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Investigation of Strength and durability properties of Raw Sugarcane Bagasse ash as partial replacement in self-compacting concrete

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Abstract

An agricultural byproduct produced during the sugar-making operations is called sugarcane bagasse ash (SBA). A number of researchers proposed that SBA ground into extremely tiny particles might perform pozzolanic characteristics, which could be advantageously employed to improve the qualities of concrete. In this study research focuses on the utilization of RSBA as a sustainable alternative in concrete production. Compression and tensile tests were the two main testing techniques used to evaluate the material's performance. By evaluating the load-bearing capacity and structural integrity of SCC with different percentages of RSBA using compression testing, the concrete's compressive strength and structural application potential were revealed. Tensile testing was done to look at the material's ability to sustain tension and resistance to applied pressures. The outcomes of both experiments provide a comprehensive knowledge of the mechanical properties of SCC with RSBA, clarifying the material's potential for building applications. Aspects of durability were carefully examined to determine the composite material's long-term resilience in a range of environmental circumstances, offering insights into its potential for durable and sustainable building methods. Ansys Workbench integration improves analytical accuracy and dependability and provides a solid assessment of SCC's performance with partial replacement from RSBA.

Keywords: Sugarcane bagasse ash, Compression test, Tensile tests, Ansys Workbench, Self-Compacting Concrete.

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1. 1ntroduction

One popular technique used in building is self-compacting concrete. SCC is intended for locations where over-reinforced buildings and regions with high reinforcement congestion exist. SCC is crucial to the concrete-laying process in regions where it is exceedingly challenging [1]. The qualities of self-compacting concrete, such as the fact that its: a) flows under its own weight and may therefore be distinguished from simply pour the controlled self-compacting concrete over the obstructed reinforcement; b) it doesn't need vibrations; and c) it creates a homogenous paste by mixing aggregates and sand without going through segregation [2-3]. Self-compacting concrete is a concrete that will be used in building in the future to improve SCC's strength and workability [4]. The researchers have used waste materials like fly ash, rice husk ash, and GGBS, among others, to improve the properties of SCC [5]. They have come to the conclusion that it is beneficial to use these wastes in Self-Compacting Concrete in place of some of the cement in order to achieve the desired outcomes from the experimental study [6]. Additionally, the experimental study's conclusion is that bagasse ash helped reduce waste by making use of waste resources. The cost and carbon emissions associated with the production of cement will both be decreased by the use of waste bioproduct mineral additive in self-compacting concrete (SCC) [7]. Admixtures with high slump values and workability are necessary for SCC in order to generate concrete that is more pliable [8]. When sugarcane is burned at temperatures above 600 degrees Celsius, waste bio-product known as bagasse ash is produced. This mineral admixture is used in various applications [9-10]. Ash is the byproduct of burning, and before it enters the environment, it is filtered to ensure that no hazardous effluents are released. Along with additional elements including magnesium, aluminium, calcium, and sulphur oxides, bagasse ash is often high in silica [11]. Although adding raw sugarcane bagasse ash (RSBA) to self-compacting concrete (SCC) as a partial replacement has several advantages like possible cost savings, environmental sustainability, and better workability it also has some drawbacks [12]. Variations in the content and quality of RSBA are a significant cause for worry as they can lead to uneven performance and unpredictably changing impacts on the resilience and strength of SCC [13].

The overall consistency of the concrete mixture may be impacted by differences in the chemical composition and particle size distribution caused by the absence of regular production techniques for bagasse ash [14]. RSBA's pozzolanic activity can differ, which could have an impact on SCC's long-term durability and strength growth. Careful consideration of its qualities is necessary to preserving the required performance of the resultant SCC [15]. Quality control procedures become crucial to assure the dependability of RSBA as a supplementary material in concrete. Modern testing techniques like ANSYS simulation can be extremely helpful in maximizing the performance of the material in order to overcome the challenges involved in mixing raw sugarcane bagasse ash (RSBA) with self-compacting concrete (SCC). A thorough examination of the mechanical and structural characteristics of SCC incorporating RSBA is made possible using ANSYS, which also offers insights into the implications of changes in pozzolanic activity and particle size distribution. By simulating the SCC's behavior under various loading scenarios using finite element analysis, ANSYS can assist in locating any weak points and regions that might cause durability problems. Scientists and engineers may simulate and evaluate how different RSBA compositions affect the overall strength, consistency, and long-term durability of SCC using ANSYS models. A more accurate knowledge of RSBA's impact on SCC may be attained via the use of ANSYS testing, which will help with the establishment of quality control procedures and guarantee the dependability of this environmentally friendly concrete solution.

2. Contribution in this work

- The environmental impact and energy consumption associated with the production of sugarcane bagasse ash compared to traditional concrete materials can provide insights into the overall sustainability of the construction industry.
- Finite element analysis (FEA) using ANSYS can simulate various loading conditions, aiding in predicting the structural response, deformation, and stress distribution within the concrete elements.
- The mechanical behavior, deformation patterns, and failure modes. Insights gained from such simulations can guide the design and application of SCC in practical construction scenarios, ensuring structural integrity and safety.

The remainder of this study is divided into five sections: section 2, which includes research on various individuals, and section 3, which provides examples of the proposed technique. The result and discussion portion are illustrated in Section 4, and the research work's conclusion is presented in Section 5.

