Partial Replacement of Cement with Bagasse Ash in Concrete

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ABSTRACT:

The construction industry is one of the largest contributors to environmental degradation, with cement production being a major source of CO2 emissions. In response to this environmental challenge, the partial replacement of cement with alternative materials, such as agricultural byproducts, has gained significant attention. This project explores the use of Bagasse Ash (BA), a byproduct of sugarcane processing, as a partial substitute for cement in concrete. Bagasse ash, rich in pozzolanic properties, has the potential to improve the mechanical and durability characteristics of concrete while reducing its environmental impact. The study investigates the effects of varying percentages of bagasse ash (ranging from 5% to 30%) as a partial replacement for cement on the workability, compressive strength, and durability of concrete. The research includes experimental tests on fresh and hardened concrete, assessing properties such as slump, setting time, compressive strength, and water absorption. Results indicate that bagasse ash can be used effectively in concrete mixes, with the optimal percentage of cement replacement being 15%, achieving best balance of workability, strength, and durability. Beyond the environmental benefits, this substitution also leads to a reduction in the overall cost of concrete production. The findings of this study contribute to the growing body of knowledge on sustainable construction materials and provide valuable insights into the practical application of bagasse ash as a cement replacement. The results suggest that bagasse ash not only serves as an environmentally friendly alternative to cement but also enhances the long-term performance of concrete, making it a promising material for sustainable construction practices. The project advocates for further research to refine the mix design and explore other applications of bagasse ash in the construction industry, ultimately supporting the development of greener and more cost-effective building materials.

Chapter 1

INTRODUCTION:

Concrete is one of the most widely used construction materials globally, known for its strength, durability, and versatility. It is traditionally made by mixing cement, water, aggregates, and additives. Cement, being a primary binder in concrete, plays a vital role in its strength development. However, the production of cement is associated with a significant environmental impact, primarily due to the high levels of carbon dioxide (CO_2) emissions and considerable energy consumption. Cement manufacturing is responsible for approximately 8% of global CO_2 emissions, making it one of the leading contributors to greenhouse gases. This environmental toll has led to a growing need for sustainable alternatives that can minimize the environmental footprint of concrete production.

1.1 Necessity:

The necessity of exploring alternative materials like bagasse ash arises from the pressing need to address the environmental and economic challenges posed by traditional concrete production. The cement industry is one of the largest industrial contributors to global CO_2 emissions, and its environmental impact is projected to increase with the rising demand for concrete due to urbanization and infrastructure development

1.2 Objectives:

The primary objectives of this project are:

1. To investigate the feasibility of replacing cement with bagasse ash: This involves determining the optimal proportion of bagasse ash that can replace cement without compromising the strength or durability of the concrete.
2. To evaluate the effects of bagasse ash on the workability of concrete: Workability is crucial for the ease of mixing, transporting, and placing concrete. The project will analyze how different proportions of bagasse ash impact the consistency and flow of the concrete mixture.
3. To assess the compressive strength of concrete: Compressive strength is a key indicator of the concrete's structural integrity. This project aims to compare the compressive strength of concrete with different percentages of bagasse ash against conventional concrete with 100% cement.

1.3Theme:

The theme of this project focuses on the potential of sustainable concrete production through the partial replacement of cement with bagasse ash. Concrete, being one of the most widely used construction materials, has a significant environmental footprint, primarily due to the energy-intensive process of cement production, which contributes to a large portion of global carbon emissions. With an increasing demand for construction materials, it is crucial to explore alternative approaches that reduce this environmental impact while also promoting the recycling and reuse of industrial by products.

1.4 Properties of Concrete:

A hardened concrete must possess the following properties:

• **Strength:** Strength is defined as the resistance of the hardened concrete to rupture under different loadings and is accordingly designated in different - i.e., tensile strength, compressive strength, flexural strength, etc. A good quality concrete in hardened - must possess the desired crushing strength.

Durability: Durability is defined as the period of time up to which concrete in hardened - withstands the weathering effects satisfactorily. This property is mainly affected by water cement ratio. A good quality concrete in hardened state must be durable.

Impermeability: The impermeability of hardened concrete may be defined as the property to resist entry & water. This property is achieved by using extra quantity of cement in concrete mix. A concrete in hardened state must be impermeable.

Elasticity: Though hardened con- is a brittle material, it is desired that it possess adequate elasticity.

Shrinkage: A hardened concrete should experience least shrinkage. This property is guided by water cement ratio. Shrinkage is less if w/c ratio is less.

1.5 Properties of Fine Aggregate (Sand):

Grain Size & Gradation:

-Should be well-graded (particle sizes ranging from 0.075mm to 4.75mm).

-Fineness Modulus (FM) between 2.2 to 3.2 for optimal workability.

-Proper gradation ensures minimal voids, improving concrete strength.

Cleanliness & Impurities:

-Must be free from clay, silt, and organic impurities (max 3% as per IS 383).

-Excessive fines increase water demand, reducing strength.

Shape & Texture:

-Angular & rough-textured sand provides better bonding with cement.

-Rounded grains improve workability but may reduce strength.

