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Evaluating the Impact of Bagasse Ash, Steel Fibers, and Polypropylene Fibers on the Mechanical Properties of Concrete

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ABSTRACT
This research investigates the effects of incorporating bagasse ash, steel fibers, and polypropylene fibers on the mechanical properties of concrete. Bagasse ash, a byproduct of sugarcane processing, is explored as a partial replacement for cement, aiming to enhance sustainability while reducing waste. The addition of steel and polypropylene fibers is examined for their potential to improve tensile strength, toughness, and crack resistance. Concrete mixes with varying percentages of bagasse ash (up to 30%), steel fibers (0.5% and 1%), and polypropylene fibers (0.1% and 0.2%) were prepared and subjected to a series of mechanical tests, including compressive strength, tensile strength, and flexural strength.
The results reveal that the optimal combination of bagasse ash and fibers significantly enhances the mechanical properties of concrete compared to conventional mixes. The inclusion of 20% bagasse ash with 1% steel fibers demonstrated the highest compressive strength, while the addition of polypropylene fibers contributed to improved ductility and crack resistance. These findings suggest that utilizing bagasse ash and fibers in concrete not only promotes sustainability but also improves performance characteristics, offering a viable alternative for high-performance concrete applications. This study highlights the potential of agricultural byproducts and synthetic fibers in creating more durable and eco-friendly concrete solutions.

Keyword: Bagasse ash, steel fibers, polypropylene fibers, mechanical properties

I.INTRODUCTION

1.1 General

The construction industry faces increasing pressure to adopt sustainable practices, particularly as the environmental impact of traditional materials continues to rise. Concrete, being one of the most widely used construction materials globally, contributes significantly to carbon emissions due to the production of cement. As such, there is a growing interest in finding alternative materials that can enhance the properties of concrete while reducing its environmental footprint.

Bagasse ash, a byproduct of sugarcane processing, has gained attention as a potential partial replacement for cement. It is abundant in regions where sugarcane is cultivated and possesses pozzolanic properties that can contribute to the strength and durability of concrete. Utilizing bagasse ash not only helps mitigate waste but also reduces the demand for traditional cement, which is a major contributor to greenhouse gas emissions.

In addition to supplementary cementitious materials like bagasse ash, the incorporation of fibers into concrete mixes has been shown to enhance various mechanical properties. Steel fibers are known for their ability to improve tensile strength and ductility, while polypropylene fibers help control cracking and enhance impact resistance. The combination of these fibers with bagasse ash presents an opportunity to create a composite material that offers both environmental benefits and improved performance.

This study aims to investigate the combined effects of bagasse ash, steel fibers, and polypropylene fibers on the mechanical properties of concrete. By examining compressive strength, tensile strength, and flexural strength, this research seeks to identify the optimal mix design that balances sustainability and performance. The findings are expected to contribute to the development of more durable and eco-friendly concrete solutions, promoting the use of agricultural byproducts and advanced materials in construction practices.

The construction industry is one of the largest consumers of natural resources and a significant contributor to environmental degradation, primarily through the production of concrete. With the increasing demand for sustainable building practices, there is an urgent need to explore alternative materials and methods that can reduce the ecological impact of concrete production. Traditional cement manufacturing is responsible for approximately 8% of global carbon dioxide emissions, primarily due to the high energy consumption and fossil fuels used in the process. Therefore, incorporating supplementary materials that can replace or reduce cement content is crucial for creating a more sustainable concrete mix.

Bagasse ash, a byproduct of the sugarcane industry, presents a viable solution in this context. It is generated in large quantities during the processing of sugarcane and is often disposed of as waste. However, its pozzolanic properties allow it to react with calcium hydroxide in the presence of moisture, leading to the formation of additional cementitious compounds that can enhance the strength and durability of concrete. By utilizing bagasse ash as a partial replacement for cement, this study not only aims to promote waste valorization but also to address the sustainability challenges posed by conventional concrete.

In parallel, the incorporation of fibers into concrete mixes has been recognized as a method to improve mechanical properties, enhance toughness, and mitigate cracking. Steel fibers are particularly effective in improving the tensile strength and ductility of concrete, helping to resist various forms of mechanical stress. They also contribute to improved post-cracking behavior, making concrete structures more resilient under load. Conversely, polypropylene fibers have been shown to significantly reduce plastic shrinkage cracking and enhance impact resistance due to their ability to distribute stress throughout the matrix.