3. Literature review

In 2018 Le *et al.*, focused on using industrial and agricultural wastes together to create environmentally friendly concrete [16]. Via an experimental program, the fresh and hardened properties of self-compacting concrete (SCC), which is formed of blended cement with sugarcane bagasse ash (SBA, an agricultural waste produced during the production of sugar), granulated blast furnace slag (BFS), and ordinary Portland cement, were investigated. Three degrees of cement replacement (10%, 20%, and 30%) for SBA linked to the development of three SCC mix groups (BA10, BA20, and BA30). Four mixes, corresponding to four cement-by-slag replacement ratios (0%, 10%, 20%, and 30%), were also used for each group. A total of twelve combinations, comprising blended cements SBA and BFS, as well as one reference mix, were created for the experiment. In 2018 Khatun *et al.*, proposed the agricultural waste Sugarcane Bagasse Ash (SCBA) is added to self-compacting concrete in varying amounts, such as 0%, 5%, 10%, 15%, 20%, and 25% [17]. The mechanical, fresh, microstructure, and durability of treated and controlled self-compacting concrete are evaluated in this study. In 2022 Memon *et al.*, investigated the impact of processed SCBA as SCM in concrete [18]. Sieving and grinding were the two steps in the SCBA processing process that eliminated fibrous and carbon-containing particles. The SCBA was utilized for further characterization and concrete inclusion after being treated for 45 minutes to a cement-like surface area. The pozzolanic reactivity of the SCBA was enhanced by 2.92 times throughout the 45-minute grinding interval. In order to include the SCBA, concrete was mixed with varying weight fractions of cement (10%, 20%, 30%, and 40%). In 2020 Hasnain *et al.*, investigated the effects of replacing river sand with blended waste ashes from RHA and BA in an environmentally responsible manner on the fresh, microstructural, physico-mechanical, and sulfate-resistant properties of SCC [19]. The pozzolanic nature of ashes was demonstrated by the microstructural characterization findings in the Chappelle activity test, and the adsorptive nature of the siliceous micro-sized ash particles contributes to the greater water requirement in SCC. In 2018 Zareei *et al.*, experimented to see if sugarcane bagasse ash (SCBA) may be used in regular, lightweight, self-compacting concrete in place of some of the cement [20]. To achieve this goal, a control specimen and specimens with 5, 10, 15, 20, and 25% SCBA were created. In 2018 Moretti *et al.*, proposed the mortar level was carried out using a statistical factorial design technique, which provides a reliable foundation for creating empirical models that enable the identification of the best configurations for the design variables to meet all performance objectives [21]. Three optimized paste formulations were evaluated for their effects on SCC characteristics at the concrete level. Property evaluations included fresh condition, mechanical, and durability. In 2018 Gopal *et al.*, focused on cement consumption needs to be controlled right away since every ton of cement manufactured emits half a ton of carbon dioxide [22]. Conversely, hazardous materials waste like sugar cane bagasse ash are difficult to dispose of and constitute a risk to the environment. In addition to reducing the permeability of the concrete, bagasse ash gives it great early strength. During cement hydration, silica from bagasse ash combines with other cement constituents to give further qualities including resistance to corrosion and chloride. Because of this, adding bagasse ash to concrete improves its qualities, lowers its cost, and lessens environmental pollution. It increases the concrete's durability. In 2020 Anjos *et al.*, evaluated the impact of SCBA on the rheological, physical, and mechanical characteristics of mortars that contain cement and limestone filler (LF) [23]. In order to create the mortars, a volumetric ratio of 0.85 was used for water and a substitution of 15%, 20%, 25%, and 30% of Portland cement (PC) with SCBA.

In 2018 Rajasekar *et al.*, the viability of using bagasse from sugarcane as a pozzolanic ingredient to make Ultra High Strength Concrete (UHSC). TBA, or treated bagasse ash, was used in place of regular Portland cement for this study [24]. The percentage of cement weight that was replaced ranged from 5% to 20%. Additionally, research was done to determine how various curing schedules affected the UHSC's toughened qualities. In 2020 Mello *et al.*, proposed to assess how SCC behaves when cement is replaced with metakaolin with sugarcane bagasse ash at temperatures between thirty and fifty percent [25]. For this reason, in addition to the visual stability index, the self-compactness of five SCC compositions was assessed using the slump-flow, J-ring, L-box, and V-funnel tests. The SCC were subjected to 200, 400, 600, and 800 degrees Celsius.

4. Methodology

The process uses binders like Ordinary Portland Cement (OPC) to evaluate the strength and durability characteristics of Raw Sugarcane Bagasse Ash (SBA). Ansys Workbench is used to do a thorough study with a particular focus on assessing the composite material's structural integrity and long-term durability. By ensuring that mechanical strength and durability exceed industry requirements, this strategy seeks to maximize the use of SBA as a sustainable addition in building materials.

4.1. Preparation of Sugarcane Bagasse Ash

Because of its high carbon content, the raw bagasse ash from nearby cogeneration dumps was a unique black hue, as seen in Fig 1. This improved material's qualities were achieved by a procedure that involved cooling the raw material after an hour of carefully regulated burning at 600^{o} C and 800^{o} C degrees Celsius. Following this, the material was finely ground into particles finer than cement, with only 3% retained on the 325 μm sieve. With great care, the Sugarcane Bagasse Ash (SBA) was prepared to maximize its properties for the use for which it was designed. In the testing phase, the processed SBA exhibited specific physical and chemical attributes. With a Blaine's fineness of 4010 g/cm^2 and a specific gravity of 2.02, the SBA's properties were compared to Ordinary Portland Cement (OPC). A thorough summary of their individual chemical and physical makeup is given in Table 2, which also shows how the SBA compares to and differs from OPC, a common building material. In particular, it establishes the groundwork for future assessments that will assess the SBA's viability and efficacy as a substitute in building applications.

3.1.1 Specimen preparation with blends

Meticulous attention to detail is necessary during the mixing process of the proposed concrete blend, which consists of 80% Portland cement and 20% Raw Sugarcane Bagasse Ash (RSBA), to ensure proper incorporation of the supplementary material while maintaining the mixture's overall integrity and workability. To provide a consistent dry mix, Portland cement and RSBA are carefully pre-blended at the start of the procedure. The hydration process is then started by gradually adding water to the dry material once it has been put to the concrete mixer. In order to encourage the uniform distribution of cementitious materials and avoid the production of agglomerates, the mixing time is a crucial parameter that has to be adjusted. Because uniform dispersion of RSBA particles is ensured by adequate mixing, the concrete matrix becomes more homogeneous. Throughout this stage, it is critical to keep an eye on the mix's consistency in order to attain the appropriate workability while keeping the precise ratios of RSBA and cement. Next, as part of the mixing process, any required chemical admixtures are added to the mixture after the fine and coarse aggregates have been added. To get the required strength and durability qualities, close attention should be paid to keeping the water-to-cementitious materials ratio within the specified bounds. The last step is to keep mixing until the concrete mixture is homogeneous and cohesive. A thorough evaluation of the possible advantages and effectiveness of the Portland cement and RSBA combination in concrete applications can then be achieved by subjecting the resultant blend to standard testing procedures to assess its fresh and hardened properties. Utilizing the sustainable qualities of RSBA while upholding the performance requirements and structural integrity of Portland cement-based concrete is the goal of this mixing process.