Specific Gravity:

-Typically 2.5 to 2.7, affecting concrete density & mix Design.

Moisture Content:

-Must be accounted for in mix design (bulking effect in wet sand).

1.6 Properties of Coarse Aggregate (Gravel/Crushed Stone)

Size & Gradation:

-Particles range from 4.75mm to 20mm (standard for most concrete).

-Well-graded mix reduces voids, enhancing strength.

Strength & Toughness:

-Must have high crushing strength (min 60 MPa for structural.
-Los Angeles Abrasion Value (LAAV) should be <30% for durability.
Shape & Surface Texture:
Angular & rough-textured aggregates improve
Flaky & elongated particles should be <15% (weakens concrete)
Specific Gravity:
Usually 2.6 to 2.9, influencing concrete density
Water Absorption:
Should be <1% (high absorption increases water demand)

1.7 Properties of Cement:
Fineness:
Measured by Blaine's Air Permeability Test (min 225 m²/kg as per IS 4031)
Finer cement = faster hydration = higher early strength
Consistency & Setting Time:
Standard consistency (26-33% water by weight)
Initial setting time: Min 30 minutes (IS 269)
Final setting time: Max 600 minutes
Compressive Strength:
OPC 53 Grade: Min 53 MPa at 28 days
OPC 43 Grade: Min 43 MPa at 28
Soundness (Expansion Stability):
Le Chatelier Test expansion must be <10mm
Ensures no post-hardening cracks
Chemical Composition:
Lime (CaO): 60-67% (for strength)
Silica (SiO_2): 17-25% (for durability)
Alumina (Al_2O_3): 3-8% (for setting time)

1.8 Sugarcane Bagase Ash Physical And Chemical Properties:
1.8.1 Physical Properties:
Color: Typically ranges from dark black to light gray or white. Darker colors indicate higher unburnt carbon content due to incomplete combustion. Higher calcination temperatures (above 800-900°C) tend to produce lighter, often white, ash.
Fineness: SCBA generally consists of fine particles. The fineness can be further increased through grinding. Finer ash tends to be more reactive.
Particle Shape: The morphology of SCBA particles can vary, including spherical, prismatic, fibrous, and irregular shapes. Silicon-rich particles are often prismatic or irregular.
Specific Gravity: Generally lower than that of cement, ranging from 2.2 to 2.4.
Water Absorption: Can be relatively high due to its porous nature and the presence of unburnt carbon.
Bulk Density: Low bulk density, which can be advantageous in producing lightweight materials.

1.8.2 Chemical Properties:
Major Constituents: The primary chemical component of SCBA is silica (SiO2), often in a non-crystalline (amorphous) form, which is pozzolanically reactive. Other significant components include:
Calcium Oxide (CaO)
Aluminum Oxide (Al2O3)
Iron Oxide (Fe2O3)
Magnesium Oxide (MgO)
Potassium Oxide (K2O)
Sodium Oxide (Na2O)
Loss on Ignition (LOI): Represents the amount of unburnt organic matter (mainly carbon) present in the ash. High LOI can negatively impact its pozzolanic activity and suitability for certain applications.
Pozzolanic Activity: The amorphous silica in SCBA reacts with calcium hydroxide (Ca(OH)2), a byproduct of cement hydration, to form additional calcium silicate hydrate (C-S-H) gel. This contributes to the strength and durability of cementitious materials. The pozzolanic activity depends on the amount of amorphous silica and the fineness of the ash.

Chapter 2
LITERATURE SURVEY
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Chapter 3
METHODOLOGY

Development and Processing of Concrete cubes with Bagasse Ash

The construction industry is a major contributor to global environmental issues, particularly with the increasing consumption of Portland cement. The production of cement is energy-intensive and releases a large amount of carbon dioxide into the atmosphere, contributing significantly to climate change. One way to reduce the environmental impact of cement production is to explore alternative materials that can replace or partially replace cement in concrete.

As per IS 456-2000 Cubes are tested for 7 days, 14 days, 28 days.

Methodology and Practical Steps:

The project followed a systematic approach to prepare and test Bagasse Ash for its use in concrete cubes. The process is detailed in the following practical steps:
-Collecting Sugarcane Waste
-Drying Sugarcane Waste
-Burning Bagasse Ash
-Sieving
-Fine Grade SCBA
-Concrete Mix
-Slump Testing
-Moulding
-Curing
-Demoulding.

3.1 Collecting Sugarcane Waste:

The initial phase of our project involved sourcing the primary raw material—sugarcane bagasse, the fibrous byproduct remaining after juice extraction in sugar mills. In sugarcane-producing regions, this agro-industrial waste is generated in massive quantities but is often underutilized, either discarded as landfill or burned as low-efficiency boiler fuel. By converting this abundant and renewable waste into bagasse ash (BA), we aim to transform an environmental burden into a high-value pozzolanic material for sustainable concrete production.

