainable concrete.

K. Kiran et al (2017): This study emphasizes the possibility of Bagasse made from sugar Ash (SCBA) as an interim replacement for cement in the construction process in concrete, delivering an environmentally acceptable waste management option. The experimental findings suggest that

SCBA may efficiently swap as much as 15% of cement by mass without appreciably reducing a compressive, extensible, or split tensile force. The study emphasizes the viability of SCBA a an alternative binding element for promoting environmentally conscious building techniques and resolving environmental challenges such as waste from farms and factories. Future research might look at prolonged durability and potential uses of SCBA in the manufacture of concrete.

Mr. M. Ganeshkumaret al (2017): In order to lessen dependency off Ordinary Portland Cement (OPC), whose is linked to significant CO2 emissions and energy consumption, this study investigates the potential application of Paper Sludge Ash (PSA) has a partial substitute for Fly Ash into potassium-based geopolymer concrete. In order to make geopolymer concrete, fly ash, a byproduct of power plants, is mixed with potassium hydroxide and potassium silicate in order to generate a binder. At percentages of 0%, 5%, 10%, 15%, and 20%, PSA was substituted. Examining characteristics such flexural strength, load-carrying capability, ductility, fracture patterns, deflection, and moment-curvature under various curing conditions—hot air oven, sunlight, and ambient conditions—the study concentrated upon the flexing behavior of geopolymer concrete beams. The findings imply that PSA can improve geopolymer concrete's sustainability without sacrificing its structural integrity.

Harsh k MIistry et al (2017):

This study investigates the utilization on Waste Paper Sludge Ash (WPSA) as well as Quartz Sand (QS) as partial substitutes for cement & natural sand, respectively, in order to mitigate the n egative environmental effects of cement production.WPSA was used in place of cement at 5%, 1 0%, 15%, and 20%; the ideal replacement rate was ound to be 5%.At this point, QS further repla ced natural sand at 25%, 50%, and 75%.A rebound hammer and compressive testing apparatus w ere used to measure compressive strength.With 5% WPSA & 50% QS, the maximum compressiv e strength measured was 44 MPa, demonstrating the materials' feasibility as sustainable substitut es in the manufacturing of concrete.

Sajjad Ali Mangi et al (2017): This study investigated the feasibility of utilizing the ash from sugar cane bagasse (SCBA) as an interim replacement with cement in concrete because with a focus on two concrete grades: M15 and M20. The experimental research, which comprised substituting 0%, 5%, and 10% of the cement by mass with SCBA, had significant results. Notably, the inclusion of SCBA led to a considerable improvement in compressive strength, particularly above the 5% replacement level. M20 concrete's compressive strength increased by roughly 12% as as opposed to its control mix (0% SCBA).The study also found that SCBA increased the workability of concrete, as seen by compatible slump levels. These findings indicate that a 5% SCBA substitution is best for obtaining ultimate concrete strength while maintaining good workability. This demonstrates that SCBA is a safe and efficient material for partially substituting cement in the production of concrete, providing both environmentally and performance benefits. In conclusion, this work sheds light on the utilization of SCBA in concrete and sets the path for further research into how it could be utilized in larger-scale applications. Future study might look at the longevity of concrete containing SCBA, and additionally, its ability to function in varied concrete grades and environmental circumstances.

P Bhargavi1et al (2016): Natural resources like clay and limestone are depleted as a result of the use of cement, a necessary component in construction. Large volumes of waste, especially paper sludge, are produced by the paper sector, making disposal and pollution management difficult. Paper sludge is proposed as a possible partial substitution in concrete because it contains lime, which is similar to that present in cement. The usage of 4%, 8%, 12%, & 16% paper sludge in place of cement is M30 concrete is examined in this study. Standard-sized specimens were subjected to a battery in tests (compressive, flexural, & tensile strength) following 3, 7, and 28 days of curing. The results demonstrate that even with the partial substitution, the compressive strength is still satisfactory.

