SYNERGISTIC EFFECTS OF BAGASSE ASH, STEEL FIBERS, AND POLYPROPYLENE FIBERS ON THE MECHANICAL PROPERTIES OF CONCRETE

[1]DR. R. BALA MURGAN, [2]CH. RAMESH,[3]M.HANUMAPPA

[1]Professor,[23]Assistant Professor

Department Of Civil Engineering

Indira Institute Of Technology And Sciences ,Markapur

ABSTRACT

The combined impacts of steel, polypropylene, and bagasse ash on the mechanical qualities of concrete are examined in this work. A byproduct of the sugar industry called bagasse ash is used in place of some cement, and steel and polypropylene fibers are added to improve the concrete's hardness, ductility, and tensile strength. The goal of the study is to assess how these materials interact to affect important mechanical characteristics including splitting tensile strength, flexural strength, and compressive strength. Concrete mixtures with varied fiber concentrations and bagasse ash percentages (10%, 15%, and 20%) were made and evaluated. The findings demonstrate that the addition of these materials considerably enhances concrete's overall performance; the best results are shown when 15% bagasse ash and a balanced proportion of steel and polypropylene fibers are added. The research comes to the conclusion that using industrial wastes to create high-performance concrete with improved mechanical characteristics while simultaneously promoting sustainability is possible when bagasse ash and steel and polypropylene fibers are combined.

I.INTRODUCTION

1.1 General

One of the most extensively used building materials in the world, concrete is renowned for its strength, resilience, and adaptability. However, the use of alternative materials and industrial wastes in the manufacturing of concrete is becoming more popular due to the rising need for sustainable building techniques. Because of its pozzolanic qualities, bagasse ash, a byproduct of sugarcane production, has drawn interest as a possible additional cementitious ingredient. Simultaneously, efforts have been made to improve the mechanical qualities of concrete, including its tensile strength, ductility, and resistance to cracking, by adding fibers like steel and polypropylene.

The combined, or synergistic, impacts of steel, polypropylene, and bagasse ash on the mechanical characteristics of concrete are the focus of this research. Although these components have been the subject of separate studies in the past, nothing is known about how their combination influences concrete's overall performance. Incorporating bagasse ash not only provides a sustainable substitute for conventional cement but also aids in mitigating the carbon emissions linked to cement manufacturing. In the meantime, concrete's hardness and fracture resistance are known to be enhanced by steel and polypropylene fibers, which may counteract the brittleness that bagasse ash brought.

This research aims to give a thorough knowledge of how these elements interact to make high-performance concrete by investigating the ideal mix proportions and assessing important mechanical qualities such compressive strength, flexural strength, and tensile strength. The findings of this study may aid in the creation of more robust and sustainable building materials, supporting the overarching objectives of lessening environmental effect while preserving structural durability and integrity.

1.2 Objectives of the research

1.2.1 General objectives:

The main objective of this research is to ascertain if sugarcane bagasse ash, which is found in sugar mills, is feasible to use as a cement alternative in India.

Examining the strength parameters of steel and polypropylene fiber reinforced concrete utilizing 0%, 0.5%, 1%, 1.5%, and 0%, 0.25%, 0.5%, 0.75%, 1%

1.2.2 Specific objectives:

The specific objectives of this analytical endeavor are as follows:

A. Verifying the nation's bagasse ash and fiber supplies.

B. Examining the chemical makeup of the bagasse ash.

C. Determining the quantity of bagasse ash that can be utilized efficiently and testing the performance of paste, mortar, and concrete made in the lab using bagasse ash as a replacement material, both fresh and hardened.

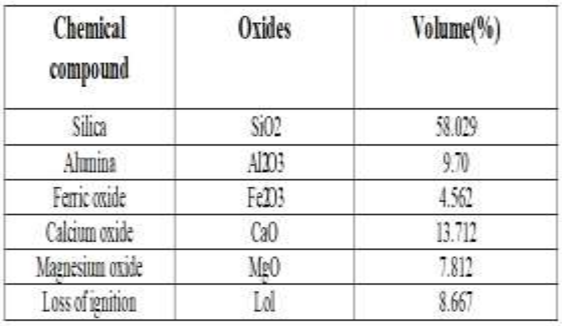
D. Next, replace a part of the bagasse ash concrete with steel and polypropylene fibers separately to assess the strength qualities.

Ultimately, after such an assessment of the bagasse ash and fiber performance from sugarcane. Some conclusions and recommendations on the material's performance and various characteristics as a cement alternative will be provided.

1.3 Bagasse ash

It's a byproduct of the sugar industry that's produced when sugar is extracted in a sugar mill. It generates a lot of Bagasse, which is a kind of oversite material. When Bagasse is burned completely, it produces a significant amount of high-quality ash at the ideal temperature. As a result, the ash was given the name Bagasse ash.

Bagasse ash is produced at a temperature of 600-800°C and has a high percentage of amorphous silicon dioxide, which has pozzolanic characteristics. This concentration allows for a partial replacement of cement in concrete, and it is affected by temperature variations. The silicon dioxide content of soil varies.



