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Studies On Behavior Of Fiber Reinforced Concrete By Incorporating Alccofine

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ABSTRACT

The paper examines challenges in steel fiber reinforced concrete design and proposes solutions using alccofine in mix design. Alccofine replaced cement at ratios of 7%, 14%, 21%, and 28% for 7 and 28-day curing, resulting in enhanced durability for global applications. Introducing alccofine significantly boosted compressive and flexural strength of fiber reinforced concrete. Steel fibers offer high tensile strength and fire resistance, reducing fire damage, while also controlling plastic and drying shrinkage, elevating toughness, energy absorption, ductility, crack resistance, and durability. This review summarizes these findings and derives conclusions for practical use.

Keywords: Alccofine, Cement, Steel Fiber Reinforced Concrete, Flexural Strength

I. INTRODUCTION

Portland Cement stands as the cornerstone of construction, forming the basis for Portland Cement Concrete—a versatile and robust building material esteemed for its strength. However, the environmental impact of its production is undeniable; each ton of cement generates roughly one ton of carbon dioxide emissions. To address this concern, research has shifted towards supplementary cementitious materials (SCMs) such as Fly Ash, Slag, Rice Husk Ash, and Metakaolin. These substances demonstrate pozzolanic characteristics, reacting with the calcium hydroxide in water to create extra cementitious compounds. By integrating SCMs into concrete mixes, Portland Cement use can be curtailed, maintaining concrete quality. SCMs not only bolster concrete's environmental sustainability but can also heighten its strength and durability. ALCCOFINE 1203, an engineered product hailing from slag with a glass-rich composition, showcases exceptional reactivity due to controlled granulation and a high proportion of low calcium silicates. Its ultra-fine nature, denoted by a Blaine value around 12000 cm^2/gm, trims water demands while preserving workability, even when replacing up to 70% of cement. With dual roles as a high-range water reducer for compressive strength and a workability enhancer for flow, ALCCOFINE proves adaptable, representing a leap towards greener, higher-performing concrete. As the construction domain gravitates toward eco-friendliness, the ascendancy of such innovative materials appears inevitable.

SIGNIFICANCE OF STUDY

Alccofine, a recently introduced micro-fine mineral additive, holds promise for improving the qualities of concrete in both its early and mature states, making its use in construction a fresh development. Despite its potential benefits, there is a lack of extensive research examining the impacts of Alccofine. As a result, this investigation was carried out to deeply explore how the addition of Alccofine affects the performance of concrete beams reinforced with fibers. The main goal was to acquire a better understanding of the behavior and attributes of these concrete beams, offering insights into the function and impact of Alccofine when applied in this specific context.

ALCCOFINE

Alccofine 1203 is characterized as an ultrafine pozzolanic material derived from slag, boasting particle dimensions of less than 10µm. Its composition includes low levels of calcium silicate and a notable glass content. The material exhibits a remarkable fineness, measured at 12000 cm2/gm, and possesses a bulk density ranging from 600 to 700 Kg/m3. The distribution of particle sizes in Alccofine is a notable aspect of its properties.

II. LITERATURE REVIEW

Luo Ting et al. By conducting experiments utilizing Alccofine, Luo Ting et al. explored a range of mass percentages, specifically from 10% to 50%. Their observations unveiled that is the dosage was elevated, the concrete exhibited earlier setting times and reduced fluidity. Notably, they also identified a direct relationship between higher Alccofine percentages and an increase in shear stress.

Magdum et al. In their research, flexural strength tests were conducted by Luo Ting et al. They employed diverse combinations of materials, including varying percentages of Alccofine (5%, 7.5%, 10%), steel fibers, and polypropylene fibers. Their analysis led them to the conclusion that the optimal configuration for achieving maximum flexural strength involved 7.5% Alccofine, 80% steel fibers, 20% polypropylene fibers by wt of cement.

Sumathi et al. Upon completion of their study, it was deduced that the incorporation of 10% Alccofine along with steel fibers into M60 concrete led to enhancements in flexural strength.

Sinha et al. In their observations, it was noted the M60 steel fiber-reinforced concrete, when combined with 10% fly ash, 9.75% Alccofine, exhibited elevated compressive strengths. Specifically, these strengths saw increases of approximately 10.10% and 21.93% for compressive strength, 12.8% ,20.09% for tensile strength, respectively. This trend was observed for both 7 and 28 days, followed by a subsequent decrease.

Gayathri et al. Based on their findings, the researchers concluded that when dealing with M20 concrete, the utilization of Alccofine up to 15% yielded superior compressive strength in comparison to alternative mixtures. Nonetheless, it was observed that as the dosage was further increased, there was a gradual decline in strength. This decrease was attributed to Alccofine serving as a filler material within the concrete matrix.

Chakravarthy et al. The researchers discovered that the highest compressive strength for M25 concrete was attained using 16% Alccofine, which held true for both the 7-day and 28-day testing periods.

P.R. Kalyana Chakravarthy, R. Rathan Raj (2017) Their study had a specific emphasis on flexural strength, involving the partially replacement of cement with Alccofine. In their study, they performed experiments involving various levels of replacement (ranging from 0% to 100% in increments of 4%, 8%, 16%, 17%, 20%, 25%, 50%, 75%, and 100%) for durations of 7 and 28 days. The concrete used in the experiments was a design mix of M25. Noteworthy results were obtained from these tests, with the most significant improvement in flexural strength occurring at the 16% replacement level. At this specific replacement proportion, a remarkable enhancement of 50.95% was observed after 7 days, and an even more substantial increase of 60.95% was recorded after 28 days, in comparison to the conventional concrete.