Bahurudeen et al (2015): This study looked at the use using Bagasse made from sugarcane Ash (SCBA) to serve as supplemental cement fiber in concrete, specifically its effects overall compressive strength, drying loss of volume, and durability. The study found that acquiring SCBA to concrete considerably increased its performance. The pozzolanic characteristics of SCBA led to strength increases via pozzolanic processes, and the concrete also had a lower degree of hydration than control mixes. Durability studies, including oxygen in the atmosphere permeability, chloride conductivity, the water sorptivity, & water permeability, revealed that SCBA-enhanced concrete was more resistant to environmental conditions. The addition of SCBA improved the pore structure, lowering permeability and increasing durability. Furthermore, the drying stiffness of SCBA concrete was comparable to that measured for control concrete, showing no negative impacts on this feature. The use of sugarcane residue Ash (SCBA) into concrete has several advantages, including enhanced strength, improved durability, and a lesser environmental imprint. The study emphasizes SCBA's potential as a feasible and sustainable solution for partially displacing cement in concrete, which aligns with the growing demand for environmentally friendly construction materials.

S. F. Seyyedalipour et al (2015): In an effort to lessen the environmental effect and disposal expenses associated with the paper industry, this study investigates the utilization of recycled paperboard mills wastes as partial substitutes for sand in the production of non-load-bearing lightweight concrete. Two waste categories were examined:

Type 1: Chips made of paperboard and a tiny bit of sand.

Type 2: expandable polystyrene and nylon combined with paperboard chips.

As required by ASTM-C129, concrete was prepared with different percentages of every kind (up to 95%). Slump, pH, density, compressive & tensile strength, flexural strength, durability, and water absorption were all tested on both fresh and hardened concrete. According to the results, Type 1 waste performed more consistently and dependably, making it a superior choice for lightweight, environmentally friendly construction.

Mounika Ch et al (2015): With the goal of lowering expenses, the influence on the environment, and disposal concerns, this study explores the application for Waste Paper Sludge Ash (WPSA) to be a partial substitute for cement in M25 concrete. To find the ideal percentage, WPSA was added at 5%, 10%, and 15% in place of cement. To improve the concrete's mechanical qualities, varying amounts of steel fibers (0.5%–2%) and glass fibers (0.1%–0.4%) were added at the ideal level. Over the course of 28 days, the concrete's compressive, split tensile, and flexural strengths were assessed. Durability tests were also carried out employing 5% H_2SO_4 and HCl concentrations. The results demonstrated that adding WPSA to fiber-reinforced concrete increased its strength and longevity, suggesting that it has potential potential a sustainable material.

Dr.M.Vijaya Sekhar Reddy et al (2015): This study looked at the feasibility of utilizing the ash of sugarcane bagasse (SCBA) to be a partial replacement for ordinary Portland cement, known as OPC, into concrete manufacture. The study examined the effect of SCBA on the completely fresh and hardened characteristics of concrete at replacement quantities of ZERO, 5%, 10% & 20%. The results prove that SCBA, a stiff remnant of the sugarcane processing industry, may efficiently substitute up to 10% of cement as well without significantly reducing concrete strength. The research stresses the economic and environmental advantages of employing agricultural waste, such as SCBA, as a secondary cementing ingredient (SCM). The substitution of OPC with SCBA reduces industrial waste and improves the ethical utilization of assets in construction. According to the research, integrating SCBA into concrete, particularly at a 10% substitute value, does not result in substantial a decrease in strength making it a realistic and reasonably priced alternative to traditional cement.

Overall, the findings encourage additional research into SCBA as an environmentally conscious material for concrete manufacturing, with the potential to reduce environmental pollution and building costs while also assisting in the recycling of waste from the industrial sector. Future study might focus on improving the SCBA replacement % and evaluating a long-term durability of SCBA-containing concrete.

Mr. R. Balamurugan et al (2014): In order to lower production costs and environmental damage, this study explores the possible application of hypo sludge, a by-product of the paper industry, as a partial cement substitute in M25 grade concrete. Tests lasting up to 28 days were performed to examine the effects of adding hypo sludge at different concentrations (5%, 10%, 15%, and 20%) on the mechanical characteristics of concrete, namely its compressive as split tensile strength. According to the results, compressive strength increased with as much as 10% hypo sludge before strength started to decrease. The study emphasizes how septic sludge can be used as an additional cementitious ingredient to create concrete that is more environmentally friendly and sustainable.