Chemical compound	Oxides	Volume(%)
Silica	SiO2	58.029
Alumina	Al2O3	9.70
Ferric oxide	Fe2O3	4.562
Calcium oxide	CaO	13.712
Magnesium oxide	MgO	7.812
Loss of ignition	LoI	8.667

Table1.3.1: Chemical composition of Bagasse Ash

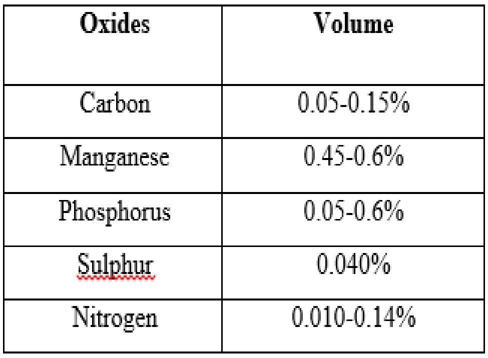
1.4 Fibers

Fibers are reinforcing materials which are used in concrete to increase its strength. Fibers are classified as hard intrusion (having a higher elastic modulus) or soft intrusion (having a lower elastic modulus) than concrete based on their modulus of elasticity and origin. Steel carbon and glass fibres are examples of materials used in higher elastic modules. Concrete with high elastic modules fibres has better flexural behaviour, whereas concrete with low elastic modules fibres has better impact resistance. Polypropylene and vegetable fibres are examples of less elastic modules.

1.4.1 Steel fibers:

Steel fibres have a discontinuous character and are short in length. In the market, there are two kinds of steel fibres: round fibres and hooked fibres. Steel fibres enhance concrete's flexural impact and fatigue strength in general. It's widely utilised in highways, airport pavements, and bridge decks. In the 1980s, steel fibres were exclusively accessible in Europe. At the time, there were no standard values for adoption of new technology. The standard values, however, are now accessible in both American and British standards. The standard requirements for steel fibres used in concrete are ASTM A-820.

Table 1.4.1: Chemical Composition in Steel Fibers



Oxides	Volume
Carbon	0.05-0.15%
Manganese	0.45-0.6%
Phosphorus	0.05-0.6%
Sulphur	0.040%
Nitrogen	0.010-0.14%

Hooked Steel Fibers are steel fibres with hooks on both ends that have excellent mechanical characteristics and tensile strength. Reinforcement has an average tensile strength of 11200Mpa,

1.4.2 Polypropylene fibers

Polypropylene is available in a variety of monofilament and film fibre forms. Mono filament fibres are removed from orifices in a spinneret and then trimmed to the appropriate length. The fibre method is identical, except that the polypropylene is manufactured using a flat film die. Longitudinal split sand is created by splitting sand into tapes and stretching them over specially engineered roller pin systems. After that, the incisions are twisted to create a variety of fibrillated fibres. At a freezing point of 180 degrees Celsius, polypropylene extraction usually yields eight polypropylene fibres. Monofilament fibres were utilised as a component in polypropylene fibre concrete a few decades ago. It comes in lengths of 1/2, 3/4, and 112 inches. The Mono filament fibres with tip buttons, which provide more mechanical anchoring, worked well as well. Fibrillated fibres are often utilised in paving applications.

II. METHODOLOGY

2.1 GENERAL

To investigate the mechanical characteristics of bagasse ash concrete with the addition of hooked steel and glass fibres, a two-stage research was carried out in the current study. The results of the inquiry were presented in this paper. Cement has been partly replaced with bagasse ash in the first stage, with the optimal replacement percentages found at 5 percent, 10 percent, and 15 percent of the total cement replacement percentage. After that, steel fibres (0.5, 0.75, 1.0, and 1.25 percent) and polypropylene fibres (0, 0.5, 1, 5, and 2.0 percent), each at an optimal bagasse ash content, were introduced one by one at the optimal bagasse ash content. The concrete mix of M40 grade has been developed in accordance with IS 10262: 2009, taking into consideration all of the design factors, such as the selection of the water-cement ratio, and the specimens have been cast and tested to determine the results. Proper Indian standards were followed to guarantee that the tests were carried out in a very exact manner, resulting in the least amount of inaccuracy in the representation of the findings. Samples such as cubes, cylinders, and beams were subjected to testing at ages of seven and twenty-eight days.