4.2. Testing procedures

ANSYS software is used in a complex analysis of the testing process that includes both compression (75*15*75) and tensile testing (75*10*15) method materials are shown in Fig 3 & Fig 4 to assess the strength and durability of the concrete blend consisting of 80% Portland cement and 20% Raw Sugarcane Bagasse Ash. To provide important insights into the mechanical performance of the concrete mixture, ANSYS, a potent finite element analysis tool, is used to simulate and forecast the structural behavior of the mixture under various loading conditions. Using the ANSYS environment, virtual models of the concrete specimens are made in order to replicate their real-world dimensions and material properties for the compression testing method. In order to evaluate parameters like compressive strength, stress distribution, and potential failure modes, the virtual specimens are subjected to compressive loads during the simulation. ANSYS facilitates a thorough analysis of how the ratio of Portland cement to RSBA affects the concrete's overall compressive performance, which helps determine the best mix composition for applications involving strength. ANSYS is used in the tensile testing method to model the concrete blend's reaction to tensile stress. In order to determine whether a material is appropriate for uses where tensile strength is essential, like in structural elements subjected to bending or flexural loads, it is important to know how well-suited the material is for pulling forces, which is provided by this analysis. Through the execution of both compression and tensile simulations, the testing process provides a thorough understanding of how the proposed concrete blend behaves under various loading conditions, contributing to a comprehensive evaluation of its quality, strength, and durability. When ANSYS software is integrated into the testing process, it improves accuracy and efficiency and facilitates better decision-making about whether Portland cement and RSBA work well together in concrete.

4.2.1. Mesh

Ansys is widely recognized for its sophisticated meshing features, which are essential for accelerating the simulation process and improving the precision of the outcomes. One of the most important steps in the finite element analysis (FEA) process is meshing, which is the breaking down of a complicated geometry into smaller elements for simulation.

Ansys offers a vast array of meshing tools that cut down on the time and effort needed to produce accurate and dependable results. By eliminating the need for labor-intensive manual mesh generation, the software's automated meshing features facilitate a more efficient workflow and free up engineers and analysts to concentrate on the essential elements of their simulations. Ansys's meshing tools make effective use of computational resources by adaptively refining the mesh in areas of interest through the use of complex algorithms. This flexibility is very helpful when working with intricate geometries or regions that have different simulation-level priorities. Ansys provides a range of meshing methods, including structured and unstructured meshing, so that users can customize their strategy according to the particular needs of the simulation. Ansys enables engineers to achieve optimal mesh quality while minimizing the time investment in the meshing process by offering a balance between automation and user control. This ultimately accelerates the overall simulation workflow and time-to-result.

4.2.2. Force acting

As seen in Fig. 7, the first case shows a compressive test configuration in which the material being tested is fixedly supported at one end. The center of the material is subjected to a compressive force of -5000 N. With this arrangement, the situation of compressive loading on the material is simulated, with the force concentrated at the center and resistance provided by the fixed support at one end. Researchers and engineers can analyze a material's strength, stability, and deformation characteristics under compressive stress by using compressive testing, which is essential for determining a material's capacity to bear compression forces. Tensile testing, which involves subjecting the material to forces in tension, is the new focus of Fig. 8. Analogously to the previous compressive scenario, the setup used in the analysis has a fixed support at one end. On the other hand, 5000 N of tensile force is applied at the material's opposite end in this instance. Tensile testing is a crucial procedure that evaluates a material's tensile strength, elasticity, and ductility as well as how it reacts to stretching forces. Through the application of force at one end and the fixing of the other, engineers can learn more about the behavior of the material under tension, which helps to characterize its mechanical properties and overall performance in practical applications.

5. Result & Discussion

The creation and evaluation of concrete mixtures with raw sugarcane bagasse ash included in them. The performance of the created blends was methodically assessed using two important testing techniques: tensile testing and compression testing. Through the process of compression testing, we investigated the material's resistance to axial loads, offering valuable information about its overall strength and structural integrity. Tensile testing was carried out concurrently, covering a variety of evaluations including elongation with deformation, shear strength, strain energy, and strain behavior. Together, the test findings allowed for a comprehensive understanding of the mechanical properties and behavior of the concrete mixtures. The purpose of adding raw sugarcane bagasse ash to the mixture was to investigate its potential as a useful and sustainable addition that may improve the concrete's deformation properties and mechanical strength. These studies' outcomes offer important information about the viability and efficiency of using sugarcane bagasse ash in concrete mixtures, as well as possible uses for it in the building sector.

5.1. Compression testing

Through the use of a compression test material dimensions are 75*15*75, which involves breaking rectangular concrete specimens inside a compression testing machine, compressive strength a crucial characteristic used to assess the toughness of hardened concrete mixtures is ascertained. This test assesses the concrete blend's capacity to support a weight before failing, offering vital information on the structural integrity of the material. The compressive strength test is a crucial tool for determining if concrete is suitable for a certain range of building applications since the test's findings show how well the material can withstand large loads and deformation. Engineers and builders depend on these tests to guarantee that concrete buildings can withstand the loads placed on them throughout the course of their planned service life and that they fulfill stipulated strength standards.

5.1.1. Directional deformation

By analyzing displacement along certain axes, such X, Y, or Z, engineers may analyze structural deformation in ANSYS Workbench and gain a more comprehensive knowledge of how the structure deforms separately in each direction. Red denotes the maximum positive deformation and blue the highest negative deformation on a color scale that is commonly used to visualize these deformations. Engineers can quickly identify and evaluate crucial spots of structural reaction, for example, in a situation where red denotes in Fig 9 maximum deformation of $9.509e^{-8}$ and blue denotes a minimum deformation of $-9.509e^{-8}$. This helps with stress evaluation and ensures the integrity of the investigated system.

5.1.2. Strain

Under uniaxial compression, the true strain ε, is calculated $\varepsilon\varepsilon = -ln(1-e), \sigma = S.(1-e)$. S denotes the engineering stress. It is important to note that both stress and strain are considered positive in compression. The visualization of compressive strain is often represented through a color scale, where red signifies the maximum principal strain, reaching up to $7.9354e^{-6}$ max, while blue indicates the minimum strain at $1.295e^{-8}$. Engineers and researchers may more rapidly identify regions of interest and assess the behavior of the material under compression with the help of this color-coded representation.

It is possible to gain a thorough grasp of the material's deformation process and analyze how it responds to different applied stress levels by utilizing the color gradient that represents the compressive strain distribution.

