International Journal of Engineering Inventions
e-ISSN: 2278-7461, p-ISSN: 2319-6491
Volume 13, Issue 6 [June. 2024] PP: 160-164

"Engineering Properties of Sustainable Concrete Incorporating Steel Mill Scale and the Impact of Admixtures on Workability Enhancement"

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Abstract-
This study explores the combined effects of superplasticizers and mill scale on M30 grade concrete's workability and compressive strength. Three superplasticizers—Auramix 200, SikaPlast®-3069 NS, and Master Polyheed 8126—are tested. Mill scale, replacing sand in proportions of 0%, 20%, 40%, 60%, 80%, and 100%, is evaluated as a sustainable aggregate. Experiments include assessing M30 concrete without admixtures, adding mill scale, and combining mill scale with superplasticizers. Workability is measured using slump cone tests, and compressive strength is tested at 7, 14, and 28 days. Results show superplasticizers significantly improve workability, especially Auramix 200. Mill scale enhances compressive strength up to 60% replacement, peaking at this level for both plain and superplasticizer mixes. Higher replacement levels reduce strength and workability. Auramix 200 performs best overall with mill scale. In conclusion, combining superplasticizers and mill scale can create high-performance, sustainable concrete. Future research should focus on long-term durability and optimizing mix designs for wider construction use.
Key words: *Mill Scale, Aggregate, Concrete admixture*

Date of Submission: 11-06-2024 Date of acceptance: 23-06-2024

I. INTRODUCTION

Concrete is one of the most widely used construction materials globally due to its versatility, durability, and relatively low cost. Efforts to enhance its properties and sustainability have driven extensive research into various admixtures and supplementary materials. Superplasticizers have emerged as crucial additives, significantly improving concrete's workability and strength. Additionally, industrial by-products like mill scale, a waste product from steel manufacturing, offer a promising avenue for partially replacing sand in concrete, thus aiding waste management and resource conservation. The study specifically focuses on three superplasticizers: Auramix 200, SikaPlast®-3069 NS, and Master Polyheed 8126. These admixtures are known for their ability to significantly reduce water content while maintaining or improving concrete workability. The inclusion of mill scale not only addresses industrial waste issues but also explores its potential benefits in enhancing the mechanical properties of concrete

II. OBJECTIVE

This study examines the performance of M30 grade concrete with and without superplasticizers, using mill scale as a partial sand replacement. The study is divided into three phases:

1. Phase I: Evaluate workability and compressive strength of M30 concrete with and without superplasticizers.
2. Phase II: Assess the effects of replacing sand with mill scale (0%, 20%, 40%, 60%, 80%, 100%) on workability and compressive strength, with and without admixtures.
3. Phase III: Analyze the relationship between workability and compressive strength across different mixes to find the optimal balance.

The research focuses on three superplasticizers—Auramix 200, SikaPlast®-3069 NS, and Master Polyheed 8126—known for reducing water content while improving workability. Using mill scale addresses industrial waste issues and explores its potential to enhance concrete properties.

III. METHODOLOGY

This project involves three phases to evaluate the impact of admixtures and the partial replacement of sand with mill scale on the workability and compressive strength of M30 grade concrete. Below is a structured approach for each phase:

Phase I: Baseline Workability and Compressive Strength Assessment

- 1.Objective: Establish the baseline workability and compressive strength of M30 grade concrete with and without admixtures.
- 2. Tasks:
  - ▪ Prepare Concrete Mix: Design M30 grade concrete mix.
  - ▪ Mix Variants: Prepare two sets of concrete mixes:
    - Without admixture
    - With admixture (choose one from Auramix 200, SikaPlast®-3069 NS, or MasterPolyheed 8126)
    - Workability Test: Perform slump cone test to determine workability.
    - Cube Casting: Cast cubes for compressive strength testing (standard size 150mm x 150mm x 150mm).
  - ▪ Curing: Cure the cubes for 7, 14, and 28 days.
  - ▪ Compressive Strength Test: Perform compressive strength tests after curing periods.
- Data Collection:
  - ▪ Record slump values for workability.
  - ▪ Measure compressive strength for each curing period.