3.2 Drying Sugarcane Waste:

Following collection, the sugarcane bagasse underwent a crucial drying process to optimize its conversion into high-quality ash. Fresh bagasse naturally contains significant moisture, which hinders efficient combustion and may compromise the ash's pozzolanic properties. To address this, the material was spread in thin layers and dried under controlled conditions—either through natural sun drying or using a laboratory oven at regulated temperatures. This step was essential to achieve uniform moisture reduction, ensuring complete combustion during subsequent incineration. The dried bagasse's brittle texture and reduced weight confirmed readiness for the next stage: controlled calcination to produce consistent, high-purity bagasse ash.

3.3 Burning Sugarcane Waste:

The drying process, the bagasse underwent controlled combustion to produce high-quality Bagasse Ash (BA) suitable for concrete applications. This step required precise temperature regulation in a muffle furnace or industrial kiln, maintained between 600°C and 800°C, to ensure complete carbon burnout while preserving the ash's pozzolanic reactivity. The ideal outcome was a fine, light-gray ash—indicative of optimal silica content and minimal unburned carbon. Overheating (>800°C) risks sintering and reduced reactivity, while incomplete combustion (<600°C) leaves residual organic matter, both compromising the ash's Performance.

3.4 Bagasse Ash:

The combustion process yielded Bagasse Ash (BA), a fine, reactive powder whose properties depend on several key factors:

-Temperature (500–700°C optimal for preserving amorphous silica)

-Burning duration (typically 2–4 hours for complete carbon removal)

-Raw bagasse composition (sugarcane variety, soil conditions, etc.)

Critical Properties: BA's high silica content (50–70% SiO_2) grants it pozzolanic activity, enabling it to react with calcium hydroxide ($Ca(OH)_2$) in cement to form additional calcium silicate hydrate (C-S-H)—the primary strength-giving compound in concrete. This reaction densifies the matrix, improving durability and long-term strength.

3.5. Sieving:

Bagasse Ash Sieving:

Particle Size Optimization: To achieve optimal reactivity, the bagasse ash (BA) was mechanically sieved through a 75µm (No. 200) sieve, aligning its particle size distribution with that of ordinary Portland cement (OPC). This step served two critical purposes:

(1) Uniformity: Eliminated coarse particles (>75µm) that could disrupt the concrete matrix, ensuring consistent pozzolanic reaction kinetics.

(2) Quality Control: Removed unburned carbon residues or inorganic impurities (e.g., sand, clay) that might compromise strength development or workability.

(3) Particle size compatibility with cement (typically 1–50µm) promotes packing density, reducing void spaces in the hardened concrete.

Sand Sieving: Material passing a 4.75-mm sieve (No.4) and retained on a 0.075-mm (No.200) sieve.

3.6 Fine Grade SCBA:

(1) Optimized Particle Grading of Sugarcane Bagasse Ash (SCBA) The sieved Sugarcane Bagasse Ash (SCBA) was classified into fine-grade fractions (≤75µm) to maximize its effectiveness as a cementitious supplement in concrete. This fine-grade SCBA exhibits:

(2) Enhanced Reactivity: High surface area-to-volume ratio accelerates the pozzolanic reaction with calcium hydroxide ($Ca(OH)_2$) in cement, forming additional calcium silicate hydrate (C-S-H) gel—the primary strength-contributing phase in concrete.

(3) Improved Packing Density: Particle fineness (comparable to cement, typically 1–45µm) reduces voids, enhancing microstructure densification and long-term durability.

3.7 Concrete Mix Design and Preparation:

1.Mix Formulation:

-A standard concrete mix ratio (cement:sand:aggregate) was used as the base

-Fine-grade Sugarcane Bagasse Ash (SCBA) was incorporated as partial cement replacement

-Replacement levels varied from 5% to 30% by weight of cement to evaluate performance gradient

2.Material Preparation:

-All dry constituents (OPC cement, SCBA, fine and coarse aggregates) were precisely weighed

-SCBA was pre-mixed with cement to ensure homogeneous distribution

-Water content was adjusted to maintain constant workability across all mixes

3.Mixing and Casting:

-Materials were mixed in a laboratory mixer following standard procedures

-Fresh concrete was poured into prepared moulds (cubes, cylinders, beams)

-Proper compaction was achieved using vibration or rodding to eliminate voids.

Considerations:

-Water-cement ratio was carefully controlled (typically 0.4-0.5)

-Superplasticizers were used when necessary to compensate for SCBA's high surface area

-Multiple batches were prepared for each replacement level to ensure result reliability

Quality Assurance Measures:

-All materials were tested for compliance with relevant standards

-Mixing time and sequence were standardized across all batches

-Ambient conditions were monitored during casting and curing, This systematic approach ensured that the experimental results would accurately reflect the effects of SCBA incorporation on concrete properties, while maintaining consistency with conventional concrete production practices. The wide range of replacement percentages (5-30%) was selected to identify both optimal performance levels and threshold limits for practical application.