5.1.3. Shear stress

In the research and design of materials and structures subjected to compressive stresses, shear stress in compression is crucial. Compression is the process of applying external forces to a material in such a way that the substance's dimensions decrease. The internal resistance of a material to deformation brought on by applied pressures, especially in directions parallel to the load, is represented by shear stress in compression, which is defined as the force per unit area operating parallel to the cross-sectional area of the material. The comprehension of the material's response to lateral forces during compression and its potential for deformation or failure under such loads necessitates a grasp of this internal resistance. Fig 11 shows that the shear stress distribution picture, where the color red denotes the highest shear stress value $6.6318e^5$ and the color blue the lowest $3.3109e^5$, offers important information on the strength of the material's internal forces. With this knowledge, engineers and designers may evaluate the behavior of the material under compression and utilize it to guide their structural design choices. It is possible to forecast probable failure locations, choose the best materials, and improve the overall performance and safety of structures subjected to compressive pressures by evaluating shear stress in compression. It is a crucial factor in guaranteeing the dependability and toughness of structures and materials in practical uses.

5.1.4. Strain energy

In Fig 12 shows that the use of Ansys in compression testing with raw sugarcane bagasse ash and concrete, the strain energy distribution representation offers important insights into the behavior of the material under compressive pressures. A thorough grasp of how the materials react to compression pressures is provided by the strain energy depiction, where blue indicates minimal values and red indicates maximum values. Numerical numbers, such the lowest of $1.4173e^{-6}$ and maximum of $2.0892e^{-6}$ for strain energy, indicate the range of internal energy that the material absorbed and stored throughout the compression test. Researchers and engineers utilize this data to examine how raw sugarcane bagasse ash composites and concrete behave structurally. This helps them to optimize material compositions, identify possible failure zones, and improve the overall durability and efficiency of constructions. A more robust and resilient building material may be designed with the help of the color-coded strain energy representation, which facilitates the comprehension of stress distribution patterns.

5.2. Tensile Testing

Commonly employed in materials science and engineering, the tensile test is a basic technique for assessing the mechanical characteristics of materials the dimensions of 75*10*15. Raw Sugarcane Bagasse Ash (RSBA) is mixed with concrete, which is prepared and inserted between two grasp fixtures that firmly clamp the specimen. With one end stationary and the other subjected to a progressive weight application, the specimen whose dimensions, including length and cross-sectional area experiences a uniaxial force. Tension is applied during this process in order to measure the material's response to stretching or elongation till failure. The test yields important information about the material's structural integrity and performance under tension, including ultimate tensile strength, elastic modulus, and elongation. An extra variable is introduced when Raw Sugarcane Bagasse Ash is added to the concrete mixture, which makes it possible to evaluate the impact of this addition on the material's tensile behavior.

5.2.1. Deformation test

The property described here is the yield strength of a material, a crucial parameter in assessing its mechanical behavior under stress. It signifies the point at which the material undergoes permanent deformation, deviating from its elastic region. The yield strength is determined by identifying the stress value at which a line with the same slope as the initial elastic portion of the stress-strain curve intersects the curve at a strain of 0.2% or 0.002. This particular strain offset is commonly employed in materials testing standards as a reference point for measuring the yield strength. Fig 12 shows that, the yield strength indicates the maximum stress a material can endure before undergoing irreversible deformation, providing valuable insights into its structural integrity and suitability for specific applications in engineering and manufacturing.

5.2.2. Elastic strain

The critical threshold for a material, which is exceeded in a tensile test to cause permanent deformation, is indicated by the elastic or proportional limit. The material now demonstrates elasticity, which allows it to assume its original shape once the imposed force is removed. But when the material surpasses the elastic limit, it moves into the plastic deformation phase. The molecular structure of the material is irreversibly altered in this regime by any further increase in load or stress. When the load is released, the material will not return to its initial, unstressed state as it does in the elastic area. It experiences ongoing, frequently noticeable deformation. Because it affects the performance and design of different structures and components, engineering and materials science depend heavily on an understanding of the elastic and plastic behavior of materials.

Table 1: Problem identification.

Author & Citation & Year	Aim	Methodology	Problem Statement
Le *et al.* (2018) [16]	Create environmentally friendly concrete using industrial and agricultural wastes.	Experimental program investigating fresh and hardened properties of self-compacting concrete (SCC) with blended cement, sugarcane bagasse ash (SBA), granulated blast furnace slag (BFS), and ordinary Portland cement.	Investigate the impact of various cement replacements (10%, 20%, and 30% for SBA) on SCC properties.
Khatun *et al.*, (2018) [17]	Assess microstructure, mechanical, fresh, and durable qualities of self-compacting concrete with varying amounts (0-25%) of Sugarcane Bagasse Ash (SCBA).	Evaluation of treated and controlled self-compacting concrete with different levels of SCBA.	Examine the effects of SCBA on concrete properties at different replacement levels.
Memon *et al.*, (2022) [18]	Investigate the impact of processed SCBA as Supplementary Cementitious Material (SCM) in concrete.	SCBA processing involving sieving and grinding, followed by concrete mixing with varying weight fractions of processed SCBA (10%, 20%, 30%, and 40%).	Explore the enhanced pozzolanic reactivity of processed SCBA and its influence on concrete properties at different replacement levels.
Hasnain *et al.*, (2020) [19]	Examine the effects of replacing river sand with blended waste ashes (RHA and BA) on fresh, microstructural, physico-mechanical, and sulfate-resistant properties of SCC.	Microstructural characterization, Chappelle activity test, and SEM analysis of SCC mixes with blended ashes of RHA and BA.	Investigate the impact of waste ash replacements on various properties of SCC, emphasizing environmental responsibility.
Zareei *et al.*, (2018) [20]	Experiment with the use of SCBA in regular, lightweight, self-compacting concrete.	Creation of concrete specimens with different percentages (5-25%) of SCBA, followed by testing for mechanical and other properties.	Assess the mechanical qualities and other characteristics of concrete with varying levels of SCBA.
Moretti *et al*., (2018) [21]	Utilize statistical factorial design to optimize paste formulations for SCC characteristics at the concrete level.	Evaluation of three optimized paste formulations for their effects on fresh condition, mechanical, and durability properties of SCC.	Identify the best configurations for design variables to meet performance objectives in SCC.
Gopal *et al.*, (2018) [22]	Focus on controlling cement consumption, reducing costs, and lessening environmental pollution by adding bagasse ash to concrete.	Emphasis on the environmental impact of cement production and the beneficial qualities of bagasse ash in concrete.	Address the need for sustainable alternatives to traditional concrete production.
Anjos *et al.*, (2020) [23]	Evaluate the impact of SCBA on the rheological, physical, and mechanical characteristics of mortars containing cement and limestone filler (LF).	Creation of mortars with varying substitution levels (15-30%) of Portland cement with SCBA, followed by experimental assessments.	Understand the effects of SCBA incorporation on the properties of mortars containing cement and LF.
Rajasekar *et al.*, (2018) [24]	Assess the viability of using bagasse ash in Ultra High Strength Concrete (UHSC) as a pozzolanic ingredient.	Use treated bagasse ash (TBA) as a replacement for regular Portland cement at levels ranging from 5% to 20%.	Investigate the impact of bagasse ash on workability, compressive strength, resistance to chloride penetration, and other properties of UHSC.
Mello *et al.*, (2020) [25]	Assess the behavior of SCC when cement is replaced with sugarcane bagasse ash and metakaolin at concentrations of 30-50% at high temperatures.	Evaluation of SCC compositions through various tests, including X-ray diffraction, mass loss, compressive strength, and visual inspection after exposure to high temperatures.	Investigate the effects of temperature exposure on SCC properties with different levels of sugarcane bagasse ash and metakaolin replacements.