2.2 Collection of Materials

The following are the materials that were utilised in the project work, with detailed explanations for each

They are as follows:

1. Cement
2. Fine aggregate
3. Coarse aggregate
4. Bagasse ash
5. Steel fibers
6. Polypropylene fibers

1. Cement

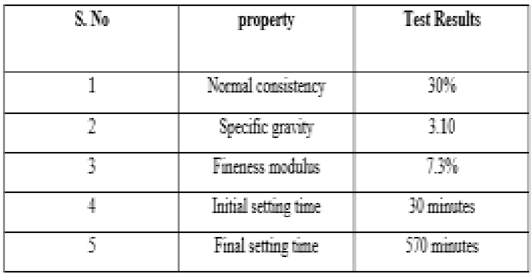
Cement is the most important component in the production of concrete. It has been used as a binding agent because of its pozolanic characteristics. It is the substance that joins the fine aggregate and coarse aggregate together in a cohesive whole. When the strength of the concrete increases, the water-to-cement ratio falls as a result. There are two kinds of cement that are most often used, and they are

1. Ordinary Portland cement is a kind of cement that is often used.

2. Portland Pozzolana Cement (also known as Portland Pozzolana)

FIG 2.1: OPC 53 GRADE CEMENT

Ordinary portland cement of grade 53 is used in the construction of this structure. The colour of the cement is a greyish green, and there are no lumps or other imperfections in the mixture at all. When storing cement bags, basic measures must be taken to ensure that they are not exposed to the elements and that no moisture is introduced into the bag. Bagasse ash is used to substitute supplementary cementation materials in the proportions of 0 percent, 5 percent, 10 percent, and 15 percent with cement, respectively. Testing for cement includes the following procedures: preliminary and final setting times; soundness; and specific gravity testing.



S. No	property	Test Results
1	Normal consistency	30%
2	Specific gravity	3.10
3	Fineness modulus	7.3%
4	Initial setting time	30 minutes
5	Final setting time	570 minutes

Table 2.1.: Test results of Traditional cement

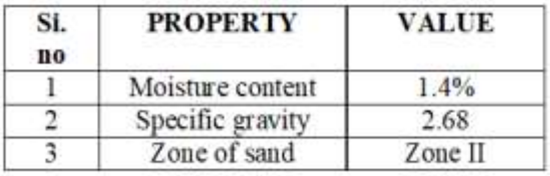
2. Fine Aggregate

Sand is a granular substance made up of finely split rock and mineral particles that occurs naturally. More than 85% of the particles in the soil are sand-sized. Sand is used in mortar and concrete, as well as for cleaning and sand blasting. Depending on grain content and size, the weight ranges from 1,538 to 1, 842 kg/m³. This experiment used fine aggregate collected from a riverbed that was free of any organic contaminants. The fine aggregate had a specific gravity of 2.68 after passing through a 4.75mm screen. According to Indian Standard standards, the fine aggregate grading zone was zone II.

The specimen preparation was done using locally available fine aggregate. Fine aggregate sieve analysis was performed in accordance with ASTM C-136-04. The fineness modulus was found to be 2.56, which is within the acceptable range. Fine aggregate has an average grain size of 600m. ASTM C-158 was used to determine the specific gravity of fine aggregate. The fine aggregate specific gravity was estimated to be 2.68.

Fig 2.2.: Fine aggregate

Table 2.2.: Physical properties of Fine aggregate



Si. no	PROPERTY	VALUE
1	Moisture content	1.4%
2	Specific gravity	2.68
3	Zone of sand	Zone II

3. Coarse aggregate

Coarse aggregate is defined as aggregate with a particle size larger than 4.75mm.

Aggregates make approximately 60 to 80 percent of the total volume of traditional concrete. The aggregate should be chosen in such a manner that it is durable, allowing for maximum efficiency and constant concrete strength and workability. A good aggregate should be angular, hard, and robust, and devoid of hazardous chemicals and other impurities. Concrete gains strength when the particles are properly sorted. If the aggregates are properly graded, the amount of cement paste needed to fill the voids is reduced, which means less cement and less water, which means more strength, less shrinkage, and better durability, as well as cheaper construction costs.

The aggregates used in the project come from an angular quarry with a size of 20mm. The moisture content of coarse aggregate is 1.4 percent, and its relative density is 2.72.

FIG.2.3.: 20 mm size coarse aggregate

Table 2.3.: Physical properties of coarse aggregate

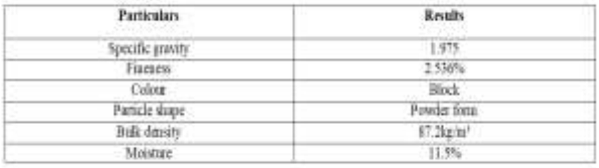
S .No	PROPERTY	VALUE
1	Moisture content	1.4%
2	Specific gravity	2.68
3	Zone of sand	Zone II

4. Sugar cane bagasse ash:

Sugarcane bagasse ash is the residue left behind when sugarcane is burned. It is a waste product that, owing to its chemical characteristics, may be used to partly replace cement. Bagasse ash was gathered in the Telangana state of India's Karimnagar district. When bagasse ash is collected from the factory, it includes 40-50 percent moisture. Bagasse is a waste product that is burned to generate electricity for various industrial operations.

