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CONCRETE PROPERTIES EVALUATED BY REPLACING CEMENT WITH ALCCOFINE

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ABSTRACT

Nowadays, many research works are being conducted throughout the world to develop cementitious materials that can replace cement. As a replacement for cement in concrete, fly ash, silica fume, GGBS, Metakaolin, Micro materials, Quartz powder, etc. are tried out in that order. This experiment tries out a new ultrafine material called Alccofine for a partial replacement. This concrete grade, M40, was developed for testing the cementing efficiency of Alccofine with a variety of percentages of replacement of cement with Alccofine, such as 5%, 10%, 15%, and 20%. A design mix has been developed for M40 grade and cubes have been cast with varying percentages of alccofine, as described above. A discussion of the results has been provided. Compared to other mix percentages, 15% of alccofine replacement with cement produces good strength. The SEM images shows that Alccofine is found to have good cementing efficiency in earlier ages of concrete.

Keywords: Cementing Efficiency, Alccofine, SCM

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1. INTRODUCTION

The whole world is moving towards globalization in infrastructure development. India is an important part of the world where globalization in every field plays a very important role. The infrastructure development of any country depends upon concrete. Concrete is one of the most commonly used construction materials in the construction industry and it is a basic civil engineering construction material used all over the world because of its structural stability, strength and high molding ability. The workability should be good for getting the desired shape on the site. As compared to steel/wooden structures, the concrete structure has a low maintenance cost. Due to the increase in the population, there is a change in living standards. The demand for infrastructure development, therefore concrete becomes a major part of the construction. Conventional concrete does not meet the present day's demands of construction hence developing new construction materials [i.e., improved properties]. For knowing the concrete quality, the compressive strength of concrete is required for 28 days of proper curing. The concrete structure may fail before their service period because of very lack of durability of the concrete. The low w/c ratio reduces the permeability of hardened concrete. The addition of cementitious materials to the concrete as replaced partially also improves the durability of the concrete.

The Alccofine 1203 product is a specially processed slag containing a high percentage of glass, resulting from a controlled granulation process. An enhanced hydration process is a result of both the latent hydraulic property and pozzolanic reactivity. With the addition of Alccofine, the paste component will pack more densely. Therefore, concrete at any age will be stronger and more durable due to a reduction in water demand.

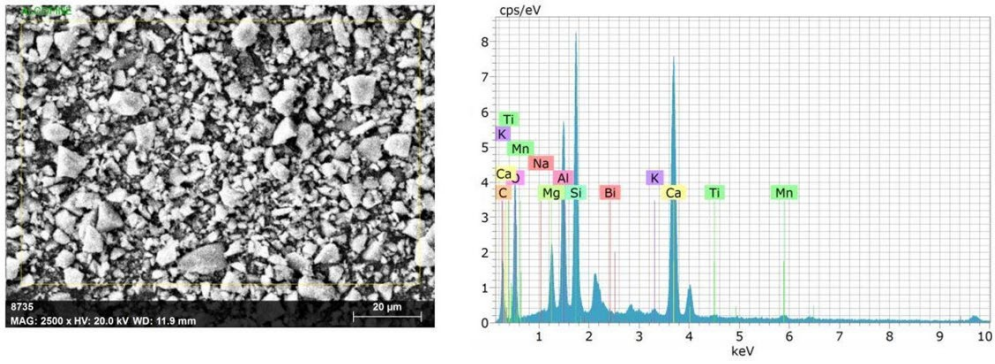

Figure 1 SEM image and chemical composition of Cement

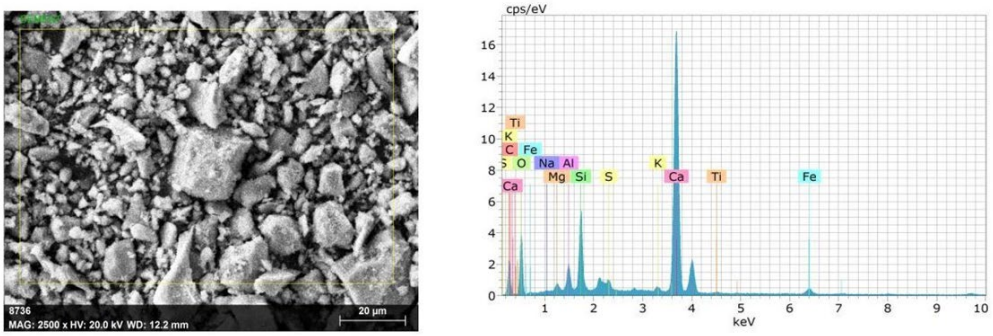

Figure 2 SEM image and chemical composition of Alccofine

Mix design was performed in accordance with IS 10262: 2019 code for trail mix for M40 grade. Alccofine was used as a substitute for cement at percentages of 0, 5%, 10%, 15%, and 20% for concrete of grade M40. In addition to cement and fine aggregate, coarse aggregate and water were also used in the mix design. Moreover, Alccofine 1203 increases concrete's strength, thereby providing the concrete with more workability and other advantages.