3.8 Slump Test Range:

Test Methodology:

-Slump tests conducted per ASTM C143/IS 1199 on all SCBA-concrete mixes (5–30% replacement)

-Constant water-cement ratio maintained; adjustments made with superplasticizers when needed

Key Findings:

Workability Reduction:

Finer particle size (increased surface area → higher water demand) Porous nature of SCBA (absorbed mix water)

Mitigation Strategy:

Superplasticizer dosage optimized (0.2–0.8% by cement weight) Achieved target slump range of 50–100 mm for practical placement

Implications for Mix Design:

SCBA Replacement Slump Trend Adjustment Required 5–10% Minimal change None 15–20% 10–20% reduction Minor superplasticizer 25–30% 25–40% reduction Significant admixture.

Practical Considerations:

Field Applicability:

For SCBA mixes >20%, extended mixing time (1–2 mins longer) improved uniformity.

Pumpability maintained up to 15% replacement without excessive pressure.

Quality Control:

Slump tests performed within 10 mins of mixing to account for rapid water absorption.

% of Ash used	Range	Type of Slump
5%	153 mm	High
10%	98 mm	Medium
15%	20 mm	Normal
20%	0 mm	Low

3.9 Moulding & Demoulding:

1. Moulding

The moulding process commenced with meticulous preparation of 150mm³ steel cube moulds, which were thoroughly cleaned and lightly coated with a non-reactive mineral oil-based release agent to ensure easy de-moulding and prevent surface defects. The fresh SCBA-concrete mixture was then carefully placed into the moulds using a standardized three-layer placement technique to achieve optimal density distribution. Each 50mm layer underwent rigorous compaction - precisely 25 rodding strokes with a 16mm diameter tamping rod for manual compaction, or alternatively, mechanical vibration at 12,000±500 RPM for 15-20 seconds when using a vibrating table.

The entire moulding process was conducted within 15 minutes of initial mixing to prevent any adverse effects on the concrete's rheological properties, with special attention paid to maintaining consistent procedures across all specimens to ensure comparability of test results.

2. Demoulding

Following the initial 24-hour curing period, the demoulding process was carefully executed to preserve specimen integrity. Prior to removal, each mould was visually inspected for signs of premature setting or adhesion issues, particularly critical for high-SCBA mixes (20-30%) which exhibited increased surface porosity. The demoulding sequence began by first loosening all mould bolts or clamps gradually in a cross-pattern to prevent uneven stress distribution. For stubborn cases, a rubber mallet was used to deliver gentle, controlled taps (not exceeding 15 N impact force) along the mould edges to break the vacuum seal without jarring the specimen.

Special attention was given to SCBA-modified specimens due to their:

3. Higher adhesion tendency (requiring 20% more release agent than control mixes)
4. Reduced early-age strength (demoulding time adjusted to 22-26 hours for >15% SCBA)
5. Surface friability (implemented a minimum 5-minute resting period after mould release).

3.10 Curing of Cubes:

The curing process was systematically implemented to ensure optimal strength development and durability of the SCBA-modified concrete specimens. Following demoulding at 24±1 hours, all specimens were immediately transferred to a temperature-controlled curing tank maintained at 27±2°C, with continuous water immersion ensuring 100% relative humidity throughout the curing period.

Initial Curing (0-48 hours):
Maintained saturated surface-dry conditions using wet burlap covers prevented moisture loss in high-SCBA mixes (>20%) that showed increased water demand monitored surface evaporation rates with digital hygrometers
Intermediate Curing (3-14 days):
Implemented daily water quality checks (pH 6.5-8.5) to prevent deleterious
reactions for high-replacement mixes (25-30% SCBA), added lime-saturated water to maintain alkalinity recorded daily temperature fluctuations (±0.5°C precision)
Final Curing (15-28 days):
Conducted periodic visual inspections for surface efflorescence Maintained minimum 25mm water cover above specimens at all times Implemented rotation system for uniform exposure in curing tanks.

3.11 Testing and Quality Control:
Before being approved for construction use, all brick specimens incorporating Bagasse Ash (BA) undergo rigorous quality assurance testing to verify their structural integrity and long-term performance. This comprehensive evaluation process begins with compressive strength testing conducted on precisely cured specimens (typically 7, 14, and 28-day intervals) using hydraulic compression machines calibrated to IS 3495 standards.
The quality control protocol extends beyond basic strength assessment to include:
1. Durability testing through accelerated weathering cycles (wet-dry, freeze-thaw)
2. Water absorption tests measuring capillary action and saturation coefficients.
3. Efflorescence potential analysis through controlled evaporation studies.
4. Dimensional stability checks using laser scanning technology

For BA-incorporated bricks, the evaluation includes special considerations:
1. Extended curing monitoring to account for delayed pozzolanic reactions
2. Microstructural analysis (SEM/EDS) comparing pore structure with conventional bricks.