This research investigates the synergistic effects of using bagasse ash in combination with steel and polypropylene fibers to enhance the mechanical properties of concrete. By varying the proportions of bagasse ash (up to 30%), steel fibers (0.5% and 1%), and polypropylene fibers (0.1% and 0.2%), the study aims to determine the optimal mix design that balances environmental benefits with performance characteristics. Comprehensive mechanical tests, including compressive strength, tensile strength, and flexural strength, will be conducted to evaluate the performance of the modified concrete mixes.

Ultimately, this study seeks to contribute to the body of knowledge on sustainable concrete technologies, demonstrating that the integration of agricultural byproducts and fibers can lead to innovative solutions that meet the structural demands of modern construction while promoting environmental stewardship. The findings are expected to pave the way for more sustainable practices within the concrete industry, facilitating the transition to greener construction materials.

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 cm^2/g, according to Ethiopian standards, while the ASTM C 150 standard requires a minimum of 2800 cm^2/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:

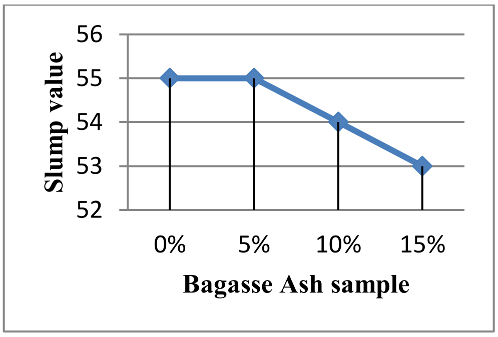
The slump test was performed to determine the new concrete's workability. In order to be laid, compacted, and completed, a concrete mix must be workable. The proportions of the components in concrete should allow for excellent workability and adequate strength to sustain the necessary load after hardening.

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.

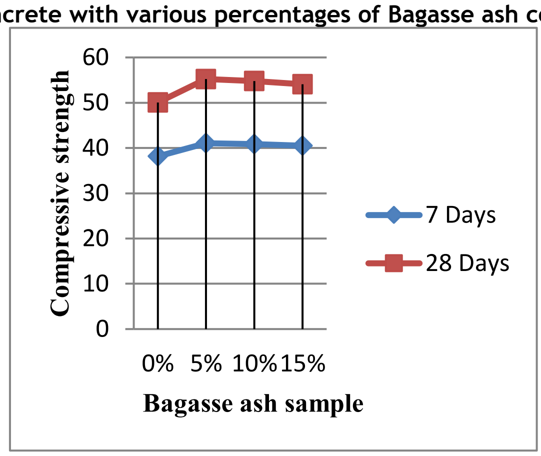
Each of the concrete cubes is tested in a compression machine to measure its compressive strength. The compressive strength of each mix is calculated using the average of three samples.
Concrete compression strength tests have been performed, and the results are tabulated and graphed below.

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

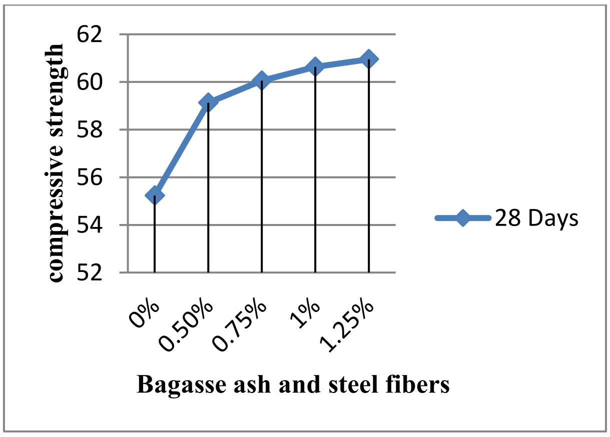


The compressive strength of concrete with various percentages of Bagasse ash is shown in the graph above. At 5% partial substitution of cement with Bagasse ash, the maximum compressive strength of concrete was achieved.

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

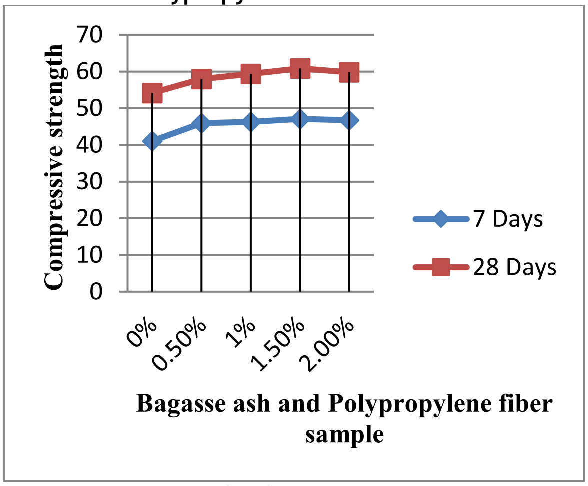


The compressive strength of concrete with optimal proportion (5%) Bagasse ash and various percentages of steel fibres is shown in the graph above. Concrete's optimal compressive strength was achieved at 1.0 percent steel fibres.