T. S. ABDULKADIR et al (2014): This study investigated the possibility of the ash from sugarcane bagasse (SCBA) as a slight substitute for cement throughout concrete, with an emphasis on the impact on concrete density as well as compressive strength. SCBA, produced by heating sugarcane bagasse with 700°C, was chemically examined and determined to have pozzolanic characteristics. The overall composition among the elements silica, alumina, & ferric oxide wasn't 80.55%, which met the ASTM 595 (1985) criteria.The experimental investigation includes substituting cement along with SCBA at 0%, 10%, 20%, & 30% levels, as well as examining concrete cubes after 7, 14, 21, & 28 days of cure time. The data suggest that SCBA is a potential partial replacement around cement, particularly at 10 to 20 percent levels, where it exhibits adequate pozzolanic activity and compressive strength. With respect to the compressive strength & PAI results, it is advised to replace 10% and 20% of the reinforced concrete with SCBA, giving an efficient and economical alternative to regular cement.

D. Neeraja et al (2014): This study looked at the feasibility of utilizing the residue of sugar cane Ash (SBA) as an interim substitute for cement in mainstream concrete. Given that cement manufacturing contributes significantly to carbon dioxide emissions, the hunt for alternative, ecologically benign binders has become more important. ScBA, a finely crushed residue of the sugarcane industry, offers a sustainable alternative for reducing environmental pollution while satisfying the growing need for concrete materials. The study examined the effect of replacing cement regarding SBA at weight percentages for 0%, 5%, 10%, & 15% on concrete characteristics. The findings show that SBA may be efficiently employed as part of the substitute within cement, providing a potential way to reduce CO2 emissions while simultaneously resolving SBA disposal issues. Using this agricultural waste promotes both environmental sustainability as well as economic concrete manufacturing. Finally, employing SBA an cement substitute has two advantages: it reduces the environmental effect of cement manufacturing while also addressing the sugar industry's disposal concerns. Future study might look at minimizing SBA replacement levels as well as assessing the long-term durability for SBA-enhanced concrete in a variety of construction applications.

Sajad Ahmad et al (2013): The study investigates the potential utilization about sludge from waste paper ash (WPSA) as an incomplete replacement for cement on concrete to reduce the environmental impact of cement manufacturing and the usage of natural resources. In the case of the study, WPSA had been employed to substitute cement in M25 combine with concrete at 5%, 10%, 15%, & 20% by weight, respectively. Over the course of 28 days, the compressive integrity, tensile tension, absorbed water, and dry density of the concrete were all measured. The findings revealed that WPSA may efficiently supplement up to five percent of cement without compromising the mechanical qualities of concrete. However, increased replacement levels lowered workability and strength. The study found that WPSA is most effective when the particle size is smaller than 90 µm. Furthermore, wastepaper sludge offers high energy density, indicating that it might be utilized as an alternative fuel previous its the ash is used to replace cement. To summarize, substituting up to 5 percent of cemented with WPSA provides an ecologically beneficial approach for reducing the environmental effect of concrete manufacturing and addressing waste disposal issues. This study reveals WPSA's potential as a competitor binder in concrete, hence fostering an ecologically friendly and environmentally aware construction sector.

G.C. Cordeiroa et al (2011): The influence of using leftover rice husk ash (RHA) and sugarcane bagasse ash (SCBA) as partial cement substitutes in conventional & high-performance concretes is examined in this study. The ashes, which were created by vibratory grinding, were added to ternary mixtures that contained 60% the cement, 20% SCBA, as well as 20% RHA at substitution levels of 0% and 20%. Young's modulus, pore size distribution, fast chloride-ion penetrability, rheology, compressive strength with different ages (7 to 180 days), and adiabatic temperature rise were all investigated in the experiments. In ternary mixes, the results showed favorable impacts on rheology, steady or enhanced compressive strength, decreased electric charges, and a markedly decreased adiabatic temperature rise. This study emphasizes how SCBA and RHA can be used in tandem to improve concrete's qualities and lessen its negative effects on the environment.