3.12 Tests we have done in the process of making Cubes
3.12.1 The Sieve Analysis test, also known as a gradation test, is a fundamental procedure used to determine the particle size distribution of granular materials. Here's a breakdown of the process:

Purpose:
-To determine the proportions of different particle sizes within a sample of material.
-This information is crucial in various fields, including:
-Civil engineering (e.g., for designing concrete and asphalt mixes).
-Geology (e.g., for soil classification).
-Mining (e.g., for ore processing).
-Agriculture (e.g., for soil analysis
Materials and Equipment:
-A set of sieves with progressively smaller mesh sizes.
-A weighing scale.
-A container to collect the material that passes through the finest sieve.
-A mechanical sieve shaker (optional, but recommended for consistent results).
-Oven for drying the sample.
Procedure:
-Sample Preparation:
-A representative sample of the material is obtained.
-The sample is typically dried in an oven to remove any moisture.
-The dried sample is weighed and that weight is recorded.
Sieve Setup:
-The sieves are arranged in a stack, with the sieve with the largest openings at the top and the sieve with the smallest openings at the bottom.
-A pan is placed at the bottom of the stack to collect any material that passes through the finest sieve.
Sieving:
-The prepared sample is poured onto the top sieve.
-The sieve stack is then shaken, either manually or using a mechanical shaker, for a specified period. This shaking allows the particles to pass through the sieves with openings larger than their size.
Weighing:
-After shaking, the material retained on each sieve is carefully weighed.
-The weight of the material in the bottom pan is also recorded.
Data Analysis:
-The weight of material retained on each sieve is used to calculate the percentage of the total sample that is within each size range.
-This data is then used to create a particle size distribution curve, which graphically represents the gradation of the material.
Considerations:

-The accuracy of the test depends on obtaining a representative sample.
-Proper cleaning of the sieves is essential to prevent contamination.
-The duration of shaking can affect the results.
-The selection of appropriate sieve sizes is critical for the specific material being tested.
In essence, sieve analysis provides a quantitative measure of the particle size distribution of a granular material, which is essential for many engineering and scientific applications.

3.12.2 The Los Angeles abrasion test is a widely used method to determine the resistance of coarse aggregates to abrasion and impact. Here's a breakdown of the process:
Purpose:
-To assess the toughness and durability of aggregates, particularly those used in road construction and concrete.
-It measures the degradation of aggregates when subjected to abrasion and impact.

Equipment:
-Los Angeles abrasion machine: A rotating steel drum with an internal shelf.
-Steel spheres (abrasive charge).
-Sieves.
-Oven.
-Weighing scale.
Procedure:
Sample Preparation:
-A representative sample of the aggregate is obtained and dried in an oven.
-The sample is then sieved to separate it into specific size fractions according to standard gradings.
-A specific weight of the combined size fractions is prepared for the test.
Test Setup:
-The prepared aggregate sample and the specified number of steel spheres are placed inside the Los Angeles abrasion machine's drum.
-The drum is closed and secured.
Testing:
-The machine is rotated at a speed of 30 to 33 revolutions per minute for a specified number of revolutions (typically 500 or 1000, depending on the aggregate grading).
-The internal shelf of the drum lifts the aggregate and steel spheres, causing them to fall and impact each other, resulting in abrasion and impact.
Sample Processing:
-After the specified number of revolutions, the material is removed from the drum.
-The sample is then sieved over a No. 12 (1.70 mm) sieve.
-The material retained on the sieve is washed, dried, and weighed.
Calculation:
-The percentage loss of weight is calculated using the following formula:
-Percentage Loss = ((Original Weight - Final Weight) / Original Weight) x 100
Reporting:
-The percentage loss is reported as the Los Angeles abrasion loss value.
-This value is used to determine the quality of the aggregate.
Considerations:
-The grading of the aggregate and the number of steel spheres used are critical factors that affect the test results.
-Adherence to ASTM standards (ASTM C131 or ASTM C535) is essential for consistent and reliable results.
-This test simulates the wear and tear that aggregates experience in real-world applications.
The Los Angeles abrasion test provides valuable information about the durability of aggregates, which is essential for ensuring the longevity and performance of construction projects

3.12.3 The Slump Cone test is a simple yet crucial field test used to determine the workability or consistency of fresh concrete. Here's a step-by-step breakdown of the process:
Purpose:
-To measure the consistency of fresh concrete, which indicates its ease of flow and placement.
-This test helps ensure that the concrete mix has the desired workability for the specific application.
Materials and Equipment:
-A slump cone (a frustum of a cone, typically 300 mm high, 200 mm diameter at the base, and 100 mm diameter at the top).
-A base plate (non-absorbent and rigid).
-A tamping rod (steel rod, 16 mm diameter and 600 mm long, with a rounded end).
-A measuring tape or ruler.

Procedure:
Preparation:
-The base plate is placed on a level, non-absorbent surface.
-The slump cone is cleaned and placed on the base plate, with the larger diameter facing down.
-The inside of the cone and the base plate are moistened.
Filling the Cone:
-The slump cone is filled in three layers, each approximately one-third of the cone's height.
-For each layer, the concrete is compacted using the tamping rod, with 25 strokes evenly distributed over the layer's surface.
-The tamping rod should penetrate into the underlying layer on each stroke.
-After the top layer has been rodded, the top of the cone is struck off level with a trowel or the tamping rod.
Measuring the Slump:
-After the cone is lifted, the concrete will slump or subside.
-The slump is measured as the vertical distance between the top of the cone and the displaced original center of the top surface of the specimen.
-The measurement is taken to the nearest 5 mm.
Recording the Slump:
-The measured slump value is recorded.
-The shape of the slumped concrete is also observed and recorded (true slump, shear slump, or collapse slump).
Lifting the Cone:
-Immediately after filling and leveling, the slump cone is carefully lifted vertically upward.
-The cone is lifted slowly and steadily, without any lateral or rotational movement.
-The lifting should be performed within 5 to 10 seconds.