FIG.2.4.: Sugarcane bagasse ash

Table 2.4: Physical composition of Bagasse ash



Particulars	Results
Specific gravity	1.975
Fineness	2.536%
Colour	Block
Particle shape	Powder form
Bulk density	87.2kg/m³
Moisture	11.5%

5. Steel fibers:

The proportion of total volume of the composite (concrete and fibres) turned volume fraction is used to indicate the number of fibres added to the concrete mix (Vf). Vf usually ranges between 0.12 and 3%. Aspect ratio of non-circular fibres is often calculated by using an equal diameter, however fibres that are too long tend to ball up in the mix and cause workability issues. According to current study, putting fibres in concrete has a little influence on the fabric's impact resistance.

Hooked steel fibres with a length of 36mm were utilised in this project. Steel fibres have an aspect ratio of 80mm and a density of 7850kg/m³.

Fig 2.5: steel fiber

Table 2.5: Physical Properties of Steel fibers:

Particular	Results
Aspect ratio	20-100
Length	6.5-80mm
Diameter	0.25-0.71mm
Tensile strength	275-2760mpa
Young's modules	200*103 mpa
Ultimate elongation	0.5-35%

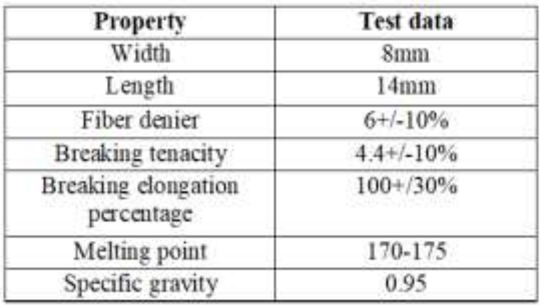
6. Polypropylene fibers:

Polypropylene fibres are generally divided into two categories. They're PP fibres, both micro and macro. During this experiment, a tiny kind of PPF with a width of 6mm and a length of 12mm is used.

The main function of the PP fibre is to change the characteristics of new concrete. They stabilises the flow of solid particles by increasing the homogeneity of the mix. This lowers the concrete's bleed capacity and decreases the bleed rate, which helps to minimise plastic settling. The filament matrix also helps to prevent plastic shrinkage cracking, which may occur when the concrete surface dries out too quickly.

Fig 2.6: Polypropylene fibers

Table 2.6: Properties of Polypropylene fibers



Property	Test data
Width	8mm
Length	14mm
Fiber denier	6+/-10%
Breaking tenacity	4.4+/-10%
Breaking elongation percentage	100+/30%
Melting point	170-175
Specific gravity	0.95

7. Water

Water is utilised in the mixing and curing processes. It must be devoid of harmful levels of oil, acids, alkalis, and other organic and inorganic contaminants. It should be devoid of iron, vegetable matter, and any other elements that may harm the concrete or reinforcement. It should be OK for drinking, since it is utilised in the concrete mixing process.

2.3 Equipments

The following is a list of the tools that were utilised in this project. This equipment is purchased in accordance with Indian Standard regulations.

1. The tamping rod
2. Cubes, cylinders, and beams
3. Weighing scales
4. Testing machine for cubes.

2.4. Cement physical properties:

Physical properties of cement are limited by specifications. Understanding the importance of certain physical characteristics may aid in the interpretation of cement test results. Instead of evaluating the characteristics of the concrete, tests of the physical properties of the cement should be utilised.

2.4.1 Fineness:

Many of cement's characteristics are influenced by its fineness. The primary characteristics that are influenced by the fineness of cement are the heat emitted and the rates of hydration. Many other characteristics of the cement are influenced by these features, such as usual consistency, setting time, strength, and so on.

Cement fineness is primarily determined by the specific surface area technique and particle size dispersion. The specific surface area of 1 gm or 1 kg of cement is the total of the surface areas of all the particles. The majority of the time, fineness is described by a single metric, specific surface area. Although the particle size distribution of cement can be measured, there is still no consensus on what factors contribute to the optimum grading curve for cement. The specific surface area is chosen over the particle size distribution for these and other reasons.

The Blaine air-permeability test (ASTM C 204 or AASHTO T 153), which indirectly evaluates the surface area of the cement particle per unit mass, is used to determine the surface area.

Ordinary Portland cement must have a specific surface area of not less than 2250 cm²/g, according to Ethiopian standards, while the ASTM C 150 standard requires a minimum of 2800 cm²/g.

Fig2.7: Fineness of cement

2.4.2. Consistency of cement paste:

The amount of water in concrete affects a lot of its characteristics. The water content of the neat cement paste affects the physical properties of the paste, such as setting and soundness. As a result, it is essential to establish and research the water content at which these tests should be performed. This is measured according to ASTM C 187 and is described in terms of the paste's typical consistency.

The quantity of water needed to produce a normal consistency as determined by a Vicat plunger penetration of 10 1 mm (ASTM C 187) is stated as a percentage of the dry cement's weight, with the typical range being about 26% to 33%. The test is very dependent on the circumstances under which it is performed, especially the temperature and the manner in which the cement is compacted into the mould. The test has no bearing on the cement's quality; it simply evaluates the plasticity of cement paste.
The beginning setting time for cement should not be less than 30 minutes, and the ultimate setting time should not be more than 10 hours, according to Indian standards.