Guilherme Chagas Cordeiroa et al (2008): A byproduct of the manufacturing of sugar and alcohol, sugarcane bagasse ash (SCBA) has the potential to be used as a pozzolanic ingredient in mortar and concrete. This study investigates how SCBA's particle size, particular area of surface, & pozzolanic activity are affected by mill type & grinding circuit topologies in both laboratory and pilot-scale settings. According to the results, SCBA's pozzolanic activity increases with fineness and, after extended grinding, reaches levels above 100%. About 42 kWh/t are needed for the process in industrialized ball mills. With no negative impacts on mechanical behavior, adding ultrafinely crushed SCBA (10–20% by mass) to high-performance concrete improved its rheology and resistance to chloride ions. This demonstrates SCBA's potential for high-performance, environmentally friendly concrete applications.

Marzuki A.Rahman et al (2006): This study looked at the feasibility of utilizing Wasted Papers Slurry the incinerator Ashes (WPSIA) as an interim replacement for cements that were in concrete. The raw materials' physical and chemical qualities were investigated, & WPSIA was used to substitute cement at 5, 10, 15, 20, 25%, & 30% by weight. The ratio of cement to water was kept constant at 0.55, a and the mix was measured for slump and its compressive strength. The results showed that introducing WPSIA onto the concrete mix resulted in lower slump values, suggesting decreased workability. In contrast, when WPSIA was added in order to replace up to 20 percent of the cement, the concrete had equivalent qualities to a control mixes (0% WPSIA) as 28 days of curing.The results show that WPSIA is capable of serving as a substitute for cement, strengthening the mechanical property of concrete while further demonstrating non-toxic hotels. This presents a probability to decrease in waste and underscores the ecological importance of using WPSIA with concrete production. provided its committing strength achievement and beneficial environmental properties, future research ought to concentrate on increasing the substitution rate and investigating the lasting properties of WPSIA-incorporated concrete across different construction-related uses. After 60 days of curing, the highest compressive stability of 44.1 N/mm^2

was observed with 15% WPSIA, which suggests the substance's potential to enhance ongoing strength.

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.

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

Material and Methodology

Cement

Cement plays a vital role in the construction industry as a key ingredient in concrete and mortar, forming the foundation for buildings, roads, bridges, and other infrastructure. It is produced by finely grinding clinker, a material composed mainly of silica, limestone, clay, and shells, which is heated to high temperatures. The resulting powder, when mixed with water, undergoes a chemical reaction called hydration, causing it to harden over time.

Ordinary Portland Cement (OPC) is the most widely used type of cement globally, though other varieties, such as Pozzolana Cement (PCC) and Quick Hardening Cement, are employed for specific applications. Cement’s primary purpose is to create a durable, load-bearing material by binding components like sand, gravel, and crushed stone. Key performance characteristics include compressive strength, which measures resistance to pressure, and setting time, indicating how long the cement takes to solidify when mixed with water.

Cement's cost-effectiveness, versatility, and reliability have made it indispensable in infrastructure development. However, growing concerns about the environmental impact of cement production, particularly its significant carbon emissions, have prompted efforts to make its manufacturing process more sustainable.

Aggregate

Aggregate is a crucial component in the construction industry, playing a vital role in the production of concrete, asphalt, and other building materials. It consists of inert materials such as sand, gravel, crushed stones, and recycled substances, which are combined with cement to create a durable and long-lasting mixture for structural applications.

Aggregates are categorized into two main types:

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 54, Issue 4, April : 2025

1. **Coarse Aggregates:** These include materials like crushed stone or gravel, with sizes larger than 4.75 mm.
2. **Fine Aggregates**: These consist of finer materials like sand, which pass through a 4.75 mm sieve.

Aggregates are integral to concrete as they provide volume, enhance stability, improve workability, and increase its lifespan, making them essential for construction durability and performance.

Fig. no:1 Aggregate

Sand

Sand, an essential material in construction, is widely used in making plaster, cement, concrete, and other building components. Composed of small mineral particles, primarily silica (SiO_2), sand is typically formed through the weathering of rocks such as stone and sandstone. In construction, sand is classified into two types: coarse sand, characterized by larger particles, and fine sand, with smaller particles.

The quality and suitability of sand for construction depend on factors such as grain size, texture, and cleanliness. Well-graded sand, featuring a mix of particle sizes, is highly valued in the construction industry as it creates dense and compact mixtures that enhance the strength and durability of concrete and mortar. Its versatility and reliability make it a fundamental ingredient in construction.