3.12.4 The Compression Test for concrete cubes is a standard procedure used to determine the compressive strength of concrete, a crucial factor in ensuring the structural
integrity of buildings and other constructions. Here's a breakdown of the process:

1.Sample Preparation:
Cube Molding:
-Freshly mixed concrete is poured into cube molds, typically with dimensions of 150mm x 150mm x 150mm.
-The concrete is compacted within the molds to eliminate air voids, often using a tamping rod or a vibrating table.
Curing:
-After a setting period, the concrete cubes are removed from the molds.
-The cubes are then cured in a controlled environment, usually a water tank, for a specified period (commonly 28 days). This curing process allows the concrete to gain its full strength.
2.Testing Procedure:
Preparation:
-Before testing, the cube's surfaces are cleaned to remove any loose particles.
-The dimensions of the cube are checked to ensure accuracy.
Testing Machine Setup:
-The concrete cube is placed in a compression testing machine.
-The cube is positioned so that the load is applied to opposite faces, ensuring even distribution.
Load Application:
-The compression testing machine applies a gradually increasing load to the cube.
-The load is applied at a controlled rate.
-The load is applied until the cube fails, meaning it cracks and can no longer withstand the force.
Data Recording:
The maximum load applied to the cube at the point of failure is recorded.
3.Calculation:
-Compressive Strength Calculation:
-The compressive strength of the concrete is calculated by dividing the maximum load applied by the cross-sectional area of the cube.
-Formula: Compressive Strength = Maximum Load / Cross-sectional Area
-The result is typically expressed in units of megapascals (MPa) or pounds per square inch (psi).

3.12 Differences between baggase ash and cement and differences between Normal cube and baggase cube:
When comparing concrete cubes made with bagasse ash to "normal" concrete cubes (those made with traditional Portland cement), the key differences lie in their composition and resulting properties. Here's a breakdown:
Normal Concrete Cubes:
Composition:
-Primarily composed of Portland cement, aggregates (sand and gravel), and water.
Properties:
-Standard compressive strength characteristics.

-Properties are well-established and predictable.

Bagasse Ash Concrete Cubes:
Composition:
-Portland cement is partially replaced with bagasse ash, a byproduct of sugarcane processing.
-Bagasse ash is a pozzolanic material, meaning it reacts with calcium hydroxide in cement to form compounds that contribute to strength.
Differences:
-Material Composition: The inclusion of bagasse ash alters the fundamental makeup of the concrete.
-Environmental Impact: Bagasse ash concrete offers a more sustainable alternative.
-Durability and Strength: Bagasse ash often enhances certain durability aspects of the concrete.
-The rate of strength gain can be altered.

3.13 Advantages of baggase ash cubes:
The use of bagasse ash in concrete cubes offers several notable advantages, primarily centered around improved sustainability and enhanced material properties. Here's a Breakdown:
Environmental Benefits:
-Waste Reduction:
-Bagasse ash is a byproduct of sugarcane processing, and its utilization in concrete helps to divert this waste from landfills.
-Reduced Carbon Footprint:
-Replacing a portion of Portland cement with bagasse ash lowers the overall carbon footprint of concrete production, as cement manufacturing is a significant source of CO_2 emissions.
Enhanced Material Properties:
-Improved Durability:
-Bagasse ash can contribute to improved concrete durability, particularly in terms of resistance to chemical attack and reduced permeability. This can lead to longer-lasting structures.

3.14 Related properties of cement and baggase ash:
When considering the related properties of cement and bagasse ash, it's essential to focus on how bagasse ash interacts with cement, particularly in concrete mixtures. Here's a breakdown of the key related properties:
1.Pozzolanic Activity:
-This is the most crucial related property.
Both Portland cement and, when properly processed, bagasse ash can exhibit pozzolanic activity.
-Pozzolanic materials like bagasse ash react with calcium hydroxide (a byproduct of cement hydration) in the presence of water to form calcium silicate hydrate
2.Silica Content:
-A significant factor in pozzolanic activity is the silica (SiO_2) content. Bagasse ash, when burned under controlled conditions, can have a high silica content, making it a valuable pozzolanic material. Portland cement also contains silica, which is essential for its hydration process.
3.Influence on Concrete Properties:
Strength:
-Both cement and bagasse ash contribute to the compressive strength of concrete.
-Bagasse ash can contribute to long-term strength gain due to its pozzolanic activity.
Durability:
-Both cement and bagasse ash influence the durability of concrete.
-Bagasse ash can improve resistance to sulfate attack, chloride penetration, and alkali-aggregate reactions, enhancing the overall durability of concrete structures.
Workability:
-The addition of bagasse ash can affect the workability of fresh concrete, influencing its flow and consistency.
-Therefore, like cement, when bagasse ash is added to concrete mixes, the amount of water used in the mix design, must be closely monitored.
Hydration:
-Both cement and bagasse ash are involved in hydration reactions.
-The pozzolanic reaction of bagasse ash occurs alongside the hydration of Portland cement.