Table 2: Chemical compositions for OPC, SBA.

	OPC	**SBA**
Chemical composition (% by mass)		
Magnesium oxide (MgO)	3.3	2.8
Potassium oxide (K_2O)	0.51	7.07
Aluminum oxide (Al_2O_3)	4.7	6.8
Calcium oxide (CaO)	63.2	3.4
Sodium oxide (SO_3)	2.01	-
Ferric oxide (Fe_2O_3)	3.13	3
Silicon dioxide (SiO_2)	20.8	53.2
Loss on ignition (LOI)	2.11	22.9
Sodium oxide (Na_2O)	0.21	0.6
Physical properties		
Fineness (g/cm^2)	3530	4010
Specific gravity	3.15	2.02

Figure 1: Images Sugarcane Bagasse Ash.

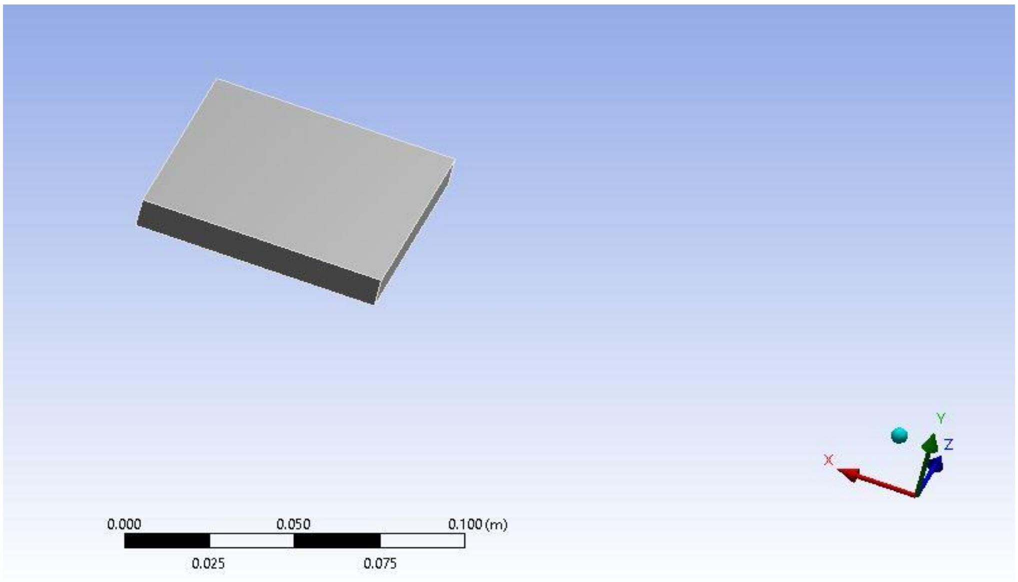

Figure 2: Compressive testing material.

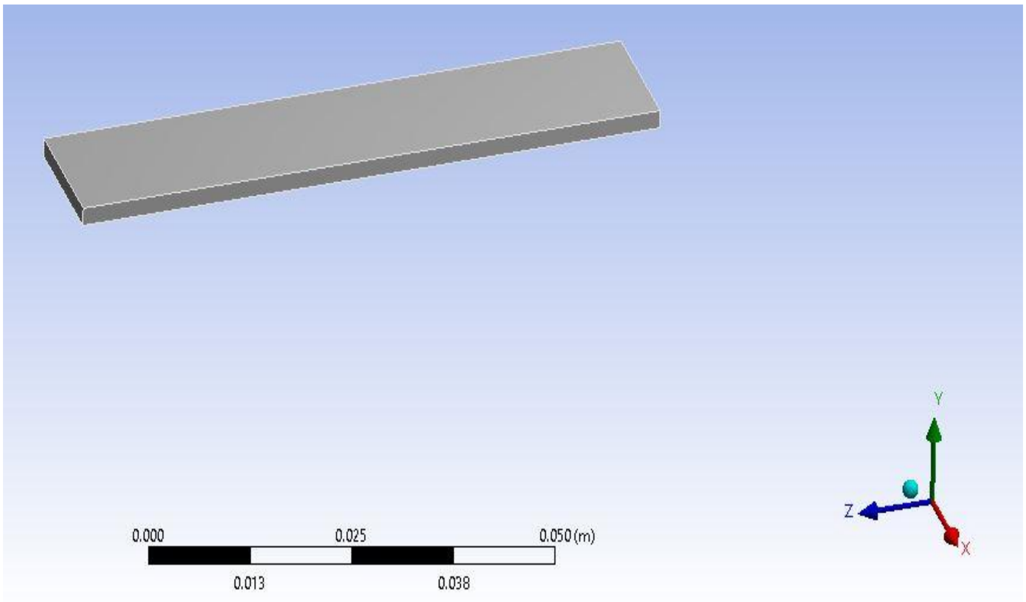

Figure 3: Tensile testing material.