Fig.no: 2 Sand

Sugarcane Bagasse Ash (SCBA)

SCBA is produced as a by-product from burning bagasse, the fibrous residue left after sugarcane juice extraction. Due to its pozzolanic properties, SCBA has gained recognition as a potential partial replacement for cement in concrete. When exposed to water, SCBA reacts with calcium hydroxide to form additional cementitious compounds, which enhance the strength, durability, and overall mechanical properties of concrete.

Utilizing SCBA as a partial substitute for cement offers environmental benefits by reducing CO_2 emissions and aiding in the efficient management of agricultural waste. The effectiveness of SCBA depends on factors such as its chemical composition, fineness, and proportion in concrete mixes. Proper incorporation of SCBA improves concrete workability, compressive strength, and resistance to chemical attacks, among other advantages.

As a sustainable alternative, SCBA presents significant potential for developing resilient and eco-friendly building materials, supporting waste recycling efforts, and reducing reliance on conventional cement. Its use aligns with the construction industry’s shift towards greener practices and resource efficiency.

Water

Water is a fundamental element in construction, primarily used to prepare grout, mortar, and concrete. Its role is vital in the hydration process, a chemical reaction between water and cement that forms a solid and durable structure. The quality of water used in construction is critically important, as impurities such as salts, chemicals, and organic matter can compromise the stability, strength, and durability of concrete.

For most construction purposes, clean, contaminant-free potable water is preferred to ensure optimal performance and long-lasting structural integrity.

Waste Paper Sludge Ash (WPSA)

WPSA is derived from burning paper sludge, a residual material produced during paper mill sewage treatment, making it a byproduct of the paper recycling process. Due to its high silica, alumina, and iron oxide content, WPSA is being explored as a partial cement replacement in concrete. Its pozzolanic properties enable it to react with cement's calcium hydroxide, forming additional cementitious compounds that enhance concrete's strength, durability, and overall performance. By partially substituting cement with WPSA, industrial waste can be effectively managed, while reducing traditional cement consumption and minimizing carbon emissions from cement manufacturing. Studies indicate that WPSA improves concrete workability and provides greater resistance to chemical attacks, such as exposure to sulfates and chlorides, which is particularly beneficial in harsh environments. Additionally, incorporating WPSA into concrete aids landfill waste reduction, supports the circular economy, and promotes sustainability.

Factors such as WPSA's chemical composition, particle size, and the optimal amount in concrete mixes are critical to its effectiveness. As the construction industry shifts towards greener practices, WPSA serves as an eco-friendly alternative to conventional cement, reducing environmental impact while maintaining key performance standards.

Methodology

Split Tensile Strength Test

Concrete's tensile strength can be determined using an Split Tensile Strengths Test, which is also referred to as the Brazilian Test. By applying the force of compression throughout its size of a spherical concrete specimen, this test indirectly determines the tensile strength of concrete, which is typically weak in tension.

Equipment:

1. **Concrete Cylinder:** A concrete specimen that is cylindrical and usually measures 150 mm in diameter by 300 mm in height.
2. A machine that delivers a compressive burden to the specimen is known as a compression testing machine.
3. **Steel Plates:** During testing, the cylinder sample will be subjected to consistent pressure from two flat steel plates.

4. Any deformation much or the displacement between the test is measured using a dial-type gauge or linear measurements device.
5. A caliper or ruler is used to measure the cylinder's dimensions.

Method:

1. **Preparing the Specimen:**

   In accordance with standard standards, concrete examples are made in cylindrical molds that are normally 150 mm in diameter and 300 mm in height.

   For 28 days, the concrete is left to cure (or for the duration specified in the project requirements).

2. **Configuration:**

   Between the two steel plates, position the concrete cylinder horizontally.

   To guarantee uniform load distribution during testing, make sure the plates are clean and smooth.

3. **Testing:** Insert the specimen into the compression testing apparatus with its longitudinal plane horizontally aligned. Then, evenly apply the compressive forces along the specimen's diameter, keeping the platen of the apparatus in direct contact with the test sample.
4. The load is applied continuously until the the sample splits along its diameter, and the amount of load is monitored when the test specimen begins to failure (i.e., crack or split).
5. **Failing:**

   Because of the tensile strains that are created in the center of the specimen, it usually splits in half along its longitudinal axis.