In summary, the related properties center on the pozzolanic

ment	0 gm
urse Aggregate	600 gm
e Aggregate	0 gm
ggase Ash	m
ter Content	0 ml

nature of bagasse ash and its interaction with the hydration products of cement, leading to improvements in the strength and durability of concrete

For 10%	7 days	14 days	28 days
Load Bearing	143 kN	288 kN	554 kN
Bearking Point	144 kN	289 kN	555 kN

CHAPTER 4

For 5%	7 days	14 days	28 days
Load Bearing	333 kN	431 kN	523 kN
Bearking Point	334 kN	432 kN	524 kN

RESULTS&DISCUSSIONS

4.1 Material used in the process of making the cubes with 0% Bagasse ash

Ratio **1:0.75:1.5** – M30 Grade for **0% ash**

For 0%	7 days	14 days	28 days
Load Bearing	438 kN	541 kN	632 kN
Bearking Point	439 kN	542 kN	633 kN

4.2 Material used in the process of making the cubes with (5%to20%) Bagasse ash:

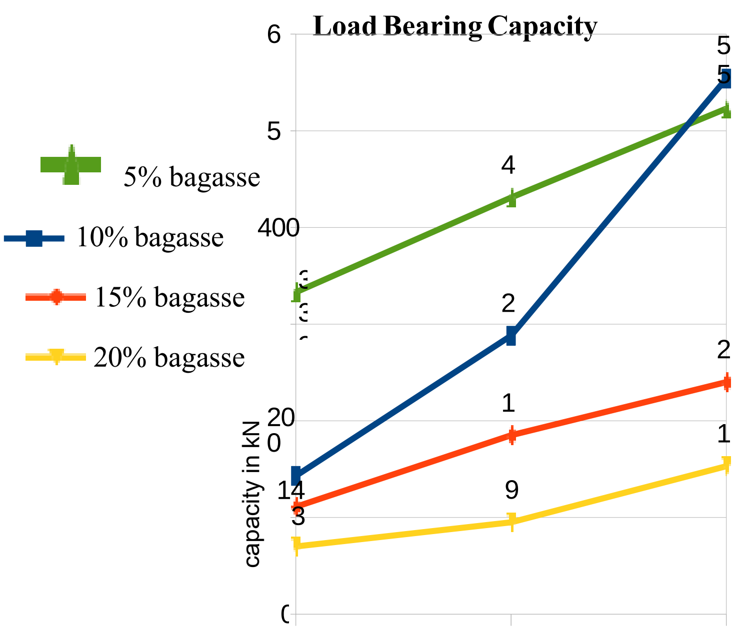
For 15%	7 days	14 days	28 days
Load Bearing	111	185	240
Bearking Point	112	186	241

Materials	Cement (grams)	Coarse Aggregate (grams)	Fine Aggregate (grams)	Baggase Ash (grams)	Water Content (ml)
For 5%	6555	12,600	5400	345	1920
For 10%	6210	12,600	5400	690	1920
For 15%	5865	12,600	5400	1035	1920
For 20%	5520	12,600	5400	1380	1920

Ratio **1:0.75:1.5** – M_{30} Grade for **5%**
Ratio **1:0.75:1.5** – M_{30} Grade cement for **10%**
Ratio **1:0.75:1.5** – M_{30} Grade for **15%**

Ratio **1:0.75:1.5** – M_{30} Grade for **20%**

For 20%	7 days	14 days	28 days
Load Bearing	70	95	153
Bearking Point	71	96	154



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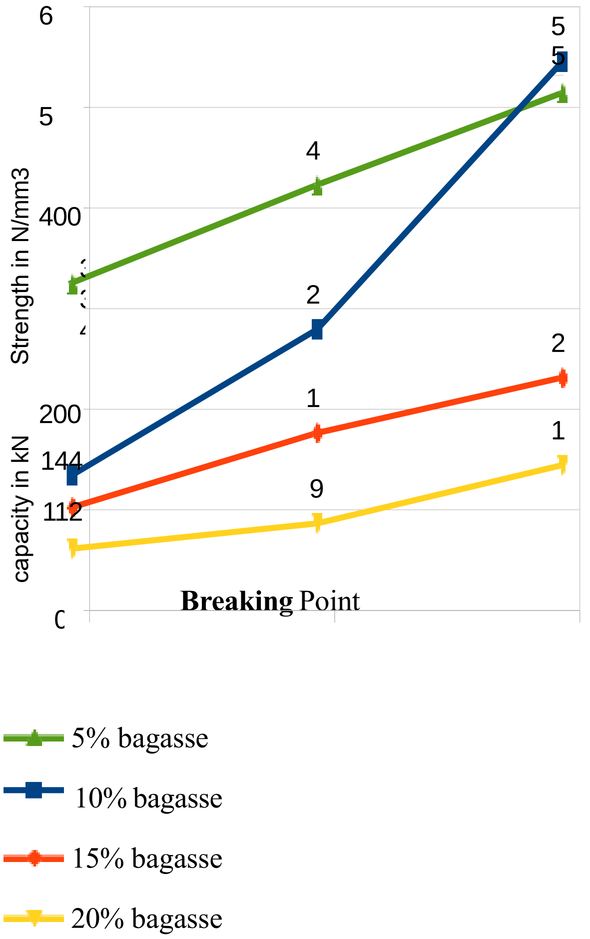
7 days 14 days 28 days No. of days Represents the **Load Bearing capacity** of cubes with 0%, 5%, 10%, 15%, and 20% of curing time left after 7, 14, and 28 days.