2.4.3. Setting time:

Setting is the transformation of a plastic consistency cementation slurry into a set material that has lost its deformability and crumbles when exposed to a significant amount of external force. It's preceded by a stiffening of the paste, in which the material's apparent viscosity rises without losing its plasticity. Initial and final setting times are the two kinds of setting times. The first setting time is when the paste starts to stiffen and can no longer be moulded, while the final setting time is when the paste is fully set. These tests are used for quality control in the same way that regular consistency tests are.

Fig 2.8: initial setting time of cement sample

2.4.4. Sieve Analysis

The particle size distribution of coarse and fine aggregates may be determined via sieve analysis. The aggregates are sieved according to IS: 2386 (Part I) – 1963. We do this by passing aggregates through various sieves that have been standardised by the IS code, and then collecting different sized particles left behind from different sieves. The mechanical sieve shaker is used to conduct the sieve analysis in the laboratory. The primary goal of the test is to determine which zone the aggregate we're utilising belongs to.

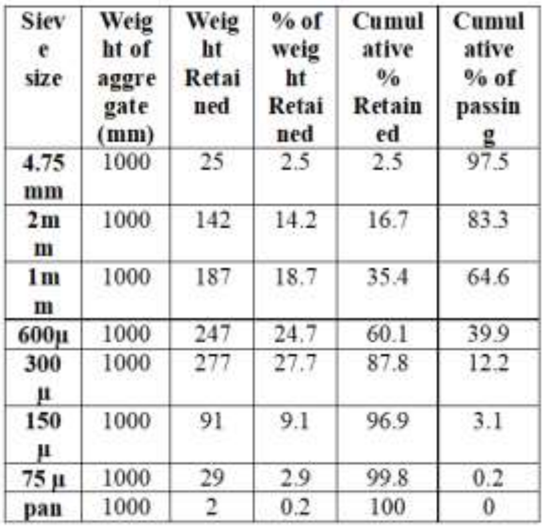
Taking a 1000g sample and analysing it using a sieve. The results are shown in the table below.

The test was carried out on both fine and coarse material. Each aggregate's fineness modulus is computed, and the results are shown below the table. Before putting aggregates through sieves, make sure they're dry and devoid of any organic components. The existence of lumps in the aggregate should be eliminated by pressing with your fingertips.

The following formula should be used to compute and report the results:

1. Retained sample weight
2. Retained weight as a percentage
3. Percentage of total weight retained

2.7.Sieve analysis



Sieve size	Weight of aggregate (mm)	Weight Retained	% of weight Retained	Cumulative % Retained	Cumulative % of passing
4.75 mm	1000	25	2.5	2.5	97.5
2mm	1000	142	14.2	16.7	83.3
1mm	1000	187	18.7	35.4	64.6
600µ	1000	247	24.7	60.1	39.9
300 µ	1000	277	27.7	87.8	12.2
150 µ	1000	91	9.1	96.9	3.1
75 µ	1000	29	2.9	99.8	0.2
pan	1000	2	0.2	100	0

2.5 Tests on blended paste

The primary goal of the research was to determine if bagasse ash could be used to replace cement. These involve researching the characteristics of paste and concrete by substituting bagasse ash for a portion of the cement at various percentages.

In order to achieve these goals, two significant experiments were also performed. The first experiment was conducted on blended powders and pastes in which a portion of the cement was substituted with bagasse ash in order to determine the fineness of the blended powder, the water need or normal consistency of the blended paste, and the setting time of the blended paste. The second experiment was conducted on concrete in which bagasse ash was used to replace a portion of the cement. These experiments were utilised to look at the pozzolanic property of bagasse ash, as well as its impact on concrete performance such as workability and strength.

Experiment Number One:

The goal of this experiment is to determine the fineness of blended powders, as well as the consistency and setting time of blended pastes.

2.5.1 Test for fineness:

The blain air permeability technique was used to evaluate the fineness of the bagasse ash, cement, and therefore the mixed powders at various percentages. The various mixtures are listed in Table. The blain air technique is based on the connection between the surface area of the particles in a porous bed and the rate of fluid flow through the bed. The replacements ranged from 5% to 15%, with a 5% increase each time.

S.NO	code	Proportion by volume	
		Cement (%)	Bagasse (%)
1	BAP 0	100	0
2	BAP 5	95	5
3	BAP 10	90	10
4	BAP 15	85	15

Table 2.5.1: Proportion of blending of bagasse ash and cement

Where:

- BAP 0 denotes a control OPC with no replacement.
- BAP is a 5-blended powder that contains 95 percent OPC and 5% BA by volume.
- BAP is a 10-blended powder that contains 90% OPC and 10% BA by volume.
- BAP 15 is a powder that contains 85 percent OPC and 15 percent BA by volume.