S. Kavitha and T. Felix Kala (2016) In their study, the researchers explored the utilize of Alccofine as a strength-enhancing component in Self-Compacting Concrete (SCC). Through their investigations, they revealed that higher dosages of Alccofine correlated with improved strength properties.

D. Sharma, S. Sharma, and Ajay G. (2016) The researchers delved into enhancing concrete strength through the utilization of foundry slag as a replacement for traditional fine aggregate, coupled with Alccofine replacing cement. Their findings culminated in the conclusion that the incorporation of foundry slag ranging from 10% to 45% as a substitute for fine aggregate, along with 15% Alccofine in lieu of cement, has the potential to yield concrete with reasonably high strength.

M.V. Sekhar Reddy, K. A. Latha, and K. Surendra (2016) Through their experimental endeavors, the researchers undertook the task of partially replacing cement in M40 Grade of concrete using for fly ash and Alccofine. Their results unveiled that Alccofine showcased an accelerated rate of early strength development and showcased greater efficacy in bolstering the concrete's long-term strength attributes when contrasted with the effects of fly ash.

K. Gayathri, K. R. Chandran, and J. Saravanan (2016) In their study, the researchers examined Alccofine's performance as a cement substitute in concrete across different proportions (5%, 10%, 15%, 20%). Their analysis led them to the conclusion that the most favorable strength outcomes were achieved with a 15% replacement, surpassing the effects observed at other replacement levels. The researchers also emphasized Alccofine's notable effectiveness in augmenting early-age cementitious properties.

Sinha et al. Their findings highlighted that the incorporation of 10% fly ash and 9.75% Alccofine into M60 steel fiber-reinforced concrete led to notable improvements in both compressive and tensile strengths. More precisely, the compressive strength exhibited enhancements of around 10.10% and 21.93%, while the tensile strength experienced increases of 12.8% and 20.09%. However, a diminishing pattern was subsequently observed for both 7 and 28-day durations in comparison to the standard mix.

III. CONSTITUENTS OF MATERIALS

The materials planned for use include Cement, Sand, Coarse aggregate, pumice, Alccofine, and Water. Here's the rearranged information about the individual components:

A-CEMENT: The selected cement type is OPC, Ordinary Portland Cement 53 grade, which adheres to the specifications of I.S. – 12269-1987.

B-FINE AGGREGATES: Sand will be employed as the fine aggregate, meeting the requirements outlined in IS: 383.

C-COARSE AGGREGATE: Coarse aggregates with a nominal size of 20mm down have been chosen. The relevant physical properties will be determined through tests conducted according to IS 383-1970.

D-STEEL FIBER: Incorporating steel fibers can lead to significant improvements in the physical characteristics of concrete. This, in turn, enhances its ability to withstand various forms of degradation such as cracking, impact, fatigue, and bending. Steel fibers contribute to reinforcing properties like durability, tenacity, and more. A comprehensive overview of these enhanced properties is presented in the subsequent table.

E-ALCCOFINE: Alccofine micro material will be utilizing to replace a portion of the OPC, Ordinary Portland Cement 53 grade.

	Steel fiber types	Length	Diameter	Density
Long steel fibers	65/60	60	0.90	7.85

F-WATER: Water holds a vital role in the concrete mixture, serving as an essential component that initiates the chemical reaction with cement. For the entirety of the investigation and concrete specimen curing, regular potable water will be employed.

SPECIFICATIONS OF CEMENT:

SL NO.	TESTS	RESULTS
1	Normal Consistency	**34%**
2	Initial Setting Time	**35 MINUTES**
3	Final Setting Time	**480 MINUTES**
4	**Specific Gravity**	**2.45**

SPECIFICATIONS OF FINEAGGREGATE:

SL NO.	TESTS	RESULTS
1	Specific gravity	**2.49**
2	**Fineness**	**2.9**

SPECIFICATIONS OF COURSE AGGREGATE:

SL NO.	TESTS	RESULTS
1	Specific gravity	**2.63**
2	Water Absorption	**0.8%**
3	Size	**20mm**
4	**Fineness**	**7.5**

SPECIFICATIONS OF ALCCOFINE:

Sl no.	Tests	Results
1	Appearance	**white**
2	**Specific Gravity**	**2.86**

IV. TEST ON CONCRETE:

TESTS ON HARDENED CONCRETE FLEXURAL STRENGTH:

FLEXURAL STRENGTH		
Alccofine percentage	7 Days (N/MM^2)	**28 Days (N/MM^2)**
0 %	0.8	**1.6**
7%	2.4	**4**
14%	3.2	**4.4**
21%	3.4	**4.8**
28%	**3.8**	**4.8**

V. CONCLUSION

The following conclusions can be drawn regarding the utilization of Alccofine in concrete:

- Incorporating Alccofine into the cement mixture results in heightened concrete strength. It is worth noting that the introduction of 21% and 28% of this admixture brings about a substantial improvement in the workability of the concrete.
- There is rapid improvement in flexural strength during the initial curing days, particularly evident in the seventh-day testing. Impressively, the flexural test results demonstrate remarkable values during the 28th-day testing.
- Minimal disparity in flexural strength is observed between replacements of 7%, 14%, and 21% by Alccofine.
- Considering cost considerations, Alccofine proves to be more cost-effective than cement. Therefore, its utilization should be encouraged in the Indian construction industry for improved concrete strength and durability.
- Alccofine's is a high surface area facilitates the creation of consistent concrete mixes.
- By introducing Alccofine, the permeability of concrete experiences a notable reduction.
- The substance adeptly enhances and occupies pores situated in the concrete's transition zone.
- Alccofine addition leads to enhancements in both the concrete's strength and its durability attributes.

In summary, Alccofine's incorporation into concrete offers a wide range of benefits that enhance the material's properties, strengthen structures, and contribute to more sustainable construction practices.

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