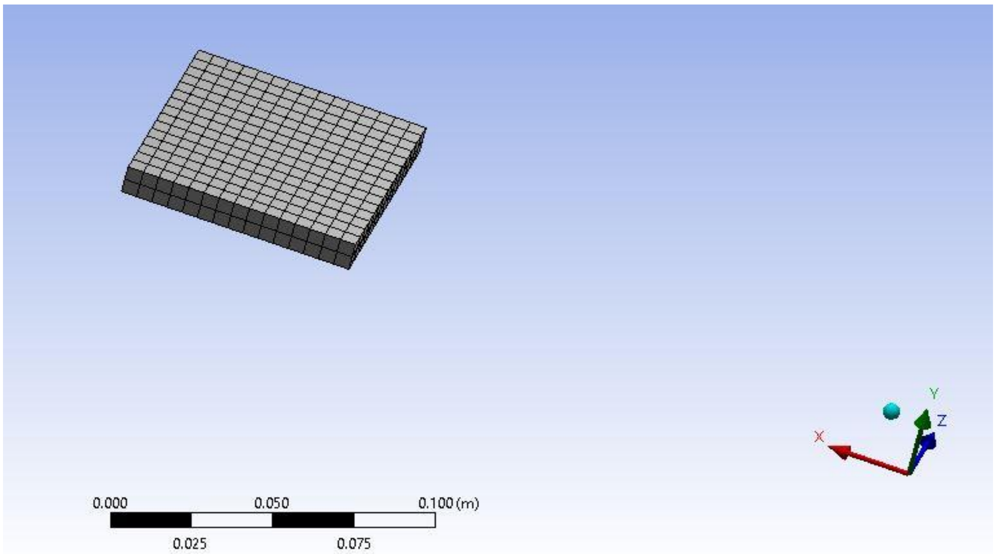

Figure 4: Meshing in Compressive testing Material.

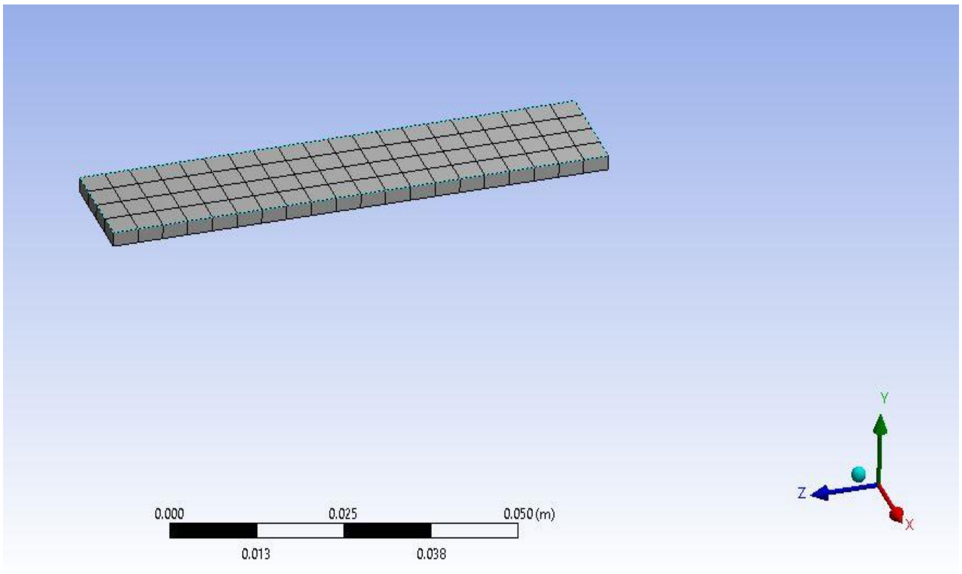

Figure 5: Meshing in Tensile testing Material.

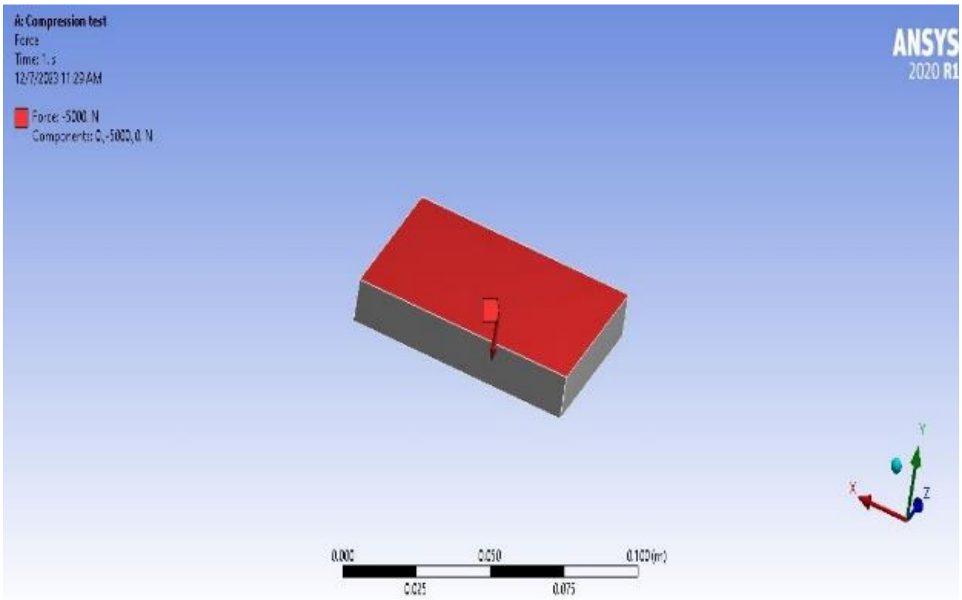

Figure 6: Force acting in compression testing.

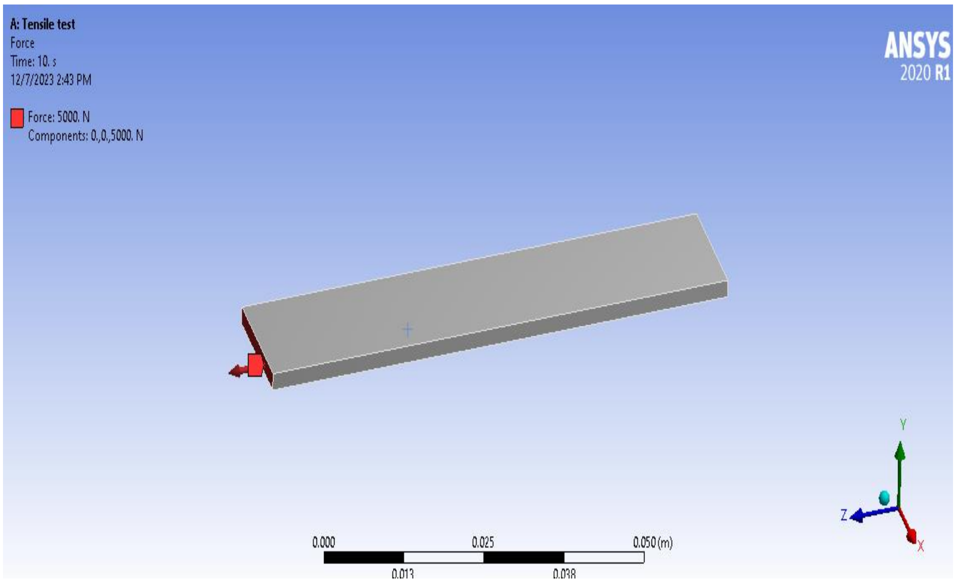

Figure 7: Force acting in tensile testing.