Phase II: Mill Scale Replacement and Workability Assessment

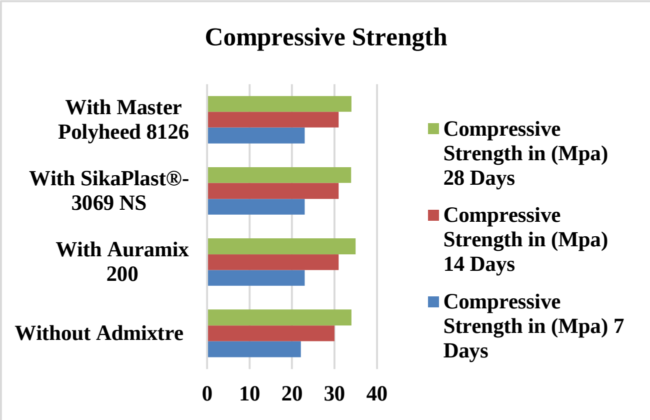
- Objective: Assess the workability and compressive strength of M30 concrete with varying proportions of mill scale replacing sand, and determine the effect of admixtures on these properties.
- Tasks
- Prepare Mixes: Create concrete mixes with sand replaced by mill scale at 0%, 20%, 40%, 60%, 80%, and 100% by weight.
- Add Admixture- Include the selected admixture from Phase I to maintain workability.
- Workability Test: Perform slump cone test for each mix.
- Cube Casting: Cast cubes for compressive strength testing.
- Curing: Cure the cubes for 7, 14, and 28 days.
- Compressive Strength Test: Conduct compressive strength tests after curing periods.
- Data Collection:
- Record slump values for each replacement level.
- Measure compressive strength for each curing period and replacement level.

Phase III: Data Analysis and Relationship Determination

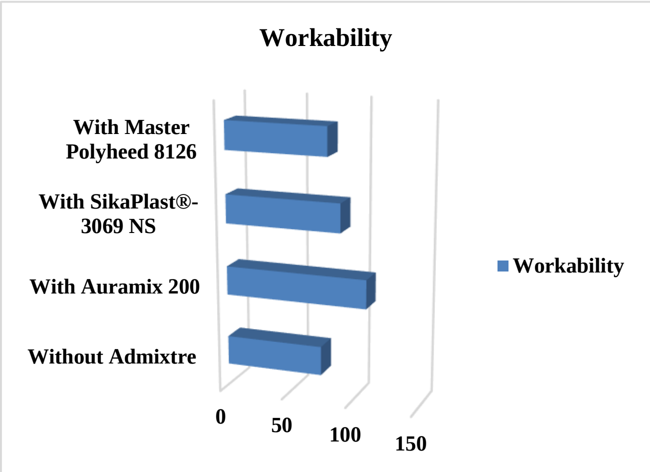
- Objective: Analyze the collected data to determine the relationship between workability and compressive strength for M30 grade concrete with varying sand replacement levels and the effect of admixtures.
- Tasks
- Data Analysis: Compare slump values and compressive strengths across different mixes.
- Graphical Representation: Plot graphs to show:
- Workability (slump) vs. Mill Scale Replacement Level
- Compressive Strength vs. Mill Scale Replacement Level
- Workability (slump) vs. Compressive Strength
- Trend Analysis: Identify trends and correlations between workability and compressive strength.

By systematically conducting these phases and analyzing the data, the project will provide valuable insights into the use of mill scale and superplasticizers in concrete, leading to more efficient and sustainable construction practices.

