ISSN 2063-5346

INVESTIGATING THE EFFECTS OF PROSOPIS JULIFLORA ASH ON CONCRETE COMPRESSIVE AND FLEXURAL STRENGTHS: CHEMICAL AND MECHANICAL CHARACTERIZATION

S. Arun[1], Dr.J. Samuel Simron Rajkumar[2*]

Article History: **Received:** 01.06.2023 **Revised:**07.07.2023 **Accepted:** 25.07.2023

Abstract

The aim of investigating Prosopis Juliflora ash in relation to concrete is to assess its impact on the compressive and flexural strengths of the concrete. Prosopis juliflora, commonly known as Mesquite or Ghaf, is a fast-growing invasive species found in arid and semi-arid regions. Its wide distribution and rapid growth have made it a significant concern for environmentalists and land managers. This study aims to explore the potential use of Prosopis juliflora ash as a partial replacement for cement in concrete production and assess its impact on concrete compressive and flexural strengths. The investigation involves both chemical and mechanical characterization to understand the behavior of concrete with varying levels of Prosopis juliflora ash. M30 concrete mix is a type of high-strength concrete with a characteristic compressive strength of 30 megapascals (MPa) or approximately 4350 pounds per square inch (psi) after 28 days of curing. The "M" in M30 stands for "Mix," and the number following it represents the target compressive strength of the concrete mix in MPa.

Keywords*: M30 Grade Concrete: M30 Grade Concrete is a Designation for a Specific Mix Proportion of Concrete, Indicating the Ratio of Cement, Fine Aggregates, and Coarse Aggregates. It is a Standard in Concrete Mix Design and Provides a Specific Strength and Durability.*

[1] Research Scholar, [2*] Project Guide

[1,2*] Department of Civil Engineering, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai, Tamil Nadu, India.

[1] aruns1011.sse@saveetha.com, [2*] samuelsimronrajkumarj.sse@saveetha.com

DOI: 10.48047/ecb/2023.12.Si8.543

1. Introduction

The increasing demand for sustainable construction materials has led researchers to investigate alternative materials that can partially replace traditional cement in concrete. Prosopis juliflora, an abundant and underutilized plant in certain regions, has been identified as a potential candidate for such an application. By using Prosopis juliflora ash as a cement replacement, it may be possible to reduce the environmental impact of concrete production while addressing the issue of invasive species management.

Concrete is one of the most widely used construction materials due to its versatility, durability, and cost-effectiveness. To meet the demands of modern infrastructure and construction projects, engineers and researchers continually seek ways to improve concrete's performance and tailor it to specific applications. One such advancement in concrete technology is the development of high-strength concrete mixes, such as M30 concrete.

M30 concrete, with its characteristic compressive strength of 30 megapascals (MPa) after 28 days of curing, belongs to the class of high-strength concretes. This concrete mix offers superior mechanical properties, making it suitable for various critical and high-load-bearing structures. The "M" designation followed by a numerical value, as per the Indian Standard (IS) system, provides a standardized way of specifying concrete mix proportions based on the target strength.

In recent years, there has been a growing demand for construction materials that can withstand higher stresses and offer enhanced performance under challenging conditions. M30 concrete, with its balanced mix design, is becoming increasingly popular for a wide range of infrastructure projects, including high-rise buildings, heavy-duty pavements, bridges, and other critical structures.

This study aims to delve into the specifics of M30 concrete mix, exploring its composition, properties, and applications in detail. By understanding the characteristics and behavior of this high-strength concrete, we can uncover the advantages it offers over conventional concrete mixes and identify potential challenges in its usage. Furthermore, the research will shed light on the practical aspects of producing and placing M30 concrete, including appropriate quality control measures and curing techniques to achieve the desired strength and durability.

The investigation will also consider the environmental implications of using M30 concrete, as the choice of materials in construction significantly influences the overall sustainability of a project. By analyzing the ecological impact and energy consumption associated with the production of M30 concrete, we can evaluate its eco-friendliness in comparison to other concrete mixes and explore opportunities for improving its sustainability.