2.1. CEMENT

used for all specimens was ordinary Portland cement of 53 grade confirming to IS: 12269:2013 was used. The cement used for all specimens was ordinary Portland cement grade 53 that complied with IS: 12269:2013.

2.2. ALCCOFINE 1203

In comparison to its chemical composition and physical characteristics listed below, ALCCOFINE 1203 has a unique chemical composition primarily composed of CaO 30-34% and SiO_2 30-36%. In terms of particle size distribution, the product is physically unique.

Figure 3 Cement and Alccofine

Table 1 Elemental compositions of cement and Alccofine by EDAX

Compounds and elements	Compound formula	Cement (%)	Alccofine (%)	Composition of cement as per IS 12269-2013 (%)
Calcium	CaO	72.82	39.17	60-67
Silicon	SiO_2	14.64	29.22	17-25
Iron	FeO	3.62	-	0.5-6
Aluminium	Al_2O_3	4.78	20.19	03-Aug
Sulphur	SO_3	2.32	-	01-Mar
Magnesium	MgO	1.14	6.62	0.1-4
Potassium	K_2O	0.4	0.25	0.1-1
Sodium	Na_2O	0.22	0.06	0.1-1
Titanium	TiO_2	0.07	0.24	-

2.3. FINE AGGREGATE

The fine aggregate is as per the IS 383-1970 code conforming that is coming under ZONE II. The fine aggregate is in accordance with the IS 383-1970 code, which falls under Zone II.

The coarse aggregate conforming to IS 383-1970 was used. In this project, coarse aggregates that conform to IS: 383-1970 were used. Aggregates ranging in size from 12 to 20 mm were used.

Figure 4 Fine and coarse aggregates used in experimentation

Table 2 Mix proportions of M40 grade concrete /cum

	0%	5%	10%	15%	20%
Cement	367	399	378	357	336
AL	0	21	42	63	84
Water	148	152	152	152	152
F.A.	767	646.6	646.6	616	646.6
C.A.	1140	1322	1322	1308	1322
SP	3.7	4.2	34.2	4.2	3.4.2

2.5. WATER

Potable water was used to mix concrete and cure specimens.

2.6. CONCRETE

The cement used is Portland Cement 53 grade. Tests are conducted on cement based on the procedures prescribed in IS: 1489. Maximum size of 20mm for aggregate and a size range of 0 to 4.75mm for fine aggregate is required. In order for the concrete to stabilize its own properties, such as compressive strength, it needs to be allowed to cure in real environmental conditions for about 28 days. A concrete cube (100mm x 100mm x 100mm) is loaded under axial compression to test its strength.

Figure 5 Casting of concrete cubes

Figure 6 Cubes allowed for curing in curing tanks

2.7. COMPRESSIVE STRENGTH

A material's capacity to withstand pressure that tends to reduce its size is its compressive strength

Figure 7 Compression testing machine (C.T.M.)

3. RESULTS AND DISCUSSION

In this study, the compressive strength of concrete mixed at various proportions will be determined. Graphs and bar charts are used to present the test results. Figure 5 shows various mix proportions of concrete and the results obtained in terms of compressive strength.

