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A Study on Compressive Strength of Concrete by using Alccofine and Quarry Dust as a Partial Replacement of Cement and Fine Aggregate

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ABSTRACT

This paper presents the study on compressive strength of concrete using Alccofine and Quarry Dust as a partial replacement of cement and fine aggregate of M-25 grade of IS cube specimen. We partially replaced cement by weight of binder with Alccofine replacement with percentages of 1% ,3%,5%,7% and 9% similarly, we partially replaced fine aggregate by the weight of quarry dust replacement with percentages of 5%,10%,15%,20% and 25% and also combination of both the above two cases. Also, we have investigated strength in compression for all various cases. The comparison is carried between the compressive strength of the conventional concrete, Alccofine concrete, Quarry dust concrete and Alccofine and quarry dust concrete

KEYWORDS: Alccofine ,Quarry Dust ,strength ,supplementary cementious material, fine aggregate.

1. INTRODUCTION

One of the most often utilised materials in the construction sector is concrete. Concrete is poured into any desired shape. The concrete is utilised in numerous ways in depends on a structure's ability to support a load. Steel reinforcement is introduced into concrete to support axial and flexural loads. Although the simple cement concrete has weak tension properties, it exhibits good compressive strength and little crack resistance. Because of incorrect reinforcement alignment, the steel in reinforced concrete structures corrodes, leading to structural failure from insufficient cover.

In addition, The compressive strength can be increased by up to by adding various compounds that may be by products. Compared to typical concrete, there is a certain dosage that can help improve compressive strength and resistance to chemical attacks to a certain amount. Concrete is insufficient due to a lack of materials, particularly cements and fine aggregate. There are many substitutes for cement, including fly ash, bottom ash, GGBS, and Metakaolin and for fine aggregate quarry dust is the replacement material. These materials are tested in the lab for strength and other qualities. When compared to cement, the replacement exhibits various beneficial characteristics.

A controlled granulation process yields the substance Alccofine. It is a slag with a high glass concentration and extremely small particle size. Alccofine is an excellent water redundant that may be used to enhance the

parameters governing strength and other aspects of concrete.

Quarry dust is a byproduct of the crushing process which is a concentrated material to use as aggregates for concreting purpose, especially as fine aggregates. In quarrying activities, the rock has been crushed into various sizes; during the process the dust generated is called quarry dust and it is formed as waste. So it becomes as a useless material and also results in air pollution. Therefore, quarry dust should be used in construction works, which will reduce the cost of construction and the construction material would be saved and the natural resources can be used properly. Most of the developing countries are under pressure to replace fine aggregate in concrete by an alternate material also to some extent or totally without compromising the quality of concrete. Quarry dust has been used for different activities in the construction industry, such as building materials, road development materials, aggregates, bricks, and tiles