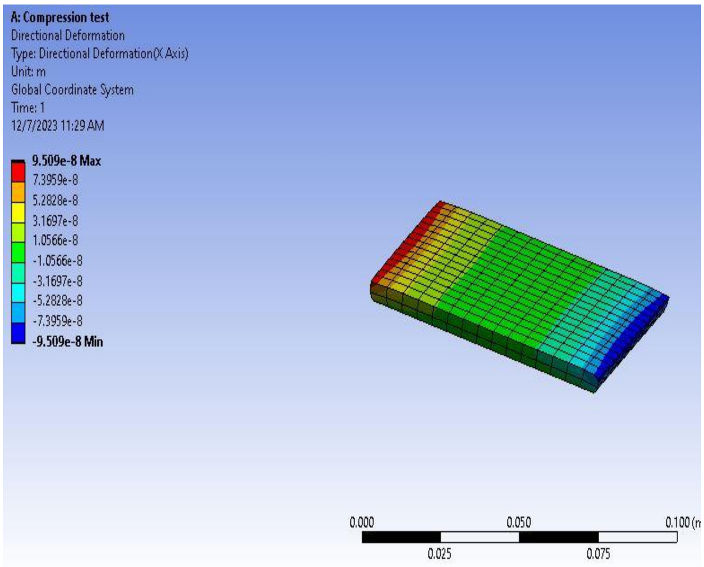

Figure 8: Deformation test in compression

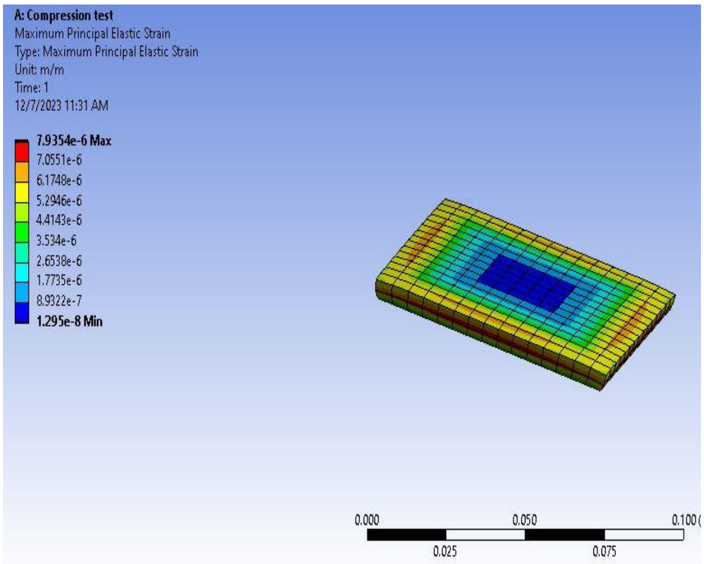

Figure 9: Strain test in compression.

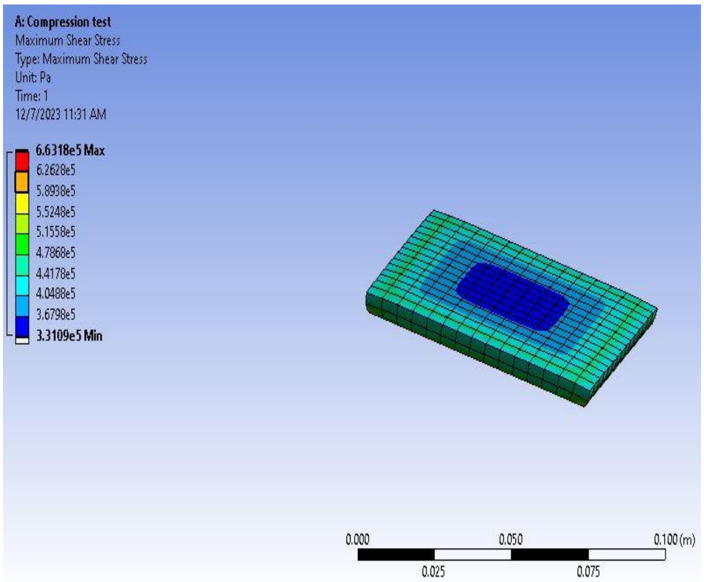

Figure 10: Shear stress compression testing.

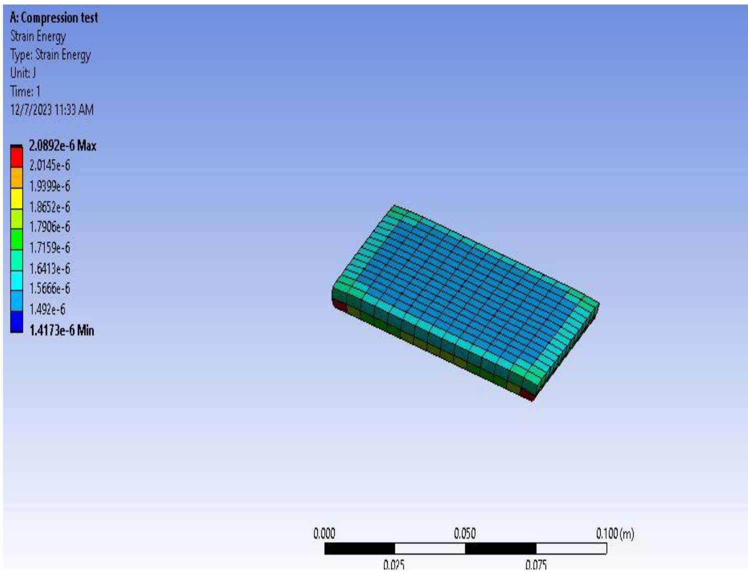

Figure 11: Strain energy in compressive testing.