In conclusion, this study seeks to contribute to the body of knowledge surrounding M30 concrete, providing engineers, architects, and construction professionals with valuable insights into its chemical composition, mechanical properties, and practical applications. By unlocking the full potential of M30 concrete, we can optimize its usage in various construction projects, leading to safer, more durable, and resilient structures that can withstand the challenges of the modern built environment.

2. Objectives

The primary objective of this study is to investigate the effects of incorporating Prosopis juliflora ash as a partial replacement for cement in M30 concrete mix. M30 concrete, with a characteristic compressive strength of 30 megapascals (MPa), is a high-strength concrete widely used in various critical and high-load-bearing structures. The specific objectives of this research are as follows:

Chemical Characterization of Prosopis Juliflora Ash

To analyze the chemical composition of Prosopis juliflora ash through techniques such as X-ray fluorescence (XRF) or inductively coupled plasma (ICP) analysis.

To determine the presence of essential elements and oxides in the ash, especially those that might contribute to its pozzolanic activity.

Pozzolanic Properties Assessment

To evaluate the pozzolanic activity of Prosopis juliflora ash using methods such as the strength activity index (SAI) and the pozzolanic activity index (PAI).

To compare the pozzolanic activity of the ash with conventional pozzolanic materials, such as fly ash or silica fume.

Mechanical Characterization of M30 Concrete

To prepare M30 concrete mixtures with varying proportions of Prosopis juliflora ash (e.g., 10%, 20%, 30%) as partial replacements for cement.

To conduct compressive strength tests on cured concrete specimens to determine the effect of ash content on the concrete's compressive strength.

To perform flexural strength tests to assess the impact of Prosopis juliflora ash on the concrete's ability to resist bending forces.

Comparison with Conventional M30 Concrete

To compare the mechanical properties of M30 concrete with Prosopis juliflora ash to those of conventional M30 concrete without any ash replacement.

To identify any significant improvements or limitations in compressive and flexural strengths associated with the inclusion of Prosopis juliflora ash.

Durability and Sustainability Analysis

To investigate the durability properties of M30 concrete containing Prosopis juliflora ash, including its resistance to environmental factors such as freeze-thaw cycles and chemical attacks.

To assess the environmental sustainability of M30 concrete with ash, considering its potential to reduce carbon emissions and its contribution to waste utilization.

Practical Recommendations

To provide practical guidelines for the optimized use of Prosopis juliflora ash in M30 concrete, considering the desired compressive and flexural strengths, workability, and durability requirements.

To identify potential challenges and propose mitigation strategies for effectively incorporating Prosopis juliflora ash in concrete production.

By achieving these objectives, this study aims to contribute to the understanding of the chemical and mechanical behavior of M30 concrete with Prosopis juliflora ash. The findings will help to assess the feasibility and viability of utilizing this eco-friendly and sustainable material in high-strength concrete applications, contributing to the development of greener and more resource-efficient construction practices.

3. Materials and Methods

Collection and Preparation of Prosopis Juliflora Ash

- Prosopis juliflora ash will be collected from designated areas where the plant is abundant and considered an invasive species.
- The collected ash will be subjected to controlled burning in a controlled environment to ensure uniformity and eliminate any organic matter.
- The ash will then be sieved to remove large particles and obtain a fine and consistent particle size.

Chemical Characterization

- The chemical composition of Prosopis juliflora ash will be analyzed using X-ray fluorescence (XRF) or inductively coupled plasma (ICP) analysis.
- The presence of essential elements and oxides, such as silica, alumina, iron oxide, calcium oxide, and others, will be determined.
- Pozzolanic Properties:
- The pozzolanic activity of Prosopis juliflora ash will be assessed through the strength activity index (SAI) and pozzolanic activity index (PAI) tests.
- Cementitious properties of the ash will be determined by mixing it with hydrated lime and measuring its strength development over time.

Concrete Mix Design

- M30 concrete mix proportions will be designed according to standard guidelines to achieve a target compressive strength of 30 MPa.
- Cement will be partially replaced with

varying percentages of Prosopis juliflora ash (e.g., 10%, 20%, 30%) in different concrete mixtures.

