



# Experimental Investigation On Strength And Durability With Alccofine And M-Sand In Concrete Mixtures

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**Abstract:** The demand for sustainable and high-performance concrete solutions has prompted the exploration of alternative materials to enhance the properties of conventional concrete. This research investigates the combined use of Alccofine, a supplementary cementitious material, and M-sand, a fine aggregate alternative, in concrete mixtures. The study focuses on optimizing mix designs to improve strength, durability, and sustainability aspects. The methodology involves a thorough material characterization of Alccofine and M-sand, followed by a systematic mix design process. The workability, compressive strength, flexural strength, and tensile strength of concrete mixes with varying proportions of Alccofine and M-sand are evaluated at different curing ages. Durability tests, including resistance to chloride penetration, chloride and sulfate attack, are conducted to assess the long-term performance of the M60 grade concrete.

**Index Terms** - Alccofine, Chloride attack, Durability, M-sand, Sulphate attack.

## I. INTRODUCTION

Concrete is a versatile and widely used construction material composed of a mixture of cement, water, aggregates (such as sand and gravel), and often additional admixtures. It is one of the most fundamental building materials, utilized in a variety of construction applications due to its strength, durability, and adaptability. While concrete is a widely used construction material with numerous benefits, there are some environmental and performance-related concerns associated with the use of cement in concrete.

The replacement of traditional cementitious materials with alternative materials or supplementary cementitious materials (SCMs) is driven by various factors, including environmental concerns, resource conservation, and the desire to improve certain properties of concrete.

Alccofine is a high-performance mineral admixture used in concrete. It is a type of supplementary cementitious material (SCM) that is often used to improve the strength, durability, and workability of concrete. Alccofine can contribute to the development of higher compressive and flexural strengths in concrete, enhancing the overall mechanical performance of the material. Alccofine concrete often exhibits improved durability properties, including resistance to chloride penetration and sulfate attack. This can result in a longer service life for structures exposed to harsh environmental conditions.

M-sand, a type of fine aggregate replacement material, can offer several advantages over conventional concrete. M-Sand is produced through controlled manufacturing processes, resulting in consistent quality and gradation. This can lead to more predictable and reliable concrete properties. M-Sand can have a more uniform particle size distribution compared to natural sand. This uniformity contributes to better packing of particles in the concrete mix, potentially improving workability and strength.

## II. LITERATURE REVIEW

[1] Suganya R and Latha maheswari R (2019), “Experimental Investigation on Alccofine Concrete”:

The main objective of this work focuses on the strength of concrete by the partial replacement of cement with alccofine and full replacement of sand by manufactured sand. The project focuses on the experimental investigation on concrete by replacing cement with alccofine on varying percentage such as 0%, 5%, 10%, 15%, 20% and 25% for 7, 14 and 28 days. The specimens casted and tested for compressive strength with replacement of cement by alccofine and fine aggregate by manufactured sand. They finally concluded that the compressive strength of the concrete get increased when the cement is partially replaced with alccofine up to 15% and gradually decreases by increasing the percentage of alccofine. Optimum level of replacement of cement by alccofine is found to be 15% and Manufactured sand can be utilized in concrete mixtures as a good substitute for natural sand gives higher strength at full replacement.

[2] A. Narender Reddy, Prof T. Meena (2017), “A Comprehensive overview on Performance of Alccofine Concrete”:

In this paper reports from few researchers have been studied on strength and durability performance of alccofine as a partial replacement of cement in concrete. The efforts made by the researchers for enhancing the performance of concrete over the last few years proved that supplementary cementitious materials with mineral and chemical admixtures can improve the strength and durability of concrete. Alccofine is one among the supplementary cementitious materials. Alccofine is new pozzolanic material which is bringing technical revolution in the construction industry. From the survey it is found the alccofine can achieve high strength when is replaced by cement at 0% - 20% compared to the traditional concrete.

[3] S.Kavitha and T.Felix Kala (2016), “Evaluation of Strength Behavior of Self-Compacting Concrete using Alccofine and GGBS as Partial Replacement of Cement”:

The study investigates that alccofine and GGBS combination can be used in the SCC as the strength enhancer. SCC being a high performance concrete after the addition of alccofine, produces a high performance and high strength concrete. Strength properties were investigated on fresh and hardened concrete and effect of alccofine (5%, 10%, 15% and 20% by volume) by keeping the GGBS percentage constant (30%). The improvement in behaviour of SCC is because of enhancement in union strength and pore refinement by GGBS. The outcome implies that the workability of SCC with 5% and 10% alccofine by volume of concrete leads to decline of other rheological properties given by codal provisions (EFNARC). In contrast, the improvement in properties of concrete like compressive strength from 36.6 to 42.9 N/mm<sup>2</sup>, splitting tensile strength from 3.8 to 7.9 N/mm<sup>2</sup> and flexural strength from 4.9 to 8.3N/mm<sup>2</sup> at 28 days was observed with increase in alccofine dosage.