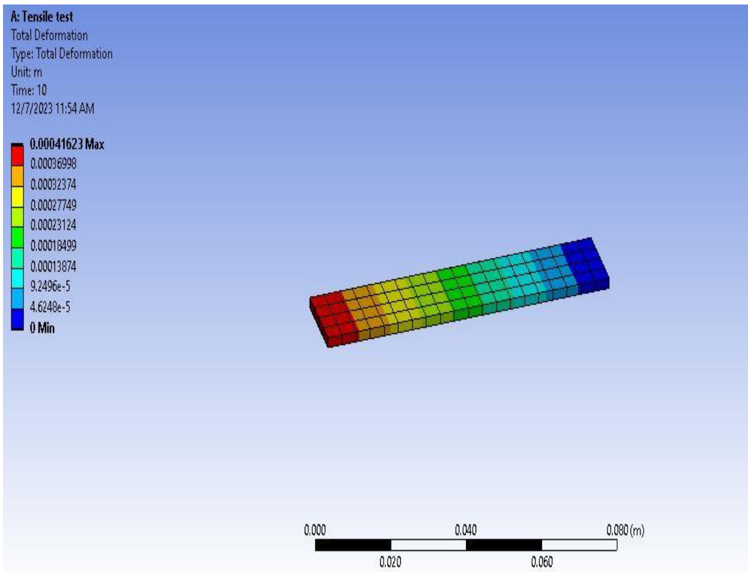

Figure 12: Deformation test in tensile testing.

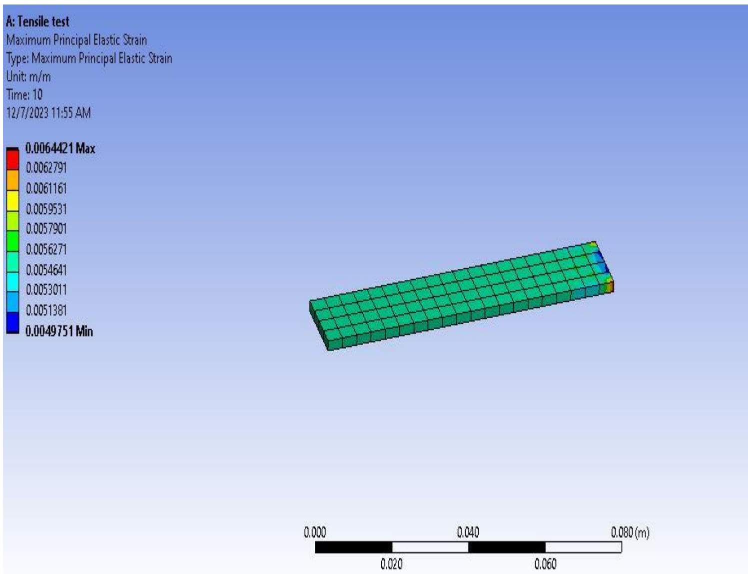

Figure 13: Elastic strain test in tensile testing.

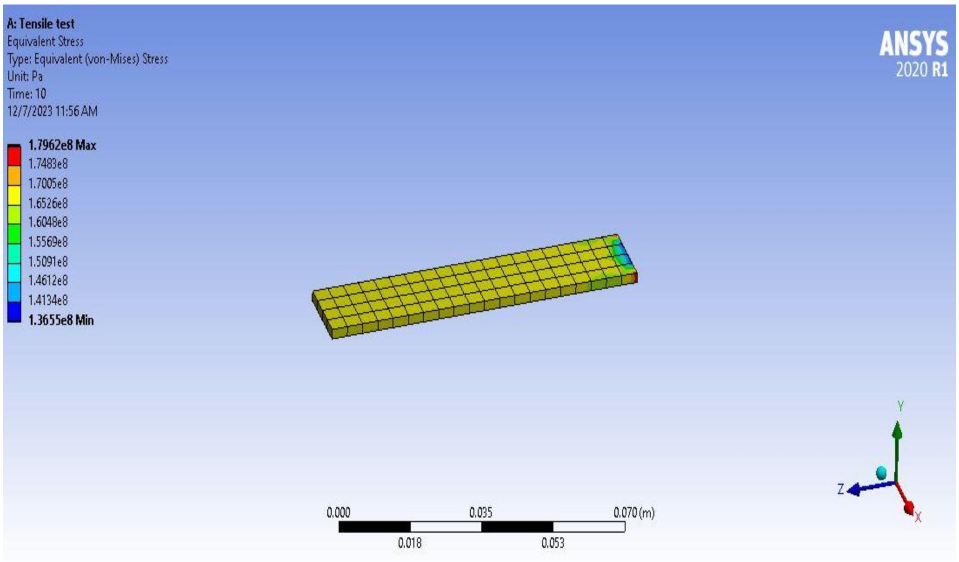

Figure 14: Equivalent stress in tensile testing.

5.2.3. Equivalent stress

In Fig 15 shows that compute equivalent stress, a thorough method was used, integrating thickness strain on the front surface (indicating decrease along the thickness direction) and width strain along the side surface (indicating reduction along the width direction). The objective of this technique was to evaluate the dynamic changes in cross-sectional area that occur during tensile deformation. A more complex and realistic depiction of the material's reaction to tension was attained by taking into account both width and thickness strains. This method offered a useful viewpoint for assessing the mechanical behavior and structural integrity of the material under examination. It also made it easier to estimate equivalent stress and gave a comprehensive grasp of how the specimen deforms in various directions.

6. Conclusions

In conclusion, this study delves into the promising utilization of sugarcane bagasse ash (RSBA) as a sustainable alternative in concrete production, with a particular focus on its pozzolanic characteristics. Through extensive tensile and compression testing, the study assesses the structural application potential, compressive strength, and load-bearing ability of self-compacting concrete (SCC) with different proportions of RSBA. The findings show how the material's mechanical characteristics might be better understood and indicate its potential for use in construction. Strict analysis of the durability elements highlights the composite material's potential for sustainable and long-lasting building methods by illuminating its long-term resistance in a range of environmental circumstances. The use of Ansys Workbench improves analytical precision and offers a solid evaluation of SCC's performance for partial replacement of RSBA, thereby bolstering the feasibility of RSBA as a useful additive in the manufacturing of concrete.

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