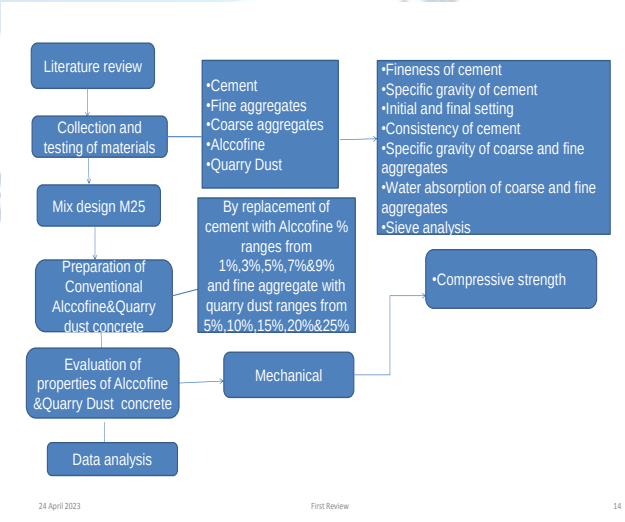
2. REVIEW OF LITERATURE

Suthar Sunil, B., et al. , had carried out the experimental investigation on compressive strength of High Strength Concrete. High Strength Concrete is made by partial replacement of cement by Alccofine and fly-ash. In this study the Class F fly ash used in various proportions 0, 20, 25, 30, 35% and that of Alccofine by 0, 4, 6, 8, 10, 12, and 14% by weight of cement. The mix proportions of concrete had a constant water binder ratio of 0.4 and super plasticizer was added based on the required degree of workability. The total binder content was 425 kg/m3. The concrete specimens were cured on normal moist curing under normal atmospheric temperature. The compressive strength was determined at 56 days. The results indicate the concrete made with these proportions generally show excellent fresh and hardened properties since the combination is somewhat synergistic. The addition of Alccofine shows an early strength gaining property and that of fly ash shows long term strength. The ternary system that is Ordinary Portland cement-flyash-Alccofine concrete was found to increase the compressive strength of concrete on all age when compared to concrete made with fly ash and Alccofine alone.

Lohani et al, studied the effect of 0%, 20%, 30%, 40%, and 50% partial replacement of sand with quarry dust for a design mix of M20 grade concrete. Due to its high fines of quarry dust it was provided to be very effective in assuring very good cohesiveness of concrete. Thorough reaction with the concrete admixture, quarry dust improved pozzolanic reaction, micro aggregate filling and concrete durability. Aggregates with higher surface area were requiring more water in the mixture to wet the particle surfaces adequately and to maintain a specific workability. Obviously increasing in water content in the mixture would adversely affect the quality of concrete. It was observed that the slump value increases with increase in percentage replacement of sand with quarry dust.

Sai Srinath, BLN., et al.(2022), had evaluated concrete properties by replacing cement with Alccofine 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.

METHODOLOGY



The above methodology was used to investigate the compressive strength of conventional concrete ,Alccofine concrete ,Quarry Dust concrete and Alccofine and Quarry Dust concrete.

4. EXPERIMENTAL PROGRAM

An experimental programme has been designed to deliver adequate data for determining the Alccofine and Quarry Dust-based concrete's quality. The behaviour of Alccofine and quarry dust in the workability and mechanical properties of the concrete has been studied.

Materials Used

Cement

For the study, Portland Pozzolona Cement (PPC) has been used.

Table 1 Specifications of Cement

Specific gravity	3.14
Standard consistency	27
time of initialization	35 minutes
Last setting time	584 minutes
Soundness	1.92
Fineness	8

Coarse Aggregate

The chosen aggregate dimension is 20 mm,12mm which is clear and devoid of surface dust and particles. At a nearby quarry, coarse aggregate was gathered.

Table 2 Specifications of Combined Coarse Aggregate

Specific gravity	2.85
Water absorption	0.90%

Fine Aggregate

For the experimental purpose, aggregate from a nearby quarry that passes through an IS sieve measuring 4.75mm is gathered.

Table 3 Specifications of Fine Aggregate

Specific gravity	2.65
Water absorption	1.21

Alccofine

Alccofine is a pozzolanic material that may be used to create concrete structures that are highly resilient.. It is a specifically processed product made from high glass content, high reactivity slag that is obtained by the controlled granulation process. Utilized is Alccofine 1203. It is collected from Ambuja Cements.

Table 4 Chemical properties of Alccofine

Cao	35.85%
SiO_2	13.62%
Al_2O_3	20.08%
MgO	2.43%

Quarry Dust

Quarry rock dust is an industrial by-product. It is formed by screening products of secondary and subsequent stages of crushing igneous rocks, sedimentary rocks or gravel. It can be classified by the size of the particles as 0 to 4.75 mm. presently a large amount of quarry rock dust is generated in natural stone processing plants. Sources of granular deposit are becoming depleted, particularly in high demand areas such as urban areas. Hence, alternative sources of aggregates must be found. One of the sources is hard rock, which is quarried and crushed. It is possible to produce both coarse and fine aggregates from hard rock quarries. Rock crushing methods and techniques together with the nature of rock itself govern the quality and properties of the product.

Table 5 Properties of Quarry Dust

S.No	Property		Value
1	Content (%)	SiO_2	62.48
		Al_2O_3	18.72
		Fe_2O_3	06.54
		CaO	04.83
		MgO	02.56
		K_2O	03.18
		TiO_2	01.21

5. MIX DESIGN

The mix design is determined by using IS 10262:2019 recommendations. M25 grade of concrete is selected for the present work.