6. When the specimen breaks, note the highest load that was applied.

Compute:

The following formula is used in order to determine split tensile strength:

$ft=2P/\pi LD$

where P (in N) is the maximum load exerted at failure.

L is the cylindrical specimen's length (in millimeters).

D is the cylindrical specimen's diameter (in millimeters).

π π = 3.1416 (static)

Megapascals, or MPa, are commonly used to represent the outcome.

Findings: The result obtained indicates the concrete's split tensile strength.

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It is crucial to remember that concrete's tensile strength is typically between 10% and 15% of its compressive strength, which is much less than its compressive strength.

Benefits:

The Split Tensile Test's benefits include:

1. **Simplicity:** The test doesn't require complex equipment and is comparatively simple to do.
2. **Indirect Assessment:** This test offers a useful and indirect way to calculate concrete's tensile strength.
3. **Standardization:** To ensure uniformity, the test has been standardized by a number of codes, including ASTM C496 (the American style standards) and IS: 5816 (Indian standards).

Applications

- Valuable for determining how long concrete will last in palaces that are subjected to tensile pressure such as pavements, slabs, and beams.
- In building projects, it is frequently used for concrete acceptance testing and quality monitoring.

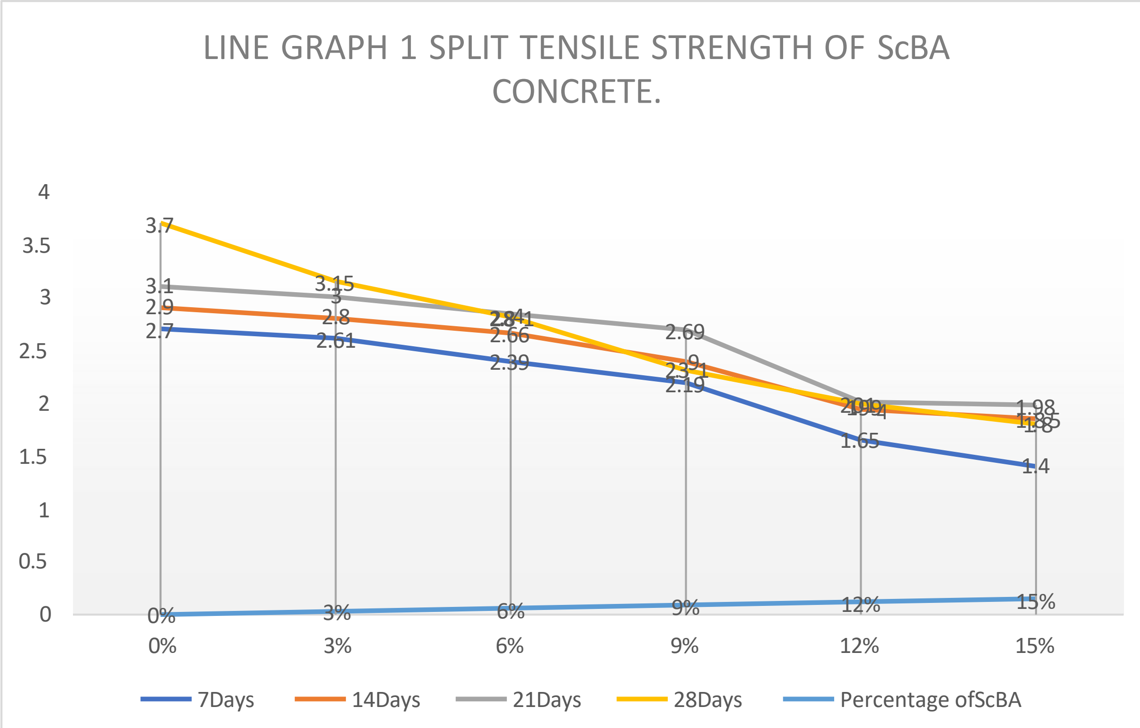
Results

Split tensile strength values for ScBA Concrete.