[4] K. Gayathri, Dr.K.Ravichandran and Dr.J. Saravanan (2016), “Durability and Cementing Efficiency of Alccofine in Concretes”:

In this thesis Alccofine of various percentages such as 5%, 10%, 15%, 20% were used to replace cement. Design mix is made for M20 grade and cubes were cast with various percentage of alccofine as said above. All the durability studies are carried out as per as per Indian standards to determine the properties. The results are presented and discussed. It is observed that 15% of alccofine replacement with the cement is yielding good strength as compared to other mix percentages. Also it is determined that the cementing efficiency of alccofine is good in earlier ages of concrete.

[5] M. Vijaya Sekhar Reddy, K. Ashalatha and K. Surendra (2016), “Studies on Eco-Friendly Concrete by Partial Replacement of Cement with Alccofine and Fine Fly Ash”:

In the present experimental investigation an attempt is made to evaluate the compressive strength of standard concrete for 7 and 28 days curing period. In this study the Class F fly ash was used in various proportions 0%, 5%, 10%, 15%, 20% and that of alccofine by 0%, 5%, 10%, 15%, and 20%. A constant water binder ratio of 0.4 was adopted for all the trail mixes. The super plasticizer was also added based on the required degree of workability. The results summarizes that the standard concrete made with these trail mixes shows excellent fresh and hardened properties. The addition of alccofine shows an early strength gaining

property and is eco-friendly to nature and that of fly ash shows improvement in long term mechanical properties. The relative cost of alccofine is cheaper than cement hence it is also economic in producing higher strength.

### III. MATERIALS USED

#### 3.1 Cement

Cement is one of the important components in concrete. Use of high grade cement gives drastic improvement in strength. The cement was tested according to IS 4031:1988. The Ordinary Portland cement of 53-grade was used in this study conforming to IS: 12269-1987. The tests on cement are carried out as per Indian Standards.

#### 3.2 M-Sand

Manufactured sand (M-Sand) is used as a substitute of river sand. M-Sand, or manufactured sand, is a type of sand that is produced by crushing rocks and stones to create sand-sized particles. M-Sand can be generated with a uniform particle size and shape, providing compatible construction materials and enhanced construction outcomes.

#### 3.3 Coarse Aggregate

The coarse aggregate used in the concrete varies based on their structural application. In this experimental work, locally available coarse aggregate of maximum size 20mm were used. For high performance concrete, the coarse aggregate particles themselves must be strong. From both strength and rheological considerations, the coarse aggregate particles should be roughly equi-dimensional; either crushed rock or natural gravels, particularly if they are of glacial origin, are suitable.

#### 3.4 Alccofine

In this project Alccofine 1203 is used. Alccofine 1203 is the new generation micro fine material of particle size much finer than other materials like cement, flyash etc. The product alccofine 1203 is a supplementary cementitious material suitably replaces silica fume used in high performance concrete. It is obtained from the materials of the iron ore industry.

#### 3.5 Mixing Water

Ordinary potable water of normally pH 7 is used for mixing and curing the concrete specimen. The water utilized in the mortar mix design and curing is potable water supply from water supply system. It is free from organic compounds or suspended solids.

#### 3.6 Superplasticizer

Superplasticizer Ceraplast is a high performance, low dosage superplasticizer based on Melamine Formaldehyde Sulphonate (MFS). Highly recommended for increased early strength of concrete, which is a must for precast and prestressed concrete industries. Ceraplast disperses cement particles more rapidly in the concrete mix.

### IV. TESTS ON CONCRETE SPECIMENS

#### 4.1 Slump Cone Test

Slump test is to determine the workability or consistency of the concrete mixture prepared in the laboratory or at the construction site during the course of work. A concrete Slump test is performed from batch to batch to check the uniform quality of the concrete during construction. The slump cone test is a widely used method for assessing the workability and consistency of fresh concrete. It provides a quick and simple way to measure the flow of concrete, which is an important indicator to be placed, compacted, and finished during construction. The test is particularly useful for routine quality control on construction sites.

#### 4.2 Strength Tests

The various strength tests performed on hardened concrete are Compressive Strength test, Split Tensile Strength test, Flexural Strength test.

### **4.2.1 Compressive Strength Test**

The compressive strength test on concrete is one of the most important tests to assess the quality and performance of concrete. Compressive strength is the ability of concrete to withstand axial loads or forces without undergoing deformation, failure, or collapse. The test is typically conducted on standard cylindrical or cubical specimens.

### **3.2.2 Split Tensile Strength Test**

The split tensile strength of concrete is one of the basic and important properties which greatly affect the extent and size of cracking in structures. The concrete is not usually expected to resist the direct tension due to its low tensile strength and brittle nature.