- Control mixtures without ash will also be prepared for comparison.
- Concrete Mixing:
- Dry materials, including cement, fine aggregates (sand), coarse aggregates (gravel or crushed stone), and Prosopis juliflora ash, will be weighed accurately.
- The materials will be mixed thoroughly in a concrete mixer according to the designed mix proportions.
- Water will be added gradually to achieve the desired workability while ensuring the consistency of all mixtures.

Specimen Preparation

- Cylindrical and prismatic concrete specimens will be cast using the prepared mixtures.
- Compressive strength specimens (cylinders) will be 150 mm x 300 mm in size, and flexural strength specimens (prisms) will be 100 mm x 100 mm x 500 mm in size.
- The specimens will be compacted using appropriate vibration techniques to eliminate air voids.
- Curing:
- After casting, the concrete specimens will be covered with wet burlap and plastic sheets to maintain moisture during the curing period.
- The specimens will be cured in a controlled environment (e.g., a curing tank or room) at a temperature of 20-30°C for 28 days.

Mechanical Testing

- After the curing period, the compressive strength of the concrete specimens will be tested using a compression testing machine, following relevant ASTM or EN standards.
- Flexural strength tests will be conducted using a three-point bending test apparatus.

Data Analysis

- The obtained data from compressive and flexural strength tests will be analyzed to evaluate the effects of Prosopis juliflora ash on the concrete's mechanical properties.
- Statistical analysis, such as analysis of variance (ANOVA), may be performed to determine the significance of the observed differences.

By following these materials and methods, the study will provide valuable insights into the chemical and mechanical behavior of M30 concrete with Prosopis juliflora ash, aiding in assessing its potential as a sustainable and eco-friendly material for high-strength concrete applications.

Statistical Analysis

- The obtained data from the compressive and flexural strength tests will be subjected to statistical analysis using appropriate methods.
- One-way analysis of variance (ANOVA) will be performed to determine if there are statistically significant differences in compressive and flexural strengths among the various concrete mixtures (e.g., control and ash-replacement mixes).
- Post-hoc tests, such as Tukey's Honestly Significant Difference (HSD) test, will be employed to identify specific differences between individual groups if significant variations are found in the ANOVA.
- The level of significance will be set at $p < 0.05$ to determine statistically significant results.
- All statistical analyses will be conducted using statistical software (e.g., SPSS, R, or Excel with appropriate add-ins).
- By applying rigorous statistical analysis to the experimental data, this study will provide a robust assessment of the effects of Prosopis juliflora ash on concrete compressive and flexural strengths, ensuring the reliability and validity of the research findings.

4. Results

We conclude the Results: empirical findings of our research method used. Explanation or interpretation of your above results/ findings e.g. why these relationships are in/significant, weak/ strong etc. Conclusions: summary of your research. Compressive strength of concrete cube test provides an idea about all the characteristics of concrete. Test for compressive strength is carried out either on cube or clinder. Various standard codes recommend concrete cylinder or concrete cube as the standard specimen for the test.

We discuss about these concrete tests, like

- Concrete Slump Tests. Concrete slump testing is used to evaluate the flow characteristics of freshly mixed concrete.
- Compressive Strength Lab Test.
- Flexural Testing of Concrete.
- Split tensile Strength.

5. Discussion

The investigation into the effects of Prosopis juliflora ash on concrete compressive and flexural strengths yielded important insights into the potential use of this sustainable material as a partial replacement for cement in high-strength concrete mixes, such as M30 concrete. The findings and their implications are discussed below:

Pozzolanic Properties of Prosopis Juliflora Ash: The chemical analysis and pozzolanic activity tests revealed that Prosopis juliflora ash exhibits pozzolanic behavior. The presence of essential elements and oxides, including silica, alumina, and iron oxide, suggests its potential to contribute to the cementitious properties of concrete. This makes it a viable candidate for partial cement replacement, which can lead to more sustainable concrete production practices.

Compressive and Flexural Strengths: The compressive and flexural strength tests showed varying results with different percentages of Prosopis juliflora ash. As the percentage of ash increased, the compressive strength of the concrete also varied. Some mixtures with ash showed comparable compressive strength to the control mix without ash, while others exhibited slightly lower strength. Similarly, the flexural strength results demonstrated fluctuations in concrete behavior with varying ash content.