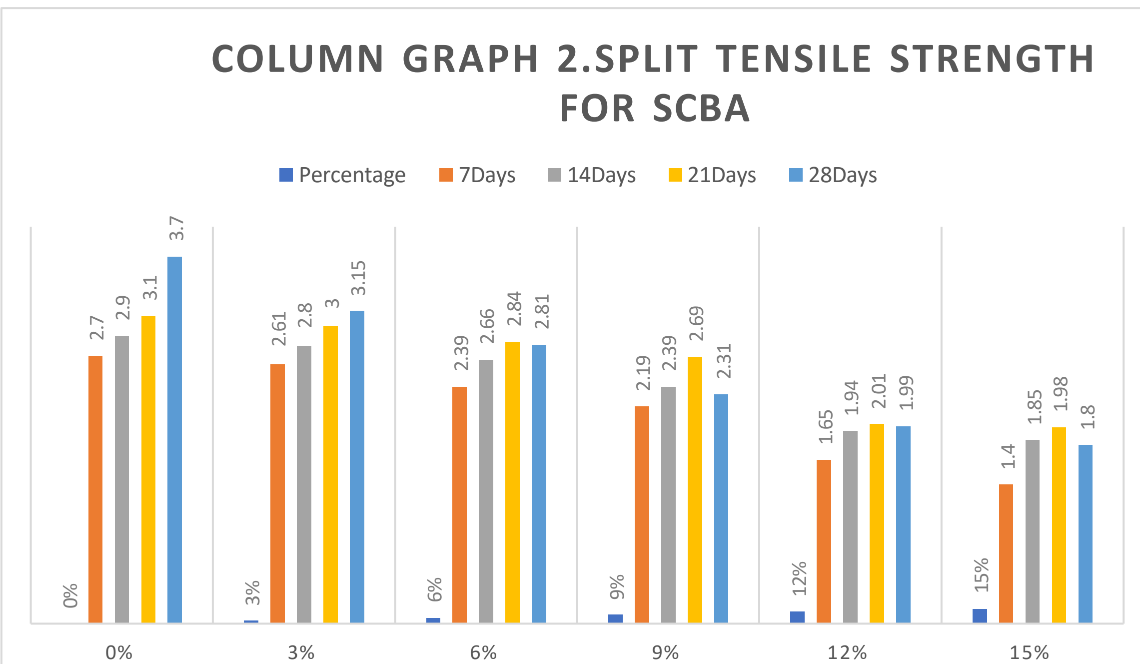
Table no.1. Split tensile strength values for ScBA

MIX	%of cement Replacement	Split Tensile Strength N/mm2			
		7 days	14days	21days	28 days
ScBA	0%	2.70	2.90	3.10	3.70
	3%	2.61	2.80	3.00	3.15
	6%	2.39	2.66	2.84	2.81
	9%	2.19	2.39	2.69	2.31
	12%	1.65	1.94	2.01	1.99
	15%	1.40	1.85	1.98	1.80