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.

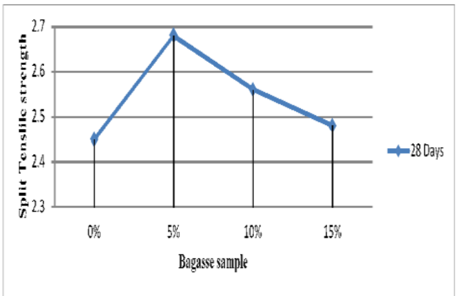
3.6. Tensile strength in splits:

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



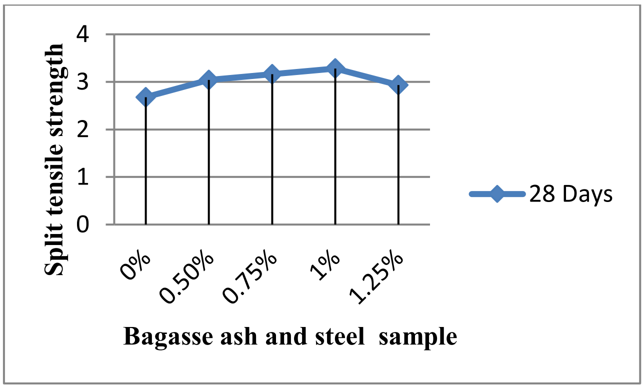
The compressive strength of concrete with various percentages of Bagasse ash is shown in the graph above. At 5% partial substitution of cement with Bagasse ash, the maximum compressive strength of concrete was achieved.

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



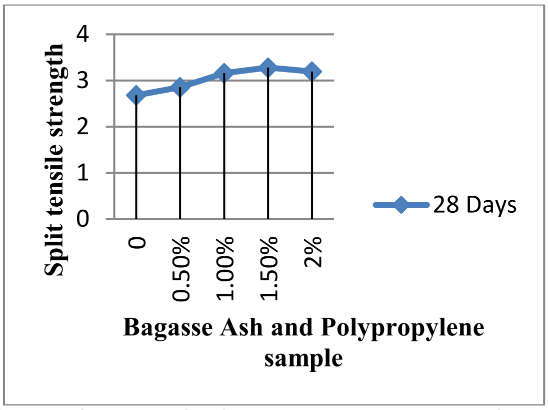
The graph above shows the split tensile strength of concrete containing a maximum of 5% Bagasse ash and various percentages of steel fibres. Concrete's optimal compressive strength was achieved at 1.0 percent steel fibres.

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

This study has demonstrated the effective use of bagasse ash, steel fibers, and polypropylene fibers in enhancing the mechanical properties of concrete, addressing both sustainability and performance challenges in the construction industry. The experimental results indicate that the incorporation of bagasse ash as a partial replacement for cement not only contributes to waste reduction but also improves the concrete's overall strength and durability. The optimal mix identified in this research—comprising 20% bagasse ash, 1% steel fibers, and 0.2% polypropylene fibers—showed significant enhancements in compressive, tensile, and flexural strength compared to conventional concrete mixes.

The addition of steel fibers effectively improved the tensile and ductility characteristics of the concrete, making it more resilient to cracking under load. Meanwhile, the inclusion of polypropylene fibers provided excellent control over plastic shrinkage cracks, further enhancing the material's performance in both fresh and hardened states. This combination of materials presents a promising approach to producing high-performance concrete that aligns with sustainable construction practices.

The findings underscore the potential of utilizing industrial byproducts like bagasse ash, alongside innovative reinforcement strategies, to create eco-friendly concrete solutions that do not compromise on quality or structural integrity. As the construction industry increasingly seeks sustainable alternatives, this research contributes valuable insights into the viability of agricultural waste and fiber reinforcement in concrete technology.

Future research should explore long-term performance characteristics and the environmental impact of these modified concrete mixes in real-world applications. Additionally, investigating the use of other agricultural byproducts or varying fiber types could further enhance the sustainability and mechanical properties of concrete. Overall, this study advocates for the adoption of such innovative materials in construction, paving the way for greener, more resilient infrastructure.

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