Table 6 Mix Proportions for 1m³ M25 Concrete

Material	Weight (kg/m³)
Cement	403.24
Fine aggregate	657.19
Coarse aggregate	1144.92
Water	188.85

6. EXPERIMENTAL PROCESS

Fresh Properties of Alccofine Concrete

Slump cone test was conducted by using slump cone apparatus.

Table 7 Fresh properties of Alccofine concrete by using slump cone test

Specimen	Slump (mm)
Conventional concrete	100
1%AF	120
3%AF	125
5%AF	133
7%AF	139
9%AF	145

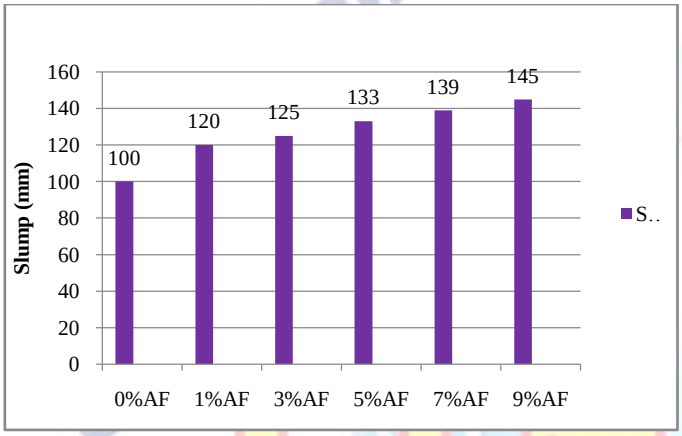


Figure- 1. Fresh State Properties of Alccofine concrete Slump (mm)

Hardened State Properties of Alccofine concrete

Strength in compression of hardened concrete were studied in this work.

Compressive strength of Alccofine concrete

Three cubes were tested for strength in compression using a compression testing machine in accordance with IS 516 - 1959.

Table 8 Compressive Strength of Alccofine Concrete

Specimen	Compressive strength (Mpa)		
	7 days	14 days	28 days
Conventional concrete	14.69	20.97	26.43
1%AF	17.62	25.53	29.68
3%AF	21.19	27.17	31.06
5%AF	27.29	32.14	36.95
7%AF	22.39	27.01	31.11
9%AF	19.16	21.82	29.10

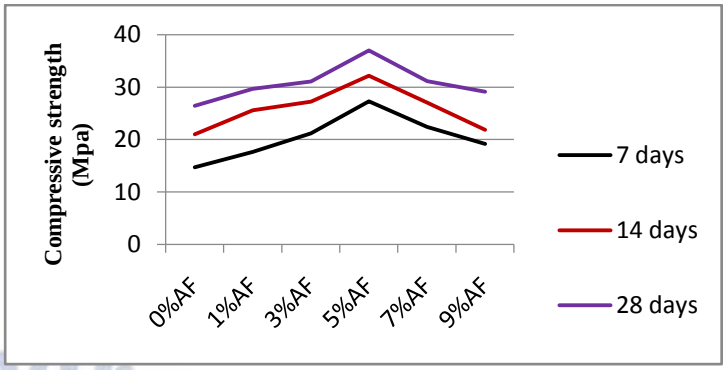


Figure-2.Compressive strength of Alccofine concrete

Fresh Properties of Quarry Dust Concrete

Slump cone test was conducted by using slump cone apparatus.

Table 9 Fresh properties of Quarry Dust concrete by using slump cone test

Specimen	Slump (mm)
Conventional concrete	100
5%QUARRY DUST	91
10%QUARRY DUST	88
15% QUARRY DUST	85
20% QUARRY DUST	83
25% QUARRY DUST	80

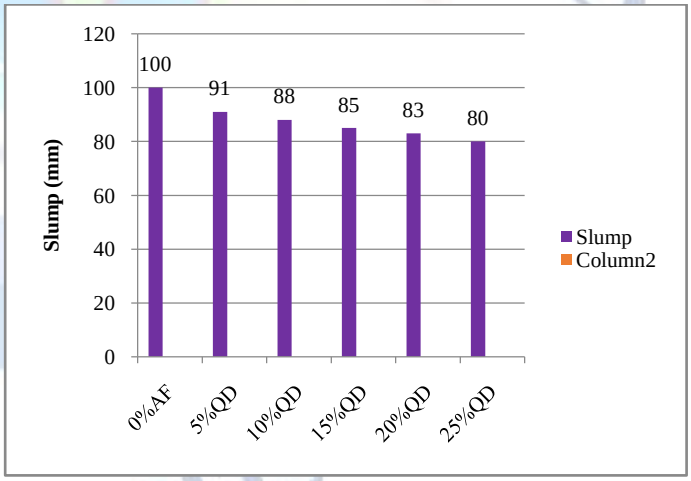


Figure- 3. Fresh State Properties of Quarry Dust concrete Slump (mm)

Hardened State Properties of Quarry Dust concrete

Strength in compression of hardened concrete were studied in this work.