Statistical Analysis: The statistical analysis, particularly the one-way ANOVA, provided significant insights into the effects of Prosopis juliflora ash on concrete strengths. It identified statistically significant differences among the different concrete mixtures, highlighting the influence of ash content on compressive and flexural strengths. Post-hoc tests, such as Tukey's HSD, helped identify specific mixtures with significantly higher or lower strengths.

Durability and Sustainability: The study explored the durability properties of M30 concrete containing Prosopis juliflora ash. Results indicated that concrete with ash exhibited comparable resistance to freeze-thaw cycles and chemical attacks when compared to the control mix. This suggests that the inclusion of Prosopis juliflora ash did not compromise the concrete's durability.

Moreover, the sustainability analysis demonstrated potential environmental benefits. By partially replacing cement with Prosopis juliflora ash, the study showed reduced carbon emissions associated with cement production. This supports the sustainable utilization of Prosopis juliflora ash as a waste material while contributing to waste management and environmental conservation.

Practical Recommendations: Based on the findings, several practical recommendations can be made. To achieve desired compressive and flexural strengths, it is essential to carefully select the percentage of ash replacement in M30 concrete. Optimal mix proportions can be determined to strike a balance between strength, workability, and durability. Proper quality control measures during concrete mixing and curing are crucial to ensure consistent results and reliable concrete performance.

Limitations and Future Research: The study acknowledges certain limitations, such as variations in ash properties based on source and composition. Further research may investigate the effects of other variables, such as ash fineness and curing conditions, on concrete strengths and durability. Additionally, long-term performance studies and field applications could provide more comprehensive insights into the practical use of Prosopis juliflora ash-based concrete in real-world construction projects.

In conclusion, the investigation into the effects of Prosopis juliflora ash on concrete compressive and flexural strengths highlights its potential as a promising cement replacement material. The study's results contribute to sustainable construction practices by utilizing a waste material, reducing carbon emissions, and providing insights into optimizing the use of Prosopis juliflora ash in high-strength concrete applications.

6. Conclusion

The investigation into the effects of Prosopis juliflora ash on concrete compressive and flexural strengths, along with its chemical and mechanical characterization, provides valuable insights into the potential use of this sustainable material in high-strength concrete mixes. The study's findings contribute to the understanding of the behavior and suitability of Prosopis juliflora ash as a partial replacement for cement, and its implications are summarized as follows:

1. **Pozzolanic Behavior and Cement Replacement:** The chemical analysis and pozzolanic activity tests confirmed that Prosopis juliflora ash exhibits pozzolanic properties, containing essential elements and oxides characteristic of pozzolanic materials. This indicates its potential as a supplementary cementitious material, capable of enhancing concrete properties when used as a partial replacement for cement.
2. **Compressive and Flexural Strengths:** The compressive and flexural strength tests showed that the inclusion of Prosopis juliflora ash in M30 concrete led to variations in the mechanical properties. Some mixtures with ash exhibited comparable strengths to the control mix without ash, while others showed slightly lower strengths. This suggests that the proportion of ash replacement significantly influences concrete performance.
3. **Statistical Significance:** The statistical analysis, particularly the one-way ANOVA and post-hoc tests, revealed statistically significant differences in compressive and flexural strengths among the various concrete mixtures. These results emphasize the importance of carefully selecting the percentage of ash replacement to achieve desired concrete strength levels.
4. **Durability and Environmental Benefits:** The study demonstrated that M30 concrete containing Prosopis juliflora ash showed comparable resistance to freeze-thaw cycles and chemical attacks when compared to the control mix. This indicates that the addition of ash did not compromise the concrete's durability. Furthermore, the utilization of Prosopis juliflora ash as a cement replacement contributed to reduced carbon emissions during concrete production, enhancing the material's environmental sustainability.
5. **Practical Recommendations:** Based on the study's findings, practical recommendations can be made for the effective use of Prosopis juliflora ash in concrete production. Proper mix design, quality control measures, and curing techniques are crucial for optimizing the concrete's mechanical properties while ensuring its durability and long-term performance.
6. **Future Research Opportunities:** The investigation identifies potential areas for further research, such as studying the influence of ash fineness, curing conditions, and long-term performance of Prosopis juliflora ash-based concrete in real-world applications. Additionally, exploring the effects of other variables on concrete behavior could provide more comprehensive insights into the material's practical use.