7 days,14 days,28 days No. of days Represents the Breaking Point of cubes with 0%, 5%, 10%, 15%, and 20% of curing time left after 7, 14, and 28 days.

Compression Strength of the Cubes :

Cross-section area of Cube = 150 x150 = 22,500 mm^2

As per IS 456-2000

For cubes with 5% bagasse ash: (523×1000)/ 22,500=23.25 N/mm^2

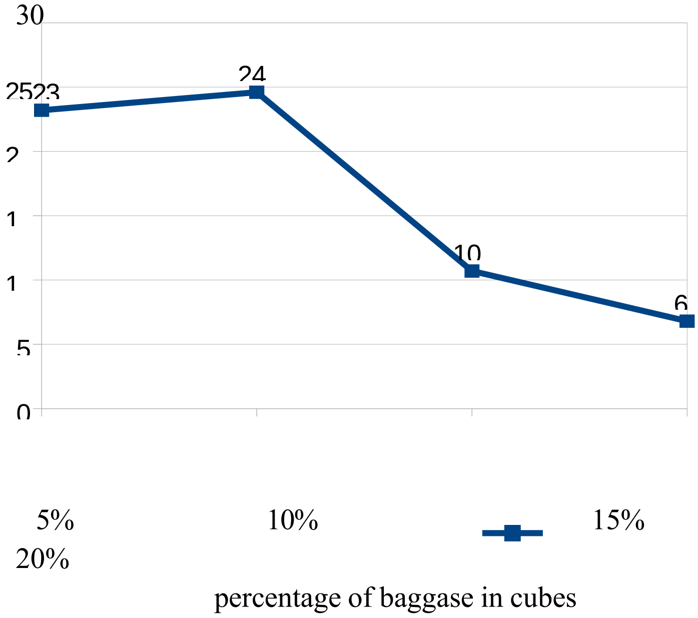
For cubes with 10% bagasse ash:(544×1000)/ 22,500=24.6 N/mm^2

For cubes with 15% bagasse ash:(240×1000)/ 22,500=10.66 N/mm^2

For cubes with 20% bagasse ash:(153×1000)/ 22,500=6.8 N/mm^2

Percent of bagasse ash cubes	Compression Strength (N/mm^2)
5%	23.25
10%	24.6
15%	10.66
20%	6.8

Compression Strength



Represents the **Compression Strength** of cubes with 0%, 5%, 10%, 15%, and 20% of bagasse ash

Chapter 5
CONCLUSION & FUTURE SCOPE

This study on the partial replacement of cement with sugarcane bagasse ash (SBA) in M30 grade concrete has yielded significant findings:

1. **Feasibility of Partial Replacement:** The study successfully demonstrated that cement can be partially replaced with SBA in M30 grade concrete up to a certain level without compromising the overall feasibility of the mix design.
2. **Optimum Replacement Level:** Experimental results indicate that replacing cement with SBA at a **10%** level produces promising outcomes, with the concrete achieving a compressive strength of **554 kN after 28 days** of curing. This suggests that SBA can effectively contribute to the strength development of M30 grade concrete at this optimal replacement level.
   1. **Impact on Appearance:** Increasing the SBA content in the mix led to a noticeable darkening of the

concrete cubes. This color change was directly proportional to the percentage of SBA used, and should be considered in applications where aesthetics are a concern.

2. **Water Absorption:** The study revealed that SBA has a higher water absorption capacity compared to cement. This characteristic necessitates careful adjustments in the water content during mixing to maintain workability, as demonstrated by slump cone test results.

3. **Weight Reduction:** A reduction in the weight of concrete cubes was observed with the partial replacement of cement by SBA. Specifically, the 10% SBA mix resulted in lighter cubes compared to the control M30 grade concrete cubes. This reduction in weight may be advantageous in applications where dead load is a critical factor.

Further Research:

Although this study provides valuable insights, further research is needed to assess the long-term durability, permeability, and other mechanical properties of SBA-based concrete under various environmental conditions. In conclusion, partial replacement of cement with sugarcane bagasse ash at a 10% level in M30 grade concrete is a viable alternative, providing comparable strength, reduced weight, and potential environmental benefits. However, higher replacement levels adversely affect the compressive strength, and the increased water demand and color changes must be considered in practical applications. Further investigation into the long-term performance and durability of SBA-based concrete is recommended.

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