Compressive strength of Quarry Dust concrete

Three cubes were tested for strength in compression using a compression testing machine in accordance with IS 516 - 1959.

Table 10 Compressive Strength of Quarry Dust Concrete

Specimen	Compressive strength (Mpa)		
	7 days	14 days	28 days
Conventional concrete	14.69	20.97	26.43
5% QUARRY DUST	15.75	25.02	27.99
10% QUARRY DUST	19.78	26.18	29.97
15% QUARRY DUST	25.11	31.39	35.68
20% QUARRY DUST	22.67	28.17	33.33
25% QUARRY DUST	20.95	25.63	28.63

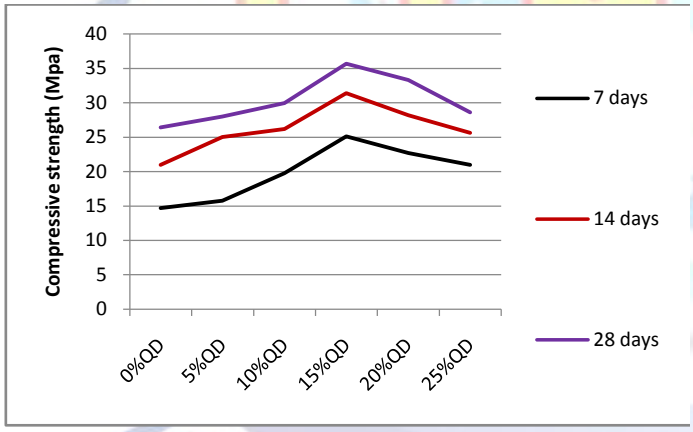


Figure-4.Compressive strength of Quarry Dust concrete

Fresh Properties of Alccofine and Quarry Dust Concrete

Slump cone test was conducted by using slump cone apparatus.

Table 11 Fresh properties of Alccofine and Quarry Dust concrete by using slump cone test

Specimen	Slump (mm)
Conventional concrete	100
1%AF&5%QD	104
3%AF&10%QD	107
5%AF&15%QD	111
7%AF&20%QD	115
9%AF&25%QD	121

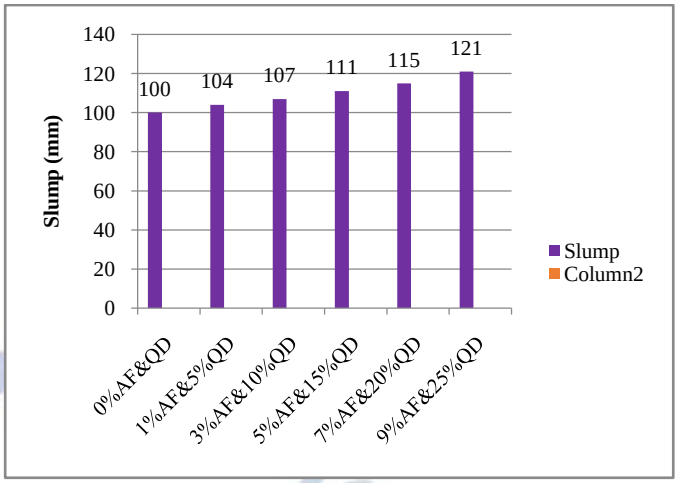


Figure- 5. Fresh State Properties of Alccofine and Quarry Dust concrete Slump (mm)

Hardened State Properties of Alccofine and Quarry Dust concrete

Strength in compression of hardened concrete were studied in this work.

Compressive strength of Alccofine and Quarry Dust concrete

Three cubes were tested for strength in compression using a compression testing machine in accordance with IS 516 - 1959.