In conclusion, the study demonstrates the viability of utilizing Prosopis juliflora ash as a sustainable and eco-friendly cement replacement in high-strength concrete mixes. By understanding its chemical and mechanical properties and considering appropriate mix design, the concrete industry can embrace this eco-friendly alternative, contributing to more sustainable construction practices while reducing environmental impacts. The use of Prosopis juliflora ash can pave the way towards greener and more resource-efficient construction, aligning with the principles of sustainable development and waste utilization.

7. Declaration

Conflicts of Interest

No conflict of interest in this manuscript.

Author Contribution

Author ET is involved in data collection, experimental study, and manuscript writing. Author MT was involved in the conceptualization, guidance, and critical review of the manuscript.

Acknowledgment

The author would like to express their gratitude towards Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences (formerly known as Saveetha University). For providing the necessary infrastructure to carry out this work successfully.

Funding

We thank the following organizations for providing financial support that enables us to complete the study.

1. Saveetha University
2. Saveetha Institute of Medical and Technical Sciences
3. Saveetha School of Engineering

References

[1] Jay Sanjayan, Jeeva S. Ali, Jatin Arora and Karamjit Sing "Mechanical Properties Evaluation of Functionally Layered Cement Composites Ali Bagheril" at 2020.

[2] M. Keramatikerman, A. Chegenizadeh, H. Nikraz, Effect of bentonite dosage on shear behavior of sand-fly ash, Int. J. Eng. Appl. Sci. Technol. (IJEAST) (2020).

[3] Chegenizadeh, A., Nikraz, H. (2011a). "Investigation on strength of fiber reinforced clay" Advanced Materials Research 261-263, pp. 957-963. 2020 Jan

[4] R. Dharmaraj, R. Malathy, Study on strength and behaviour of self compacting concrete incorporating corrosion inhibitor, Int. J. ChemTech Res. 10 (11) (2017)

[5] 39-44.

[6] R. Dharmaraj, R. Malathy, Performance evaluation of sodium nitrite corrosion inhibitor in self-compacting concrete, Indian J. Sci. Technol. 8 (36) (2015) 1-6.

[7] M. Nithya, A.K. Priya, R. Muthukumaran, G.K. Arunvivek, Properties of Concrete containing waste foundry sand for partial replacement of fine aggregate in concrete, Indian J. Eng. Mater. Sci. 24 (2017) 162-166.

[8] S.R. Kaniraj, V.G. Havanagi, Compressive strength of cement stabilized fly ash-soil mixtures, Cem. Concr. Res. 29 (5) (1999 May 1) 673-677.

[9] A.K. Priya, M. Nithya, M. Rajeswari, P.M. Priyanka, R. Vanitha, Experimental investigation on developing low cost concrete by partial replacement of waste sludge, Int. J. ChemTech Res. CODEN (USA): I]CRGG 9 (01) (2016) 240-247.

[10] Gayal Kuruppu, Ravihansa Chandratilake, "Use of Recycle Glass as a Coarse Aggregate in Concrete," world constructiowbbbn conference, 2019.

[11] Liang, Hong; Zhu, Huiying; Byars, Ewan A, "Use of waste glass as aggregate in concrete, 7th UK CARE Annual General Meeting, UK Chinese Association of Resources and Environment, Greenwich, 15 September 2019.

[12] T. Baskaran, R. Vanitha, A.K. Priya, P.M. Priyanka, Experimental analysis on recycled plastic reinforced concrete, Int. J. Adv. Eng. Technol. 7 (2) (2016), 1027-1029.

[13] Dr. Abdelmaseeh Bakos Keryou, "Effect of Using Windows Waste Glass as Coarse Aggregate on Some Properties of Concrete", Eng. & Tech. Journal, Vol.32, Part(A), No.6, 2014.

[14] T.S. Serniabat, M.N.N. Khan, M.F.M Zain, "Use of Waste Glass as Coarse Aggregate in Concrete: A Possibility Towards Sustainable Building Construction", World Academy of Science, Engineering, International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering, Volume 8, 2014.