2.5.2 Normal consistency test:

The ASTM C 595 standard requires that the normal consistency test of blended cements be performed using the ASTM C 187 technique, which is the hydraulic cement method. As a result, a Vicat apparatus was used to determine the usual consistency. This test determines the paste's resistance to penetration by a 300g plunger or needle discharged at the paste's surface.

The ASTM C 187 method was utilised to conduct this test.

By substituting a portion of the standard Portland cement with bagasse ash, several pastes were created, both control and mixed. For each of the pastes created, the water quantity was adjusted until a normal, consistent paste was achieved.

2.5.3 Conducting a time trial:

The ASTM C 595 standard suggests using the ASTM C 191 method of determining setting time for hydraulic cements. The initial setting time of the paste was determined by measuring the time it took for a Vicat needle to penetrate 25mm into the paste in 30 seconds after it was released, while the final setting time was determined by measuring the time it took for the needle to penetrate the paste to zero penetration.

III. RESULTS AND DISCUSSIONS

3.1 Introduction:

The laboratory test findings of bagasse ash for its potential as a cement-replacing material are given and evaluated in this section. The following are the many characteristics of bagasse ash that have been investigated:

- The consistency and setting time of mixed pastes with various bagasse ash replacement contents.

- The workability of bagasse ash-containing concrete at various replacement levels. Concrete's compressive, flexural, and split tensile strength tests are also available.

3.2 Blended paste consistency:

Table 8 shows the normal consistency of pastes including bagasse ashes. The control paste, which did not include bagasse ash, had a typical consistency of 30%. All of the bagasse ash pastes had normal consistency, which was equivalent to or better than the control paste. The normal consistency remained steady up to 10% replacement; at 15% replacement, the normal consistency increased slightly to 30.5 percent.

S.NO	% OF BA	CONSISTENCY (%)
1	0%	30
2	5%	30
3	10%	30
4	15%	30.5

Fig 3.1: Normal consistency of blended pastes containing bagasse ash

3.3 Setting time of blended pastes:

The initial setting time of cement must not be less than 30 minutes, and the ultimate setting time must not exceed 10 hours, according to Indian standards. The findings for the setting time in the table showed that adding bagasse ash slowed the setting time; nevertheless, this slowed was within the limitations of the Indian standard. Even if there are few outliers, the setting time has increased as the amount of bagasse ash has increased.

S.NO	% OF BA	Initial setting time (minutes)	Final setting time (minute)
1	0%	30	410
2	5%	44	436
3	10%	60	458
4	15%	74	470

Table 3.2: **Setting time of pastes containing bagasse ash**

3.4. Fresh concrete properties:

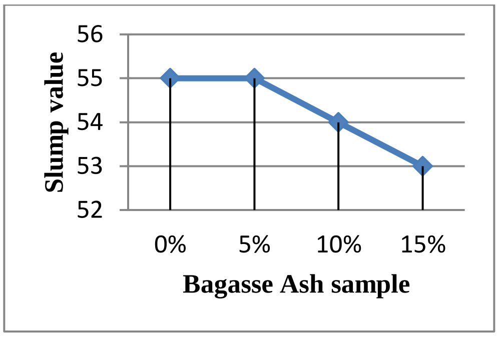
The slump test was performed to determine the new concrete's workability. In order to be laid, compacted, and completed, a concrete mix must be workable. The proportions of the components in concrete should allow for excellent workability and adequate strength to sustain the necessary load after hardening.

The trial mix for the control concrete gave a slump of 55mm.

SNO	Mix code	Replaced OPC (%)	Observed slump (mm)
1	BA 0	0	55
2	BA 5	5	55
3	BA 10	10	54
4	BA 15	15	53

Table 3.3: Slump value at various Bagasse ash percentages

The slumps of concrete containing bagasse ash have demonstrated a small decrease as the bagasse ash concentration rises, as can be observed.



Graph 3.1: Slump value at varying percentage of Bagasse ashes

3. 5 Hardened concrete properties:

This section covers the many characteristics of hardened concrete that have a significant impact on its performance. The compressive strength, flexural strength, and split tensile strength of concretes are tested in this study and the results are given in the sections below.

3.5.1 Concrete compressive strength:

The most frequent kind of test for hardened concrete is the compressive strength test. Many regulations and design guides are based on this property, many other characteristics of concrete are dependent on compressive strength, and it is a simple test when compared to others.

Each of the concrete cubes is tested in a compression machine to measure its compressive

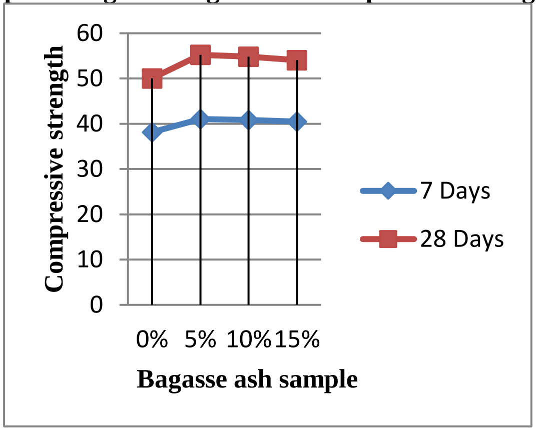
strength. The compressive strength of each mix is calculated using the average of three samples.
Concrete compression strength tests have been performed, and the results are tabulated and graphed below.