Table 12 Compressive Strength of Alccofine and Quarry Dust Concrete

Specimen	Compressive strength (Mpa)		
	7 days	14 days	28 days
Conventional concrete	14.69	20.97	26.43
1%AF&5%QD	18.72	27.54	29.94
3%AF&10%QD	23.76	28.57	31.30
5%AF&15%QD	28.38	34.36	39.88
7%AF&20%QD	20.46	28.16	32.97
9%AF&25%QD	18.63	22.70	31.88

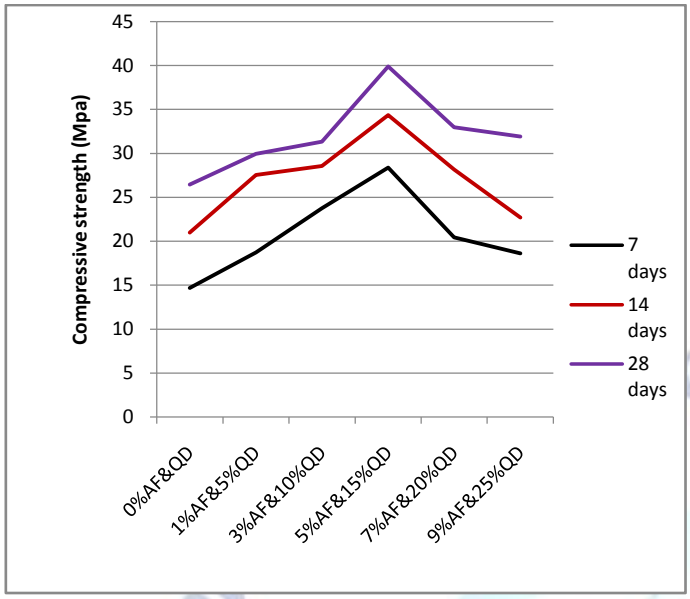


Figure-6.Compressive strength of Alccofine and Quarry Dust concrete

Comparison of test results

Several concrete compositions' maximum values for strength in compression are compared in the 28-day strength test.

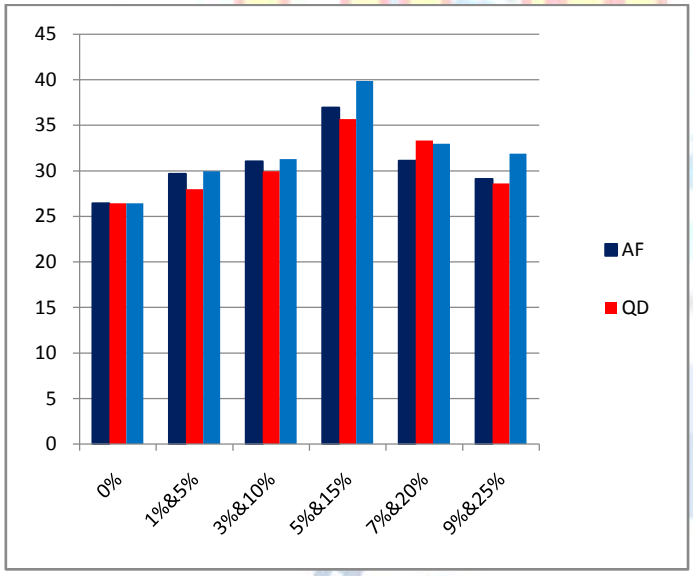


Figure-7.Comparison of results (Mpa)

7. CONCLUSIONS

Based on comparative study on compressive strength for 28 days with various percentages of replacement of Alccofine and Quarry Dust in the place of cement and fine aggregate, the following conclusions were drawn based on the test results arrived from the compressive strength of cubes.

- From the tests we are concluded that Alccofine concrete , Quarry Dust concrete and Alccofine and Quarry Dust concrete gives more strength than Conventional concrete.
- Alccofine concrete gives maximum strength at 5% of replacement of cement in Alccofine.
- Quarry Dust concrete gives maximum strength at 15% of replacement of fine aggregate in Quarry Dust.
- Similarly, the combination of Alccofine and Quarry Dust concrete gives more strength than Alccofine concrete , Quarry Dust concrete and Conventional concrete at a optimum dosage of 5% Alccofine and 15% of Quarry Dust

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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