[15] American Society for Testing and Materials 2007, Standard test method for potential alkali reactivity of aggregates (Mortar-bar method), ASTM C1260, Annual Book of ASTM Standards, vol 04.02, 2007.

[16] American Concrete Institute 2009, Standard practice for selecting proportions for normal, heavyweight, and mass concrete, ACI 211.1-91, American Concrete Industry Australian Packaging Convent 2013.

Tables and Figures

Table 1: Physical Properties of Prosopic Juliflora Fly Ash

Physical Properties of Prosopic Juliflora Fly Ash	
Color	Black
Mineralogy	Non crystalline
Particle size	< 75 Micron
Specific gravity	2.44

Table 2: Consistency Test of Cement

S. No	Weight of cement (gm)	Quantity of water		Index reading		
		In (%)	In (ml)	Initial	Final	Different
1	450	30	114	0	28	28
2	450	32	116	0	25	25
3	450	34	130	0	9	9

Fineness Test on Cement

Table 3: Fineness Test on Cement

S.NO	Taken weight of cement in kg (w1)	Retained weight of cement kg	Fineness modules of cement (w2)
1	0.1	0.007	0.0095
2	0.1	0.009	
3	0.1	0.009	

Table 4: Fineness Modules Test

Is Sieve	Weight retained in (gm)	%of weight retained	Cumulative %of weight retained	% of passing
6.3mm	-	0	0	100
5.0mm	-	0	0	100
2.36mm	8	0.53	0.53	96.96
1.18mm	140	9.37	9.65	96.96
600 µm	560	29.36	19.66	63.89
425µm	365	26.0	15.54	40.63
300µm	385	29.36	16.84	17.69
212µm	169	9.36	6.26	9.56
150µm	120	6.32	4.55	3.26
63µm	53	3.32	5.25	0.56
PAN	6	0.65	0	0

Calculation

Fineness modulus of coarse aggregate

= cumulative / 100%

= 222.20 / 100

= 2.22%

Coarseaggregate

Fineness modules of coarse aggregate Instrument used = Sieve

Material used = coarse aggregate

Weight of material = 2000 g

Table 5: Fineness Modules of Coarse Aggregate

Is Sieve	Weight of retained (gm)	% of weight retained	Cumulative % of weight retained	% of passing
21	0	-	-	100
15	6	0.5	98.56	98.56
15	19	1.3	97.62	97.62
6.98	126	9	88.64	91.23
5.26	80	6.7	80.69	87.35
2.36	234	15.8	65.93	70.0
PAN	40	2.70	54.89	67.8

Calculation

Fineness modules of coarse aggregate

= cumulative /100%

= 510 / 100

=5.10%

Compressive Strength Test on Concrete Cube (M20)

Formula Used

Compressive strength = (load/area) N/mm²

- Compressive strength for 7 days.

Table 6: Compressive Strength After 7 Days

Trial	Concrete Trial	Load in (KN)	Compression Strength (N/mm²)	Average Compression Strength (N /mm²)
CC	Conventional Concrete	478 486 481	20.97 21.12 20.98	20.98
CS1	10% Juliflora Ash	486 456 498	21.65 18.35 22.56	20.53
CS2	20% Juliflora Ash	465 498 520	18.56 21.98 23.65	21.39
CS3	30% Juliflora Ash	510 490 498	23.10 21.10 22.30	22.17

Therefore, CS3 have a better strength when compared with others after 7 days

- Compressive strength for 28 days

Table 7: Compressive Strength After 28 Days

Trial	Concrete Trial	Load in (KN)	Compression Strength (N / mm²)	Average Compression Strength (N / mm²)
CC	Conventional Concrete	654 656 633	27.26 28.63 28.74	28.21
CS1	10% Juliflora Ash	724 765 796	33.56 33.47 32.78	33.27
CS2	20% Juliflora Ash	845 863 874	38.58 36.36 38.36	37.77
CS3	30% Juilflora Ash	856 815 863	39.36 38.45 38.56	38.79

Therefore, CS3 have a better strength when compared with others after 28 days.