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 54, Issue 4, April : 2025



Graph 1. Split Tensile Strength Value along Percentage of ScBA



Column Graph 2. Split Tensile Strength for ScBA

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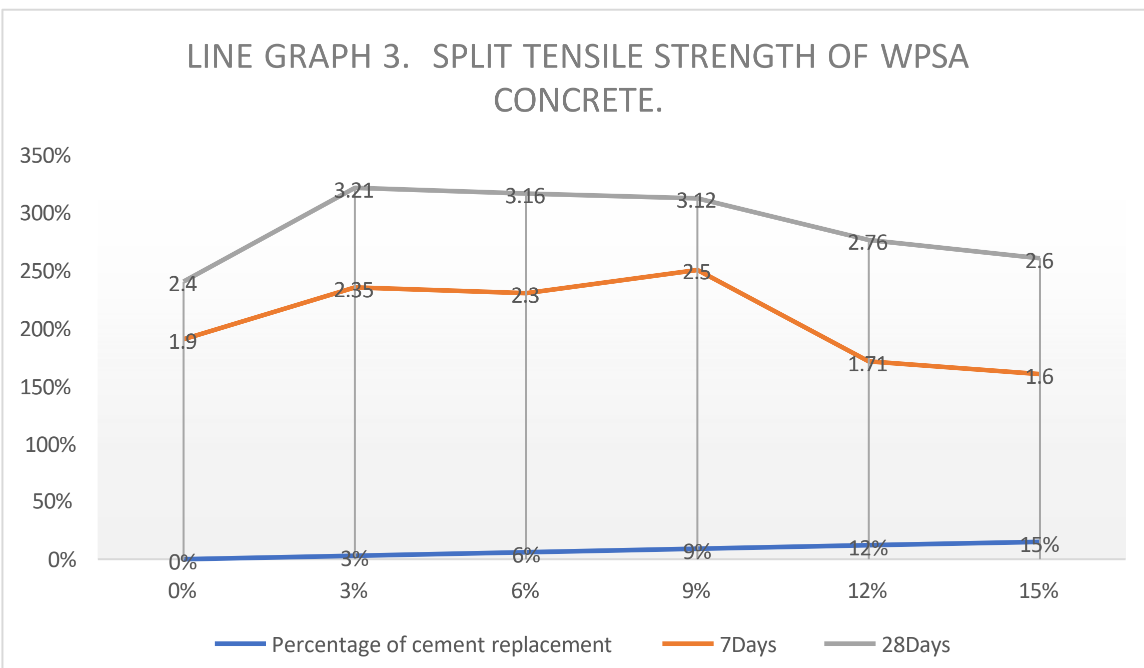
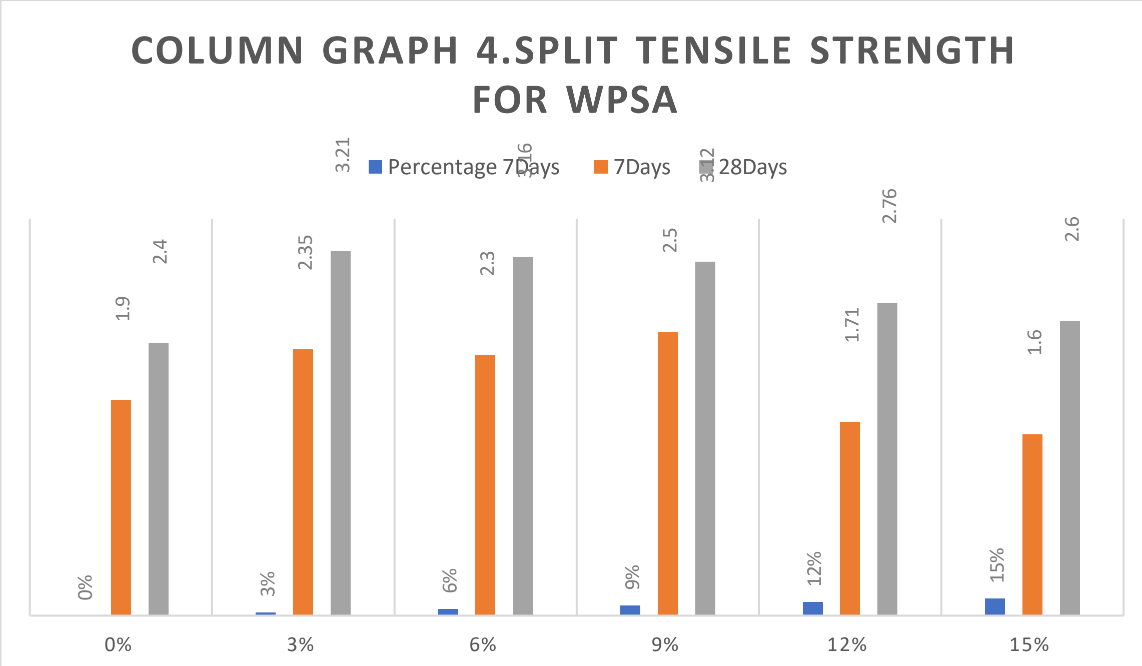
Split Tensile Strength of WPSA Concrete

Table no.2. Split Tensile Strength Value For WPSA

MIX	Percentage of Cement Replacement	Cube Compressive Strength N/MM2	
		7 days	28 days
Control	0%	1.90	2.40
WSPA	3%	2.35	3.21
	6%	2.30	3.16
	9%	2.5	3.12
	12%	1.71	2.76
	15%	1.60	2.60



Graph 3. Split Tensile Strength Value along Percentage of WPSA



Column Graph 4. Split Tensile 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.

- **Split Tensile Strength:** Split tensile strength showed a similar trend, with SCBA causing a steady decline in tensile strength as the percentage increased. However, WPSA led to an initial increase in tensile strength up to 3% replacement, after which it decreased at higher percentages.

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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