M40 concrete compressive strength with various percentages of Bagasse ash

S.NO	Percentage of Bagasse ash	Compressive strength(N/mm²)	
		7days	28days
1	0	38.15	50..05
2	5	41.05	55.23
3	10	40.84	54.81
4	15	40.50	54.05

Table 3.4: Compressive strength values of concrete

Graph 3.2: M40 concrete with various percentages of Bagasse ash compressive strength

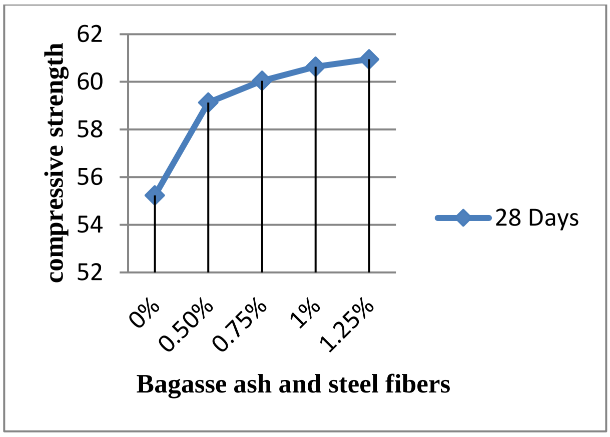


The compressive strength of concrete with various percentages of Bagasse ash is shown in the graph above. At 5% partial substitution of cement with Bagasse ash, the maximum compressive strength of concrete was achieved.

3.5 Compressive strength of M40 concrete with optimal Bagasse ash content and varied steel fibre content

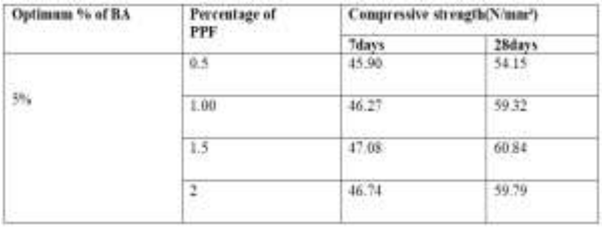
Optimum % of BA	Percentage of steel fibers	Compressive strength(N/mm²)	
		7days	28days
5%	0.5	46.65	59.13
	0.75	46.51	60.05
	1.00	47.10	61.63
	1.25	46.93	60.95

Graph: 3.3: Compressive strength of M40 concrete with optimal Bagasse ash content and variable steel fibre content



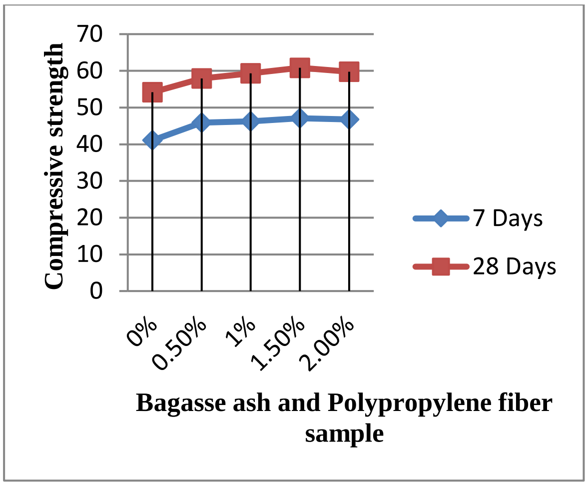
The compressive strength of concrete with optimal proportion (5%) Bagasse ash and various percentages of steel fibres is shown in the graph above. Concrete's optimal compressive strength was achieved at 1.0 percent steel fibres.

3.6. Compressive strength of M40 concrete with optimal percent of Bagasse ash and variable percent of Polypropylene fibres.



Optimum % of BA	Percentage of PPF	Compressive strength(N/mm²)	
		7days	28days
5%	0.5	45.90	54.15
	1.00	46.27	59.32
	1.5	47.08	60.84
	2	46.74	59.79

Graph 3.4: Compressive strength of M40 concrete with optimal Bagasse ash content and variable Polypropylene fibre content



The graph above shows the compressive strength of concrete containing a maximum of 5% Bagasse ash and various percentages of glass fibres. Concrete's optimal compressive strength was achieved with 1.50 percent steel fibres.

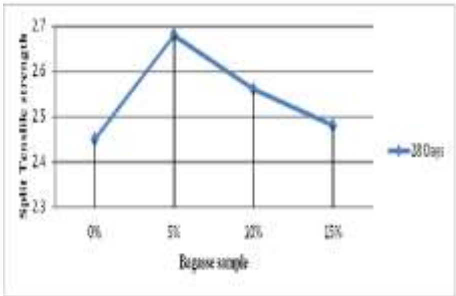
3.6. Tensile strength in splits:

The results of split strength tests on concrete have been collated, and graphs have been produced below.