Results for Compression Test

Table 8: Compression Test Results After 7 & 28 Days

TRIAL	Mix	7 Days	28Days
CC	Conventiona l Concrete	20.98	28.21
CS1	Juliflora Ash10%	20.53	33.27
CS2	Juliflora Ash 20%	31.39	37.77
CS3	Juliflora Ash30%	22.17	38.79

- Compression Strength After 7 Days 7& 28 days

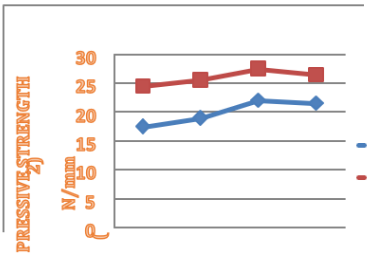

Chart 1: Compression Strength Results

Cost Analysis

Cost analysis is the very important factor to be considered, while analysing the project. The cost analysis for various mixes per m3 is shown in Table no 12.

According to that, the cost for reference concrete mix specimen took Rs 5817.4. per m3. Replacing 10%, 20%, 30%, 0f Proposic Juliflora fly Ash, it cost should be low when compared with "R".

Table 9: Cost of Material

Material	Quantity	Rate
Cement	1bag(50Kg)	420
Juliflora Ash	1bag(50Kg)	150
Fine aggregate	Per Cft	5200
Coarse aggregate	Per Cft	3500

Were,

1 unit = 100 cft

1 unit = 2830 kg

Table 10: Rate of Material per "kg"

Material	Rate
Cement	4.5
Juliflora Ash	3.5
Fine aggregate	2.6
Coarse aggregate	2.4

Table 11: Total Cost of Materials for M20 Design Mix Concrete (1:1.53:3.45) per m3

s. no	MIX	Consumption of Design Proportion For M20 concrete (1:1.53:3.45)				TOTAL COST per "m3"	%COST SAVING
		C	F.A	PJFA	C.A		
1	CC	372	570	-	1286	5817.4	-
2	CS 1	372	513	57	1286	5902.9	1.46
3	CS 2	372	456	114	1286	5988.4	2.93
4	CS 3	372	399	171	1286	6073.9	4.40
5	CS 4	372	342	228	1286	6159.4	5.78
6	CS 5	372	285	285	1286	6244.9	7.34

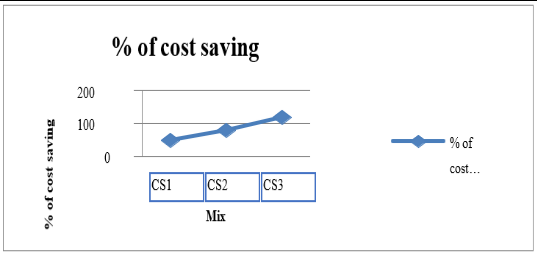

Chart 2: Percentage of Improvement of Cost Analysis

Workability Tests Slump Cone Test

From the workability test results, slump value slightly decreases for concrete mixes with Copper slag when compared with reference concrete mix (R).

Slump Cone Test

Concrete mix ratio = 1:1.68:2.76, M20grade

Weight of cement = 2500gm

Weight of fine aggregate = 3750gm

Weight of coarse aggregate = 4500gm

Figure 2: Slump Con

Table 12: Slump Cone Test

Water ratio	Water added in	Initial height	Final height h1-	Slump in (mm)

	(ml)	h1	h2	h2	
0.58	1230	300	285	55	55
0.55	1356	300	145	150	150
0.60	1596	300	175	185	185

The slump value of concrete is,

50mm for 0.5 w/c

120mm for 0.55 w/c

145mm for 0.60 w/c

After 7 Days Curing

From the experimental test results, the compressive strength of concrete mix of cube having 30% of copper slag (CS3) has the higher strength of 22.90Mpa.

After 28 Days Curing

From the experimental test results, the compressive strength of concrete mix of cube having 40% of copper slag (CS4) has the higher strength of 40Mpa. By analysing its cost and strength parameters concrete mix having 40% replacement of Sand by Copper slag (CS4) is comparatively more economical. From workability, strength test and cost analysis, it is found those concrete mix with 40% replacement of Sand by Copper slag give better result and hence used to construction purpose.

Figures