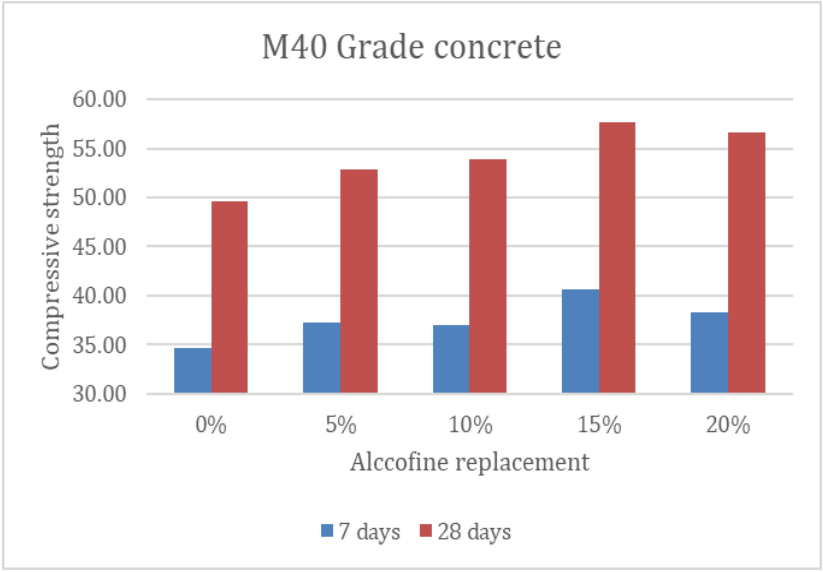

Figure 8 Compressive Strength for M40 Grade Mix

Figure 7 and Figure 8 illustrate the compressive strength values of Alccofine dosages in concrete after 7 and 28 days of curing. With increasing curing durations and extended hydration periods, the compressive strength improves with age. In the initial mixes containing only Alccofine, the maximum strength was observed for 15%.

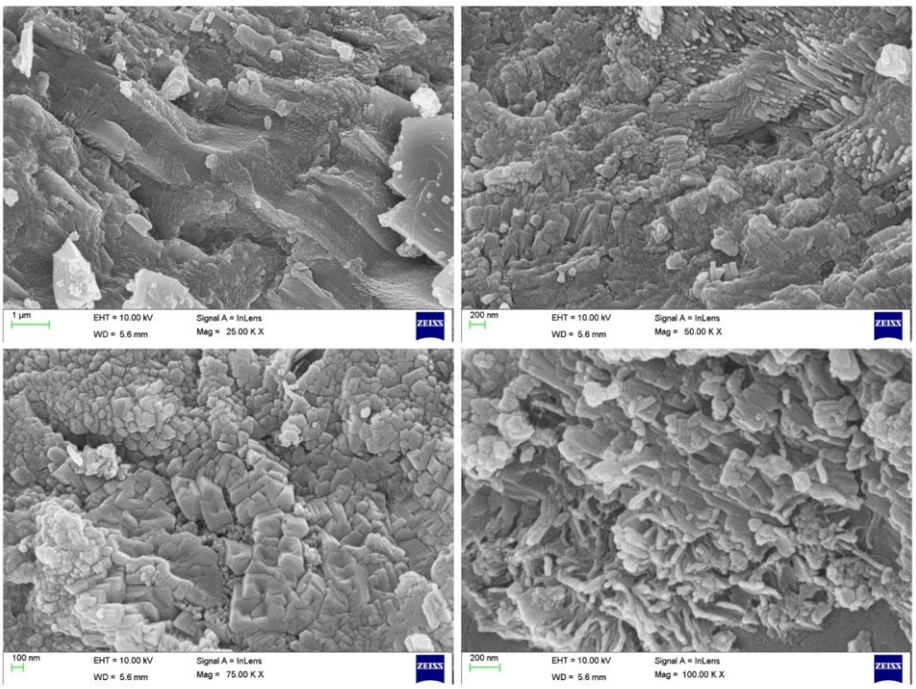

Figure 9 Microscopic images of M40 grade concrete at 15% optimum dosage of Alccofine

For M40 grade concrete with 15%, Alccofine replacement, it exhibited a maximum compressive strength of 40.62mpa and 57.65mpa after 7 days and 28 days respectively.

For this mix, from 7 days to 28 days, there was an increase of 29.54%. At 7 days and 28 days, the compressive strength gain compared to the conventional mix is 17.06% and 16.23% respectively. At 7 days, the compressive strength of 10% mix and 20% mix is lower than that of 15% mix, by 10.08% and 6.34% respectively. At 28 days, the compressive strength of 10% mix and 20% mix is lower than that of 15% mix, by 7.16% and 1.68% respectively. Therefore, it is observed that the 15% mix shows higher strength than all other mixes.

4. CONCLUSIONS

According to the experimental results, the following conclusions can be drawn:

- Compared to other mixes (0%, 5%, 10% and 20%), 15% replacement mix gives better compressive strength. Concrete's compressive strength increases when alccofine is added.
- Increasing the level of alccofine above 15% in a mix will only act as a filler material, while its strength will gradually decrease over time.
- The test results indicate that weight loss decreases as alccofine addition increases. However, there is a limitation that strength will decrease with increased alccofine concentration.
- We conclude that alccofine 1203 was a good cementitious material replacement to the extent of 15%. Furthermore, its durability is also excellent.
- Furthermore, further research is needed to standardize the use of alccofine in concrete.
- The concrete shows denser and homogeneous microstructure for concrete containing 15% alccofine. Due to presence of silica and calcium

in Alccofine, there was extra formation of CSH gel which is clearly shown in the microstructure.

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