3.7. Split tensile strength of M40 concrete with optimum % of Bagasse ash

S.NO	% of Bagasse Ash	28 Days
1	0%	2.45
2	5%	2.68
3	10%	2.56
4	15%	2.48

Graph 3.5: Split tensile strength of M40 concrete with varying % of Bagasse ash



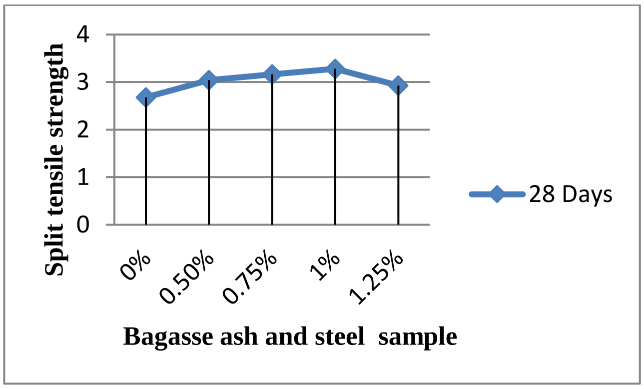
The compressive strength of concrete with various percentages of Bagasse ash is shown in the graph above. At 5% partial substitution of cement with Bagasse ash, the maximum compressive strength of concrete was achieved.

M40 concrete split tensile strength with optimal percent Bagasse ash and variable percent steel fibres

Optimum % of BA	% of Steel fibers	28 Days
5%	0.5%	3.04
	0.75%	3.16
	1.00%	3.28
	1.25%	2.93

Fig 3.8: Split tensile strength values of concrete

Graph 3.6: Split tensile strength of M40 concrete with optimum % of Bagasse ash and varying the % of steel fibers



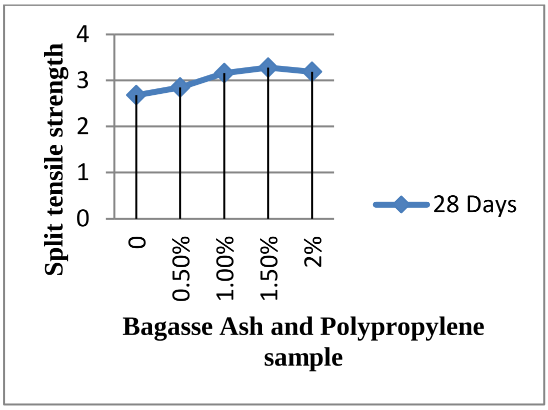
The graph above shows the split tensile strength of concrete containing a maximum of 5% Bagasse ash and various percentages of steel fibres. Concrete's optimal compressive strength was achieved at 1.0 percent steel fibres.

M40 concrete split tensile strength with optimal percentage of Bagasse ash and various percentages of Polypropylene fibres

Optimum % of BA	% of Steel fibers	28 Days
5%	0.5%	2.85
	1.0%	3.16
	1.5%	3.18
	2.0%	3.19

Fig 3.9 Split tensile strength values of concrete

Graph.3.7 M40 concrete split tensile strength with optimal percent of Bagasse ash and variable percent of Polypropylene fibres



The graph above shows the split tensile strength of concrete with optimal Bagasse ash (5%) and various percentages of Polypropylene fibres. At 1.5 percent polypropylene fibres, the optimal Split tensile strength of concrete was achieved.

IV.CONCLUSION

The investigation into the combined impacts of polypropylene, steel, and bagasse ash on the mechanical characteristics of concrete has produced important results that further our knowledge of high-performance, sustainable concrete. The results show that the mechanical qualities of concrete are improved by the combination of these components, especially in terms of compressive strength, flexural strength, and tensile strength. Remarkably, the best results were obtained when 15% of the cement was substituted with bagasse ash and steel and polypropylene fibers were evenly distributed. This mixture increased the concrete's ductility and resilience to cracks in addition to its overall strength.

The ability to lessen the environmental effect of concrete manufacturing is shown by the effective substitution of some of the cement with bagasse ash, an industrial waste. Furthermore, the addition of steel and polypropylene fibers successfully made up for the natural brittleness of bagasse ash concrete, producing a material that is more robust and long-lasting. According to the results, this synergistic method presents a workable way to produce concrete with better mechanical qualities and encourage sustainability in the building sector.

The research also shows that the distribution and quantities of the fibers might have an impact on the performance of fiber-reinforced concrete, necessitating careful mix design and quality assurance. Future studies should look at the long-term resilience of these composites in a range of environmental settings and examine ways to better optimize the distribution and composition of the fibers. All things considered, this study offers a solid basis for the creation of creative tangible solutions that strike a balance between affordability, sustainability, and performance.

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