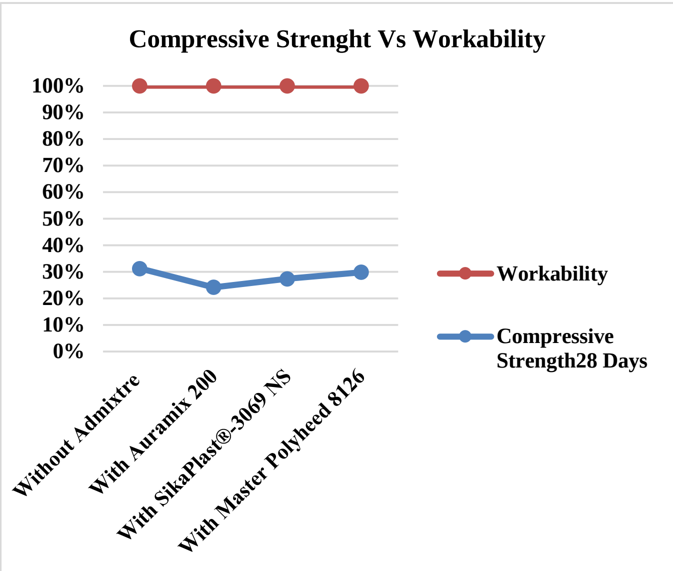
IV. RESULT



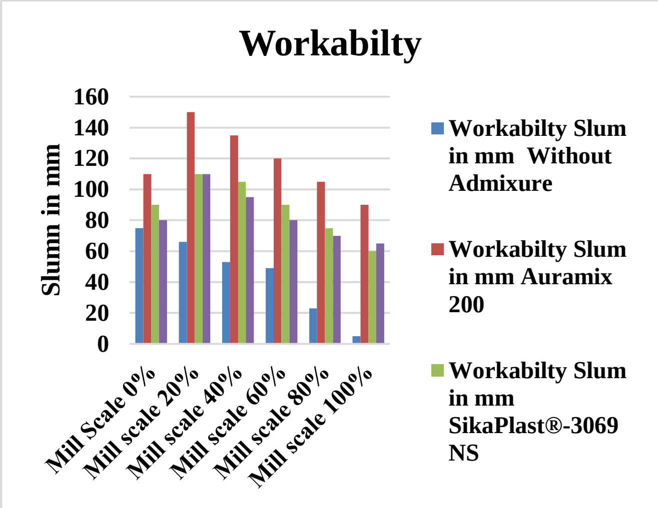
Graph No. 1 Compressive Strength of M30 Mix Grade Concrete



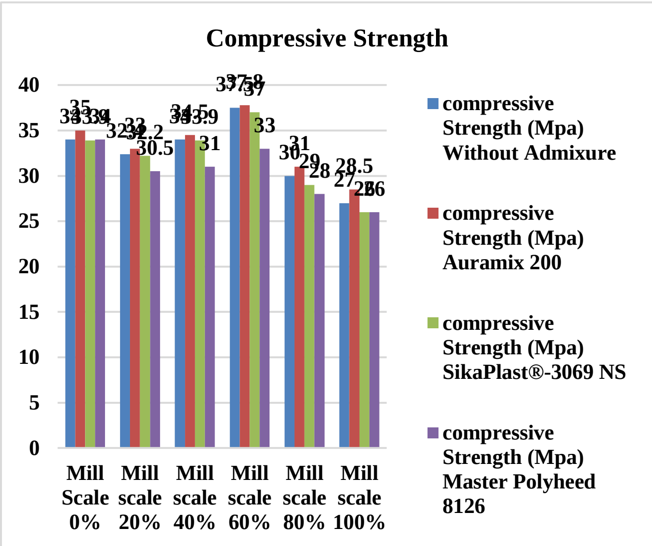
Graph No.2 Workability Results of M30 Concrete with and without Admixtures



Graph No.2 Workability & Compressive Strength Results of M30 Concrete with and without Admixtures



Graph No.3 Effect of Mill Scale replacement on Workability with all admixture



Graph No.4 Effect of Mill Scale on Compressive Strength with and without admixture

V. CONCLUSION

The study reveals that replacing up to 60% of sand with mill scale can enhance the compressive strength of M30 grade concrete, especially when combined with effective superplasticizers like Auramix 200. Auramix 200 is identified as the most effective superplasticizer for both improving compressive strength and workability, making it suitable for high-performance concrete applications. SikaPlast®-3069 NS also shows considerable benefits, particularly in balancing workability and strength. Master Polyheed 8126, while less effective in strength enhancement, still provides a viable option for maintaining a stable mix with slight improvements in workability.

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