### **3.2.3 Flexural Strength Test**

Flexural strength of Concrete, also known as Modulus of rupture, is an indirect measure of the tensile strength of unreinforced concrete. Modulus of rupture can also be defined as the measure of the extreme fibre stresses when a member is subjected to bending. Apart from external loading, tensile stresses can also be caused by warping, corrosion of steel, drying shrinkage and temperature gradient.

### **3.3 Durability Tests**

The various durability tests performed on hardened concrete are Sulphate attack test, Chloride attack test and Acid attack test.

#### **3.2.1 Sulphate Attack Test**

The sulphate attack testing was conducted by immersing concrete specimens of the size 150 x150 x150mm and cured for 28 days. Then, they were cured in 5% sodium sulphate solution for 28 days respectively. The specimens are cured in water for 28 days. The cured specimens were weighted and immersed in water diluted with 5% sodium sulphate solution.

#### **3.2.2 Chloride Attack Test**

The Chloride attack testing was conducted by immersing concrete specimens of the size 150 x150 x150mm and cured for 28 days. Then, they were cured in 5% sodium chloride solution for 28 days respectively. The specimens are cured in water for 28 days. The cured specimens were weighted and immersed in water diluted with 5% sodium Chloride solution medium.

#### **3.2.3 Acid Attack Test**

To perform the acid attack studies in the present investigation immersion technique was adopted. After 28 days curing 150 x 150 x150 mm cube specimens were immersed in 3.5% of HCL solution. The solution was kept at room temperature and the solution was stirred regularly, at least three days to maintain uniformity. The solution was replace at regular intervals to maintain concentration of solution throughout the best period. The evaluations were conducted after 28 days from the date of immersion.

## IV. RESULTS AND DISCUSSIONS

### 4.1 Workability Test-Slump Cone

**Table 1: Slump Cone Test Results**

Mix ID	Slump Value(mm)
A0	90
A1	100
A2	105
A3	112
A4	120
A5	120

### 4.2 Strength Test Results

**Table 2: Compressive Strength Results**

Mix ID	Compressive Strength (N/mm <sup>2</sup> )		
	3Days	7Days	28Days
A0	29.65	47.57	69.90
A1	28.42	46.50	67.85
A2	30.15	48.20	73.65
A3	32.45	49.65	80.62
A4	28.30	46.75	77.65
A5	27.45	44.60	72.45

**Table 3: Split Tensile Strength Results**

Mix ID	Split Tensile Strength (N/mm <sup>2</sup> )
	28 Days
A0	5.93
A1	6.20
A2	6.75
A3	7.80
A4	7.30
A5	7.00

**Table 4: Flexural Strength Results**

Mix ID	Flexural Strength (N/mm <sup>2</sup> )
	28 Days
A0	5.59
A1	6.15
A2	7.12
A3	8.15
A4	7.89
A5	7.50

### 4.3 Durability Test Results

**Table 5: Sulphate Attack Test Results**

Mix ID	Average reduction in weight (%)	Average reduction in strength (%)
	28 days	28 days
A0	0.70	2.06
A1	2.10	2.02
A2	1.52	1.60
A3	1.25	1.20
A4	1.00	0.90
A5	0.90	1.05

**Table 6: Chloride Attack Test Results**

MixID	Average reduction in weight (%)	Average reduction in strength (%)
	28days	28days
A0	0.05	2.09
A1	0.18	2.05
A2	0.07	1.72
A3	0.05	1.35
A4	0.039	1.00
A5	0.02	1.05

**Table 7: Acid Attack Test Results**

Mix ID	Average reduction in weight (%)	Average reduction in strength (%)
	28days	28days
A0	1.05	2.10
A1	0.40	2.06
A2	0.50	1.85
A3	0.35	1.53
A4	0.55	1.10
A5	0.60	1.12

## V. CONCLUSIONS

The conclusions from the experimental investigations are as follows:

1. From the experimental results, A15 mix gives higher compressive strength than all other mixes (A0, A5, A10 and A20). It shows that the addition of alccofine in concrete increases the compressive strength by 20 to 30%.
2. If the percentage level of alccofine is increased more than 15% then it acts as a filler material only and the strength gradually decreases by increasing the percentage of alccofine.
3. From the Sulphate attack test it is observed that A15 mix shows better performance in the compressive strength and weight loss is also less compared with A0. From the test it is found that the alccofine addition increases, the weight loss decreases. But there is a limitation that strength will be decrease in the increase of alccofine.
4. From chloride attack test, it is observed that it is well resistant against chloride attack, because the percentage of weight loss is well below the conventional concrete mix where as in compressive strength, A15 mix gives more strength than conventional mix.
5. From the acid resistant test, it is observed that the compressive strength slightly higher than the conventional concrete. But percentage of weight loss is very less when compare to conventional concrete mix and it shows that the alccofine is very good against the acid attack.

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