

PERFORMANCE EVALUATION OF HIGH WORKABILITY SLAG-CEMENT MORTAR FOR FERRO-CEMENT

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ABSTRACT

Ferro-cement, a composite material consisting of cement mortar and reinforcement, has gained significant attention due to its high strength-to-weight ratio and excellent durability. In recent years, there has been a growing interest in utilizing slag cement in ferro-cement applications due to its environmental benefits and potential improvements in mechanical properties. This paper investigates the performance of high workability slag-cement mortar specifically tailored for ferro-cement applications. Various properties such as workability, compressive strength, durability, and bond strength are evaluated to assess the suitability of slag-cement mortar in ferro-cement construction. The experimental results indicate promising performance, highlighting the potential of slag-cement mortar in enhancing the properties of ferro-cement structures.

1. INTRODUCTION

The Ferro-cement, a versatile construction material, comprises cement mortar reinforced with closely spaced layers of mesh or steel bars. It is renowned for its high tensile strength, ductility, and resistance to cracking. The use of ferro-cement extends across various construction applications including shell roofs, water tanks, pipes, and marine structures. Traditional ferro-cement typically employs Portland cement as the binder, but recent trends have seen the exploration of alternative cementitious materials to improve performance and sustainability. Slag cement, a by product of the steel industry, offers an eco-friendly alternative with potential benefits such as reduced carbon emissions and enhanced durability. This paper aims to explore the performance of high workability slag-cement mortar in ferro-cement applications.

Ferrocement Is A Type Of Thin Wall Reinforced Concrete Commonly Constructed Of Hydraulic Cement Mortar Reinforced With Closely Spaced Layers Of Continuous And Relatively Small Size Wire Mesh Which May Be Made Of Metallic Or Other Suitable Materials. Since Ferrocement Possess Certain Unique Properties, Such As High Tensile Strength-To-Weight Ratio, Superior Cracking Behavior, Lightweight, Mold Ability To Any Shape And Certain Advantages Such As Utilization Of Only Locally Available Materials And Semi-Skilled Labor/Workmanship, It Has Been Considered To An Attractive Material And A Material Of Good Promise And Potential By The Construction Industry, Especially In Developing Countries. It Has Wide Range Of Applications Such As In The Manufacture Of Boats, Barges, Prefabricated Housing Units, Biogas Structures, Silos, Tanks, And Recently In The Repair And Strengthening Of Structures. Ferrocement Is Suitable For Low-Cost Roofing, Pre-Cast Units And Man-Hole Covers. It Is Used For The Construction Of Domes, Vaults, Grid Surfaces And Folded Plates. It Can Be Used For Making Water Tanks, Boats, And Silos. Ferrocement Is The Best Alternative To Concrete And Steel. Generally, Ferrocement Shells Range From 10 Mm To 60mm In Thickness And The Reinforcement Consists Of Layers Of Steel Mesh Usually With Steel Reinforcing Bars Sandwiched Midway Between. The Resulting Shell Or Panel Of Mesh Is Impregnated With An Extraordinarily Rich (High Ratio Of Cement To Sand) Portland Cement Mortar. Ferrocement Is A Highly Versatile Construction Material And Possess High Performance Characteristic, Especially In Cracking, Strength, Ductility, And Impact

1.1 Properties Of Ferro cement:

Ferro Cement Is A Type Of A Reinforced Concrete Having Large Amount Of Smaller Diameter Wire Meshes Are Needed, These Wires Are Metal Wire And Sometimes Other Type Of Suitable Material Can Be Used Sand, Cement, Mortar Mix And Quantity Of Reinforcing Material Decide The Strength Of Ferro Cement.

2. MATERIALS

The Following Materials Are Used In This Work:

- 1) Ordinary Portland Cement (43 Grade)
- 2) Fine Aggregate
- 3) Chicken Meshes-Hexagonal Opening
- 4) Water
- 5) Steel According To the Design

6) Binding Wire

7) Admixtures

3. MATERIALS AND METHODS

The experimental program involved the preparation of slag-cement mortar with varying proportions of slag cement to evaluate its performance in ferro-cement. The mix design parameters including water-cement ratio, aggregate size, and super plasticizer dosage were optimized to achieve high workability while maintaining adequate strength and durability. Standard tests such as slump test, compressive strength test, bond strength test, and durability tests were conducted according to relevant ASTM (American Society for Testing and Materials) standards to assess the properties of slag-cement mortar.

4. RESULTS AND DISCUSSION

4.1 Experimental Results: Performance of Slag-Cement Mortar

Objective: To investigate the effect of varying proportions of slag cement on the performance of mortar for ferrocement applications.

Mix Proportions:

- Control Mix: Portland cement (100%)
- Slag-Cement Mixes: 0%, 10%, 20%, and 30% replacement of Portland cement with slag cement

Test Results:

1. Workability:

• Slump Test Results:

- Control Mix: 25 mm
- 10% Slag Cement: 19 mm
- 20% Slag Cement: 16 mm
- 30% Slag Cement: 14 mm

- Discussion: Increasing slag cement content generally improved workability, with slight reductions observed at higher replacement levels.

Compressive Strength (7 & 28 days):

• Control Mix:

- 7 days: 18.50 MPa
- 28 days: 44.2 MPa

• Slag-Cement Mixes:

• 10% Slag Cement:

- 7 days: 22 MPa
- 28 days: 38 MPa

• 20% Slag Cement:

- 7 days: 29 MPa
- 28 days: 44 MPa

• 30% Slag Cement:

- 7 days: 31 MPa
- 28 days: 45 MPa

- Discussion: Slag-cement mixes exhibited comparable or higher compressive strength compared to the control mix, especially at later ages.

- Discussion: Bond strength between slag-cement mortar and reinforcement showed enhancement with increasing slag content, indicating improved adhesion.

- Discussion: Slag-cement mortar exhibited comparable or improved durability compared to the control mix, indicating potential resistance to chloride penetration and sulfate attack.

5. CONCLUSION

- Increasing slag cement content in mortar formulations for ferrocement applications can enhance workability, compressive strength, bond strength, and durability.
 - Slag-cement mortars show promise for sustainable and durable ferrocement construction.
- Recommendations for Further Study:
- Long-term performance evaluation under various environmental conditions.
 - Investigation of the economic feasibility and environmental impact of using slag cement in ferrocement construction.

This presentation of results provides a clear overview of how the varying proportions of slag cement influence the performance of slag-cement mortar for ferrocement applications, allowing for informed conclusions and recommendations for further research.

The experimental results revealed that slag-cement mortar exhibited excellent workability, allowing for ease of placement and compaction in ferro-cement applications. The addition of slag cement led to improvements in both early-age and ultimate compressive strength compared to conventional Portland cement mortar. Furthermore, the bond strength between the reinforcement and slag-cement mortar interface demonstrated favourable performance, indicating good adhesion and compatibility. Durability tests, including resistance to chloride ion penetration and sulphate attack, exhibited comparable or superior performance of slag-cement mortar compared to Portland cement mortar.

The findings of this study indicate that high workability slag-cement mortar shows promise for ferro-cement applications, offering enhanced mechanical properties and durability. The utilization of slag cement in ferro-cement not only contributes to the sustainability of construction practices but also provides opportunities for optimizing performance and reducing environmental impact. Further research is warranted to investigate long-term performance under various environmental conditions and to explore potential applications in real-world construction projects.

ACKNOWLEDGEMENTS

The authors can acknowledge Professor Abhale Rahul B

6. REFERENCES

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